World Meteorological Organization

Symposium on Nowcasting and Very Short Term Forecasting

Whistler, British Columbia
31 Aug - 4 Sep 2009

Organized by:

Environment Canada

Supported by:

World Meteorological Organization

World Weather Research Programme

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George Isaac: Chair, Canada
Paul Joe: Canada
Tom Keenan: Australia
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Chris Collier: U.K.
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Edwin S.T. Lai: China
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Roy Rasmussen: U.S.A.
Stéphane Sénési: France
Jian Jie Wang: China
Marilyn Wolfson: U.S.A.
Isztar Zawadzki: Canada

Local Arrangements

Paul Joe: Chair
George Isaac: Program Chair
Monika Bailey: Abstracts
Faisal Boudala: Distribution Lists
Edwin Campos: Sponsorships/Exhibits
Robert Crawford: CD
Desiree Dallas: Admin, Invitation
Lizz Gow: Conference Kit
Karen Haynes: Menus

Conference information

Location
Sea to Sky Ballroom C, Telus Conference Centre, 4010 Whistler Way, Whistler Village

Hours
The Conference Centre will open at 7am for breakfast and registration and remain open after close of sessions for evening events

Registration desk
Open at 7:30 am on Monday 31 August and at 8:00 am each following day

Breakfast and Lunch are included in the registration and will be provided each day in the Sea to Sky Ballroom B

Ice breaker (sponsored SELEX-SI Gematronik)
Monday 31 August, 17:30 - 19:30, in the Sea to Sky Ballroom B

Banquet (sponsored by Vaisala)
Thursday 3 September, 18:30 – 21:00, in the Grand Foyer at the Conference Centre

FOREWORD

The mission of the World Weather Research Programme (WWRP) of the World Meteorological Organisation (WMO) is to advance society's ability to cope with high impact weather. This is achieved through research focussed on improving the accuracy and utilisation of weather prediction techniques. Nowcasting forms an important component of weather forecasting given it represents the stage providing the most up to date and specific meteorological information. Virtually all members of WMO provide a nowcasting service given their responsibilities related to severe weather and a range of other high impact events.

Given the importance of nowcasting, the WWRP strategy supports an active research program aimed at advancing the science of nowcasting for use by members nations within the WMO framework. Forecast demonstration projects, research and development projects and meetings enabling the exchange of information between researchers, operational forecasters, and end-users form integral parts of the initiative.

For over twenty years there were no regular large international fora devoted to nowcasting. To this end WWRP supported the first International Symposium on Nowcasting and Very Short Range Forecasting in 2005 hosted by Meteo France in Toulouse. This meeting continues that approach, moving to Canada to again provide the largest international forum devoted to primarily to exploring opportunities for improving the science of very short term forecasting. In this case, the nowcasting of high impact winter weather is of particular interest as well advancing the application of numerical weather prediction techniques to nowcasting. The nowcasting symposium represents an important event on the WMO calender contributing to the overall objective of building a seamless approach to weather forecasting.

Tom Keenan - Chair, WWRP Nowcasting Working Group

Welcome participants to the International Symposium on Nowcasting and Very Short Range Forecasting (WSN09) in Whistler, British Columbia, from 30 August to 4 September 2009. This meeting is organized by the World Weather Research Programme (WWRP) of the World Meteorological Organization (WMO) and is hosted by Environment Canada. It attracted 157 papers from 29 countries which makes it a truly international meeting.

Whistler is an all season resort and it is the location of many of the outdoor events for the Vancouver 2010 Olympic and Paralympic Winter Games. Hosting the Symposium in Whistler, provides a vivid and first hand experience in understanding the nowcast challenges in winter and in complex terrain for both safety and security, for games operations and for safe and fair competition during the Games. It is also the site for the Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10), which is a recently approved WWRP project. During WSN09, papers on past WWRP projects associated with the Beijing 2008 and Sydney 2000 Summer Olympic Games will be discussed.

Nowcasting or short range forecasting (0-6 hours) is a relatively new subject area in weather forecasting. It now blends observations and numerical weather prediction models into forecasts that are often more accurate than the simple extrapolation techniques used in the past. In-situ and remote sensing specialists, NWP and data assimilation scientists, as well as experts in forecast verification, impacts and services must work together. The WWRP also has a requirement to make sure that such forecasts have a positive and measureable impact on society, and that the new techniques be made available to less developed countries. Overall, the challenges are quite considerable. This Symposium brings together experts from around the world to discuss the latest developments. Hopefully, ideas will be generated which might yield new and positive results for the next meeting.

Symposia are not only a time to present scientific results but an important place to gather, to meet, to discuss, to share, to laugh, to scheme and to dream. We have organized the meeting to provide many opportunities to do this. The venue with its Grand Foyer is a heavy traffic, well lit and inviting area where we have focussed much of the activities – coffee breaks, poster viewing and exhibits. We included the breakfasts and lunches to provide opportunities to sit and meet each other. We have organized daily panel discussions on key topics to stimulate open discussion for all to contribute their views.

We would like to thanks the many individuals who worked on the Program and Local Arrangements for this meeting. The support of our sponsors, listed elsewhere, are also very much appreciated. These meetings cannot exist without many hardworking individuals who often go unrecognized. So whenever the opportunity exists, please thank them for their efforts.

Paul Joe – Chair, Local Arrangements
George Isaac – Chair, Program Committee

World Meteorological Organization
Symposium on Nowcasting and Very Short Term Forecasting

Whistler, British Columbia, 31 Aug - 4 Sep 2009

Sunday, 30 August 2009

18:30 – 20:00 **Registration** (Grand Foyer)

Monday, 31 August 2009

07:00 **Breakfast** (Sea to Sky Ballroom B)

07:30 **Registration**

SYMPOSIUM OPENING

08:15 **Welcome and Opening Remarks** (Sea to Sky Ballroom C)

SESSION 1: **Olympic Nowcasting** (Sea to Sky Ballroom C)
Chair: George Isaac and Paul Joe

08:30 **1.1** Legacy of S2K: 10 Years Later
Tom Keenan

09:00 **1.2** The implementation of Beijing 2008 World Weather Research Programme Forecast Demonstration Project: Overview and impacts of Nowcast Demonstration.
Jianjie Wang, Tom Keenan, Paul Joe, Jim Wilson, Edwin Lai, Feng Liang, Yubin Wang, John Bally, Beth Ebert, Qian Ye, Alan Seed, Mingxuan Chen, Jieshan Xue, Bill Conway

09:15 **1.3** Overview, Observations and Implications of the B08 FDP Forecast Process
Paul Joe, Feng Liang, Jim Wilson, Jianjie Wang, John Bally, Beth Ebert, Debin Su

09:30 **1.4** A System for Nowcasting Convective Storm in Support of 2008 Olympics
Ming-Xuan Chen, Feng Gao, Rong Kong, Xian Xiao, Ying-Chun Wang, Jian-Jie Wang, James Wilson, Juanzhen Sun, Rita Roberts, Sue Dettling

09:45 **1.5** Applications of the Hong Kong Observatory Nowcasting System SWIRLS-2 in Support of the 2008 Beijing Olympic Games
Linus H.Y. Yeung, W.K. Wong, Philip K.Y. Chan and Edwin S.T. Lai

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10:00- 10:30 **Coffee** (Grand Foyer)

SESSION 1: **Olympic Nowcasting (cont'd)**
Chair: George Isaac and Paul Joe

10:30 1.6 Composite products and nowcast decision support for the Beijing 2008 Forecast Demonstration Project
John Bally, David Scurrah, Beth Ebert, Debin Su

10:45 1.7 Applying scale decomposition method to verification of quantitative precipitation nowcasts
Rong Kong, Elizabeth Ebert, Jianjie Wang, Feng Liang

11:00 1.8 Real time nowcast verification during the 2008 Beijing Olympics Forecast Demonstration Project
Elizabeth Ebert, Feng Liang, Rong Kong, Yuxiao Duan and Barbara Brown

11:15 1.9 Weather Services for the 2010 Olympic and Paralympic Winter Games
Chris Doyle, Al Wallace, Bill Scott, Paul Joe and George Isaac

11:30 1.10 The Observing System for the Vancouver 2010 Winter Olympic Games
Bill Scott , Paul Joe, Chris Doyle, George Isaac and Stewart Cober

11:45 1.11 Science and Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) -- A World Weather Research Program Project
George Isaac, S. Bellair, A. Bott, B. Brown, M. Charron, S. G. Cober, C. Doyle, W. F. Dabberdt, D. Forsyth, G. L. Frederic, I. Gultepe, P. Joe, T. D. Keenan,J. Koistinen, J. Mailhot, M. Mueller, R. Rasmussen, R. E. Stewart, B. J. Snyder and Donghai Wang

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12:00 – 13:30 **Lunch** (Sea to Sky Ballroom B)

13:00 – 13:30 **Poster 1 and Exhibit Viewing** (Grand Foyer)

SESSION 2: **Role of Forecaster** (Sea to Sky Ballroom C)
Chair: Stewart Cober and Stéphane Sénési

13:30 2.1 Nowcasting and forecasting thunderstorms for air traffic with an integrated forecast system based on observations and model data
Caroline Forster, Arnold Tafferner

13:45 2.2 The NWS/NCAR Forecaster Over The Loop (FOTL) Nowcasting Demonstration: Progress on Auto-Nowcaster Integration with NWS AWIPS and other System Enhancements
Eric Nelson, Rita Roberts, Dan Megenhardt, Mamoudou Ba, Ken Sperrow, Scott O'Donnell, Steve Fano, Dave Albo, Greg Patrick, Stephan Smith, and William Bunting

14:00 2.3 Operational multi-sensor nowcasting of severe convective storms in the Swiss Alpine area
Alessandro Hering, U. Germann, P. Ambrosetti, I. Giunta, L. Clementi and L. Nisi

14:15 2.4 Thunderstorm risk monitoring service
Pascal Brovelli, Etienne Arbogast, Michel Bouzom, J. Reynaud, F. Autones, Yann Guillou, Isabelle Bernard-Bouissieres, Stéphane Sénési

14:30 2.5 A Decision-support System for Winter Weather Maintenance of Roads Bridges, and Runways
Michael Chapman, Sheldon Drobot, William Mahoney, Jim Cowie, Seth Linden

14:45 2.6 The forecaster role in operational Nowcasting over complex terrain
Paolo Ambrosetti, Alessandro Hering

15:00 – 15:30 **Coffee, Poster 1 and Exhibit Viewing** (Grand Foyer)

SESSION 2: **Role of Forecaster (cont'd)**
Chair: Stewart Cober and Stéphane Sénési

15:30 2.7 Experiences from Nowcasting Convective Storms for the Beijing Olympics: Future Nowcasting Implications,
James W. Wilson, Yerong Feng and Rita D. Roberts

15:45 2.8 A Proposed Strategy for the Environment Canada Nowcasting Program,
Stewart Cober

16:00 2.9 iCAST: a Protoype Thunderstorm Nowcasting System Focused on Optimization of the Human-Machine Mix
David Sills, Norbert Driedger, Brian Greaves, Emma Hung and Robert Paterson

16:15 2.10 A Role for the Forecaster in Improving Convection Initiation Nowcasts: Operational Methodology and Validation of Approach
Rita Roberts, Eric Nelson and Barbara Brown

16:30 – 17:30 **Panel Discussion on Operational Systems and the Role of the Forecaster**
Chair: Steve Goodman and Tom Keenan

17:30 **Sessions end for the day**

17:30 - 19:30 **Ice Breaker** Sponsored by SELEX-SI Gematronik (Grand Foyer)

P2.27
Comparison of nowcasting methods in the context of high-impact weather events for the Canadian Airport Nowcasting project

Monika Bailey, George Isaac, Norbert Driedger, Janti Reid
Environment Canada

The focus of this study is the improvement of forecasts of high-impact weather events at Pearson International airport for the Canadian Airport Nowcasting Project (CAN-Now). A comparison is presented of short-term point forecasts in which observations are blended with NWP model data (the Canadian GEM Regional and GEM-LAM models) to correct the model for local effects. Data collection for CAN-Now began in February 2007 and a two year archive is now available for such studies. The study is organized as follows. (1) Definition of significant aviation related weather scenarios in terms of observables such as winds, temperature, relative humidity, occurrence of precipitation, ceiling and visibility. (2) Extraction of hourly surface observations from the Environment Canada archives and identification of the start and end times of significant events. (3) Extraction of high time-resolution data from the archive of on-site instrument data for these times. (4) Verification, separately for each scenario, of forecasts of temperature, relative humidity, winds and precipitation occurrence. The forecasting performances of the models, of the blended models, extrapolated observations and of persistence are compared and ranked for forecast lead times out to 6 hours. Results show that, in general, methods that blend model and observations perform better than the raw model at all times and on average perform better than purely observational methods after one hour. In each case the optimum method depends on the event type, the forecast variable and the forecast lead time. The implications of these results for forecasting derived variables such as visibility and ceiling will be discussed.

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Tuesday, 1 September 2009

07:00 Breakfast (Sea to Sky Ballroom B)

07:30 Registration

SESSION 3: NWP, Ensembles and Assimilation (Sea to Sky Ballroom C)
Chair: Linus Yeung and Matthias Steiner

08:15 3.1 Integrated assimilation of radar, satellite, and METAR cloud data for initial hydrometeor/divergence fields to improve hourly updated short-range forecasts from the RUC, Rapid Refresh, and HRRR,
Stan Benjamin, Ming Hu, Steve Weygandt, Dezso Devenyi

08:45 3.2 Data assimilation for a 1.5 km grid length version of the unified model, for short range forecasting of convective precipitation
Susan Ballard, Zhihong Li, David Simonin, Mark Dixon, Helen Buttery, Graeme Kelly, Catherine Gaffard, Owen Cox and Humphrey W Lean

09:00 3.3 Data Assimilation Issues Related to Very Short-Range Forecasts of Precipitation with the Operational Convection-Permitting Model COSMO-DE
Klaus Stephan and Christoph Schraff

09:15 3.4 Numerical weather prediction and machine learning in operational short-term wind power forecasting
Eric Grimit, Scott Otterson, Kristin Larson, and Cameron Potter

09:30 3.5 A real-time radar wind data QC and analysis system for nowcast application
Qin Xu, Kang Nai, Li Wei, Pengfei Zhang, Qingyun Zhao and P. R. Harasti

09:45 3.6 Data Assimilation of Hydrometeor Types Estimated from the Polarimetric Radar Observation
Kosei Yamaguchi, Eiichi NAKAKITA,Yasuhiko SUMIDA

10:00 – 10:30 Coffee, Poster 1 and Exhibit Viewing (Grand Foyer)

SESSION 3: **NWP, Ensembles and Assimilation (cont`d)**
Chair: Linus Yeung and Matthias Steiner

10:30 3.7 Developing an Ensemble Kalman Filter for Improving High-resolution Data Assimilation and Forecasting at NRL,
Qingyun Zhao and Qin Xu2
10:45 3.8 UK Met Office Operational NWP capability at Convective Scale,
Jorge Bornemann, Peter A. Clark, Humphrey W. Lean, Peter Lean, Yongming Tang, Clive A. Wilson [1]
11:00 3.9 Overview of the Rapid Update Cycle and Rapid Refresh
Stephen S. Weygandt, T. G. Smirnova, M. Hu, J. M. Brown, D. Devenyi, S. G. Benjamin, W. R. Moninger, S. E. Peckham, G. A. Grell, K. J. Brundage, B. D. Jamison, C. W. Harrrop, J. B. Olson
11:15 3.10 Advanced NWP for Short-Term Wind Power and Precipitation Forecasting
Richard L. Carpenter, Jr., Brent L. Shaw, Phillip L. Spencer, and Zachary M. DuFran
11:30 3.11 Application of a high-resolution, non-hydrostatic limited-area atmospheric model in airport environments
Klaus Dengler and Christian Keil
11:45 3.12 Translating Ensemble Weather Forecasts into Probabilistic User-Relevant Information,
Matthias Steiner, Robert Sharman, Tom Hopson, and Yubao Liu

12:00 – 13:30 **Lunch** (Sea to Sky Ballroom B)
13:00 – 13:30 **Poster 1 and Exhibit Viewing** (Grand Foyer)

SESSION 3: **NWP, Ensembles and Assimilation (cont`d)**
Chair: Stan Benjamin and Steve Weygandt

13:30 3.13 Experiments with a 1.5km gridlength version of the Unified Model for short range forecasting of convective precipitation
Humphrey Lean,Carol Halliwell, Nigel Roberts, Peter Clark
13:45 3.14 A WRF-based rapid updating cycling forecast system of BMB and its performance during the summer and Olympic Games 2008
Min Chen, Shui-yong, Jiqin Zhong, Xiang-yu Huang, Yong-Run Guo, Wei Wang, Yingchun Wang, Bill Kuo
14:00 3.15 Verification of winter weather: Examples of products from the UK
Marion Mittermaier
14:15 3.16 Severe weather indices: Adaptation of thresholds to metropolitan region of Säo Paulo, Brazil
Ana Carolina Nóbile Tomaziello, Adilson Wagner Gandu

P2.26
A Novel Approach For Evaluating World Area Forecast System Global Icing Forecasts Using CloudSat Data

Michael P. Kay [12] Sean Madine [13] Chungu Lu [13] Jennifer Luppens Mahoney [1]
[1] NOAA Earth System Research Laboratory (ESRL), Boulder, Colorado [2] Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, Colorado [3] Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, Colorado

Historically, numerical predictions of high impact weather events have been linked to mesoscale models run over limited areas. Recent trends however indicate that the demand for global predictions of hazards, especially from the global aviation industry, has become very large. These trends are expected to continue in parallel with the increase in air traffic where the number of aircraft flown around the world is predicted to double by 2025. The World Area Forecast System (WAFS), with centers in the United States and Great Britain, provides a set of forecasts for aviation hazards such as thunderstorms, turbulence, icing, and volcanic ash for enroute aircraft worldwide. The WAFS system has recently begun testing production of global gridded predictions of icing, turbulence, and thunderstorms to augment or replace existing products for lead times that range from 6 hours to 36 hours. This study will illustrate the unique application of high spatial- and temporal resolution CloudSat satellite data to provide insight into forecast performance of the WAFS global icing forecasts in ways that other datasets are not capable of. CloudSat is an experimental satellite that has been developed to study clouds and precipitation from space. The satellite information is combined with global reanalysis data to produce an icing diagnostic product that is then applied as the observation field for verification. The diagnostic has been compared extensively to a high-resolution nowcast (CIP; Current Icing Potential) over the Continental United States and shows significant promise for our purposes. Details of the development of the diagnostic product will be given. Global verification results will be presented for the new WAFS icing forecasts using the CloudSat-derived diagnostic.

P2.24
Nowcast of the Rainstorm in Beijing Downtown Area on 6 August 2007 during the WWRP/B08FDP Trial Run Period

Xiaoding Yu [1], Wei Yuan[1], Xiuming Wang[1], Xiaogang Zhou[1], Yingqiong Wang[2]
[1] Training Center, China Meteorological Administration [2] Yichang Forecast Office, China Meteorological Administration

During the WWRP/B08FDP trial run period, a rainstorm hit Beijing downtown area in the afternoon on 6th August 2007. This storm was generated locally around 13:00 local time, and developed into a supercell storm 1 hour later, showing typical hailstorm radar echo characteristics: strong reflectivity core is high aloft above the -20°C level, the clear weak echo region and echo overhang, and three body scattering. However, because the relative high 0°C level (5.5 km), no hail was observed on the ground, instead, more than 60 mm rainfall was observed during 2 hour period over one station in the downtown Beijing, leading to local flash flooding. A detailed analysis and discussion concerning the nowcast issue of the event is conducted. Key word: Nowcast, Rainstorm, B08FDP, Supercell, Haihstorm Structure

P2.25
Study on the 3D structure of the heavy rainfall in Chuzhou area during 1~2 August 2008 with Dual-Doppler radar data

HaiGuang Zhou
State Key Laboratory of Severe Weather, Chinese Academy of Meteorological Science, Beijing, 100081, P. R. China

Due to the effect of Fung-Wong tropical depression, it produced a heavy precipitation in east region of Anhui province in China during 1~2 August 2008. The daily precipitation in Chuzhou is 429mm from 0800 LST 01 to 0800 LST 02 August that break the record. It shows clearly that the primary feature of this event is local, sudden. The three dimensional (3D) wind fields are retrieved by the dual-Doppler radar that were located in Nanjing and Maanshan cities. The evolution of the 3D wind fields and the formation mechanism of this sudden heavy rainfall were investigated. It is a convective cloud precipitate based on the radar echo analyses. The reflectivity is very active in the heavy precipitation period. The height of the reflectivity at 30dBZ is more than 8.5km, and the height of echo at 45dBZ is about 5km. The meso--scale convective system (MCS) and the meso-scale system located on the MCS played an important role on this heavy rainfall. The meso--scale convective cloud has high precipitation efficiency. The dual-Doppler retrieval wind shows that the heavy rainfall was caused by the northwest-southeast oriented meso-scale convergence lines at the low and the middle levels. The northwest flow on the north side and the west flow on the south side formed the convergence line. The convergence line plays an important kinematic mechanism for the moisture transportation. It triggered, breakout and maintained the heavy rainfall. There were strong convergence and vorticity at the low and middle levels of the MCS. When the convergence line began to weak, the precipitation began to weak too. The intensity of the precipitation weakened obviously when the convergence line dissipated. The 3D kinematic conceptual structure model of this heavy precipitation case is also given.

14:30 3.17 Evaluation of the High Resolution Rapid Refresh (HRRR): an hourly updated convection resolving model utilizing radar reflectivity assimilation from the RUC / RR
Steve Weygandt, Stan Benjamin, Tanya Smirnova, Kevin Brundage, Curtis Alexander, Ming Hu, Brian Jamison, Susan Sahm

14:45 3.18 Initialization of hydrometeors and its impact on very short range NWP
Jishan Xue, Hongya

15:00 – 15:30 **Coffee, Poster 1 and Exhibit Viewing** (Grand Foyer)

SESSION 3: **NWP, Ensembles and Assimilation (cont`d)**
Chair: Stan Benjamin and Steve Weygandt

15:30 3.19 Merging of radar-based ensemble nowcasts of precipitation with NWP forecasts applying image morphing
Jarmo Koistinen, Seppo Pulkkinen, Harri Hohti, and Markus Peura

15:45 3.20 Assessment of convective forecast uncertainty using high-resolution model ensemble data
James Pinto, Mei Xu, David Dowell, Matthias Steiner, and John Williams

16:00 3.21 Short-term QPE From Blended Ensemble Model Forecasts and Observations: Implications for Heavy Rainfall Forecasts in Severe Terrain
Edward Tollerud, Huiling Yuan, John A. McGinley, Steven L. Mullen, Tomislava Vukicevic, Chungu Lu, and Isidora Jankov

16:15 3.22 An Objective Framework for Assimilating Coherent Structures
Sai Ravela Chris Yang, John Williams, Kerry Emanuel

16:30 – 17:30 **Panel Discussion on NWP, Ensembles and Assimilation**
Chair: Jenny Sun and Sue Ballard

17:30 **Sessions end for the day**

World Meteorological Organization
Symposium on Nowcasting and Very Short Term Forecasting

Wednesday, 2 September 2009

07:00 Breakfast (Sea to Sky Ballroom B)

08:00 Registration

SESSION 4: Applications or Operational Systems (Sea to Sky Ballroom C)
Chair: Chris Doyle and Walter Dabberdt

08:30 4.1 INCA - A new operational nowcasting system for mountainous areas
Thomas Haiden, Alexander Kann

08:45 4.2 Winter Weather Nowcasting for Aircraft Ground Deicing using the WSDDM, LWE, and Check Time systems
Roy Rasmussen, Scott Landolt, Jenny Black, Paul Kucera, Andy Gaydos

09:00 4.3 Operational Frost Nowcasting System Using Satellite Data
Leonardo Peres, Costa I., Angelis C. F.and DaCamara C. C.

09:15 4.4 Canadian airport nowcasting project (CAN-Now): Short term forecasts for airports
George A. Isaac, M. Bailey, F. Boudala, W. Chang, B. Clark, S. G. Cober, R. Crawford, N. Donaldson, N. Driedger, M. Fournier, I. Gultepe, I. Heckman, L. Huang, A. Ling, J. Reid and Z. Vukovic

09:30 4.5 Towards the Blending of NWP with Nowcast - Operation Experience in B08FDP
Wai-kin Wong, Linus H.Y. Yeung, Ying-chun Wang, Min Chen

09:45 4.6 Evaluation of a hydrometeorological forecast system for the metropolitan area of São Paulo
Augusto Pereira Filho, O. Massambani, R. Hallak, F. Vemado, L. R. Pereira, F. Vemado, C. G. M. Ramos

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10:00 – 10:30 Coffee, Poster 2 and Exhibit Viewing (Grand Foyer)

SESSION 4: Applications or Operational Systems (cont`d)
Chair: Chris Doyle and Walter Dabberdt

10:30 4.7 Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts
Curtis Alexander, Doug Koch, Steve Weygandt, Tanya Smirnova, Stan Benjamin, and Huiling Yuan

P2.22
Statistical analysis of convective storms based on C-band radar observations

E. Goudenhoofdt, M. Reyniers, and L. Delobbe
Royal Meteorological Institute of Belgium (RMI)

The performance of current numerical weather prediction models for the short term prediction of severe convective storms remains relatively limited. The extrapolation of high resolution precipitation patterns from weather radar is clearly valuable at the small time and spatial scales associated with these events. However, this approach generally fails in predicting storm initiation and evolution. In this study, several years of volume reflectivity measurements from a C-band weather radar are used to study the characteristics of convective storms observed in Belgium. These data are analysed with the TITAN cell tracker which has been recently installed at the Royal Meteorological Institute of Belgium. First encouraging results are obtained from a 3-year dataset. The distribution of different storm properties such as duration, maximum reflectivity, echo-top heights are analysed. Statistics on the kinematics of the storms are shown. The influence of the diurnal and seasonal cycles is presented as well. The final goal of this study is to analyse the relation between storms evolution and some relevant parameters with the aim of improving convective storms nowcasting.

P2.23
The large scale circulation of the snow disaster in southern China in the beginning of 2008

Yafei Wang
CAMS

This study analyzed the heaviest snowfalls or icy rainfalls occurring in southern China in the beginning of February 2008. The results are summarized as follows: associated with the global warming, the disaster was formed by the persistent front of warm / air mass in southern China, which displayed an interaction between the weather systems in higher latitude and lower latitude. There was an adjustment for circulation in hemisphere scale during the middle of January by a sign of variation of the AO index from negative to positive value. The long lasting precipitation well coincided with a blocking situation centered about ~80°E during the middle of January to the beginning of the February. The diagnostic analysis indicates that stationary waves with an energy dispersing accompanying the blocking high propagated from high latitudes to the south of the Yangtze River that formed a maintaining energy source for the cyclonic circulation in situ. This resulted in that the large mass of cold air in high latitudes could not easily invade south area but slowly shift southward. On the other hand, the SST in warm pool of the western Pacific increased in a new history record by the strong La Nina episode, which also blocked the cold air mass from the north. The blocking high collapsed about 30 January and the energy source for the local cyclonic circulation was cut. Thus, the precipitation in southern China stopped after 1 February.

P2.20
Nowcast of the Rainstorm in Beijing Downtown Area on 6 August 2007 during the WWRP/B08FDP Trial Run Period

Xiaoding Yu [1], Wei Yuan [1], Xiuming Wang [1], Xiaogang Zhou [1], Yingqiong Wang [2]
[1] Training Center, China Meteorological Administration [2] Yichang Forecast Office, China Meteorogical Administration

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P2.21
Graphic processing system of BO8FDP nowcasting forecast poducts

Wenfang Zhao, Feng Liang
Beijing Meteorological Bureau, China

The graphic processing system of B08FDP nowcasting forecast products was introduced in this paper. The system was designed to generate image products from all common forecast products in B08FDP nowcasting systems and observation data (which are NETCDF file format or XML file format) by using the Interactive Data Language (IDL). The image products are in the same size, with same geographic information background and same color scale, including precipitation, probability of precipitation, reflectivity, storm track and severe weather forecast, were transferred to B08FDP products display website for all meteorological experts, local champions and forecasters. The system was the important background support for B08FDP products display website, ran stably during the Olympic Games and guaranteed the realtime update for the products displayed in B08FDP products display website, made the application of the website more widen. Especially in the Shunyi Olympic Rowing-Canoeing Park, the B08FDP product display website was the first decision support tool for the forecasters

10:45 4.8 A proposed integrated weather observing system for nowcasting applications
I.Gultepe, L. Malenfant, R. K. Ungar, S. Cober, and G. Isaac

11:00 4.9 Convective storms initiation in Romania
Aurora Bell

11:15 4.10 Nowcasting flash floods in mountainous terrain
Geoff Austin, Paul Shucksmith and Luke Sutherland-Stacey

11:30 4.11 A Coastal Atmospheric River Monitoring and Early Warning System
Allen White, Paul Neiman, Dan Gottas, Seth Gutman, Isidora Jankov

11:45 4.12 CB Nowcasting in FLYSAFE: Improving Flight Safety Regarding Thunderstorm Hazards,
Stéphane Sénési, Y. Guillou, A. Tafferner, C. Forster

12:00 – 13:30 **Lunch** (Sea to Sky Ballroom B)

13:00 – 13:30 **Poster 2 and Exhibit Viewing** (Grand Foyer)

SESSION 5: **Radar** (Sea to Sky Ballroom C)
Chair: Jarmo Koistinen and Geoff Austin

13:30 5.1 Nowcasting a prolific and intense tornadic storm: The Greensburg, KS supercell of 4 May 2007
Howard Bluestein

13:45 5.2 Implementation of tracking radar echoes by correlation (TREC) for US Navy radar nowcasting
Paul Harasti, Timothy Maese, Robert Owens, Lee Wagner, Randy Case, Michael Frost, John Cook

14:00 5.3 Unattended Automatic Real-time SMS flood warning using high-Resolution X-Band radar data and automatic real time calibration of X-band radar data
Einar Jensen, Lisbeth Pedersen

14:15 5.4 The CASA Nowcasting System
Evan Ruzanski, Yanting Wang, V. Chandrasekar, Eric Lyons

14:30 5.5 Improved Tracking and Nowcasting Techniques for Thunderstorm Hazards using 3D Lightning data and Conventional and Polarimetric Radar Data
Vera Meyer, Hartmut Hartmoller, Hans-Dieter Betz

14:45 5.6 Real Time Detection of Reflectivity Calibration Differences Between Radars
David Patrick

15:00 – 15:30 Coffee, Poster 2 and Exhibit Viewing (Grand Foyer)

SESSION 5: Radar (cont`d)
Chair: Jarmo Koistinen and Geoff Austin

15:30 5.7 Tracking edges of polygons (TREP)
Willi Schmid

15:45 5.8 Objective Classification of storm types using shape information and model atmospheric environment parameters
Neil Fox , Athanasios C. Micheas

16:00 5.9 A Study of Convective Triggering Mechanism in Beijing Area for Nowcasting Thunderstorm: Diagnosis from a Rapid Update Radar Analysis System During B08FDP,
Juanzhen Sun, Mingxuan Chen, Yingchun Wang, Rita Roberts, and Jim Wilson

16:15 5.10 The 0-8 Hour Collaborative Storm Prediction for Aviation (CoSPA) Forecast Demonstration
William Dupree, D. Morse, X. Tao, H. Iskenderian, C. Reiche, and M. Wolfson

16:30 – 17:30 Panel Discussion: Nowcasting Systems and Impacts
Chair: Roy Rasmussen and Jian Jie Wang

17:30 Sessions end for the day

P2.18
HAIL STORM AND DAMAGE WIND OVER NORTH OF VIETNAM

Phung Kien Quoc
Aero - Meteorological Observatory of National Hydro Meteorological Service of Vietnam (VNHMS)

From the afternoon 19 Nov 2006, a widespread heavy rain and thurnderstorm has been observed over all the Northwest area and over the North mountain area. From 20 Nov. to 21 Nov., the hail storm and heavy rainfall had spread over all provinces in the North Delta of Vietnam. The period of strong rainfall was from 13h of 20 Nov. to 19h of 21 Nov. The hail partices were about 1 cm to 7cm. With the analyzes of Synoptic situation, radiosounding indexes, satellite and radar images the severe weather could be warned due to the affect of cold surge and the strong wind shear in both direction and speed. A pilot real-time warning and Nowcasting system for Vietnam is planed.

