CAS/CAeM AVIATION RESEARCH DEMONSTRATION PROJECT (AvRDP) OVERVIEW

Joint AvRDP SSC Concluding Meeting

cum Aviation Serminar

19 – 22 Aug 2019

South Africa Weather Services (SAWS)

PW Peter Li

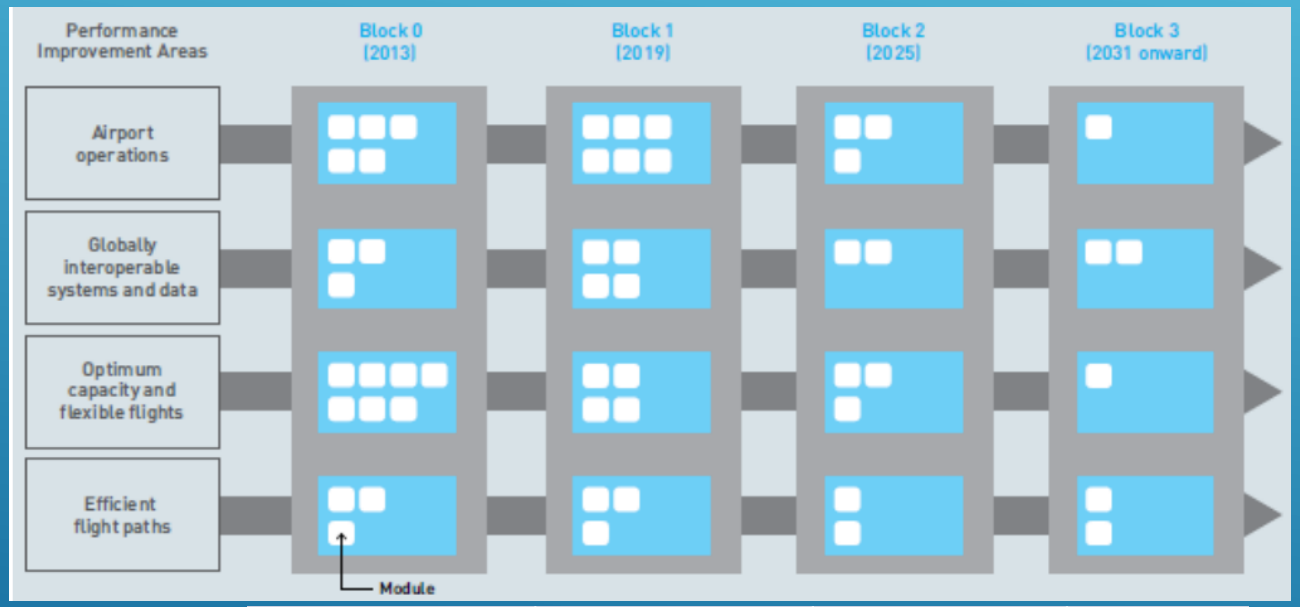
Chair, AvRDP SSC

ICAO Global Air Navigation Plan (GANP)
MET developments as part of the Aviation System Block Upgrades (ASBU) methodology and timeline (15+yr strategic direction)

WMO CAS/CAeM Aviation Research Demonstration Project (AvRDP)

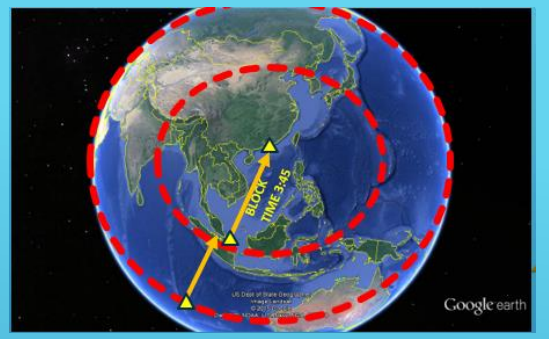
National Projects:

- *SESAR – Europe*
- *NextGen – USA*
- *CARATS – Japan*
- *SIRIUS – Brazil*
- *China*
- *Canada*
- *Etc.*



Advanced MET Information (AMET)

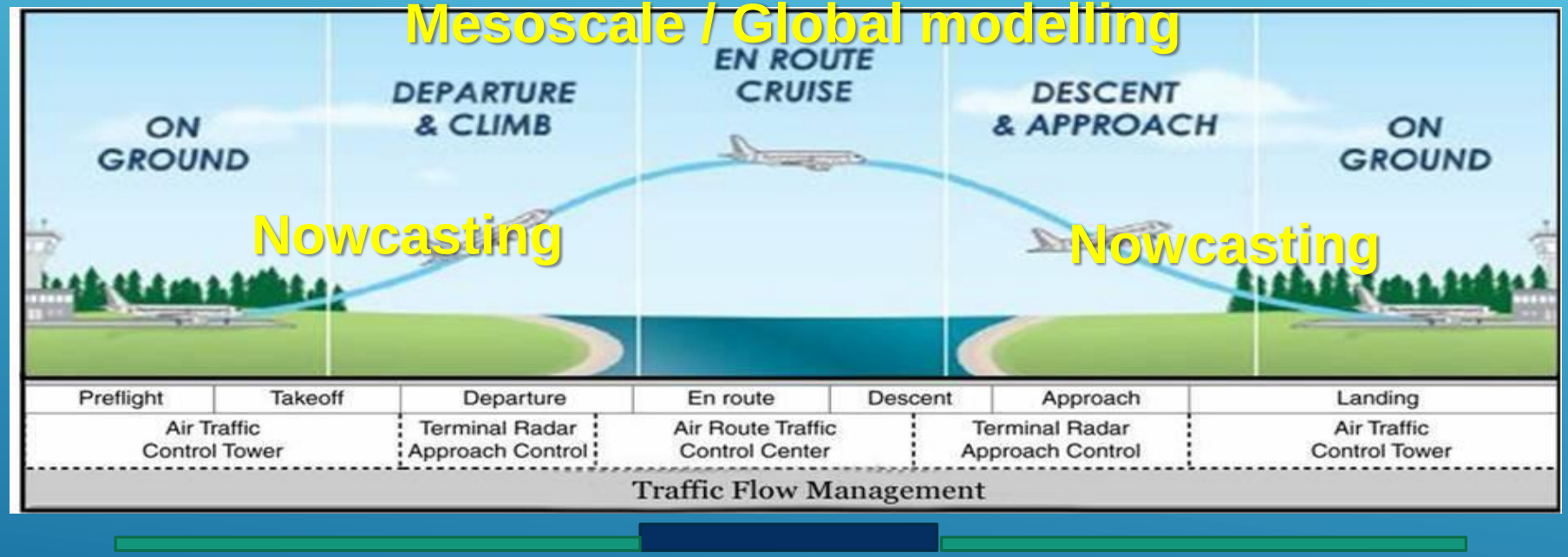
Trajectory-based operation (TBO)



~ 6 ours flight radius

- Seamless MET information, not bounded by FIR
- Trajectory-based operation; gate-to-gate info

Seamless nowcasting -> mesoscale -> global scale -> mesoscale -> nowcasting scale



Terminal Control Area: Location specific

En Route Phase: Supported by Satellite and models

Terminal Control Area: Location specific

6+5 AvRDP AIRPORTS

AvRDP Airport	Climatological regime	Weather elements to be studied in AvRDP
Charles de Gaulle Airport (CDG) 	Mid-latitude in Northern Hemisphere Location: Inland	Winter weather - snowfall, icing, low temperature Fog
Hong Kong International Airport (HKG) 	Subtropical in Northern Hemisphere Location: Surrounded by water Next to high mountain	Convection and Thunderstorm Low visibility and ceiling
O.R. Tambo International Airport (Johannesburg Airport) (JNB) 	Subtropical in Southern Hemisphere Location: Inland	Convection Fog
Shanghai Hongqiao Airport (SHA) 	Subtropical/mid-latitude in Northern Hemisphere Location: Inland not far away from River Estuary and East China Sea	Convective weather
Toronto Pearson International Airport (YYZ) and Iqaluit Airport (YFB)  	Mid-latitude in Northern Hemisphere Location: Inland but not far away from Lake High-latitude in Northern Hemisphere Location: On Frobisher Bay	Winter weather – snowfall, icing, precipitation type and amount, visibility, wind speed, direction shear, and gust, turbulence, and low ceilings Convective Weather Artic weather – Winds, blowing snow, fog, visibility, ceiling

Changi Airport (SIN) 	Tropics 01°21'33.16" N103°59'21.5"E 2 Runways: 02/20 Location: Coastal	Convective Thunderstorm
Pulkovo Aiport (LED) 	Mid-latitude in Northern Hemisphere 59° 48' N 30° 15' E 2 Runways: 10/28 Location: Inland but between 2 Lake	Visibility and Cloud Ceiling
Indira Gandhi International Airport (IGI) 	Subtropic in Northern Hemisphere 28°34'07''N 77°06'44''E 3 Runways: 09/27 10/28 11/29 Location: Inland	Summer Convection Winter Fog/Low VIS
Tokyo Airport (Narita/Haneda Airport) 	Subtropic in Northern Hemisphere 35°45'55''N 140°23'08''E 2 Runways: 16/34 Near shore	Summer Convection A/P TS, Low VIS, Cloud ceiling winds ATC Sectors Convection Low level winds

Joined since 2015

Joined since 2017/18

AvRDP OBJECTIVES – 2 PHASES 1 CAP BUILD

A joint effort between CAS/WWRP and CAeM in 5 years (2015-2019)

- **Phase I (MET Capability enhancement)**
  - to conduct research in **nowcasting and mesoscale modelling** at a number of **international airports** located in Northern and Southern Hemisphere with a view to supporting the development of the next generation aviation initiative, the Aviation System Block Upgrade (ASBU) under the new Global Aviation Navigation Plan (GANP) of International Civil Aviation Organization (ICAO). Key concepts under ASBU are the development of seamless **Trajectory-Based-Operation (TBO**, or "gate-to-gate").
- **Phase II (MET-ATM translation)**
  - to collaborate with the respective Air Traffic Management (ATM) to **translate** the Meteorological (MET) information into ATM Impact products so as to **demonstrate the benefits** of the MET information (nowcast and mesoscale modelling) in the aviation industry;
- **Capacity Building**
  - to help in **capacity building** via the knowledge gained in AvRDP other WMO Members who need to enhance their aviation MET services so as to meet the ASBU initiative.

