WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Advances in weather and climate science

Second ICAO Global Air Navigation Industry Symposium (GANIS/2)

11 to 13 December 2017, Montreal, Canada

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

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Content

- WMO – who we are and what we do
- Advancing weather and climate science to serve aviation's evolving needs
- Final thoughts

WMO

Who we are and what we do…

Advancing weather and climate science

To serve aviation's evolving needs

Gate-to-gate needs

AERODROME	TERMINAL AREA	EN-ROUTE	TERMINAL AREA	AERODROME
Pre-flight planning	Take-off	Climb	Manoeuvering/Hold	Taxi
Parked	Initial climb	Cruise	Initial approach	Gate arrival
Gate push-back		Descent	Final approach	Parked
Taxi			Landing	Post-flight analysis

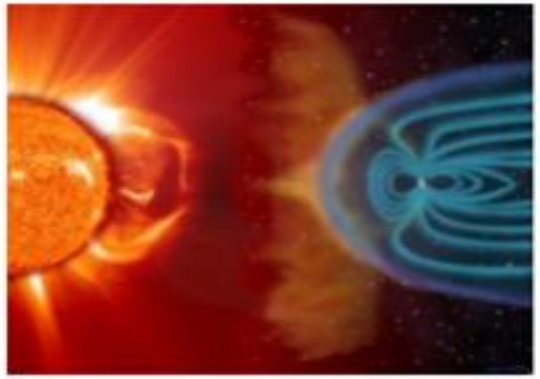
Consideration of the weather impact at *every stage* in the decision-making process

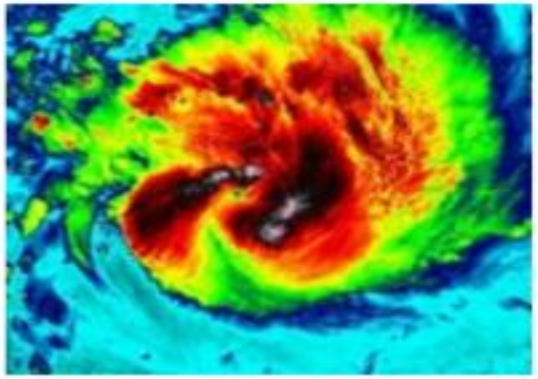
Strategic planning → Pre-tactical → Tactical → Post-flight analysis

WMO OMM

Aviation's vision for the 2030s

- Globally interoperable, harmonized ATM system
  - TBO
  - CCO/CDO
  - PBN
- **Meteorology** as a **key enabler**
  - Through SWIM
  - Data ***and*** services



WMO Aeronautical Meteorology Scientific Conference 2017

- Held 6 to 10 November 2017 in Toulouse
- Aviation, weather and climate: *Scientific research and development for future aeronautical meteorological services in a changing atmospheric environment*

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

Science R&D

- 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

Service Delivery

- In-cockpit and on-board MET capabilities
- Terminal area and impact-based forecast
- Enroute hazards information systems
- 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

Climate change & variability

- Jet stream position and intensity and related phenomena
- Extreme weather events and airports, changes to established scenarios
- Re-evaluation of airframe/avionics resilience standards and certification

