HTAP O_3 Analysis Using CMAQ: Comparison with Global Model Results

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SR Scenarios Simulated

- SR1: Base-case simulation for year 2001.
- SR2: CH_4 mixing ratio reduced by 20% from 1760 to 1408 ppbv
- SR3: Anthropogenic NOx emissions reduced by 20% in EA and NA
- SR6: Combined reduction of anthropogenic NOx/NMVOC/CO/SO_2 by 20%
- SR7: Mercury emissions reduced 20%

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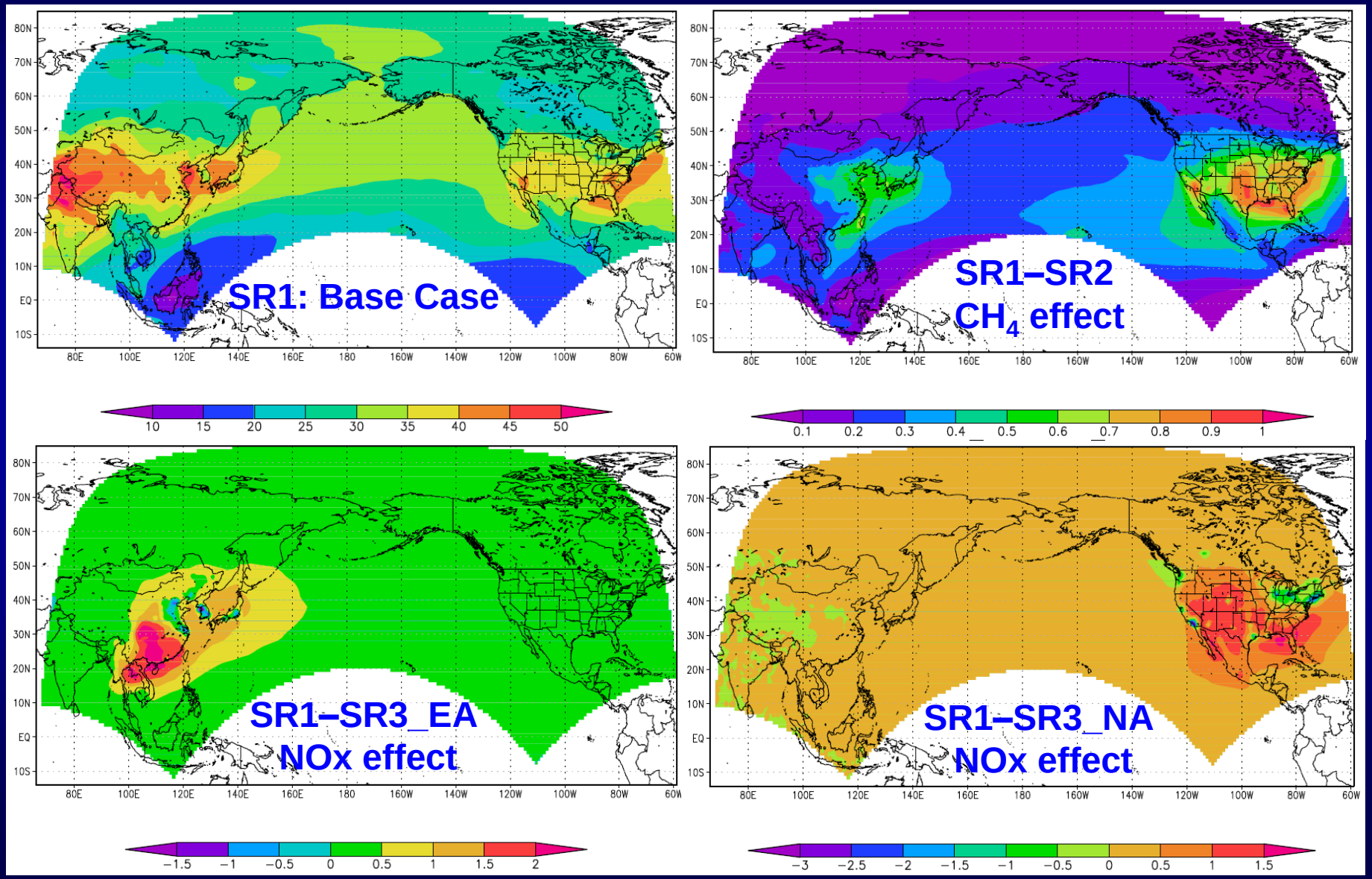
- SR7: Mercury emissions reduced 20%

