



Met Office

VAAC London: Modelling and forecasting uncertainty

Dr Matthew Hort (Talking about the work of many others...)



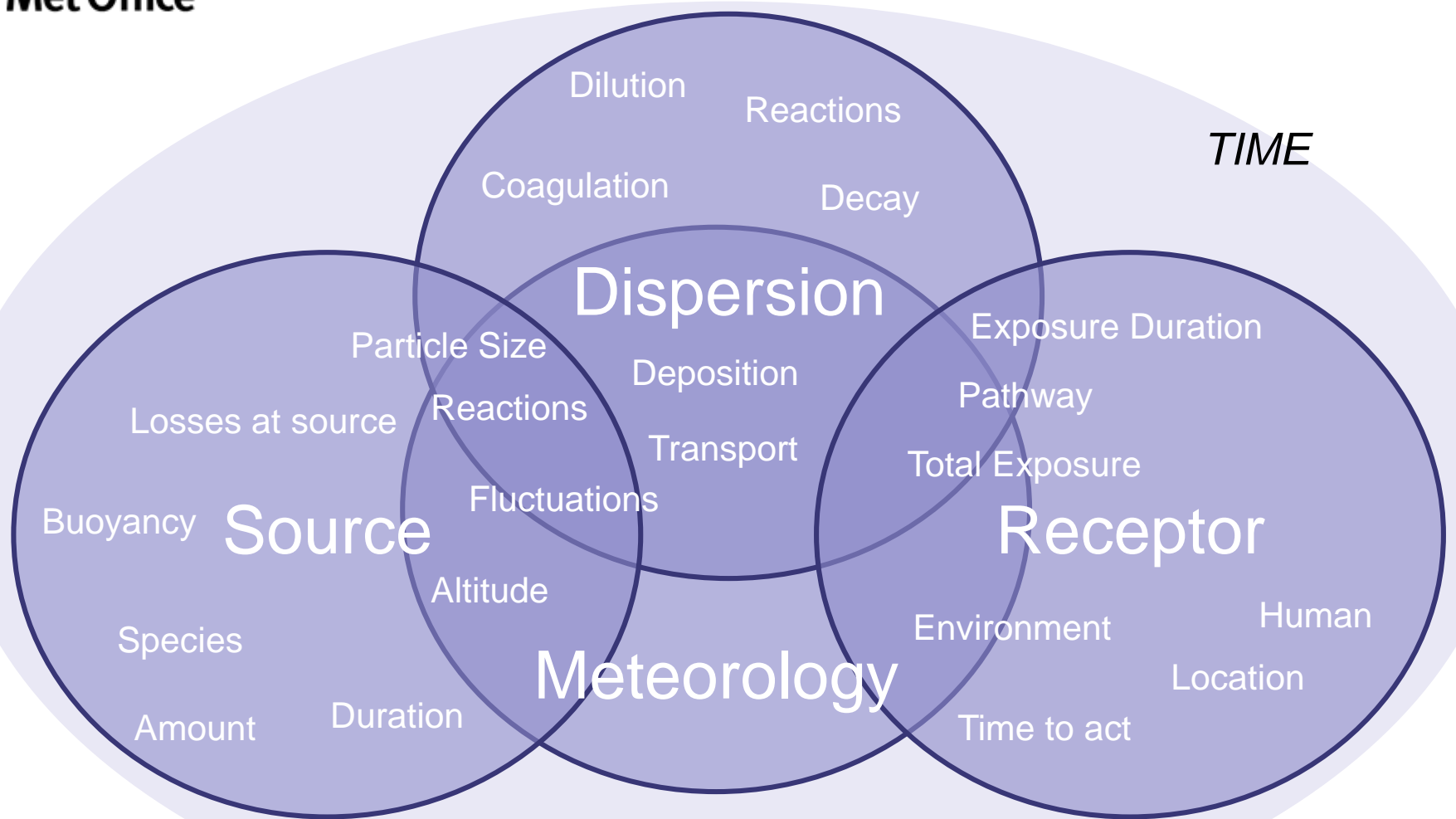
Contents

- Sources of uncertainty
- Forecast process
 - Why it is more than just modelling
- Parts of forecast chain & how uncertainty incorporated
 - Observations
 - Meteorology
 - Dispersion modelling
 - Interpretation and expert judgment
- Summary

