Challenges in Evaluating Health Impacts from Large-scale Climate and Air Pollution in Asia

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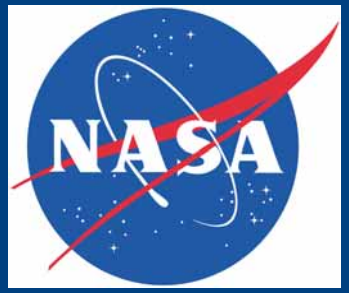
2009 NCAR Climate and Health Workshop



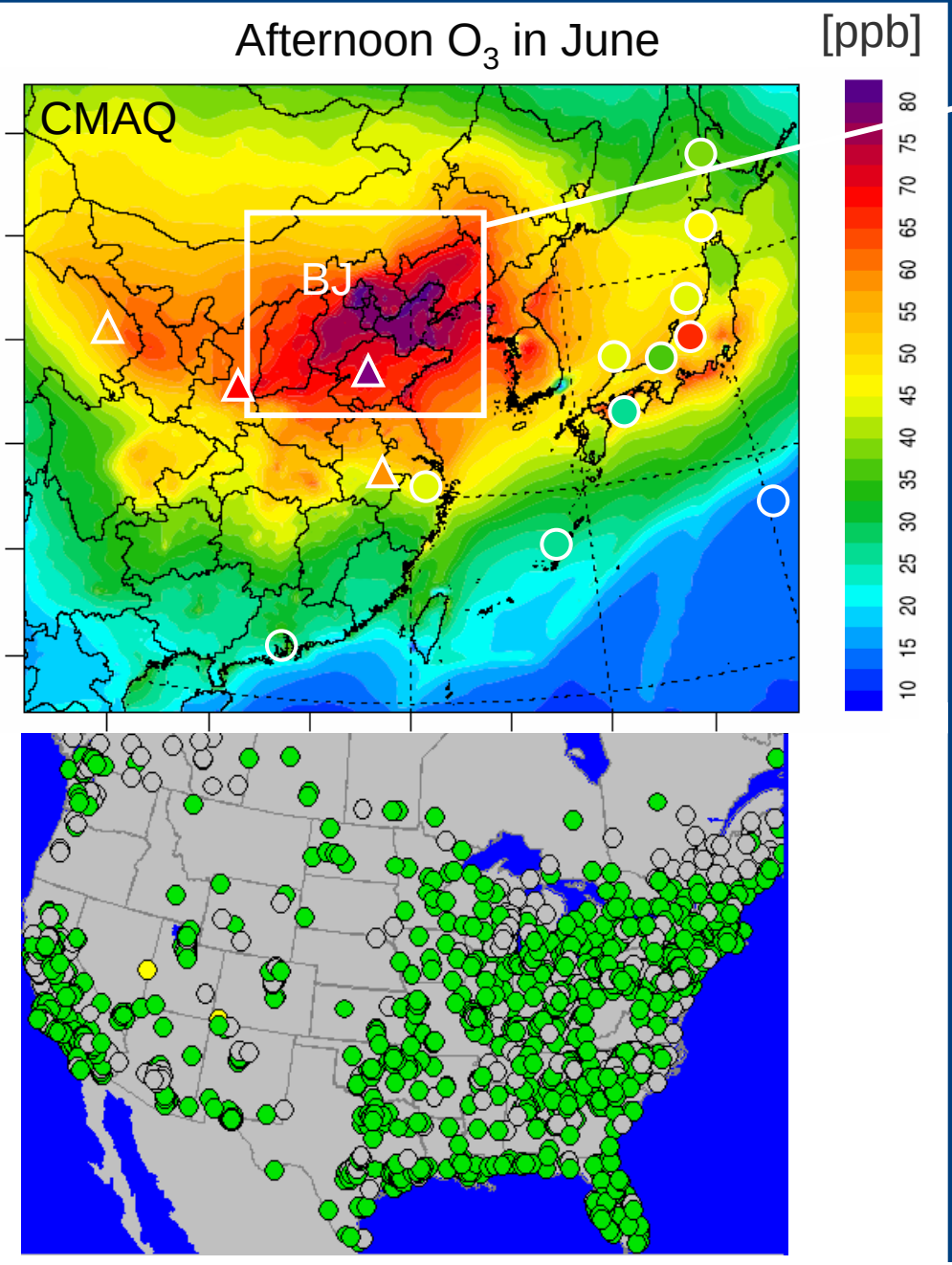
Ongoing research and challenges

- **Regional to urban scale characteristics and uncertainties in large-scale analysis**
  - Shortage of measurement data
  - Uncertainty of precursor emissions
  - Impacts of large-scale climate (monsoon system and mid-latitude cyclones etc.)
  - Urban photochemistry