Model and Data

- *Model*: CMAQ V4.6 (released Oct. 2006)
- *Modeling period*: Year 2001
- *Domain*: ICAP trans-Pacific domain in Lambert Conformal projection covering EA and NA, 108-km spatial resolution
- *Emission Inventory*: NEI99 and modified Trace-P
- *Meteorology*: ICAP 2001 MM5, model-ready
- *Chemistry*: CB-IV and CMAQ-AERO4
- *Initial and boundary conditions*: re-gridded from GEOS-Chem annual simulation in 2001

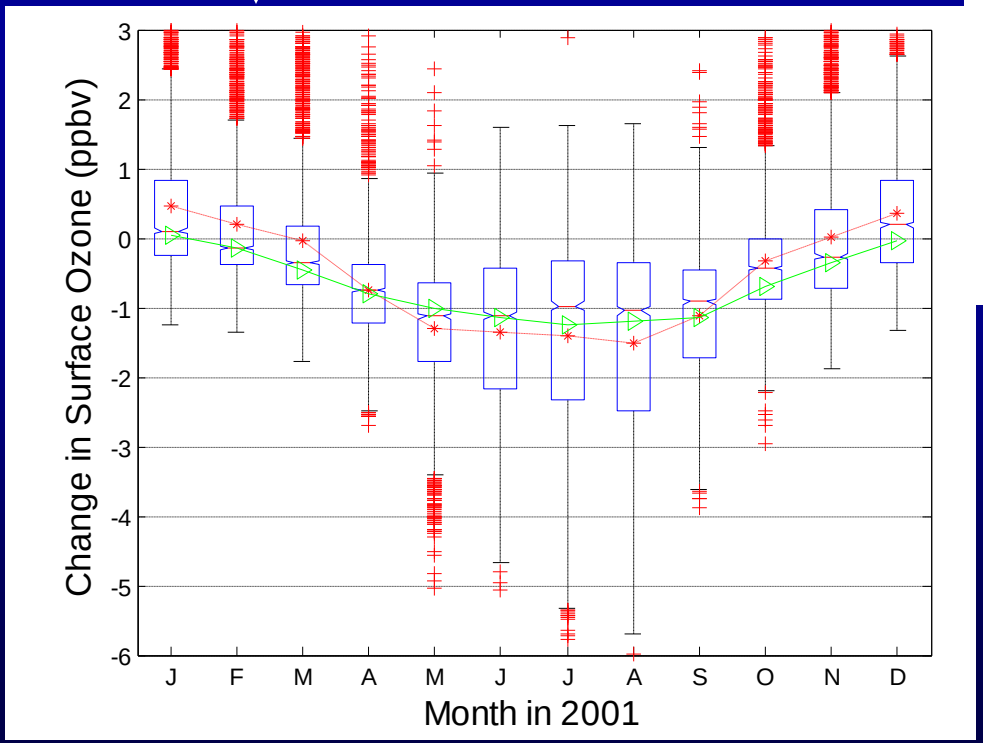
Spatial Distribution

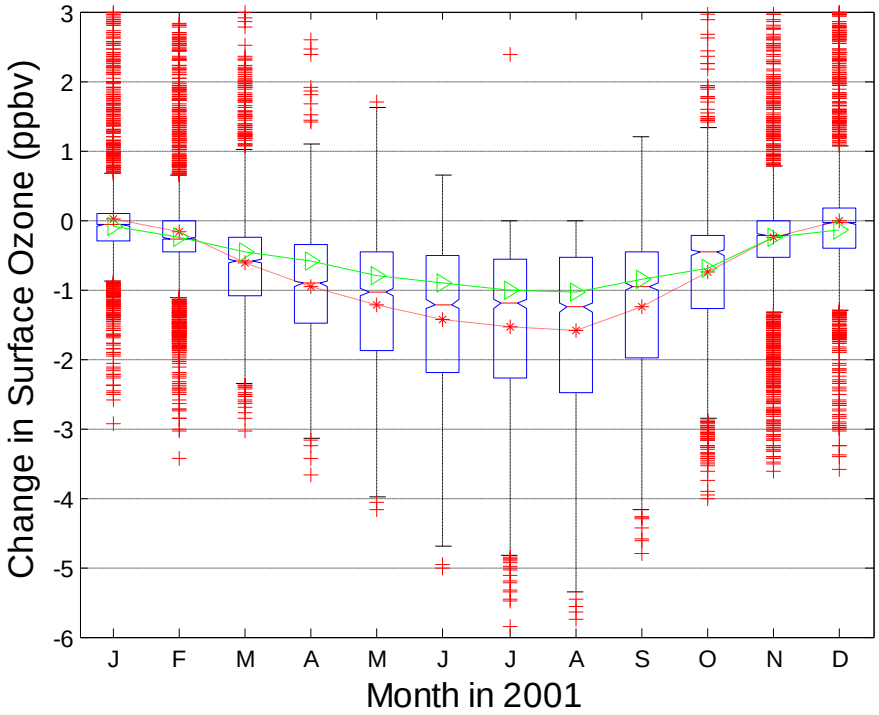


Domestic Impact (20% NOx reduction)