4 COMPONENTS

A. Nowcasting Component

(i) Radar-based nowcasting system or satellite-based nowcasting system, including human-machine interfaced and expert system-based system;
(ii) Convection-resolving mesoscale or microscale NWP model;
(iii) Blending of observations with high resolution NWP model;
(iv) Blending of radar/satellite-based nowcasting products with NWP system; and
(v) Ensemble/probabilistic nowcasting product.

B. Verification Component

C. Impact and validation Component (MET-ATM Translation)

D. Capacity Building Component

The AvRDP will include a couple of training workshops that include lectures, demonstration and hands-on training activities geared toward capacity building and ultimately technology transfer. The aim is to enable WMO Members enhancing their aviation weather services in order to meet the ASBU requirements.

2 PHASES

- **Phase I**
  - Focuses on MET research and development
  - Concluded in 2017 (except for the new airports)
  - Preliminary results presented at the WMO 4th International Symposium on Nowcasting and Very-short-range Forecast (WSN16, http://wsn16.hk) Hong Kong in July 2016
  - Capacity building: 1st Training Workshop back-to-back with the Symposium focusing on enhanced nowcasting and forecasting techniques
- **Phase II**
  - Focuses on translating MET information into ATM impact
  - Capacity building: Hong Kong, China has organized a 2nd Workshop via the WMO Voluntary Cooperation Programme (VCP) on the MET-ATM translation and integration on 8-10 October 2018 (https://worldweather.wmo.int/vcp_2018/index.php)

AVRDP TIMELINE

Nov 2014	**Endorsement of the AvRDP proposal by WWRP SSC**
Nov 2014 – Feb 2015	Formation of AvRDP SSC and identification of AvRDP Participants
24 – 26 Jun 2015	Kick-off Meeting cum Science Meeting
May 2015 – 2017+	***Phase I – MET capacity research***
May 2015 - Oct 2015	1st IOP for convective weather (over Airports in Northern Hemisphere)
Nov 2015 – Mar 2016	1st IOP for winter weather, visibility and ceiling (over Airports in Northern Hemisphere)
Dec 2015 – Mar 2016	2nd IOP for convective weather (Southern Hemisphere)
May 2016 – Jul 2016	3rd IOP for convective weather (Northern Hemisphere)
Nov 2016 – Mar 2017	2nd IOP for winter weather, visibility and ceiling (Northern Hemisphere)
May 2015 – Jul 2017	Nowcasting research including MET verification on convective weather
Nov 2015 – Jul 2017	Nowcasting research including MET verification on winter weather, visibility and ceiling
20 - 22 Jul 2016	1st AvRDP Training Workshop on aviation nowcasting and mesoscale modelling
22 – 23 Jul 2016	2nd SSC Meeting
25 – 29 Jul 2016	Preliminary Phase I results presented in WWRP Symposium on Nowcasting and Very-short-range Forecast
Jul 2016 – Sep 2019	***Phase II – MET-ATM impact translation and validation (some airports started later)***
Jul 2016 –	Research on MET-ATM impact translation
Jul 2017 –	Demonstration of MET-ATM impact
6 - 10 Nov 2017	AeroMetSci-2017 Conference & 3rd SSC Meeting
Jan 2018	4 more airports joined the Project
8 -10 Oct 2018	2nd AvRDP Training Workshop on ATM-MET integration
11 – 12 Oct 2018	4th SSC Meeting
Oct 18 – Sep 2019	Continue MET-ATM impact translation and demonstration
Aug 2019	Concluding Meeting & Seminar

Phase I

Phase II

MEETINGS AND WORKSHOPS

- Concluding Meeting & Seminar (19-23 August 2019)
- 4th SSC Meeting (11-12 October 2018)
- 3rd SSC Meeting (6-7 November 2017)
- 2nd SSC Meeting (22-23 July 2016)
- Kick off Meeting (24-25 June 2015)

- WMO VCP Workshop on Meteorology - Air Traffic Management Integration (MET-ATM) (8-10 October 2018)
- Aviation Nowcasting Capacity Building Workshop (20-22 July 2016)
- WSN 16 (25-29 July 2016)

KICK-OFF MEETING (24-25 JUNE 2015, SHANGHAI)

Name (Last, First)	Affiliation
BAZLOVA, Tatiana	IRAM
BOCHARNIKOV, Nikolai	IRAM
BRENGUIER, Jean-Louis (by Video Conference)	Meteo-France
CHADWICK, Peter (by Video Conference)	CAD, HK
CHEN, Baode	SMS
CHEN, Zhenlin	SMS
de CONING, Estelle	South Africa Weather Service
DAI, Jianhua	SMS
DESBIOS, Stephanie	Meteo-France
DIALLO, Alpha Mamadou Malaado	ANACIM
HAROU, Abdoulaye	WMO
LAU, Sharon	Hong Kong Observatory
LI, Peter	Hong Kong Observatory
MINER, Cecilia (by Video Conference)	NOAA
MITTERMAIER, Marion (by Video Conference)	UKMO
NIKITINA, Larisa	ROSHYDROMET
REID, Janti	Environment Canada
RUTI, Paolo	WMO
SEED, Alan	Bureau of Meteorology Australia
SHUN, CM (by Video Conference)	Hong Kong Observatory
STRAHAN, Matt	NOAA
TANG, Xu	WMO
TIAN, Cuiying	CMA
WANG, Fengyun	CAAC
WANG, Jianjie	CMA
WANG, Yong	ZAMG
YANG Yinming	SMS
YU, Jun	CMA
ZHANG, Zhikai	CAAC
ZHANG, Zhongfeng	CAAC
ZHOU, Qingliang	CMA
LOC	
QIQIGE, Wuyun	SMS
LI, Baiping	SMS

3RD AvRDP SSC (6-7 NOV 2017, MeteoFrance)

- The Meeting agreed on adding 4 new airports
  - LED (Russia), IGI (India), NRT (Japan), SIN (Singapore)
- Time line:
  - The meeting decided to extend Phase II of the project to summer 2019.
- Verification:
  - It was proposed that verification activities be focused on convection
  - It was agreed that a Guidance material for meteorologists on how to evaluate convection be prepared.
- Training Workshop:
  - The meeting agreed to organize a three-day training workshop in October 2018 (Venue TBD) focusing on Aviation Impact (MET-ATM translation)
- AvRDP activities to be incorporated in the WWRP Implementation Plan (2016-2023)
- The meeting decided that the drafting of a Project Implementation Plan for the (CBS/CAeM/CAS) Inter-commission Aviation Research Project (2019) should start in 2018 for presentation to the next WMO Congress in spring 2019 (EC-68 supported the transition of the AvRDP to an extended aviation research project)

4TH AVRDP SSC (11-12 OCT 2018, HONG KONG)

- Progress: Most Airports have completed/nearly completed Phase I (MET enhancement) and moving towards Phase II (MET-ATM Integration)
- Main deliverable: To publish a WMO guideline on MET-ATM Integration based on the outcomes of the AvRDP for other Members' reference, to public a scientific journal on AvRDP
- Concluding Meeting and Seminar (Oct 2019):
  - To conclude the Project outcomes
  - To endorse the Implementation Plan of the extended Aviation Research Project

Airport	Phase I (MET capability)	Phase II (MET-ATM translation)
HKG	√	On going
CDG	√	On going
JNB	√	On going
SHA	√	On going
YYZ	√	Progress slow*
YFB	√	Progress slow*
IGI	On going	to come
LED	On going	On going
NRT	On going	On going
SIN	On going	to come

WMO VCP WORKSHOP ON MET-ATM INTEGRATION (HONG KONG, OCTOBER 2018)

- Attended by a total of 20 participants from 17 countries (18 States/Administrations) in WMO Regions I, II, IV, V and VI
  - Australia, China, Congo, Egypt, Honduras, India, Malaysia, Mongolia, Myanmar, Nepal, Nigeria, Russia, South Africa, South Sudan, Thailand and Uzbekistan.
- Lectures included:
  - MET-ATM integration practices at various AvRDP airports;
  - Modernization programmes - SESAR, NextGen, CARATS;
  - ATM requirements under the GANP/ASBU;
  - Regional network flow coordination;
  - Verification and validation;
  - XML and ASEAN SWIM Demonstration; and
  - Aviation nowcasting, mesoscale NWP and relevant forecasting techniques and tools.
- provided free access to a nowcasting software (COM-SWIRLS) (https://rsmc.hko.gov.hk/nowcast/) and web platforms for capacity building

https://worldweather.wmo.int/vcp_2018/index.php

FEEDBACK FROM WORKSHOP PARTICIPANTS

What benefits have you received from this workshop?

