1.4 THE USE OF INTER-REGIONAL TRANSPORT SIMULATIONS TO VERIFY THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM

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1. INTRODUCTION

The Australian Air Quality Forecasting System (AAQFS) is a joint project between the Bureau of Meteorology, CSIRO Atmospheric Research, CSIRO Energy Technology, the Environment Protection Authority Victoria and the New South Wales Environment Protection Authority to develop a high-resolution air quality forecasting system. Currently 24–36 hour forecasts are produced in both Melbourne and Sydney twice daily at a horizontal resolution of 1 km in urban areas and 5 km in rural areas. Forecasts are provided for a number of species including, NO_x, O_3, SO_2, CO, C_6H_6, CH_2O, PM10, PM2.5 and passive tracers if required. A description of the complete system and its performance is given by Manins (2001).

Meteorological and air quality verification is routinely conducted within the Melbourne–Geelong and Sydney Airsheds. The present paper seeks to extend the verification by considering urban plume transport of CO from Melbourne to Geelong, 320 km southward to Cape Grim on the northwestern tip of Tasmania. The Cape Grim Baseline Air Pollution Station (CGBAPS) monitors global atmospheric composition and meteorology. CO is primarily generated by motor vehicles and is quasi-conservative; the path between Melbourne and Cape Grim is (nearly) free of sources. A similar study of inter-regional transport of CO to Cape Grim has been carried out by Cox et al. (1999), using analysed winds and a different model, TAPM.

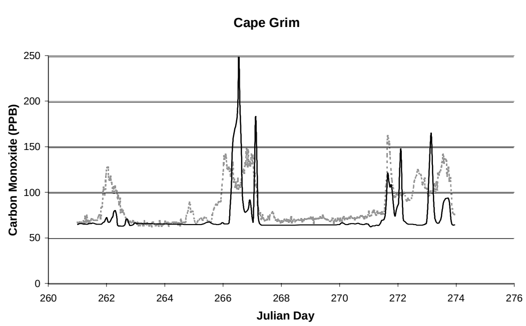

Fig. 1 Time-series of modeled (dark) and observed (pale) CO concentrations at Cape Grim (40.68 °S, 144.68 °E).

2. VERIFICATION

The study period began on 18 September 2001 and ran for 13 days. In this time elevated CO concentrations were recorded during three distinct periods; 18–19, 23–24, and 28–30 September (Julian days 261–262, 266–267 and 271–273). Time-series of observed (pale) and modeled (dark) CO are presented in Fig. 1. The modeled values correspond to the maximum concentration within a 0.1° radius of Cape Grim. This is a severe test of the system. The accuracy of long-range transport predictions depends on meteorological conditions. Typical errors for trajectories, based on forecast winds, are of the order of 30% or more of the travel distance (Stohl, 1998), i.e., approx. 1° for this study.

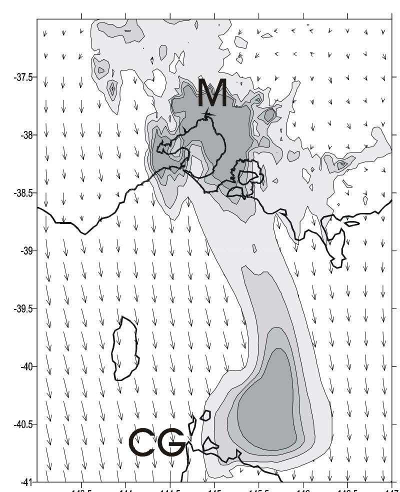

Fig. 2 CO (shaded, 80–140+ ppb) at 0600 LST 19 September 2001. 'M' and 'CG' represent Melbourne and Cape Grim respectively.

Figure 1 shows the AAQFS under-predicted CO concentrations during the first period; correctly forecast the double peak of the second period, although the timing was a few hours late and the magnitude of the first peak was too great; and it predicted a series of peaks during the third period. The timing of the third period onset and cessation was very good (accurate to within an hour).

