North America as a Source and Receptor of Hemispheric Ozone Pollution:

Seasonal Variability, Uncertainties, and Policy Implications

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A33-E01

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LRTAP Task Force on Hemispheric Transport of Air Pollution

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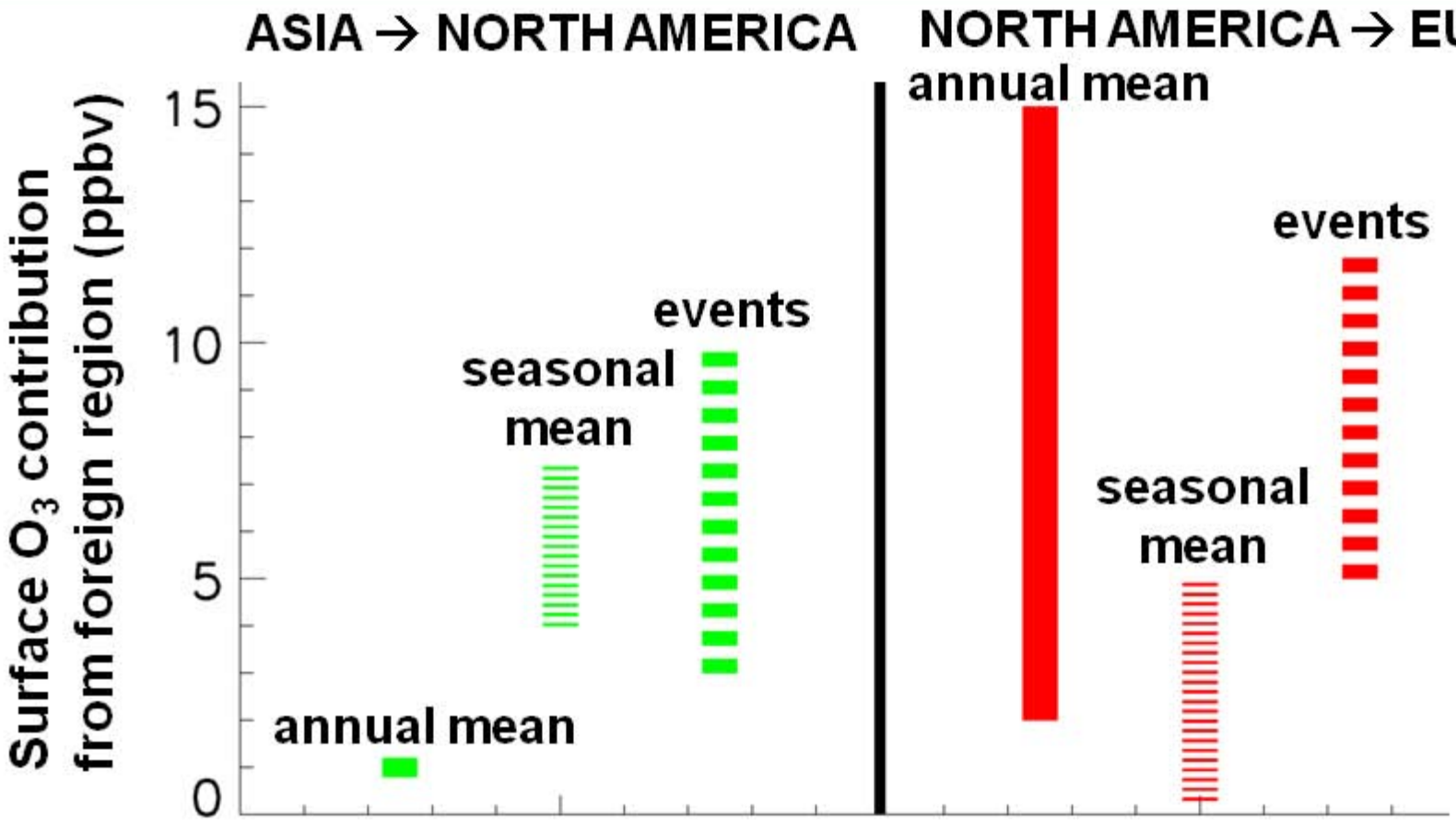
Wide range in prior estimates of intercontinental surface ozone source-receptor (S-R) relationships



Studies in TF HTAP [2007] + *Holloway et al.*, 2008; *Duncan et al.*, 2008; *Lin et al.*, 2008

Assessment hindered by different (1) methods, (2) reported metrics, (3) meteorological years, (4) regional definitions

Few studies examined all seasons

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Objective: Quantify & assess uncertainties in N. mid-latitude S-R relationships for ozone

