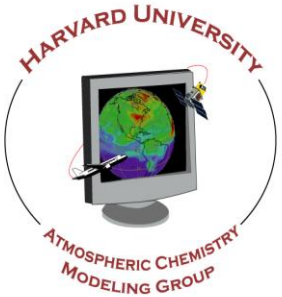
Chemical nonlinearities in relating intercontinental ozone pollution to anthropogenic emissions



Shiliang Wu

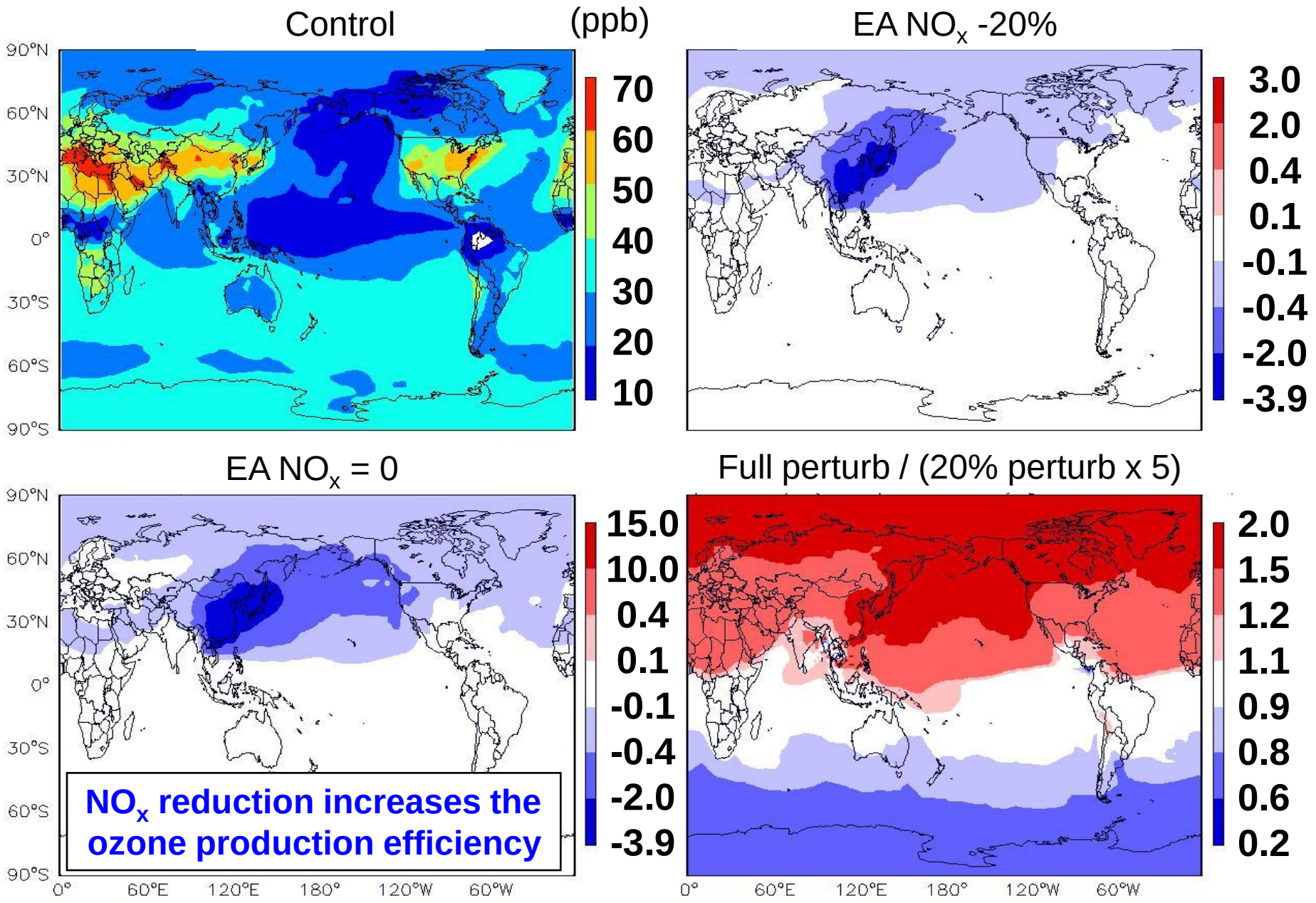
Bryan Duncan, Arlene Fiore,
Oliver Wild, Daniel Jacob

HTAP meeting, Washington, DC
June 12, 2008

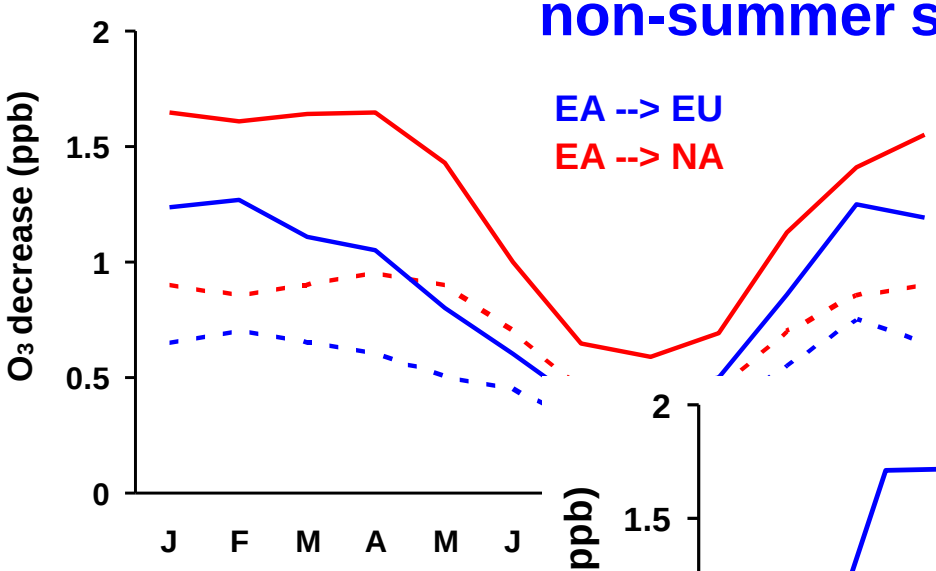
with support from the NASA/MAP program

Non-linearity in NO_x perturbations (GMI – JJA)