P2.19
Data Quality Metrics for Assessing the B08FDP Radar Network

Paul Joe [1], Alan Seed [2], Haiyan Yu [3], Debin Su [3], Liping Liu [3], Hongyan Wang [3], Zhuang Wei [3], Jianyun Zhang [4] and Chian Zhang [4]
[1] Environment Canada, [2] Centre for Australian Weather and Climate Research, [3] China Meteorological Agency/Beijing Meteorological Bureau, [4] The Metstar Company

Three S Band and one C Band radar, manufactured by Metstar, were used in the Beijing 2008 Forecast Demonstration Project. In the year prior to the Olympic period, radar data was provided to the FDP team for testing and integration. Beijing is located at the edge of mountainous terrain about 150 km from Bohai Bay. Data quality issues due to ground targets is always an issue in an urban and mountainous environment but the atmospheric environment proved to be conducive to considerable anomalous propagation situations. In cooperation with Metstar and the CMA radar quality team, various ground clutter removal strategies such as Doppler notch filtering, ground echo masks and fuzzy logic identification and correction were used to mitigate their impact. Synchronization of the radars by a central master computer was implemented by CMA and Metstar to mitigate the impact of scan cycle drift to maintain the temporal consistency of the data. Reflectivity and radial velocity accumulations are used to qualitatively assess the quality of the various techniques to produce a surface reflectivity map for QPE applications. Various qualitative and quantitative metrics are proposed to assess the quality of the corrections and include z statistics, spatial correlations, inter-radar reflectivity comparisons, variance and Z-R comparisons with distrometers and raingauges.

P2.17
Automatic procedures and the role of human forecasters in nowcasting services of ARPAV-CMT

G. Formentini, L. Lago, M. Marco, and A. Tarde
ARPAV DRST-CMT

For many years ARPAV (regional environmental agency) in the Veneto Region (north-eastern Italy), have been delivering nowcasting products to different end users groups related to highway maintenance, hydrology, sailing, etc. Severe weather events in the Veneto Region are quite frequent due to the particular geographic position which include mountain chains with peaks over 3000 meters, a long coastline and the largest lake in Italy, the Garda Lake. Severe thunderstorms affect many areas of the Region during the summer season with strong winds, large hail, flash floods and dangerous lightning. On the other hand, in winter cold air outbreaks or anticyclonic situations featuring strong temperature inversions at the surface, give rise to snow or fog events in the Po Valley, both being a major challenge for road traffic. In Spring and Autumn long lasting precipitation events often can cause critical hydrologic conditions., including floods. In this complex scenario the role of the human forecaster in the nowcasting activity is still fundamental. This role is differentiated according to the end users the forecast products have to be delivered to. In order to respond to the increasing requests for such services, ARPAV established three kinds of nowcasting products. The first is an automatic product with no human role and commit to sailing activities in the Northern part of the Adriatic Sea. A complex multi-sensor monitoring system, named HDSS (Hydrometeorological Decision Support System), is able to mosaic volumetric data of three C-band Doppler radars and integrate a real time lightning field to provide every five minutes a forecasted product of precipitation and lightning risk in the following thirty minutes. The HDSS platform uses the MAPLE (McGill Algorithm for Precipitation Nowcasting Using Langrangian Extrapolation) algorithm and the Lightning Prediction Algorithm. The role of the forecaster is present in the second nowcasting product realized for highways maintenance and management companies during the cold semester. The enhancement of the human role is justified not only by the low number of end users but also by the difficulties of monitoring and forecasting particular weather events as snow and fog. The support includes a daily meteorological forecasting for the probability of occurrence of snow, ice and fog events, and real time phone assistance (nowcasting) during snow events with allowing frequent information updates. The third nowcasting product relies even more on human contribution. Its a nowcasting product for the quantitative precipitation forecast within the following three hours and for an area extremely important in Veneto: the Venice urban area. This area includes not only of the City of Venice but also the densely populated urban surroundings. The nowcasting product is delivered every three hours and it is completely realized by a meteorologist making primarily use of the radar derived precipitation estimates. In a very complex landscape like the Veneto Region, the role of the human nowcaster is very important and probably this will be for the coming years. At the same time proper automatic products both for meteorologists as well as for selected users could improve efficiency and reliability of the nowcasting information.

World Meteorological Organization
Symposium on Nowcasting and Very Short Term Forecasting

Thursday, 3 September 2009

07:00 **Breakfast** (Sea to Sky Ballroom B)

08:00 **Registration**

SESSION 6: **Techniques** (Sea to Sky Ballroom C)
Chair: Jim Wilson and Augusto Pereira

08:30 6.1 Olympic Nowcasting with Continuous Upper-Air Profiling
Randolph Ware

08:45 6.2 Frontal Passages During the 2009 Winter observed with the Remote Sensing Network for Vancouver 2010 Olympic Winter Games
Edwin Campos, Norman Donaldson, and Paul Joe

09:00 6.3 Kalman Filter for Nowcasting
Zuohao Cao, George A. Isaac, and Monika Bailey

09:15 6.4 Extending VERA towards 3D applications
Barbara Chimani, Reinhold Steinacker, Stefan Schneider, Wolfgang Gepp, Matthias Ratheiser, Manfred Dorninger

09:30 6.5 Assimilation of surface observations for RUC and Rapid Refresh
Dezso Devenyi, Stanley G. Benjamin,Stephen S. Weygandt, Ming Hu

09:45 6.6 Assessing the impact of local observations on a boundary layer 1D numerical model
Samuel Rémy and Thierry Bergot

10:00 – 10:30 **Coffee, Poster 2 and Exhibit Viewing** (Grand Foyer)

SESSION 6: **Techniques (cont`d)**
Chair: Jim Wilson and Augusto Pereira

10:30 6.7 Utilization of frequently-updated mesoscale analysis for thunderstorm nowcasting: an examination of relevant predictors
Ernani de Lima Nascimento, Stéphane Sénési

10:45 6.8 A Comparison of Visibility Measurements obtained during FRAM-S project during freezing fog and warm fog events
Ismail Gultepe, R. Rasmussen, L. Malenfant, B. Zhou, R. K. Ungar, S. Cober, and R. Nitu

11:00 6.9 Improved short-term quantitative precipitation forecast combining radar data with a high-resolution NWP model
Zachary M. DuFran, Richard L. Carpenter, Jr., Brent L. Shaw

11:15 6.10 High resolution precipitation analysis and forecast validation over complex terrain using an inverse VERA approach
Benedikt Bica, Stefan Schneider, Reinhold Steinacker

11:30 6.11 Probability density function of visibility and cloud ceiling during snowfall: Application in numerical models for winter nowcasting (0-6hr) visibility and cloud ceiling
Faisal Boudala and George A. Isaac

11:45 6.12 Data mining for thunderstorm nowcast development
John K. Williams, David A. Ahijevych, Susan Dettling and Matthias Steiner

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12:00 – 13:30 **Lunch** (Sea to Sky Ballroom B)

13:00 – 13:30 **Poster 2 and Exhibit Viewing** (Grand Foyer)

SESSION 7: **Verification and Impacts** (Sea to Sky Ballroom C)
Chair: Barbara Brown and Liang Feng

13:30 7.1 Verification methods for spatial forecasts
Barbara Brown, Eric Gilleland, David Ahijevych, Barbara Casati, Beth Ebert

13:45 7.2 Scientific Assessment and Diagnostic Evaluation of CoSPA 0-8 hour Blended Forecasts
Huaqing Cai, James Pinto, Matthias Steiner, Peiqi He, Susan Dettling,, David Albo, and Barbara Brown

14:00 7.3 Towards an analysis ensemble for NWP-model verification
Manfred Dorninger, Theresa Gorgas, Reinhold Steinacker

14:15 7.4 Bayesian Procrustes verification of ensemble radar reflectivity nowcasts
Neil I. Fox, Athanasios C. Micheas, Yuqiang Peng

14:30 7.5 An Operational Perspective for Evaluating Convective Nowcasts for Aviation
Steven A. Lack, Geary J. Layne, Michael P. Kay, Sean Madine, and Jennifer Luppens Mahoney

14:45 7.6 Evolution of NWS Storm-based Warnings, Part I: NSSL's Experiments in Probabilistic Hazard Information (PHI)
Greg Stumpf, David Andra, Harold Brooks, Don Burgess, Kristin Kuhlman, Jim LaDue, Les Lemon, Mike Magsig, Kevin Manross, Kiel Ortega, Kevin Scharfenberg, Travis Smith

in a time frame up to 2 hours for applications in aviation meteorological service provision, such as optimizing safety and economic impact in the context of sub-scale phenomena. On the basis of tracking radar echoes by correlation (TREC) the movement vectors of successive weather radar images are calculated. For every new successive radar image a set of ensemble precipitation fields is collected by using different parameter sets like pattern match size, different time steps, filter methods and an implementation of history of tracking vectors and plausibility checks. This method considers the uncertainty in rain field displacement and different scales in time and space. By validating manually a set of case studies, the best verification method and skill score is defined and implemented into an online-verification scheme which calculates the optimized forecasts for different time steps and different areas by using different extrapolation ensemble members. To get information about the quality and reliability of the extrapolation process additional information of data quality (e.g. shielding and blocking in Alpine areas) is extrapolated and combined with an extrapolation-quality-index. Subsequently the probability information of the forecast ensemble is available. In close collaboration between ATM and the Aeronautical Meteorological Service of the Austrian Air Navigation Service, Austrocontrol, the system works semi-operational as guidance for decision-making and will be further optimised.

P2.16
The web display on nowcasting products of WWRP Beijing 2008 Forecast Demonstration Project

Feng Liang, Lili Yuan, Wenfang Zhao
Beijing Meteorological Bureau, CMA

After four years preparation, the Beijing 2008 Forecast Demonstration Project of World Weather Research Project (WWRP B08FDP) was conducted in Beijing Meteorological Bureau (BMB) of CMA during the 2008 Olympics and Paralympics. The final B08FDP product suite was decided. Over 40 kinds of products from 8 nowcasting systems were provided in every 6 minutes interval. A dedicated web was developed for easy using and comparison of FDP products from different systems. For forecasters convenience, the FDP products were categorized into analysis, consensus products, common products and individual products. Suitable domain and color scheme were chosen to display different type of forecasts. Real-time verification results were also put on the web. A blog like text product was designed for FDP champions to update FDP forecast opinion besides the consensus products. The web could also be used to monitor the radar data collection and forecast product generation in real-time. During the Olympics and Paralympics, forecasters at BMB headquarter and Olympic venues, end users from Beijing Water Authority, Chinese Civil Aviation, and Summer Palace Park could access B08FDP forecasts through this website. Part of products was transferred to BMB's Olympic weather service web for public too. The goodness and weakness of this web-based products display interface were discussed from forecaster's viewpoint.

P2.14
News on the European Weather Radar Network (OPERA)

Iwan Holleman [1], Laurent Delobbe [2], and Anton Zgonk [3]
[1] Royal Netherlands Meteorological Institute (KNMI) [2] Royal Meteorological Institute of Belgium (RMI) [3] Environmental Agency of Slovenia

The OPERA programme (Operational Programme for the Exchange of weather Radar information, www.knmi.nl/opera) is the Weather Radar programme of EUMETNET, the Network of the European Meteorological Services (NMSs). The objective of OPERA is to harmonize and improve the operational exchange of weather radar information between national meteorological services. The third phase of the OPERA programme is a joint effort of 29 European countries, runs from 2007 till 2011, and is managed by KNMI. OPERA-3 is designed to firmly establish the Programme as the host of the European Weather Radar Network.The OPERA-3 programme will focus on the operational generation and quality control of an European weather radar composite, exchange of reflectivity and velocity volume data, exchange of quality information, and availability of radar data for operations and research. An European Pilot Data Hub (PDH) for weather radar data was established at the UK Met Office between 2005 and 2006. During the third phase an OPERA Data Center (ODC) has been specified and development should start mid 2009. Start of operation of the ODC is planned for early 2011. Besides the ODC development several other activities are performed in the framework of OPERA. Studies on the merits of polarimetric radar focused on operational application are performed, and harmonized production practices for volume data, low-level reflectivity and weather radar wind profiles are established. Furthermore OPERA actively participates in the discussion on (potential) RLAN disturbances at C-band. Finally OPERA also works on a new information model for exchange of radar volume data and products using BUFR and HDF5/NetCDF. On the poster, the OPERA programme and its objectives will be introduced and the progress of the ODC development and the other projects will be discussed.

P2.15
Applications of Weather Radar Extrapolation in Aviation Weather Service Provision

Kaltenboeck Rudolf [1], Kerschbaum Markus [1], Hennermann Karin [2], Mayer Stefan[2]
[1] Austrocontrol, Aeronautical Meteorological Service, Vienna, Austria [2] Meteoserve, Vienna, Austria

Nowcasting of precipitation events, especially thunderstorm events or winter storms, has high impact on flight safety and efficiency for air traffic management (ATM). Future strategic planning by air traffic control (ATC) will result in circumnavigation of potential hazardous areas , reduction of load around efficiency hot spots by offering alternatives, increase of handling capacity, anticipation of avoidance manoeuvres and increase of awareness before dangerous areas are entered by aircraft. To facilitate this rapid update forecasts of location, intensity, size, movement and development of local storms are necessary. Weather radar data deliver precipitation analysis of high temporal and spatial resolution close to real time by using clever scanning strategies. These data are the basis to generate rapid update forecasts

15:00	**7.7**	The network of EUMETCast stations in Ukraine as a tool for providing real time meteorological data for forecasters Oleksiy Kryvobok

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15:15 – 15:45 **Coffee, Poster 2 Viewing** (Grand Foyer)

15:45 – 16:45 **Panel Discussion on**
Challenges in Nowcasting in Developing Countries
Chair: Volker Gärtner and Rita Roberts

16:45 **Sessions end for the day**

18:30 - 21:00 **Banquet** Sponsored by Vaisala (Grand Foyer)

World Meteorological Organization
Symposium on Nowcasting and Very Short Term Forecasting

Friday, 4 September 2009

07:00 **Breakfast** (Sea to Sky Ballroom B)

08:00 **Registration**

SESSION 8: **Satellite** (Sea to Sky Ballroom C)
Chair: Aurora Bell and John Mecikalski

08:30 8.1 Satellite Nowcasting Applications,
Marianne Koenig
09:00 8.2 Clustering, Nowcasting and Data Mining Spatial Grids
Valliappa Lakshmanan, Travis Smith
09:15 8.3 Convection Diagnostic and Nowcasting Activities at UW-CIMSS
Kristopher Bedka, Jason Brunner, Justin Sieglaff, Lee Cronce, Wayne Feltz, Richard Dworak
09:30 8.4 Evaluation of Different Nowcasting Algorithms using SEVIRI Data
Daniel Vila , Bob Kuligowski
09:45 8.5 MIMIC-TPW: Real-time, hourly total precipitable water imagery over the oceans from advective blending of polar-orbiting microwave satellite retrievals
Anthony Wimmers, Christopher Velden

10:00 – 10:30 **Coffee** (Grand Foyer)

SESSION 8: **Satellite (cont`d)**
Chair: Aurora Bell and John Mecikalski

10:30 8.6 Progress Toward Satellite-based Atmospheric Turbulence Interest Field Detection
Wayne Feltz, Kristopher Bedka, Anthony Wimmers, Robert Sharman, John Williams
10:45 8.7 Exploiting MSG Infrared and Visible Satellite data for 0-1 hour Convective Initiation Nowcasting,
John R. Mecikalski, Wayne M. Mackenzie, Marianne Koenig
11:00 8.8 Implementation of the EUMETSAT RDT Algorithm for New York City
Brian Vant-Hull, Shayesteh Mahani, Arnold Gruber, Reza Khanibilvardi, Robert Rabin, Robert Kuligowski, Mamoudou Ba, Stephen Smith

towards to out of the radar site, the process had a better Doppler radar data. Every stages of this heavy precipitation supercell storm have been analyzed by used based products and derived products, such as base reflectivity, base velocity, vertically integrated liquid (VIL), mesocyclone (M), tornadic vortex signature (TVS), etc. It was found that some based and derived products can be used to provide some of the indicators and warning signals for large hail and tornado.

P2.12
Road weather nowcasting system

T. Bazlova, N. Bocharnikov, V. Olenev and A. Solonin
Institute of Radar Meteorology, Russia

MeteoTrassa system has been developed to provide the road authorities with actual data and short range forecasts of the road weather. Correct prediction of ice and snow is a key factor in facilitating efficient winter road maintenance. State-of-the-art technology has been used to ensure the means for accurate prediction. The system is based on the following data inputs: road weather stations, thermal mapping, weather radars, hydrological sensors, area specific weather forecasts and warnings of regional Hydrometeorological Center, and GRIB – encoded data of World Area Forecast Centers.

P2.13
Overview of GRAPES-SWIFT Nowcasting System in B08FDP
Wang Ying, Feng Yerong, Xue Jishan, Zeng Qin, Hu Shen, Liang Qiaoqian, Huang Yanyan
Guangdong Meteorological Bureau, China

GRAPES-SWIFT, short for the GRAPES-based Severe Weather Integrated Forecasting Tools, was developed jointly by Guangdong Meteorological Bureau, China Meteorological Administration (CMA) (GMB/CMA) and Chinese Academy of Meteorological Sciences (CAMS/CMA). Aiming at providing an integrated severe weather nowcast platform for operational application, GRAPES-SWIFT is able to ingest data from China's new generation radars, automatic weather station, satellite, and mesoscale numerical weather prediction model. It offers a platform for severe weather monitoring, analysis, warning and prediction. The current version of GRAPES-SWIFT system provides a software package that integrates a series of nowcast algorithms and functions. The operational GRAPES-SWIFT system was built on a GIS platform. It can provide detailed geographic information such terrain, administrative districts, high ways, or even detailed street information in a city. This GIS-based system facilitate geographic display of the products, storm positioning, and the indication of warning area. This article provides a brief introduction on the structure and products of the GRAPES-SWIFT nowcasting system. Discussion is made to the system on its performance according to the verification statistics generated during the 2008 Beijing Olympics Forecast Demonstration Project period. Some future improvements are suggested.

P2.10
Systematic variation of Drop Size in convective of Beijing and Radar-rainfall Relations

Xian Xiao[1],Yu HaiYan[2]
[1]Institute of Urban Meteorological, CMA No.55 Bei-Wa-Xi-Li Road, Hai-Dian District, Beijing, China ,100089 [2]Beijing Meteorology Bureau , No.44 ZI-Zu-Yuan-Lu Road, Hai-Dian District , Beijing , China ,10089

Based on the raindrop size distribution data of 50 convection precipitation events measured in Beijing during 2007 by a parsivel Disdrometer, which has 32 channels and measures the raindrop diameter from 0.62mm to 24.5 mm, microphysics parameters and its fluctuation features with the relation between Z and R or coefficient a and exponent b , were analyzed. It found that the gamma function is more perfect agreement than Marshall-Palmer (M-P) exponential function between fits and observation. The storms observed in Beijing could be divided into 3 phase: convective (C), transition (T), and stratiform (S). For different precipitating phase, the relation between Z and R or coefficient a and exponent b, with raindrop size distribution (DSD) parameters are quite different. The convective phase of a storm often accounts for a major share of the rain accumulation despite its shorter duration, which is always more than 76%. Six kinds of diameters are calculated, including the mean diameter D0, the mode diameter Dd, the mean volume diameter Dv, the predominant diameter Dp, the median volume diameter Dn and the median diameter Dnd , it found the mean diameter D0 has the same evolvement as the other except for the mode diameter Dd, which changes no systemically. For convective phase of each precipitation , there were the biggest median diameter D0 and coefficient a; for transition phase of each precipitation, there were the smallest median diameter D0 and coefficient a ; for stratiform phase , there were middle median diameter D0 and coefficient a. Especially ,when R , or N T , or Z gradually increases, coefficient a (or the exponent b) approaches to a constant value. Drop growth occurs predominantly below the 0°C level by collision, coalescence, and breakup in the convective phase. The light and role of cumulus merger process may influence DSD, which median volume diameter D0 grows as and so the DSD narrows; that is both â and Đ increase. Moreover, that there is a linear correlation between R and Z , in other words , exponent b is 1 , when Dm is a constant .However, when R

P2.11
The nowcasting feature analysis of heavy precipitation supercell storm based Doppler weather radar observation

ZHOU Xiaogang, LIU Shijun, LIU Hua
Chinese Meteorological Administration Training Centre, Beijing 100081, China

As China's new generation of Doppler weather radar network, some cases on the supercell storm have been studied. The process of heavy precipitation supercell storm has received relatively little research attention to date. The understanding on the supercell storm depends on careful analysis of the case. Here, an analysis is presented of a heavy precipitation supercell in Yongzhou, Hunan province, in association with heavy hail and tornado on April 9, 2006. Because of its generation, development, maturity and demise were just moving

11:15	**8.9**	The GOES_R satellite proving ground: nowcasting applications and results from the 2009 hazardous weather testbed experimental forecast and warning demonstration *Steven Goodman, James Gurka, Timothy Schmit, Mark DeMaria, Daniel Lindsey, Wayne Feltz, Scott Bachmeier, Kris Bedka, Steven Miller, Eric Bruning, Gary Jedlovec and Richard Blakeslee*
11:30	**8.10**	Detection and monitoring of Convective clouds by satellite *Yann Guillou, F. Autones, Stéphane Sénési*
11 :45		**Closing Remarks**

Poster Session 1
Monday and Tuesday (Grand Foyer)
Chair: George Isaac and Paul Joe

P1.1 Assimilation of dual-polorimetric radar observations and its impact on short-term rainfall forecast of two convective systems
Xuanli Li , John R. Mecikalski

P1.2 Development of radar data assimilation using 3DVAR in X-Net: radar network
Shingo Shimizu,Takeshi Maesaka,Seiichi Shimada, Ryohei Misumi, Koyuru Iwanami,Masayuki Maki,Tadashi Yamada

P1.3 High resolution Regional Model (HRM) performance in now casting and very short range forecasting in Pakistan
Ata Hussain

P1.4 Very short-time quantitative precipitation forecasting using X-band polarimetric radar and C-band conventional radar
Atsushi Kato

P1.5 Heuristic probabilistic nowcasting of orographic precipitation
Luca Panziera, Urs Germann

P1.6 Variationally based nowcasting utilizing radar reflectivities
Martin Ridal, Magnus Lindskog, Nils Gustafsson, Guenter Haase

P1.7 Circulation detection and tracking with Doppler velocity derivatives
Travis M. Smith, V. Lakshmanan, K. L. Elmore, K. L. Ortega, K. Hondl

P1.8 A numerical Case Study on the Evolution of Hail Cloud and the Three-Dimensional Structure of Supercell
Xiu-Ming Wang

P1.9 Sensitivity Analysis of Radiation Fog Under Different Synoptic Conditions
Xiaojing Zhang, Luc Musson-Genon, Bertrand Carissimo, and Eric Dupont

P1.10 Fine-Scale Road Stretch Forecasting
Alexander Mahura , Claus Petersen, Bent Sass, Kai Sattler

P1.11 Influences of different soil moisture conditions upon South Atlantic convergence zone associated precipitation forecasting performed by a regional model
Ana Carolina Nóbile Tomaziello, Adilson Wagner Gandu

P1.12 The Design and Implementation of B08FDP Data Support System
WANG Yubin, YU Dongchang, SU Debin, ZHOU Haiguang, ZHOU Yong, LIANG Feng

P1.13 Storm Series Algorithms in the SWIFT and applications during the "B08FDP"
Hu Sheng, Liang Qiaoqian, Wang Ying, Zeng Qin, Feng Yerong

P1.14 A composite approach of radar echo extrapolation based on radar-derived vectors in combination with model-predicted winds
Liang Qiaoqian, Feng Yerong, Zeng Qin, Hu Sheng, Wang Ying

P1.15 A Bayesian Hierarchical Particle Filter model for storm cell motion forecasting
Neil Fox, Yong Song, Christopher K. Wikle

P1.16 Quality Control of Aircraft Moisture Soundings
Seth Gutman and David Helms

P1.17 Retreival of Temperature from the Whistler V10 Gondola-Sonde
Paul Joe, Vincent Fortin

P2.8
Aviation TREND and TAF short-range visibility forecasts and their verification for aerodromes of Lithuania

Ms Regina Cepaityte MSc   Head of Aviation Meteorology Centre
Lithuanian Hydrometeorological Service

Despite high level the aviation development, visibility (Meteorological Optical Range MOR) remains a factor of great importance in all ordinary aircraft operations, both civil and military. A pilots increasing interest in visibility (MOR) is explained by the fact that the MOR often changes rapidly (particularly in radiation fog). There are 4 international aerodromes operating in Lithuania, one of them military. Fog recurrence at these aerodromes is distributed unevenly over the year. The situation varies during a day as well as over a very short period (from 1 to 30 min). This is because fogs are very sensitive to local influences. Both topography and conditions on the ground are factors responsible for the local nature of many radiation fogs. They may cover a large area, but usually are more localized*. And this amounts to a problem for aeronautical forecasters in Lithuania - not merely to predict a MOR in their TREND and TAF forecasts, but also to verify them following strict ICAO Annex 3 requirements an equally important task. The objectives of this presentation are the following: To demonstrate and evidence a jumpy changeability of the meteorological visibility during a very short period and over a very limited area (on runways of the aerodromes of international airports in Lithuania) To raise an issue of the verification of short-range aeronautical forecasts in accordance with ICAO Annex 3, Attachment (unfortunately, these requirements are uniform for entire world, though they should not) To present proposals concerning observations and their verification for meteorologists consideration.

P2.9
A New Approach in Radar Information Presentation for Forecasters in Cuba

Orlando L. Rodriguez [1], Wilfredo J. Pozas [1], Jorge L. Perez [1], Albio Barreiras [1]
[1] Centro de Radares. Instituto de Meteorología de Cuba

There are 8 operational weather radars in Cuba, so Cuban archipelago is well covered by overlapping radars umbrellas. This fact suggested a new approach to deliver radar information to forecasters in provincial centers. We made a WEB site presenting not individual radar images, but Mosaics of overlapping radars. This way forecasters can stay abstracted about which radar is working or not. Any available radar information over his province will be WEB posted in the Mosaic of his province. Besides the Mosaics, forecasters have comments from at least two radar operators about his province Mosaic. This new way of presenting radar information has demonstrated to be very usefull in local forecast.

P2.7
Studying on How to Maximize Users Benefits from a Case of Failure Downburst Forecast

Xun Li [1], Yingchun Wang [1], Qian Ye [2], Deping Ding [1]
[1] Beijing Meteorological Bureau, China [2] Consortium for Capacity Building, University of Colorado, USA

During Beijing Olympic Games, 2008, Beijing Meteorological Bureau (BMB) fulfilled the Forecast Demonstration Project (B08FDP) approved by WWRP SSC. A famous resort of Beijing, the Summer Palace was quantitatively evaluated with the product of downburst of SWIRLS (Short-range Warning of Intense Rainstorms in Localized System) developed by Hong Kong Observatory. The summer Palace has high demands on the accuracy of downburst forecast, especially on the beginning time of its occurrence and its location. Although SWIRLS had considerably good performance over the whole period of investigation, there was one forecast on Aug. 14, 2008 was failure while an unexpectedly downburst hit right at Summer Palace, which led to Tourists injury and caused great losses. In this paper, starting from this event, the applications of new technology, the needs of end user and process of decision-making are analyzed in detail. Furthermore, a new model associated with the benefit evaluation is theoretically raised. To meet the end users need, the emphases of model are shifted on the communication and application of forecast. As a result, some suggestions are prompted on how to maximize end users benefits and how to minimize the uncertainty of forecast. Key words: downburst, users need, maximum benefit, uncertainty of forecast.

P1.18 Utilization of Radar-based Precipitation Forecasts for Improvement of Hydrological Forecasts
Petr Novák, Lucie Březková, Petr Frolík, Zbyněk Sokol, Hana Kyznarová

P1.19 Storm severity nowcasting by real-time return period imaging
Maarten Reyniers, L. Delobbe, P. Dierickx, M. Thunus, C. Tricot

P1.20 Analysis of Convective Cells and Lightning using Tracking Methods
Pekka Rossi, Vesa Hasu, Antti Makela, Elena Saltikoff

P1.21 A Real Time Data Quality Control Tool based on a Variational Approach
Reinhold Steinacker, Dieter Mayer, Stefan Sperka

P1.22 Regional Multiple Doppler Radar Synchronization Control Strategy and Its Operational Realization
Debin Su, Jianyun Zhang, Paul Joe, Chian Zhang, Yubin Wang, Dongchang Yu, Bo Shen

P1.23 Quantitative precipitation nowcast for real-time application in flood risk management
Tanja Winterrath, Wolfgang Rosenow, Thomas Reich

P1.24 Development of MCS and Convective Storm Nowcasting Technique and MCS Climatology in China Using Geostationary Satellite and Radar Data
Yongguang Zheng , HAN Lei, WANG Hongqing

P1.25 The development of fuzzy-logical Stepped ground clutter detection algorithm
Wei Zhuang, Liping Liu, Debin Su, Paul Joe

P1.26 Nowcast Performance in the WWRP 2008 Beijing Olympics Forecast Demonstration Project
Elizabeth Ebert, John Bally, Mingxuan Chen, Bill Conway, Yerong Feng, Paul Joe, Alan Seed, Jim Wilson, Wai-kin Wong, Jishan Xue, Linus Yeung

P1.27 Mesoscale convective systems (MCSs) over elevated terrains in West Africa
Cyprian U. Okoloye, Wassila Thiaw, Vadlamani Kumar

Poster Session 2
Wednesday and Thursday (Grand Foyer)
Chair: George Isaac and Paul Joe

P2.6
Nowcasting and Very Short Range Weather Forecasting; Understanding Societal Impacts and user needs

Patrick Mukunguta, Tichaona Muhwati, Jonathan Chifuna
Zimbabwe Meteorological Services Department

Zimbabwe is a country with diverse resources and most of these resources are sensitive toweather conditions. Lake Kariba is one of largest lakes in Africa and there are many activities on the lake which include recreation and fishing. Furthermore, the country is heavily dependant on rainfed agriculture. Most users have a perception that weather is the driving force behind their operations. They rarely treat it as a resource. This paper will therefore make an attempt to illustrate that the use of nowcasting and short range forecasting can have a multi-dimensional impact on the economy and sustainable development of Zimbabwe. Nowcasting can be compared to long-range forecasting in case of planning purposes, especially for operational uses. For example nowcasting can be used in aviation and this helps to improve the efficiency, safety and comfort of the operations through tracking of severe weather conditions such as thunderstorms. Thunderstorms and other related weather conditions pose a safety hazard to marine, fishing, aviation, agriculture, hydrology, recreation, transport, power generation industry, transport, and small-scale businesses and also to homeland safety. There is need to provide very short term forecast or warnings of thunderstorms since they have proven to be destructive to human and infrastructure as well as to many sectors of life due to lightning, high rainfall intensity, hail, and also strong winds. For instance during the rain season (October last year to March this year) in Zimbabwe which can be described as a wet year yet thunderstorms and hailstorms resulted into death of 5 people, 5083 households affected, and 6484 hectares of crops were damaged. Nowcasting and warnings can only be timely, and reliable when all the required tools for nowcasting that can also capture mesoscale features are available. In Zimbabwe we rely much on synoptic scale and one weather radar which leaves out small features which also affect the economy. Basically, nowcasting can be highly achieved using tools such as radars and NWP products with high resolution which are currently being utilized in Zimbabwe.

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The IPCC Data Distribution Centre (DDC): http://ipcc-ddc.cru.uea.ac.uk/
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I would like to pay specially tribute the Central Forecast Office for helping me in coming up with this paper. I would also like thank Zimbabwe's Permanent Representative Dr. A. Makarau for his excellent guidance.

P2.5

Impact Analysis on Forecast Demonstration Project in Beijing 2008 Olympic Games Weather Service

Yuxiao Duan [1] Yingchun Wang [1] Qian Ye [2] Qingchun Li [2] [1] Beijing Meteorological Bureau, Beijing ,China,100089 [2] Institute of Urban Meteorology, CMA, Beijing 100089 CMA

The Beijing 2008 Forecast Demonstration Project (B08FDP) was initiated by the World Meteorological Organization World Weather Research Programme to enable the world meteorological community to cooperatively demonstrate advanced technologies and methods for accurate and specific short-term weather forecasting (nowcasting), at the same time to provide support for the Beijing 2008 Olympics weather service, and included an impact assessment on B08FDP. The impact study was implemented from 2006, and surveyed both the FDP primary users and the end users to consider how forecasters started to believe in the FDP information, and employed the enhanced FDP information to produce more user-satisfied products, and how the end users accessed, utilized, and acted upon these enhanced forecasts during their decision-making processes. The main factors which significantly affected the value of B08FDP in support of weather service were found, and the qualitative and quantitative impact of B08FDP was evaluated through analyzing these main factors. Based on the results obtained from this study, some suggestions were given to maximize the benefits and utility of new weather forecast technologies and new products.
Keywords: weather services, Olympic Games, FDP product, weather forecaster, decision-making user, impact assessment This study was supported by the research project (Z0006279040191) of the Beijing Science and Technology Committee.

