

HTAP Multi-model Assessment of Ozone Source-receptor Relationships



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Draft interim report at www.htap.org

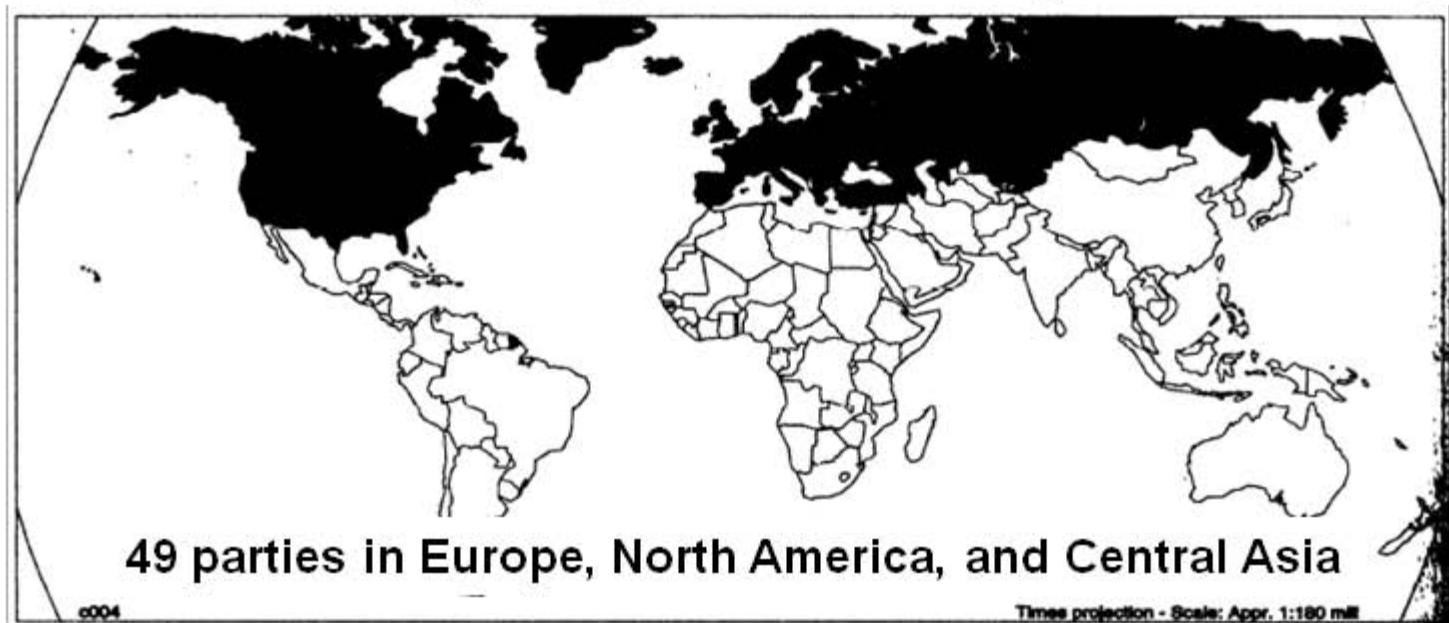


**Task Force on Hemispheric
Transport of Air Pollution**

3rd GEOS-Chem Users' Meeting, Harvard University
April 13, 2007

TF HTAP mission: Develop a fuller understanding of hemispheric transport of air pollution to inform future negotiations under CLRTAP

Convention on Long-Range Transboundary Air Pollution (CLRTAP)

