Envisioned changes in air traffic management and their impact on requirements for meteorological information

Jeanette Onvlee
With thanks to Ping-Wah Peter Li, HKO

EWGLAM 2013, Antalya
2 October 2013

Currently

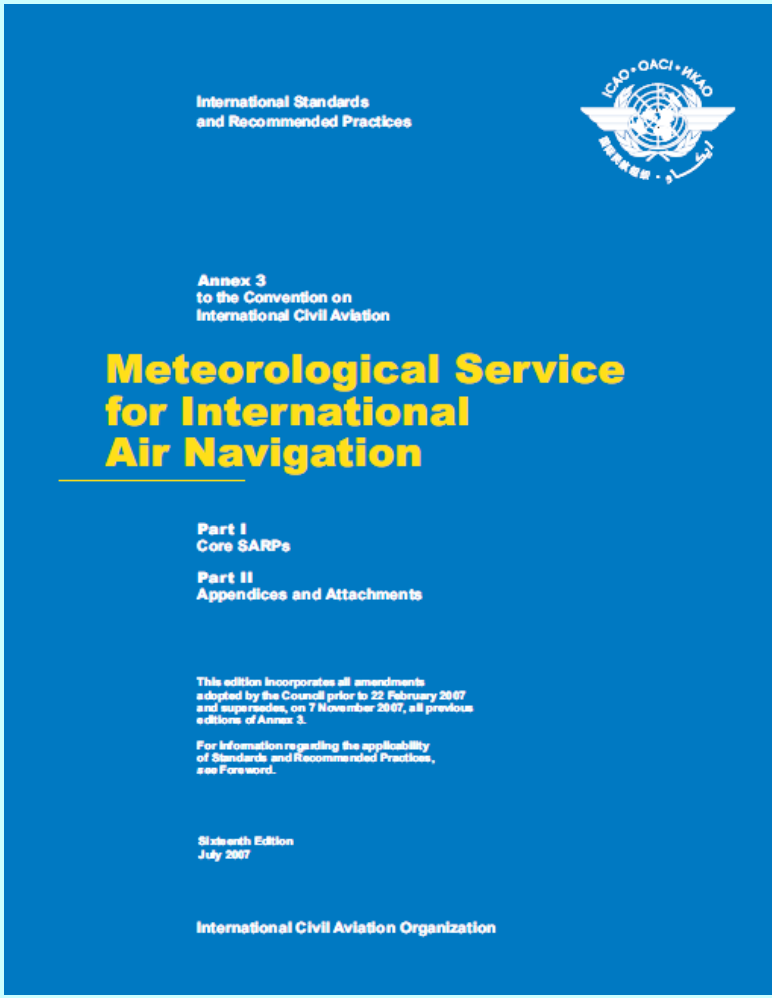
Standards and Recommended Practices (SARPs) on aeronautical MET services are given in ***ICAO Annex 3 / WMO Tech Reg Vol II***

Regulated (legacy) MET products:

- Coded TAF/TRENDs, landing/take-off forecasts, warnings → for aerodrome
- AIRMET/SIGMET → regional scale
- SIGWX → En-route (global scale)

However, these present products do not specifically address evolving **Air Traffic Management (ATM)** needs:

- increasing air traffic, pushing air space and terminal area capacities to their limits
- need to reduce complexity of ATM decision-making
- need to enhance safety, cut costs, and lessen environmental impact



NEXTGEN and SES: creating the next generation air traffic management

Single European Sky goals for ATM:

The future ATM system should be able to:

- Handle 3x more traffic in European skies
- 10x increase in safety
- -10% environmental impact
- -50% ATM costs
- To be achieved with new ATM practices and tools, and technical and ICT developments.
- To be realized by 2030

Relevance/impact of MET to ATM

- **Weather-related delays**

  en route and in terminal area => increase cost to airlines and safety and environmental impact

- Complex **ATM decision-making:**

  At present MET supplies weather info, ATM translates to impact and decisions in communication with pilot

  ⇒needs more precise wx info and forecast, in both time and space, for **sharing with all parties,** and **tailored towards impact/decision-making**

  ⇒ Aviation users (airlines) starting to experiment with/use **probabilistic** wx forecasts for decision-making => need **"level of confidence"**

- **New approaches** to aircraft handling in landing/take-off procedures, and activities in terminal area:

  • Steeper ascent/descent, aircraft closer together => requires more dynamic ATM, more attention to turbulence along flight path and runways

  • More stringent information requirements to minimize weather-related delays in terminal area (e.g. thunderstorms)

ATM requirements

Trajectory-based ATM:

