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Outstanding Student & PhD candidate Presentation contest

Examining the climate impacts of volcanic eruptions

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Motivation & Objective

Volcanic forcing in standard climate projections:

- **Is represented in terms of a constant volcanic forcing**
(e.g. CMIP6 ScenarioMIP, O'Neill et al., 2016)

- **Does not account for climate-volcano feedbacks,**
i.e. the potential impacts of climate change on volcanic forcing (e.g. Aubry et al., 2021)

- **Does not account for small-magnitude eruptions,**
which has recently shown to be important (e.g. Solomon et al., 2016; Schmidt et al., 2018)

Objective:

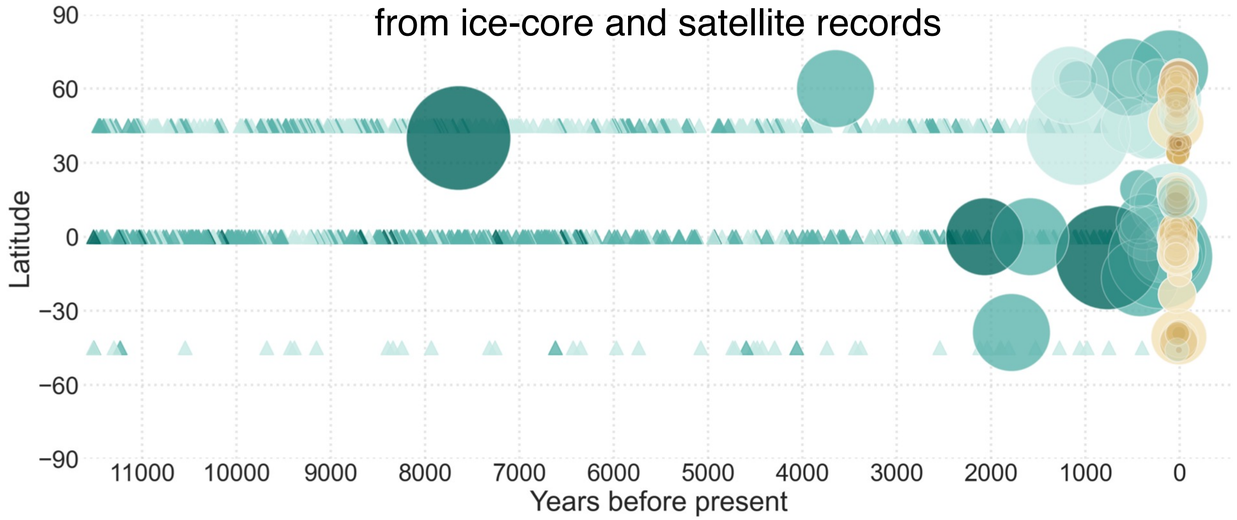
To examine how **future volcanic eruptions of all magnitudes** affect the **projected volcanic radiative forcing and selected climate metrics**

