DOWNSCALING OF WEATHER PREDICTION MODELS FOR SHORT-TERM ALERT SYSTEMS FOR AIR QUALITY AND OTHER DECISION-SUPPORT SYSTEMS

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Summary

Current advanced numerical modelling schemes cannot yet routinely produce reliable forecasts of basic weather variables out to a horizon of 6-10 days at a half-hourly time resolution and at spatial scales of 1 km. Yet many applications involving weather-related impacts (e.g. smog forecasting, agricultural management, industrial scheduling) require this facility at a reasonable cost. Should a real-time local weather station be available, the coupling of monitoring information and even coarse-scale (75 km, 6 hourly) numerical forecasts can be "downscaled" to give robust and relatively inexpensive point forecasts of winds, temperatures and other derived variables. A variety of tools now available to perform such point forecasts in Australasia and elsewhere includes statistical, time series, neural network and other artificial intelligence methods. Experience for many sites in eastern Australia using relatively simple techniques has been very encouraging (and useful for energy trading). Extreme events may require a more holistic approach. The implications for urban and industrial air quality management are discussed.

Keywords: weather forecasting, real-time weather station, downscaling, decision support system, numerical modelling, smog forecasting.

1. Introduction

Many air quality problems involve the assessment of near-surface source contributions to levels of dust, odour or air toxics in the near-field, often over small time frames (minutes – 1 hour). These assessments can include:

- Ground-level concentrations or dosages at key receptors for the recent past and near-future;
- Similar considerations over a grid so that maximum values can be estimated;
- Interpretation of any monitoring results;
- Anticipation of forthcoming adverse conditions or impacts to facilitate proactive use of mitigation measures;
- Emission estimation for meteorologically-dependent processes (e.g. fugitive dust generation from a material surface).

Boundary-layer profiles or parameters are the key inputs to tools such as dispersion models that can assist in the above. These can be severely affected by terrain or land-use, being governed by synoptic, mesoscale and local flows.

Automatic weather stations (AWS) are increasingly used for determining wind, temperature and radiation characteristics for the height range 1-30 m above ground on a 5-60 minute time scale.

These studies invariably show the limited applicability of non-continuous historical measurement programmes and the high sensitivity of local flows to station setting. Especially in the sub-tropics and inland Australia where low windspeeds are the rule rather than the exception, the range of applicability of AWS information is often less than 10-20 km.

The degree of influence of terrain/land-use features also becomes important when using numerical models to predict spatial variability of meteorological fields, both for historical events and for future horizons such as the 1-7 day view offered by modern weather forecasting schemes. Prognostic models utilise available surface information as input to the conservation and flow equations for the atmosphere. For example, the Australian Bureau of Meteorology (BoM) offers global and limited area models (GASP, LAPS etc.) that cater for spatial scales of 5-75 km and timescales of 1-6 days. Data assimilation is usually limited to BoM AWS information from key locations and recent radiosonde/balloon profiles at airport sites. By the time of the issue of the weather forecasts, this information is at least 6-10 hours out of date.

Meteorological models such as TAPM and HIRES (Leslie et al, 2002) and air pollution forecasting schemes such as AAQFS (Manins et al 2002a) may utilise