The Eyjafjallajökull eruption: A view from the Met Office

Contents

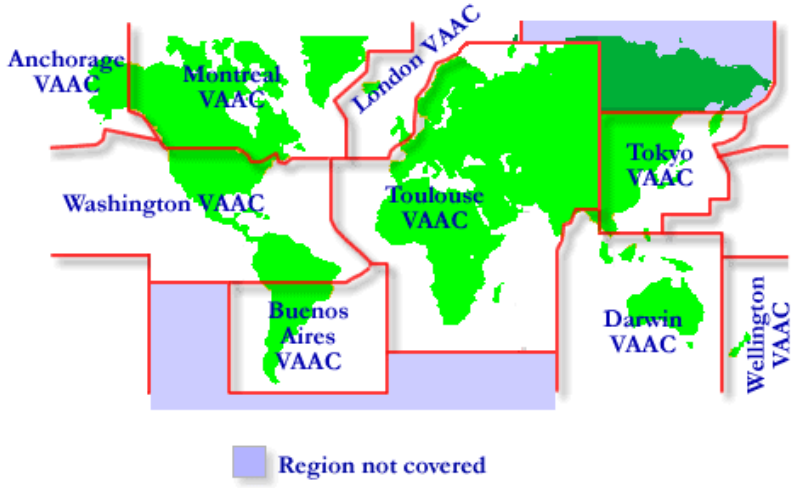
- VAAC
- Eyjafjallajökull
  - NAME VAAC set up
  - NAME output
- Ongoing/other activities
- Close

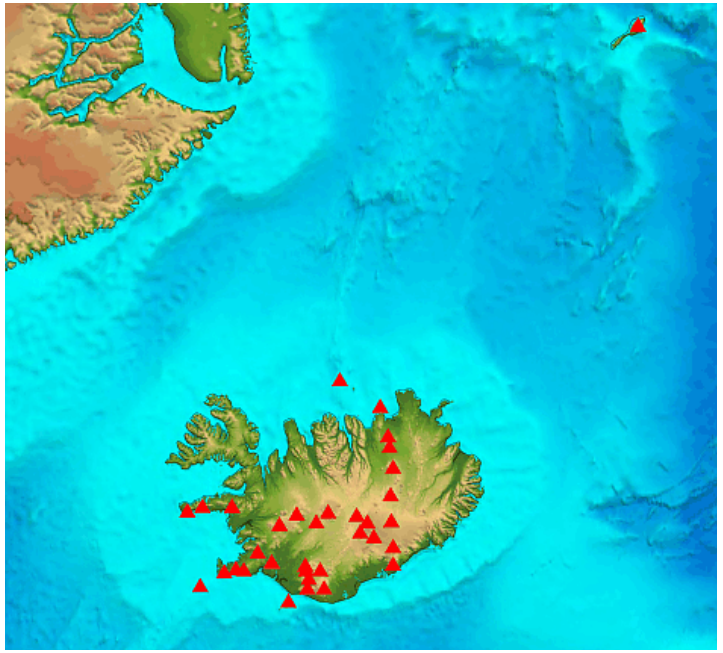
VAAC Setup & Response

VAAC

Volcanic Ash Advisory Centre

- 1986 International Airways Volcano Watch instituted by International Civil Aviation Organisation (ICAO)
- Volcanic Ash Advisory Centres designated by ICAO and World Meteorological Organisation
- Role of VAAC - ICAO Annex 3:
  - Production of advisories detailing the spatial dispersion of VA
  - Running (and/or utilisation of output from) NWP dispersion models
  - Monitoring of observational data, especially satellite imagery for the presence of VA.