EA →

NA ↓



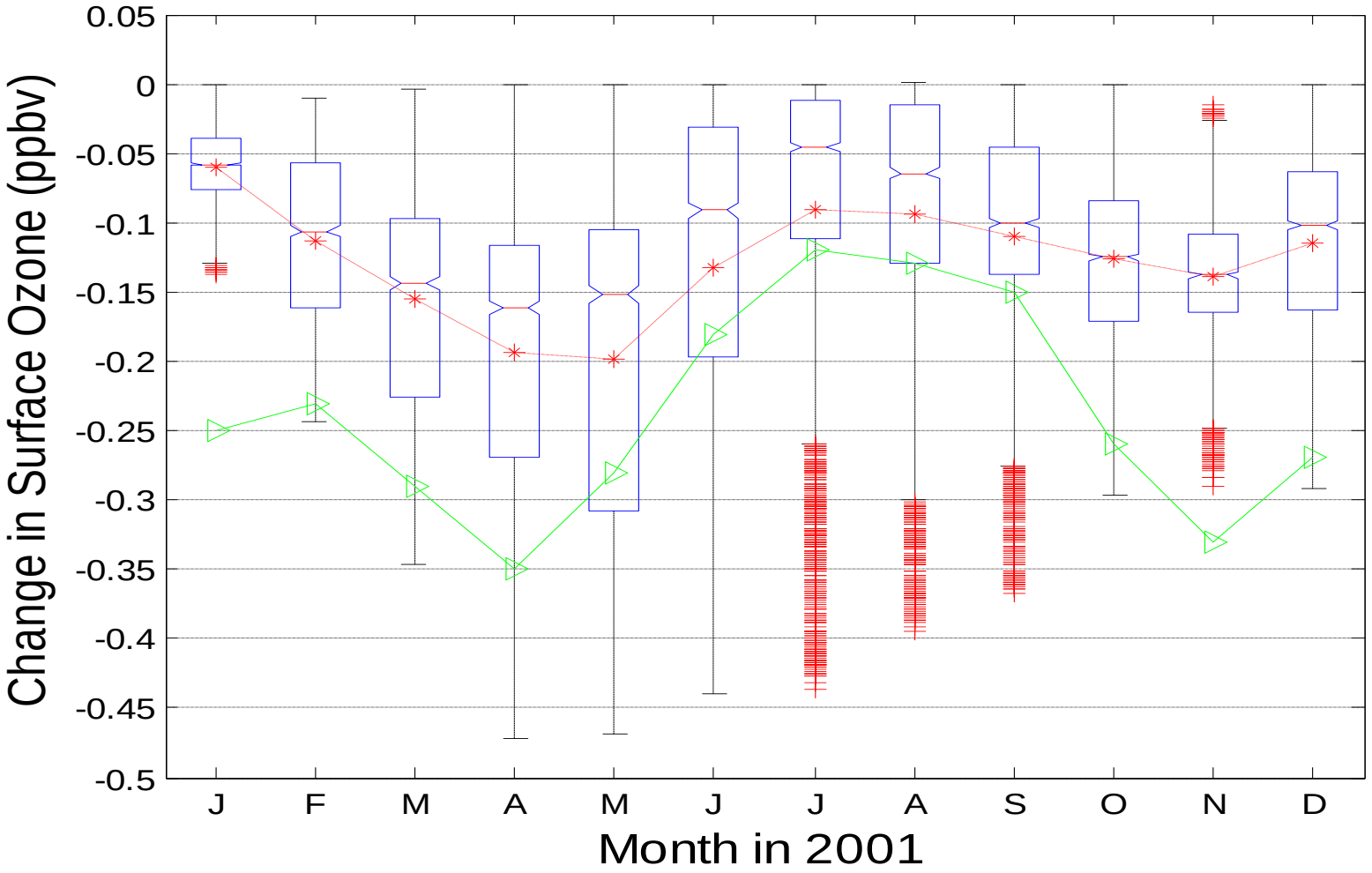


Boxplot shows within-region variability

Red line shows regional mean by CMAQ

Green line shows results from Fiore et al. (2008)

