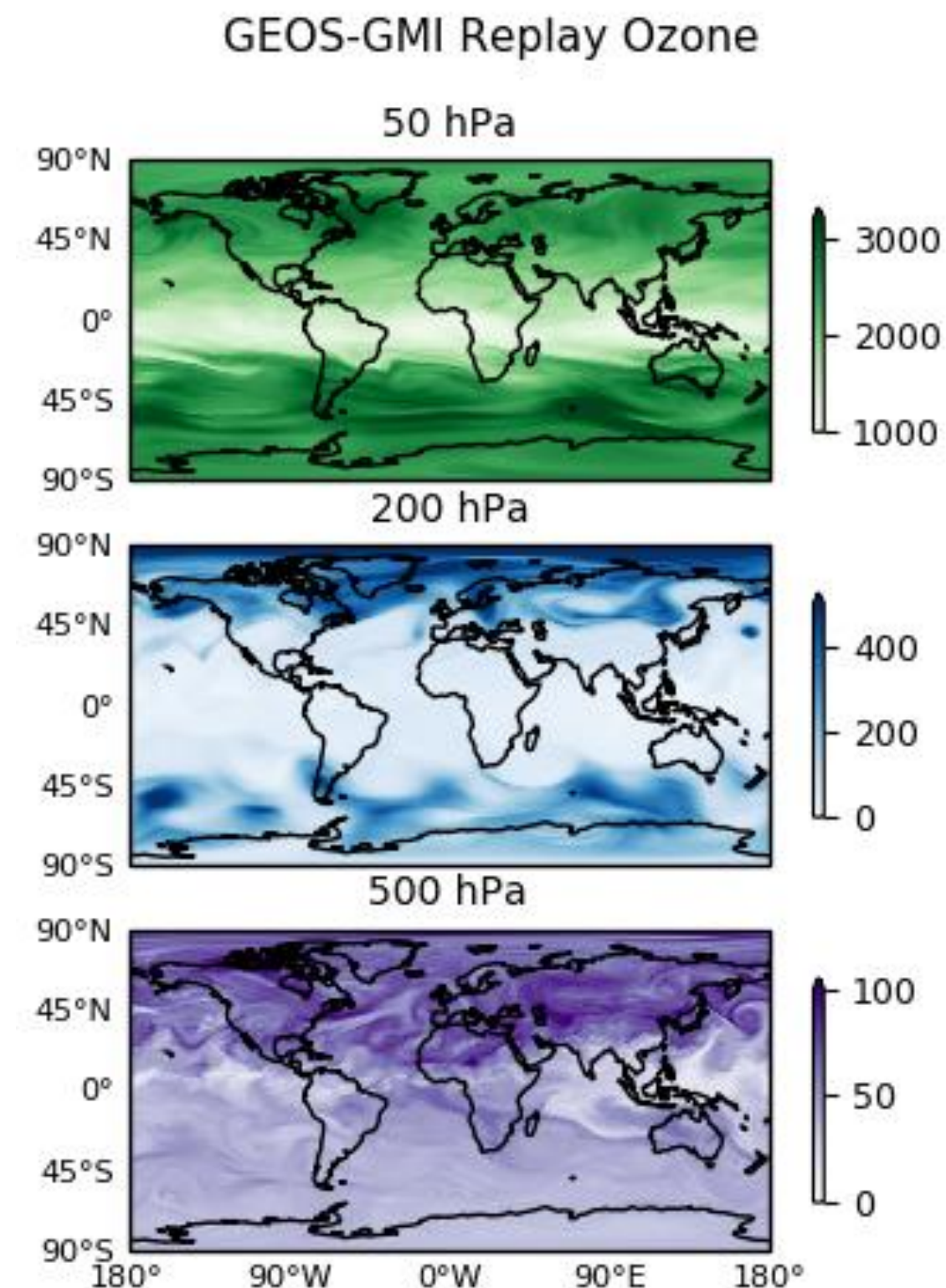


GEOS-GMI Output for NDACC

Sarah Strode

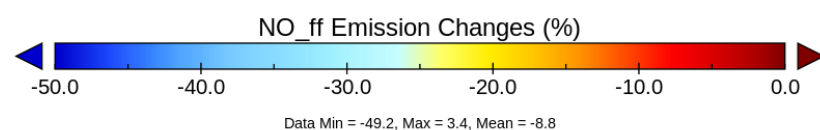
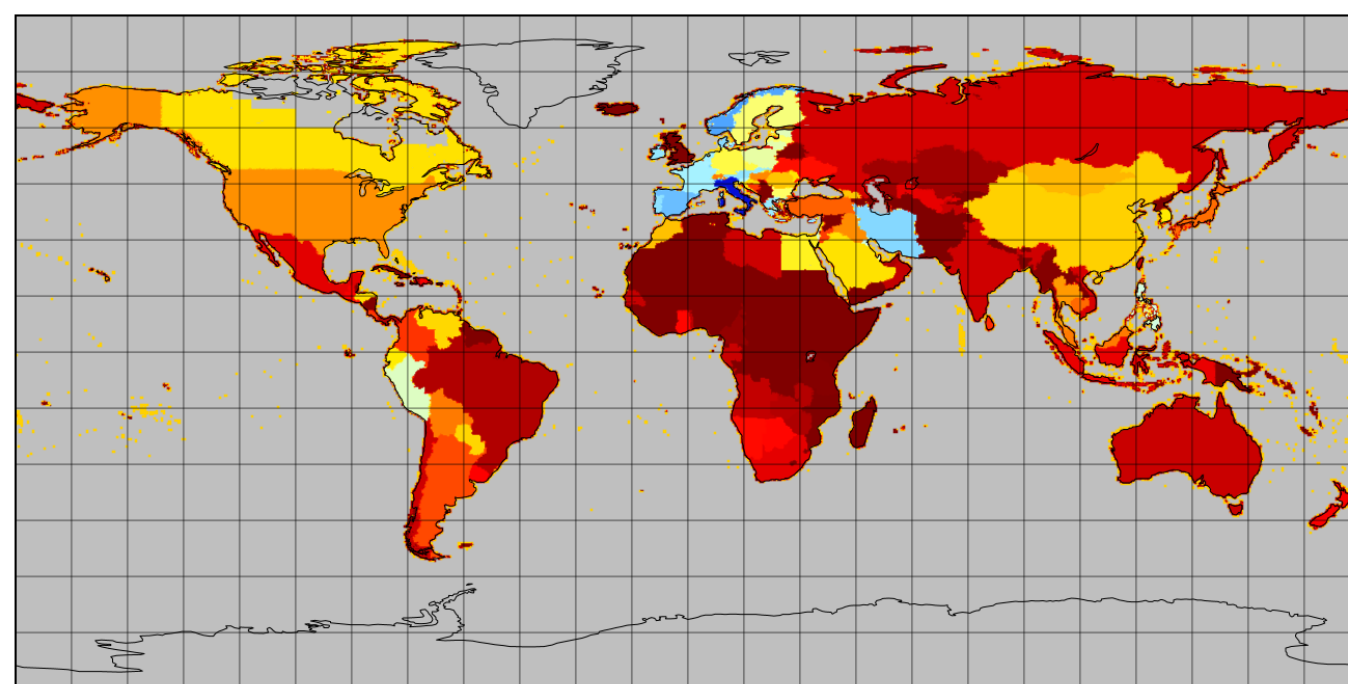
- GMI chemistry mechanism includes >100 species and ~400 reactions representing stratospheric and tropospheric chemistry
- GMI historically ran within chemistry and transport model (CTM) and now runs within the GEOS chemistry climate model (GEOSCCM)
- GEOS-GMI can run as a free-running CCM, or be constrained to reanalysis meteorological fields using a “replay” technique
 - Replay, like a CTM, follows the actual year-specific meteorology, ideal for reproducing historical observations
 - Free-running CCM can capture radiative feedbacks, simulate future conditions