- **Challenges in current & future evaluations**

Source: The New York Times

Extreme shortage of monitoring data in China



- Exceeding 75 ppb -- US EPA 8-h standard
- highly polluted & densely populated
- Basin feature (terrain <200m)
- Extreme shortage of surface monitoring
  -EANET
  -Research sites

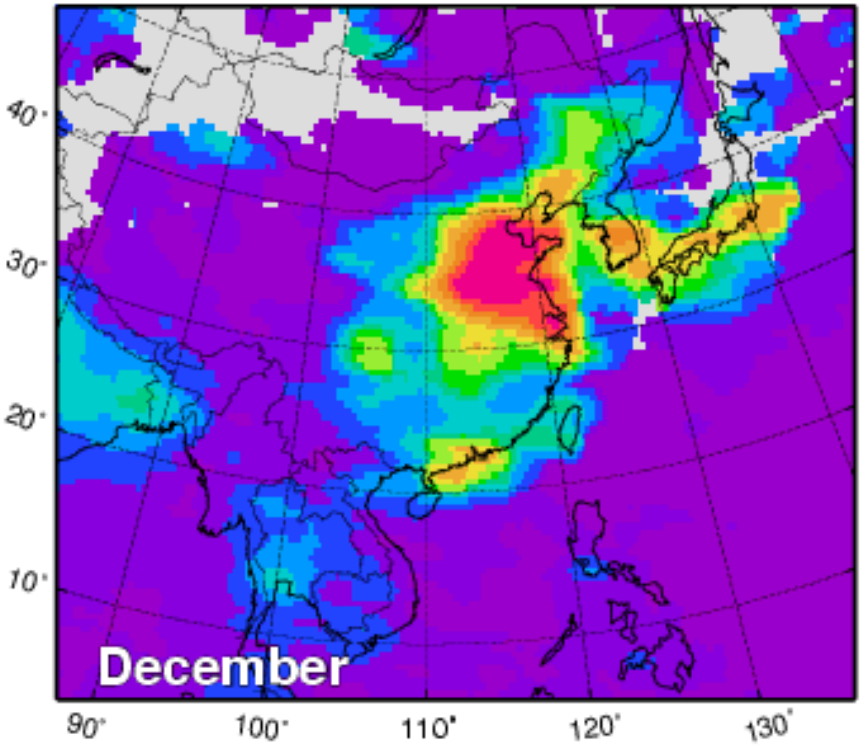
Lin et al.,2009, ACP

Public O_3 monitors

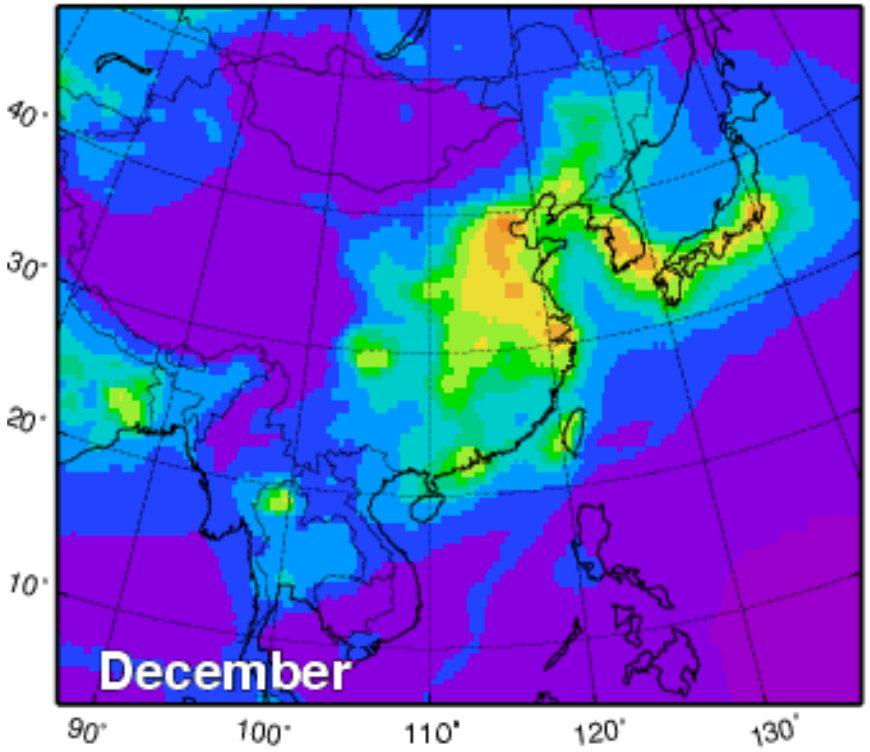
- US: >1000!
- China : 0!

How can satellites and models inform Chinese emissions?

