Climatic and environmental impacts of an Oruanui-like supereruption in the Southern Hemisphere extratropics

Christina Brodowsky[1], Simon Barker[2], Michael Sigl[3], Kirstin Krüger[1]

1 Department of Geosciences, University of Oslo, Oslo, Norway; 2 School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Wellington 6012, New Zealand; 3 Climate and Environmental Physics, Physics Institute & Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

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1 Introduction

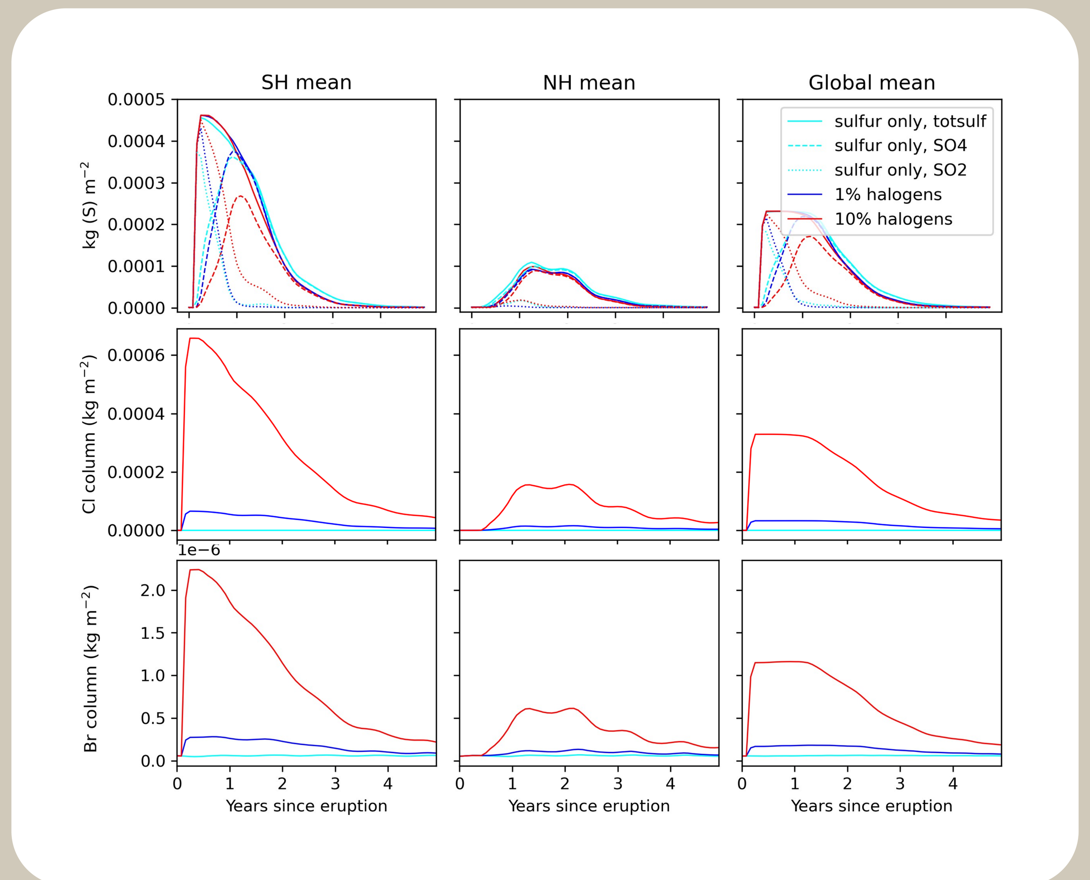
At least four volcanic eruptions with VEI 8 happened in the past 100'000 years[1,2]. We seek to evaluate the climatic and environmental impacts of the ~25.5 ka Oruanui eruption (Taupō caldera, 38°S, 175°E, New Zealand)[3] using the Community Earth System Model[4,5] and various emission scenarios, derived from petrology and ice core records[6]. We thereby refine our understanding of the volcanic forcing.

