Past and Future Trends in Source-Receptor Relationships

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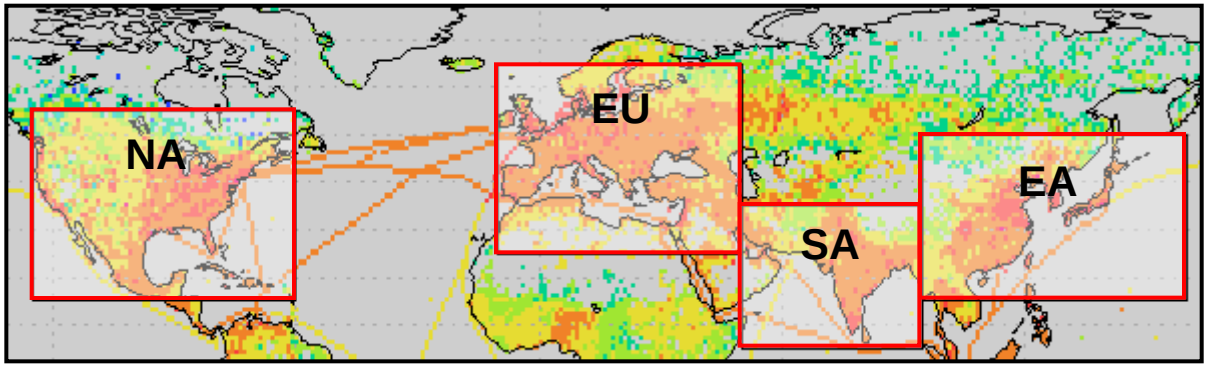
HTAP/NAS/AC&C Workshop, Washington DC, June 2008

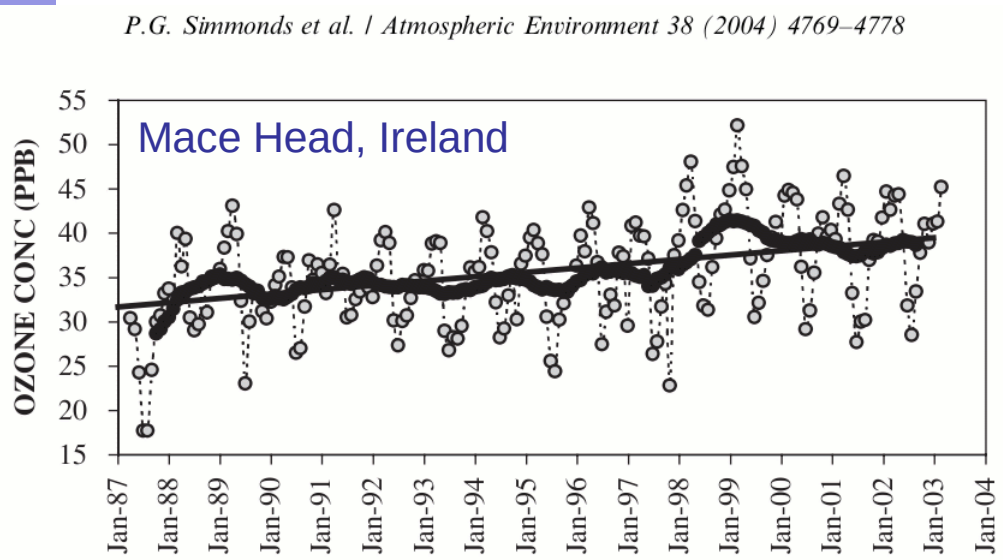
- Source-Receptor Regions

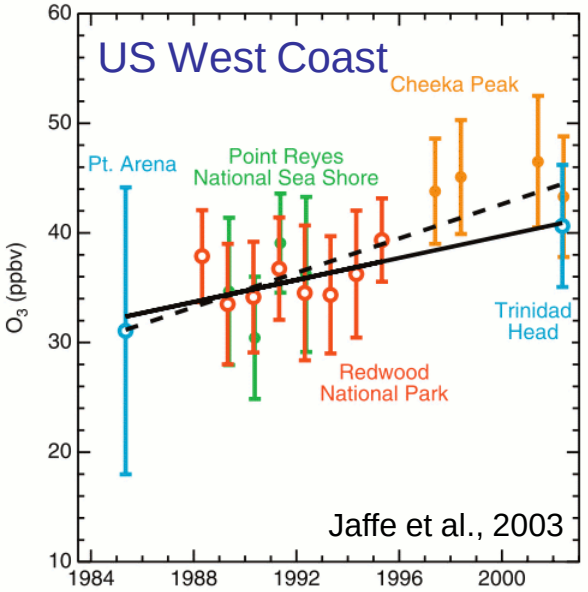


- Model Runs
  - Control run (SR1), 20% reduced CH_4 run (SR2)
  - 20% reduced NO_x emissions over each region (SR3)
  - 20% reduced VOC emissions over each region (SR4)
  - 20% reduced CO emissions over each region (SR5)
  - 20% reduced NO_x/VOC/CO/aerosol emissions (SR6)
- Derive current source-receptor relationships
  - How will future changes in emissions affect these?