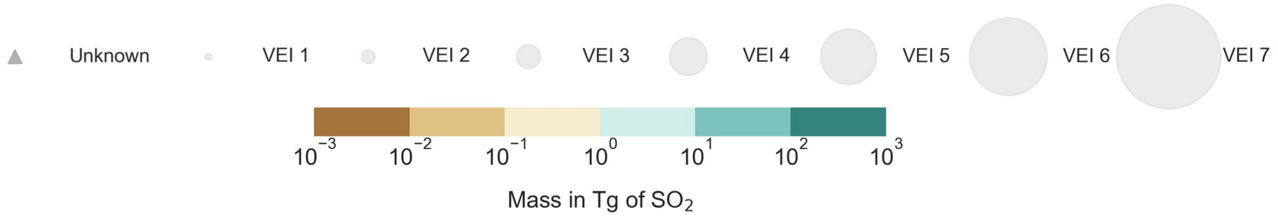
Methodology

Generation of stochastic future eruption scenarios

Historical eruptions

from ice-core and satellite records

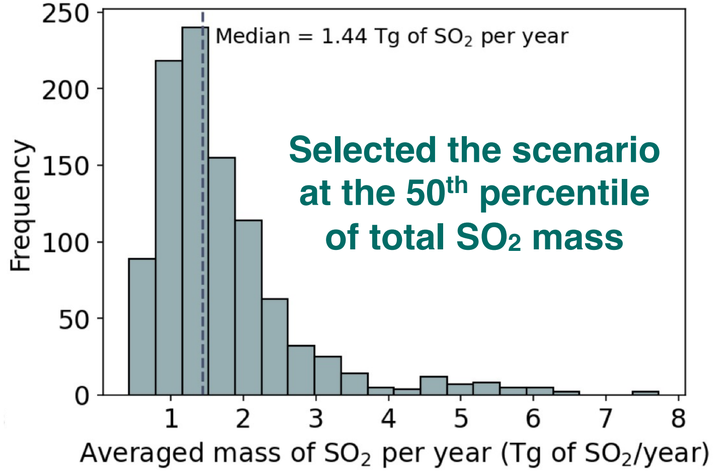




Monte Carlo Resampling

Stochastic future eruption scenarios

from 2015 to 2100 (1000 members)