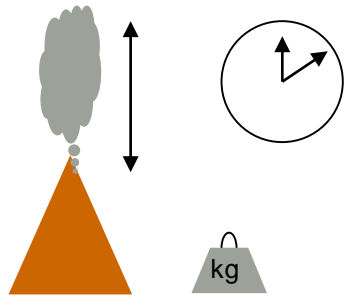


Inputs, Processes and Outputs

a.k.a. sources of uncertainty

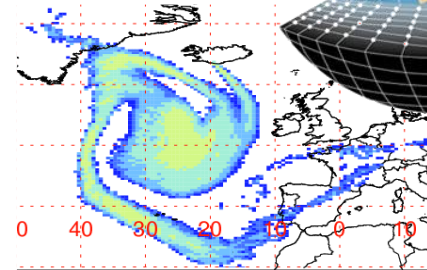


Forecast Process



Source Terms

Interpretation

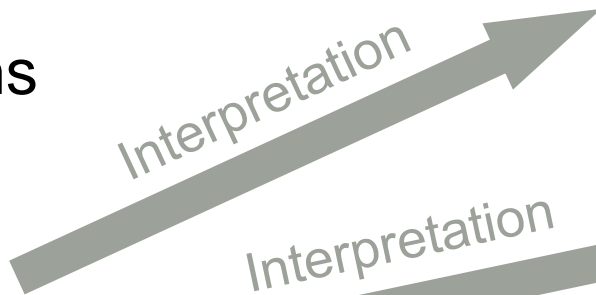


Modelling

Interpretation



Interpretation



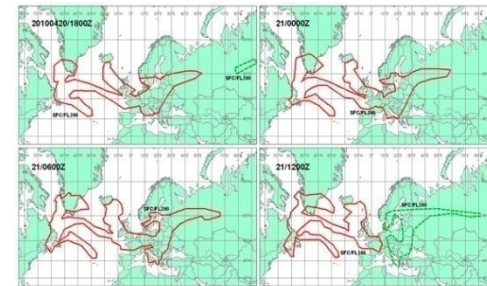
Interpretation



Interpretation



Observations



VA ADVISORY: DTG: 201004201100Z VACC: LONDON VOLCANO: EYJAFALLAJOKULL 1792-02 PSW: 04133 001517 AREA: ICELAND
 SUMMIT ELEV: 1668M ADVISORY NR: 2010027 INFO SOURCE: ICELAND MET OFFICE AVIATION COLOUR CODE: RED ERUPTION DETAILS: ERUPTION CONTINUING TO AROUND FL100 TO FL130
 RMK: NO SIG ASH ABOVE FL100. ASH CONCENTRATIONS UNKNOWN. THE TWO FL005 OR 201004201100Z AND 211120Z CHARTS ARE BOTH AT SFC-FL200. NAT ADVISORY: 20100421000Z

Forecast



Forecast Process

- Observations are limited
- Modelling is a simplified representation of reality
- Impacts/end users are varied
 - What is the purpose of forecast?
- Judgment and interpretation must occur at every step
 - Requires information and expertise
 - London VAAC process is a collaborative team approach