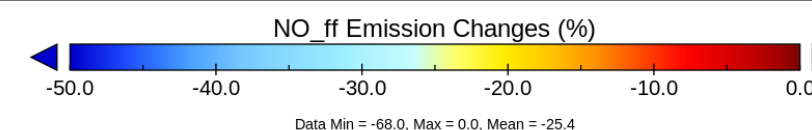
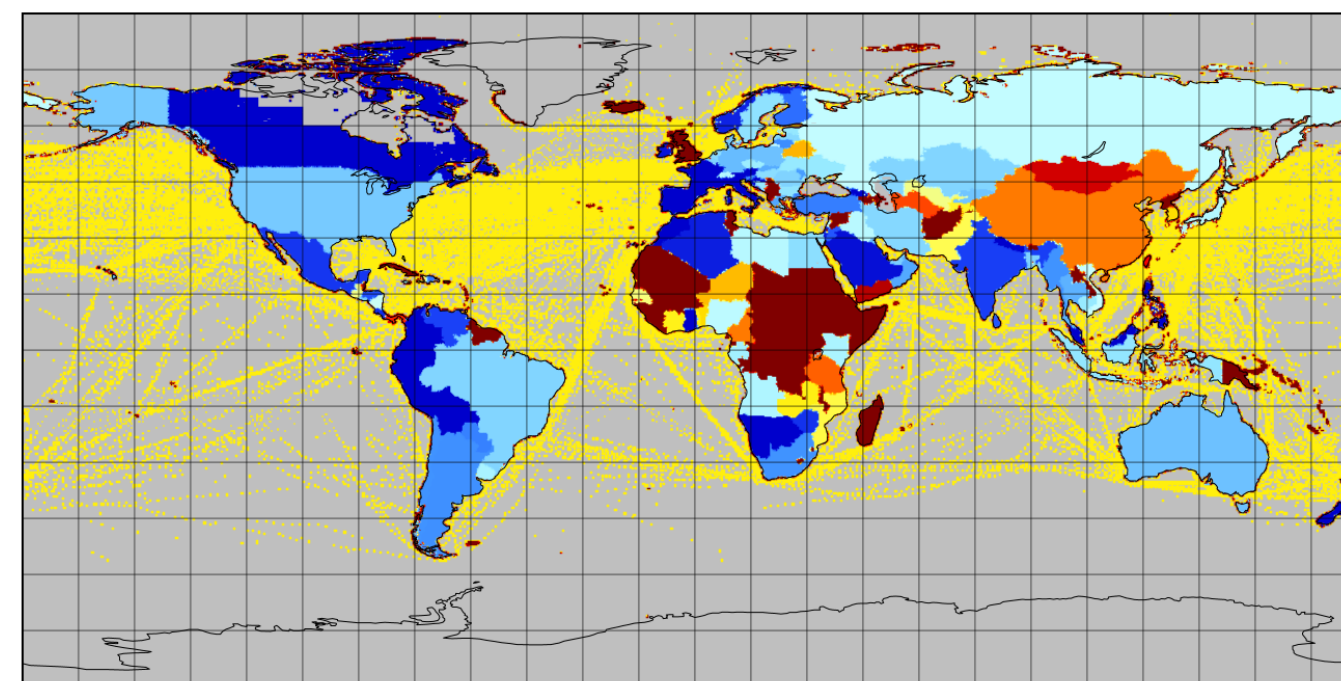
- Output from the Global Modeling Initiative (GMI) is provided to support NDACC analyses
- Output is available from the GMI CTM and more recently, a GEOS-GMI replay simulation Most recent update: Spring 2023 – another coming soon!
- Vertical profiles extracted at NDACC stations :
 - 3-hourly O_3 , NO_2 , water, temperature, pressure, potential vorticity, tropopause pressure, and age of air interpolated to geometric altitude
 - 24-hour averages of FTIR species on model levels and as columns

- “MINDS” GEOSCCM simulation (courtesy of Luke Oman) with GMI chemistry and GOCART aerosols replayed to meteorological fields from the MERRA2 reanalysis
- Available 1996-2023: more years since last update
- Emissions change over time, include COVID-related updates

Mid-March 2020 Emission Changes (2020-2019)



Mid-April 2020 Emission Changes (2020-2019)



