Tropospheric ozone burden and budgets in AerChemMIP experiments

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https://doi.org/10.5194/acp-2019-1216

National Centre for Atmospheric Science
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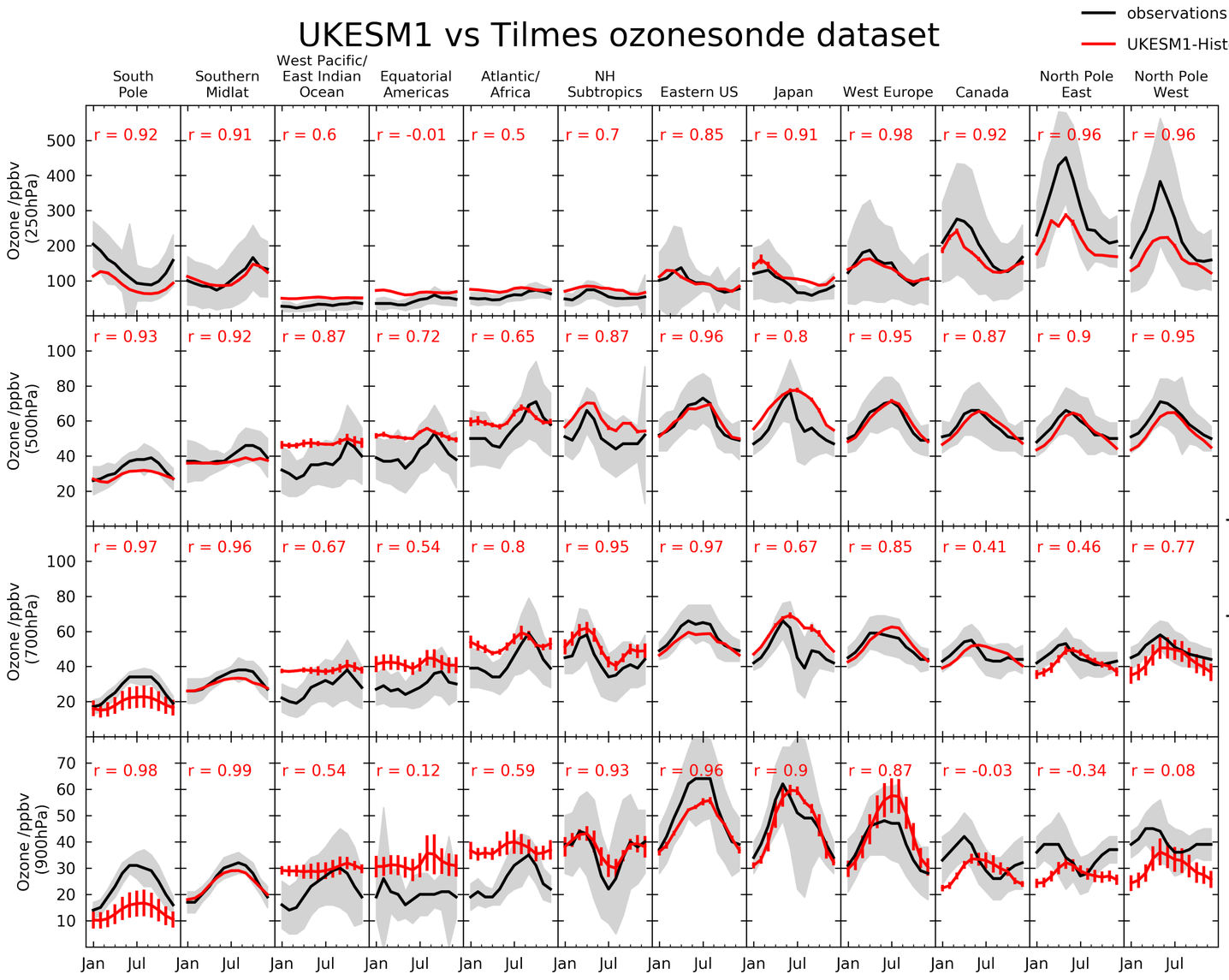
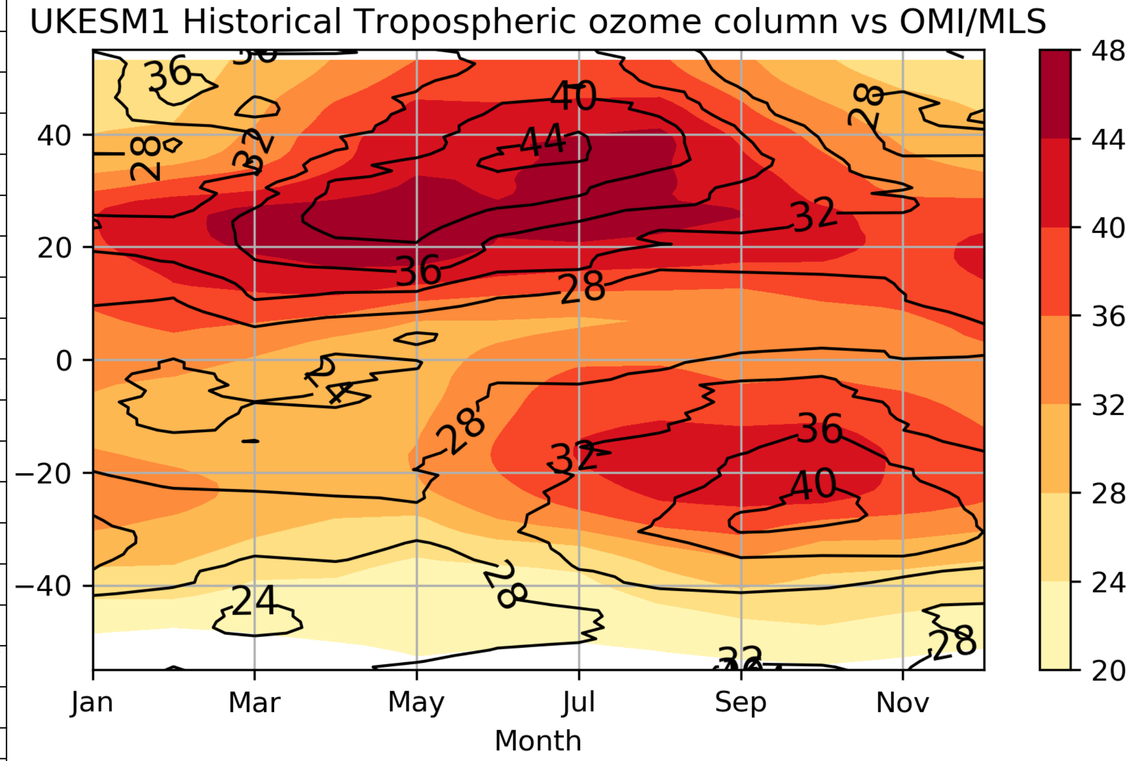
How does UKESM1 tropospheric ozone compare against observations?

