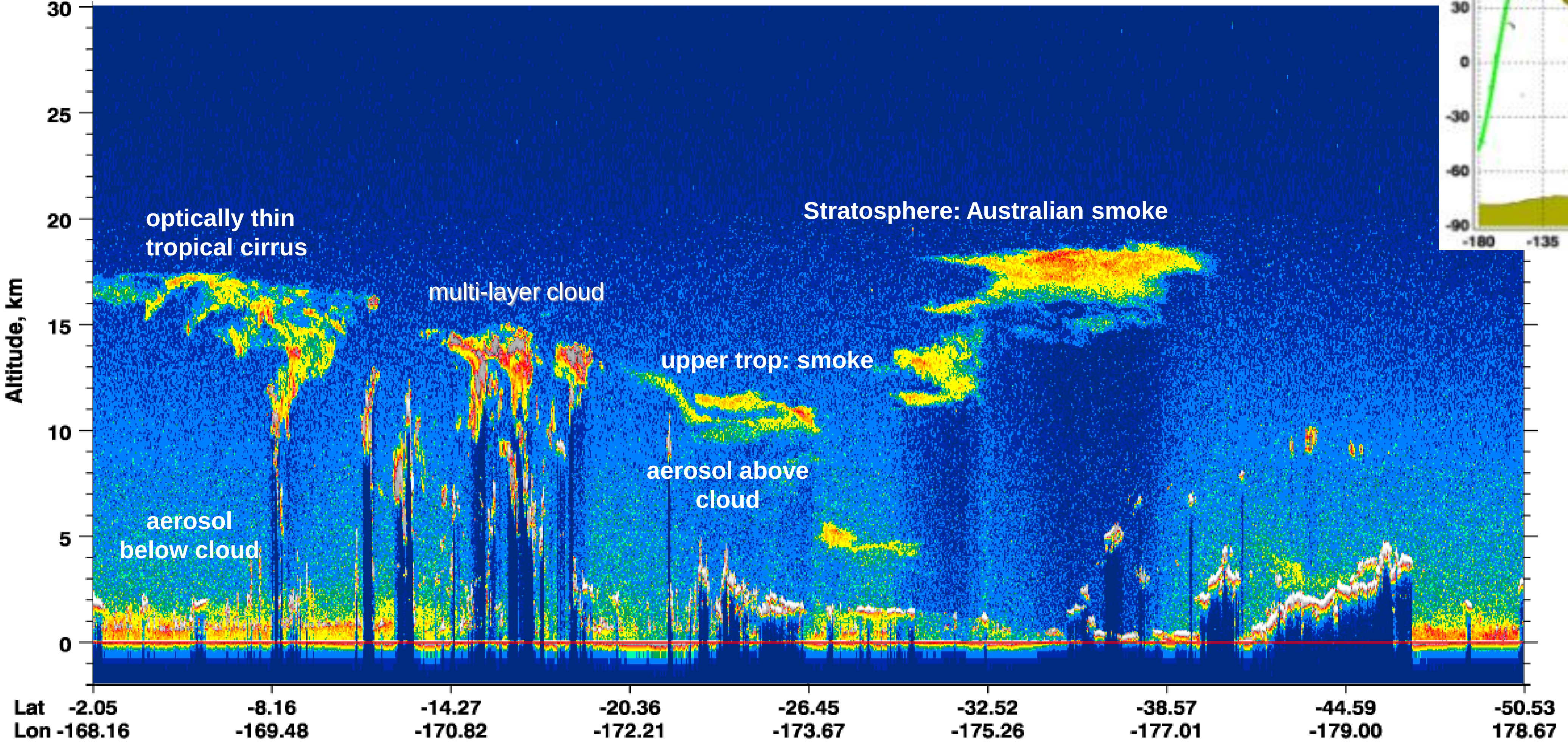
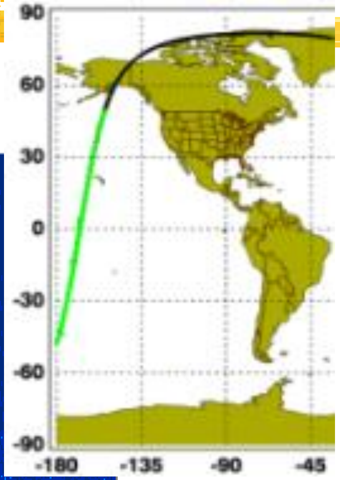
PI Presentation

