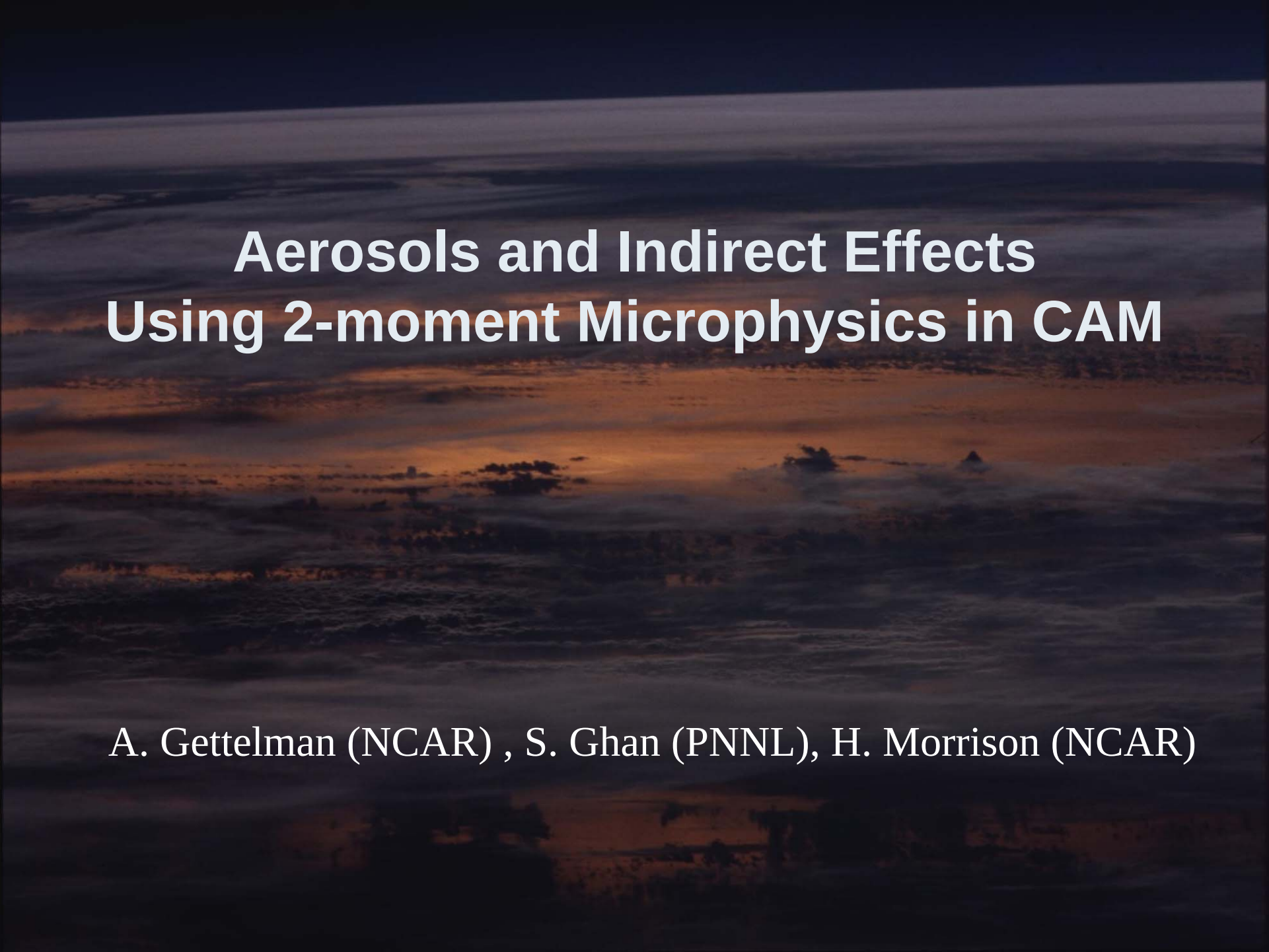
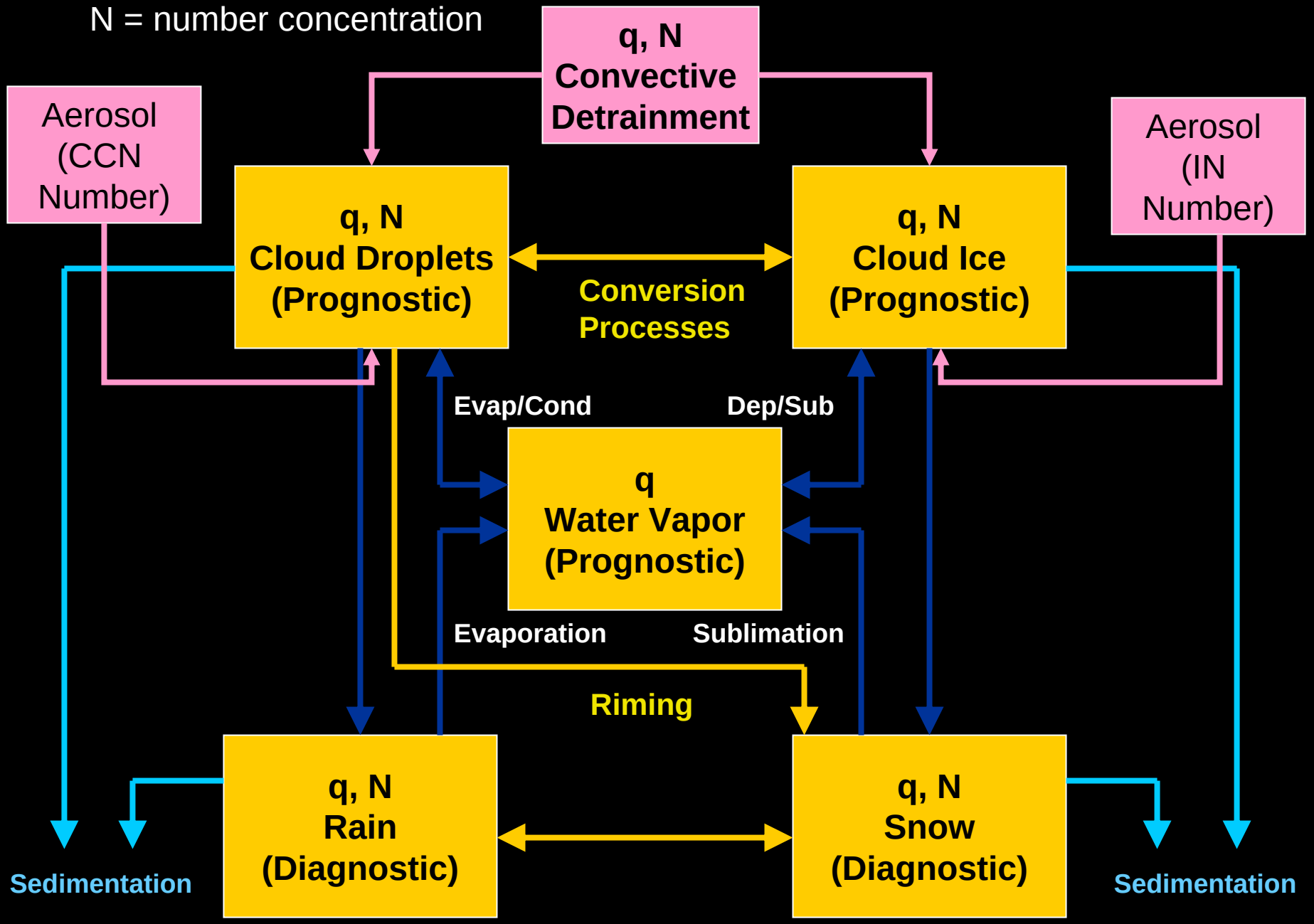


Aerosols and Indirect