2 Experiments

Simulation	SO_2 (Tg)[6]	Cl (Tg)[6]	Br (Tg)	Halogen injection efficiency
Sulfur only	260	0	0	0%
1% halogens	260	18	0.06	1%
10% halogens	260	180	0.6	10%

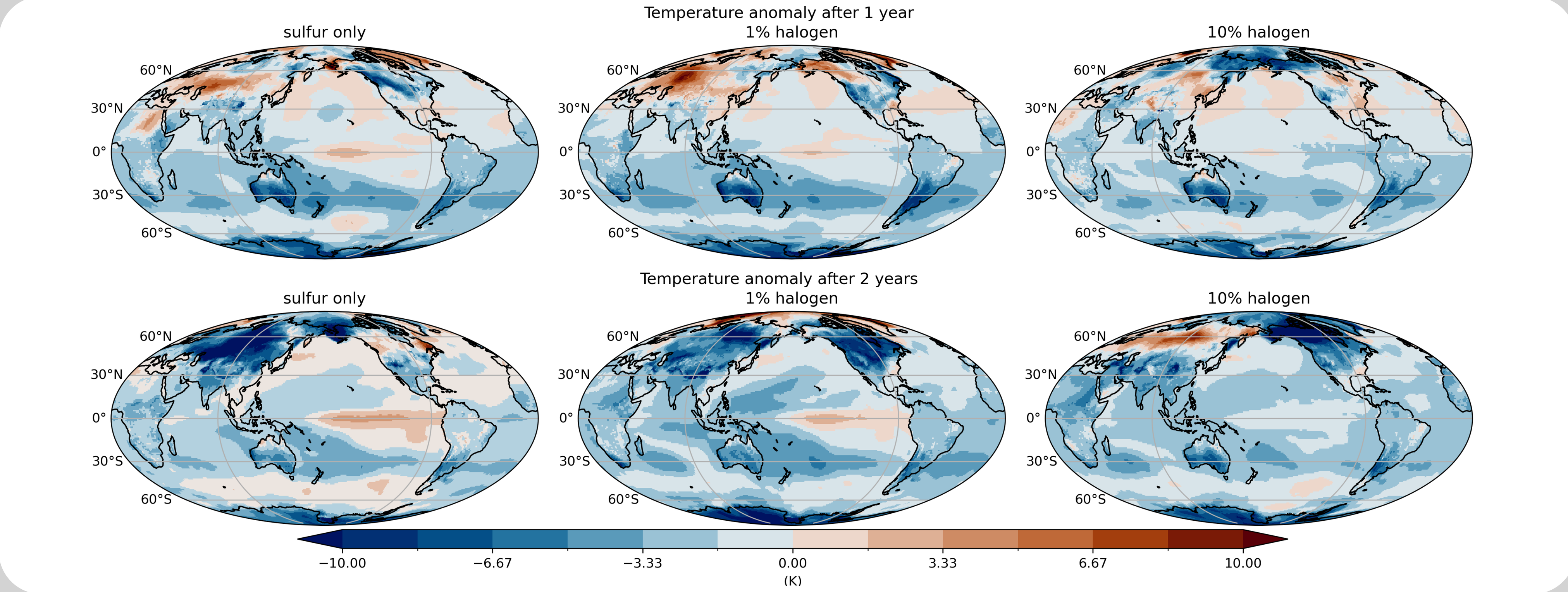
Simulation set-up

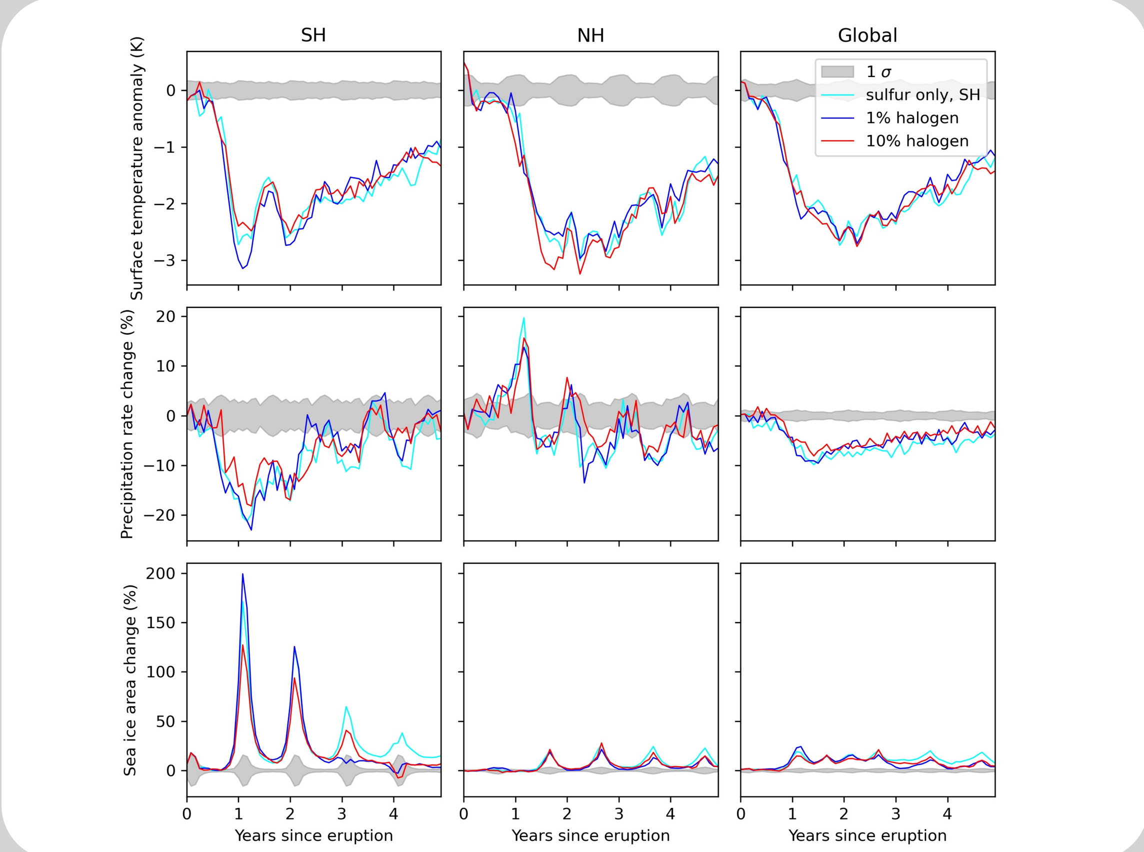
- Scenario modelled after the ~25.5ka Oruanui eruption (Taupō caldera, 38° S, 175° E, NZ)[1,2,3]
- CESM2/WACCM[4,5] (fully coupled, full chemistry)
- Pre industrial (1850) boundary conditions
- Injection of: SO_2[6], HCl[6], and HBr
- Timing: SH late summer/autumn (March)
- Eruption duration: 6 days[7]
- Injection altitude: 24 km[8]
- Initial conditions: Westerly QBO, neutral ENSO