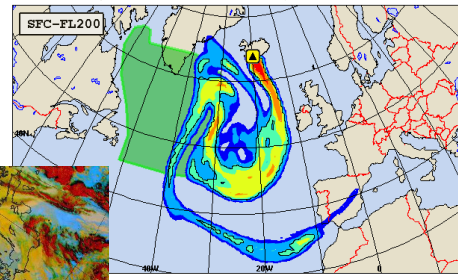




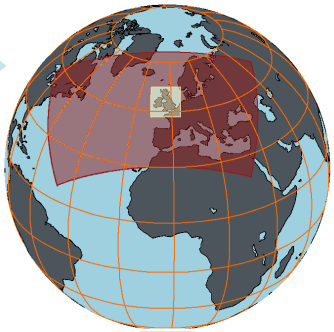
The VAAC process

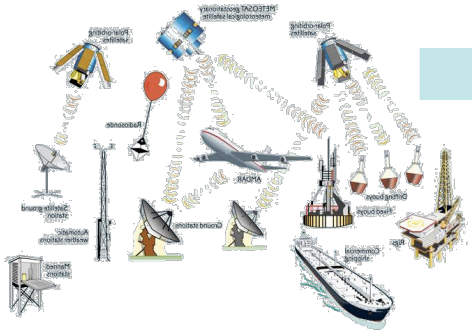
Met Office

Other models

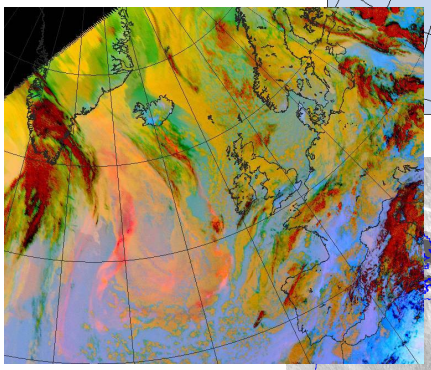


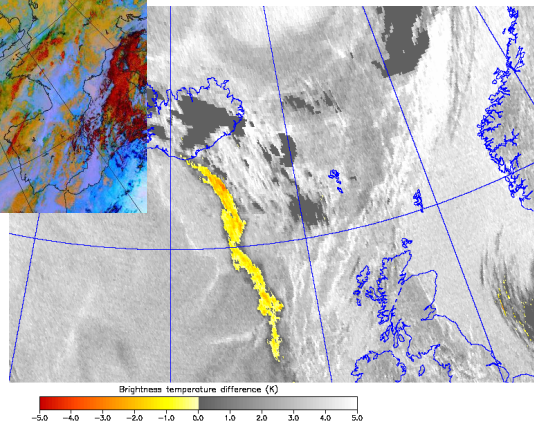
Met Office Weather forecast models





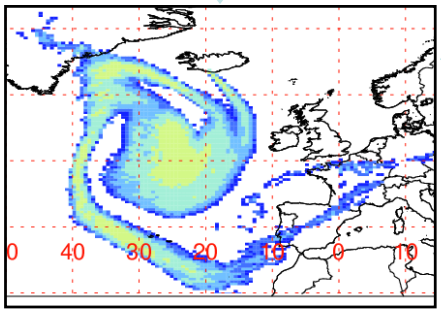
Weather observations





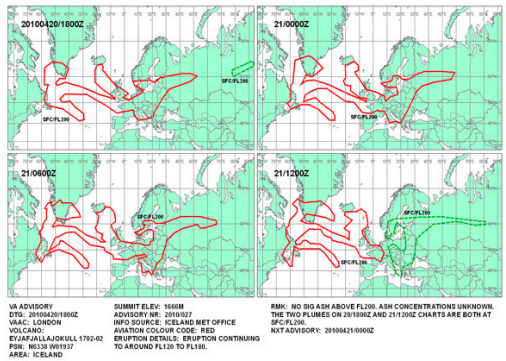
Satellite + Other Observations

Volcano data



NAME

Forecaster



VAAC Chart & other products

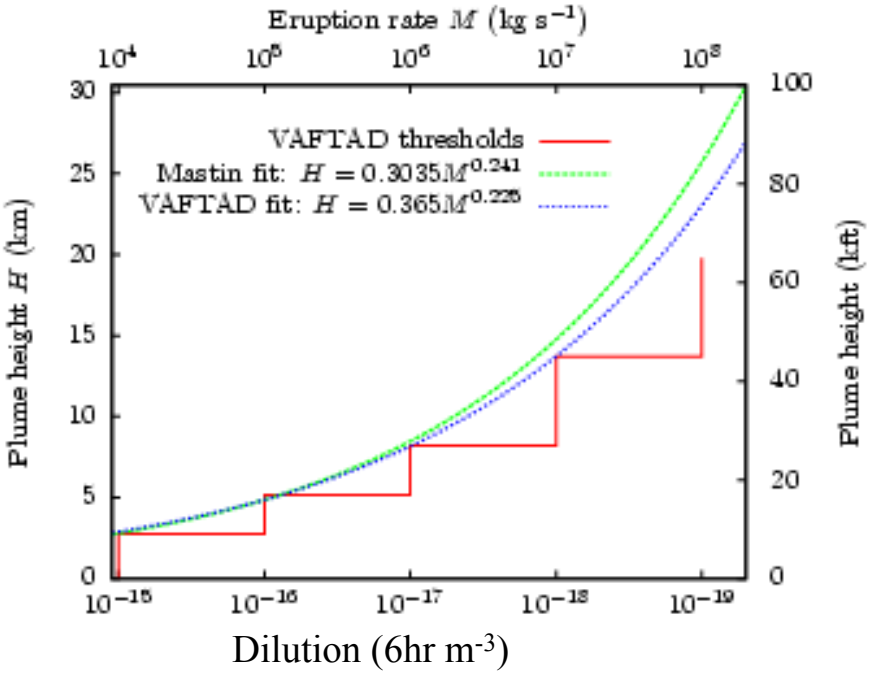
Operational

- Normal:
  - 24/7 Forecast centre
  - Response by specialist forecaster with access to NAME
  - All software operational and on operational hardware
    - Full change control, documentation, approval process
    - Dual systems, UPS, different electricity supplies, diesel backup, all changes run on backup server, redundant web/dissemination routes
  - Science staff provide support when needed
- Eyjafjallajökull response:
  - Required changes/additions make it impossible to use normal framework
  - New more complex model run/code/graphics/products all generated by research
  - New code deployed on new standalone hardware with operational like change control
  - Research staff on shifts 0500-2200 + on call

London VAAC Model Configuration

- Vertical line source
- Bottom: summit height; top: observed plume rise from IMO
- Uniform vertical ash distribution at source
- 6 bin particle size distribution 1 – 100mm (peak 10 – 30mm)
- Ash density = 2300 g/m3
- 6 day spin up + 5 day forecast (ash age limited to 6 days)
- Global UM NWP data
- Sedimentation, wet + dry deposition

