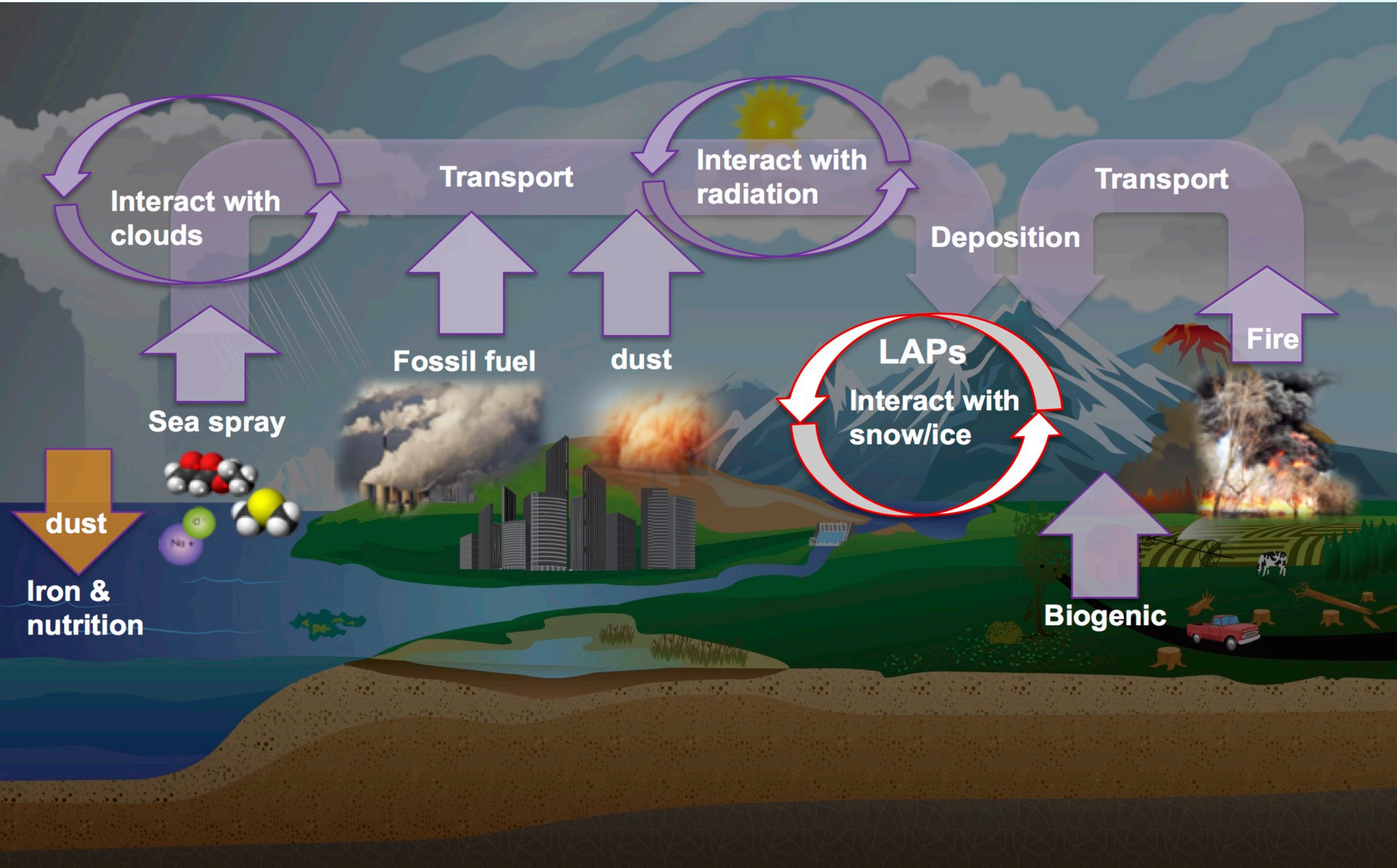
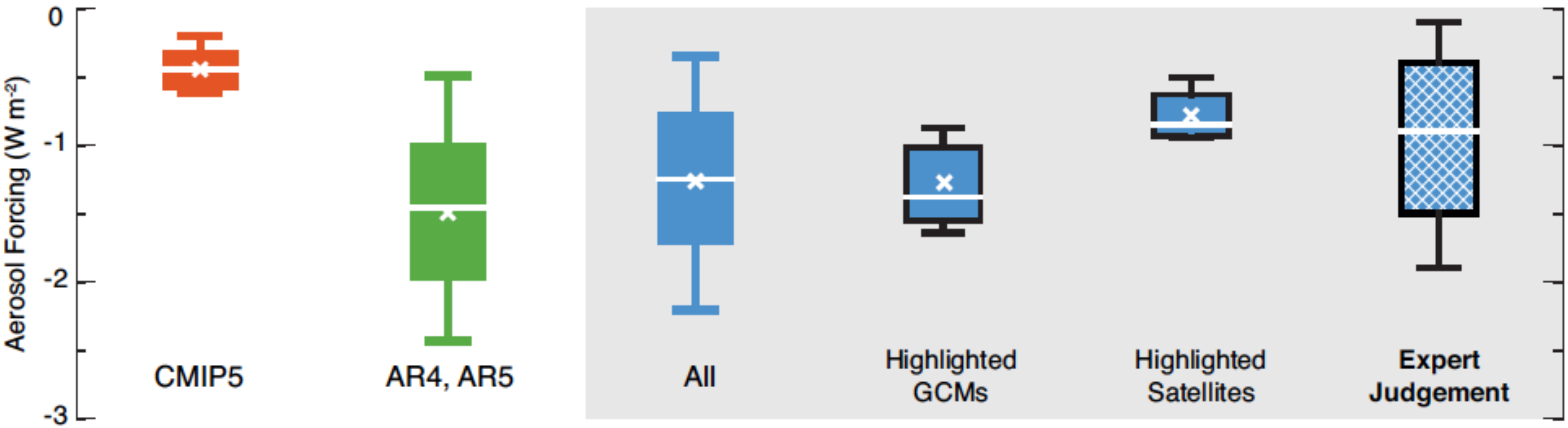
Aerosol Forcing and Biases in E3SMv1