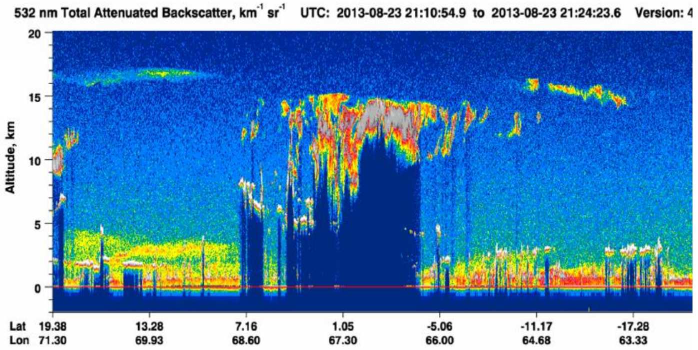
Dave Winker
NASA LaRC

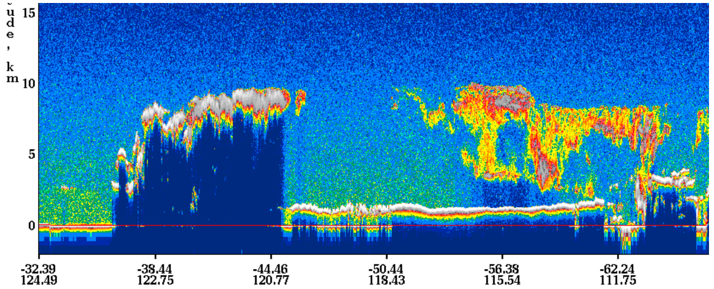
10 February 2009 12:46 to 13:13 UTC

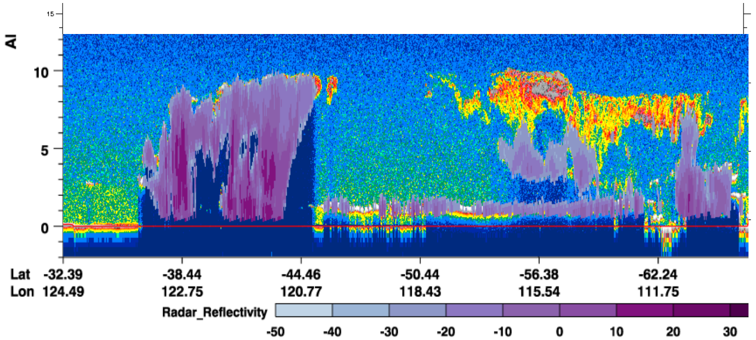




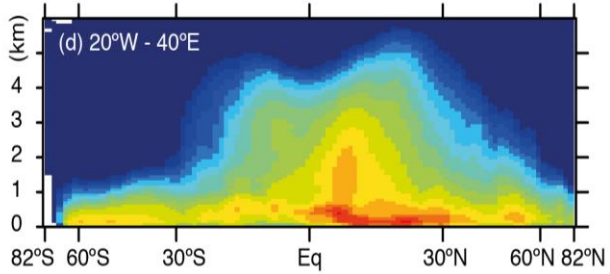
Science Highlights





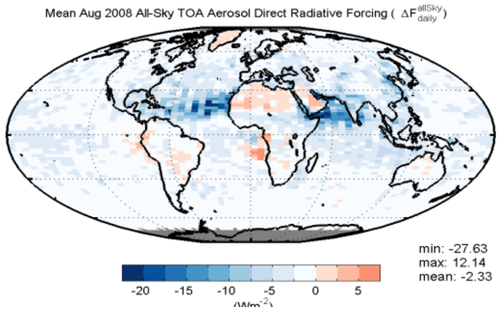


Vertically-resolved aerosol climatology

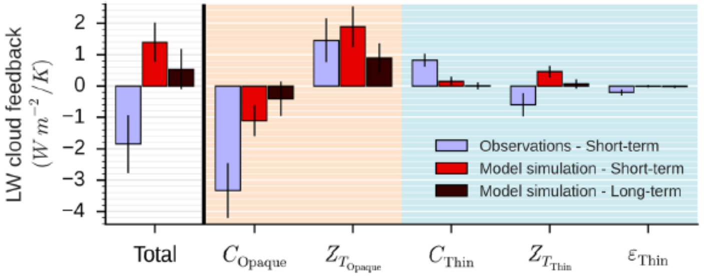


(IPCC AR5)

All-sky aerosol radiative effects



LW Cloud Radiative Feedbacks

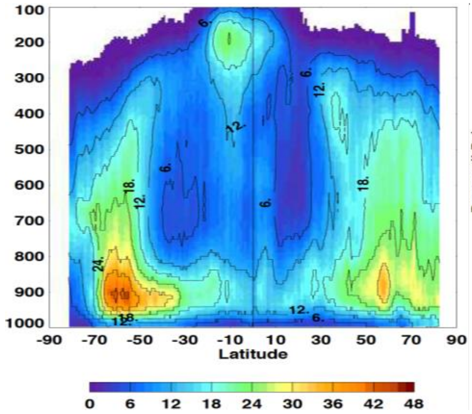


(Vaillant de Guélis et al., 2019)