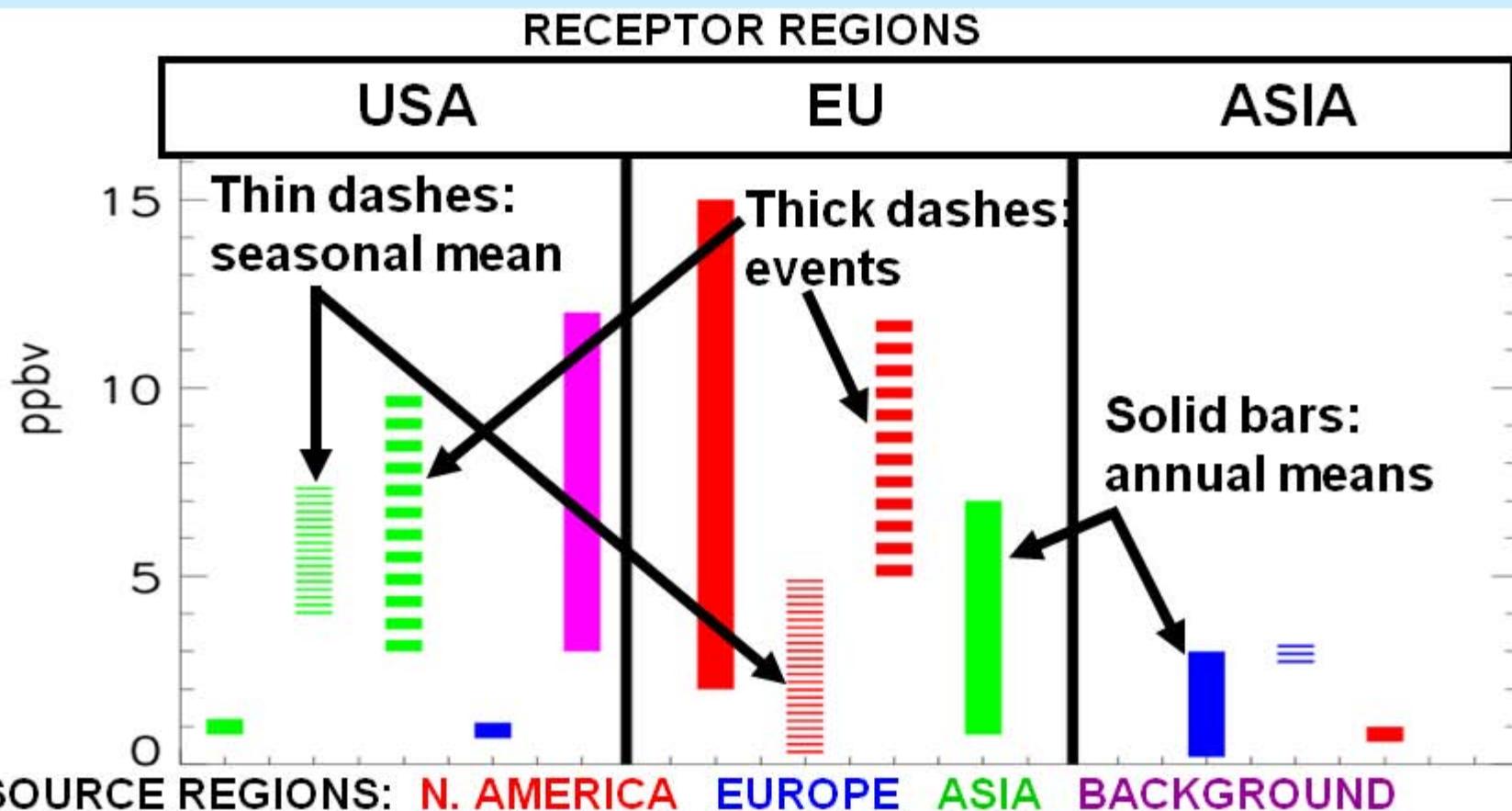


**Task Force on Hemispheric
Transport of Air Pollution**

Co-chairs: Terry Keating (U.S. EPA) and André Zuber (EC)

TF HTAP Products: 2007 (Interim) and 2009 (Final) Assessment reports

Literature Estimates of Surface O₃ Enhancements at Northern Mid-latitudes from Hemispheric Transport



Estimates are from studies cited in current draft of TF HTAP interim report Ch5, updated from tables in Holloway et al., ES&T, 2003 and Fiore et al., EM, 2003

Difficult to conduct meaningful assessment due to differences in:
1) methods 2) regional definitions 3) reported metrics