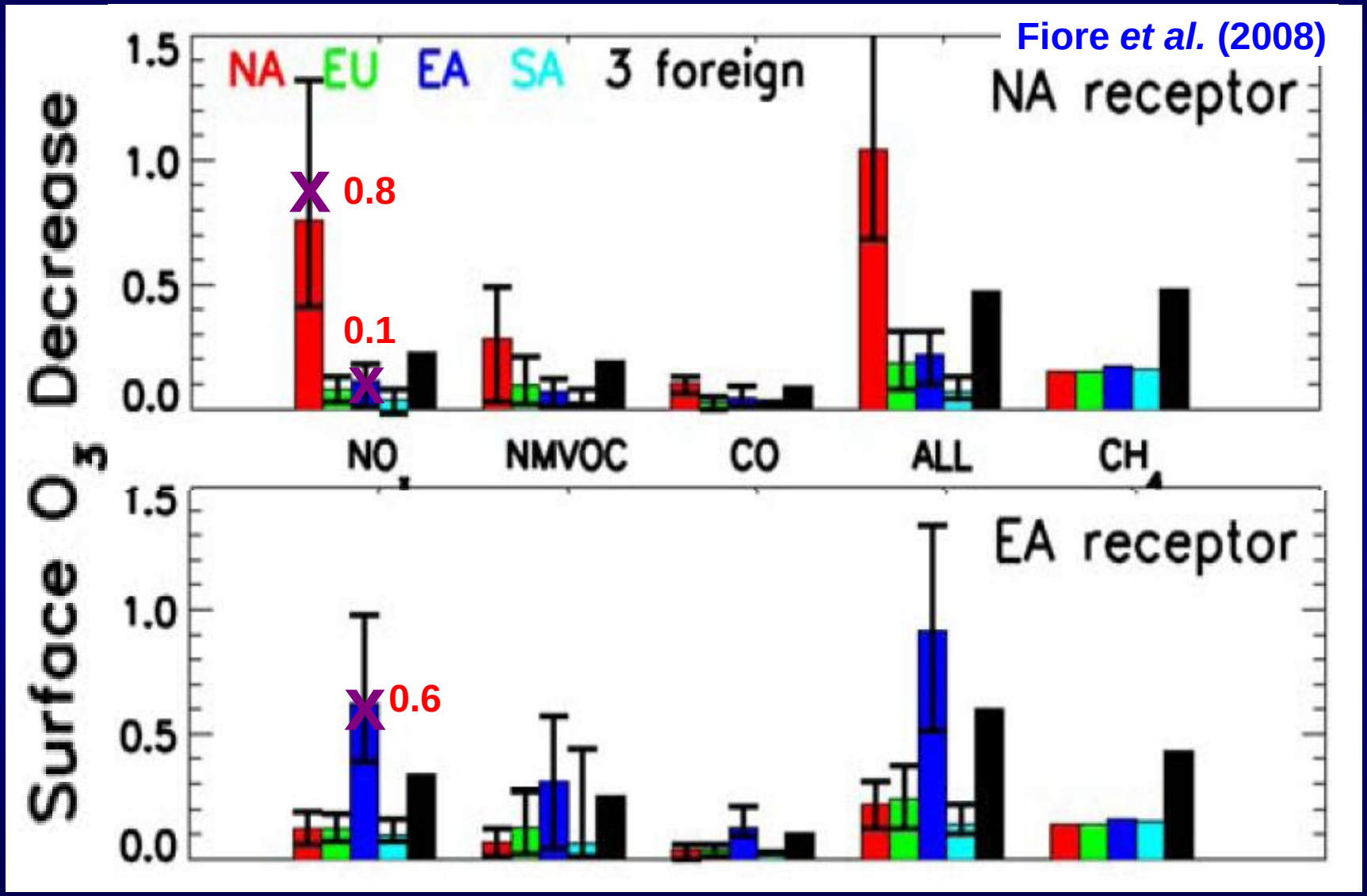
Foreign Impact (20% NOx reduction)*