- Better understanding on CDM and how to conduct **MET-ATM impact assessment**.
- Experiences on advanced aviation forecast technique and **MET-ATM integration progress shared by HKO**
- Understand the importance of forecast information to users. Know how USA, Japan, Hong Kong China develop products to improve forecasts for aviation
- **Information in IWXXM in SWIM**. Modelling of Meteorological parameters, e.g. for fog forecasting.
- Learnt much about **collaboration with relevant stakeholders** on how to transform or translate MET information to impact particularly to the end-users.
- **Verification of MET forecast** for ATM.

Feedback from workshop participants

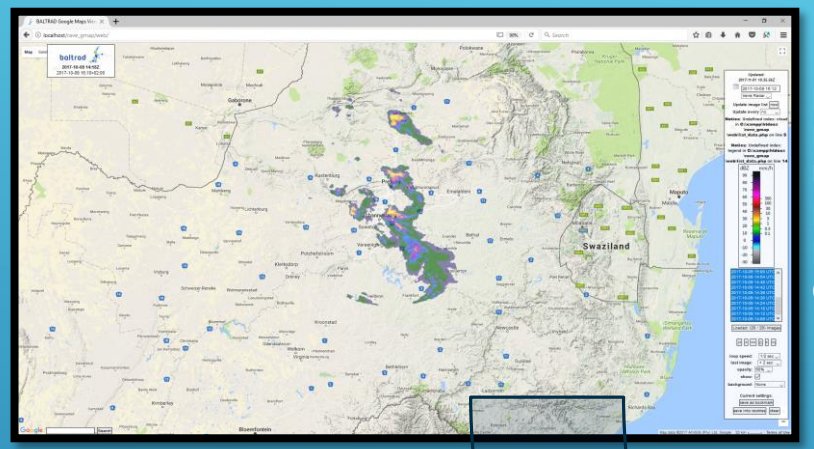
What new ideas, skills, procedures or attitudes do you intend to implement/apply when you are back to your office?

- Nowcasting
- How to start and proceed with the collaboration with ATM
- Business cases for MET-ATM integration
- Collaboration with new colleagues from other countries
- Keep on the work on translation. Make progress on MET-ATM integration and validation
- Further contact with ATM to reach the best ways to achieve integration with MET-ATM in Egypt
- Improve the forecast
- New blending of products, visualization and impacts
- How to adapt or implement IWXXM
- Share experience on IWXXM. This workshop provided me with the method to start the collaboration between MET and ATM in my country
- Translation of weather information into weather impact information
- Share the workshop information with the relevant stakeholders, including ATC and airlines
- Leant much about how to structure MET-ATM integration and management system for my country
- Leant more about SESAR and SWIM
- To start identify the MET information that is important for collaboration with ATM

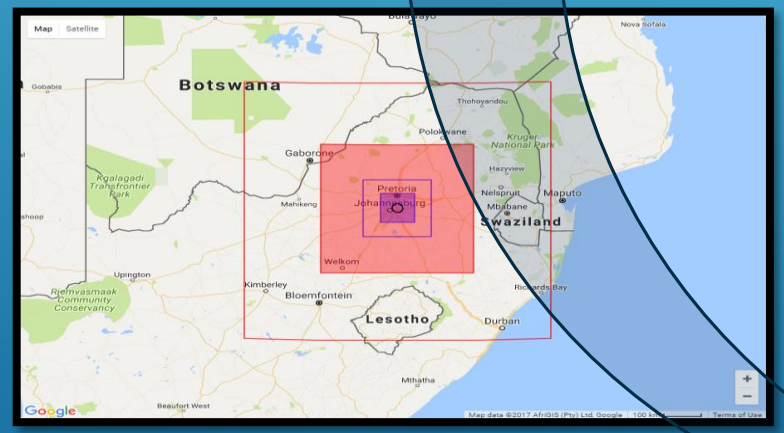
AVRDP AIRPORTS' PROGRESS

Airport	Phase I (MET capability)	Phase II (MET-ATM translation)	Remarks
HKG	✔	✔	
CDG	✔	✔	
JNB	✔	✔	
SHA	✔	✔	
YYZ/YFB	✔	stopped	Mission changed
IGI	✔	✔	
LED	✔	✔	
NRT/HND	✔	✔	
SIN	On-going	Not started	

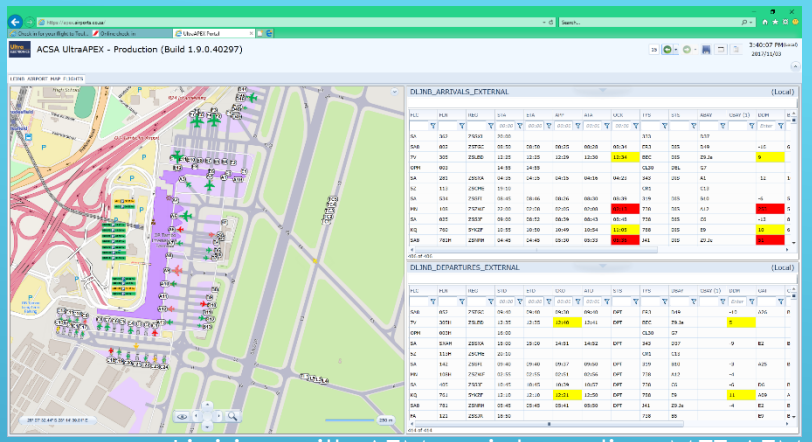
JNB (JOHANNESBURG AIRPORT)



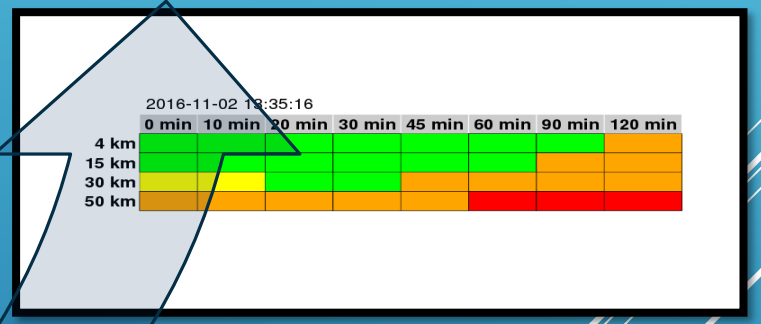
Radar-based Com-SWIRLS
Nowcasting system
Updates every 6 min
Lead-Time extrapolation = 2 Hour
Resolution = 1 km
Operational end of 2017

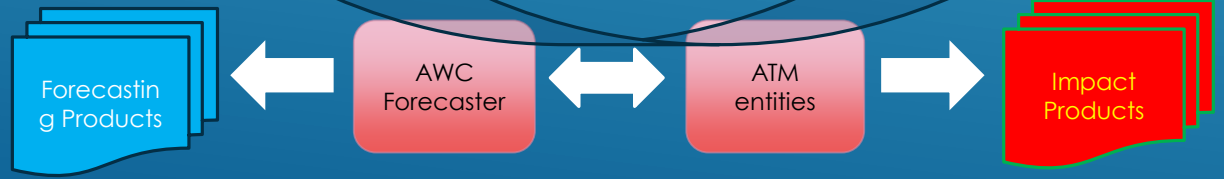


UKMO down to 300 m resolution
Storm moved over OR Tambo Int. Airport
Severe impact on airport operations



Liaising with ATM on integrating MET-ATM





Likelihood		Minimal	Minor	Significant	Severe
	High		2	6	10
	Medium		1	5	9
	Low			4	8
	Very Low			3	7
		Impact			

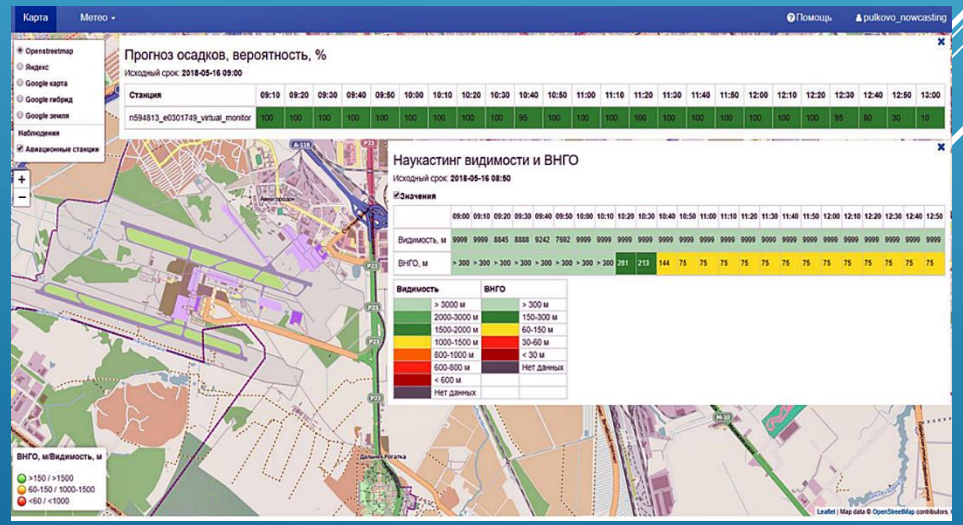
Risk Matrix Table

LED (PULKOVO AIRPORT)

- **Stage 1 (1st IOP, finished):** 01.02.18 – 31.05.18
  - Additional equipment (AWS station) was installed at the aerodrome meteorological observational site
  - MeteoExpert nowcasting system (visibility, ceiling and precipitation, 4h ahead at 10-min intervals) was installed and put into operational use since 16.02.2018
  - Observations and nowcasts data are archived in MeteoCube database and visualized on the forecasters workstation and at the specialized website
  - Nowcasting verification scheme was developed.