AeroMetSci 2017

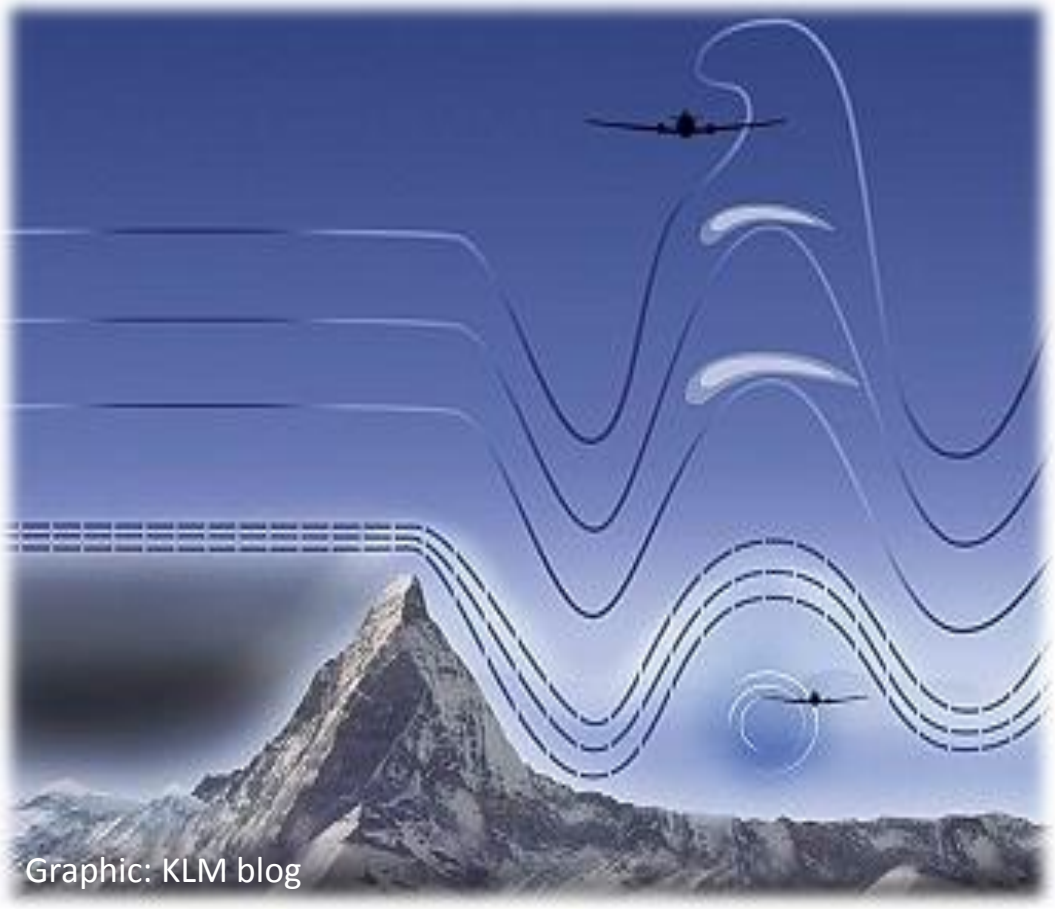
High-altitude ice crystal icing research

Graphic: NASA

- Infrequent but high impact events
- Meteorologically complex to parameterize
- Observation/detection
- Nowcast and forecast
- Experimental trials ongoing
- More encounter reports needed to validate observations and calibrate forecasts

Atmospheric turbulence research

- Multiple types/sources
- Often localized, often transient but often high impact
- Observation/detection
- Nowcast and forecast
- **More encounter reports needed to validate observations and calibrate forecasts**


Graphic: KLM blog

Significant convection research


Graphic: WMO

- Towering Cumulus (TCU) and Cumulonimbus (CB)
- Pose multiple aviation hazards
- Observation/detection
- Nowcast and forecast

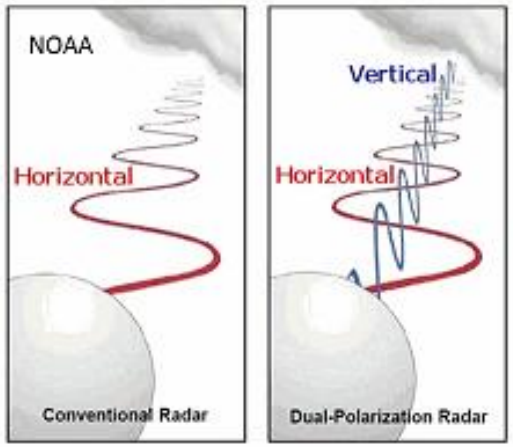
Wake vortex detection and prediction

- Ground/near-ground and enroute hazard
- Prevailing meteorological conditions important
- Aircraft parameters important
- Wake vortex or low-level wind shear?
- Experimental trials ongoing
- **More encounter reports needed to validate observations and calibrate forecasts**