- Requires much more accurate and timely MET information than is currently available in Annex 3
- Type, probability, accuracy and timing of MET information → essential for ATM operations

Performance Based Navigation (PBN) approach:

- MET information need to be integrated into decision support → impact related
- Allows user to select the most efficient route, minimizing flight time, or a safe route that limits expected encounters with “dangerous” areas or high levels of turbulence

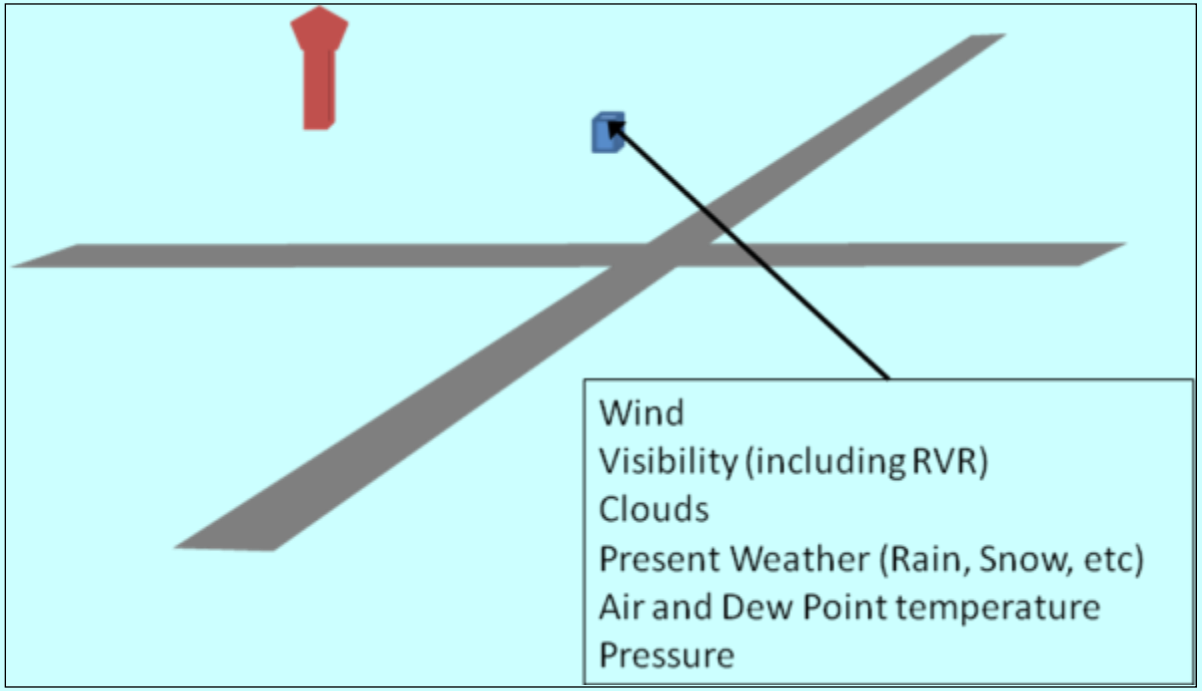
Trajectory-based ATM and Performance-based navigation (PBN)

For ATM, *Performance-based navigation* and *Trajectory-based ATM* is a fundamental shift away from the highly interactive (reactive) and resource-intensive continuous monitoring and controlling of aircraft separation as condition of safe flight, to a more pro-active, 4-D planning of airspace use that would ensure conflict-free separation between aircraft, without any interaction needed between aircraft and ATC throughout the planning horizon.

For MET this implies:

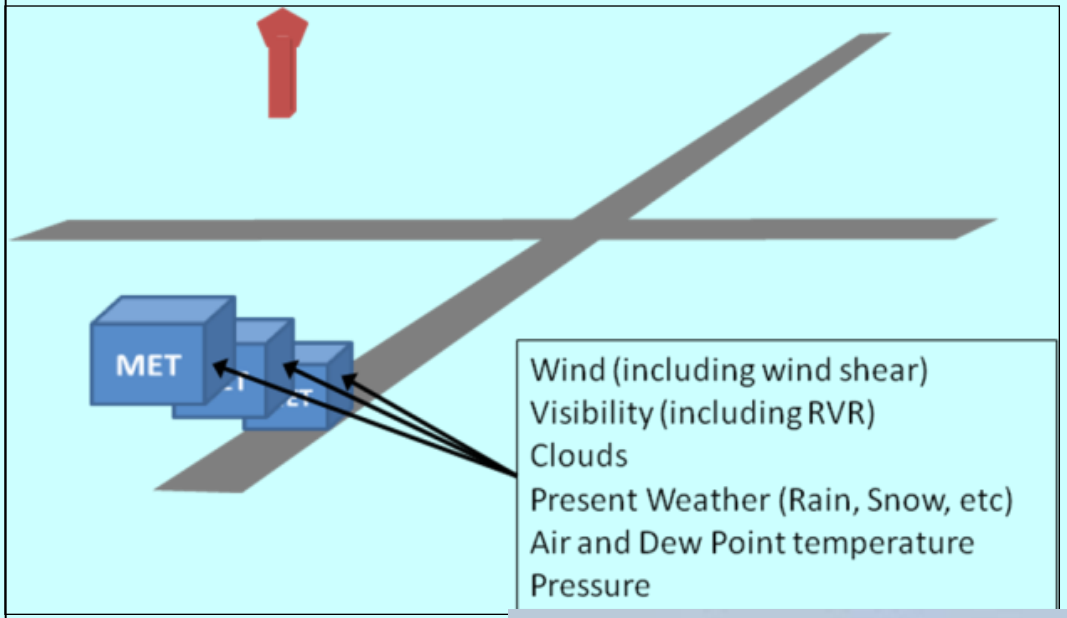
- delivery of quasi-continuous 4D weather info on intensity, onset, longevity, probability, … of weather phenomena
- At latitude, longitude, height and time of aircraft (trajectory-based)
- To ATM and to the pilot
- Especially important for busy/growing airports worldwide
- NOT the single effort of MET service – close collaboration with ATM

Traditional MET information



MET information (observations and reports) for the aerodrome which are derived from instrumentation at one or more locations on the aerodrome. Forecasts are based in part on these observations.

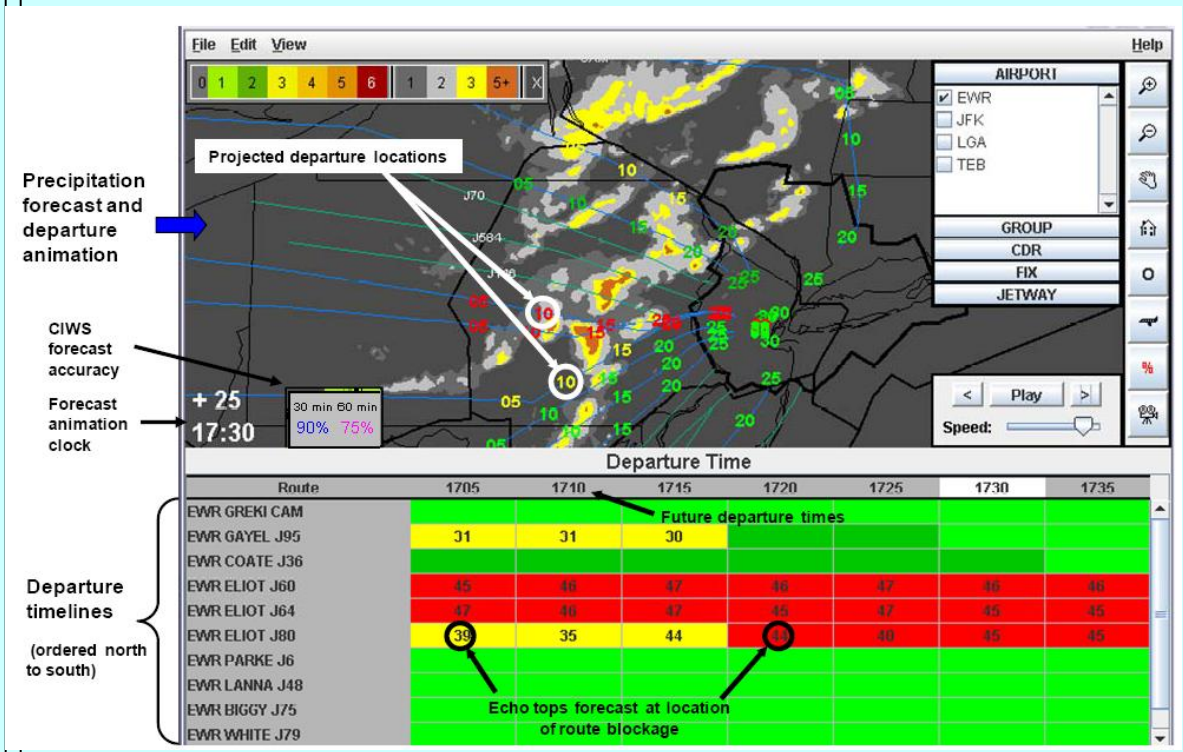
New approach of MET support to ATM and PBN