- **Stage 2 (2nd IOP + Phase II):** 01.08.2018 – 01.12.2018
  - Development and operational use of advanced nowcasting scheme using additional weather stations and temperature profiler MTP-5 (to collect high density, rapidly updated observations for nowcasting system).
  - Development of the technology for nowcasts data translation into the ATM systems (preliminary to ATM Simulator) by the means of MeteoServer system to identify the requirements and benefits from end user's perspective

Aerodrome Pulkovo forecaster's working desk



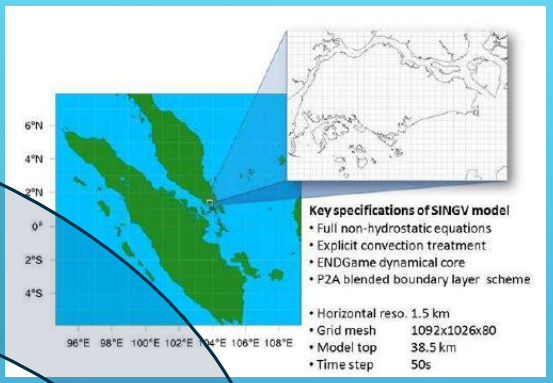
MeteoExpert nowcasting system (website configuration

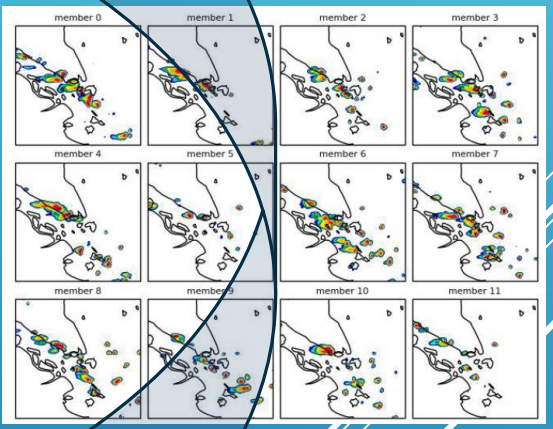
SIN (CHANGI AIRPORT)

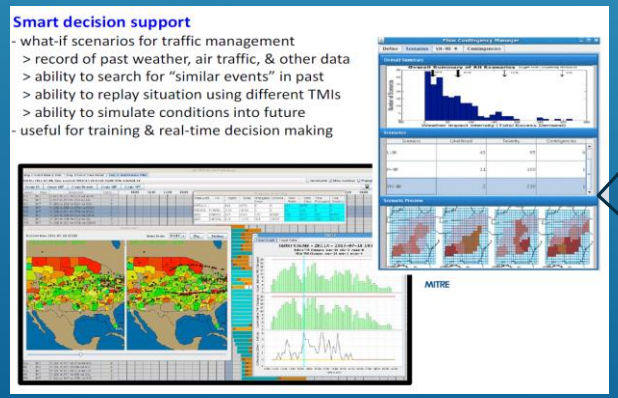
- **Phase I (Jun 18 – Dec18)**
  - Enhanced Nowcast system of convection
  - IOP (Jun – Sep) NWP (1.5km) to provide guidance
  - Evaluation (Sep – Oct) including user feedback collection
  - Report (Nov – Dec)

- **Phase II (Jan 19 – Jun 19)**
  - Operational trial on MET Impact Translation on air traffic flow management and airside operation (Jan – Mar)
  - Review and analysis (Apr – May)
  - Final Report (Jun 2019)

Airport	Observations							Nowcasting and Modelling			ATM Data				
	Weather Radar (Doppler)	Geostationary Satellite	Wind Profiler	LIDAR	Automatic weather stations	AMDAR data	Other observations	Nowcasting system	Mesoscale NWP	Regional model	Aircraft position data (ADS-B)	PIREP/ AIREP	Air traffic data	Aircraft data	ATM capacity data
WSSS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

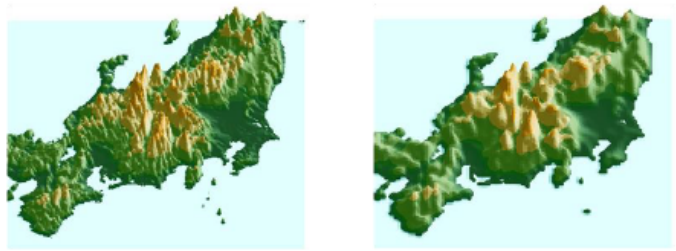






NRT (NARITA/HANEDA AIRPORT)

	Local Forecast Model (LFM)	Meso-Scale Model (MSM)
Grid size and/or number of grids	2 km/ 1,581 x 1,301	5 km/ 817 x 661
Vertical levels/Top	58/ 20.2 km	76/ 21.8 km
Forecast range (Initial time)/number of ensemble members	9 hours (hourly)	39 hours (00, 03, 06, 09, 12, 15, 18, 21 UTC)
Initial condition	3D-Var Analysis	4D-Var Analysis
Operation	2012 -	2001 -



Terrain of the central region of the Main Island of Japan used for the LFM (left, 2-km horizontal resolution) and for the MSM (right, 5-km horizontal resolution)

2km, hourly output

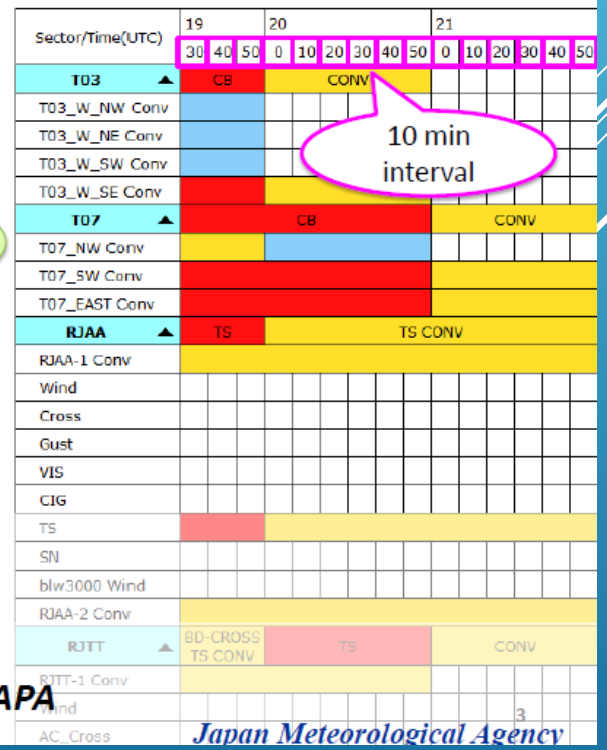
Overview of ATM CIEL (ATM Categorized Impact of weather ELement prediction)

- Contents

The degree to which weather conditions affect **ATC capacity (CAPA) , not air traffic flow.**

It's considered JCAB's operation.

ATM Categorized Impact of weather ELement prediction

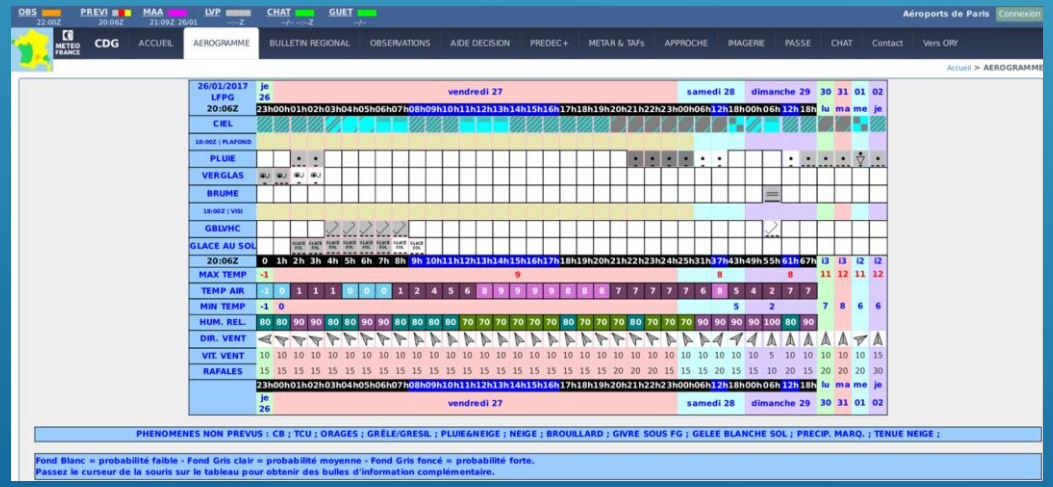


High	**Need to *reduce CAPA* significantly**
Medium	**Need to *reduce CAPA***
Slight	**Need to *reduce CAPA* slightly**
None	**Not need to *reduce CAPA***