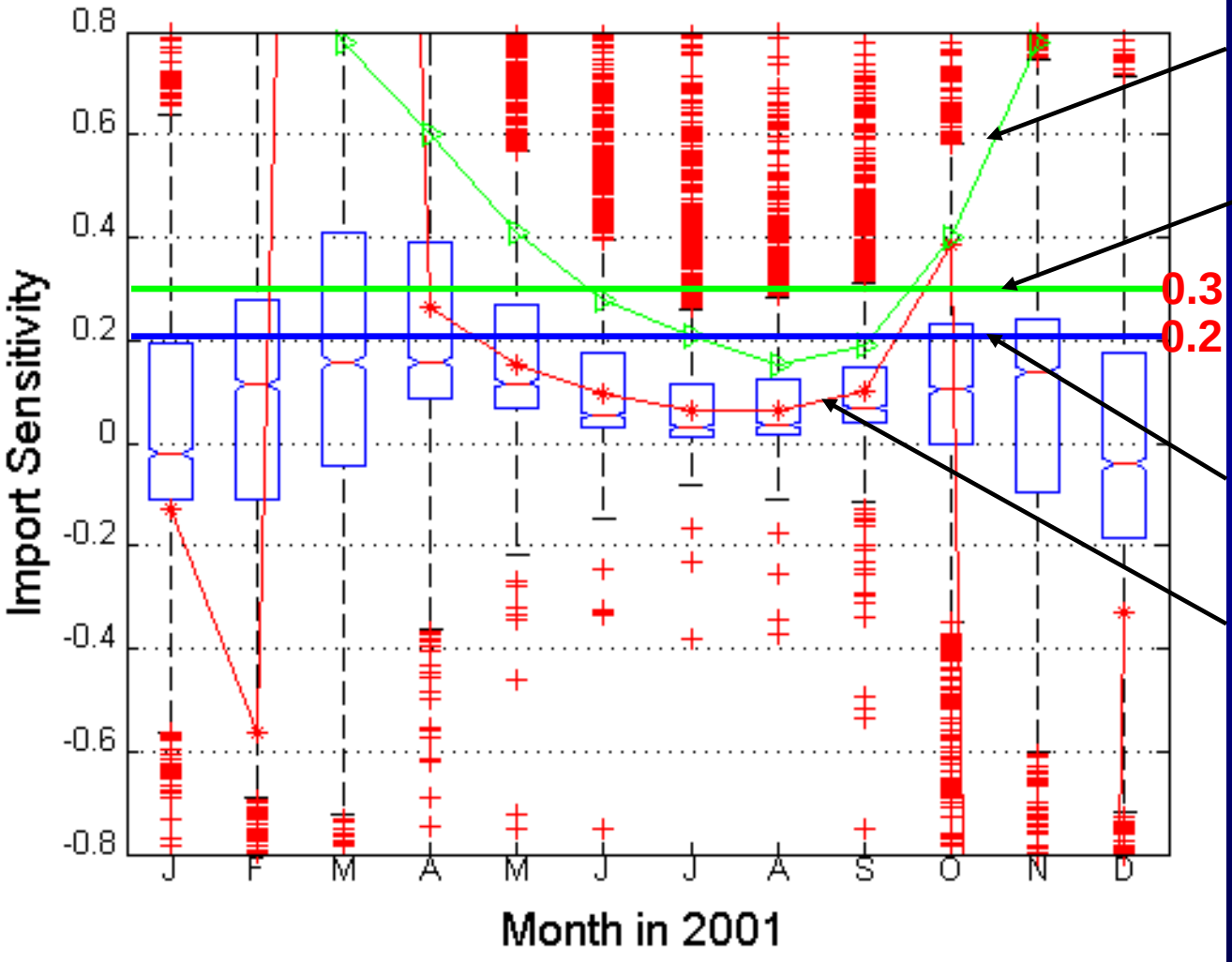
Red line shows the foreign impact by CMAQ from ***EA ONLY***

