Composition-climate models

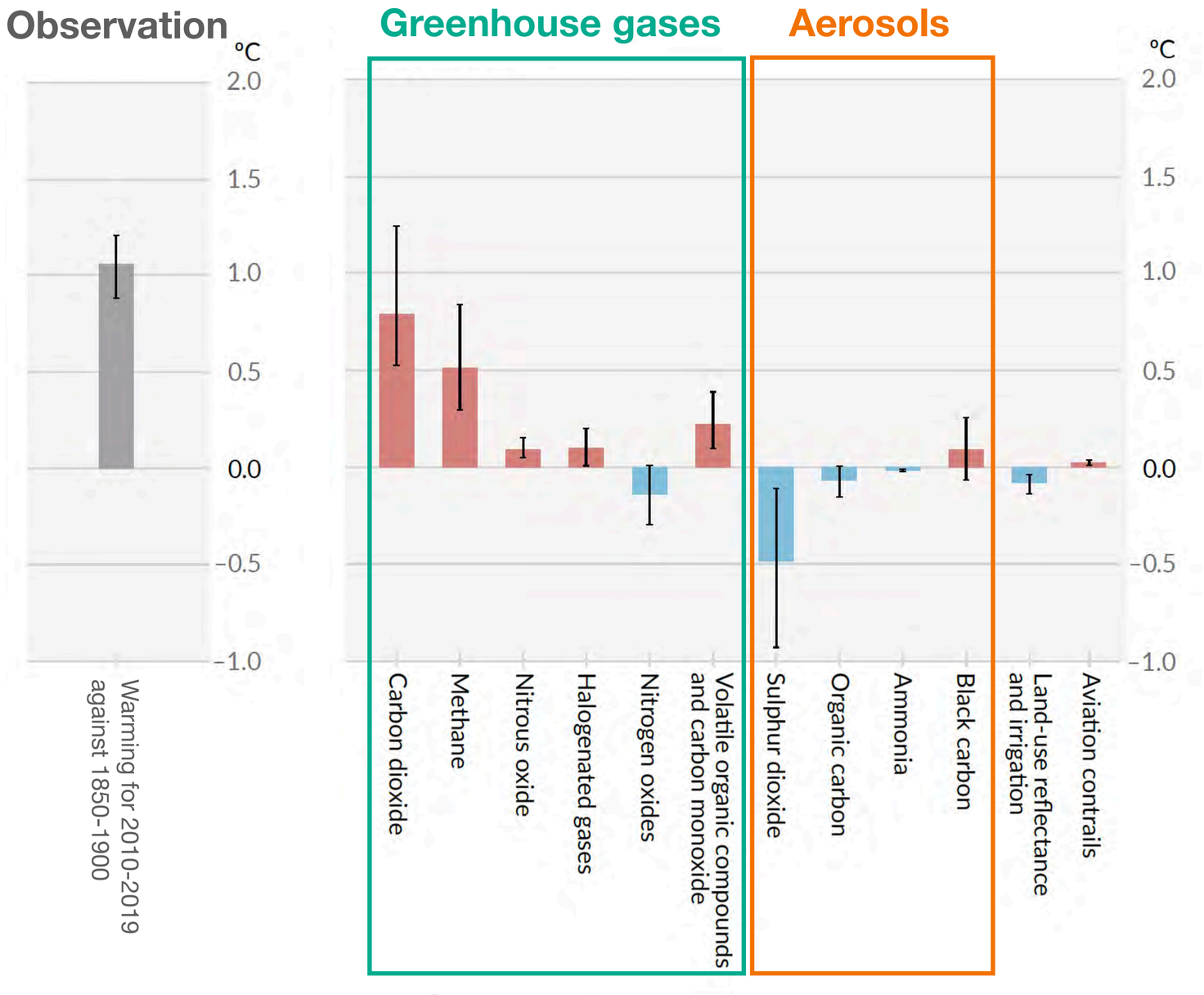
Stephanie Fiedler

University of Cologne, Germany

WCRP Workshop on Future of Climate Modelling

22 March 2022

Contributions of anthropogenic changes to warming

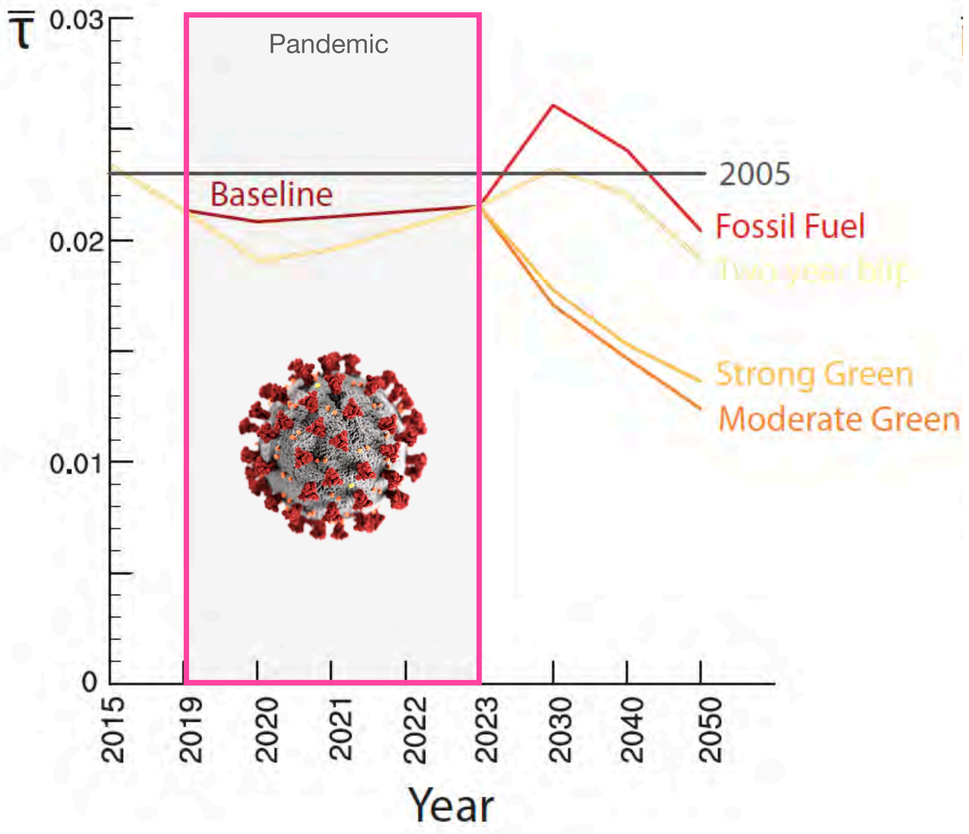


