Integrating adverse weather, disruptive events, or environmental sensitivity in an advisory for future air traffic management

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Safe, efficient, and sustainable aviation

- How can air traffic be managed and guided in the future when it must become **safer**, more **efficient** and largely **sustainable**?

- How can air traffic be managed and guided to avoid **adverse weather**, **disruptive events** and minimize **environmental impact**?

- **Adverse weather**: deep convection / thunderstorm, turbulence, wind shear, in-flight icing, winter weather, wake vortex

- **Disruptive events**: volcanic ash clouds, dust clouds

- **Environmental sensitivity**: climate, noise
Safe, efficient, and sustainable aviation
Proposal: „5D MET Advisory“

• Provision, **distribution** and **integration** of complex information on different hazards or sensitive areas in a **standardised** form with interfaces to different users (ATC, ATM, AOC, crews in flight, airports) (WXXM / SWIM ?)

• Presentation of the (weather) hazard as a (weather) **object**

• Is it doable ?

• Which hazards are “cooperative” (w.r.t. a standardisation) ?

• The **5D MET Advisory** approach
Example: thunderstorms as objects: CbO
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Bottom: Rad-TRAM
weather radar data analysis
→ take-off and landing

Top: Cb-TRAM
satellite data analysis
→ en-route

Contours mark the observed and nowcast thunderstorm objects

available every 5th or 15th minute
Example: winter weather as objects: WWO

**WWO: Vertical column of air**
- to characterise hazardous winter weather situations on the ground
- with snow covered / iced runways and taxiways and iced aircraft

**Responsible weather**
- snow
- freezing precipitation
- Icing

**Required information**
- Type, onset and duration of precipitation
- Icing areas
- Intensity of winter weather events
Example: winter weather as objects: WWO

Case study: January 20, 2013
Felix Keis

Analysis: North-South cross section

Freezing rain

MUC
Example: volcanic ash cloud as objects: VAO

Detection of volcanic ash clouds and nowcasting

MSG-SEVIRI, combination of 2 channels

Predictions of volcanic ash mass concentrations
Towards standardisation:
objects coded in GML/XML format

Output in GML/XML
Towards standardisation: objects coded in XML/GML format

Format: WXXM (FAA & EUROCONTROL) → GML/XML

- Quickly readable, ASCII, can be compressed
- Contains only necessary information (no grid points without content)
- Extendable with extra information (by additional tags)
- User only reads the parts he is interested in (no unpacking of everything)
- Output of different algorithms appears in the same format
- Information of different categories can be combined: meta data, geographical data (position of an object), analysis and nowcasts with attributes (object height, intensity, trend, … and confidence level)
- Amount of data is small (data links are expensive)
Towards standardisation: objects coded in XML/GML format

Format: WXXM (FAA & EUROCONTROL) → GML/XML

- All users get one (the same) product (per hazard) and take what they need to know for their decision making, e.g. for Cb:
  - ANSP (<60 min): Cb locations → closing of sectors, sequencing
  - ANSP (>60 min): Cb probability → regulation at EUROCONTROL
  - Airport authorities: lightning → stop of ground handling
  - Crew: (< 30 min): Cb locations → re-routing
  - AOC: (< 60 min): Cb locations → flight planning, passengers, personnel
Generation of products and data transfer during the summer campaign 2012 at MUC

Cb-TRAM → XML file → Internet → METFROG Server

Cb-TRAM → DLR Nowcasting-Seite

Cb-TRAM → DLR AutoAlert

Automatically generated Cb warnings → EMAIL

ProMUC
5D MET Advisory

- **Platform** for deducing, tailoring, and delivering information on *all* hazards (weather related, detected and predicted) as objects in WXXM standard (using XML)
5D MET Advisory

- **Working principle:** Monitoring, seamless and continuous prediction, and fusion of data
- Considering different temporal and spatial scales
- Combining output of different approaches, algorithms, and measurements
- Modelling the region of the hazard or the environmentally sensitive zone as objects according to the users' requirements
- Coding acc. to WXXM for SWIM / 4d-WxCube in SESAR
5D MET Advisory

- Output is provided simultaneously and can easily be interpreted and further processed and displayed at the user’s site.
5D-MET Advisory: an integrated advisory for weather, climate and disruptive events

- 5D MET Advisory provides standardised data on hazards which are enablers for
  - Planning of optimised flight routes (ATFM) and sectors (TAM) w.r.t. weather, climate, disruptive events, … well in advance
  - Short-term and effective adaptations of flown trajectories and measures at the airport
5D-MET Advisory and air transportation simulation: A research attempt at DLR

- Use of seamless 5D-MET-Advisories to compute flight trajectories
- Continuous consideration of planned and real data for flight planning and execution taking into account the reduced uncertainties when time proceeds
- More realistic modelling of the decision mechanisms of airlines, airports and ANSP
- Analysis of the system behaviour impacted by disruptions
- Identification of optimisation potential in the air transportation system