HTAP Multi-model approach to estimate intercontinental source-receptor (S-R) relationships for ozone



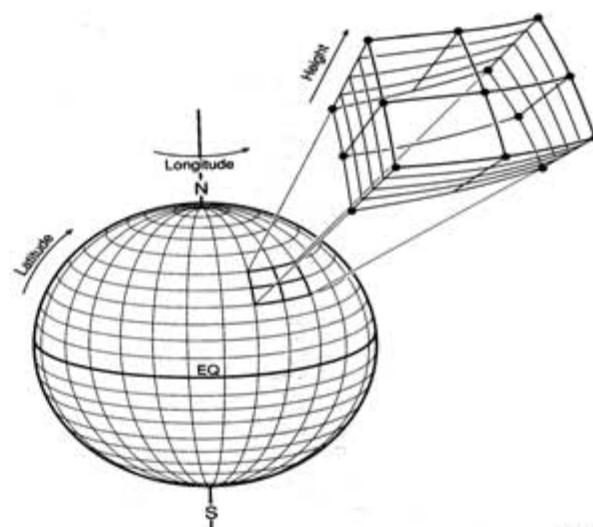
Conduct base simulations with 3-D models

- horizontal resolution of $4^{\circ} \times 5^{\circ}$ or finer
- 2001 meteorology
- each group's best estimate for emissions in 2001
- methane set to a uniform value of 1760 ppb

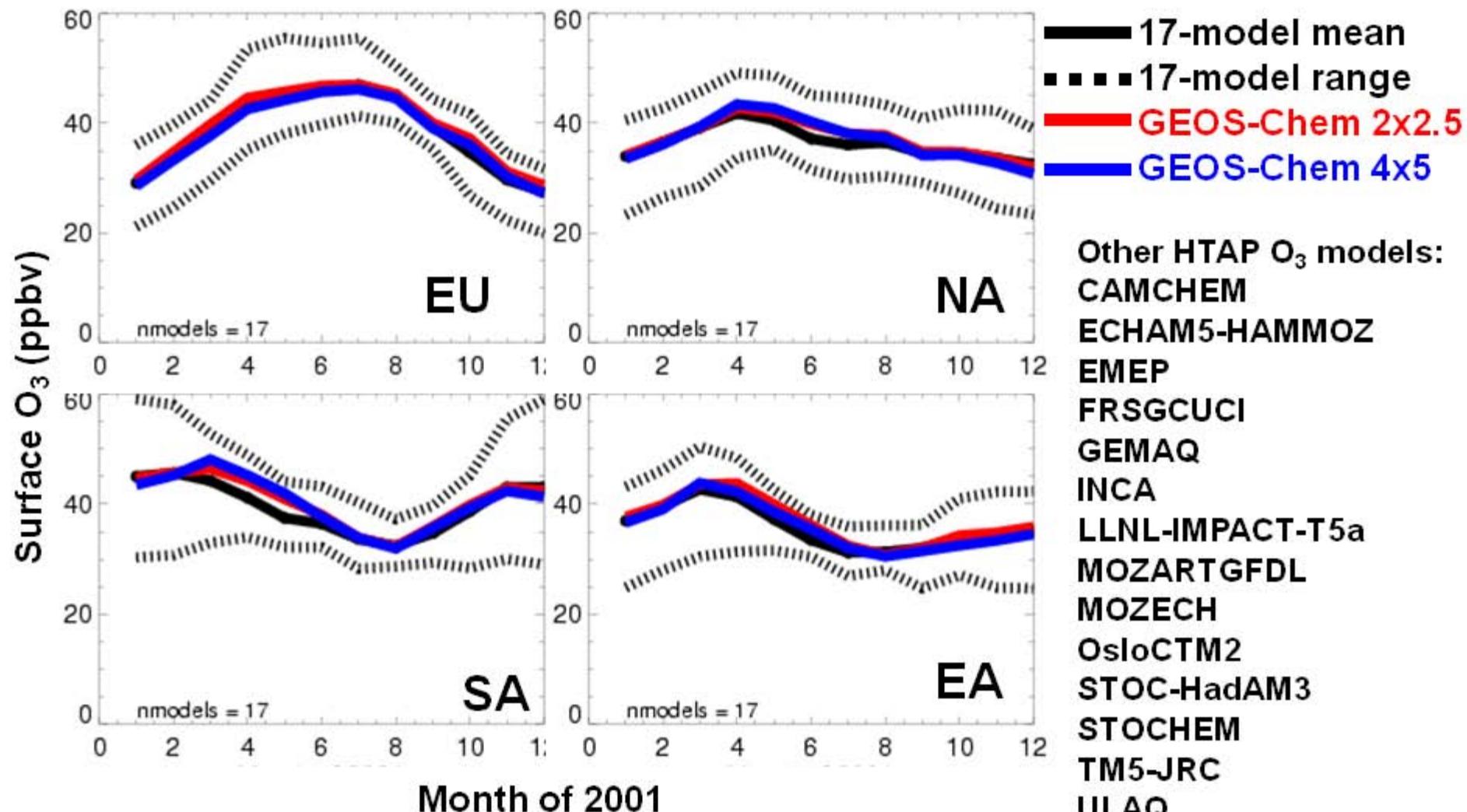
Conduct sensitivity simulations (17 total)