Green line shows results from Fiore et al. (2008) shows the foreign impact from ***three foreign regions COMBINED***

Comparison of Annual Mean



Import Sensitivity* ($\Delta O_{3,fr}$ / $\Delta O_{3,do}$) by 20% NOx emission reduction



Monthly IS from Fiore et al. (2008)

Annual IS from Fiore et al. (2008)

Annual IS from CMAQ results

Monthly IS from CMAQ results

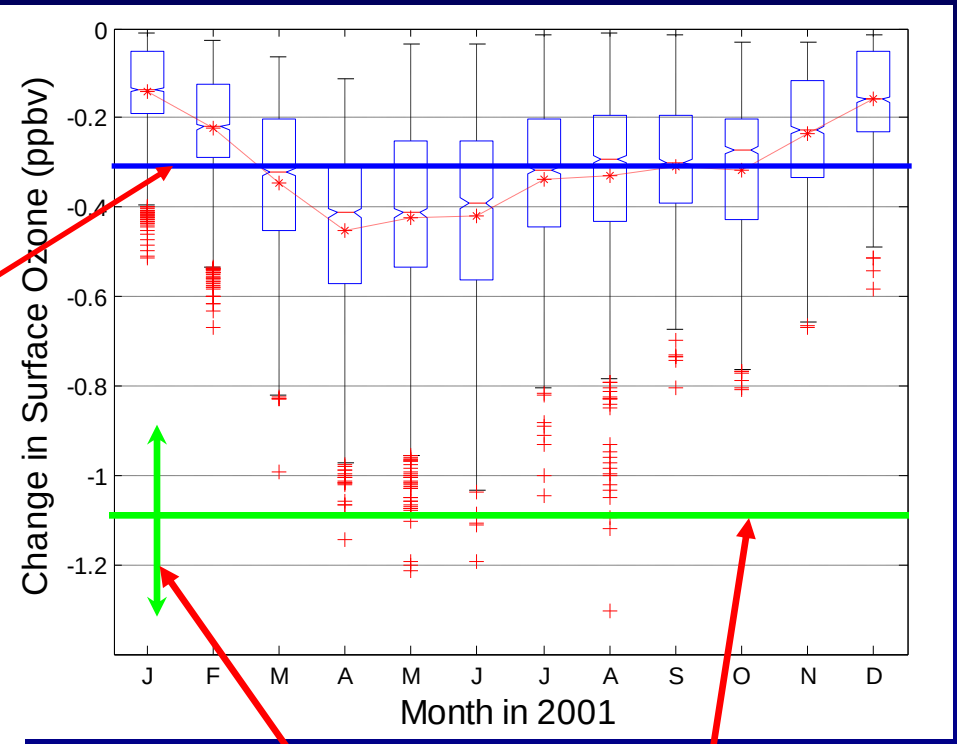
*Data from Fiore et al. (2008) consider $\Delta O_{3,fr}$ from ALL foreign source region.