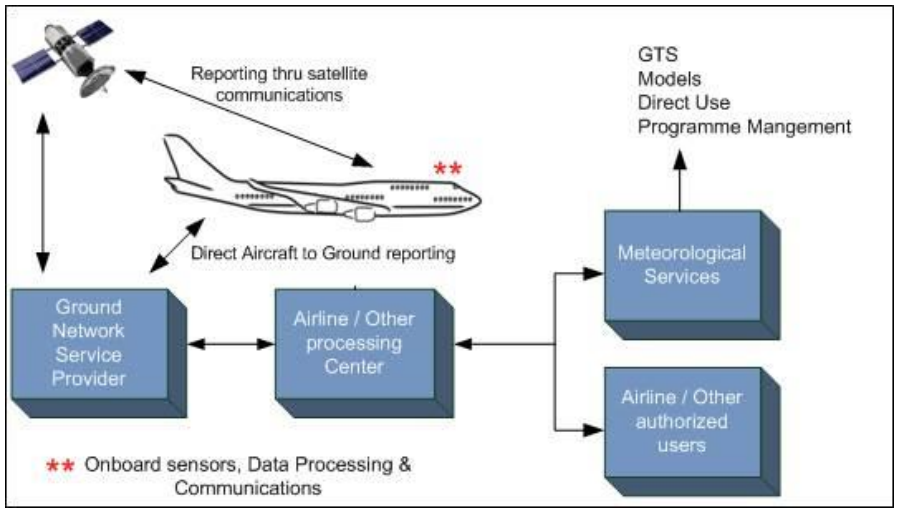
Graphic: Thales

Advances in observing methods and use of observations

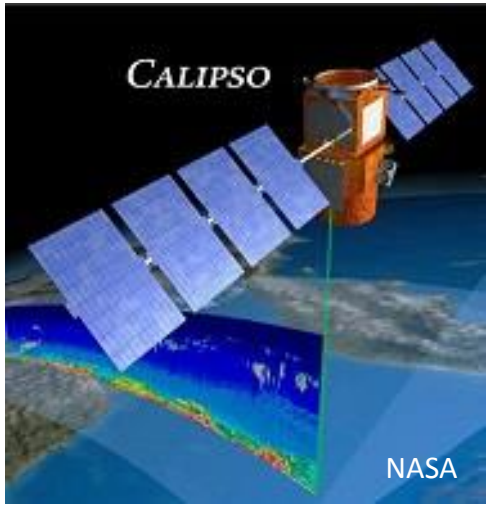
Dual-polarization radar

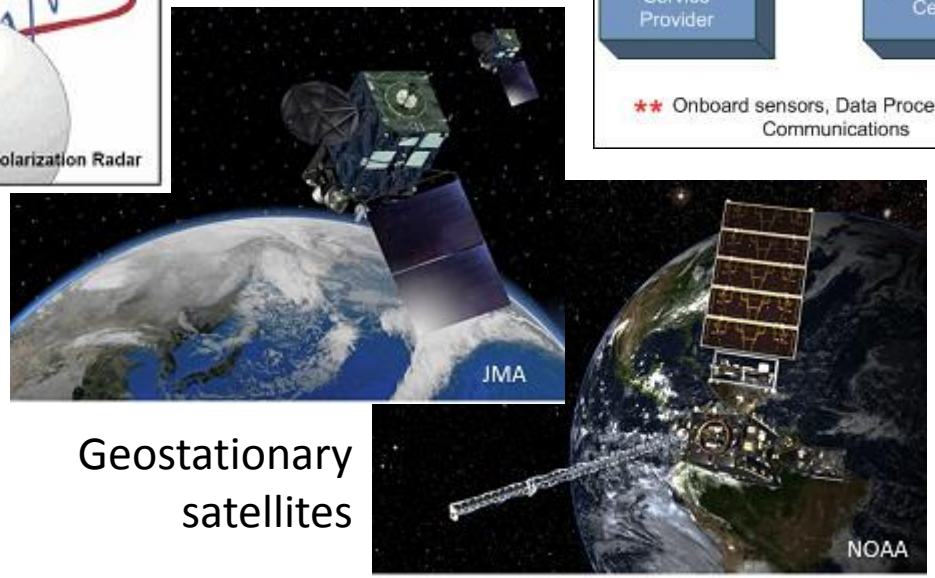


Aircraft-derived MET data including moisture



Ground-based, aircraft-based and satellite-based
LIDAR vertical profiles



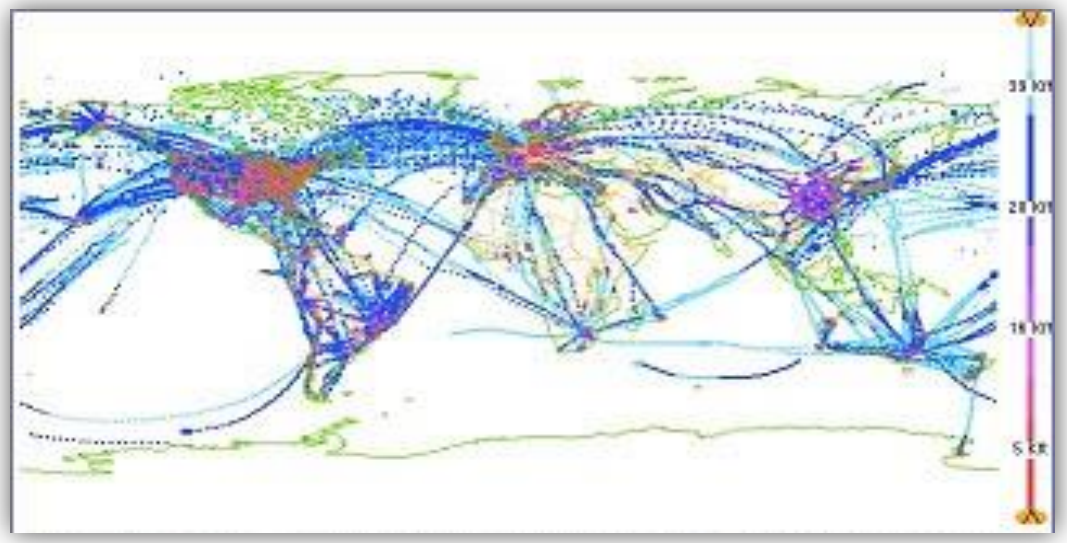


Geostationary satellites

- Complementing or even replacing ‘traditional’ methods of observation
- Direct support to NWP and in-cockpit user applications

Importance of aircraft-based observations

- **A**ircraft **M**eteorological **DA**ta **R**elay (AMDAR)
- Low cost, high benefit
- **Wind and temperature** via AMDAR are amongst the **most important data sources**
  - Other key parameters include **pressure, turbulence and moisture**
- In-situ moisture measurements/water vapour datasets **important for climate studies**