P2.16 The web display on nowcasting products of WWRP Beijing 2008 Forecast Demonstration Project
Feng Liang, Lili Yuan, Wenfang Zhao

P2.17 Automatic procedures and the role of human forecasters in nowcasting services of ARPAV-CMT
G. Formentini, L. Lago, M. Marco, and A. Tarde

P2.18 HAIL STORM AND DAMAGE WIND OVER NORTH OF VIETNAM
Tan Thanh Nguyen, Phung Kien Quoc

P2.19 Data Quality Metrics for Assessing the B08FDP Radar Network
Paul Joe, Alan Seed, Haiyan, Debin Su, Liping Liu, Hongyan Wang, Zhuang Wei, Jianyun Zhang and Chian Zhang

P2.20 Nowcast of the Rainstorm in Beijing Downtown Area on 6 August 2007 during the WWRP/B08FDP Trial Run Period
Xiaoding Yu, Wei Yuan, Xiuming Wang, Xiaogang Zhou, Yingqiong Wang

P2.21 Graphic processing system of BO8FDP nowcasting forecast poducts
Zhao Wenfang, Feng Liang

P2.22 Statistical analysis of convective storms based on C-band radar observations
Edouard Goudenhoofdt, Maarten Reyniers, Laurent Delobbe

P2.23 The large scale circulation of the snow disaster in southern, China in the beginning of 2008
Yafei Wang

P2.24 Nowcast of the Rainstorm in Beijing Downtown Area on 6 August 2007 during the WWRP/B08FDP Trial Run Period
Xiaoding Yu, Wei Yuan, Xiuming Wang, Xiaogang Zhou, Yingqiong Wang

P2.25 Study on the 3D structure of the heavy rainfall in Chuzhou area during 1~2 August 2008 with Dual-Doppler radar data
HaiGuang Zhou

P2.26 A Novel Approach For Evaluating World Area Forecast System Global Icing Forecasts Using CloudSat Data
Michael P. Kay, Sean Madine, Chungu Lu, Jennifer Luppens Mahoney

P2.27 Comparison of nowcasting methods in the context of high-impact weather events for the Canadian Airport Nowcasting Project
Monika Bailey, George Isaac, Norbert Driedger and Janti Reid

ABSTRACTS

SESSION 1: Olympic Nowcasting

1.2
Overview of the Beijing 2008 Olympics Forecast Demonstration Project. Part I: Nowcasting Demonstration

Jianjie Wang(1), Tom Keenan(2), Paul Joe(3), Jim Wilson(4), Edwin Lai(5), Feng Liang(1), Yubin Wang(1), John Bally(2), Beth Ebert(2), Qian Ye(5), Alan Seed(2), Mingxuan Chen(1), Jieshan Xue(5), Bill Conway(6)
(1) Beijing Meteorological Bureau, China Meteorological Administration (2) Bureau of Meteorology of Australia (3) Environment of Canada (4) National Centre of Atmospheric Research (5) Hong Kong Observatory

Given the high probability of high impact weather during the Beijing 2008 Olympics, two WMO World Weather Research Programme (WWRP) projects were conducted during 2004-2008 to enhance the technical support available to the Beijing 2008 Olympic weather services of the China Meteorological Administration (CMA) and to provide an international focus for research and development leading to operational nowcasting. The project had two parts: The Beijing 2008 Forecast Demonstration Project (B08FDP), provided real time 0-6nowcasting and a Research Development Project (B08RDP) nvolved advancing 36 h meso-scale numerical ensemble forecasts over the Beijing area. The FDP built on previous experience gained during the Sydney 2000 (WWRP) FDP described by Keenan et al (2003) and this paper focuses on the implementation of B08FDP, describes its achievements and lessons learned from the international activity. Eight international nowcasting systems from the Australia, Canada, United States, China and Hong Kong of China participated and were deployed at the Beijing Meteorological Bureau (BMB) of the CMA to demonstrate and quantify the benefits of an end-to-end nowcasting weather services during the Beijing Olympics. The B08FDP focused on the prediction of the convective severe weather in 0-6 h, especially in 0-2 h time-frame, using the latest science and technology. Through this international activity, significant advances in nowcasting were evident (compared to the experiences from Sydney 2000 FDP) and included: a) Enhanced Use of Observing Systems. Real time ingest of new comprehensive meso-scale observing systems providing rapid updates (resolution of order minutes) by all participants. As part of this activity significant effort was devoted to multi-Doppler radar synchronization, data quality control, and the development of mosaic techniques to optimize the utility of the operational Doppler radar and associated operational observing network around Beijing. Development of New Approaches to Nowcasting. New nowcasting techniques were developed and/or applied in the participating systems. Examples include the use of polygon cell tracking, new blending methods for combining radar echoes with NWP products, and the use of ensemble and probability based nowcasts. For the first time, real time nowcast verification was available as part of the forecast process Enhancing the Nowcast Process. Mechanisms were created for enhancing the interaction between researchers and forecasters in real-time . The nowcast process within the BMB office was designed to allow local weather forecasters and on-site weather service teams to directly access B08FDP individual nowcast system and verification

P2.4
Evaluation of very short term precipitation forecasts for management of urban sewer systems

Hernandez, Olver [1][2], Pfeifer, Monika [1], Sanchez-Diezma, Rafael [1], Sempere, Daniel [2]
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The alert system HIDROMET for real-time management of the sewer systems of Barcelona has been developed in the last years by Clavegueram de Barcelona S.A. (CLABSA, from the AGBAR group) funded by R+i Alliance, to prevent urban flooding. This system feeds radar based short term forecasts of precipitation together with observations from limnimeters, gates and pumps into a hydraulic model of the sewer system to monitor simulated and observed water levels. The radar nowcasting module uses advection techniques and has been develop by CRAHI-UPC based on the S-PROG approach. The input to the hydraulic model are 6 hours of precipitation data in terms of 5-minutes accumulations: 4 hours observations and 2 hours of forecasts. Alarm levels are activated when predefined thresholds of accumulated precipitation are reached for selected time intervals. This work presents an evaluation of the short-term high-resolution rainfall forecasts in terms of resulting alarms and the precipitation fields used as input to the HIDROMET. Classical skill scores will be applied to a number of case studies which are representative to the most relevant meteorological conditions for high impact weather. The results of this study will provide a first estimate for the benefits and the reliability of radar based short term forecasts for urban flood prevention in function of different meteorological conditions

a map where this nowcasting expert is pointing out the regions where severe weather could form, with an anticipation of 12-24 hours, and a short text explaining the map. The language used in this text is a technical one, as the product is not for the large public but rather an internal guide to help the forecaster. This product has been elaborated daily during the convective season (May-September) since 2006 and was posted on an intranet available for all the forecasters in the country. This product has been verified against the precipitation measurements at ground stations. The first conclusion was that this forecast enhanced strongly the skills of the nowcasting expert in searching the worse scenario, the forecasts being better and better even if the models were the same. We plan to use this experiment for training new forecasters in finding the needle in the hay stack.For this year we detailed this forecast for the electrical activity of the storms, the main cause of deaths from meteorological reasons in Romania. We also verify these forecast against lightning data. The paper will present these results.

P2.3
Verification and analysis of DMI-HIRLAM NWP precipitation forecasts using weather radar and satellite data

Thomas BÃ¸vith, Claus Petersen, Rashpal S. Gill, Kristian Pagh Nielsen, Bent Hansen Sass
Danish Meteorological Institute

Traditionally, precipitation forecasts from numerical weather prediction (NWP) models are verified using point measurements of precipitation by rain gauges. In recent years, however, NWP model resolution has increased to levels where rain gauge networks do not provide optimal data input for verification. This motivates the use of data from weather radars, which have the ability to resolve precipitation patterns at a high spatial resolution, and multispectral satellite sensors, which provide good separation between cloudy and cloud-free areas. This work aims at verifying and analysing the precipitation forecasts of the high-resolution DMI-HIRLAM model by comparison with weather radar data and multispectral satellite data. The DMI-HIRLAM-S05 model is run every 6 h on a 0.05° horizontal grid and provides rainfall estimates of both stratiform and convective precipitation. Different methods for forecast verification are used to quantify the skill of the NWP model in forecasting rainfall in comparison with rainfall estimates based on observations from a network of C-band weather radars. The expected results of this work is 1) evaluation of the usefulness of DMI-HIRLAM forecasts as input to a precipitation nowcasting system and 2) better verification of DMI-HIRLAM precipitation forecasts and documentation of changes in the forecasting skill in connection with changes to the NWP model set-up (the upcoming DMI-HIRLAM-E03 model, e.g., features a horizontal grid resolution of 0.03°).

products in a user-friendly manner. Expert domain knowledge present within the WWRP B08FDP teams was also transferred to local champions and BMB forecasters through researcher-forecaster interactions during the Intensive Demonstration Period (1-24 August, 2008). Impact Studies. 3-year surveys were conducted with different end users of nowcasting products (i.e. forecasters, decision makers, citizens, foreigner tourists and commercial users) to estimate the impacts of project implementation on improving nowcast services for Beijing Olympics. Acknowledgment: This project was conducted with the direct and indirect support of many agencies and individuals. The BMB/CMA, as host, provided great ongoing and infrastructure support for the FDP and many individuals contributed much to ensure the projects success. Special thanks go to BMB/CMA staffs: Pu Xie, Yingchun Wang, Debin Su, Li Bo, Xiaoding Yu, et al. and international participants: Linus Yeung, Waikin Wong, K.Y. Chang, Jenny Sun, Rita Roberts, Yerong Feng, Linda Anderson-Berry, Tony Bannister, Barbara Brown, Bill Kuo, Zhaochong Lei.

1.3
Overview, Observations and Implications of the B08 FDP Forecast Process

Paul Joe [1], Feng Liang [2], Jim Wilson [3], Jianjie Wang [2], John Bally [4], Beth Ebert [4], Debin Su [2]
[1] Environment Canada [2] China Meteorological Agency/Beijing Meteorological Bureau [3] National Center for Atmospheric Research [4] Centre for Australian Weather and Climate Research

The ensemble of B08 FDP systems created a prototypical nowcast office of the future including advanced sensing systems and telecommunications, data quality control, automatic data and product processing, interactive nowcast production systems and display systems to provided very specific and tailored weather services. Considerable effort was made to create an end (data) to end (forecast operations) to end (end users) system in a relatively short period of time. The forecasting and decision-making concepts and processes evolved throughout the development of the project. The forecast process refers to the steps taken, including the use of the nowcast systems, the resulting products, the discussions and interactions, that result in either forecast or user decisions. The BMB forecast team would prepare for the day through a series of forecast briefings. The FDP team would participate in the briefings and would have their own debriefs/briefings whenever there was new information - every few hours in the pre-storm scenario and as frequently as 15-20 minutes during severe weather. Information between the two teams was conveyed via automated web products, manual override of these products, a blog or direct interaction - the FDP team, through daily champions, could interrupt the BMB team or vice versa. The process was very dynamic as confidence, experience developed and evolved in the systems, in each other and in the situation. Preceding the period of the Olympics, there was an extensive training program on the systems and the local weather. Considerable insight was experienced and gained about the systems, the products, the process, the nature of decision-making that could be articulated which has strong implications for the future role of the forecaster. These insights included the status and role of automation, the design of products, the role of training in the implementation of a nowcast service, the need for diagnostics, the need for radar data assimilation in high-resolution models, the role of ensemble and probabilistic products, the

role of real-time verification, the requirements gap and most importantly the role of the human in the process.

1.4
A System for Nowcasting Convective Storm in Support of 2008 Olympics

Ming-Xuan Chen [1], Feng Gao[1], Rong Kong[1], Xian Xiao[1], Ying-Chun Wang[2], Jian-Jie Wang[2], James Wilson[3], Juanzhen Sun[3], Rita Roberts[3], Sue Dettling[3]
[1] Institute of Urban Meteorology, Beijing, CMA [2] Beijing Meteorological Bureau, CMA [3] National Center for Atmospheric Research

Beijing Meteorological Bureau (BMB) of China has collaborated successfully with the National Center for Atmospheric Research (NCAR) to transfer the convection nowcasting technology of NCAR to BMB to enhance capability of the very-short-term forecasting of convective weather in Beijing from 2004 till 2008. An operational system for nowcasting convective storm in Beijing region named BJ-ANC has been developed by Institute of Urban Meteorology (IUM) of China Meteorological Administration (CMA) in support of 2008 Olympics, based on Auto-Nowcaster system of NCAR and the international research collaboration project.In order to adapt to Beijing local terrain, climate conditions and local data characteristics, many algorithms and modules of storm analysis and nowcasting from Auto-Nowcaster have been further developed and tuned by IUM's meteorologists and software engineers since 2004, including radar data QC, reflectivity mosaic, storm tracking and extrapolation, thermo-dynamical field retrieval at lower layer, fuzzy logic, etc., based on a lot of real-time forecast experiments performed by IUM and BMB' weather forecast office, and a joint study on the characteristics of storm initiation and evolution and their relationship with boundary layer convergence line (boundary) using observations from the Beijing-Tianjin-Hebei local network by IUM, Peking University and NCAR. The close relationships of boundary location and storm development in Beijing-Tianjin-Hebei area have been revealed preliminarily. Also IUM has developed several new algorithms for improving severe weather nowcasting in Beijing, including quantitative precipitation estimates (QPE) and quantitative precipitation forecast (QPF), etc., as well as Chinese interactive display system under both MS Windows and Linux for operational nowcasting.A Forecast Demonstration Project (B08FDP) has been performed during the summer of 2008 that included the period of the summer Olympics in Beijing. This demonstration was sanctioned by World Weather Research Program (WWRP) of the World Meteorological Organization (WMO). The demonstration included eight state-of-the-art forecast systems from China, Hong Kong of China, Australia, Canada and the United States. The focus was on forecasting convective storm for the time period of 0-6 hours during the period of 2008 Olympics and Paralympics. BJ-ANC was one of these B08FDP systems.During 2008 summer that included the period of Beijing Olympics and Paralympics, data from four synchronized CINRAD radars, 106 5-min AWS, five enhanced rawinsonde, satellite and meso-NWP model based on rapid update cycling was ingested in real-time mode by BJ-ANC system and other B08FDP systems. Radar data QC, including dealiasing, AP/NP and brightband removal, was done by BJ-ANC for restraining radar clutter. BJ-ANC system come into being storm analysis and nowcasting products with 6-min updating and 1-km resolution for operational storm warning within 500 km by 500 km domain centered at Beijing, including 3-D radar reflectivity mosaic, storm tracking and extrapolation, reflectivity TREC

POSTER SESSION 2

P2.1
Operational Satellite-Based Nowcasting of Rainfall in the GOES-R Era

Robert J. Kuligowski [1]   Valiappa Lakshmanan [2]   J. Clay Davenport [3]
NOAA/NESDIS Center for Satellite Applications and Research (STAR), Camp Springs, MD USA [1]   NOAA/NWS National Severe Storms Laboratory (NSSL), Norman, OK USA [2]   I. M. Systems Group, Inc., Camp Springs, MD USA [3]

The next generation of National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellites (GOES), which will begin with GOES-R in early 2015, will feature new capabilities that will enhance observation and nowcasting of a wide variety of atmospheric and oceanic phenomena. One of these new instruments is the Advanced Baseline Imager (ABI), which will expand the GOES spectral imaging capability from 5 to 16 bands. For precipitation-related applications, this will result in increased skill at differentiating different types of precipitating clouds and thus producing more accurate estimates of rainfall. One of the required GOES-R operational products will be a forecast of potential rainfall accumulation during the next 3 hours. From an intercomparison of multiple candidate algorithms, the GOES-R Hydrology Algorithm Team has selected the K-Means algorithm developed by Lakshmanan and colleagues for use in the demonstration GOES-R ground processing system. The algorithm uses current and immediately previous estimates of rainfall from GOES-R (currently using METEOSAT Spinning Enhanced Visible InfraRed Imager (SEVIRI) data as a proxy) to produce a forecast of 3-hour future rainfall accumulation every 15 minutes for the entire Western Hemisphere. This poster describes the current state of algorithm development and validation along with plans for additional enhancements prior to implementation in the demonstration system.

P2.2
Forecasting the worse weather of the day in Romania

Bogdan Antonescu, Daniel Victor Carbunaru, Sorin Burcea and Aurora Bell
Romanian National Meteorological Administration

One of the most difficult task in the forecasting division in the met service is to unify the conceptual models used by forecasters at different time ranges. The idea of nowcasting as an approach only for 1-3 hours ahead is not satisfactory for many of the users, so we try to extend the anticipation on severe weather up to 24-48 hours. In this respect we have started an experiment to think the forecast on short range (1-3 days ahead) using the concepts of nowcasting, i.e. identifying the possibility of having the base ingredients for severe weather present in a certain region. We do not have yet numerical weather products devoted to severe weather as these products would need threshold values for Romania. Before establishing these thresholds values we need to have a better understanding of what the actual models can offer. So, the experiment consists in using a nowcasting forecaster expert looking at all classical products available (not derived ones) and finding spots in Sun regions where is possible to have the worse weather of the day, the unhappy situations. The output is

same quantities, where the unique cell ID was used to follow each cell through time. The resulting mean error in cell location ranged from 17 to 25 km after one hour. The cell nowcasts were also projected to a 1 km grid and verified against gridded detections using categorical statistics. The nowcasting systems that used lower reflectivity thresholds for cell detection produced larger cells and tended to score higher values of CSI than the systems that used higher cell detection thresholds.

P1.27
Mesoscale convective systems (MCSs) over elevated terrains in West Africa

Cyprian U. Okoloye1, Wassila Thiaw2, Vadlamani Kumar2 1
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This work uses a case study approach to describe synoptic circumstances associated with the occurrence of Mesoscale convective systems over West Africa during the height of the 2005 Atlantic Hurricane season. The analysis which is limited to the months of August through September 2005 is carried out using NCEP-NCAR Reanalysis Project Dataset. The results show that the African Easterly Waves (AEWs) are preceded by a large convective event composed of several mesoscale convective systems over elevated terrains. The convection provides a forcing on the baroclinically and barotropically unstable state that exist over tropical West Africa. It is observed that near the West African Coast, the baroclinic structure weakens, while convection is maintained. Sometimes, organized convective systems are produced during the afternoon convection near the high elevation areas such as Air Mountains, Guinea highlands, Jos Plateau in northcentral Nigeria, in the vicinity of Lake Chad and Darfur in Western Sudan. The method used in this study to identify and track the waves is that of (Hodges 1995). In the tracking method, a significant vorticity centre at 850 hPa propagates along the baroclinic zone. Therefore, there is a deliberate focus on the positive relative vorticity centres that exist north and south of the Easterly Jet over West Africa and their relevance as potential precursors for Tropical Cyclones. Cloud clusters on satellite imagery relates well to synoptic features on observational analysis. Preliminary result suggests that Atlantic Tropical Cyclones activity may be influenced by the number of AEWs leaving the West African coast, and may have significant low-level amplitudes, and not simply by the total number of AEWs.

vector, nowcasts of storm evolution and reflectivity, probability of hail, boundary location and its extrapolation, QPE and QPF from convective storms, based on fuzzy logic blending of reflectivity extrapolation and many forecast factors that from several algorithms of data analysis, storm identification and detection, cloud analysis, thermo-dynamical retrieval, meso-NWP, etc. Other than auto-nowcasting of storms, BJ-ANC system has interactive human entry function for inputting boundaries to enhance storm nowcasts of initiation, evolvement and decay based on the close relationship of boundary location and storm development.BJ-ANC provided available and useful storm analysis and nowcasting products for severe weather support of 2008 Olympics and Paralympics and had successful forecasts for 8.8, 8.10, 8.14, 8.29 convective events, etc., those occurred during the period of Beijing Olympics and Paralympics, and helped BMB's nowcasters and B08FDP experts to make right decision of storm warnings and forecasts.Evaluation results of 30-min and 60-min forecasts of storm reflectivity and convective precipitation (QPF) during the period of B08FDP formal demonstration (August 1 till September 20) from B08FDP real-time verification system (RTFV) indicated BJ-ANC system had outstanding performance for operational storm warning and nowcasting.

1.5
Applications of the Hong Kong Observatory Nowcasting System SWIRLS-2 in Support of the 2008 Beijing Olympic Games

Linus H.Y. Yeung, W.K. Wong, Philip K.Y. Chan and Edwin S.T. Lai [1]
[1] Hong Kong Observatory

The Hong Kong Observatory nowcasting system SWIRLS (an abbreviation for Short-range Warning of Intense Rainstorms in Localized Systems) has been in operation since 1999. Its second-generation version (referred to as SWIRLS-2) has been under development and real-time testing in Hong Kong since 2007. To support the 2008 Beijing Olympic Games, a special version of SWIRLS-2 was implemented and operated during the Beijing 2008 Forecast Demonstration Project (B08FDP) under the auspices of the World Weather Research Programme of the World Meteorological Organization. A significant expansion has been achieved in SWIRLS-2 when compared to its first generation, which focused primarily on rainstorm and storm track predictions. In essence, SWIRLS-2 comprises a family of sub-systems, responsible respectively for the ingestion of various types of conventional and remote-sensing observation data, execution of a comprehensive list of nowcasting algorithms, as well as product generation, dissemination and visualization via different channels. Evolving from its predecessor, SWIRLS-2 embraces new nowcasting techniques, namely: (a) blending and combined use of radar-based nowcast and high-resolution numerical weather prediction model analysis and forecast; (b) conceptual model-based detection and nowcasting of high-impact weather including lightning, severe squalls and hail; (c) a robust grid-based, multi-scale storm-tracking method; and (d) probabilistic representation of nowcast uncertainties arising from storm tracking, growth and decay. In this paper, SWIRLS-2's participation in B08FDP will be introduced. The system design, functionalities and full product suite of SWIRLS-2 will be presented. The nowcasting techniques behind various sub-systems of SWIRLS-2 will be summarized. The performance of SWIRLS-2 will be demonstrated with selected cases. The major limitations of the various

nowcasting algorithms and the lesson learnt in B08FDP will also be discussed. The paper will be concluded with some thoughts on the way forward.

1.6
Composite products and nowcast decision support for the Beijing 2008 Forecast Demonstration Project.

John Bally [1], David Scurrah [1], Beth Ebert [1], Debin Su [2]
[1] Centre for Australian Weather and Climate Research; [2] Bejing Meteorological Bureau

The Beijing 2008 Forecast Demonstration Project (B08FDP) brought together a range of advanced radar based nowcast systems in a challenging forecasting environment. Many of these systems produced similar outputs, but each took a different approach to solving the nowcast problem. This provided to opportunity to treat the systems as a poor mans ensemble and produce composite consensus products, and also presented the challenge of producing coherent forecaster guidance from the available range of system output. Six systems produced Quantitative Precipitation Forecasts (QPFs) that were used as the raw material for generating consensus forecasts of wetting rain for the Olympic events, and of rain heavy enough to disrupt transport and infrastructure in the city of Beijing. To calculate the probability of exceeding a set threshold of precipitation, the QPFs from each system were regressed against rainfall observed at gauges during the 2007 FDP forecast trials. The modeled probabilities from all nowcast systems were averaged to produce consensus products. The thresholds required to reach warning thresholds were estimated from the accumulated rainfall already observed and measured by one of the systems (STEPS). Many of the FDP systems produced forecasts of thunderstorm location by detecting and tracking thunderstorm signatures in radar data. The error characteristics of these storm tracks were estimated and the probability that each point in the area of concern would be affected by the thunderstorm modeled using the Thunderstorm Environment Strike Probability Algorithm (THESPA). The strike probabilities from three thunderstorm tracking systems were combined assuming that each storm cell was independent and the output of each tracker was highly correlated. \t\n
Consensus wetting rain, damaging rain and thunderstorm strike probability products were made automatically with every radar scan during the FDP, and supplemented by manually prepared consensus strike probability products. Manual products were generated for the most intense bursts of convection during the FDP, and reflected the FDP consensus view of storm development and individual system performance at each forecast time. Automatic and manual consensus products were delivered to the Beijing Meteorological Bureau (BMB) forecasters by web pages available on forecaster workstations and also directly into the new BMB developed nowcast product generation system (VIPS). The consensus products verified well, demonstrating that the techniques used show significant skill and have the potential to improve operational rainfall and thunderstorm nowcasts.

P1.26
Nowcast Performance in the WWRP 2008 Beijing Olympics Forecast Demonstration Project

Elizabeth Ebert1, John Bally1, Mingxuan Chen2, Bill Conway3, Yerong Feng4, Paul Joe5, Alan Seed1, Jim Wilson6, Wai-kin Wong7, Jishan Xue8, Linus Yeung7
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The WWRP Beijing 2008 Olympics Forecast Demonstration Project (B08FDP) demonstrated a large number of state-of-the-art nowcasting systems, with six systems making quantitative precipitation forecasts (QPFs), two making probability of precipitation (PoP) nowcasts, four systems nowcasting radar reflectivity, and five systems tracking thunderstorm cells. Severe weather elements were also detected and predicted by some nowcasting systems. The Real Time Forecast Verification (RTFV) system provided real time feedback on the performance of systems predicting similar quantities (e.g., precipitation verification plotted together for all systems), enabling forecasters to better interpret the nowcast products and make informed decisions whether to issue warnings. Post-real time verification of the nowcast products issued from 1 August-20 September 2008 was conducted to evaluate the performance of the nowcasts for the project as a whole.
Hourly rain accumulations were available every 5 minutes from 106 rain gauges in the greater Beijing region, and were used as the primary verification data for all QPFs and POP forecasts. The nowcast systems showed bias in the predicted rainfall amounts, with one system predicting too much rainfall by a factor of about 3, while most of the others predicted too little rainfall. The smoothest QPFs, i.e., those that dampened unpredictable high intensity small scale precipitation over time, had the lowest root mean square errors and the highest correlation coefficients. Categorical statistics showed optimal QPF performance at light (1 mm h-1) rain thresholds with critical success index CSI ~ 0.2-0.5 for 60-minute nowcasts. The nowcast performance for rain ? 10 mm h-1 was much poorer. One-hour PoP nowcasts for rain exceeding 1 mm h-1 were reliable, i.e., the observed rain frequency approximately matched the predicted probability over a large number of cases. They were also well able to distinguish raining cases from non-raining cases according to the relative operating characteristic (ROC) plot. As with the QPFs, the PoP performance deteriorated for higher intensities.
Reflectivity nowcasts were verified against their own reflectivity analyses at t=0. The pixel-scale performance was fairly discouraging, with CSI ~ 0.2 for 30 minute nowcasts of reflectivity ? 35 dBZ and CSI ~ 0.05 for 30 minute nowcasts of reflectivity exceeding 50 dBZ. However, pixel scale statistics do not adequately reflect the usefulness of the nowcasts, and neighborhood spatial verification methods could be used to quantify the scales for which these nowcasts show skill.
Thunderstorm cell nowcasts were verified in two different ways. The nowcasts of cell tracks and cell properties from each nowcasting system were verified against its detections of those

P1.25
The development of fuzzy-logical Stepped ground clutter detection algorithm

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Non-precipitation echoes, such as ground echo (Natural Propagation and Anomalous Propagation) and radio interference echo, are the very important factors that have effect on radar data quality of CINRAD. Under mean propagation conditions, clutter echoes (mainly caused by targets such as mountains of large building) can be found in almost fixed locations. However, in anomalous propagation conditions, new clutter echoes may appear (sometimes over the sea), and they may be difficult to distinguish from precipitation returns. Therefore, an automatic algorithm is needed to identify clutter on radar scans, especially for operational uses of radar information (such as real-time hydrology).This paper is developed based on the method developed by Kessinger. It uses some statistics to highlight clutter characteristics to output a value that quantifies the possibility of each bin being affected by clutter, in order to remove those in which this factor exceeds a certain threshold. The advantage of this paper is to improve past fuzzy logic algorithm in filling the gaps in rainfall echo areas potentially created by the AP echoes embedded in precipitation. In order to reduce the possibility of misidentification of convective cloud, the threshold of each bin in the algorithm will be changed for different ranges from the radar. We also presented a preliminary method that can automatically identify and remove newly appeared radio interference echo caused by interference of other electromagnetic sources. The significance of identifying non-precipitation echo has been tested by statistical method. The radar data after AP detection are used in 4 radar data QC for the nowscasting systems in Beijing 2008 Olympic Game. The results showed that most of AP clutters is detected by the algorithm, the algorithm improve the radar data quality. Key words: ground clutter, fuzzy-logical, radar data quality control.

1.7
Applying scale decomposition method to verification of quantitative precipitation nowcasts

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The present article describes the use of the ‘intensity-scale’ technique introduced and developed by Casati et al. (2004, 2009) to assess radar based 1 hour quantitative precipitation forecasts for four different nowcasting systems of B08FDP. The intensity-scale verification approach accounts for the spatial structure of the forecast field and allows the skill score to be diagnosed as a function of the spatial scale of the forecast error and intensity of the precipitation events. Different precipitation types (convective, stratiform and mixed type) during the B08FDP demonstration period are selected to get representative results. Results shows that: (1) For radar based 1 hour precipitation nowcasts, the forecasts only exhibited skill at spatial scales higher than 32km despite the using the most advanced high resolution nowcasting systems in the world. For spatial scales lower than 32km, the forecasting ability is very limited. Only precipitation with intensity lower than 5mm/hr exhibited some forecasting skill. (2) Most forecasting error (more than 60%) comes from smaller scales (less than 8km). Improving the forecasting ability of smaller scale precipitation is the key to enhance the nowcasting quality.

1.8
Real time nowcast verification during the 2008 Beijing Olympics Forecast Demonstration Project

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Verification is a critical component of the Forecast Demonstration Project, providing important quality information at all stages of the FDP. The verification was performed using the Real Time Forecast Verification (RTFV) system, which is a purpose-built nowcast verification application. RTFV generates verification products with three different levels of complexity. The simplest are the visual products such as maps, time series, and correspondence plots, to help the user to see how the nowcasts and observations differ from each other. On the next level, statistical comparisons between nowcasts and obser¬vations using such measures as root mean square error, correlation coefficient, probability of detection, etc., quantify the nowcast accuracy and enable easy inter-comparison of forecast quality among competing systems. Finally, diagnostic products are generated using advanced verification methods such as multi-scale and object-oriented verification. Because these methods are more computationally intensive than the simple statistical products, diagnostic products were not created in real time. In preparation for the FDP, verification results from the 2007 trials gave information on the nowcast quality for most of the participating systems. This assisted forecasters, experts, and champions to interpret the automated nowcasts in an appropriate way in 2008. It also provided the initial calibration of multi-system rainfall nowcasts that were combined into ensemble probability of precipitation forecasts of light and heavy rain. During the FDP, real time verification results were automatically generated as soon as verifying observations became available (every 5 minutes for rainfall, every 6 minutes for radar-derived products), and immediately posted online to the B08FDP Product Viewer web site. The results focused on the latest data, showing mapped nowcasts and observations, as well as performance diagrams and statistics corresponding to the most recent 6 h period. It was originally intended to update the ensemble rainfall calibration in real time using the most recent verification results, although this did not occur. A survey of BMB forecasters, local champions and system experts was conducted to assess their understanding and use of the real time verification products. During the FDP the forecasters looked at the RTFV products whenever there was weather. They felt that the verification products were useful, particularly used the quantile-quantile plots. However, they felt they could have benefited from more training, examples and help to fully understand and use the verification products. Longer experience with nowcasts and real time verification in an operational setting will likely change the way forecasters use the these products. Most surveyed nowcast system experts felt the real-time verification was less useful than retrospective verification. They preferred to look at the results some time after the investigation and try to understand how and why the performance statistics relate to the physical situation, sample selection, network design, etc., which means being able to select a sub-sample of the data (e.g., stratiform vs. convective area statistics, differences in performance for mountainous vs. flat regions, the point by point comparisons, etc.) Future FDPs should include an interactive forecast verification application

Online Adjustment Procedure (RADOLAN) of DWD adjusts the radar based precipitation estimates every hour to surface precipitation observations resulting in areal quantitative precipitation analyses. In the case of forecasts surface measurements are naturally not available for adjustment. Therefore, DWD developed a technique to quantify the forecasted amounts of precipitation making use of the most recent gauge-adjustment procedure assuming persistence of the precipitation frequency distribution. Frequency distributions of Weibull type are derived for both, the forecasted hourly precipitation sum and the most recent gauge-adjusted analysis. The transformation function mapping the frequency distributions is applied to the latest forecast product resulting in the quantitative precipitation forecast for the next two hours with an update frequency of 15 minutes. Here we will present results from case studies of recent flood events in Germany with emphasis on forecast verification focussing on the effect of quantification on forecast accuracy.

