Tenerife, March 2018

Stratospheric heating and surface cooling caused by volcanic aerosols in CM2.1 model

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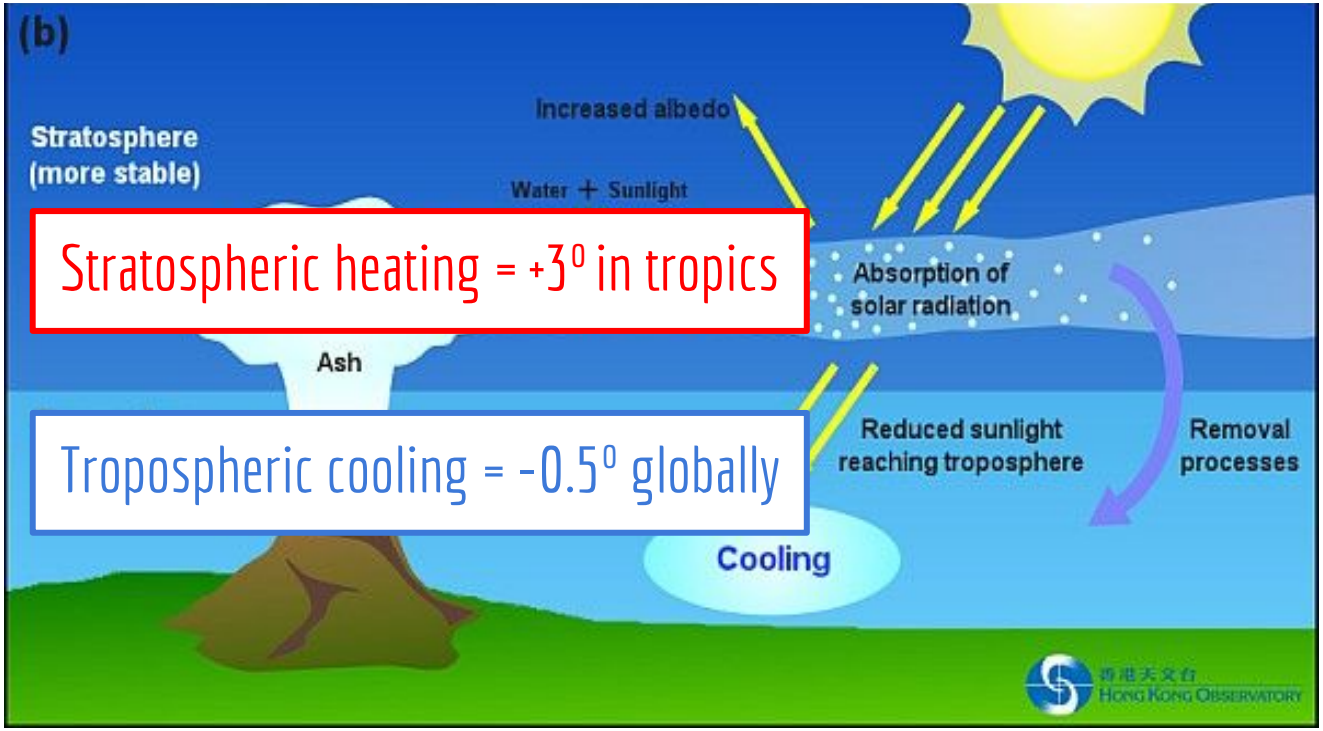
Volcanic Impact on Climate



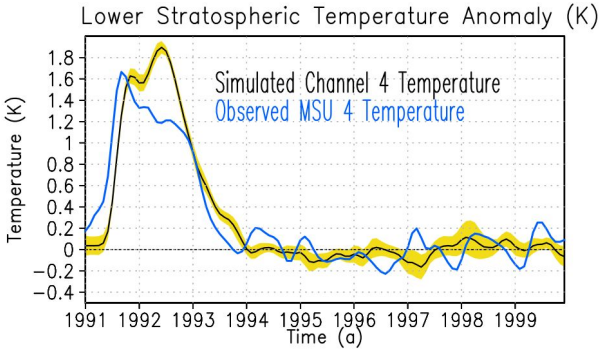
Volcanic aerosols in models

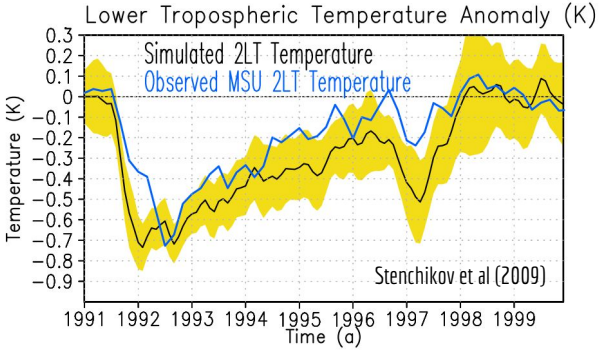
Ways to account for the volcanic aerosols in models:

Interactive simulation of the plume

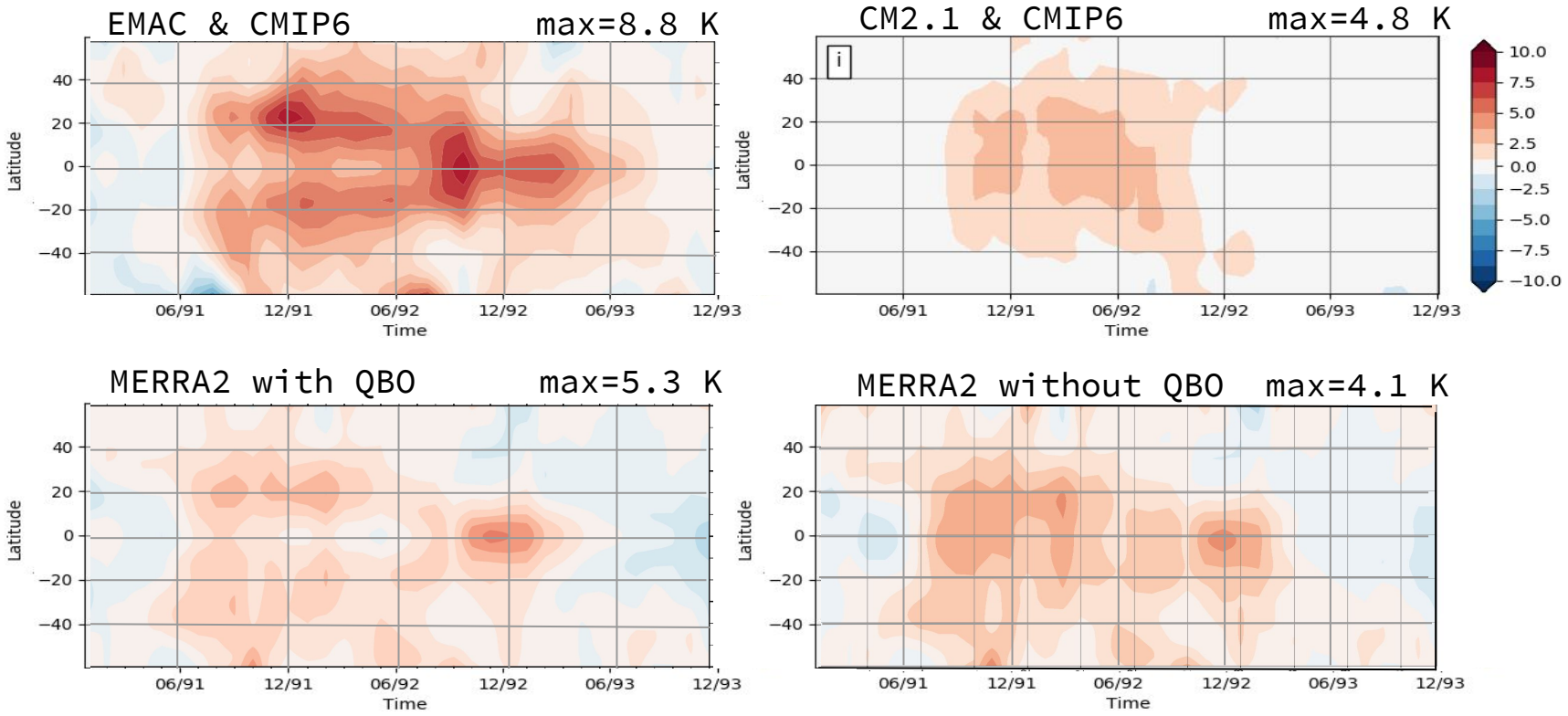
Prescribed aerosol characteristics:

- aerosol extinction
- single scattering albedo
- asymmetry parameter





50 hPa temperature anomaly, Pinatubo 1991



Radiative impact

Radiative impact is the changes in:

1. **TOA radiative fluxes**
   [the energy balance change of the entire system]
2. **Atmospheric heating rates**
   [stratospheric heating]
3. **Surface fluxes**
   [surface cooling]

Sensitive to:

Radiative scheme

Model dynamics

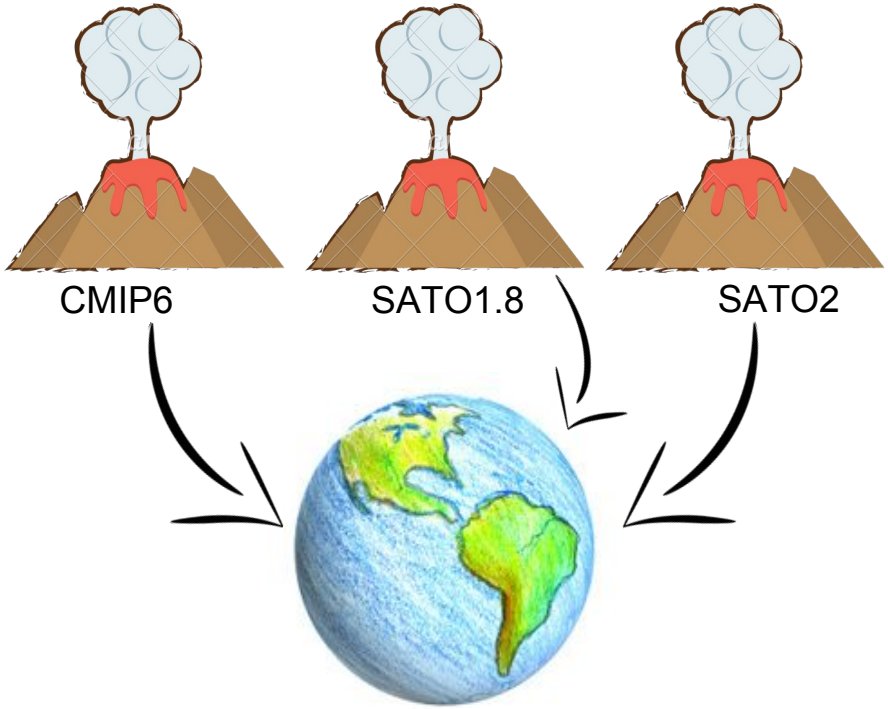
Aerosol optical properties

Objective

Evaluate different volcanic datasets

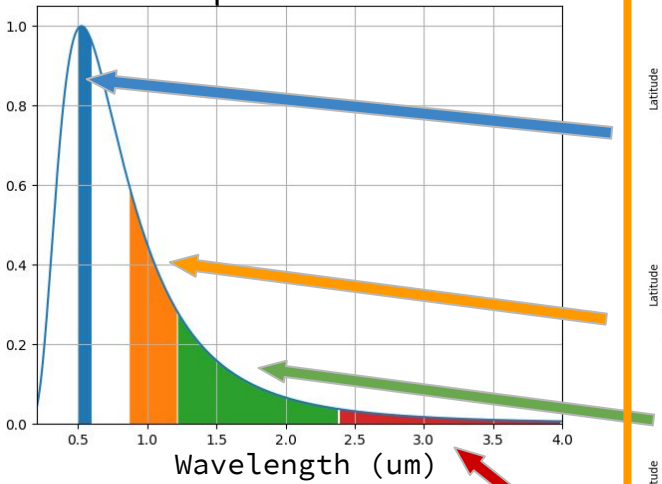
Questions:

1. What are the most important characteristics of a dataset that define the radiative impact?
2. How does the model reproduce the observed stratospheric heating and tropospheric cooling?