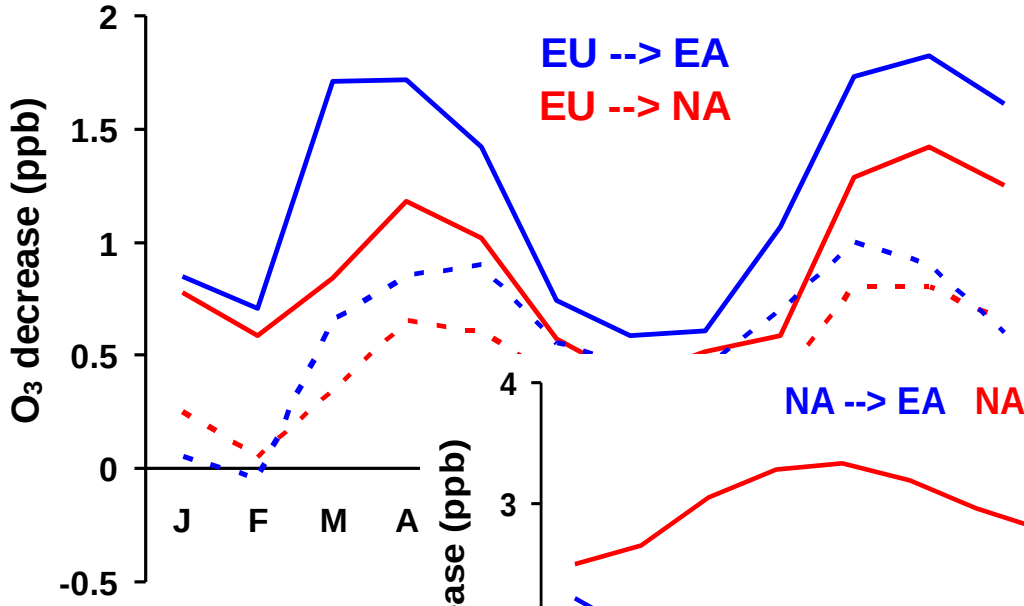
(surface ozone and changes due to perturbations in EA NO_x emissions)

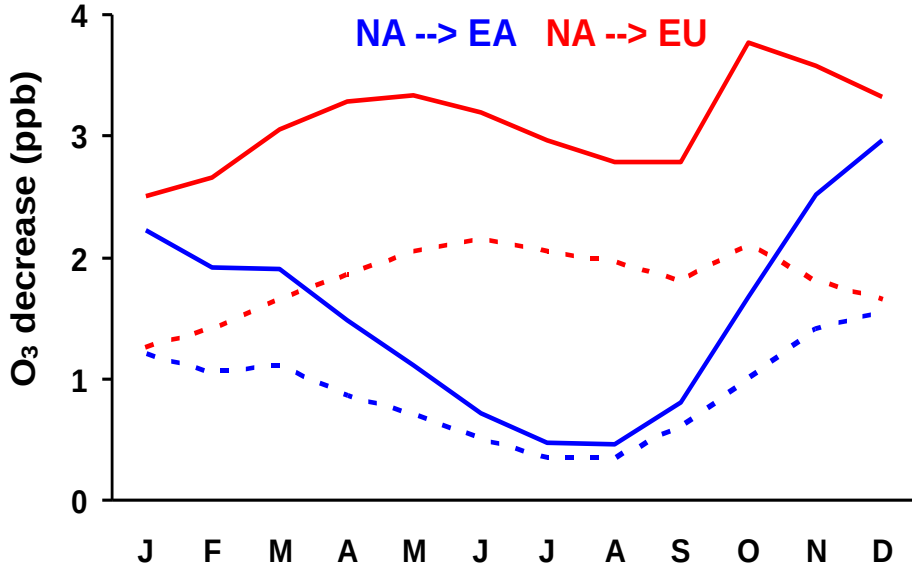


Even stronger nonlinearity in NO_x perturbations for non-summer seasons (GMI)



Ozone production is most NOx-limited in summer and hence shows the best linearity