P1.24
Development of MCS and Convective Storm Nowcasting Technique and MCS Climatology in China Using Geostationary Satellite and Radar Data

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The MCS and convective storm identification, tracking and nowcasting method is one of the important nowcasting methodologies. We developed an MCS tracking technique to nowcast the MCSs based on the overlapping between MCSs in successive satellite images. We also propose a novel approach to identify, track and short-term forecast (nowcast) convective storms based on the 3-D radar dataset. The novel approach to identify 3-D storms is based on mathematical morphology. The approach combines the dilation operation and a special erosion process using dynamic convolution mask when doing multi-threshold identification. The experiment results prove that the approach successfully tackles the problem of false merger. Concerning isolating storms from a cluster of storms, the approach can also keep the internal structure of sub-storms as much as possible. As for the difficult tracking problem, sequential Monte Carlo (SMC) method is utilized to simplify the tracking process. It is not only inherently suitable to handle complicated splits and mergers, but also capable of handling the case of storm missing detection. In order to provide more accurate forecast of storm position, we incorporates the advantages of the cross correlation method into the proposed method. The qualitative and quantitative evaluations show the efficiency and robustness of the proposed approach. The climatological distribution of mesoscale convective systems (MCSs) over China and its vicinity during summer is statistically analyzed, based on the 10-year (1996-2006, 2004 excluded) June-August infrared TBB (Temperature of black body) dataset. The diurnal variations of MCSs over different underlying surfaces show that there are two types of MCSs over China and its vicinity during summer. One type of MCSs has only one active period all day long (single-peak MCSs), and the other has multiple active periods (multi-peak MCSs). Single-peak MCSs occur more often over plateaus or mountains, but multi-peak MCSs are more common over plains or basins.

P1.22
Regional Multiple Doppler Radar Synchronization Control Strategy and Its Operational Realization

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A strategy for regional multiple Doppler radar synchronization observation which includes hardware and software components, equipment additions, realtime data transmission etc. is introduced. This paper describes the use of GPS timing and slice scanning transmission technology to synchronize multiple weather radar observation in Beijing region for 4 Doppler radars. With the radars running in VCP21 mode, a complete volume scan can be acquired in the central computer facility in exactly 6 minutes and at the same time. This technology has been running successfully in an operational mode for Beijing Olympic weather service and afterwards. The effectiveness has also been analyzed for World Weather Research Program / Beijing 2008 Forecast Demonstration Project (WWRP/B08FDP). It significantly improves the consistency and timeliness of the realtime radar data which is greatly favoured for nowcasting systems of B08FDP.

P1.23
Quantitative precipitation nowcast for real-time application in flood risk management

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Quantitative precipitation analyses and forecasts with high temporal and spatial resolution are essential for hydrological applications in the context of flood risk management. Therefore, the hydrometeorological department of Deutscher Wetterdienst (DWD) jointly with representatives of the water management authorities of the German Länder developed high-resolution quantitative precipitation analysis and forecast products based on the combination of surface precipitation observations and weather radar based precipitation estimates. The operational weather radar network of DWD comprises 16 sites at which precipitation scans are performed every 5 minutes. The reflectivity fields measured by the 16 radars are combined to a 1 km x 1 km composite covering Germany and are transformed into amounts of precipitation applying a categorized Z-R relation. The qualitative-quantitative radar composites serve as input for a radar tracking algorithm providing nowcasts for up to two hours. The crucial nowcasting technique is a special pattern recognition algorithm applied to radar data making additional use of channel 4 (IR) data of the Meteosat Second Generation satellite in the marginal area of the radar composite range. The tracking algorithm is based on the advection of precipitation elements using the displacement vector field that is derived from the mapping of detected precipitation structures in successive picture data. The Radar

that is easy to manipulate and highly flexible, thus allowing users to control the parameters of the verification.

1.9
Weather Services for the 2010 Olympic and Paralympic Winter Games

Chris Doyle, Al Wallace, Bill Scott, Paul Joe and George Isaac
Environment Canada

Six years of planning and program development by Environment Canada (EC) will culminate in January 2010 with the commencement of the Official weather services program for the Games. Informed by weather services programs from prior games, in particular Salt Lake City in 2002 and Turin, in 2006, EC planners sought to provide a comprehensive weather service; one responsive both to the needs for safety and security of the public and spectators, and to meet the needs by sport venue operators to successfully hold safe and timely sporting events. Early assessments of capabilities versus requirements indicated a number of infrastructure and capacity shortfalls that would need to be addressed. These included:

- Surface observing infrastructure
- Radar and other vertical profiling
- Forecaster training and skill in complex Alpine terrain; specifically at the outdoor sport venues.
- Localized Numerical weather prediction (NWP)
- A detailed understanding of the meteorological requirements for sporting events and essential Federal services, like security.

It became clear in short order that meeting the need for capability enhancements would provide a three fold benefit; A much better general understanding of the weather of the region; an opportunity to accelerate progress in the national prediction systems of EC through high-tempo innovations in NWP and an opportunity to engage in detailed weather research given the richness of the observing infrastructure planned for the Games and the resources committed to complete the project. In all respects, the preparations for the Games and accomplishments to date have exceeded the expectation of the planners. A cadre of 34 meteorologists has developed a very high level of understanding of the weather of the venues and the needs of the event operators. A rich array of NWP is readily available at a resolution and quality unsurpassed by prior Olympic events. Underway is a WWRP endorsed experiment on nowcasting and short range weather prediction that promises to deliver new insights into the properties of weather in alpine areas while supporting the operational program by delivering new data and forecast information into the hands of venue forecasters. Although it is far too early to predict the weather for the Games, the state of preparations has formed the foundation for a capable weather service at Game's time.

1.10
The Observing System for the Vancouver 2010 Winter Olympic Games

Bill Scott, Paul Joe, Chris Doyle, George Isaac and Stewart Cober
Environment Canada

Prior to the preparations for the Vancouver 2010 Olympics, few detailed observations were available from the Whistler-Blackcomb mountain area even though it was a popular ski destination. The area is in a coastal complex terrain environment where the average temperature in the valley in the Olympic period is around 0 Celsius. Snow, visibility and high winds are the forecast and observing issues. Snowfall varies in density and can be heavy at times, mid-cloud formation can create visibility issues and confound ski race operations and high winds can shut down the lifts in the Alpine region (about 30 days a year) in the Whistler venues. Cypress Mountain, located on the north shore of the Frasier Valley, also has significant visibility issues. Special operational in-situ surface weather stations have been developed and installed at traditional low land locations but also on mountain-slope locations. Extra upper air observations are planned. Adequate instrumentation, access, maintenance, power and communications are some of the monitoring issues. A C-band Doppler radar has been installed at the junction of three steeply sloped valleys but has go views of the key Olympic venues. Overcoming ground clutter, siting for good visibility and developing concepts for effective scanning were some of the challenges. In order to understand the physical processes and therefore to improve nowcasting of precipitation, visibility and winds, vertical profiles of precipitation (intensity and particle size distribution), temperature, visibility and wind are made using a combination of in-situ (Remote Video systems, particle size distribution sensors, visibility sensors, high temporal resolution precipitation sensors) and remote sensing (wind profiler, radiometer and micro-rain radar). Data is collected at one minute intervals in many cases. Observations in the penultimate Olympic year have already revealed mesoscale features that clearly demonstrate the value of these extra observations including small scale but significant differences in temperature profile on different sides of the Whistler ridge, small pockets/jets of strong wind features up the valley, a wide variety of precipitation profiles inferring the different precipitation processes in effect.

P1.21
A Real Time Data Quality Control Tool based on a Variational Approach

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Although the analysis of meteorological fields without taking into account (prognostic) model fields is commonly seen as suboptimal, such an approach for real time application has despite being developed and tested in an aspiring venture within the framework of VERA (Vienna Enhanced Resolution Analysis) system. Without any doubt, such a (prognostic) model independent scheme will have the advantage, that a truly independent (real time) model validation may be carried out. That such a venture is successful, several conditions must be fulfilled: First, such an approach for the low troposphere/boundary layer can only work with a fairly dense observational backbone as is now available in several countries by operational surface mesonets. Second, a sophisticated quality control and correction module has to be applied as a preprocessing step to the analysis. Third, a very high topographic data base has to be available, to apply such a methodology to fields over complex terrain. The data quality control scheme we use, is based on a variational algorithm, taking into account spatio-temporal self consistency. For each single observation an interpolated value is compared to the observed value. The statistics of series of such differences allow to abtain the microclimatological characteristics of each station, observational biases and gross errors. Hence, a suitable filter may be applied to adjust the analysis to the resolution and topography of a model field. This quality control module, which has been applied to produce a high resolution reanalysis of surface fields of pressure, temperature, humidity and wind over the Alpine region for the last 35 years and is as well run continuously in real time is being utilized at operational institutions for real time quality monitoring. Also for part of British Columbia this tool is being tested presently in the framework of the Olympic Winter Games 2010 in Vancouver. A short outline of the method and some results will be presented.

P1.19
Storm severity nowcasting by real-time return period imaging

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We report on the development of a real-time product at the Royal Meteorological Institute of Belgium (RMI) that combines radar data with Intensity-Duration-Frequency (IDF) curves, in order to get an overview of the return period of an ongoing event, as a measure of the storm severity. The product was developed on request of the hydrological service of the Walloon region (South of Belgium). Experience in this hydrological service has shown that the hydrological model that is used for issuing flood warnings over the Walloon river catchments, performs well in widespread, large-scale precipitation, but that it largely fails in extreme local rainfalls causing flash floods. Therefore, a specialised product allowing fast reaction is needed in these situations. For this purpose, precipitation accumulation images from the RMI radar in Wideumont with different durations are compared in real-time with IDF curves recently determined by the RMI. We will show that, despite the large uncertainties in the radar data accumulations, the product is a very useful nowcasting tool in the case of extreme events.

P1.20
Analysis of Convective Cells and Lightning using Tracking Methods

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Convective cells and lightning cause hazardous situations throughout the world. This paper proposes a method for convective cell tracking and analysis using weather radar and lightning observations. The combination of these two measurement sources enables an efficient tracking of convective cells using machine vision techniques. The cell tracking enables the analysis and spatially accurate short term prediction of convective cells. In addition, the paper proposes a fuzzy logic algorithm for the determination of the life cycle phase of cells. Therefore, the approach not only provides information on the cell movement but also analyses the temporal development of individual cells. The fuzzy logic algorithm mimics the expert's view of the convective cell phase and it deduces automatically if cells are intensifying or dissipating. This is since the human expert is able to perceive different life cycle phases of a cell from weather radar and lightning data. The algorithm utilizes several input parameters in the fuzzy inference, such as cell area, lightning activity, CAPPI and EchoTop 20 dBZ information. The approach is demonstrated through case examples in Southern Finland. Moreover, the proposed tracking algorithm is applied to study statistical life cycle properties of convective storms in Finland. This includes, for example, convective cell lifetime distribution and relationship between the cell life cycle and different radar and lightning parameters.

1.11
Science and Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) -- A World Weather Research Program Project

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A new project of the World Weather Research Programme (WWRP) of the World Meteorological Organization (WMO) is now underway for the Vancouver 2010 Olympic and Paralympic Winter Games. Short term weather forecasting or Nowcasting, which concentrates on 0-6 hr predictions, has been the focus of several WWRP projects associated with the Sydney 2000 and the Beijing (2008) Summer Olympic Games. SNOW V10 will be the first similar project to look at winter weather. It will produce better techniques to nowcast cloud, fog, visibility, precipitation type and amount, and wind and turbulence in mountainous terrain, The project should have long-term societal benefits for those interested in transportation, recreation and water management in complex terrain. SNOW-V10 will use state-of-the-art numerical modeling systems, new on-site surface and remote sensing observing systems, as well as Nowcasting systems which will blend observations and model predictions into improved short term forecasts. Short term forecasts will be provided to the weather forecasters supporting each venue, and some products will be available to special on-line users. An evaluation and impact study will be conducted to determine the effectiveness of the forecast systems. This talk will describe the plans for the project and discuss what has been accomplished to-date.

SESSION 2: Role of Forecaster

2.1
Nowcasting and forecasting thunderstorms for air traffic with an integrated forecast system based on observations and model data

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This study presents the concept and first results of the Weather Forecast User Oriented System Including Object Nowcasting (WxFUSION), an integrated system using observations and numerical model data to nowcast and forecast weather hazards for air traffic. WxFUSION is currently under development within the project “Wetter und Fliegen” (“Weather and Flying”) under the lead of the Institute of Atmospheric Physics (IPA) at DLR. WxFUSION aims at combining data from real-time observations with nowcasting tools and numerical model forecasts accordingly in order to detect, nowcast (0-1 hrs) and forecast (1-24 hrs) target weather objects (TWO) which are pre-defined and specified by the user. These TWOs represent hazard areas for air traffic like thunderstorms, icing, clear-air turbulence or heavy snowfall. Within this study, we focus on thunderstorms (Cb) as TWOs with Cb top volumes representing the turbulent anvil areas and Cb bottom volumes representing areas of heavy rain, hail, and turbulence. The former are detected from space by satellite while the latter are detected by radar. The system’s central element for nowcasting TWOs is the fusion of the different data sources by using fuzzy logic, a method that deals with parameter ranges instead of fixed thresholds and allows to account for imprecise observations and forecasts. Based on conceptual models and expert knowledge mathematical functions are defined in order to characterize a particular weather hazard and to estimate its probability to occur in a defined region. The functionality of the method is demonstrated in case studies of thunderstorms. For instance, the intensity of a thunderstorm is estimated by combining three measures: the cloud top temperature within its Cb top volume, the maximum reflectivity within its Cb bottom volume, and the lightning density. The use of numerical model forecasts for the time range one to several hours is accounted for by another part of WxFUSION called “forecast validation”, where the quality of the forecasts is checked against observations. Cb top (bottom) volumes are detected from synthetic satellite (radar) images and compared to the Cb top (bottom) volumes seen in real satellite (radar) images. In a user-defined window in space and time overlapping synthetic and real TWOs are searched for. If a synthetic object overlaps an observed object, specific attributes like size, moving speed, moving direction, trend and history are compared, and the quality of the forecasted TWO is assessed. This method enables the selection of the best forecast out of an ensemble which can then be used for further predictions of the observed patterns beyond the nowcasting horizon.In 2010, WxFUSION will be operated in real-time at the airports in Munich and Frankfurt, Germany, in order to test its nowcasting and forecasting skills and demonstrate the benefits for the user (e.g. weather providers for air traffic management and pilots). After the testing phase, it is envisaged to install it operationally for use at these airports in close collaboration with the German Weather Service (DWD).

P1.18
Utilization of Radar-based Precipitation Forecasts for Improvement of Hydrological Forecasts

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Accurate quantitative precipitation forecast (QPF) is highly demanded by operational hydrologists. QPF calculated from extrapolated radar fields could give better results for the lead time of several hours than forecasts obtained from NWP models, whose results are widely used as a precipitation input into the hydrological models. Radar echo extrapolation technique COTREC is routinely used in the Czech Hydrometeorological Institute (CHMI) for qualitative precipitation and severe weather nowcasting since 2003. Good experiences with these forecasts have led to the evaluation of their potential benefit in hydrological modeling. Several flood case studies as well as long-term statistical comparisons have shown that COTREC QPF gives better results than NWP model ALADIN QPF for 0-1h and 1-2h and similar results for 2-3h. These results have led to routine use of COTREC QPF 0-1h, 1-2h and 2-3h as an operational input into hydrological model HYDROG since spring 2007.At present, development of radar-based QPF continues in two main directions. The first direction is improvement of COTREC technique by inclusion of radars from neighboring countries and use of NWP model ALADIN outputs for calculation of the first guess of motion field. The second one is development of new statistical advection model (SAM) that uses as inputs radar, lightning, satellite data and prognostic fields of the NWP model ALADIN and calculates both probabilistic and quantitative QPF with lead time up to 3 hours. Goals of these new methods are improvement of QPFs mainly for the second and third hour and possibly extend QPF lead time. It is planned that during spring 2009 hydrological model HYDROG should start operational calculation of ensemble of hydrological forecasts based on different NWP and radar based QPFs and their combinations. Newly developed methods are planned to be integrated into this ensemble calculation.
The paper will present results of COTREC QPF evaluation and its operational implementation into hydrological modeling. Status of current development and future outlook will be also presented.

location in close proximity to the airport. Examples of comparisons made at different locations over the United States will be presented and discussed.

P1.17
Retreival of Temperature from the Whistler V10 Gondola-Sonde

Paul Joe, Vincent Fortin
Environment Canada

In support of the Vancouver 2010 Winter Olympic and Paralympic Games, one cabin on the Village Gondola was outfitted with a temperature, humidity, pressure and GPS instruments. The gondola travels from about 600 m to about 1800 m ASL or from about 750 to 950 hPa. It makes the round trip in about 40 minutes. There are three loading stations for skiers - at either end and about a third of the way up. A typical sounding shows that there is a temperature lag in the measurements as the up and down legs show about a 1 degree Celsius difference. The difference is attributed to a lag in response of the temperature probe plus enclosure as it moves from warmer to cooler air on the upward leg and vice versa. If an inversion exists in the profile, the peaks are similar in magnitude but displaced in the vertical which is also indicative of the lag response of the sensor. Several retrieval techniques were attempted from a simple averaging, to modeling and assuming an exponential response of the probe and to a Kalman filter approach. The various techniques appear to be able to retrieve the temperature profile to better than 0.2 degree accuracy and can sharpen the peaks of the inversion.

2.2
The NWS/NCAR Forecaster Over The Loop (FOTL) Nowcasting Demonstration: Progress on Auto-Nowcaster Integration with NWS AWIPS and other System Enhancements

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The Forecaster Over The Loop (FOTL) demonstration emphasizes the role of the human in short-term (one hour) automated nowcasts of thunderstorm initiation growth and decay. When the demonstration began, the Auto-Nowcaster (ANC) was a stand-alone system that required U.S. National Weather Service (NWS) forecasters to interact with the system using a single dedicated workstation in the operations area of the forecast office. Recently, software has been deployed to the forecast office that allows the human interaction with the ANC to be done through the Advanced Weather Interactive Processing System (AWIPS.) Convergence boundaries can now be analyzed on any of the data that resides in AWIPS, entered into the system using the AWIPS drawing tool already familiar to forecasters, and ANC nowcasts are displayed in AWIPS next to products forecasters are already accustomed to using. This demonstration has lead to improvements in the ANC beyond the engineering efforts needed to integrate ANC interaction functionality into AWIPS. At the beginning of the demonstration, a single set of fuzzy logic rules and membership functions was used to generate thunderstorm nowcasts. Drawing on the unique knowledge and experience of the NWS forecasters in Ft. Worth, seven different sets of fuzzy logic rules have been developed that attempt to improve nowcast performance. The new rules attempt to tailor the use of predictor fields, membership functions, and weights to better predict thunderstorms based on the synoptic environment. The forecasters have control over which set of forecast logic is used to generate nowcasts in real-time. This paper will highlight the engineering and scientific improvements to the ANC achieved during the FOTL demonstration. Increases in forecaster interaction with the system and performance improvements resulting from tuning the fuzzy logic rules for synoptic regimes will be examined.

2.3
Operational multi-sensor nowcasting of severe convective storms in the Swiss Alpine area

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For the automatic detection, tracking and analysis of intense convective cells MeteoSwiss uses operationally the real-time nowcasting system TRT (Thunderstorms Radar Tracking), as part of its severe thunderstorms nowcasting and short-term warning facility. The presentation will focus on the current version of the TRT system including the latest operational improvements in the hail products, and show first preliminary results from two new projects that can be included into TRT.TRT is a multi-sensor system that uses volumetric reflectivity data of multi-radar composites (mosaic) to analyse the 3D storm structure and compute severe weather attributes based on heuristic and centroid-methods, as well as cloud-to-ground lightning flashes. Gridded fields and cell-based attributes of individual storms like e.g. VIL, Echo Tops, altitude of maximum reflectivity, hail probability, are computed every 5min and are available in real-time to the forecasters as 2D animations and time series. TRT was used in real-time during MAP D-PHASE (a FDP of the WWRP of WMO) and was available to end-users on the project visualisation platform. A “cell severity ranking” product, developed and tested for MAP D-PHASE, was introduced operationally to find and highlight the most dangerous and strongest storms based on their severity. It includes also the computation of a 60 minutes position forecast, based on the motion of individual cells. The uncertainty of the expected position is taken into account increasing the area of the forecasted cell proportionally to the spread (standard deviation) of the velocity vectors from the last three 5min time steps. The cell ranking is successfully used by forecasters and allows them to focus on the most severe cells maintaining situational awareness and to speed-up the decision process of thunderstorms warnings.The latest operational improvement in TRT is the computation of the estimated probability of hail of any size, as well as the maximum expected hail size. These products are based on the difference between the altitude of the Echo Tops at 45 and 51 dBZ, and the freezing level, determined from the high-resolution, nonhydrostatic NWP model for the Alpine region COSMO-2.
For a future improvement of the TRT-system we plan to include the results of two initiating international projects. The first will develop an improved extrapolation technique that combines Lagrangian persistence of radar precipitation fields with orographic forcing in complex orography. This information can be used to extend the lead-time of the nowcasting warnings. The second aims to merge severe convection predictors, retrieved from satellites, with the properties of evolving thunderstorms. The satellite based anticipation of convection initiation will be available in form of continuously updated probability maps. This will allow it to improve nowcasting, combining satellite information during the whole thunderstorm cycle, from early detection until dissipation, with the TRT system and to better characterise the different phases of a convective storm.

P1.15
A Bayesian Hierarchical Particle Filter model for storm cell motion forecasting

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A new storm motion forecasting method is proposed that uses a particle filter concept within a Bayesian Hierarchical framework to better predict nonlinear cell motion. The motion of individual cells is predicted using a spatio-temporal model within which the cells are characterized by as having mass, parameterized by maximum radar reflectivity, and are allowed to interact with one another. The model is based on Euler-Lagrangian dynamics and uses a Markov Chain Monte Carlo (MCMC)) based particle filter to assess dynamic state and parameter estimation. This estimation is completed by finding the Bayesian posterior distribution of state locations and model parameters. There are opportunities within the parameterization to utilize additional information such as wind velocity. Tests were conducted on selected cases featuring both linear and nonlinear motion of convective cells where interaction between those cells may or may not be evident. Results show that the scheme is capable of predicting storm cells moving both linearly and nonlinearly while allowing one cell to affect the motion of its neighbors.

P1.16
Quality Control of Aircraft Moisture Soundings

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The growing availability of moisture observations from Tropospheric Airborne Meteorological Data Report (TAMDAR) and Water Vapor Sensing System (WVSS-II) sensors installed on commercial aircraft and the ability to rapidly assimilate them into numerical weather prediction models such as the Local Analysis and Prediction System (LAPS) and the Rapid Refresh (RR next generation RUC) provides forecasters with a greatly improved severe weather nowcasting capability. All observing systems, including these, are subject to systematic and random errors. Characterization of systematic errors is a necessary precondition for effective data assimilation, but even mature observing systems such as radiosondes have systematic errors that have largely gone undetected until recently. The detection of random errors is even more difficult unless independent observations with high precision and comparable accuracy are available. This presentation describes a technique to assess the accuracy of aircraft moisture soundings in near real-time. The technique was developed to assess the accuracy of Radiosonde Replacement System moisture soundings made by GPS radiosondes for the U.S. National Weather Service. The method integrates the (calculated or measured) mixing ratio during aircraft ascent or decent and compares it with a Global Navigation Satellite System (GNSS) estimate of total precipitable water vapor made at a

technique of TREC, and storm locations in the next hour are provided.These algorithms have been applied in the B08FDP. It is found that more than 1500 storms are identified and the mean absolute errors in the X-axis and Y-axis for 30-minute storm forecast are about 7 and 6 kilometers respectively. With the increase of forecast length, the mean absolute errors of the storm product become larger, and the X-axis error is greater than that in the Y-axis.

P1.14
A composite approach of radar echo extrapolation based on radar-derived vectors in combination with model-predicted winds

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Extending the lead time of precipitation forecast is vital to operational heavy rainfall warning. Usually an approach for rainfall nowcast that utilizes radar motion vectors to extrapolate radar-observed precipitation echoes provides a relatively poor skill if the lead time is beyond 30 min. This is because the derived radar vectors, i.e., the TREC (Tracking Radar Echo by Correlation) winds, represent only the instant trend of precipitation echo motion. For a longer lead time, the effect that background air flow exerts on echo movement is of importance. In this paper, an extrapolation architecture that extended forecast lead time up to 3 hours was developed to fuse radar-derived motion vectors with model-predicted winds. The TREC vector fields were derived from radar reflectivity patterns over the 3-km CAPPI (Constant Altitude Plan Position Indicator) mosaics through cross correlation technique. The background steering winds were provided by the analyses or predictions of the rapid update assimilation model CHAF (Cycle of Hourly Assimilation and Forecast). A similarity index was designed to determine the level on which model winds were applied to the extrapolation process via a comparison between model winds and radar vectors. Verification showed that the introduction of background steering air flow in the extrapolation provided considerable gain in prediction skill, compared to the radar-only extrapolation technique, in a summer rainfall case that was investigated.

2.4
Thunderstorm risk monitoring service

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The SIGnificant weather Object Oriented Nowcasting System (SIGOONS) is based on a scheme combining forecaster's expertise and observation data advanced automated processing ; it is an object oriented system for detection and forecasting significant phenomena at a few hours range. Downstream, SIGOONS feed warnings automated generation. Today, SIGOONS manages thunderstorms only. SIGOONS development follows two streams:

- Operating a "fully automated" SIGOONS to produce thunderstorm risk warnings, in order to demonstrate the capability of warnings service for Météo-France customers at the short nowcasting range. At this stage of automation, warnings are limited to a range of one hour
- Ensure interaction feasibility and efficiency to match forecaster's expertise on thunderstorms forecasting, for improving warnings timeliness, intensity and location.

The 2009 SIGOONS schedule was populated by the marketing of the thunderstorms warnings service named "Thunderstorm risk monitoring service" and by experiments with the seven regional forecasting services in real-time to assess adding expert value to warnings. Beyond, the goals are to operate thunderstorms expertise routinely using SIGOONS, to improve automation in thunderstorms description using new radar data (3D, doppler, polarization data) and mesoscale numerical weather prediction data, to introduce a probabilistic description of warnings location and intensity, and to manage another phenomena, namely the strong wind events.

2.5
A Decision-support System for Winter Weather Maintenance of Roads, Bridges, and Runways

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Maintaining control of snow/ice buildup on roadway surfaces during winter storms is challenging for road maintenance entities. Some of the more critical challenges include making effective and efficient decisions for treatment types, timing of treatments, and location of greatest impact to the roadway based on precipitation rates/types and other weather conditions. These decisions are critical because of the implications to roadway safety, as well as economic impacts to the agency and the environmental impacts of treatments. In order to mitigate the challenges associated with winter road maintenance, the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA) initiated the development of the Maintenance Decision Support System (MDSS) in 2001. MDSS provides a single platform, which blends existing road and weather data sources with numerical weather and road condition models in order to provide a display of the diagnostic and prognostic state of the atmosphere and roadway (with emphasis on the 1- to 48-hour time period) as well as a decision-support tool for roadway maintenance treatment options. In the past, the system has been used mainly for strategic purposes 12-24 hours prior to a storm's arrival in order to prepare the maintenance vehicles and schedule personnel. However, during the 2008–2009 winter season, MDSS has been modified and applied for use over Denver International Airport (DIA), including all six runways and the main arterials leading into the airport. The users at DIA want to utilize MDSS for strategic decision-making but also have a need for a more accurate tactical (0-6 hours) component to the system. Currently, MDSS uses three numerical weather models, model output statistics from two models, and various pavement and weather–related surface observations in order to generate both weather and road surface forecasts. In order to address the short-term forecasting needs, radar data assimilation and/or high resolution mesoscale numerical weather models are being assessed for possible inclusion into MDSS. Additionally, a non-wintertime MDSS is also being developed that may also require the addition of other nowcasting capabilities, such as lightning data and radar storm-tracking (e.g. TITAN).The objective of this presentation is to provide an overview of the present and future capabilities of the MDSS system as they relate to the diagnoses and short-term forecasting of weather that may impact the roadway/runway maintenance operations for various decision-makers.

2.6
The forecaster role in operational Nowcasting over complex terrain

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Nowcasting addresses not only "severe weather" events, but more and more all kinds of significant weather changes at local level impacting people and goods. Many weather related decisions with economic and life protection consequences are very often deterministic, therefore requiring a high accuracy and a great time/space resolution. These requirements are mostly satisfied only at 0-3 hour time range. Particularly in complex terrain like the Alps, operational forecasters are under stress dealing with strong meteorological gradients observed both in space and time. These are usually poor resolved by numerical models, therefore heuristic nowcasting techniques are necessary. Depending from the parameter or weather phenomena gridded or object approaches are better suitable. For heavy thunderstorms the object techniques have demonstrated great capability, but the early phase is usually missed. For road maintenance weather a gridded approach is mostly better suited, like the snow limit altitude. A blending of the results of the two approaches is mostly left to the forecaster. The rapid updating of the data, typically 5 minutes, represents a challenge for the humans, because most of the time there is no relevant or significant change. So the early phase of the significant change can be easily missed, loosing precious time. To cope with this problem a high degree of automation has to be introduced. This should assure a very high probability of detection (POD) of significant, relevant changes. The experience shows that the side effect is an also high false alarm ratio (FAR), unacceptable for the end users. The role of

P1.12
The Design and Implementation of B08FDP Data Support System

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For 2008 Olympic weather service, there were eight nowcasting systems operated in B08FDP (WWRP/Beijing 2008 Forecast Demonstration Project). In this paper the data environment requirement from the B08FDP participants has been analyzed, which includes data acquisition, transmission, dissemination, monitoring and the data formats. Within the given domain of the mesoscale observation network, a GPS timer was setup to synchronize the data acquisition and computer timer. The File Alteration Monitor (FAM) system based on the inotify (a Linux kernel subsystem that provides file system event notification) was used to guarantee the data transmission timeliness and the realtime synchronization technology for Doppler radars was used on the Doppler radar operation. For supplying a common data interface for all FDP participants, XML, NetCDF that conformed to the international rule has been setup for all systems. For a better support to very short range forecasting systems, the Hi-MAPS (High-resolution Mesoscale data Acquiring and Pre-processing System) was developed and operated in Beijing Meteorological Bureau. It showed that it has been running successfully and can provide an efficient data environment for B08FDP participants throughout the demonstration period.

P1.13
Storm Series Algorithms in the GRAPES-SWIFT

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The storm series algorithms in the SWIFT, including storm cell identification, storm convection assessment, storm tracking and storm position forecast, are discussed. Storm cell identification algorithm tests the intensity and continuity of the objective echoes by multiple-prescribed thresholds to build 3-D storms.It uses multiple reflectivity thresholds, newly designs the techniques of cell nucleus extraction and close-spaced storms processing, and therefore is capable of identifying embedded cells in multi-cellular storms. The strong area components at a long distance are saved as 2-D storms.By using the fuzzy logic technique, a convection index of a storm is obtained. A set of features of storm morphology are combined to describe convective characteristics of storm cells, and every feature is given a weight. The likelihood values that the features match with the convective characteristics of storm cells are calculated in the fuzzy logic engine. The convection index is the weighted average of all the likelihood values, and signs the convective strength of a storm instantly. Storm cells identified in two consecutive volume scan are associated temporally to determine the cell tracking. The distance between the centroid of each cell detected in the current volume scan and each of the first-guess location is calculated to check distance correlation. Those similar storms with distance correlation are matched.The motion vector for each storm is computed by using the implementation of the methods and approaches suitable for forecasting and verification of the RCM performance for fine-scales at road stations/ stretches. The applicability of results related to the improved quality of detailed forecasts at road stretches will: (1) Facilitate the use of data from the road stretch forecasting to automatic adjustment of control of the dosage spread by salting spreaders, i.e. for optimization of the amount of salt spreaded over the road surface to prevent the icing/freezing as well as better timing of schedule for such operations by the road authorities; (2) Lead to improvement of the overall safety of the road traffic in winter weather; (3) Contribute to further development and improvement of the visualization tools for the road stretches forecasting; (4) and Reduce the environmental impact in the road surroundings due to an optimized spreading of the salt.