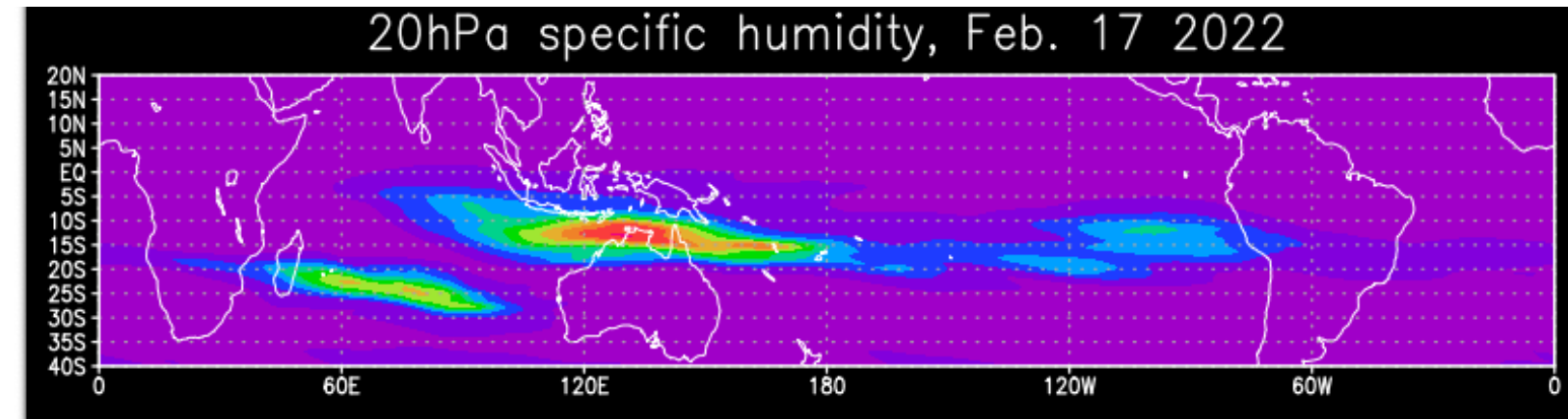
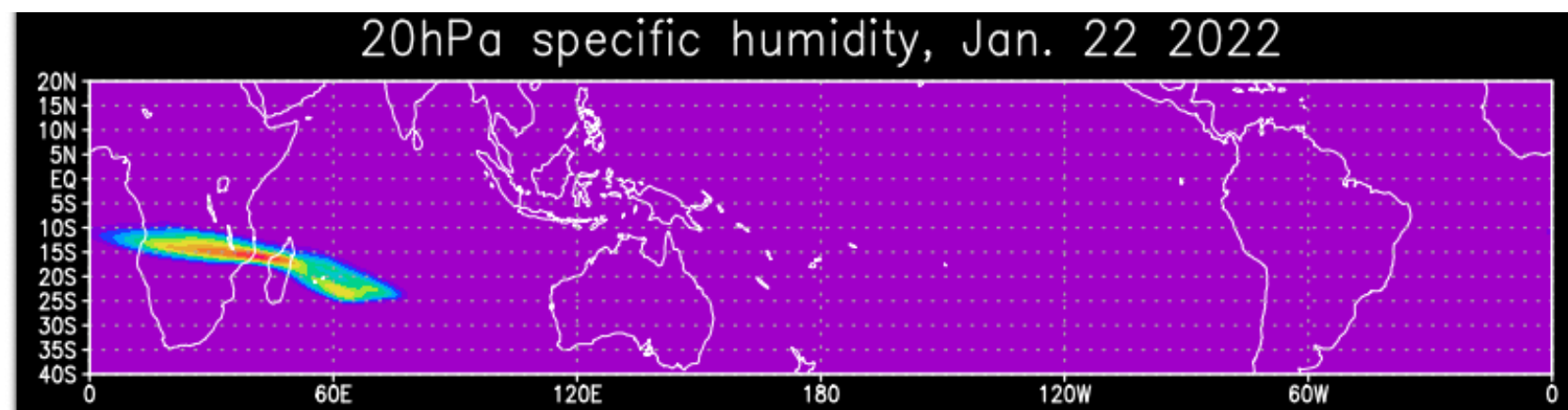
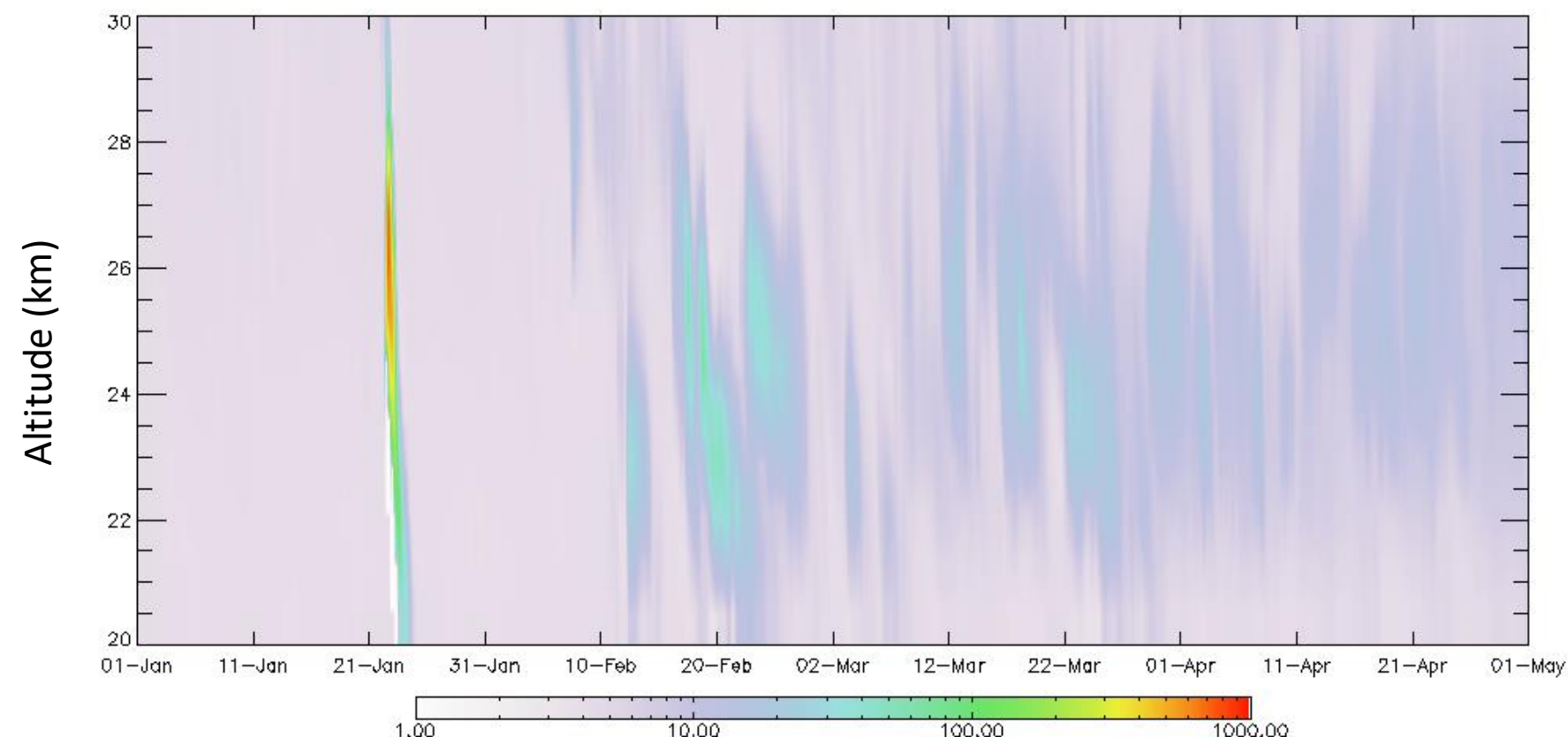
- Last year of previous submission to NDACC was 2020
- Updating soon to add 2021-2023 from replay output
- New years will also include PAN and C₃H₈ for FTIR comparisons
- New years cover the Hunga Tonga eruption
 - Water vapor enhancement incorporated through adjustment of restart file