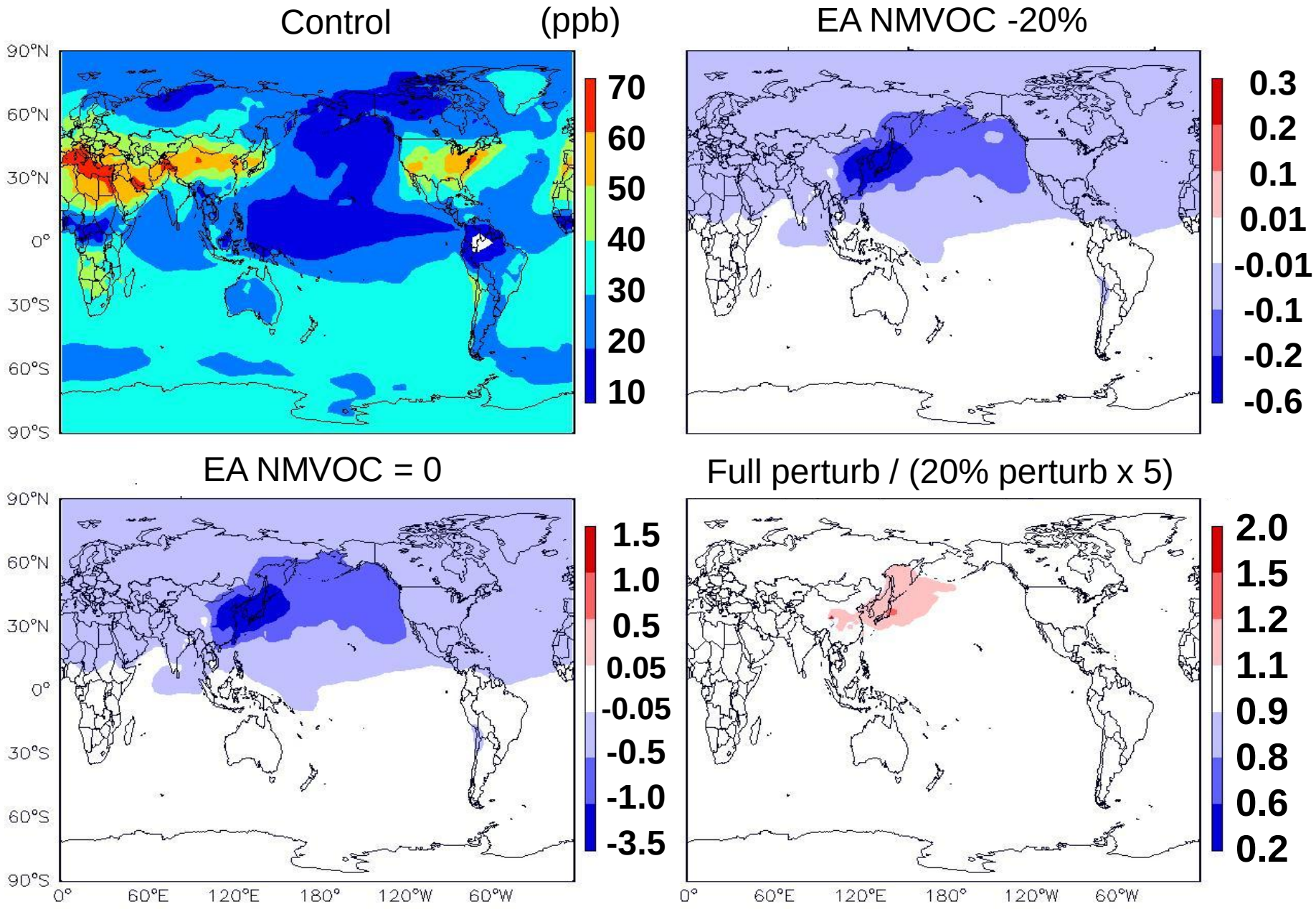


- - - - (effects from -20% NO_x) x 5

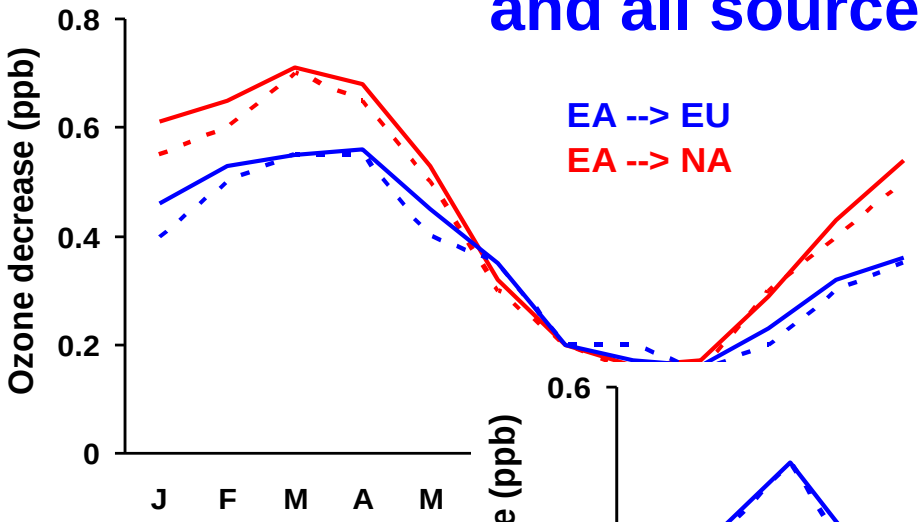
____ effects from -100% NO_x

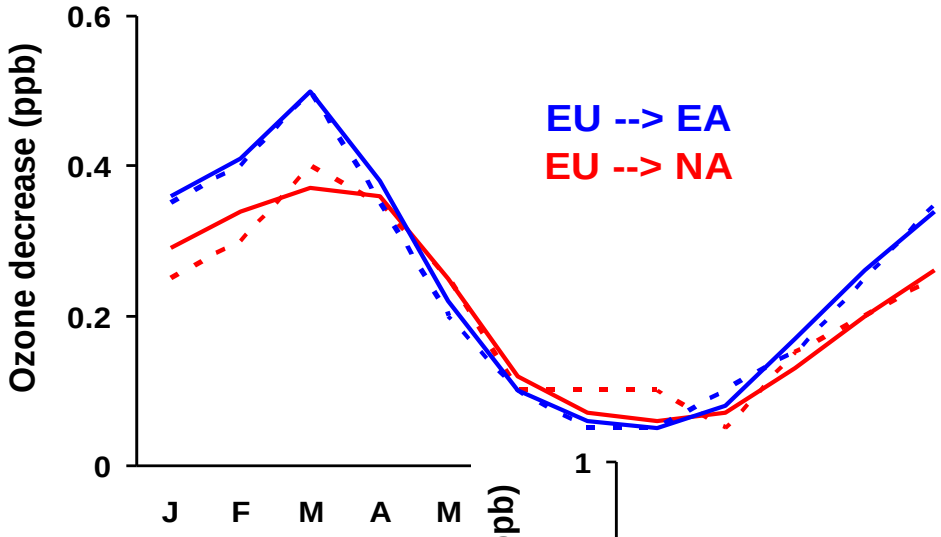
VOC perturbations show very good linearity (GMI – JJA)

(surface ozone and changes due to perturbations in EA VOC emissions)

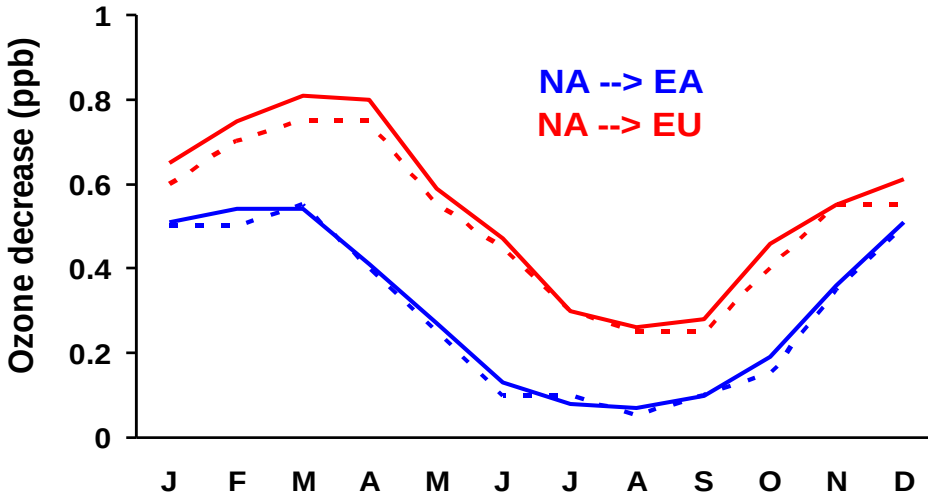


VOC perturbations show very good linearity for all seasons and all source-receptor pairs





