RMetS Meteorological Masterclass Series

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less dense return at this point, indicative of reduced ash fall and cloud density. At 06h00 I ventured out onto the open deck of the vessel which was covered in a fine powdery ash. I have observed very active thunderstorms in this part of the world before and would compare the frequency of lightning this night to some of the most intense thunderstorms I've ever seen.

A photograph, taken by the second author, looking towards Saint Vincent at 0122 local time is reproduced in Figure 1.

A chronological sequence of selected geostationary satellite (GOES) mesoscale sector images between 0500 and 0600 UTC (0100 to 0200 local time, and therefore corresponding to the account above) is shown in Figure 2. Saint Vincent was largely clear of cloud at 0502 UTC (Figure 2a). By 0509 UTC (Figure 2b) the Global Lightning Mapper (GLM) instrument on-board GOES-16 detected bursts of lightning discharges over the northern part of the island. By 0512 UTC (Figure 2c) lightning activity was on-going and an area of cold cloud tops, marking the top of the eruption plume can be seen growing above the island. Animation of 1min imagery shows at least one shock wave propagating through low cloud away from the island. By 0545 UTC (Figure 2d) lightning activity had ceased and the area of cold cloud tops associated with the newly formed plume was drifting eastwards. Around the same time of this event all electrical grid power was lost on the island, adding to the disruption and hazards already caused by ash fall.[2]

[2]https://twitter.com/NEMOSVG/status/1381122419654541316 (accessed 16 April 2021).

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Meeting report

RMetS Meteorological Masterclass Series: Anticipating floods, droughts and heatwaves

The second series of RMetS Meteorological Masterclasses, co-hosted by the University of Reading, took place virtually during February and March 2021. The theme of 'anticipating floods, droughts and heatwaves' was developed during three separate sessions, with illustrated talks and Q&A sessions led by expert scientists. The purpose of the series was to provide developmental training for professionals in weather and climate science.

Masterclass 1: Flood forecasting days to months ahead

On Wednesday 24 February 2021, the RMetS held the masterclass 'Flood forecasting days to months ahead', bringing together speakers with different perspectives on flood forecasting. Topics discussed included the latest research challenges, the information that forecast agencies need, and how best to communicate forecasts with the broader public. In total, there were 31 attendees from across the United Kingdom and Europe.

To begin, Dave Throup from the UK Environment Agency gave the industry viewpoint, stressing how dependent their work is on flood forecasts – not just to forecast flooding, but also for river pollution, toxic smoke plumes and drought forecasts. Dave also highlighted what the Environment Agency looks for in a flood forecast: an early warning, an estimate of the scale of the issue, reasonable worst case and best estimate forecasts, regular updates, accuracy, as well as good graphics and data representation.

The main speaker of this session was Dr Linda Speight, a hydro meteorologist at the University of Reading who has experience both in research and as an operational flood forecaster. Linda gave an overview of the whole flood forecasting system, explaining how forecasts are created and how current forecast methods perform on different scales. Especially since the Pitt Review in 2007, when the Environment Agency teamed up with the Met Office to create the Flood Forecasting Centre, UK flood forecasts have improved steadily, with forecasters making the most of local knowledge and flood maps. Linda also considered why progress on a global scale has been slower, with UK techniques being more difficult to apply elsewhere due to a lack of information and flood maps. However, the global appetite for flood forecasts is now increasing, with new interest from aid agencies and charities asking where they should be concentrating their efforts to mitigate future flooding impacts.

Finally, Charlie Pilling, chief hydrometeorologist at the Flood Forecasting Centre in Exeter, talked about Storm *Christoph* which hit the UK in January 2021. The storm was successfully predicted, and the multi-agency response to this forecast included a government COBRA emergency meeting. It was refreshing to hear how increased collaboration between relevant agencies and researchers has led to improvements in UK flood forecasting systems over recent years.

These talks were followed by a discussion, where participants quizzed the speakers, asking questions ranging from future flood forecasting services to communicating forecasts to the public, and why certain types of flood defences were used.

Masterclass 2: Representing convection in numerical weather prediction (NWP) models and its implications

'Representing convection in numerical weather prediction (NWP) models and its implications', was held on Wednesday 10 March 2021 with 38 attendees. There were three speakers who discussed the computational and operational challenges of representing convection in weather models.

The main speaker was Professor Bob Plant, a specialist in atmospheric convection at the University of Reading with industry experience in radioactive waste management. Convection plays a major role in the planetary budgets of heat, moisture, and momentum, and therefore it is essential to model it well for the purposes of accurate extreme event and flood forecasting. Bob explained the methods being used to represent convection within weather models. Notable improvements have been made in recent years, and an example of the use of a convection-permitting model during the 2004 Boscastle Flood was discussed (see Golding *et al*., 2006). Bob highlighted the difficulties experienced in representing convection and finished with a discussion around how model outputs could be presented effectively.

Paul Knightley, forecast manager at DTN, spoke about the importance of accurately forecasting convection from his perspective as an operational meteorologist for

over 20 years. Forecasting for winter road maintenance can be straightforward under clear or cloudy nights, but enormously challenging when the convection experienced is between those scenarios. Paul explained how snow forecasting is particularly difficult, and how providing a wide range prediction of snowfall depths is not useful. Paul noted that weather model outputs are increasingly used as visuals in television forecasts, which look highly realistic. It is a challenge to visualise these effectively to avoid model bias being conveyed to the public.

Ivan Tsonevsky, an operational meteorologist at the European Centre for Medium-Range Weather Forecasts (ECMWF), discussed how improving the representation of convection is key to developing several weather products. ECMWF is currently increasing the resolution of its met models, and Ivan explained that there is a difficulty in reducing error where convection is modelled at finer scales.

Several topics were covered in the question-and-answer session, from representing convection in tropical regions to issues in the modelling of convection for European storm tracks, and the reasons for selecting certain methods to model convection.

Masterclass 3: Heatwaves and climate change in urban microclimates

The final masterclass 'Heatwaves and climate change in urban microclimates' took place on Wednesday 24 March 2021, with 25 attendees. The main speaker was Professor Sue Grimmond, a specialist in urban meteorology at the University of Reading, and joint chair of the Met Office Academic Partnership (MOAP).

Sue discussed how we measure meteorological variables in urban environments, and the urban heat island effect, which occurs where towns and cities are warmer than surrounding rural areas. Sue explained that scale is important in urban meteorology, as NWP models typically consider 'neighbourhood'-sized areas, rather than capturing the characteristics of individual buildings and streets. Large spatial temperature differences can occur across urban areas, with temperatures in cities depending on many factors, including the amount of land which is built-up or vegetated, the structure of the buildings, and most importantly, how many people live in the area and what they do in their day-to-day lives. Sue also discussed the increasing incidence of heatwave events, drawing on examples from different global cities and noting how the events are driven by regional synoptic conditions.

The first responder was Chris Almond, an operational meteorologist at the Met Office. Chris began by addressing the many available definitions of a 'heatwave', advising that the Met Office created an official definition in 2019 (McCarthy, Armstrong and Armstrong 2019), based on days where the air temperature exceeds 25–28°C (dependent on location). Chris then talked about the new heat health watch service for England which the Met Office is launching later this year. This service will have four levels of severity, from zero (no risk) to four (when there is serious risk of death). This service is being implemented to help protect those most vulnerable to heat-related illness, particularly the elderly and care home residents. Discussions are on-going with the devolved governments of Scotland, Wales and Northern Ireland regarding future implementation in these nations.

Finally, Associate Professor Clare Heaviside, a NERC research fellow at University College London who has spent 10 years working for Public Health England, discussed the health issues associated with heatwaves. Investigating how urban air temperatures impact heat and cold-related mortality is a key part of Clare's work. In the summer of 2003 alone, heatwaves caused more than 2000 potentially avoidable deaths in the UK. Clare suggested that we could make our cities cooler by changing the colour of roofs to increase their reflectivity or increasing the amount of green infrastructure by planting trees or increasing the number of roof gardens. This would help to reduce heat-stress related mortalities.

These talks were followed by another interesting discussion which focused on potential strategies for reducing heatwave risks, and how different town layouts such as those in Milton Keynes or Barcelona impact maximum temperatures. The usefulness of citizen science projects was also considered, with possibilities including placing thermometers inside care home rooms, and asking people for their personal experiences. As people spend around 95% of their time indoors (on average), this might help more than heat warnings based on outdoor temperatures alone.

The next RMetS Meteorological Masterclass series, 'Maritime Meteorology', will take place in Summer 2021.

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