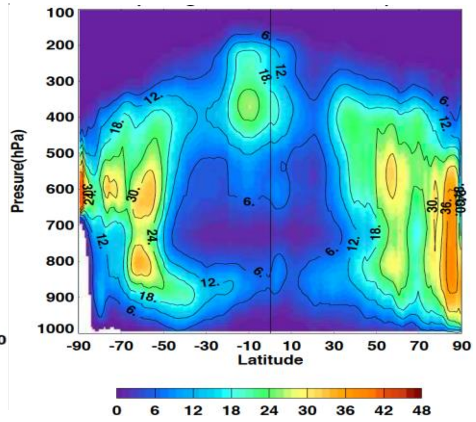
Cloud Climatology &

Radiative Heating Profiles

CALIOP-CloudSat

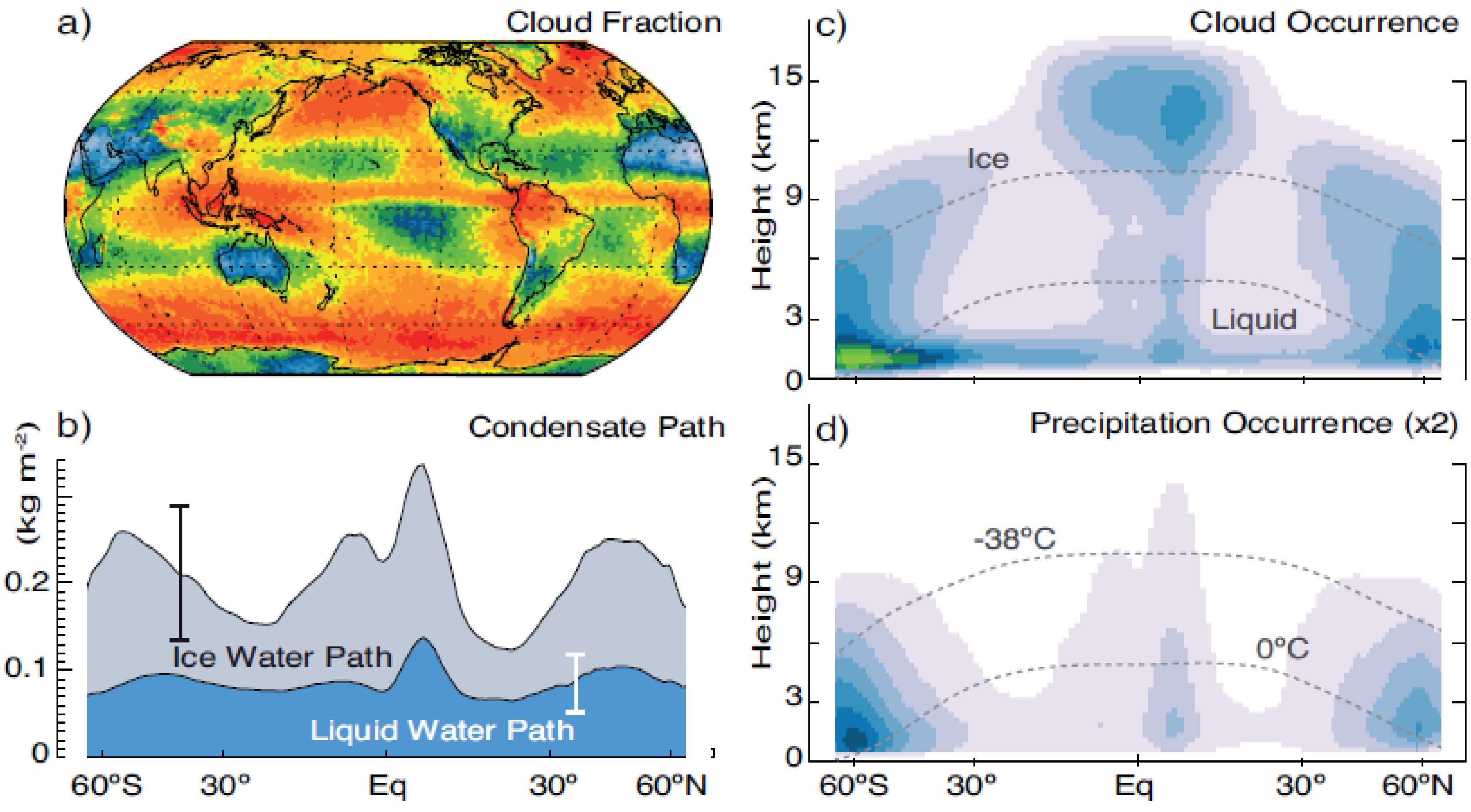


MODIS + GEO sensors



(Kato et al, 2019)

"An improved ability to quantify vertical profiles of cloud occurrence and water content" (IPCC AR5)

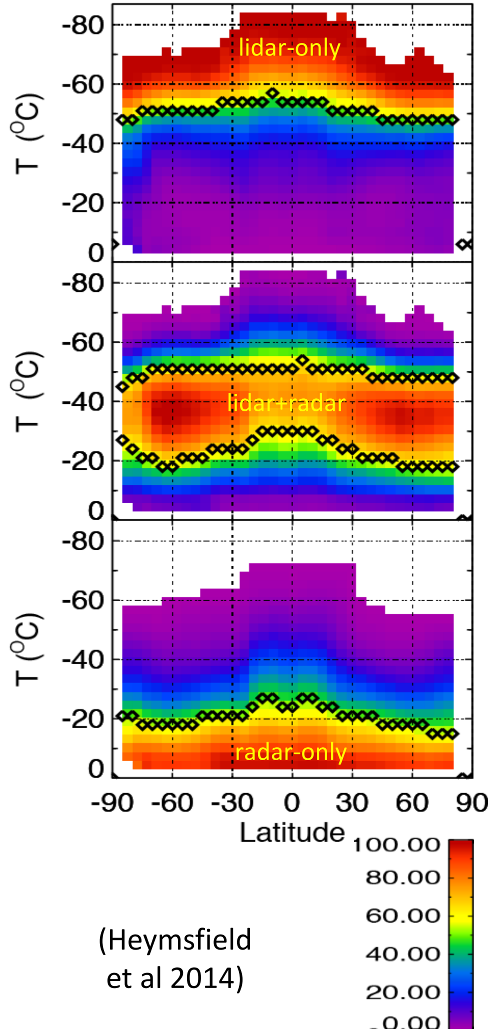


(a) CloudSat/CALIPSO 2B-GEOPROF-LIDAR dataset
(b) liquid water path : microwave radiometer data
ice water path: CloudSat 2C-ICE

c, d) 2B-GEOPROF-LIDAR data set.