- Alignment of MET information volumes along flight path (route-specific)
- Presentation of information to all users (also in cockpit)
- Integrate weather information as much as possible in impact assessment/decision-making

Examples of new tools for departure and approach (1)

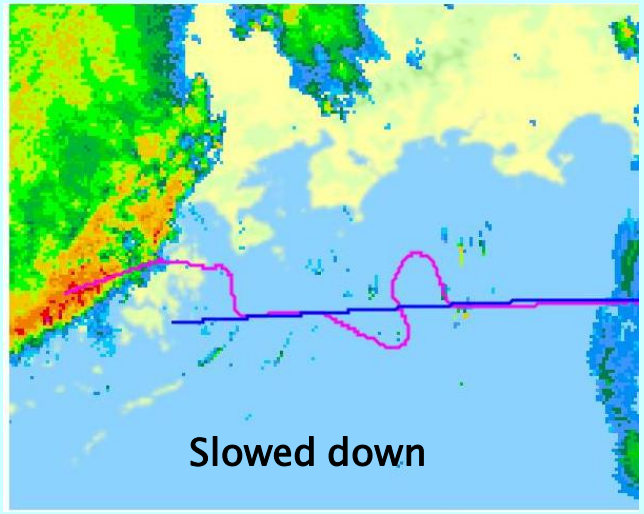
MIT Lincoln Lab Route Availability Planning Tool (RAPT)

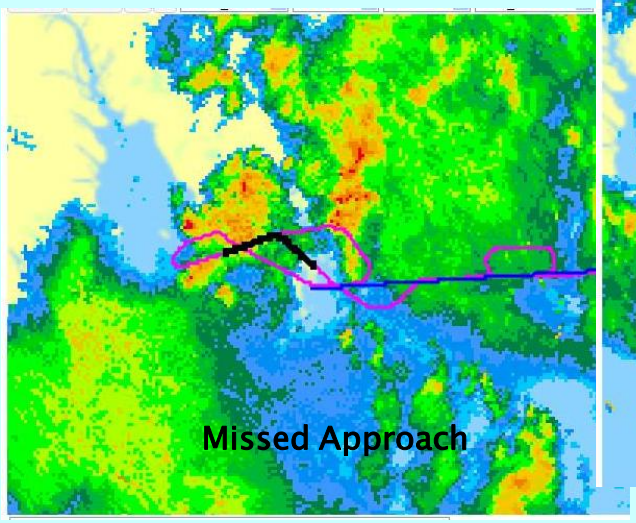


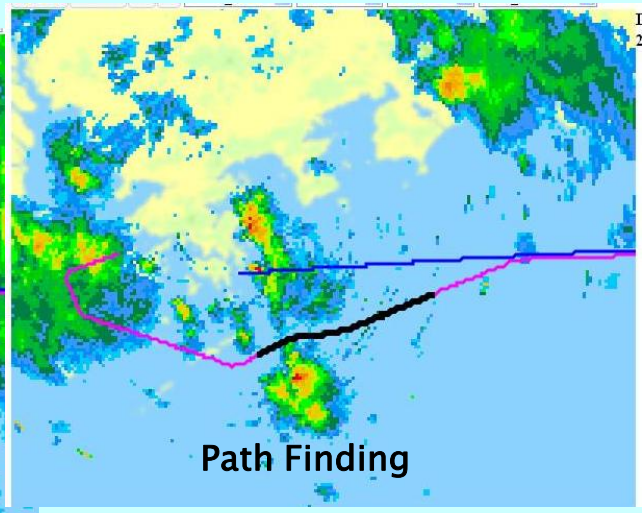
- *Operational at New York. Integrated into FAA Integrated Terminal Weather System (ITWS)*
- *An automated tool intended to help ATC and airline dispatchers determine the specific departure routes and departure times that will be affected by significant convective weather*

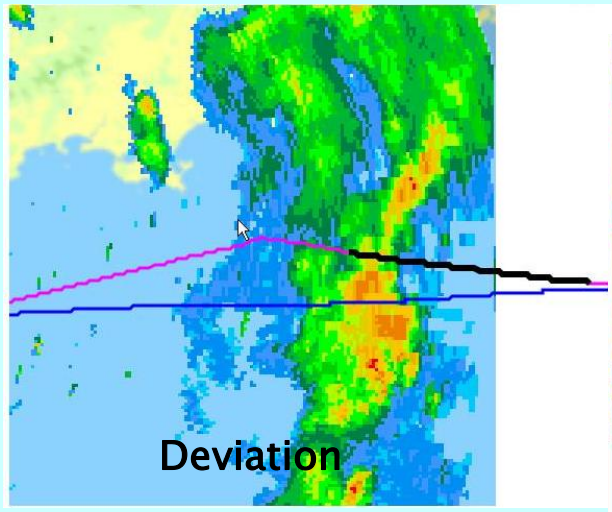
Examples of new tools for departure and approach (2):