AIRS Prata SO₂ Index

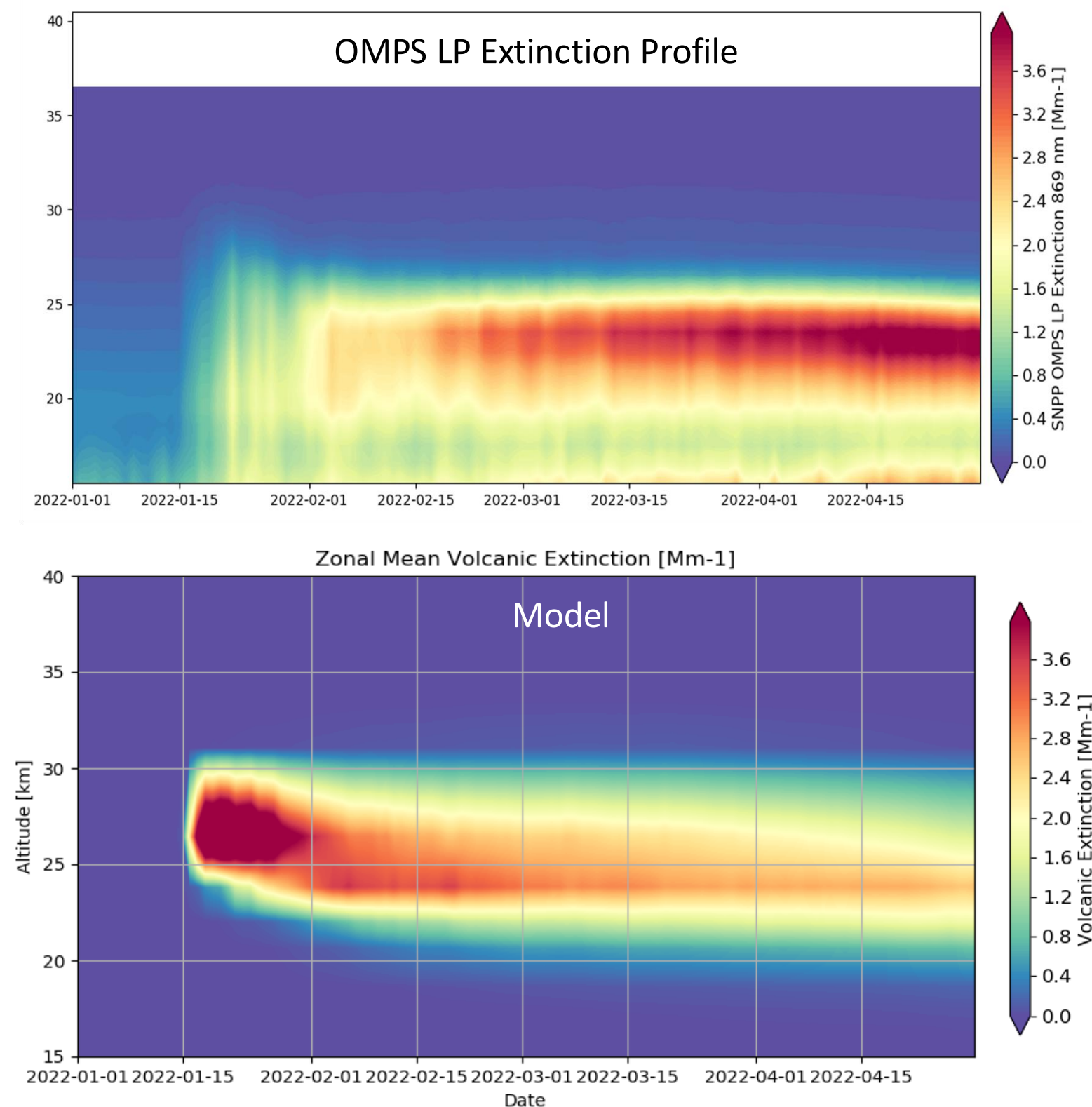


- Water vapor perturbation is included, but not aerosols
- 3-D output from model can provide additional spatial context for station data