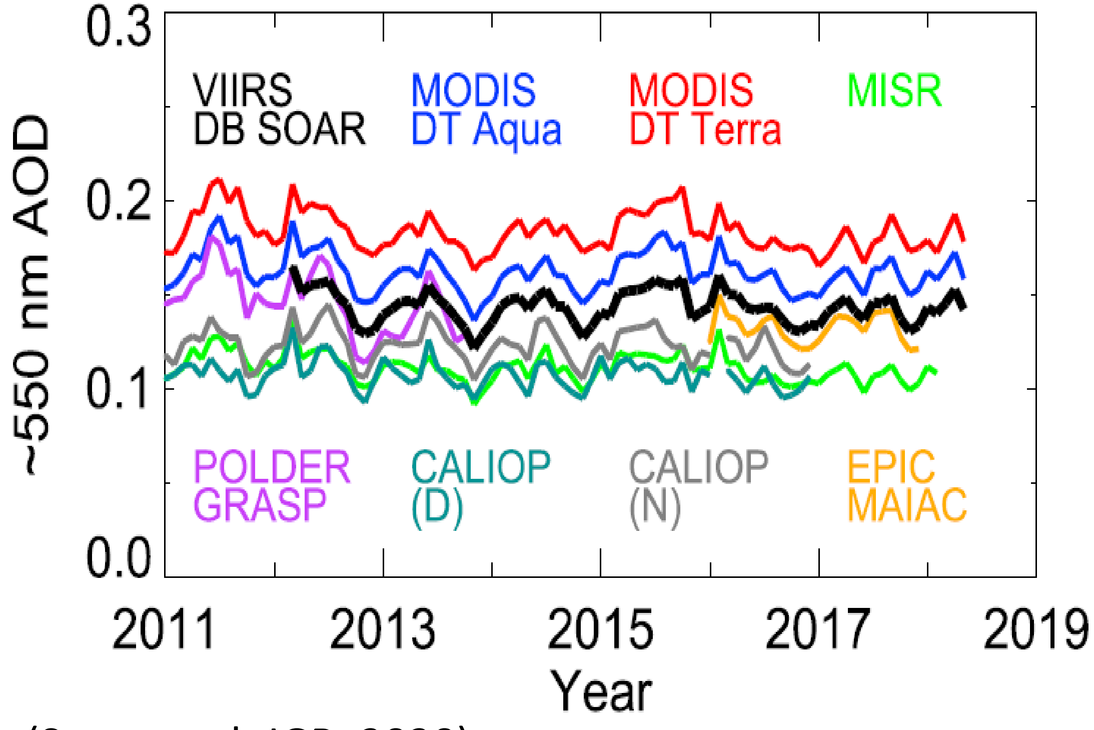
(Fig 7.5, IPCC AR5)

Probability of cloud detection as a function of temperature



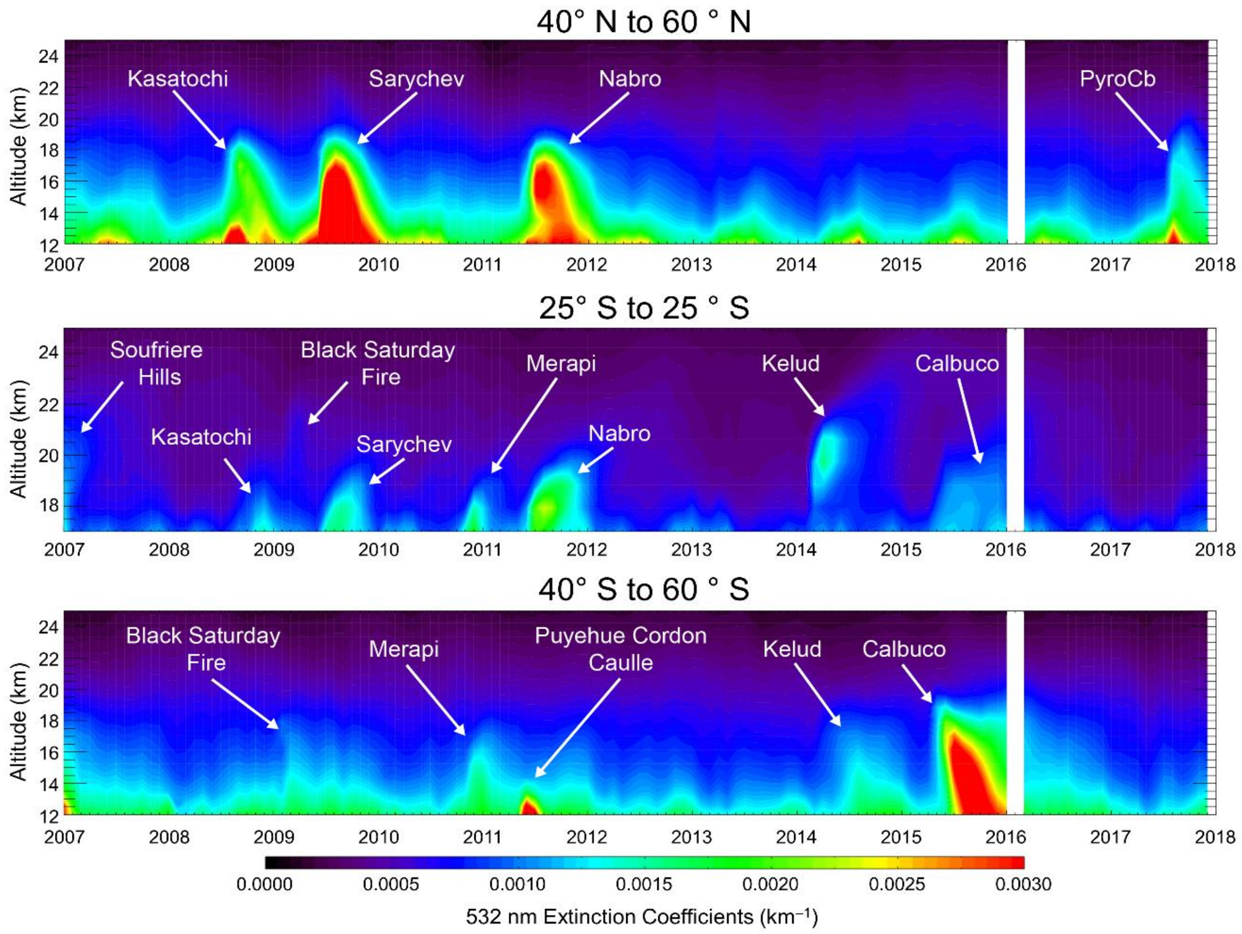
(Heymsfield et al 2014)

Time series of over-ocean AOD from seven different sensors



(Sayer et al, JGR, 2020)

