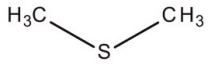
Exploring Natural Aerosol Formation from DMS Oxidation and Implications for Aerosol Forcing

Dimethyl Sulfide (DMS)



Ka Ming Fung (kamingfung@mit.edu), Colette Heald (MIT)

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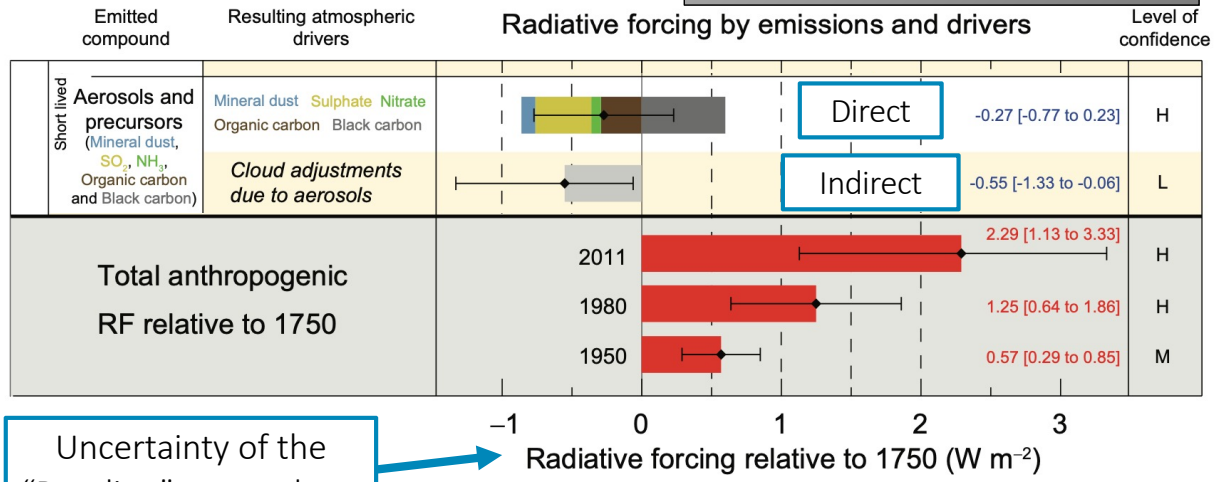
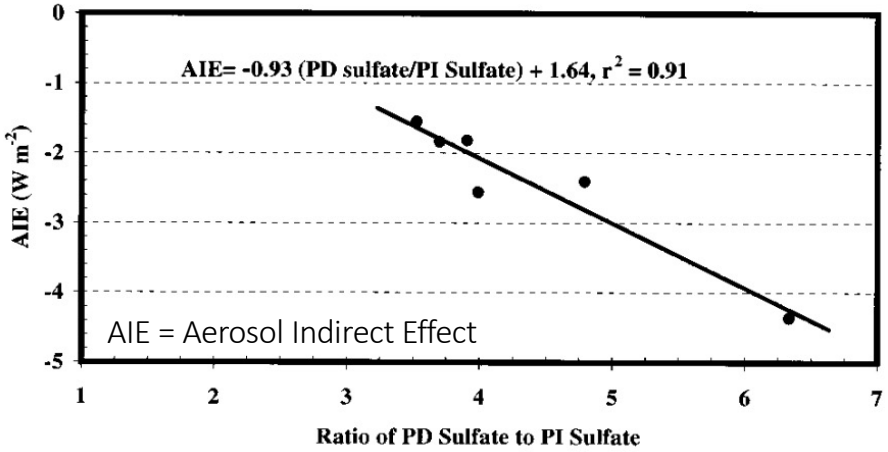
(NCAR) Louisa Emmons, Simone Tilmes, Siyuan Wang, Becky Schwantes & Duseong Jo

Disproportionate effects of natural aerosol on forcing uncertainty

Modified Figure SPM.5, IPCC AR5 (2013)