IPCC (2021)

Quantifying the impact of the Covid-19 on climate

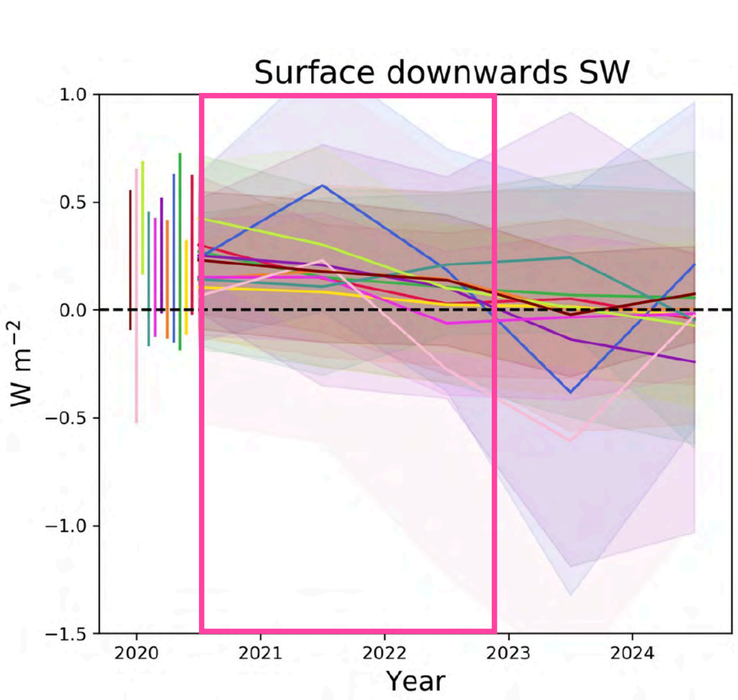
Results from CovidMIP

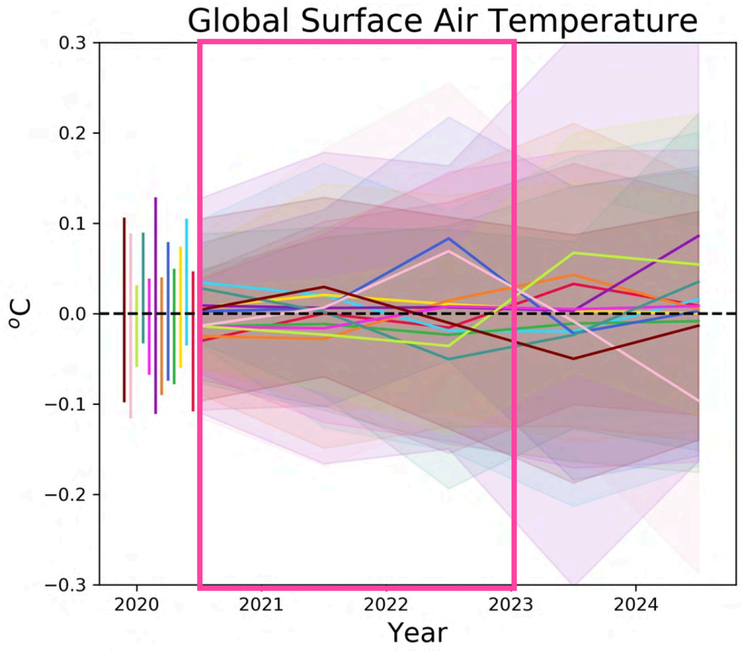
Covid-19 scenarios for aerosol optical depth

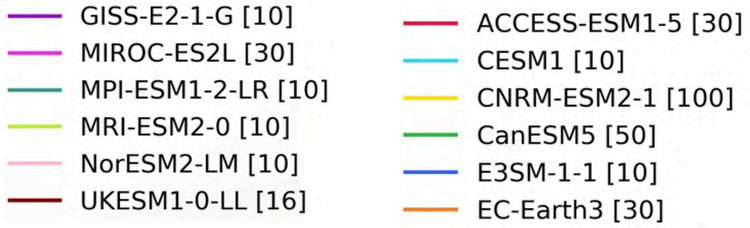


Fiedler et al. (2021)