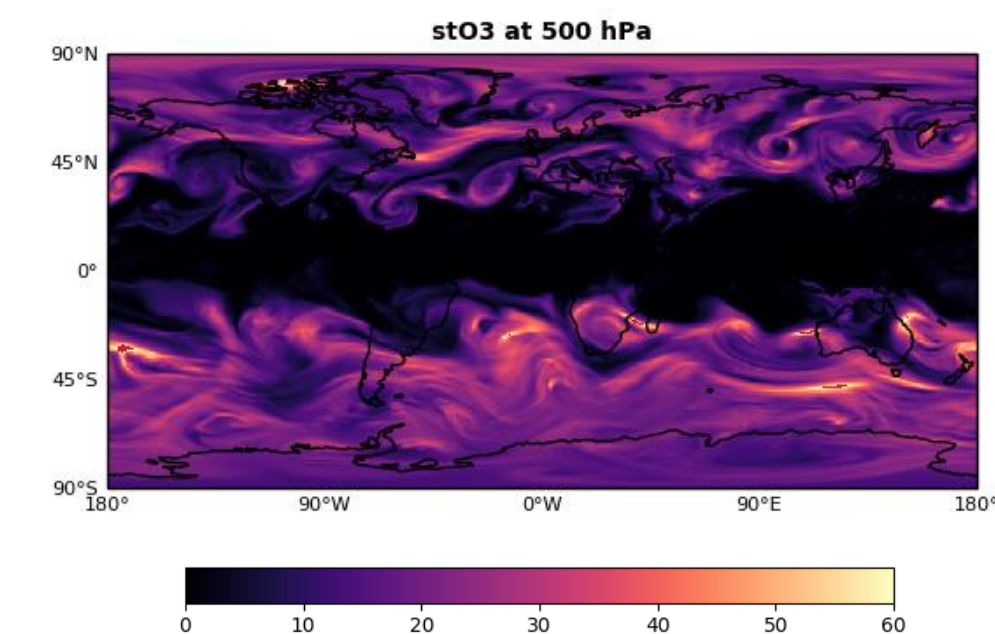
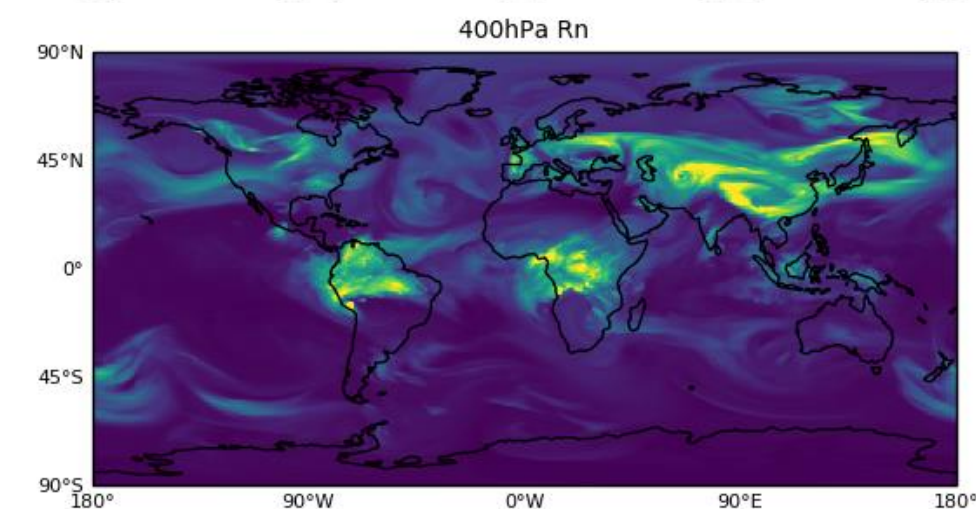
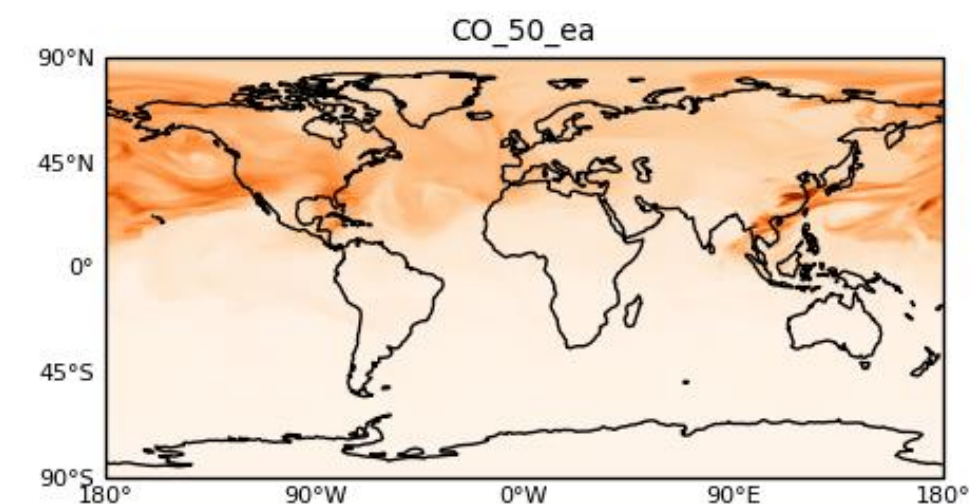
