SWISS CONTRIBUTION TO THE

ANNUAL JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS) AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES (NWP) FOR 2006

1 Summary of highlights

(AUTHOR: ALEX RUBLI)

- The upgrading of the IT hardware was focussed on the client infrastructure. Highly efficient Windows clients have been installed at the forecaster's desks to run the NinJo application, a newly developed software for the processing of meteorological data.
- Considerable effort has been put into the development of new nowcasting tools and the improvement of the existing nowcasting system as well as into the diffusion nowcasting information and warnings.
- The availability of trajectory data for the National Emergency Operations Centre (NEOC) has been improved with the aim to guarantee an "all-time-service-continuity".
- MeteoSwiss has established a quasi-operational monthly forecasting system, using ECMWF monthly forecast data.

2 Equipment in use at the Centre

(AUTHOR: STEFAN SANDMEIER)

In the past year, we focused on renewing the client infrastructure used at MeteoSwiss. Older generations of laptops, PCs, and Sun Solaris Workstations were replaced by state-of-the-art machines. Wherever possible, Sun Solaris Workstations were substituted by Windows clients or completely eliminated. In the same time, both, Windows and Solaris Clients were upgraded to Windows XP and Solaris 10 operating systems, respectively. In order to facilitate access to Unix applications from Windows clients, new X-Servers were purchased and installed at all sites of MeteoSwiss. With the NinJo application, a newly developed software for the processing of meteorological data became available and required the introduction of highly efficient Windows clients at the forecasters desks. A significant improvement in the processing of meteorological and climatological data in our MeteoSwiss Data Warehouse could be achieved by leveraging the central server hardware and by upgrading the Oracle and Power Center software to Version 10g and Version 7.1.3, respectively. Finally, with HP PocketPCs new PDAs were introduced to MeteoSwiss.

3 Data and Products from GTS in use

No report available.

4 Forecasting system

4.1 System run schedule and forecast ranges

4.2 Medium range forecasting system (4-10 days)

4.3 Short-range forecasting system (0-72 hrs)

4.4 Nowcasting and Very Short-range Forecasting Systems (0-6 hrs)

(AUTHORS: ALESSANDRO HERING/URS GERMANN)

4.4.1 Nowcasting Systems

4.4.1.1 In operation

Tracking and characterisation of convective cells by radar (TRT)

Since 2003 MeteoSwiss runs operationally the real-time object-oriented nowcasting tool TRT (Thunderstorms Radar Tracking), as a part of its severe thunderstorms nowcasting, warning and information system. TRT is a multiple-radars nowcasting system that uses heuristic and centroid-based methods for the automatic detection, tracking and characterisation of intense convective cells.

During the summer season, based on the TRT, MeteoSwiss starts the diffusion, by local and national radio stations, of heavy thunderstorms warnings in whole Switzerland for the general public as well as to civil protection authorities, with simple flash-news, with a lead time of 30-120 min (Hering et al., 2005).

TRT is based on a dynamic thresholding scheme applied on the reflectivity data of multiple-radar composites (Hering et al., 2004). The dynamic scheme is able to identify each storm object at individual thresholds, depending on the stage of its life cycle. A detected storm cell is tracked in successive images using the method of the geographical overlapping of cells. It is then possible to create the time history of cell displacement, and tracks are created from a sequence of radar images. Since TRT is tuned to identify individual cells rather than storm systems, the evolution of cell-based characteristics is available to the forecasters. Complex cases with several cells, splits and merges are also taken into account.

As input the TRT uses the reflectivity data of the Swiss composite image of 3 volumetric C-Band Doppler radars with a time resolution of 5 minutes (Joss et al., 1998). A 20-elevation volume scan between -0.3° and 40° is performed operationally. For the cell detection we use the vertical maximum projection from 12 constant altitude surfaces (CAPPI) between 1 and 12 km.

Quantitative precipitation estimation by radar (RAIN)

The quantitative precipitation estimate (QPE) Nowcasting radar product RAIN was developed to meet both the meteorologist’s and the hydrologist’s requirements. It is the best radar estimation of precipitation amount on the ground in Switzerland. The RAIN product is the result of sophisticated correction algorithms for radar operation in the Alps. Data processing includes automatic hardware calibration, adjustment with gauge measurements, 7-step dynamic elimination of ground echoes, frequency-based residual ground echo removal, and correction for beam shielding and vertical reflectivity profile (Germann et al. 2006a).