20% decreases in:

- anthrop. emis. in HTAP regions for NO_x , CO, NMVOC individually
- anthrop. emis. of all O_3 and aerosol precursors in HTAP regions
- global CH_4



Surface O₃ seasonal cycles in base simulations over the HTAP regions

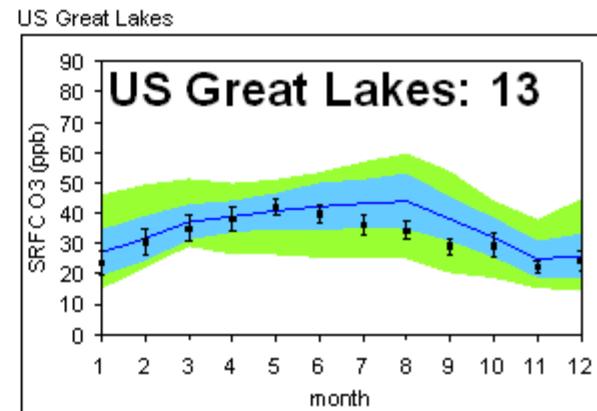
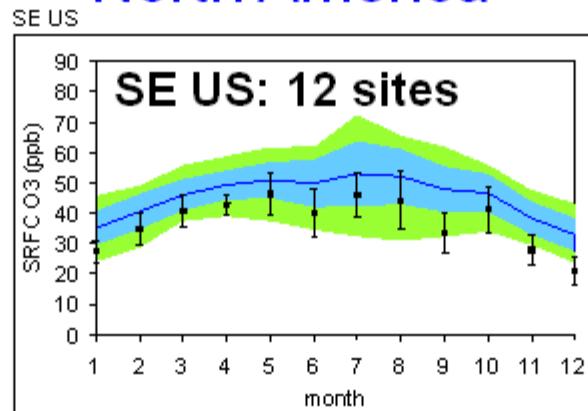
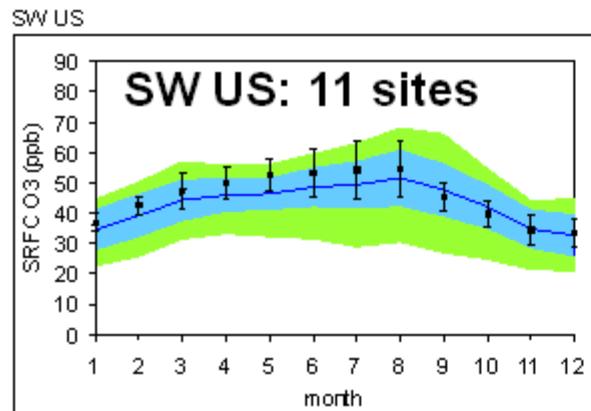