P1.11
Influences of different soil moisture conditions upon South Atlantic convergence zone associated precipitation forecasting performed by a regional model

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Brazil south and southeast regions suffer periods of intense rainfall, generally associated to South Atlantic Convergence Zone (SACZ) during austral summer, which causes serious problems to the inhabitants. The objective of this work was to study the influence of soil moisture initial conditions in SACZ position and associated rainfall intensity. This study was carried out through simulations with model BRAMS (Regional Atmospheric Modeling System with Brazilian Developments) during a SACZ episode. In order to evaluate the model performance a statistical analysis was performed. The model positioned SACZ southwestward of observations and tended to overestimate precipitation. Comparing simulations with horizontally homogeneous and heterogeneous initial soil moisture, we concluded that the first simulation showed higher accuracy on ocean than the latter. For Amazon region, the best model performance was to heterogeneous soil moisture. Without surface-atmosphere interaction the system was not well marked, so this interaction plays an important role in SACZ formation. The best model performance is provide occurrence/nonoccurrence of rain than predict and locate more intense rainfall nuclei. We pretend, in future stages, to verify the role that sea surface temperature in South Atlantic plays in SACZ and analyze differences between simulated SACZ during El Niño and La Niña periods.

the forecaster is therefore to reduce the FAR to a reasonable value, without a significant change in the POD. Usually such systems are designed for an availability of all input data as well as failure proof computer hard- and software. The real world includes all kind of possible failure and the forecaster has to cope with them, particularly when issuing weather warning. The change in the forecaster role often generates some fears to loose the control in the forecasting process. Adequate training and coaching in difficult situations should help to mitigate such a fear.The presentation will show some concrete examples with existing operational systems, as well as some work in progress and outlook on that topic at MeteoSwiss.

2.7
Experiences from Nowcasting Convective Storms for the Beijing Olympics: Future Nowcasting Implications

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A Forecast Demonstration Project (B08FDP) took place during the summer of 2008 that included the period of the summer Olympic Games in Beijing China. This demonstration was sanctioned by the World Meteorological Organization World Weather Research Program. The focus was on forecasting convective storms for the nowcasting time period (0-6 hours). The demonstration included state-of-the-art forecast systems from Beijing, Hong Kong, Australia, Canada and the United States.The metropolitan area of Beijing is on a flat plain located at the foot of a mountain range, Yan Shan Mountain, that extends west and north of the city. Beijing is at an altitude of only 30 m and is open to the south and east to the influx of very warm moist air. Significant forecast challenges present themselves in the vicinity of Beijing in response to this very humid air impinging on the nearby mountains. Thunderstorms frequently initiate over the mountains and move towards Beijing. Sometimes these storms dissipate on reaching the foothills and other times grow and organizing into major squall lines. A variety of boundary layer convergence lines frequent the plains and play a significant role in storm initiation and evolution.Initiation and dissipation in close proximity to Beijing meant that radar echo extrapolation techniques were often unreliable. Very short period numerical model forecasts were not well suited to predicting the convective storms since they were strongly influenced by local terrain. However, at the same time, the human forecaster who had a good understanding of local influences and experiences with high resolution data sets showed skill in nowcasting these events. This includes past experiences in studying the movement of convective storms from the mountains to the plains and the initiation of storms by localized boundary layer convergence lines. Examples of thunderstorm initiation and evolution will be shown for a variety of forecasting challenges that occurred during the B08FDP. Based on B08FDP experience implications for development of future nowcasting systems will be presented.

2.8
A Proposed Strategy for the Environment Canada Nowcasting Program

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In March 2003, the Meteorological Service of Canada initiated a five-year restructuring program in order to modernize the observation networks and to establish a sustainable organization. The transition program included the consolidation of forecasting operations into five major centres in order to produce a more efficient and effective forecasting program. It was also supposed to allow greater emphasis on the provision of specialized weather information to weather-sensitive communities, including the agriculture, aviation, forestry, marine, transportation and tourism communities. The role of the human operational forecaster was expected to be increasingly focused on short-term forecasts of high impact and severe weather while longer term weather forecasting was expected to be largely automated through the application of numerical weather prediction forecast models. A white paper developed in 2008 for the Meteorological Service of Canada reiterated these goals, while also advocating the evolution of the forecaster role towards greater emphasis on contributing to the decision making processes for clients. The Environment Canada research program was tasked with developing a comprehensive research and development strategy for nowcasting that would support the achievement of the goals listed above.

During the development of a research and development strategy for nowcasting, numerous implicit definitions, assumptions and questions were identified that needed to be defined, challenged and answered respectively. For example, what is the definition of nowcasting? What does automated mean with respect to human oversight? What can and cannot be automated? Are NWP models capable of providing fully automated output products at 12 hours, day 1, day 3, etc.? Can forecasters provide decision support for clients without having undertaken analysis, diagnosis and prognosis? Is the role of the operational forecaster changing with respect to the provision of watches and warnings and short term forecasts of high impact weather? What is the difference between severe weather and high impact weather? Can consensus within the department be achieved with respect to the resolution of these ideas?

A nowcasting strategy is much broader than the research and development program alone because it will impact on the entire prediction program. Consequently a nowcasting research strategy includes the requirement for significant coordination, cooperation and collaboration between monitoring, research, development, implementation, prediction-operations, performance measurement, informatics technology, client services and the clients. The nowcasting component must be seamlessly integrated into the overall prediction program. There must be an effective and rapid technology transfer system that allows advances in monitoring, research or development to impact on the prediction program and the clients.

The preliminary results of this exercise include recommendations on the following:

parameterized physical processes suggests that the subtle balance between the various processes is achieved. This study also shows that the fog evolution depends on the turbulent exchange coefficients, the single scatter albedo of cloud droplets, the condition of cloud droplet activation, and the sedimentation velocity.

P1.10
Fine-Scale Road Stretch Forecasting

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The DMI has in collaboration with the Danish Road Directorate (DRD) for almost two decades used a Road Condition Model (RCM) system (based on a dense road observations network and the numerical weather prediction model - HIgh Resolution Limited Area Model, HIRLAM) to provide operational forecasts of main road conditions at selected road stations of the Danish road network. Presently there are about 350 road stations (equipped in total with more than 400 sensors), where measurements and forecasts of road surface temperature, air and dew point temperatures are provided for the end users. Forecasts of other important meteorological parameters such as cloud cover and precipitations as well as radar and satellite images are also distributed to the users through the web-based interface vejvejr.dk and through DMI and DRD web-pages. For icing conditions, new technology has made it easy to vary the dose of spreaded salt, making it possible to use salt only on the parts of the road network where it is really needed. Measurements of road surface temperature from road stations and salt spreaders have additionally been used to examine both road stations and road stretches (among 17000 points along the Danish road network) forecasts. These results have underlined critical importance of detailed characteristics of road stretches themselves as well as their surroundings. In other words: if you want to make local forecasts in a specific point you need all possible local information.   Until now the description of the physiographic conditions in the used RCM system is at a relatively low resolution. Since the high resolution models running at faster supercomputers as well as detailed physiographic datasets now are available, it provides possibility to improve the modelling and parameterization of significant physical processes influencing the formation of the slippery road conditions and their operational forecasting. First of all, it is based on a new dataset available from Kort og Matrikel styrelsen, the so-called Danish Height Model (Danmarks Højdemodel) which now allows access to details of the topography with a precision and high resolution much better than in previous datasets, and to take into account the shadowing effects when forecasting the road surface temperature.   The main aim of this study is to research, develop, and improve the quality of the road condition forecasts by refining, setting up, and running the fine-scale resolution numerical weather prediction model with integration (from high resolution databases) of characteristics and derived parameters of land-use, terrain, positioning and road properties at road stations/ stretches. The main objectives include: (1) Research and development of the existing RCM based on input from a fine-scale numerical weather prediction modelling; (2) Analysis and integration of detailed data and derived parameters at road stations/stretches into the RCM based on available detailed Danish datasets on terrain, GPS positioning, land-use, and road properties; and (3) Elaboration, testing, evaluation, and

P1.8
A numerical Case Study on the Evolution of Hail Cloud and the Three-Dimensional Structure of Supercell

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Using the high resolution mesoscale numerical model WRF (Weather Research and Forecast), this paper simulated a severe hailstorm which occurred in Beijing on 31 May 2005. The simulated precipitation, moving path of the hail cloud are all accordance with the observation fairly well. Characters of mesoscales are also successfully reproduced, for example, low trough at the bottom of the cold vortex, a warm and humid tongue at the lower layer, and the topographic flow convergence line as well. It is worth to mention that we also simulated the evolution and the cell structure of a long-lived hailstorm, which is very similar with that of being observed by a doppler radar in Beijing. It bears many features common to the conception model of supercellar, involving the bounded weak echo area, one giant pair of slantwise updraft and downdraft, the splitting and right moving, etc.This paper also analyzes the supercells three-dimension structure on dynamics and thermodynamics, based on the numerical results combined with the observation of radar. Special attentions have been paid on the unique characteristics of the hailstorm occurred in Beijing, and the possible reasons leading to the long-life of supercell. Key words: cloud ensemble model, hailstorm, supercell, severe convection

P1.9
Sensitivity Analysis of Radiation Fog Under Different Synoptic Conditions

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This study gives a survey on the use of analyze design for what-if analysis, including sensitivity analysis and validation, in nudging simulation for radiation fog from the formation to the dissipation. The study is divided into two phases. The first phase is a pilot stage, which consist of employing maximum data collected (temperature, humidity, and wind velocity) as possible to search for the important factor among the turbulence, the radiation, and the microphysics for radiation fog simulation; The second phase use the remained data (LWC, visibility, and cloud droplet size spectrum) for model validation. So special attention is given to the detailed and complete simulations and validation technique used is to compare the simulated results using one-dimensional version of the three-dimensional computational fluid dynamical model Mercure Saturne with one of the best collected in situ data during the ParisFog campaign. The validation results will be employed a statistical study of radiation fog events in forecasting mode over a long-time period later. The comparison between the simulated and the observed visibility, in the single-column model case-study, shows that the evolution of fog is properly simulated. The analysis of the behavior of the different

- The requirement to explicitly outline a clear science-based vision of the future end-to-end forecast production system;
- A definition of nowcasting as the precise skilled prediction in time and space of a high impact (including severe) weather or environmental element starting from time zero (pre-detection or detection) and extending out to approximately 6 hours;
- The role of the human operational forecaster should be to undertake a thorough analysis, diagnosis and prognosis of the weather in order to add value to nowcasts and forecasts of severe and high impact weather elements;
- In Canada the nowcasting program should be primarily tied to the severe weather warning program;
- Advances in future forecasting and nowcasting techniques should be based on scientifically sound and clearly demonstrated objective performance metrics from which the value added to the clients of any method or technique (including human-based methods) is measured and evaluated;
- Reexamination of some existing nowcasting and forecasting methods in the department to evaluate whether they are entirely effective or whether they optimize the human-machine mix;
- Establish clearer identification of the clients and their decision processes with respect to the influence of weather predictions;
- The development of significantly deeper linkages between the research program and the monitoring, informatics technology, client services and development programs in order to develop or improve common visions and rapid technical transfer mechanisms;
- The development of deeper connections and a common vision of nowcasting within the research program itself, specifically between groups that focus on observational-based and NWP-based studies.

A common vision based in part on these recommendations would lead to a nowcasting strategy for Environment Canada, which would require a comprehensive research and development strategy to support it. Some key elements of this research and development program will be presented.

2.9
iCAST: a Protoype Thunderstorm Nowcasting System Focused on Optimization of the Human-Machine Mix

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Cloud Physics and Severe Weather Research Section, Environment Canada

A prototype thunderstorm nowcasting system, tentatively named iCAST (interactive Convective Analysis and Storm Tracking), is being developed at Environment Canada with an emphasis on optimizing the ‘human-machine mix’. The prototype aims to build on the strengths of the human forecaster in the thunderstorm nowcasting process while making the best use of machine computing capabilities. iCAST is being prototyped on a platform

developed at Environment Canada called Aurora. Aurora is an object-oriented conceptual modeling system that allows forecaster interaction with graphical objects such as grids, areas, lines, points, and time links. Aurora also ingests NWP (currently the Canadian GEM and US RUC models), high-resolution satellite data, radar data (Canadian and US), surface station observations, and lightning network data.iCAST employs a three-stage approach to nowcasting. First, NWP model output, past weather, current observations, and conceptual models are used to generate a mesoscale prognosis for the T+6 time frame. The forecaster identifies and creates objects for both synoptic-scale features (such as fronts and jets) and mesoscale features (such as lake-breeze fronts and outflow boundaries). In addition, the forecaster identifies areas where convection may be expected to occur at that time.Next, mesoscale analyses are performed hourly by the forecaster to verify the existence and locations of the mesoscale features using mainly observations, but also some NWP guidance. The forecaster must use pattern recognition and conceptual models to build a coherent depiction of the weather, despite any missing or conflicting data.Lastly, once thunderstorms are present or imminent, storm-scale nowcasting is undertaken. A TITAN-based radar cell identification and tracking algorithm is used and storm cells are priority ranked. The forecaster may use conceptual models, analyzed/nowcast mesoscale feature information, current observations, and NWP model output to modify cell tracks and convective trends for the highest priority storms.In the prototype phase, iCAST will help to assess the value of human input to the convective nowcast problem via an automated verification process. In addition, we will test whether a semi-automated warning generation interface leads to more efficient and effective warning generation.It is anticipated that successful components of the iCAST prototype will be proposed for transfer to Environment Canada's national forecaster workstation presently under development (NinJo).iCAST will be used in a real-time, operational setting during the summer of 2009 via a Research Support Desk at the Ontario Storm Prediction Centre in Toronto. Preliminary results will be presented at the symposium.

2.10
A Role for the Forecaster in Improving Convection Initiation Nowcasts: Operational Methodology and Validation of Approach

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The U.S. National Weather Service has been supporting the deployment of the NCAR very short term thunderstorm nowcasting system (the Auto-Nowcaster or ANC) at the Ft. Worth/Dallas Texas weather forecast office (FWD WFO) for the past 5 years as part of the Forecaster-Over-the-Loop (FOTL) demonstration project. Because of the dearth of sufficient real-time operational datasets it is difficult for automated algorithms to routinely detect the total spatial extent of local and mesoscale convergence boundaries such as gust fronts, cold fronts, and drylines that trigger new convection. The forecaster plays an important role in the production of 1 h thunderstorm nowcasts by entering the location of convergence features into the ANC system using forecaster-interactive tools recently added to the NWS AWIPS display. Approval for deployment of the AWIPS-ANC system at NWS offices across the country will depend on the value-added performance when the forecaster is involved in the

P1.6
Variationally based nowcasting utilizing radar reflectivities

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A nowcasting system for generation of short-range precipitation forecasts has been developed at the Swedish Meteorological and Hydrological Institute (SMHI). The methodology consists in utilizing a time-series of radar reflectivity composites for deriving an advection field, which will give a better representation of the motion of the precipitation pattern compared to a model wind field. The advection field is derived applying 4-dimensional variational data assimilation scheme. The resulting field is then used for a semi Lagrangean advection of the latest available reflectivity field forward in time. During the forecast, the advected field is gradually replaced by an NWP forecast in order to include the onset of convection and advection into the radar coverage area. Results demonstrating the functionality of the methodology will be presented. Validation of the results show that the amplitude, structure and location of the precipitation patterns are significantly improved as compared to a short range forecast from the operational forecast model used at SMHI.

P1.7
Circulation detection and tracking with Doppler velocity derivatives

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Azimuthal and radial shear fields are extracted from single-Doppler radial velocity data using a two-dimensional, local, linear least-squares technique. The presentation shows how these fields may be applied to detect and assess the properties of storm-scale rotation with different types of radars, including 10-cm WSR-88D, 3-cm CASA radars, and high temporal resolution Phased Array Radar.We illustrate that this method of calculating the shear properties of a radial velocity field has several practical uses. Since radial velocity fields cannot be easily visualized in three-dimensional space, the scalar azimuthal and radial shear derivatives provide a useful tool for viewing velocity-derived fields that are not radar-relative. These derived quantities may also be easily integrated into a multi-radar mosaic field or used by multi-radar, multi-sensor algorithms. Clustering techniques are employed to isolate and track features of significance and to analyze statistical properties and trends of associated data fields such as gate-to-gate velocity difference, convergence into the circulation and depth of the circulation. Through analysis of many such circulations, a probabilistic nowcast of the future behavior of an analyzed circulation may be generated.

Very short-time quantitative precipitation forecasting using X-band polarimetric radar is proposed. The method includes C-band conventional radar as complementary data. Inland flooding tends to occur more frequently in urban areas due to the large proportion of impervious surfaces, and flooding in such areas is of considerable public concern. Due to the rapid response of rivers and drainage infrastructure in urban areas, quantitative precipitation forecasting is required in order to realize timely flood prediction. However, as the X-band has a relatively short observation range and is affected by strong signal attenuation under heavy rainfall, X-band alone are insufficient for nowcasting. In the proposed method, X-band polarimetric radar provides highly accurate rainfall data, and real-time corrected C-band conventional radar provides the gap filling data. The results of the method are demonstrated to accord well with rain-gauge data and superior to a conventional radar rainfall. The accuracy of the proposed method is also comparable to the method whithc is corrected using a high-density rain-gauge network in near real-time. The nowcasting experiments were conducted using the conventional radar rainfall and the radar rainfall based on the proposed method. The results showed that the method can improved rainfall nowcasting.

P1.5
Heuristic probabilistic nowcasting of orographic precipitation

Urs Germann
MeteoSwiss

A tool for nowcasting orographic precipitation in the Lago Maggiore region in Southern Switzerland, excluding isolated convection cases, is currently being developed at MeteoSwiss. High-quality precipitation and Doppler wind radar estimates, as well as other observational data, are used. Probabilities to exceed precise thresholds of rain rates in defined time periods within specific mountainous catchments are produced. 58 heavy orographic rainfall events occurred from 2004 to 2008 in the Lago Maggiore region, corresponding to 106 days of rain, are taken into account. Significant dynamic and thermodynamic parameters (predictors) are estimated in real-time; rain rates measured in the 106-days data set in correspondence with the values of the predictors most similar to those estimated in real-time lead to the final probabilities.In order to find the most significant predictors, a preliminary investigation of the mesoscale features of the heavy precipitation events was performed by means of statistical analyses. A strong relation between the upstream flow, air mass stability and heavy precipitation in the mountains was found. This analysis highlighted that the orographic forcing gives repeatability to the rainfall patterns typically observed in the region with certain environmental conditions, and thus it can be exploited for nowcasting orographic precipitation.

process. Categorical skill scores have been calculated to evaluate the performance of the Autonowcaster 1 h nowcasts over the large FWD domain with and without the forecaster involved in the nowcast process, particularly in the production of the convection initiation nowcasts. The resulting categorical or dichotomous performance metrics (e.g., POD, FAR, CSI) indicate that some improvement occurs when the forecaster is involved, but it is typically difficult to discern significant improvement in skill scores, when the statistics are calculated for the entire FWD domain. This is due to the disproportionately large number of extrapolation forecasts that overwhelm and dominate the performance statistics and mask any appreciable improvements in skill arising from the convection initiation nowcasts which occur less frequently. An alternative approach has been taken to validate FOTL performance, by sub-dividing the FWD domain into smaller domains that are more relevant to the scale of the phenomena being forecast (convection initiation) and to the scale or horizontal resolution of the ANC nowcasts as well. Computing categorical skill scores on these sub-domains, results show that the forecaster plays an important role in significantly improving the performance and accuracy of convection initiation nowcasts. This paper will document the operational methodology of the forecaster with the AWIPS-ANC system, highlight the real-time, nowcast verification plots available to the forecaster on AWIPS, and present results of the FOTL nowcast performance for several different days over the past 4 years by rendering the sub-domain categorical statistics on single performance diagrams after Taylor (2001).

SESSION 3: NWP, Ensembles and Assimilation

3.1
Integrated assimilation of radar, satellite, and METAR cloud data for initial hydrometeor/divergence fields to improve hourly updated short-range forecasts from the RUC, Rapid Refresh, and HRRR

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A radar reflectivity assimilation technique and a related generalized cloud analysis package with both stable and convective cloud modules have been developed and utilized within the both the 13-km Rapid Update Cycle (RUC) and Rapid Refresh (RR) regional assimilation systems. This package is applied within both the real-time RUC and RR testing, and also used to initialize the 3-km hourly updated High-Resolution Rapid Refresh (HRRR) nest (see Weygandt et al. at this Symposium). Within the operational RUC 3DVAR analysis, the cloud analysis package utilizes GOES satellite derived cloud top pressure and temperature data, as well as surface METAR cloud and visibility information. An effective method to assimilate radar reflectivity data was added into the operational RUC at NCEP on 17 Nov 2008. Within the Rapid Refresh system (currently in real-time testing at ESRL/GSD as a planned replacement for RUC in 2010), the cloud analysis has been integrated into the Gridpoint Statistical Interpolation (GSI) analysis software. In the presentation, we will illustrate the integrated effects on assimilation of these different observational data sets on both stable and convective cloud/precipitation systems in both the RUC and RR (and subsequent effect initializing the nested 3km HRRR). The radar reflectivity assimilation via a diabatic digital filter initialization uses estimated hydrometeors only indirectly (via a Z-R relationship), in contrast with the stable cloud initialization in which hydrometeors (and water vapor mixing ratio) are directly specified. There is, however, a common QC treatment, with radar reflectivity data checked against satellite data for spatial consistency, satellite cloud data checked for ambiguity issues, and METAR observations (ceilometer with limited vertical range) also checked against satellite cloud data for consistency.Within both the RUC and Rapid Refresh experimental forecast cycles, additional data sets, including lightning and satellite-derived integrated liquid water path products, are also being tested.The integrated assimilation of these observations is critical for improvements to very short-range forecasting, the theme of the symposium.

3.2
Data assimilation for a 1.5 km grid length version of the unified model, for short range forecasting of convective precipitation

Susan P Ballard, Zhihong Li, David Simonin, Mark Dixon, Helen Buttery,
Graeme Kelly, Catherine Gaffard, Owen Cox and Humphrey W Lean
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The Met Office is developing a high resolution (1.5km) NWP system for nowcasting and short range forecasting. Hourly cycling 3D-Var and 4D-Var systems have been set up and the use of more frequent conventional and remote sensing observations are being investigated. Work is underway on asssimilation of radar radial doppler winds and radar derived precipitation rates as well as work to exploit radar reflectivity data and MSG imagery data. Results will be shown comparing the different data assimilation methods and the impact of the different observation types - principally on forecasts of convection over southern England.

3.3
Data Assimilation Issues Related to Very Short-Range Forecasts of Precipitation with the Operational Convection-Permitting Model COSMO-DE

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Mainly for very short-range forecasting of convective precipitation, the convection permitting NWP model COSMO-DE has been developed and is run operationally at DWD with a horizontal mesh width of 2.8 km. The model's prognostic treatment of precipitation allows for accounting horizontal drift of precipitate. To initialize convective events, radar-derived surface precipitation rates are assimilated by means of a latent heat nudging (LHN) scheme. Using a conventional formulation of LHN designed for larger-scale models with diagnostic treatment of precipitation resulted in a strong overestimation of precipitation during LHN and in the first 2 hours of the forecast, when it was applied to the setup of COSMO-DE. In such a setup, surface precipitation rate and vertically integrated latent heat release are far less correlated horizontally and temporally, and this violates the basic assumption of LHN. Therefore, several revisions to the original version of the LHN scheme have been developed in order to re-enhance this correlation and thereby decrease precipitation during the assimilation and

Using the multiple Doppler radar analysis data obtained in the radar network, we are trying to develop a real-time assimilation system for a short-range (up to 2 hours) forecast of severe weather. In this study, a 3DVAR assimilation procedure Doppler velocity and precipitable water derived from GPS were developed in cloud-resolving storm simulator (CReSS). A severe storm observed in 15 July 2006 and 5 Aug 2008 in X-Net were simulated using the CReSS-3DVAR. The RMSE of velocity at a height of 1 km was 0.2 m/s in 3DVAR system.

P1.3
High resolution Regional Model (HRM) performance in now casting and very short range forecasting in Pakistan

Ata HUSSAIN
[Pakistan Meteorological Department]

Owing to the complexity of the dynamics of the South Asian Summer Monsoon (June-September), the prediction of monsoon weather systems and associated extreme weather events have always been very challenging to the meteorologists of South Asian countries. Although, Pakistan receives about 150 mm during the summer monsoon season (which is 50% of the annual rainfall), seasonal weather prediction as well as the day-to-day weather forecasting during this season have always been exigent. Pakistan Meteorological Department (PMD) has been making use of various tools and techniques for weather forecasting in Pakistan. In the recent years, PMD has implemented the High resolution Regional Model (HRM) of DWD (the national meteorological service of Germany) as an operational model for numerical weather prediction in Pakistan. The initial and later boundary conditions for HRM are taken from DWDs global model GME with the multilayer soil model. The model is run with the resolution of 22 Km. In this study, the performance of HRM has been examined for very short range forecasting. The model has been found to be a very useful tool and a valuable addition in the forecasting practices of PMD. Different extreme weather events at various locations in Pakistan as predicted by the HRM have been looked at and compared with the observed weather conditions. The weather events in addition to others include the rainfall events at Multan (a major city about 500 km south of Islamabad) and Islamabad on 4th July, 2005 and 5th August 2006 respectively, wide spread rainfall on 10th February, 2007, a hailstorm at Islamabad on 10th January, 2008, and tropical cyclones of Gonu and Yemyin which formed over the North Arabian Sea during June, 2007. It has been found that spatial and temporal distributions of predicted weather conditions may vary from the observed events. Some times, the variations are quite significant. In some cases, however, the model has captured the events very well especially, the hailstorm event at Islamabad and the tropical cyclone Yemyin.

P1.4
Very short-time quantitative precipitation forecasting using X-band polarimetric radar and C-band conventional radar

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POSTER SESSION 1

P1.1
Assimilation of dual-polorimetric radar observations and its impact on short-term rainfall forecast of two convective systems

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Doppler Radar observation can provide detailed information for mesoscale structures of convective systems with a high spatial and time resolution. It is shown that assimilation of radar data can improve forecasts of convective storms. Studies also show that radar data assimilation still remains a challenging problem partly due to the uncertainties in radar observations. Dual-polarimetric radars typically transmit both horizontally and vertically polarized radio wave pulses. Owing to the additional information, the dual-polarimetric radars are able to determine the type, shape, and size of hydrometeors with a better accuracy. With the forthcoming dual-polarimetric capabilities of the U.S. NEXRAD radar system (set to become installed beginning now ~ 2010), the time is upon us to begin understanding how the polarimetric data can improve forecast initialization. Very little previous research has been done on assimilating these fields, describing microphysical precipitation information, as derived from dual-polarimetric observations. Our main goal in this study is to develop the methodology to assimilate the polarimetric radar data, hence to improve the skill of short-term quantitative precipitation forecasts. The WRF model and its 3DVAR data assimilation system are used in our work. The polarimetric data from the ARMOR radar (located at Huntsville International Airport (34.6804°N, 86.7743ºW)) is used in our study. We will present our recent work on assimilating the ARMOR data for two convective storms, a squall line case on Mar 15, 2008 and Tropical Storm Fay on Aug 25 2008. Details of the methodology of data assimilation for the two storms will be presented in the conference. We will also discuss the influences of each radar variable on model initial condition and their impacts on the short-term prediction of precipitation.

P1.2
Development of radar data assimilation using 3DVAR in X-Net: radar network

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[1] National Research Institute for Earth Science and Disaster Prevention [2] Chuo University

The National Research Institute for Earth Science and Disaster Prevention (NIED) in Japan developed a multi-parameter (MP) radar at the X-band wavelength (MP-X) for hydrological and meteorological application. We designed a real-time radar network (X-Net) consisting of multiple MP radars and Doppler radars over Kanto Plain, Japan. A cooperative observation in the radar network (a MP radar and a Doppler radar) has been started from July in 2006. By the warm season in 2008, 2 MP radars and 3 Doppler radars are operated in the network.

reduce spin down effects early in the forecast. With the revised LHN, the precipiation patterns agree well with the radar observations during the assimilation. The strong positive impact, however, decreases rapidly during the first few hours of the forecast. One factor contributing to this limitation of the benefit is model bias. The capability of the model to simulate convective events explicitly is restricted, and the mean diurnal cycle of predicted convective precipitation is severely underestimated. This capability depends above all on the physical parameterisations used in the model but also on the interaction of the parameterisations with the model state provided by the assimilation process. Spin-up effects often occur when the mean state obtained from assimilating (even unbiased) observations disagrees with the model climate, i.e. the mean state resulting after longer-term free forecasts. However, it is not always easy to discriminate between the spin-up effects and biases in the model climate. Experiments are underway to better discriminate between these two, to quantify biases and to indicate reasons for the spin-up. This could eventually help to adjust the assimilation process, e.g. by application of bias corrections to observation data, such that spinup effects are alleviated and forecasts especially in the time range of nowcasting are improved.

3.4
Numerical weather prediction and machine learning in operational short-term wind power forecasting

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To integrate variable power generation sources, such as wind energy, into the electric grid economically and reliably, the power output needs to be predicted on short time scales from minutes to hours ahead. In particular, the rapid changes in wind power generation need to be anticipated to allow utilities and grid operators to appropriately manage reserve electric capacity and the transmission system. State-of-the-art operational methods for short-term wind power forecasting are rooted in both auto-regressive statistical models and supervised machine learning techniques (e.g., neural networks) using predictors from both on-site data and nearby (off-site) meteorological observations. Numerical weather prediction output is sometimes used directly as further input variables to the statistical models, or it is blended with the statistical model output with weights that increase with the forecast horizon. Adaptive methods for predictor selection are employed using information theoretic techniques. Since model performance varies with the weather regime and the power generation characteristics, further accuracy can be obtained using adaptive regime-switching methodologies. Typical skill scores for the one-hour forecast horizon range from 5% to 25% relative to the root-mean-squared error of a persistence benchmark forecast.

3.5
A real-time radar wind data QC and analysis system for nowcast application

Qin Xu [1], Kang Nai [2], Li Wei [2], Pengfei Zhang [2], Qingyun Zhao [3] and P. R. Harasti [3]
[1] NOAA/National Severe Storms Laboratory, USA, [2] CIMMS, University of Oklahoma, USA, [3] Naval Research Laboratory, USA

A real-time radar wind analysis system has been developed for monitoring low-level wind conditions at high (up to 2 km) spatial and (5-10 min) temporal resolution. The system has capabilities to integrate multi-sensor observations to produce real-time vector wind field. In additional to WSR-88D radar level II data and Oklahoma Mesonet data, real-time NPN (NOAA Profiler Network) data are also ingested into the system to improve the accuracy of retrieved wind field and derived products. This system can display the retrieved horizontal vector wind field at each selected vertical level or on each conical surface of radar scans synchronized and overlapped with real-time reflectivity and/or Doppler velocity fields from the radar. The real-time wind products have been displayed on NSSL/WDSS-II ORPG and made available to NWS Norman Forecast Office. The early version of the system was delivered to the Pacific Northwest National Laboratory to provide the very needed real-time radar wind retrieval capability to derive high-resolution emergency response dispersion models for homeland security applications. The system's data quality control package was also tested and adopted at NRL Monterey for radar data assimilation and nowcast applications. The key technical elements developed in the system for the radar data quality control and wind retrieval will be presented with illustrative examples at the workshop.