**HANDLING SOURCES OF
UNCERTAINTY**

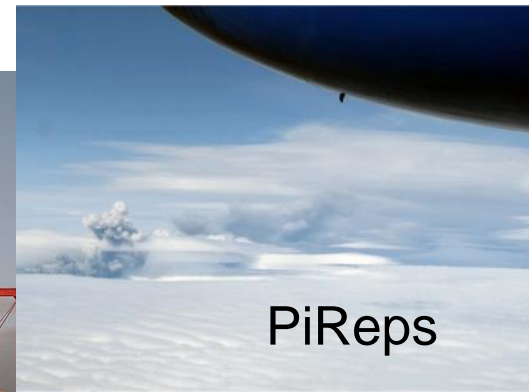


Observations

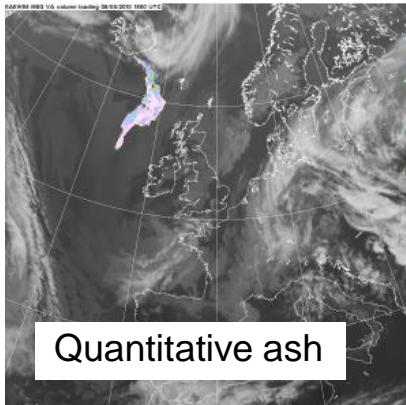
Multi-layered



Radar

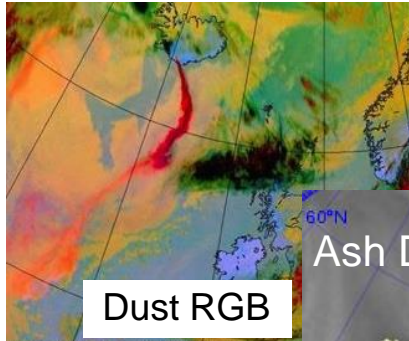


PiReps



Quantitative ash

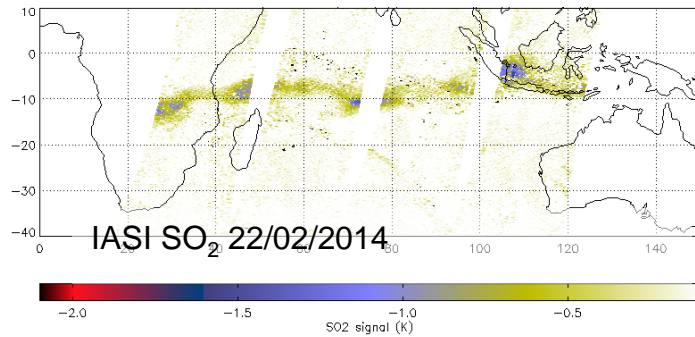
Satellite



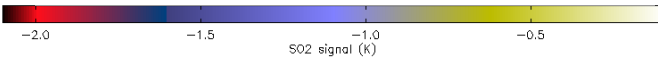
Dust RGB



Ash Detection



IASI SO₂ 22/02/2014



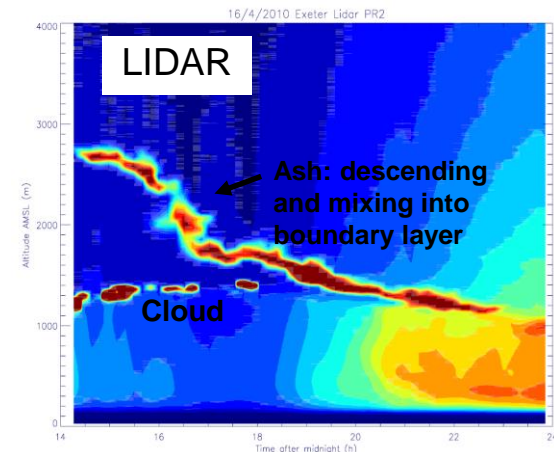
Ground Observers



MOCCA



FAAM

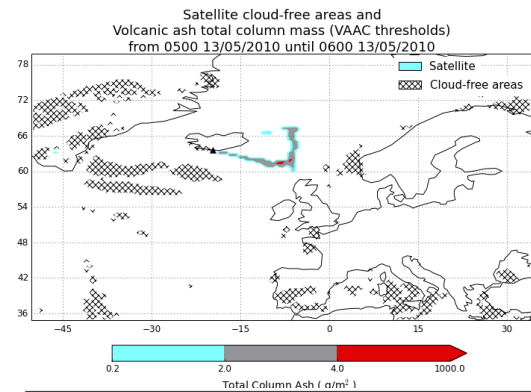


LIDAR

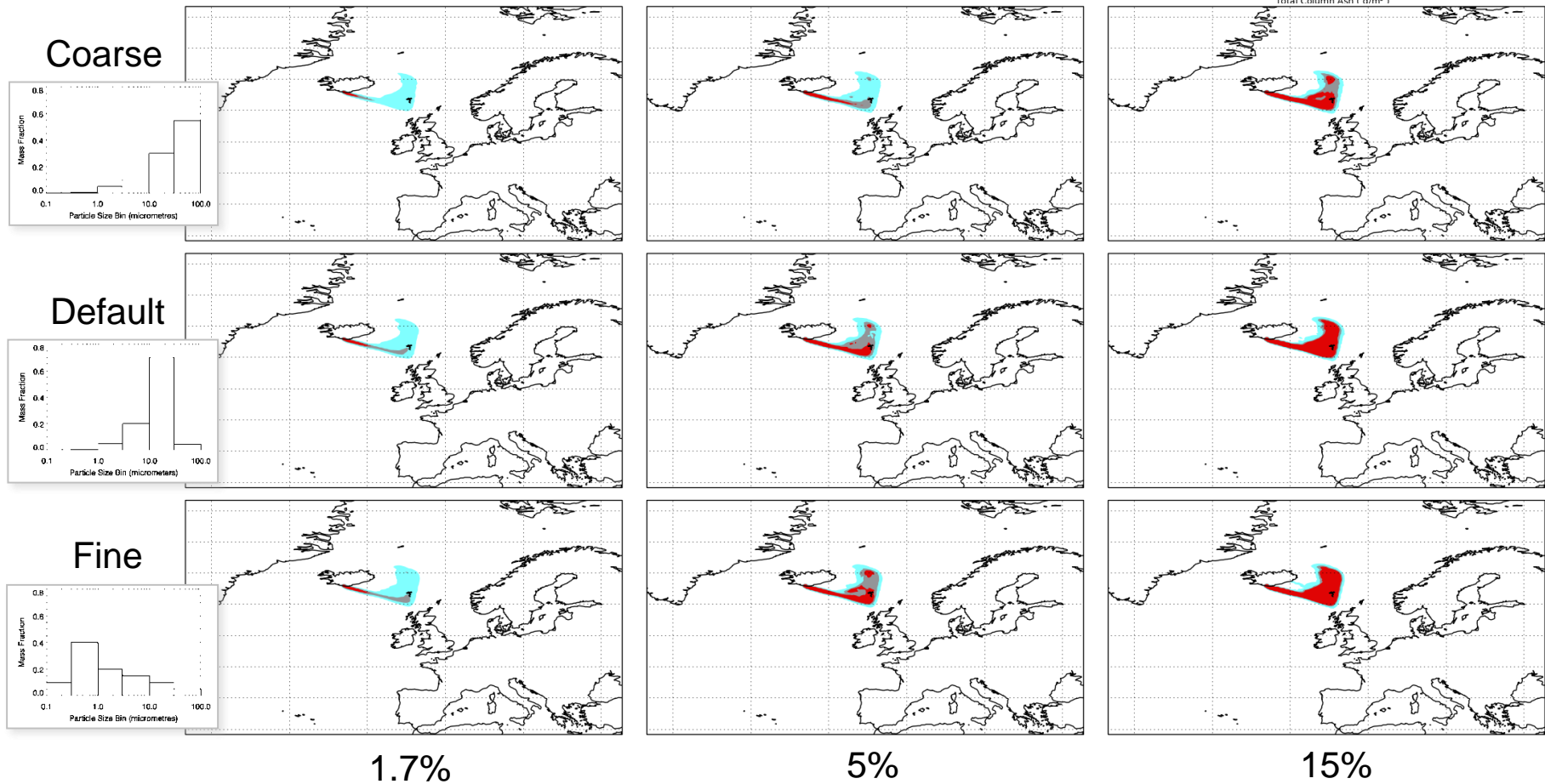
Ash: descending and mixing into boundary layer