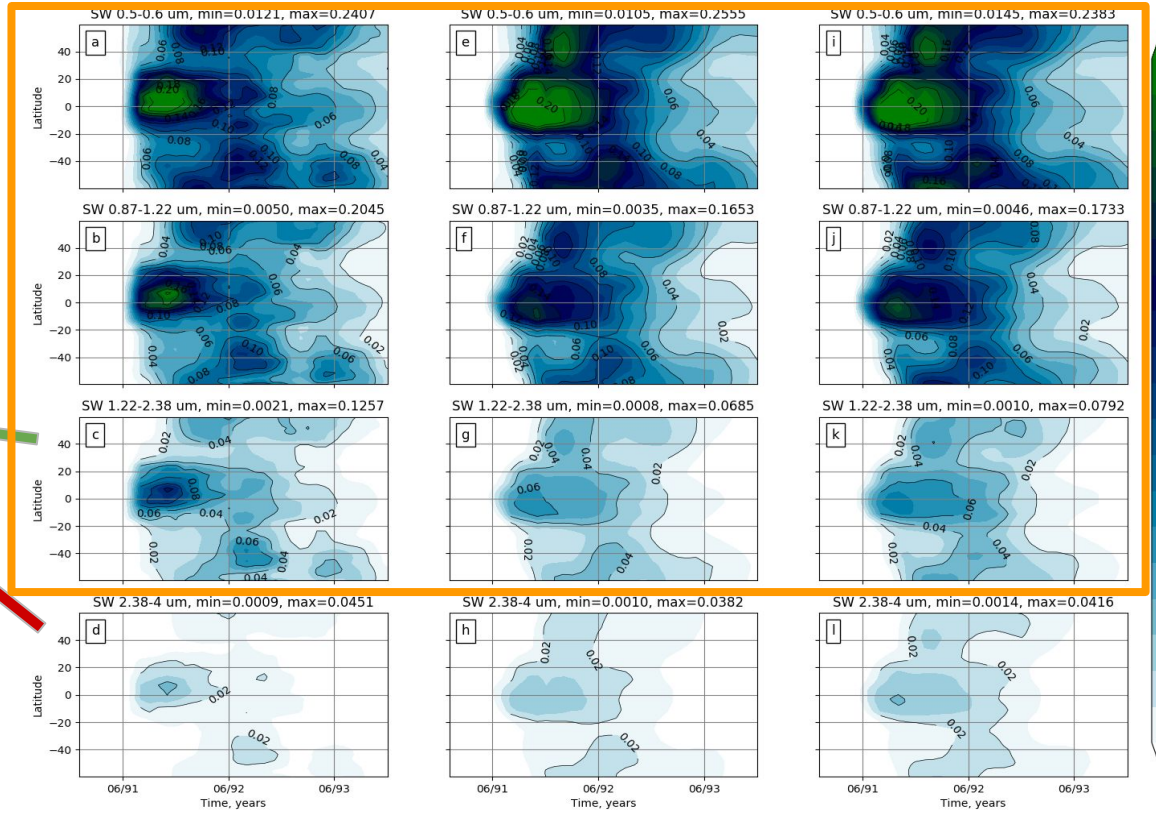
Extinction optical depth

Solar spectral irradiance

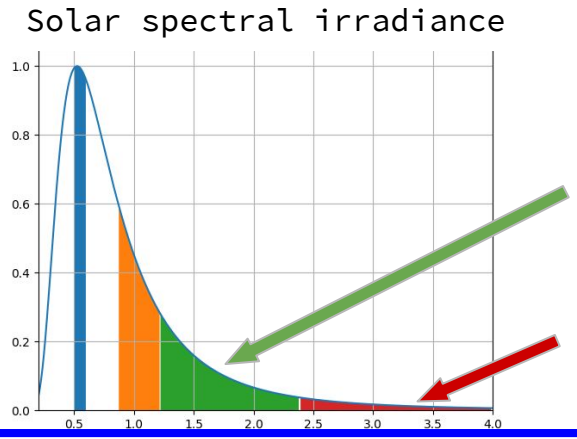


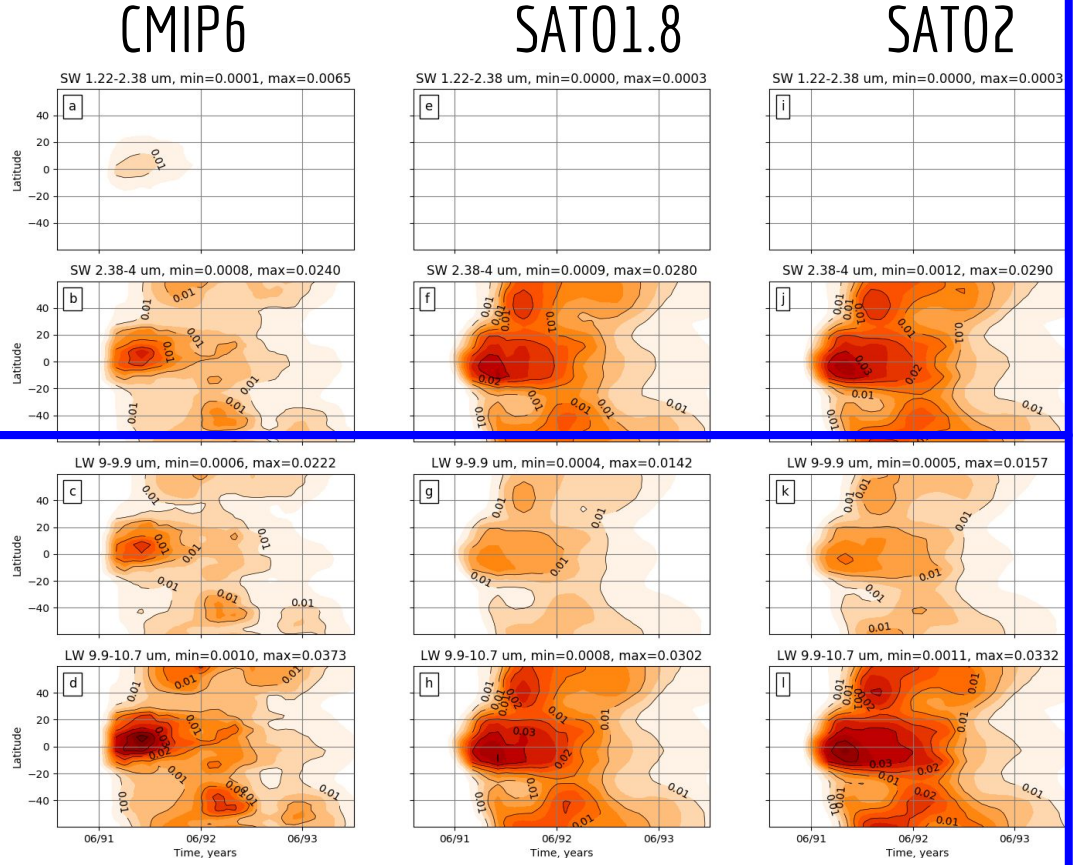
EAOD defines how much of solar radiation was prevented from reaching the surface by scattering and absorption.