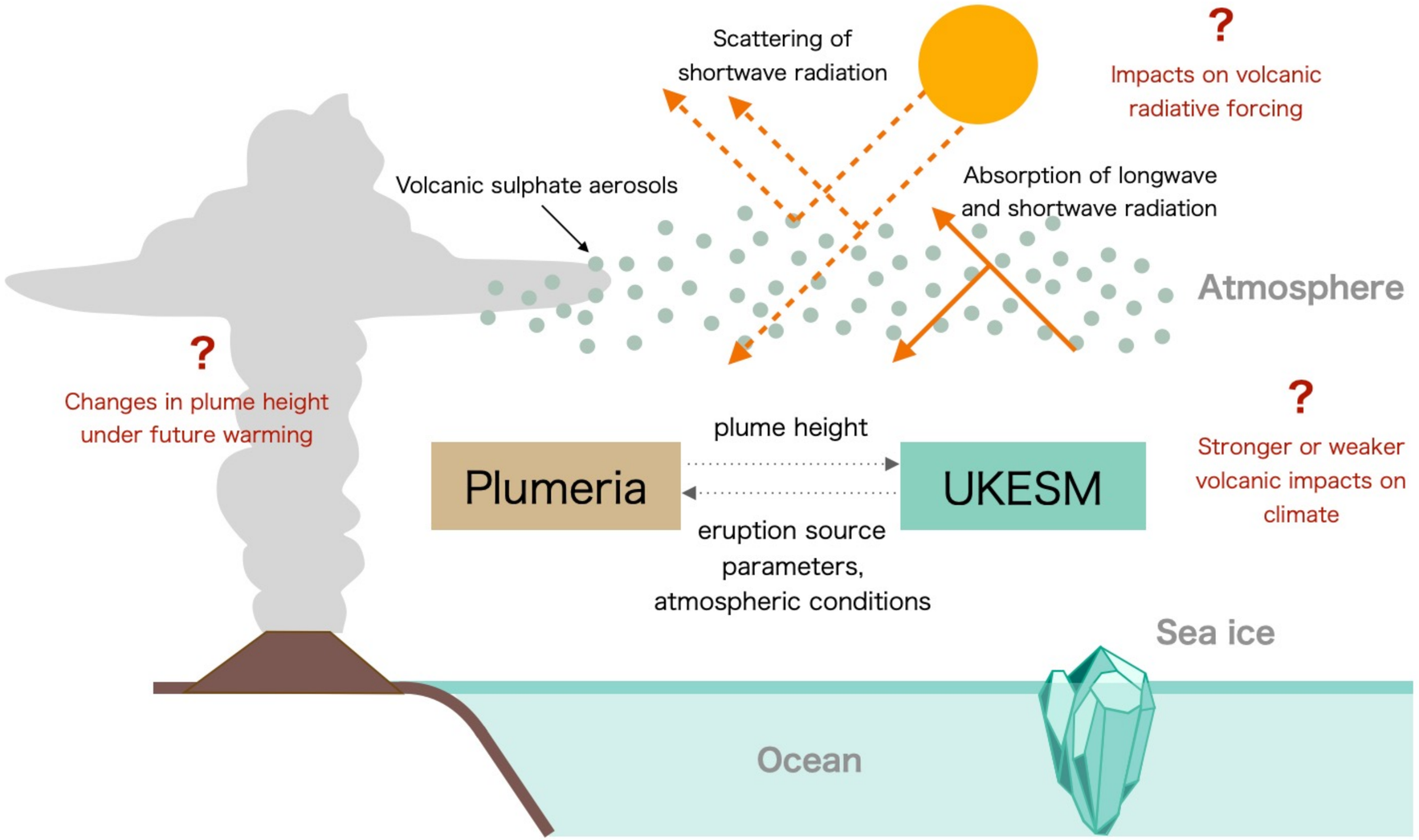


Model runs from 2015-2100, SSP370:

VOLC-All	With **large- and small**-magnitude eruptions
VOLC-Small	With **small-**magnitude eruptions only
VOLC-CONST	With **constant** volcanic forcing
NOVOLC	**Without** any eruptions