Questions to Address

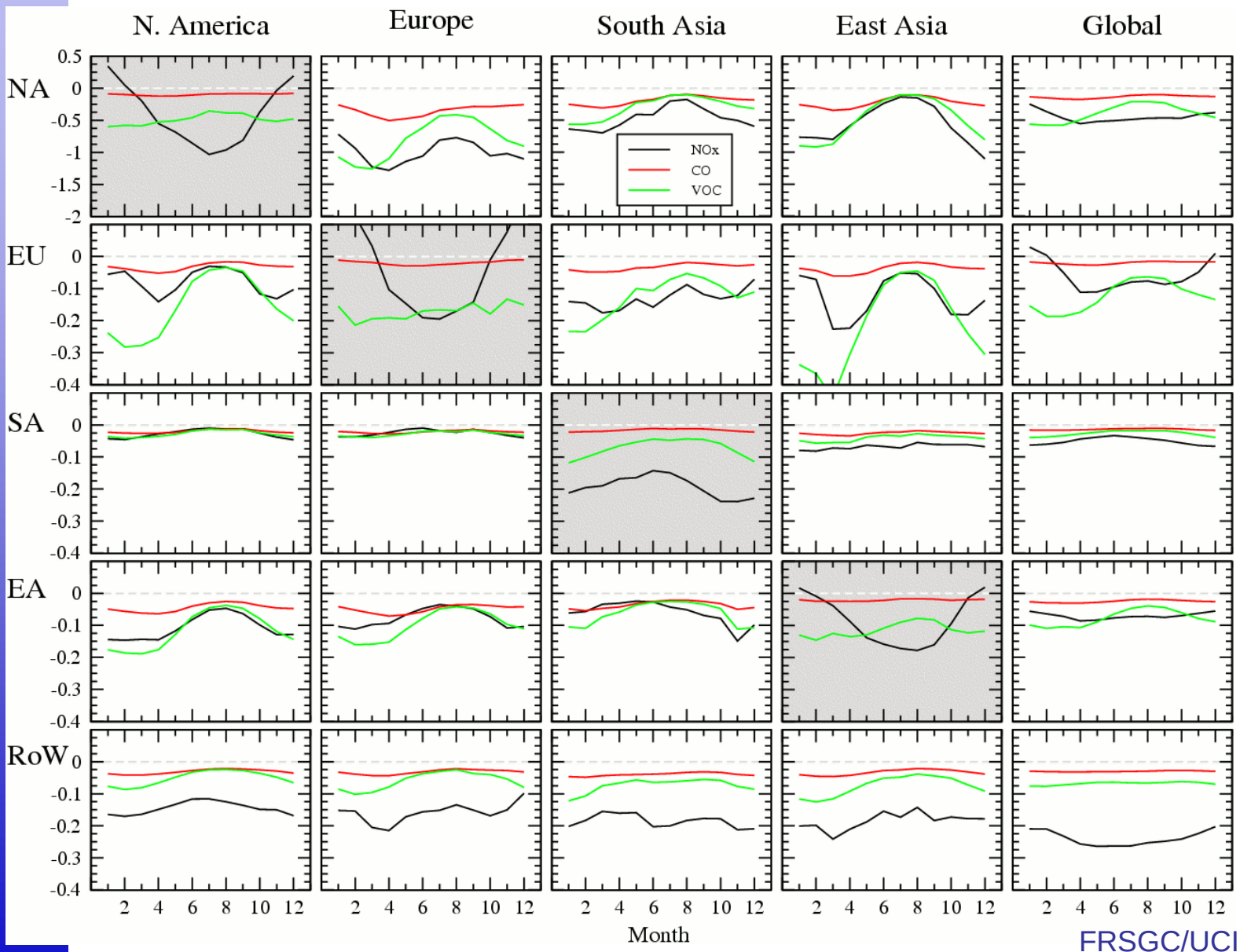
- How sensitive are intercontinental Source-Receptor relationships to future changes in emissions?
- Can we quantify the anthropogenic contribution to observed surface O_3 trends?