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. NO_x, CO, NMVOC emissions, individually + all together (=16 simulations)
→ -20% global methane (to 1408 ppb)

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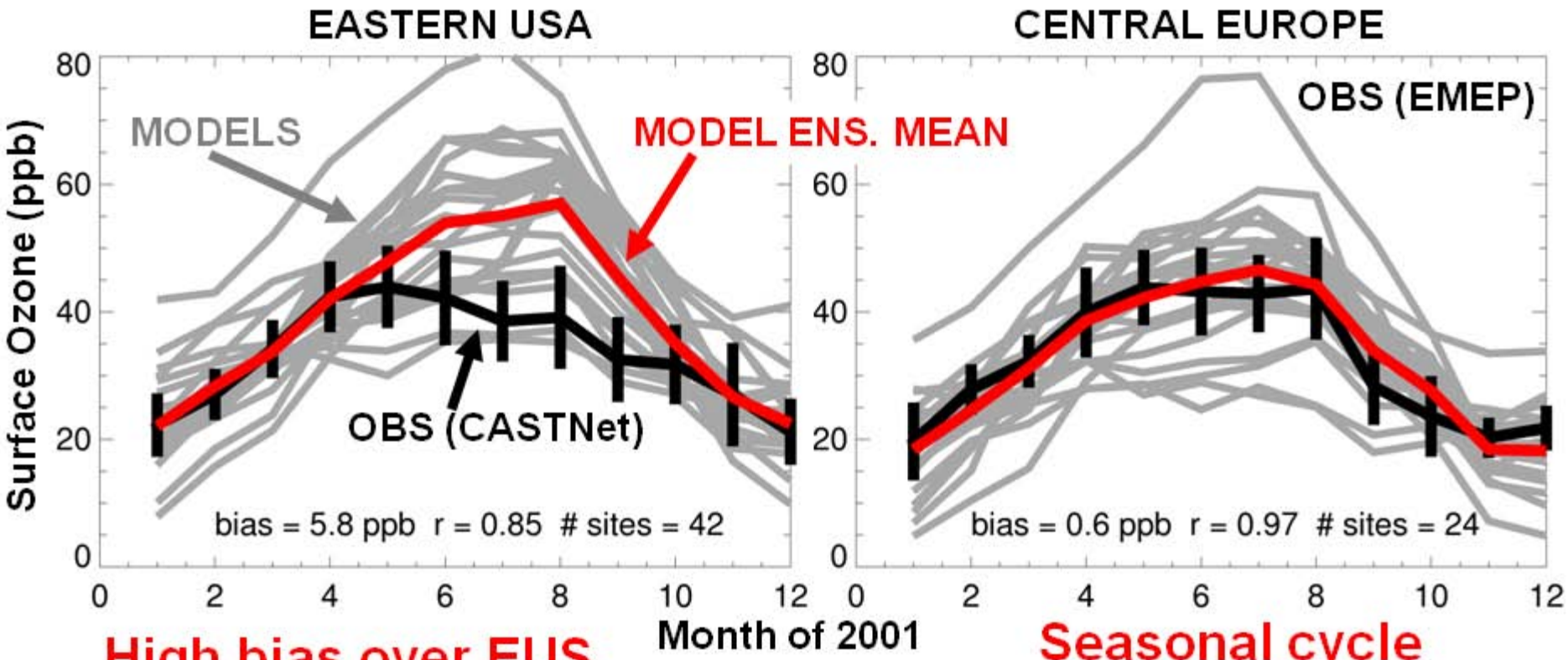
Simulated vs. observed monthly mean surface O_3