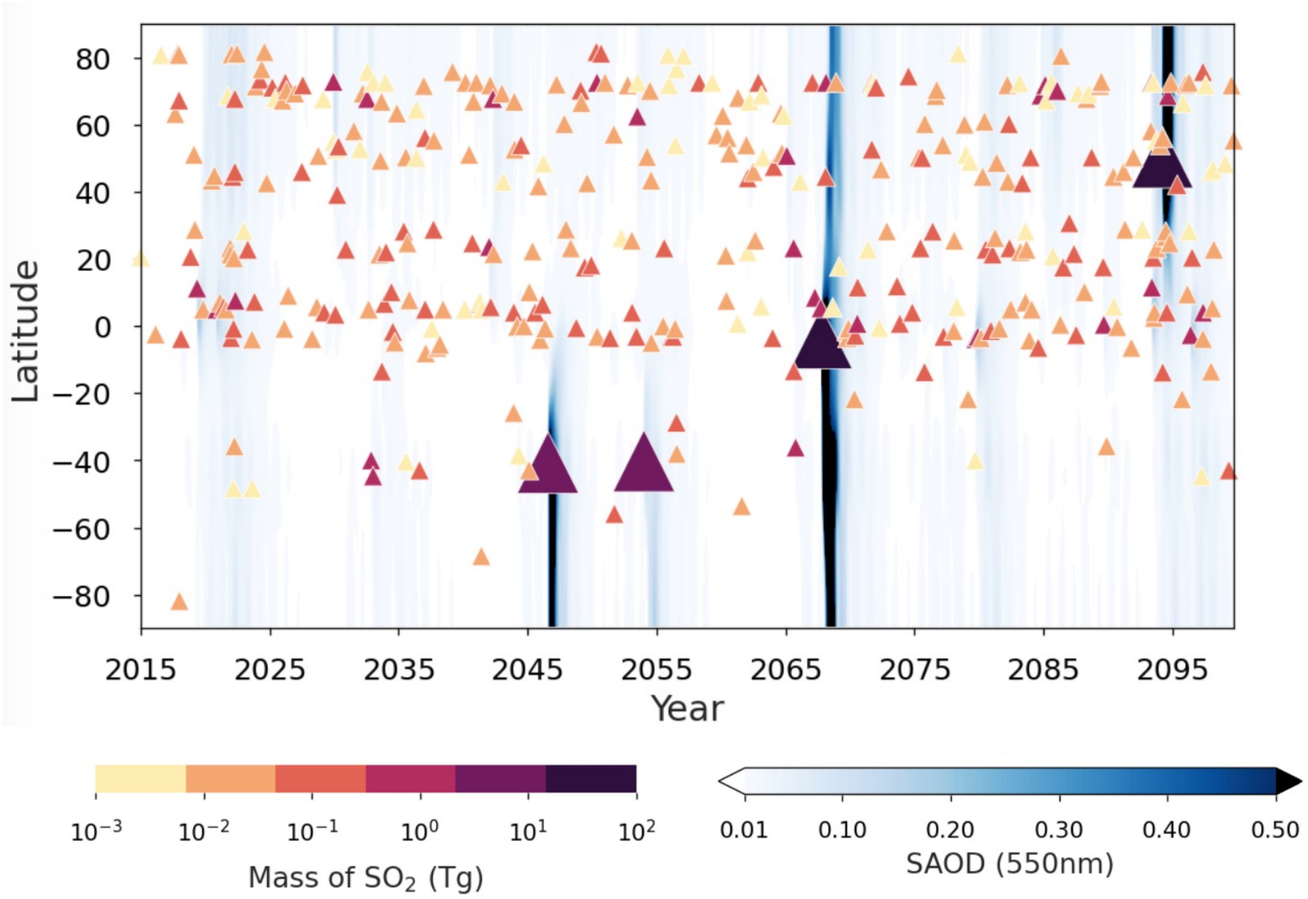
Methodology

UKESM-VPLUME: Fully-coupled plume-aerosol-chemistry-climate simulations



Results

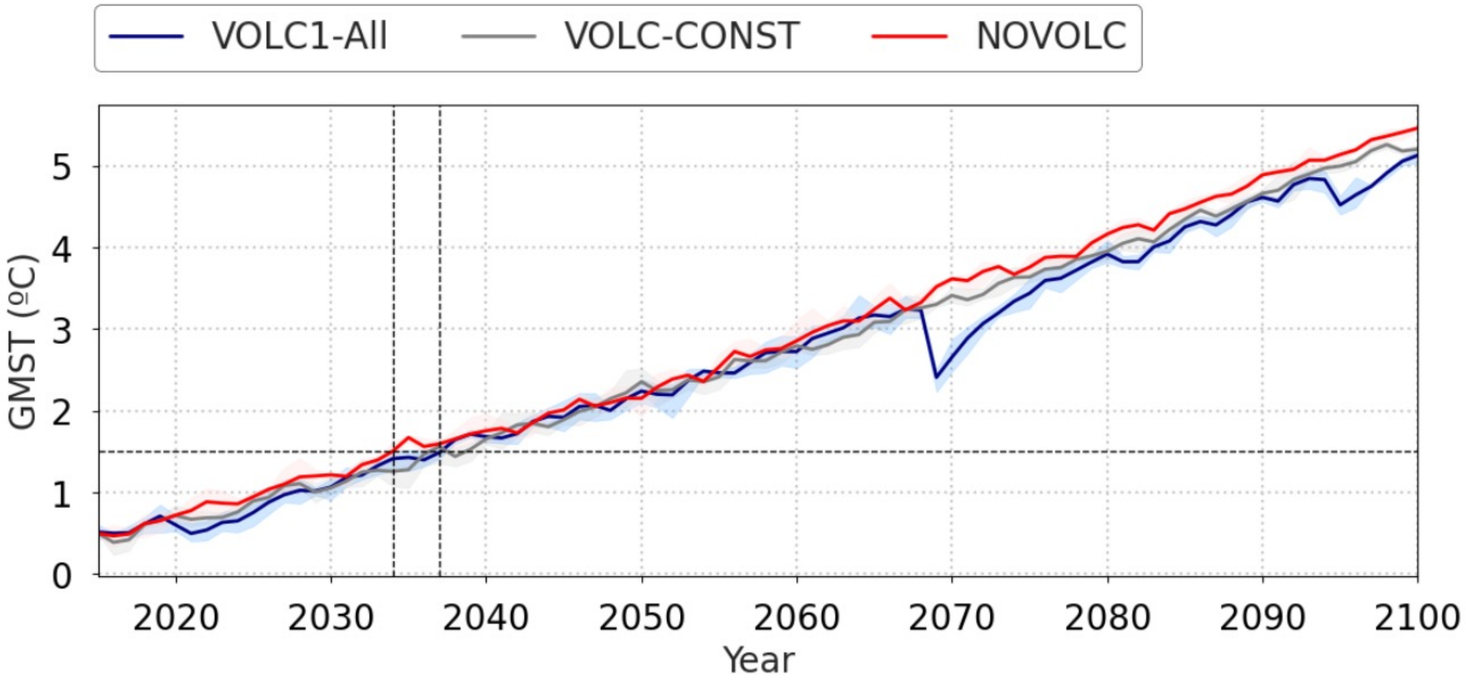
Zonal mean Stratospheric Aerosol Optical Depth (SAOD) and eruption time series