Hailong Wang and many others

Aerosol interacts with the Water Cycle, BGC, and the Cryosphere



$ERF_{aci,ari}$ estimates from GCMs and satellites



RFari from GCMs

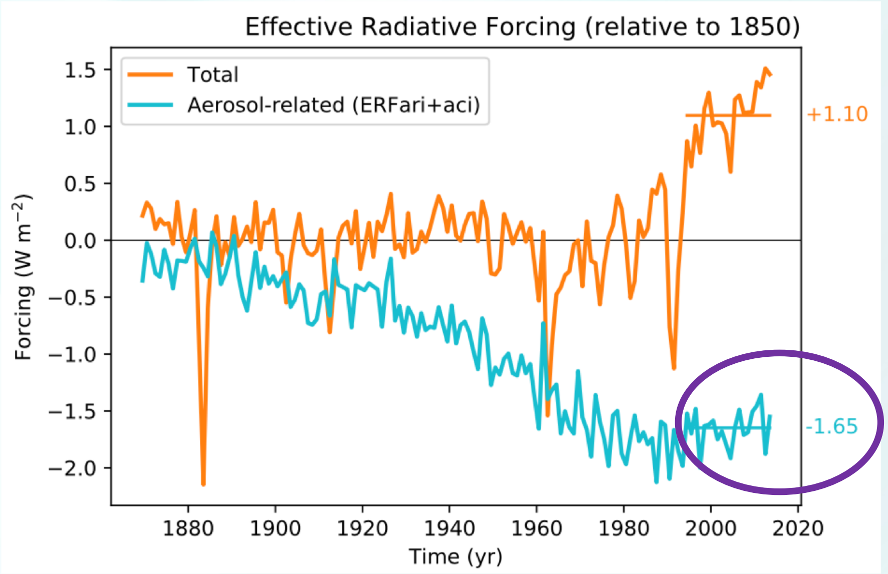
ERFaci from GCMs

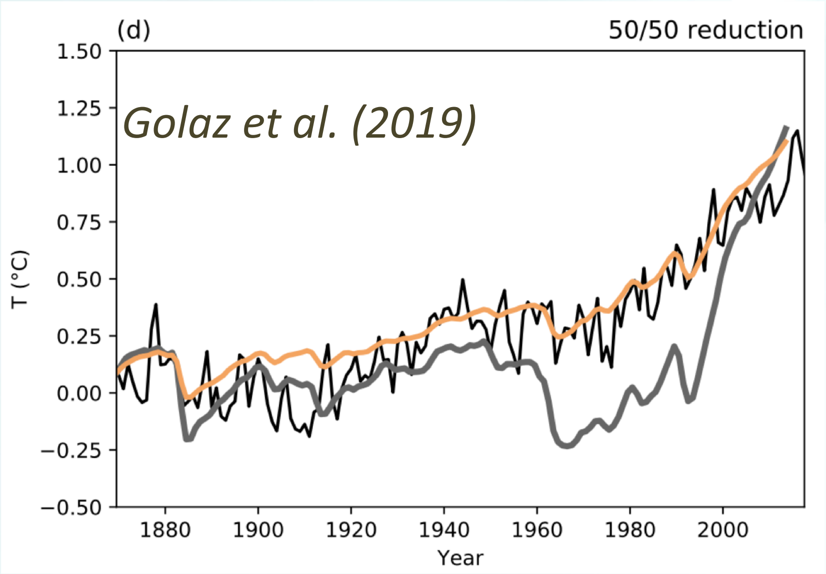
ERFari+aci

ERFari+aci from selected GCMs, satellites, and Expert Judgment

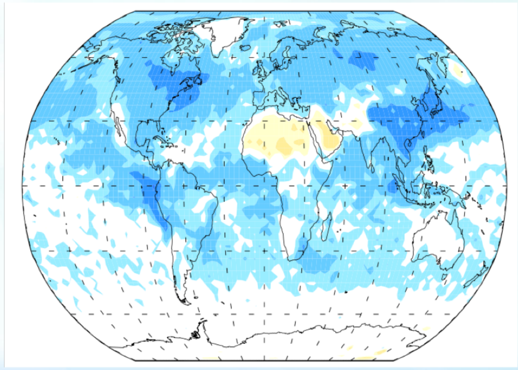
- **RFari:** radiative forcing due to aerosol-radiation interactions
- **RFaci:** radiative forcing due to aerosol-cloud interactions
- **ERFari, ERFaci**: effective radiative forcing including rapid adjustments to the initial changes in radiation and clouds, respectively.