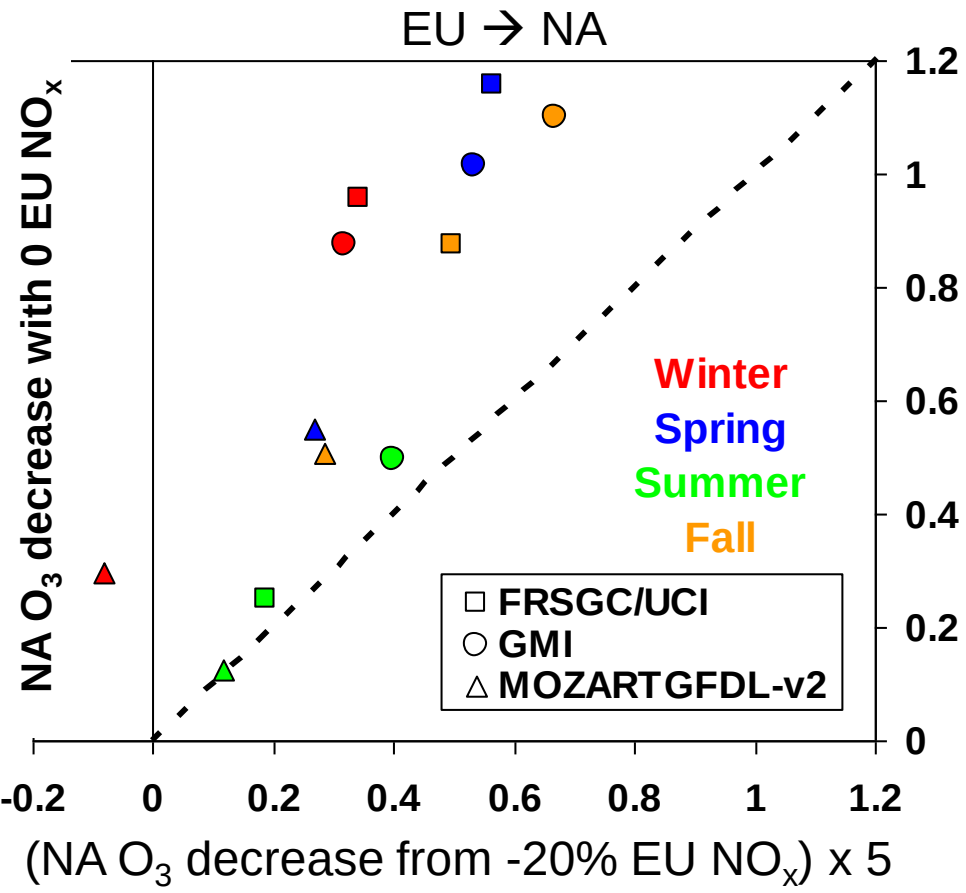
Much less variability in OPE with regard to VOCs compared to NO_x
[Wang & Jacob, 1998]



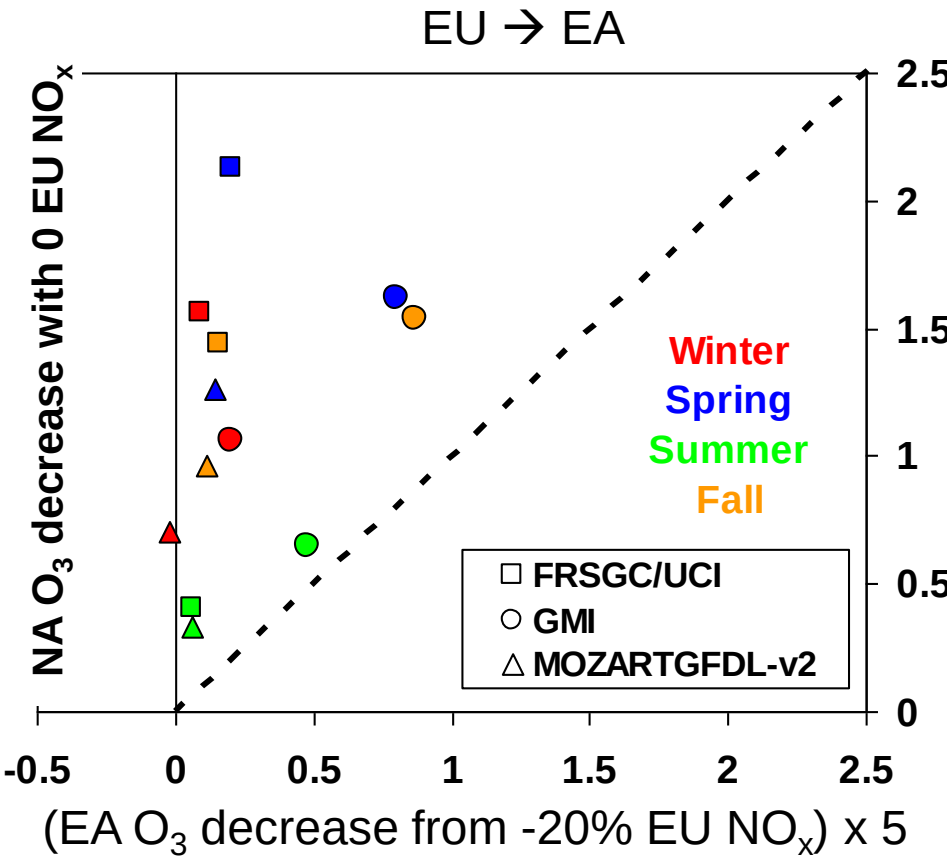
- - - - (effects from -20% VOC) x 5

____ effects from -100% VOC

Nonlinearity with EU NO_x perturbations - model intercomparison



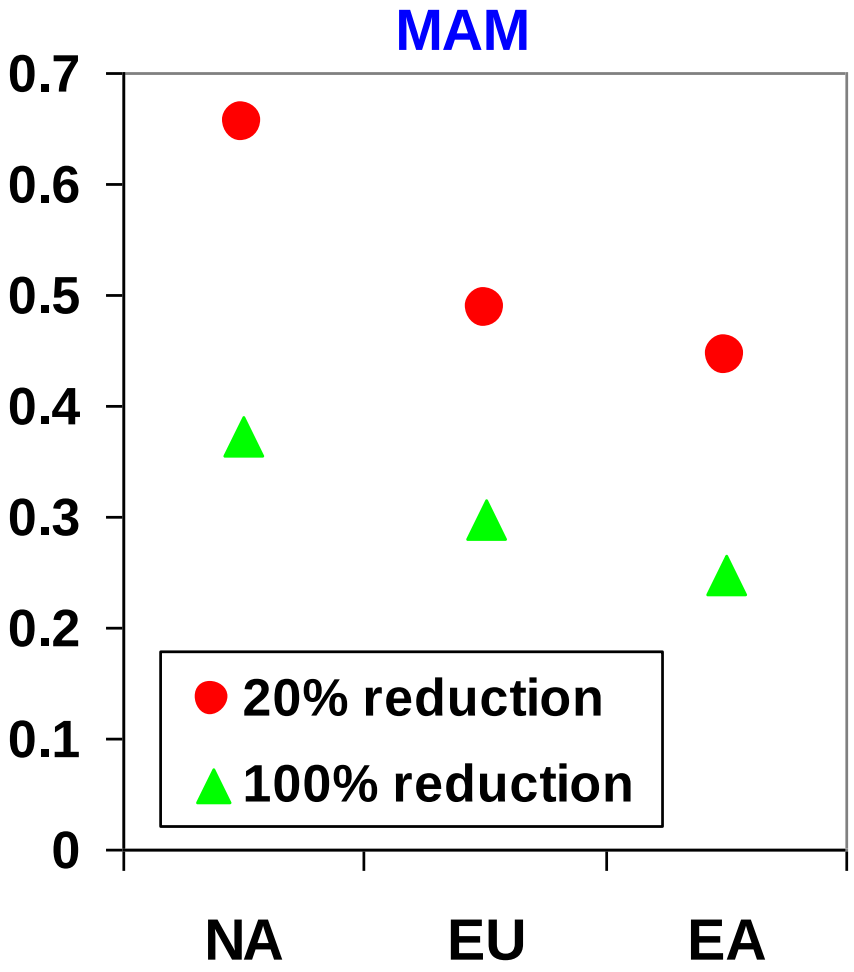
Despite differences in ozone response magnitudes, all models show best linearity in summer.

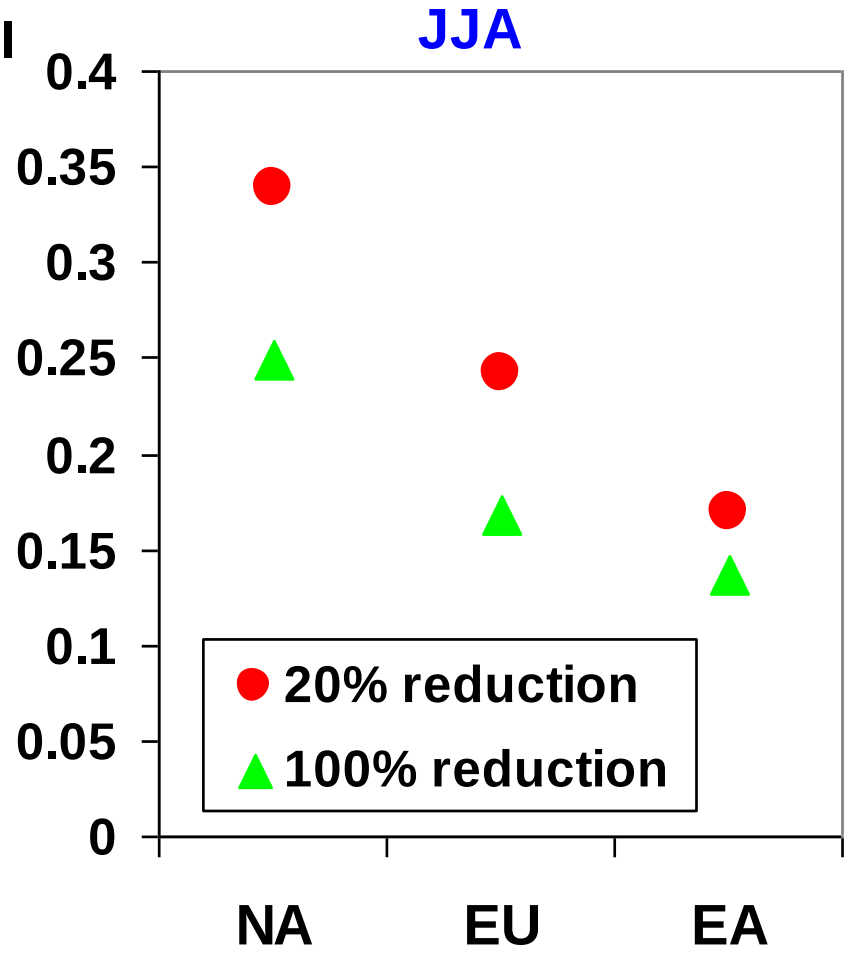


Relative benefit in controlling NMVOCs vs. NO_x is larger with smaller magnitude of emission reductions

$$\frac{\Delta\,(O_3) \text{ from foreign NMVOC reduction}}{\Delta\,(O_3) \text{ from same \% foreign } NO_x \text{ reduction}}$$

GMI

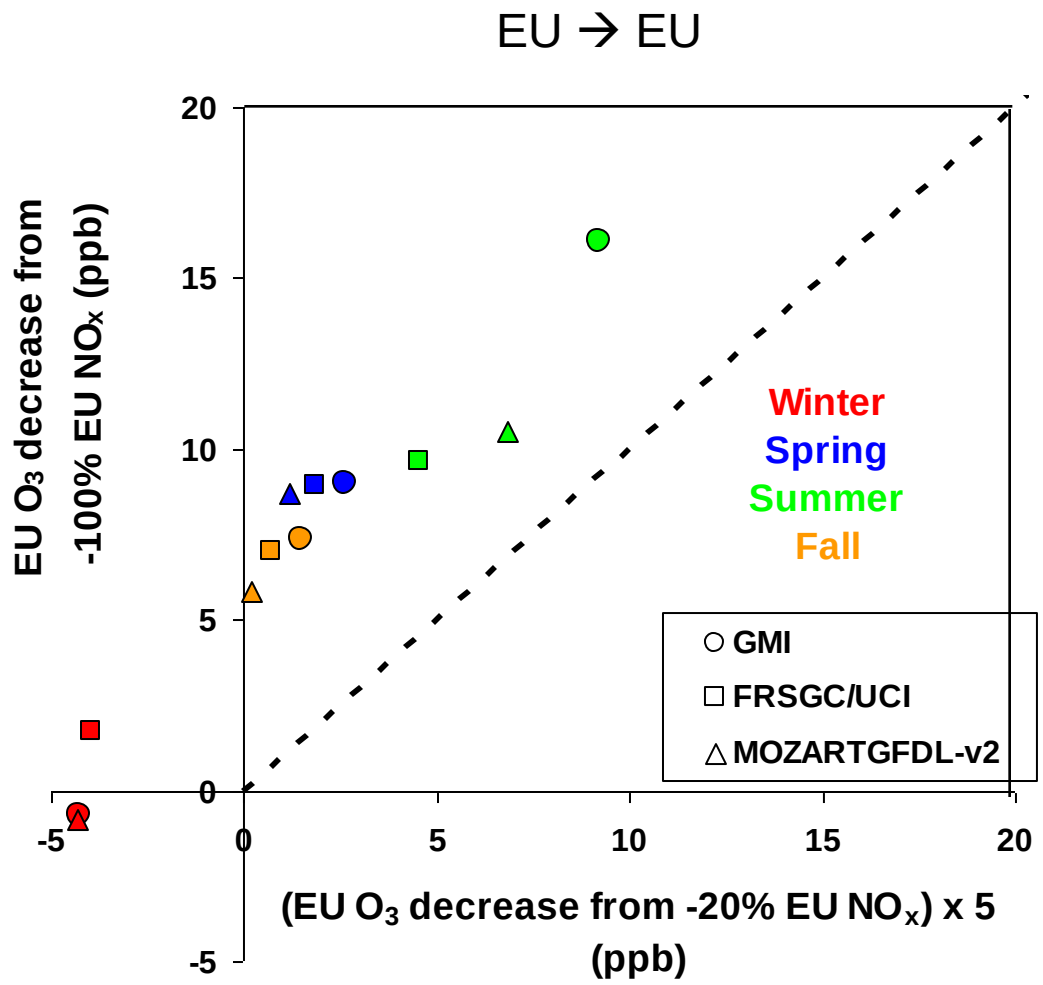




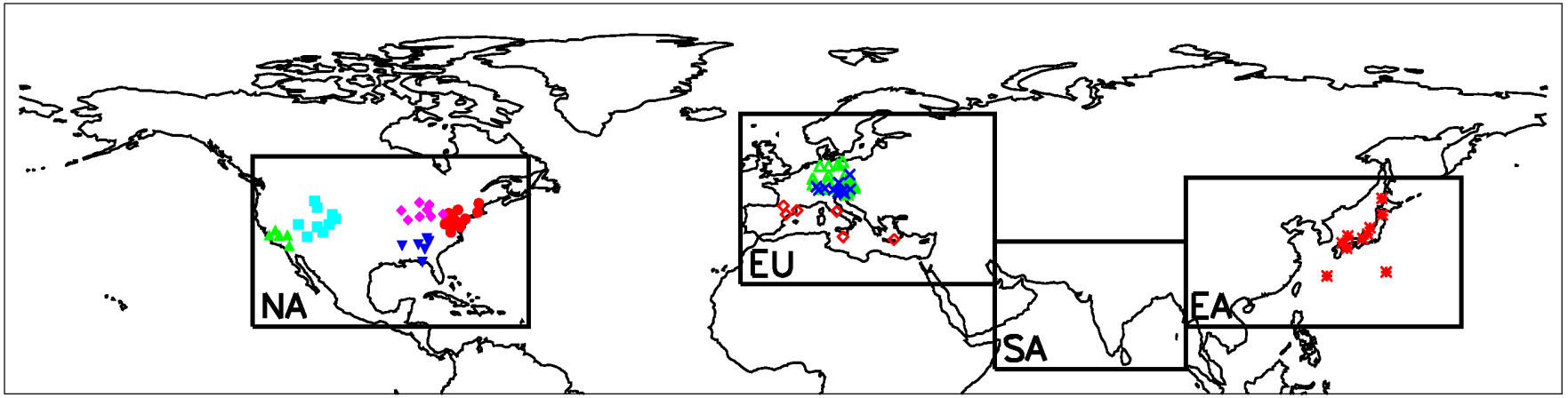
Thank you!

Backups

Nonlinearity with EU NO_x perturbations – model intercomparison



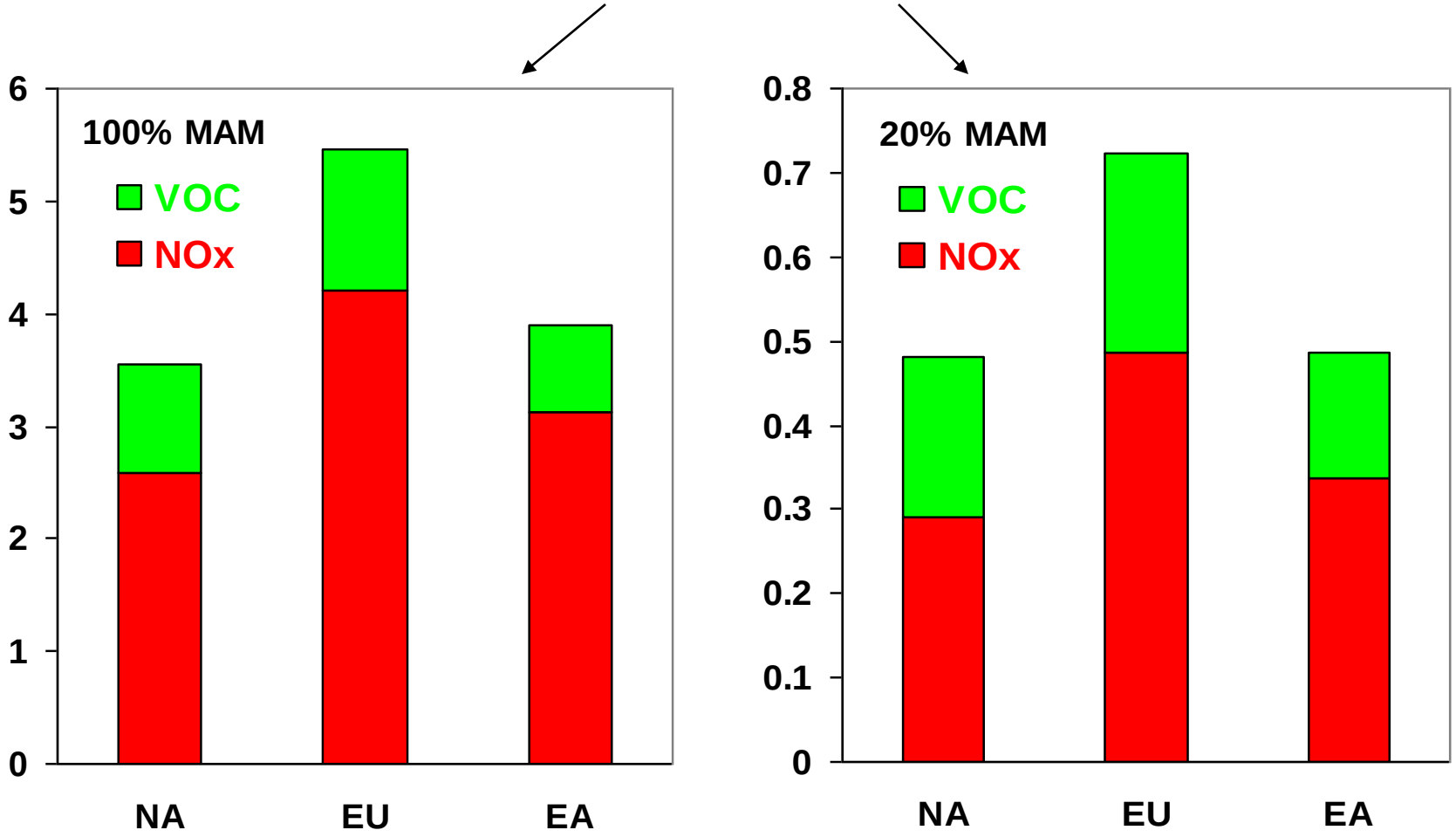
Region definition



Fiore et al., 2008

Changes in surface ozone due to perturbations in 'foreign' emissions (GMI / spring)

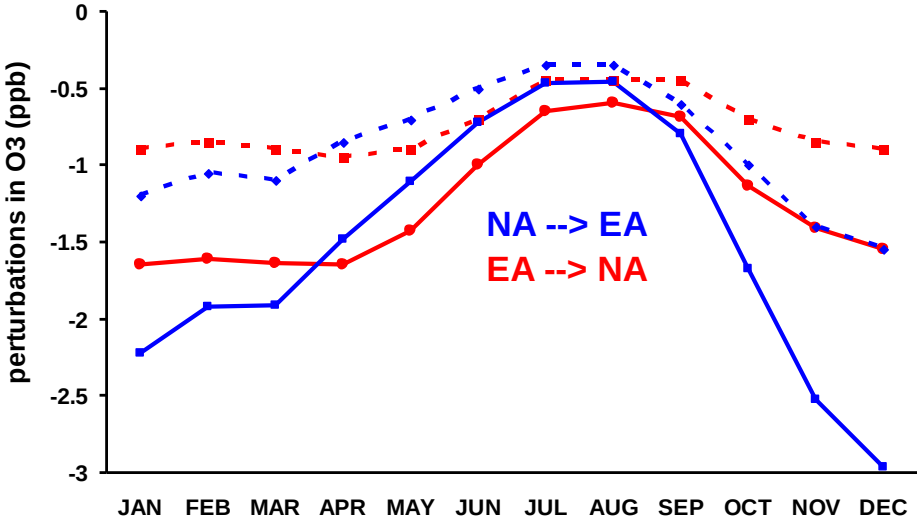
Relative importance of NOx vs. NMVOCs in intercontinental transport depends on the magnitude of emission reductions

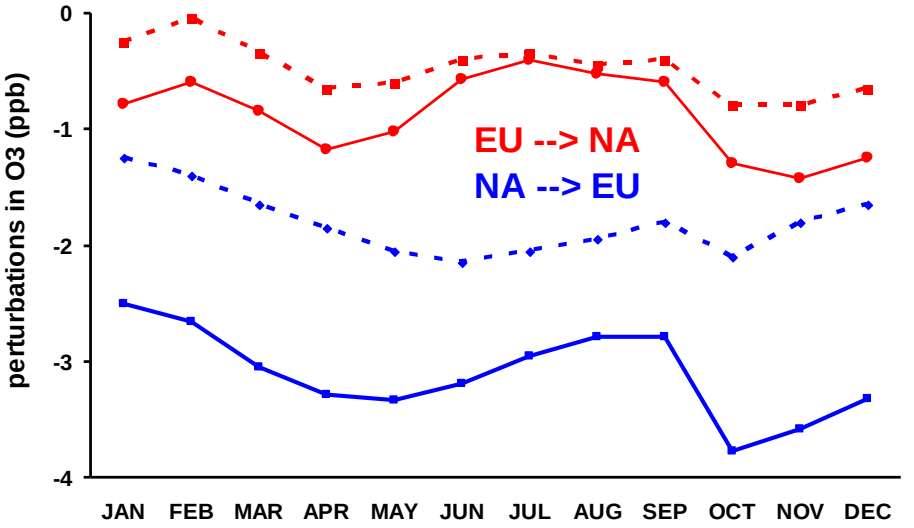


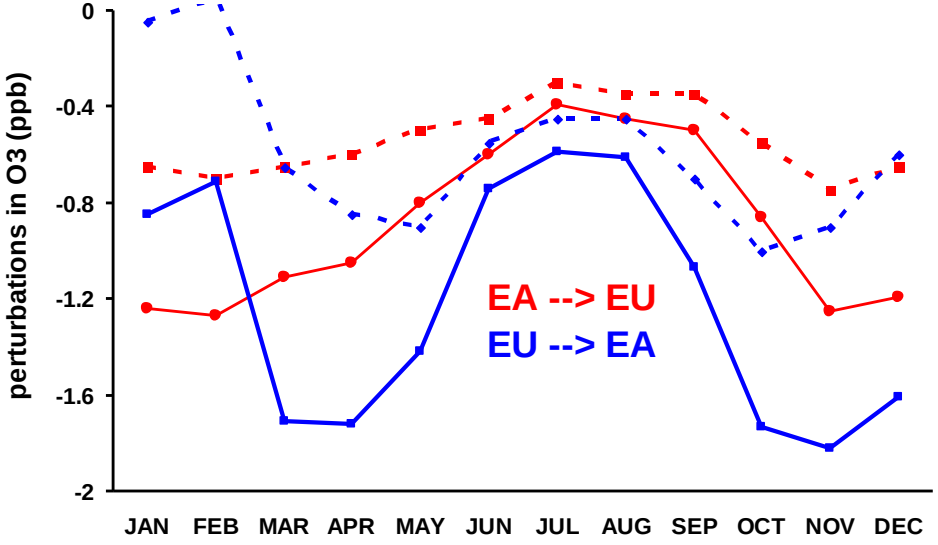
Mutual comparison among different pairs in sensitivity to intercontinental NO_x perturbations