Climate Response to Covid-19



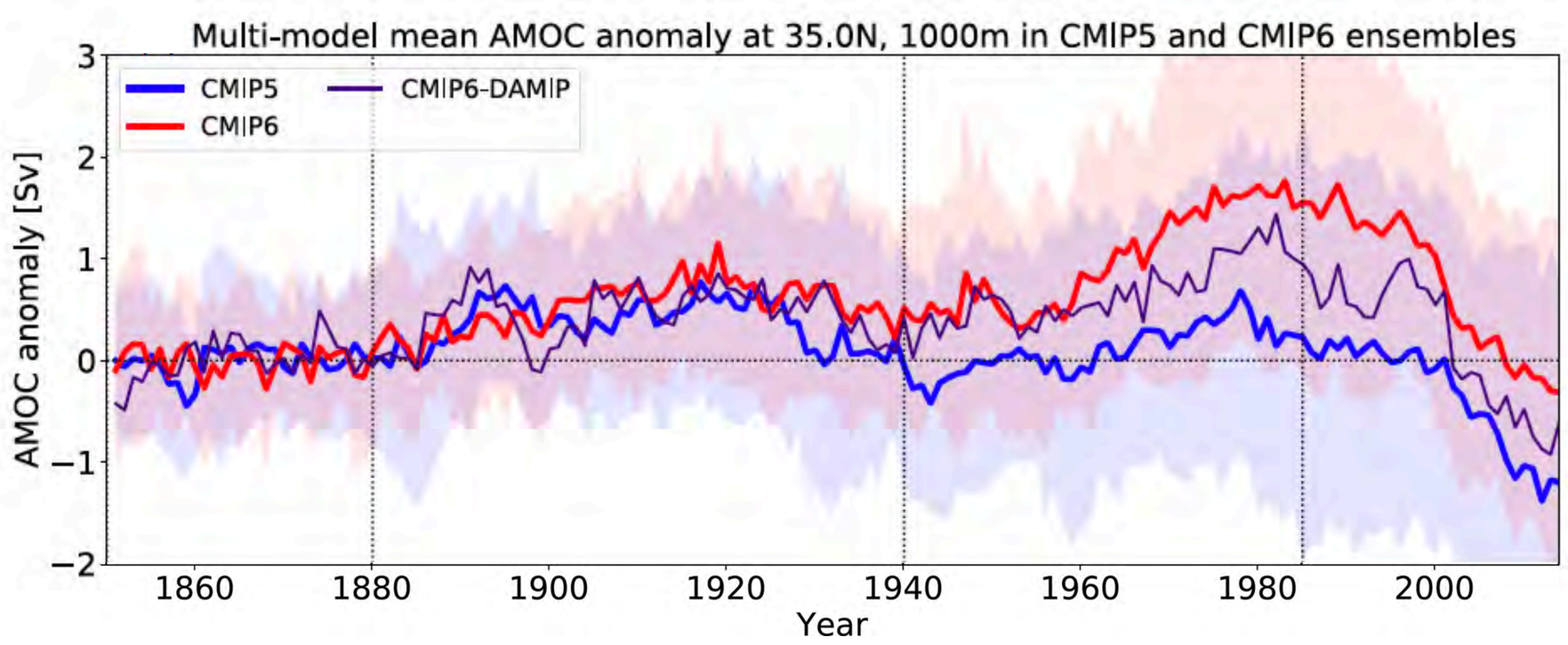




Jones et al. (2021)

Implication of atmospheric composition for ocean circulation in CMIP ensembles

Atlantic Meridional Overturning Circulation (AMOC)

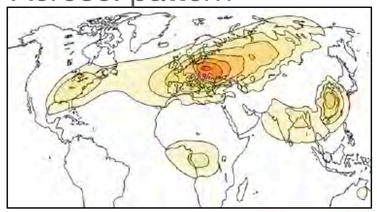


10% stronger AMOC in CMIP6 than CMIP5 associated with aerosol forcing

Menary et al. (2020)