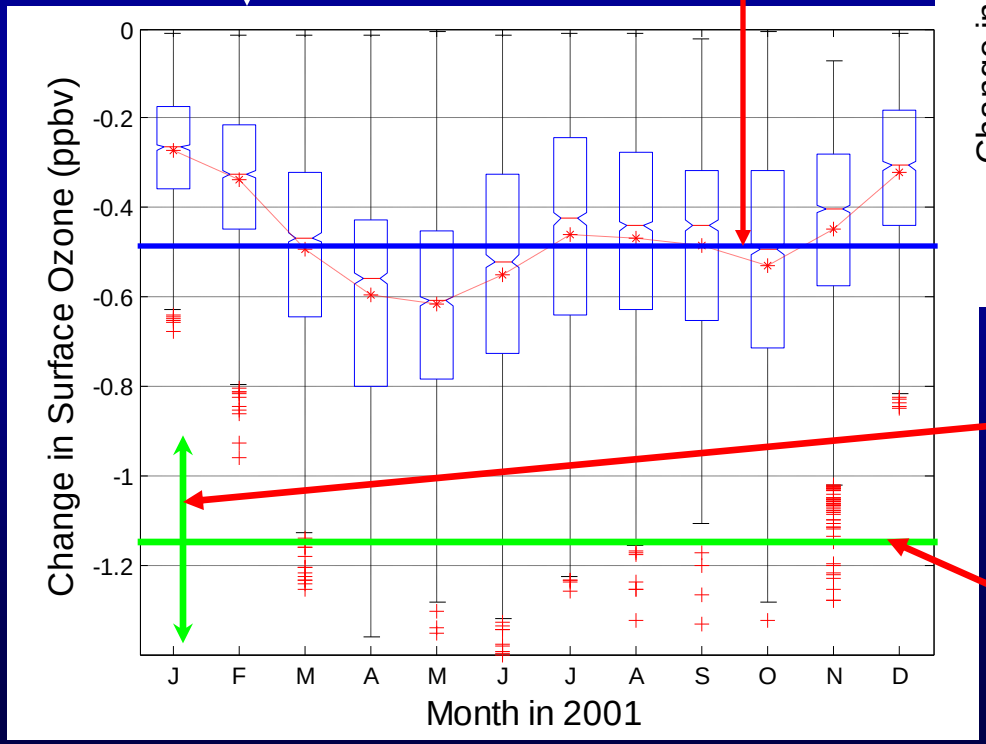
Effect of CH_4 Perturbation

EA

NA

Mean from CMAQ





Variability in Std. Dev.

Mean from all global models in Fiore et el (2008)

Summery

- 20% decrease of domestic NOx emission changes monthly mean surface O_3 by +7.1 to -6.4 ppbv, and decreases annual mean O_3 by -0.8 ppbv in EA and -0.6 ppbv in NA.
- 20% NOx emission reduction in EA causes a decrease of up to 0.5 ppbv of monthly surface O_3 in NA. The effect is stronger in spring and late fall. The decrease in the annual mean surface O_3 is 0.13 ppbv.
- The monthly mean import sensitivity (IS) in NA caused by the 20% EA NOx emission reduction show a large variability.
- The IS in the warm months (April - October) shows similar trend compared to global model results.
- 20% decrease of CH_4 levels in the domain decreases annual mean O_3 by 0.47 ppbv in NA and 0.31 ppbv in EA. This is weaker than the global model results.
- The CMAQ model results seems to agree reasonably with global model results, although the domestic effect shows a greater seasonal variability.