Effects Using 2-moment Microphysics in CAM

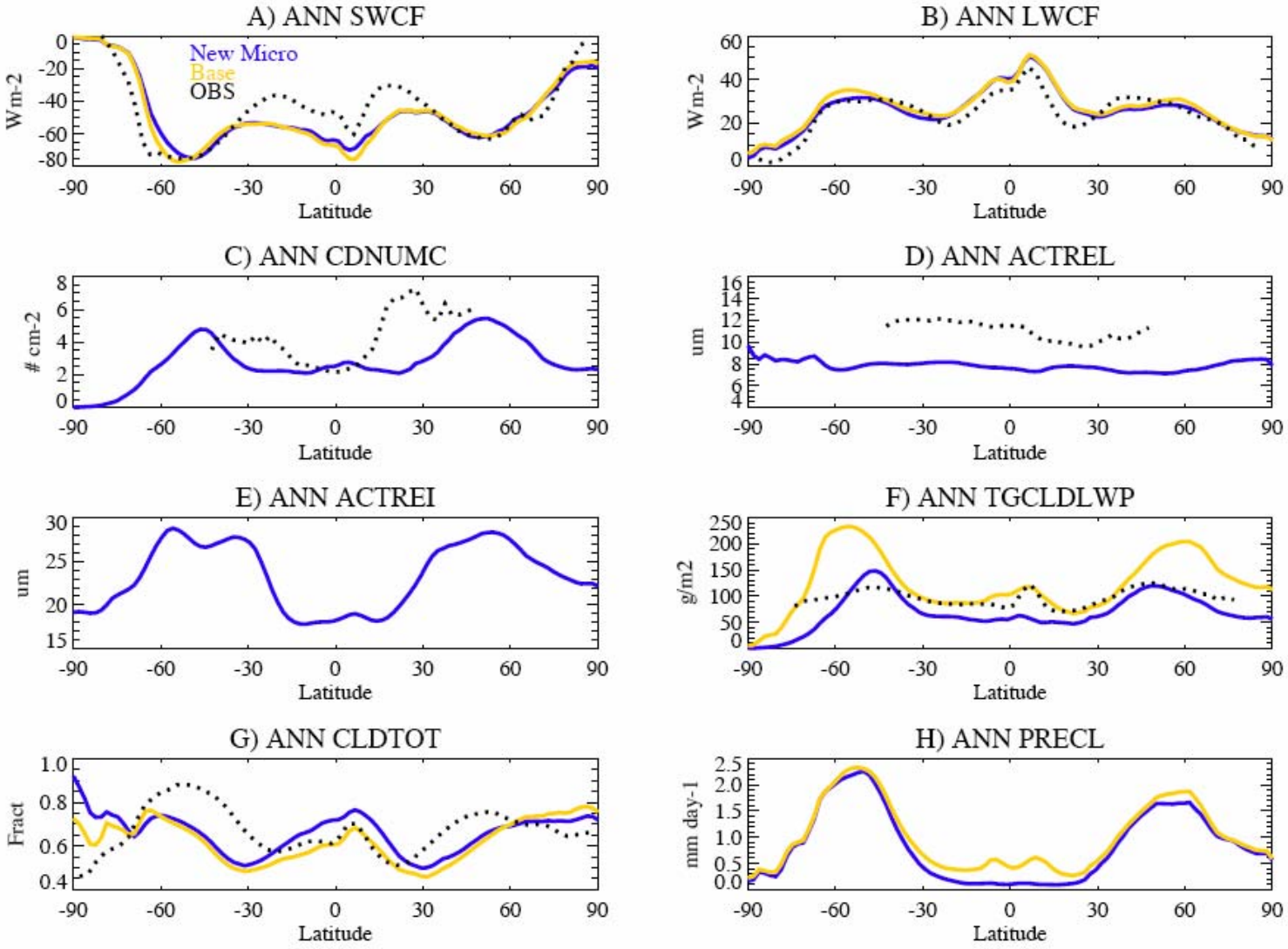
