



Modelling Transport of Volcanic Emissions from Iceland to the UK

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Air Quality Seminar, Imperial College 14th July 2010

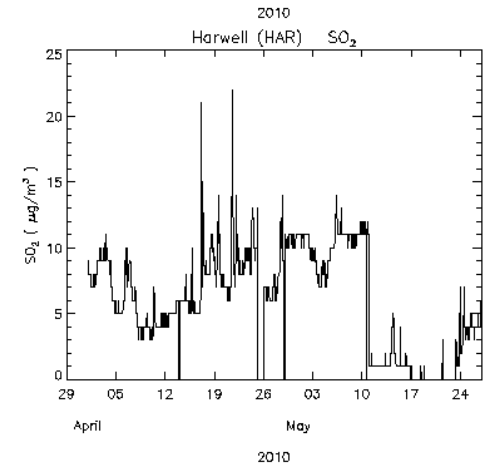
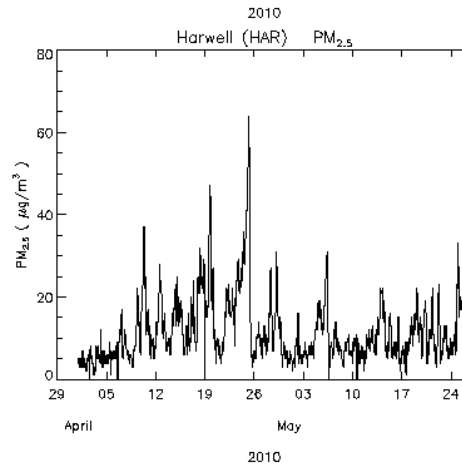
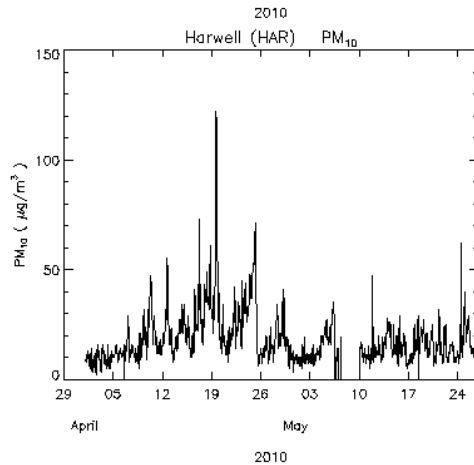
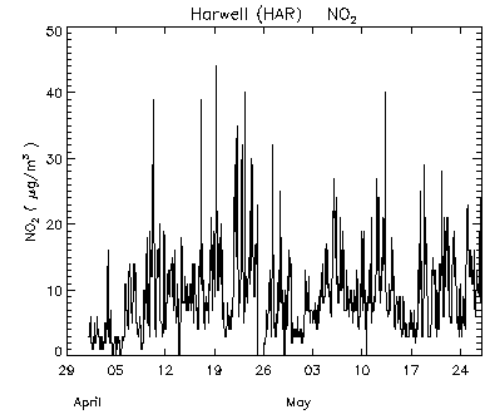
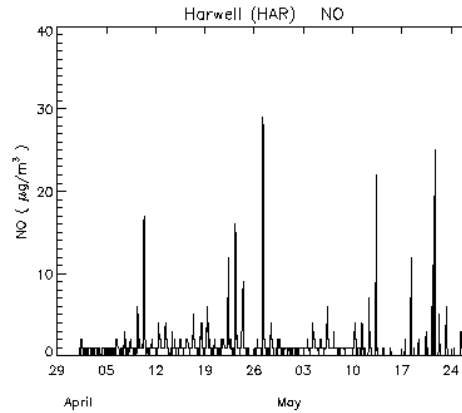
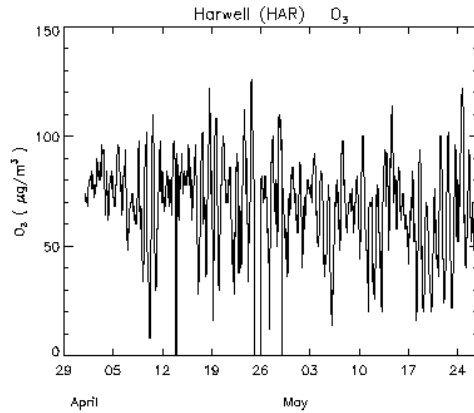


Overview

- General features of the eruption
- Monitoring PM and SO₂
- Focus on SO₂
 - Estimated emissions
 - Modelling transport and dispersion
 - Modelling scenarios
- Acknowledgements: Jim Haywood, Chilbolton Observatory / Rutherford Appleton Lab

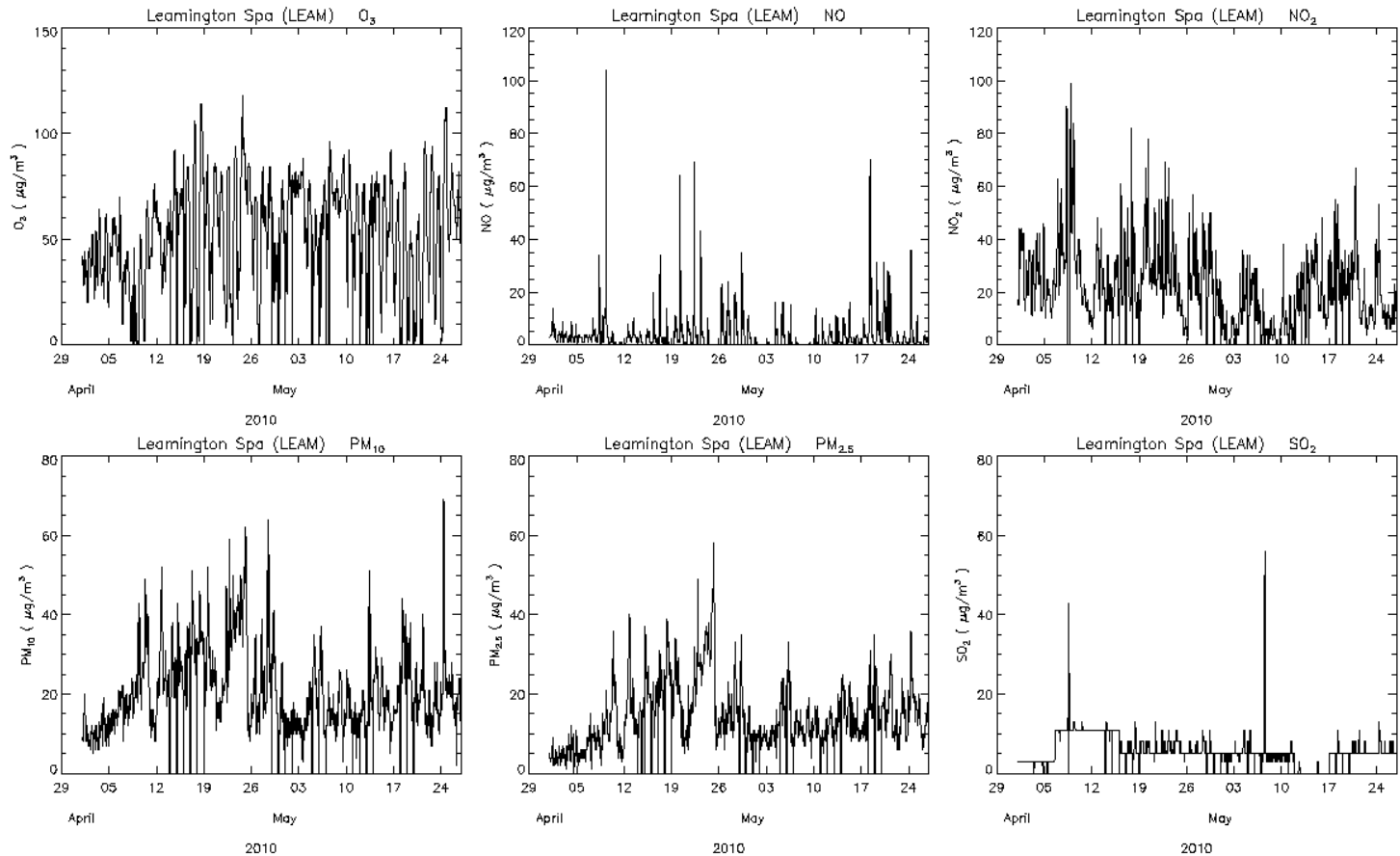


AURN Measurements at Harwell





AURN: Leamington Spa





Lidar stations

- 15th April: 6 lidar stations mobilised with the help of the NERC community





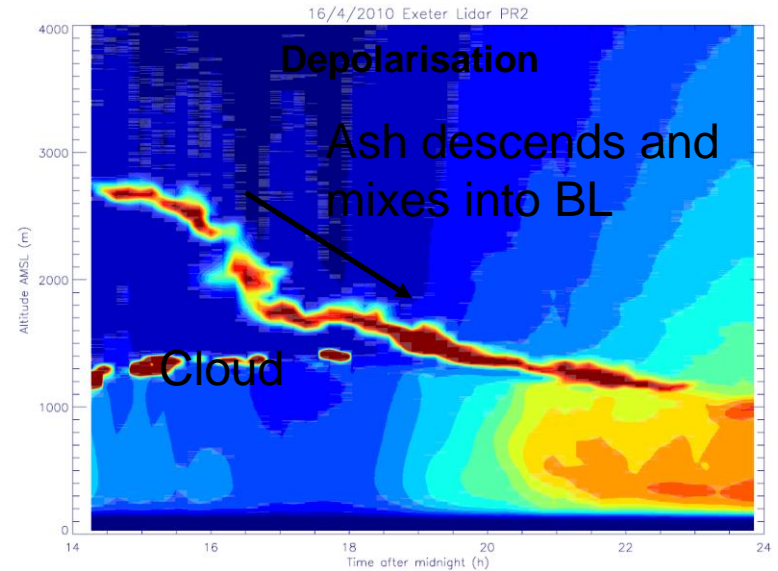
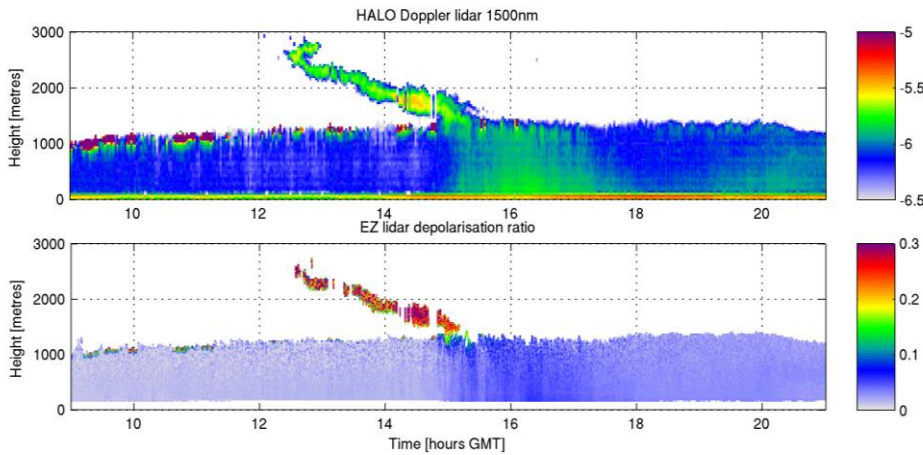
Met Office

BL mixing processes: 16th April

- Ash “descends” into BL...

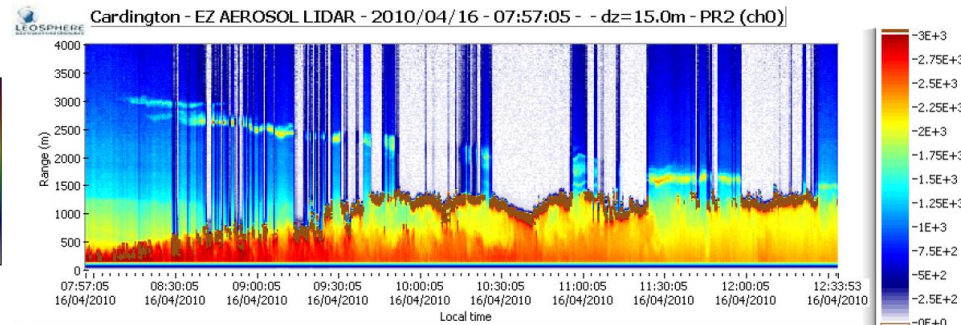
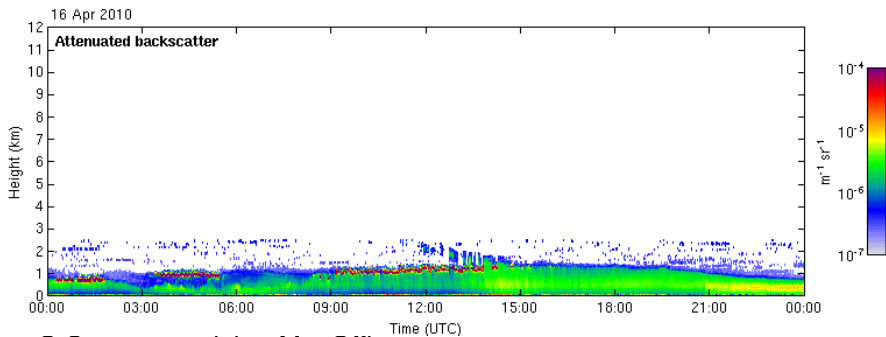
Exeter: mixing at 19.00 UTC

Chilbolton (Judith Agnew): mixing at 15.00 UTC



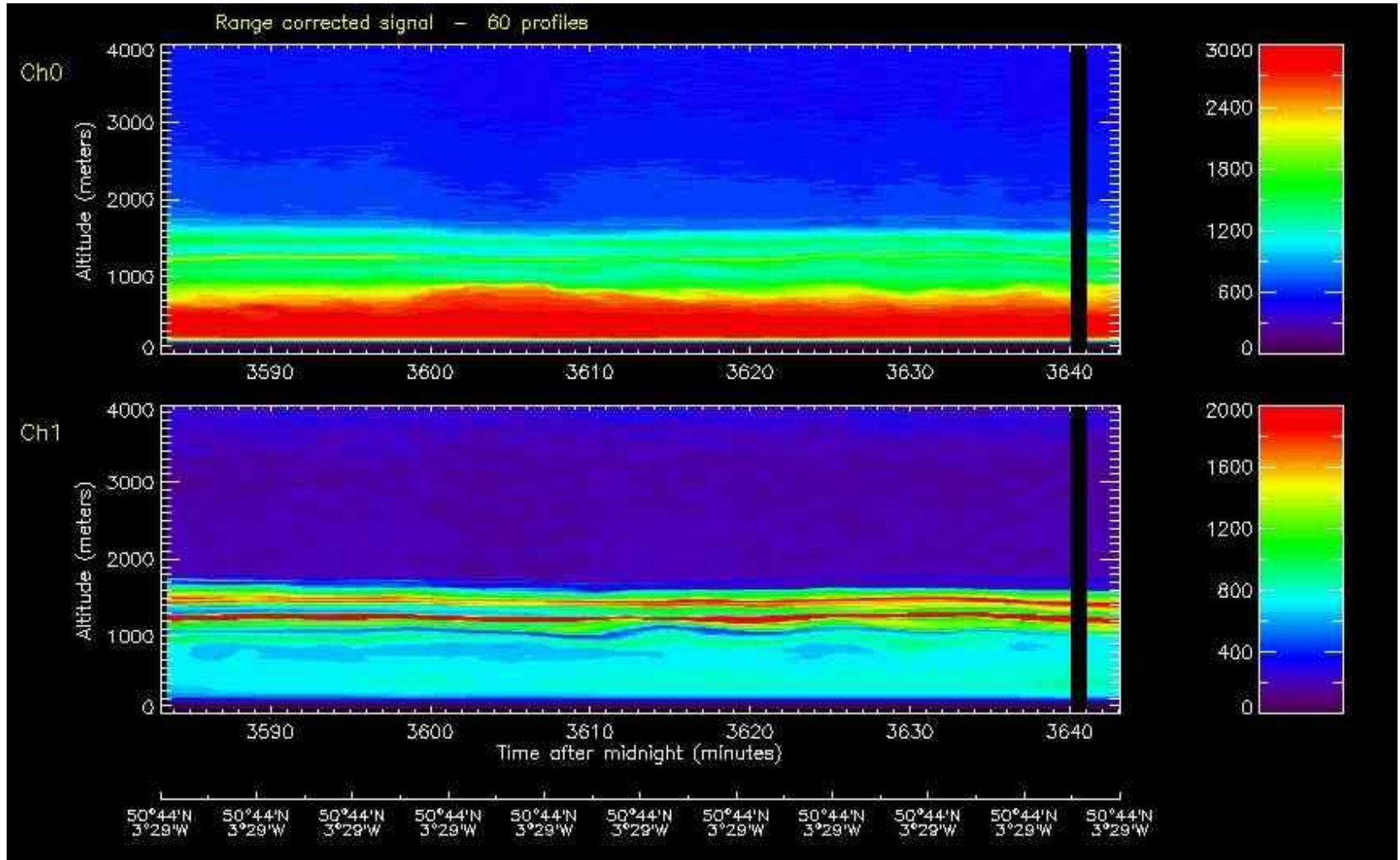
Reading: mixing at 14.00 UTC

Cardington: mixing at ~13.00 UTC?



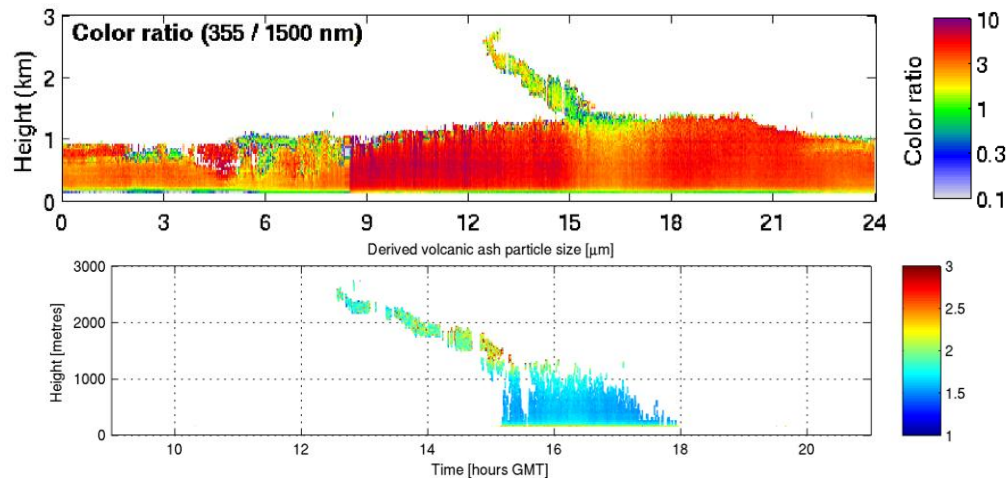


The layering/stratification is clearly visible over Exeter (18th April).

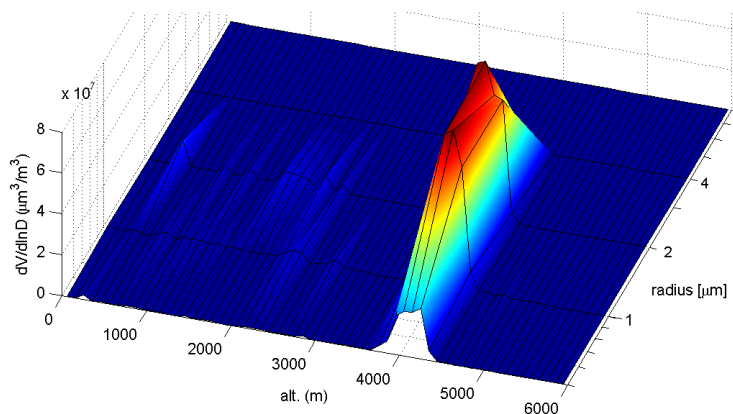




Comparison of particle size estimates

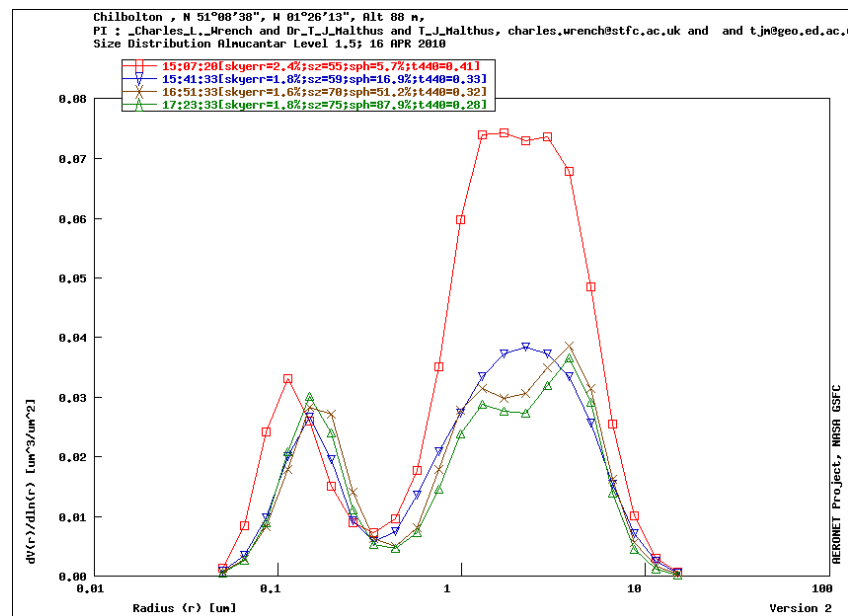


Chilbolton: two-colour lidar: $r \sim 1$ microns
 Refractive index assumed $1.5 - 0.001i$ (Chris Westbrook)

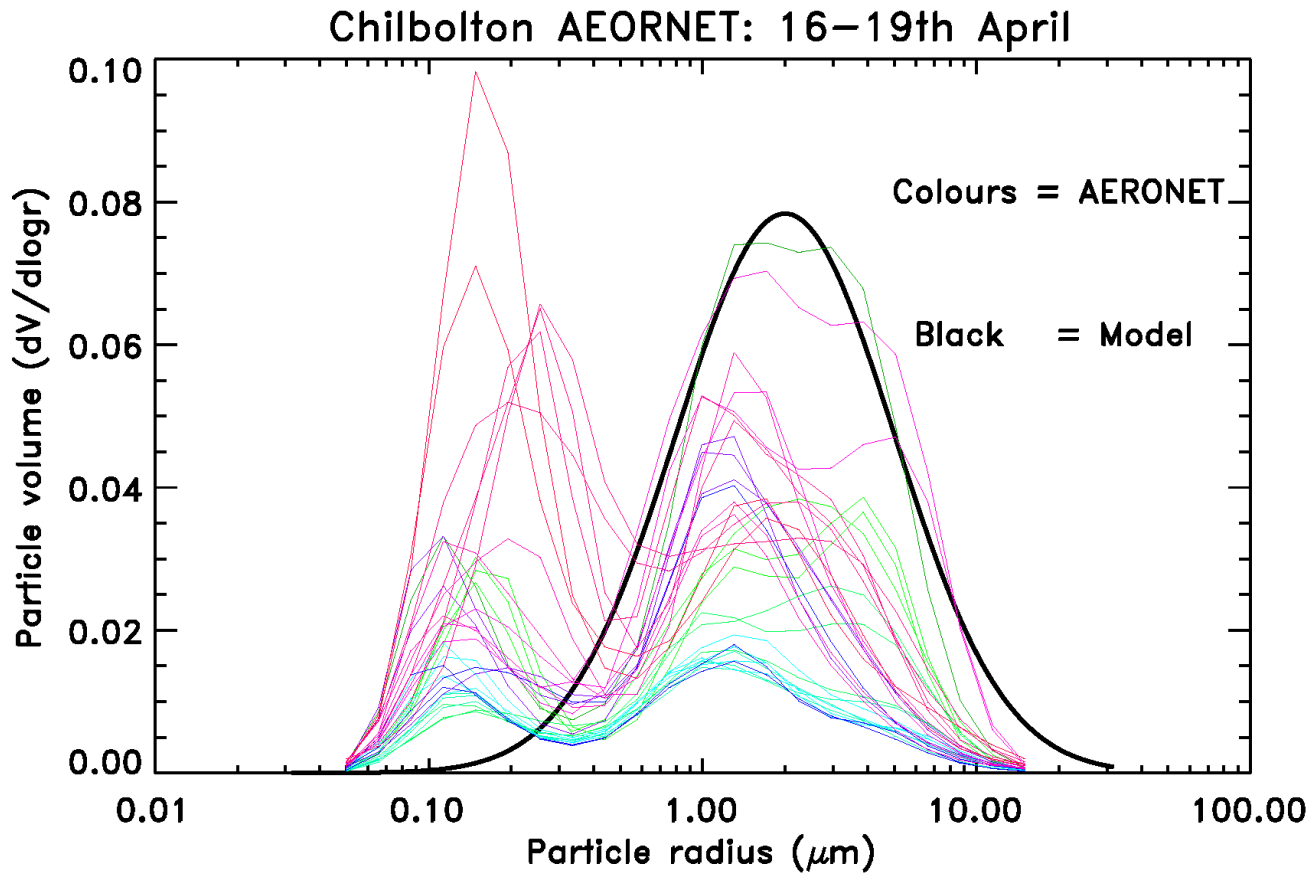


Scotland: balloon probe: $r \sim 2$ micron

(Giles Harrison, Joseph Ulanowsky)



