Tender for work requested by ADMLC

Topic for which funding is sought: Investigating the impact of applying different grid resolutions of NWP met data in atmospheric dispersion modelling

An investigation into the impact of applying different grid resolutions of NWP met data when modelling the atmospheric dispersion of material in different types of assessments, particularly, in the regulatory modelling impact assessment for EPR permitting and Planning, and probabilistic accident consequence assessments e.g. in respect of radiological releases. The aim is to look into the selected NWP models and provide recommendations on resolution of NWP met data to be used in these scenarios.

Name and address of organisation	

ADMLC technical annex

Draft Technical Annex:

Meteorological (met) station sites may be too far from, and situated in differing topography to, the release location(s) and thus met station derived data may be unrepresentative. The quality and availability of numerical weather prediction (NWP) model data is continuously improving. As a result, NWP model data is becoming more widely used as input to air dispersion modelling for regulatory air quality impact assessments, and for probabilistic accident consequence assessments in respect of radiological releases.

The resolution of NWP model data has been improving with the advances in predictive algorithms and computing power. For example, Met Office Unified Model (UM) NWP data resolution was 60 km prior to 2004, then down to 12 km in 2004, 4 km in 2007 and 1.5 km in 2013. Currently, most environmental permit applications, and environmental agencies use the Met Office UM 1.5 km NWP met data when representative observational met data is not available. Some consultants provide other NWP model data with different resolutions, i.e., GFS[1] NWP data has a resolution of about 13 km and achieved at 0.5 degree, WRF data[2] has a resolution of 1 km and 4 km, and NEMS[3] data has a resolution of < 4 km.

Different NWP modelling approaches and spatial resolutions result in different degrees of representativeness of NWP met data at a local level. The effect of terrain on air flow may be considered in an NWP model, depending on the scale of terrain and NWP model resolution. Since some atmospheric dispersion models, e.g. ADMS Flowstar, also explicitly consider the impact of terrain effects on air flow, there is concern that double counting of the terrain effect for a regulatory air dispersion modelling assessment may occur.

The ADMLC is interested in investigating the consequence of using different spatial resolution of NWP met data on model predictions of annual mean concentration and high percentile hourly concentrations for a regulatory assessment. Furthermore, the Committee wishes to investigate the consequence of using different spatial & temporal resolutions of NWP met data on model endpoints derived by way of probabilistic accident consequence assessments. The aim of this project is to

[1] https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-forcast-system-gfs#:~:text=The%20Global%20Forecast%20System%20(GFS,moisture%20and%20atmospheric%20ozone%20concentration.

[2] https://www.weblakes.com/services/met_data.html

[3] https://nomads.ncep.noaa.gov/txt_descriptions/NEMS_NMM_doc.shtml

recommend optimal spatial (and where applicable, temporal) resolutions of NWP data currently available to be used in 1) regulatory air dispersion modelling and 2) probabilistic accident consequence assessments. This project should consider only archived or reanalysis (and not forecast) NWP met data. Application of WRF model and/or Met Office UM model data in this study would be preferred but it is recognised that this is dependent on the availability and access to data.

The investigation should include the following aspects.

1) The work should include an introduction of NWP models (including Met Office UM model, WFR, NEMS and GFS), and a review of their performance in terms of their weather prediction accuracy from published literature in the last ten years. Model grid resolution should be included in the introduction and review.

2) For one (or more) chosen NWP model(s), at three spatial resolution levels (i.e. 1-1.5 km, 4 km and 12 km), compare model endpoints derived for each of the hourly NWP met datasets for a range of receptor locations, over both flat and complex terrain conditions.

   Comparison between NWP wind data and observed wind data should also be included with a view to see whether the application of more finely resolved NWP met data results in more representative dispersion modelling prediction. The NWP met data should be representative of the same location as the observed met station. It's known that information from a chosen observed met station may be reflected in the NWP data already but observed met modelling serves a purpose as a reference for NWP modelling with different resolutions.

3) For the investigation for regulatory atmospheric dispersion modelling, carry out comparison studies for several chosen scenarios, i.e. typical intensive farming emission (simplifying to a close to ground level point source) and elevated point source emission. Both flat and complex terrain should be included. Three years NWP met data for each location should be used in the comparison studies.

   These model comparison studies should include NWP met data at three different resolution levels as well as observed met data. Both long term (annual mean) and short term (100^{th} and 98^{th} percentile hourly average) model predictions should be included in the comparison. The modelling domain can be divided into eight equal wind directions, and model predictions for each wind direction at an appropriate distance should be compared and analysed. This distance can be determined by using the distance to the maximum predicted concentration location for each case (i.e., annual mean, 100^{th} and 98^{th} percentile) over the whole modelling domain.

   Consideration of ADMS and AERMOD would be preferred, but the models to be applied can be agreed in consultation with the Committee.

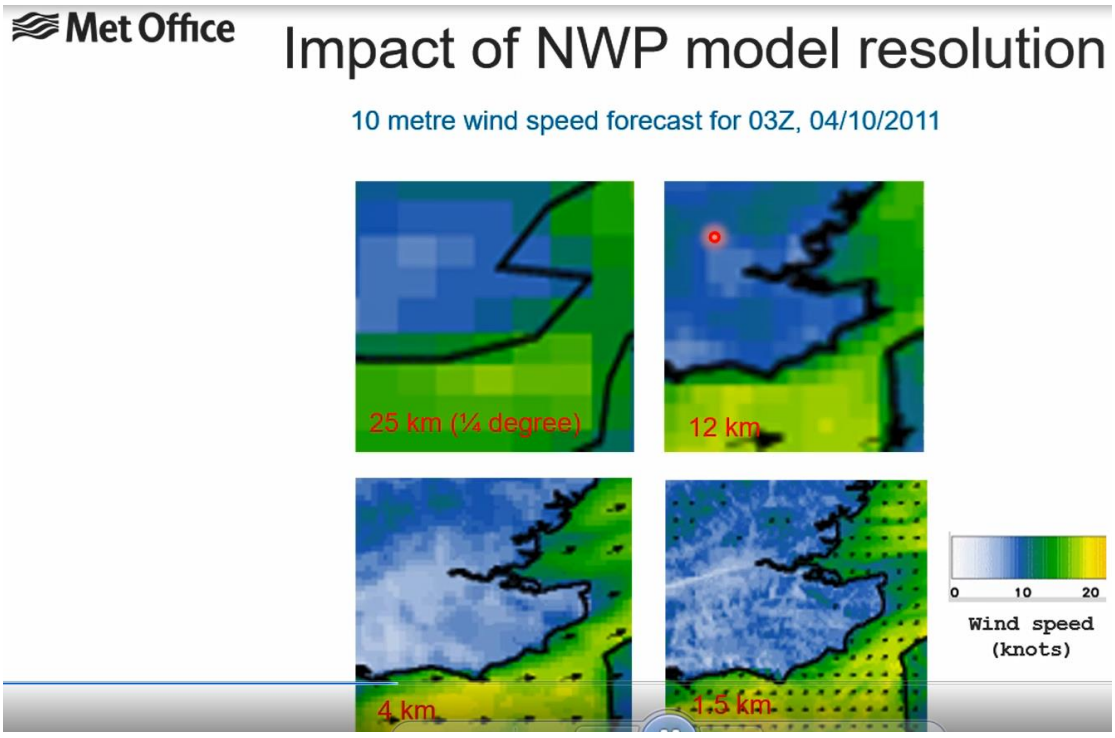
4) The work should also examine whether there is potential for double counting of the impact of terrain. A model domain of 1 km x 1 km from the release location for intensive farming emissions and of several kms for an elevated point source should be considered. It should be noted that the ADMS terrain module has been verified in many case studies by CERC using observed single point met data. To date CERC have not identified double counting as a potential issue when using locally observed met data[4].

[4] https://www.cerc.co.uk/environmental-software/model-validation.html

5) For probabilistic accident consequence assessments, the investigation should consider the impact on model endpoints of applying different spatially and temporally (for example 1 hour vs 3 hour) resolved NWP met data. It is important that the same NWP model is applied in order to isolate the impact of grid resolution alone. Model endpoints derived by way of radiological probabilistic accident consequence assessments are typically estimated at distances of a few kilometres to a few hundred kilometres where single site observed met data is unlikely to be representative. Therefore there is little value in evaluating model runs applying different resolutions of NWP met data against a model run based on single site observed met data. The contractor should assess whether the differences in model endpoints derived are significant as a result of applying different resolutions of NWP met data. Or are the differences relatively small and therefore is there a greater benefit to a model user in applying more coarse data (due to significantly reduced model runtime, ease of "handling" smaller datafiles, and the potential for easier access to a specific temporal period of data and availability of large periods of unbroken data). PHE's PACE suite of models or a suitable alternative probabilistic accident consequence assessment code should be applied in the study.

Additional information:

1. Nachamkin J.E., Cook J. Frost M, Martinez D. Sprung G., Evaluation of Dispersion Forecasts Driven by Atmospheric Model Output at Coarse and Fine Resolution, American Meteorological Society, November 2007, DOI: 10.1175/2007JAMC1570.1.
2. Higher resolution NWP met data (1 km and 4 km) is recommended to be used for air dispersion modelling at complex terrain and coastal locations. https://www.weblakes.com/services/met_data.html
3. Illustration of impact of NWP model resolution



Timescales		
	Item or deliverable	**Date**
	Start date	
	Intermediate stages or deliverables	Add rows as needed
	Draft report for ADMLC comment	
	Final report	

Costs

Indicate points at which intermediate payments, if any, are required.

Note that ADMLC will only make intermediate payments on receipt of identified deliverables or the draft report

CVs of Project Staff

Provide CVs of 2 staff involved in the project.

This section should be no more than 1 page in total.