High bias over EUS in summer and early fall

Seasonal cycle captured over Europe

→Greater uncertainty in results for summertime NA

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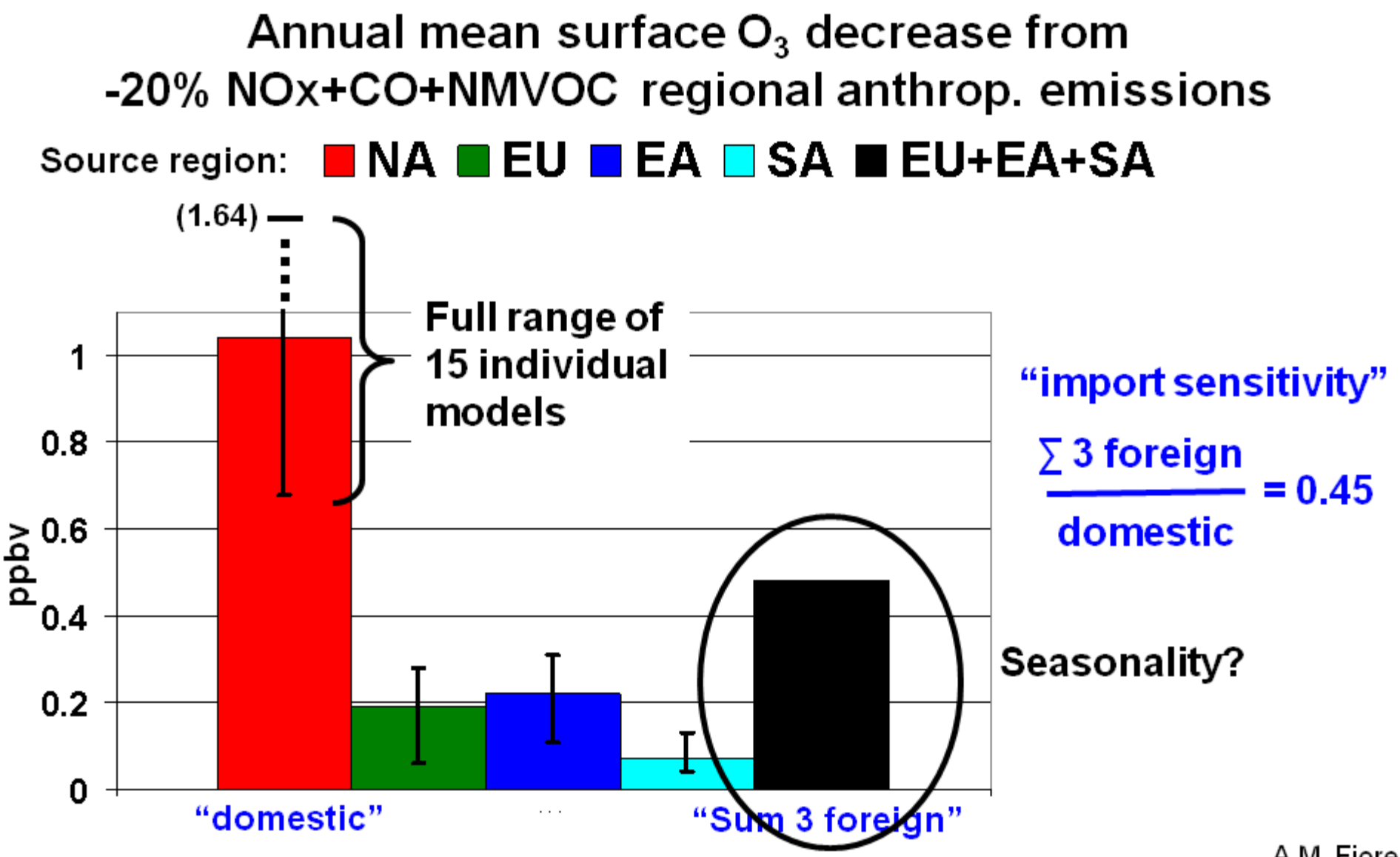
North America as a receptor of ozone pollution: Annual mean foreign vs. domestic influences



