The Emerging MET Capability to Meet the Future Aviation Needs

CM Shun
President, CAeM

6 to 10 November 2017, Météo-France, Toulouse
Smooth recovery after Hato

23 August 2017

Actual

Actual
Drivers for change
Drivers for Change

Aviation’s No. 1 Priority:

SAFETY

Doubling of air traffic every 15 years

Weather: 2nd biggest threat to flight safety

International scheduled passenger traffic (RPK) growth in 2016 (Source: ICAO)
Press Release No.: 55
Date: 24 October 2017

2036 Forecast Reveals Air Passengers Will Nearly Double to 7.8 Billion
It's going to be a bumpy

Updated: 2017-10-20 06:13

By Honey Tsang(HK Edition)

Climate change is well advanced, and that special air turbulence will only worsen. Honey Tsang reports.

The Boeing 747 plummeted for what seemed like just a few minutes, the shock lifted him out of his seat. Only a few seconds later, the plane flew level. Fung saw two fellow passengers sail aloft, 5000 feet above him. In the galley a flight attendant thrown to the back by the impact turned to him and shrieked. "The second jolt was the most ravaging one. It was the old passenger on the 747."
Too Hot to Fly? Climate Change May Take a Toll on Air Travel

Excess heat in Phoenix grounded more than 40 flights in recent days, and scientists say a warming climate could also mean more turbulent rides.
Sum of its parts

Final assembly of first Cathay A350 begins in Toulouse this month

With less than 10 months to go before entry into service, production of Cathay’s first A350 is about to move into full swing.

At the time of writing, the major sections of the aircraft were being constructed at various sites across Europe and are set to commence performing a number of interim quality inspections,” he adds.

Meanwhile, different teams within the airline are busy working on entry-into-service project preparations.

In addition to the arrival of the first A350 flight simulator for Cathay (see story below), one of the areas of high activity is the preparation for e-operations.

“The A350 is fully e-enabled which means the aircraft is designed to operate paperless and its onboard systems can communicate with ground systems to share large amounts of operational and system health data as well as software updates,” says Bob.

“The move to e-operations is therefore driving new infrastructure as well as new support teams and the need for regulatory approval.”

COMING TO LIFE: The nose of MSN 034, scheduled to be Cathay’s third A350 for delivery in 2016, under construction. Five future Cathay aircraft are having at least one of their sections built.
Available on Airbus A350 above 10,000 feet.
Terms and conditions apply.

Inflight Wi-Fi now available on our new A350.
Paper-based $\rightarrow$ eEnabled

My Observatory App
- Developed for public since 2010
- 6.7 million downloads (90%)
- 2017: expect 150 billion pageviews
EFB Wx App

Partnership between CPA and HKO
EFB Wx App – More Examples

Partnership between AFR, GTD & MF
Still More Examples
Enroute HI Weather
High-altitude Engine Icing

- Experimental satellite-based product developed in response to airlines’ concern – algorithm tuning using QAR data
Forecast of HIWC

H8 observed data: (without VIS) Red (Band 09-Band13): deep convection Blue (Band 12-Band13): high cloud tops (regions with ice crystals) True skill statistics (TSS): 0.42

WRF simulation: 20161006 0000Z base T+24H F/C Base image: simulated H8 IR1 Highlighted: Sig. convection (red) and potential HIWC (blue) using multi-channel radiance simulation

WRF simulation (cal): 20161006 0000Z base T+24H F/C Histogram matching of observed and simulated channels
Numerical Weather Prediction
**GOALS BY 2025**

To provide forecast information needed to help save lives, protect infrastructure and promote economic development in Member and Co-operating States through:

Research at the frontiers of knowledge to develop an integrated global model of the Earth system to produce forecasts with increasing fidelity on time ranges up to one year ahead. This will tackle the most difficult problems in numerical weather prediction such as the currently low level of predictive skill of European weather for a month ahead.

Operational ensemble-based analyses and predictions that describe the range of possible scenarios and their likelihood of occurrence and that raise the international bar for quality and operational reliability. Skill in medium-range weather predictions in 2016, on average, extends to about one week ahead. By 2025 the goal is to make skilful ensemble predictions of high-impact weather up to two weeks ahead. By developing a seamless approach, we also aim to predict large-scale patterns and regime transitions up to four weeks ahead, and global-scale anomalies up to a year ahead.
NWP Products

Simulated Reflectivity
Deep Convection

2017-11-03 00:00 UTC (Fri) 12 hr F/C

Turbulence Index
T2 on FL300

2017-11-03 00:00 UTC (Fri) 12 hr F/C

dBZ
Flood Guidance Statements for Cumbria for 5/6 Dec 15

FGS on Friday 4 Dec (10:30)

FGS on Friday 4 Dec (15:30)

FGS on Saturday 5 Dec (10:30; 15:00; 21:30) and Sunday 6 Dec (10:30; 15:30 & 21:30)

Flood Risk Matrix
(river, tidal/coastal, surface water & groundwater flooding)

Likelihood
- High
- Medium
- Low
- Very Low

Potential Impacts
- Minimal
- Minor
- Significant
- Severe

Overall Flood Risk
- HIGH
- MEDIUM
- LOW
- VERY LOW

FGS on Tuesday 1 Dec (10:30) - for Day 5

FGS on Wednesday 2 Dec (10:30) – focus was on Wales and west Midlands (Significant impacts) for Days 4/5