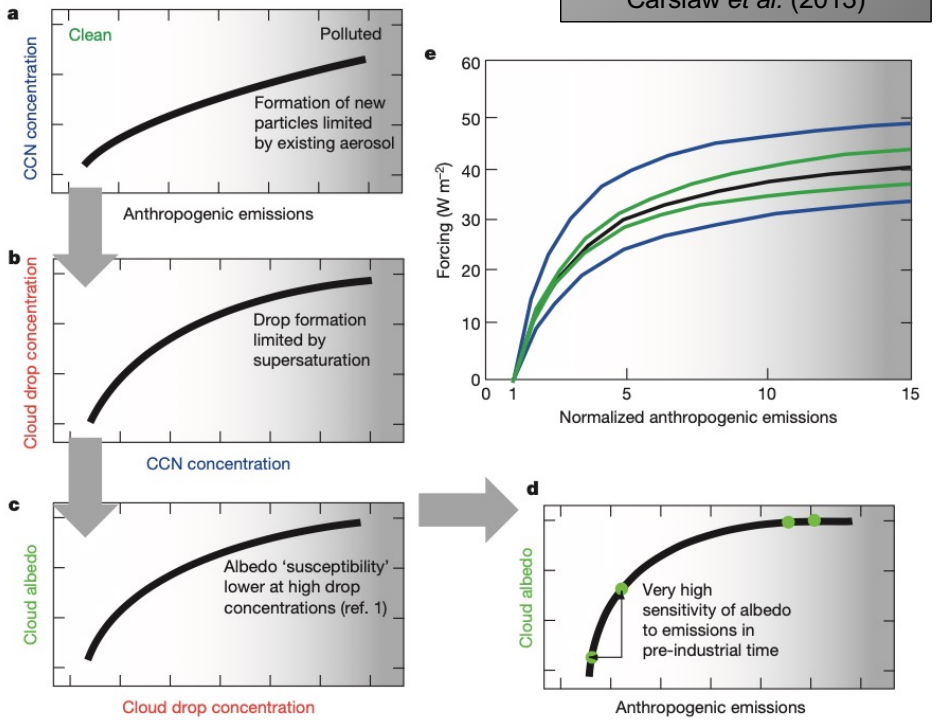


Uncertainty of the "Baseline" atmosphere

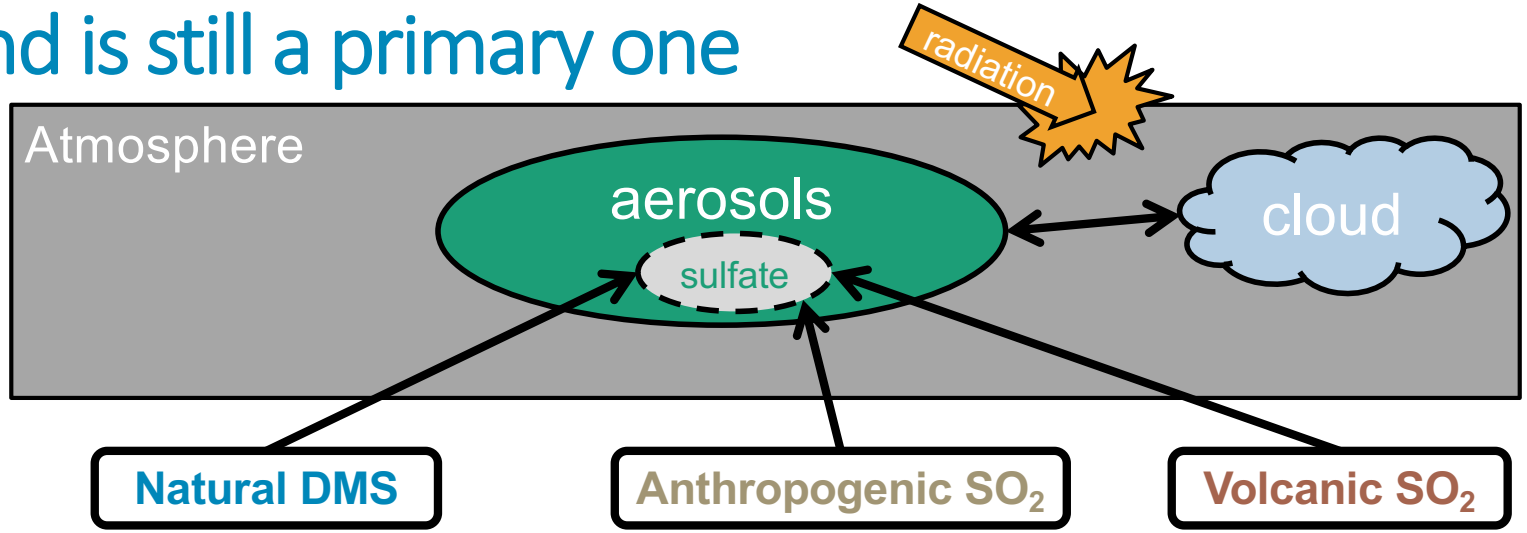


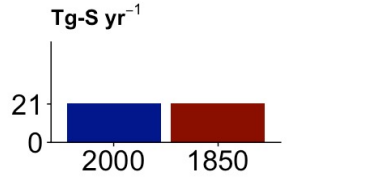
Menon *et al.* (2002)

Carslaw *et al.* (2013)

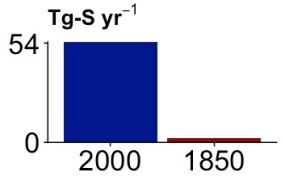


DMS was the main precursor of sulfate aerosol, and is still a primary one

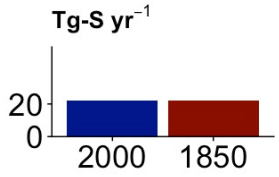




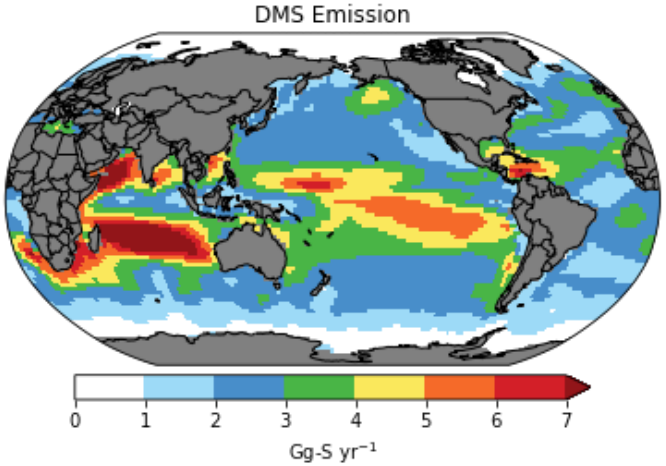
OASISS + Lana *et al.* (2011)

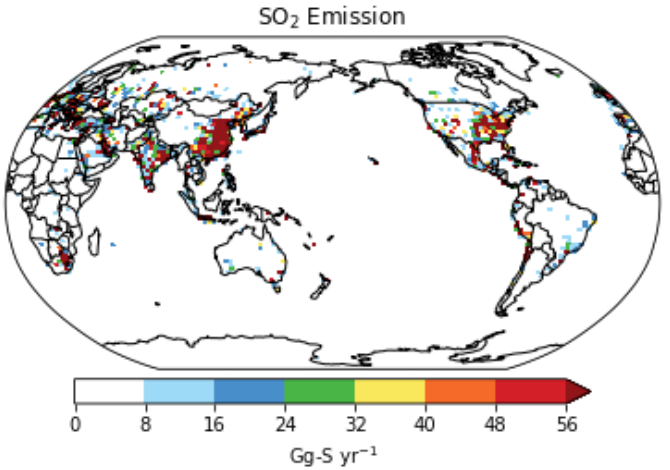


Hosely *et al.* (2018)