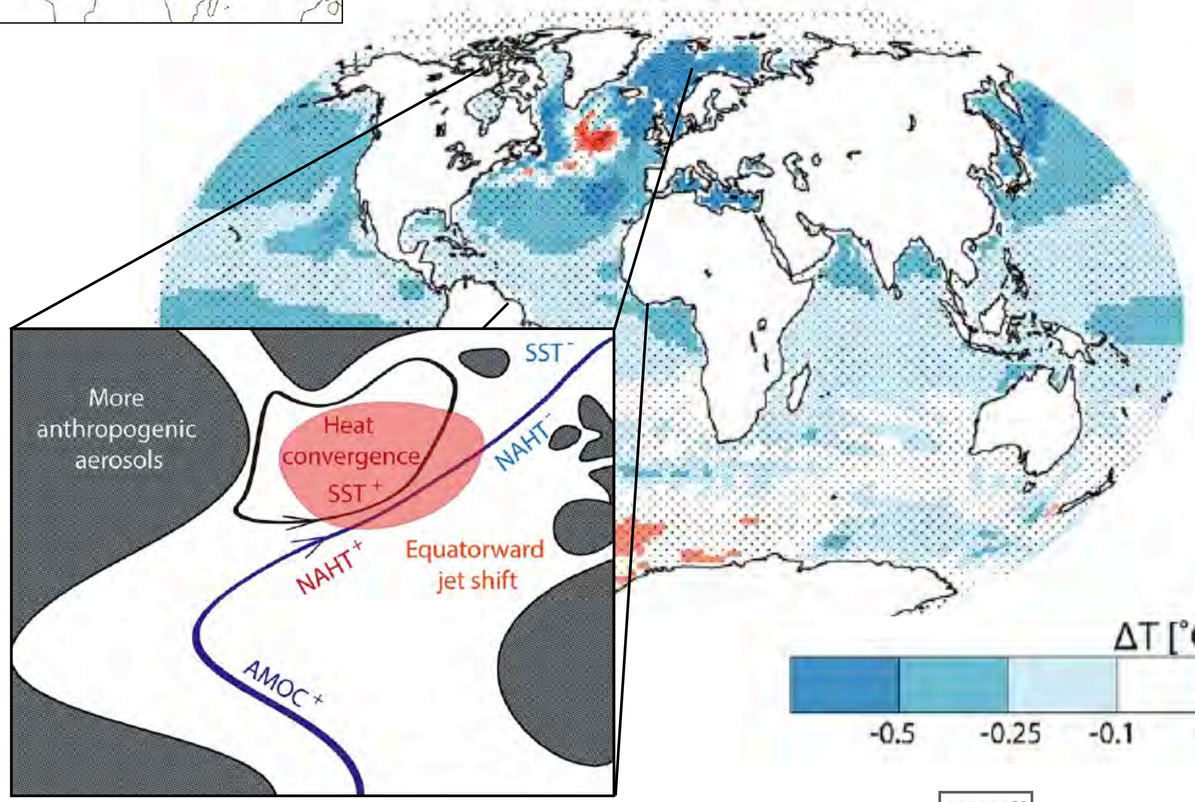
Sea-surface temperature and circulation response to aerosol patterns