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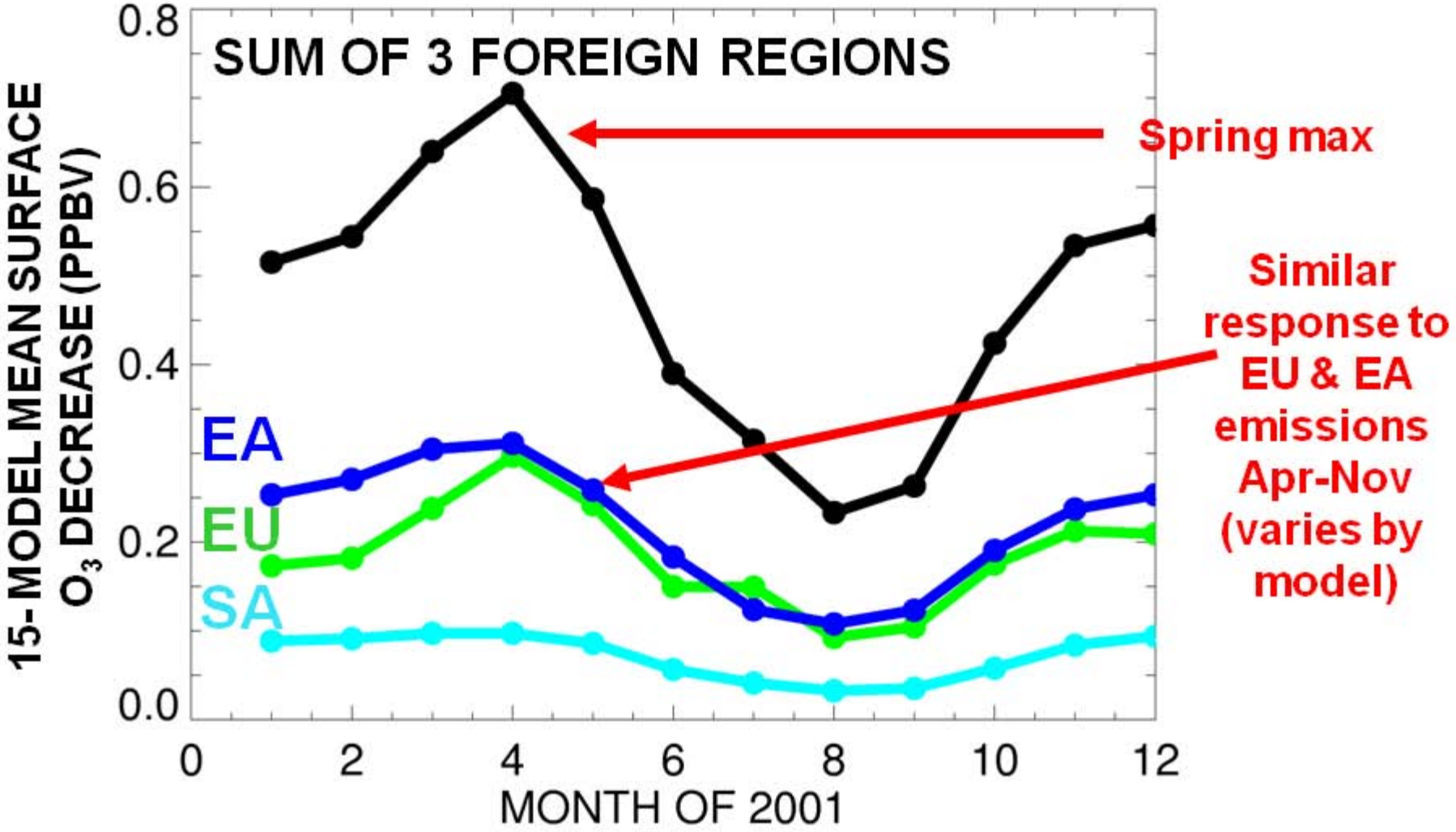
North America as a receptor of ozone pollution: Seasonality of response to -20% foreign anthrop. emissions



Spring (fall) max due to longer O_3 lifetime, efficient transport

[e.g., Wang et al., 1998; Wild and Akimoto, 2001; Stohl et al., 2002; TF HTAP 2007]

