Ash Clouds

The MOAP supports secondments to partner universities from the Met Office as one of its activities. We are keen to foster two-way exchange. As part of this, Helen Dacre recently paid an extended visit to Met Office HQ to work with the Atmospheric Dispersion Group on volcanic ash clouds.

Sabbatical Visit to the Met Office

Helen Dacre, University of Reading

As part of my sabbatical I visited the Atmospheric Dispersion Group at the Met Office for 4 weeks in March/April. The aim of the visit was to investigate the effect of free-tropospheric turbulence on volcanic ash cloud layer depth.

During a volcanic eruption the London Volcanic Ash Advisory Centre issues hazard maps of volcanic ash coverage using the Numerical Atmospheric Dispersion Modelling Environment (NAME) model. Within NAME, volcanic ash is transported in the atmosphere by both advection and mixing processes. The sub-grid scale mixing processes are represented by turbulence and convection parametrizations which mix volcanic ash both horizontally and vertically.

In NAME turbulent mixing values are currently set to constant, empirically determined values everywhere above the diagnosed boundary layer top. These values are chosen to represent temporally and spatially averaged free-tropospheric mixing. Since aircraft experience significant turbulence in highly localized patches (< 1% of their flight times) it is likely that volcanic ash clouds may only experience the represented levels of turbulence for a small part of their travel time. It is thus hypothesized that the generally observed model overestimation of ash layer depth is a result of the models homogeneous representation of sub-grid scale mixing.

During my 4-week visit to the Met Office I compared NAME simulations with ground-based lidar observations to evaluate the vertical structure of volcanic ash clouds and found that NAME underestimates both the very thin (<1500m) and very thick (>2000m) ash cloud layers (Fig 1a). I then performed sensitivity studies to determine which processes (turbulence, convection, particle size distribution and emission profile) was most important for determining the ash cloud depth (Fig 1b). Finally I implemented a space and time varying free-tropospheric turbulence parameterisation, based on a clear air turbulence diagnostic (e.g. Fig 1c).

The results showed that the new space and time varying turbulence scheme decreased the mean ash layer depth and reduced the underestimation of thin ash layers (Fig 1a). Analysis is still needed to determine the cause of the underestimation of the very thick ash layers.

As well as providing the opportunity to work with my existing collaborators in the Atmospheric Dispersion Group, my secondment gave me the chance to interact on a daily basis with scientists in other areas such as the Boundary Layer Group and Observations Group and thus form new links with the Met Office. In addition, being away from my duties in Reading allowed me the space and time I needed to focus on a new science area, and I made fast progress as a result. I would like to thank my hosts in the Atmospheric Dispersion Group, Helen Webster and Dave Thomson in particular, for making my visit both productive and enjoyable and the MOAP secondment scheme for providing funding to facilitate my visit.

Fig: (a) 15-30th April 2010 ash layer depth distributions from lidar observations (red), control NAME simulation (blue) and time and space varying turbulence NAME simulation (green), (b) Simulated ash layer depth at 00Z 17 April 2010 for NAME control run (crosses show locations of lidar observations, green colours represent deeper ash clouds), (c) Time and space varying turbulent diffusion at an altitude of 8km on 00Z 17 April 2010 (warm colours represent higher turbulent values), (Please note that this is work in progress).
Working Group Meetings

Microphysics Working Group

The Microphysics Working Group (MWG) at the Met Office held a joint meeting with the University of Reading and ECMWF on 29 January 2014 at the University of Reading. The MWG was set up in 2009 to increase the coordination and collaboration of microphysics parameterization development within the Met Office and to increase collaboration with scientists outside the Met Office on science related to cloud and precipitation microphysics.

The day included very short talks from all partners on their latest research results. Half of the time was spent in discussion following each talk or set of talks.

The ECMWF presentations on recent cloud/microphysics-related activities in the Integrated Forecasting System (IFS) included:

- Mixed-phase cloud processes and impacts on the forecast and
- Warm-phase cloud processes including low cloud and light rain.

