

Sensitivity of surface ozone and source receptor relationships to changing climate in the STOC-HadAM3 Model

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- **Part 1:** Change in surface ozone between 2000 and 2050 under a single future climate forcing/emissions scenario
- **Part 2:** Comparison of the ozone response to the same 20% NA emission reduction under 2000 and 2050 climates



Runs Performed

- Run 1: 2000 baseline (2000 climate and emissions) SR1
- Run 2: 2050 baseline (2050 climate and emissions) SR1
- Run 3: HTAP SR6NA type perturbation to Run 2 (i.e., all anthropogenic emissions reduced by 20% over North American region)
- Run 4: 2000 climate, with 2050 emissions
- Run 5: SR6NA perturbation to Run 4, (thus applying same emission perturbation as Run 3 but under a 2000 rather than 2050 climate)

All 10-year runs except Run 5, which was 6 years

2000 and 2050 emissions and climate forcings

•Emissions

- Source-gas emissions from IIASA CLE scenario applied to 'socioeconomics' of SRES B2
- 2000 anthro NO_x emissions 33.8 (global) 6.9 (NA) Tg N year⁻¹
- 2050 anthro NO_x emissions 20.2 (global) 2.1 (NA) Tg N year⁻¹
- Specified CH_4 mixing ratios: 1760 ppbv for 2000 and 2363 ppbv for 2050
- Interactive lightning NO_x and isoprene (sensitive to climate)

•Climate

- SST and sea ice from the HadGEM ocean/atmosphere transient run using SRES-A1B climate forcing scenario for 2000 and 2050 decades
- CO_2 : 370 ppmv for 2000 and 532 ppmv for 2050
- ΔT 2050-2000 = 1.5K

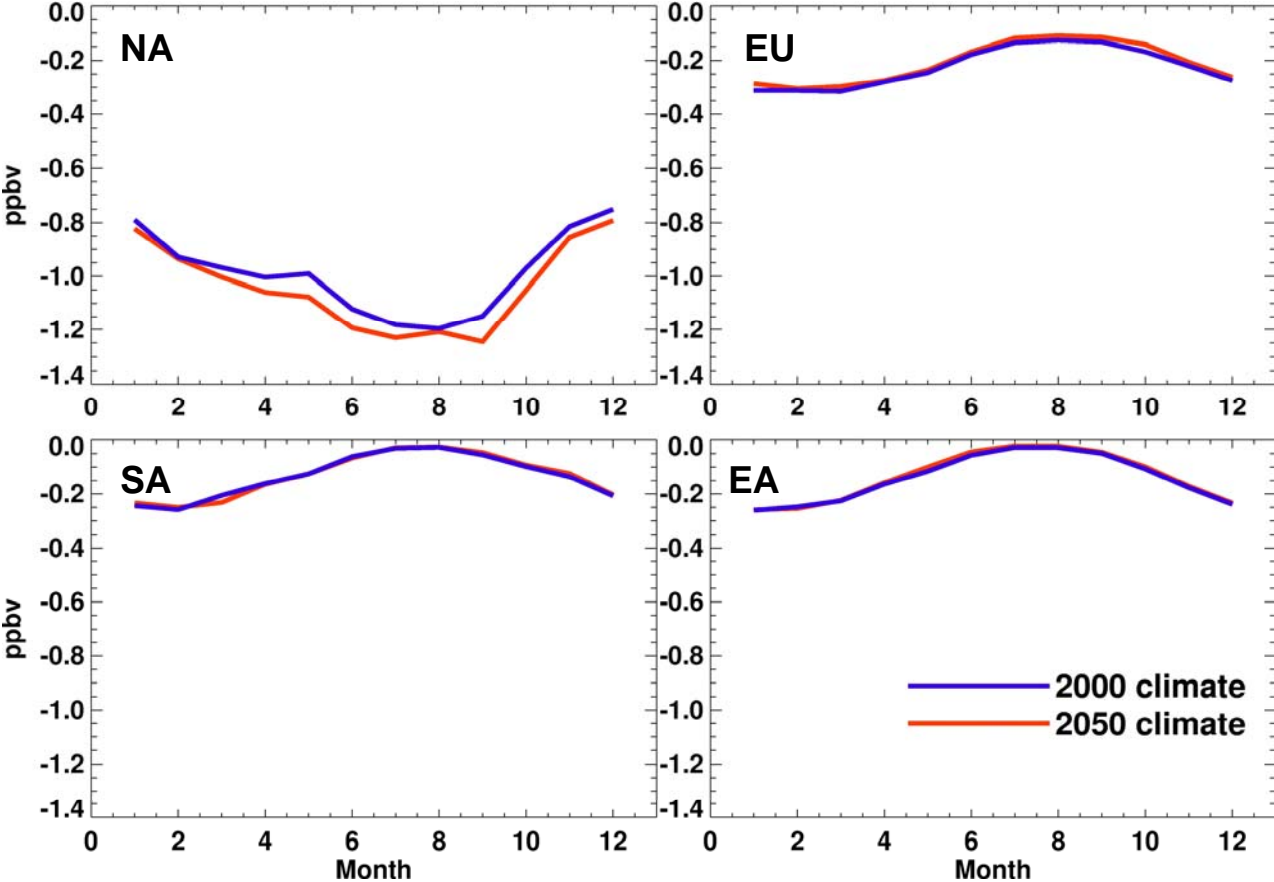
Part 1:

**Change in emissions, climate and surface ozone
between 2000 and 2050**

Part 2:

**Comparison of the ozone response to the same
20% NA emission reduction under 2000 and 2050
climates**

Annual cycle in Difference in Surface Ozone SR6NA minus SR1 with 2000 and 2050 Climates (same emissions and perturbation)



Conclusions

- In this study both future anthropogenic emissions changes and climate change affect surface ozone by a few ppbv
- Increased humidity in future climate tends to increase ozone over continents and decrease ozone over oceans—related to the NO_x abundance. Increased temperatures reduce PAN leading to greater local NO_x availability hence ozone production; also higher isoprene emissions which may contribute to increased ozone over the continents
- Spatial distribution of impact of NA emission reduction looks almost identical in 2000 and 2050 climates—little evidence of difference in transport patterns
- Small differences in surface ozone responses to perturbed emissions under 2000 and 2050 climates may be the result of changes in NO_x to PAN conversion:
 - Greater local ozone reduction in source region following NO_x reduction in 2050 than in 2000—possibly higher temperatures lead to less NO_x being sequestered into PAN in 2050. (Suggests ozone may be marginally more susceptible to emission controls in future)
 - In EU, downwind of NA emission, NO_x reduction has smaller effect on ozone in 2050 climate than 2000—less transport of NO_x in the form of PAN (LRT of ozone however may be less susceptible to emission controls)

Recommendations from the two studies

- These two studies use the same future emissions and same future climate SSTs.
- Both sets of results suggest a slightly larger ozone sensitivity (~ 0.05 - 0.2 ppbv) to NA emission reductions in a warmer climate in the source region due to less NO_x to PAN conversion but a slightly reduced ozone sensitivity downwind (~ 0.02 - 0.1 ppbv)
- This effect occurs in the 4 HTAP source regions
- The ozone sensitivity to emissions reductions in the source region increases in a warmer 2090 compared to a 2050 climate
- Overall the differences in the effects of emission perturbations to climate are relatively SMALL
- Run length of 5 years seems sufficient to exclude interannual variability
- Further experiments should probably use large climate changes and large emission perturbations. In these experiments 2050 emissions over NA are small