THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM

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The Australian Air Quality Forecasting System (AAQFS) is a joint project between the Bureau of Meteorology (BoM), CSIRO Atmospheric Research (CAR), CSIRO Energy Technology (CET), the Environment Protection Authority of Victoria (EPA Victoria) and the New South Wales NSW Department of Environment and Conservation (NSW DEC) to develop a high-resolution air quality forecasting system. The initial development of AAQFS was funded by the Air Pollution in Major Cities Program (sponsored by Department of Environment and Heritage).

The project has a number of specific goals: to provide the ability to generate 24/36-hour air quality forecasts twice per day (available 9 am and 3 pm); provide forecasts for a range of air pollutants including oxides of nitrogen (NO_x), ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), benzene (C_6H_6), formaldehyde (CH_2O) and particulate matter (PM10 and PM2.5); provide forecasts at a resolution sufficient to consider suburban variations in air quality; and to provide the ability to generate simultaneous forecasts for a 'business-as-usual' emissions scenario and a 'green emissions' forecast. The latter scenario may correspond to minimal motor vehicle-usage, for example, and which could be used to indicate the reduction in population exposure that could result from a concerted public response to a forecast of poor air quality for the next day.

The AAQFS consists of five major components: a numerical weather prediction (NWP) system, an emissions inventory module (EIM), a chemical transport module (CTM) for air quality modelling, an evaluation module, and a data archiving and display module.

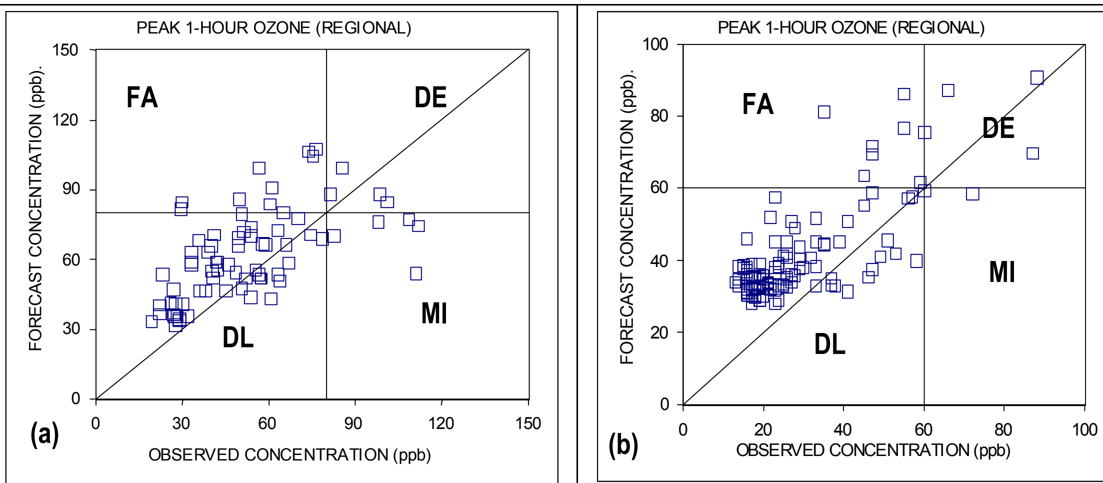
The BoM's operational Limited Area Prediction System (LAPS) has been adapted for the AAQFS NWP component. Comprehensive numerics and physics packages are included and recent work has paid special attention to the resolution and treatment of surface processes. The model has 29 vertical levels and a horizontal resolution of 0.05° (covering the State of Victoria and most of New South Wales). This model is nested in LAPS at 0.375° resolution, which in turn is nested in the BoM global model, GASP.

EPA Victoria and CSIRO, with support from NSW DEC, have developed the emissions inventory. The inventory component includes estimates of size-fractionated and speciated particle emissions, 0.01° gridded area sources over the densely populated regions and meteorologically-dependent emissions that are generated based on LAPS predictions.

The CTM has been custom-built for the project using state-of-the-art methodologies. A notable inclusion to the CTM is the Generic Reaction Set photochemical mechanism, a highly condensed (7 species and 7 reactions) photochemical transformation mechanism featuring minimal computational overhead. Parallel tests of a more comprehensive photochemistry, Carbon Bond IV, are currently being conducted for a second oxidant season. Particle transformation is modelled by a sectionally-based particle scheme. The transport fields are updated every 60 minutes. The CTM has 17 vertical levels, and simulations use a 0.05° outer grid, with nested 0.01° inner grids for major urban areas.