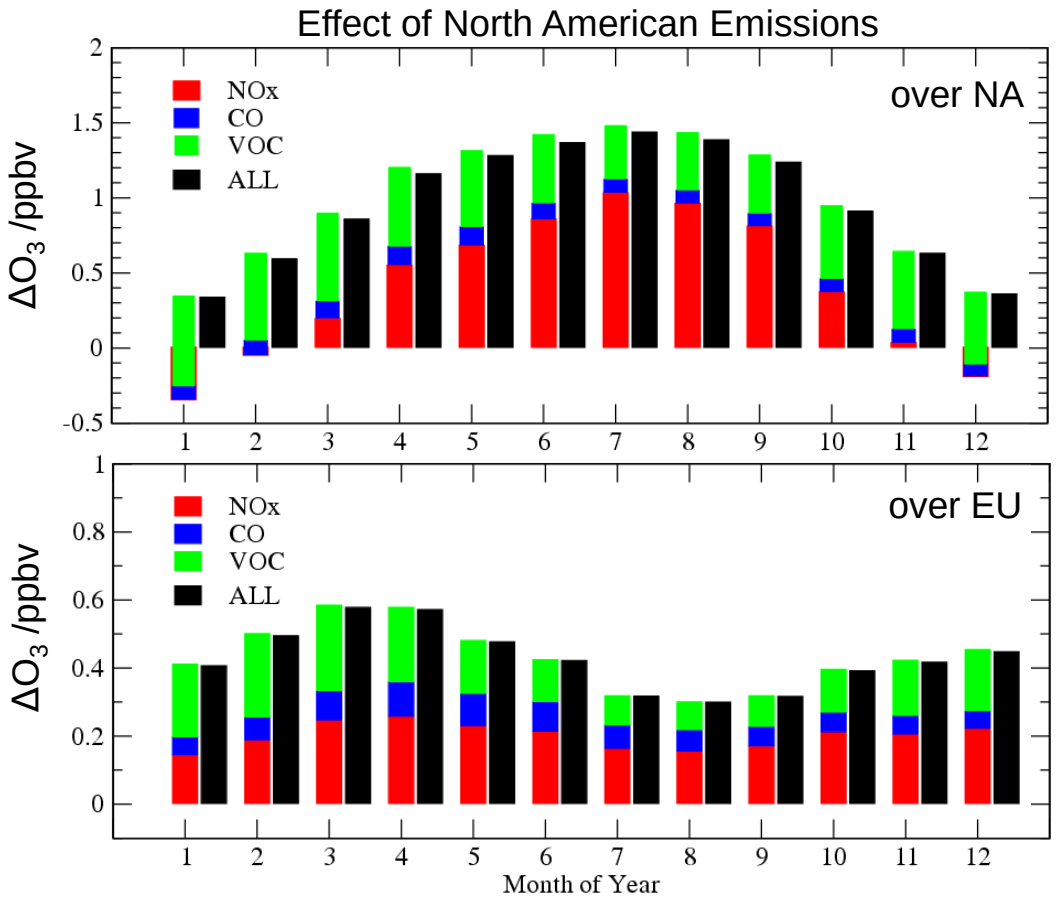
Observed background trends of 0.1-0.5 ppb/yr

HTAP S-R Matrix



Testing Linearity