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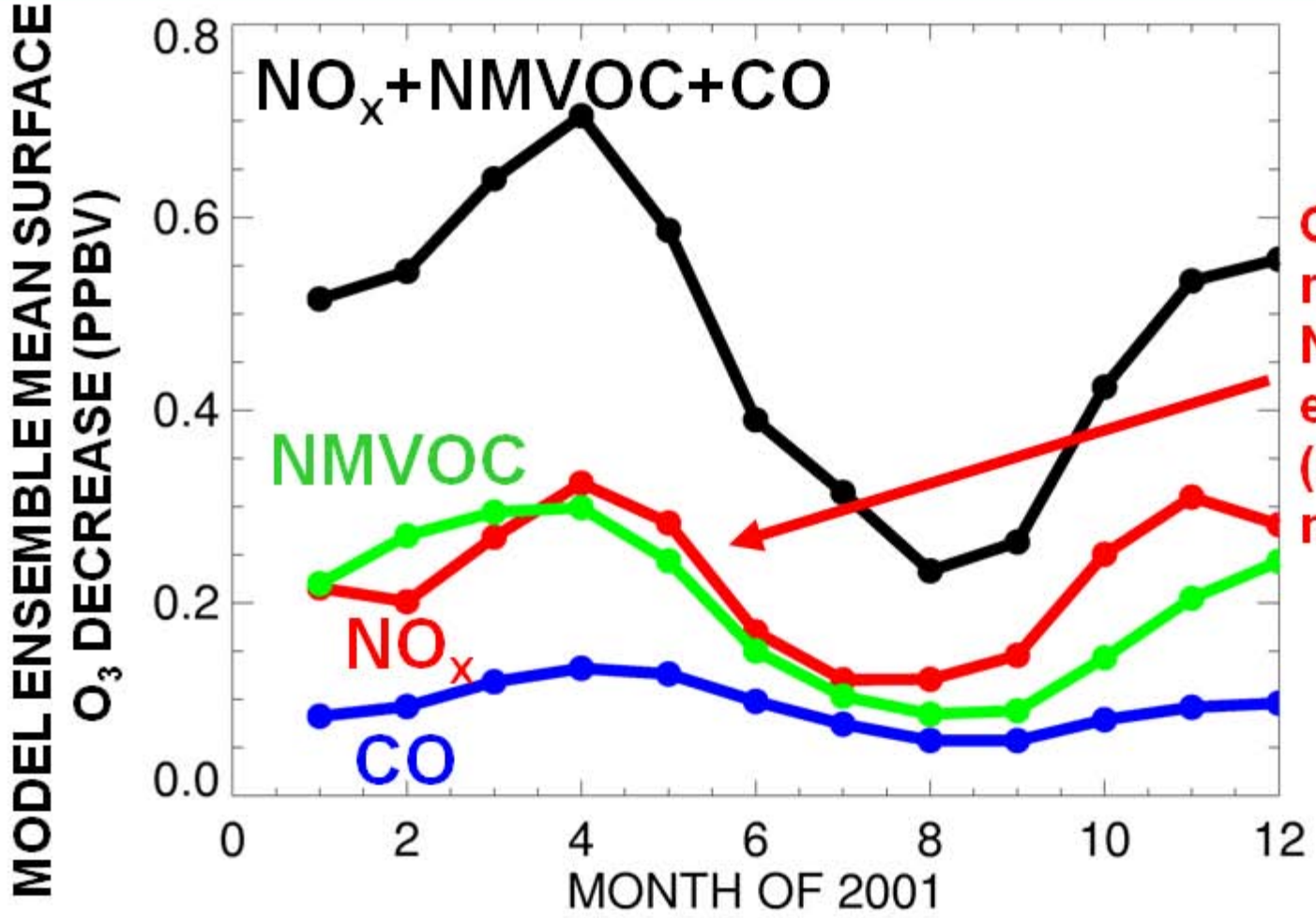
North America as a receptor of ozone pollution: Seasonality of response to -20% foreign anthrop. emissions



Comparable response to NO_x & NMVOC emissions (but varies by model)

Wide range in EU anthrop. NMVOC inventories

→ large uncertainty in the estimated response of NA O_3

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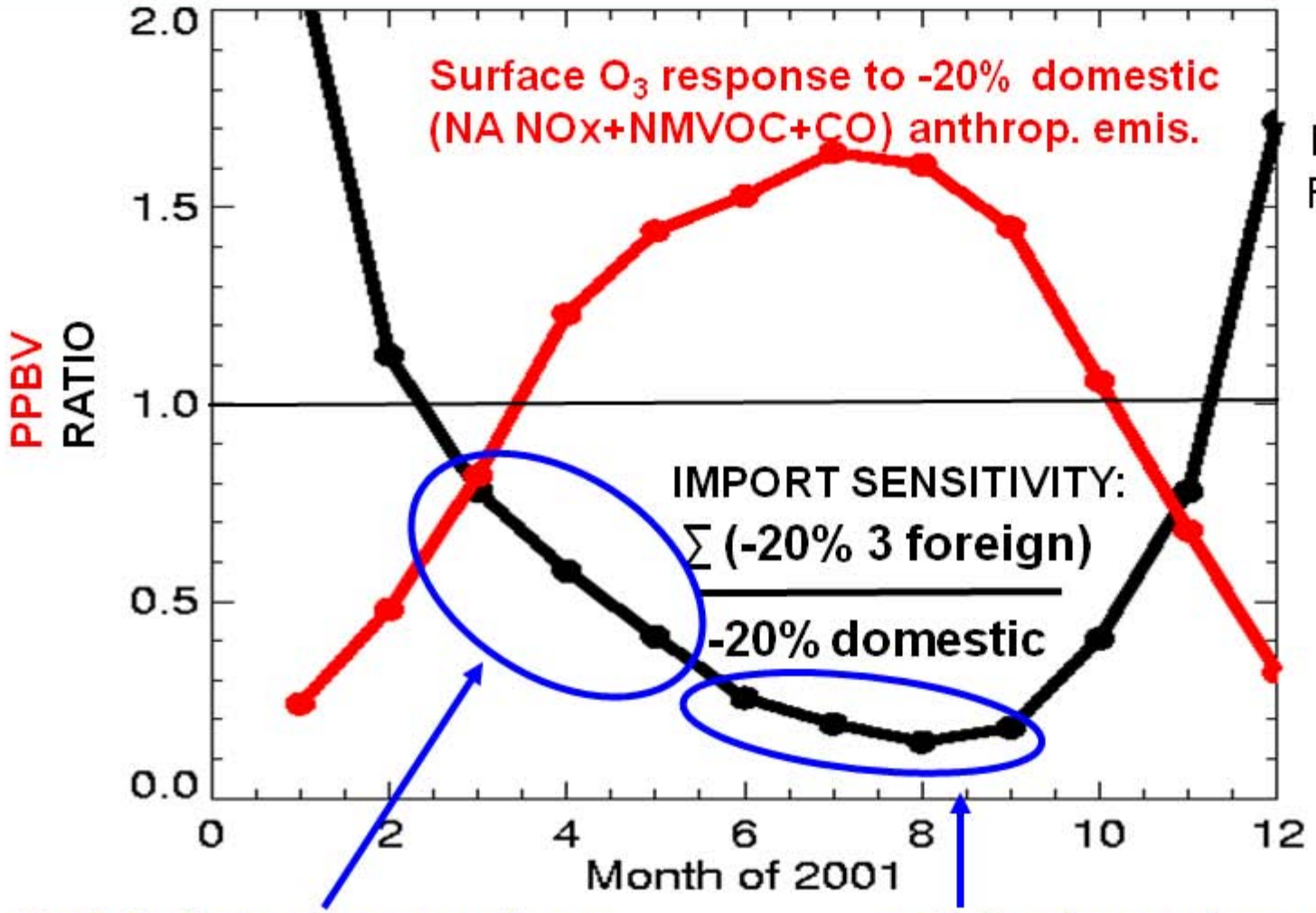
North America as a receptor of ozone pollution: Seasonality in "import sensitivity"



