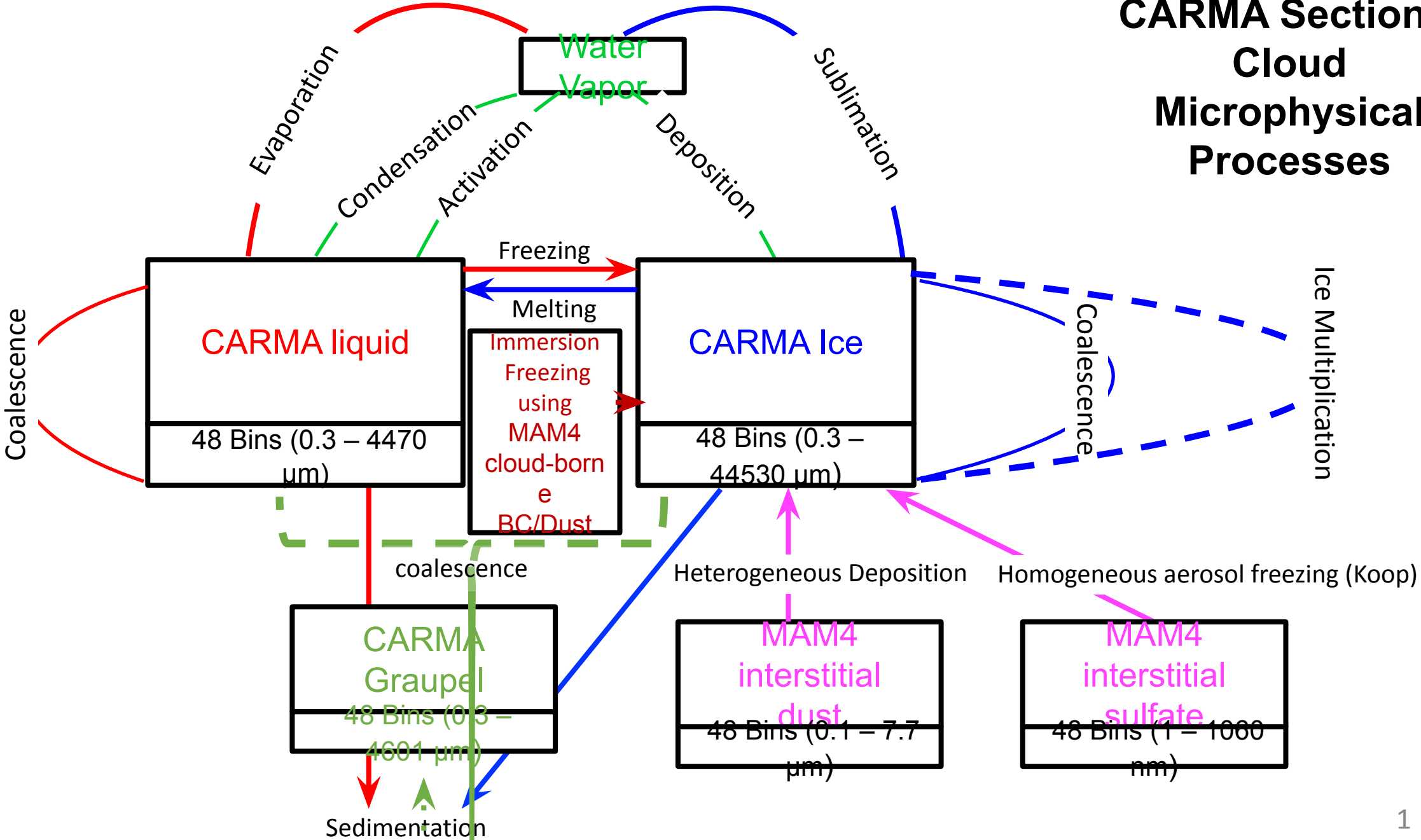


Sectional Cloud Model for CESM2 (CESM2-CARMA Cloud)