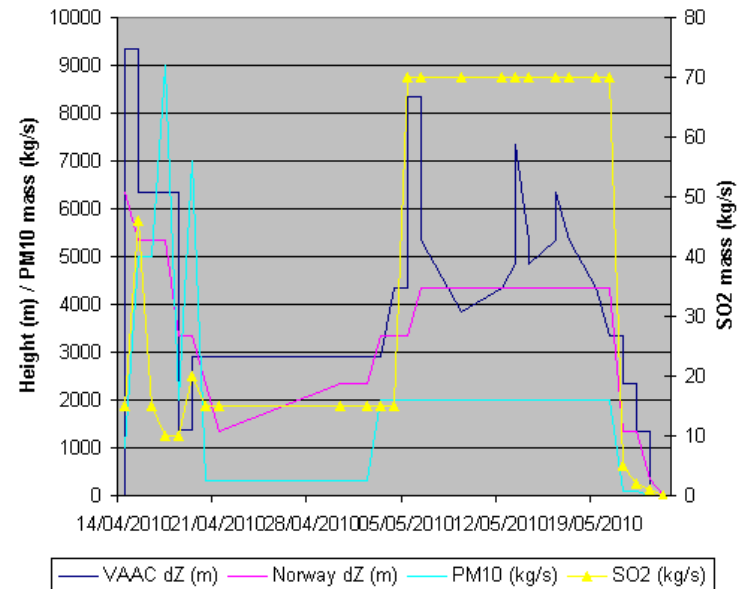
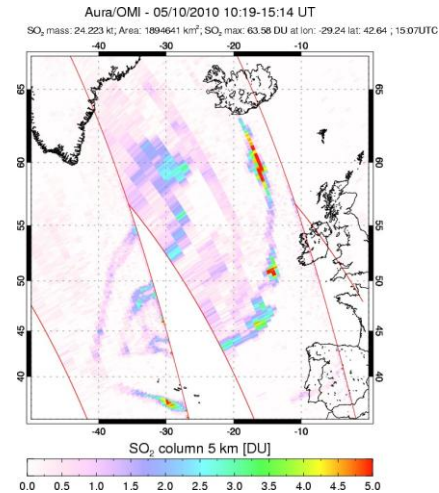
Sun-photometers: $r \sim 2$ microns
 (Charles Wrench – Chilbolton/RAL)



Log-normal distribution with mode radius of $2\mu m$ and standard deviation of $2.5\mu m$

SO2 source strength estimates

- Best estimates from satellite measurements of total column SO2
- Early estimates from study by Norwegian Met Service based on OMI data
https://wiki.met.no/emep/emep_volcano_plume
- We are undertaking a separate study based on IASI data.....





SO₂ emission scenarios

- Use plume heights as used by VAAC
- Use SO₂ emissions as derived by Norwegian Met Service
- SO₂ emissions based on OMI SO₂ for 15th April then scaled according to trends in SO₂ for other days
- To understand the uncertainty in emission strength, we consider 10x and 100x SO₂ strength as well as 'best guess' SO₂ estimates

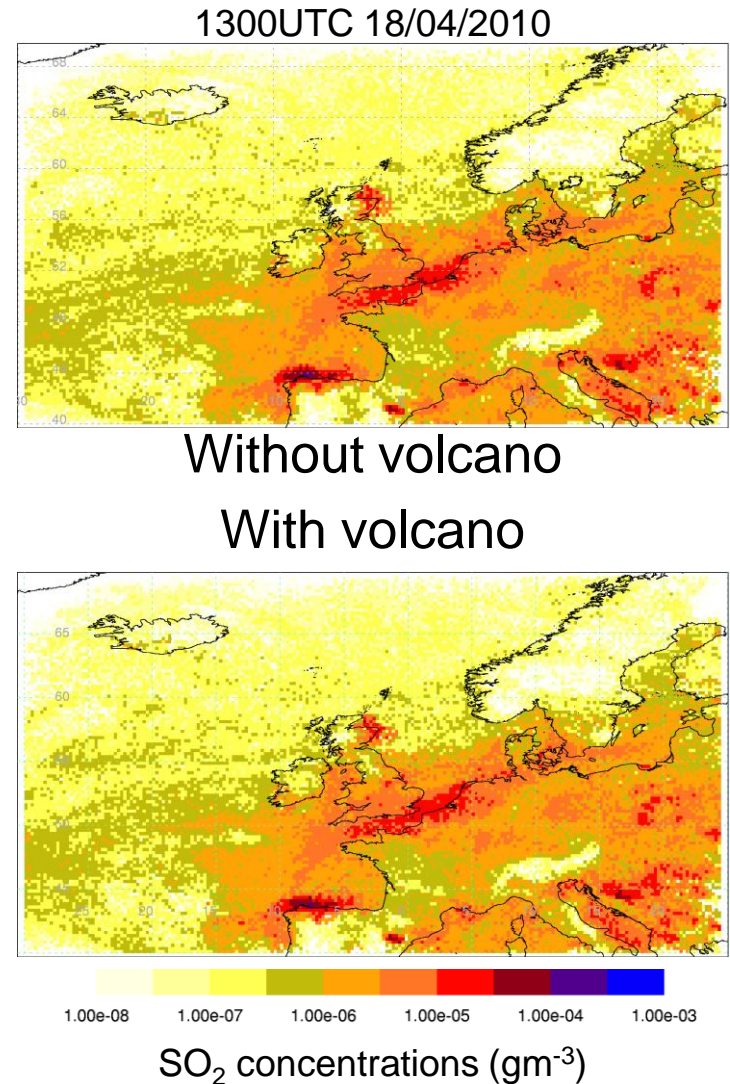


NAME AQ Modelling

- Lagrangian dispersion model used for routine regional AQ forecasting and modelling
- 3D meteorological fields from the Unified Model
- Complex tropospheric chemistry scheme
- Wet/dry deposition
- For this work we used EMEP (50km) emissions over the whole domain for consistency