3 Results

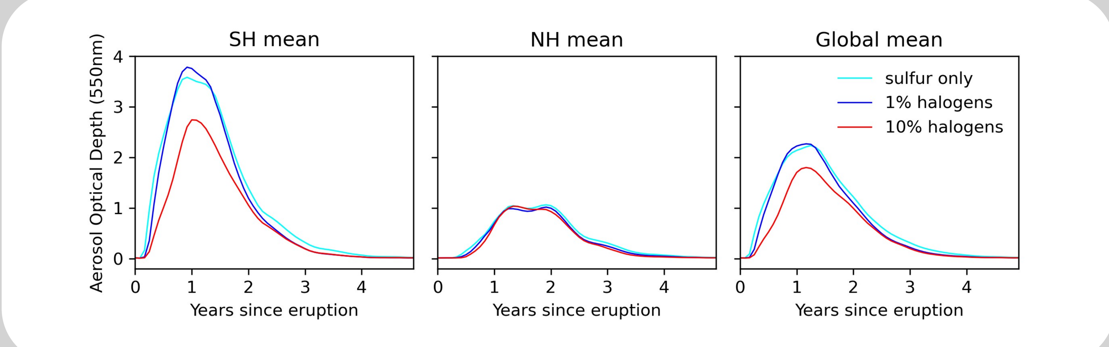
Climate impacts



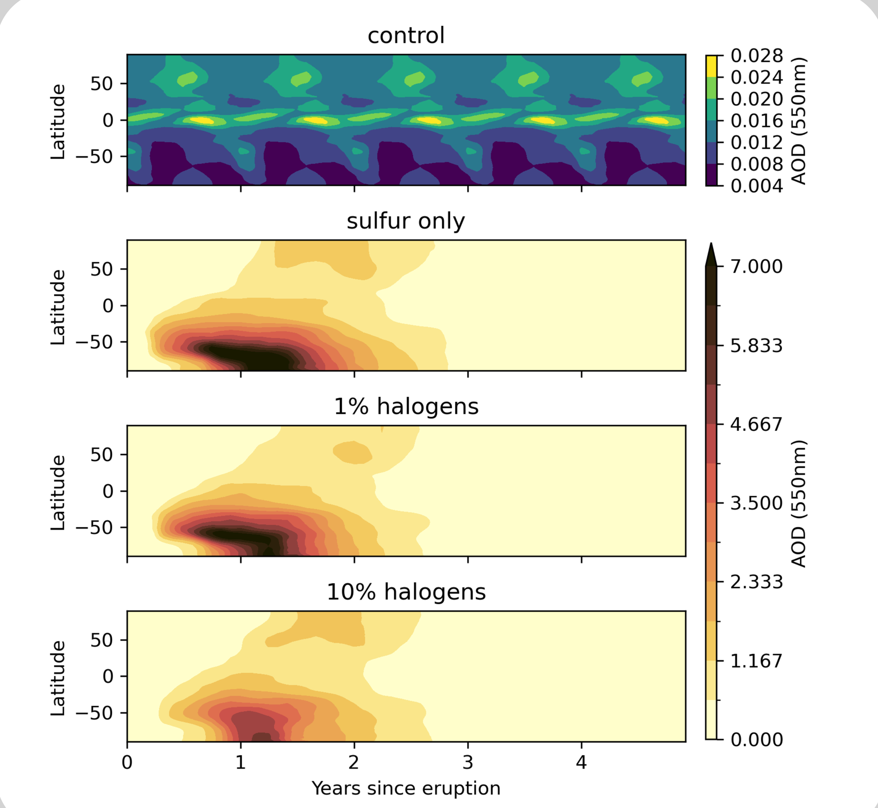


- SH: Strongest cooling after ~1y, 2.5-3 K
  - Most pronounced at 30-40°S (NZ)
  - Strongest cooling in 1% halogen simulation