Automatic heavy precipitation alert system (NASS)

The multiple-radar-based Nowcasting application NASS is specifically designed for situations with heavy precipitation. NASS was implemented to generate automatic alerts whenever accumulated radar rainfall exceeds a predefined threshold for periods of 3, 6, 12 and 24 hours (Germann et al. 2006a). An alert message consists of an identification number, a time stamp, the area, the mean accumulated rainfall, the geographic region, and the predefined threshold for that region. For each alert message, a map indicates the individual pixels. Based on radar and other sources of information, the forecaster then decides whether the alert is forwarded to the authorities.

Requirements

For a successful detection and tracking of even relatively small convective cells in complex orography it is necessary to have a qualitatively good radar network with effective clutter elimination algorithms, as well as a high temporal update rate and high vertical resolution. The reflectivity values used as input for the TRT have already passed a sophisticated 7-step clutter elimination algorithm and an extensive quality control program (Joss et al., 1998). In addition the product RAIN and the automatic alert system NASS put high demands on the accuracy of radar quantitative precipitation estimates; they can only work if bias and scatter are low (Germann et al. 2006a).

4.4.1.2 Research performed in this field

Tracking and characterisation of convective cells (TRT)

In order to explore the capability of the tool to assess the severe weather potential of thunderstorms, the new version of TRT fully exploits 3D-radar data and has been expanded to a multiple-sensors system including cloud-to-ground lightning data with both polarities (Hering et al., 2006). Cell characteristics describing the 3D storm structure and properties as well as the accompanying time series, are computed from the volumetric radar data. These recently introduced parameters include grid- and cell-based 15/45 dBZ echo tops, VIL (Vertically Integrated Liquid), as well as the altitude of the maximum storm reflectivity. To compute the new multiple-radar severe storms detection products TRT uses the 3D Cartesian composite image of the Swiss radar network.

Ensemble radar precipitation estimation

The uncertainty in radar quantitative precipitation estimates is the superposition of errors of many different sources. In spite of significant improvements in the past decade, for quantitative hydrological applications the residual uncertainty is still relatively large. An elegant way to express this residual uncertainty is the generation of an ensemble of radar precipitation fields using stochastic simulation and knowledge of errors (Germann et al. 2006b).

The Mesoscale Alpine Programme forecast demonstration project MAP D-PHASE of the WWRP of WMO will serve as a hydro-meteorological testbed to investigate propagation of uncertainty and demonstrate progress in forecasting. MeteoSwiss developed and implemented a prototype ensemble system to represent uncertainty in quantitative radar precipitation fields for MAP D-PHASE partners. This includes detailed analysis of the space-time correlation structure of errors in radar measurements. The idea of using ensemble techniques to express the uncertainty in radar precipitation fields is fully novel and MAP D-PHASE will probably be the first testbed for real-time assimilation of radar ensemble precipitation estimates in a hydrological runoff model. The propagation of uncertainty is characterised by the response of runoff processes to the space-time structure of radar errors.

Heuristic nowcasting of orographic precipitation by radar

As a result of the strong orographic forcing heavy precipitation in the Alps is often persistent over several hours and exhibits typical spatial patterns. Research of the Mesoscale Alpine Programme MAP has shown that these features are related to the meso-scale wind, whose direction and intensity determine the lifting of the air masses over the orography and then influence the spatial and temporal precipitation patterns. As a consequence of this relation, a significant variation in direction or intensity of the mesoscale wind field may constitute a short-term precursor of a change in the location and intensity of the heavy orographic precipitation and can thus be used for nowcasting. First results obtained with wind and precipitation measurements of the Monte Lema Doppler radar confirm the above hypothesis. Data processing includes four-dimensional Doppler de-aliasing, least-squares techniques for linear wind retrieval and sophisticated correction schemes for quantitative radar precipitation estimation.

4.5 Specialized numerical predictions

(AUTHOR: THOMAS EGLI)

MeteoSwiss (MCH) Trajectory and Dispersion Forecasts in favour of the National Emergency Operations Centre (NEOC) in Zurich

The operational weather service in Zurich is operating a system of several trajectory- and dispersion models. Its main goal is the “all time”-availability of such calculations in order to provide NEOC with essential meteorological information about the behaviour of emitted pollutants in case of emergencies occurring anywhere in the world.

It is in the responsibility of MCH to provide first information to NEOC within 40 minutes of time after their request.

In order of the different scales of application, MCH is operating and running a variety of models with different feasibilities and areas of spatial extension. Weekly tests, done by the bench forecasters, enable us to guarantee the highest degree of availability. Additionally, exercises on a monthly base in collaboration with the NEOC is taking place, as well as a yearly exercise with representatives of NEOC, MCH, the Swiss Federal Nuclear Safety Inspectorate and members from the cantonal authorities.

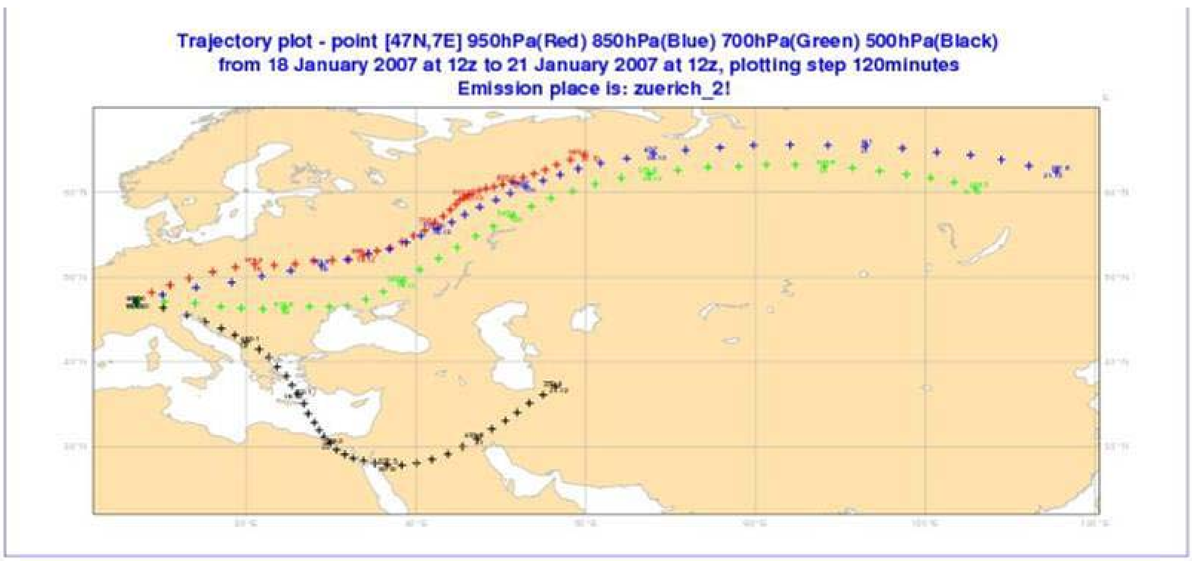
Subsequently there is an overview of the trajectory and dispersion models used in the operational service and a short description of their origin, maintenance and area size. In graphics 1-3 examples of the MetviewTraj trajectory model, as well as of the LPDM dispersion model and the Trajekmodell are presented.

Trajectory models:

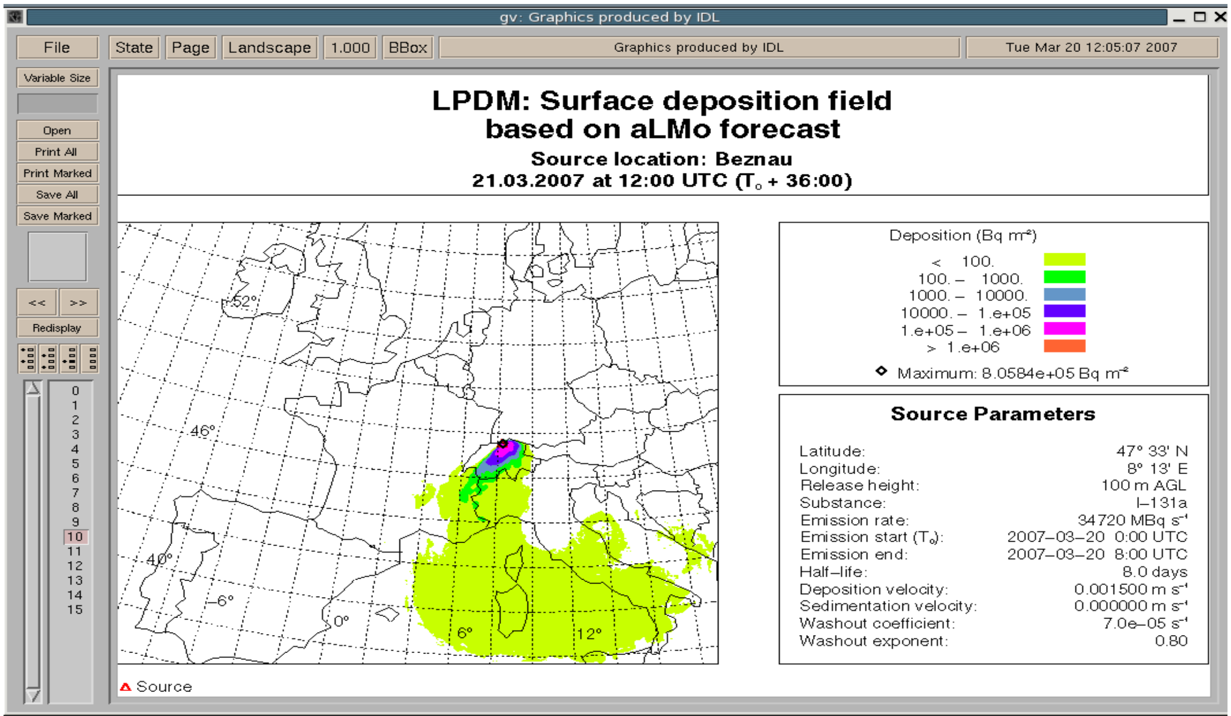
Name:	**area:**	**origin/input data:**	**maintenance:**
Trajek	local	MCH local model aLMo	modelling group MCH
NOAA-Hysplit	global	NOAA/GFS-model (Data Transfer by Internet)	NOAA
MetviewTraj (since October 2006)	global	ECMWF/IFS model	Meteo Zurich

Dispersion models:

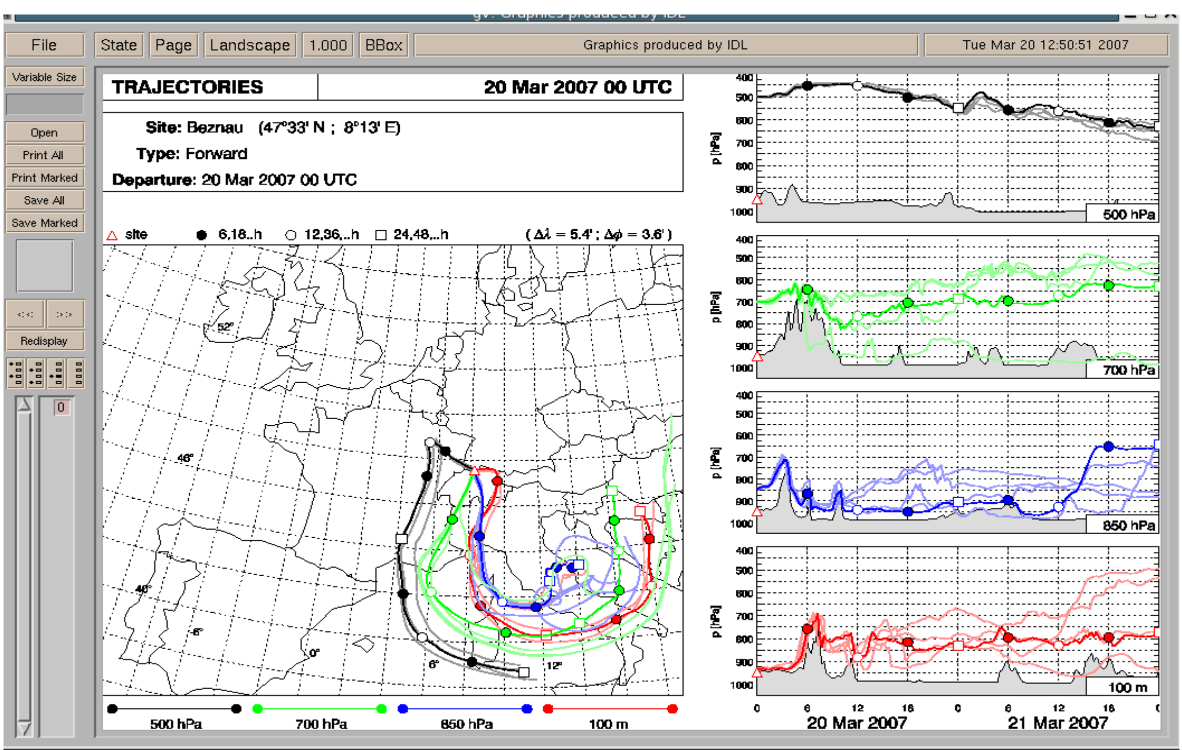
Flexpart	global	Dr. A. Stoll (currently at NILU)/ IFS model	IT-MCH/ Meteo Zurich
NOAA-Hysplit	global	NOAA/GFS model (Data-Transfer by Internet)	NOAA
LPDM	local	MCH local model aLMo	MCH model group
LORAN	local	Joint Research Center, Ispra/ IFS model	MeteoZurich



Graphic 1: Example of the MetviewTraj-Modell. Place of emission is Zurich and the different colours represent trajectory lines at different pressure levels (950/850/700 and 500 hPa). The visualization has been done with the Metview software from ECMWF.



Graphic 2: Example of the LPDM dispersion model. Place of Emission is Beznau in the canton of Argovia. The example shows the dispersion of the element Iod-131.



Graphic 3: Example of the Trajek'Modell. Place of emission is Beznau in the canton of Argovia. In the left image the horizontal trajectories can be seen for different pressure levels (100m above ground, 850, 700 and 500 hPa). On the right side the vertical propagation of the same trajectories can be seen.

4.6 Extended range forecasts (10 days to 30 days) (Models, Ensemble, Methodology and Products)

(AUTHOR: ANDREAS WEIGEL)

Within the framework of the national NCCR climate research programme, MeteoSwiss has established a quasi-operational monthly forecasting system, using ECMWF monthly forecast data. Calibration and visualization techniques are applied in a similar way as in the long range seasonal forecasts. Products include maps of weekly categorical probability forecasts of surface temperature, precipitation and geopotential height over various regions. A detailed probabilistic verification has been started for temperature, quantifying prediction skill in function of lead-time, season and location. In collaboration with Agroscope Reckenholz-Tänikon ART, first attempts to use monthly forecasts for agriculture in Switzerland have been undertaken.

4.7 Long range forecasts (30 days up to two years) (Models, Ensembles, Methodology and Products)

(AUTHOR: ANDREAS WEIGEL)

MeteoSwiss issues long range forecasts on the basis of the ECMWF seasonal forecast system 2 (before March 2007) and system 3 (since March 2007), respectively. Research results from the NCCR Climate project optimized the calibration of the forecasts and facilitated an appropriate probabilistic verification. The operational products (climagrams, probability charts and tercile data for surface temperature, precipitation and geopotential height) are available for customers. Moreover, a quarterly climate outlook bulletin for Switzerland has been developed, informing the public in an appropriate way about probabilistic seasonal climate forecasts. Within the framework of the NCCR Climate project, methods have been developed to improve the seasonal predictions by multi-model combination. The development of a quasi-operational multi-model on the basis of this research is under consideration.

5 Verification of prognostic products

No report available.

6 Plans for the future (next 4 years)

6.1 Development of the GDPFS

6.2 Planned Research Activities in NWP, Nowcasting and Long-range Forecasting

6.2.2 Planned Research Activities in Nowcasting

(AUTHORS: ALESSANDRO HERING/URS GERMANN)

Plans for future research activities consist in a successive increase of the multi-sensors capabilities of TRT including data from the NWP model COSMO-CH2, satellite data (e.g. NWCSAF) and mesonet data. Progress in quantitative radar precipitation estimation, in particular using the ensemble generator, will be evaluated in quasi-operational hydro-meteorological testbed. Another issue is the increase in spatial and temporal resolution of the radar systems. Further research activities include the investigation of snow and hail by the radar network as well as by additional sensor systems.

7 References

(AUTHORS: ALESSANDRO HERING/URS GERMANN)

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