Aerosol forcing ($ERF_{aci+ari}$) in E3SMv1

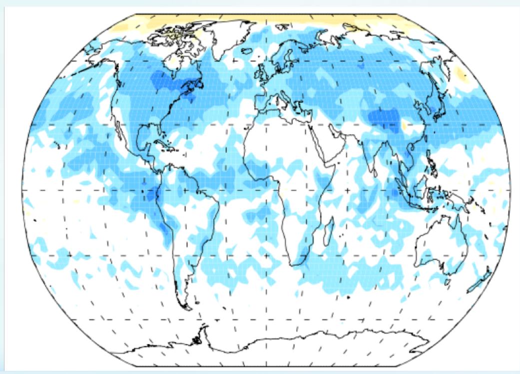




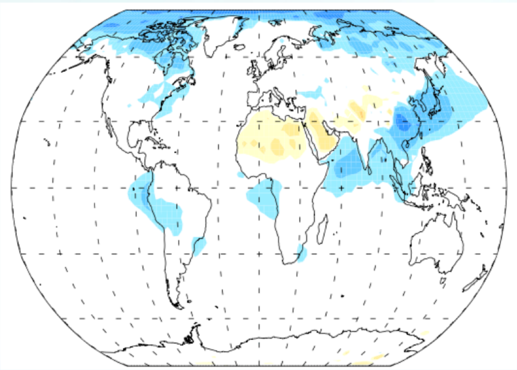
$ERF_{aci+ari}$ −1.64 W m^{-2}

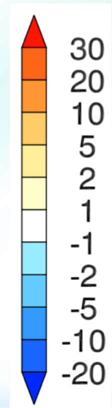


ERF_{aci} −1.14 W m^{-2}



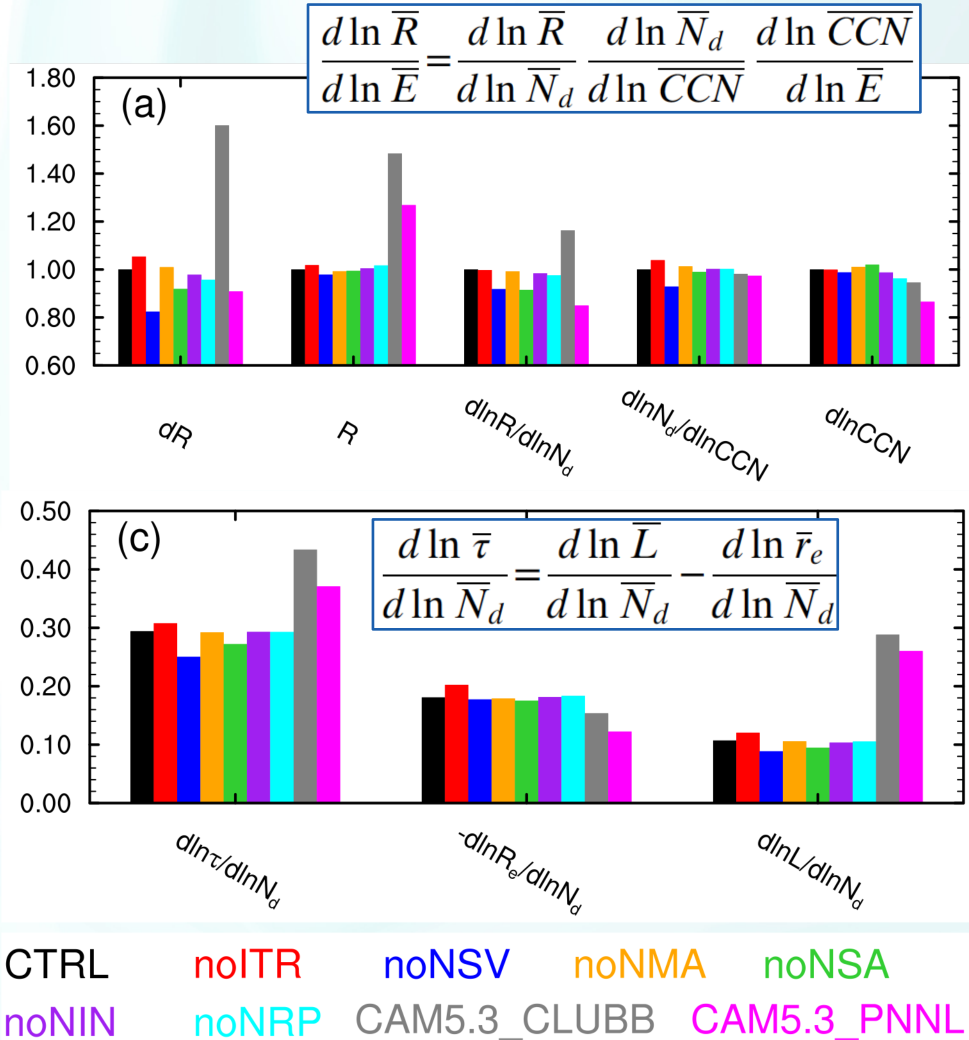
RF_{ari} −0.5 W m^{-2}





Wang et al., in prep.