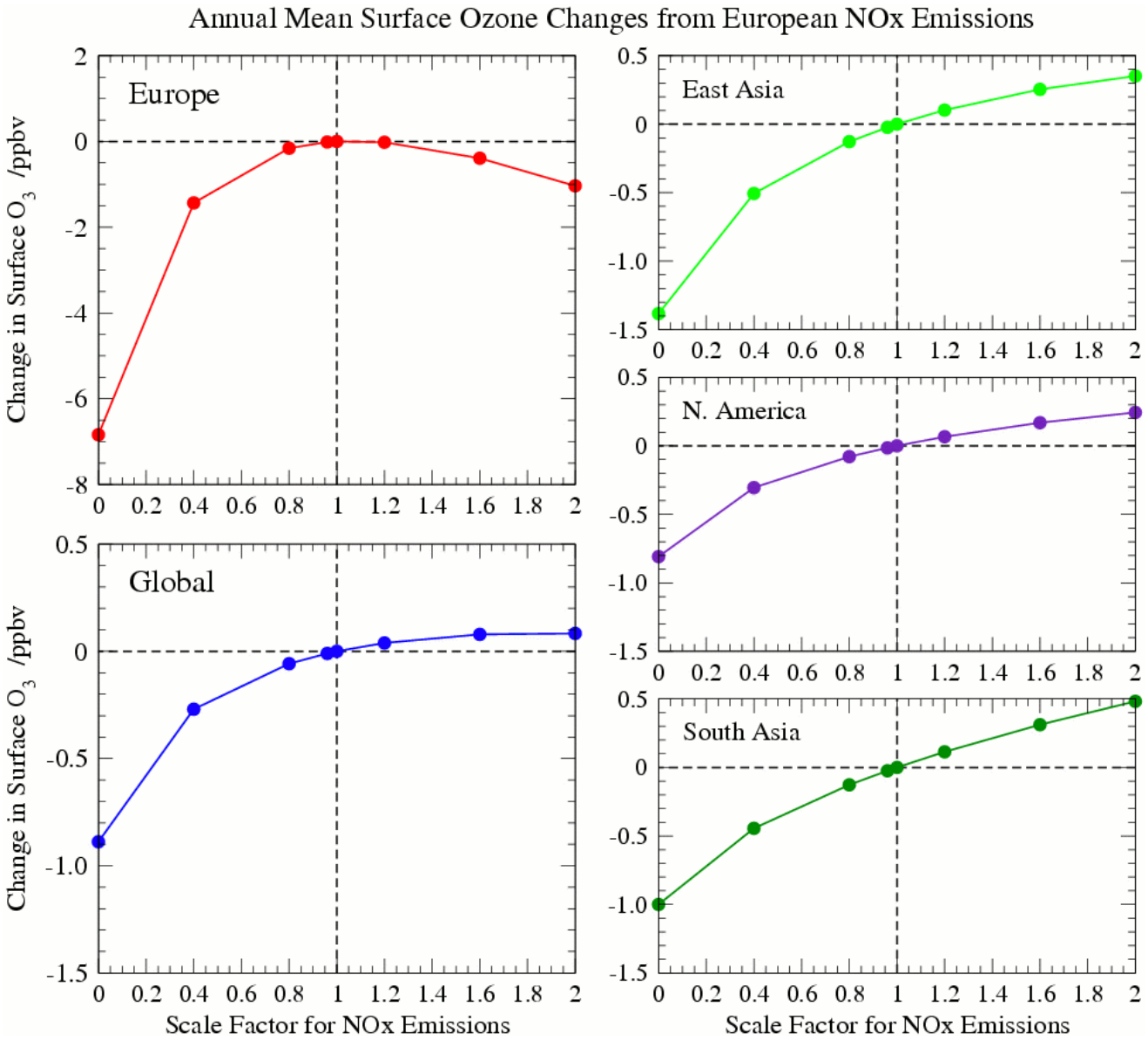
- Species additivity
  - Does $\Delta O_3^{NOx} + \Delta O_3^{VOC} + \Delta O_3^{CO} = \Delta O_3^{NOx+VOC+CO}$?