→ Model range often spans ~15 ppbv

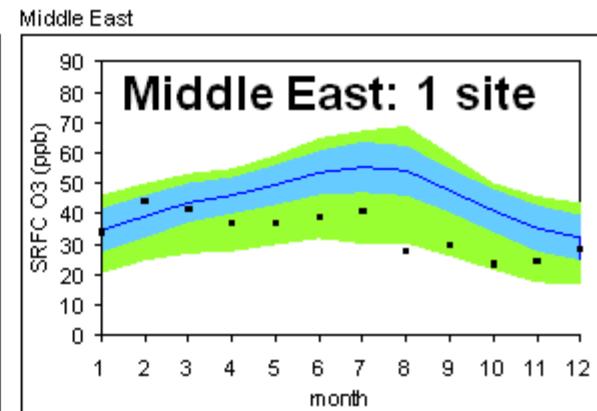
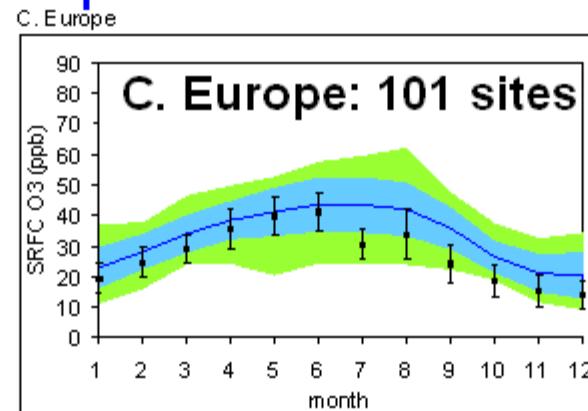
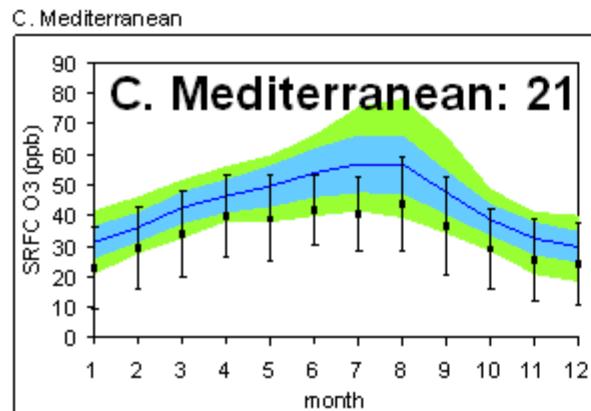
Recent ACCENT multi-model surface O₃ vs. observations in HTAP regions: NA and EU