Cloud

Source Term Uncertainty



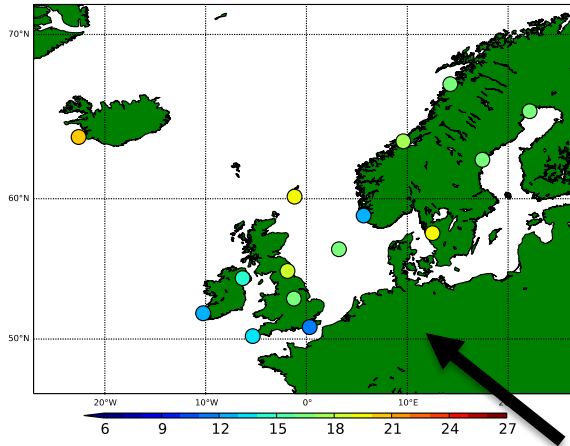
Changing size distribution



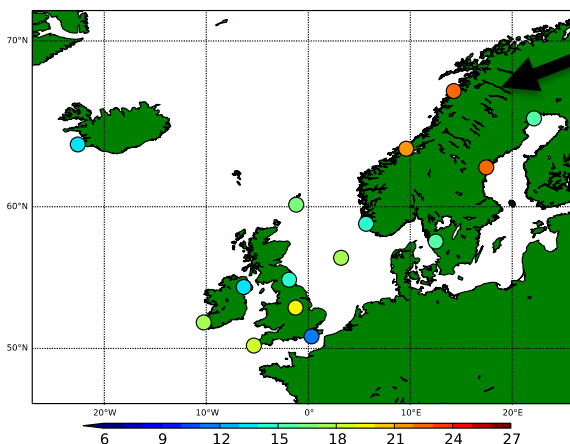
Changing mass fraction

Meteorological Uncertainty

Systematic Analysis



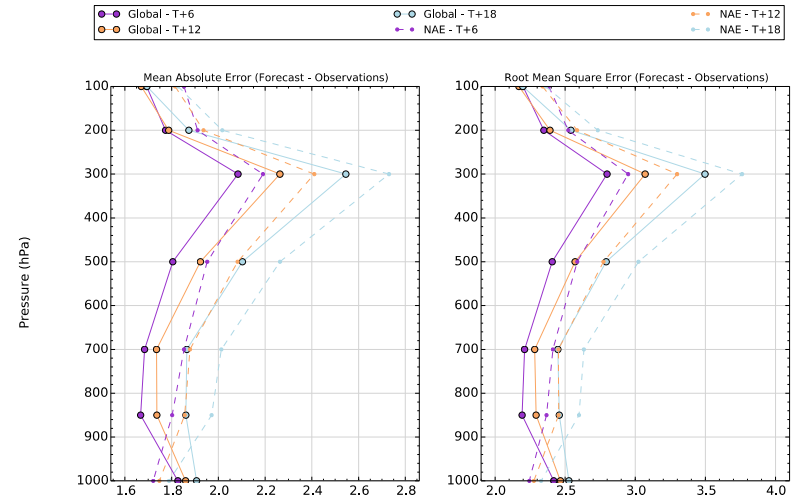
RMSE of wind direction @ 300 hPa for 2010 and 2015



“UM Global model configuration has been shown to be consistently more accurate than UM LAM output at forecasting upper air winds over the area of responsibility covered by the London VAAC.”