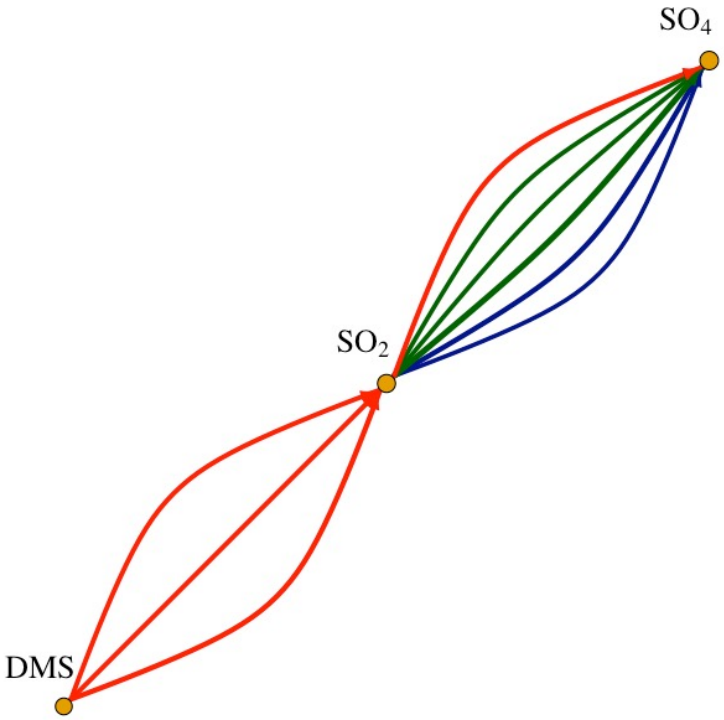


Carn *et al.* (2017)
Mills *et al.* (2016)



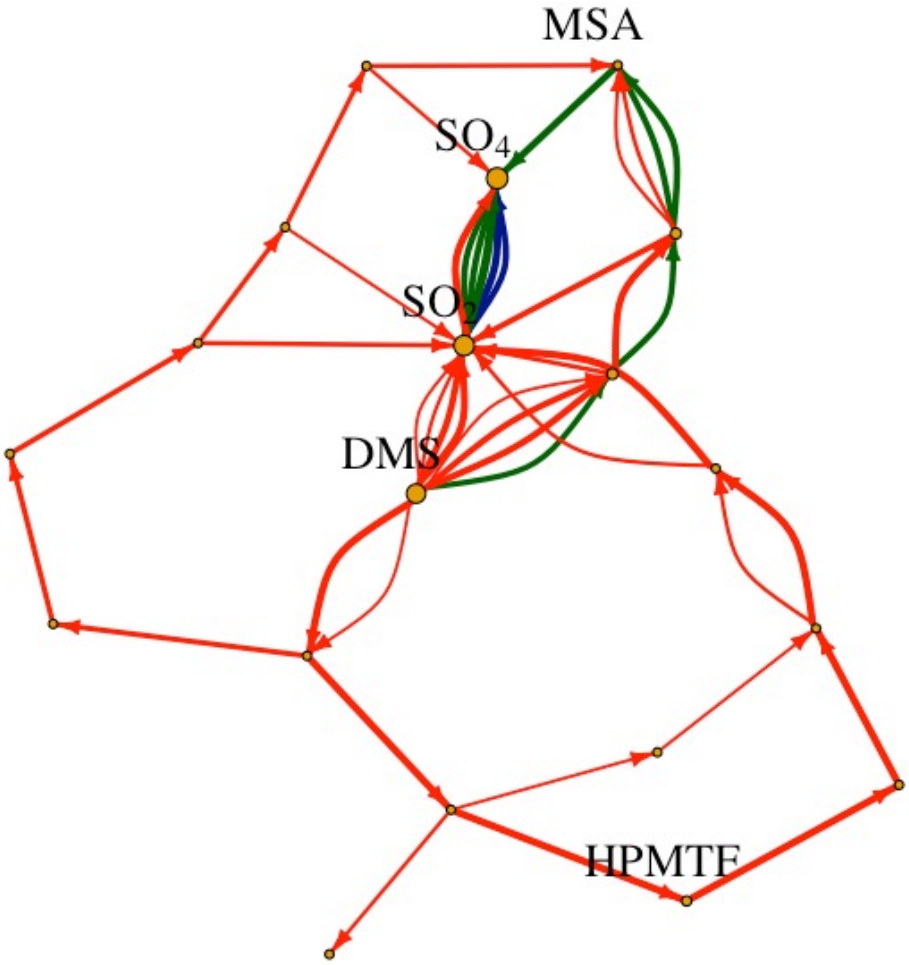


"Simplified" DMS oxidation scheme [STD]



TS1-simpleVBS from Tilmes *et al.* (2019) & Emmons *et al.* (2020)
+ phase-transfer from Schwartz (1986)
+ 3 aqueous-phase SO_2 reactions

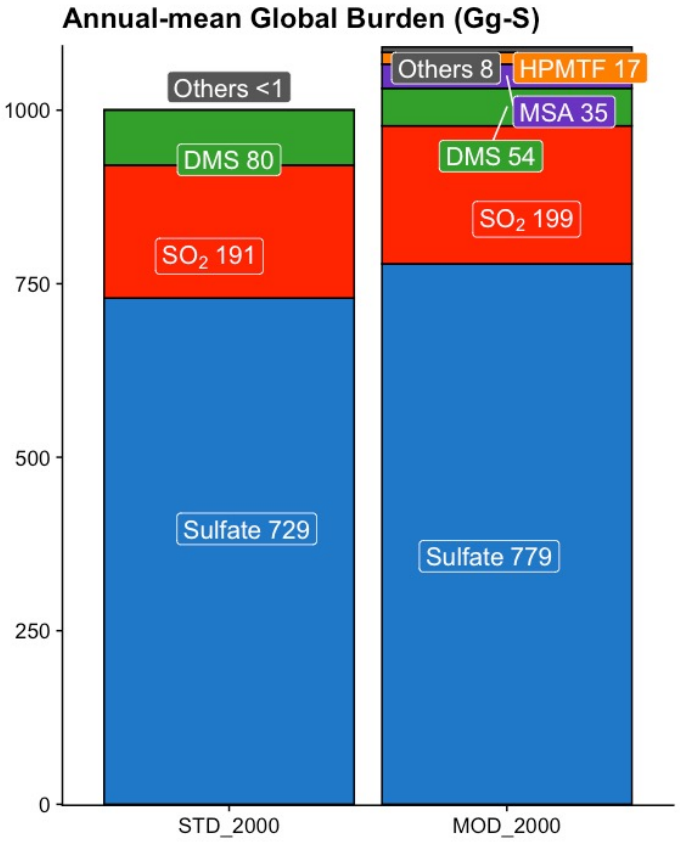
- Gas-phase reactions
- Aqueous-phase reactions in interstitial aerosol particles
- Aqueous-phase reactions in cloud drops