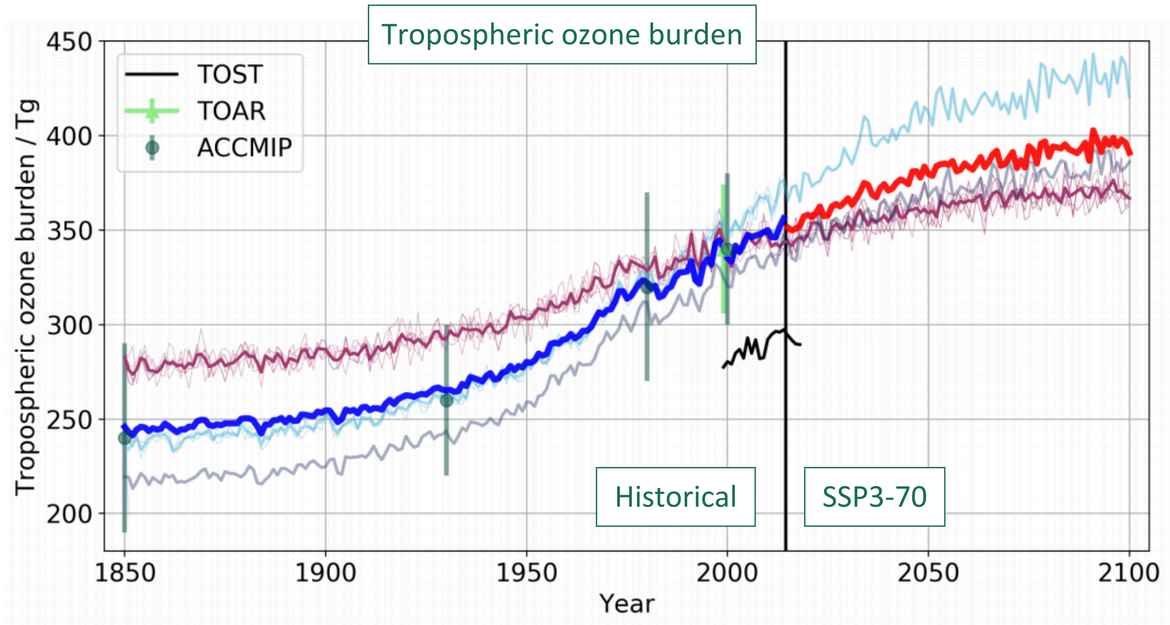


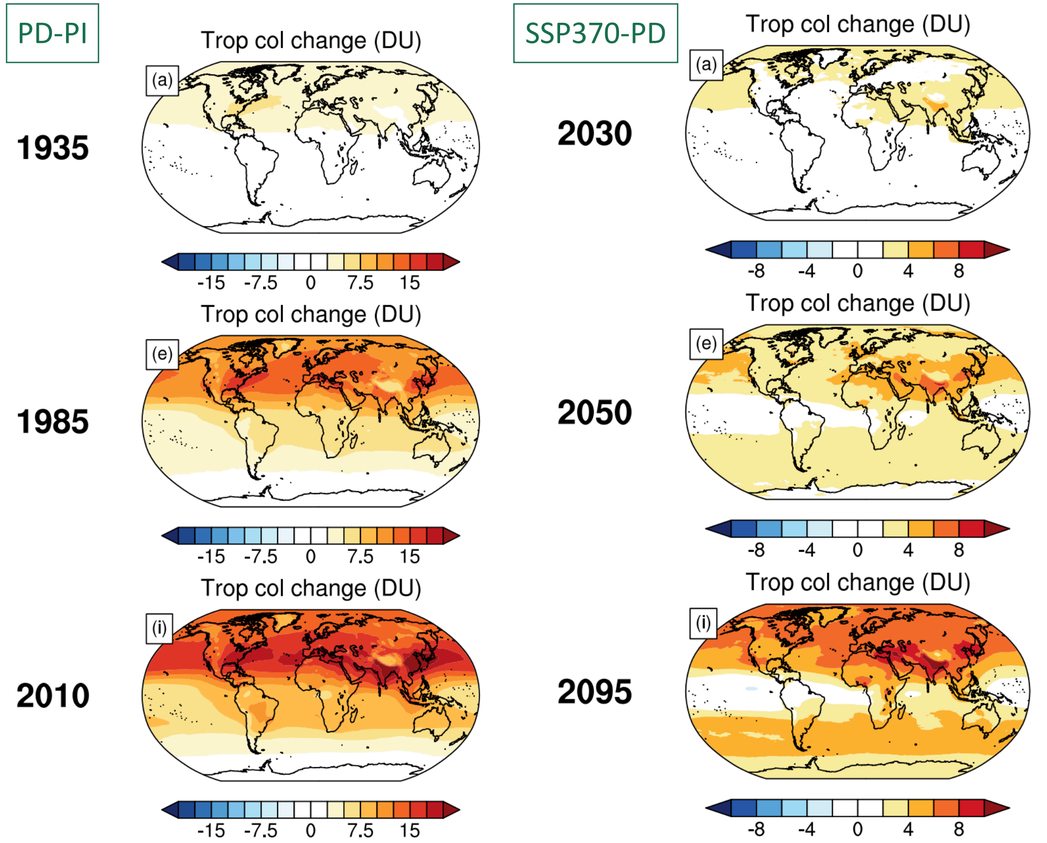


- UKCA tropospheric ozone compares well with observations, particularly in-situ .
- Integrated quantities, such as column amounts, sensitive to tropopause definition.