CMIP6 SAT01.8 SAT02

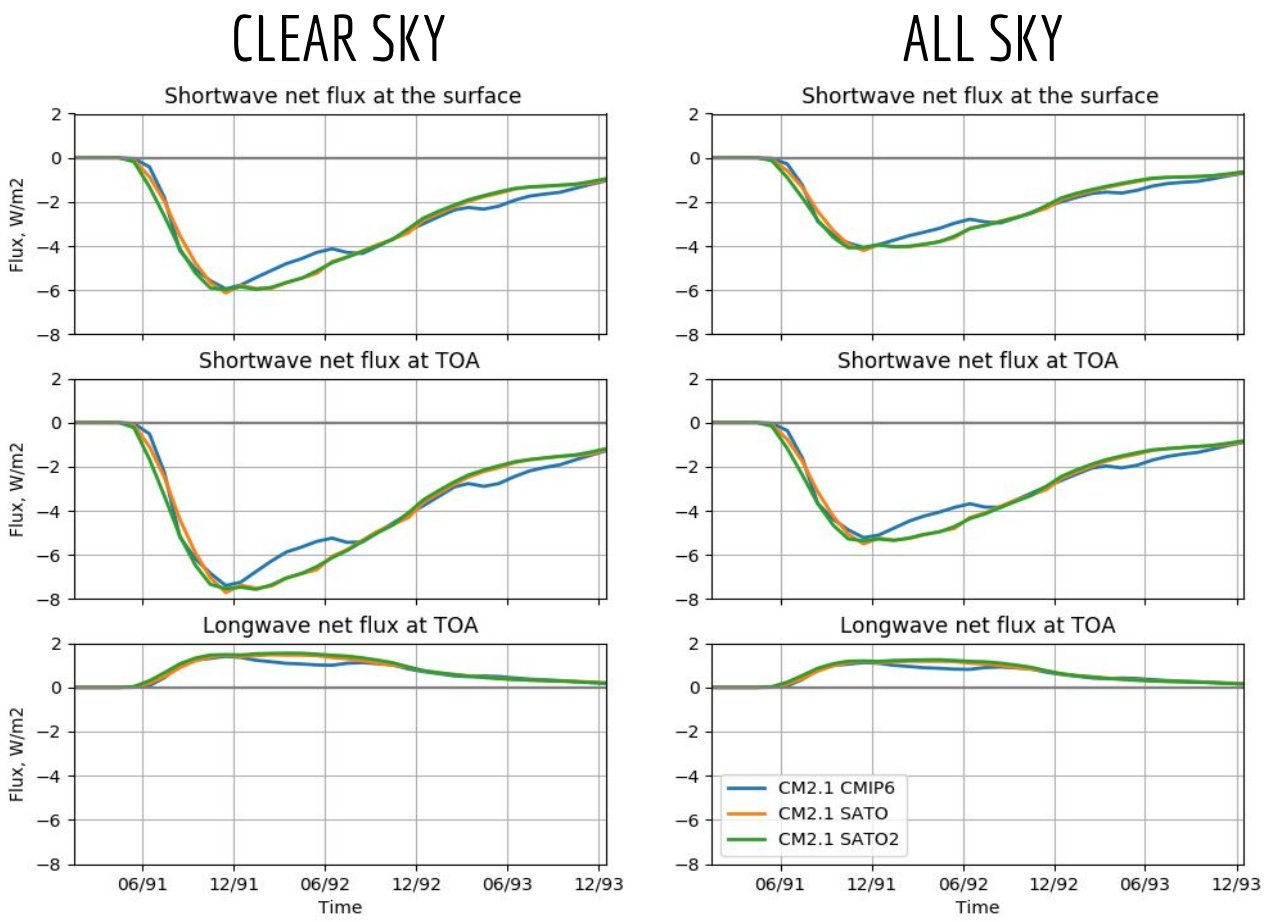


Absorption optical depth

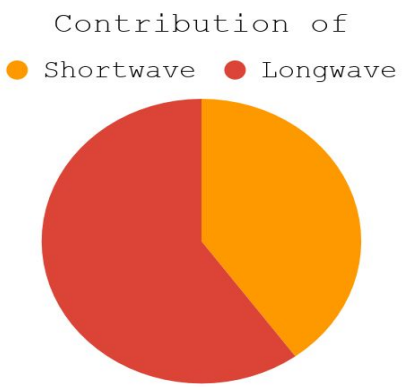