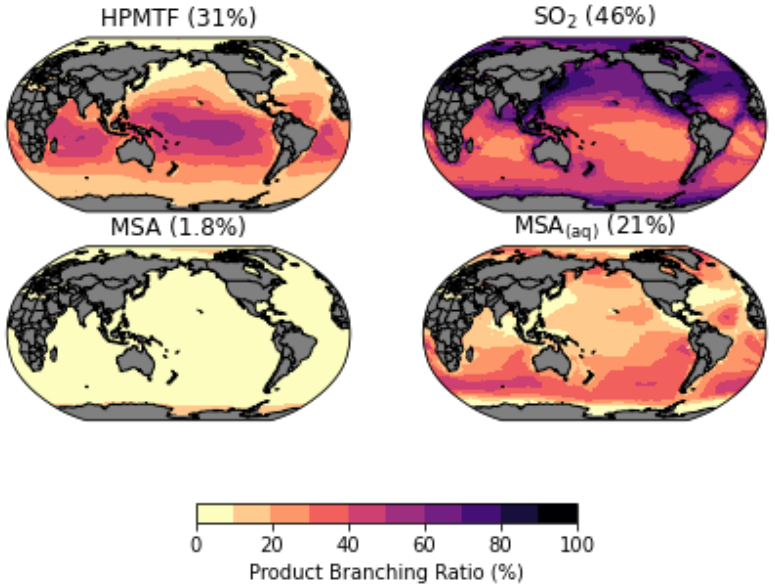


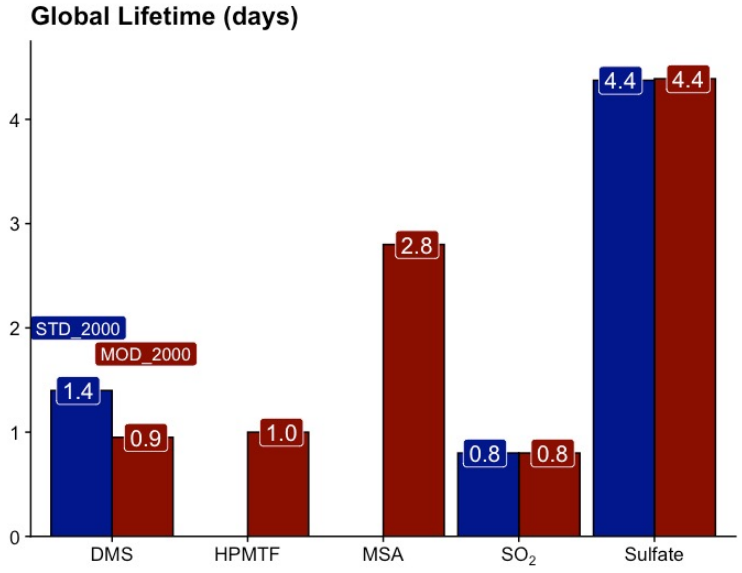
Extended DMS oxidation scheme [MOD]

TS1-simpleVBS from Tilmes *et al.* (2019) & Emmons *et al.* (2020)
+ phase-transfer from Schwartz (1986)
+ 3 aqueous-phase SO_2 reactions
+ 44 new reactions based on various lab and field studies