■ OBS Multi-model — mean ■ standard deviation ■ range

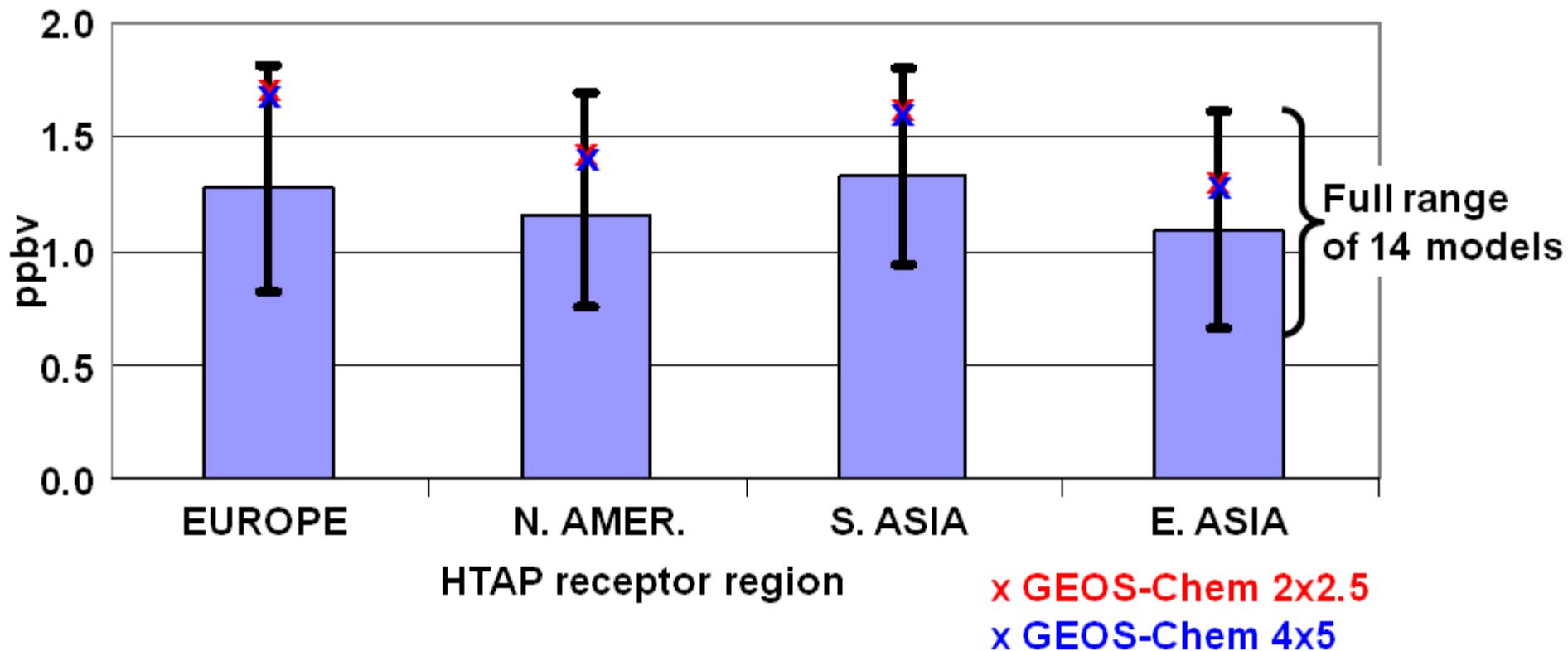
North America



Europe and North Africa



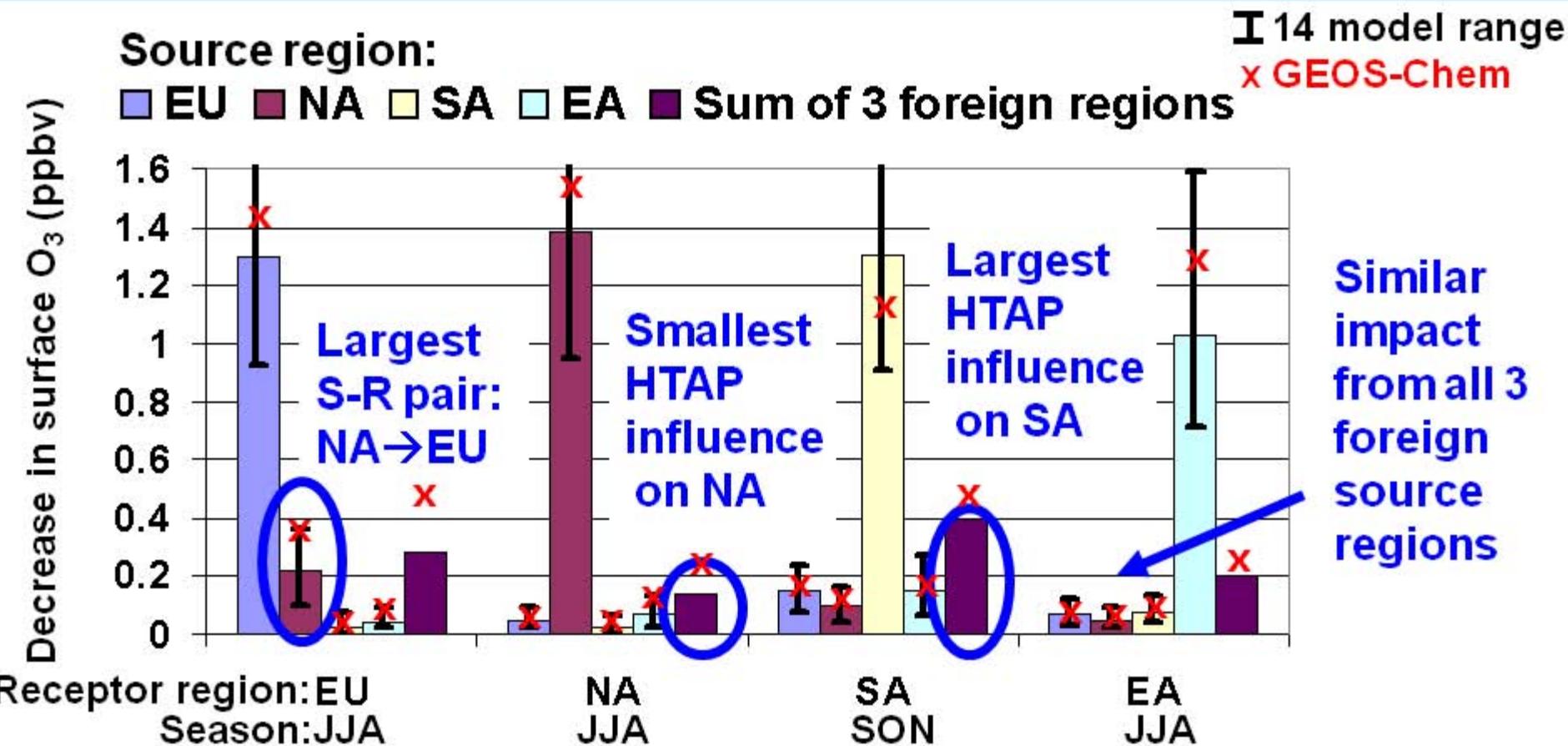
Estimates of S-R relationships: Annual mean surface ozone decrease due to 20% global methane reduction



→ 1 ppbv O₃ decrease over all NH receptor regions
→ Consistent with prior studies