Emission rate and concentration threshold

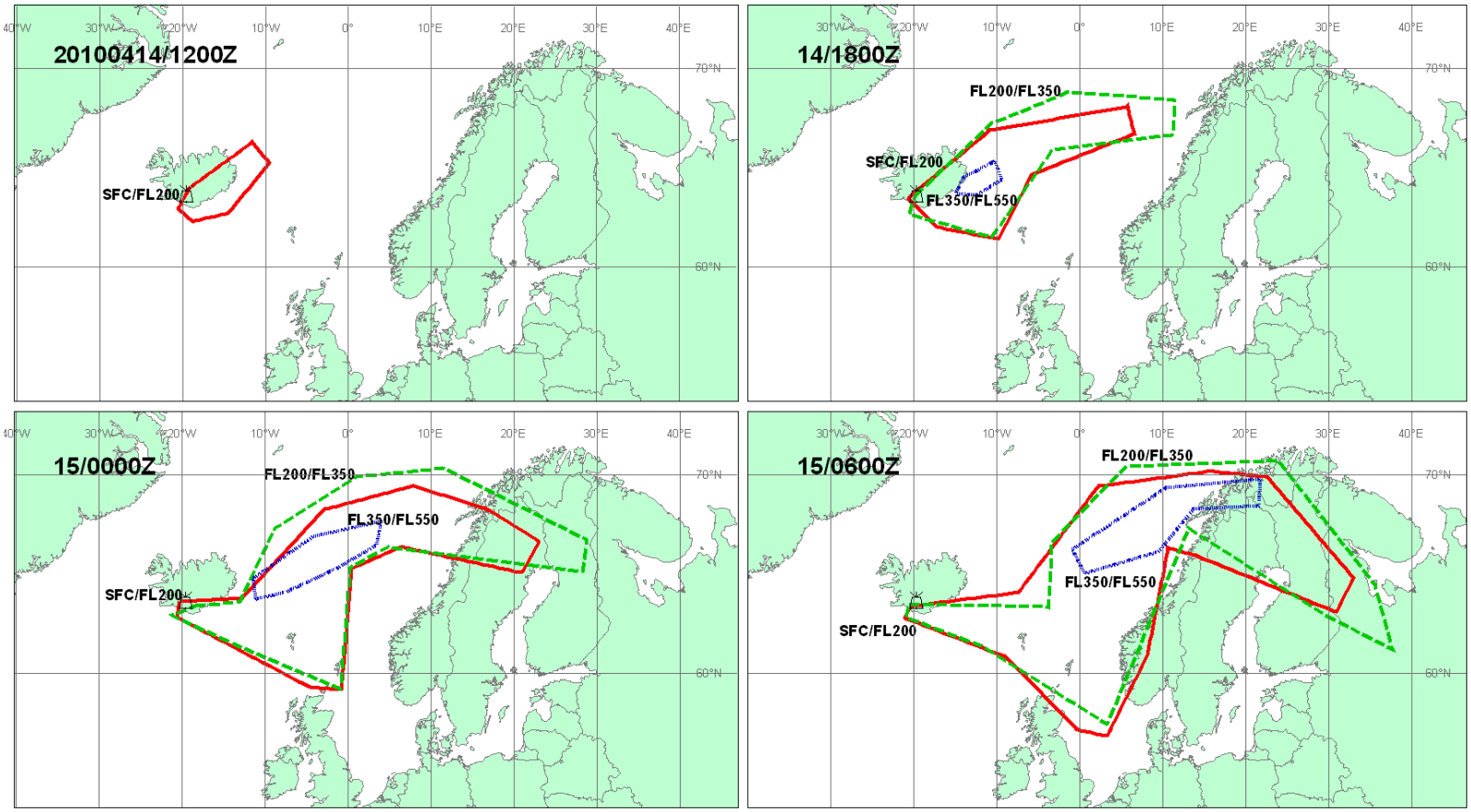


- Initial aviation rules were “avoid ash”
  - ‘VAFTAD’ table used – gives dilution for “area of ash” as function of plume rise height – stepped function
  - No attempt to estimate source strength or predict concentrations quantitatively
- On 19/4/10 rules changed to avoid concentrations above 2000 μg/m^3 & enhanced procedures above 200 μg/m^3, requiring quantitative predictions
  - VAFTAD table calibrated using Mastin et al’s (2009) emission rate v. plume rise curve, making agreement best where VAFTAD is least conservative
  - Later replaced by smooth curve – very close to Mastin et al (2009), Sparks (1997)

Uncertainties

- Eruption mass estimated from empirical height to mass relationship
  - Considerable error bars reflecting differences in eruptions and meteorology
- Eruption height observation ± 1km --> x10 mass
- Eruption very intermittent
- Current particle size distribution ≤ 100 microns, but a significant fraction (~90%) of material is larger (individual & aggregates)
- The plume is patchy and has thin high concentration layers which are not resolved by our model configuration
  - peak to mean concentrations can be ~10
- Small errors in position of narrow plumes can lead to large concentration errors

ICAO Advisories



VA ADVISORY
DTG: 20100414/1200Z
VAAC: LONDON
VOLCANO:
EYJAFJALLAJOKULL
PSN: N6338 W01937
AREA: ICELAND

SUMMIT ELEV: 1666M
ADVISORY NR: 2010/001
INFO SOURCE: ICELAND MET OFFICE
AVIATION COLOUR CODE: UNKNOWN
ERUPTION DETAILS: PLUME FROM VOLCANO
REPORTED TO BE UP TO 6000M