DMS is oxidized to MSA, HPMTF, & SO_2; sulfate burden increased

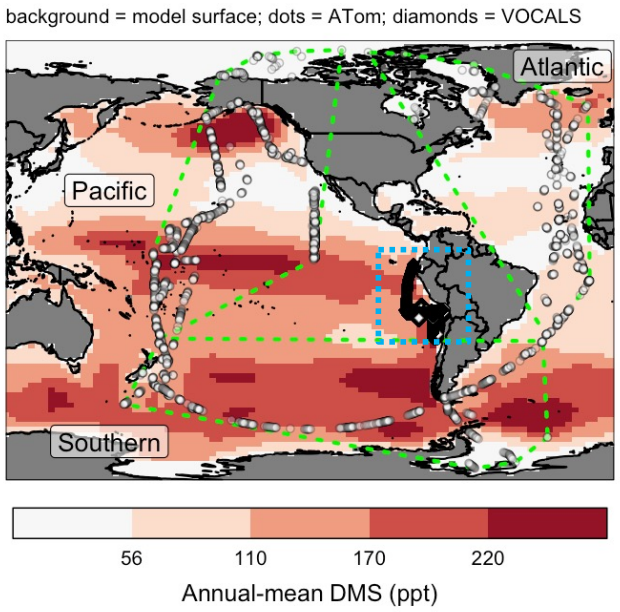


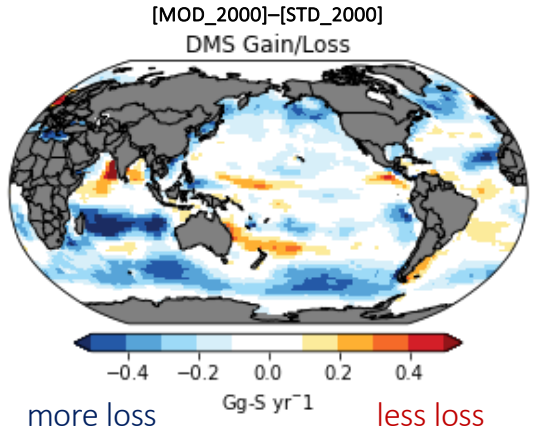


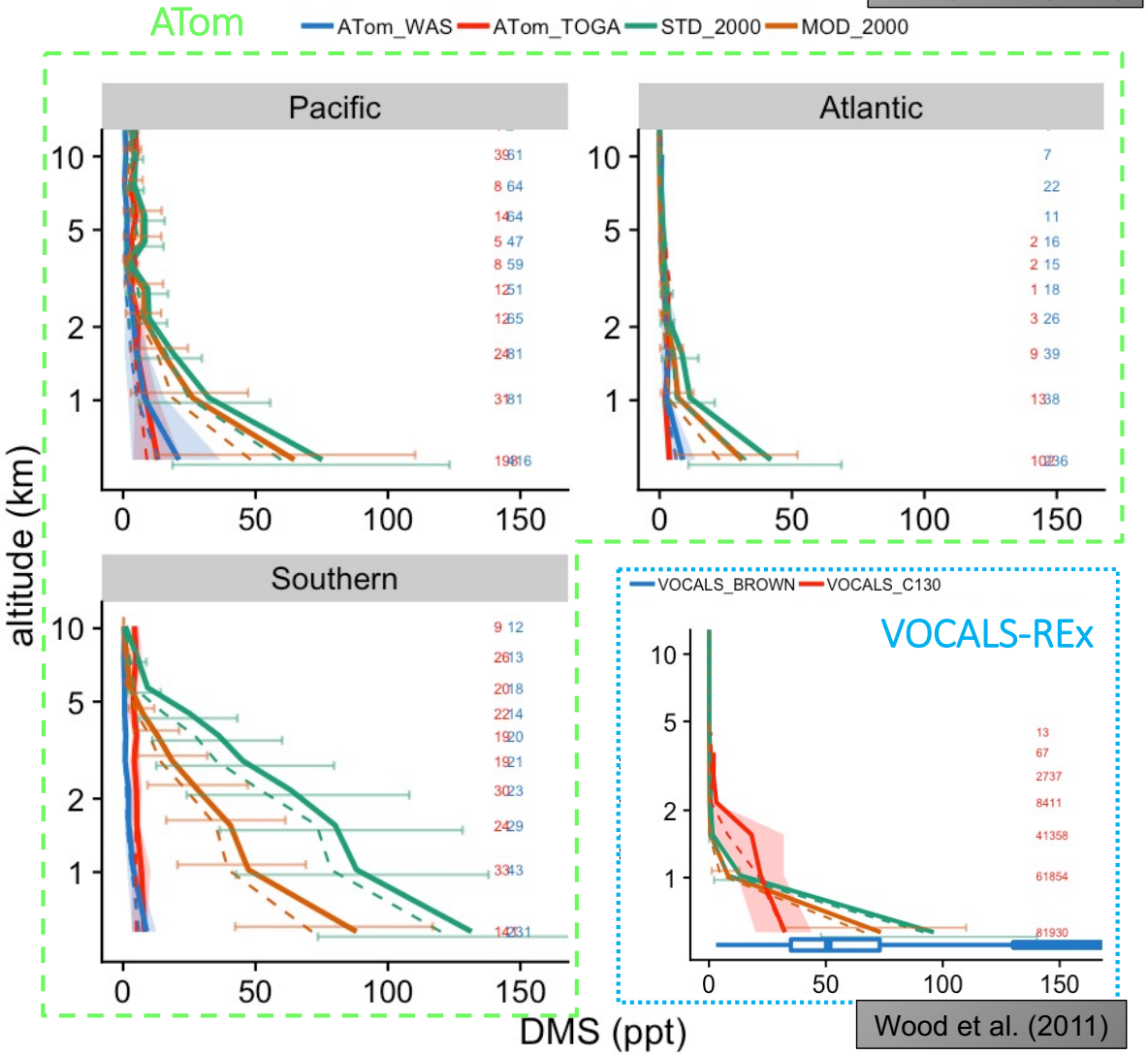


Model DMS is higher than measurements by ATom and VOCALS-REx

Wofsy et al. (2018)

