# 7.1 THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM- A REVIEW OF PHOTOCHEMICAL SMOG FORECASTING CAPABILITY

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## 1. INTRODUCTION

The Australian Air Quality Forecasting System (AAQFS) is a numerical forecasting system that has been operating since August 2000. Funded by Environment Australia through the Natural Heritage Trust, the system generates twice-daily 24–36 hour forecasts for primary and secondary gaseous pollutants, aerosols and air toxics. Forecasts are generated for the city of Sydney and surrounding regions in the state of New South Wales, Australia (see Fig. 1), and for the city of Melbourne and surrounding regions in the state of Victoria. Regional-scale forecasts are generated on a grid with a spacing of 5 km. Nested within the regional grid is an urban-scale grid with a spacing of 1 km. A comprehensive description of AAQFS may be found in Manins (2001).

One of the priority air pollutants for forecasting is ozone (as the principal component of photochemical smog). Australian Standards for ozone are 100 ppb (1-hour average) and 80 ppb (4-hour). Note that a 1-hour concentration of 80 ppb is also used by some authorities as an indicator of significant photochemical activity. Ozone has been observed to reach concentrations above these standards in both Sydney and Melbourne. Presented below is a brief review of AAQFS performance for forecasting days of photochemical smog potential.

## 2. PERFORMANCE OUTCOMES

AAQFS performance for forecasting ozone was initially poor, with peak concentrations often remaining close to background, even on days when moderate to high ozone concentrations were observed. The causes of poor performance were identified to be mis-matches between the turbulence dispersion schemes used in the numerical weather prediction system and the chemical transport model; to the incorrect prescription of boundary concentrations for reactive organic compounds (ROC) as required by the highly condensed AAQFS photochemical transformation mechanism (see Manins 2001 for a description of the mechanism); to an under–prescription of ROC emissions (for Sydney); and to an error in the software implementation of the vertical advection scheme.

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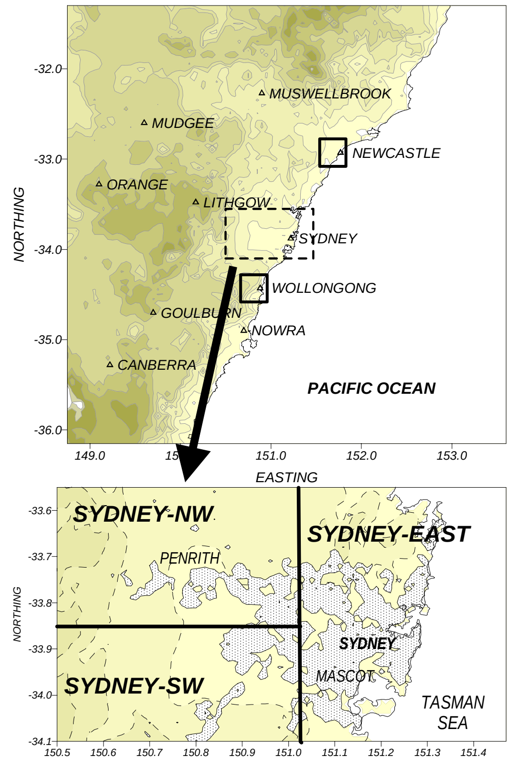


**Fig.1** Regional (top) and urban forecasting domains for Sydney and environs. Topography and Sydney urban region (bottom) are shown. Sub-regions are outlined.

Following this initial phase of performance analysis and adjustment to the system and inputs, ozone forecasts have begun to show good promise. This is illustrated in Fig. 2 for Sydney (see Manins 2001 for Melbourne), where the fractional bias, for forecast-observed region-wide daily peak 1-hour ozone concentration has been plotted as a function of observed ozone concentration. For example, it can be seen that observed ozone concentrations in the critical range 80–120 ppb have been forecast with a mean fraction bias of 0.08 (corresponding to a mean error of < 10%), which is an excellent result. Conversely, it can also be seen that AAQFS has a tendency to under-predict the most extreme ozone concentrations.

