



Aerosols and Indirect Effects Using 2-moment Microphysics in CAM

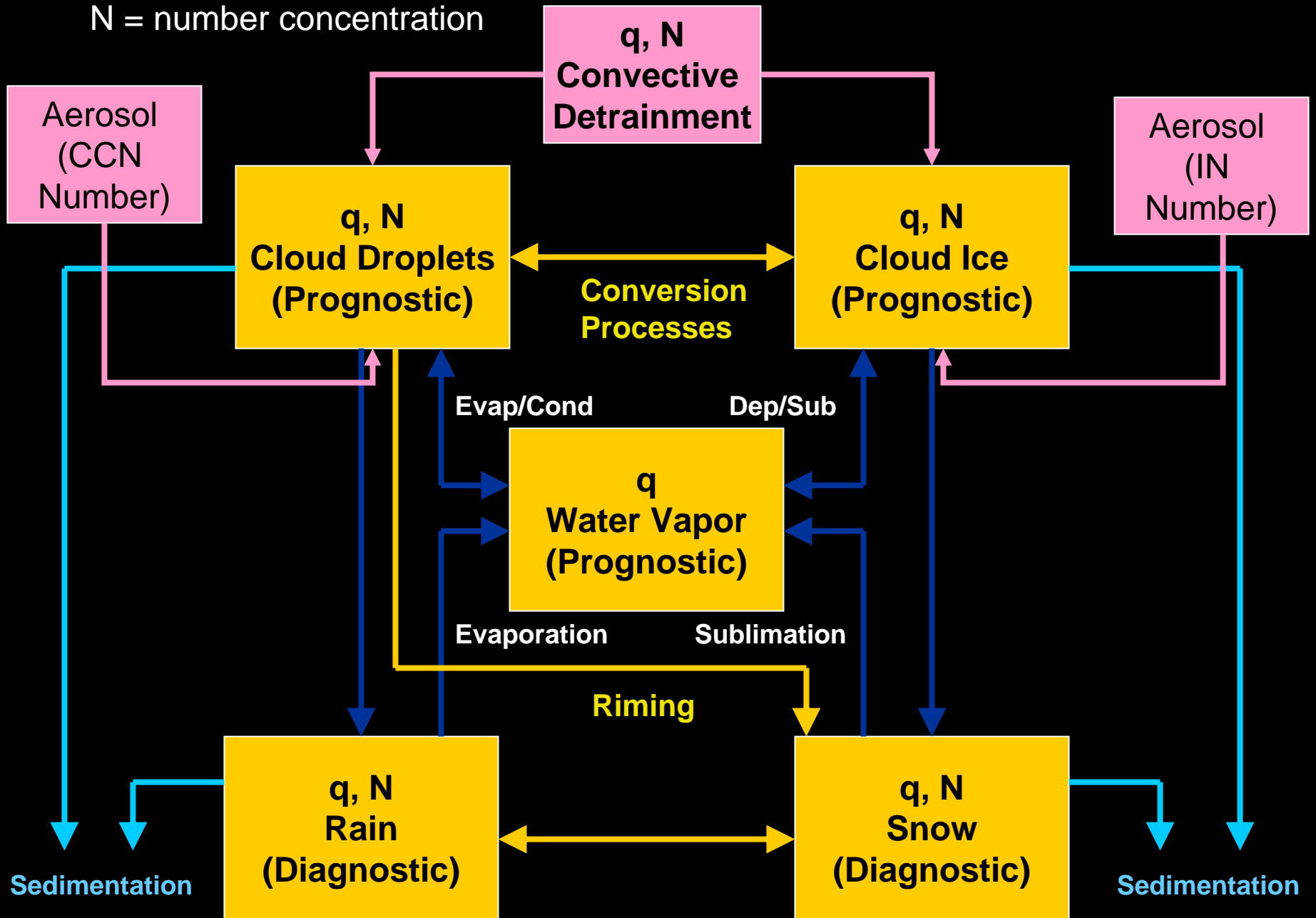
A. Gettelman (NCAR) , S. Ghan (PNNL), H. Morrison (NCAR)