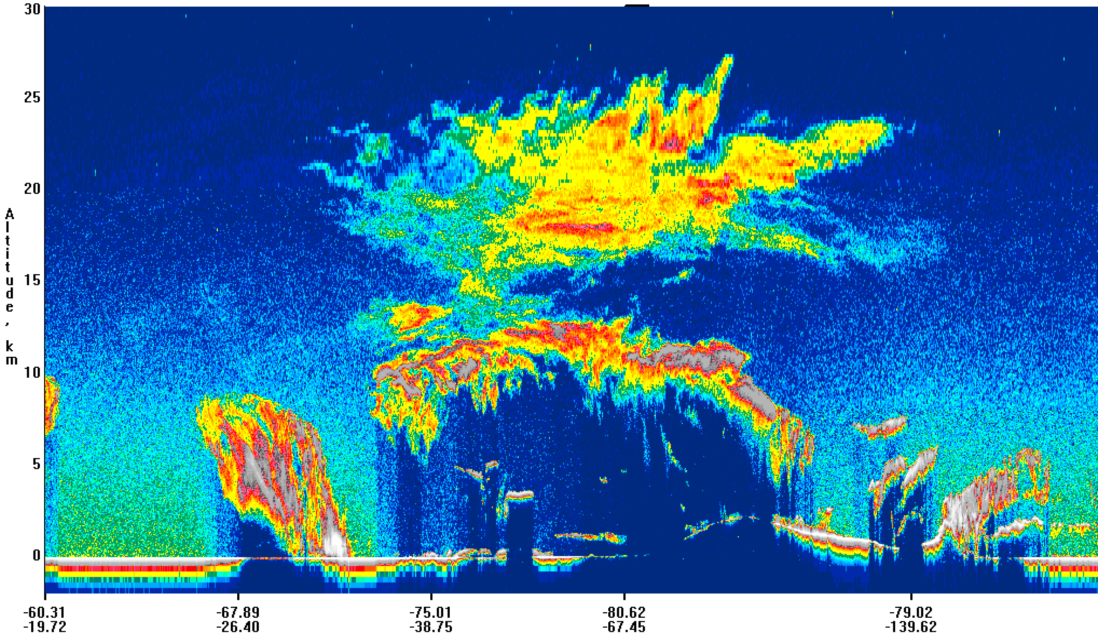
Evolution of stratospheric aerosol distribution, 2007-2017

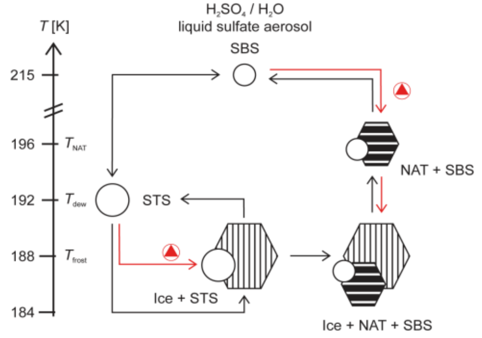


(Kar et al, AMT, 2019)