A common methodology for appraising the performance of forecasting systems is the contingency table (Manins 2001). Shown in Fig. 3a for Sydney and environs is the proportion of

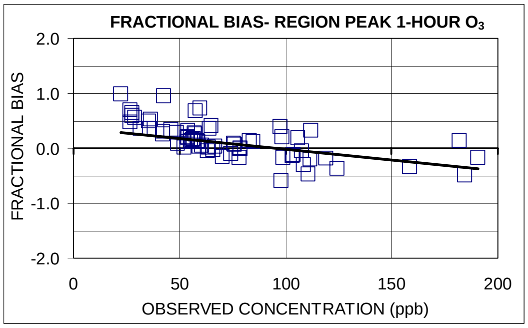


**Fig. 2** Scatter plot of fractional bias vs. observed regional daily peak. Trend line is for ozone > 50 ppb

days (expressed as a percentage) for which AAQFS correctly forecast the occurrence of a daily 1-hour ozone peak in excess of a designated concentration in the range 40–100 ppb. Plots are given for the forecast of regional ozone peak (*Region*), for the forecast of sub-regional ozone peak (*Sub-region*; see Fig. 1 for definitions of the sub-regions), and for a *suburb*-scale forecast (defined as the peak forecast concentration within a 10 km region of a monitoring station). Shown in Fig. 3b is the proportion of days for which a prescribed ozone concentration was incorrectly forecast (the false alarm rate). For comparison, results generated using a simple observation-based persistence model are shown in Fig. 3c, d.

The literature (see Manins 2001 and references therein) reports detection rates in the range 30–70% and false alarm rates in the range 15–65% for the forecasting of daily short-term ozone peaks. If we define acceptable forecast performance to be one with a 60% or higher detection rate, a 40% or lower false alarm rate, and performance that is superior to persistence, it can be seen from Fig. 3 that AAQFS achieved acceptable regional-scale forecasting performance for concentrations in the range 60–90 ppb. AAQFS sub-regional scale forecasts satisfy the criteria for most exceedence thresholds up to 80 ppb and suburb-scale forecasts generally achieve the criteria for exceedence thresholds up to 60 ppb.

## 3. CONCLUSIONS

These results provide quantitative evidence of the potential for AAQFS to provide accurate numerical air quality forecasts. The challenge now is to further improve the accuracy of the system. In the next phase this will be addressed through improved characterization of biogenic emissions, through enhancements to the chemical transformation mechanism and, potentially through enhancements to the vertical resolution of the meteorological analysis.

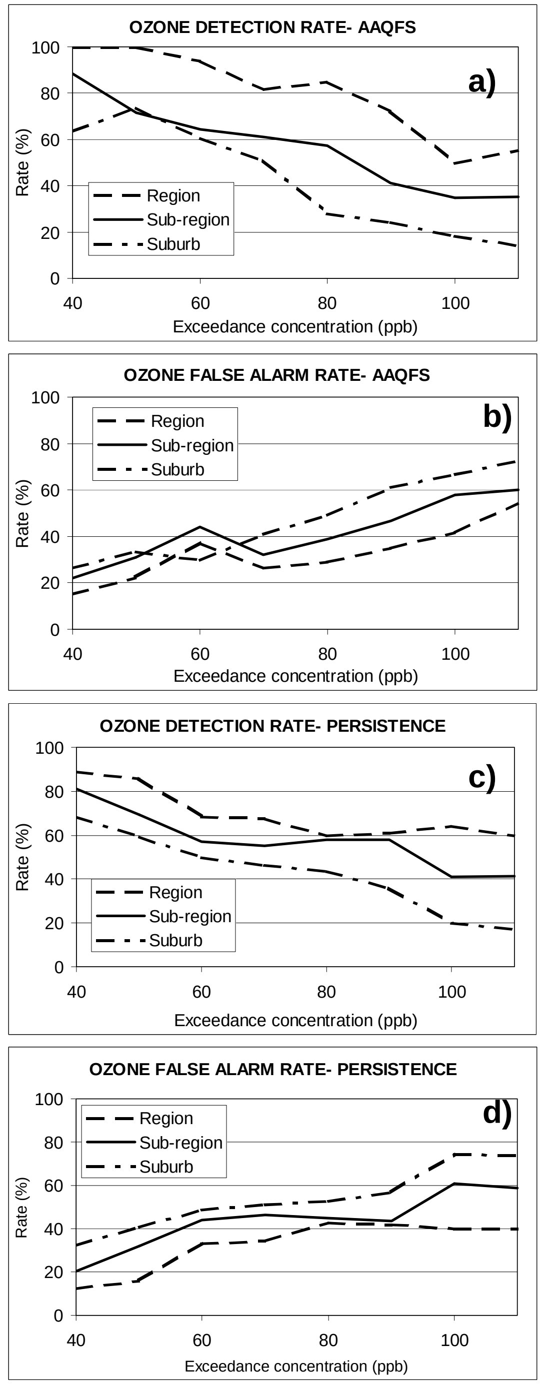


**Fig. 3** Contingency table outcomes for daily peak 1-hour ozone forecasts for Sydney and environs.

## 4. REFERENCES

Manins, P.C. (Chair of Committee), 2001: Air Quality Forecasting for Australia's Major Cities– Final Report. Project Management Committee: CSIRO Atmospheric Research, Aspendale, Australia. See http://www.dar.csiro.au/information/aaqfs.html