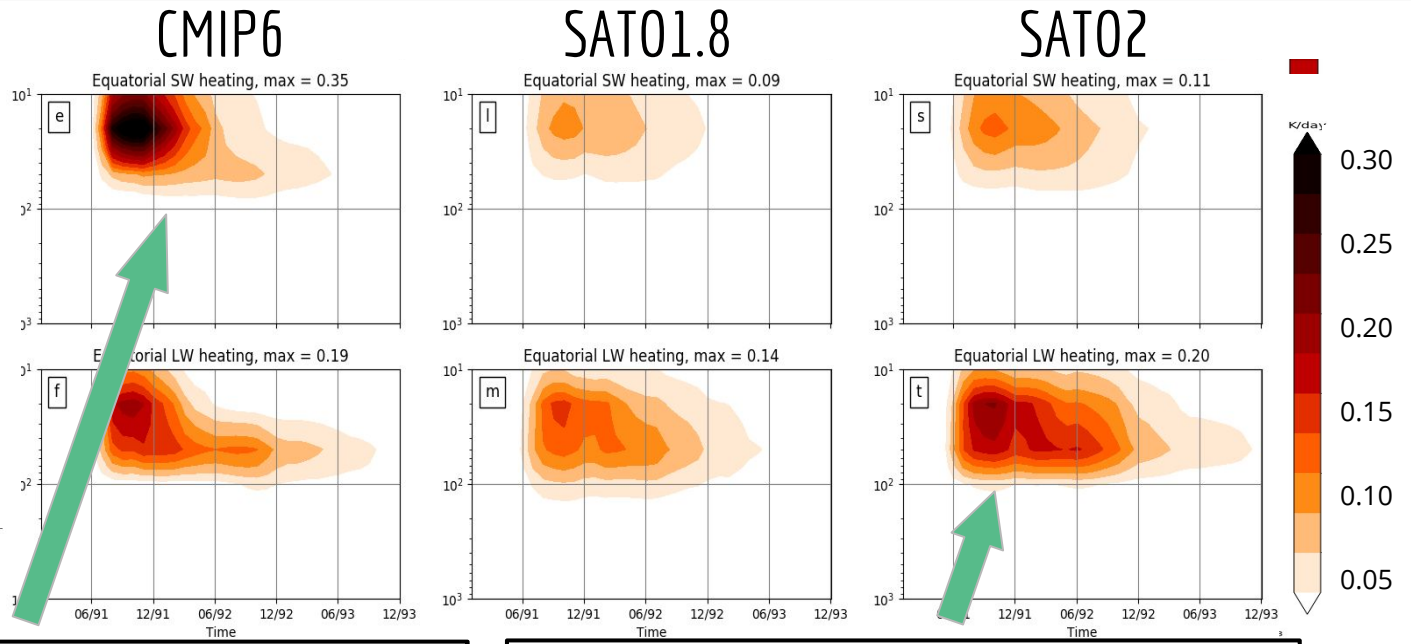
Radiative forcing at TOA and BOA



Equatorial SW and LW heating rates (K/day)



