EVALUATION OF REGIONAL AIR QUALITY MODELS OVER SYDNEY, AUSTRALIA

Elise-Andrée Guérette[1], Khalia Monk[2], Steven Utembe[3], Jeremy David Silver[3], Kathryn Emmerson[4], Alan Griffiths[5], Hiep Duc[2], Lisa Tzu-Chi Chang[2], Toan Trieu[2], Ningbo Jiang[2], Yvonne Scorgie[2], Martin Cope[4] and Clare Paton-Walsh[1]

[1] Centre for Atmospheric Chemistry, University of Wollongong, Wollongong, NSW, Australia

[2] Climate and Atmospheric Research, NSW Office of Environment and Heritage, NSW, Australia

[3] School of Earth Sciences, University of Melbourne, Melbourne, VIC, Australia

[4] CSIRO Oceans and Atmosphere, Aspendale, VIC, Australia

[5] Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW, Australia

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1. Introduction

Air quality models are valuable tools to investigate the complex and dynamic interactions between meteorology and chemistry that lead to poor air quality episodes. Furthermore, well validated models can be a useful means of testing various future scenarios likely to impact regional air quality. As part of the Western Air-shed and Particulate Study for Sydney, which is a project of the Clean Air and Urban Landscapes hub funded by the National Environmental Science Programme, we are evaluating the performance of several regional air quality models by comparing their output to observations. This project leverages regional modelling efforts from several groups, including the University of Melbourne, CSIRO, the NSW Office of Environment and Heritage and ANSTO.

2. Models, modelling domain and modelling periods

For this project, the following models are being evaluated: WRF-Chem, WRF-CMAQ, WRF, and two versions of the CCAM-CTM developed by CSIRO, one of which is the operational version run by the NSW Office of Environment and Heritage.

All models are run over the same geographical domain using the same grid resolution (down to 3 km) for three time periods that coincide with intensive measurement campaigns that were conducted within the Greater Metropolitan Region of NSW in recent years (Sydney Particle Study 1: February-March 2011, Sydney Particle Study 2: April-May 2012 and MUMBA: December 2012 to February 2013).

Meteorological model output is evaluated against observations made at 8 sites belonging to the Bureau of Meteorology and the air quality model output is evaluated against observations made throughout the network of air quality monitoring stations maintained by the NSW Office of Environment and Heritage. The modelling domain and the sites used for model evaluation are shown on the map in Figure 1.

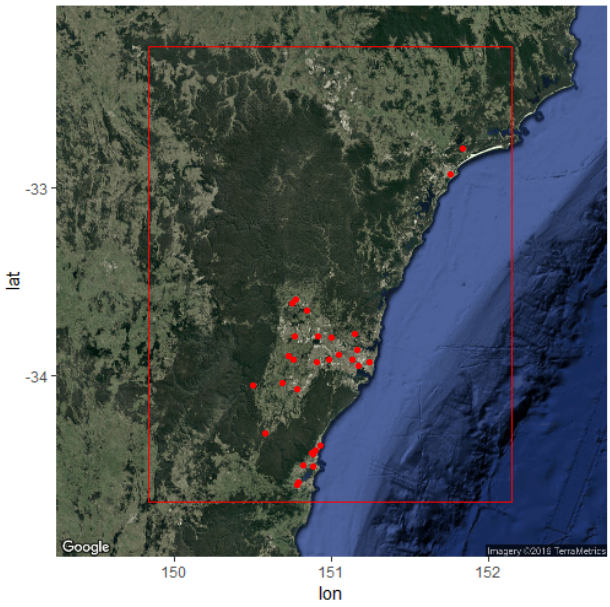

Figure 1. Map of the Greater Metropolitan Region of NSW showing the modelling domain and the sites selected for model evaluation

3. Emission inventories

All models use the 2008 Air Emissions Inventory for the Greater Metropolitan Region in NSW from the NSW EPA (EPA 2012) as their anthropogenic emission inventory, but may use different schemes for biogenic and other natural sources of emissions. The 2008 EPA Air emissions Inventory data are re-gridded to a 3-kilometre resolution to match that of

the models. Figure 2 shows an example of gridded emissions for CO.

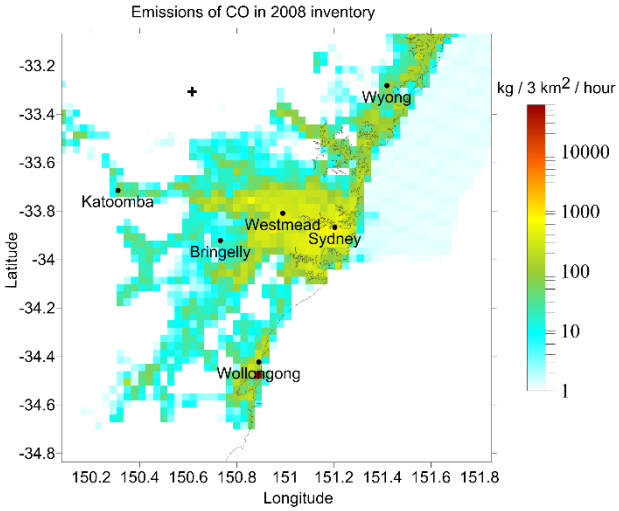

Figure 2. 2008 Emissions of CO in kg/hr gridded to 3 km resolution

4. Evaluation

The model output is evaluated against air quality and meteorological data from the NSW Office of Environment and Heritage and the Bureau of Meteorology. The parameters examined include wind speed, temperature, ozone and PM2.5. Wind speed is an important parameter as it influences dilution and transport time between sources and receptor locations, and controls the emission of sea salt and dust. Temperature controls the rate of chemical reactions and alters the gas/particle phase partitioning, as well as potentially controlling the rate of certain emissions, depending on model parameterisation. Ozone and PM2.5 are two air quality indicators that have seen little improvement in the Sydney region over the last decade and both cause exceedances of the air quality standards.

Model output is compared to observations on an hourly and daily basis and their performance evaluated using statistical metrics such as mean bias (positive or negative deviation from the mean), correlation coefficient (linear agreement) and standard deviation (spread of the data).

5. Model performance

Performance is assessed both over the entire domain and at specific sites, to detect, for example, coastal effects. The model performance is assessed against benchmarks sourced from the literature, including reported performance in other evaluation exercises over other parts of the world (e.g. Brunner et al 2015; Im et al. 2015), as well as being judged in the context of what is needed in the region. It is essential to characterise the biases present in air quality models through performance evaluations such as these so that models can be used in policy scenario analysis in a considered way.

In this presentation, we give an overview of the model evaluation project and present an assessment of model performance for selected meteorological parameters, ozone and PM2.5. The end goal of the project is to advance the reliability of modelling of current and future air quality over the Greater Metropolitan Region of NSW to a point where it becomes possible to use the models to test different policy scenarios.

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