A. Gettelman (NCAR) , S. Ghan (PNNL), H. Morrison (NCAR)

Key features of the new scheme

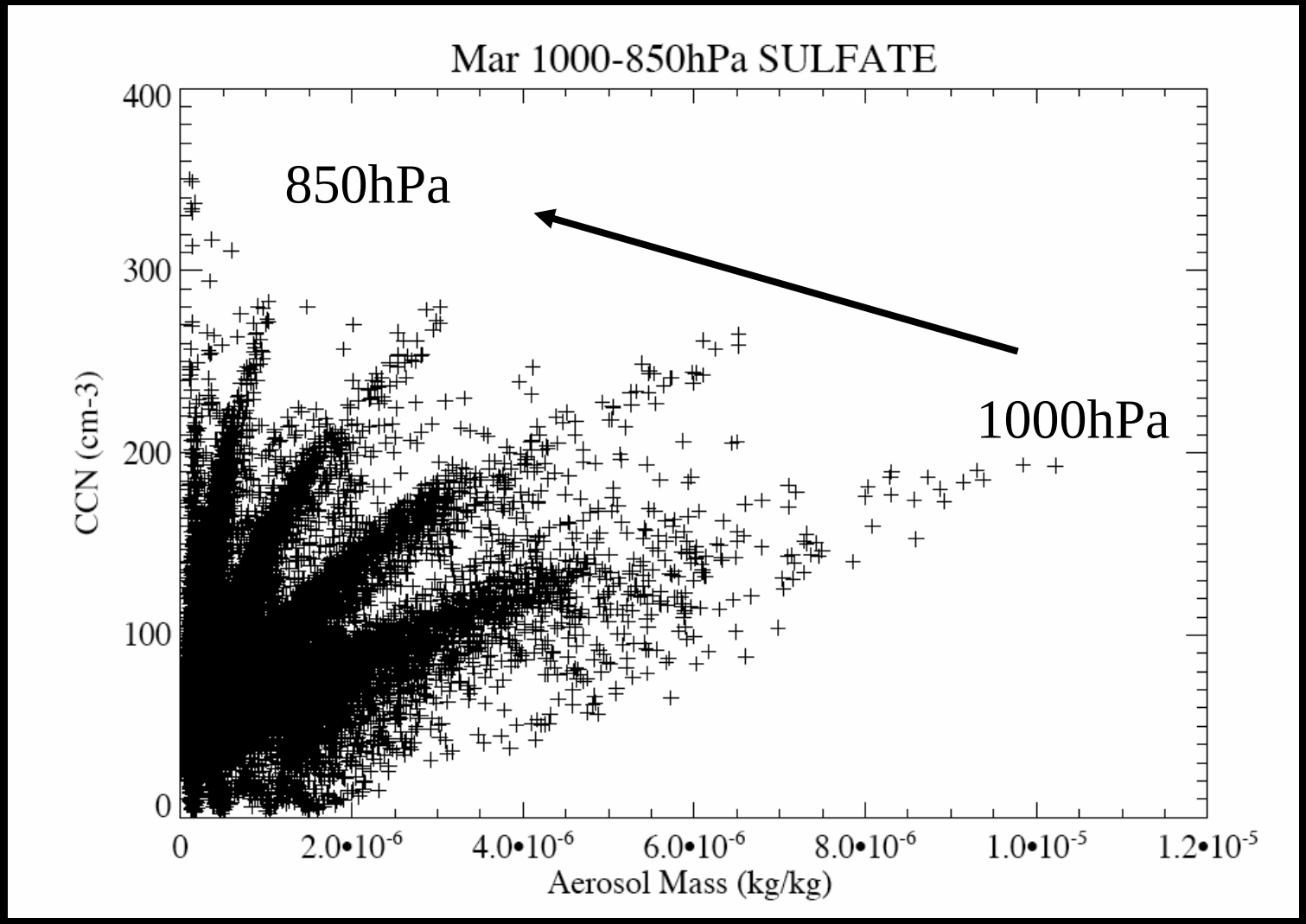
- Two-moment – predicts number concentrations and mixing ratios of cloud water and ice.