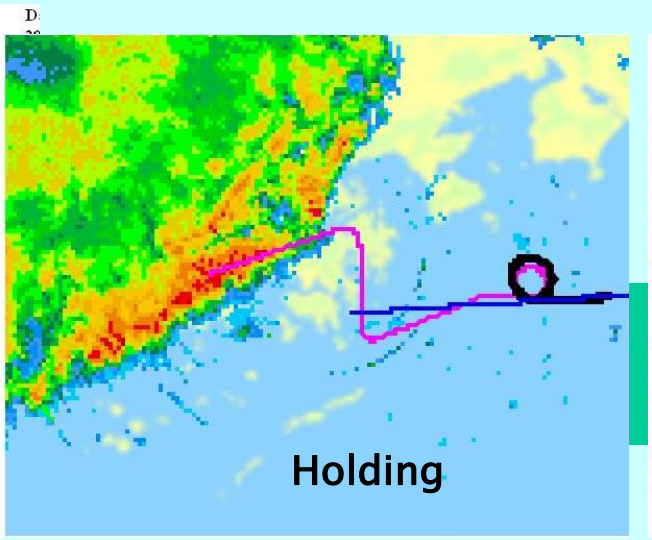
Assessing impact of severe convection in approach area (HKO)

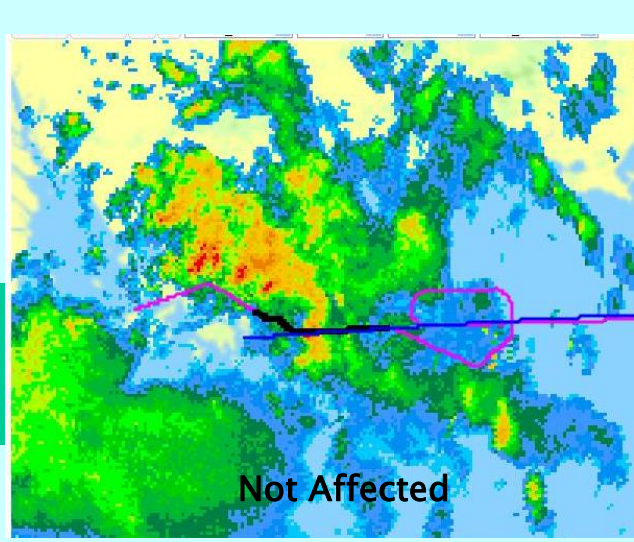






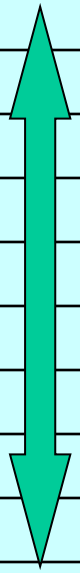






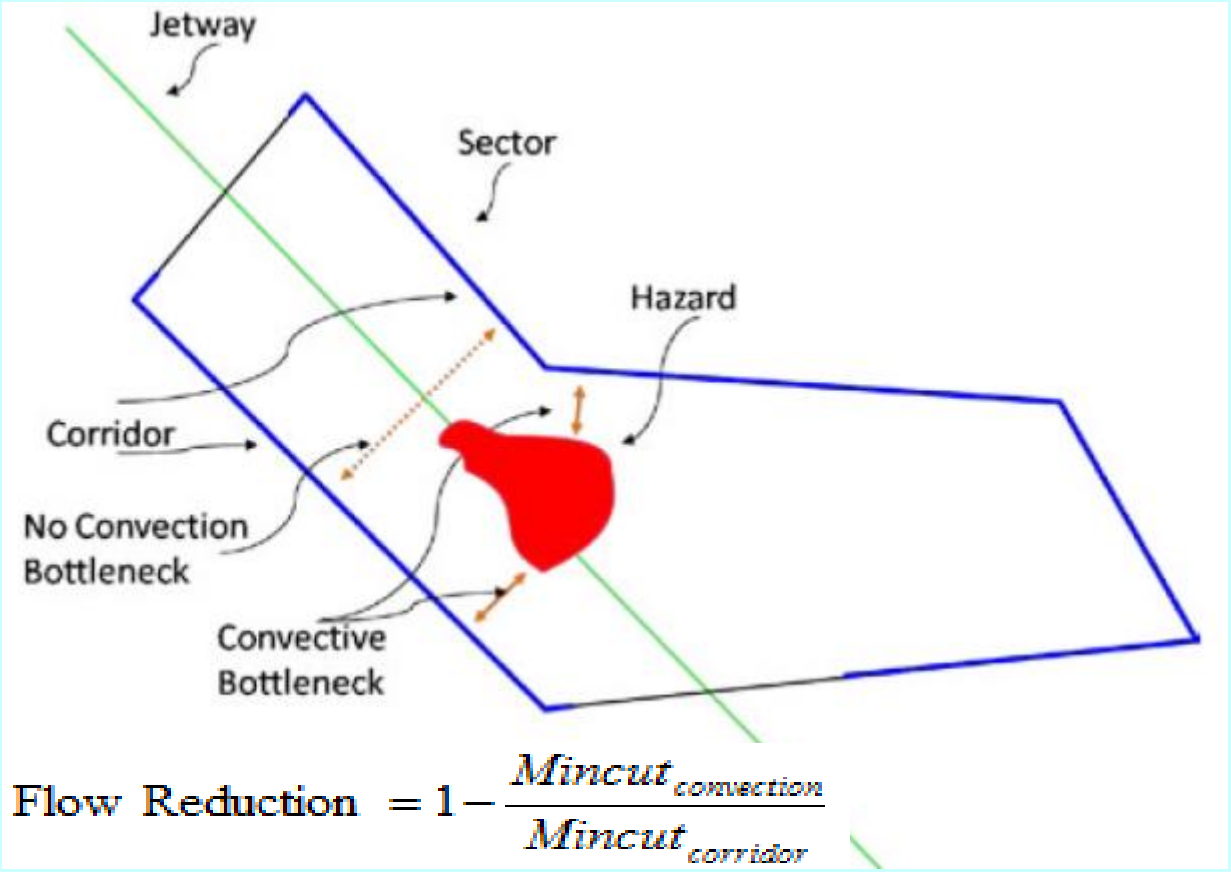
Runway and holding areas capability can be significantly reduced by severe convection over and near an aerodrome

27-Apr-12	Scheduled	Actual
Local Time	Arrival	Arrival
0800-0859	6	13
0900-0959	24	16
1000-1059	32	30
1100-1159	31	29
1200-1259	32	28
1300-1359	32	31
1400-1459	32	21
1500-1559	32	23
1600-1659	30	25
1700-1759	32	23
1800-1859	28	24
1900-1959	30	25
2000-2059	30	25
2100-2159	32	26
2200-2259	32	25
2300-2359	12	19