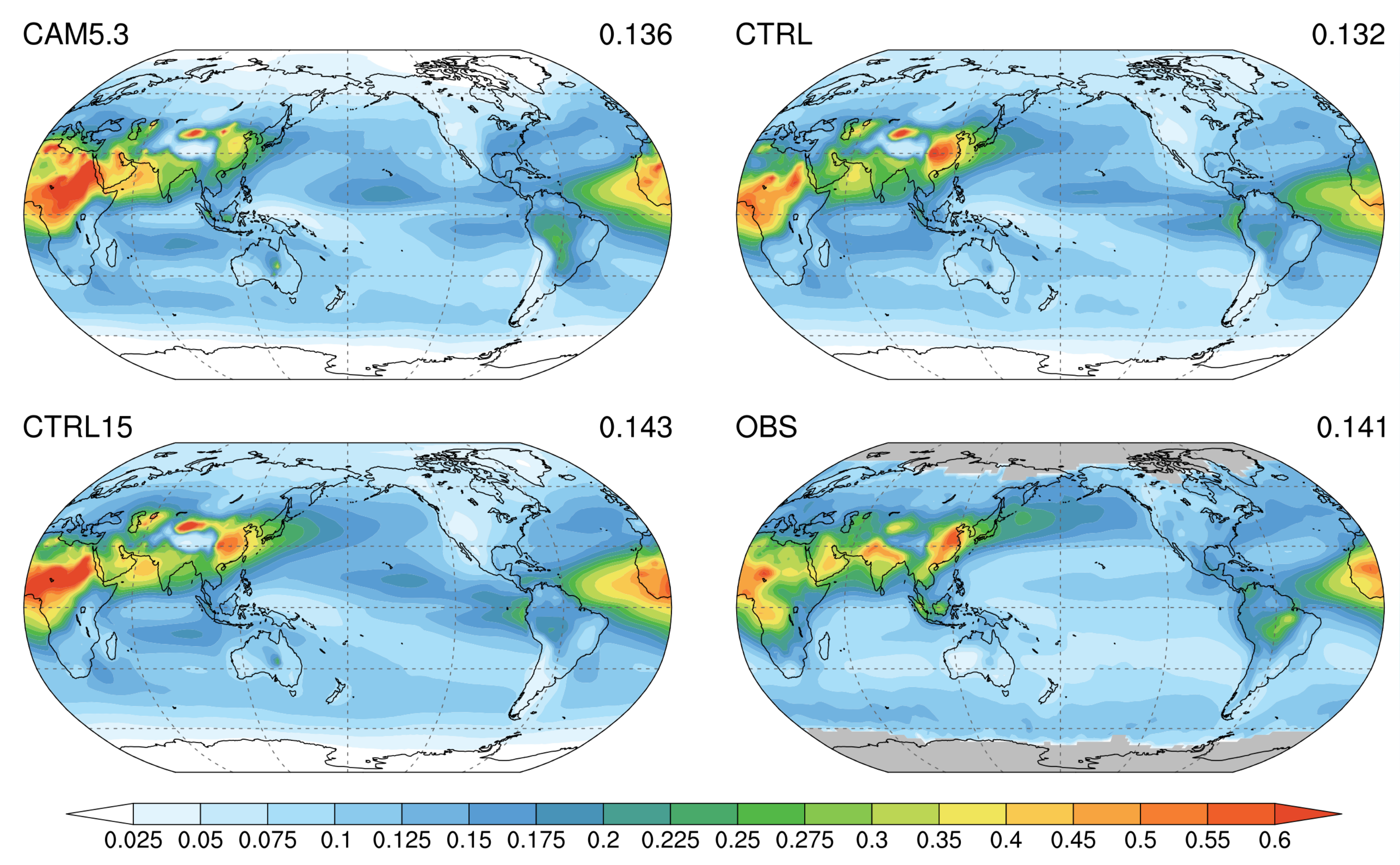
Aerosol indirect effects in E3SMv1



- Following Ghan et al. (2016) to decompose ACI to different warm cloud/aerosol processes and compare between v0 and v1
- E3SMv1 has smaller indirect forcing, mainly coming from the weaker sensitivity of cloud water to drop number change
- The various new aerosol treatments in v1 have relatively small impact on the forcing and sensitivity