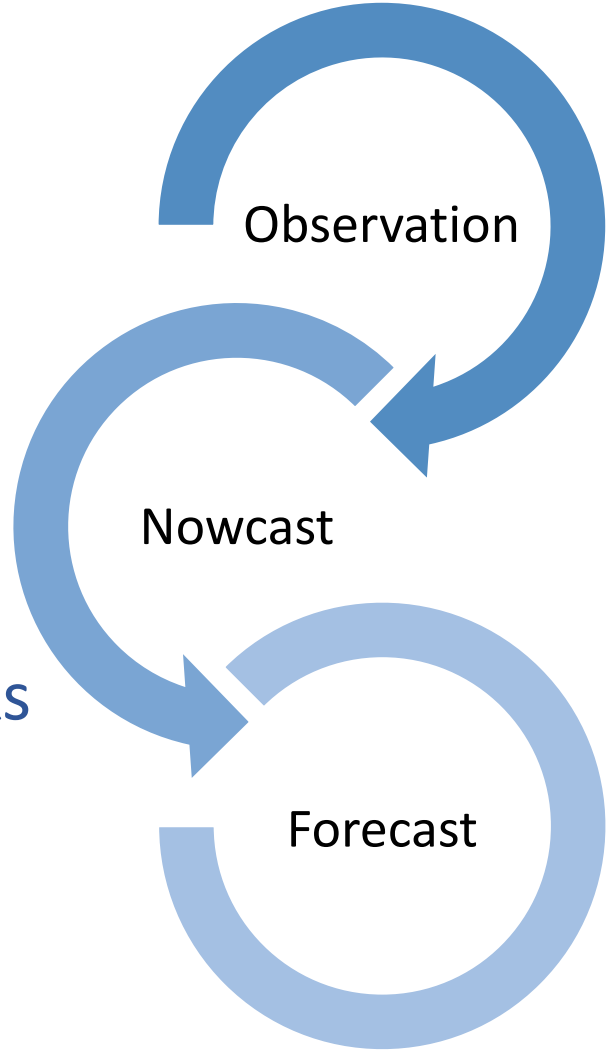
Working arrangement signed July 2017

IATA

Seamless nowcast and forecast

TEMPORAL AND SPATIAL SCALES

- **Observation**: 'Now' with reduced latency
  - Ground-based
  - In-situ/aircraft-based
  - Satellite-based
- **Nowcast**: Next few minutes up to next few hours
  - Advection/extrapolation + NWP
  - Rapid refresh
- **Forecast**: Several hours up to several days or weeks
  - Blending, ensembles, probabilistic
  - NWP + climatology
  - Regular update



ALL METEOROLOGICAL PARAMETERS

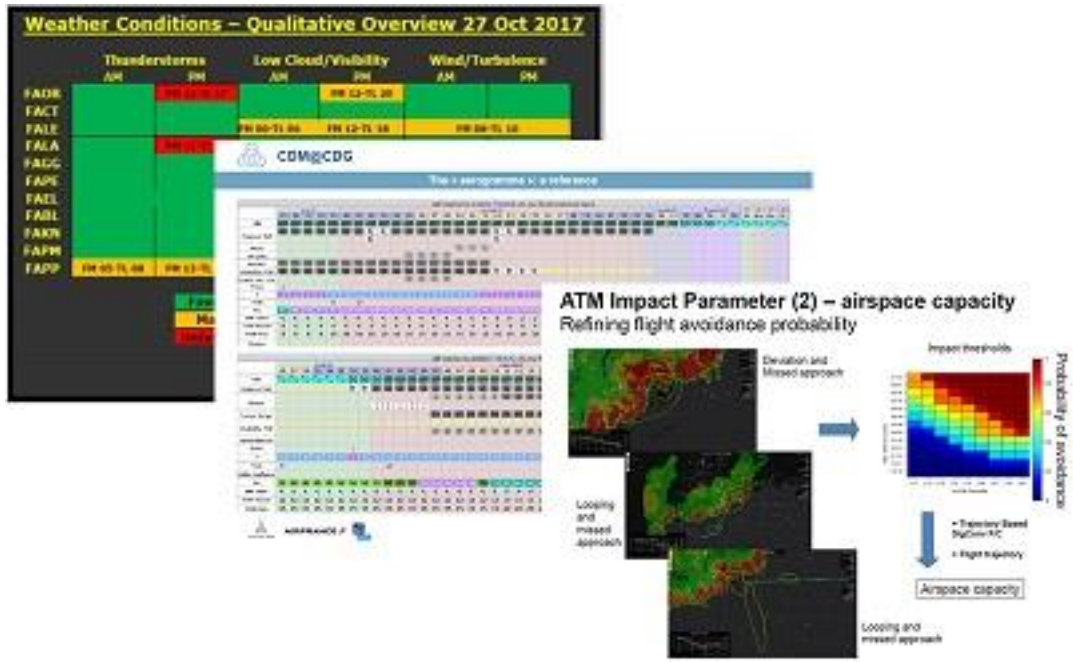
Impact-based forecasting

- Many solutions emerging tailored to the various ATM users' needs
- 'Playbook' scenarios

- Pro-active management of weather impacts on ATM system
- **MET-ATM COLLABORATION KEY**