Key features of the new scheme

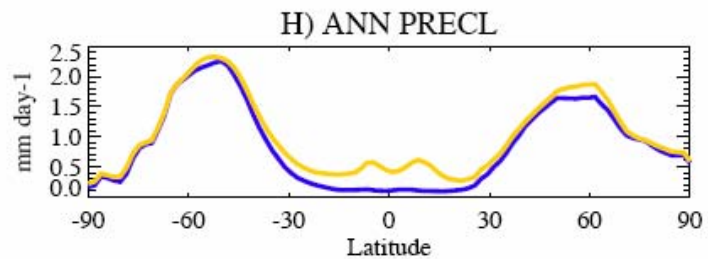
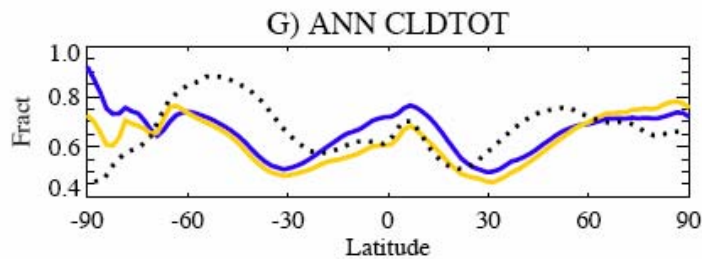
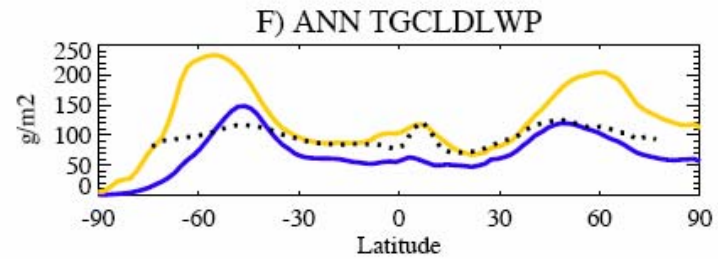
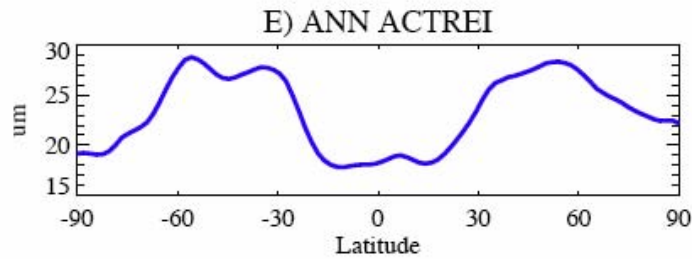
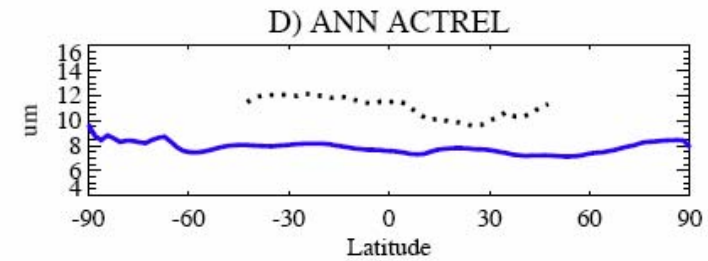
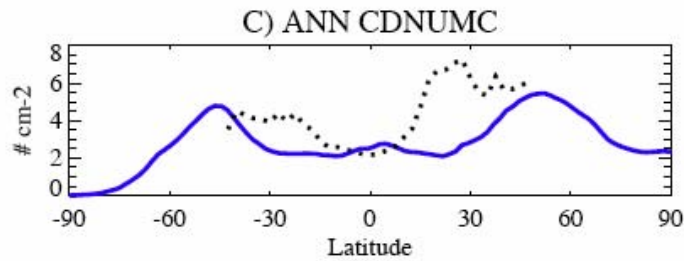
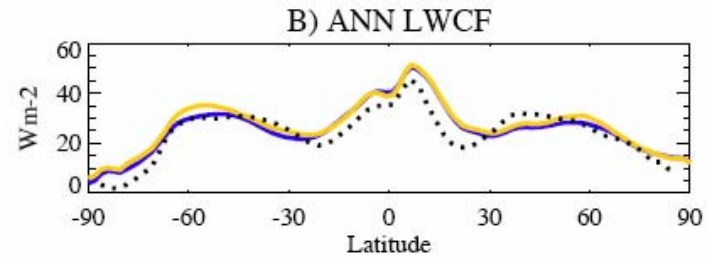
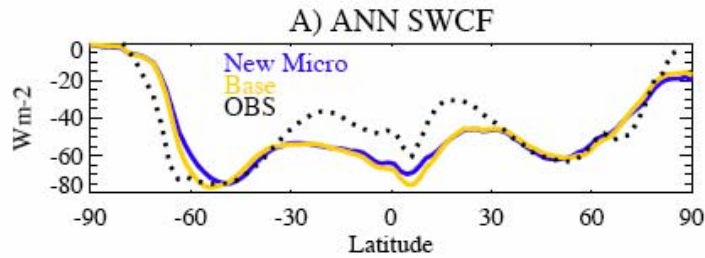
- Two-moment – predicts number concentrations and mixing ratios of cloud water and ice.
- Liquid/ice fraction determined by microphysical processes (Bergeron, heterogeneous freezing) instead of simple function of temperature.
- Coupled with aerosol by treating droplet nucleation (Abdul-Razzak and Ghan 1998) and ice nucleation (Cooper 1986).
- Diagnostic treatment of rain and snow mixing ratio and number concentration.
- Self-consistent treatment of sub-grid cloud water distribution for all relevant microphysics processes – straightforward to couple with diagnostic cloud scheme.
- Flexibility to allow independent column approach.