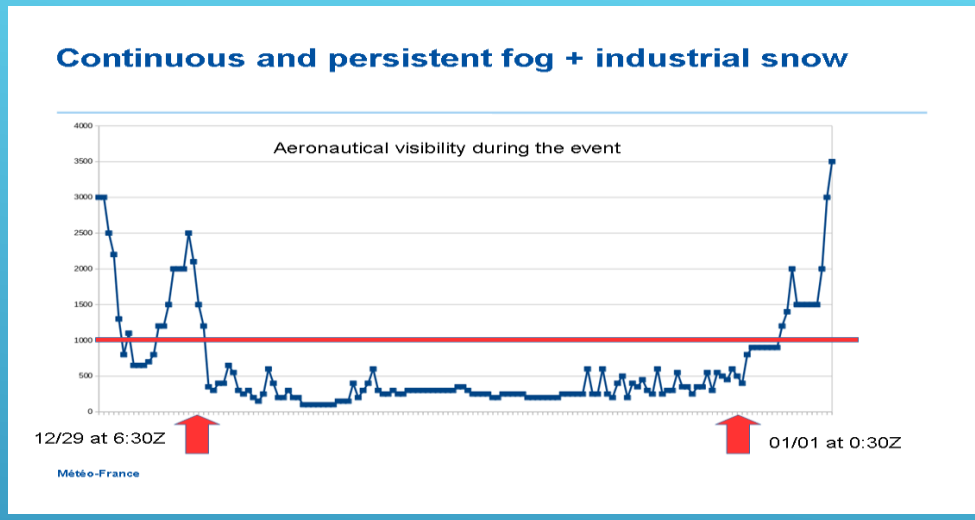
Japan Meteorological Agency

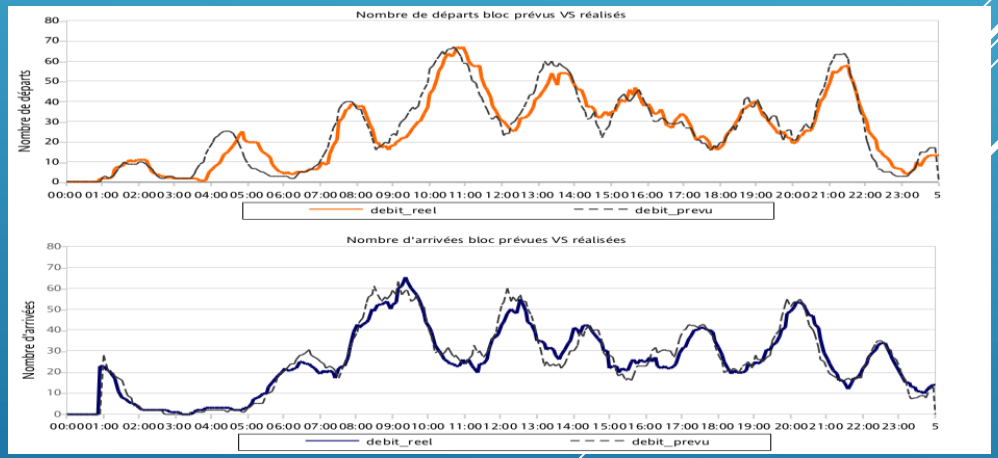
CDG - ATM IMPACT PARAMETER AIRPORT CAPACITY

- Impact of winter weather, including fog, industrial snow and freezing rain using the 1.3 km resolution, hourly updated, rapid output (15min), NWP Nowcasting system AROME-PI.
- A statistical model PEIP which determines on-ground aircraft icing probability has also been developed.
- Integrated AROME-PI forecast with ATM via the CDM@CDG tool for diagnostic and assessing the airport conditions for decision-making.



Weather predictions from CDM@CDG tool

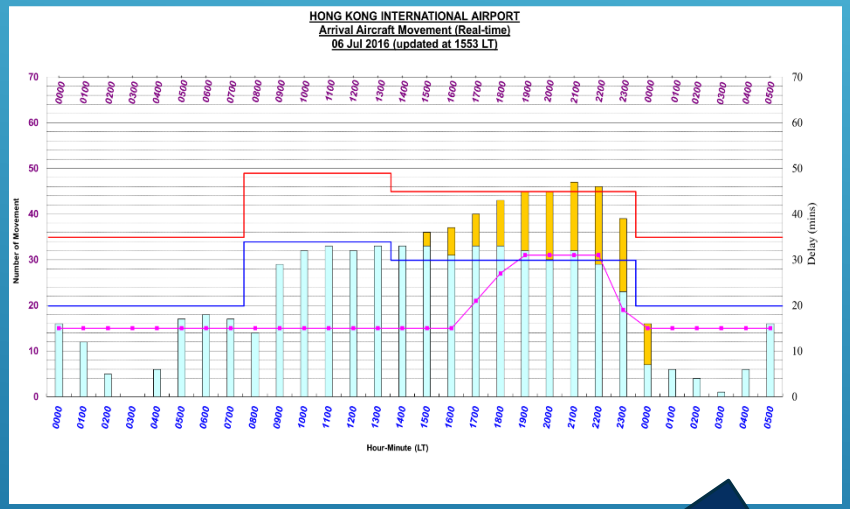


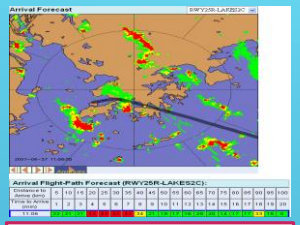


Departure and Arrival Rate well predicted

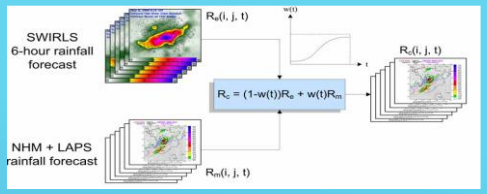
ATM Impact Parameter - airspace capacity reduction

Weather radar overlaid with lightning



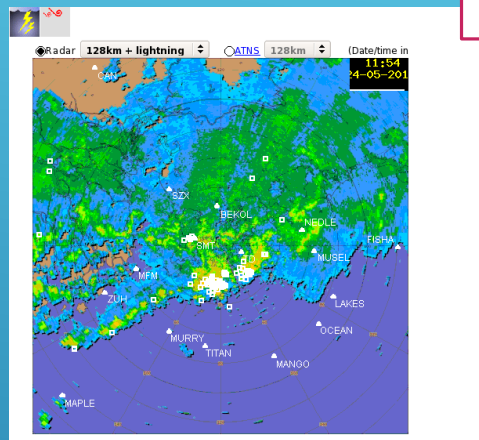


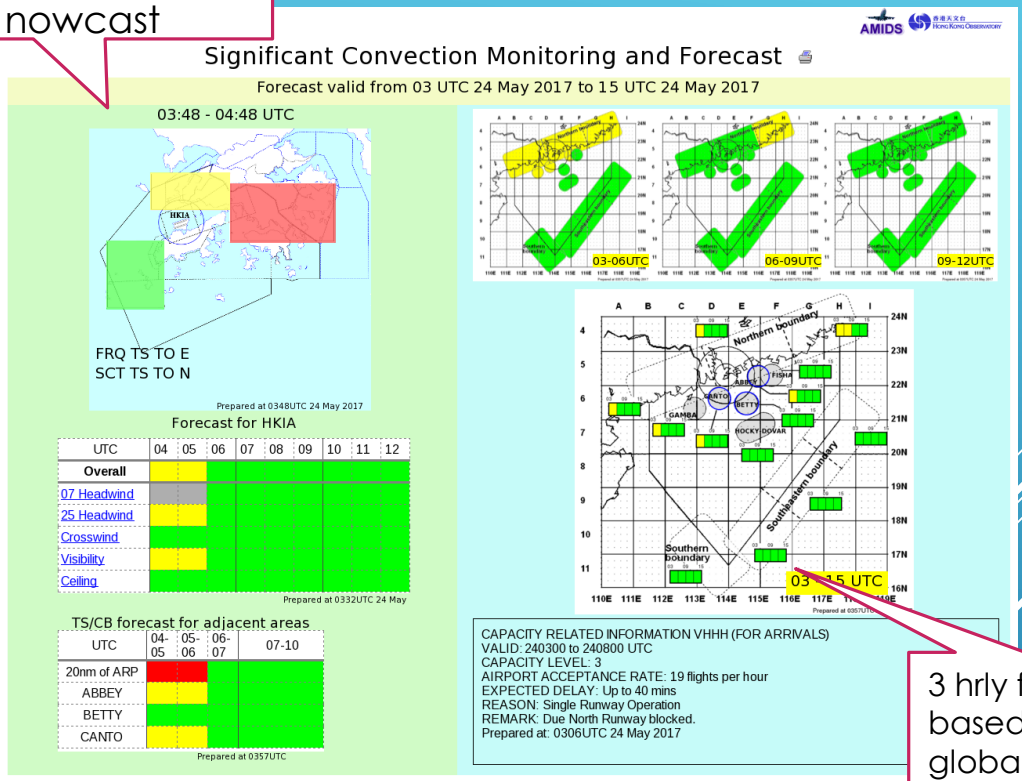
Flight/route specific convection nowcast