0.4-0.8 during spring
"high transport season"

~0.2 when domestic O_3 production peaks in summer

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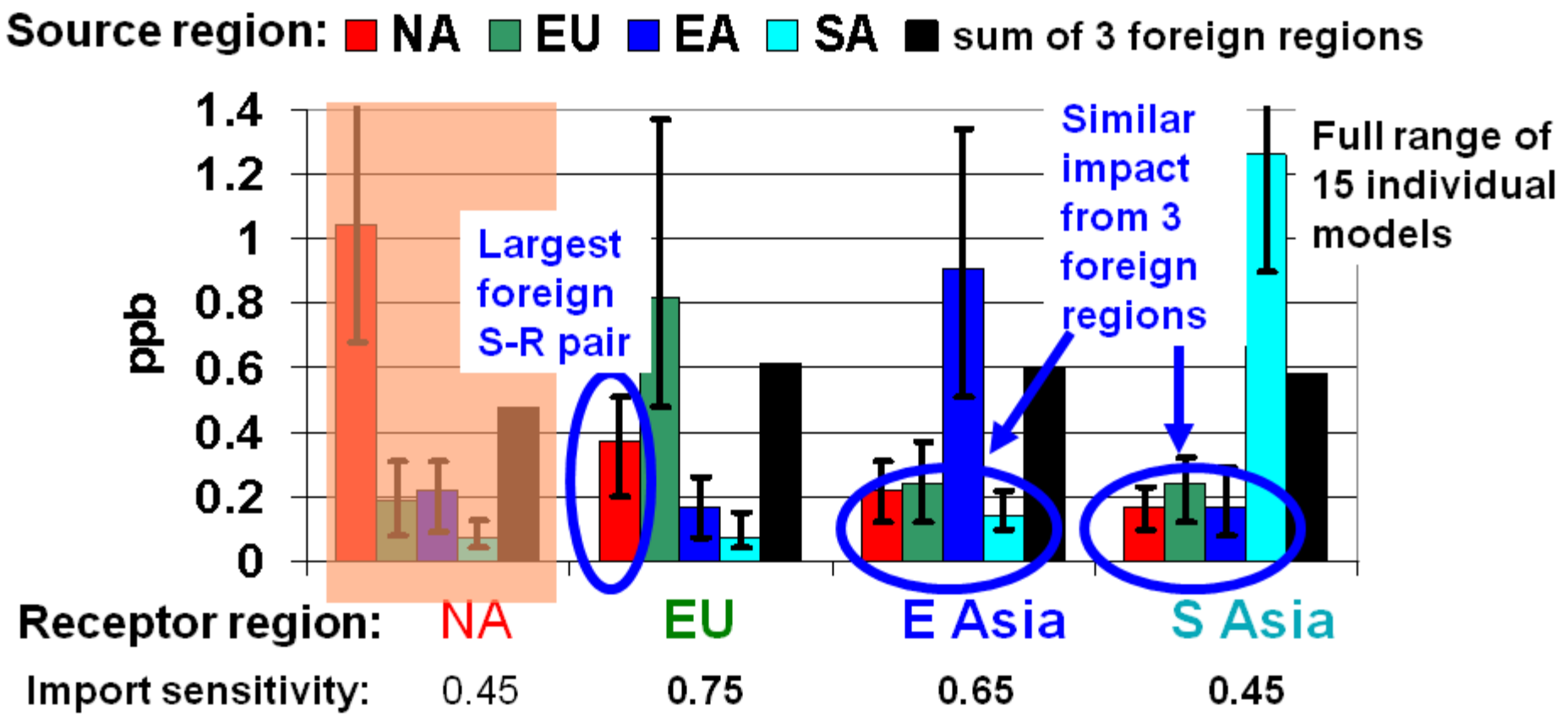
North America as a source of ozone pollution