q = mixing ratio

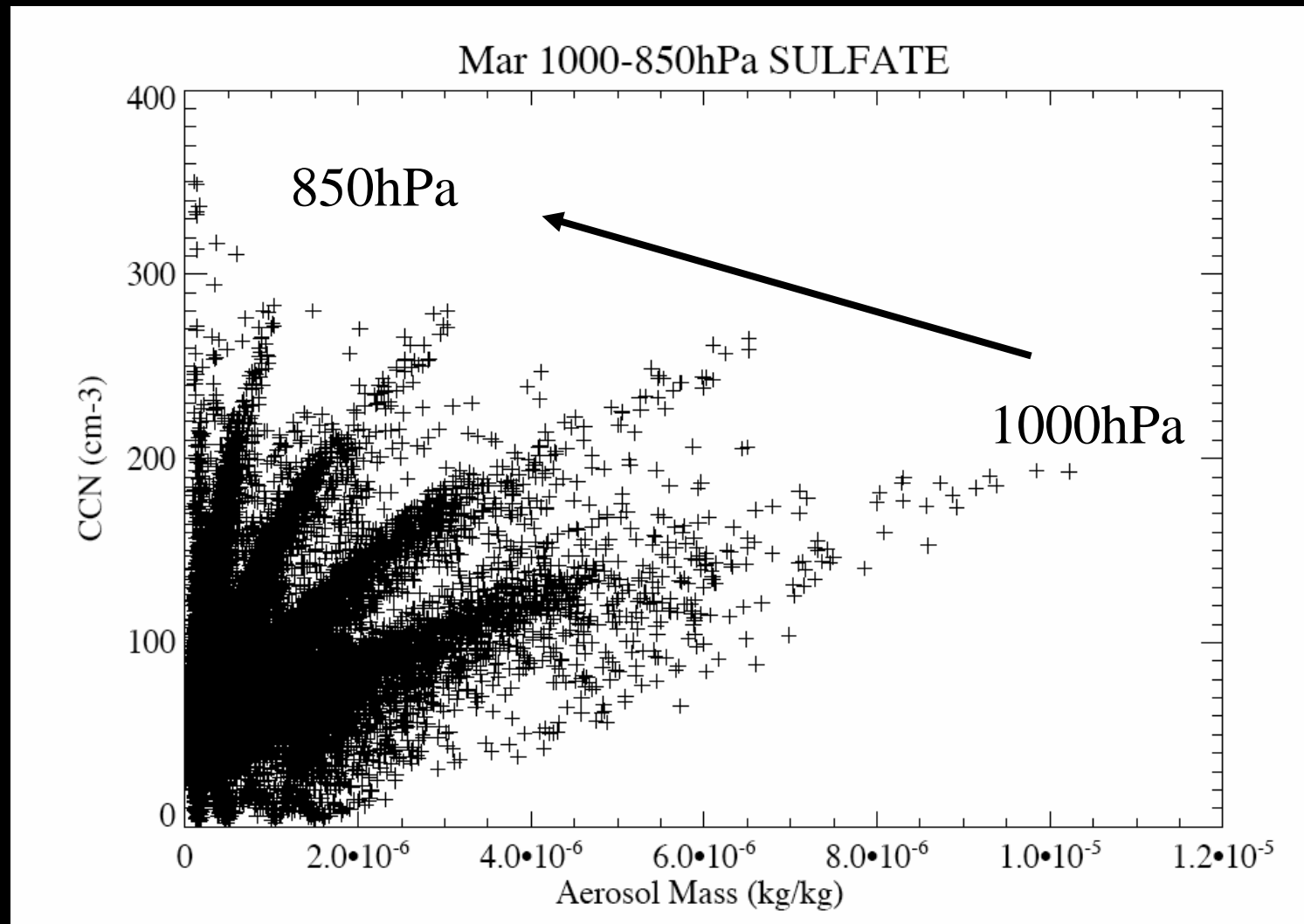
N = number concentration



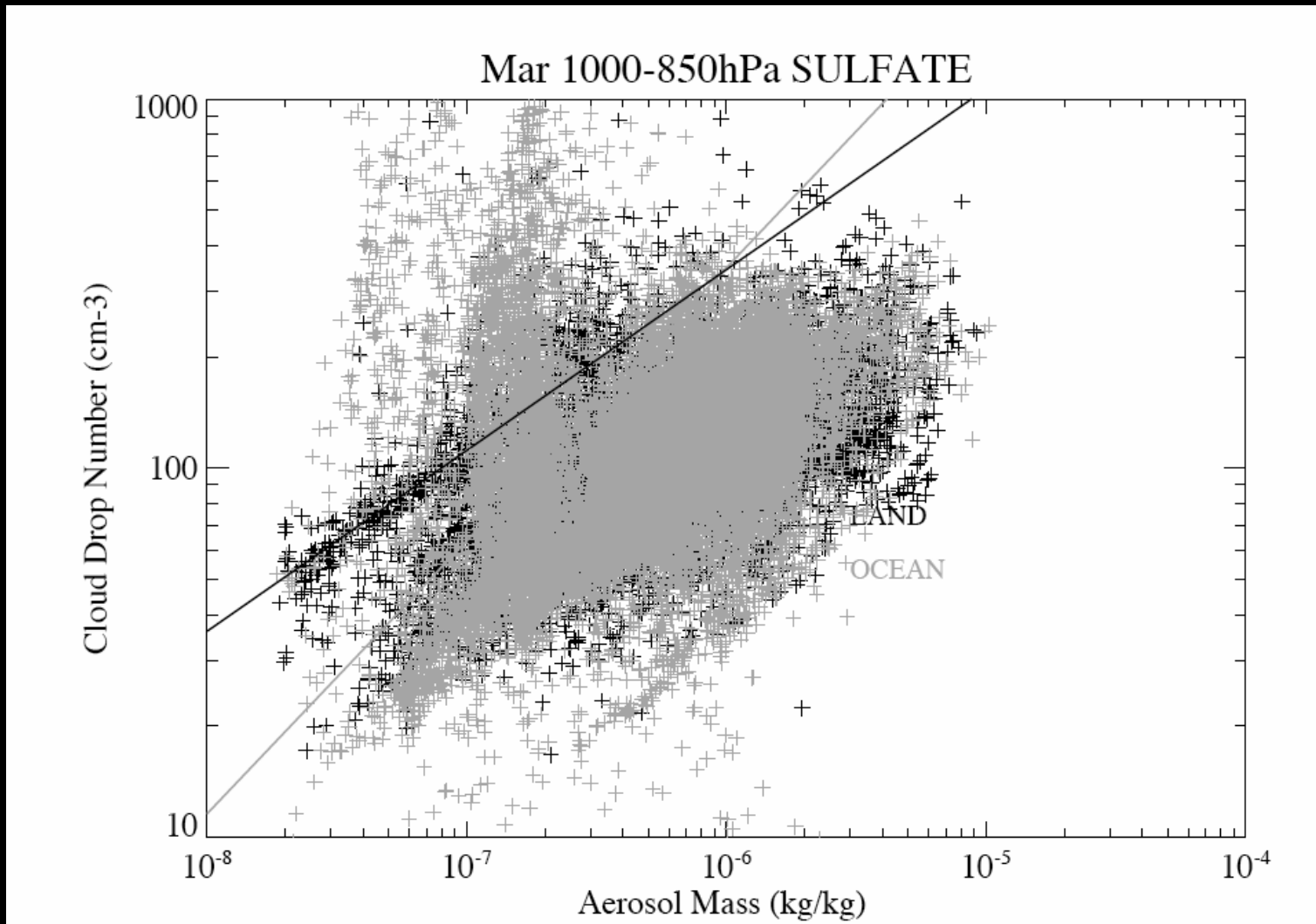
Scheme Performance Summary



Sulfate and CCN



Sulfate Nucleation

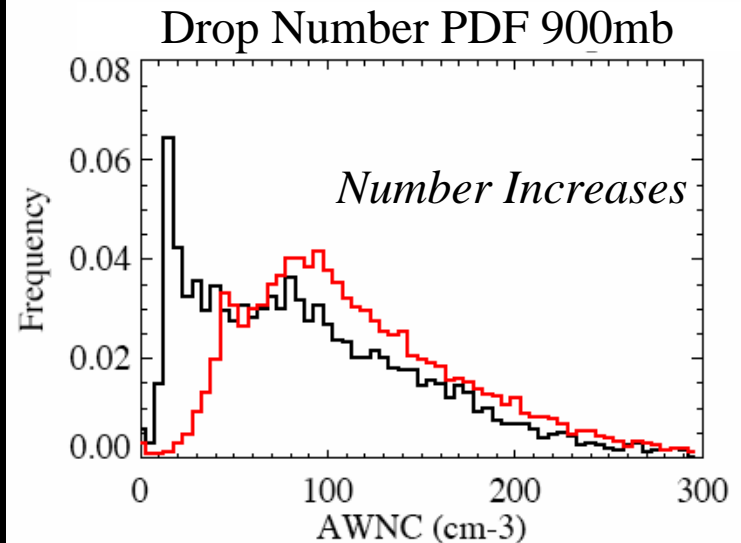
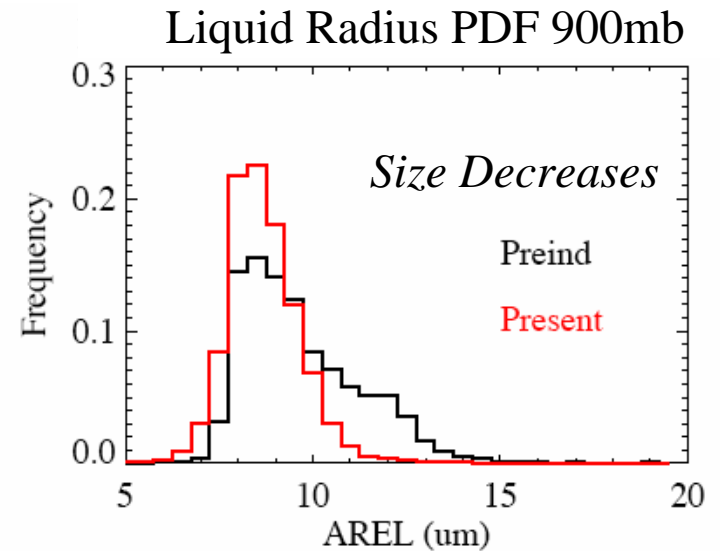