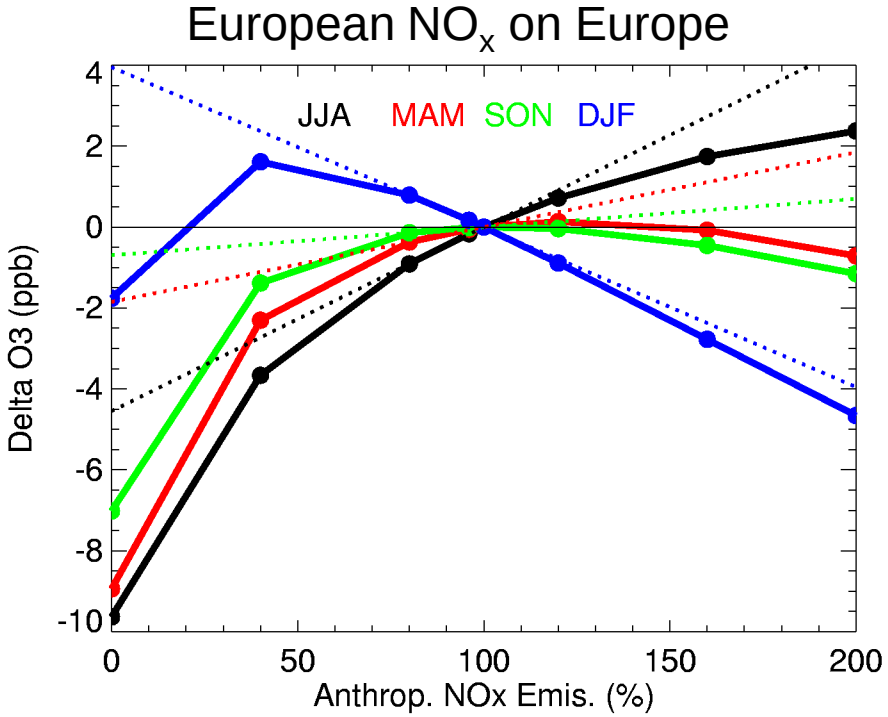
Typically 3-7%

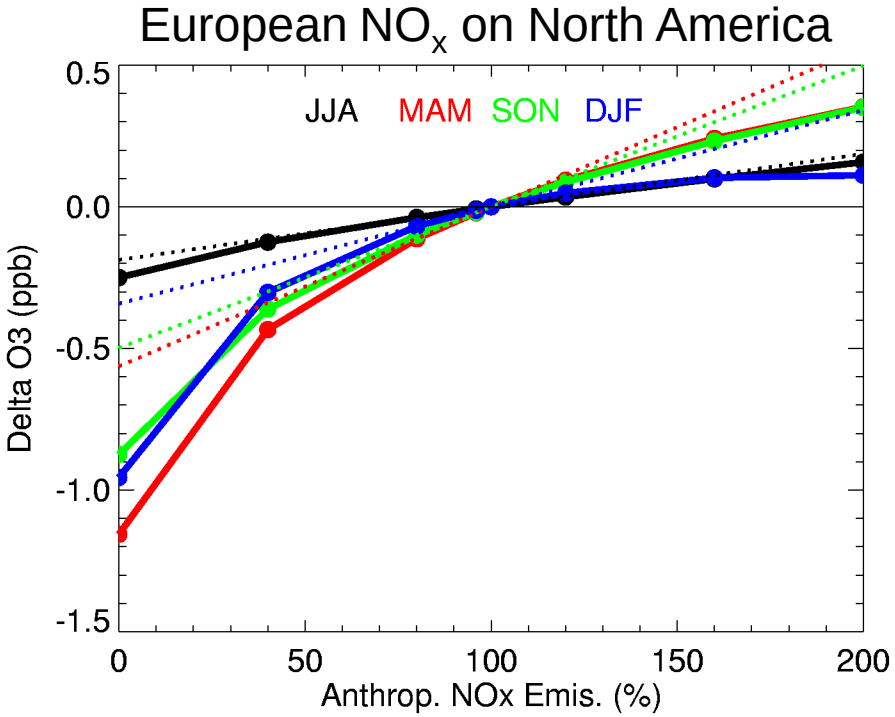
Typically 1-3%

Testing Linearity



Testing Linearity





- Emission perturbation size
  - Some caution required!

Figures: Arlene Fiore

Reconstruction

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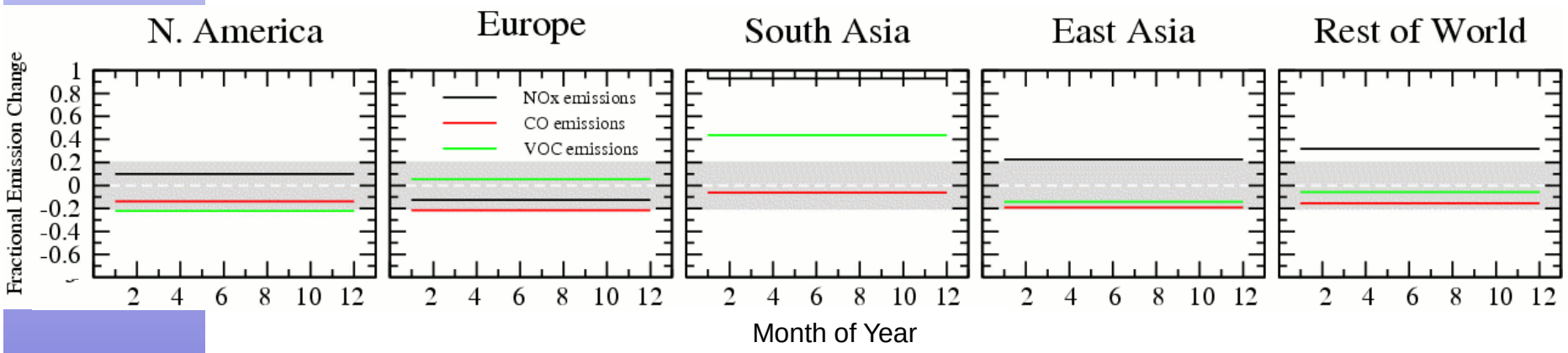
- To test, reconstruct earlier model studies

Run	Meteorology	Emissions	CH_4
ACCENT/AR4 model intercomparison			
S1	2000	2000	1760 ppb
S2	2000	IIASA 2030 CLE	2088 ppb
S3	2000	IIASA 2030 MFR	1760 ppb
S4	2000	IIASA 2030 A2	2163 ppb
Royal Society model intercomparison			
RS1	2001	2000	1760 ppb
RS2	2001	IIASA 2050	2363 ppb
RS4	2001	- No anth -	700 ppb
RS5	2001	IIASA 2050	1760 ppb