Satellite



Model



Lin et al. (2008a), AE

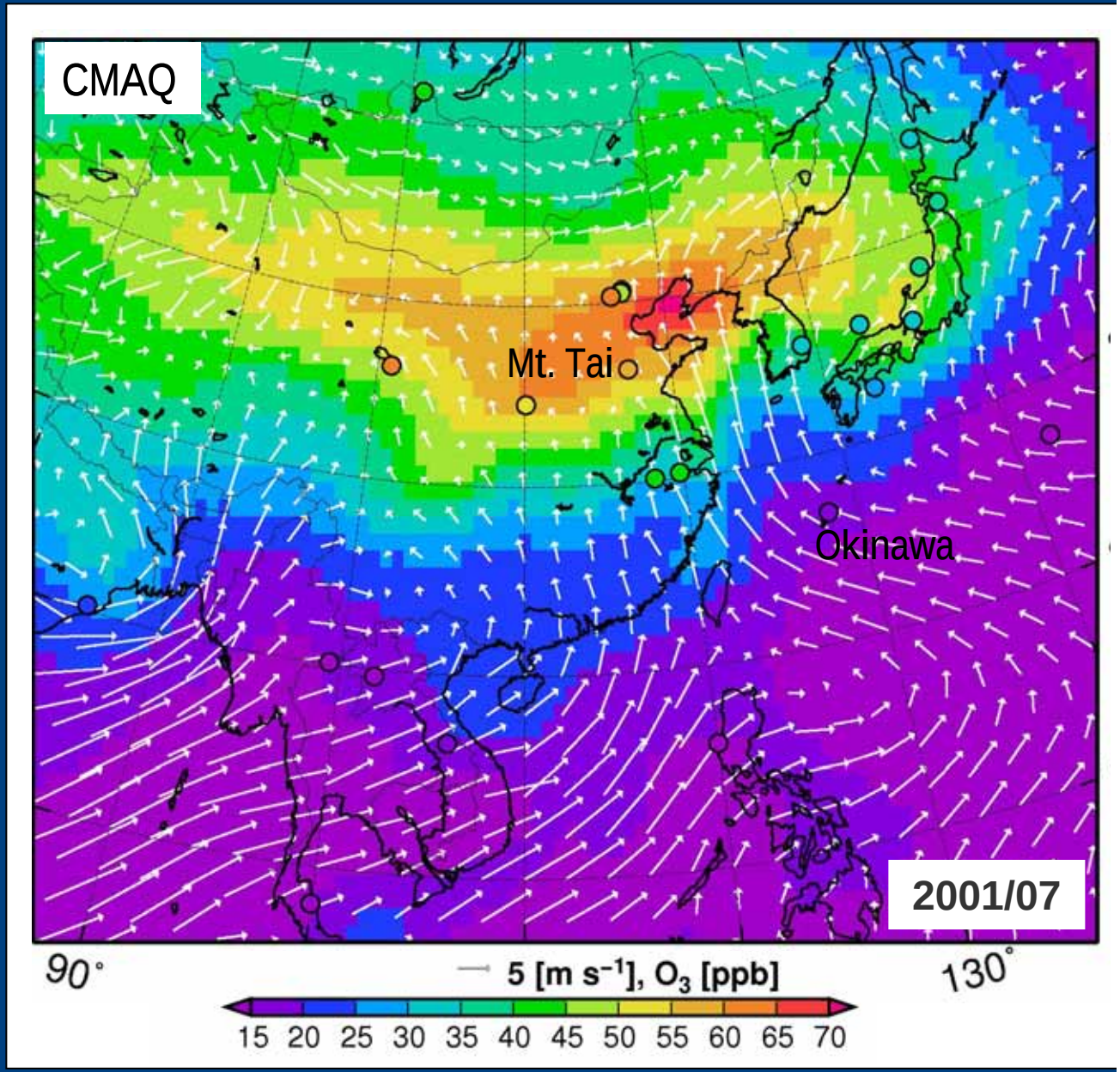
Ground-level ozone exhibits summer minimum

US and EU:

- Heat → Ozone
- O_3 is summertime problem

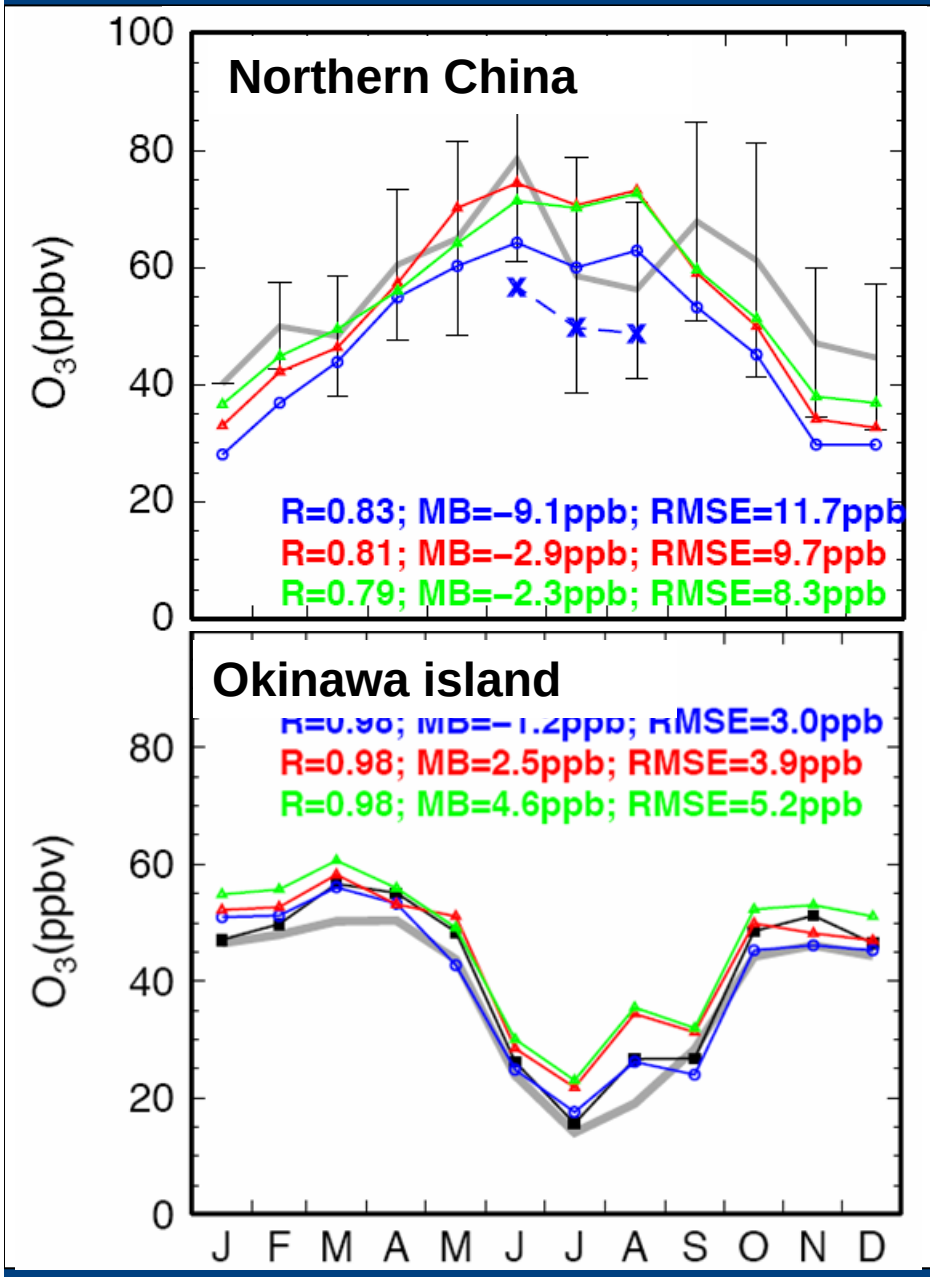
East Asia:

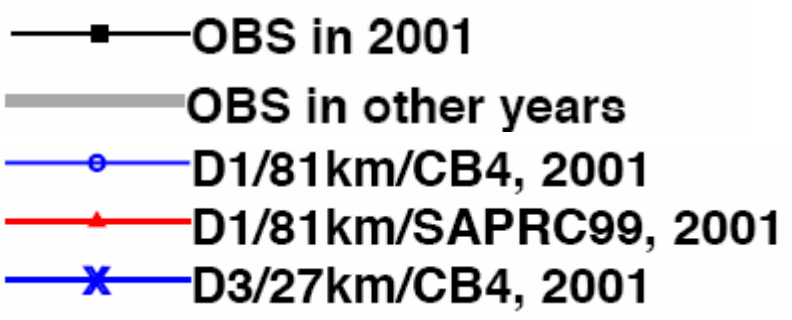
- Peak in spring or early summer
- Minimum in July & August
- Impacts of large-scale climate



Lin et al. (2009), ACP

Ozone seasonality in northern China and Okinawa island





Limitation of large-scale model to accurately simulate monsoon clouds

Overprediction of summertime O_3 by ~20 global models (Fiore et al. 2009)