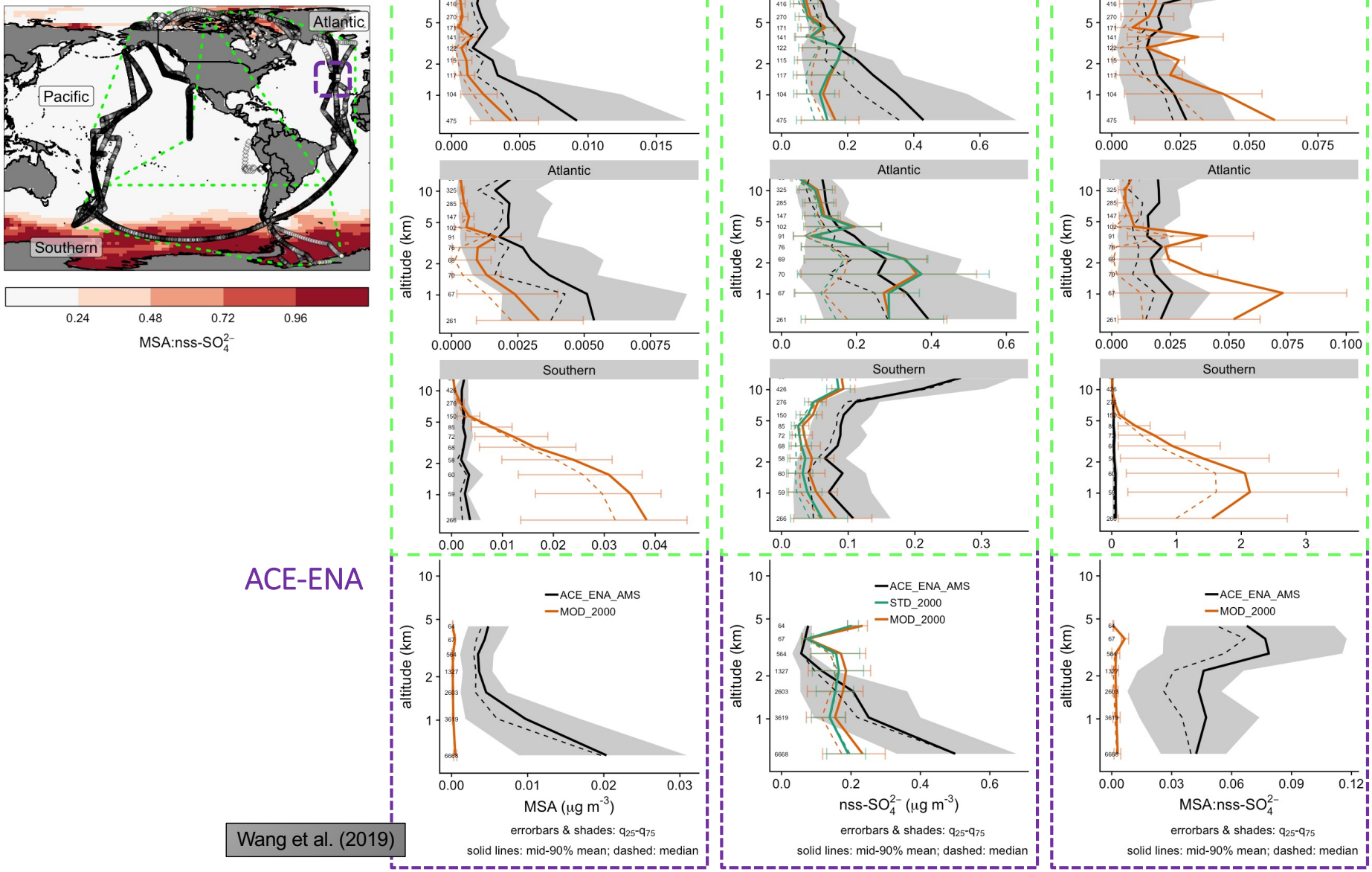




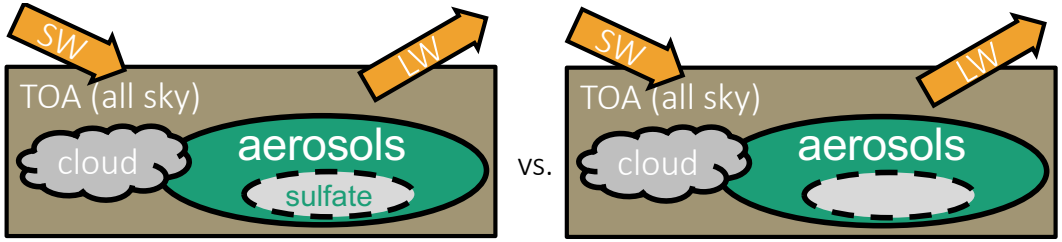


Wood et al. (2011)

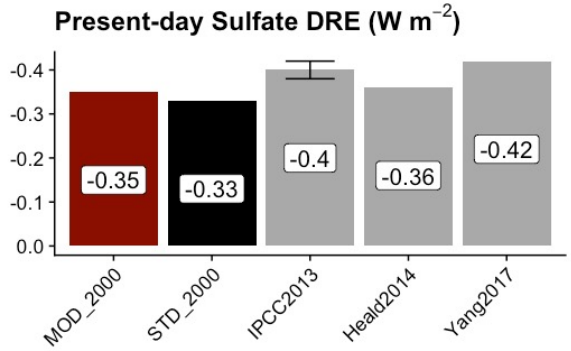
MSA:nss-SO_4^{2-}, a measure of biogenic contribution to atoms. S burden



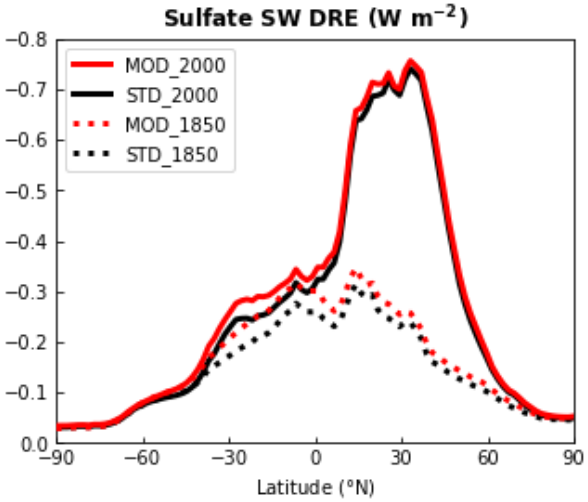
Negative correlation between sulfate burden and direct radiative effect (DRE)

