Intercomparison of two regional chemistry models: WRF-Chem and CMAQ

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Motivating questions

- **Challenging problem**: complex processes occurring at global to local scales, and their strong coupling across scales
- **Recent developments**: coupling regional and global CTMs
- **CMAQ**: initially developed for regulatory purpose in the US, for which ground-level ozone is the greatest concern
- **WRF-Chem**: the coupled climate-chemistry model to address scientific questions
Motivating questions (2)

By comparing WRF-Chem and CMAQ …

• identify physical and chemical processes missing in the model, or poorly parameterized processes

By comparing WRF-Chem and MOZART …

• What regional processes can explain the differences between regional and global models?
Intercomparison Framework

36x36 km, 30 layers (20 m depth of first layer), 2001

**Emissions:** Streets et al. (2003) + MICS-Asia II update

**Boundary Conditions:** MOZART Fiore et al. (2009)

**WRF-Chem:**
- RACM/SORGAM chemistry
- YSU boundary layer scheme
- FNL reanalysis + FDDA

**CMAQ:** CB4/AERO3 chemistry

Meteorology

6-hourly

3-hourly
Surface Ozone in March 2001

Oki Ijira Hêdo Ogasawara

CMAQ WRF-Chem MOZART

Obs. data: EANET(2001), Want T. et al. (2001), Li et al. (2007)
Evaluation with EANET measurements
Rain!

Rural Ijira (35.6N, 136.7E)

Remote Hedo (26.8N, 128.2E)

Remote Ogasawara (27.1N, 142.2E)
Compared with TRACE-P aircraft measurements

DC8 Flight 15 on March 27, 2001: Convective Outflow and Stratospheric Influence
TRACE-P DC8 Flight 15

WRF-Chem/radm, 36km

CMAQ/cb4, 36km

OH (ppbv)

PAN (ppbv)

H₂O₂ (ppbv)

O₃ (ppbv)

2001-03-27

TIME (UTC)
Ozone in Asia: Europe Enhancement

Surface

CMAQ mm

MOZART mm

March 2001

ppb

ppb

ppb

ppb
Ozone in Asia: Europe Enhancement

Surface

WRF-Chem

MOZART

March 2001

ppb
EU Enhancement (cross section at 43° N)

MOZART

WRF-Chem

O₃ (ppb)
Conclusions and future plans

• CMAQ and WRF-Chem show similar ability in reproducing the variations of ground-level ozone from EANET

• WRF-Chem better captures vertical profiles of major species from a TRACEP flight sample, which is intended to examine convective transport and stratospheric influence

• Current version of CMAQ might not be well suited for examining the exchange between the surface and the free troposphere

• Regional model WRF-Chem and global model MOZART show similar pattern for EU enhancement of ozone in Asia, but WRF-Chem exhibits fine scale variations reflecting the impacts of regional processes such as urban titration, land-sea breeze, and topographical circulation
Thank You!

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