Volcanically induced stratospheric water vapour changes

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Kroll et al in prep, 2020

experimental setup:

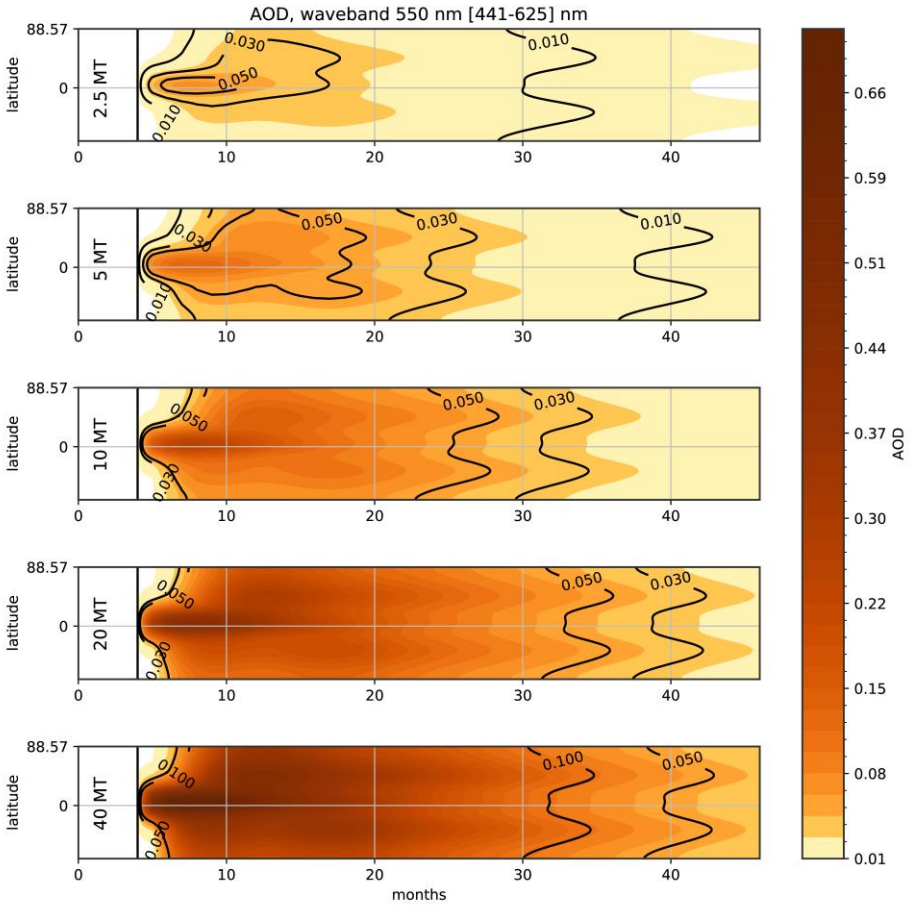
MPI-ESM-LR with volcanic EVA-Forcing

(Azoulay 2019 [1], Azoulay et al, paper in prep, 2020)

100 ensemble members each

for Pinatubo-like eruptions of

- 0 MT, 2.5 MT, 5 MT, 10 MT, 20 MT and 40 MT of sulfur
- described by their optical properties
- eruption time: June 1991
- eruption location: equator