(Beckett et al 2015 – MetO Futurevolc report)

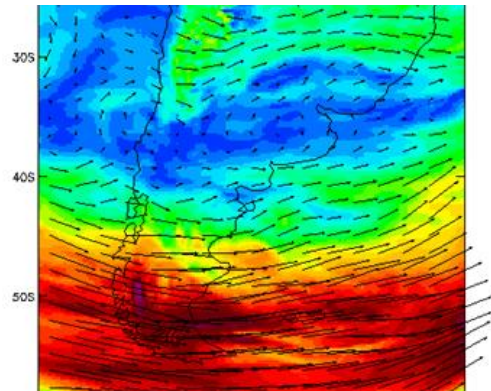
Wind speed (m/s) for 2010 Combined Stations



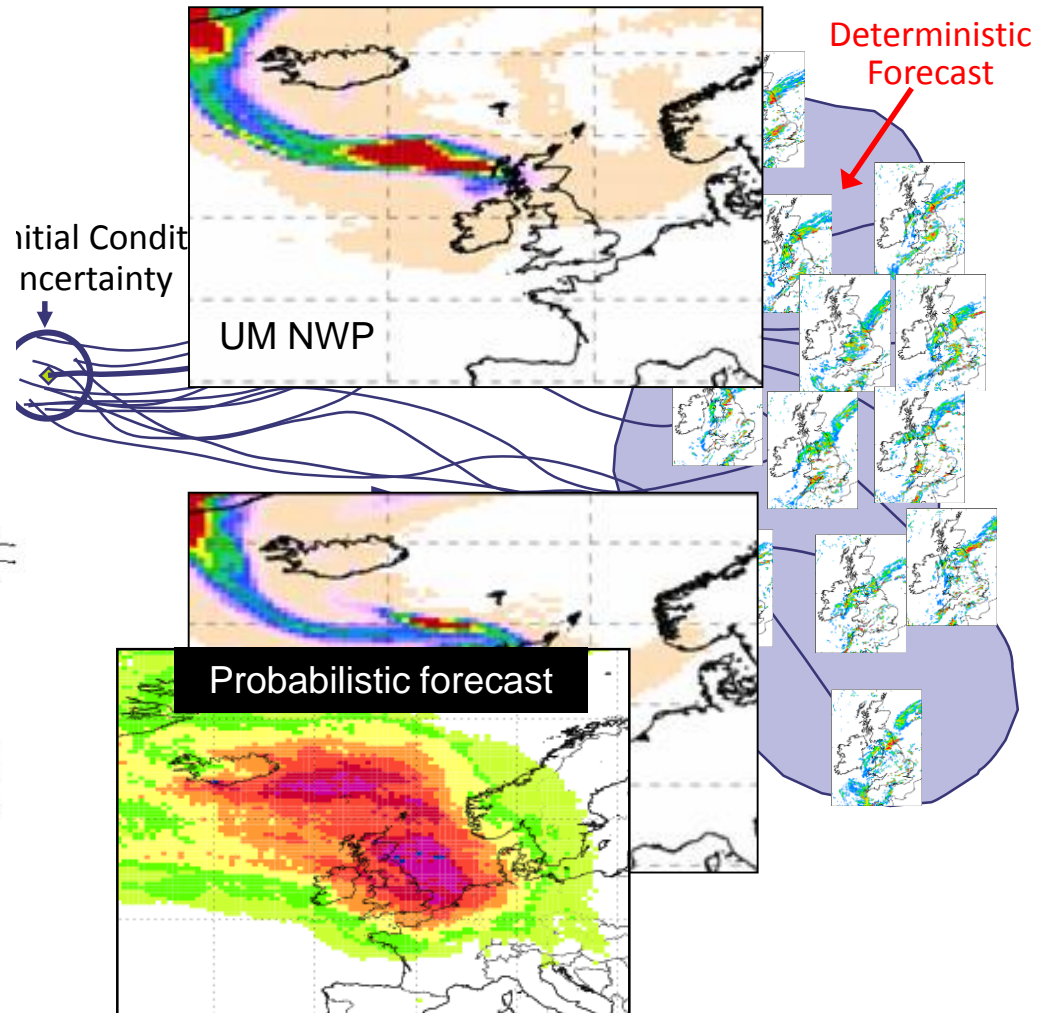
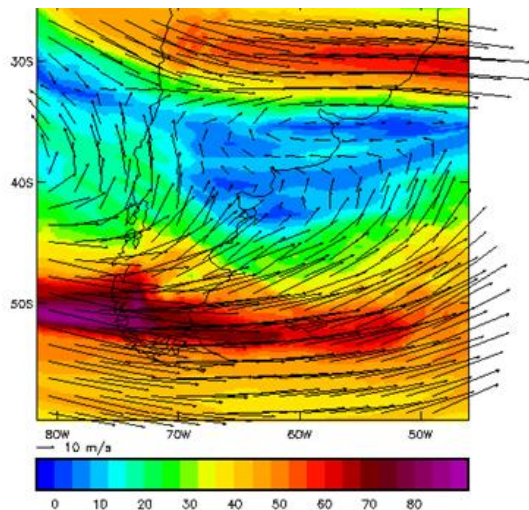
Meteorological Uncertainty