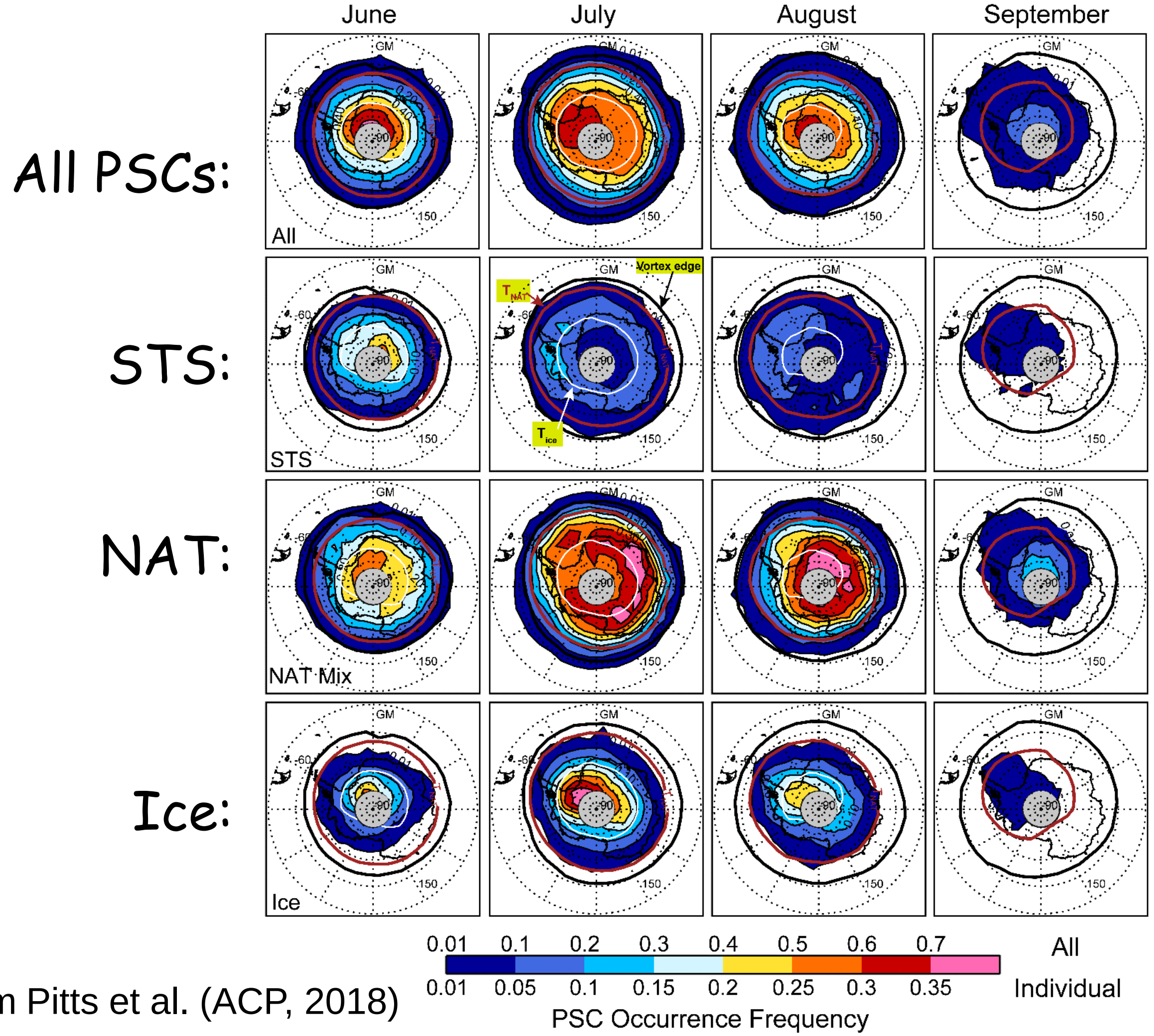
PSCs: Climatology and Composition

Vertical structure of Polar Stratospheric Cloud (PSC)





Monthly mean polar maps of PSC occurrence frequency at θ=500 K (~20 km), 2006-2018



Updated from Pitts et al. (ACP, 2018)

AGU Advances

RESEARCH ARTICLE

10.1029/2021AV000546

Key Points:

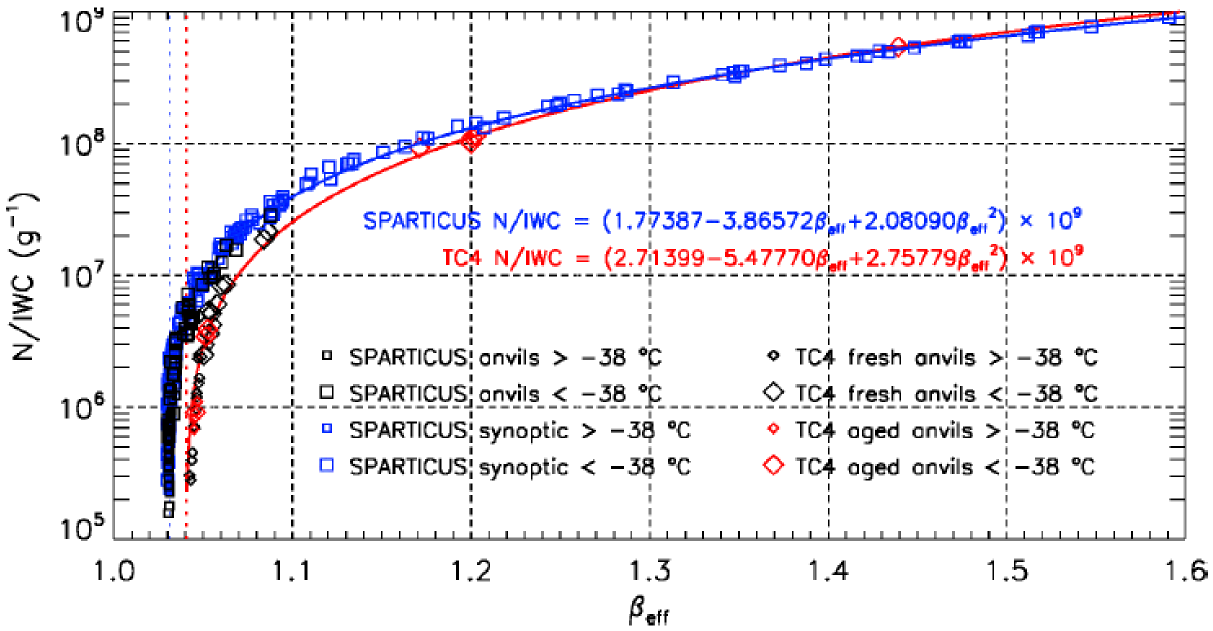
- A significant increase in the number of ice crystals in cirrus clouds was

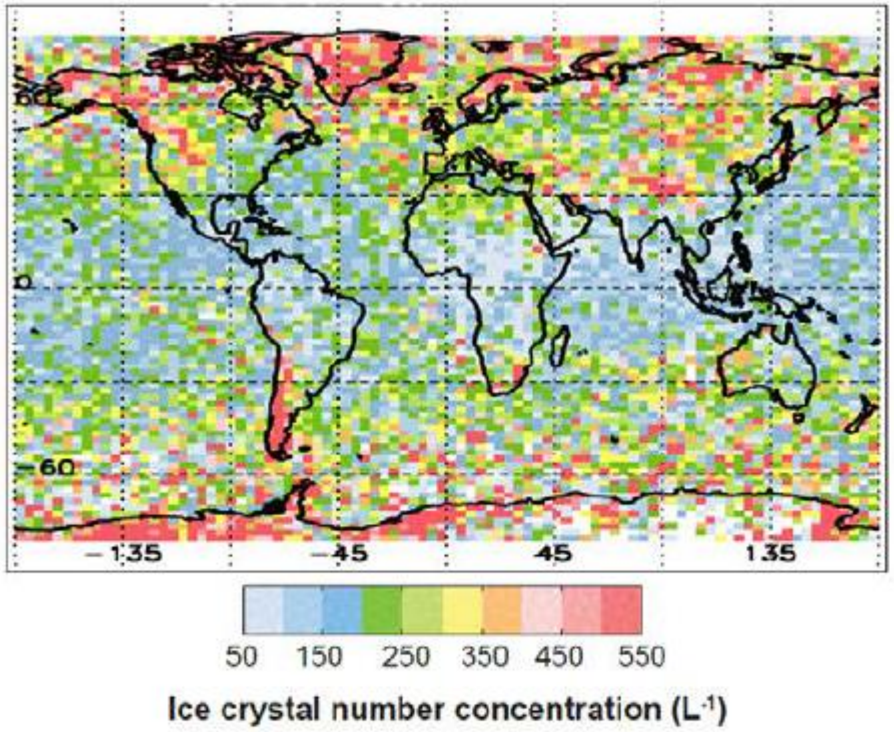
Decreased Aviation Leads to Increased Ice Crystal Number and a Positive Radiative Effect in Cirrus Clouds