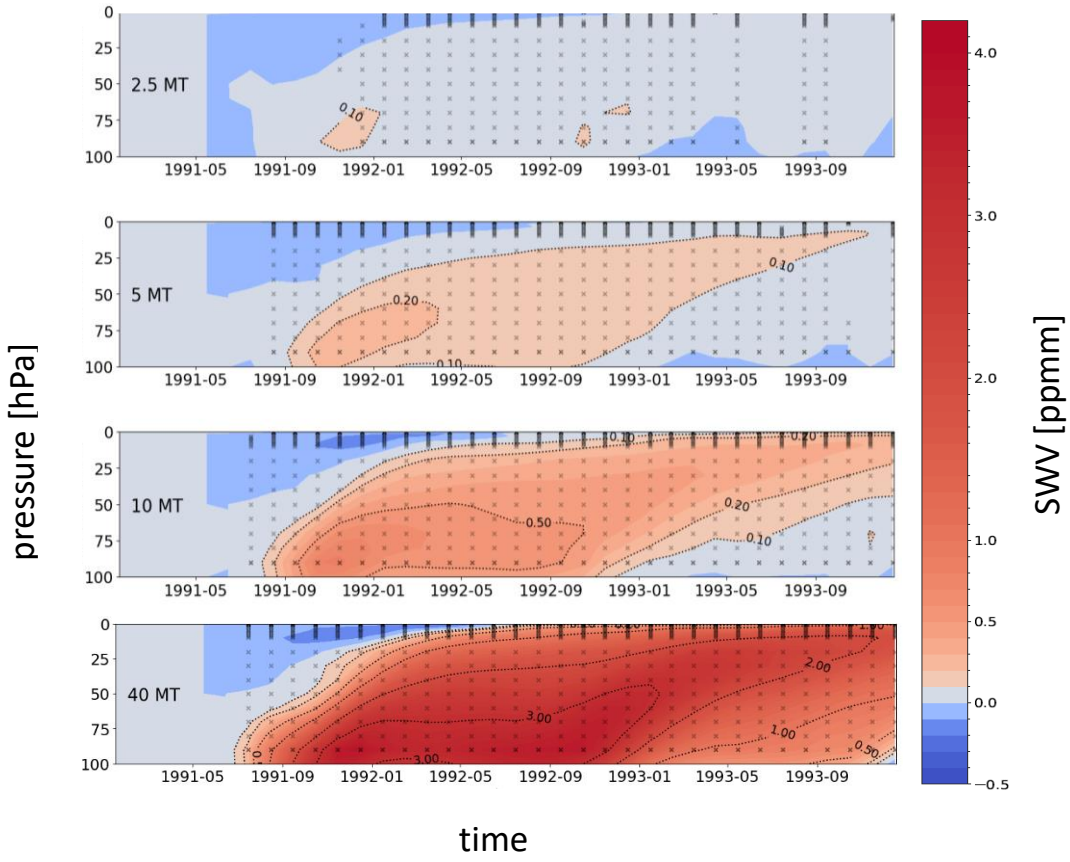


Kroll et al in prep, 2020

research question:

How does the (simulated) SWV response depend on the emission strength?

differences in SWV – tropical average [-23,23]°N



results:

- statistically significant SWV increases already visible in the ensemble mean of 2.5 Mt run
- max increases up to 4 ppmm
- initial net reduction of upper SWV due to increased upwelling of water vapour poor air

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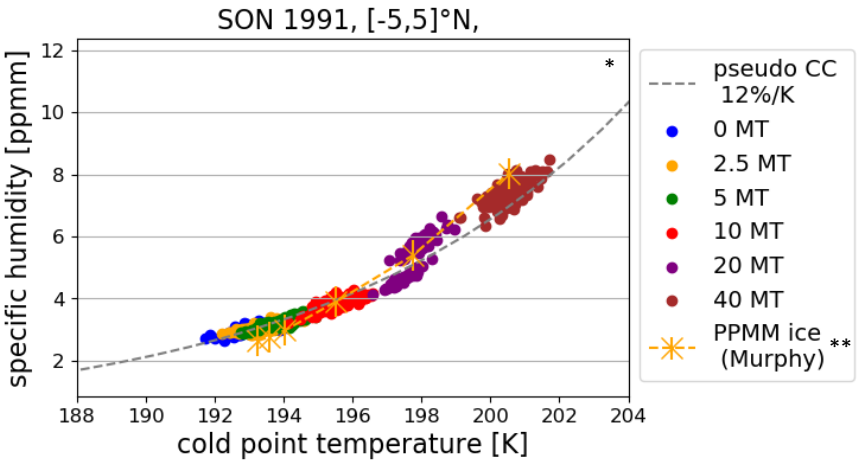
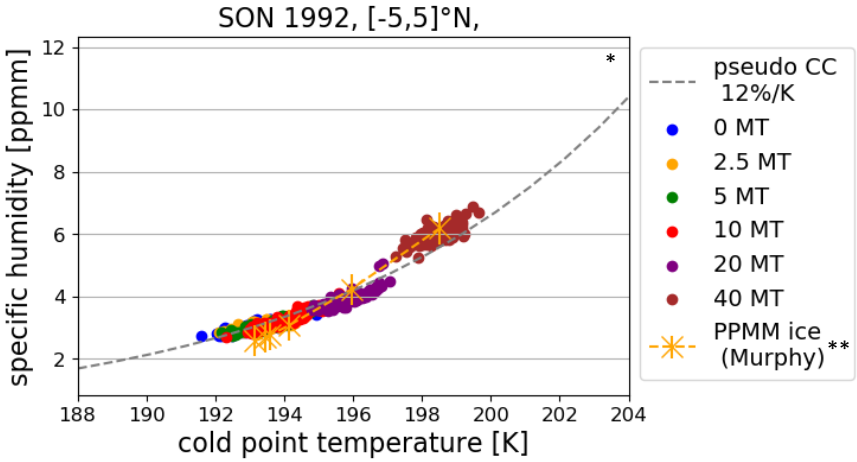
research question:

How large is the intra-ensemble variability of the SWV responses?