Annual mean surface O_3 decrease from -20% NOx+CO+NMVOC regional anthrop. emissions



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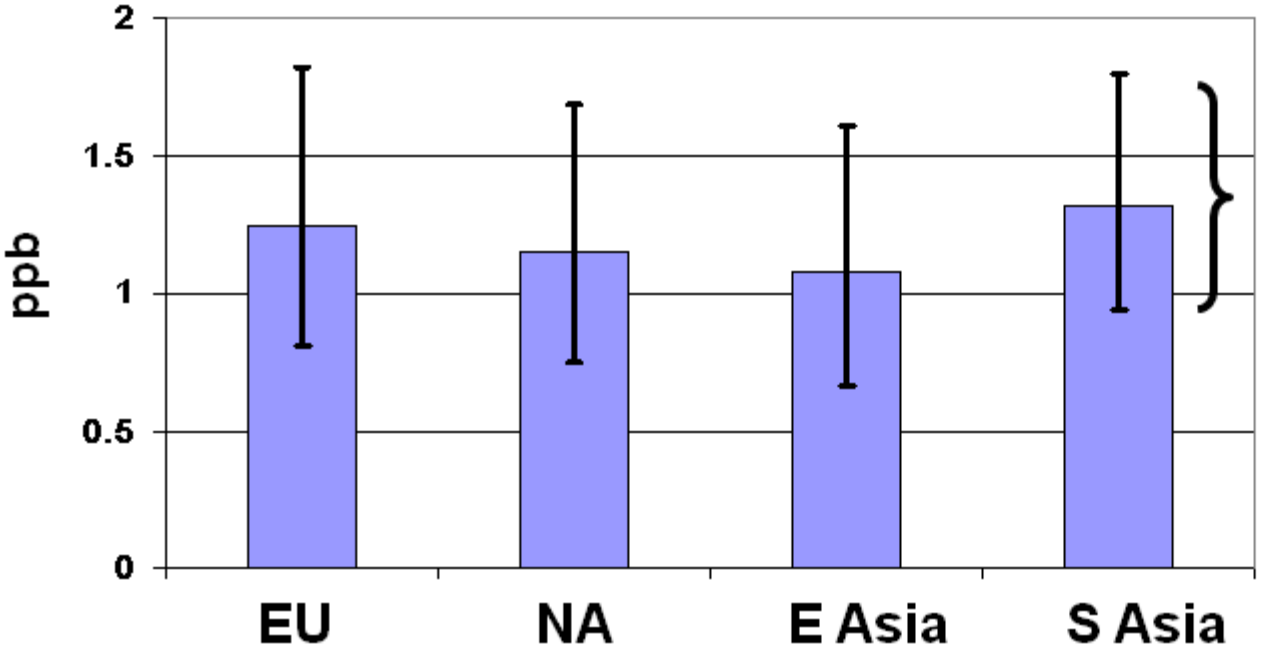
Surface ozone response to -20% global [CH_4]: similar decrease over all regions



1 ppbv O_3 decrease over all regions

[Dentener et al.,2005; Fiore et al., 2002, 2008; West et al., 2007]

Estimate O_3 response to -20% regional CH_4 anthrop. emissions to compare with O_3 response to NOx+NMVOC+CO:

(1) -20% global [CH_4] ≈ -25% global anthrop. CH_4 emissions
(2) Anthrop. CH_4 emis. inventory [*Olivier et al.*, 2005] **for regional emissions**
(3) Scale O_3 response (linear with anthrop. CH_4 emissions [Fiore et al., 2008])

