Tropospheric ozone budget in AerChemMIP experiments

Paul Griffiths, Youngsub Matthew Shin, James Keeble, N. Luke Abraham and Alexander Archibald

National Centre for Atmospheric Science Yusuf Hamied Dept of Chemistry, University of Cambridge

Tropospheric ozone budget in CMIP6 experiments

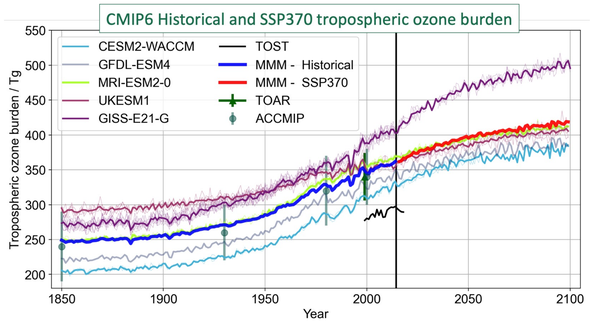
The CMIP6 Historical (CMIP) and SSP3-7.0 (ScenarioMIP) experiments revealed a wide diversity in simulated ozone levels and trends.

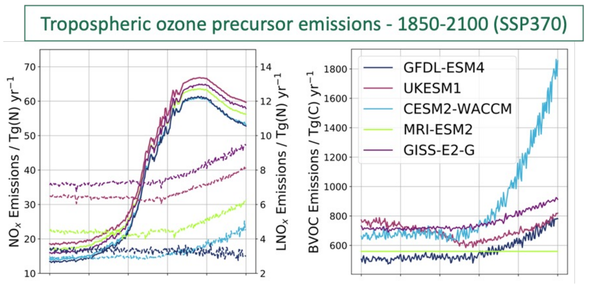
Understanding these differences requires a good understanding of emissions of ozone precursors and stratosphere-troposphere transport.

Online precursor emissions e.g. LNOx and BVOCs vary widely between models. Can we use AerChemMIP [Collins et al., 2017] experiments to add value to this process of understanding model diversity?

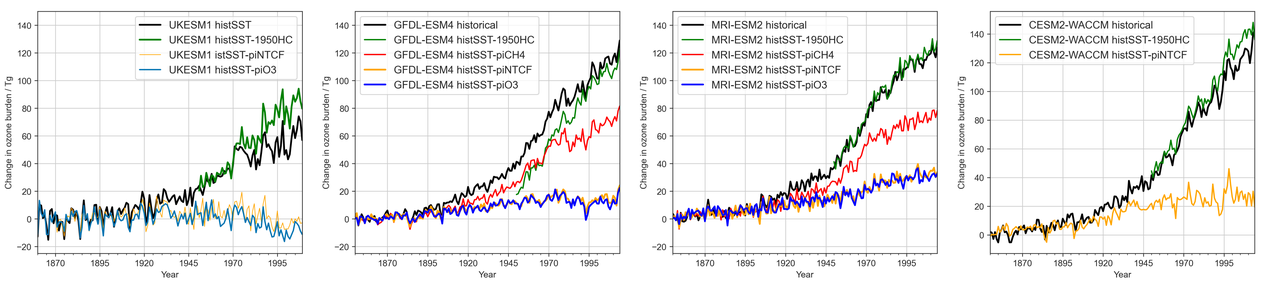
AerChemMIP experiments involve attribution experiments where emissions are held constant at 1850 values.
We focus on histSST-piX AerChemMIP experiments which hold various forcings constant at 1850 level during historical AMIP transient experiments. Data from four online chemistry models are analysed.

The figure shows ozone burden changes in the histSST experiments, with a focus on ODS/halocarbons, near-term climate forcers (piNTCF = aerosols + ozone precursors, but not methane, piO3=ozone precursors only) and methane.