Model run scenarios

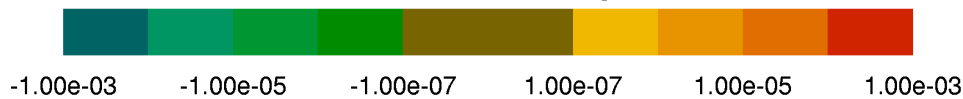
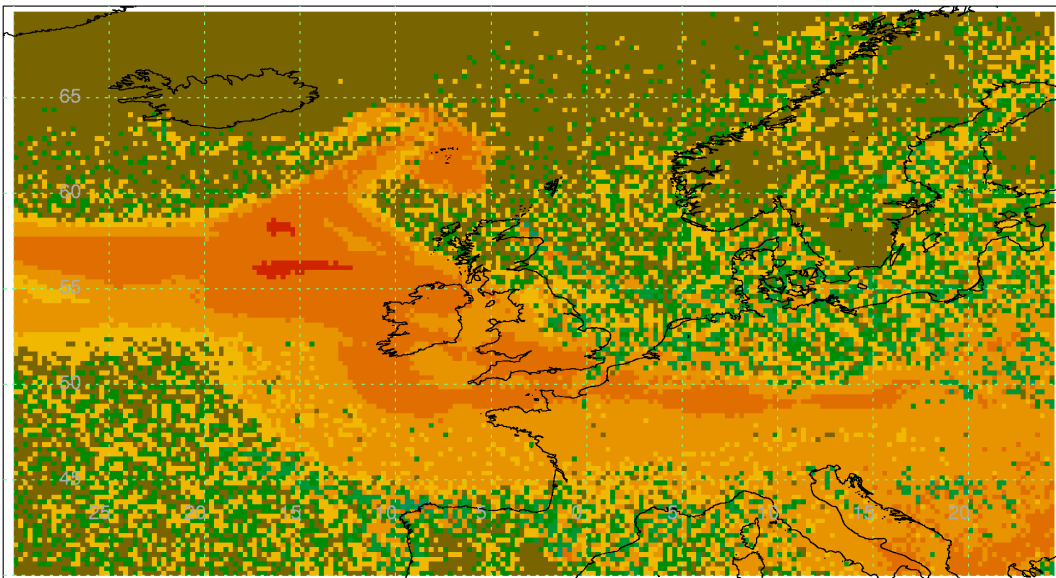
- Compare standard air quality run with / without volcano
- General observation:
 - Using best estimates of source strength magnitude of SO₂ reaching boundary layer in UK is v. small, resulting in no increment in AQ index



Scenarios

- Plot shows difference between 100x strength and 'Control' run with no volcanic emissions

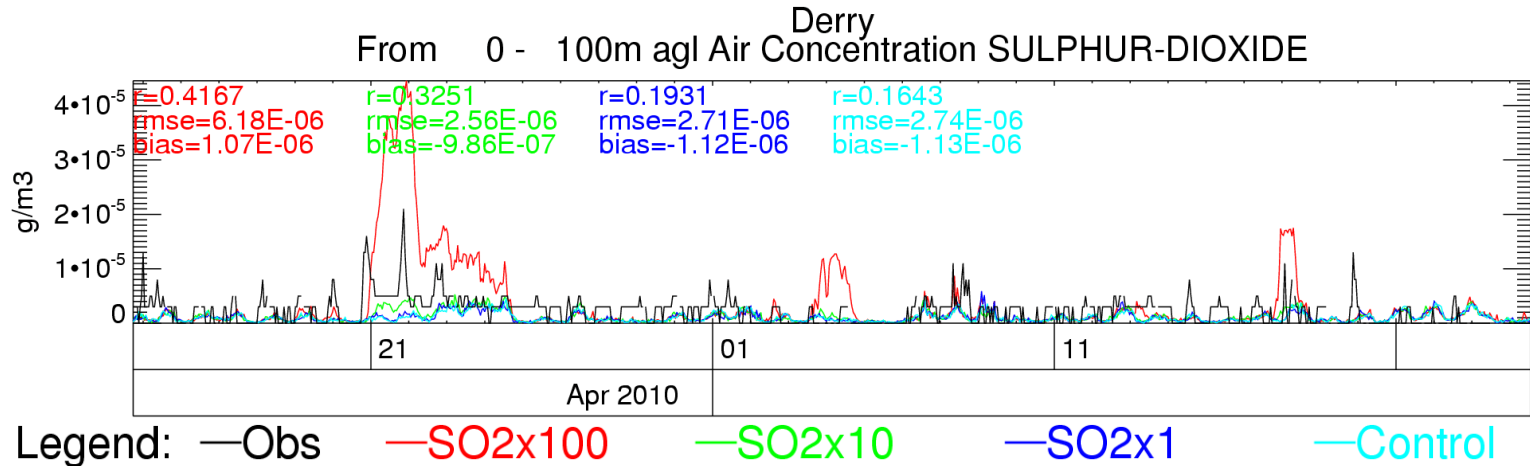
1300UTC 21/04/2010



SO₂ due to volcano

- SO₂ reaches most of Europe
- Difference reaches 145 μg m⁻³ at 100x SO₂
- High plume height means most SO₂ does not reach ground level in 'best estimate' case