Aerosol pattern



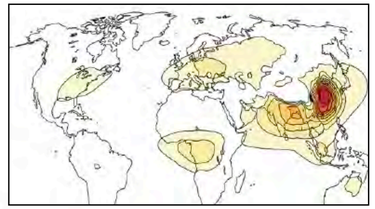
Effect of aerosol increase

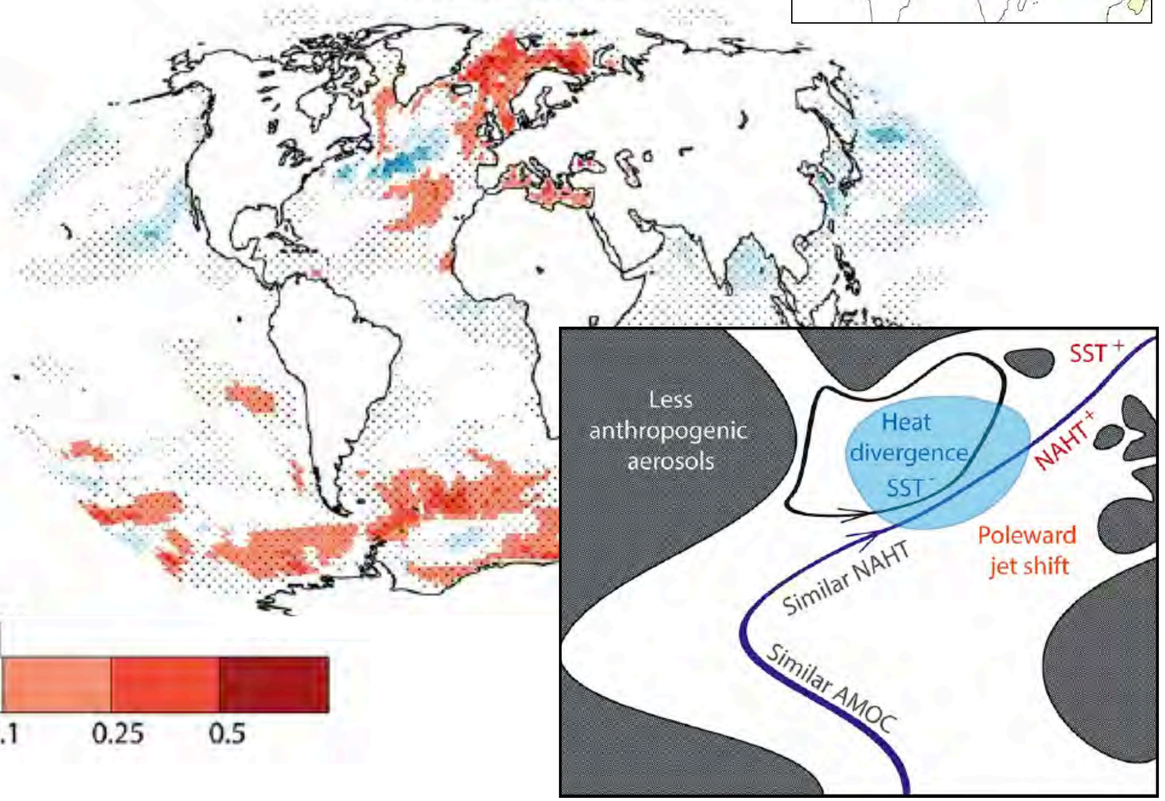
1850 to 1970s



Effect of aerosol shift

1970s to 2000s





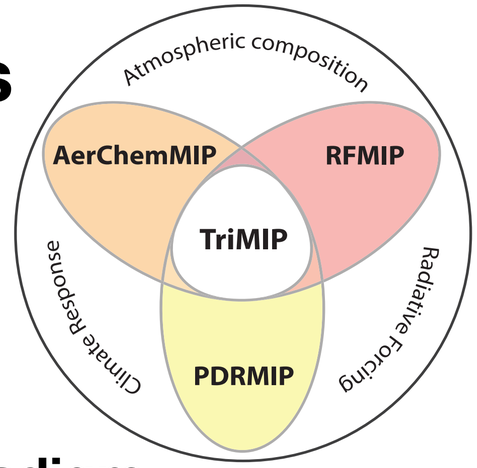
Statistically significant signal

- Contribution of aerosol reduction since 1970s to Arctic amplification and emergence of warming hole.
- Sub-polar gyre plays important role in the response through divergence in northward heat transport.

Fiedler & Putrasahan (2021)

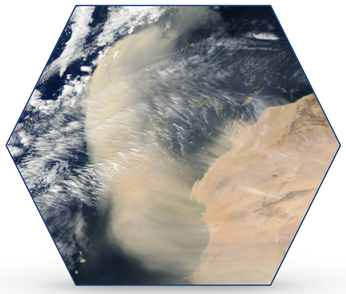
Challenges of composition-climate models

Discussions in TriMIP community



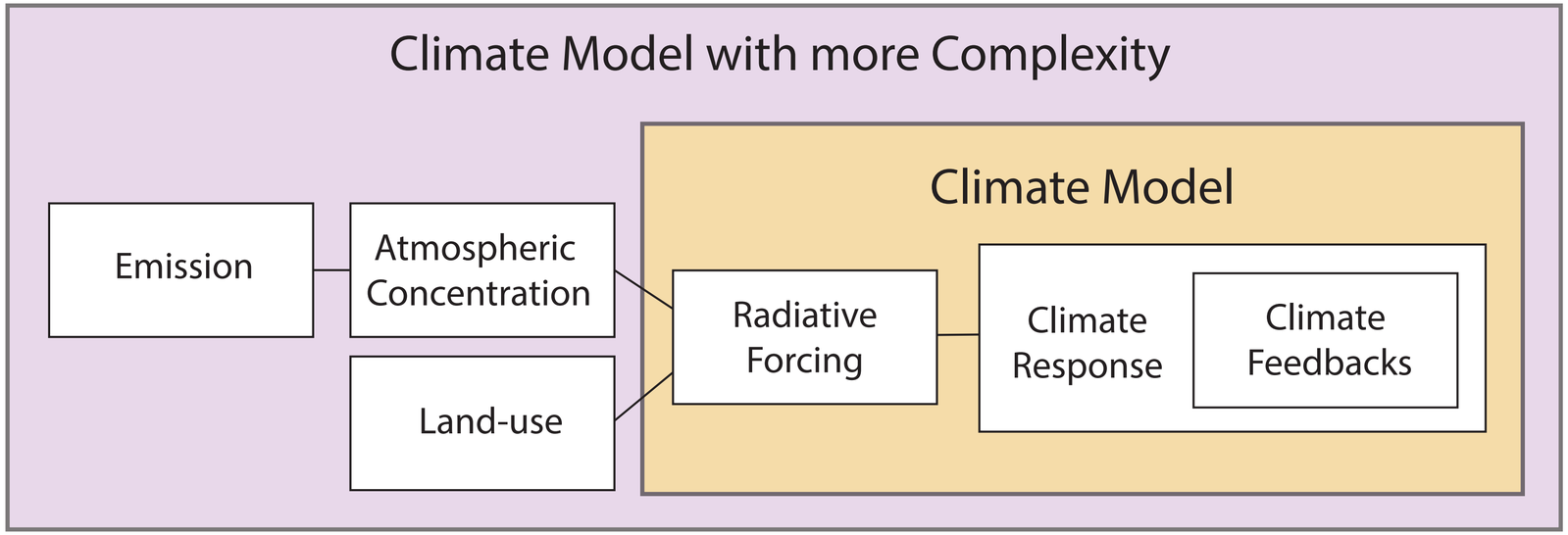
Anthropogenic aerosol

Natural aerosol



Clouds and circulation

Atmospheric Compositon - Forcing - Response - Feedback paradigm



Necessary tradeoff in Modelling

Model complexity - Model resolution - Ensemble size

WCRP grand challenge

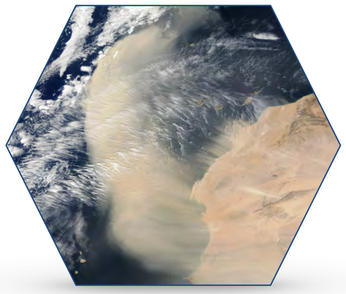
Fiedler et al. (in prep.)