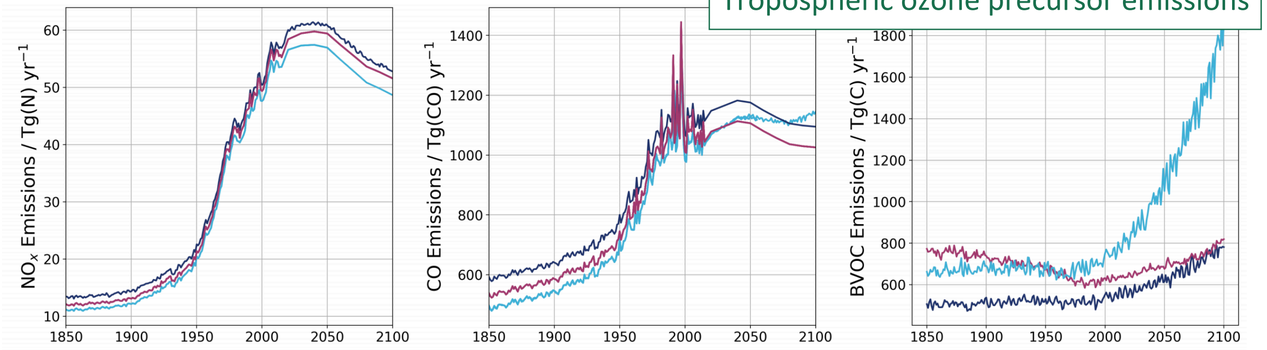
How does tropospheric ozone burden evolve in CMIP6?

- Analysis so far has focused on CMIP Historical and ScenarioMIP SSP3-70 experiments, for which suitable diagnostic output was available.
- Picture has changed little since CMIP5, MM range is also similar.
- Ozone burden increased by about 40% from 1850 levels of 240 Tg (MMM) with steepest rate of increase around 1960.
- In SSP3-70, the rate of growth of the burden declines further, as NOx emissions start to fall along this pathway after 2050.
- Nevertheless, strong local changes in ozone seen regionally at the end of the century.

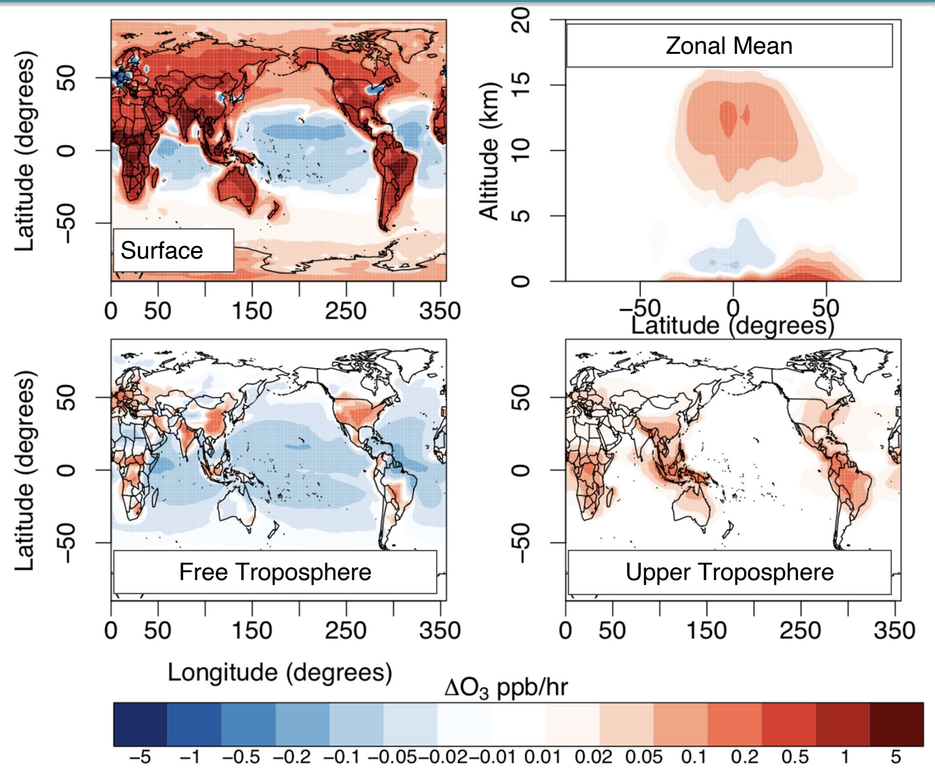


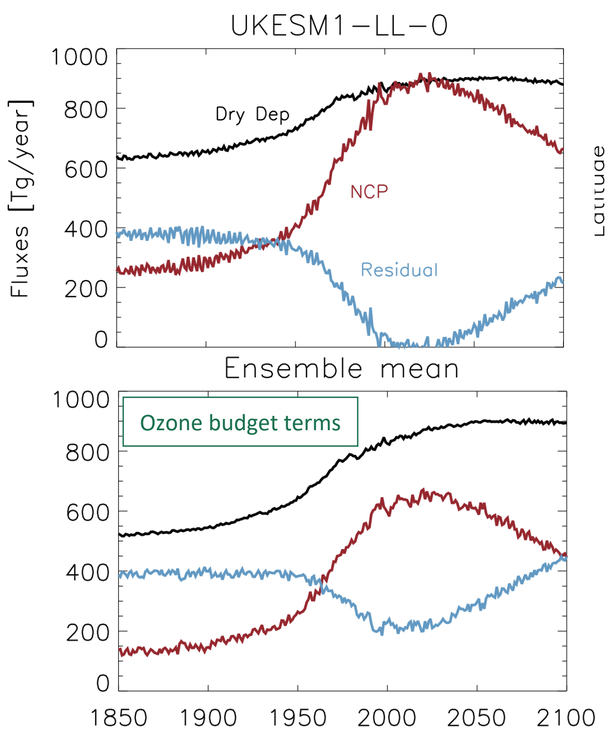


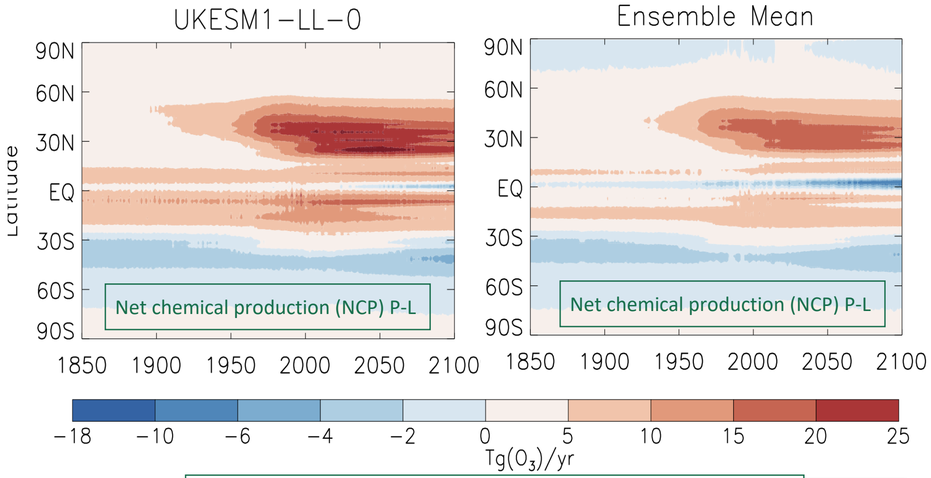
Tropospheric ozone precursor emissions

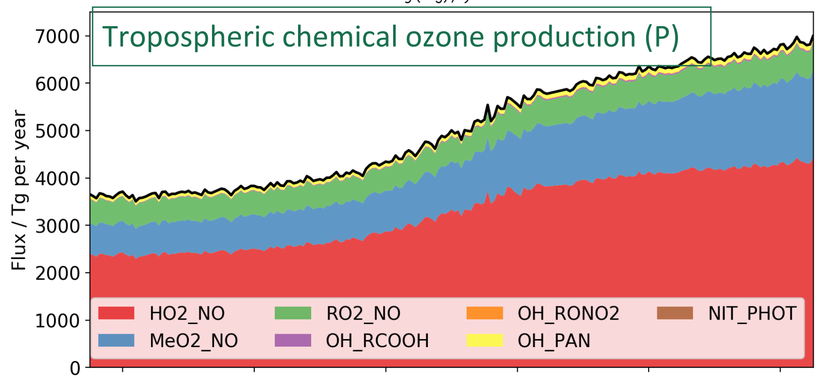


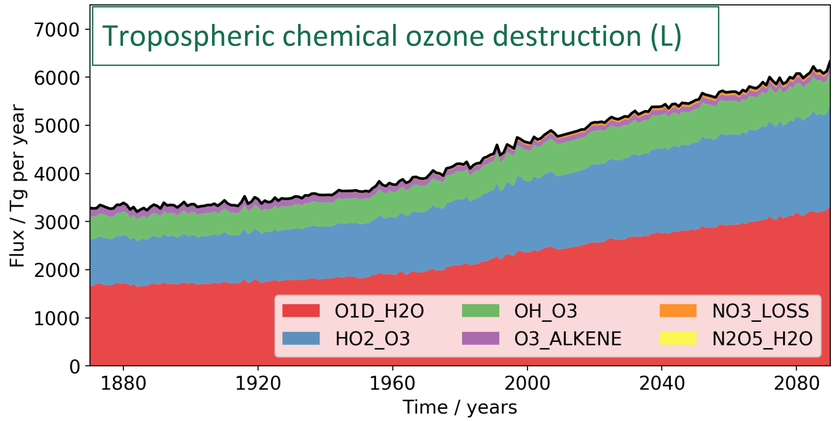
How does tropospheric ozone budget evolve in CMIP6?







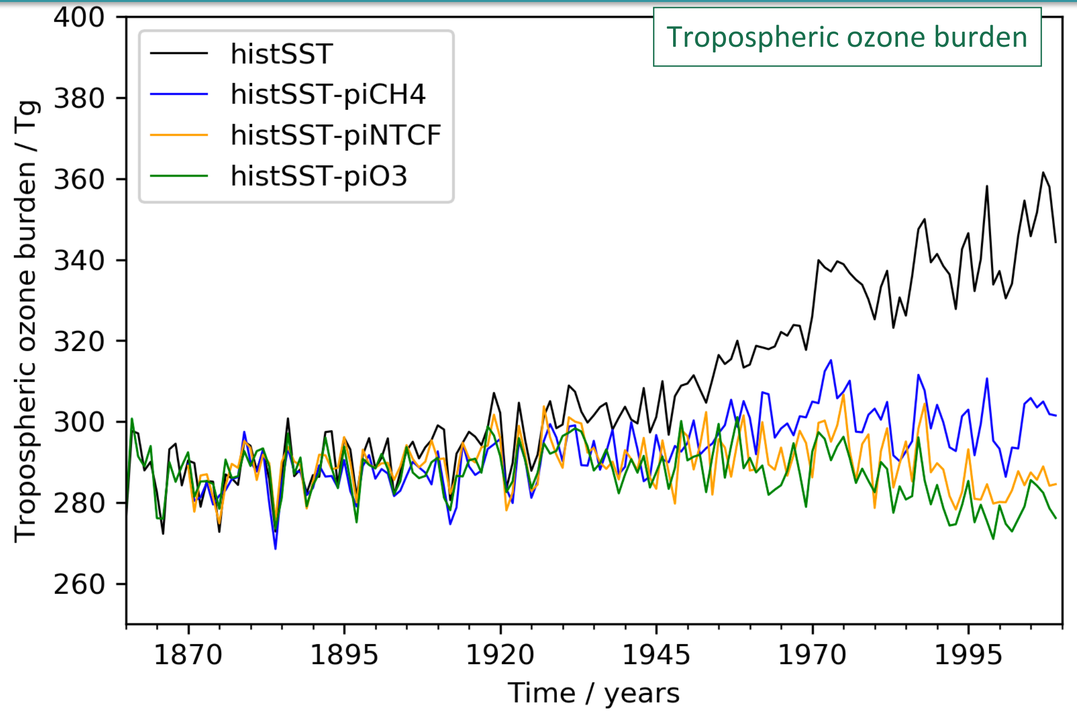




- Ozone burden is controlled by balance between chemical production and loss, transport from the stratosphere and deposition at the surface. Production and loss occur in different regions.
- Significant changes in all these terms, CMIP6 diagnostics limit analysis somewhat
  - Increased emissions of VOCs, including BVOCs, contribution of methane increasing.
  - More NOx, including LNOx.
  - Location of emissions in NH shifting southwards at end of 20th century
- Different drivers for O_3 production over the 21st century with an important contribution from CH_4.

What does AerChemMIP add to CMIP6?

- AerChemMIP is a CMIP6 sub-project aimed at isolating effect of chemically active gases and aerosol on climate via tiered attribution experiments.
  - Selected components held at 1850 levels, other forcings evolve along historical trajectories.
  - Using atmosphere-only configuration with SSTs from historical experiments
- Initial results – 10% change in ozone burden when CH_4 held at PI levels, with larger changes to individual terms in chemical ozone budgets; 20% change when ozone precursors held at 1850 levels. P-L only part of the story.



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-piAer	Hist	Hist	1850	Hist	Hist	2
histSST-piO3	Hist	Hist	Hist	1850	Hist	2
histSST-piCH4	1850	Hist	Hist	Hist	Hist	1
histSST-1950HC	Hist	Hist	Hist	Hist	1950	1
histSST-piN2O	Hist	1850	Hist	Hist	Hist	2