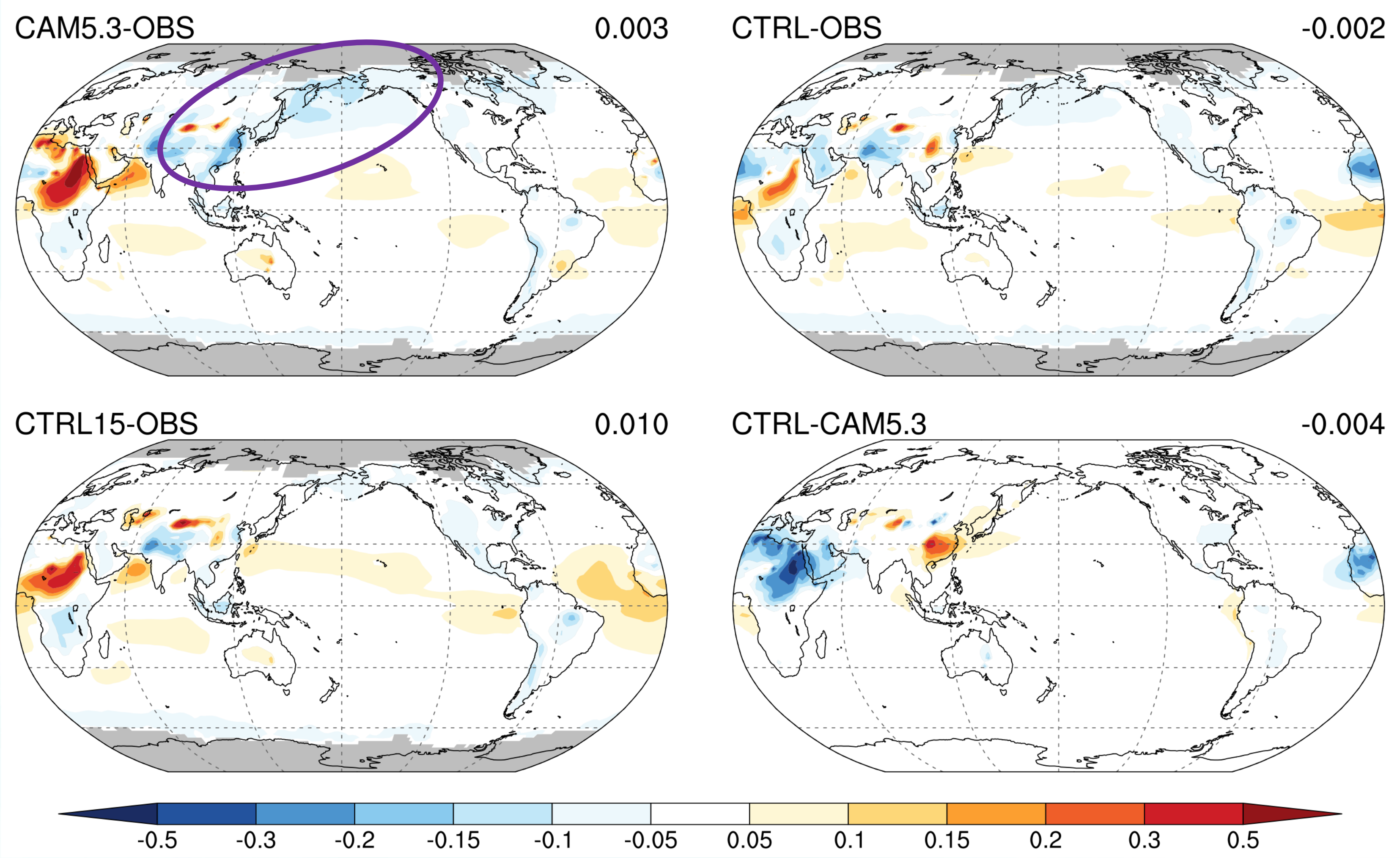
Wang et al., in prep.

Global distribution of AOD



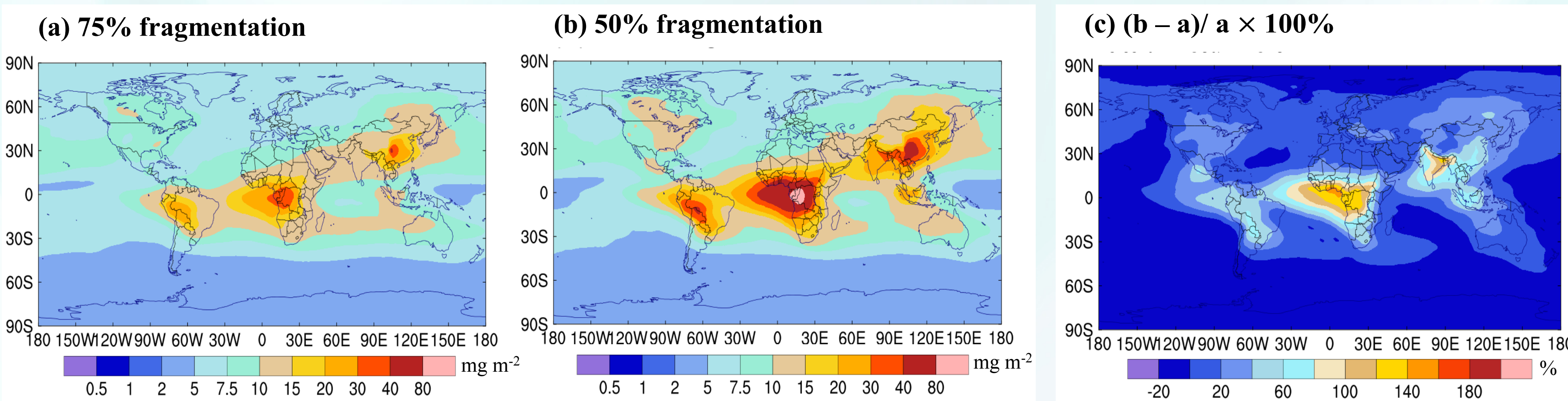
Wang et al., in prep.