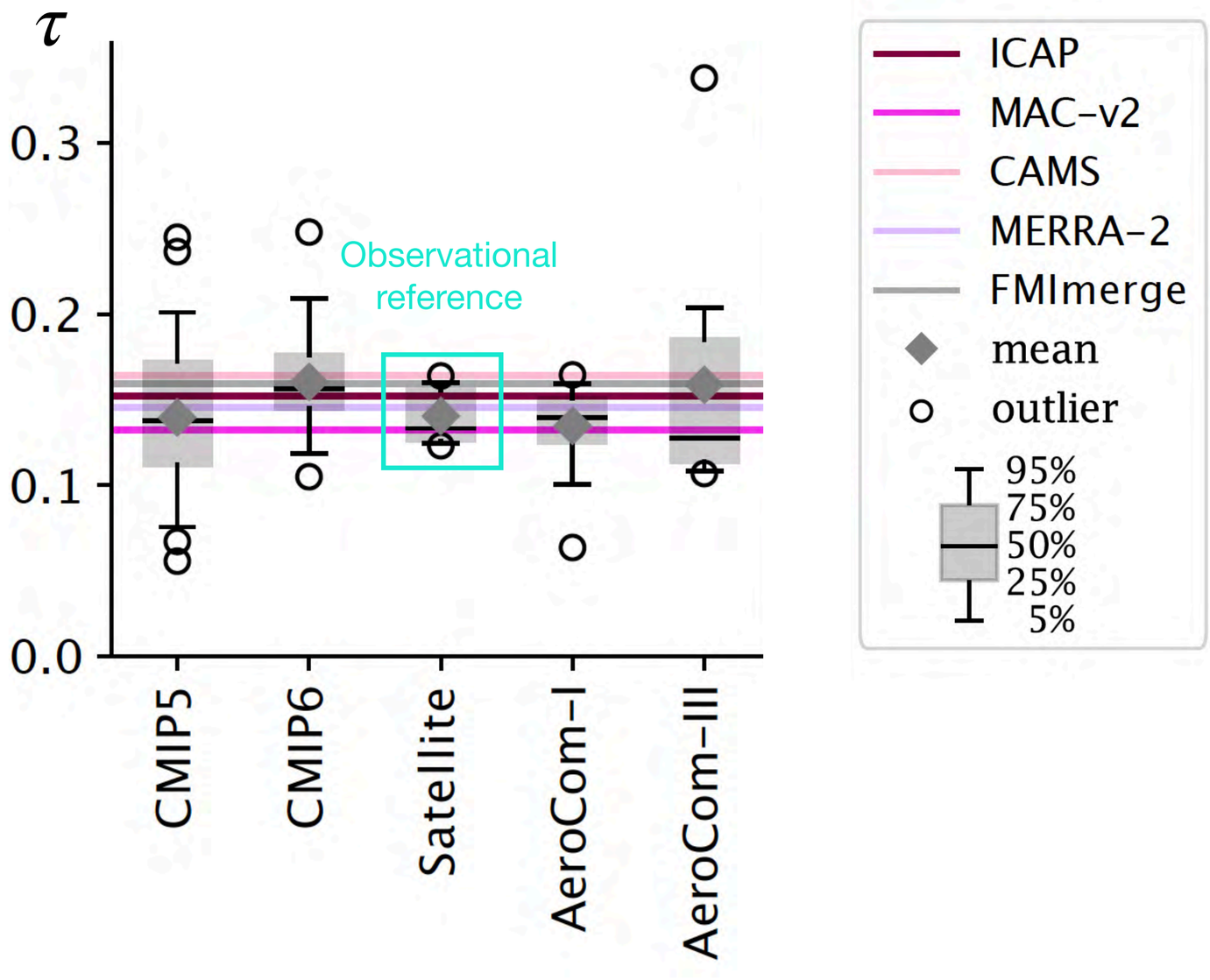
Model diversity in aerosol optical depth

Opportunity for further model improvements based on observations

Anthropogenic aerosol

Natural aerosol



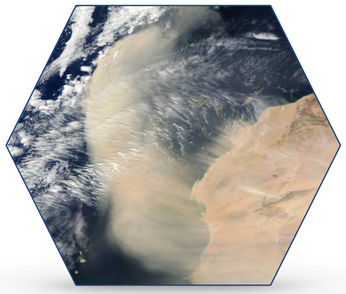


Vogel et al. (2022)