- NH: Strongest cooling after ~1.5y, 2.5-3 K
  - Strongest cooling in 10% halogen simulation
- Precipitation, sea ice: Clearer signal in the SH
- Not recovered after ~5y

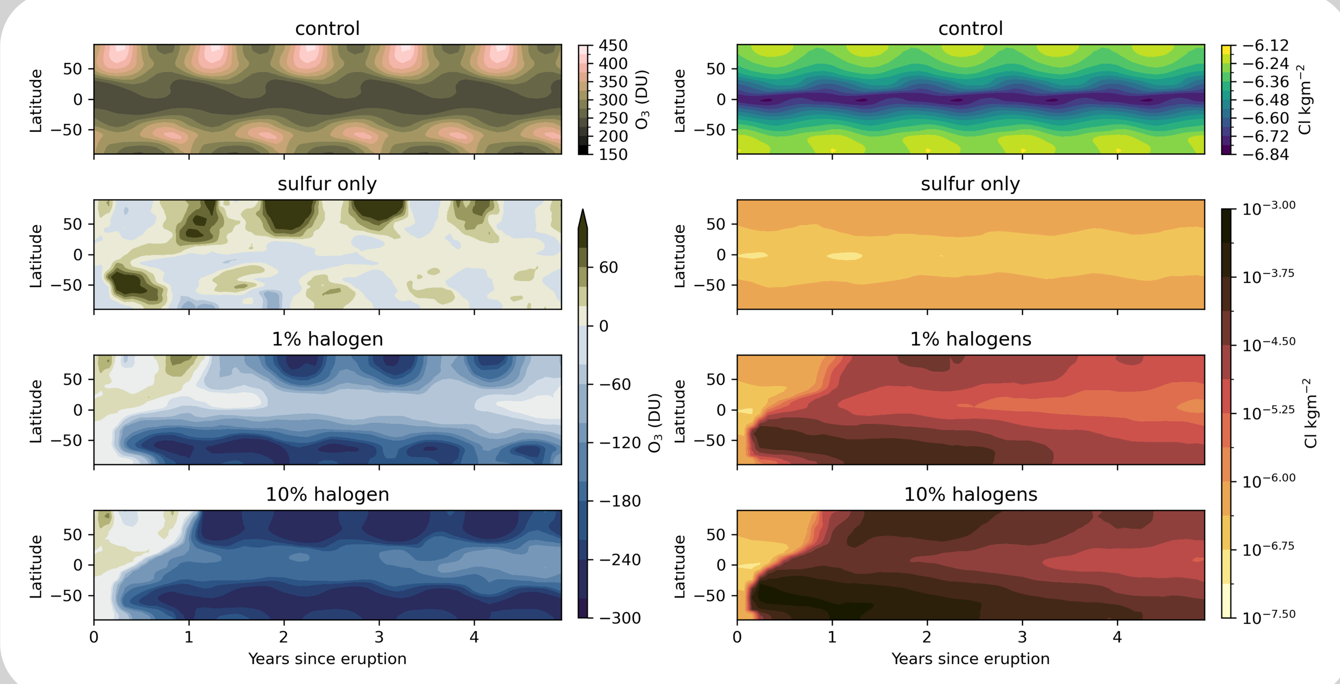
Aerosol optical depth (550 nm)