FGS on Thursday 3 Dec (10:30)
Hong Kong

ECMWF against Best Track - Hato (1713) 100 kt Max

Error for Max. Wind

-30 kt
T +36 h
-50 kt
-60 kt

KLM887 (AMS → HKG)

UTC 02:21:30 (Lat: 22°00′32″ Long: 113°49′25″)
Geometric Height: 4325 ft
Ground Speed: 274 kts
ECMWF against Best Track - Pakhar (1714) 60 kt Max

Error for Max. Wind

Max. Wind [kt]

-30 -25 -20 -15 -10 -5 0 5 10 15 20

T-30 T-12 T-24 T-36 T-48 T-60

T +24 h

-20 kt

-25 kt
Use of Satellite Data – Detection & Nowcast

Initial time: 201711020720
Forecast hr: 6

The numbers are the cloud top height (x100 feet)
Blue: Actual  Green: Fcast (6hr pos)

(Purple : actual; Green : forecast)
Regional Hazardous Weather Advisory
Commercial Products

TAMDAR Point

EDR-based turbulence forecast
(Schneider Electric)
Commercial Products

TAPS turbulence observation (WSI)
Commercial Turbulence Reports

- **Automatic** reporting
- Effectiveness depending on **crowdsourcing**
- Validate / enhance **NWP**
- Available only to **subscribers**
- **Proprietary** information
WMO AMDAR Programme

- Enable turbulence reporting
- Data shared within MET community
- **Idea:** Global/regional database for sharing both AMDAR and commercial reports (PPP) – Win-Win-Win
Turbulence Avoidance a Priority from Airline Perspective
Future

• Many private companies offering data and alerting systems, but operate independently.
• For maximum benefit the industry requires a global approach.

Global solutions led by observatories (NMHSs)
Data, data, data...

ADS-B receiver

MET-ATM integrated display system

Daily ADS-C reports

- 1-4
- 5-9
- 10-14
- 15+

“ADS-C Observations”, ET-ABO-3, Jakarta, 2017
Terminal Area
HI Weather
Weather Impact
(Terminal Area)
### WMO - AvRDP

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Climate Region</th>
<th>Weather Elements to be Studied in Autop</th>
<th>Probability of Avoidance under Convective Weather</th>
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</thead>
<tbody>
<tr>
<td>Noth McNicoll Airport (CDD)</td>
<td>Meridional in Northern Hemisphere</td>
<td>Mist, fog, snowfall, ice, low temperature</td>
<td>Fog</td>
</tr>
<tr>
<td>Hong Kong International Airport (VHH)</td>
<td>Subtropical in Northern Hemisphere</td>
<td>Low visibility and fog</td>
<td>Fog</td>
</tr>
<tr>
<td>O.R. Tambo International Airport (JNB)</td>
<td>Subtropical in Southern Hemisphere</td>
<td>Convective weather</td>
<td>Fog</td>
</tr>
<tr>
<td>Shangai Hongqiao Airport (SHA)</td>
<td>Subtropical and Mid-High Attitude in Northern Hemisphere</td>
<td>Convective weather</td>
<td>Fog</td>
</tr>
<tr>
<td>Tokyo Haneda International Airport (RJTT)</td>
<td>Mid-latitude in Northern Hemisphere</td>
<td>Winter weather - snowfall, ice, precipitation type and amount, wind, visibility, wind speed, direction change, and gusts, turbulence, and low ceiling</td>
<td>Fog</td>
</tr>
</tbody>
</table>

**Probability of avoidance under convective weather**

![Probability Map](image.png)

**Significant Convection Monitoring and Forecast**

![Forecast Map](image.png)
Terminal Area - Impact-based forecast
Probabilistic Forecast

Probability Ceiling < 1000ft

"Applying Probabilistic Aviation Forecast Grids from the LAMP/HRRR Meld"
18th Conf on Aviation, Range, and Aerospace Meteorology, Seattle, 2017
Aerodrome HI Weather
Aerodrome – Observations

Long-range LIDAR: windshear

Short-range LIDAR: wake vortex
Aerodrome – Sub-km model simulation

64 flights reported windshear during that day of which 3 reached 30 kt. Model simulation provided good guidance to forecaster.
Nowcasting – airport lightning

Site-specific alerting within the airport to maximize serviceable time with POD > 95%
Nowcasting – deeping learning

Prediction accuracy vs prediction horizon

Different parameters are used in ROVER1,2,3 optical flow estimators

Deep learning
Optical flow
WHAT : ATM Requirements

MET-ATM integration for CDM (B1, ACDM, B1-DATM, B1-SWIM, B1-AMET)

Improved upper air winds and thunderstorm forecast to optimize departure, surface and arrival management (B1-RESQ, B1-CDO)

RVR forecast to optimize airport accessibility (B1-APTA)

Improved en-route weather forecast to optimize ATS routing (B1-FRTO, B1-NOPS, B1-TBO)

Wake turbulence, wind forecast to increase runway throughput (B1-WAKE)

Improved wind and thunderstorm forecast to optimize airport accessibility (B1-APTA)
Illustration of the temporal and spatial relationship between meteorological phenomena and aviation interest area

**HOW: Research**
- Predictability
- Scalability
- Fit for purpose
- Uncertainty
Concluding Remarks

- Paradigm shift in service provision (global / regional / subregional / national)
- High competitive environment (PPP)
- Service edge depends on research
- Informed by state-of-the-art science & data (authoritative)
- Communicate uncertainties (lead time, scale)
- Engage the users as partners
- Deliver the best to stay ahead of the game
Thank you