Lin et al. (2009), ACP

Coupling regional and global models

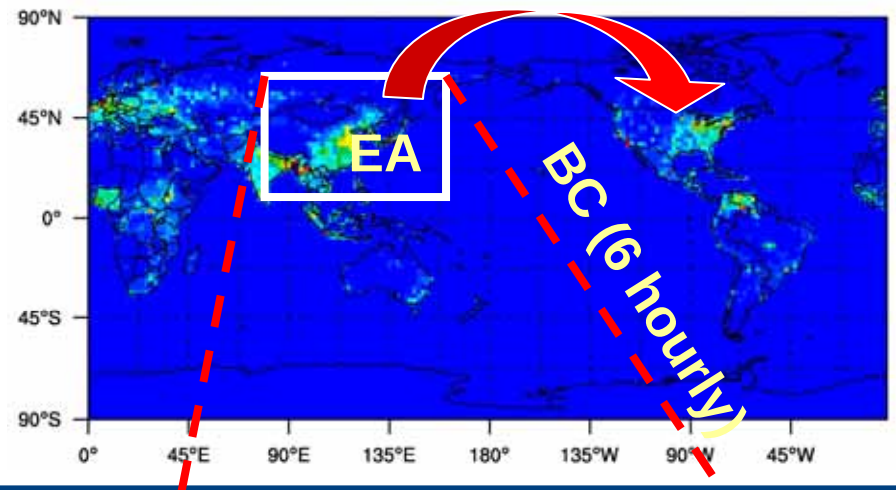
Large-scale global met. reanalysis data

Climate downscaling

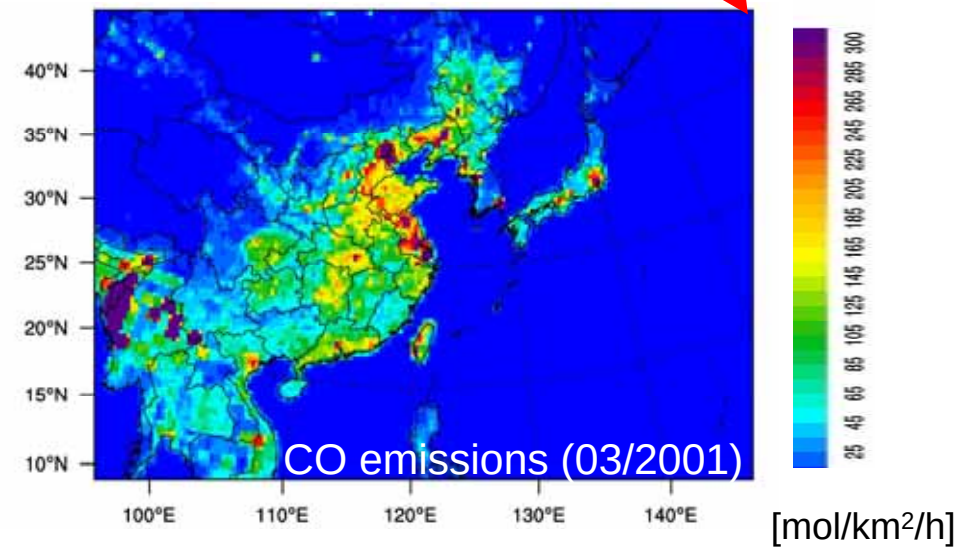
online

Regional climate model (WRF)

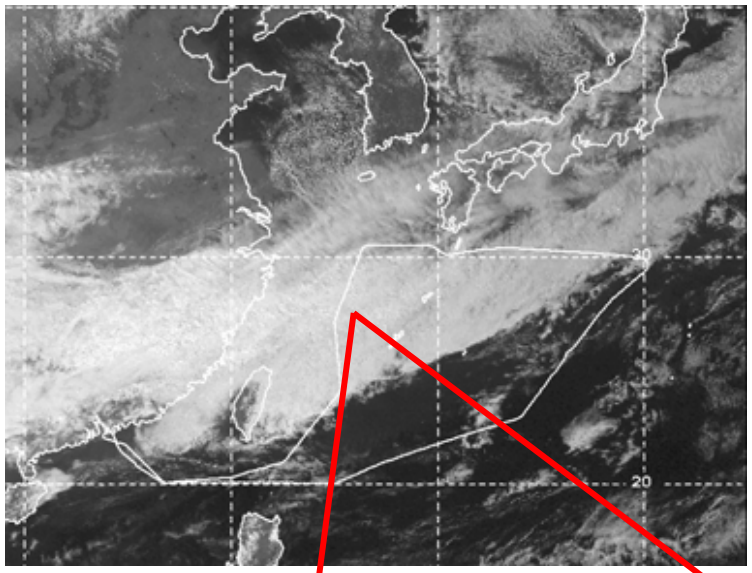
Global CTM: MOZART(1.9 °)