What causes the ~1 ppbv range across individual models?
-- examine ozone production efficiency; NO_x:VOC ratios

Estimates of S-R relationships: Sensitivity of surface O₃ to NO_x sources during season of max domestic O₃ production



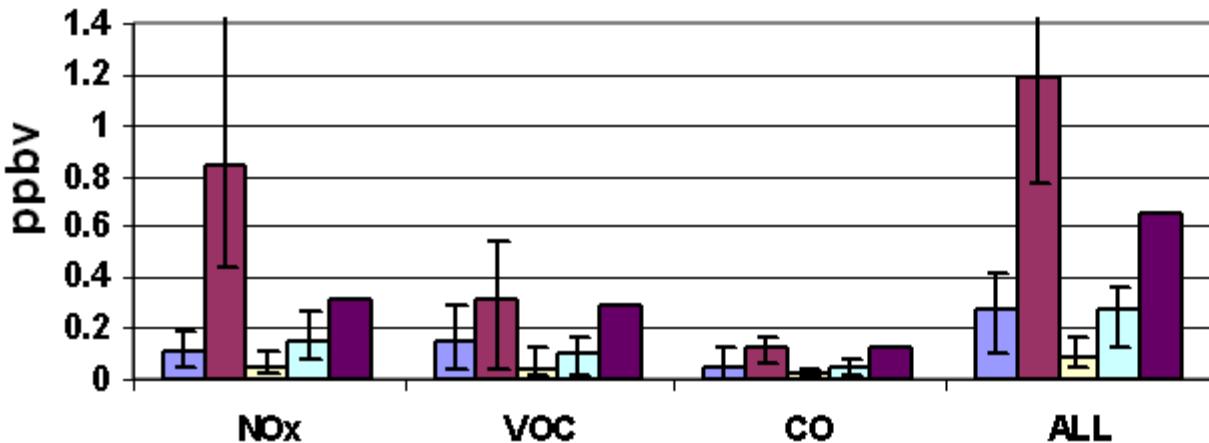
$$\frac{\sum(20\% \text{ decreases in foreign } \text{NO}_x)}{20\% \text{ decrease in domestic } \text{NO}_x} = 10-30\%$$

