DATA RETRIEVAL, ANALYSIS AND REPORTING

A user friendly menu package has been developed around the SIR (Scientific Information Retrieval) data base management system to establish and maintain the archive as well as to facilitate data retrieval and analysis.

To assist users, a range of packaged reports are available to enable access to the following information:

- monitoring agency;
- monitoring sites;
- pollutant parameters;
- collection and analysis methods;
- reporting units;
- unit conversion;
- common air quality standards/ goals;
- monitoring history; and
- comments.

The tables have been compiled to enable users to ascertain what data is available. The tables provide details such as a listing of monitoring sites in a certain city and particulars of those sites, including location by map grid reference, height above the surrounding areas and above mean sea level, as well as site characteristics (whether industrial, residential etc). For any air pollutant, the tables provide a listing of sites at which the parameter is monitored and the start and end date of the period over which data is available at each site.

The tables enable a user to select sections of the data held in the NAQDC for analysis. Once the data of interest has been decided, work databases can be constructed as subsets of the information in the full archive. Typically work databases span a specified time period and contain data for selected parameters and sites. Such work databases are constructed as needed, used and then discarded on completion of the research. Users can request work databases by writing to the Department of the Arts, Sport, the Environment, Tourism and Territories in Canberra. The data bases will be supplied on disks.

The NAQDC system provides a range of in-built reporting and analysis facilities for the more common investigations. Special packages have also been developed for the NAQDC for more sophisticated analyses specific to air quality studies. They include facilities to determine, for any nominated time period:

- daily, monthly or annual means and maximas;
- highest n original data;
- maximum n values of an arithmetic or geometric mean;
- exceedences of standards or nominated values;
- correlation between sites (for the same parameter) or between parameters (for a particular site); and
- autocorrelation coefficients for a particular parameter for a particular site.

The statistics generated by the above analyses are normally the information required by users. However, they can also help researchers in their identification of special 'blocks' of raw data on which other analyses, such as numerical modelling of pollution formation and dispersion, are to be performed.

FURTHER NAQDC DEVELOPMENT

Acquisition of data for the NAQDC has been held in abeyance while the system is being transferred from CSIRONET to in-house personal computer facilities. Acquisition of current and historical data is expected to resume in the latter half of 1988.

So far, NAQDC efforts have been concentrated in the collation of data from State/Territory environmental agencies. It is envisaged that the data base will be expanded to cover air quality data generated by other organisations.

Although the data holding is still small, information held in the Data Centre has already contributed to research and air quality management. This includes provision of data for research by the Centre for Resource and Environmental Studies (CRES) of the Australian National University and for guidance in town planning by the National Capital Development Commission (NCDC) in Canberra.

With further development of the NAQDC and accumulation of more data, the Data Centre should make an important contribution towards air quality management in Australia.

*** The permission of the Department of the Arts, Sport, the Environment, Tourism and Territories to publish this paper is acknowledged. The views expressed are those of the author and are not necessarily those of the Department.**

LABORATORY SIMULATION OF TOPOGRAPHIC EFFECTS ON ATMOSPHERIC FLOWS IN STABLE CONDITIONS

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INTRODUCTION

Air flow past topography causes a number of significant dynamical effects in a stably stratified atmosphere. These can have a controlling influence on the wind field in light wind, high pollution situations. Since the shape and form of the Earth's terrain is generally quite complex, determining what these effects are in a given region is a non-trivial task. Laboratory modelling provides a reasonably quick and relatively cheap method for investigating stratified airflow around mesoscale topography, and quantitative results may be obtained from suitably designed experiments. These are normally done with topographic models towed through stratified salt water; attempts to model stably stratified flows with topography in wind tunnels have not been very successful so far.

BASIS FOR MODELLING

The principal requirement for modelling is to make the important dynamical balances in the model as close as possible to those in the atmosphere. Complete dynamical similarity is usually impossible, and one must compromise and identify the essential parameters. Much has been learnt in recent years about stratified flow past simple topographic shapes (e.g. Snyder et al., 1985, Baines, 1987) and this information is useful in modelling more complex terrain. We consider a region of complex terrain such as shown in Figure 1 which defines notation, with stratification as shown in the inset. In fluid of total depth D, with constant buoyancy (Brunt-Vaisala) frequency N (where $N^2 = -g/\rho . d\rho/dz$) above a stable interface

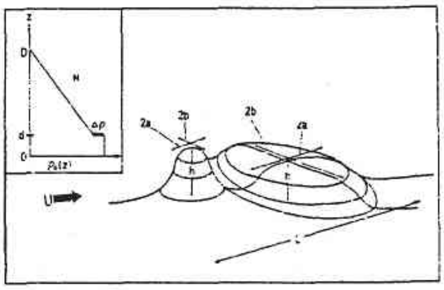

Figure 1: Schematic definition sketch for flow with mean speed U past complex terrain. The density profile is shown in the inset. A given region of complex terrain may have several values of a, b and h.

at height d, the relevant dimensionless parameters are

$$Nh/U,\ h/a,\ a/b,\ K = ND/\pi U,$$
$$R_e = 2Ub/\nu,\ d/h,\ \text{and}\ g\Delta\rho/\rho N^2 d,$$

where ρ is the fluid density and ν is the kinematic viscosity. The Earth's rotation is assumed to be unimportant for the small space and time scales of interest here. Ideally, the values of these parameters should be the same in the laboratory analogue as in the atmosphere. For the Reynolds number, R_e, we must use "Reynolds