3.6
Data Assimilation of Hydrometeor Types Estimated from the Polarimetric Radar Observation

[1] Kosei YAMAGUCHI [2] Eiichi NAKAKITA [3] Yasuhiko SUMIDA
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It is important for 0-6 hour nowcasting to provide for a high-quality initial condition in a meso-scale atmospheric model by a data assimilation of several observation data. The polarimetric radar data is expected to be assimilated into the forecast model, because the radar has a possibility of measurements of the types, the shapes, and the size distributions of hydrometeors. Its information is useful for the estimation of the cloud microphysical state by the data assimilation. In this study, an impact on rainfall prediction of the data assimilation of hydrometeor types (i.e. raindrop, graupel, snowflake, etc.) is evaluated. The observed information of hydrometeor types is estimated using the fuzzy logic algorism (Nakakita et al., 2008). As an implementation, the cloud-resolving nonhydrostatic atmospheric model, CReSS (Tsuboki and Sakakibara, 2002), which has detail microphysical processes, is employed as a forecast model. The local ensemble transform Kalman filter, LETKF (Hunt et al., 2007), is used as a data assimilation method, which uses an ensemble of short-term forecasts to estimate the flow-dependent background error covariance required in data assimilation. A heavy rainfall event occurred in Okinawa in 2008 is chosen as an application. As a result, the rainfall prediction accuracy in the assimilation case of both hydrometeor types and the Doppler velocity and the radar echo is improved by a comparison of the no assimilation case. The effects on rainfall prediction of the assimilation of hydrometeor types appear in longer prediction lead time compared with the effects of the assimilation of radar echo only.

8.10
Detection and monitoring of Convective clouds by satellite

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Meteo-France develops, in the SAF NWC framework, a tool for the detection and tracking of thunderstorm from satellite imagery. This tool, known as RDT , is particularly useful in areas without radar network for monitoring thunderstorm. Meteo-France implements it on MSG (Europe and West Africa) and on GOES (Caribbean Area) to address multiple needs: research on the African monsoon, meteorological support on ocean areas, meteorological support for the French armed forces. The identification of convective clouds (or discrimination) is a mix between a statistical approach and empirical rules. It has been adapted to the cloud development stage, with a different decision model tuning for the following three stages : Development (before lightning occurrence for low clouds) Intermediate (triggering of flashes and quick vertical development) Mature (anvil spread, and overshoot). Most aspects of the discrimination are separately tuned for each phase : the choice of input parameters and whether they are time-averaged or instantaneous, and their respective weights. For instance, the cloud top temperature instantaneous change rate is a discriminating parameter for development stage but not for mature stage, and inversely for the GCD index (defined as the difference between brightness temperatures in water vapor and infrared channels).The following scores are achieved for summer period over Europe using only satellite data. For each cloud track, periods of significant, somewhat continuous, electrical activity are considered, and called electrical intervals. More than 70 % of electrical intervals are detected by RDT. Among it, more than 50% are detected no later than the first lightning occurrence, more than 80% 30 minutes after. 25% of electrical interval are discriminated at least 15 minutes before the first lightning occurrence.The developments undertaken for the year to come have for main objective to improve the diagnosis earliness, in order to extract satellite information for a development stage which is not well described by radar networks.

8.9
THE GOES-R SATELLITE PROVING GROUND: NOWCASTING APPLICATIONS AND RESULTS FROM THE 2009 HAZARDOUS WEATHER TESTBED EXPERIMENTAL FORECAST AND WARNING DEMONSTRATION

[1] Steven Goodman and James Gurka [2] Timothy Schmit [3] Mark DeMaria and Daniel Lindsey [4] Wayne Feltz, Scott Bachmeier and Kris Bedka [5] Steven Miller [6] Eric Bruning [7] Gary Jedlovec and Richard Blakeslee
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The key mission of the GOES-R Satellite Proving Ground is to demonstrate new satellite observing data, products and capabilities in the operational environment to be ready on Day 1 to use the Geostationary Operational Environmental Satellite (GOES-R) suite of measurements. Algorithms, tools, and techniques must be tested, validated, and assessed by end users for their utility before they are finalized and incorporated into forecast operations. The GOES-R Proving Ground proxy data for the 16-channel Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) focus on evaluating how the infusion of the new technology, algorithms, decision aids, or tailored products integrate with other available tools in the hands of the forecaster responsible for issuing forecasts and warning products. Proxy fields and products for ABI are derived from simulated mesoscale model data and satellite sensors such as the Earth Observing System (EOS) Terra/Aqua MODIS and Meteosat SEVERI. The GLM proxy data are derived from the EOS Lightning Imaging Sensor and available ground-based lightning VHF mapping networks. Additionally, the testing concept fosters operation and development staff interactions which will improve training materials and support documentation development. Initial assessments of ABI and GLM proxy products - Convective Initiation, Statistical Severe Weather Forecast, Total Lightning Density and Trends - for severe storm warning and forecasting provided to NWS forecasters during the 2009 Hazardous Weather Testbed Spring Experimental Forecast and Warning Program during the period April 27-June 10 will be discussed.

3.7
Developing an Ensemble Kalman Filter for Improving High-resolution Data Assimilation and Forecasting at NRL

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An ensemble Kalman Filter (EnKF) data assimilation system is under development at the Naval Research Laboratory (NRL) to provide initial conditions for the US Navy's nowcast and ensemble forecasts to address some uncertainties in the prediction of some high-impact weather events. One of the objectives of developing such a system is to improve the assimilation of high-resolution sensor data, especially those from radar and satellite, into the Navy's Coupled Ocean/Atmospheric Mesoscale Forecast System (COAMPS) to improve the short-term and very-short-term prediction of some mesoscale and storm-scale high-impact weather. With the calculation of flow-dependent background error covariance, which is critical at small scales where the large-scale geostrophic balance is no longer useful, the EnKF can better estimate the state of some severe storms with appropriate storm intensity and structures in the model initial fields than the three-dimensional variational (3dVar) data assimilation system that uses a static background error covariance. Currently, some satellite products have been assimilated into the EnKF along with the large-scale conventional observations. Radar data assimilation capability is also being added to the system. An algorithm has been developed to improve the computational efficiency of the EnKF in a distributed parallel computational environment using MPI. The adaptive time-expanded sampling technique developed at the National Severe Storms Laboratory (NSSL) will also be adopted and tested to enlarge the ensemble size without increasing the computational cost for the expensive ensemble integration.

3.8
UK Met Office Operational NWP capability at Convective Scale

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In December 2006 a forecasting system with 1.5 Km gridlength was put in production to complement existing NWP guidance, particularly in severe weather situations. Limitations in computing power meant that the configuration was restricted in several aspects: a) The model was requested by the Chief Forecaster rather than run in a routine fashion; b) Initial conditions were provided by interpolation of 4 Km model data without any Data Assimilation; c) the spatial coverage of the UK was achieved by selecting one out of nine pre-defined domains; d) forecast length was constrained to 18 hours. Despite these shortcomings the system has proved to be a very valuable forecasting tool, adding detail to standard NWP guidance particularly in severe weather situations, and it has been used regularly, with scope

and flexibility expanded during its life cycle.With the procurement of the next generation high performance computing system the convective scale capability is expanded to provide coverage of the whole UK with forecast lengths of at least 24 hrs. 4 times per day. This configuration is to be implemented in June 2009 and eventually will replace the current high resolution, 4 Km gridlength, operational and the 1.5 Km On-demand models. The new system will be nested in the regional, 12 Km gridlength, NAE model using a stretched grid from 4 Km to 1.5 Km to avoid numerical problems arising from a high nesting ratio and to keep the transition area, where the convective showers spin up from parametrised convection at the boundaries to resolved convection, away from the region of interest at an affordable computational cost. Initial conditions will be provided by a continuous Data Assimilation 3D-VAR system with either three hours or hourly update cycle.This presentation covers the description of both systems, results during pre-operational tests and production, and plans for future development.

3.9
Overview of the Rapid Update Cycle and Rapid Refresh

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The Rapid Update Cycle has served as the "situational awareness" and very short-range numerical weather prediction forecast model at the USA National Oceanic and Atmospheric Administration's National Centers for Environmental Prediction since 1994. Forecasts of 9- or 12h duration are initialized every hour from a 1-h assimilation cycle using a 3dVAR analysis using the previous 1-h forecast as the background. The domain covers the 48 contiguous states of the USA (excluding Alaska and Hawaii). The 3dVAR analysis is tailored to use of in-situ observations from aircraft and from surface station networks, but also includes a variety of frequently-available remotely sensed observations such as profilers, weather radars and GPS zenith wet delay. Because of its rapid updating and its emphasis on careful and thorough use of asynoptic data, the RUC has become the primary source of weather guidance for aviation operations, and is also used extensively by forecasters in the USA responsible for prediction of short-fused, high-impact weather events. A unique feature of the hourly assimilation cycle is a hydrometeor assimilation based on satellite and radar, followed by diabatic initialization of the model initial state through use of a digital filter to provide a measure of dynamical balance between the diabatic heating field and the divergent component of the horizontal wind. This procedure, to be described in a separate talk by Benjamin et al., greatly improves the prediction of precipitating systems during the first few hours of the forecast and greatly mitigating the non-physical adjustment process often seen during the first few hours of NWP forecasts. The Rapid Update Cycle is due to be replaced in NCEP operations by a new system, but with similar functionality as the RUC, in 2010. This new system is called the Rapid Refresh. It will operate on a much larger domain, covering nearly all of North America including Alaska. Further, the present RUC 3dVAR analysis will

channels, ~82 separate indicators that assess cumulus clouds can be formed, 67 derived from the eight infrared channels. Although past research describes how some of the channel, channel differences, and time-trends of channel differences may be used to monitor aspects of growing convective clouds, this work adds to our understanding as various new uses of MSG data are found. Through correlation and principal component analysis, between 15 and 21 infrared interest fields are shown to contain unique information for nowcasting CI at 3 km scales. Data from the 2007 Convective Orographically Induced Precipitation Study (COPS) experiment will be exploited for this effort, with 122 selected CI events analyzed.Other aspects of this talk will focus on how SATCAST CI nowcasts are used within real-time systems that forecast aircraft routing, and arrivals and departures at major U.S. airports. Through research involving the Corridor Integrated Weather Systems (CIWS) we are fortunate to be able to test these improvements within a methodology to nowcast CI. Work already completed shows that GOES information from moving convection has value above that previously used within this system. This presentation will report on our progress and most recent findings. Other transition activities in the NOAA Algorithm Working Group, within Central America, and for EUMETSAT, will be discussed.

8.8
Implementation of the EUMETSAT RDT Algorithm for New York City

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The EUMETSAT Rapidly Developing Thunderstorm (RDT) algorithm detects and tracks thunderstorms. Storm shape and life history is used to identify storms using a single IR window channel. In cooperation with the Meteo-France developers of the algorithm, NOAA-CREST at the City College of New York has modified RDT to work with GOES data and has implemented it using a direct satellite receiver station.Validation is done via the Vaisala National Lightning Detection Network. Tests show that the False Alarm Ratio (FAR) is generally below 10%, but the Probability of Detection (POD) ranges from 40% for warm cloud tops to nearly 100% for cold cloud tops. The horizontal extent of the storm has a much smaller effect on POD and FAR. Increasing the image frequency allows detection of smaller cells.A comparison of RDT to the SatCast algorithm is underway. While RDT uses a single IR channel to detect cloud tower structures and growth, SatCast uses multiple channel thresholds to detect the presence of cold or cooling cloud pixels relative to the water vapor layer. This particular comparison is of interest because the FAA has requested implementation of the SatCast algorithm in the New York area. The main concern is detection of convective cells before radar would indicate precipitation. Lightning data will be used as validation, using RDTs capability to backdate a trajectorys status depending on later indications of convection. Preliminary results of this cross validation study will be presented.

8.6
Progress Toward Satellite-based Atmospheric Turbulence Interest Field Detection

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The University of Wisconsin-Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS) has been conducting research into satellite-based detection of areas the where possibility of atmospheric turbulence is enhanced due to convection, tropopause folds, and/or mountain waves. We have been collaborating with National Center for Atmospheric Research (NCAR) turbulence team, which is responsible for the NOAA Aviation Weather Center (AWC) Graphical Turbulence Guidance (GTG) nowcast product to identify possible areas in which satellite-based turbulence interest fields would provide value added information. This paper will present progress made in deriving satellite-based turbulence interest fields as the GTG moves from CONUS to global coverage forecasts of turbulence.

8.7
Exploiting MSG Infrared and Visible Satellite data for 0-1 hour Convective Initiation Nowcasting

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This presentation will overview the analysis of how to enhance convective initiation (CI) nowcasting (0-1 hour forecasting) using infrared and visible data from the Meteosat Second Generation (MSG) satellite. The CI and lightning initiation (LI) nowcasts are provided by an entirely satellite-based algorithm, so-called SATCAST, as originally developed for use with the Geostationary Operational Environmental Satellite (GOES) series of meteorological satellites. Convective initiation is defined here as a transition from below to above 35 dBZ echoes as observed by radar, while LI is defined as the first occurrence of a flash (cloud-to-cloud, cloud-to-air, cloud-to-ground) within a convective cloud. Use of MSG data provides SATCAST at least a 50% increase in nowcast capability.Analysis focuses on how to utilize data from the 8 3-km resolution infrared channels, three 3-km resolution visible channels, and one high-resolution (1 km) visible channel for describing aspects of growing cumulus clouds. These physical aspects of cumulus clouds include cloud depth/height changes, cloud-top glaciation indicators, and updraft strength determinations. Other goals of this study include: (1) to determine a use of 5-min MSG imagery in CI nowcasting, and (2) evaluating a replacement for the atmospheric motion vector-tracking step in SATCAST; both of these goals are interrelated, and solved through object tracking methods.From the 12 MSG

be replaced by the Gridpoint Statistical Interpolation (GSI) 3dVAR analysis currently used for the North American Mesoscale and Global Forecast System at NCEP. For the RR, the RUC hydrometeor analysis has been added to the GSI, and other modifications to the GSI needed for more effective use of surface and aircraft data are under development (abstract by Devenyi et al in this meeting), including improved quality control using platform-dependent history of observation minus 1-h forecast background differences.A third major change in transitioning to the RR from the RUC will be use of the WRF non-hydrostatic model in place of the current hydrostatic hybrid-sigma-isentropic RUC model. For the initial operational implementation of the RR, the Advanced Research WRF (WRF-ARW) will be the forecast model. A DFI capability in the WRF-ARW allows use of the same diabatic initialization procedure as developed for the RUC. This talk is intended as an overview of RR development progress toward the initial 2010 operational implementation, and will describe the configuration of the RR that is currently in testing at the Earth System Research Lab of NOAA. Aspects of current performance will be discussed, and examples of recent forecasts will be shown.

3.10
Advanced NWP for Short-Term Wind Power and Precipitation Forecasting

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Weather Decision Technologies, Inc. (WDT), in Norman, Oklahoma, USA, is utilizing and developing several NWP tools for short-term forecasts of wind power and precipitation. The Weather Research and Forecasting (WRF) model is used as the underlying NWP model. WRF is initialized with a wide variety of data, including wind profiler, radar, and satellite radiance. The analysis is performed using the Local Analysis and Prediction System (LAPS), with surface analyses based on the Space-Time Mesoscale Analysis System (STMAS). Four Dimensional Data Assimilation (FDDA) is also employed. For wind power applications, the WRF output is fed into the Uncoupled Surface Layer (USL) model. Developed by NanoWeather, Inc., the USL is a microscale model tuned for each grid point’s surface characteristics and terrain. The result is a high-resolution forecast of winds and temperatures in the lower boundary layer. Forecasts are computed at individual wind turbine hubs at high temporal resolution. Finally, we describe WRF runs in support of Adjustment of Rain from Models with Radar (ARMOR) short-term forecasts of precipitation. As described in the companion paper by DuFran, et al., ARMOR, developed by McGill University, compares past model forecasts and radar mosaics to remove model spatial phase intensity errors.

3.11
Application of a high-resolution, non-hydrostatic limited-area atmospheric model in airport environments

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The demand for efficient, safe, and environmentally sustainable air traffic is steadily increasing. Major airports already today operate at their capacity limits. One of the major contributors to incidents, accidents, and delays in air traffic are adverse weather conditions, also en-route but especially at and around busy airports. Detailed studies of the impact of weather upon aviation show that there is a need for improved weather forecast which is also essential for improved and successful wake vortex forecast in airport environments.In recent years the 'NOwcasting Wake Vortex Impact Variables' model NOWVIV with the MM5 code as the dynamical core has been developed at DLR to forecast weather parameters in airport environments. A systematic comparison of NOWVIV and the COSMO-FRA model which is based on the operational COSMO-DE model of the German Meteorological Service DWD has been done. Both models have been adjusted to the area around Frankfurt airport and were run at resolutions of 2.1 km and 2.8 km. The 24h-forecasts of vertical profiles of runway crosswind, head/tail wind, temperature, and turbulent kinetic energy (TKE) starting at 00 UTC are validated against Wind and Temperature Radar (WTR/RASS) measurements operated by the German Air Navigation Service Provider DFS within a 60 day period during winter 2007. Model and WTR output is provided every 10 minutes.In general it was found that COSMO-FRA predictions were more accurate during the winter period while NOWVIV predictions were advantageous during the fall period. This result is based on the root mean square error (RMSE) statistics of the crosswind (the most important parameter in the context of wake vortex transport) and the false alarm-rate statistics in forecasting different crosswind thresholds. RMS crosswind errors at low levels range between 2 m/s and 2.5 m/s. Both models overestimate the crosswind in a similar manner at all altitudes. Based on the results obtained from this analysis the COSMO model is replacing the MM5 model in the currently developed airport weather prediction system.To further improve the forecasts data gathered within the airport environment such as WTR/RASS and AMDAR data as well as precipitation data from radar will be assimilated into the COSMO-FRA model. Furthermore the model is started hourly in a Rapid Update Cycle (RUC) mode providing very short range time-lagged ensemble forecasts. An improvement especially of the short term forecasts up to 6 h is expected which is very relevant for wake vortex forecast and airport operations. Results of the model intercomparison and the time-lagged ensemble will be presented.

8.4
Evaluation of Different Nowcasting Algorithms using SEVIRI Data

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One of the objectives of the GOES-R Algorithm Intercomparison Test Plan is to objectively intercompare the performance of different nowcasting algorithms under consideration by the Algorithm Working Group (AWG) Hydrologic Algorithm Team (AT) for the implementation on the Advanced Baseline Imager (ABI) onboard GOES-R and the generation of the rainfall potential product (RP). While the version 1 of the Rainfall Potential Product has being tested by the Hydrologic Algorithm Team, this particular study shows the performance of two different nowcasting techniques: KMeans (Lakshmanan, 2003) and ForTrACC (Vila et al, 2008). Several case studies during January, April, July and October 2005 using SEVIRI thermal IR channel (10.8μm) over South America are used to evaluate both techniques. Similarities and differences between both methodologies are discussed in order to assess the validation results.

8.5
MIMIC-TPW: Real-time, hourly total precipitable water imagery over the oceans from advective blending of polar-orbiting microwave satellite retrievals

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We describe a novel data blending technique that combines separate swaths of microwave observations from polar orbiting satellites in order to create near-seamless hourly imagery of total precipitable water (TPW) over the oceans. MIMIC-TPW was originally developed as an experimental, real-time visualization tool utilizing microwave-derived moisture fields to follow the development and progression of cyclone- spawning easterly waves and the cyclone-impeding Saharan Air Layer in the North Atlantic Ocean.The process of advective blending is well suited to the task of tracking TPW, which can normally be treated as a quasi-conservative tracer over time scales of greater than 20 hours. Because the microwave satellite constellation normally retrieves oceanic TPW more frequently than 20 hours, we can use model winds to advect TPW between orbital overpasses with high accuracy. The resulting synthetic image product is much like a composite geostationary image, with only minor artifacts. Animations of sequential images create smooth and coherent depictions of moisture transport that have been promoted by operational weather analysts. We will also discuss the possible application of this technique to other quasi-conservative quantities retrieved by polar orbiting satellites.We will present the method of producing this derived product as well as the results of validation; sensitivity studies; and case studies showing the utility of this product for tropical cyclone forecasting and the tracking of major dust events.

8.2
Clustering, Nowcasting and Data Mining Spatial Grids

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We describe a technique of clustering grid points in an observation field to find self-similar and spatially coherent clusters that meet the traditional understing of what storms are. A hybrid cluster-to-image cost-minimization technique is employed to create a motion field and this motion field is used to create several types of nowcasts including nowcast fields, accumulation forecasts and probabilistic swaths. Scalar features within the geographic and temporal extent of the identified storms are captured. From these storms, geometric, spatial and temporal features can be extracted. These scalar features can then be data mined to answer many types of research questions in an objective, data-driven manner. The entire set of techniques is illustrated on both radar and satellite data, and some examples of the data mining approach are presented.

8.3
Convection Diagnostic and Nowcasting Activities at UW-CIMSS

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UW-CIMSS is actively involved in developing objective products for diagnosing and nowcasting convective storms in geostationary and polar-orbiting satellite imagery. These products include: 1) atmospheric destabilization rate, 2) convective initiation nowcast, 3) overshooting top identification, 4) enhanced-V signature detection. These products have shown to be useful in evaluating: where and when convective storms are likely to form, locations where rapidly vertical cloud growth is occurring, storm severity, aviation turbulence potential, and the likelihood for nearby cloud-to-ground lightning. Imagery and derived products from GOES-12, MSG SEVIRI, MODIS, synthetic GOES-R ABI, CALIPSO, and CloudSat are being used to either produce these convection products or to evaluate product performance. These products are being combined into an end-to-end framework for convection diagnosis and nowcasting that will cover the entire life-cycle of convection from pre-storm to mature storm decay. This presentation will describe current efforts and future plans for satellite-based convection research at UW-CIMSS.

3.12
Translating Ensemble Weather Forecasts into Probabilistic User-Relevant Information

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Weather-related decisions increasingly rely on probabilistic information as a means of assessing the risk of one potential outcome over another. Ensemble forecasting presents one of the key approaches trying to grasp the uncertainty of weather forecasting. Moreover, in the future decision makers will rely on tools that fully integrate weather information into the decision making process. Through these decision support tools, weather information will be translated into impact information.This presentation will highlight the translation of gridded ensemble weather forecasts into probabilistic user-relevant information. Examples will be discussed that relate to the management of air traffic, noise and pollution dispersion, water resources and flooding, and wind energy production. The primary take-home message from these examples will be that weather forecasts have to be tailored with a specific user perspective in mind rather than a one fits all approach, where a standard forecast product gets thrown over the fence and the user has to figure out what to do with it.

3.13
Experiments with a 1.5km gridlength version of the Unified Model for short range forecasting of convective precipitation

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In common with other meteorological centres the Met Office is moving towards using high resolution NWP models for nowcasting and short range forecasting. Of particular interest is application of these models to forecasting convection. We describe experiments with an hourly cycling 1.5km gridlength version of the Met Office Unified Model running over a domain covering the southern half of the UK as a potential nowcasting/short range forecasting system. Although the overall results are very encouraging, some problems with the models representation of convection remain. The effect of several aspects of the model configuration including turbulence and convective parameterisations on the representation of convection and its initiation will be discussssed.

3.14
A WRF-based rapid updating cycling forecast system of BMB and its performance during the summer and Olympic Games 2008

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A real-time rapid updated cycling forecast system (BJ-RUC) based on WRF model and WRFVAR data assimilation system was built in BMB with the primary goal to improve the short-range forecasts and support the weather service for the XXIX Olympic Games held in Beijing, 2008. A preliminary evaluation was performed for the operational forecasts of BJ-RUC system during the summer season from June to September of 2008 including the Olympic and Paralympic Games period. The forecast quality for precipitation and conventional variables of the system were evaluated against AWS and conventional observations. In addition, two strong convective cases that occurred during the Olympic Games were examined. As the forecast length was 24 hours, there're 8 comparable forecasts from cycling runs with different initial time in each 3-hr period such as 00-03utc, 03-06utc,…,21-00utc. To give an idea about which run has the best forecast quality for each 3-hr time interval, the forecast performances were evaluated with 3-hr time interval. For all verification thresholds, better precipitation forecast skills were illustrated for the very initial 0-3hr and 0-6hr forecasts. This can be ascribed to the fact that the spin-up problem has been partly better resolved via the rapid updating cycling assimilation style than the cold-start runs. AWS rainfall observations revealed an obvious diurnal cycle of precipitation in Beijing area that most convection occurs in late afternoon and nighttime. All cycling runs were found to be capable of forecasting this diurnal cycle of precipitation whatever their initial time or the valid forecast length. Especially, the best precipitation forecast were in 15-18UTC, and the worst forecasts were in 03-06utc, corresponding to local 21-00BJT and the time at noon, respectively. Herein, the cycling runs initiating from 06, 09, 12 and 15utc and their 0-6 hour short-range precipitation forecasts would be more significant for forecasters to predict the convection occurring at night. For surface forecasts, there was very significant systematic error for 2-m temperature and moisture, while most error of 10-m wind was due to non-systematic error, such as random error, etc. For each identical valid time with 3-hour interval, the analysis of the cycling runs initiating at the current time did have the best quality when comparing with the forecasts from other 7 cycles, especially at 12UTC, the cold-start initial time. There're significant distances between analysis and 3-hr forecast of previous cycles. For cold-start runs initiating from 12UTC, the distance was the largest, that is, the accumulated model forecast errors would have a chance to be reduced to a new low level; for hot-start runs, these distances could be regarded as analysis increments, which modified the error of the background (3-hr forecast of previous cycle) and pushed it toward observations. From this point of view, the data assimilation by WRFVAR was effectively performed. Also for the surface forecast valid at each 3-hour interval, nearly all of the best forecast quality came from the very latest cycle; while other cycles whose forecast range among 6-24 hours had similar forecast skills. So it is found that the positive impacts brought by the assimilation of latest observations would at least last for 6 hours, which was also consistent to the better

SESSION 8: Satellite

8.1
Satellite Nowcasting Applications

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EUMETSAT

Geostationary satellite data with their fast image repeat cycles play a key role for a number of nowcasting applications, e.g. fog detection, monitoring large dust outbreaks, general airmass identification, and tracking of volcanic ash clouds. Satellite images are especially useful to support the nowcasting and short term forecasting of possibly severe convective storms by providing information on the pre-convective air mass conditions, and monitoring the cloud development, especially identifying the convective initiation phase.
The European Meteosat Second Generation (MSG) satellite data with its multi-spectral imagery and 15 minute repeat cycle can well support these aspects of convection forecasting. In order to provide air mass properties with respect to tropospheric stability, a so-called "Global Instability Indices" (GII) product is operationally derived from the MSG imagery data. The GII data is only available for clear skies, i.e. it shows the pre-convective conditions. Once first clouds appear, MSG data can be used to detect the convective initiation (CI) phase of individual cumulus-type clouds. Within a current research project, the already established CI technique for the US GOES satellites is modified and refined using the additional spectral information provided by MSG, and this concept is currently being validated against storm reports, lightning data, and radar observations.
In addition, during the entire life cycle of clouds, their microphysical properties can be retrieved from the multi-spectral satellite data. Although satellite views only provide information on the very cloud top, a time sequence of such parameters, together with their local spatial variability, helps to detect the vigour of such storms.
This presentation will show application examples, for both Europe and Africa, of this suite of products that can be derived from MSG. In the end, an outlook will be given on the future new capabilities of the Meteosat Third Generation suite of satellites, which will provide higher spectral, temporal, and spatial resolution.

7.7
The network of EUMETCast stations in Ukraine as a tool for providing real time meteorological data for forecasters

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Ukraine Hydromet

One of the main the problem of the Ukrainian Hydrometeorological Service is a lack of real time meteorological data for forecasting purposes, because of insufficient meteorological network. The most effective and cheap solution is to install some EUMETCast stations in the different regions of the country. From 2006-2008 EUMETCast stations were installed in the main (Ukrainian Hydrometeorological Center(UHC), Kyiv) and local forecasting centers (Lvov, Odessa and Simferopol) and in the scientific department (Ukrainian HydroMeteorological Insitute (UHMI)). Taking into account that one EUMETCast station can receive a huge amount of satellite data, which is very difficult to proceed and transmit to users in real time, each center is specialized on specific kind of data processing and development satellite products. For example, local forecasting center in Odessa and UHMI is specialized on development of SST, Sea-Ice, Fog and Wind over Sea products, UHC and UHMI are specialized on 5 min Severe Weather product. All local forecasting centers develop their own local severe weather product based on 15 min data, also, because of insufficient radar network in Ukraine. Exchanging of products between different centers based on FTP servers. Our experience shows that satellite data are very useful for nowcasting in summer to detect rapid developing thunderstorms, heavy rains and in winter to detect fog and snowfalls. Some examples of RGB products demonstrate such usefulness of satellite data. One severe weather case close to Lvov on 23 June 2008 is discussed with the details. Mesoscale convective system moved to the city with the speed of 100 km/h and destroyed buildings, trees and even killed people. Satellite RGB products helped to detect it in advance and forecast the time when it came to the city. The warning of local forecasters helped to minimize damages and save human lifes.

precipitation forecast for the very first 0-6 hour for BJ-RUC system. From this point of view, the quality of the short-range numerical forecast was greatly improved.

3.15
Verification of winter weather: Examples of products from the UK

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Winter weather poses many challenges for modelling, observing and, consequently also verification. The advent of high-resolution (in the horizontal and vertical) NWP has meant that aspects such as snow-rain discrimination in the models is improving and local temperature variations are resolved better due to more detailed orography. The advent of high-resolution lagged very-short-range ensemble forecasts also shows potential, especially for precipitation (of all types) as a whole, but also potentially for snow alone (even though this is rare for the UK). Verifying high-resolution NWP, and showing that the forecasts are better than the coarser resolution counterparts, remains a challenge, not least of all because we need good quality observations to do so. In this presentation I will be focussing on February 2009 which was one of the coldest and snowiest in the UK for almost 20 years, leading to huge disruption which affected all sectors of the economy. I will be showing examples of winter weather forecasts that are produced and show
how we verify them. These will include: cloudiness and visibility, aircraft deicing, road conditions, probabilistic forecasts of snow amounts from short-range lagged ensembles and also conventional ensembles.

3.16
Severe weather indices: Adaptation of thresholds to metropolitan region of Säo Paulo, Brazil

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The Metropolitan Region of So Paulo (MRSP), Brazil, is one of the largest urban areas of the world. The routine movement of this complex region can be affected by severe storms events, which occur mostly in summer, causing enormous economic and social impacts, like traffic jam, flash floods and occurrences of fatal victims. Therefore, the purpose of this work was to study the atmospheric thermodynamical characteristics when these phenomena occur, setting up criteria and more appropriate atmospheric parameters, indicating the probability of occurrence of these systems. Diverse instability indices were calculated and analyzed, threshold values and their performance in severe convection forecasting over the region were determined. Taking particularly four indices, Showalter, Lifted Index (LI), CAPE and CINE, we concluded that two of them presented themselves adequate to severe events forecasting in MRSP with the usage of new thresholds. LI presented the best performance between all the indices. The majority of these indices can be useful to assist the severe storms nowcasting in other parts of the world, if a numerical weather prediction is available. Sometimes they just need an adaptation of its thresholds to a specific region, what can be done based on the methodology applied on this study.