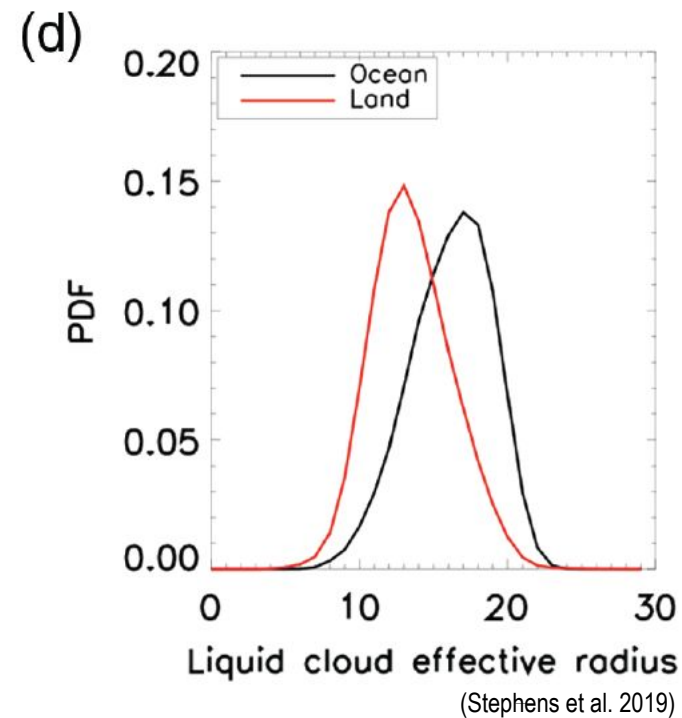
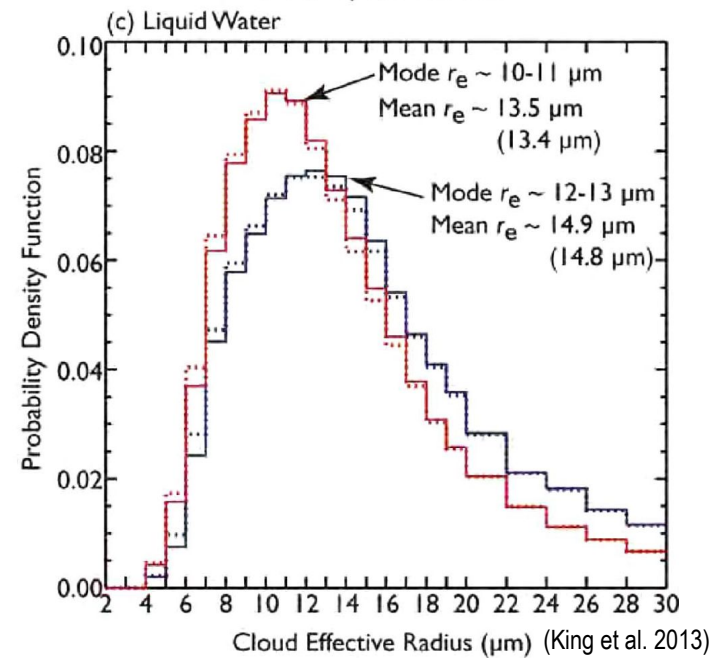
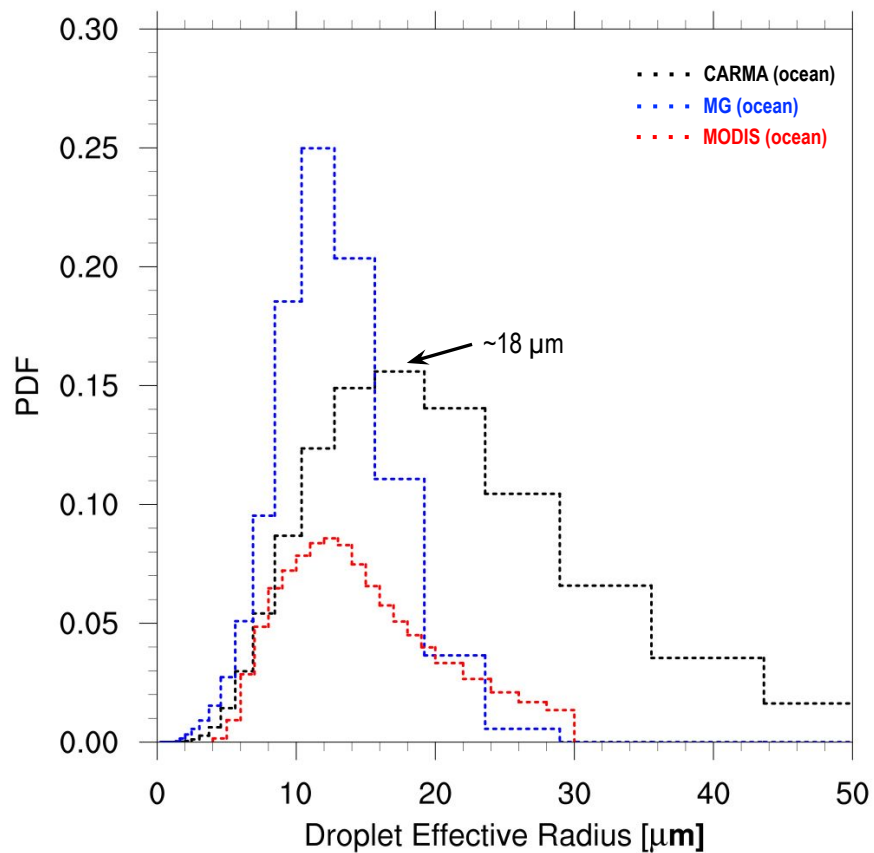
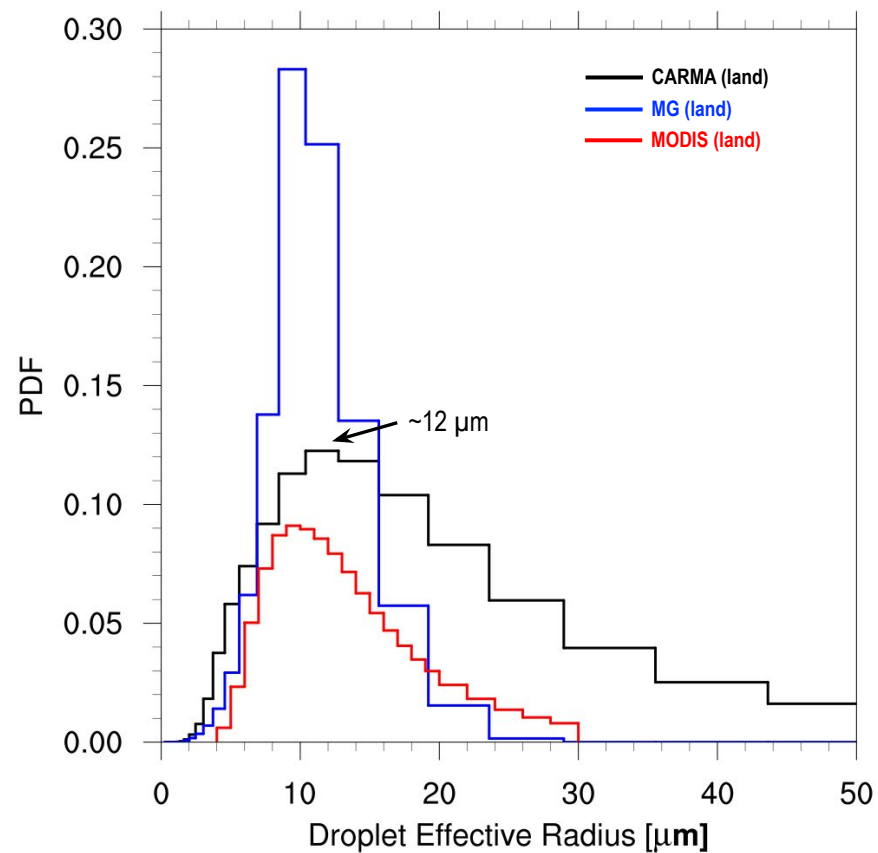
Lu Wang¹, Yunqian Zhu^{1,2}, Charles G. Bardeen³, Christopher Maloney^{1,2},
Andrew Gettelman⁴, Owen B. Toon¹

¹*U. Colorado*, ²*NOAA*, ³*NCAR*, ⁴*PNNL*

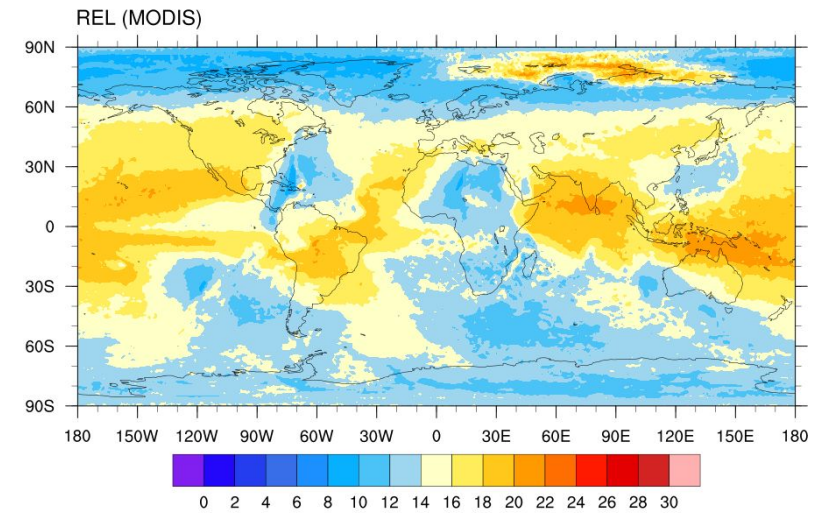
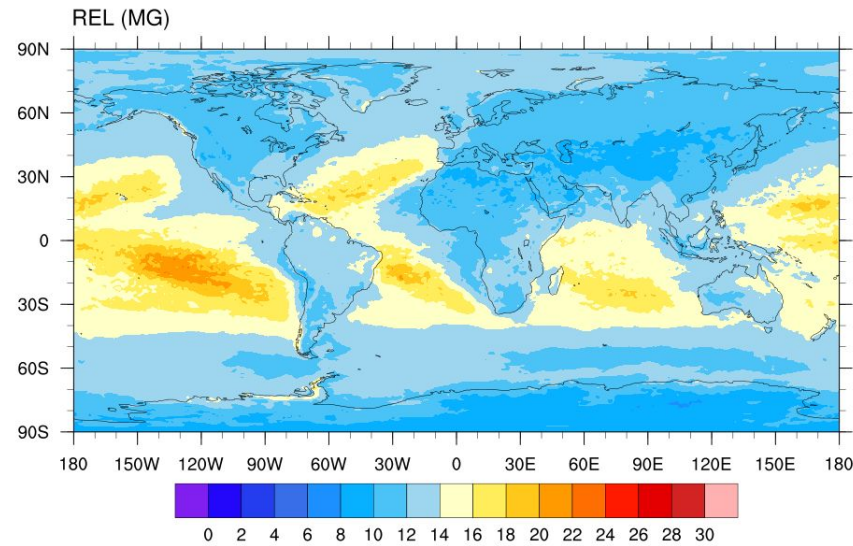
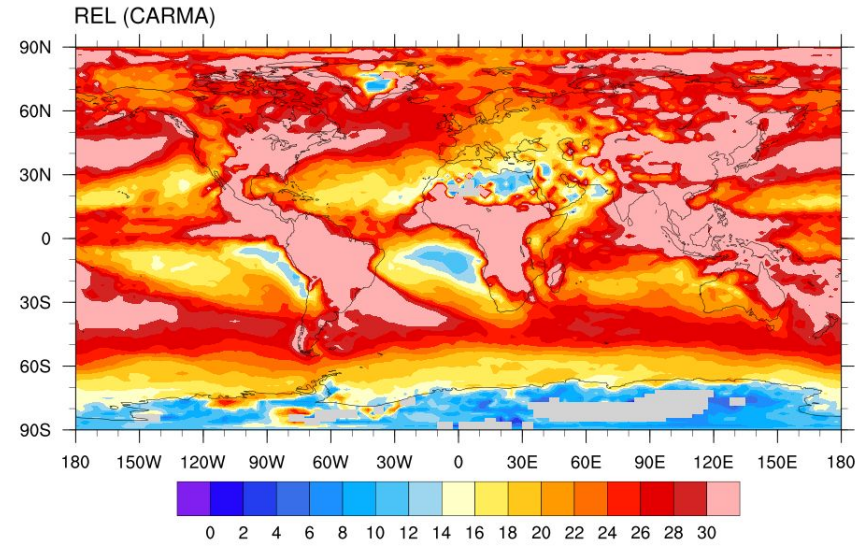
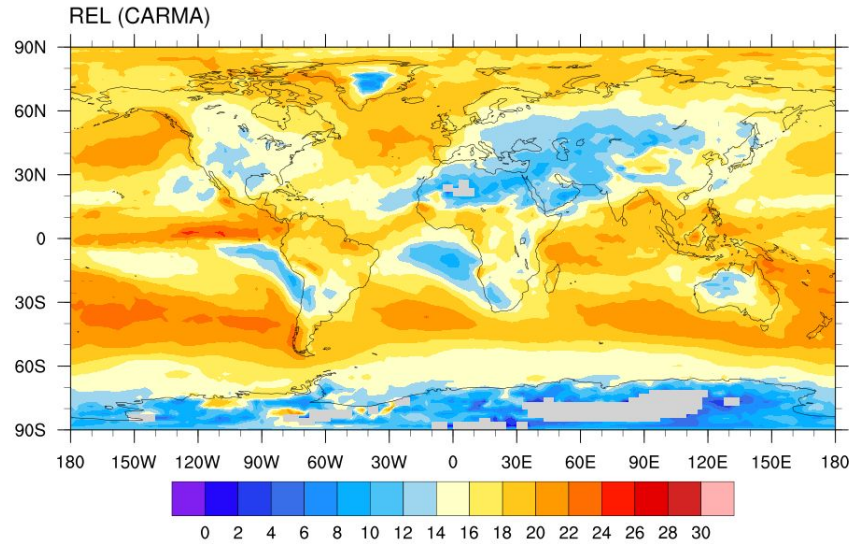
CARMA Sectional Cloud Microphysical Processes



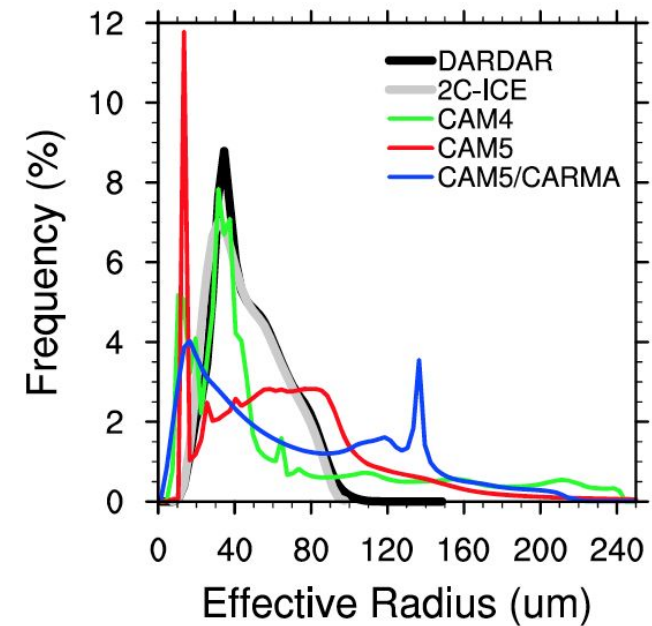
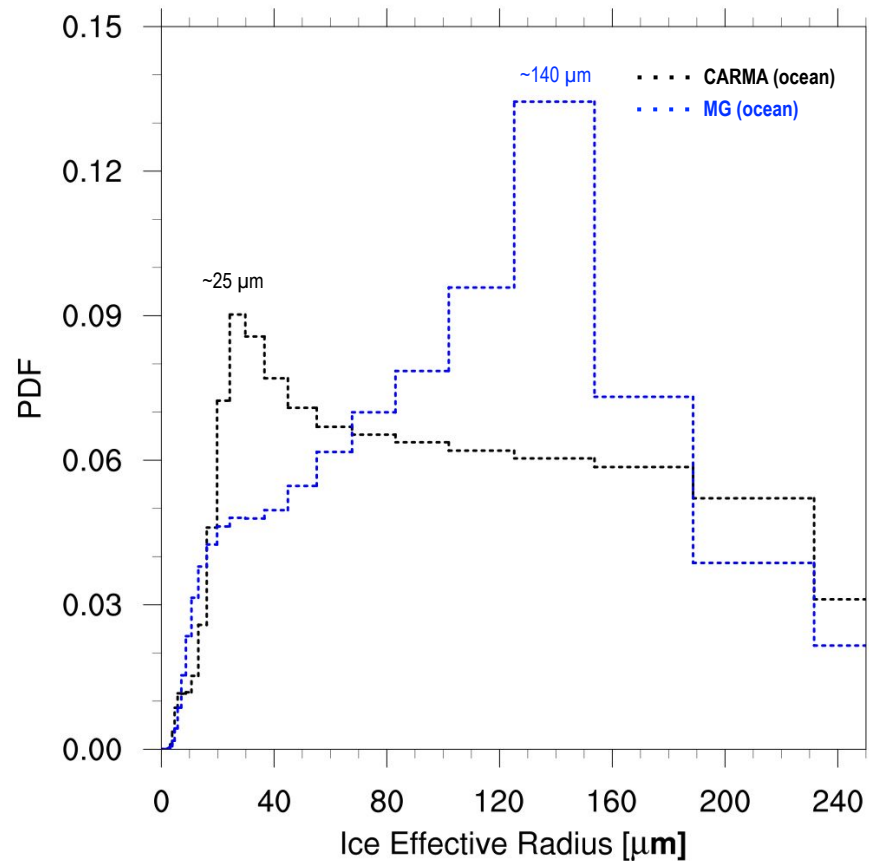
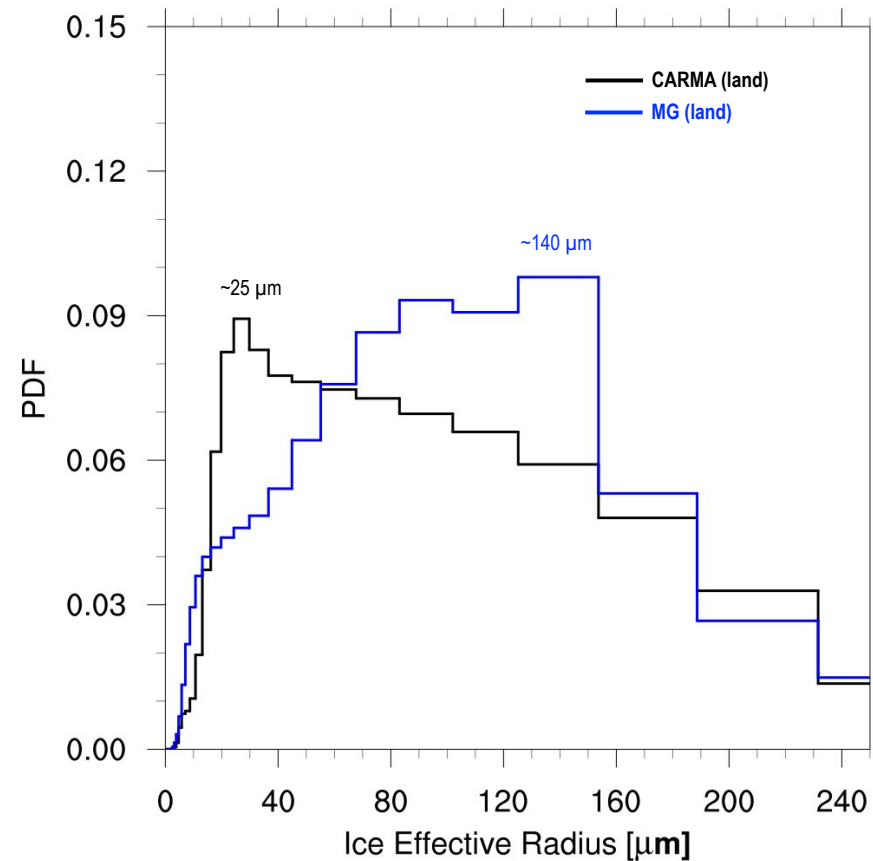
Droplet Effective Radius PDF (CARMA-MG-MODIS)



Droplet Effective Radius Map

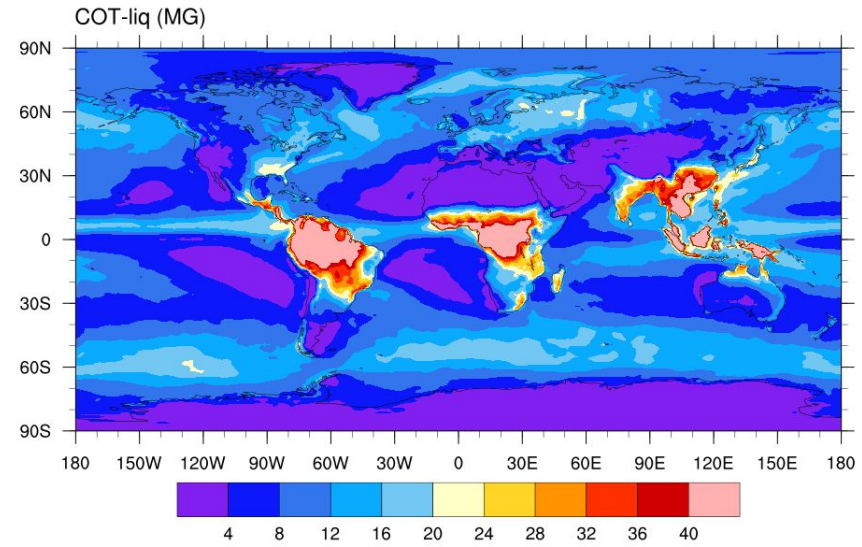
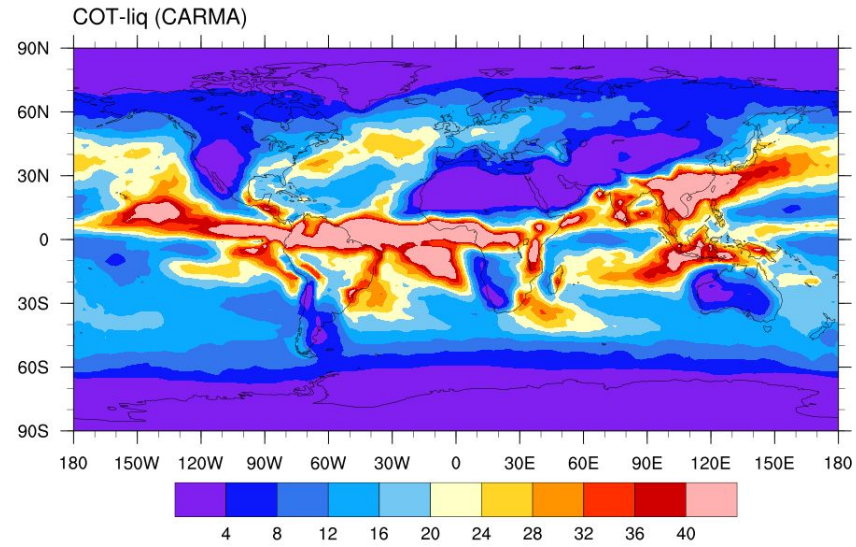


Ice Effective Radius PDF (CARMA-MG)

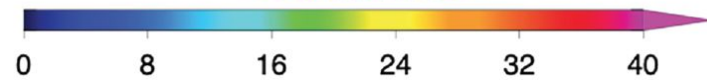
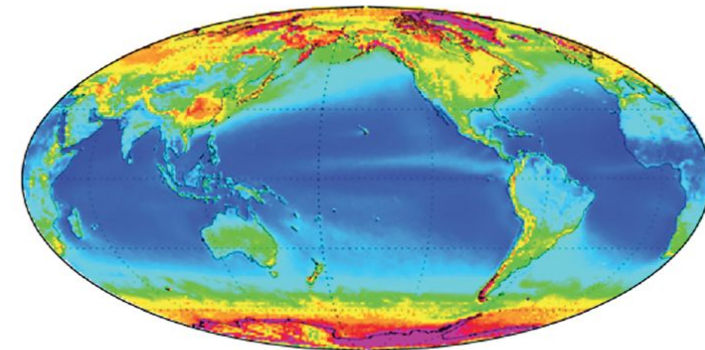


(Bardeen et al. 2013)

Cloud Optical Thickness (Liquid) Map

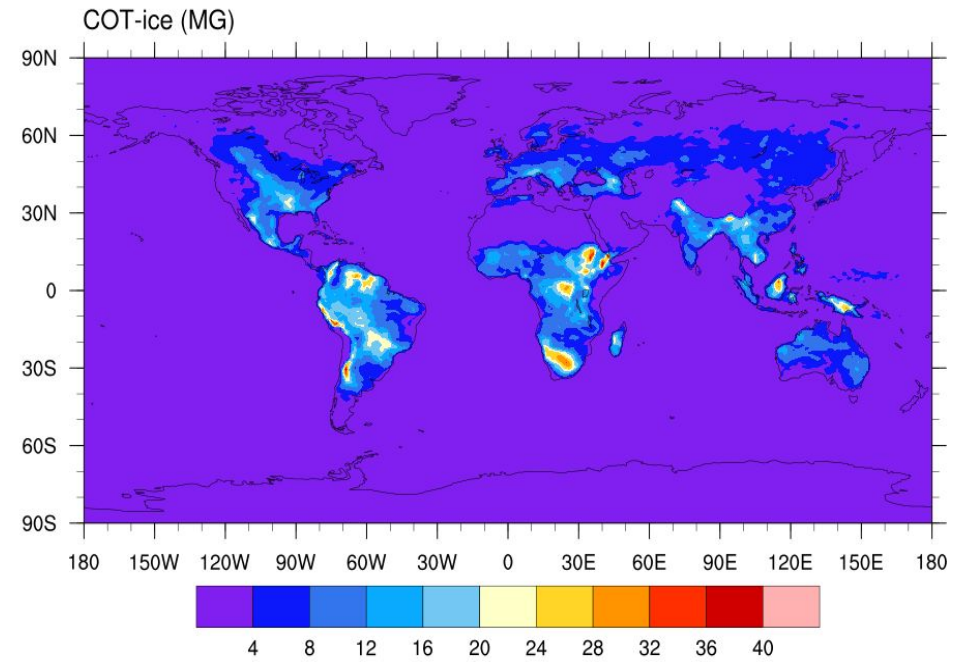
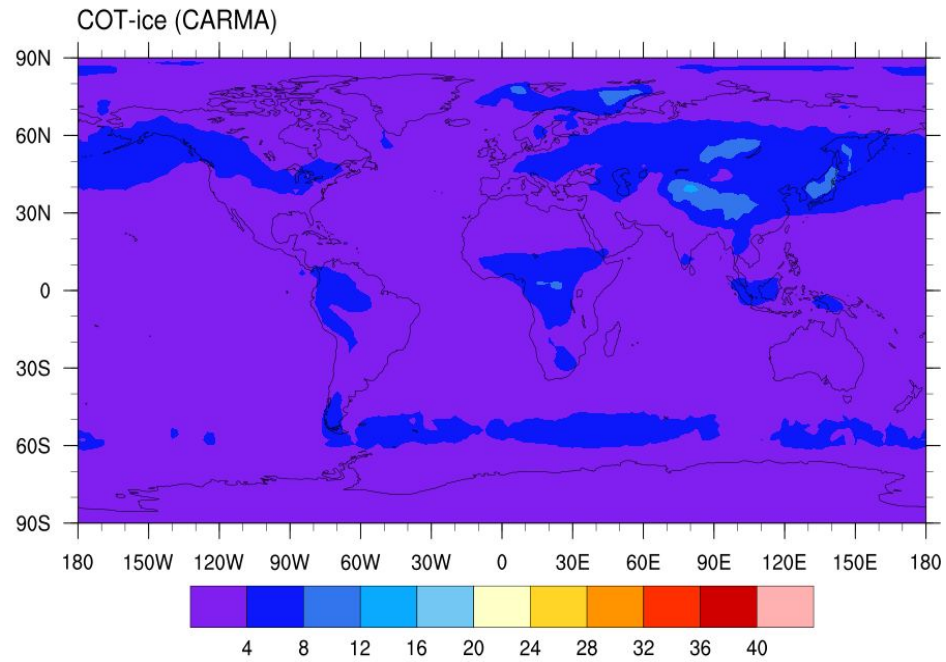


(a) Liquid optical depth

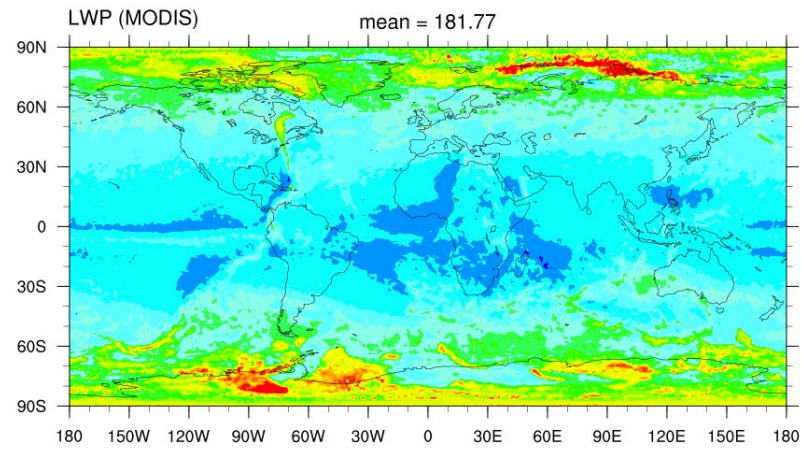
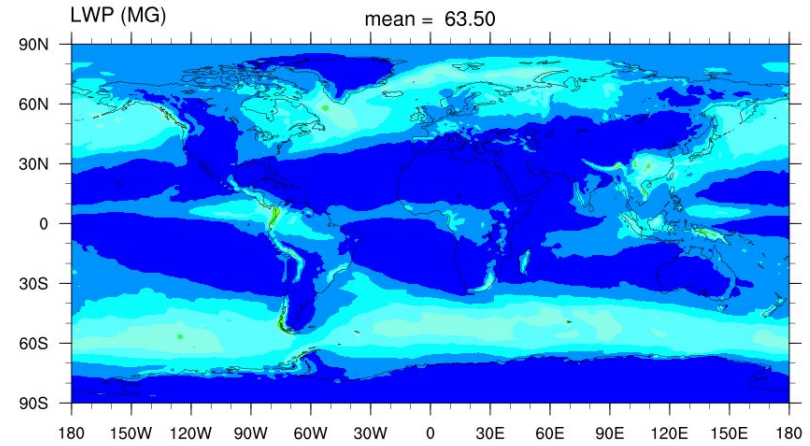
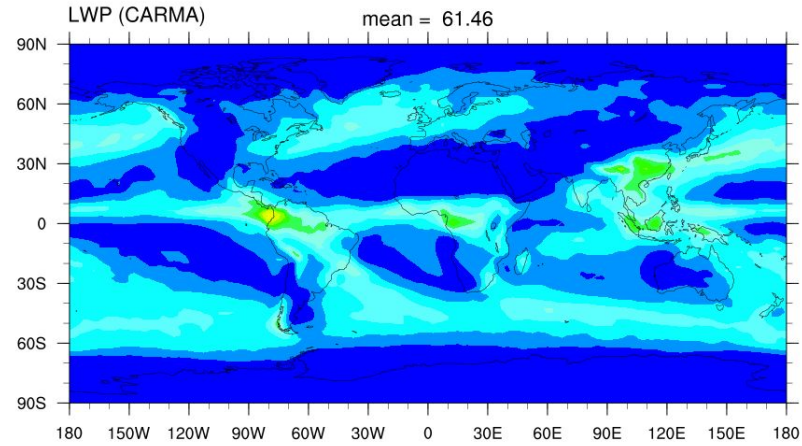


(Stephens et al. 2019)

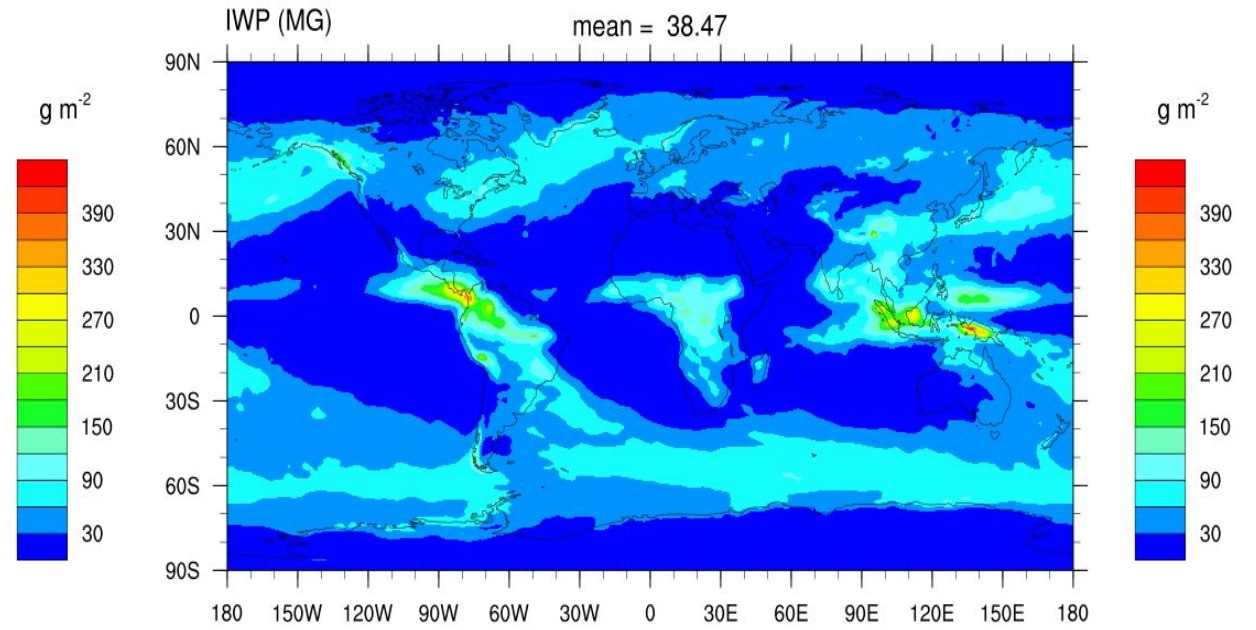
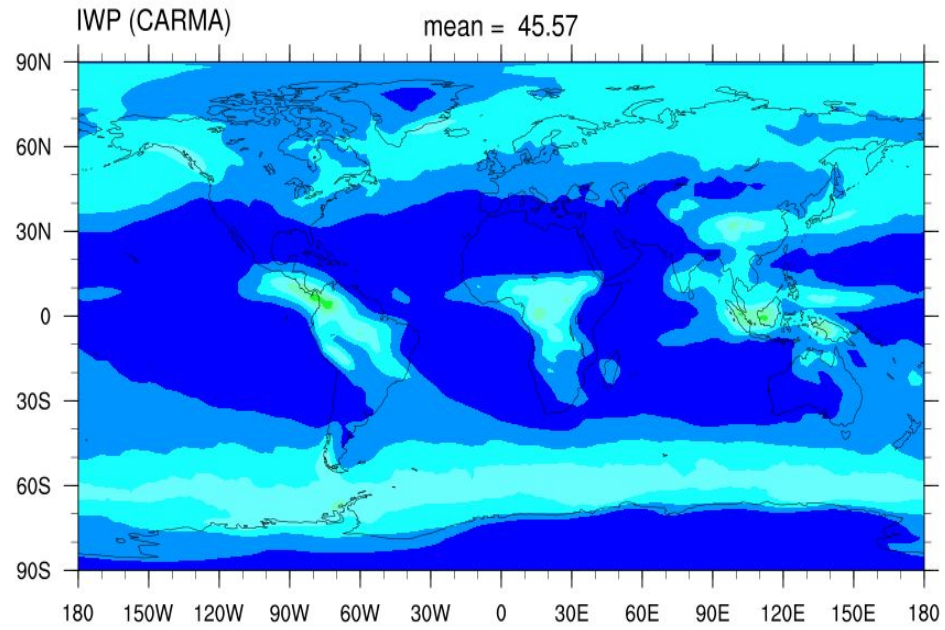
Cloud Optical Thickness (ice) Map



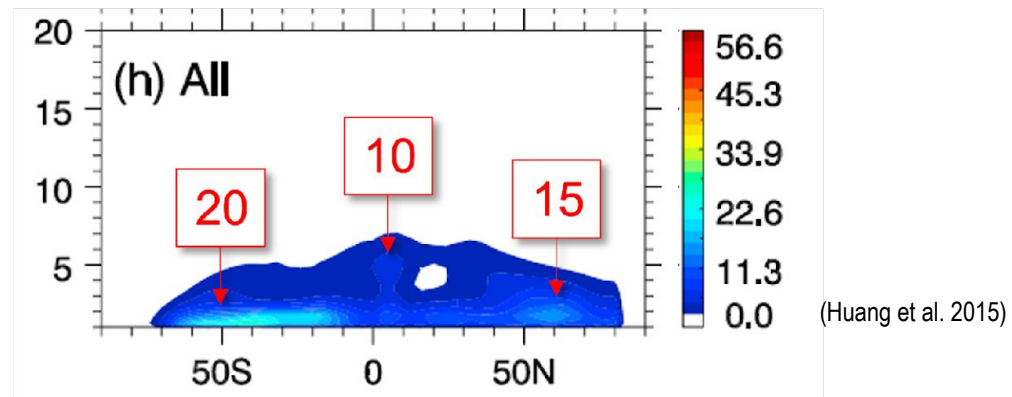
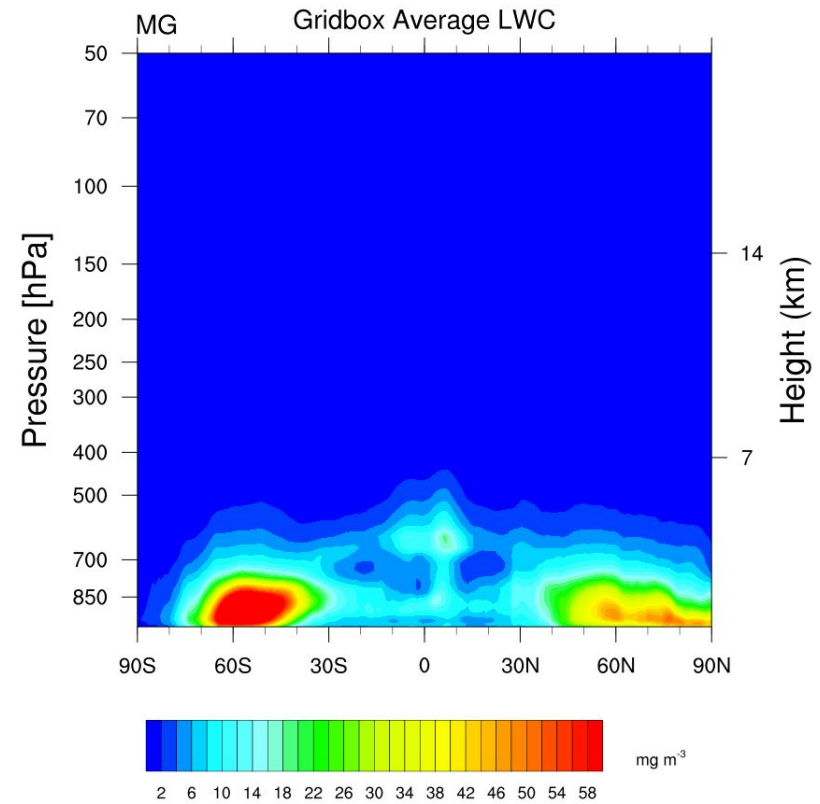
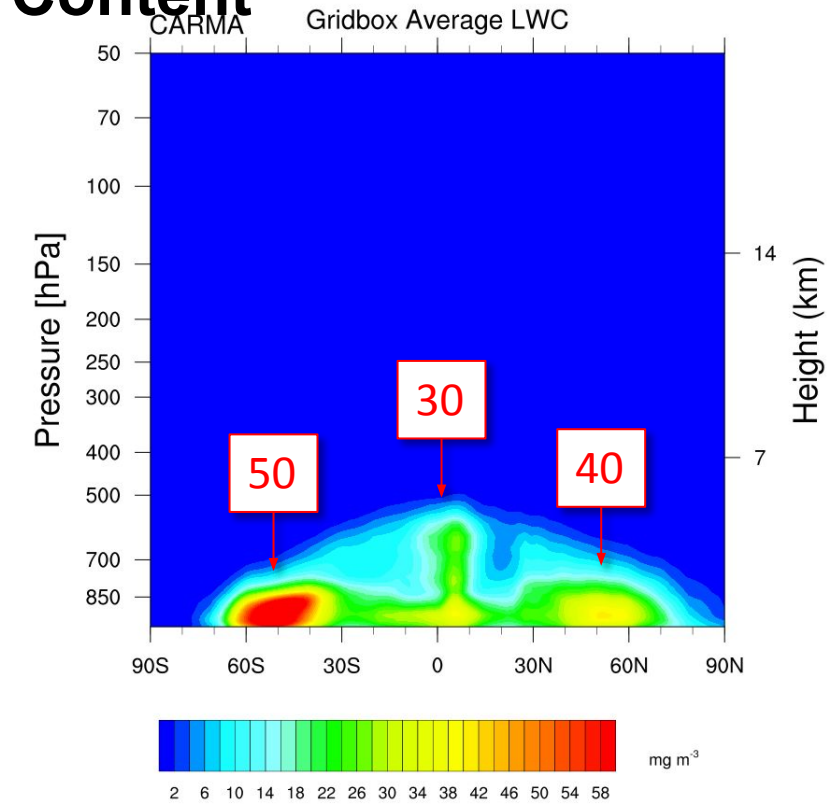
Cloud Liquid Water Path



Cloud Ice Water Path

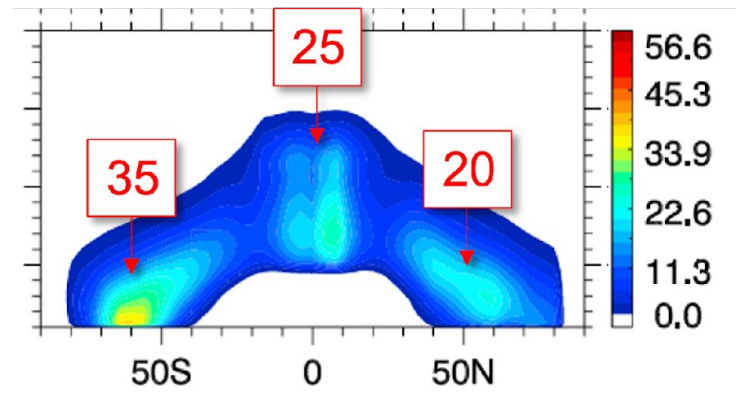
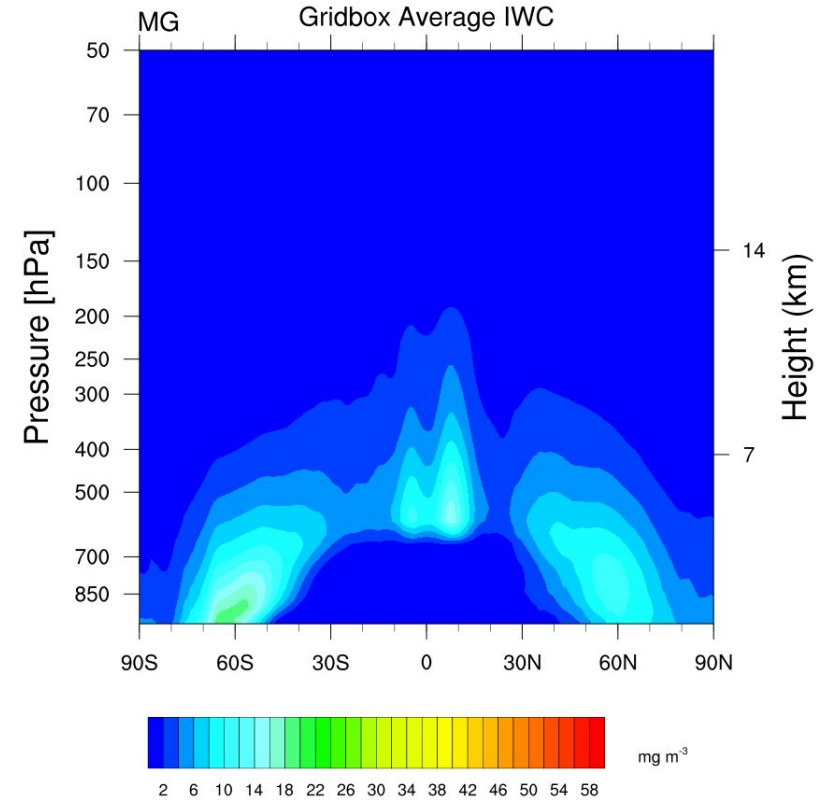
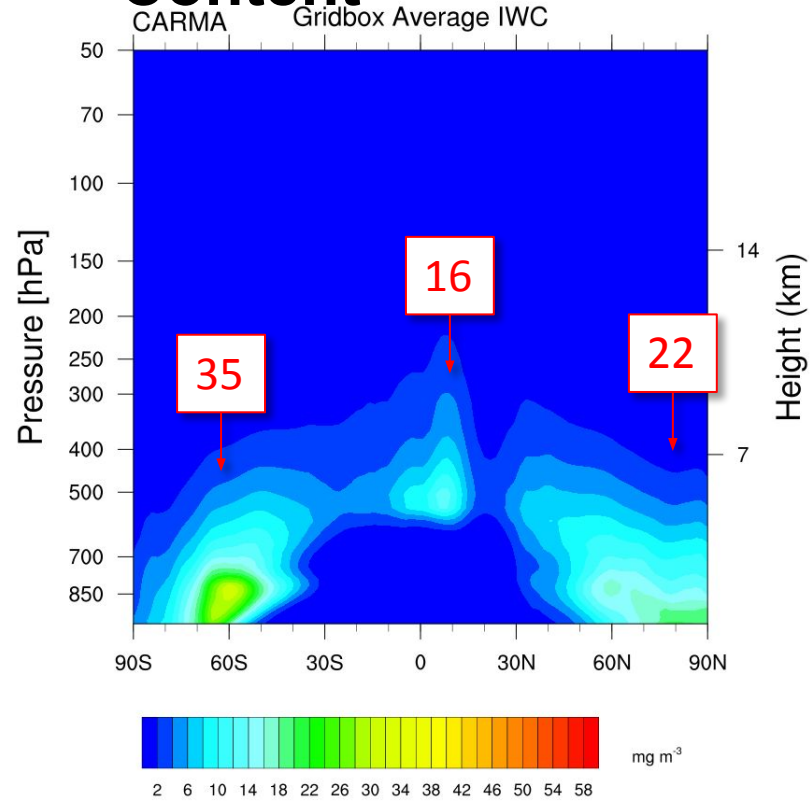


Cloud Liquid Water Content



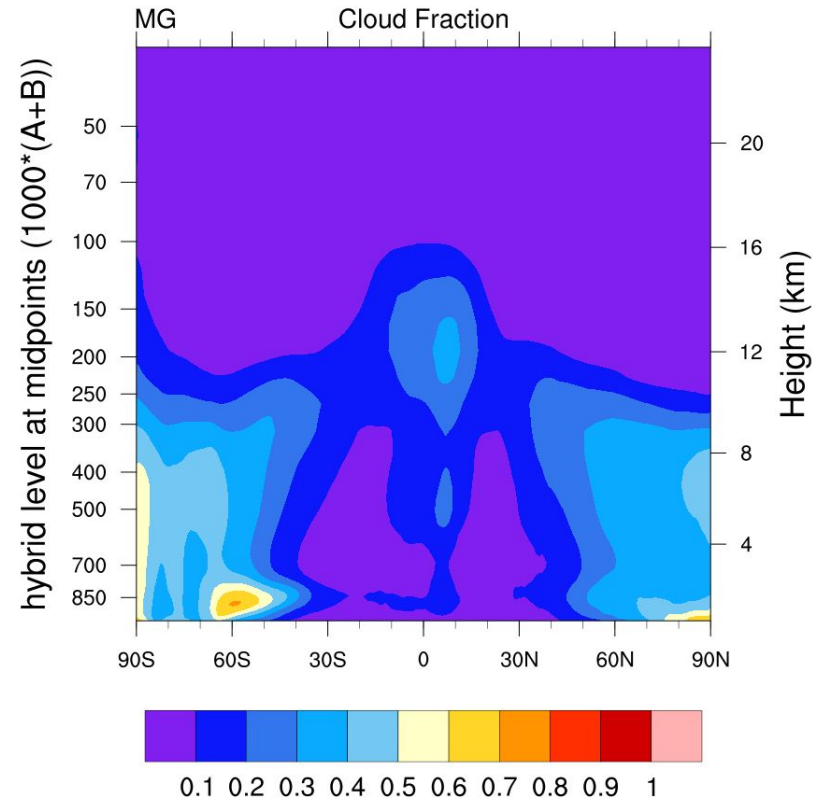
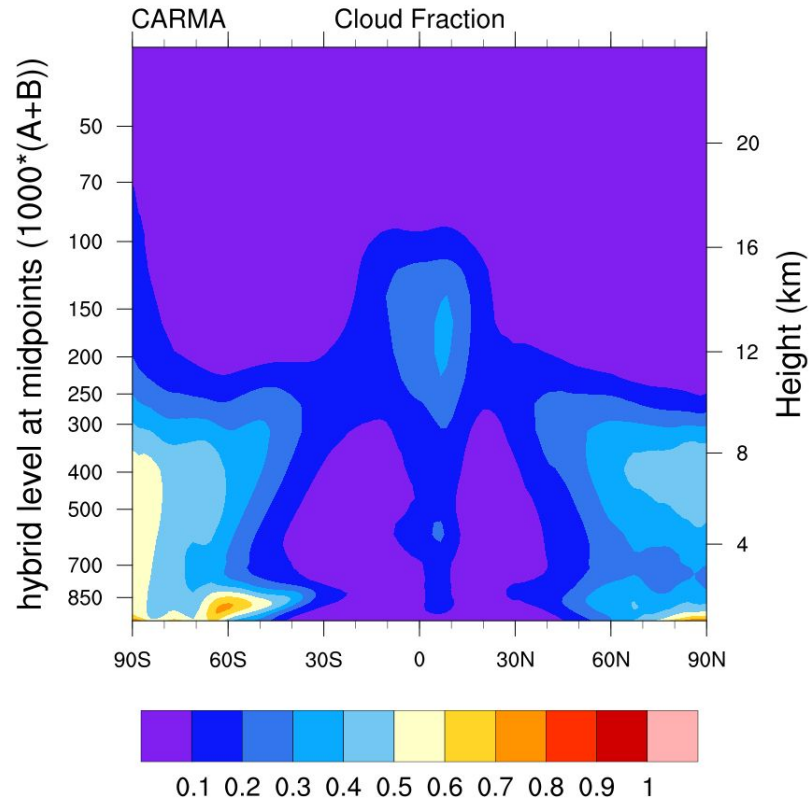
Cloud Ice Water

Content



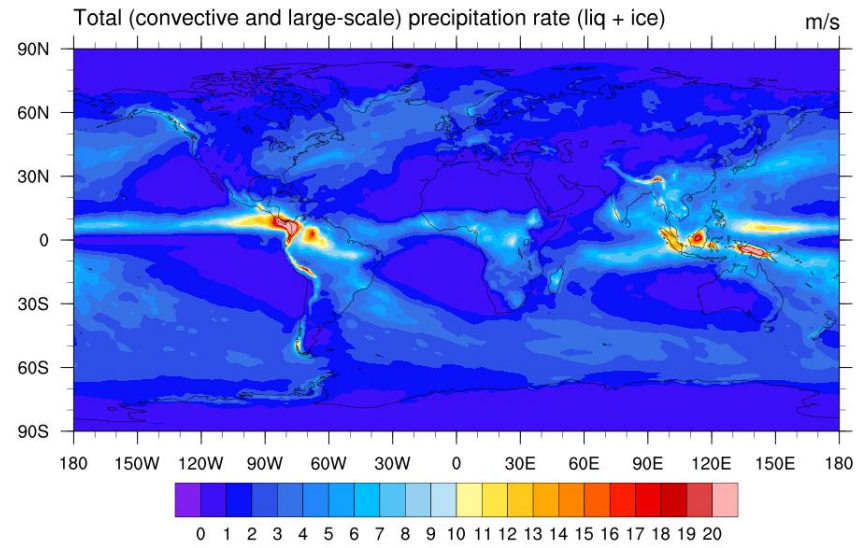
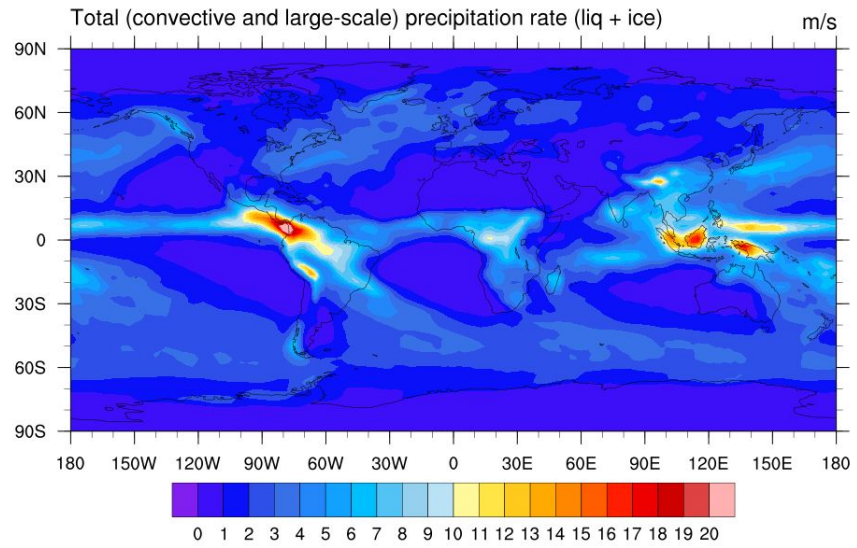
(Huang et al. 2015)

Cloud Fraction

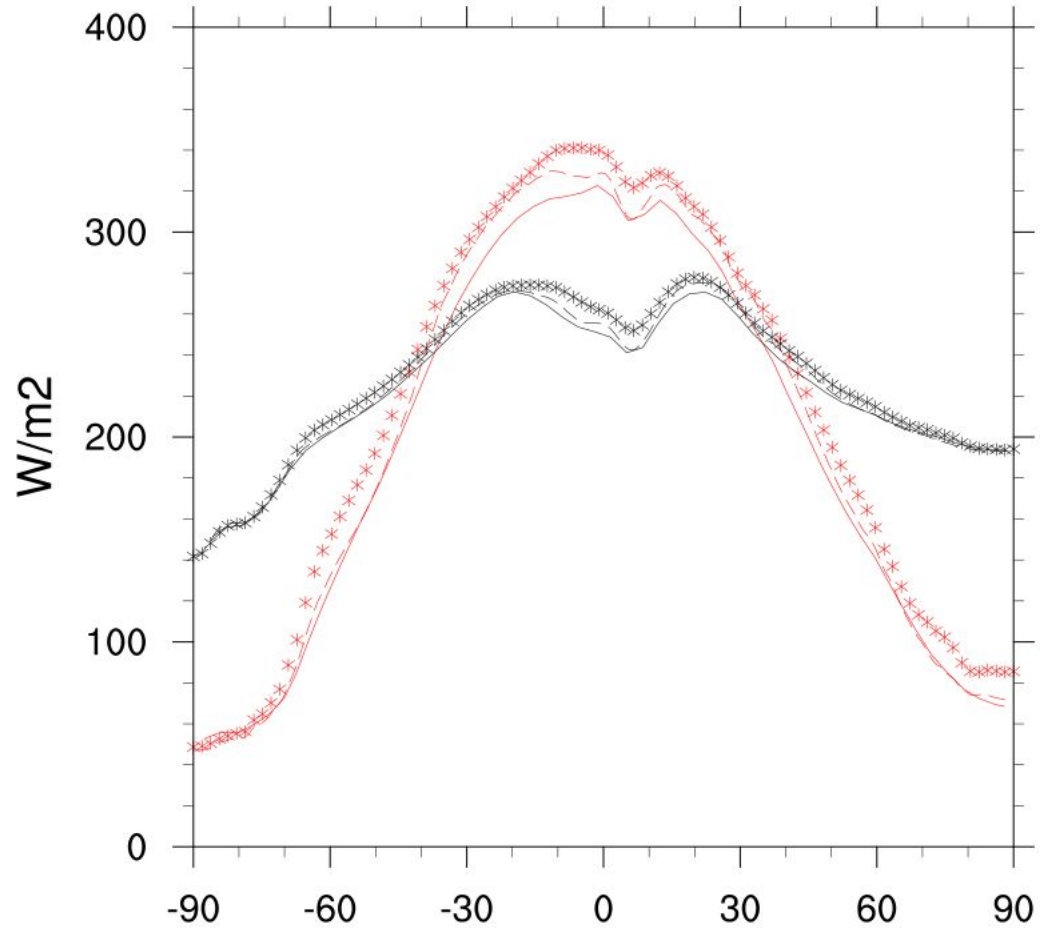


Precipitation

on



TOA Radiation



- Longwave Flux (CERES)
- - - Longwave Flux (MG)
- ***** Longwave Flux (CARMA)
- Absorbed Solar (CERES)
- - - Absorbed Solar (MG)
- ***** Absorbed Solar (CARMA)

(CERES data based on Stephens et al. 2015)

Conclusions & Ideas of Improvement

1. For liquid droplets, we have expanded the size range to drizzle and rain drop sizes. For cloud ice, the size range is expanded to snow. We solve the coagulation equation directly instead of using autoconversion.
2. For liquid droplets, we simulated large cloud droplets better compared to observation.
3. CARMA Cloud simulation is comparable to the MG simulation in terms of CWC, Cloud Fraction, and Precipitation.
4. CARMA Cloud model currently has a little too high TOA radiation fluxes. We are investigating the cause of this issue.