Model diversity in wind response to quadrupled CO_2

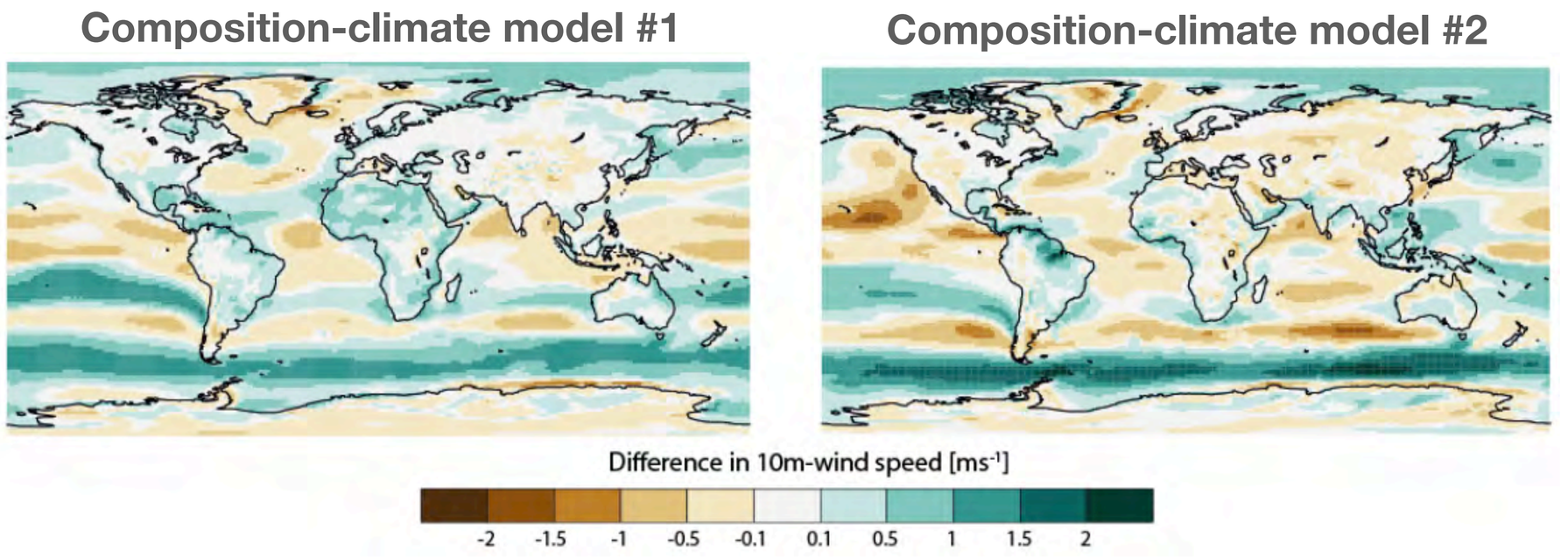
Composition-climate model results from AerChemMIP

Natural aerosol



Clouds and circulation

WCRP grand challenge

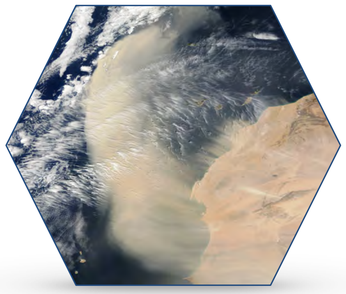


Thornhill et al. (2020)