3.17
Evaluation of the High Resolution Rapid Refresh (HRRR): an hourly updated convection resolving model utilizing radar reflectivity assimilation from the RUC / RR

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In Sept. 2007, the Global System Division (GSD) at NOAA/ESRL began running an hourly, convection resolving model, driven by the radar reflectivity assimilating Rapid Update Cycle (RUC), over a domain covering the NE U.S. aviation corridor. Known as the High Resolution Rapid Refresh (HRRR), the model utilizes a 3 km horizontal grid spacing configuration of the WRF-ARW model. Model initial conditions are obtained from the hourly cycled Rapid Update Cycle (RUC) model, which has an advanced mesoscale data assimilation system to accurately depict the evolving 3D mesoscale storm environment and a novel radar reflectivity assimilation procedure to specify ongoing precipitation systems. The RUC radar reflectivity assimilation procedure (see Benjamin at al. at this symposium) uses a diabatic digital filter (DFI) initialization to generate storm scale circulations in regions of ongoing convection. This procedure has significantly improved short-range precipitation forecasts (especially for convective systems) in both the RUC and HRRR. This RUC reflectivity assimilation (previously running in GSD parallel RUC cycles) was implemented in the NCEP operational RUC in Dec. 2008 and has been ported to the Rapid Refresh, which will replace the RUC at NCEP in 2010. The HRRR nest will be switched to the radar reflectivity assimilating Rapid Refresh later in 2009. During the summer of 2008, HRRR forecasts initialized from RUC versions with and without the reflectivity assimilation were completed and compared. 3-km reflectivity forecast skill scores were computed, and showed significant improvement for short-range (3-6 h forecasts) for the RUC radar reflectivity assimilating HRRR compared to the HRRR without the RUC radar assimilation. Smaller reflectivity forecast skill improvements extended out to 12-h and, as expected, significant diurnal aspects to the skill improvement were documented. Output from these HRRR forecast were used as input to the Collaborative Storm Prediction for Aviation (CoSPA), an experimental probabilistic convective guidance product produced jointly by ESRL/GSD, NCAR/RAL, and MIT/LL. For the 2009 convective season, the HRRR domain has been expanded to cover most of the eastern 2/3 of the U.S. A more extensive demonstration / evaluation of its utility in providing convective storm guidance for aviation (in conjunction with CoSPA) and other applications (severe weather) is planned. In addition, work is nearly complete to begin creating a probabilistic thunderstorm guidance product from time-lagged ensemble output from the HRRR (see Alexander et al. at this Symposium). HRRR forecasts have continued in the cold seasons as well, and informal evaluation of HRRR forecast skill for mesoscale features (precipitation bands, lake effect snow, and terrain-related surface fields) is ongoing. At the symposium, we

7.6
Evolution of NWS Storm-based Warnings, Part I: NSSL's Experiments in Probabilistic Hazard Information (PHI)

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Recently, the United States National Weather Service (NWS) improved warning services for severe convective weather (hail, wind, and tornado) by transitioning from county-based to storm-based warning services and verification. This improvement has led to more geographically specific warnings that are intended to focus the area of threat. While this polygon approach is a significant step improving severe weather warning services, further improvements are possible. Although the warning areas are being refined, the geopolitical boundaries are sometimes still apparent in the polygon shapes for various reasons. Variable updates to polygons also lead to inequitable lead times for downstream locations – points in the downstream portions of new warning polygons have greater lead time relative to the upstream portions. In addition, the threat information conveyed in today's warning polygons is monotonic, as each location within the polygon is under the exact same threat for the exact same time, along with an assumed 100% certainty of the threat.The National Severe Storms Laboratory (NSSL) has designed a new approach in delivering severe convective weather hazard information which offers more specific information that can be adapted to the spectrum of users' exposure and response time to the hazards. This model is seen as the next step toward a future "Warn-On-Forecast" concept in which storm type and behavior statistics and numerical ensemble models will be used to help create probabilistic guidance about severe weather threats in time frames beyond today's typical NWS warning lead-times (approximately 10-15 minutes). This technique provides hazard information on a high temporal and spatial resolution digital grid which is rapidly refreshed as the storms move and evolve. Forecasters "over-the-loop" define initial threat areas, motion, and motion uncertainty, and then provide updates to the hazard information when needed. This method easily lends itself to the inclusion of uncertainty information to the hazard grids. This can be particularly useful for users who are at higher risk to hazards and who may require action at lower thresholds and longer lead times than those offered by current NWS warnings. This Probabilistic Hazard Information (PHI) grid can be used to generate a wide variety of useful information and user-specific threat products, including warning swaths over a time period, meaningful information on time of arrival and departure for any location within the warned area, and spatial and temporal expressions of hazard uncertainty. The concept was evaluated within the NOAA Hazardous Weather Testbed in Norman, OK, by visiting NWS and Environment Canada forecasters. The forecasters had the opportunity to issue probabilistic hazard grids during real-time severe weather events across the continental United States.

7.5
An Operational Perspective for Evaluating Convective Nowcasts for Aviation

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The modeling community, when evaluating their own products, often find ways to increase standard categorical skill scores (CSI, Bias, POD, etc.) when presenting results. In addition, they may find ways to tune their models to score the best for specific high impact events while allowing lower impact events to score poorly. In the operational realm, forecasts must be reliable for more than a few select cases and have to exhibit skill beyond information obtained from categorical skill scores. As the United States is moving toward automated air traffic decision tools (NextGen), evaluating forecasts for potential operational use is key. Air traffic management, current or future, needs convective nowcasts (0-6 h) for information on how to best route traffic between aviation centers, sectors, and jetways. Current and future operational air traffic management needs focus on how to best supplement (or replace) the current operation standard, the coarse Collaborative Convective Forecast Product (CCFP). Finer scale products (i.e. simulated reflectivity from models) have to be evaluated for additional information, namely value added by increasing structural information and increasing temporal resolution. Structure can be quantified by examining bias behavior of this fine scale forecast or by providing information on the convective objects or clusters of objects within and outside of the broad-scale operational standard forecast. Additional structural information comes from evaluating the porosity of sectors when overlaid with convective objects for the assessment of potential reductions in air traffic capacity. Value added by increasing the temporal resolution of forecasts can be evaluated by a planning point evaluation of all forecasts covering a valid range of time. In this evaluation, all lead times from a forecast are assessed from forecast initial time until a point beyond the valid time of the final lead using all observations present in that valid range. A key to all of these evaluations is being able to stratify all days from a study period into different degrees of air traffic impact which is made possible from a normalized air traffic impact score. Other important stratifications involve the delineation of significant and non-significant convection. This study will detail the approaches outlined above and provide examples for sample nowcasts being evaluated for future use in air traffic management.

will provide an overview of the HRRR, illustrating the impact of the RUC reflectivity assimilation procedure on HRRR forecast skill and show real-time results from 2008 and 2009.

3.18
Initialization of hydrometeors and its impact on very short range NWP

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A series of modeling experiments using high resolution NWP model with explicit cloud scheme are conducted to investigate the impact of initialization of hydrometeor variables on the 0-6 hour prediction of precipitation and circulation for selected severe weather cases. It is shown that the initial fields of hydrometeors are not so crucial to the prediction longer than 1hour as expected. In contrast, the initial water vapor plays more important role for the model usually produces the clouds during a rather short period in the area where the humidity and vertical motion are favorable for the formation of clouds and precipitation. The assignment of initial hydrometeors such as cloud water, cloud ice, rain and snow et al may positively contribute to the predictions in 1-6 hours only when they are consistent with the concurrent moisture and dynamical fields. If the moisture is not properly initialized to support the maintenance of the clouds, the evaporation of hydrometeors will result in a circulation opposite to the right one degrading the prediction. Base on the results stated above, an initialization scheme which ensures the consistency of cloud hydrometeors, moisture and dynamic fields is proposed.

3.19
Merging of radar-based ensemble nowcasts of precipitation with NWP forecasts applying image morphing

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The Finnish Meteorological Institute has derived operational radar based nowcasts of precipitation up to lead times of 3-5 hours during the last 10 years. The method applies modified correlation based atmospheric motion vectors (AMV) originally provided by EUMETSAT for the movement of satellite based cloud patterns but adjusted for radar data at FMI. Composite reflectivity fields from 8 radars with time intervals of 5 minutes are used as the input to the AMV system. That generates a smooth vector field of movement from which inverse trajectory field is calculated. Inaccuracies in the speed and direction of each trajectory define elliptic source areas inside which 51 ensemble members are picked to represent alternative nowcasts for each grid point and lead time.The predictability of radar based nowcasts varies approximately between 0.5-6 hours depending on the growth and decay of precipitating weather systems and on the quality of the derived trajectory field to represent actual movement of precipitating areas. The present operational forecasting process “jumps” abruptly from the radar-based nowcasts to NWP-based precipitation fields typically at around

lead time moment of 3-4 hours from the latest radar measurement. As the high resolution NWP applies 4D variational assimilation and as the model is initialized every 6 hours, the time elapsed from the initial moment in NWP based VSRF is typically 7-12 hours. Especially in convective cases, the discrepancy between the two forecasts can be substantial. Meteorologists can perform manual interpolation of the nowcast products to avoid striking disagreement between the NWP- and radar-based precipitation forecasts.In order to guarantee a smooth and automatic transition from radar-based precipitation nowcasts to NWP forecasts we have tested a morphing algorithm. Assuming linear transformation between the precipitation pattern from the radar nowcast and the pattern from the NWP-based VSRF, it utilizes the transformation field between them to produce smooth transition during a time period Δt. During the period the radar pattern is transformed to NWP pattern so that the location and size change linearly. This transformation trajectory based interpolation technique yields substantially better results than simple fading between the two forecasts. The computation is performed applying the commercial CineSat software. There is no dynamic-physical forcing in the algorithm but at least it can provide in many cases a smooth transition between radar-based precipitation nowcasts and those from NWP models.

3.20
Assessment of convective forecast uncertainty using high-resolution model ensemble data

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The short-term prediction of convective weather is inherently uncertain owing to the seemingly random nature of the processes that interact to determine the four-dimensional evolution of thunderstorms. The skill of a particular forecast depends on a number of intrinsic (i.e., property of the storm – e.g., storm size) and extrinsic (acting on the storm – e.g., environment) characteristics of the storm and how well they are represented in the numerical weather prediction (NWP) model. Toward improved short-term forecasting of aviation weather hazards, the FAA has funded NOAA-GSD, NCAR-RAL and MIT-LL to develop a short-term forecasting system that utilizes best available techniques for combining nowcasting and NWP to produce a seamless, rapidly updating, 0-8 hour forecast of precipitation intensity, phase and storm top heights (see Dupree et al. abstract for this conference). An important component of this Collaborative Storm Prediction for Aviation (CoSPA) forecast system currently under development is the estimation of forecast uncertainty. In this study we use components of CoSPA including high-resolution observations from MIT-LL and NWP data from the High-Resolution Rapid Refresh (HRRR) run by GSD to predict forecast uncertainty. The availability of a new 12-hour long HRRR forecast every 1 hour can be used to build a time-lagged ensemble that can be compared with observations to assess the forecast uncertainty. In this paper we explore several methods (image processing and statistical data mining techniques) for quantifying forecast uncertainty. A methodology for estimating forecast uncertainty (which can be interpreted as confidence in the forecast) is presented and demonstrated on selected cases from the summers of 2008 and 2009.

7.3
Towards an analysis ensemble for NWP-model verification

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One of the great challenges in verification is the definition of the “truth”. Common verification methods use either observations or analysis fields from a model as reference data. Both methods have their advantages and drawbacks. Observation data are irregularly distributed and lack spatial and sometimes also temporal representativeness. Model analyses on the other hand are not really independent from the verifying model itself. We use the model independent analysis tool VERA (Vienna Enhanced Resolution Analysis) for NWP –model intercomparison. One key problem arises from the availability of a dense data set. Within the WWRP projects D-PHASE and COPS a joint activity has been started to collect GTS and non-GTS data from the national meteorological services in Central Europe for 2007. Data from more than 11.000 stations allow to run the analysis with a spatial resolution of 8 km on an hourly basis. VERA includes a data quality control module which gives a correction proposal for each station every analysis time. All in all this results in 8760 correction proposals for each station as a maximum for the whole year. In a next step a statistical evaluation is performed and finally, the station data are varied randomly within the limits of the correction proposals. As a result we get analysis maps with some information about the sensitivity of the analysis in different regions. In the presentation we will give the current implementation status of the procedure described above.

7.4
Bayesian Procrustes verification of ensemble radar reflectivity nowcasts

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This paper presents a Bayesian Procrustes approach to the verification of multiple spatial forecast fields. The Procrustes fit provides measures of dilation, rotation and translation required to match a forecast of an object to the observed (true) shape of the object. Within the Bayesian framework multiple two-dimensional shapes can be compared to a ‘truth’ image, by firstly obtaining the Full Procrustes Fit that provides an average of the forecasts, and consequently using a Procrustes fit of this average against the truth allows us to evaluate how well the forecasts are performing (verification of the ensemble). The Bayesian framework provides a way to capture variability of the forecasts via calculation of credible sets (confidence intervals). The verification scheme is demonstrated using a limited ensemble of nowcasts of radar reflectivity. However, it is equally applicable to model precipitation fields or other forecast products that are usually presented as discrete areas.

provide guidance on the types of information that can be provided by the different approaches.

7.2
Scientific Assessment and Diagnostic Evaluation of CoSPA 0-8 hour Blended Forecasts

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The NCAR Research Applications Laboratory, MIT Lincoln Laboratory, and NOAA Earth System Research Laboratory are jointly developing a national short-term storm prediction system under sponsorship of the Federal Aviation Administration (FAA) Aviation Weather Research Program (AWRP). This “Collaborative Storm Prediction for Aviation (CoSPA)” product builds upon blending heuristic extrapolation nowcasts with high-resolution numerical weather prediction output to generate a seamless 0 – 8 hour blended forecast. The real-time 0 – 8 hour CoSPA forecasts will be monitored utilizing automated performance assessment metrics that are based on standard statistical scoring and more advanced diagnostics. The focus of this presentation is to show how automated procedures can be used to monitor algorithm performance and provide diagnostic insight. Traditional scores, such as the Probability of Detection (POD), False Alarm Rate (FAR), and Critical Success Index (CSI), provide basic measures of forecast skill, but they do not yield insight to why forecasts may have low skill scores. More advanced techniques, such as the Method for Object-based Diagnostic Evaluation (MODE), which is freely available as part of the Model Evaluation Toolkit (MET), can be used to characterize forecasts and observations with detailed feature-based attributes that yield valuable insight to forecast performance. For example, these advanced attributes may include the distance between forecast and observed storms (i.e., displacement error), and aspect ratio and orientation of storms, among many others more. Thus, one might recognize that low CSI scores were caused by forecasted storms that were offset in location and/or had a totally wrong orientation. The presentation will discuss aspects of both the real-time and off-line scientific assessment of CoSPA forecasts. The emphasis will be on lessons learned utilizing more advanced verification approaches.

3.21
Short-term QPE From Blended Ensemble Model Forecasts and Observations: Implications for Heavy Rainfall Forecasts in Severe Terrain

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For short-term forecasts of imminent flooding during extreme precipitation events in mountainous terrain, accurate and timely quantitative precipitation estimates (QPE) are of great importance. To address this need, several QPE products have been developed. Unfortunately, observing systems including radar and gages are often compromised in regions of severe terrain. due to poor density, maintenance difficulties, and beam blockage. We describe a QPE system that blends rain gage observations with short-term, high-resolution ensemble forecasts in an optimal fashion. Implied in this product is an assumption that the physics packages and high-resolution terrain background in these models can help fill in critical observational gaps in the analysis of precipitation fields. The QPE fields thus produced for an extreme event during the first HMT-West field campaign in winter 2005-6 suggest good performance for at least this one storm; further confirmation awaits similar studies during other episodes. Since assessment of the QPE methodology must of necessity involve quantitative verification, several issues involving verification strategies and suitability of verifying observation sets are vital. These include assessing methods for selecting withheld observations, establishing and simplifying procedures to include ensemble forecasts in probabilistic verification products, developing effective ways to perform verification in catchments and basins, and perhaps most critically choosing metrics that accurately estimate uncertainty of the results of various verification algorithms. We describe some implications of these choices for the QPE methodology describe here as well as for other QPE analyse.

3.22
An Objective Framework for Assimilating Coherent Structures

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Classical formulations of data assimilation, whether sequential, ensemble-based or variational, are amplitude adjustment methods. Such approaches can perform poorly when forecast locations of weather systems are displaced from their observations. Compensating position errors by adjusting amplitudes can produce unacceptably 'distorted' states, adversely affecting analysis, verification and subsequent forecasts. There are many sources of position error. It is non-trivial to decompose position error into constituent sources and yet correcting position errors during assimilation can be essential for operationally predicting strong, localized weather events such as tropical cyclones. We propose a method that accounts for both position and amplitude errors using a variational approach. We show that the objective can be solved for position and amplitude decision variables using stochastic methods, thus corresponding with ensemble data assimilation. We then show that if an Euler-Lagrange approximation is made, can solve the objective nearly as well in two steps. This approach is entirely consistent with contemporary data assimilation practice. In the two-step approach, the first step is field alignment, where the current model state is aligned with observations by adjusting a continuous field of local displacements, subject to certain constraints. The second step is amplitude adjustment, where contemporary assimilation approaches are used. We will then demonstrate several choices of constraints on the displacement field, first starting with fluid-like viscous constraints and then proceeding to a multiscale wavelet representation that allows better balance in the factorization of error into position and amplitude subspaces. Our new data assimilation by field alignment approach does not rely on the detection of storm features, and can be used with sparse station observations, just as easily as with detected features. The two-step approach can be used with any assimilation method in practice; 3DVAR, 4DVAR, and EnKF (and variants). The new method has been implemented with multivariate fields, and extensions to 3D is straightforward. Ancillary benefits to velocimetry for rainfall modeling and wind-from-satellites have also been realized. A new data assimilation system, FAVAR, has been developed to co-exist with using the WRF-VAR system. Demonstrations on storms using OSSEs and identical twins will be shown as a run-up to a live Hurricane DA & Forecasting System at the Atmospheric Sciences Group at MIT.

SESSION 4: Applications or Op Systems

4.1
INCA - A new operational nowcasting system for mountainous areas

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The high-resolution analysis and nowcasting system INCA (Integrated Nowcasting through Comprehensive Analysis) provides 3-D hourly fields of temperature, humidity, and wind, and 2-D fields of cloudiness, precipitation rate, and precipitation type at an update frequency of 15 min. The system operates on a horizontal resolution of 1 km and a vertical resolution of 100-200 m. It combines surface station data, remote sensing data (radar, satellite), forecast fields of numerical weather prediction models, and high-resolution topographic data. In the alpine area, the system provides meteorological input for operational high-resolution flood forecasting and is used for winter road maintenance. INCA employs a new radar/raingauge combination algorithm and includes elevation effects on precipitation using an intensity-dependent parameterization. In temperature analysis and nowcasting the pooling of cold air is parameterized as a function of terrain parameters. Verification results showing the skill of the nowcast compared to a high-resolution NWP model (AROME) are presented and the potential for application of INCA to the 2010 Winter Olympics in the Vancouver/Whistler area is discussed.

6.12
Data mining for thunderstorm nowcast system development

John K. Williams, David A. Ahijevych, Matthias Steiner and Susan Dettling
National Center for Atmospheric Research, Research Applications Laboratory

This paper describes a data mining statistical analysis approach to developing real-time thunderstorm nowcasts for aviation users. While fuzzy logic expert systems are often used to combine observation and NWP model data to form short-range predictions of thunderstorm intensity evolution, evaluating and incorporating new data sources is often a time-intensive manual process, and it is difficult to know whether available information is being used efficiently. A technique called random forests (RFs) provides a means of objectively identifying the potential contribution of candidate predictor variables, along with a method for creating a nowcast logic using a minimal skillful set of predictors. The RF methodology was used to evaluate radar, satellite, lightning, and RUC model data and derived features collected during the summer of 2007 and 2008 over the eastern U.S., including data fields produced by MIT Lincoln Laboratory's Corridor Integrated Weather System (CIWS). The resulting data fusion system produces real-time probabilistic and deterministic nowcasts of thunderstorm intensity (VIP level). Statistical evaluations of the RF-based nowcast's performance are shown and several case studies are analyzed, demonstrating the value of this approach. This research has been funded by the U.S. Federal Aviation Administration to support the development of the Consolidated Storm Prediction for Aviation (CoSPA), which is intended to provide the thunderstorm nowcast capability for the Next Generation Air Transportation System (NextGen).

SESSION 7: Verification and Impacts

7.1
Verification methods for spatial forecasts

Barbara Brown [1] Eric Gilleland [1] David Ahijevych [1] Barbara Casati [2] Beth Ebert [3]
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In recent years, many new methods have been developed to evaluate forecasts that have coherent spatial structures. Several different categories of approaches have been developed, including object- or features-based, scale separation, neighborhood, and field deformation methods. Because the majority of nowcasts (e.g., convective nowcasts based on radar reflectivity) are characterized by identifiable spatial features and structures, the spatial verification methods are appropriate for the evaluation of these products and can provide meaningful information on their quality. Over the last several years, the developers of many of the spatial verification methods have been involved in an intercomparison project that was designed to compare the capabilities of the methods and provide information about how the aspects of performance are measured by each approach. The intercomparison was based on the evaluation of the same set of high-resolution spatial forecasts by each method. In addition, the methods were applied to a set of artificial geometric cases with simple, known forecast errors. This presentation will summarize the results of the intercomparison and

(fingerprint) in the analysis process. In an inverse approach, the fingerprint weighting factors that are gained in the course of the analysis process can be used to evaluate local agreement of forecast models and observations in an innovative way. This is shown for a MM5 field of the August 2005 flooding event in western Austria, Switzerland and Bavaria. The results prove that the VERA fingerprint technique may lead to a significant improvement of analysis quality and that it further facilitates an innovative approach for local model validation.

6.11
Probability density function of visibility and cloud ceiling during snowfall: Application in numerical models for winter nowcasting (0-6hr) visibility and cloud ceiling

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Weather conditions that are associated with winter snow storms affect daily human activities including air and ground transportation by reducing visibility and causing other severe weather phenomena such as blowing snow and heavy snow precipitation. Most of the current numerical weather prediction models are not capable of predicting visibility and cloud ceiling directly, but rely on parameterizations. Normally these parameterizations provide deterministic forecast and subjected to some uncertainties and hence it is sometimes more meaningful to use probability instead of deterministic approach. Using visibility, cloud ceiling and other relevant meteorological parameters such snowfall rate, relative humidity, and temperature measurements obtained during the winters of 2005, 2006 and 2007 at the Centre for Atmospheric Research Experiments (CARE) site, Ontario, Canada , Boudala and Isaac (2009) have derived probability density function (pdf) for visibility and cloud ceiling under varying atmospheric and snowfall conditions. They have shown that both parameters can be parameterized using Inverse Gaussian pdf. In this paper, the development and application of the parameterizations in Global Environmental Multi-scale (GEM) model for probabilistic nowcasting/forecasting of visibility and cloud ceiling will be disused. Some preliminary results using data collected during Canadian Airport Nowcasting (CAN-Now) project will be presented.

4.2
Winter Weather Nowcasting for Aircraft Ground Deicing using the WSDDM, LWE, and Check Time systems

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The Weather Support for Deicing Decision Making (WSDDM) system is an integrated winter weather nowcasting system designed to provide real-time and one hour nowcasts of snowfall and visibility at airport specific locations updated every 5 minutes. The system integrates a variety of weather information, tailors the information for winter storm airport operations, and is designed to be an interactive product on a computer monitor or web display. The product utilizes weather information in the form of WSR-88D radar reflectivity from the National Weather Service, as well as METAR (MÉTéorologique Aviation Régulière) surface weather reports from National Weather Service observers and National Weather Service Automatic Surface Observing Stations (ASOS). A key component of the WSDDM system is the deployment of accurate snowgauges at sites at and around the airport. The WSDDM system utilizes these real-time snowgauges to depict liquid equivalent snowfall rates at and in the region surrounding the airport with a one minute update frequency. The snowgauge sites are typically chosen to be upstream of the predominant storm tracks. Recently, a Liquid Water Equivalent (LWE) system has been developed that provides standalone liquid equivalent precipitation rate every minute on a web site or stand alone display. The Check Time system takes the one minute liquid equivalent precipitation data combined with know deicing fluid performance to automatically determine the expiration time of deicing fluids. Recent improvements to these systems will be presented at the symposium, including an evaluation of their performance over two seasons and plans for deployment during the Vancouver Winter Olympics.

4.3
Operational Frost Nowcasting System Using Satellite Data

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Winter weather conditions in the South and South-eastern Regions of Brazil can cause frost resulting in serious losses, in particular for coffee, wheat and corn crops that are very important to the Brazil economy, which is the world's largest coffee producer, and is world’s third largest exporter of agricultural products. Frost damages these crops very often and usually takes places from May to August. In order for the agricultural community to take preventative measure against possible frost on the agricultural fields and thus minimize losses, reliable short term warning of frost is increasingly important and valuable tool for the farmers. There is no doubt that accurate nowcasting and very short range forecasting are able to provide farmers with vital information about where and when frost is likely to occur. To

reduce damages, it's possible to modify the crops microclimate by different techniques. For instance, short-term forecast of minimum night temperatures is a useful tool for farmers to organize their actions. Accordingly, the aim of this work is to provide a brief description and the results of the operational frost nowcasting system developed in the framework of the Satellite and Environmental Systems Division (DSA) at the Center for Weather Prediction and Climate Studies (CPTEC) of the National Institute for Space Research (INPE) using land-surface temperature product derived from real-time METEOSAT Second Generation (MSG)/Spinning Enhanced Visible and Infrared Imager (SEVIRI) high-rate data every 15 minutes. The frost nowcasting system forecasts night land-surface temperature with a time resolution of one hour and provides information on expected frost conditions up to 12 hours ahead. The validation of the system is performed using data from different automatic weather stations located at Santa Catarina and Paraná estates during the year 2008. Results show that the system allows early warning information about the 2 frost events and also more accurate quantification of the frost impact, contributing to reduce speculations in the economical area and to inspect the agricultural insurance.

4.4
Canadian airport nowcasting project (CAN-Now): Short term forecasts for airports

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The Canadian Airport Nowcasting Project (CAN-Now) is developing an advanced prototype all-season weather forecasting and nowcasting system that can be used at major airports. This system uses numerical model data, pilot reports, ground sensor observations (precipitation, ceiling, visibility, winds, etc) as well as remote sensing (satellite, radar, radiometer) information to provide detailed nowcasts out to approximately 6 hours. The nowcasts, or short term weather forecasts, should allow decision makers at airports such as pilots, dispatchers, de-icing crews, ground personnel or air traffic controllers to make decisions with increased margins of safety and improved efficiency. The system is being developed and tested at Toronto Pearson International Airport (CYYZ) with an eventual aim of adapting the resulting concept and forecasts to other Canadian airports such as Montreal, Calgary and Vancouver. The preliminary displays being tested, which include high glance value situation displays, will be discussed along with initial evaluations. Plans for future work will also be described including finalizing the system products, testing and validating them, and implementing them operationally

6.9
Improved short-term quantitative precipitation forecast combining radar data with a high-resolution NWP model

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Techniques of short term extrapolation have been moderately successful for precipitation nowcasting, but lack the ability to forecast precipitation initiation, growth and decay that are seen in dynamical numerical weather prediction models. Although NWP models provide the best automated guidance beyond 6-12 hours in the future, they are generally less accurate than extrapolation techniques for the first few hours of a forecast due to initialization errors, resolution, and deficiencies in even the best microphysical parameterizations. The Adjustment of Rain from Models with Radar (ARMOR) algorithm was developed at McGill University to combine the latest radar data with a model forecast of precipitation to produce a phase and intensity-corrected forecast with enhanced skill out to six hours.The ARMOR algorithm has been licensed and implemented at Weather Decision Technologies, Inc. WDT uses a high-resolution (10-km horizontal grid spacing with 15-minute temporal resolution) implementation of the Weather Research and Forecast (WRF) model to produce ARMOR forecasts over the contiguous United States. ARMOR combines the WRF15-minute precipitation accumulation with 1 km resolution North American low altitude radar mosaics which are updated every 5 minutes.ARMOR uses the WRF model forecast as the background, taking advantage of the model's ability to replicate mesoscale precipitation patterns that occur over the 0-12 hour time frame. Model spatial phase errors and precipitation intensity correction are derived by comparing the past radar mosaics with the model forecasts over the last hour. Corrections are applied to the WRF model forecast at each time step to produce the ARMOR forecast.This presentation will explain the ARMOR algorithm, provide samples of QPF output along with real-time radar verification and discuss the observed skill of ARMOR compared with other techniques.

6.10
High resolution precipitation analysis and forecast validation over complex terrain using an inverse VERA approach

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Precipitation diagnosis and prognostics over mountainous terrain still poses a challenge due to the complex influence of topography. Both stratiform and convective precipitation usually show patterns that can hardly be resolved by an observation network. Similarly, the data quality control, analysis and modelling of precipitation fields is subject to limitations that arise from the steep gradients which might occur in precipitation fields over mountain regions. In the proposed presentation, the VERA (Vienna Enhanced Resolution Analysis) method is applied to precipitation fields in order to assess its suitability for analysis, nowcasting and model validation purposes. VERA is based on the variational principle and further allows the inclusion of supplemental knowledge of typical patterns of meteorological parameters

6.8
A Comparison of Visibility Measurements obtained during FRAM-S project during freezing fog and warm fog events

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The purpose of this work is to compare the visibilities (Vis) obtained from the five sensors to human-based observations of Vis values to better understand issues related to low visibility conditions. The ground-based observations from the Fog Remote Sensing and Modeling Project in St. John’s (FRAM-S), which took place during April of 2009, were being used for comparisons. The instruments used to measure Vis were 1) the Biral HSS VPF-730 Combined Visibility & Present Weather Sensor, 2) Sentry VIS sensor, 3) Vaisala FD12P present weather sensor, 4) Vaisala PWD12 sensor (two of them), and 5) Belfort Vis sensor. Human-based Vis observations were also available during the project. In the analysis, the measurements of Vis were compared to human-based Vis observations and to each other. In addition, validations were performed estimating Vis from the particle measurements of a) MetOne aerosol sensor (for small wetted aerosols and droplets; 0.3-10 micron), b) DMT Fog Measuring Device (FMD; 2-50 micron), and 3) DMT Ground Cloud Imaging Probe (GCIP; 7.5-900 micron). Results representing various freezing fog, drizzle, and snow conditions will be presented in the talk and probability curves developed earlier based on only FD12P measurements will be discussed. Possible applications of the results will be offered for nowcasting issues.

4.5
Towards the Blending of NWP with Nowcast - Operation Experience in B08FDP

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One of the major advancements achieved in the Beijing 2008 Forecast Demonstration Project (B08FDP), under the World Weather Research Programme of the World Meteorological Organization, was the incorporation of numerical weather prediction (NWP) model outputs in an attempt to extend the nowcast of precipitation and convective storm development beyond the radar extrapolation technique. In several participating nowcasting systems in B08FDP, storm-scale NWP models with horizontal resolution at several kilometres were operated on a real-time basis to simulate the evolution of severe weather systems. Various types of observations from the automatic weather stations, wind profilers, Global Positioning System (GPS), radars and satellites were assimilated in the models in order to better describe the initial conditions and produce more skilful numerical guidance for blending computation. The analyses and short-term forecasts from the NWP models also provided valuable reference to forecasters for their subjective assessment of the potential of convective storm development and related decision making.In this paper, the impact of NWP models in blending with radar nowcast techniques on aspects like quantitative precipitation forecasts (QPF), convective storm development and storm tracking will be discussed. In particular, the phase correction technique adopted in the Hong Kong Observatory nowcasting system to correct the location of model QPF, the methodology to adjust the model rainfall intensity and the blending algorithm to seamlessly merge the radar-based QPF with that from NWP models will be illustrated by cases. By applying the time-lagged ensemble approach to the rapidly updated NWP model forecasts and blending computation, probabilistic precipitation nowcast products were also developed, the performance and potential benefits of which in nowcast applications will be discussed. On the other hand, the Beijing rapid update cycle system (BJ-RUC) based on the Weather Research and Forecasting (WRF) model was developed with the primary goal to improve the very short range forecasts (3-12h) and to support nowcast operation. The application of analyses and forecasts from BJ-RUC including the model output soundings, stability indices and wind shear to predict the evolution of near storm environment will be presented. The experience gained during B08FDP operation will be summarized, and suggestions and views on the future development and application of the NWP products and blending techniques in nowcasting will be presented.

4.6
Evaluation of a hydrometeorological forecast system for the metropolitan area of São Paulo

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A Hydrometeorological Forecast System (HFS) has been implemented for Metropolitan Area of São Paulo (MASP) to mitigate the effects of severe rainfall events. This work shows an evaluation of ARPS high resolution precipitation forecasting and MXPOL rainfall nowcasting over the MASP for the rainy seasons of 2008 and 2009. Significant improvements of ARPS rainfall forecasting have been accomplished by using explicit cloud microphysics. On the other hand, the MXPOL higher sensitivity and polarimetric measurements have increased the leading time on the inset of heavy rainfall convective systems by monitoring boundary layer features associated with local circulation in the MASP.