Event Analysis

Velocity @ 4330 m asl
21:00 22/04/15 from 18:00 forecast



Velocity @ 10940 m asl
21:00 22/04/15 from 18:00 forecast

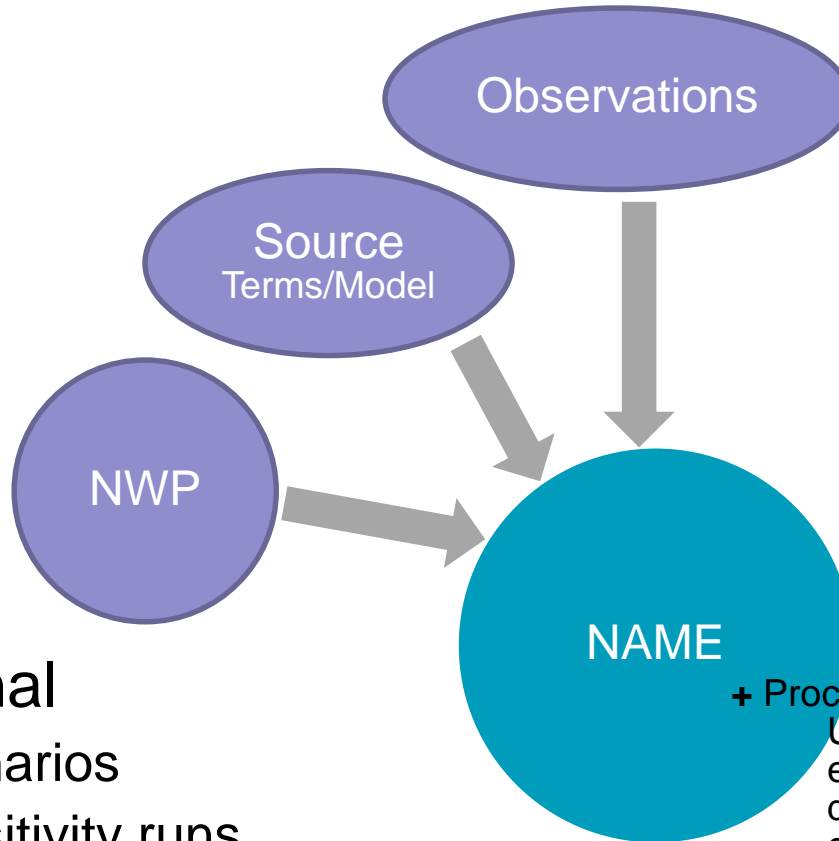


Dispersion Modelling

A melting pot

Research

- Particle characteristics
- Plume rise
- Free-trop turbulence
- Convection
- Validation
- etc, etc