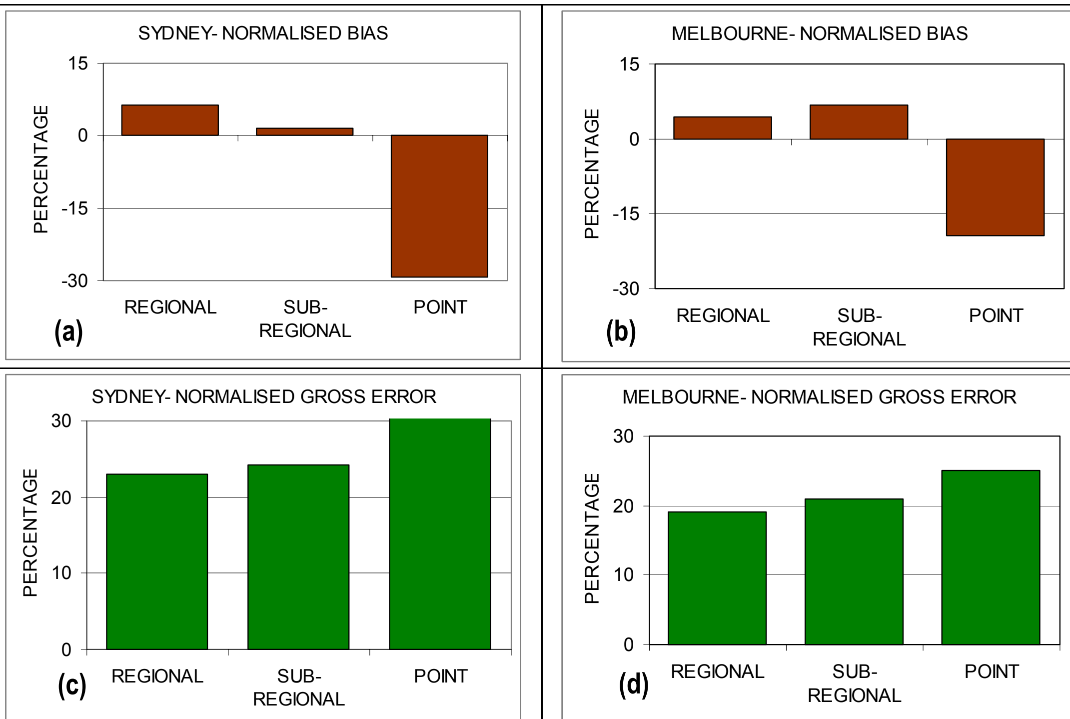
While the focus of the AAQFS to date has been the forecasting of urban air quality, other applications have been considered. The AAQFS has been adapted to forecast dust storms and the transport of bushfire smoke. Recent work (cf. Fig. 1 and 2) has focused on verification of peak 1-

hour ozone forecasts and provision of an initial benchmark for investigating the limits of predictability for air quality in the Sydney and Melbourne regions by looking at the dependence of the forecasts on spatial scale, the starting time, and the sophistication of the photochemical mechanism.



Sydney 0000 UTC forecast	Melbourne 0000 UTC forecast

Figure 1. Scatter plots of regional-scale forecasts (uncoupled in space) and observed daily peak 1-hour ozone concentration for (a) the Metropolitan Air Quality Study Region (Sydney and environs) and (b) the Port Phillip Control Region (Melbourne and environs). The upper left quadrant indicates the region of false alarms, FA, the lower left quadrant, DL, the region of detection of low and medium concentration events, the lower right quadrant, MI, the region of missed forecasts, and the upper right quadrant, DE, the region of detection of extreme concentration events. The diagonal lines indicate a perfect forecast.



Sydney 0000 UTC forecast	Melbourne 0000 UTC forecast

Figure 2. Performance statistics for normalized bias at (a) Sydney and (b) Melbourne, and for normalised gross error for (c) Sydney and (d) Melbourne for the forecasts of daily peak 1-hour ozone, as a function of the spatial scale of the forecasts.