Collaborative decision-making support

- Numerous trials, evaluations and best practices already exist
  - Ground-based and in-cockpit applications
- Qualitative and quantitative impact assessments of the weather on ground and air operations



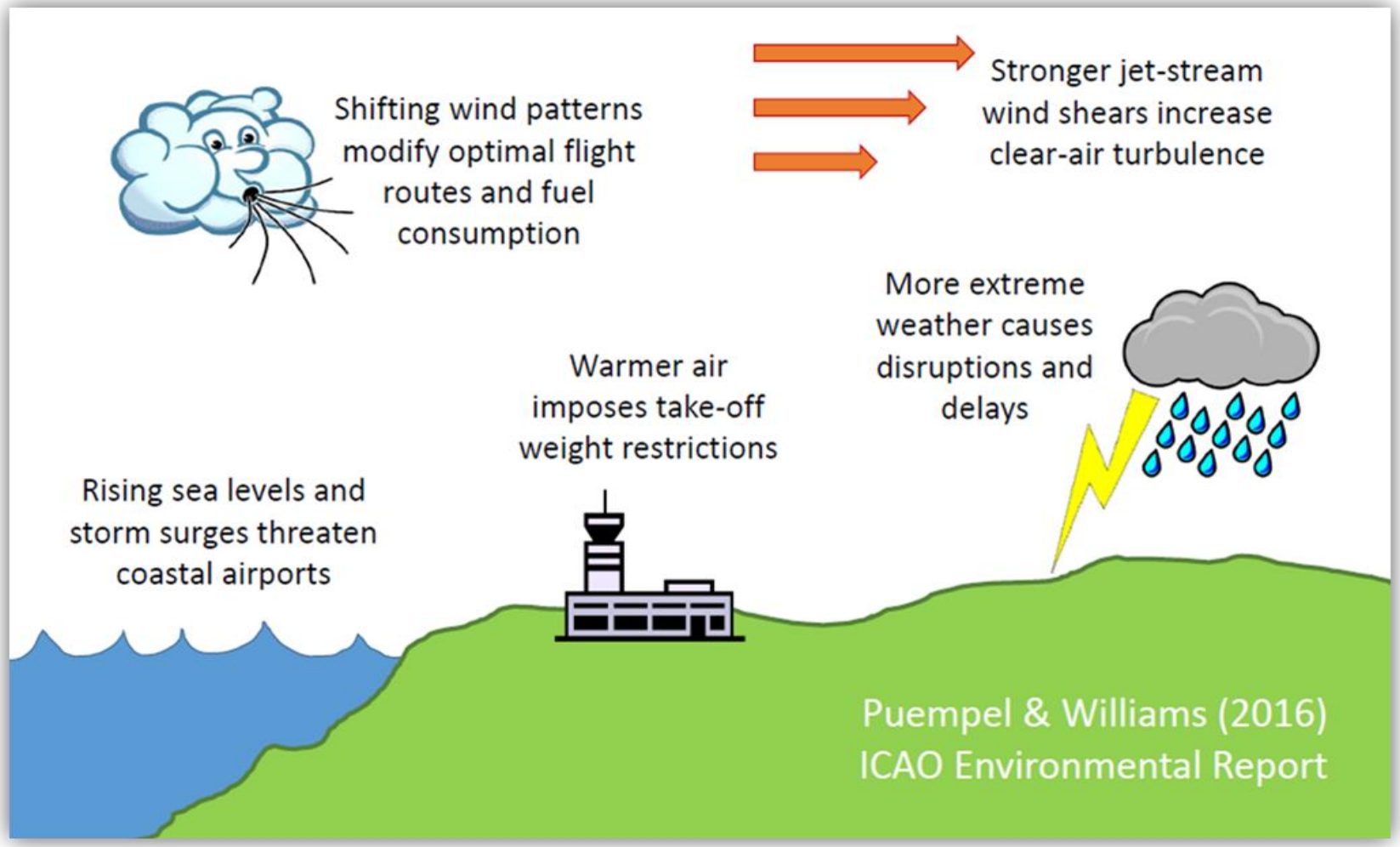
- Common, shared situational awareness
- Met information in combination with air traffic loads
  - Actual and forecast
- Proactive airspace management
- Quality, reliability, predictability