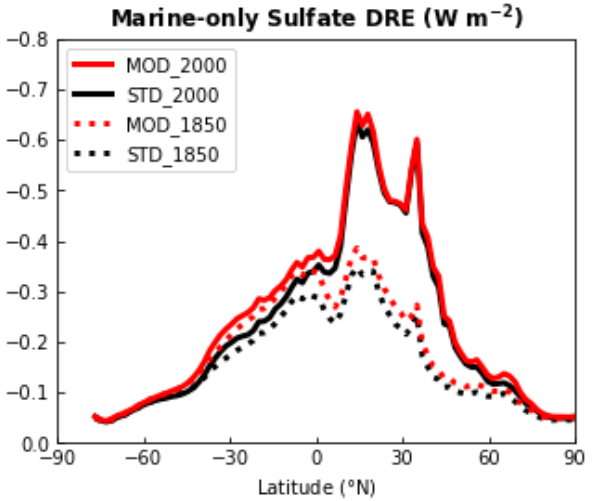


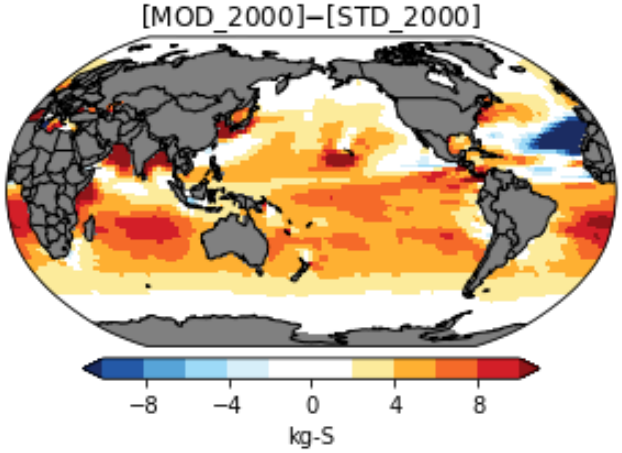
*annual global means



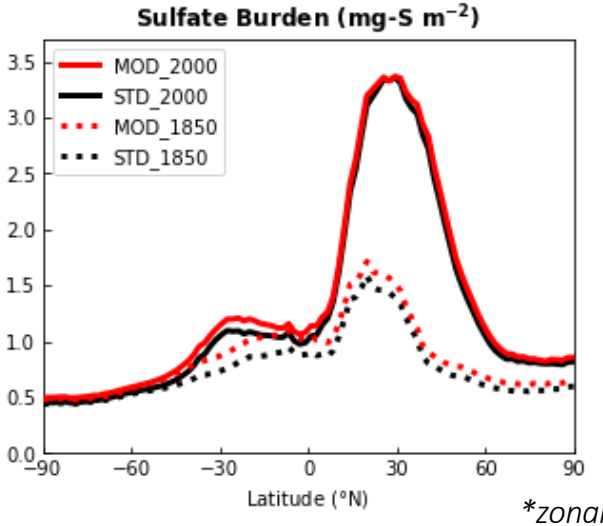
*note the flipped y-axes

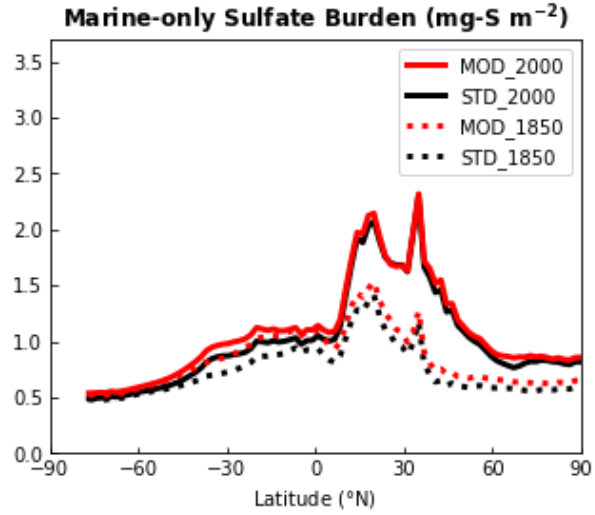






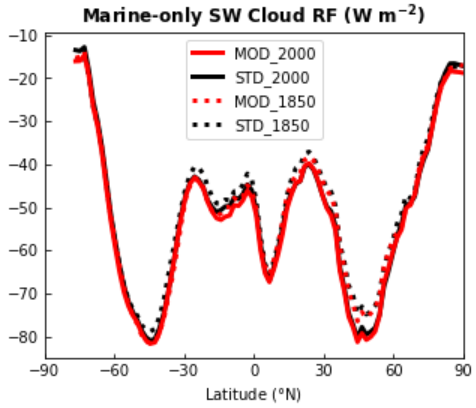
Sulfate Burden



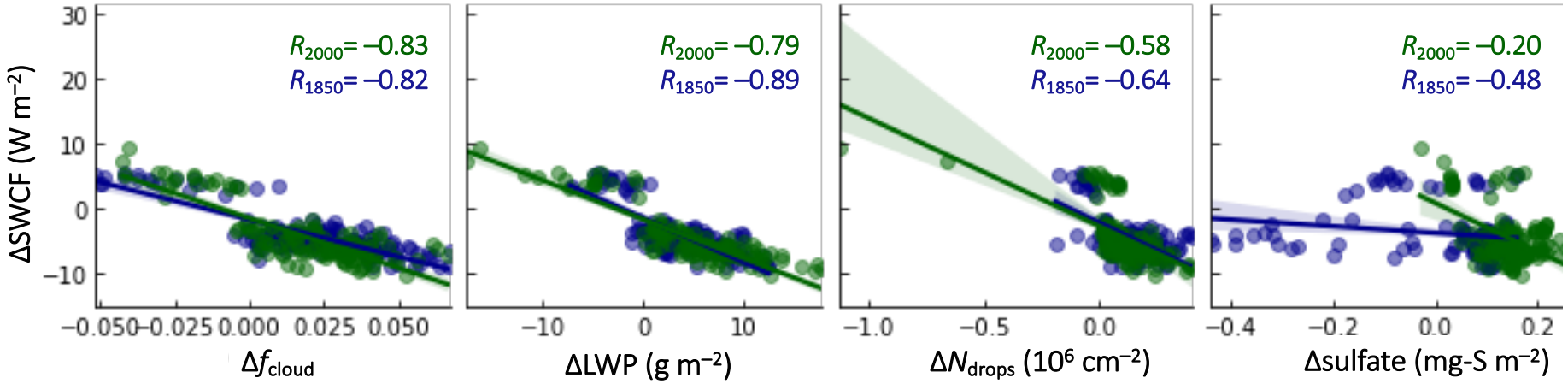


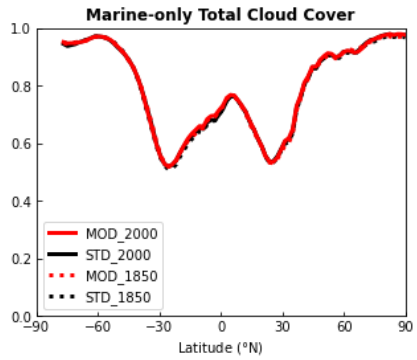
*zonal means

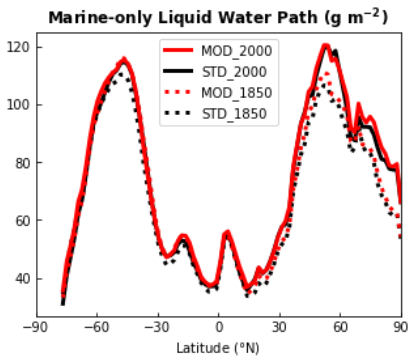
Cloud RF (CRF) =
$F_{TOA,clean,cloudy} - F_{TOA,clean,clear}$