*each point in the graphs represents the average value of one ensemble member

** Murphy and Koop, 2005 [2]

results:

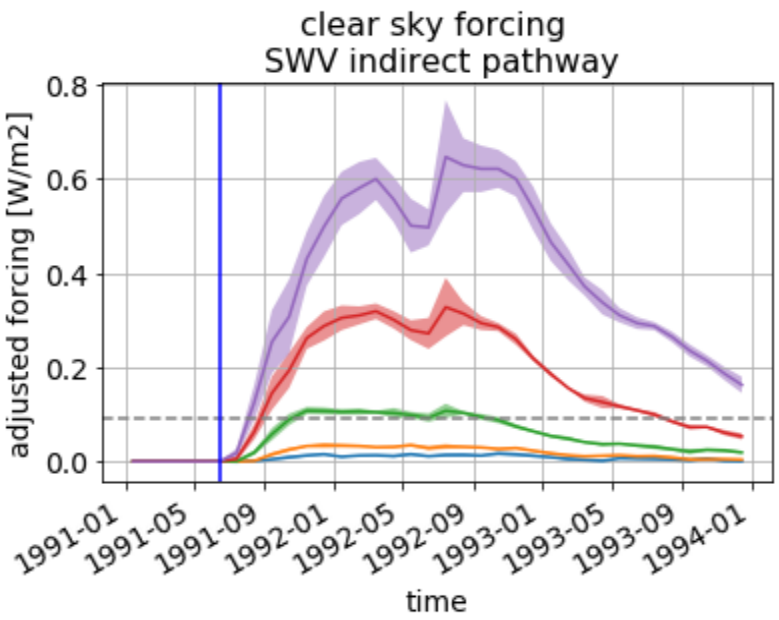
- overlap with the control run exists up to the 10 Mt ensemble
- good agreement with theoretical values by Murphy and Koop for saturation water vapour pressure over ice

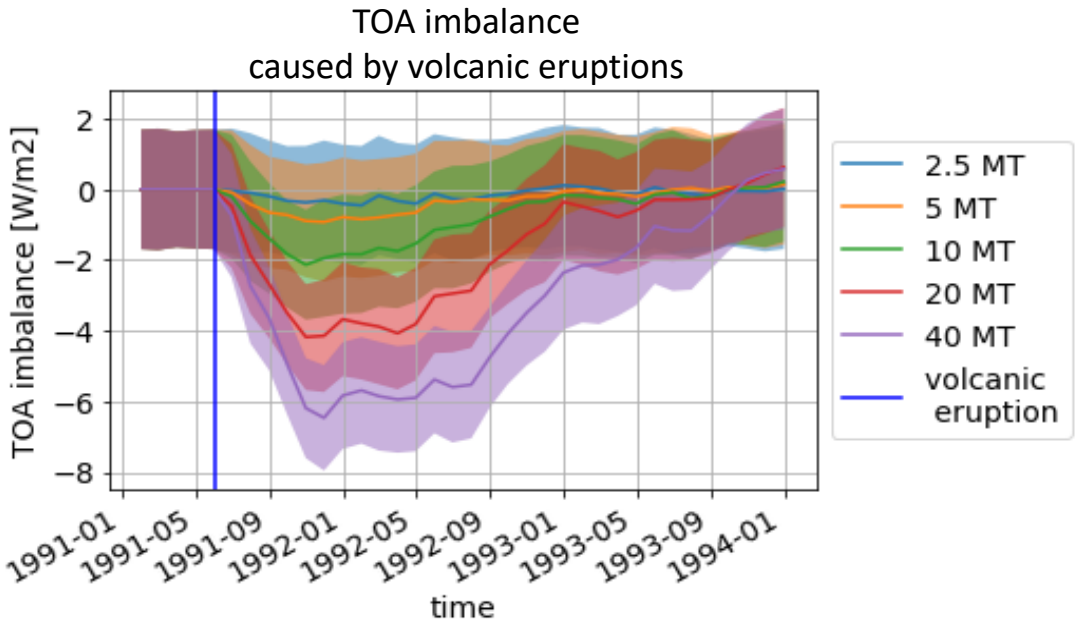
research question:

What is the corresponding SWV forcing?

model setup:

- 1 D RCE model konrad (Kluft et al, 2019 [3], Dacie et al, 2019 [4])
- MPI-ESM input data





results:

- SWV forcing up to 0.7 W/m2
- max 1/10 of TOA imbalance

Kroll et al in prep, 2020

references:

[1] Azoulay, A., 2019: The Arctic polar vortex response to volcanic forcing of different strength. Master thesis, University of Hamburg

[2] Murphy, D.M. and T. Koop, 2005: Review of the vapour pressures of ice and supercooled water for atmospheric applications. Q.J.R. Meteorol. Soc., 131, 1539-1565. doi:10.1256/qj.04.94

[3] Kluft, L., S. Dacie, S.A. Buehler, H. Schmidt, and B. Stevens, 2019: Re-Examining the First Climate Models: Climate Sensitivity of a Modern Radiative–Convective Equilibrium Model. J. Climate, 32, 8111–8125. doi:10.1175/JCLI-D-18-0774.1

[4] Dacie, S., L. Kluft, H. Schmidt, B. Stevens, S.A. Buehler, P.J. Nowack, S. Dietmüller, N.L. Abraham, and T. Birner, 2019: A 1D RCE Study of Factors Affecting the Tropical Tropopause Layer and Surface Climate. J. Climate, 32, 6769–6782. doi:10.1175/JCLI-D-18-0778.1