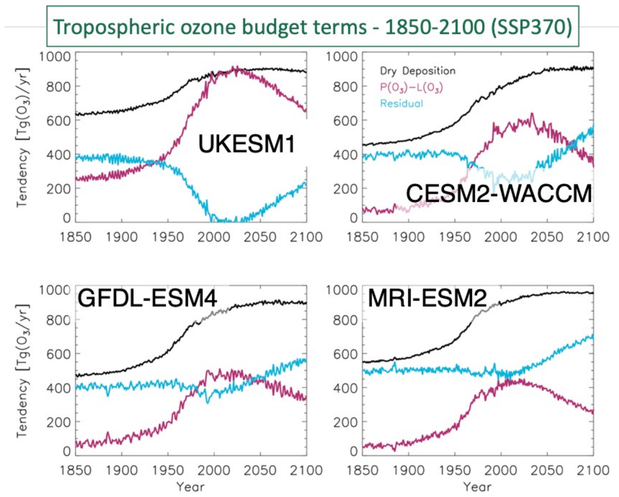
Experiment_ID	CH4	N2O	Aerosol Precursors	Ozone precursors	CFC/HCFC	Tier
histSST	Hist	Hist	Hist	Hist	Hist	1
histSST-piNTCF	Hist	Hist	1850	1850	Hist	1
histSST-piO3	Hist	Hist	Hist	1850	Hist	2
histSST-piCH4	1850	Hist	Hist	Hist	Hist	1
histSST-1950HC	Hist	Hist	Hist	Hist	1950	1

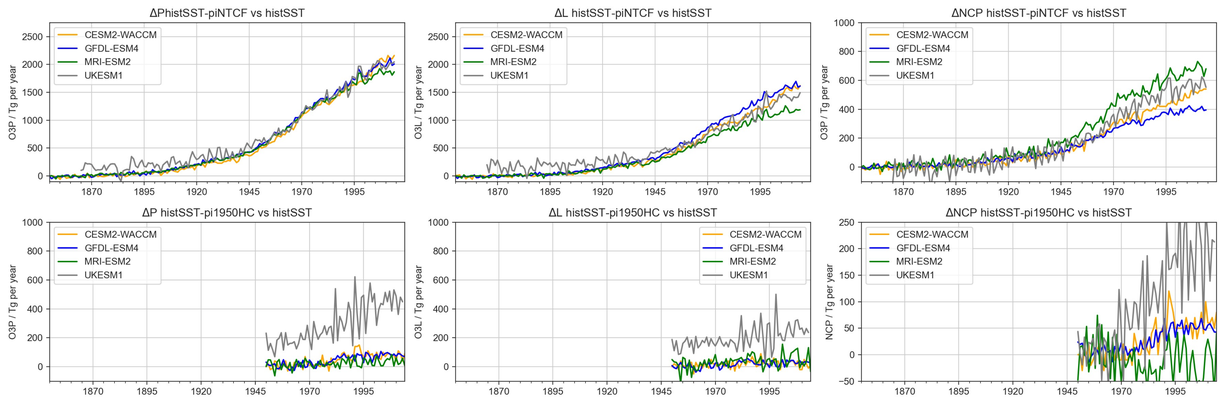


Large diversity in ozone changes are seen, broadly consistent with previous work. The sensitivity of ozone to individual forcers is quite similar across GFDL-ESM4 and MRI-ESM2. MRI response to CFCs and and UKESM1 behaviour across the historical period in piO3/piNTCF is in the opposite sense to other CMIP6 models.

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

Tropospheric ozone budget in CMIP6 experiments





In AR6 analysis, we found large differences between models, particularly in the magnitude of net chemical production (O3P-O3L) and in inferred STE.

We performed a selected analysis of ozone budget, O3P, O3L and NCP across models and AerChemMIP experiments. We find that changes in O3P across the historical period are broadly similar, with greater diversity in O3L, driving differences in NCP.

The change in NCP across the historical period is around 200 Tg per year, smaller than the diversity between model NCP.

Summary

The AerChemMIP experiments have been used for attribution of the drivers of historical ozone burden and budget changes. Further work will concentrate on other CMIP6 models and experiments.

Historical transient experiments are useful for assessing changing chemistry sensitivity to emissions changes, e.g. changes to ozone production efficiency.

Acknowledgements

Funding from NCAS is acknowledged, and the contribution of contributing centres (NCAR, NOAA-GFDL, MOHC and MRI) are gratefully acknowledged.

UKRI Natural Environment Research Council