CAM-Chem and hemispheric transport of ozone and PAN

Arlene M. Fiore

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Larry Horowitz, Vaishali Naik (NOAA GFDL)
Emily Fischer, Dan Jaffe (U WA)
Johannes Stähelin, Shubha Pandey (ETH Zürich)
TF HTAP Modeling Team
GFDL Atmospheric Model Development Team

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Multi-model effort to quantify & assess uncertainties in N. mid-latitude hemispheric O₃ transport

Task Force on Hemispheric Transport of Air Pollution (TF HTAP) to inform policy negotiations under CLRTAP

BASE SIMULATION (21 models):
- horizontal resolution of 5°x5° or finer
- 2001 meteorology
- each group’s best estimate for 2001 emissions
- methane set to 1760 ppb

SENSITIVITY SIMULATIONS (13-18 models):
- -20% regional anthrop. NOₓ, CO, NMVOC emissions, individually + all together (=16 simulations)
Models differ in estimates of surface $O_3$ response to foreign emission changes… which are most accurate?

$O_3$ decrease from -20% foreign anthropogenic NO$_x$+CO+NMVOC emissions

→ No obvious correlation of strength of foreign influence with individual model biases relative to $O_3$ observations [Fiore et al., JGR, 2009; Reidmiller et al., ACP 2009; Jonson et al., ACPD 2010]

→ Generally not due to model differences in anthropogenic emissions (one exception)
Sensitivity of exported EU O\textsubscript{3} to large spread in EU NMVOC inventories (anthrop. NO\textsubscript{x} fairly similar across models)

Annual mean surface O\textsubscript{3} decrease over NA (ppb) from 20% decreases in anthrop. EU NMVOC

Regression line: $R^2 = 0.5035$

Individual models:
- CAM-Chem
- MOZART2 (GFDL)

Fiore et al., JGR, 2009
PAN: A more sensitive indicator of emission changes?

[Jaffe et al., Fall AGU, 2007]

5 mountain sites with multi-year observed PAN (and some NOy)

No obs in 2001 (year used by models)
Model differences in relative contributions of source regions to PAN at Mount Bachelor, Oregon, USA

Model fraction of PAN from source region
EU NA EA SA

More EA influence
More EU influence

4 example HTAP models sampled at Mount Bachelor

CAM-Chem

MOZART

Model EA_PAN/EU_PAN
Mount Bachelor, April: r²=0.85

Individual HTAP models
EA/EU PAN influence correlates with EA/EU AVOC emissions

Model EA_AVOC/EU AVOC

EA/EU PAN influence correlates with EA/EU AVOC emissions
Model differences in relative contributions of source regions to PAN at Jungfraujoch, Switzerland

4 example HTAP models sampled at Jungfraujoch

CAM-Chem

MOZART

Model fraction of PAN from source region
EU NA EA SA

More EU influence
More NA influence

Wide range of EU NMVOC inventory contributes to model discrepancies.
Constraints from observations?

Jungfraujoch, APRIL: $r^2=0.40$

Fraction of PAN at JFJ from EU vs. NA

Ratio: EU AVOC / NA AVOC
HTAP multi-model sets of experiments: Analysis ongoing

- **Source-Receptor (SR)**, -20% anthrop. emissions within HTAP regions (EA, EU, NA, SA, + global), year 2001
  -- NOx, CO, NMVOC, CH$_4$, aerosols, Hg, POPs
  -- AEROCOM: zero out anthrop., dust, biomass burning
- **Idealized Tracers (TP)**, 25d lifetime, insoluble and soluble
- **Event Simulations (ES)**, June-Sept 2004 to evaluate with ICARTT observations
- **Future Emissions (FE)**, 2030 MESSAGE 8.5 and 2050 IMAGE 2.6
- **Future Climate (FC)**, 2100 A2 climate

www.htap.org  TF HTAP, 2007 HTAP 2010 report in prep

Sanderson et al., GRL, 2008; Shindell et al., ACP, 2008; Fiore et al., JGR, 2009,
Reidmiller et al. ACP, 2009; Casper Anenberg et al., ES&T, 2009; Jonson et al., ACPD, 2010
# Status of GFDL CM3 contributions to ACC-MIP

## Historical

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## Future

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Others TBD.
Status of GFDL CM3 contributions to IPCC-AR5

CM3 IPCC-AR5/CMIP5 Experiments’ Progress

Total No. of Model Years Run = 3419

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