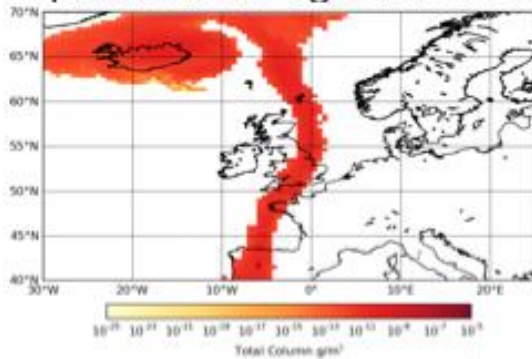
Operational

- Scenarios
- Sensitivity runs
- Multi-model ensembles
- Plume rise models

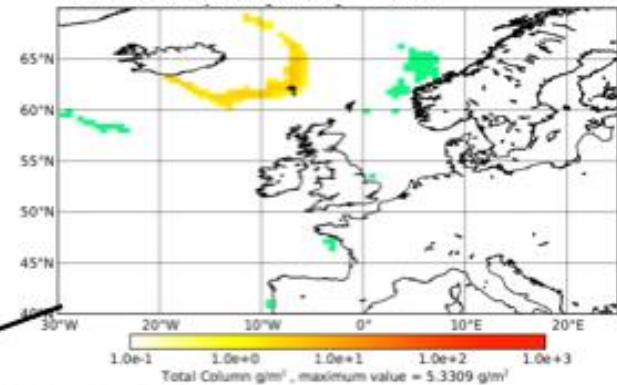
Modelling + Observations

Inversion

Example of modelled plume from 1g/s release



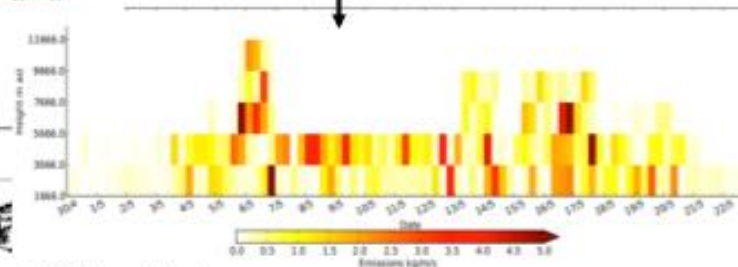
Observational Data



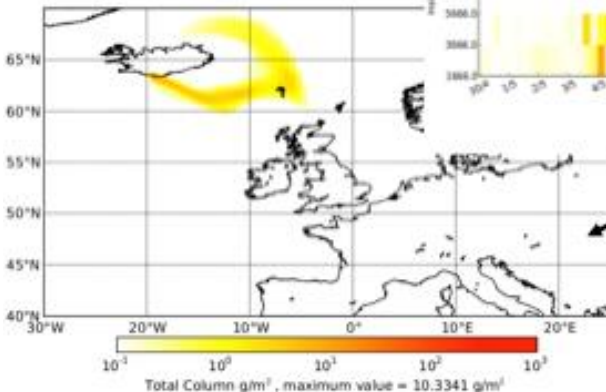
Inversion system

$$M_e \approx o_a$$

New source term profile



Gives a new modelled plume closer to satellite observations

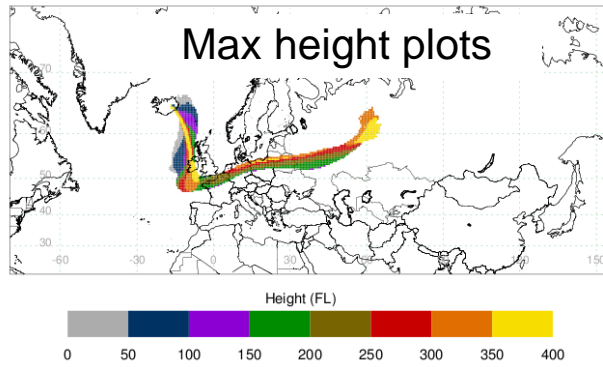
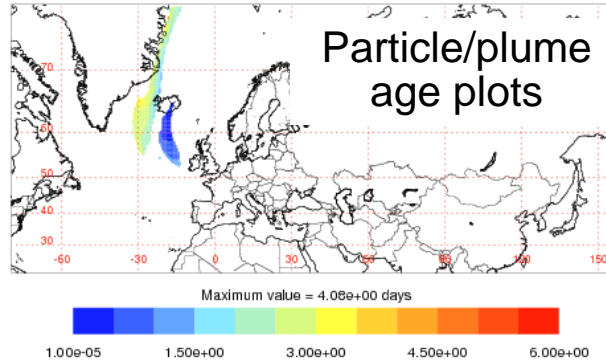
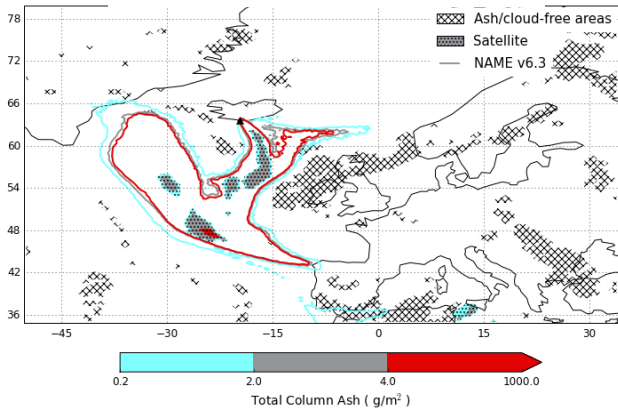