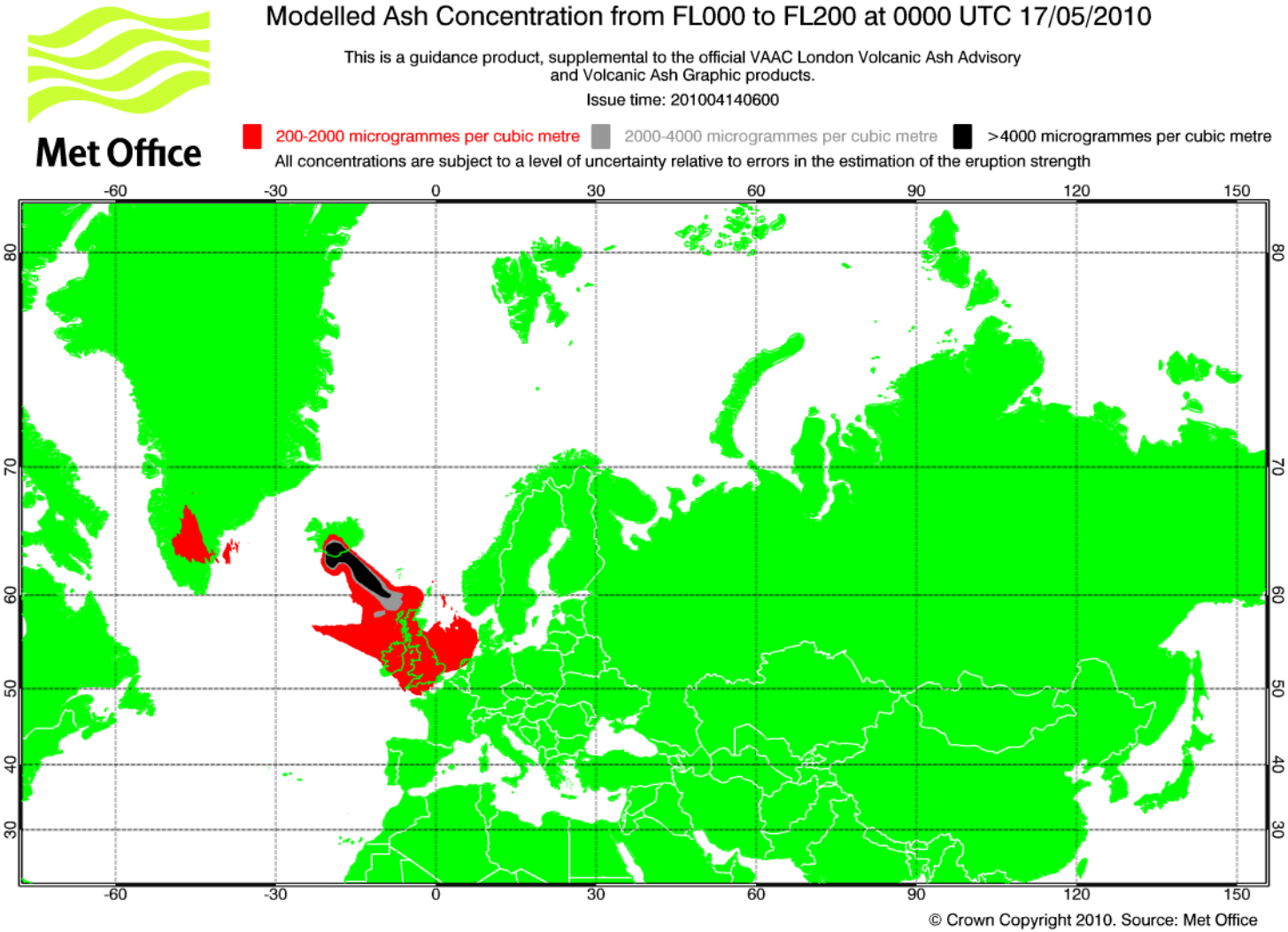
RMK: NIL
NXT ADVISORY: 20100414/1800Z

Supplemental quantitative advisory from 16th May 2010

Red area:
c > 200 mg/m^3

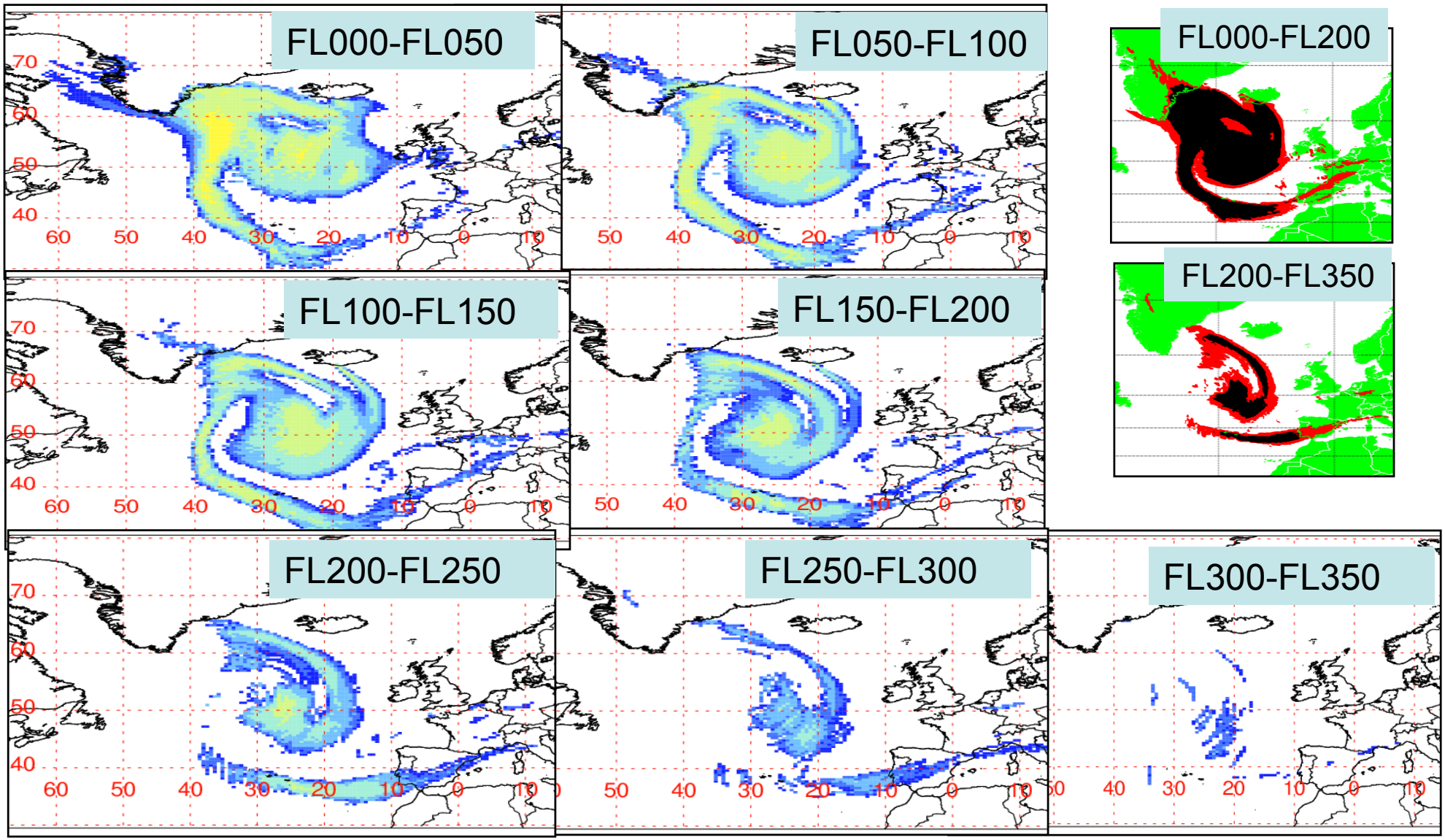
Grey area:
c > 2000 mg/m^3

Black area:
c > 4000 mg/m^3



‘Raw’ NAME output

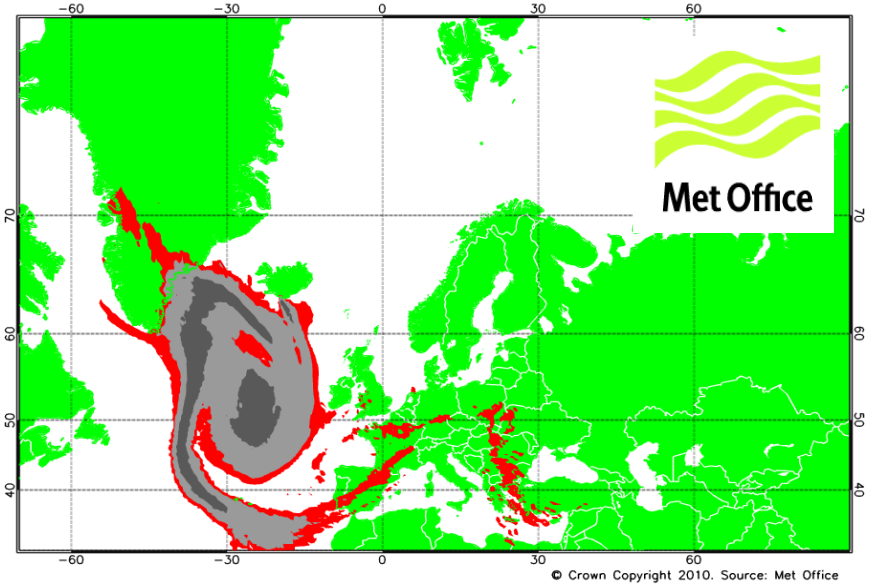