4.7
Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts

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Since September 2007, ESRL GSD has been running an hourly updated convection-resolving model known as the High Resolution Rapid Refresh (HRRR) (see Weygandt et al. at this symposium). The HRRR uses the hourly updated data assimilation cycle of the Rapid Update Cycle (RUC) model including a highly effective radar reflectivity assimilation procedure (see Benjamin et al. at this symposium). An experimental probabilistic thunderstorm guidance (thunderstorm likelihood) product known as the HRRR convective probabilistic forecast (HCPF) is being developed.For each hourly HRRR initialization, 0-12 hour forecasts are produced with model output available once per hour during the 12 hour integration period. Using staggered lead times from consecutive HRRR forecast cycles, sets of forecasts with the same valid time are constructed as time-lagged ensembles. Model reflectivity and instability fields are used to identify regions of convection among the time-lagged ensemble members. The HCPF is generated using the fraction of total grid points across the ensemble and within specified radii of each grid point that exceed model reflectivity and surface lifted index thresholds (currently lower than +2 °C).Performance of the HCPF (skill and reliability) at various lead times is being optimized by changing the weighted contribution of individual HRRR forecasts and adjusting other parameters including reflectivity thresholds and adjacent grid point radius of influence. Verification of the HCPF is performed using the 4 km National Convective Weather Diagnostic (NCWD) product on an hourly basis. Demonstration and evaluation of HRRR time-lagged ensembles in providing 1-12 hr

6.7
Utilization of frequently-updated mesoscale analysis for thunderstorm nowcasting: an examination of relevant predictors.

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Data from an automated mesoscale objective analysis system updated at 15-min intervals are assessed as part of a diagnostic tool for describing the relevant mesoscale environment around and downstream of ongoing thunderstorms which is relevant for nowcasting the evolution of convective activity within the 120-min range. Following an ingredients-based forecast methodology, the objective is to search for physically meaningful and statistically significant relationships between meteorological parameters obtained from the rapidly-updated mesoscale analysis and trends in radar reflectivity for the evolving thunderstorms. These relationships are evaluated in both qualitative and quantitative ways through a multiple linear regression approach in which the predictand is the change in (the spatially-smoothed field of) reflectivity over distinct time intervals, ranging from 30-min to 120-min. The main atmospheric ingredients examined for generating the predictors include (but are not restricted to): conditional instability, low-level moisture availability, low-level convergence, and deep layer vertical wind shear. A total of eleven convective episodes that occurred over north-central France during the warm season of 2006 are analyzed. The final goal is to expand the resources of the current automated nowcasting system developed at Météo-France by incorporating the capability of predicting storm intensification and decay (in response to non-linear processes) to the already existing capability to nowcast storm position based on linear extrapolation. The results shown here refer to the predictor screening and the goodness of fit and explained variance of the reflectivity in the regression procedure.A considerable case-to-case variability was found in terms of the linear relationship between the atmospheric parameters and the reflectivity trend. Best results were found for slower-moving thunderstorms evolving under weak synoptic forcing, for which the predictors and adjusted equations explained a fairly large part of the variation in the (spatially-smoothed) reflectivity change. Among the selected predictors, moisture convergence, height of the lifting condensation level (LCL) and a combination of CAPE and moisture convergence were the ones with best performance from a univariate standpoint. Interestingly, better results were obtained: (i) when sampling the mesoscale environment at the current location of the convective activity rather then downstream of it; and (ii) for longer nowcast ranges. Our results suggest that the later finding is due to a better representation of the variance of the reflectivity change when stratifying this field in a longer time interval. We also found that having a more frequent cycle of mesoscale analysis (15-min intervals) yields better results in terms of goodness-of-fit when compared to a regular 1hr-spaced analysis. Implications of these preliminary findings to the predictive skill of the procedure are also discussed.

6.6
Impact of local observations on a local numerical fog prediction system

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As poor visibility conditions have a great influence on air traffic, a need exists for accurate, updated fog and low cloud forecasts. COBEL-ISBA, a boundary layer 1D numerical model, has been developed for the very short term forecasting of fog and low clouds. This forecasting system assimilates the information from a local observation system designed to provide details on the state of the surface boundary layer, as well as that of the fog and low cloud layers. We aim to assess the influence of each component of the observation system on the initial conditions and low visibility forecasts. The objective is to obtain a quantitative assessment of the impact on numerical fog forecasts of using reduced (for smaller-sized airports) or enhanced (using a sodar) set of observations. We first used simulated observations, and focused on modeling the atmosphere before fog formation, and then on simulating the life-cycle of fog and low clouds.

convective storm guidance for aviation and other severe weather applications is the focus of this research.

4.8
A proposed integrated weather observing system for nowcasting applications

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In this study, the ground-based surface observations from the Fog Remote Sensing and Modeling Project in St. John’s (FRAM-S), which took place during April of 2009, will be used to develop an integrated weather observing system (IWOS). The instruments that will be used in this system are the Biral HSS VPF-730 Combined Visibility & Present Weather Sensor, Adolf Thies GmbH & Co. KG Laser Precipitation Monitor (LPM), Sentry VIS, YES Inc total precipitation sensor (TPS), Young wind sensor, Vaisala DSC111 and DST111 sensors, and MetOne Inc aerosol/nuclei counter. Present weather conditions e.g. precipitation type and rate, and visibility from the HSS and LPM, Vis from Sentry Vis sensor, precipitation amount and rate from the YES TPS, 16Hz 3D wind measurements from a Young anemometer, surface friction, water phase, water depth, temperature (T), and Relative Humidity (RH) from DSC111 and DST111 sensors will be used in the analysis. Aerosols or small droplets from 0.1 to 10 micron particle size range will also be obtained using the MetOne sensor. These measurements and analysis results representing various freezing fog and drizzle conditions will be presented in the talk. The IWOS can be used for the analysis of current visibility, precipitation, aerosol, fog, and turbulence in support of real time aviation, public, marine, and transportation. It is proposed that the same unit will be deployed during the Vancouver 2010 Olympic and Paralympic Winter Games in British Columbia, Canada.

4.9
Convective storms initiation in Romania

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The paper presents the most common and uncommon ways of convective storms initiation in Romania. Mechanisms like the Blak Sea breeze, lakes and mountains breeze, gust fronts, convective rolls, convergence zones and lines, boundaries intersections are presented, together with the associated conceptual models. A special attention is given to the Black Sea breeze, highlighting the situation when it has a major role in convective initiation vs situations when it is inactive. The data analyzed are based on Doppler radar data archive since 2002, complemented with satellite, ground station data and NWP. The conceptual models are specific for the Romanian topography and mesoscale circulation and are included in the operational forecasting decision.

technical influences like of the domain size and the used deviations have to be considered. The 3D–version will be applied to the Rhine Valley in the Austrian Alps. In this presentation the VERA method and the fingerprint concept will be explained. Some examples for analyses within the Whistler region will be shown as well as first experiments with the 3 - D version.

6.5
Assimilation of surface observations for RUC and Rapid Refresh

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Assimilation of surface observations is of particular importance in an hourly updated assimilation cycle used for very short-range forecasting, as done by the hourly-updated Rapid Update Cycle (RUC). The Rapid Refresh (RR) is a new hourly data assimilation and forecast system intended to replace th RUC in operations at NCEP. Users of RR will include aviation, severe weather forecasters, traffic and public weather forecasters among others, just as for the current RUC.The RR consists of Gridpoint Statistical Interpolation (GSI) for data assimilation and a version of the WRF model including the ARW core and RUC-like physical parameterizations for the model component. A digital filter initialization (DFI) is employed for noise suppression and assimilation of radar reflectivity data.Assimilation of surface data is an important feature of RR because the contribution of these observations to the analyses is especially important at non-synoptic times. Over the past 5 years, three key modifications have been made to the RUC, to improve the effectiveness of assimilation of surface observations. Because GSI based RR analysis is required to produce a similarly effective surface analysis, maintaining a close fit to the observations without unwanted noise in the subsequent forecasts, an effort is now in progress to install these same features into the GSI installed in RR. In order to achieve this goal, first, the station pressure is reduced to the model elevation using the background field. Then, surface temperature and dewpoint observations are reduced according to local lapse rate from station elevation to model terrain height if the reduction does not exceed a given threshold (usually 50 hPa). Land-water contrast is taken into account modifying observation innovation according to surrounding gridpoint values. Finally, pseudo-observations are introduced in the planetary boundary layer (PBL) to achieve appropriate propagation of surface information in all PBL. To incorporate all the new features above, the GSI has been modified accordingly. Results of testing of the new features in RR system will be presented at the symposium.

6.3
Kalman Filter for Nowcasting

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Short range weather prediction or nowcasting has a wide range of applications such as sports events and airport control, but accurate nowcasting for these activities over a short time period, for example 0-6 h, is a challenge, mainly due to small scale high impact weather systems and the infancy of nowcasting methodologies. Observation based persistence and extrapolation methods usually have more skill for a short time period, while numerical weather prediction (NWP) model based approaches have more skill over a longer time period. How to effectively use information obtained from these two methods and to mathematically/physically blend them into more skillful forecasts is a difficult problem. In this work, the Kalman filter approach has been used for nowcasting applications for Canadian airports and the 2010 winter Olympic and Paralympic game sites with complex terrain. Since the Kalman filter technique takes into account the systematic errors of NWP models, the forecasts corrected by the Kalman filter through combining model predictions with high temporal resolution in-situ observations are expected to be more accurate. The detailed results will be presented at the conference.

6.4
Extending VERA towards 3D applications

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The Vienna Enhanced Resolution Analysis (VERA) is an analysis tool which uses a Spline approach. In this variational concept a cost functional containing a combination of first and second derivatives is minimised. For downscaling purposes a priori knowledge (“fingerprints”) is used. The fingerprints can be either simple physical models of known properties of meteorological properties (such as thermally or dynamically induced pressure perturbations over complex terrain) or additional areal data like radar fields. These fingerprints are impressed to the analysis if the pattern is recognised in the station data. The VERA method is independent of any forecast model and as the station data is of great importance in this analysis procedure a sophisticated Quality Control System for the input data is used. The 2D - version of this analysis tool has been in use at the Austrian Aviation Weather Service for many years and efficiently supports meteorologists in Nowcasting issues. In an ongoing cooperation efforts are being made to implement VERA on the Vancouver 2010 Olympia region. Extending this concept to 3D creates some difficulties as the amount of data decreases with height and consequently the data distribution gets more and more anisotrop. Moreover the anisotropy of the meteorological parameters has to be taken into account. Also

4.10
Nowcasting flash floods in mountainous terrain

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The major weather hazards in New Zealand are heavy rain events associated with low pressure systems, often downgraded Tropical Cyclones. When these systems interact with the mountainous terrain flash floods occur. Summer thunderstorms can also produce floods but usually at a less hazardous level. The operational forecasting problems associated with these events are severe:
* The national network of radars does not give adequate coverage or resolution in the majority of the mountainous flood prone areas.* Radar data is in any case problematic in hilly terrain unless the radar is well placed for the particular catchment and the bright band problem is corrected.
* The steep terrain can result in significant enhancement of the rainfall amounts from dynamical processes requiring continuous interaction between the very high-resolution mesoscale model and observations.

Earlier work in this area has revealed that although potentially useful precipitation nowcasts have been made, inter-organizational communications are insufficient to allow these data to be used with a stream flow model in a timely manner. In an attempt to address these problems we have constructed a field programme, which deploys in a mountainous subcatchment of the Waikato River initially one but eventually two high resolution, small X Band radars. These are operated at modest range (25km), largely due to beam blocking, but at high spatial (100m) and temporal (12 sec) resolutions. These data are supported by a vertically pointing radar (VPR), enhanced rain gauge network, stream flow gauges and met tower. The data is all transmitted to the control system at the University where the distributed hydrological model and WRF mesoscale models are run. Whilst this is a relatively standard set up it is providing a real time test bed for trying various different techniques in terms of their ability to improve stream flow predictions including;
* Nowcasting and hind casting to increase effective radar coverage area
* Evaluating the quantitative improvement resulting from more frequent updating and higher resolution of the mesoscale model
* Quantifying the contribution of the VPR and indeed the radars themselves
* Running the hydrological model with an ensemble of possible future rainfall fields derived from radar nowcasting and WRF to find a probabilistic short-term flow forecast including possible hazardous events

4.11
A Coastal Atmospheric River Monitoring and Early Warning System

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Atmospheric rivers (ARs) are narrow regions of enhanced water vapor transport positioned along and just ahead of the leading edge of the polar cold front in many land-falling extratropical cyclones. ARs are responsible for producing heavy precipitation, especially in orographically favored regions, such as along the West Coast of North America. Satellites do an adequate job of measuring the water vapor content in ARs over the oceans, but not the winds that transport the water vapor onto land because the maximum transport occurs above the surface at the altitude of the low-level jet. Therefore, both wind profile and water vapor measurements are needed to extend the satellite measurements of ARs over land. Using Doppler wind profilers and Global Positioning System Integrated Water Vapor (GPS-IPW) receivers, scientists at NOAA's Earth System Research Laboratory (ESRL) created a bulk integrated water vapor flux tool. The tool uses a controlling wind layer, defined as that which exhibits the highest correlation between the upslope component of the horizontal wind measured by the wind profiler located at the coastline, and the precipitation rate measured in the coastal mountains downstream of the wind profiler. More recently, ESRL scientists have added numerical model output to the tool to give weather forecasters a way to calibrate the model and to provide nowcasting capability. This presentation will describe the water vapor flux tool, demonstrate its capability for a severe winter storm that stuck the U.S. West Coast in early 2008, and show how the current version of the quasi-real time tool compares the observations to successive 3-hour forecasts from a rapid update version of the Weather Research and Forecasting model.

4.12
CB Nowcasting in FLYSAFE: Improving Flight Safety Regarding Thunderstorm Hazards

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An important piece of the ACARE (Advisory Council for Aeronautics in Europe) plan has been put in place early in 2005: the FLYSAFE Project (http://www.eu-flysafe.org/). FLYSAFE aims at defining and testing new tools and systems contributing to the safety of flights for all aircraft. It focuses on the development of new on-board systems and of a ground segment for feeding them with the information that they require. The project is structured upon the three “threats” which play a major role in aircraft accidents: collision with other aircraft, collision with terrain, adverse atmospheric conditions. For the latter, specialised ground based weather information management systems (WIMS) have been developed for the weather hazards icing, clear air turbulence, wake vortex turbulence and thunderstorms. These systems provide

SESSION 6: Techniques

6.1
Olympic Nowcasting with Continuous Upper-Air Profiling

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Radiometrics Corporation

Met Service Canada is sensing upper-air temperature, humidity, liquid water and wind to enhance Nowcasting for the 2010 Vancouver Winter Olympics, using microwave radiometer and wind radar systems. These continuous data can be assimilated into numerical weather models and can also be used to generate traditional forecast indices. New forecast indices generated from radiometer liquid and supercooled liquid profiles have the potential to enhance precipitation, fog and icing hazard prediction. Microwave radiometer and wind radar data were used to enhance Nowcasting for the 2008 Beijing Summer Olympics, and are used for aviation weather applications at the Dubai International Airport. However, this will be the first use of continuous profiling methods for Winter Olympic Nowcasting. Strategies to optimize the impact of continuous profiles in local Nowcasting will be discussed.

6.2
Frontal Passages During the 2009 Winter observed with the Remote Sensing Network for Vancouver 2010 Olympic Winter Games

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To support nowcasting operations during the Vancouver 2010 Olympic and Paralympic Winter Games, Environment Canada has enhanced its observing network with remote sensors along the Sea-to-Sky corridor (Highway 99 in British Columbia). High winds, reduced visibility and mixed-phase precipitation are some of the forecasting challenges for the Games venues, all enhanced by the complex terrain conditions.Weather radars, wind profilers and microwave profiling radiometry will provide key measurements. A dedicated weather radar is located in the valley, which is able to provide local analyses in the main valleys around Whistler. An operational weather radar at Mount Sicker provides a mesoscale context over the venues. Profiles of radiometer observations of relative humidity, of cloud liquid water content, and of temperature will facilitate monitoring the growth and depletion of ice particles and supercooled droplets in winter environments. This analysis leads to a technique for nowcasting precipitation phase. A 915 MHz wind profiler was located upstream of the Olympic venues, at the junction of three valleys. Analyses of these wind profiler observations provide insight on the topographic influence over the local winds.The objective here is to demonstrate that these remote sensors will enhance the nowcasting of winter weather over complex terrain. For that we analyze cold front events during the winter of 2008-2009.

5.10
The 0-8 Hour Collaborative Storm Prediction for Aviation (CoSPA) Forecast Demonstration

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Air traffic congestion in the United States (US) has become a serious national problem resulting in a critical need for timely, reliable and high quality forecasts of precipitation and echo tops with forecast time horizons of up to 8 hours. In order to address the short-term needs of the Federal Aviation Administration (FAA) as well as the long-term goals of the US's Next Generation Airspace System (NextGen), MIT Lincoln Laboratory, NCAR Research Applications Laboratory and NOAA Earth Systems Research Laboratory (ESRL) Global Systems Division (GSD) are collaborating on developing a forecast system under funding from the FAA's Aviation Weather Research Program (AWRP). During the summers of 2008 and 2009 a research version of the CoSPA forecasting system was demonstrated to the FAA and parts of the aviation weather research community. The CoSPA system combines the latest technologies in heuristic nowcasting, extrapolation, statistical techniques and numerical weather prediction to produce rapidly updating (15 min) 0-8 hour forecasts of storm locations, echo tops and intensities. The system blends highly-skillful heuristic nowcasts with output from NOAA's High Resolution Rapid Refresh (HRRR) using phase correction and statistical weighting functions. The CoSPA 0-8 hour forecasts are accessible to the aviation community via an operational situation display and a password protected website that builds upon the FAA's Corridor Integrated Weather System (CIWS) and shows current time situational awareness products including: VIL, echo tops, lightning, growth and decay, forecasts and verification contours, as well as an animation of the weather from 8 hours in the past to 8 hours into the future. This presentation will discuss how this system satisfies current FAA needs and is an important first step in providing automated high-resolution probabilistic forecasts of storm characteristics that will be required for NextGen's automated air traffic planning system. The presentation will include a description of the forecast algorithm, examples of the forecast features and forecast performance, and provide some details of ongoing research and planned efforts.
This work was sponsored by the Federal Aviation Administration under Air Force Contract No. FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the United States Government. This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

met data on the individual weather hazards over a defined area ranging from high resolution short-range on a local scale to long-range forecasts on a global scale. All WIMS data are sent to a ground-based weather processor (GWP). By request from an aircraft selected information about a weather hazard tailored to the respective flight corridor is passed through the GWP to the on-board Next Generation Integrated Surveillance System (NG-ISS). On the NG-ISS, a fusion not only with on-board weather data, but also with the other threats terrain and traffic is carried out in order to achieve a consolidated picture of the hazard situation. Finally, the situation is presented to the pilot by means of simple, easy to read graphics on a special display together with the possible solution on how to avoid the hazard. For thunderstorms a so-called CB WIMS (Cb = Cumulonimbus) has been developed with involvement of partners from the German Aerospace Center (DLR), Météo-France, ONERA (Paris), the UK Met-Office and the University of Hannover. As thunderstorms appear in various shapes and sizes, from small single convective cells to mesoscale convective complexes and thunderstorm lines with corresponding life times from a few minutes to several hours, a major task during the development stage of CB WIMS was to reduce this complexity to a hazard information which can be handled by airspace users. Therefore, instead of presenting all the detailed information about thunderstorms to a pilot, which would certainly not help him in decision making, the strategy followed was to identify the hazards for aircraft in thunderstorm situations, to find corresponding thresholds for the specific hazard levels “moderate” and “severe”, and based on these, to define hazard objects which represent these hazard levels. The task of CB WIMS was then to detect and forecast these hazard objects on the very short term, e.g. for up to one hour in advance. Results are shown from the implementation of the CB WIMS, its successful application in case studies and its testing in operational flight tests during the FLYSAFE summer campaign in August 2008.

SESSION 5: Radar

5.1
Nowcasting a prolific and intense tornadic storm: The Greensburg, KS supercell of 4 May 2007

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During the evening of 4 May 2007, a large, powerful tornado devastated Greensburg, Kansas. The synoptic and mesoscale environments of the parent supercell that spawned this and other tornadoes are described from operational data. The formation and early evolution of this long-track supercell, in the context of its larger-scale environment, are documented on the basis of WSR-88D radar data and mobile Doppler radar data. The storm produced tornadoes cyclically for about 30 min before producing a large, long-lived tornado. It is shown that in order to have forecasted the severe weather locations and times accurately, it would have been necessary to have predicted (1) the localized formation of an isolated convective storm near/east of a dryline; (2) the subsequent splitting and re-splitting of the storm several times; and (3) the growth of a new storm along the right-rear flank of an existing storm; and (4) the transition from the cyclic production of small tornadoes to the production of one, large, long-track tornado. It is therefore suggested that both extreme sensitivity to initial conditions associated with storm formation and the uncertainty of storm behavior made it unusually difficult to forecast/nowcast this event accurately.

5.2
Implementation of tracking radar echoes by correlation (TREC) for US Navy radar nowcasting

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The Marine Meteorology Division of the Naval Research Laboratory is working with Basic Commerce and Industries and Space and Naval Warfare Systems Center to implement Tracking Radar Echoes by Correlation (TREC) as a wind nowcasting tool within the Hazardous Weather Detection and Display Capability (HWDDC). The HWDDC is a weather radar processor and web-display server that passively taps into volume scan data from the SPS-48E air defense radar onboard the US Navy's aircraft carriers and large-deck amphibious ships.
A new version of TREC has been developed, specifically designed for use by the HWDDC at sea. Allowances have been made for ship movement, mast reflection artifacts, ground and

Other categories or sub-categories could be added.This approach can also aid in the assessment of whether or not models are forecasting the correct convective mode.

5.9
A Study of Convective Triggering Mechanism in Beijing Area for Nowcasting Thunderstorm: Diagnosis from a Rapid Update Radar Analysis System During B08FDP

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During the Beijing 2008 Forecast Demonstration Project (B08FDP), the 4DVar-based Variational Doppler Radar Analysis System (VDRAS) was implemented at Beijing Meteorological Bureau. VDRAS assimilates Doppler radar radial velocity and reflectivity and surface AWS observations with the WRF-based rapid update cycle system (BJ-RUC, 3-hourly update cycle) as background, providing analysis of low-level 3D wind, temperature, and humidity with a rapid update cycle of 12 minutes. The vertical velocity analysis from VDRAS was used as an input predictor field in BJANC (Beijing Auto-Nowcaster). VDRAS analysis fields, such as wind, temperature, horizontal convergence, and vertical velocity, are displayed along with BJANC to provide detailed and rapid-updated dynamical and thermodynamical information to assist the forecasters and FDP participants in their nowcasting decision-making. During B08FDP, it was found that the development and rapid strengthening of cold pools were a good indication for strong convective activities in the following hours. A good number of convective initiation episodes were associated with cold pool outflow boundaries that were not detected by the radar or analyzed by mesoscale models. The vertical velocity field and low-level convergence field were found to be useful in providing some guidance for forecasting the location of the initiation of new storms or strengthening of existing storms. Further diagonostic studies based on VDRAS analysis are being conducted to further examine the roles of cold pool, low-level wind shear, vertical velocity, and CAPE/CIN in convective initiation and maintenance. The role of terrain forcing in convective initiation is also being studied. The objectives of this study are to identify predictor fields that have meaningful correlations with storm initiation and strengthening and to generate conceptual models for thunderstorm nowcasting. Since VDRAS was implemented with a shallow domain that has a 5km depth in the vertical, the study focuses on the low-level triggering mechanisms. The findings resulted from the Beijing data will be compared with those from IHOP data in central U.S. Plain.

optionally be applied through software to generate adjusted radar products. A number of adjusted products are presented and evaluated.

5.7
Tracking edges of polygons (TREP)

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We introduce a new technique for tracking radar echoes which is similar to existing video processing procedures. In that technique, a radar map is represented by a set of polygons, instead of an array pf pixel values. We define an edge of a polygon as a normalized vertex, characterized by the orientations of the two neighboring vectors forming a vertex. In our tracking model, these orientations remain quasi-persistent. Hence, we search, in two subsequent radar maps, pairs of edges best matching this criterion. The resulting sample of pairs contains hits (correct matching) and failures (erroneous matching). Statistical procedures identifying and processing the hits lead, at the end, to a realistic motion field.TREP combines the individual strengths of the traditional box tracking and cell tracking techniques. Our comparisons between TREP and the older COTREC clearly demonstrate a better representation of the motion of convective cells with TREP, whereas the performance for stratiform radar echoes is almost the same for both techniques. Therefore, we introduced TREP in our operational tracking procedures. In this contribution, we will give an overview about the technique, show some examples and summarize our performance tests.

5.8
Objective Classification of storm types using shape information and model atmospheric environment parameters

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As different varieties of convective storm follow different development cycles and propagate with different tendencies, the classification of storm type is one step to improved automated nowcasting. Knowledge of storm morphology can help both in predicting future motion and development, and assessing the severe weather threat. However, what can be a relatively straightforward assessment for an experienced meteorologist is a complex problem to reproduce algorithmically. We propose a classification scheme that combines radar reflectivity structure information such as storm shape, with velocity information (divergence; rotation), and near-storm environment fields in an object-oriented framework. All available measures are assessed in a cell-based to determine the best indicators of storm type in an unbiased statistical manner. The storm types differentiated are: general thunderstorm; air mass thunderstorm; pulse thunderstorm; small rotating thunderstorm; severe small rotating thunderstorm; supercell; linear convective system; and linear convective system with rotation.

sea clutter, and an improved wind smoothing technique has also been developed. The HWDDC creates base reflectivity data in NEXRAD NIDS format at 60 second intervals, while the adjunct TREC algorithm processes these data every 5 minutes to allow sufficient time to resolve reflectivity echo movement between analysis grid points. The HWDDC displays the TREC winds as conventional wind barbs, which ship personnel will use along with other data to enhance the near-term ship and flight course planning, operations and safety.

5.3
Unattended Automatic Real-time SMS flood warning using high-resolution X-Band radar data and automatic real time calibration of X-band radar data

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In summer 2008 the city of Hvidovre started the test of is new automatic short term flood warning system. The system is based on a LAWR-X band radar, an automatic one hour forecasting tool and a simple hydrological bookkeeping model for 22 urban catchments. Warnings are issued to subscribers using SMS.The radar system is calibrated automatically on a daily basis using the last two months of radar images and gauged rainfall data from the Danish Meteorological Institute. The SMS warning system operates in a 5 minutes' cycle starting with the reception of the past 5 minute radar images from the radar. The forecast is performed using weighted cross-correlation. Measured and forecasted reflectivity images are transformed into intensity and accumulated precipitation for the past 5 hours + one hour forecast is calculated for each catchment. If predefined threshold values are exceeded for a given catchment, subscribing citizens in this area will receive a warning SMS indicating warning level.The concept of a fully automated warning system based on radar technology has proved to be quite ambitious. The paper focuses on stability problems related to the automatic calibration radar vs rain-gauges. The findings presented here are based on operation of the system in the autumn of 2008 and spring of 2009.

5.4
The CASA Nowcasting System

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Small-scale, high-impact weather events such as rapidly evolving supercells and tornadoes can pose a severe threat to life and property. Quickly and accurately producing short lead time forecasts of such events allows for better preparation and response to mitigate this threat. Several nowcasting algorithms currently exist to provide short-term forecasts for tens of minutes up to a few hours. Recently a new nowcasting algorithm, the Dynamic and Adaptive Radar Tracking of Storms (DARTS), was developed. This method describes a sequence of observed reflectivity fields as a spatiotemporal linear model. The governing flow equation is discretized and solved in the spectral domain using Linear Least-Squares Estimation to estimate storm motion. The estimated motion vector field is globally constructed over the whole spatial region where radar images are rendered and the observed reflectivity fields are advected forward in time to produce predicted reflectivity images. The smoothness of the estimated motion field and computational efficiency are achieved by truncating the Fourier space. The scale of estimated storm motion is controlled by the number of spectral coefficients representing the motion vector field in the model. Thus, the DARTS algorithm is “dynamic” in the sense it is built upon a fluid dynamics-based equation and is “adaptive” in the sense tracking scale can be selected by choosing the number of Fourier coefficients representing the motion vector fields. The DARTS algorithm was implemented within the Collaborative and Adaptive Sensing of the Atmosphere (CASA) X-band radar network to provide end-users with real-time predicted reflectivity images for lead times up to 10 minutes during the 2009 CASA IP1 experiment. Attenuation correction and clutter removal algorithms are employed at each of the 4 CASA radar nodes at Chickasha (KSAO), Rush Springs (KRSP), Cyril (KCYR), and Lawton (KLWE), Oklahoma. The System Operations Control Center (SOCC) located at the University of Oklahoma at Lawton, OK, receives the radar node data, performs conversion to Network Common Data Format (NetCDF), and transmits the data to the University of Massachusetts at Amherst via a Local Data Manager (LDM). After the radar data files are suitably synchronized by an ingester, the individual radar data files are gridded and merged. These files serve as input to the DARTS nowcasting module, which provides predicted reflectivity images to the end-user via an Internet-based display. The predicted images are also used in the network closed-loop to steer the radar nodes by directing future sector scans to volumes where future precipitation echoes will be. This paper shows the DARTS algorithm performs favorably in terms of speed and accuracy in the CASA operational nowcasting environment where reflectivity images of high spatial (0.5 km) and temporal resolution (1 min.) are rendered to detect characteristics of and precursors to severe weather events. The DARTS algorithm is described and the development of a real-time nowcasting system in a closed-loop networked radar testbed is presented. Case studies from data collected during the CASA IP1 2009 Spring Experiment are presented which demonstrate favorable nowcasting performance.

5.5
Improved Tracking and Nowcasting Techniques for Thunderstorm Hazards using 3D Lightning data and Conventional and Polarimetric Radar Data

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Improved nowcasting of thunderstorm-related hazards like lightning, hail or heavy rain are of high benefit for many weather related industries. In the framework of the German BMBF “Klimazwei”-project RegioExAKT (Regional Risk of Convective Extreme Weather Events: User-oriented Concepts for Climatic Trend Assessment and Adaptation) a prototype of a tool for very short-term nowcasting is developed and tested. The capabilities of the warning parameters are demonstrated for the terminal manoeuvring area of Munich Airport during

summer seasons of 2008 and 2009. Based on 3D lightning data and 2D high resolution radar data a new tracking algorithm ec-TRAM (Tracking and Monitoring of electrically charged cells) has been developed in order to record the radar and lightning parameters of thunderstorm cells during their different stages of development. The algorithm is a further development of the tracking algorithm rad-TRAM [1] and designed to track, monitor and combine the information of radar cells based on radar reflectivity fields and lightning cells based on spatially and temporally clustered lightning frequency maps.VLF/LF lightning data are provided by the European lightning detection network LINET, which records lightning locations, amplitudes and polarities of total lightning activity. The three-dimensional resolution of lightning incidents allows for the discrimination of intra-cloud (IC) and cloud-to-ground (CG) events and provides emission heights for the IC strokes. Primary radar data for the cell-tracking algorithm are obtained from the operational DWD C-band Radar in Fürholzen near Munich. For case studies the C-band dual-polarization Doppler radar POLDIRAD of DLR provides additional polarimetric radar quantities such as reflectivities at horizontal or vertical polarization, differential reflectivity (ZDR) or linear depolarization ratio (LDR), which allow for a hydrometeor classification. The new combined radar-lightning ec-TRAM algorithm provides more detailed information about thunderstorm history and development than would have been attained with lightning or radar data alone. It shows promising features which seem capable to improve forecast time and forecast quality of thunderstorm related hazards. Especially the IC/CG ratio and the polarimetric hail signal promise to be useful additional parameters for severe weather warnings.The performance of the new algorithm is demonstrated and case studies such as the example of a thunderstorm recorded on 25 June 2008 will be presented. The electrical activity of this thunderstorm starts IC activity during enhanced cell growth whereas CG activity starts about 15 minutes after the first recorded IC event. The ratio of IC and CG events ranges between 2 and 40 during the whole lifecycle. After a cell splitting observed in the precipitation field the electrical activity first shifts to the right moving cell and then diminishes while the precipitation rate of the cell increases significantly. Lightning activity finally stops after 160 minutes. During the lightning period hail to the ground was observed, too.[1] Kober, K. and Tafferner, A., “Tracking and nowcasting of convective cells using remote sensing data from radar and satellite”, Meteorol. Z., Volume 18, Number 1, February 2009, pp. 75-84, 2009.

5.6
Real Time Detection of Reflectivity Calibration Differences Between Radars

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It is important that radar networks be uniformly calibrated in order to maintain consistency in the interpretation of radar products across the network. Due to differences in radar hardware and difficulties in performing system calibration, significant reflectivity differences can develop between radars. This presentation describes a procedure that monitors the radar volume scans in real time, notes the position and degree of overlap between radar bins, and develops statistics over time of the three-dimensional difference in reflectivity in the overlap volume. An optimal mean reflectivity difference is determined between the radars. This can