Model Visualisation

Supporting Interpretation

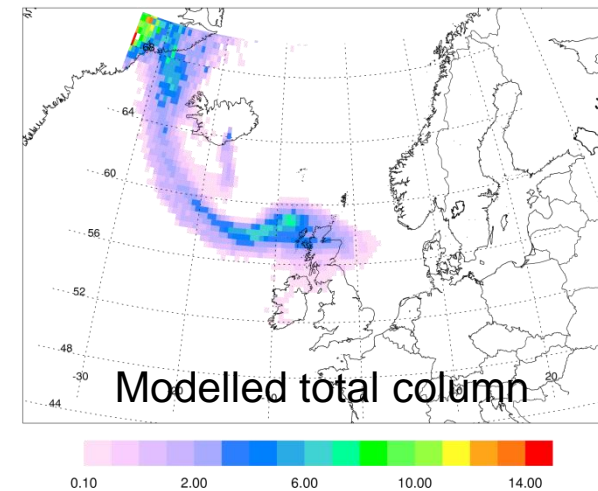
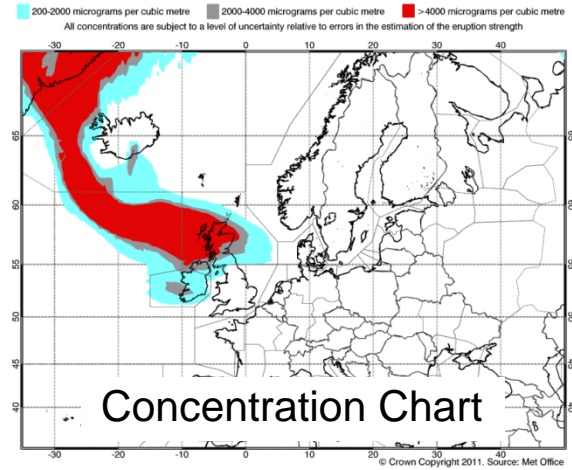
Composite



Modelled Ash Concentration from FL000 to FL200 at 0600 UTC 24/05/2011

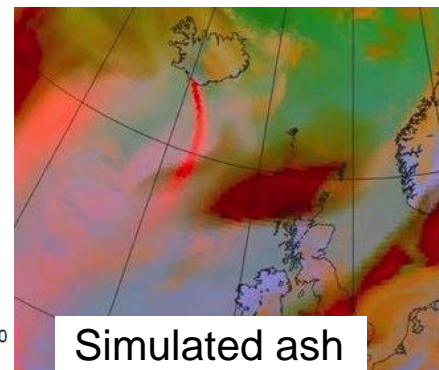
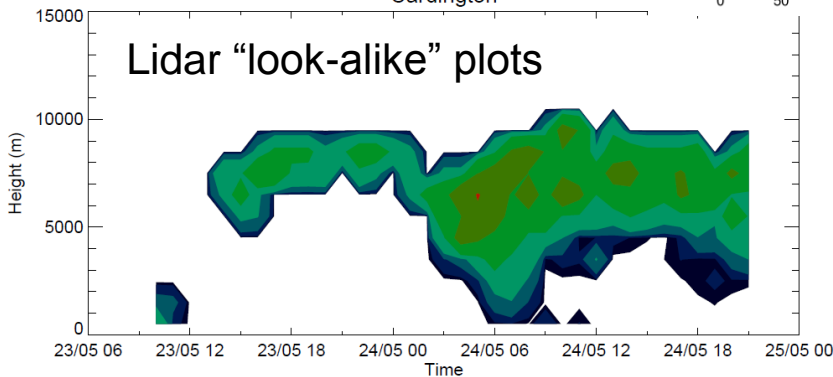
Issue time: 201105240600

This is a guidance product generated from model data and is supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products. FIR boundaries are indicated for reference.



Cardington

Lidar "look-alike" plots





Expert Interaction

“Elicitation”

- Close links across teams within science and with operations
- Cross team training delivered between operations, science, advisors, etc
- Strong national and international links
- Example
 - Grimsvötn Advisory team
 - Focus: supporting operational changes to input parameters
 - Output: Agreed, accepted and common position

Summary

- Ongoing research vital for
 - Understanding, constraining and reducing uncertainty
 - Maintaining expert capability
- Collaboration is key
 - Subjects are wide ranging and need multi-disciplinary collaboration/understanding
 - Delivery agencies/organisations must also maintain ongoing/growing collaboration and links
- Validation – volcanic ash and wider:
 - Volcanic gas; Fukushima; biomass burning