- Examine springtime when intercontinental transport typically peaks
- Compare role of NO_x emissions with other O₃ precursors

Estimates of S-R relationships: Springtime surface O₃ decrease in HTAP receptor regions from 20% reductions of O₃ precursors

SOURCE REGIONS: ■ EU ■ NA ■ SA ■ EA ■ Σ 3 foreign regions

RECEPTOR = NORTH AMERICA

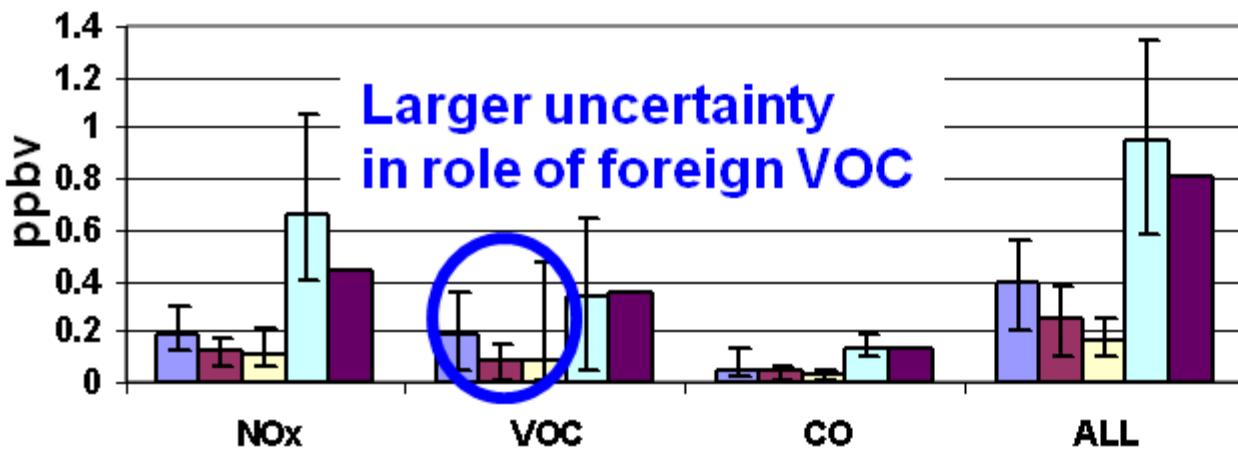


EA/EU contribute similarly

EU VOC at least as important as NO_x

$\frac{\Sigma(-20\% \text{ foreign emis.})}{-20\% \text{ domestic emis.}} \approx 55\%$

RECEPTOR = EAST ASIA



Larger uncertainty in role of foreign VOC

EU and NA \geq SA

$\frac{\Sigma(-20\% \text{ foreign emis.})}{-20\% \text{ domestic emis.}} \approx 85\%$

Some remaining questions...

(to be examined as part of the TF HTAP project)

Overall conclusion from previous analysis:

Range of estimates narrows from that in the literature under HTAP setup

- Which processes contribute most to uncertainty in S-R relationships?
 - Insights from idealized tracer experiments
 - Normalize model response to emission perturbations
- How can we best test models of hemispheric transport of air pollution?
 - Need to test processes (export, chemical evolution, mixing to surface)
- Can 20% emission decreases be scaled to reductions of other magnitudes?
 - Yes for CH₄; simulations underway for other O₃ precursors
- Role of hemispheric transport in polluted vs. background conditions?
 - Examine range of model responses across the O₃ distribution
- How will climate change affect hemispheric transport of air pollution?

www.htap.org for more info and to comment on draft 2007 interim report