Extreme weather and climate events

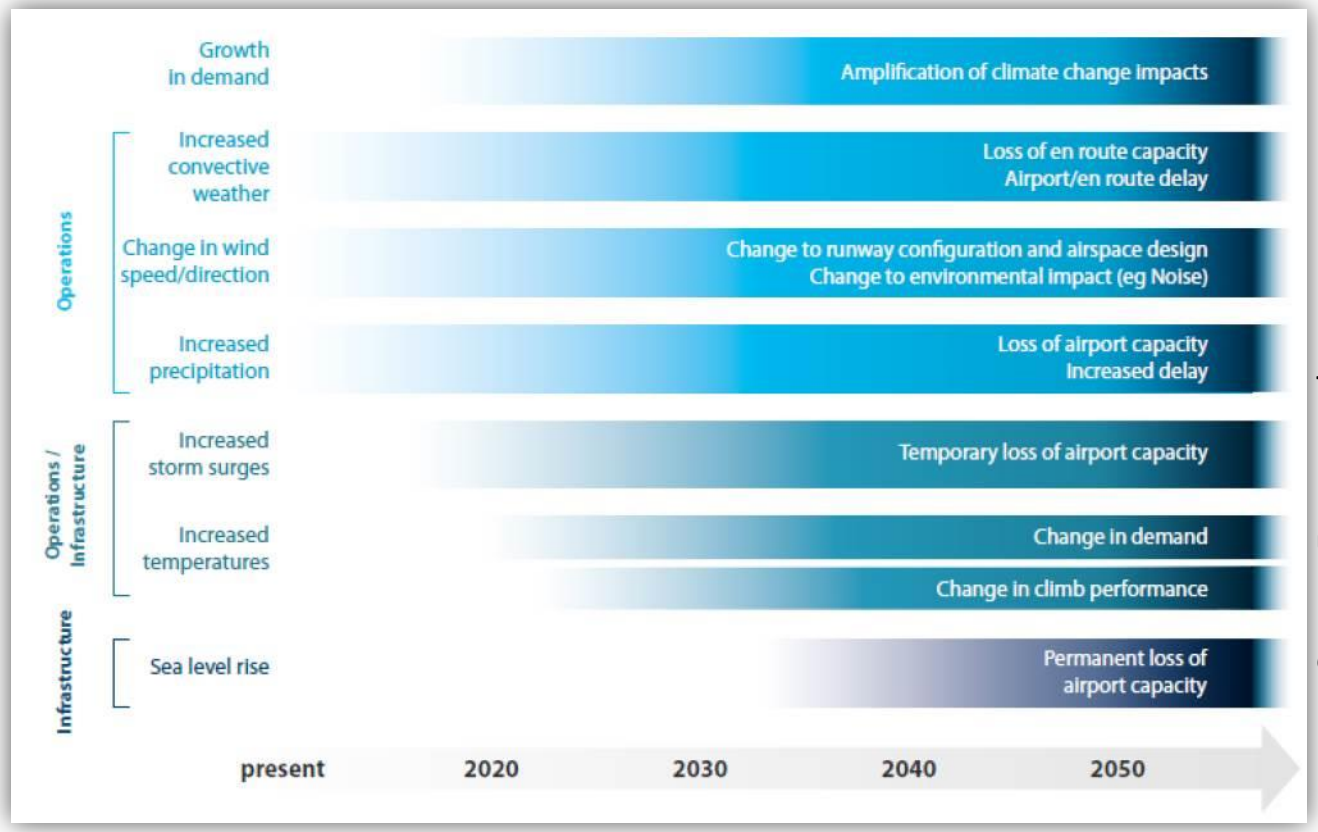
Excerpt of IPCC Fifth Assessment Report, 2013