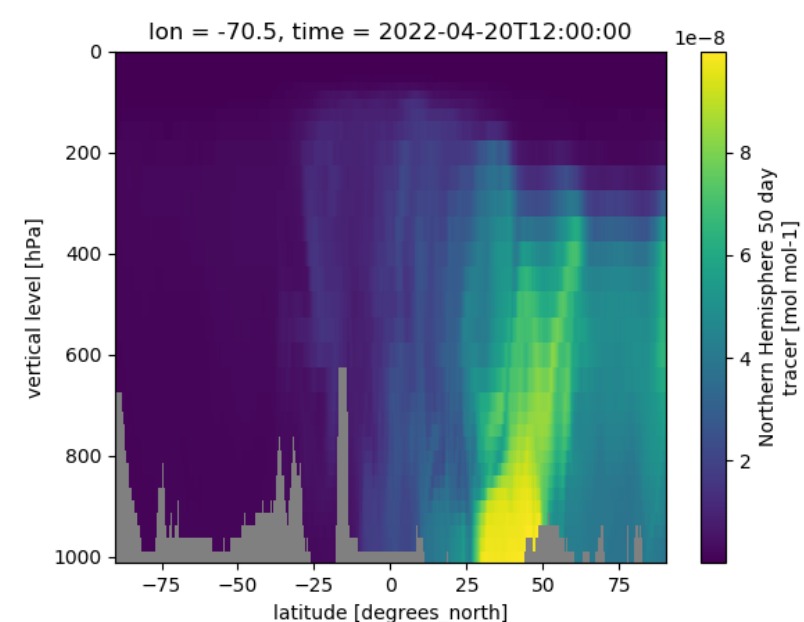
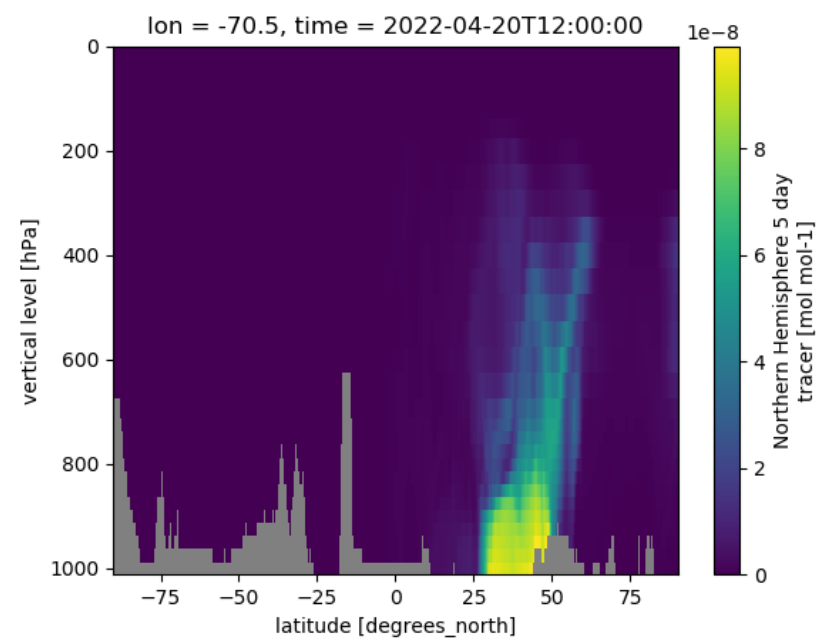
Water Vapor Model Output Above La Reunion