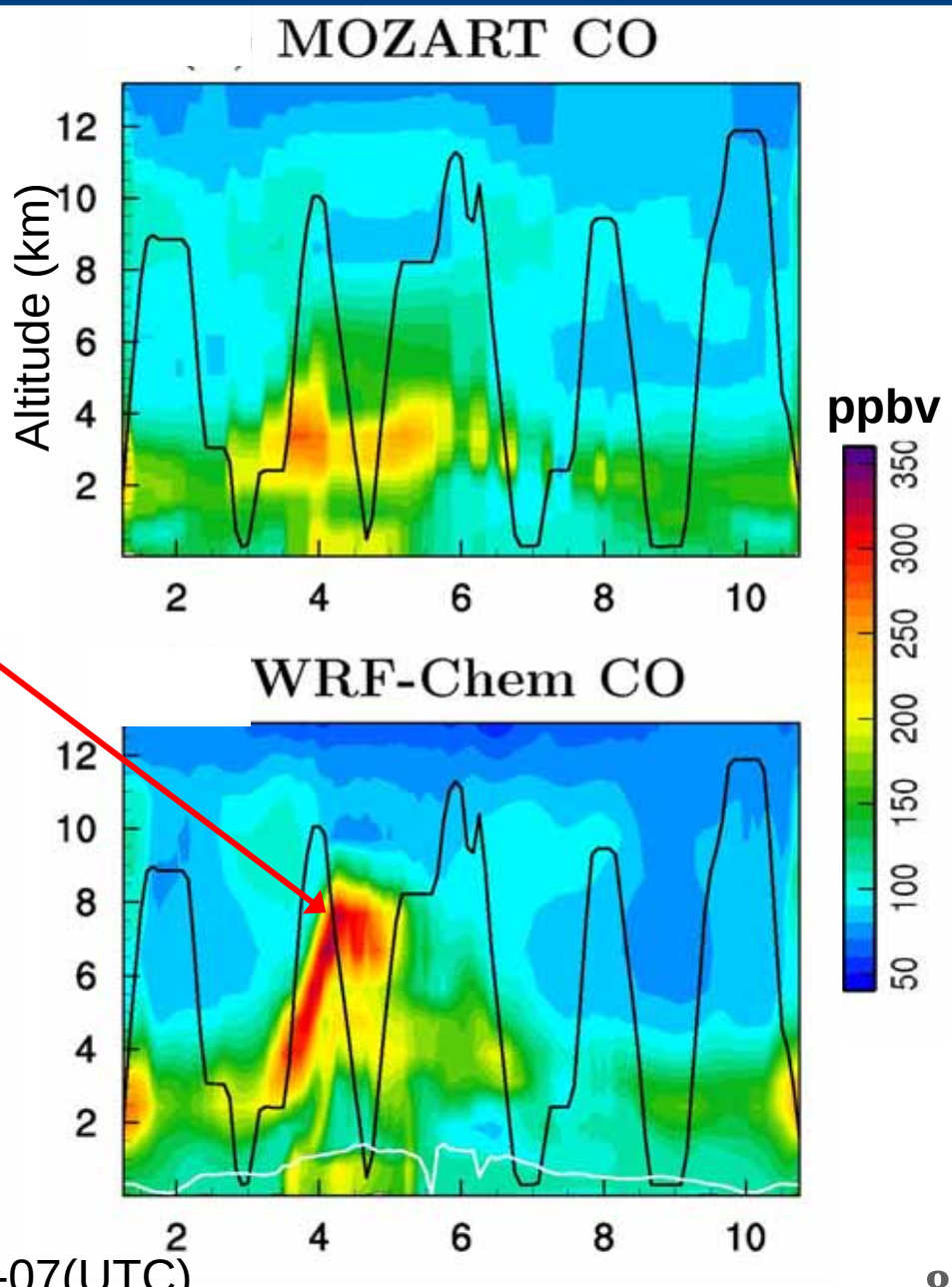


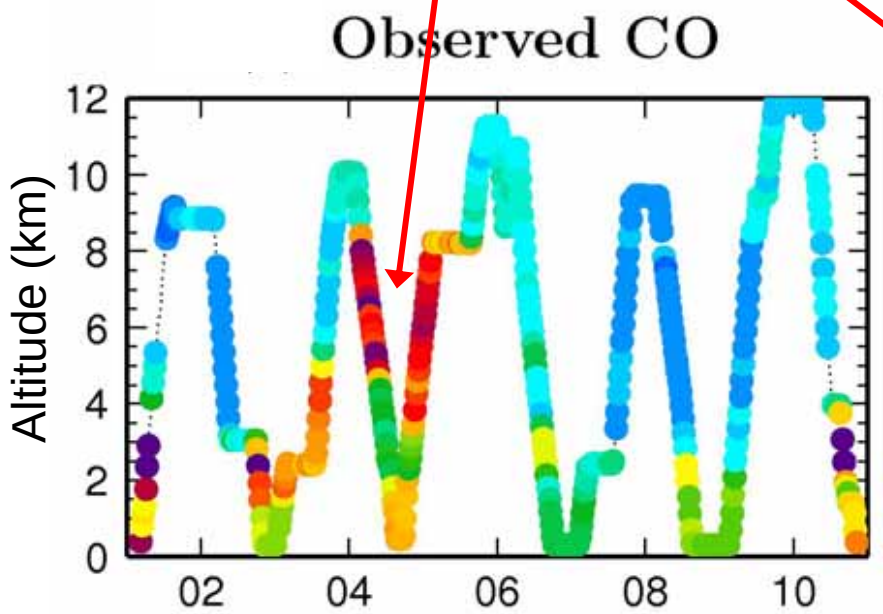
Regional CTM: WRF-Chem: 36km



Outflow of Asian Pollution to the Pacific







2001-03-07(UTC)

