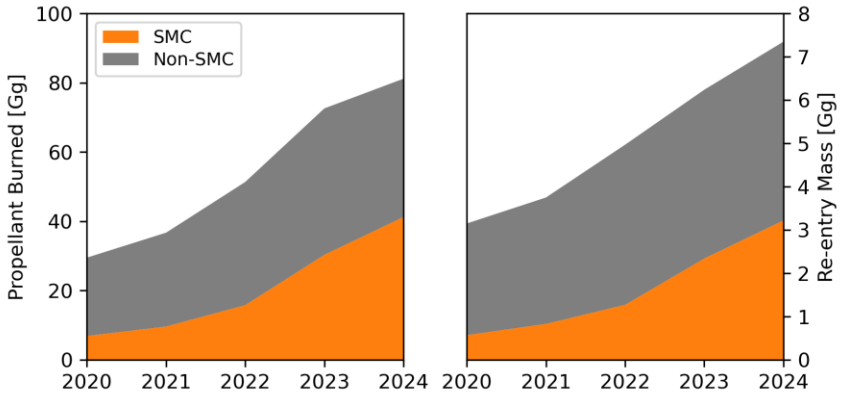
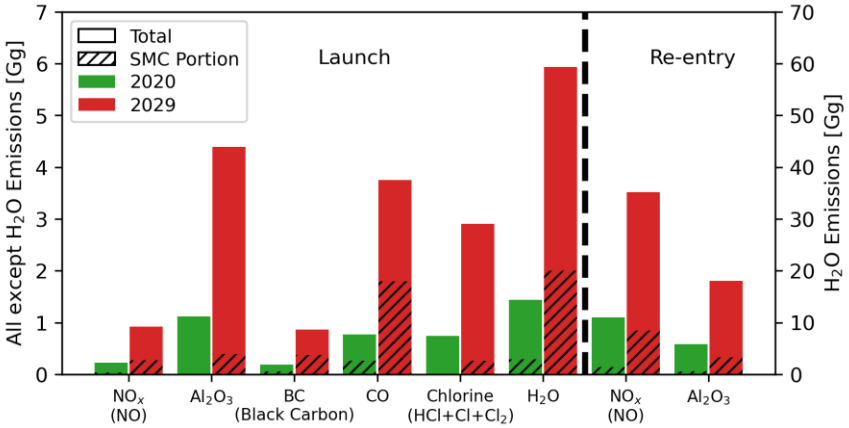
Radiative forcing and ozone depletion of a decade of growth in satellite megaconstellation missions

Connor R. Barker (connor.barker@ucl.ac.uk), Eloise A. Marais, Eric Tan, Sebastian D. Eastham, Glenn S. Diskin, Joshua P. DiGangi, Yonghoon Choi, Andrew Rollins, Eleanor Waxman, T. Paul Bui, Charles Gatebe, Jonathan Dean-Day

Propellant consumption and re-entry mass from the space industry



Global, 3D, hourly rocket launch and re-entry emission inventory for 2020-2022, extrapolated to 2029.

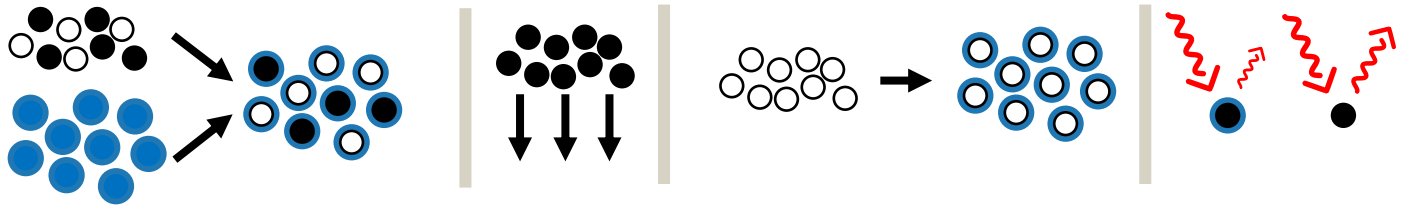


Satellite megaconstellations are a growing fraction of space industry emissions, threatening stratospheric ozone and climate

Updated radiative forcing

+

Updated aerosol treatment



GEOS-Chem + RRTMG

1. No missions
2. All missions
3. SMC missions only

2020-2029
4° x 5° x 47 layers

Atmospheric Composition Radiative Forcing

[Barker *et al.*, 2024, IPCC 2007]