1200UTC 10 May

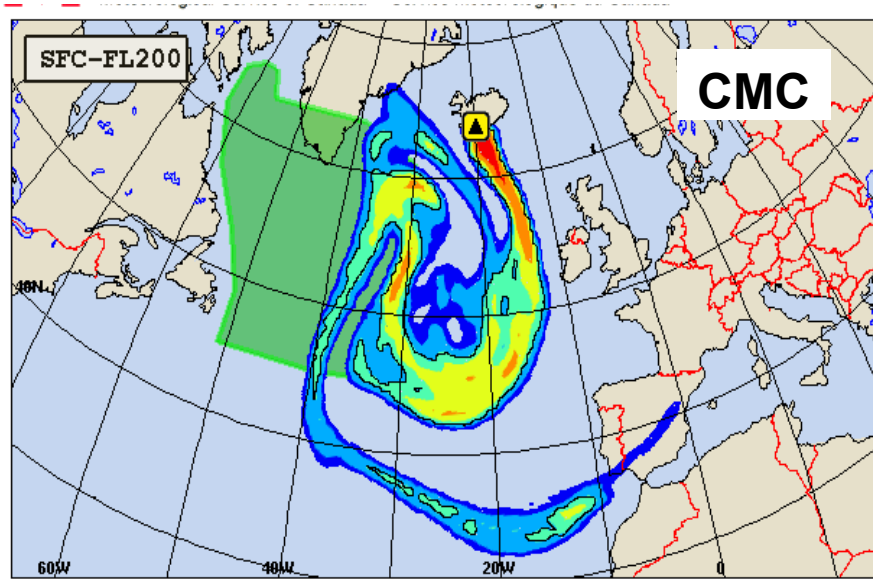


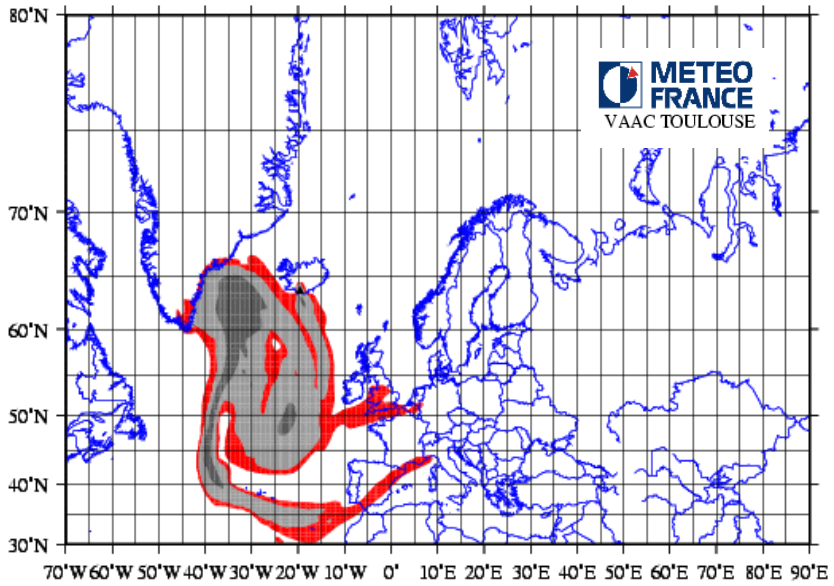

Met Office
Model Verification

Model Comparisons

1200z on 10 May



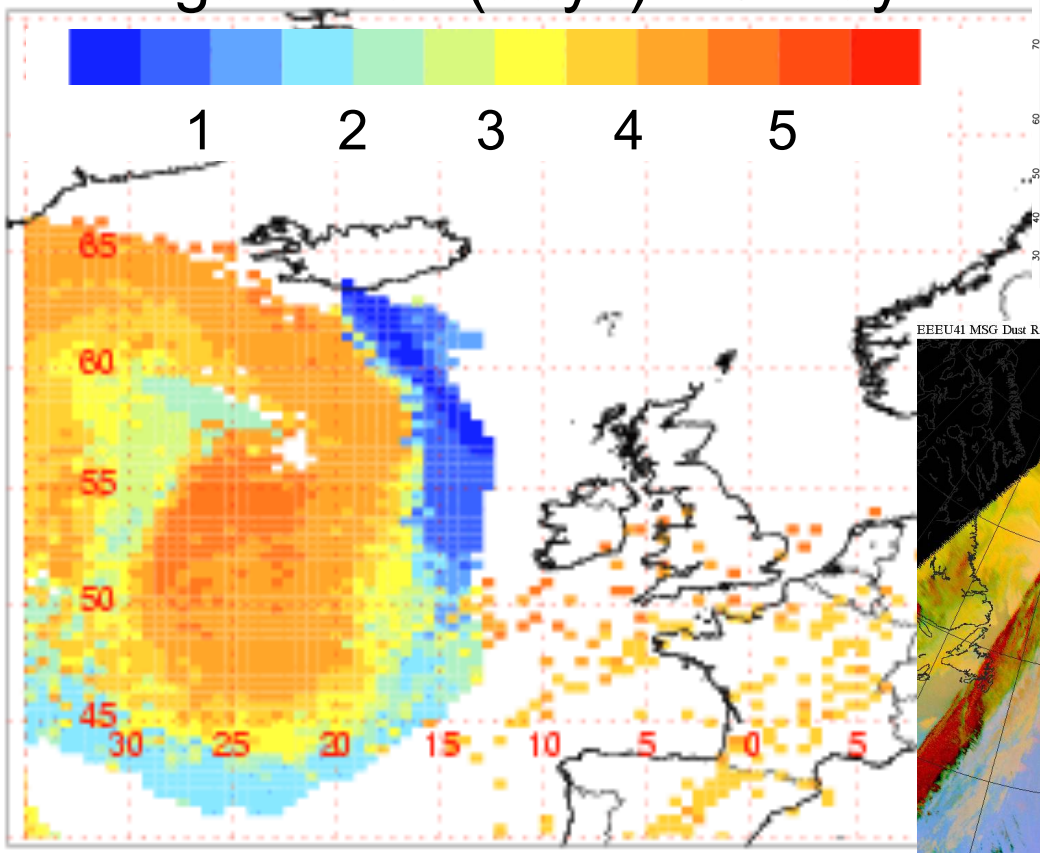


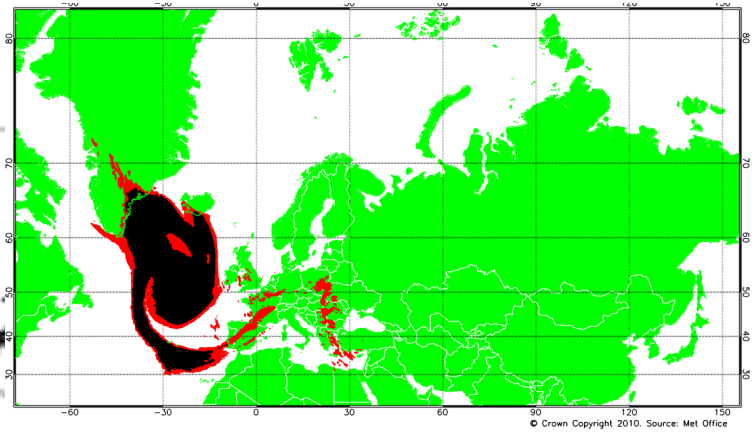


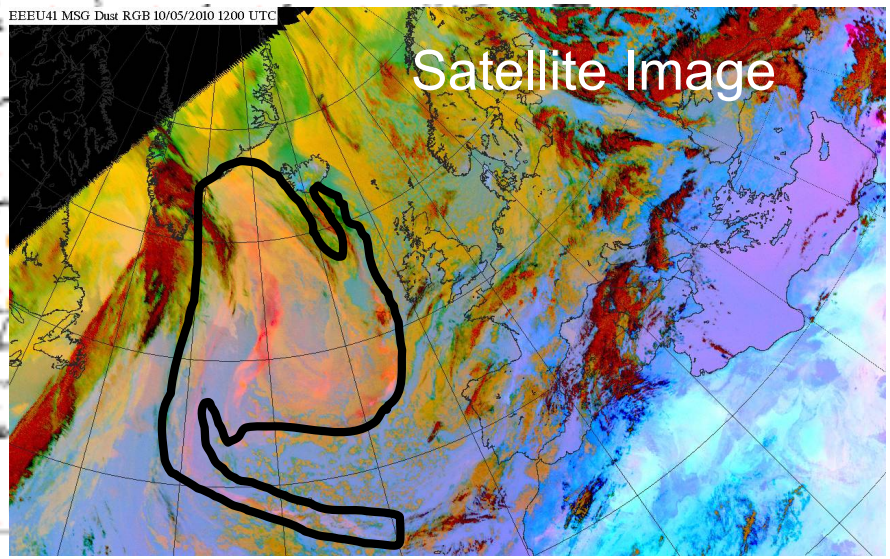
Comparison with observations:

Many satellite products

Age of ash (days): 10 May



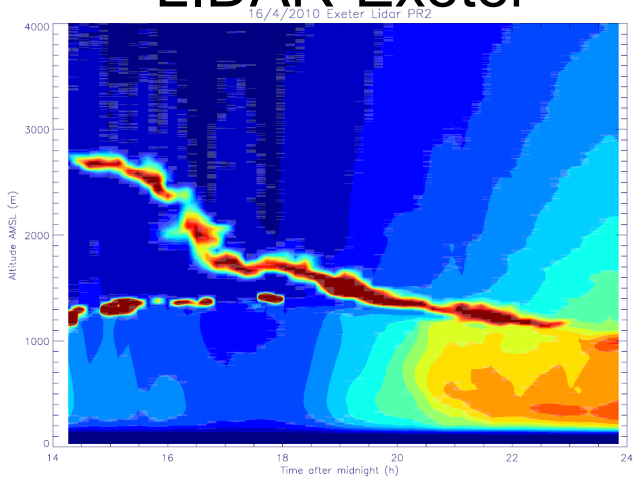




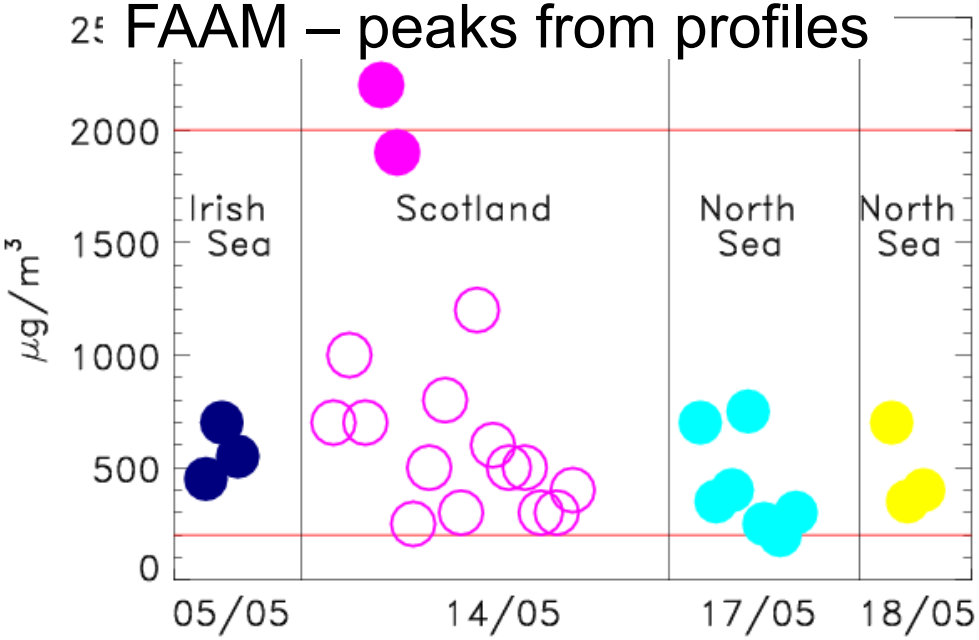
Comparison with observations

- Ad hoc comparisons during event suggest model predicts peaks within an order of magnitude
- Comprehensive post-event comparisons not yet complete