- The time-averaged SAOD over 2015-2100 for VOLC-All (0.023) is **two times greater than that of using a constant volcanic forcing (0.01)**
- **Small-magnitude eruptions contribute about 50% (0.013)** to the time-averaged SAOD

Results

Global annual mean surface temperature relative to 1995 - 2014



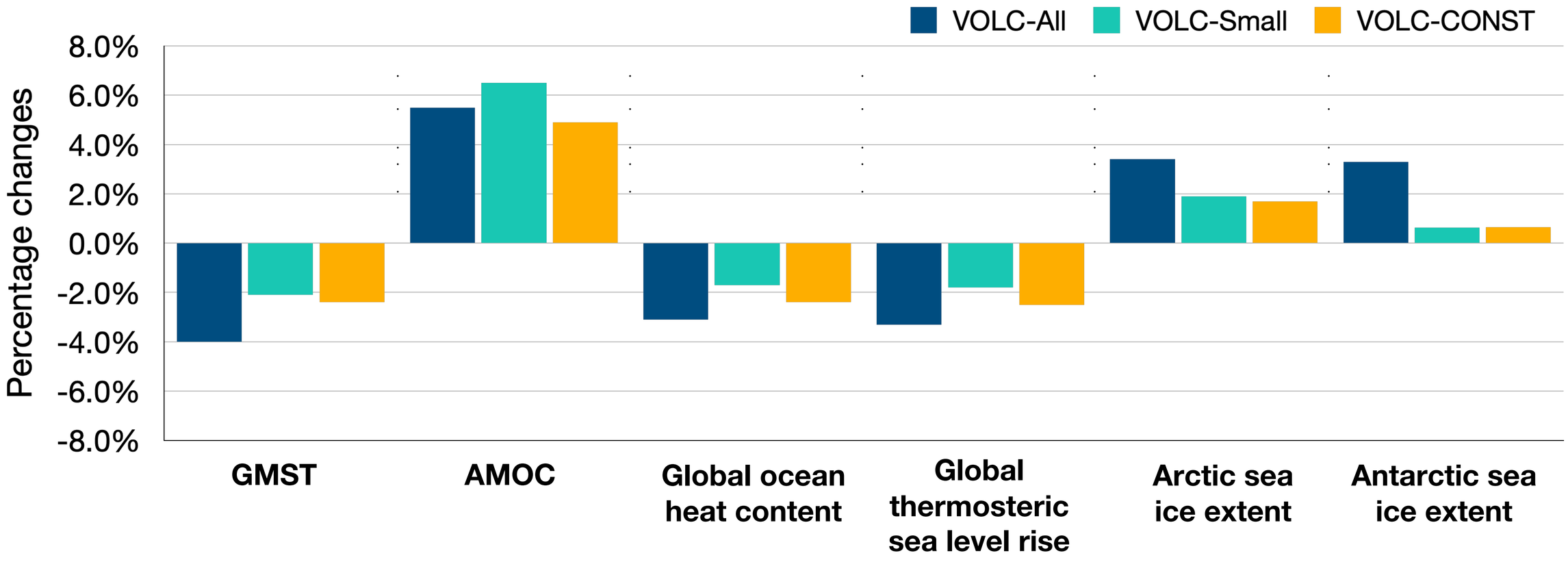
- **The year during which the GMST passes 1.5ºC can be delayed for 3 years** if sporadic eruptions are considered

- There is **little reduction in the overall anthropogenic warming trend** due to eruptions

Results

Percentage changes of the mean differences ($\overline{VOLC - NOVOLC}$) of the selected climate metrics over 2015-2100 relative to NOVOLC

VOLC-All exerts stronger impacts on all the selected climate metrics than VOLC-CONST



Conclusion

- This study developed statistically realistic stochastic eruption scenarios and a new plume-aerosol-chemistry-climate modelling framework (UKESM-VPLUME) to examine the climate impacts of future volcanic eruptions
- **The use of a constant volcanic forcing in climate projection (as in CMIP6) underestimates time-mean SAOD value and the volcanic impacts on selected climate metrics**
- Future scenarios with different temporal and spatial distribution of volcanic eruptions can introduce large variability in terms of climate responses.
- Future work: Other VOLC scenarios at the 2.5th and 97.5th percentiles and SSP1-2.6

Thank you!

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