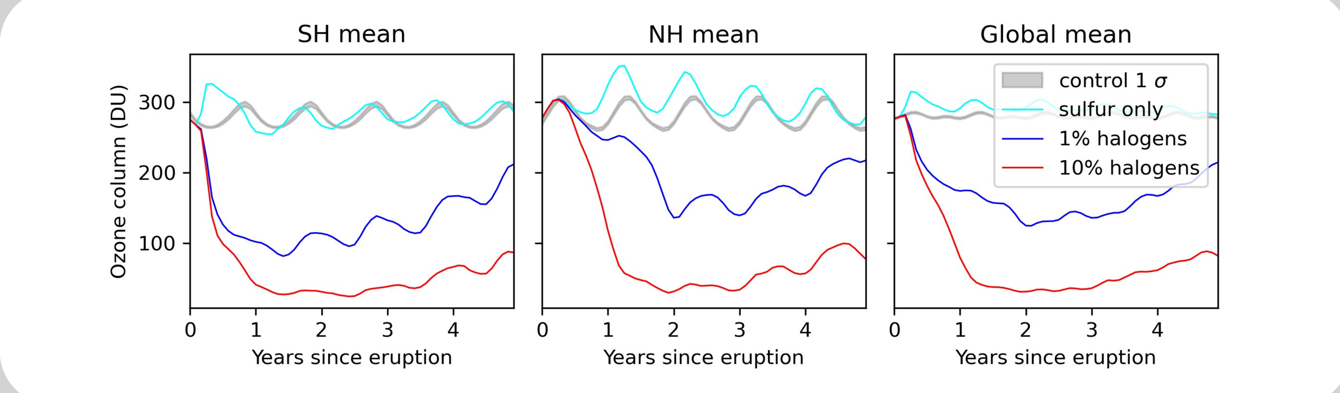


- Peak in SH: ~ 2.7 – 3.7
- Peak in NH: ~1
- 10% halogens: OH is depleted, less SO_2 converted to sulfate
- Back to baseline globally after ~4y
- Still considerable transport to the NH



Ozone impacts





4 Summary & Outlook

- Stronger effects in SH but still significant changes also in the NH
- Cooling up to 3 K (SH) or 2.5 K (global mean), one year after the eruption, not recovered after 5 years
- Strong O_3 depletion even outside the polar vortex
- O_3 recovery slower than temperature

Outlook

- Extend simulations, ensemble
- Model the eruption in Last Glacial Maximum conditions
- Assess land and ocean response, using model and paleoenvironmental proxies
- Compare with other (super-)eruption model simulations located in the tropics

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Contact: christina.brodowsky@uio.no Profile: