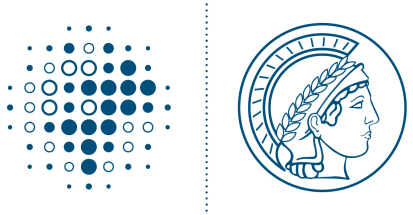
Max Planck Institute for Chemistry



Megacity Emissions from South-East Asia

Supervisor

Jos Leliveld

Candidate

Kabitri Nag

December, 2012

Background

Mega cities from South-East Asia are some of the most important hot spots for anthropological emissions.

These emissions and their distributions are best studied with:

- NWP models
- ground-based or aerial measurements, if available

Project goals

Major questions addressed in this study

- The fraction of total emission that can travel a certain distance and pollute some remote regions
- A comparative role of wet and dry deposition processes in cleaning atmosphere
- How the lifetime of a tracer and the size of aerosols influence its overall transport
- The effect of geographical location on the strength of long-range transport of local pollutants

Project highlights

- A network of 12 mega-cities were taken
- Emission studied with global AC-GCM EMAC model
- Model results to be validated against aircraft campaign data

Model overview

Model: Numerical global atmosphere-chemistry model EMAC (ECHAM/MESSy)

It calculates:

- processes in the troposphere and middle atmosphere,
- their interactions with ocean and land surfaces,
- estimating their anthropogenic inflences

Model applicable in different horizontal and vertical resolutions.

Model layout for gaseous tracers

- 10 artificial radioactive tracers considered
- lifetimes can range from hours to months
- Aerosols distributed in 0.1, 0.5, 1.0, 2.5, 10.0 μm diameter bins
- 2 different solubilities have been imposed on each aerosol bin
- The only loss process considered is radioactive decay

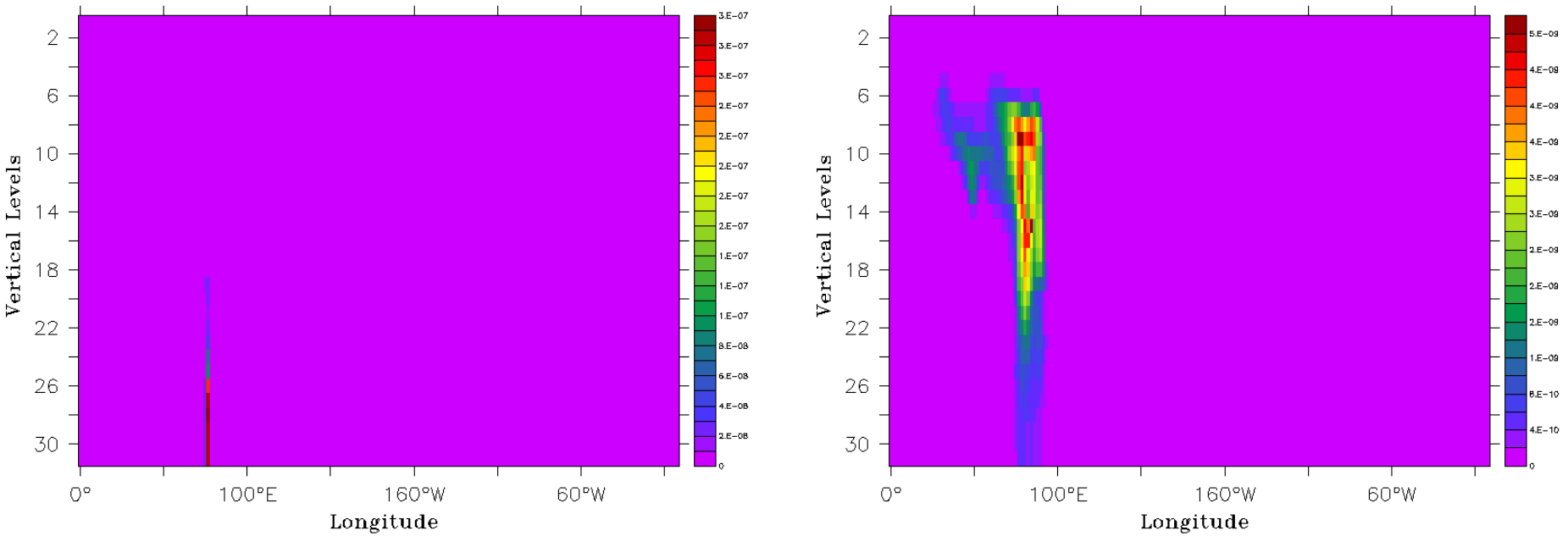
Model layout for aerosols

- Dry deposition includes sedimentation and surface roughness
- Wet deposition includes nucleation and scavenging

Model findings

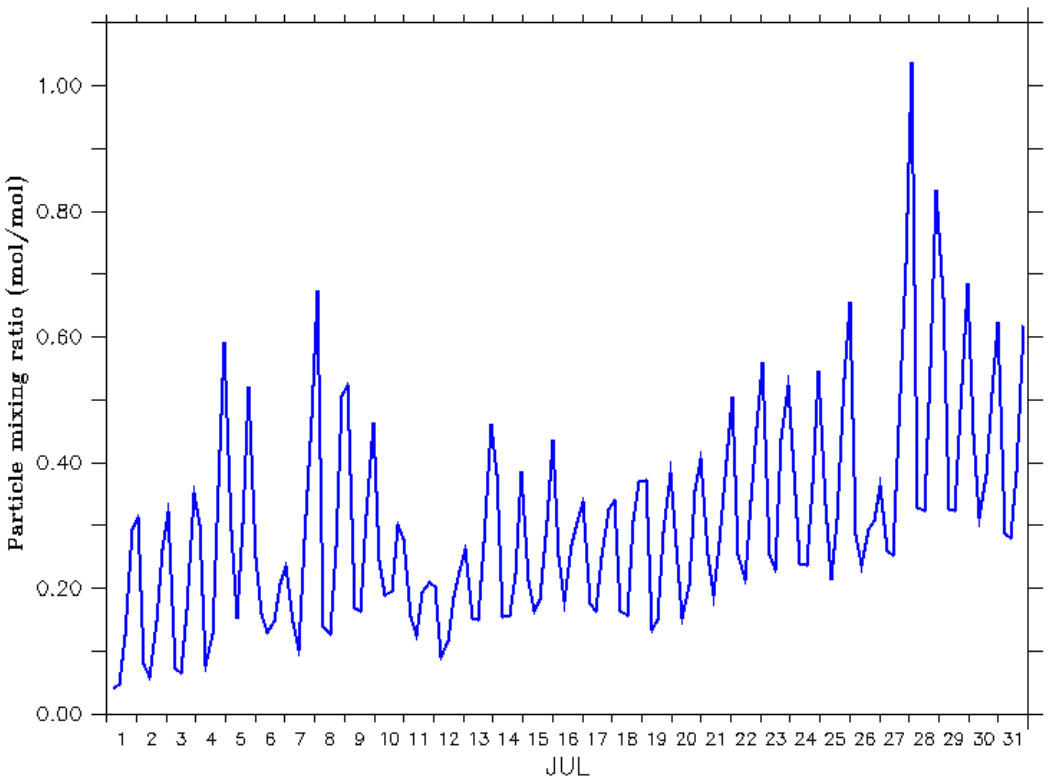
- Larger particles are more prone to gravitational settling
- Soluble particles are removed fast by wet deposition
- This is most pronounced during monsoon period
- Sparingly soluble small particles tend to build up over time
- Initial fluctuation removed as the spin-up of the model

Vertical distribution of tracers



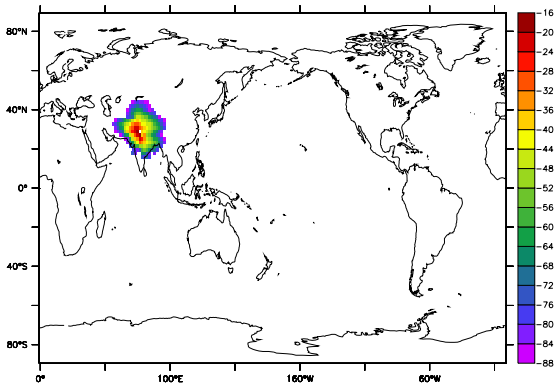
Vertical distribution of sparingly soluble aerosols with 1 μm diameter

Particle build-up

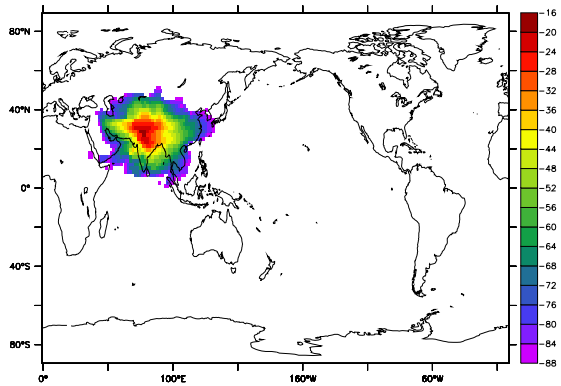


Build-up of sparingly soluble aerosols with 1 μm diameter

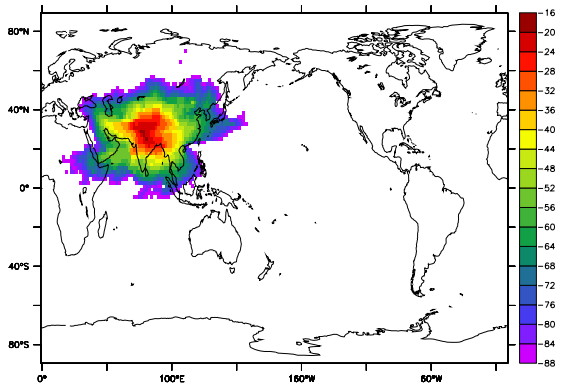
Tracer distribution



T=t_1



T=t_5



T=t_{10}

Cross-section of horizontal distribution of tracer emission from New Delhi, 1000 hPa level (example given for tracer lifetime of 3 days)

Outlook

- Extending model domain to include other important hot spots
- Studying the effect of rapid vertical transport during monsoon
- Validating results with 2013 aircraft campaign data
- Further validating CO emissions with satellite data