Phenomenon	Early 21st century (2016-2035)	Late 21st Century (2081-2100)
Warmer and/or **fewer cold days and nights** over land areas	Likely	**Virtually certain**
Warmer and/or **more frequent hot days and nights** over most land areas	Likely	**Virtually certain**
Warm **spells/heat waves**. **Frequency and/or duration increases** over most land areas	Not formally assessed	**Very likely**
Heavy precipitation events. **Increase in the frequency, intensity and/or amount** of heavy precipitation	Likely over many land areas	**Very likely** over most of the mid-latitude land masses and over wet tropical regions
Increase in **intense tropical cyclone activity**	Low confidence	**More likely than not** in the Western North Pacific and North Atlantic
Increased incidence and/or magnitude of **extreme high sea level**	Likely	**Very likely**

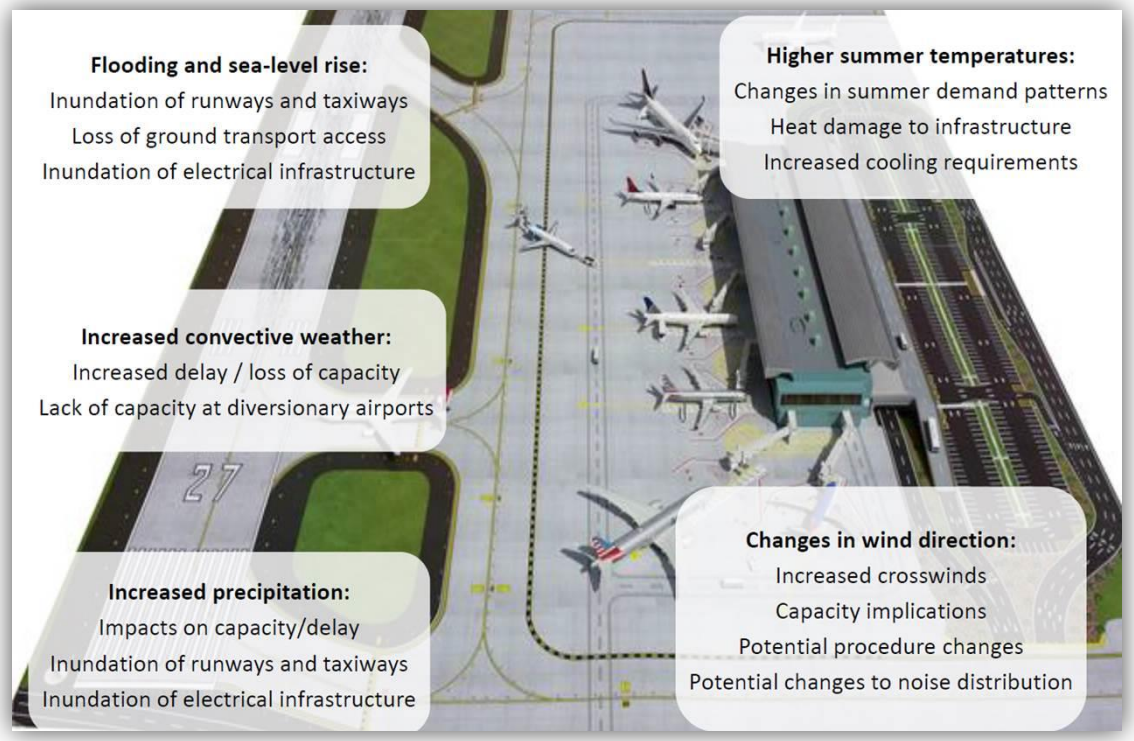
Changes to established scenarios



Changes to established scenarios



Source: Eurocontrol



More information…

www.meteo.fr/cic/meetings/2017/aerometsci/

www.wmo.int/aemp/AMSC-2017

…on the web

Final thoughts

- Weather and climate scientific research activities demand **improved access to data**, especially aircraft-derived MET observations
- The **transition from scientific research to operations** needs to be **accelerated** and **well-communicated** in concert with users' needs
- Conveying **forecast uncertainty** is a **priority** but remains a **challenge** that needs further research and guidance
- The **mitigation** of extreme weather events and the **adaptation** to a changing climate by aviation demands a **multidisciplinary effort**

- The time to act is now!

Thank you

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WORLD METEOROLOGICAL ORGANIZATION