Lines indicate fits from Observations (Lowenthal, 2004)

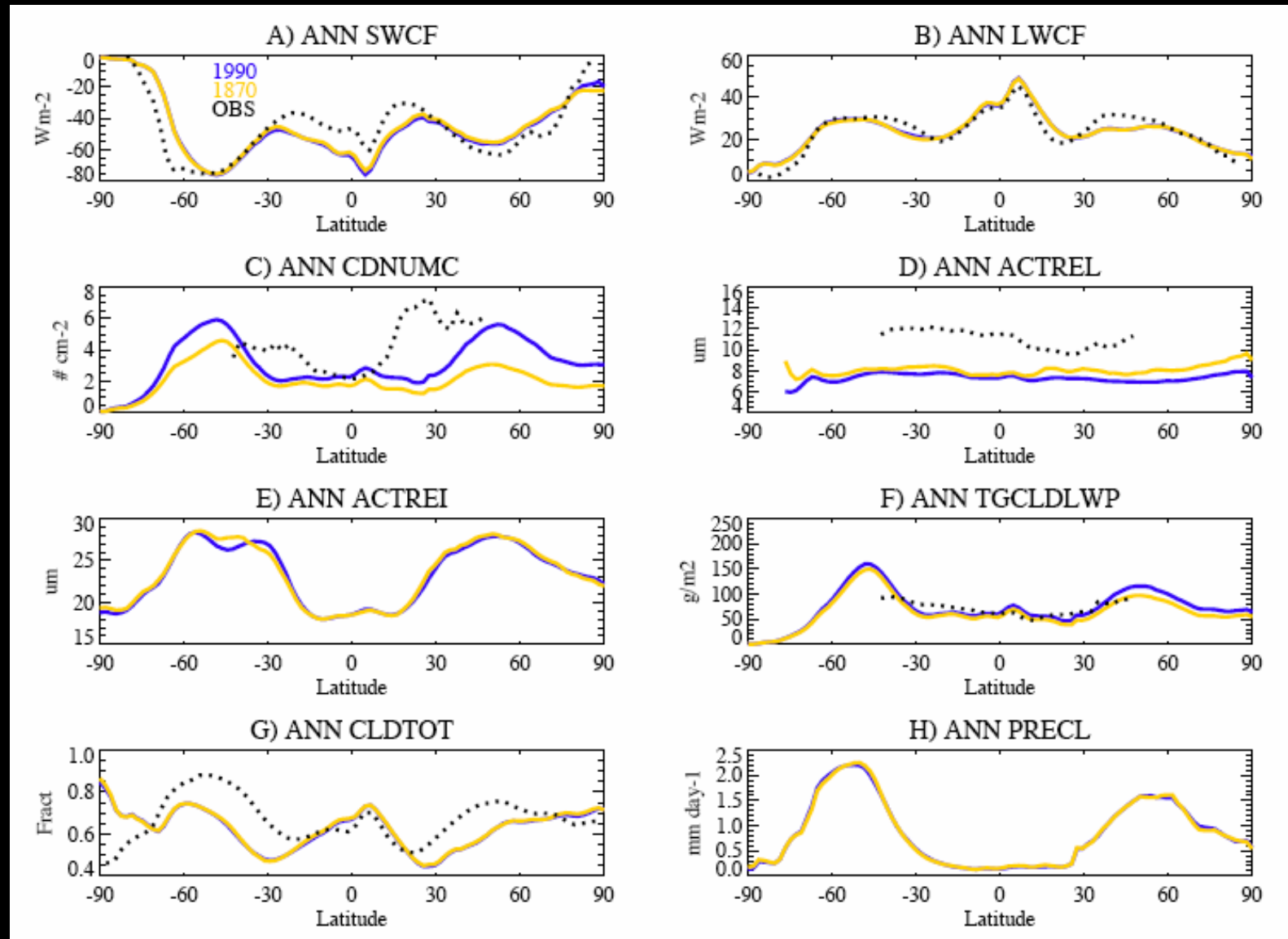
'Indirect' Effects

- Use New Prescribed Aerosols
- See differences in:
 - Radiative Forcing
 - Size and number
 - Liquid water path
- Changes to Radiative forcing (Wm^{-2}), using Ghan method:

Total	Direct	Indirect	Num-1st	Size-2nd
-3.0	-0.7	-2.3	-1.0	-1.3



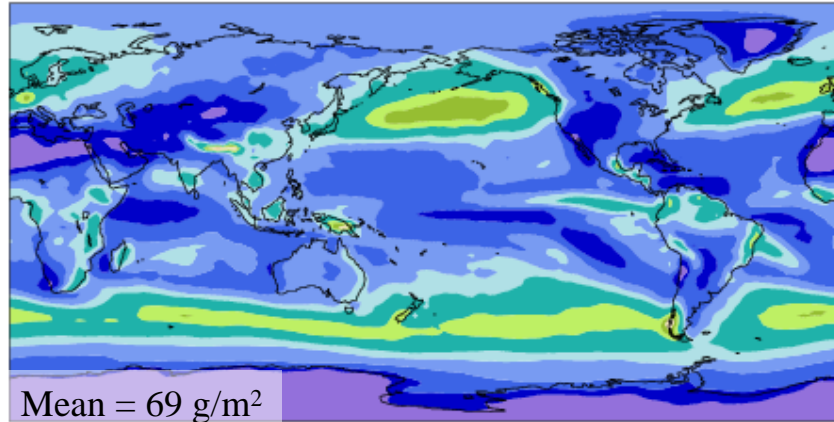
Global Effects



Change in Liquid water

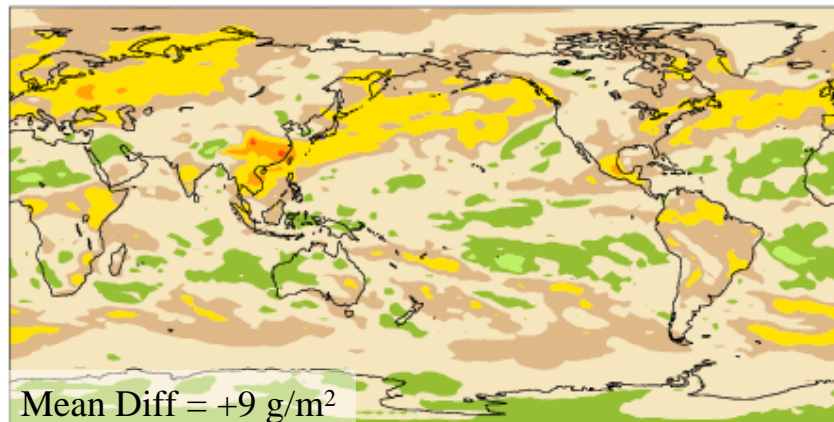
Preindustrial (1870)

Total grd-box cloud LWP mean = 68.77 g/m²



Present- Preindustrial

mean = 8.64 rmse = 12.83 g/m²



Largest changes in
Storm Tracks
(where LWP large)

Little change in
stratocumulus regions

Summary/Conclusions

- New scheme performs well
 - Reasonable drop size distribution
 - Reasonable number distribution
 - 2 paper submitted to J. Climate (copies available)
- Aerosols affect clouds
 - Sizes, Number, Liquid water path & Radiation
- Model ‘indirect’ effects are ‘large’
 - Issues with existing prescribed aerosols
- Next Steps
 - Analyze sensitivity to aerosols (with S. Ghan)
 - Ice Phase work (with X. Liu)