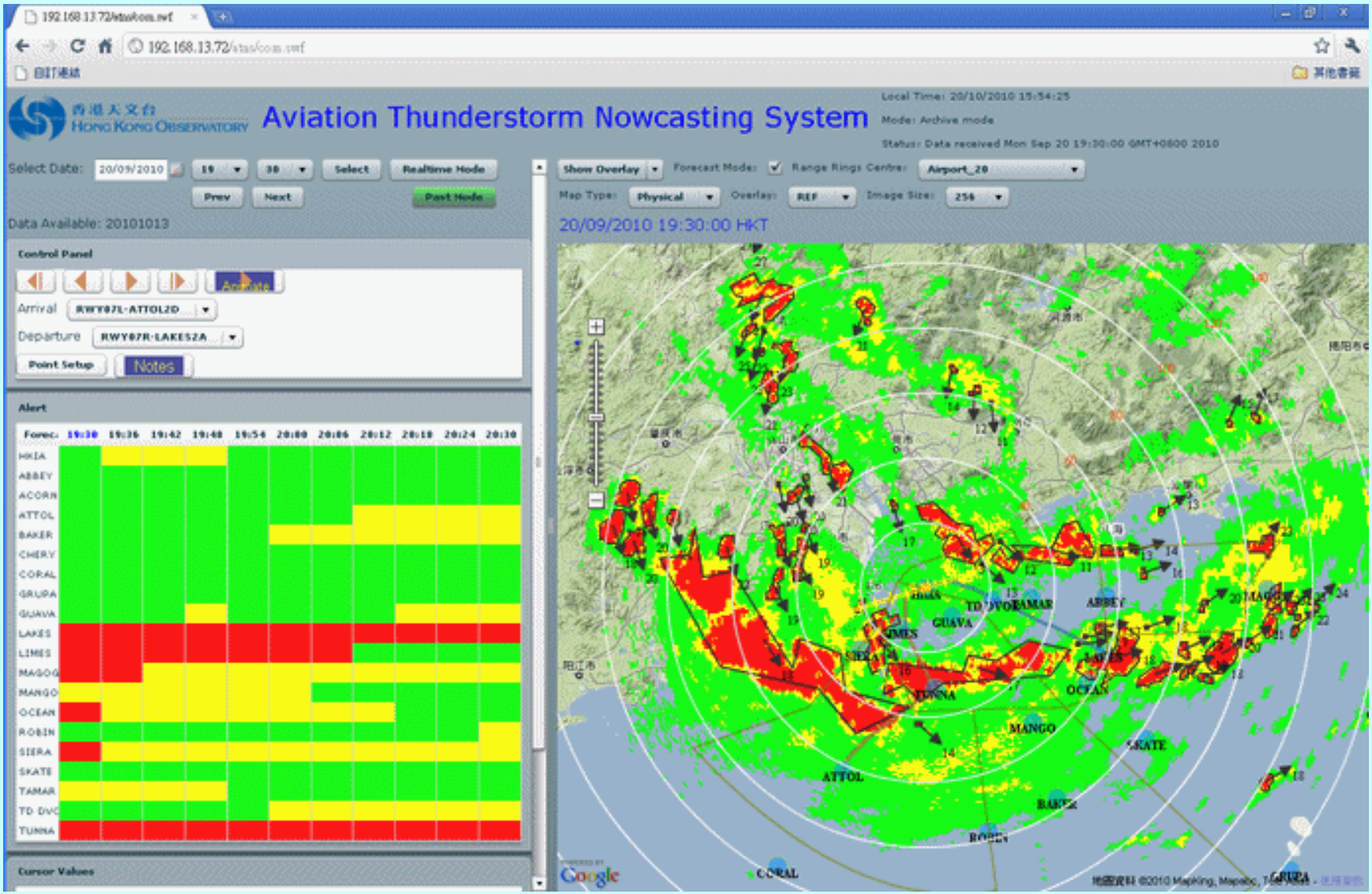
dropped by ~15-35%

Assessing flow reduction in corridors



$$\text{Flow Reduction} = 1 - \frac{Mincut_{convection}}{Mincut_{corridor}}$$

Airport thunderstorm Nowcasting System (ATNS)



Information needs in terminal area

Low level windshear

Cross and tail winds on runways

Low level turbulence

Wake vortices

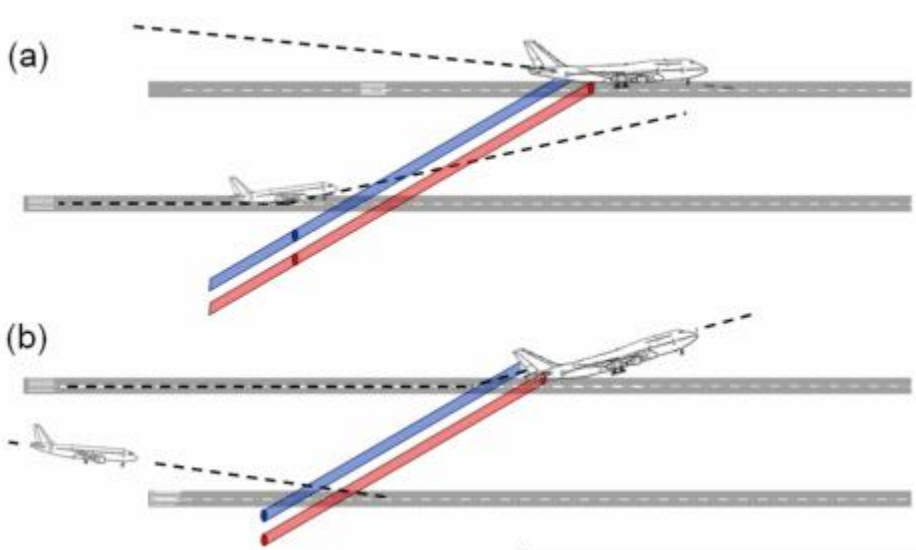
