#### **Objectives of the Workshop**

- ✓ To obtain an overview of the current operational air quality forecasting tools and their requirements, including measurement needs
- ✓ To obtain an overview of the current status of relevant research that can be expected to improve operational models in the next few years
- To develop recommendations for the direction of improving air quality forecasting
- To present the above information in such a way that it is useful for NMHSs that are starting or developing their air quality forecasting activities

### Why Forecast Air Quality?

 Provide information to the public operationally to help them better manage their health and welfare (heat stress, comfort, pollen, flight operations, large scale pollution/fire events, safer more effective conditions to apply chemicals)

#### Why Forecast Air Quality?

- Strategic issues if weather services don't do it others certainly will!
- Weather infrastructure is invaluable measurement, models, assimilation expertise.

#### Charge to Working Groups

- Identify research <u>needs</u> and <u>priorities</u> to advance air quality forecasting capabilities.
  - 1) Underlying science perspective What are the science issues that need to be addressed to advance our capability to forecast air quality?
  - 2) Operational perspective What are the major issues/barriers to providing air quality forecasts? ---- methods, verification, measurements, dissemination.....

Breadth of perspectives sought -- from those with on-going efforts and those with interests in initiating and/or expanding activities.

#### Identified Key Science Issues

- Scale
- Local Winds
- Measurements
  - Meteorology
  - Chemistry
- Processes
- Chemical Transformations, Models
- Emissions
- Uncertainty

## Identified Key Operation Issues

- Reasons for forecasting (Why)
- Barriers to forecasting
- Monitoring Networks Needed to Support AQF
- Dissemination of AQF
- Developed vs. Developing Country Needs
  - Capacity Building
  - Pilot Projects



### Is a prognostic air pollution forecasting system worth the considerable effort?

## Why not a use a statistical forecasting system?

- Are spatial and temporal information needed from the forecast? (e.g. hour-by-hour, suburb-by-suburb)
- Support air quality management & policy development? (e.g. VOC controls)
- Are monitoring data limited? (no extensive network)?



#### **Need to Gain Experience**

- The Australia experience: started with a trial version of System
- Problems in joining models
  - Mass conservation easy to disturb!
  - Turbulence schemes mis-match in NWP, CTM
  - Errors in code for vertical advection
- Substantially wrong VOC budgets
  - Boundary conditions for VOC difficult
- Particle inventory and weatherdependent emissions fraught with difficulties



#### **Levels of Complexity**

- Embedded in a operational National Weather Forecasting System – AAQFS
- 2. Extension of Numerical Weather Forecasting Capability *e.g.*, Beijing
- 3. NMHS seeking to develop both a national numerical weather and pollution forecast Malaysia?
- 4. NMHS focussed on forecasting air pollution for a limited region is this you?



#### **Judging Performance**

- Daily verification against monitoring data important
- Adequate spatial resolution fundamental
- Australian cities isolated, so mostly a test of the science, but data assimilation important
- Use case studies
- Use statistical tests of performance
- Use qualitative information too
- Data management issues are substantial



#### The Need for High Resolution

- Leads to improved weather forecasts
  - Changes in space and time important
- Necessary to resolve regional flows
  - For air pollution, wind trajectory vital
- Boundary layer must be resolved
  - For air pollution levels, mixing height vital



# Working Group Identified Issues (summary)

- Emissions Inventories must be validated our biggest problem
- Wind-blown dust, other particle sources, difficult effort by Met. Service of Canada commendable
- Timeliness and quality of air pollution monitoring data are vital for warm starts (assimilation)
- Simple chemistry adequate for urban ozone forecast, not for secondary aerosol, other reactive chemicals
- Routine verification of forecasts against monitoring data important for identifying weaknesses
- Backgrounds/domain-size an issue elsewhere
- Cooperation between Agencies is important
- Uptake by others is slow patience!



#### **Support AQ Management, Policy**

- Detailed knowledge of emissions is required for Policy actions
- An AQFS will exercise the inventory like no other means!
- Collaboration with other Agencies leads to success

#### Plenary Workshop Summary

- There is growing experience and interest in air quality forecasting.
- There are a variety of tools for forecasting air quality.
- Improvements in air quality forecasting will come from:
  - Increasing accuracy in the meteorological forecasts
  - The act of doing increase experience needed Improvements in emission estimates
  - Better understanding of key processes
- Simple models outperform complex numerical models at present.
- Urbanization of meteorological models needed to improve physical representation of weather at urban scales.

#### Summary (continued)

- Resolution matters in many circumstances
  - But there are limits to when increasing resolution increases quality – we need to understand this better.
- Emission are important but not a limiting factor.
- Tools commonly used to improve meteorological forecast need to be explored in the air quality forecasting arena (e.g., data assimilation, ensemble forecasts, etc.)
- Satellites as a key element of air quality forecasting system is an important topic as they hold promise for providing key information that can be used anywhere around the globe.

### Summary (continued)

- Use of aircraft data (AMDAR)
- Research and operations are complementary activities
- Measurement needs to support operational air quality forecasting needmust to be articulated – met, chem/aerosols, surface & vertical, etc.



## GURME's Roles—some things that are *already* being done!

- facilitate contacts, fora for sharing experiences, ...
- collate these experiences
- run a Web site for sharing information
- provide an international reference to support/give credibility for local efforts.
- capacity building
- future activities
  - expand pilot projects
  - regional workshops

### GURME The WMO Gaw Urban Research Meteorology and Environmental Project

Overview

Strategic Plan

Meetings

Scientific Advisory Group(SAG)

Pilot Projects

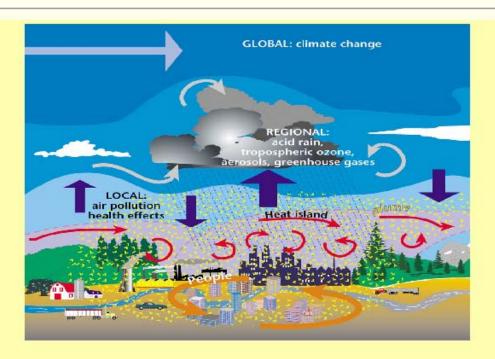
Reports

**Modeling Information** 

Links

General Information on Urban Pollution

Back to GRC homepage



The GURME project arose in response to the requests for assistance by many National Meteorological Services (NMSs) dealing with urban issues, and in recognition that the management of urban environments requires special attention. The genesis of the project began in the Twelfth World Meteorological Congress (1995) where it was determined that meteorological and climatological aspects of urban environments should

#### http://www.cgrer.uiowa.edu/people/carmichael/GURME/GURME.html

and the Role of the National Meteorological Services was convened in Geneva in October 1996 to help define issues and needs and to plan for future WMO activities related to urban environments.