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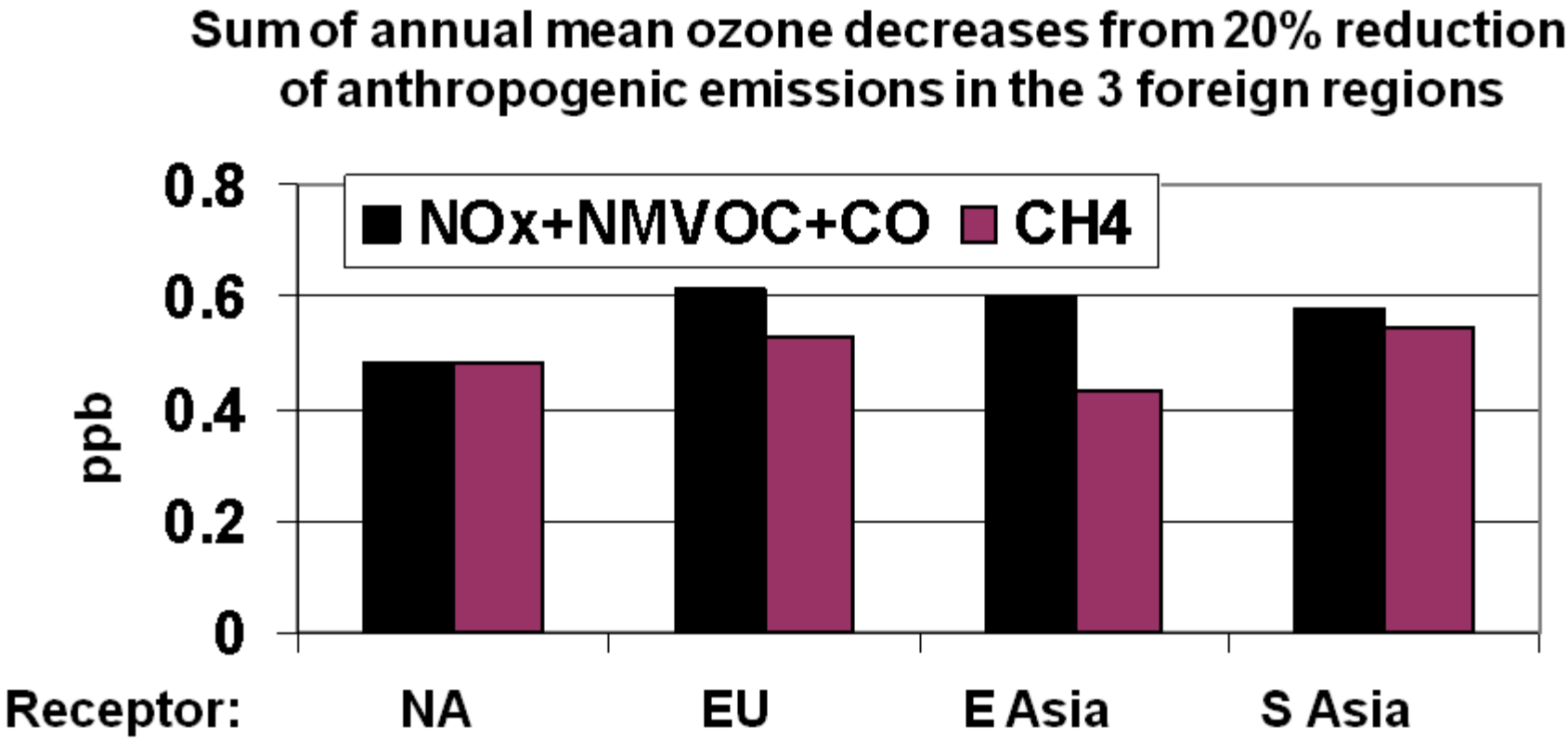
Comparable annual mean surface O_3 response to -20% foreign anthropogenic emissions of CH_4 vs. NO_x+NMVOC+CO



(Uses CH_4 simulation + anthrop. CH_4 emission inventory [*Olivier et al.*, 2005] to estimate O_3 response to -20% regional anthrop. CH_4 emissions)

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Conclusions: S-R relationships for O_3 pollution

- **Benchmark for future: Robust estimates + key uncertainties**

  Robust: NA→EU largest; SA→others smallest

  Uncertainties: Model transport, emissions, chemistry

  particularly NA in summer, EU/EA -> NA, NO_x/NMVOC -> NA

- **NA response to foreign anthrop. emissions 40-80% that to domestic anthrop. emissions in spring and late fall**

- **Reducing equivalent % of CH_4 yields an O_3 decrease similar to that achieved with NO_x+NMVOC+CO over foreign regions (0.4-0.6 ppb for 20% reductions)**

www.htap.org for 2007 TF HTAP Interim Report and information about TF HTAP activities

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