Blended nowcasting and non-hydrostatic model to forecast 0 to 6 hrs ahead

0-1 hr nowcast





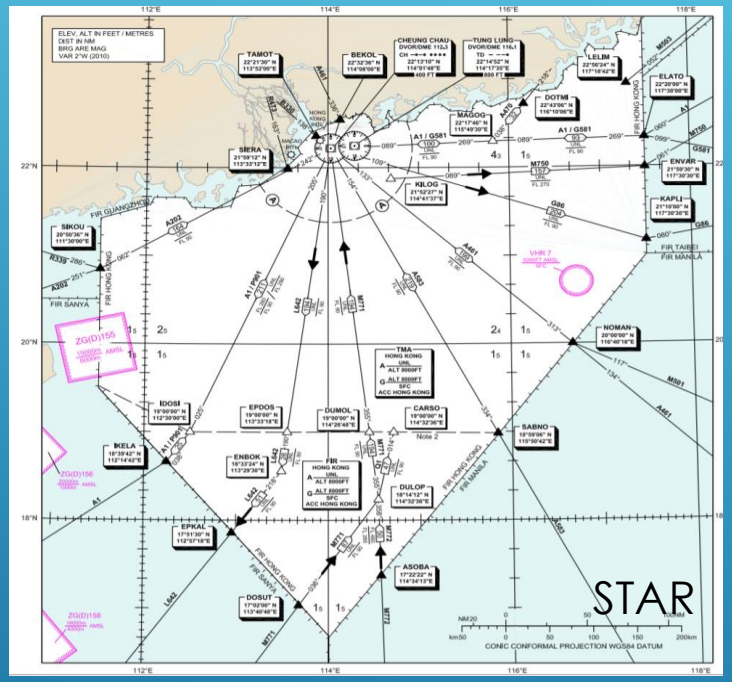
3 hrly forecasts based on global model

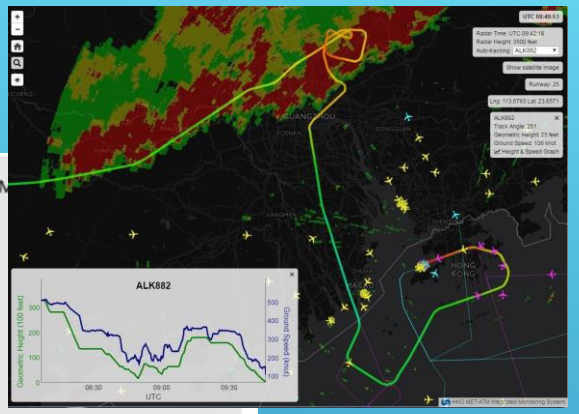
Satellite animation

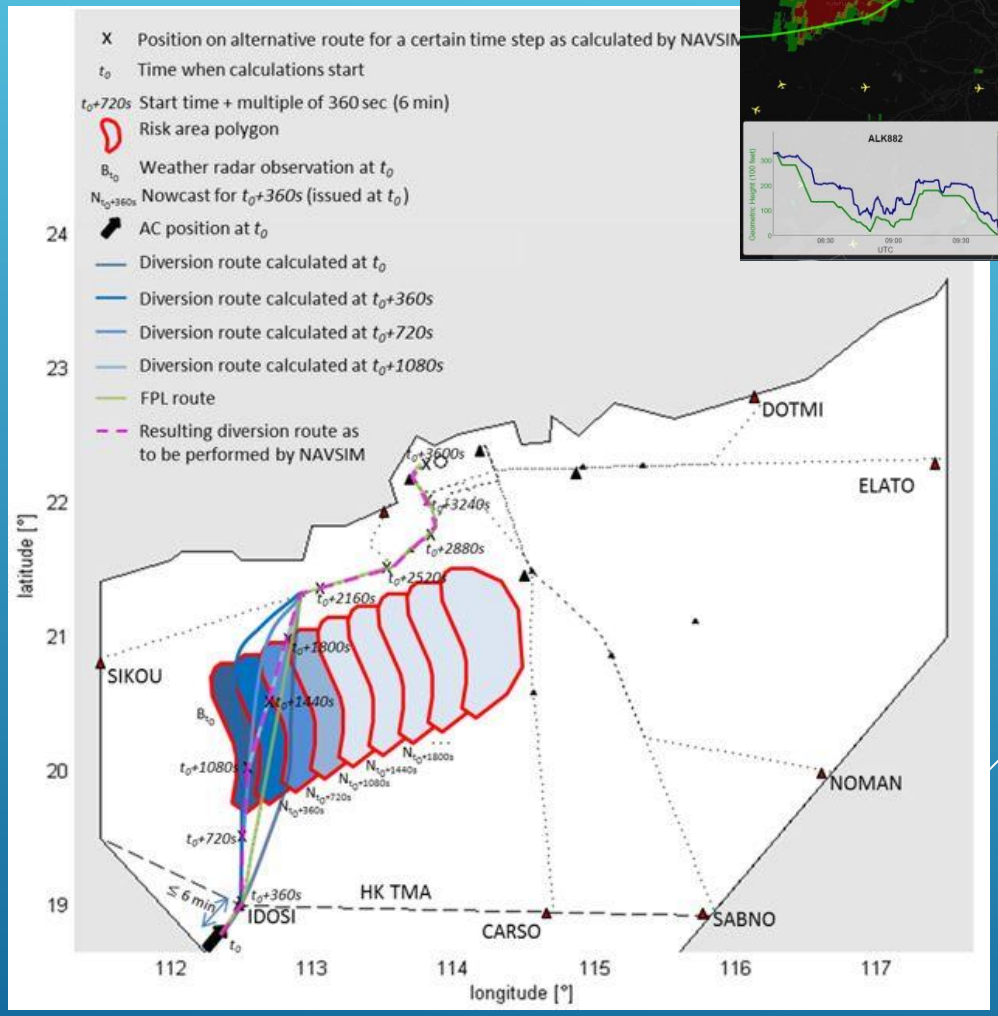
0-6hr blended nowcast over various significant areas

Airport Capacity Notification sent to regional airports

ATM IMPACT PARAMETER – OPTIMIZED FLIGHT TRAJECTORY AND FLIGHT DELAY



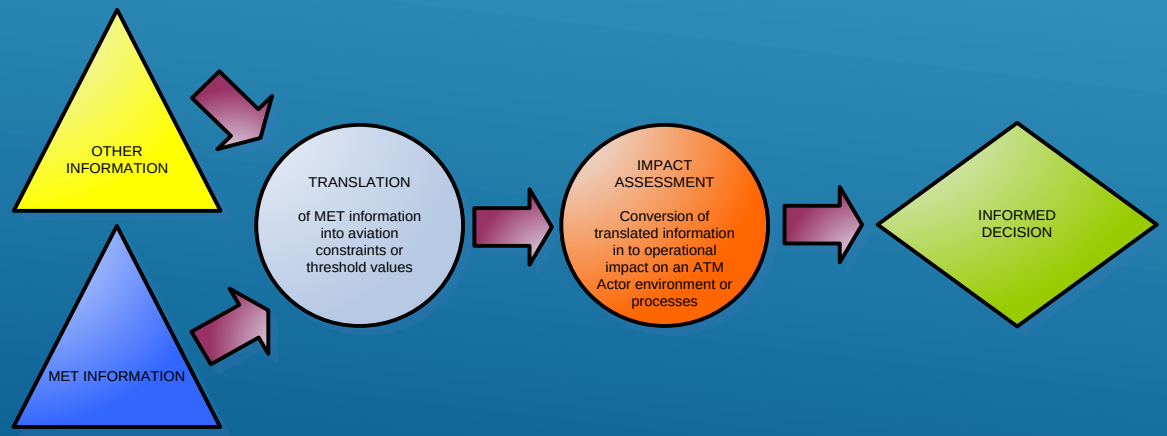




The simulation would be useful for ATC to optimize the sequencing, reduce unnecessary holding, shorten the delay and reduce the waste of fuel to protection environment

TRANSLATION MET INFORMATION INTO ATM IMPACT

- Airport Capacity
- Airspace Capacity
- Arrival/Departure Delay
- Fuel consumption
- Aircraft de-icing, runway clearance, engine icing in freezing fog
- Lightning strike affecting ground ops.



WMO AERONAUTICAL METEOROLOGICAL SCIENTIFIC CONFERENCE

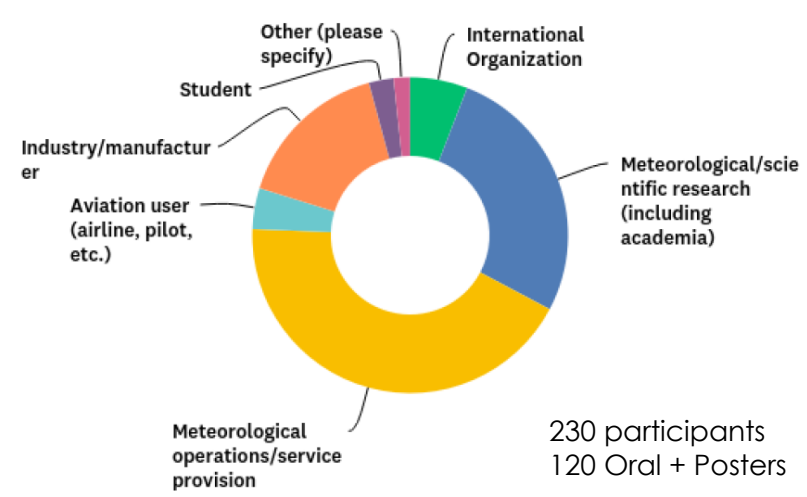
6-10 NOVEMBER 2017
TOULOUSE, FRANCE

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Co-sponsored by:
AIRBUS
Selex ES
A Finmeccanica Company
THALES
METEO FRANCE

THEME: "AVIATION, WEATHER AND CLIMATE: SCIENTIFIC RESEARCH AND DEVELOPMENT FOR FUTURE AERONAUTICAL METEOROLOGICAL SERVICES IN A CHANGING ATMOSPHERIC ENVIRONMENT" -