The University of Reading presentations were very diverse and included the topics:

- Problems with the simulation of mixed-phase altostratus
- Probing ice microphysics using multiwavelength radar
- 3D liquid cloud retrievals using ground-based sensor synergy
- Cloud observations using ground-based passive and active sensors
- Aerosol-cloud-precipitation effects on warm clouds in observations and in the UKV
- 3D structure of convective storms
- EarthCARE satellite launch (Nov 2017) which is the follow-on for CloudSat/Calipso
- Cloudnet: skill scores for representing clouds in NWP forecast models
- "Toprof", a new COST action (2014-2018) Towards operational ground based PROFiling with ceilometers, Doppler lidars and microwave radiometers for improved weather forecasts

The Met Office presentations varied between talks about observational campaigns, parameterization, forecasting and data assimilation:

- Boundary layer clouds, observed and simulated
- Mixed-phase cloud physics
- Ice particle size distributions
- Lightning forecasting
- Introducing the "CAUSES" project (Clouds Above the United States and Errors at the Surface)
- Cold air outbreak research
- Assimilation of radar reflectivity data

Participants were energised by the exchange of ideas on the day. A suggestion was made that the MWG hold another collaborative meeting with ECMWF and academic partners next year.

For more information on the Microphysics Working Group, Met Office staff and collaborators with access to the collaboration twiki can see http://collab.metoffice.gov.uk/twiki/bin/view/Project/MWG-Collab.

Urban Working Group

The Urban Working Group (UWG) met at Reading on 22 July. This group, chaired by Maggie Hendry, is an informal group aimed at coordinating research in urban meteorology in and with the Met Office.

The primary purpose of this meeting was to discuss a general strategy for future urban work, and, in particular, proposals for strategic ideas to be put forward to the NERC Strategic Programme Advisory Group.

As a result, a ‘Roadmap for Urban Research’ is being developed within the group. In view of this, it was decided to open the group up to include other groups in the UK who might wish to contribute. If interested, please contact Maggie Hendry in the Met Office.

For more information on the Urban Working Group, Met Office staff and collaborators with access to the collaboration twiki can see http://collab.metoffice.gov.uk/twiki/bin/view/Development/UrbanWorkingGroup.

New Projects

The role of air-sea interactions in sub-seasonal variability

Congratulations to Nick Klingaman on being awarded a NERC Fellowship to start March 2015. His recent research on improving the simulation of the Madden-Julian oscillation in the Met Office Unified Model has produced two peer-reviewed publications (see References), covering the roles of convective entrainment and air-sea interactions.

EUCLEIA: new EU project on attribution of European climate events

Len Shaffrey and Rowan Sutton (Reading) are leading Reading’s involvement in the major EU project EUCLEIA (see http://eucleia.eu for more information).

IMPETUS: Improving Predictions of Drought for User Decision-Making

Len Shaffrey is also leading the NERC IMPETUS project. To quote from the NERC web page:

“IMPETUS aims to improve the forecasting of UK drought on monthly to decadal timescales, which will lead to the development of improved decision-making processes. This will be achieved by improving meteorological, hydrological and water demand forecasts and how they are combined to produce drought forecasts. This will be done in conjunction with stakeholders to ensure that drought forecasts are relevant for decision-making.”

Doctoral Training News

Reading was fortunate to succeed in being awarded two NERC Industrial CASE awards this year. These are:

- ‘Novel techniques for evaluating air quality forecasts’, supervised by Helen Dacre in Reading and Marion Mittermaier at the Met Office.
- ‘Using vertical profiles of atmospheric backscatter as observed with the Met Office ceilometer network to improve weather forecasts at high-resolution, convection-permitting scales’, supervised by Anthony Illingworth and Chris Westbrook at Reading and Sue Ballard in the Met Office.

A third project CASE project is funded under the SCENARIO DTP;

- ‘What controls the structure of thunderstorms in the UK?’, supervised by...
Chris Westbrook and Peter Clark at Reading, and Humphrey Lean at the Met Office.

We congratulate CASE students Rob Warren (‘Stationary Storms’) and Sian Lane (‘London Boundary Layer’) on being awarded their PhDs. Rob has taken up a post doctoral position at Monash, Australia, and Sian has joined the Met Office, Cardington.

The MOAP poster event

A MOAP poster session, mainly featuring collaborative work between the MOAP partners and Met Office, was held in Exeter on 21 February. Reading was well-represented, and the event as a whole successful in advertising the wide variety of collaborative work more widely in the Met Office. Thanks to all who attended. Another event will be held next year, probably in February again.

References