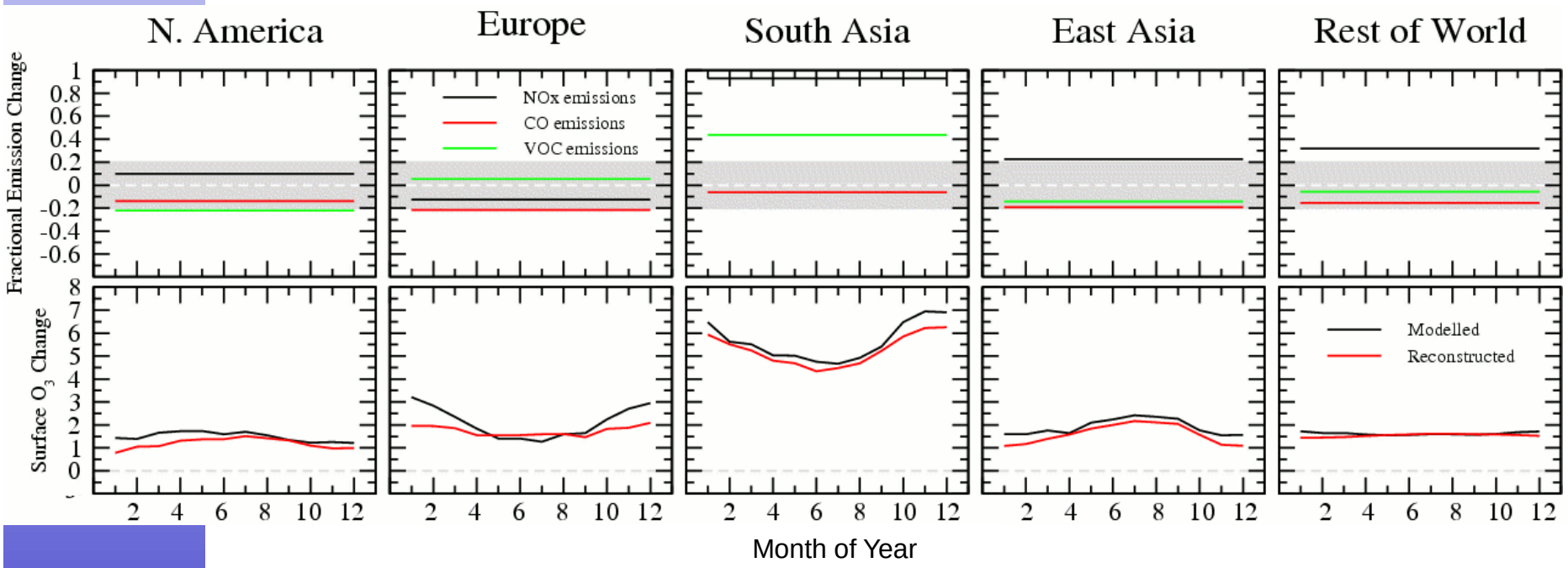
ACCENT run S2: IIASA 2030 CLE

(CH_4=2088 ppbv)



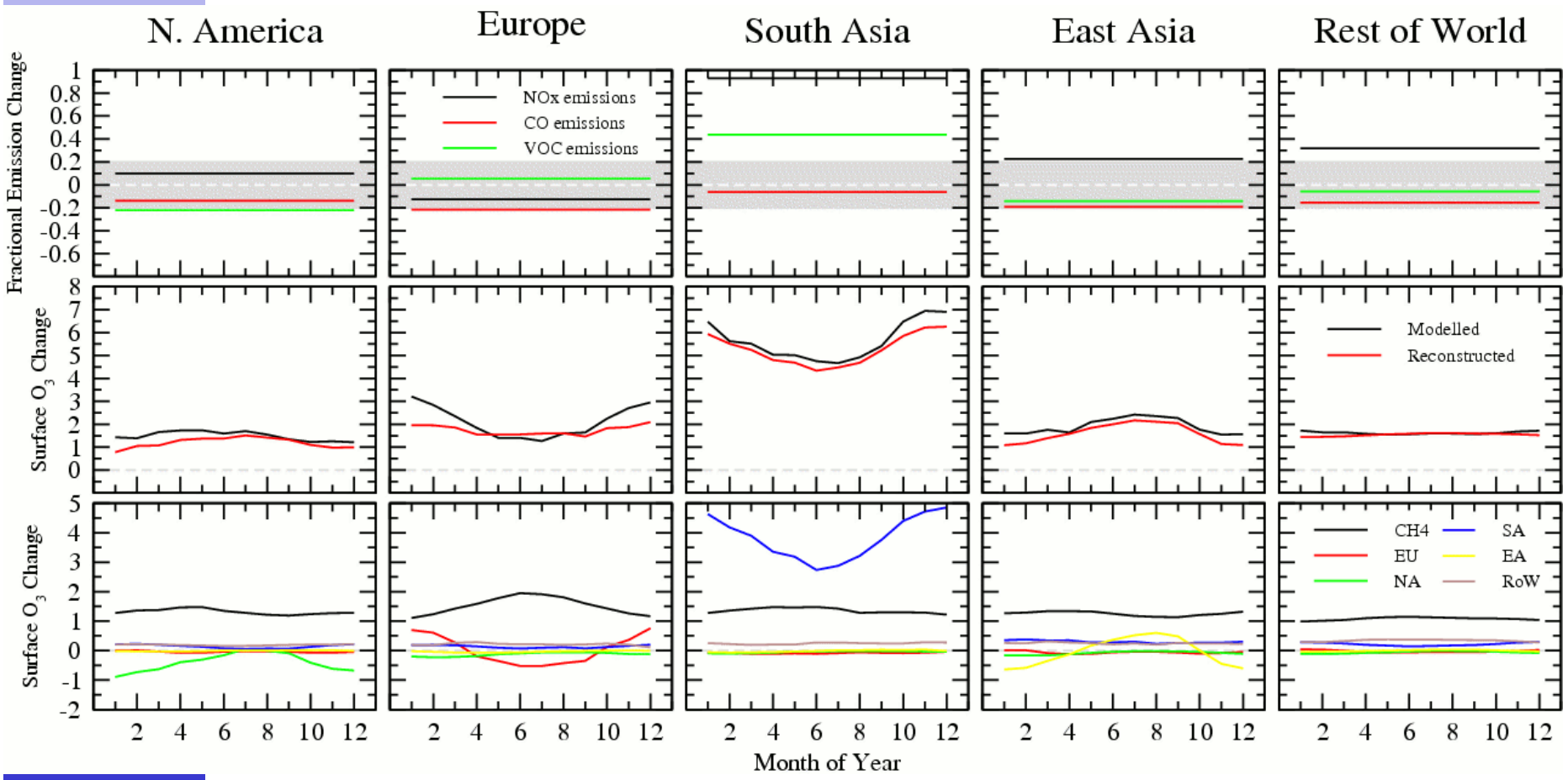
- Fractional emission change over each region
- Grey region indicates 20% changes w.r.t. present
  - Our comfort zone for linearization