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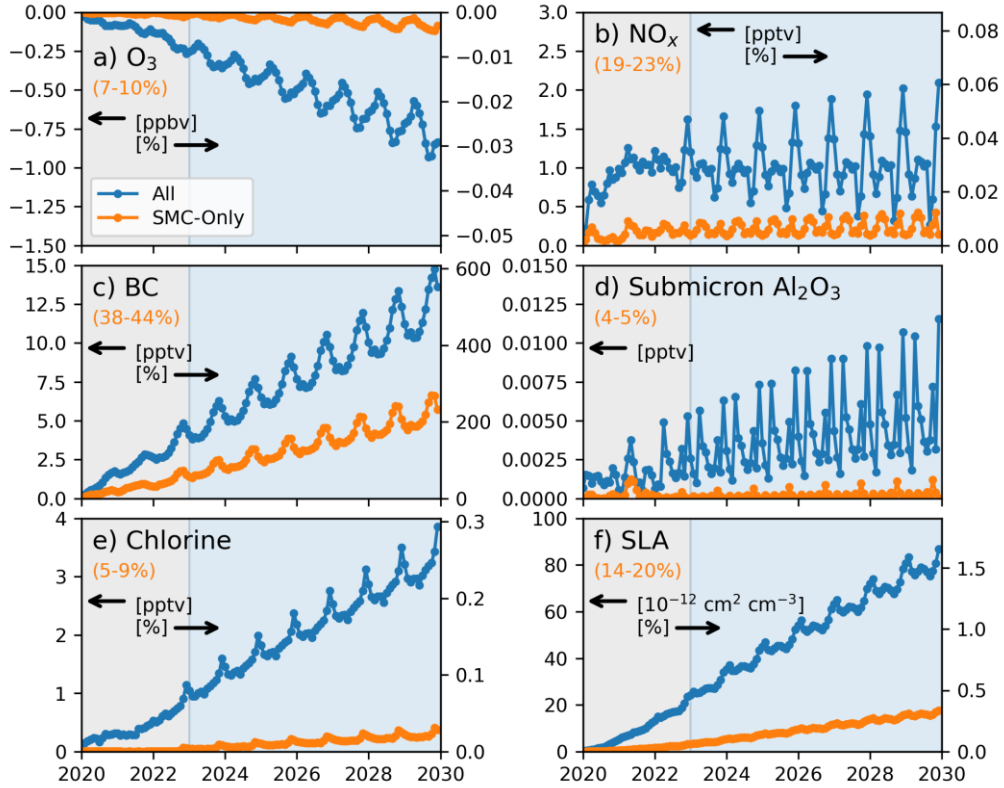
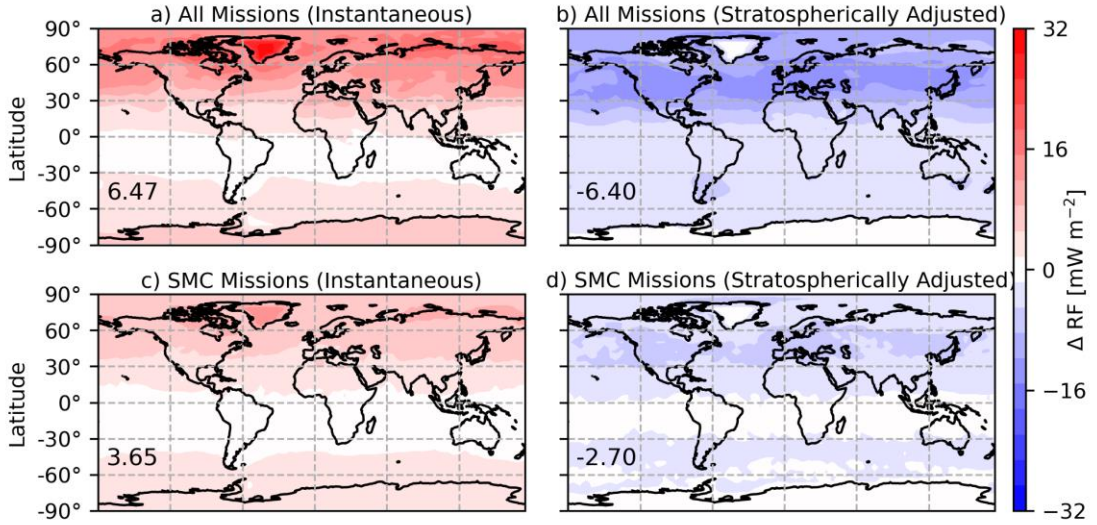
Monthly Mean Change in Stratospheric Concentration



SMC launches mostly (98%) use kerosene fuel, emitting large amounts of black carbon but no ozone-depleting Al_2O_3 and chlorine, limiting SMC ozone depletion to 10% of the total.

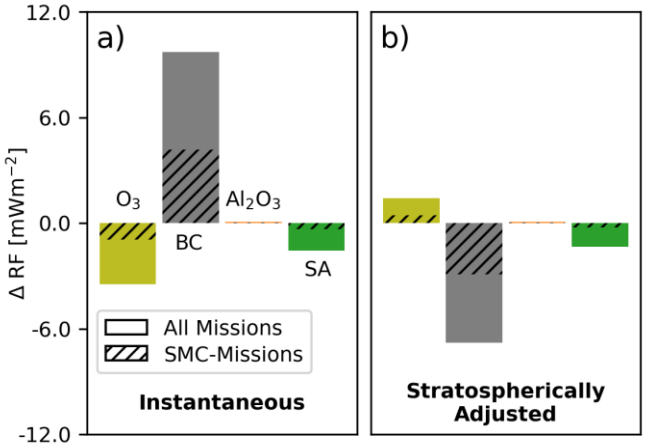
Global stratospheric ozone depletion by the space industry is low (0.03%) at the end of the decade compared to surface sources (~2% in 2022).

Global Radiative Forcing in 2029



Most forcing is from BC absorbing SW radiation in stratosphere.

42-56% of BC forcing from SMCs.



Overall effect is like geoengineering strategies to cool the troposphere, but uncontrolled and untested.