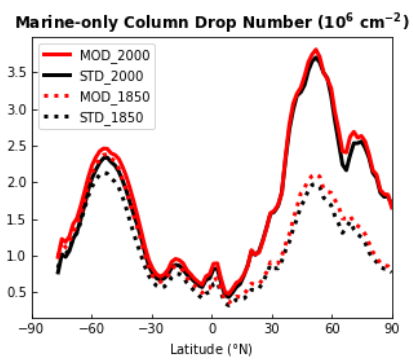


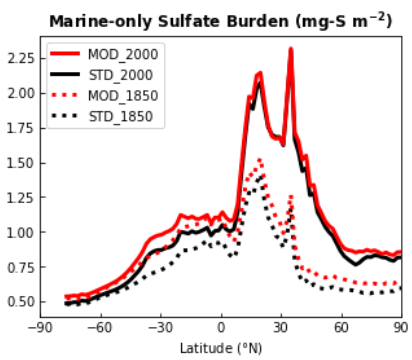
*Δ = [MOD]–[STD]





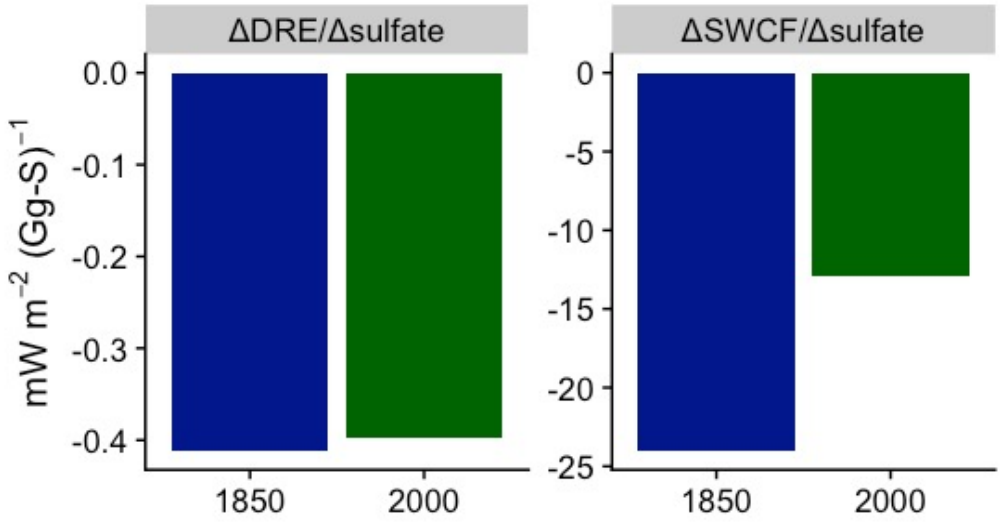




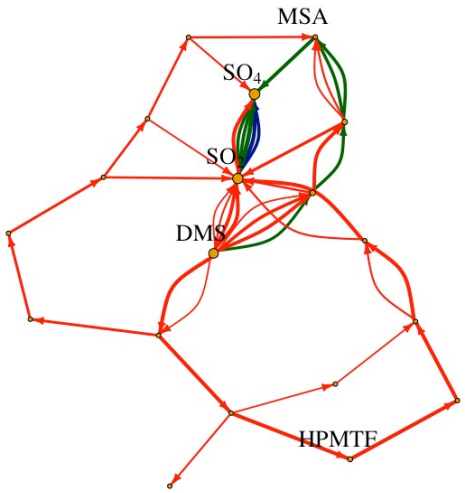


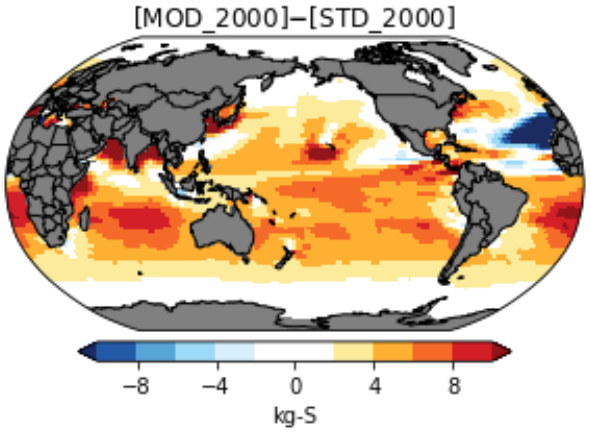
Stronger correlation between Δ(Cloud Forcing) & Δ(Sulfate Burden) Induced by the New Chemistry in PI (1850) than PD (2000)

Disproportionate RE/RF sensitivity to sulfate burden induced by the new DMS chemistry



*Δ = [MOD]–[STD]



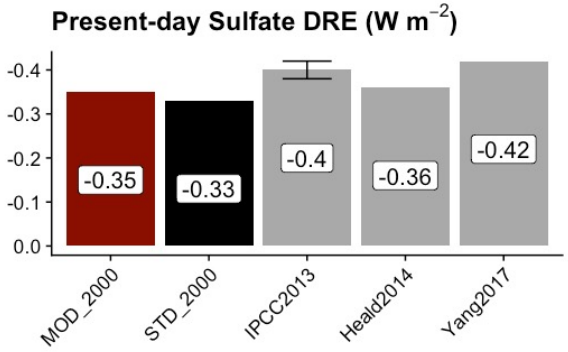


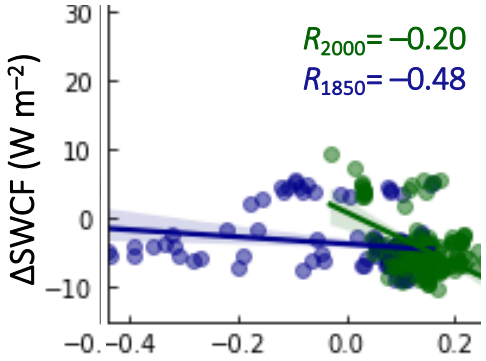
Sulfate Burden

Thank you!

For more, please visit
https://kamingfung.github.io

*annual global means





Δsulfate (mg-S m^{-2})