Jialei Zhu[1], Joyce E. Penner[2], Anne Garnier[3], Olivier Boucher[4], Meng Gao[5], Lei Song[6], Junjun Deng[1], Cong-qiang Liu[1], and Pingqing Fu[1]

- Particles in aircraft exhaust may impact cirrus particle nucleation and cause cirrus clouds to dim, but estimates vary widely
- Zhu et al. (2022) use IIR retrievals of cirrus particle concentration to examine changes in cirrus early in the COVID-19 pandemic
- Model simulations were used to attribute the observed changes in cirrus to the reduction in air traffic

IIR Retrieval of Ice Crystal Concentration





$\beta_{eff} = \tau_{abs}$ (12.05 µm)/ τ_{abs}(10.6 µm)

N = ice crystal number concentration

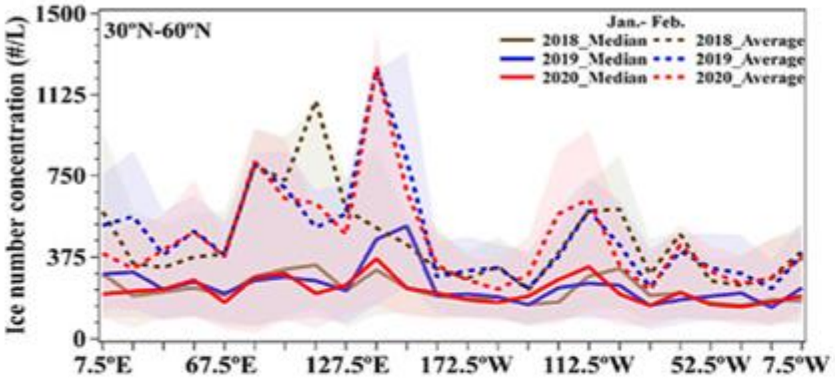
(Mitchell et al. ACP 2018)

Model Verification

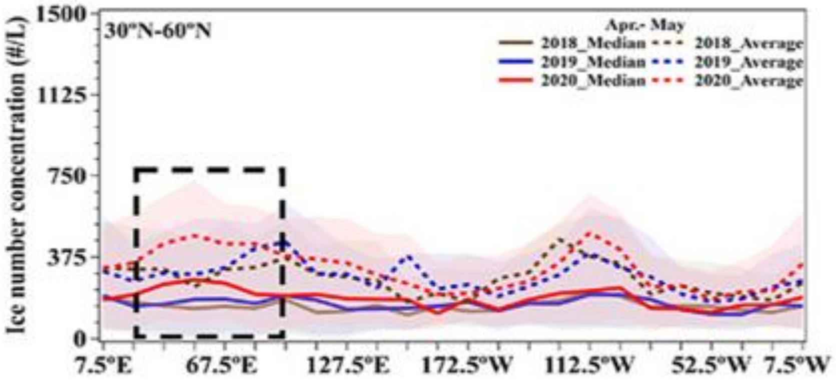
30N-60N

CALIPSO Cirrus Number Concentration (N_{ice})

January/February



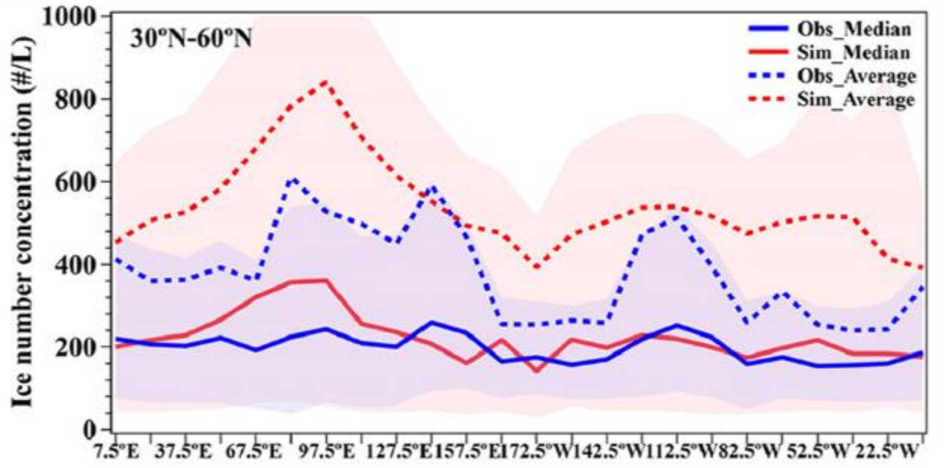
April/May



Examined changes in April-May 2020 relative to earlier years

Used CALIPSO retrievals to evaluate model simulation

N_{ice} Comparison
(Jan-May 2018-2020)



(Zhu et al. 2022)