AOD bias and difference b/w v1 and v0



Wang et al., in prep.

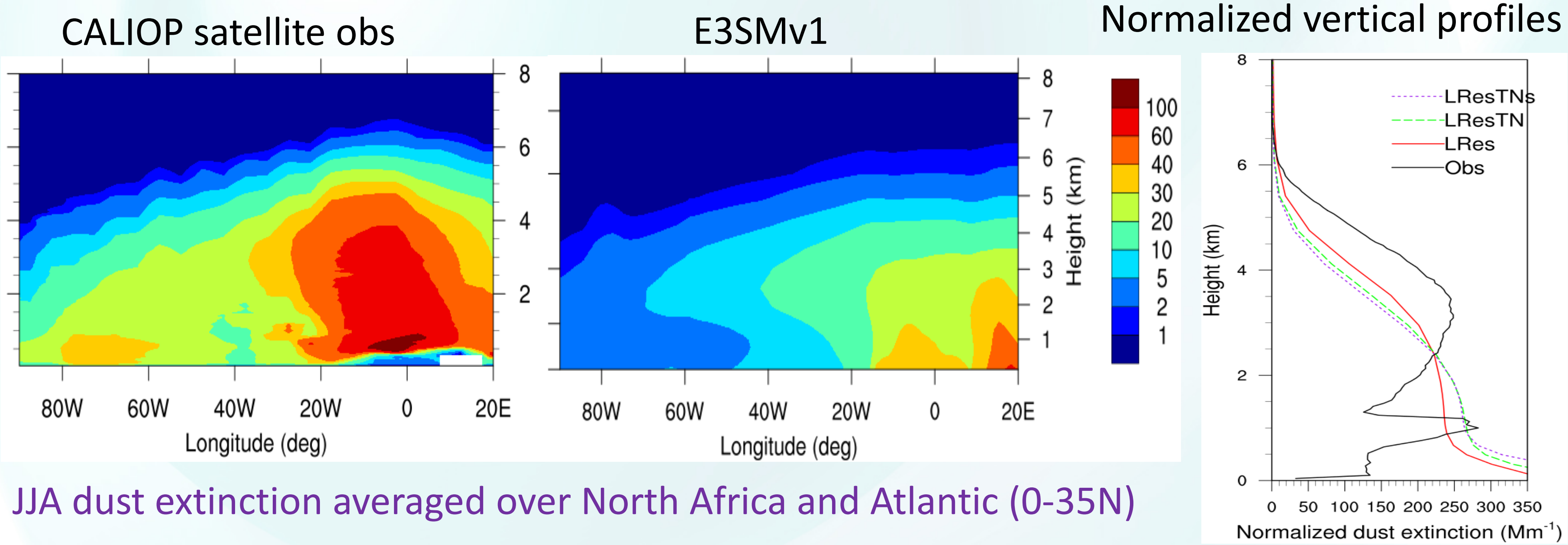
Sensitivity of SOA burdens to chemistry treatments



- Greatest effects of gas-phase fragmentation chemistry are over source regions including the South African biomass burning outflow, the Amazon, and India
- High latitudes such as the Arctic show much smaller effects of fragmentation chemistry on SOA burdens

Lou, Shrivastava et al. 2019: Sensitivity of biomass organic aerosols to emissions, oxidation reactions, cloud-aerosol interactions, and vertical resolution in E3SM, T*o be submitted to JAMES.*

