Generating and evaluating the next generation of ensemble atmospheric dispersion forecasts

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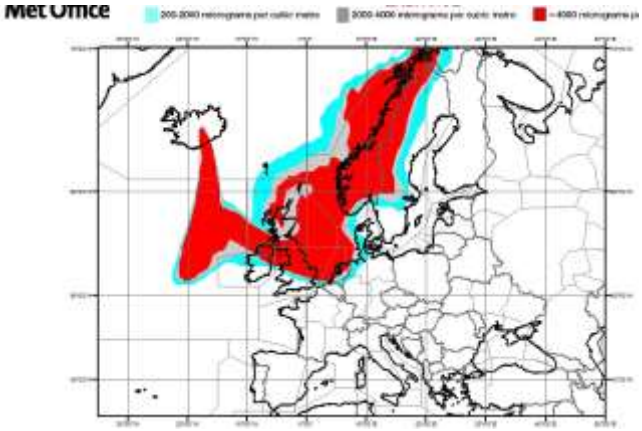
Many hazardous events including volcanic eruptions, chemical or radiation releases, industrial fires and wildfires, release aerosols and gases into the atmosphere. Near the Earth's surface these aerosols and gases can be damaging to human and animal health, vegetation, and infrastructure. At higher altitudes, they are a significant hazard to aircraft. Accurately predicting the concentration and location of aerosols and gases as they are transported away from their sources is needed to aid emergency response decision making. For example, flights are restricted if there is volcanic ash forecast to be present in airspace. Similarly, sheltering or evacuation plans are implemented using forecasts of radiation dispersion following nuclear accidents.

Dispersion forecasts require accurate knowledge of the source characteristics and perfect representation of the atmospheric processes controlling the transport of aerosols and gases in the atmosphere. Current forecasts do not explicitly consider the inherent uncertainty in our knowledge of these factors. Thus, decision makers currently have incomplete information regarding the risks present in the atmosphere. To address this problem, it is necessary to develop the next generation of dispersion forecasts. In this project we will address the issue of missing uncertainty representation by producing probabilistic dispersion forecasts using ensemble forecasting techniques. The aim of this project is to explore methods for generating and evaluating the reliability and skill of dispersion ensemble forecasts with a view to developing an operational dispersion ensemble prediction system. We will achieve this by bringing together the latest research into dispersion forecasting, probabilistic prediction, and uncertainty communication.

The Met Office is responsible for forecasting the dispersion of ash over the UK, Ireland and Scandinavia. It is also responsible for forecasting the dispersion of radioactive material in Europe and Africa. During the project the PhD student will work with the Met Office to investigate the most reliable and skilful dispersion ensemble prediction system and to develop the capability to communicate the reliability and skill to end users.



Current VAAC volcanic ash hazard chart showing the location of volcanic ash in a single vertically integrated layer of the atmosphere during the 2010 Eyjafjallajokull volcanic eruption

Training opportunities:
The student will visit the Met Office several times during the project to discuss the design and implementation of experiments using the Met Office Dispersion Model.

Student profile:
This project will be suitable for students with a degree or extensive experience in mathematics or physics or a closely related physical or environmental science. Students should have a strong interest in high impact atmospheric dispersion events and their predictability.

Funding particulars:
This project is CASE funded by the Met Office

References:
Prata, A.T., Dacre, H.F., Irvine, E.A., Mathieu, E., Shine, K.P. and Clarkson, R.J., 2019. Calculating and communicating ensemble-based volcanic ash dosage and concentration risk for aviation. *Meteorological Applications*, *26*(2), pp.253-266.

Harvey, N.J., Huntley, N., Dacre, H.F., Goldstein, M., Thomson, D. and Webster, H., 2018. Multi-level emulation of a volcanic ash transport and dispersion model to quantify sensitivity to uncertain parameters. *Natural hazards and earth system sciences.*, *18*(1), pp.41-63.

https://research.reading.ac.uk/scenario/