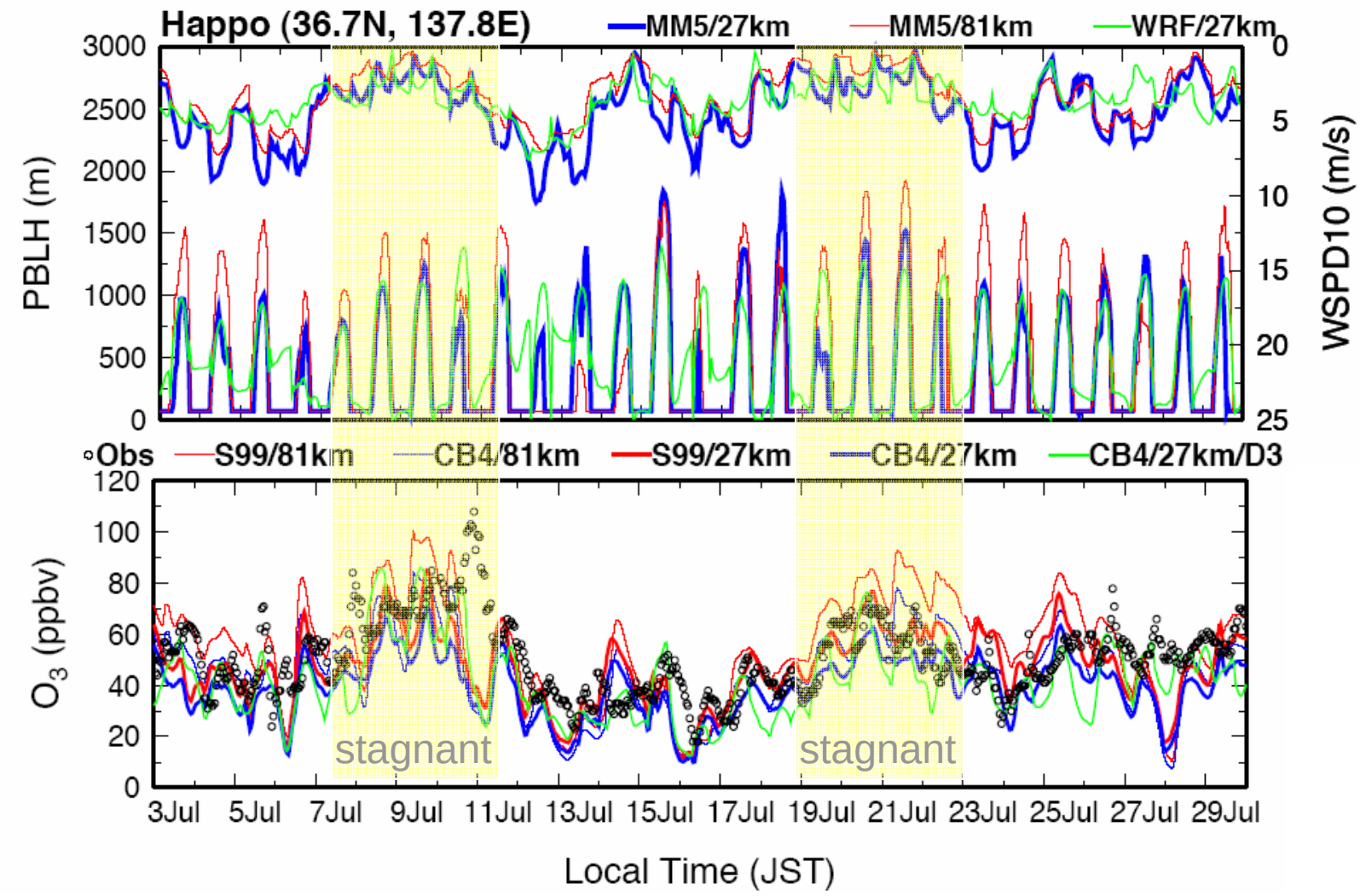
Regional characteristics of emissions, climate, and transport processes

- Models generally underestimate Asian emissions
  - -Missing of activity data in rural areas
  - -Possible error of emissions factor
- Significant impacts of large-scale climate
  - -Summer minimum
  - -Large-scale models tend to overestimate summertime O_3
  - -Large-scale models tend to underestimate the transpacific transport of Asian pollution
- Build-up of ground-level ozone and urban chemistry