230 participants
120 Oral + Posters

https://public.wmo.int/en/media/press-release/aeromet-conference-focuses-aviation-safety-efficiency-and-environment

Key Area 1: Aeronautical Meteorology Science
• Ice crystal icing and airframe icing research
• Turbulence research
• Significant convection research
• Wake vortex detection and prediction
• Fog/low visibility research
• Space weather research
• Atmospheric aerosols and volcanic ash research
• Advances in observing methods and use of observations
• Seamless nowcast and numerical weather prediction, probabilistic forecast and statistical methods

Key Area 2: MET-ATM Integration
• In-cockpit and on-board MET capabilities
• Terminal area and impact-based forecast
• En-route hazards information systems
• Translation of MET information for impact and risk assessment
• Collaborative decision-making (CDM), air traffic flow management (ATFM) and network management
• Trajectory-based operations (TBO), flight planning and user-preferred routing
• Use of MET information for climate-optimized trajectories

Key Area 3: Climate Change and Impact on Aviation
• Building awareness of potential impacts
• Jet stream position and intensity and related phenomena, such as CAT
• Extreme weather events and airports, changes to typical scenarios (storm surges, heat waves, visibility regimes, etc.)
• Re-evaluation of airframe/avionics resilience standards and certification
• Focus on downscaling of aviation impacts to regional and local scale

CONFERENCE STATEMENT

- Conference recognized the tremendous amount of ongoing cross-disciplined research in the field of Aeronautical Meteorology. This **collaborative scientific excellence** should be leveraged to enable the future global ATM system.
- The role of MET as a key enabler to aviation's vision for a globally interoperable, harmonized ATM system of the future that is safer, more efficient and more environmentally responsible will only be realized through the **accelerated transition of scientific research and technological advancement into operations** based on aviation users' needs, new and improved community partnerships, trust, transparency and openness.
- As the potential impacts of climate change and variability on aviation operations become better understood, the research community should continue to advance relevant science and **communicate in a style that is well understood by the user**.

Conference outcomes to be used to guide the Roadmap of the CAS/CAeM/CBS Inter-commission Aviation Research Project

B0-AMET (EXISTING TECHNOLOGIES AND CAPABILITIES)

- Block 0 is composed of Modules containing technologies and capabilities which have already been developed and can be implemented today. Based on the milestone framework established under the overall Block Upgrade strategy, ICAO Member States are encouraged to implement those Block 0 Modules applicable to their specific operational needs.

B0-AMET	**Meteorological information supporting enhanced operational efficiency and safety**
	Global, regional and local meteorological information: a. forecasts provided by world area forecast centres (WAFCs), volcanic ash advisory centres (VAACs) and tropical cyclone advisory centres (TCAC); b. aerodrome warnings to give concise information of meteorological conditions that could adversely affect all aircraft at an aerodrome, including wind shear; and c. SIGMETs to provide information on occurrence or expected occurrence of specific en-route weather phenomena which may affect the safety of aircraft operations and other operational meteorological (OPMET) information, including METAR/SPECI and TAF, to provide routine and special observations and forecasts of meteorological conditions occurring or expected to occur at the aerodrome. This information supports flexible airspace management, improved situational awareness and collaborative decision-making, and dynamically-optimized flight trajectory planning. This module includes elements which should be viewed as a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety
	Applicability
	Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.

B1-AMET

B1 are intended to be available beginning in 2019, satisfy one of the following criteria:

- a. the operational improvement represents a well understood concept that has yet to be trialed;
- b. the operational improvement has been trialed successfully in a simulated environment;
- c. the operational improvement has been trialed successfully in a controlled operational environment; and
- d. the operational improvement is approved and ready for roll-out.

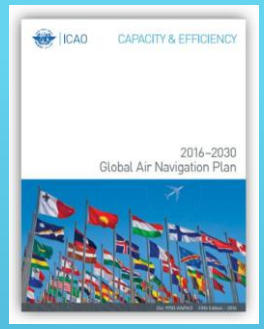
B1-AMET	**Enhanced operational decisions through integrated meteorological information (planning and near-term service)**
	To enable the reliable identification of solutions when forecast or observed meteorological conditions impact aerodromes, airspace or operations in general. Full ATM-Meteorology integration is needed to ensure that meteorological information is included in the logic of a decision process and the impact of the meteorological conditions on the operations are automatically derived, understood and taken into account. The supported decision time-horizons range from minutes, to several hours or days ahead of the ATM operation. This includes optimum flight profile planning and execution, and support to tactical in-flight avoidance of hazardous meteorological conditions (improved in-flight situational awareness) to typical near-term and planning (>20 minutes) type of decision making. This module promotes the establishment of standards for global exchange of the MET information closely aligned with other data domains and adhering to a single reference (ICAO-AIRM). It also promotes the further enhancement of meteorological information on various quality-of-service aspects including the accuracy and consistency of the data when used in inter-linked operational decision making processes. Appreciating that the number of flights operating on cross-polar and trans-polar routes continues to steadily grow and recognizing that space weather affecting the earth's surface or atmosphere (such as solar radiation storms) pose a hazard to communications and navigation systems and may also pose a radiation risk to flight crew members and passengers, this module acknowledges the need for space weather information services in support of safe and efficient international air navigation. This module builds, in particular, upon Module B0-AMET, which detailed a sub-set of all available meteorological information that can be used to support enhanced operational efficiency and safety.
	Applicability
	Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.

B3-AMET (ON-BOARD ADVANCEMENT)

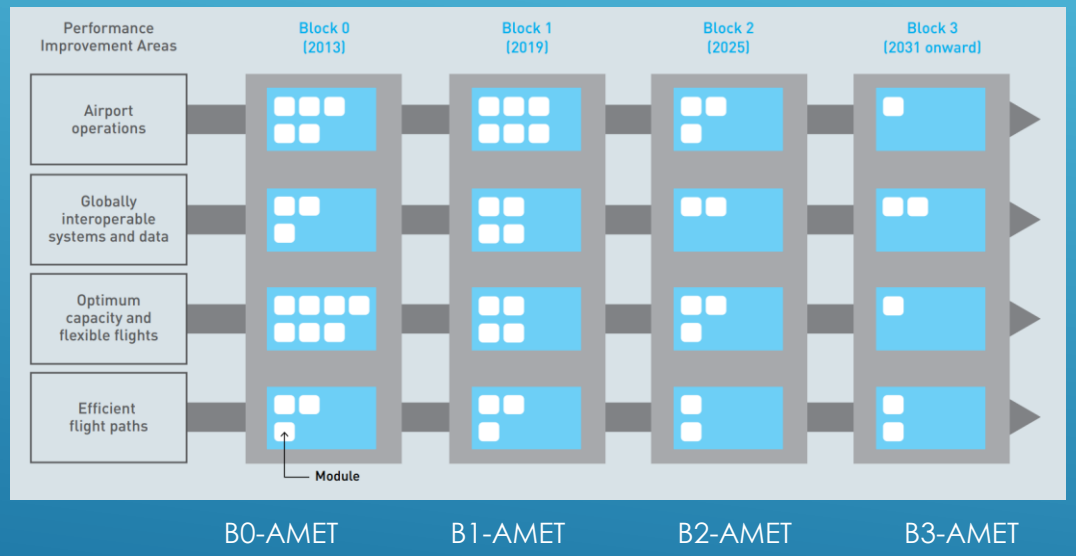
- Block 3, intended to be available for implementation in 2031, must satisfy at least one of the following criteria:
- a. represent a natural progression from the preceding Module in Block 2;
- b. support the requirements of the operating environment in 2031; and
- c. represent an end-state as envisaged in the Global ATM Operational Concept.

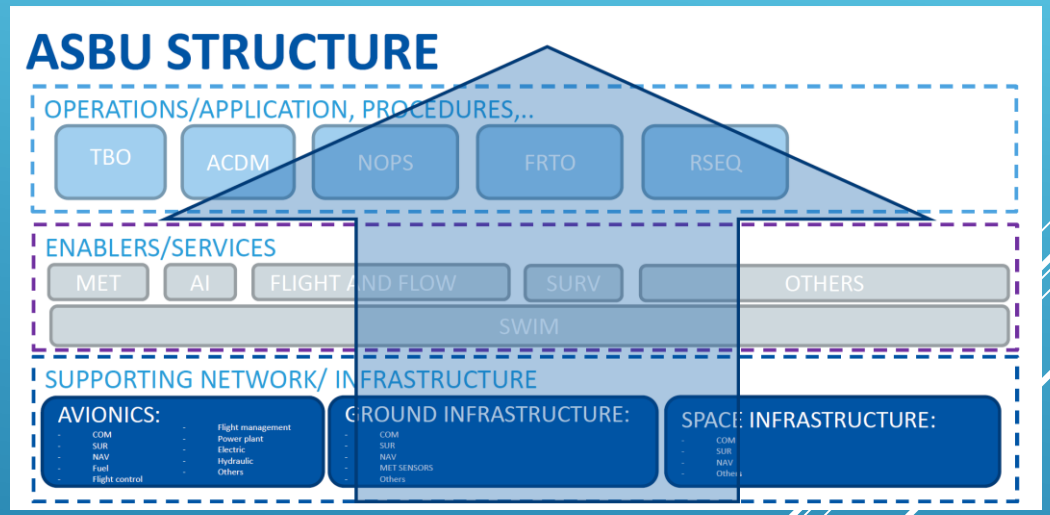
B3-AMET	**Enhanced operational decisions through integrated meteorological information (near-term and immediate service)**
	The aim of this Module is to enhance global ATM decision making in the face of hazardous meteorological conditions in the context of decisions that should have an immediate effect. This Module builds upon the initial information integration concept and capabilities developed under B1-AMET. Key points are a) tactical avoidance of hazardous meteorological conditions in especially the 0-20 minute time frame; b) greater use of aircraft-based capabilities to detect meteorological parameters (e.g. turbulence, winds, and humidity); and c) display of meteorological information to enhance situational awareness. This module also promotes further the establishment of Standards for the global exchange of the information.
	Applicability
	Applicable to air traffic flow planning, en-route operations, terminal operations (arrival/departure) and surface. Aircraft equipage is assumed in the areas of ADS-B IN/CDTI, aircraft based meteorological observations, and meteorological information display capabilities, such as EFBs.