Evaluation of dust in E3SMv1

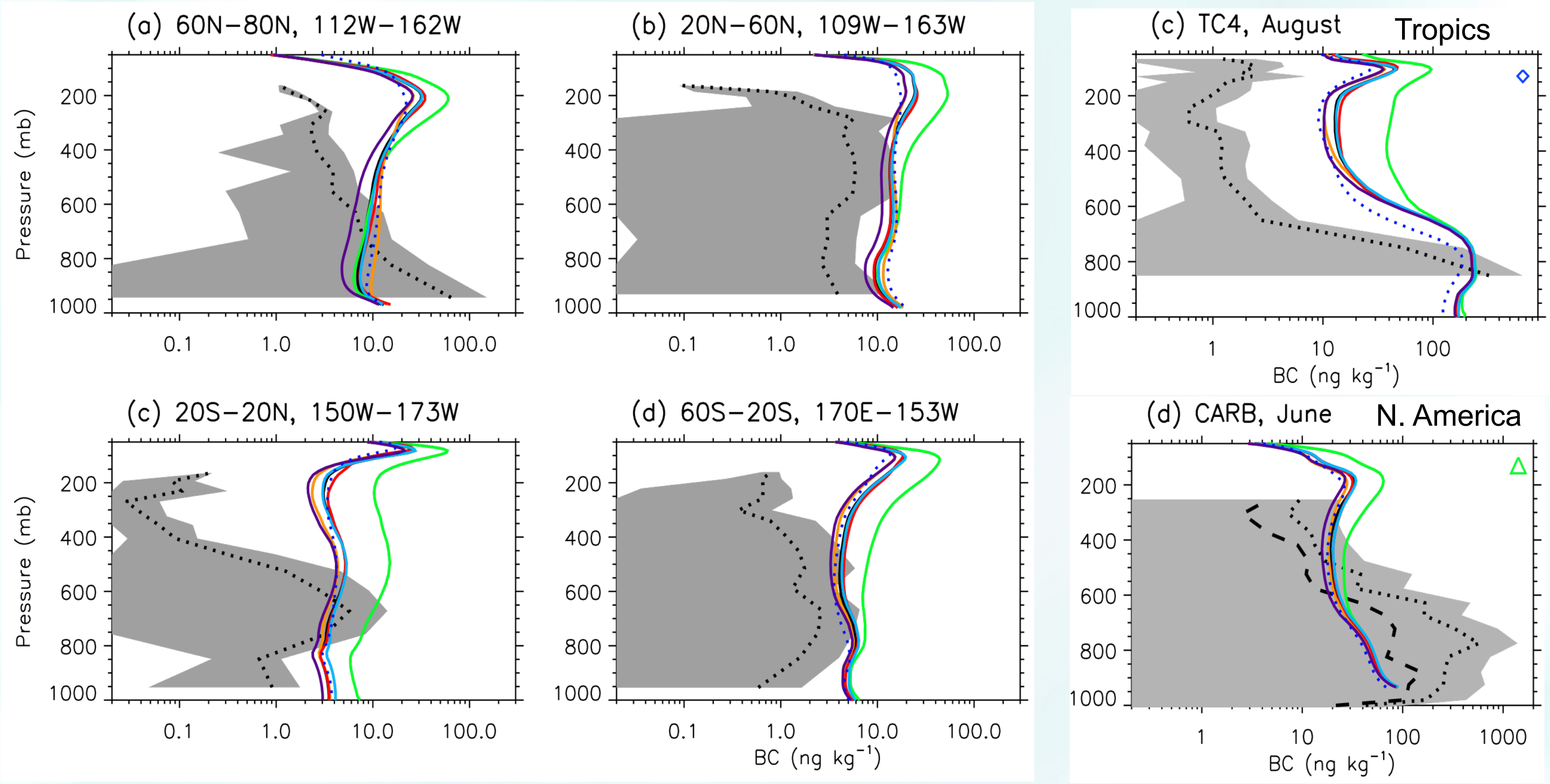


JJA dust extinction averaged over North Africa and Atlantic (0-35N)

- Overestimated dry deposition and underestimated dust plume height contribute to the underestimation of dust longwave warming compared to CAM5
- New dust emission and dry deposition schemes are being implemented in E3SM

Feng, Y., H. Wang, R. Easter, P. Rasch, K. Zhang, W. Lin, P.-L. Ma, S. Xie, J. Kok, D. Hamilton, N. Mahowald, and H. Yu, Global Dust Cycle and Direct Radiative Effect in the E3SM: Impact of Increasing Model Resolution, to be submitted.