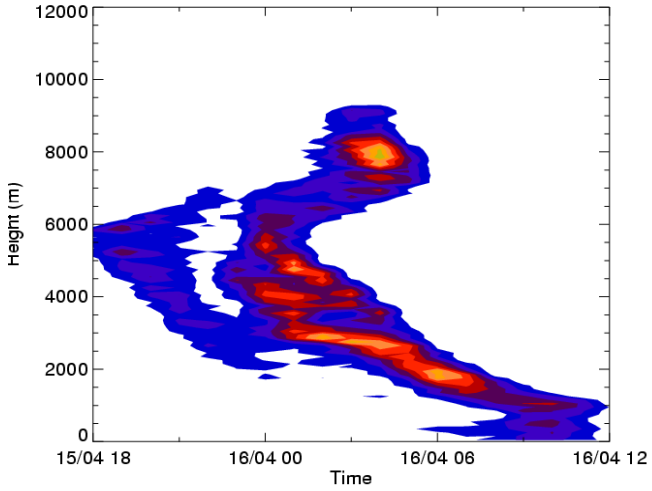
LIDAR-Exeter

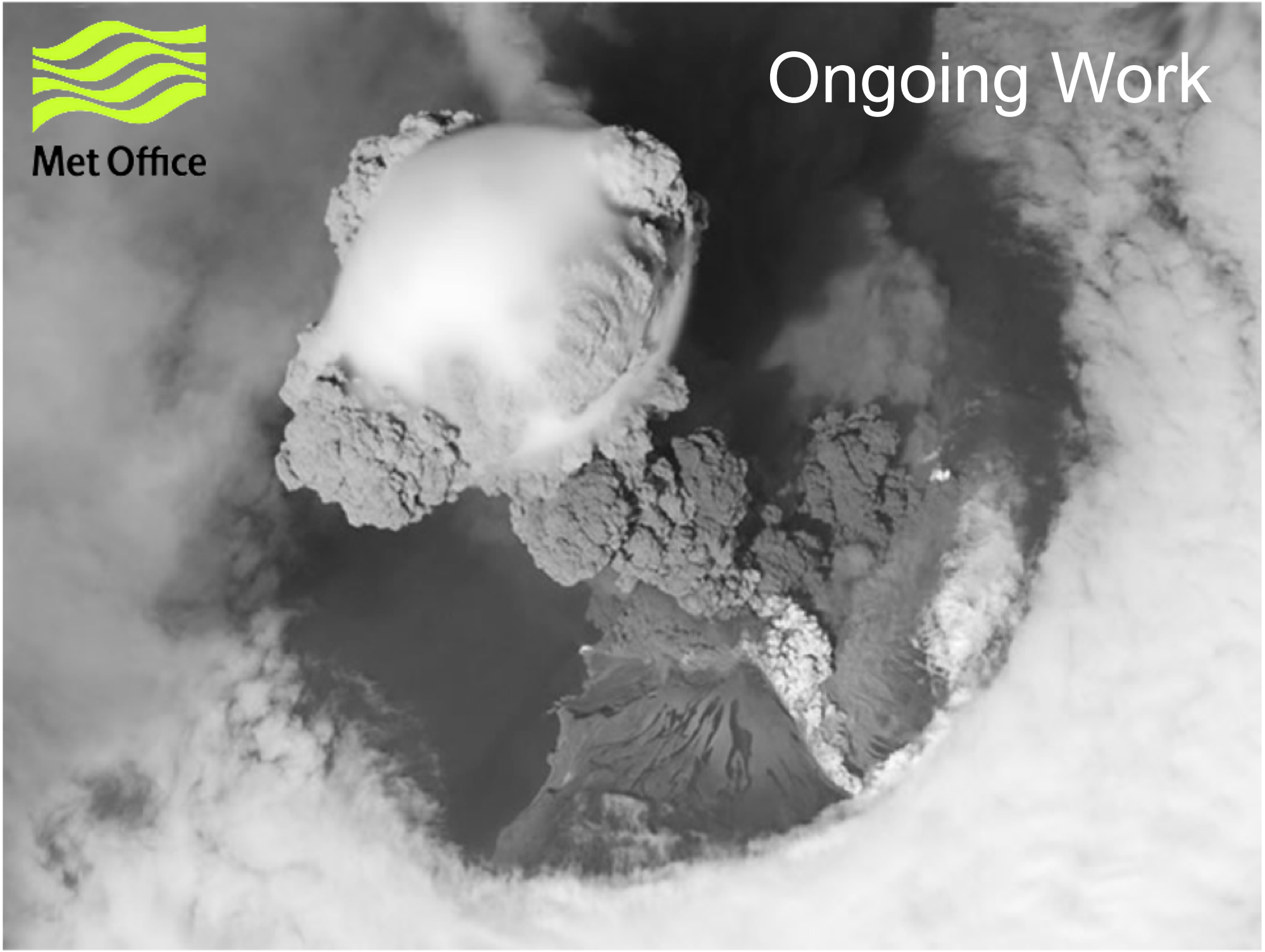


FAAM – peaks from profiles



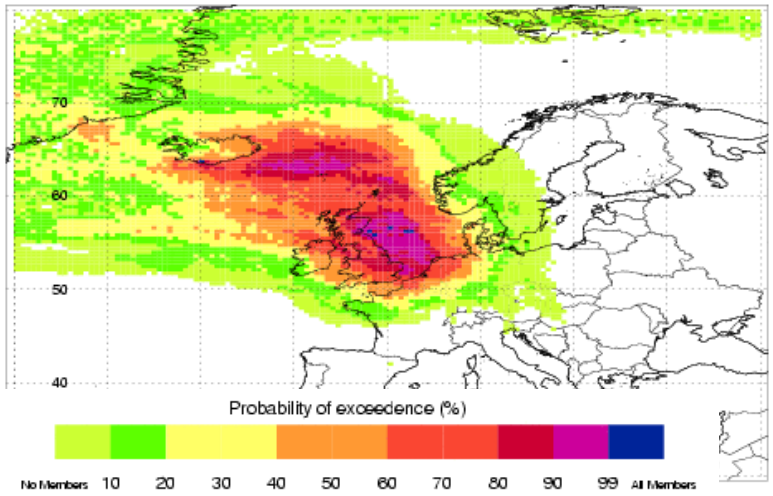
NAME

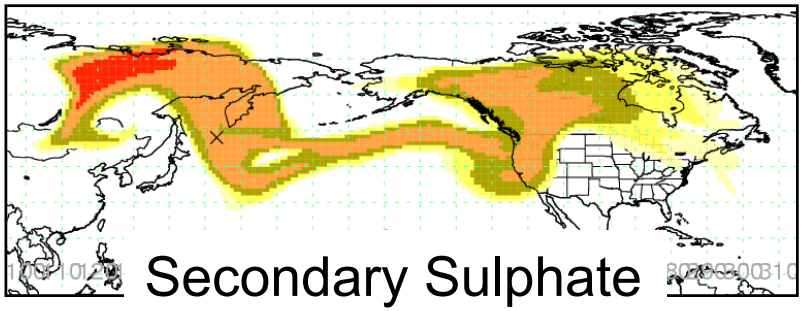



Met Office
Ongoing Work

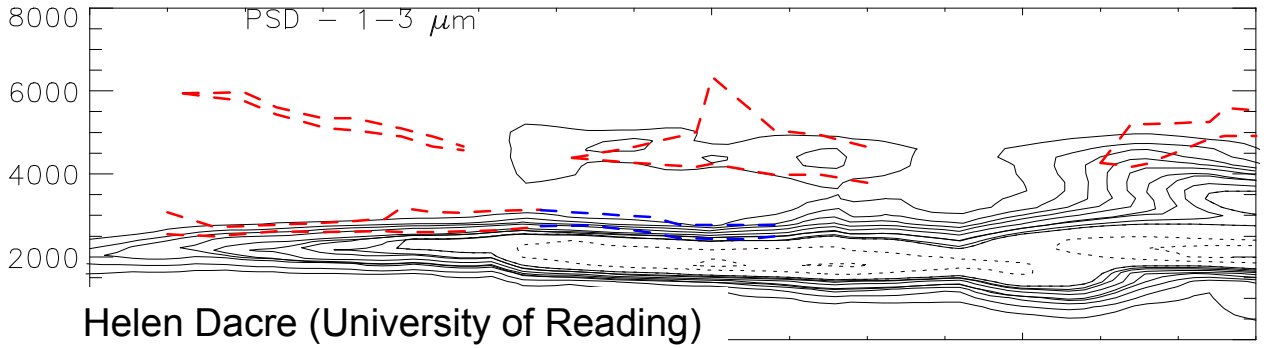
Activities: Dispersion

- Model inter-comparisons
- Evaluation against observations: concentration and deposition
- Evaluation of both peak and mean concentration predictability
- Sensitivity analysis: paricle sizes, eruption timings, etc
- Inclusion of chemistry in emergency response VA plume
- Ensemble/probabilistic predictions





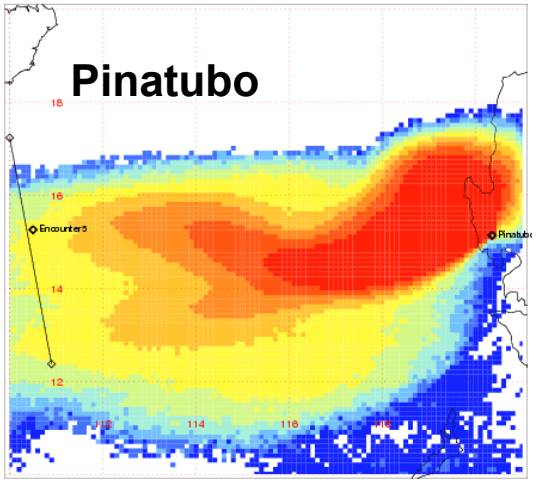
Secondary Sulphate

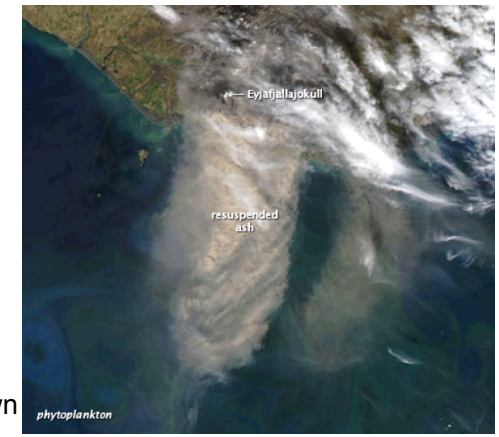


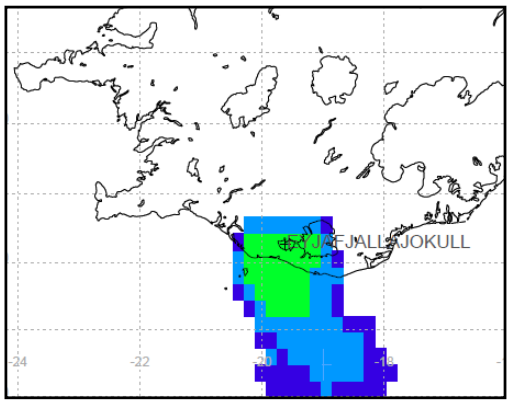
Helen Dacre (University of Reading)

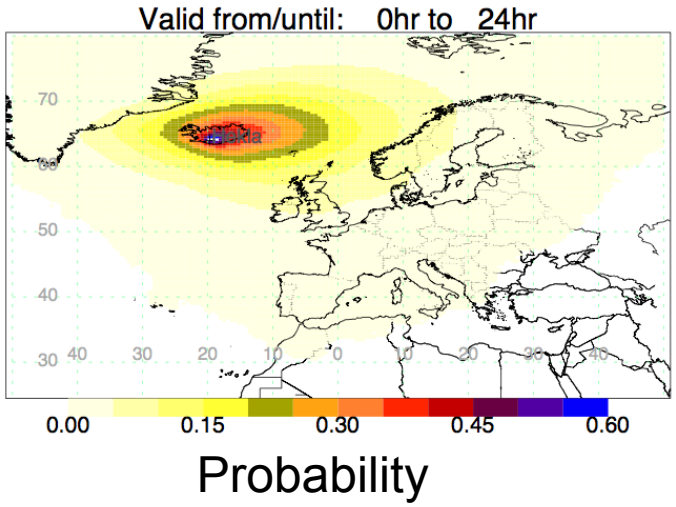
Activities: Dispersion

- Improvements to model definition of eruptive source term
- Analysis of historic eruptions/ash encounters
- Evaluation of inversion modelling and data assimilation processes
- Climatological studies to better quantify risks
- Resuspension – Air quality + airport operations
- **Recommendations for operational implementation**.









Activities: Observations

- Observation data analysis – (many partners)
  - Airborne, LIDAR, Lightning strike, sonds, etc, etc
- Satellite data analysis/processing
  - Work on quantitative retrievals, hyperspectral instruments, etc
  - Simulated satellite products – from NAME data
- Lightning strike data
- Operational integrated VA observation networks
- New ‘emergency response’ aircraft
- etc, etc.

Thoughts

- Model performance very encouraging
- Quantitative prediction is possible
- However potential error bars remain large
  - Source term data largest source of error
  - Observations required if errors to be constrained
- Relevant model physics, current and new, needs further evaluation and development
- Relevant NWP accuracy very important
- Volcanic eruption response is more than aviation….
- Met Office can not and does not want to do this on it's own
  - Committed to international forums
  - Committed to collaboration
  - Committed to full transparency – everything will be published