- - - - (effects from -20% NO_x) x 5

—— effects from -100% NO_x

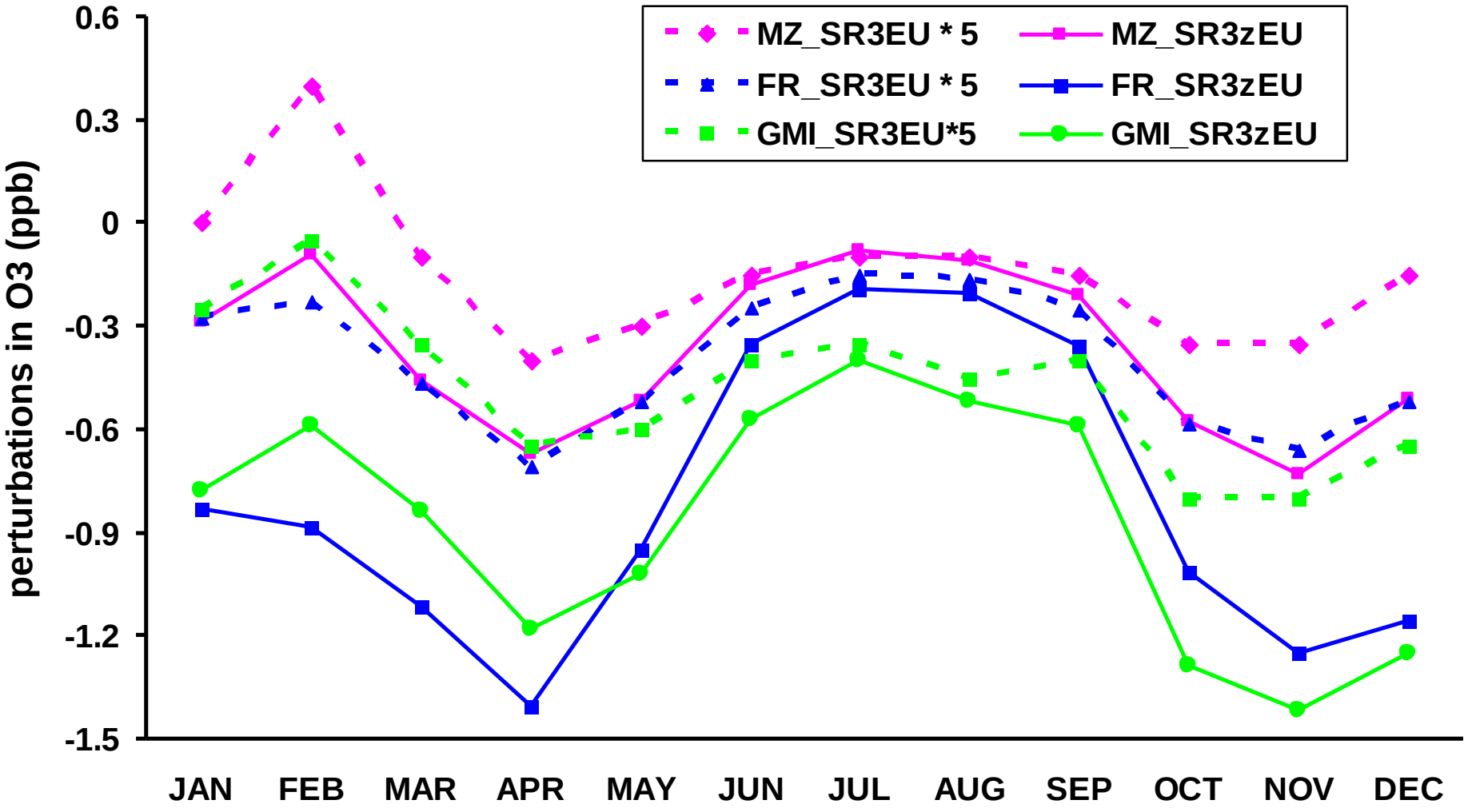






Consistency and discrepancy across models

(Changes in NA surface O_3 due to changes in EU NO_x emissions)



- - - (perturbations from -20% EU anthro. NOx) x 5

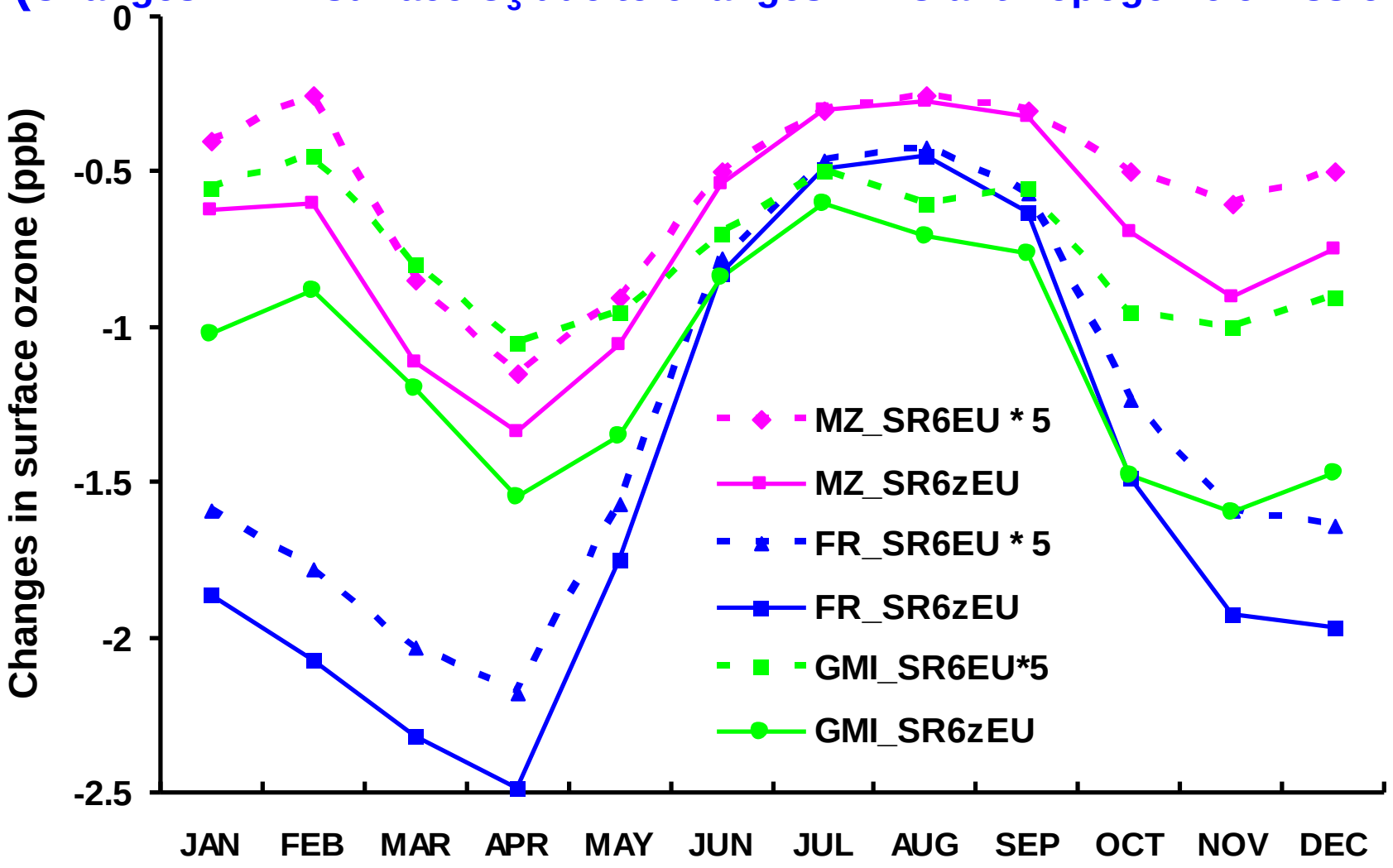
__ perturbations from zeroing out EU anthro. NOx

MZ = MOZART-v2 (Arlene Fiore)

FR = FRSGCUNI (Oliver wild)

Consistency and discrepancy across models

(Changes in NA surface O_3 due to changes in EU anthropogenic emissions)



- - - (perturbations from -20% all EU anthro. emis) x 5

__ perturbations from zeroing out EU anthro. emis