GANP 2016 -> GANP 2019 (DIGITIAL ASBU FRAMEWORK)



https://www4.icao.int/ganpportal/ASBU





ASBU UNDER GANP 2019

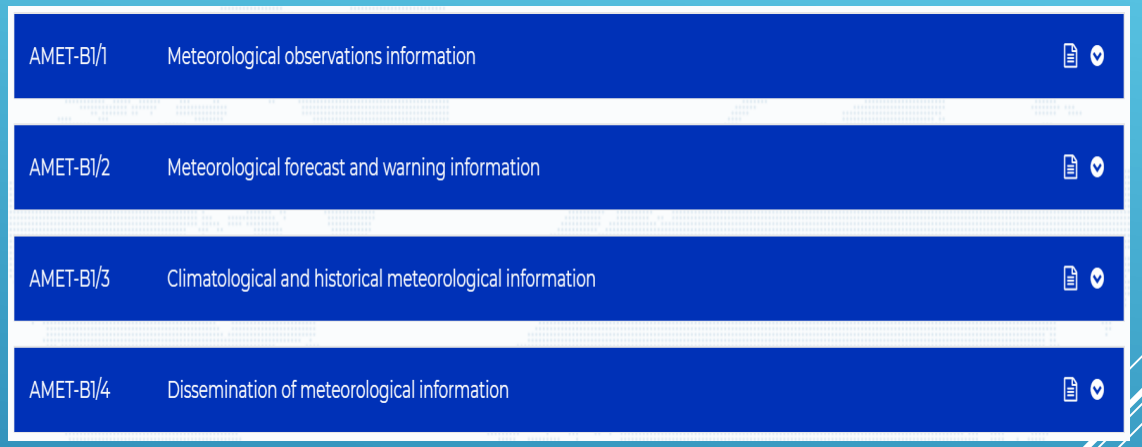
https://www4.icao.int/ganpportal/ASBU?Threads=5

ASBU UNDER GANP 2019

https://www4.icao.int/ganpportal/ASBU?Threads=5

B0 (2013+)

B1 (2019+)

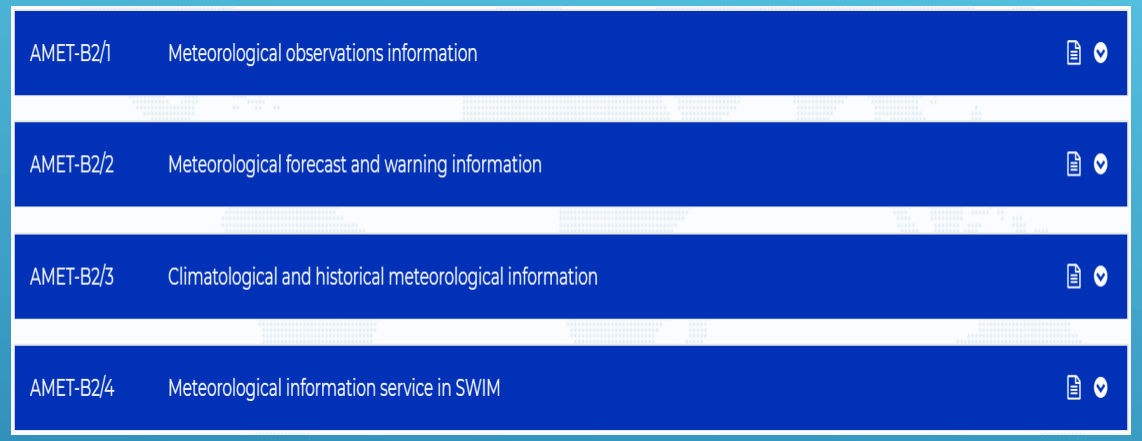


Dissemination of meteorological **products** in support of flexible airspace management, improved situational awareness, collaborative decision-making and dynamically optimized flight trajectory planning

Meteorological **forecast and warning information** for automated support for decision processes or aids and performance based requirements, involving meteorological information, **meteorological information translation, ATM impact conversion and ATM decision processes**.

B2 (2025+) AND B3 (2031+)

B2 (2025+)



Space weather and radioactive material services.
Forecast and warning services for **terminal areas**.
Phenomena-based meteorological information is no longer constrained by FIRs (**cross-boundary**)
Implementation of a data-centric information set.
Higher spatial and temporal resolution of meteorological forecasts and warnings.
Automated user-defined **forecast and warning** products derived from meteorological information in (**IWXXM**) form.
Further development of **probabilistic** information derived from ensemble prediction systems

B3 (2031+)

- Further development of **space weather** information service.
- Forecast and warning services for **terminal areas**.
- **Higher spatial and temporal resolution** of meteorological forecasts and warnings.
- Further development of **probabilistic** forecast information.
- Further development towards a **fully integrated meteorological forecast service** fit for the purpose of all flight phases and ATC operations, in support of **gate-to-gate seamless** operations

EC-71 (2019)

44 (EC-68) Intercommission Aviation Research Project

"2019 last year of the Aviation RDP, outcomes will be reviewed by WWRP SSC in October, and CAS and CAeM will analyse the next step"

THIS MEETING – TO COME UP WITH A VISION FOR THE NEXT AVIATION RESEARCH PROJECT FOR WMO CONSIDERATIONS

- Review the AvRDP achievement so far
- Identify the gap between "now" and "then" in ASBU
- Taken into account the following:
  - WMO AeroMetSci Conference 2017
  - AeM Long Term Plan
  - End-users' Vision
  - CAeM EN-MHS views
  - …
- Proposal a vision for submission to WWRP/SSC, CAS & CAeM Presindents considersions

- Production of a WMO guidance on MET-ATM integration in support of Next Generation Global Navigation Plan

Thank you very much for the AvRDP SSC Members

AvRDP SSC – Kickoff Meeting 2015

Name	Representation
Peter Li, Chair	HKO rep of CAeM
Estelle de CONING	SAWS rep of JNB
Janti REID	EC rep of YYZ & YFB
Jean-Louis BRENGUIER	MeteoFrance rep of CDG
Fengyun WANG	CAAC rep of SHA
Sharon LAU	HKO rep of HKG
Peter M. CHADWICK	CAD rep of HKG (ATM expert)
Baode CHEN	SMS rep of CMA
Cecilia MINER	NOAA rep of NextGen
Stefane BELAIR	EC rep of NMRWG
Paul JOE	EC rep of NMRWG
Marion MITTERMAIER	UKMO rep of JWGFVR
Dennis HART	EuroControl rep of SESAR (will participate in Phase

gov.hk)

AvRDP SSC – Today

Name	Representation
Peter LI, Chair	HKO rep of CAeM
Morne GIJBEN	SAWS rep of JNB
Janti REID	ECCC rep of YYZ & YFB
Stephanie DESBIOS	MeteoFrance rep of CDG
Fengyun WANG	CAAC rep of SHA
Sharon LAU	HKO rep of HKG
Kamaljit RAY	IMD rep of IGI
Larisa NIKITINA	Roshydromet rep of LED
Kato YUKI	JMA rep of NRT
Chui Wah YAP	MSS rep of SIN
Peter M. CHADWICK	CAD rep of HKG (ATM expert)
Baode CHEN (inactive)	SMS rep of CMA
Matt STRAHAN	NOAA rep of NextGen
Stefane BELAIR (inactive)	ECCC rep of NMRWG
Barbara BROWN	NCAR rep of JWGFVR
Herbert PUEPEL	Ex-WMO C/AeM and AustroControl

AVIATION SEMINAR

	19 Aug (Mon)	20 Aug (Tue)	21 Aug (Wed)	22 Aug (Thu)
9:00 - 10:30		– ATM Expectations – Airline Expectations	– Airport SIN report – Airport LED report	– ASBU & AMET – LTP-AeM
10:30 – 11:00	Registration	Coffee break	Coffee break	Coffee break
11:00 – 12:30	Opening – SAWS Welcoming speeches – WWRP & CAeM speech – Overview of AvRDP Progress	Intl' Programmes – SESAR – NextGen – CARATS	– Airport IGI report – Airport NRT report	– Gap analysis and Research Needs – AvRDP Vision Statement for WWRP/SSC-12 – Seminar Closing
12:30 – 14:00	Lunch	Lunch &	Lunch &	Lunch
14:00 – 15:30	– Airport CDG report – Airport HKG report	– ATM Expectations – Airport SHA final report	– Probabilistic Information Needs – Verification	–
15:30 – 16:00	Coffee break	Coffee break	Coffee break	
16:00 – 17:30	– Airport YYZ and YFB reports – Airport JNB report	– Breakout Session #1	– Breakout Session #2	

Q & A