ACCENT run S2: IIASA 2030 CLE



- **Black**: Surface O_3 changes in full model run
- **Red**: O_3 reconstructed with HTAP linearization

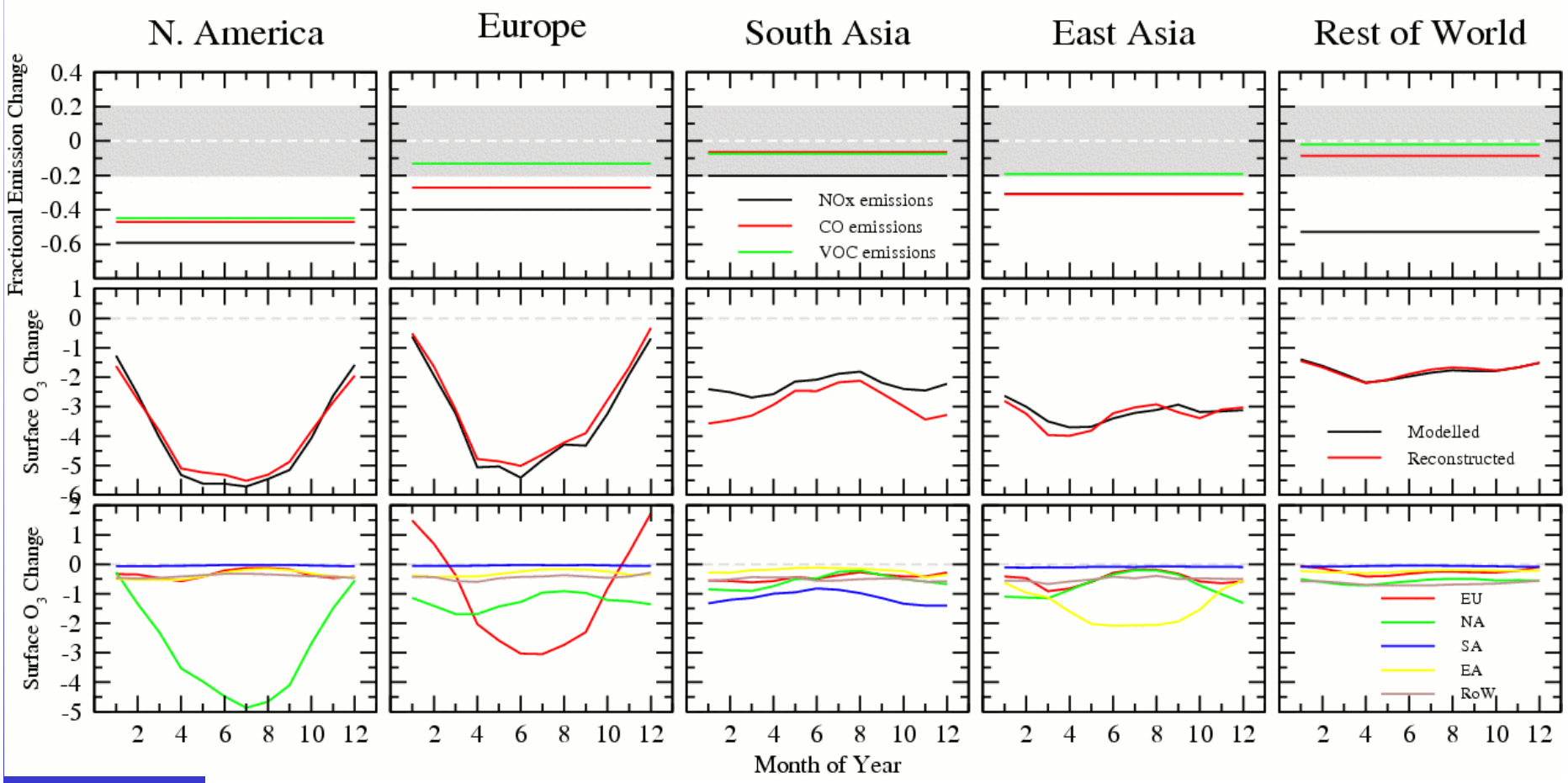
ACCENT run S2: IIASA 2030 CLE



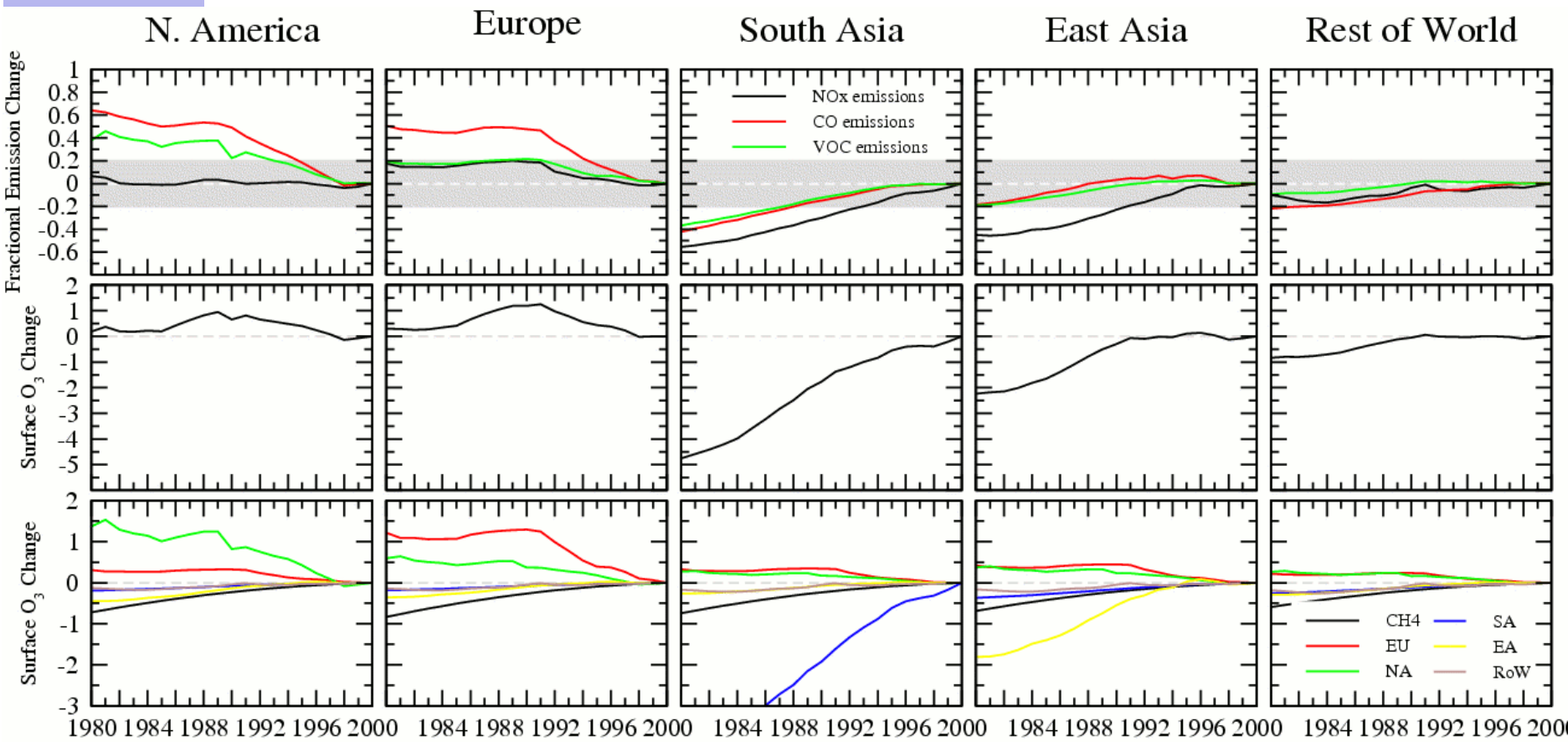
- Linearization allows estimate of source attribution

Royal Society RS5: IIASA 2050

(CH_4=1760 ppbv)



Surface O_3 trends from RETRO emissions (relative to 2000)



- Issues: fractional vs. absolute emission changes, long-term CH_4 response neglected, FRSGC/UCI CTM results only (for now…)

Summary

- Linearization provides useful information
  - Can estimate S-R relationships with changing emissions
  - Can estimate anthrop. contributions to surface O_3 trends
  - Assumptions hold – but don't push too far!

- To complete analysis, require:
  - A few additional runs from HTAP models
    - SR3GL/SR4GL/SR5GL (20% reduced global emissions)
    - 1980/2030 emission runs (to allow more robust testing)
    - Add ensemble/uncertainty envelope to results shown here
  - Self-consistent regional emission data and trends
    - O_3 trend estimates rely on these!
    - Trend analysis at specific measurement locations