TABLE I
REQUIREMENTS FOR LABORATORY MODELLING OF STRATIFIED FLOW OVER COMPLEX TERRAIN

D is fluid depth, N buoyancy frequency, ν kinematic viscosity. See Figure 1 for definition of other symbols. The values given below should be taken as a guide rather than as fixed quantities. We normally require the following:

$(\nu a/U)^{1/2} << h$; $h/D < 1/2$

a/b, d/h and g^1/N^2d should both have equal values in the laboratory and atmosphere respectively. Other criteria depend on Nh/U, as follows:

If d = 0 we have

Nh/U	Flow Regime	Requirements
0	↑ Lee waves	↑ $ND/\Pi U > 3$; Na/U same as for atmosphere;
0.5	↓ ↑	h/a same as for atmosphere for quantitative results
1.0		↑ ↓
2.0	Columnar (blocking) disturbances	$Ub/\nu >> 1$
4.0		
∞	↓	↓

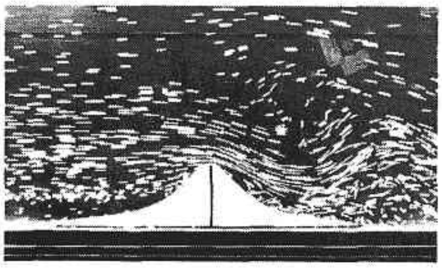

Figure 2: Two-dimensional flow field relative to the topography for Nh/U = 2.36. Flow is from left to right. The tank is effectively infinitely deep, in that internal waves are not reflected from the upper boundary.

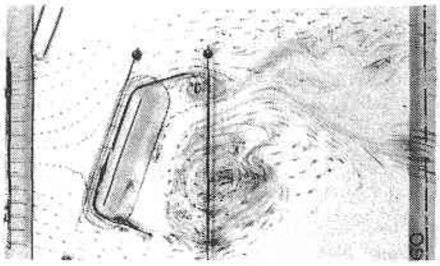

Figure 3: Flow pattern at a low level around an obstacle with Nh/U = 6. The flow is visualised by dye from three rakes at the same level: one upstream, and one in the wake region. Note the nearly two-dimensional flow pattern, with time-dependent vortices formed in the wake.

number similarity", which states that the value of the Reynolds number is immaterial provided that it is large enough (≥ 500). For models with length scales of centimetres, this implies fluid speeds greater than about 1 cm/sec. The parameter h must also be greater than the relevant boundary-layer thickness. The parameters a/b, d/h and $g\Delta\rho/\rho\ N^2 d$ must be equated with the atmospheric values. Since the atmosphere has no upper surface, K in the experiments must be sufficiently large for the finite depth of the tank to have minimal effect on the lee wave structure ($K > 3$ at least).

FLOW CHARACTER

If there is no neutral layer ($d = 0$), the flow character is determined by Nh/U. If $Nh/U < 0.5$, the flow is dominated by lee waves and the value of h/a must be correct in order to get the correct magnitudes. As Nh/U increases above 1 the lee waves break and form stagnant regions above and behind the topographic peaks; if $\frac{Nb}{U}$ is large the flow takes on an increasingly hydraulic character, and horizontally propagating disturbances (columnar disturbance modes) cause low-level blocking upstream at heights below $h - U/N$, with a compensating increased speed near mountain top level. These features are shown in a two-dimensional experiment with $Nh/U = 2.36$ in Figure 2. More details of such experiments are given in Baines and Hoinka (1985). For three-dimensional obstacles, the blocked low-level fluid passes around the obstacle and separates on the lee side (Figure 3) to form a time-dependent wake which may resemble a Karman vortex street. This property implies that flow fields in complex terrain with horizontally separating flow may be essentially unsteady. When Nh/U is large, the topography may be stretched in the vertical to improve the resolution, without altering the character of the flow. General requirements for flow modelling in terms of Nh/U are given in Table 1, which shows the ranges of occurrence of the two main flow types when $d = 0$.

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AIR QUALITY ASPECTS OF A NEAR-TROPICAL COASTAL POWER STATION — GLADSTONE

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INTRODUCTION

The Queensland Electricity Commission operates a 1650 MW coal-fired power station at Gladstone, an important industrial centre on the Queensland coast. The Commission maintained a continuous air monitoring network in the Gladstone region from August 1982 until March 1986.

The major objective of the network was to determine the impact of the power station on air quality in the Gladstone region, including the identification of the causes (e.g. power station operations or meteorological conditions) of any significant effects on air quality. A subordinate objective during the final year of the network's operation was to gather sufficient data on meteorological conditions, ground-level concentrations (glc's) and emissions for future power station design (e.g. the setting of stack heights) as well as a determination of the air quality effects at sites not directly monitored in the Gladstone region.

THE NETWORK

The power station's effects on air quality have been clearly identified by the continuous monitoring. To be successful, dispersion models need to be able to reproduce these effects. This paper describes some measured characteristics of plume effects in the near sub-tropical coastal region.

A total of eight sites were monitored for various periods. Sulfur dioxide (SO_2), oxides of nitrogen, particulates and ozone (0_3) were recorded. After determining that the higher SO_2 glc's occurred during NE sea-breeze conditions, the network was realigned in September 1985 to provide four monitoring site in line to the SW of the station to determine the magnitude and location of the highest glc's..

The network of air quality monitors and instrumented 10m meteorological towers was supplemented by an upper-level meteorological study and a continuous recording of stack emissions of (SO_2) and nitric oxide (NO) during its final year of monitoring.

Additional studies (including also an instrumented aircraft and tracer gas releases) measured dispersion parameters necessary for the future Stanwell Power Station Stack Height determination and also the rate of oxidation of nitric oxide into the more toxic nitrogen dioxide (NO_2).