Stenchikov et.al 1998



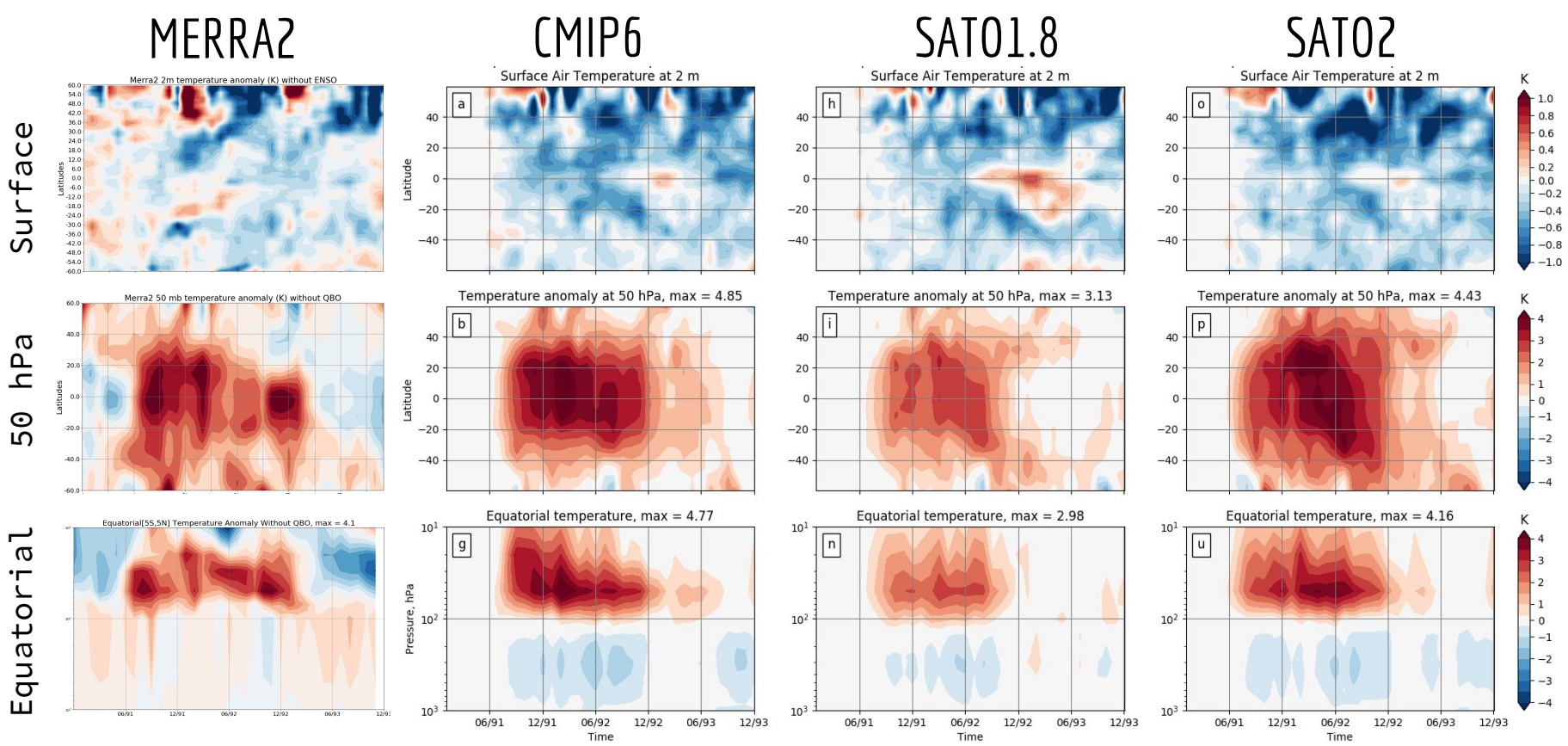
CMIP6:

1. Overestimates SW absorption
2. SW heating rate is 3x larger than in SATO or SATO2.

SATO2:

1. Due to the larger number of coarse particles, LW heating is enlarged

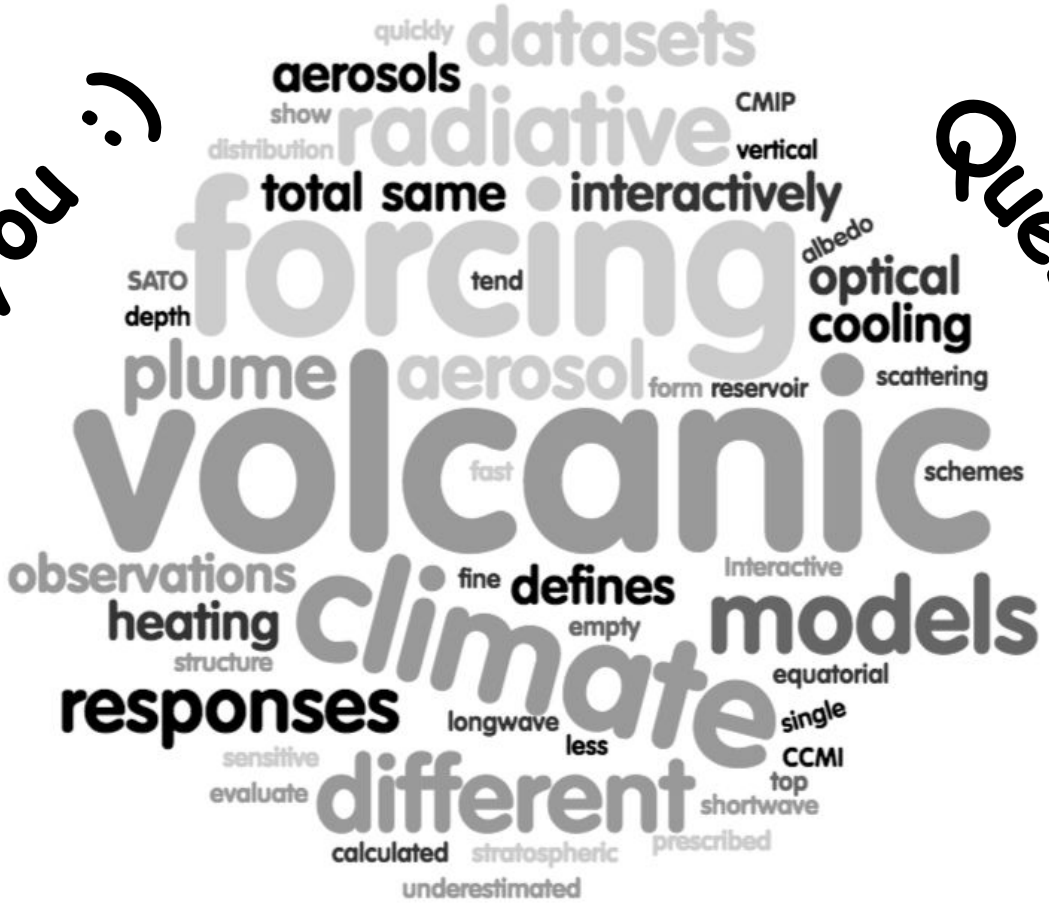
Temperature response



Conclusions

1. All datasets produce comparable forcing and climate impacts
2. Extinction and absorption optical depth are the most important aerosol characteristics to be preserved during processing
3. Stratospheric heating response is sensitive to SW and LW aerosol absorption. LW absorption is more important for stratospheric heating than the SW
4. CMIP6 overestimates solar heating rates as it absorbs starting from 1.22 um
5. LW absorption is sensitive to the width of aerosol size distribution
6. Tropospheric cooling is sensitive to solely SW optical depth

Thank you :)



Questions?

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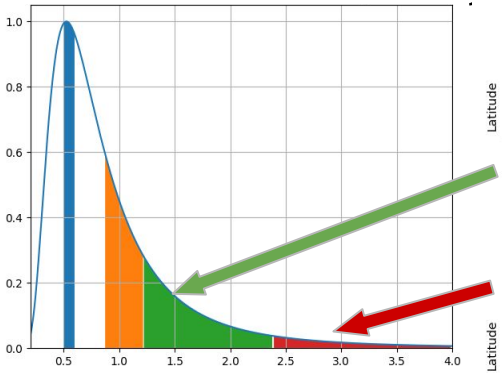
A = 1 - SSA (absorption)

Shortwave radiation intensity



CMIP6

SAT01.8

SAT02