Eyjafjallajökull – one year on

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Eyjafjallajökull, volcanic clouds, and aviation - one year on

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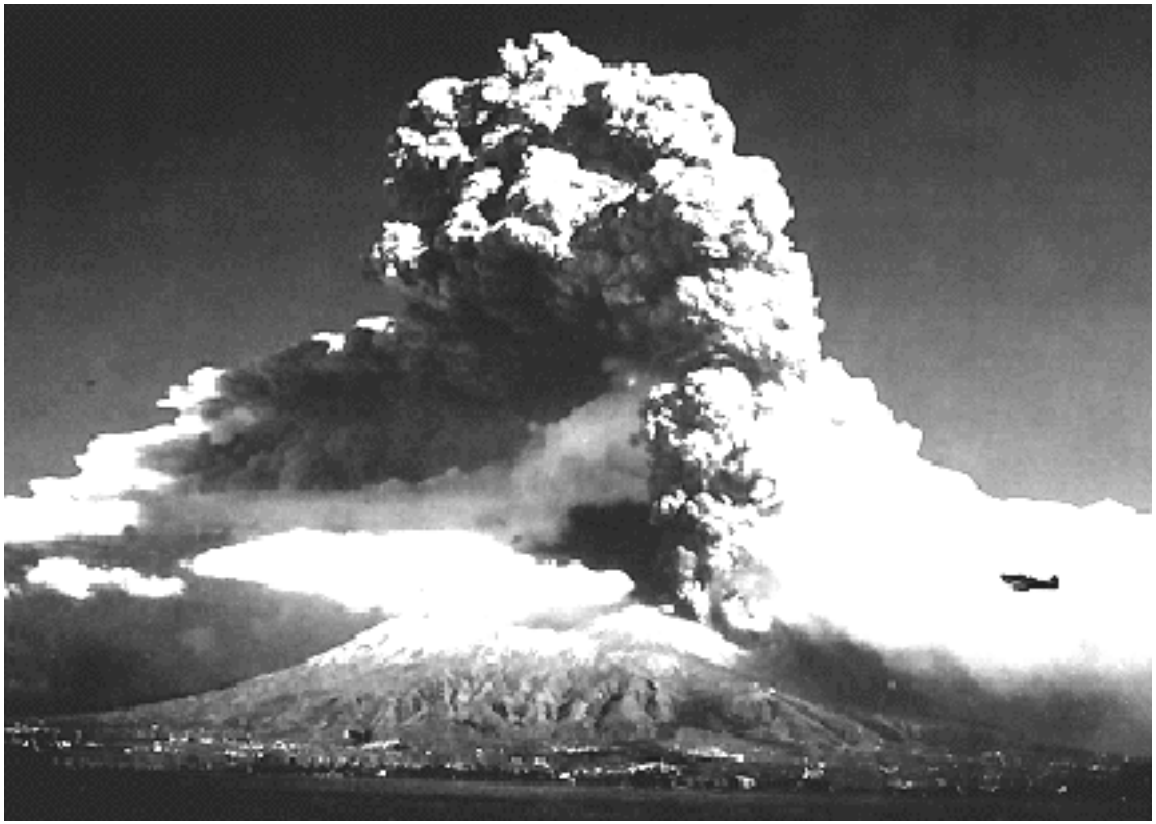
Unprecedented impact

- The April-May 2010 Eyjafjallajökull eruption has had a tremendous unprecedented impact on civil aviation in Europe, especially during the 14-20 April week.