Results

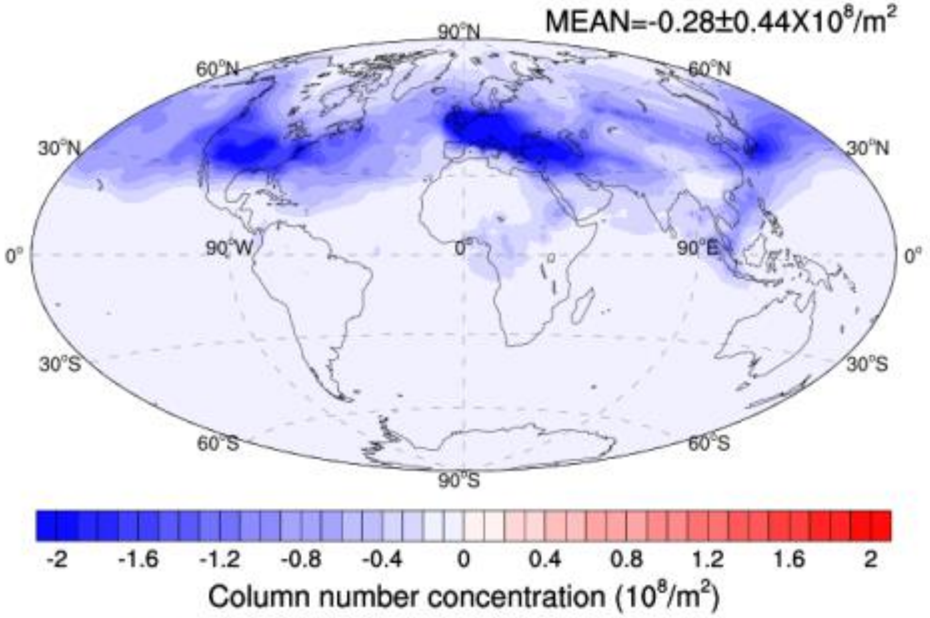
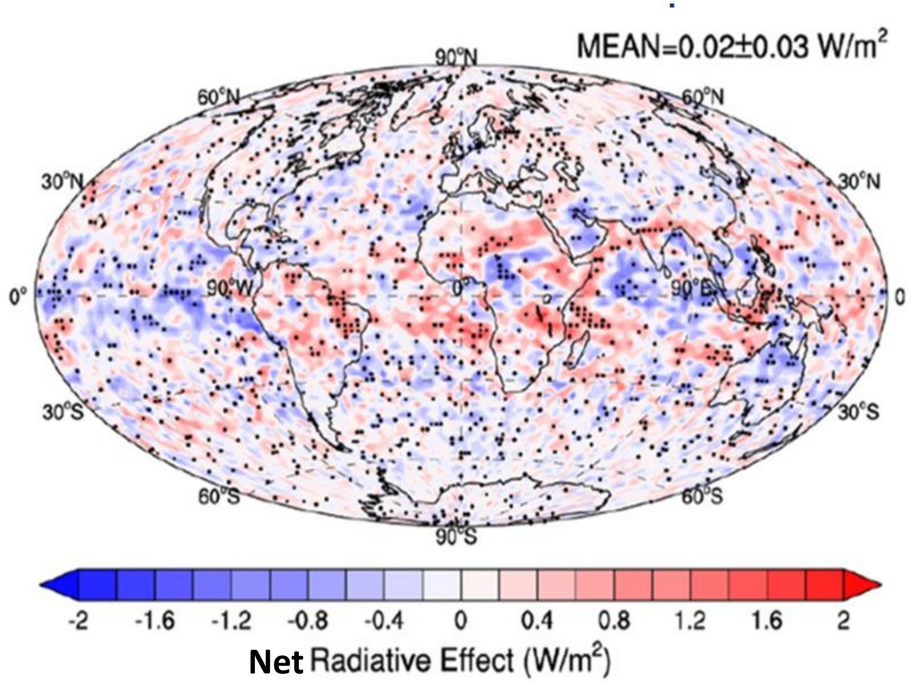
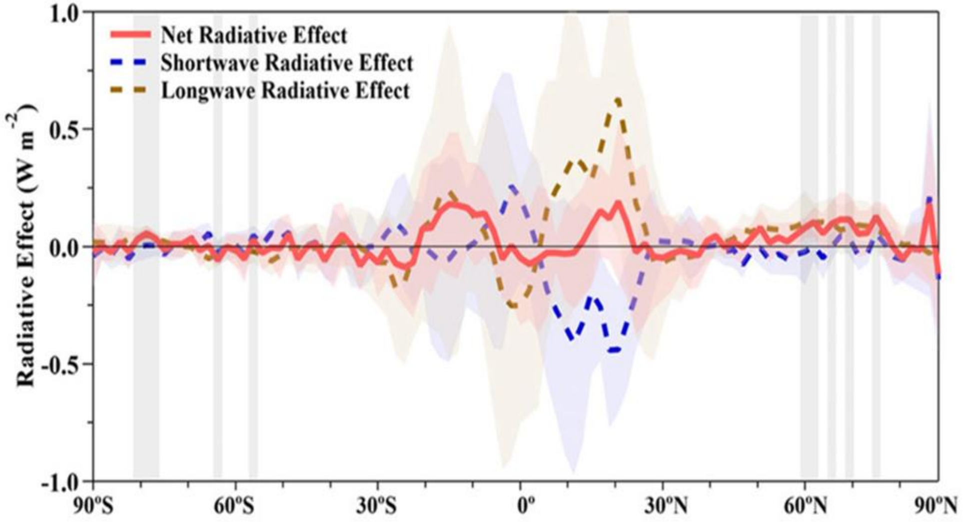


Figure S7. Reduction in the vertically integrated number concentration of contrail-processed aircraft soot (INPs) due to the COVID-19 pandemic in April-May 2020 compared to the assumption of no travel restriction (difference between EX_S2 and EX_S1).





(Zhu et al. 2022, Figs S7 and 3)

Zhu et al: Summary

- Addition of particles from aircraft exhaust can result in fewer but larger cirrus cloud particles → dimmer clouds → a radiative forcing
- Verified that model simulations of high ice crystal concentrations are consistent with CALIPSO retrievals
- "Soot" from aircraft exhaust produces measurable change in cirrus radiative effects:
  - Global radiative impact of aircraft emissions is small (0.02 W/m^2)
  - Driven by impacts on ambient cirrus rather than contrails
- Using biofuels could reduce soot emissions and produce a rather small positive radiative effect