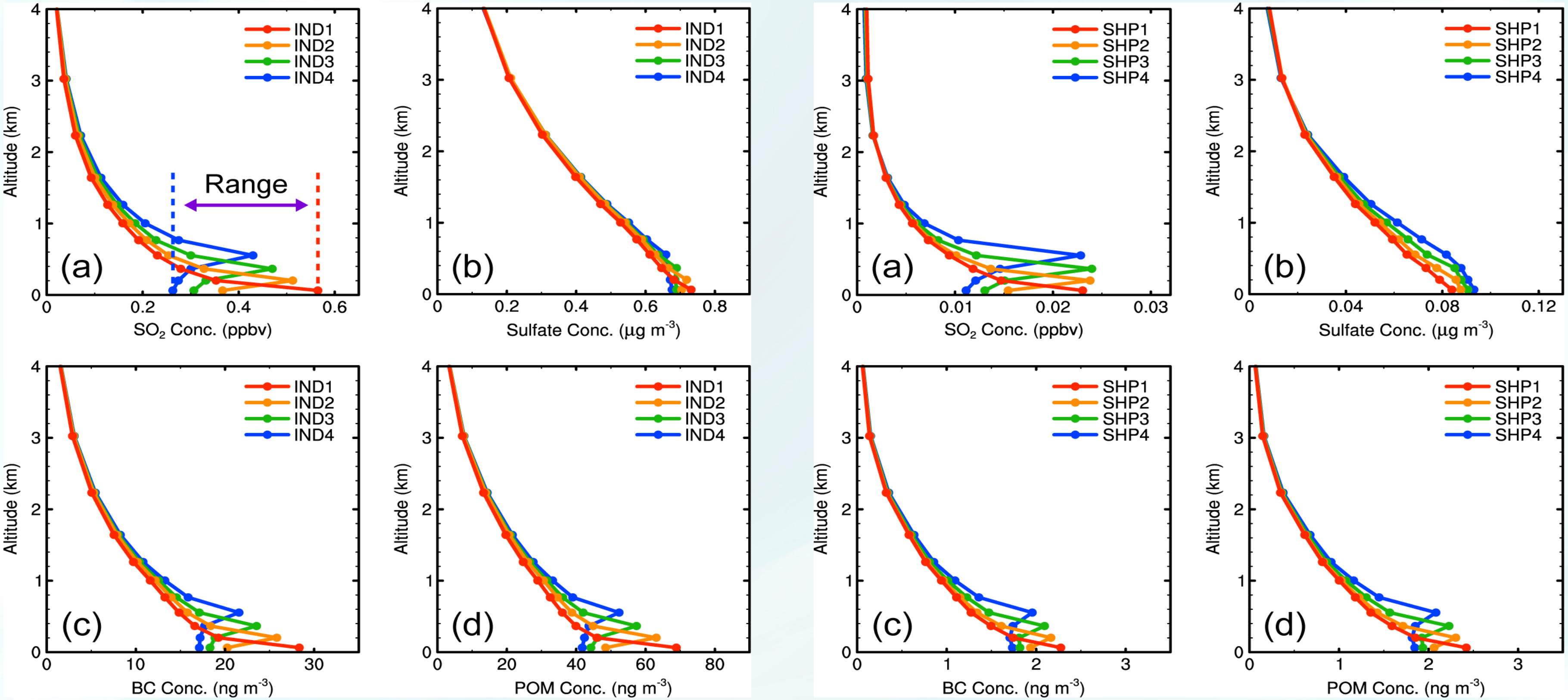
Biases in vertical distributions



Wang et al., in prep.

Biases in the vertical distribution of black carbon (BC) and other species are still large

Initial injection height matters



Yang et al., submitted.

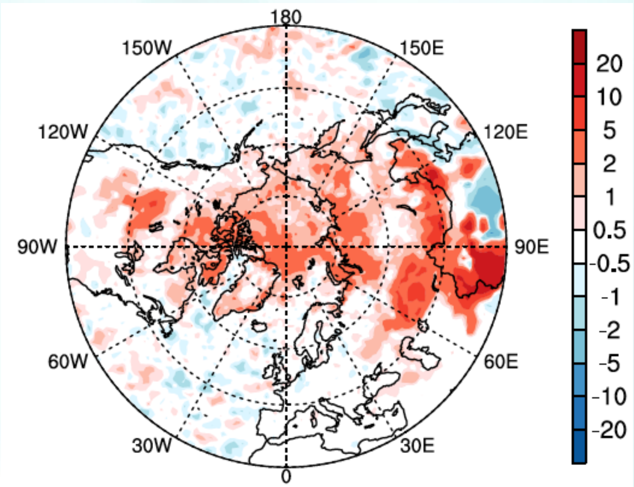
EmisSMIP: Emissions Sensitivity Model Intercomparison

Steve Smith (PI), Hailong Wang, Susanne Bauer (GISS)

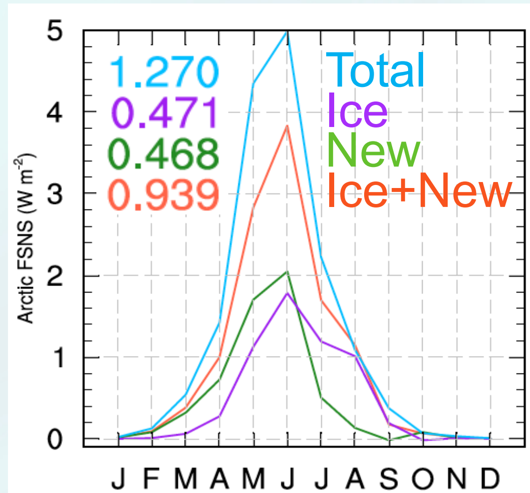
GSFC (GEOS-5), GISS, GFDL, NCAR, HadGEM-UKCA, PNNL (E3SM), OsloCTM3

Impact of LAPs in snow/ice on surface radiation

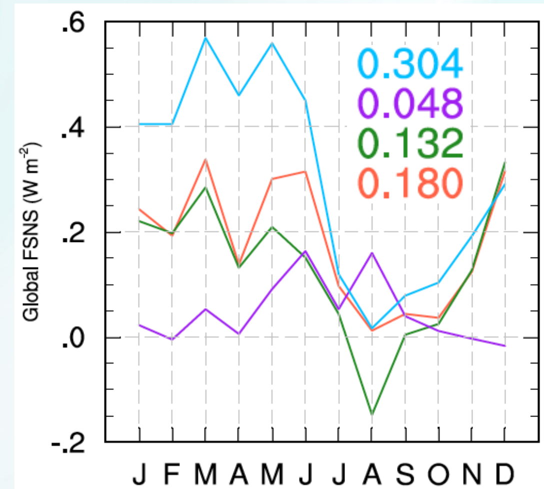
All-sky ANN FSNS (W m^{-2})



Arctic mean



Global mean



- Unified radiative transfer calculation for snow and ice surfaces, including LAPs (Dang et al., 2019)
- An important capability gap: light-absorbing OC and SOA in the atmosphere and snow/ice