Visibility (haze, dust, fog)

Cloud-to-ground lightning

Icing

…

Assessing impact of wake vortices and turbulence on runways



Wind direction-dependent impact of wake vortices on nearby runways

Wind direction-dependent impact of nearby buildings on cross- and tail winds near touchdown/takeoff

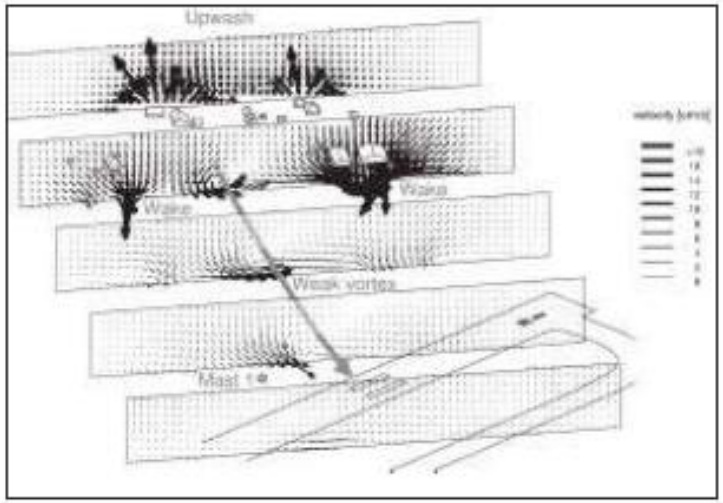


Figure 1. Cross sections of wake flow and vortices behind farm buildings.