- GEOSCCM group is conducting shorter GEOS-GMI simulations for TongaMIP and SPARC, specifically aimed at representing the Hunga Tonga eruption
- These simulations include both SO₂ and water injections
- Output from a Hunga-Tonga simulations could be extracted at NDACC stations and provided to NDACC
- Figures, courtesy of Peter Colarco, show example simulation results for 30°S-0° compared to OMPS LP



- MINDS simulation includes a suite of idealized tracers for specific processes or influences:
 - Transport from specific regions: CO_50_ea, CO_50_na, etc., NH_50
 - Region/process influence: stO3 and st80_25 (stratospheric ozone or air), Rn-222, CH3I (continental or marine convection influence)
 - Age of air (already extracted at NDACC stations)
 - Many others



- Model can provide 3D spatio-temporal context for observations
- Future simulations can include additional species in output
- Are there specific idealized tracers you would like extracted at NDACC stations?
- Please keep us in the loop if you are using NDACC model outputs in your work
 - helpful to show our program managers how products they fund are used in the international community
 - We can identify or answer questions about model issues

- Promotion of NDACC data as a resource for model validation?
 - Long-term records especially valuable for e.g. trend studies
- More/different model output, or interaction with more models/modelers?
- Bring in experts in other areas of "theory", such as statistics or radiative transfer?