Monsoon clouds in Nepal

Rush hour haze in Beijing

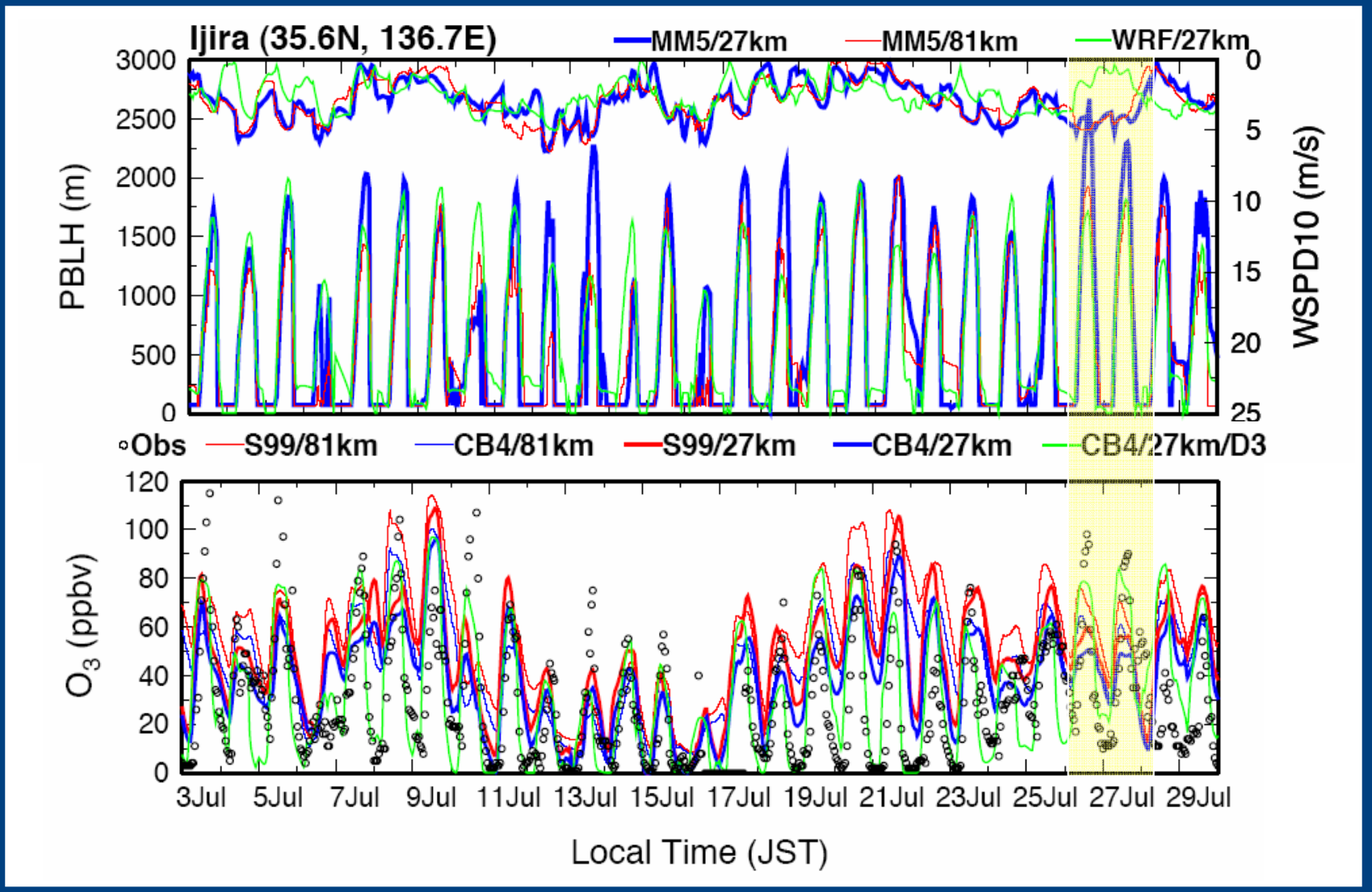
Ozone exposure under stagnant conditions



- An elevated-O_3 episode is generally associated with stagnant weathers, anti-cyclonic / high-pressure systems & heat waves

Lin et al. (2009), ACP

Role of diurnal BL processes and urban chemistry



- Intensified diurnal variation of ground-level O_3 at rural & urban areas
- Nighttime depletion of O_3 by freshly emitted NOx
- Role of boundary layer fluctuations and vertical mixing

Lin et al. (2009), ACP

Challenges and research opportunities

What we know:

- Regional to urban scale characteristics of emissions, chemistry, transport & land-atmosphere interactions strongly affect ground-level ozone exposure and hence ozone-related health outcomes

Good news:

- Emerging high-resolution regional models (CMAQ & WRF-Chem) show some ability to capture most of these fine-scale features

Road forward:

- These regional characteristics should be considered in assessing current and future health impacts of air pollution and climate change in Asia

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