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Although Fig. 1 showed CO was under-predicted during the first period, maximum values of 130 ppb were predicted within a 0.5° radius. The AAQFS CO forecast at 0600 LST 19 September is presented in Fig. 2, and shows that the plume passed eastward of Cape Grim. This result illustrates how a small trajectory error can be responsible for a “missed” forecast, and how a reliance on observation station performance alone does not do justice to the forecasting system.

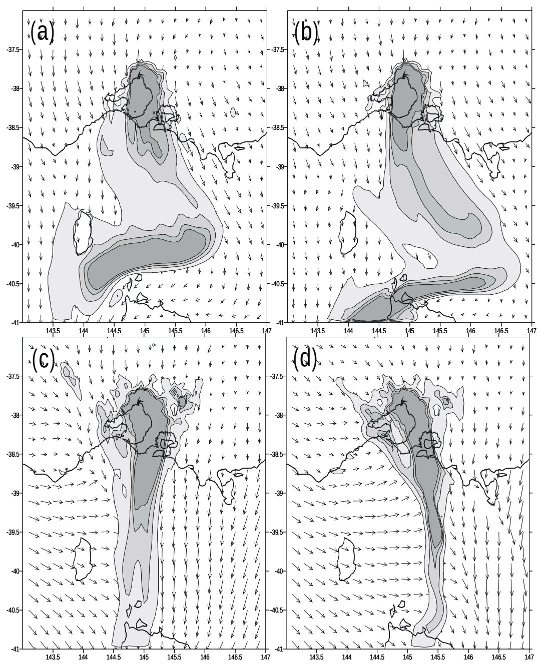

Fig. 3 Same as Fig. 2, except at (a) 1000 LST and (b) 1500 LST 23 September 2001 (second period), and (c) 1800 LST and (d) 2100 LST 30 September 2001 (third period).

During the second period Fig. 1 shows a double peak in both the observed and modeled CO concentrations. The modeled double peak was caused by the wind shifting from NE to NW then to N, which generated a dog-leg shape in the CO plume. The upper panels of Fig. 3 show the plume at (a) 1000 LST and (b) 1500 LST 23 September. The two images together begin to illustrate the procession of the two CO maxima within the dog-leg plume, over Cape Grim. Figure 3a corresponds to a time just prior to the second-period first-maximum, evident in Fig. 1, and Fig. 3b corresponds to a time between the second period peaks, when the clean air located behind the “knee” of the dog-leg plume approached Cape Grim.

The wind direction during the third period, as in the second period, was predominantly northerly with shifts to the east and west. This led to the development of a CO plume that swept back and forth across Cape Grim, and the resultant multi-peaks evident in Fig. 1. An interesting feature of the third period is the very good timing of the initial plume arrival and final departure. The passage of a cold front was responsible for clearing the forecast plume from Cape Grim. This is evident in the lower panels of Fig. 3, which show the plume at (a) 1800 and (b) 2100 LST 30 September, being swept away to the east at the leading edge of the cold front.

3. CONCLUDING REMARKS

As a forecasting tool, the AAQFS has demonstrated considerable success in identifying “pollution” events, at a qualitative level, during this 13-day period. If the detecting radius was extended to 0.5 degrees (half the recognized typical trajectory error) the success rate climbs to 100%. This result is complimented by the ability of the AAQFS to provide considerable spatial and temporal detail of the development and track of the CO plume, although the verification of such detailed inter-regional transport is limited to the single point observations at Cape Grim. Thus, the explanations of the predicted plumes presented in the previous section can only offer a plausible explanation for the real plume transport. It seems likely that a plume similar to that presented in Fig. 2 was present, although the true trajectory must have at least partly encompassed Cape Grim. Similarly for the second and third periods, the shifting east–west component of the northerly winds was likely to be responsible for the observed multi-peaks evident in Fig. 1 as the plume swept from side to side across Cape Grim.

These results are encouraging when considering the potential to apply the system to other areas of the globe where inter-regional transport is of considerable importance.

ACKNOWLEDGEMENTS

We thank the AGAGE team, Paul Fraser, Paul Steele, Paul Krummel and the staff at CGBAPS for providing the high quality trace gas data. Initial funding was received from Environment Australia through the National Heritage Trust.

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