Model biases in tropical rain from CMIP6

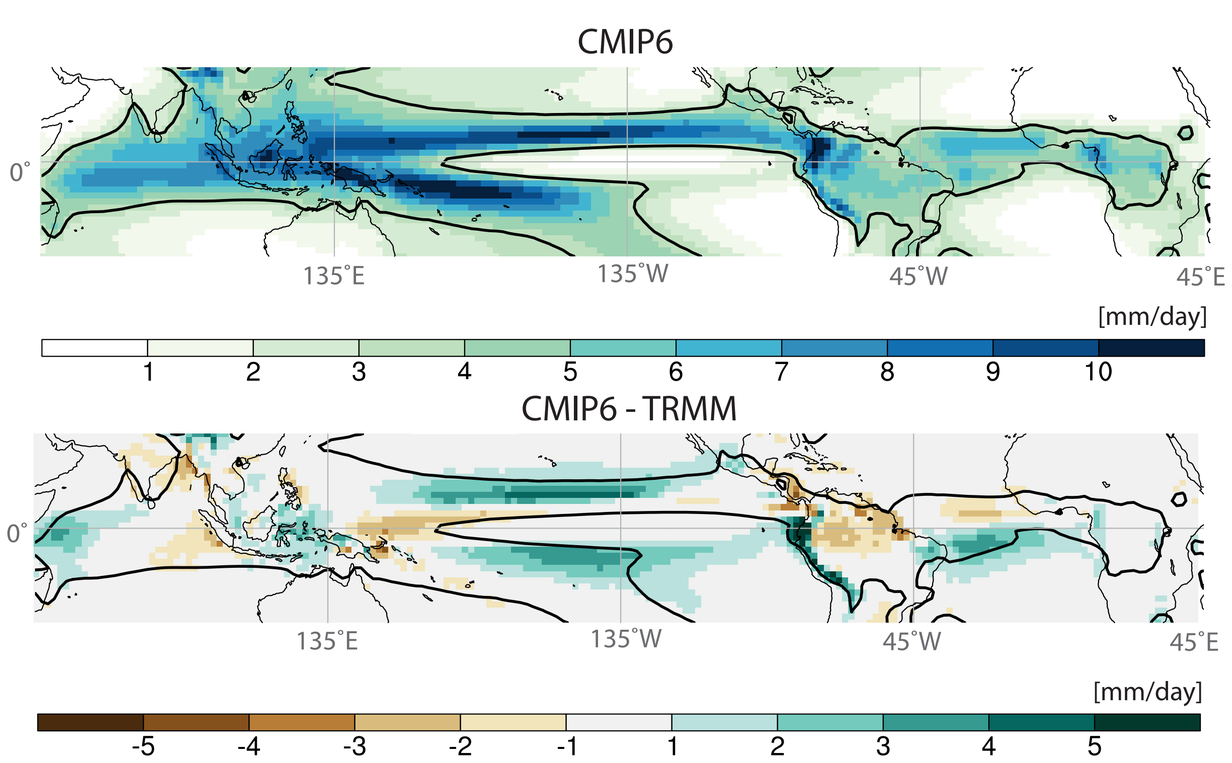
Anthropogenic aerosol

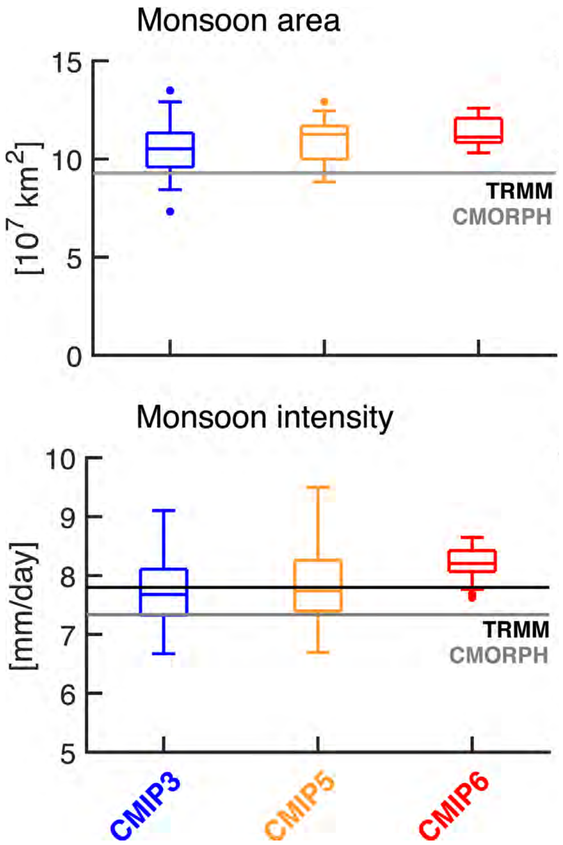
Natural aerosol



Clouds and circulation

Implication for aerosol deposition





WCRP grand challenge

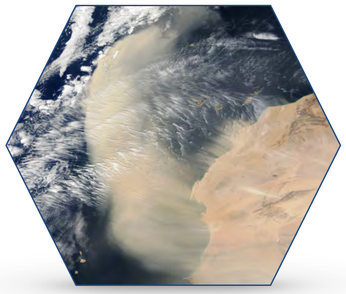
Fiedler et al. (2020)

Model spread in aerosol effective radiative forcing

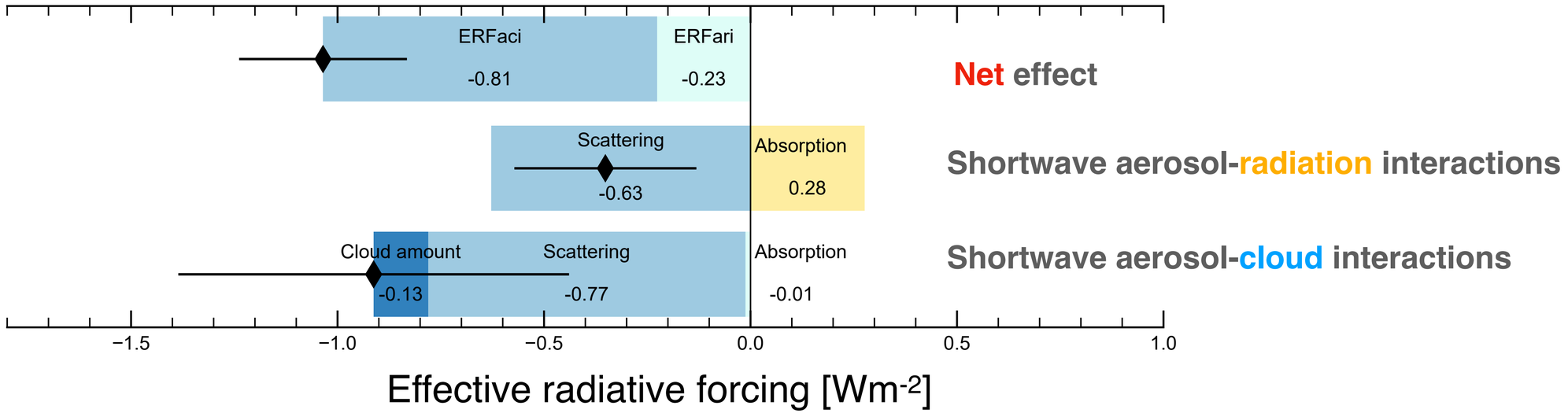
Composition-climate model results from RFMIP

Anthropogenic aerosol

Natural aerosol



Clouds and circulation



WCRP grand challenge

Smith et al. (2020)

Interested?

- **Vogel et al. (***2022, J. Geophys. Res. Atmos.***)**
  Uncertainty in aerosol optical depth
- **Fiedler and Putrasahan** *(2021, Geophys. Res. Lett.)*
  SST and circulation response to aerosols
- **Jones et al.** *(2021, Geophys. Res. Lett.)*
  Temperature response during COVID-19 pandemic
- **Fiedler et al.** *(2021, Atmos. Res.)*
  Forcing from aerosol reduction during COVID-19 pandemic
- **Smith et al.** *(2020, Atmos. Chem. Phys.)*
  State-of-the-science for aerosol forcing
- **Thornhill et al.** *(2020, Atmos. Chem. Phys.)*
  Climate-driven composition feedbacks in CMIP6
- **Fiedler et al.** *(2020, Mon. Wea. Rev.)*
  Tropical precipitation across CMIP phases
- **Menary et al.** *(2020, Geophys. Res. Lett.)*
  AMOC differences in CMIP

stephanie.fiedler@uni-koeln.de

www.geomet.uni-koeln.de/forschung/ag-fiedler

LinkedIn

Follow me on ResearchGate

Thank you.