IMPORTANCE OF MULTISCALE INTERACTIONS FOR PREDICTING AND FORECASTING URBAN AIR QUALITY - EXPERIENCE FROM WMO/GURME

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WMO/GAW Urban Research Meteorology and Environment Project (GURME)

Created under WMO Global Atmospheric Watch in 1995
Global focus on urban air quality and meteorology research

Overarching aims of GURME:
1. To initiate and exploit new scientific advances in meteorology and atmospheric composition by engaging proactively with the wider community for improving air quality in urban areas within a regional context

2. To provide strategic research direction and highlight future scientific challenges relevant to urban air quality and meteorology

Specific objectives
(i) Advancing modelling
(ii) Representing urban processes
(iii) Understanding scale interactions
(iv) Integrating observations and modelling
(v) Science for impact assessment, mitigation and adaptation
(vi) Promoting dissemination, outreach and training
WMO/GAW Urban Research Meteorology and Environment Project (GURME)

Projects affiliated to GURME

- PROMOTE (NERC/MOES) – Delhi AQ
- Paris Olympics 2024 – AQ forecasting
- SAFAR - 1st AQ Forecasting System in India (Beig, IITM)

Shanghai: multi-hazards forecast system *(Lead by Tang Xu, SMB)*

Latin American cities
- Mexico City, Sao Paolo, Santiago…
Linking scales – downscaling for cities
Integrating air quality, climate, health across scales

Challenges – consistency of emissions, meteorology, chemistry coupling/interfaces

Source: NERC/MOES PROMOTE
Linkages within the operational system (Mexico City)

**METEOROLOGICAL MODEL (WRF)**
- NCEP GFS 0.25º x 0.25º
- WRF-ARW 27 km x 27 km
- WRF-ARW 9 km x 9 km
- WRF-ARW 3 km x 3 km
- WRF-ARW 1 km x 1 km

**AIR QUALITY MODEL (CMAQ)**
- UCAR MOZART4 1.9º x 2.5º
- CMAQ 3 km x 3 km
- CMAQ 1 km x 1 km

**EMISSION MODEL (HERMES-Mex)**
- HERMES-Mex 1 km x 1 km

**PRODUCTS**
- Secretaría del Medio Ambiente

**Downscaling**
Shanghai – WRF-Chem performance distribution of PM2.5 (131 cities) and O₃-8h (130 cities)

PM2.5
- 71 city ≥0.6, 34 ≥ =0.7; better in north
- 109 city <0; Worse in north

O₃ – 8h
- 62 city ≥0.7, 18 ≥ =0.8; Better in north
- Almost >0; Better near coast
Nitrate dominated

PM2.5 episode over the UK (March – April 2014)

Composition of PM2.5 at Rural Site (HAR)

PBL: 40-700m (220m)
WS: 1.6 m/s

PBL: 70-740m (280m)
WS: 3.0 m/s

PBL: 280-2130m (1240m)
WS: 4.9 m/s
Importance of regional contribution (source apportionment)

Regional contributions to PM2.5 in London (Annual)

Singh et al (2014) JAWMA

Make up of regional PM2.5 contributing to European cities

Source: TRANSPHORM Project
Development of GRIDDED Emission Inventory of Kharif Stubble burning of Punjab-Haryana and simulated its % share in Delhi’s Air Quality (PM2.5) using SAFAR-Model
Multimodel Health Impact Assessment for Europe

Avoided health damages in DALY, attributed to particulate matter, efficiency scenario 2020

Avoided health damages in DALY, attributed to particulate matter, effectiveness scenario 2020

Model comparison: Avoided health damages in DALY, model output, 2020

UI = Urban increment

Source: TRANSPHORM Project
Delta_C is relatively large for ozone compared with delta_E. The combined effects could lead to an increase of 1-6 ppbv ozone over most of Europe by 2030s.

Delta_C for regional PM2.5 over Europe is less than delta_E, but substantial spatial variations across Europe and climate influences may be relatively more important in the future.
- **Scale issues** are critical to reach end goal of air quality improvement
- **Regional models coupled with street scale models** offer a process-based assessments of air quality and its impacts
- **Suitability** – complex terrain, dynamics, chemical transformations; complex source distributions; detailed processes based analysis; linking sources - distributions – impacts on multiple scales
- **Complementarity** of approaches to get the right solutions and increase confidence
- **WMO-GURME**
  - Urban focus within a regional context – experience in many global cities
  - Prediction, forecasting, observations for mitigation and training
  - Science to support Integrated Assessment for city and regional scales

Final remarks