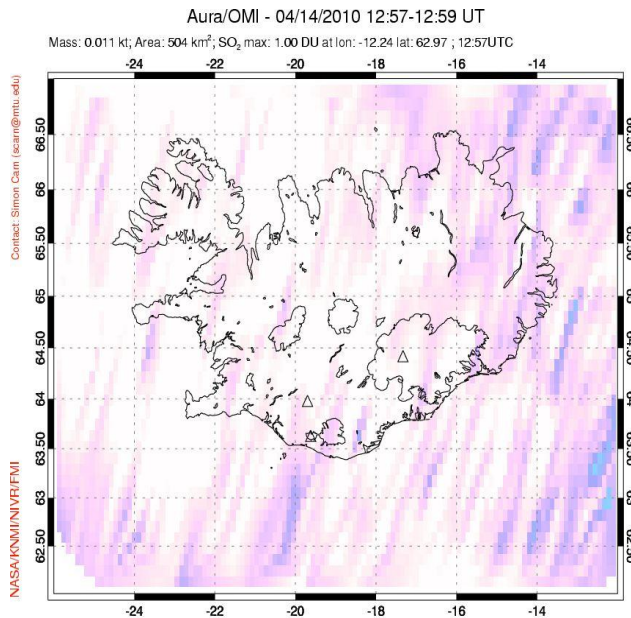
Results – Time series



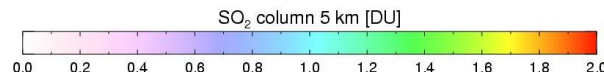
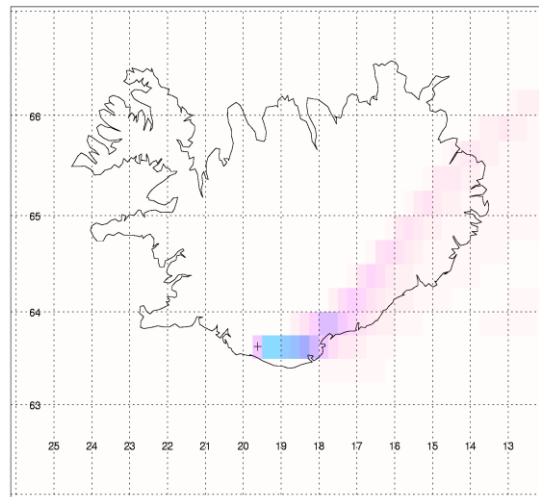
- Shows peaks around 16th-19th April, 21st-23rd April and 17th-18th May are possibly due to Volcanic SO₂
- Underestimated source strength for some peaks by factor 50?

Results – Satellite comparisons

- Compare against OMI satellite data by outputting total column SO₂ in Dobson Units

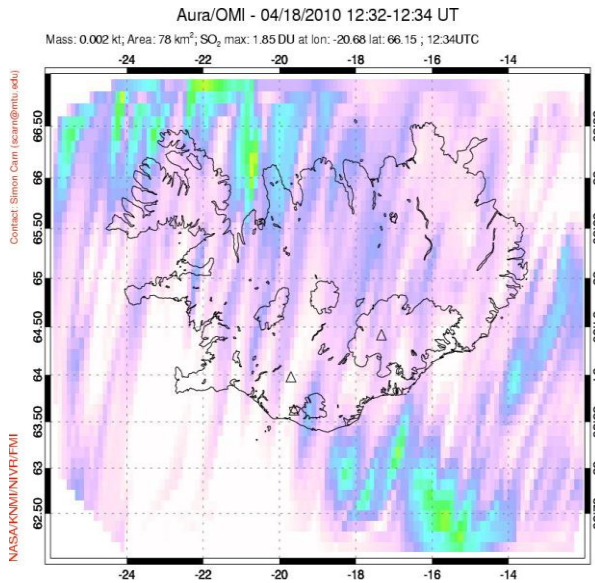


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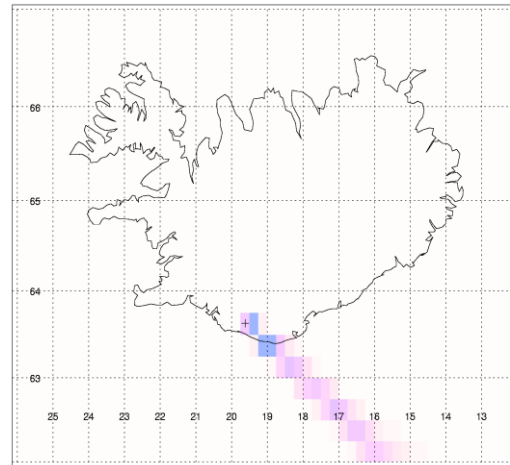


- ‘Best estimate’ is generally correct order of magnitude.....
 ...however

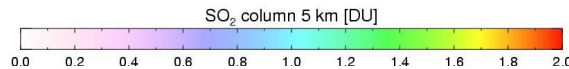
Satellite comparisons



1300UTC 18/04/2010



OMI



Model

- Underestimate of emission strength on 18th April
- Corresponds to under prediction on 21st April

- Ability to compare modelling scenarios with satellite imagery should allow a better estimate of source strength



Conclusions

- Current best estimates of SO₂ source strength show negligible impact on air quality
- Even at 100x source strength, only a few AURN stations would reach air quality index 2 – comparable to impact of Grangemouth on local sites
- Possible to derive simulated satellite imagery from dispersion modelling to deduce better source strength estimates