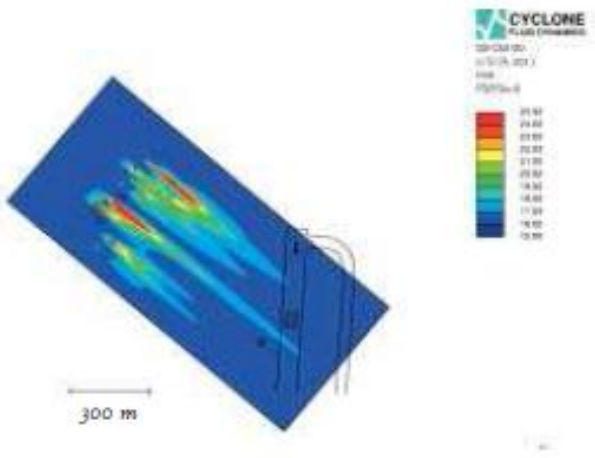


Figure 2. Calculated turbulence intensity. The positions of the runway and wind mast are indicated.

Examples of new tools for terminal area:
automated thunderstorm alerts

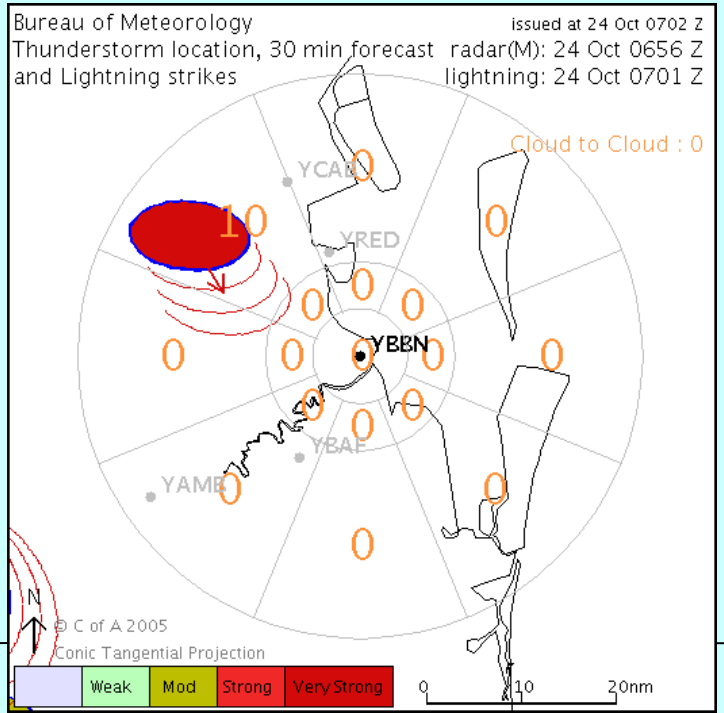
In case of thunderstorms over the airport:

•All ground operations have to stop and measures need to be taken to safeguard staff against lightning strikes

• Re-fueling, embarkation /disembarkation, baggage/cargo handling are delayed, causing major disruption to airport operations

->**highly precise, automated lightning alerting system is needed**

Existing thunderstorms alert nowcasting systems based on e.g. tracking of lightning observations or physical interpretation of radar data



Requirements on new MET products for ATM

- Weather information with:
  - More details between 0-6 hours, higher spatial and temporal resolution
  - Longer lead times
  - More and more difficult weather parameters (turbulence, visibility, convection)
  - Probabilistic forecasts/nowcasts for assessment of uncertainties
- Translate MET information into impacts
  - Visualize in graphical/tabular form with alerting (impact) criteria
  - Scenario-based and flightpath-based
- Collective Decision Making products (MET, ATM and pilot all having access to the same information), available quasi-continuously
- Localized information for specific areas:
  - Aerodrome area (~8 km radius)
  - Specific holding area (~ 40 km radius)
  - Terminal area (~100-200 km range)
- Still supplemented by TAF/TREND, weather summary in text and/or forecaster briefings

User engagement: essential to close the gap between expectations and capabilities