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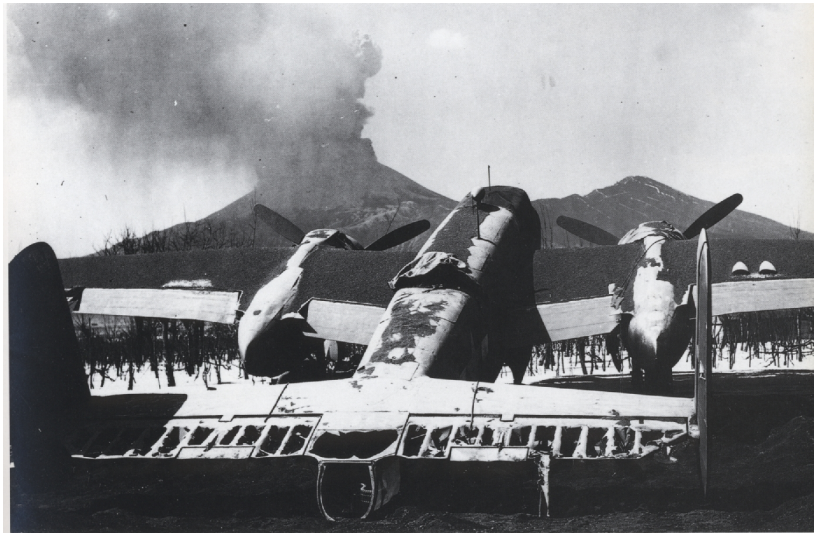
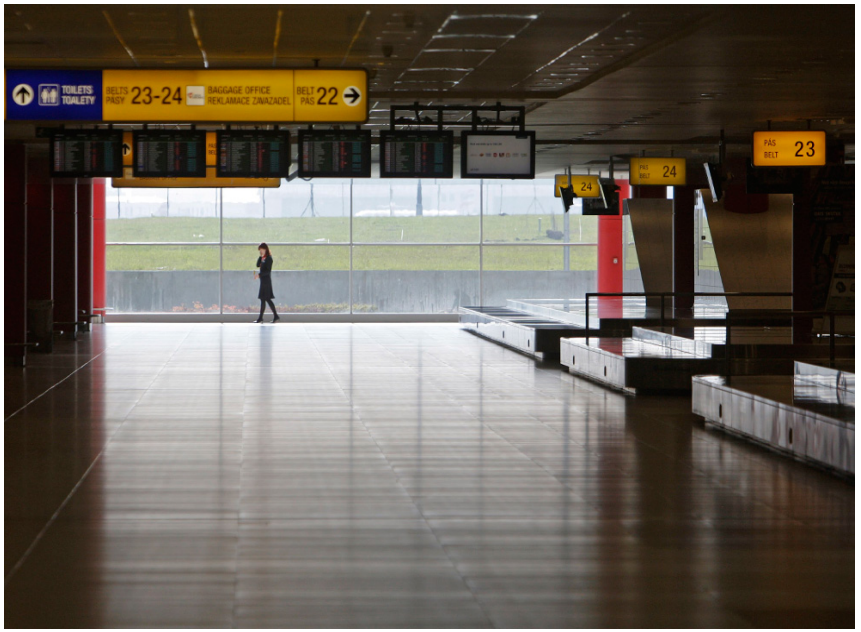


Unprecedented impact

- Net aviation sector impact around US$2.2 billion.
- 25 countries were directly affected.
- 100.000 cancelled flights (over 4 million passengers affected).
- Impact on global GDP through 24 May 2010 to approximately US$5.0 billion.



VATDM

- VATDM models are based on the transport of a released mass of ash in the atmosphere (characterized by 4D wind, air temperature and air density fields) provided by a Numerical Weather Prediction (NWP) model.

- Any VATDM needs the following types of **inputs**:
  - **Meteorological** inputs from either a global or regional NWP model.
  - **Volcanological** inputs:
    - Ash particle properties (size, density and shape).
    - Grain size distribution (fraction of particles of each size).
    - Definition of the source term (eruptive column) including:
      - Column height.
      - Vertical distribution of mass.
      - Mass eruption rate (erupted mass per unit of time).

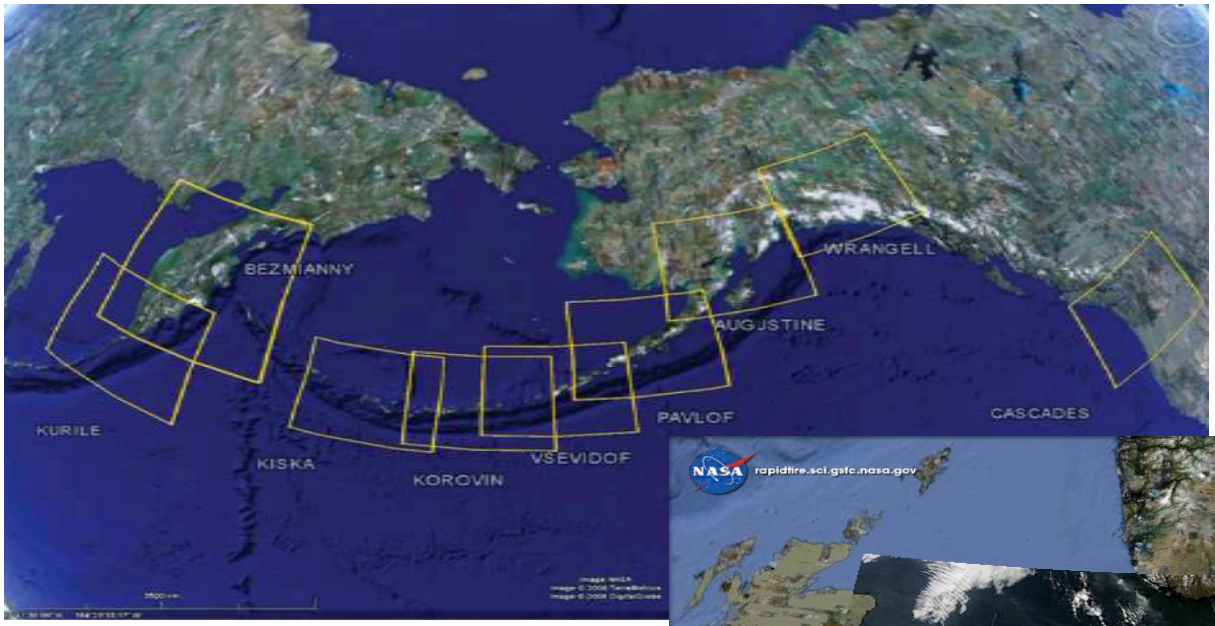
Change of criteria…

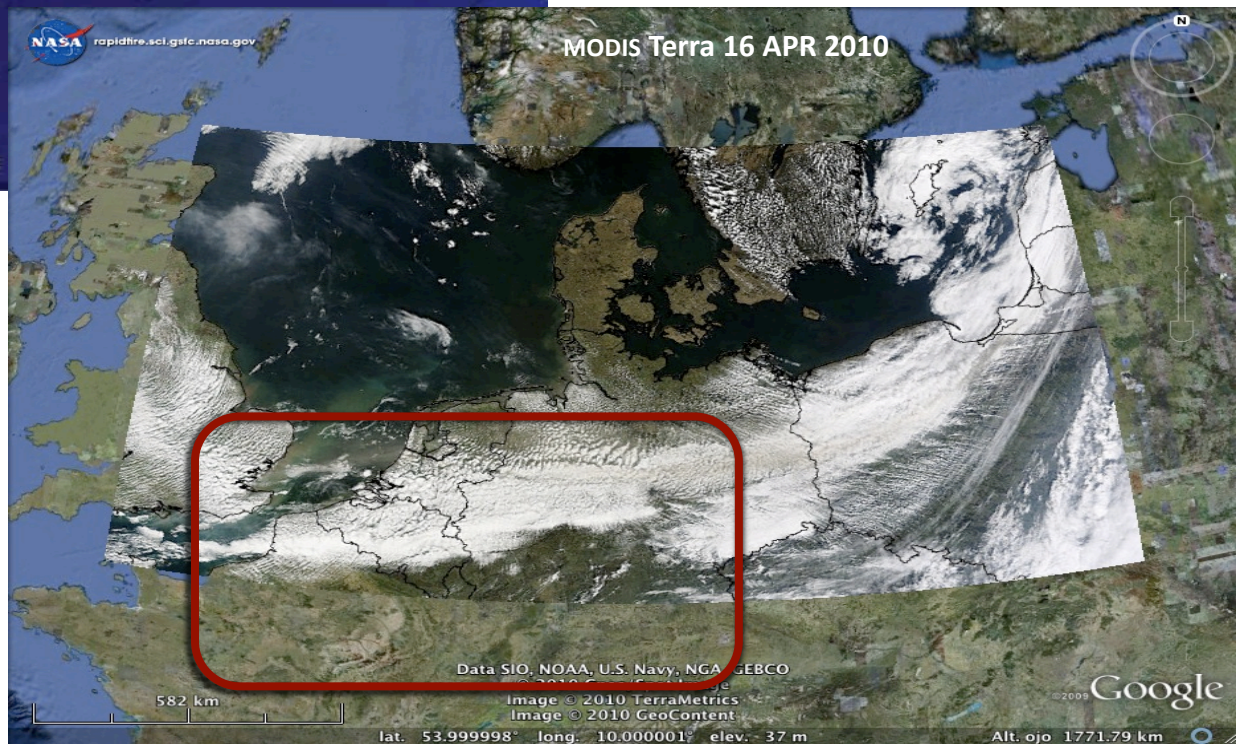
○ Before the crisis, the criterion to define "contaminated areas" was based on a "**zero-ash tolerance**" criterion.

- Strategy designed in a context of relatively short-extent ash clouds.
- Air-routes with room to manoeuvre.
- Avoidance and alternative flight paths possible.

○ When applied to large-extend long-duration clouds over areas like West Europe the "zero-ash tolerance" criterion led to a collapse.

Only one criterion for very different situations…



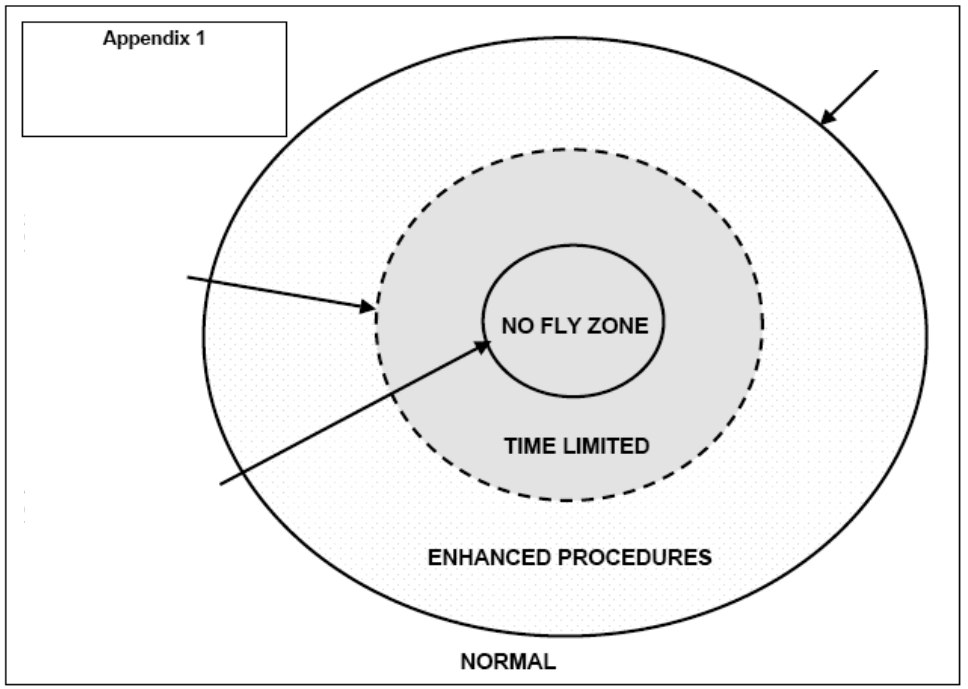


The U.K. CAA values (not ICAO product!)

- The "zero-ash tolerance" criterion was successively relaxed during the crisis following several "monitoring flights" and because of the pressure of the airlines.

- From 19 May 2010, the limits used by the UK Civil Aviation Authority (CAA) changed to:

  - 4 mg/m^3 for the no fly zone (black zone).
  - 2 mg/m^3 for the time-limited zone (grey zone).
  - 0.2 mg/m^3 for the enhanced procedures zone (red zone).
  - <0.2 mg/m^3 for the normal zone (white zone).



However, if adopted….. IMPORTANT IMPLICATIONS ON MODELS!

- To assess the source term becomes crucial.
  - In a “zero-tolerance” context the most important is the column height.
  - In the new context, a good estimation of the mass flow rate and vertical distribution of mass become also crucial.

- It is difficult (if not impossible) for current models to discriminate concentrations of few mg/m^3 due to a number of reasons:
  - Inherent difficulty of the physical processes involved.
  - Insufficient definition of inputs (especially the volcanological).
  - Inherent uncertainty and transient behaviour of the eruptive phenomenon. This is important because, even in the ideal scenario where the first two items are addressed, a fully deterministic approach will always find the limit of uncertainty.

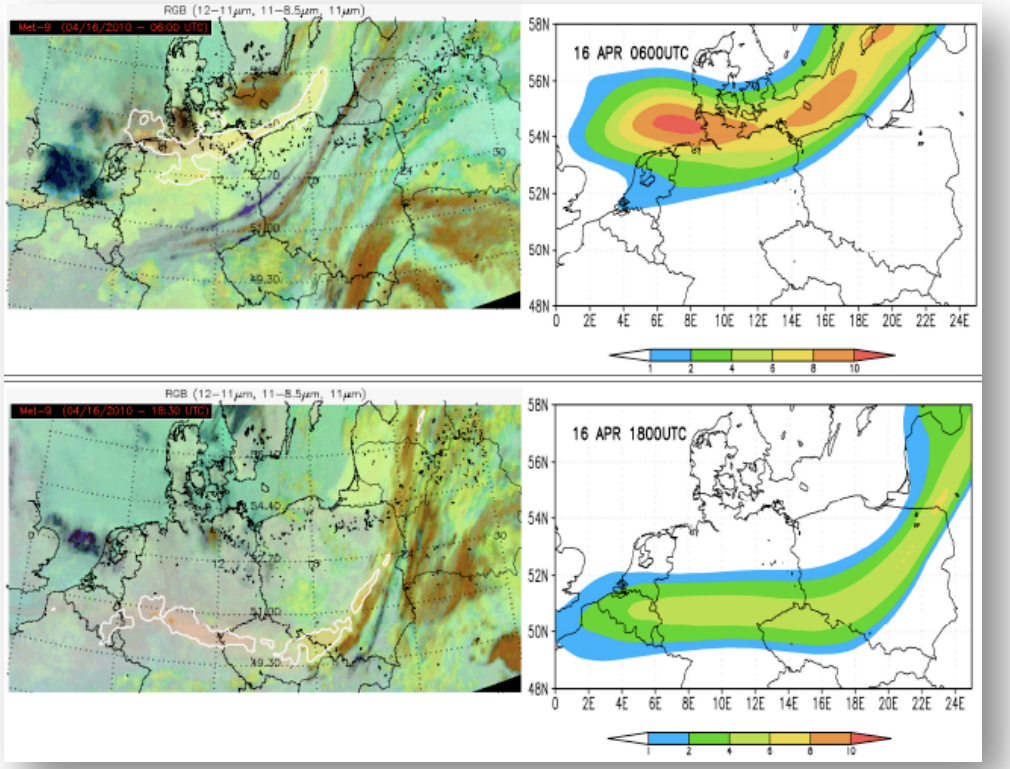
From a scientific point of view is a unique case for validation

Example: Eyjafjallajökull 14-23 april 2010 far-field ash cloud a posteriori simulation

- FALL3D model simulation
- Hourly plume height + BPT
- 8 bins (250 µm – 1 µm)
- 0.25º x 0.25º x 100m grid resolution

Model validation

1. Remote space-based observations
   - SEVIRI
2. Remote ground-based observations
   - Ceilometers (DWD)
   - Lidar (EARLINET)
   - Sun-photometers (AERONET)
3. In-situ observations
   - Aircraft particle counter
   - Ground particle counters



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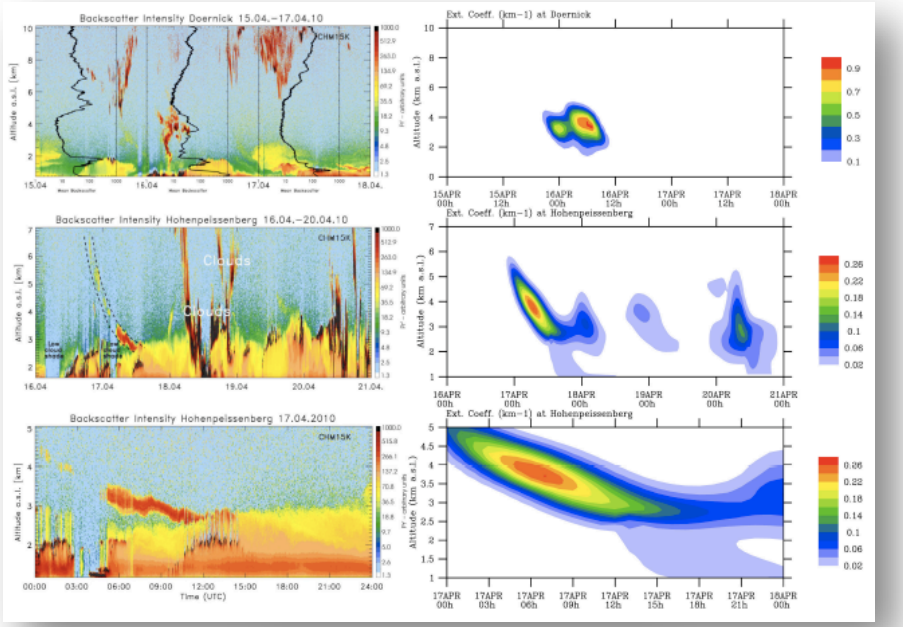

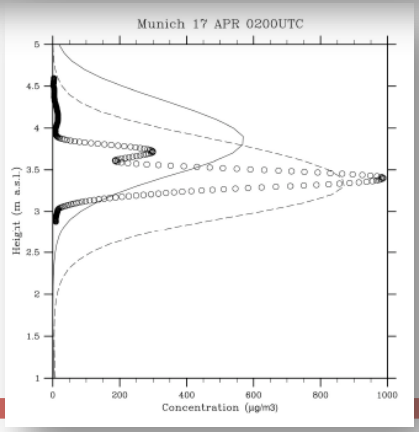

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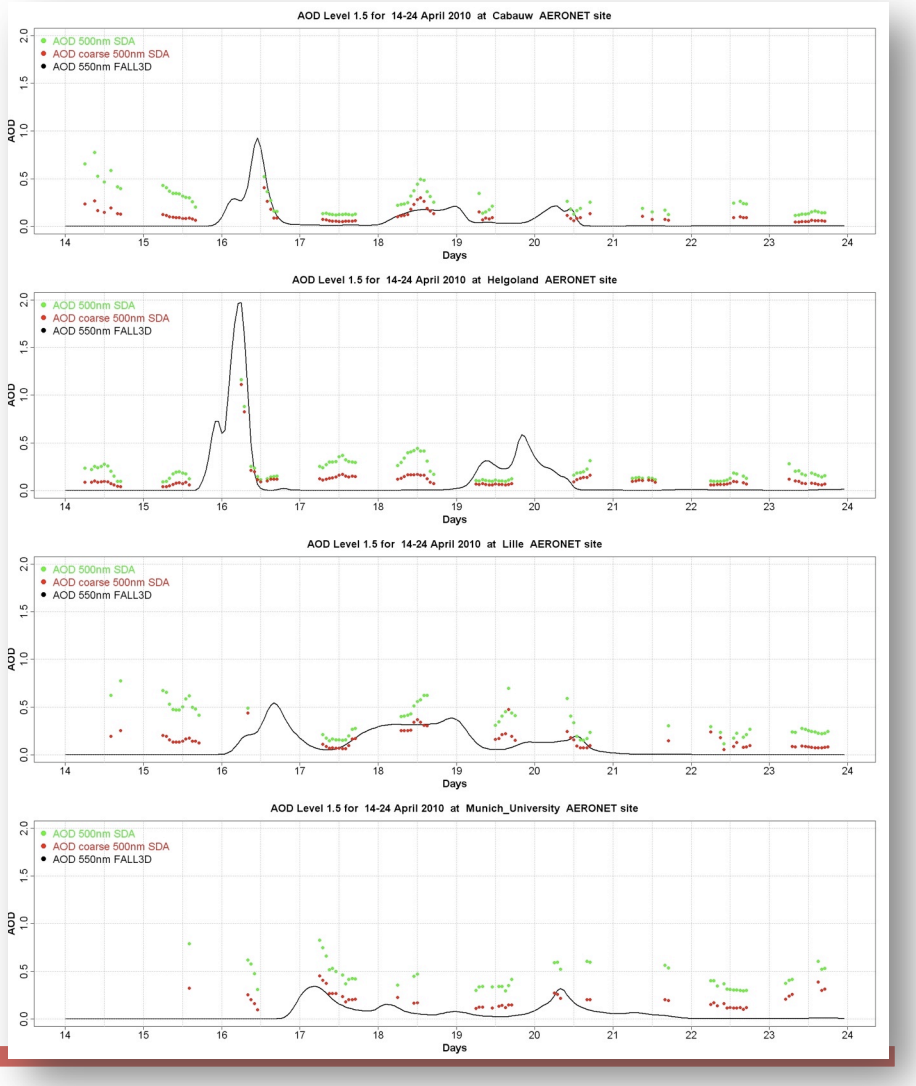

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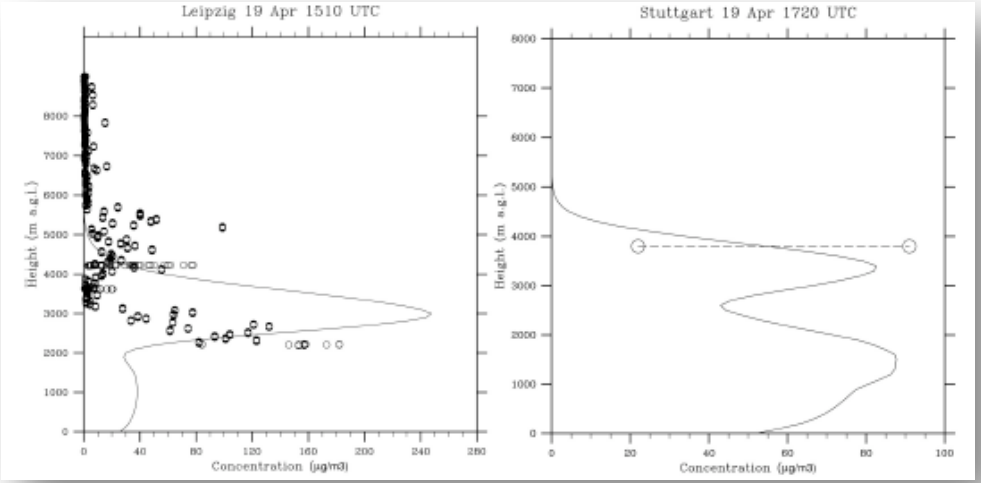

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