- Liquid/ice fraction determined by microphysical processes (Bergeron, heterogeneous freezing) instead of simple function of temperature.
- Coupled with aerosol by treating droplet nucleation (Abdul-Razzak and Ghan 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
q, N
Convective
Detrainment
Aerosol
(CCN
Number)
Aerosol
(IN
Number)
q, N
Cloud Droplets
(Prognostic)
q, N
Cloud Ice
(Prognostic)
Conversion
Processes
Evap/Cond
Dep/Sub
q
Water Vapor
(Prognostic)
Evaporation
Sublimation
Riming
q, N
Rain
(Diagnostic)
q, N
Snow
(Diagnostic)
Sedimentation
Sedimentation

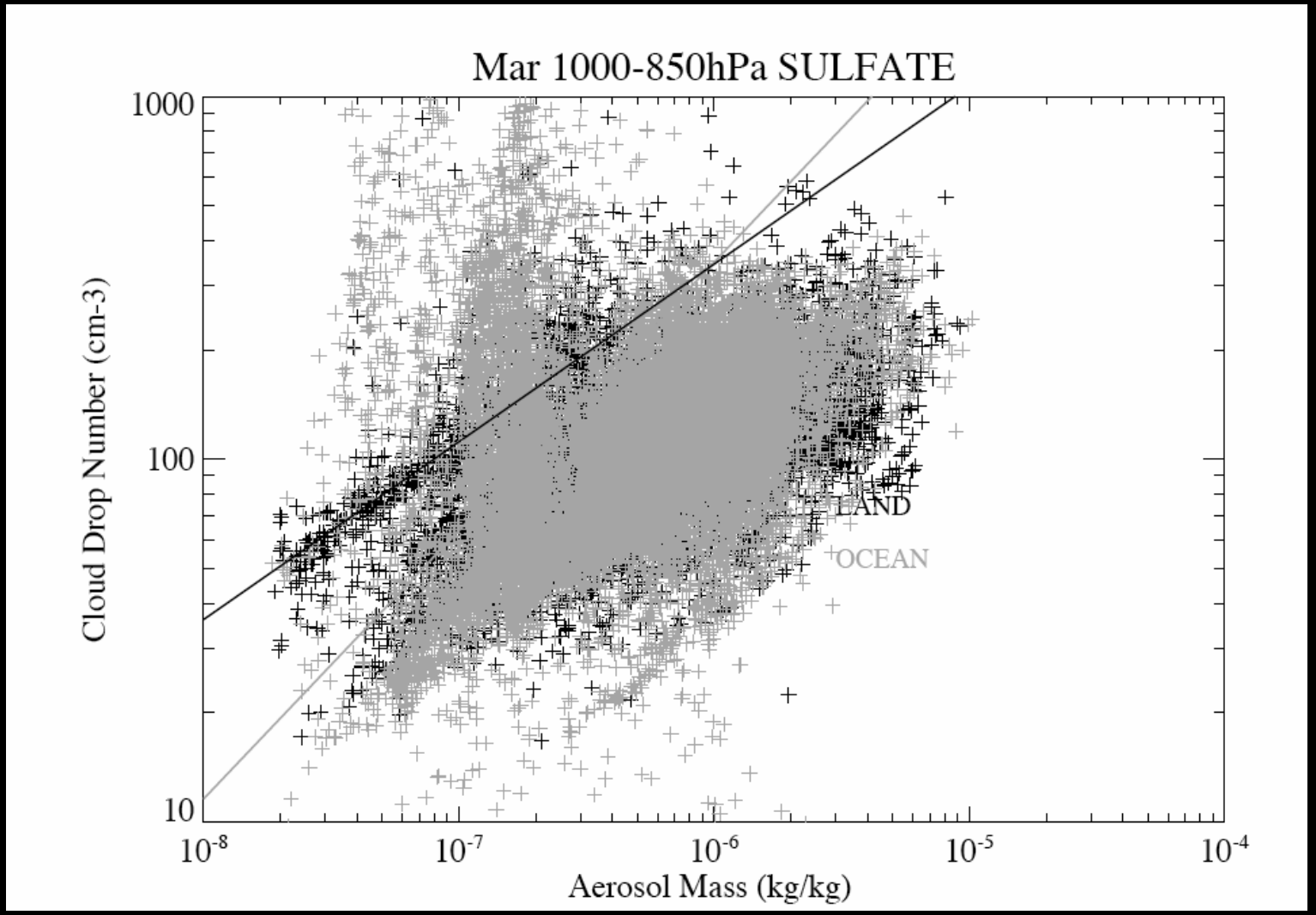
Scheme Performance Summary



Sulfate and CCN



Sulfate Nucleation

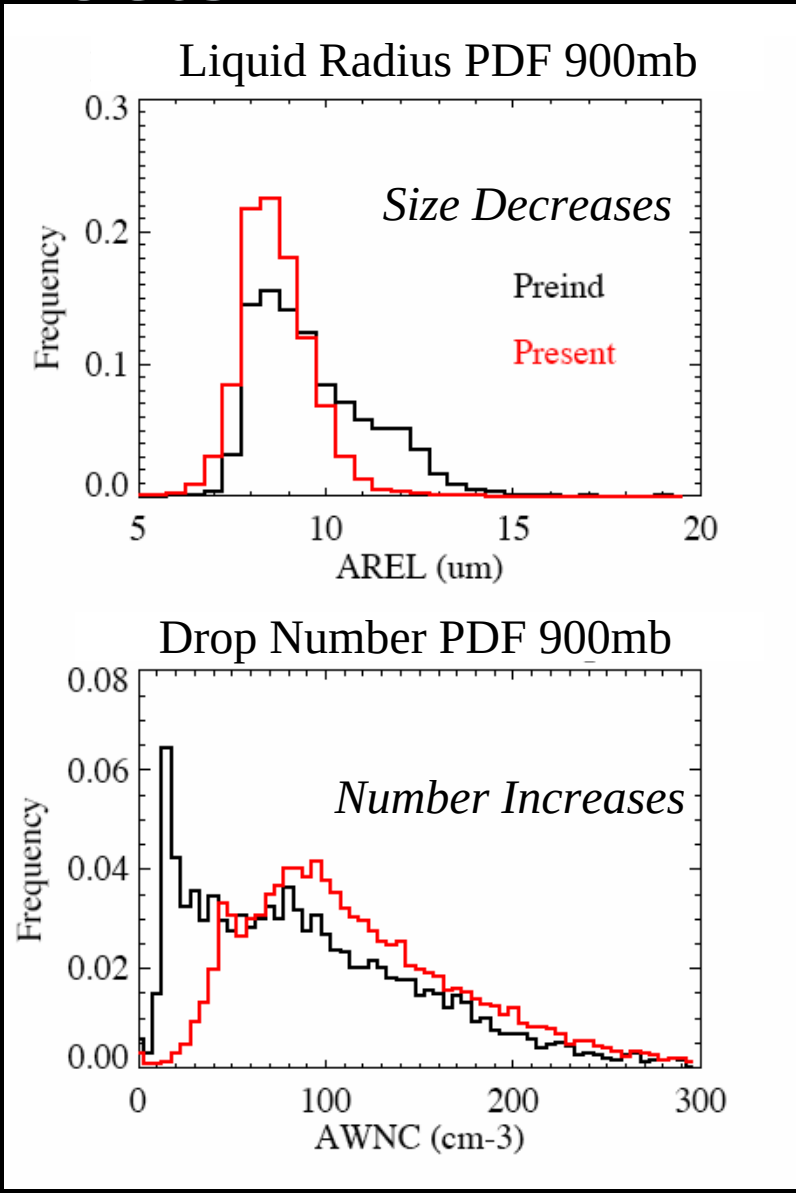


Lines indicate fits from Observations (Lowenthal, 2004)

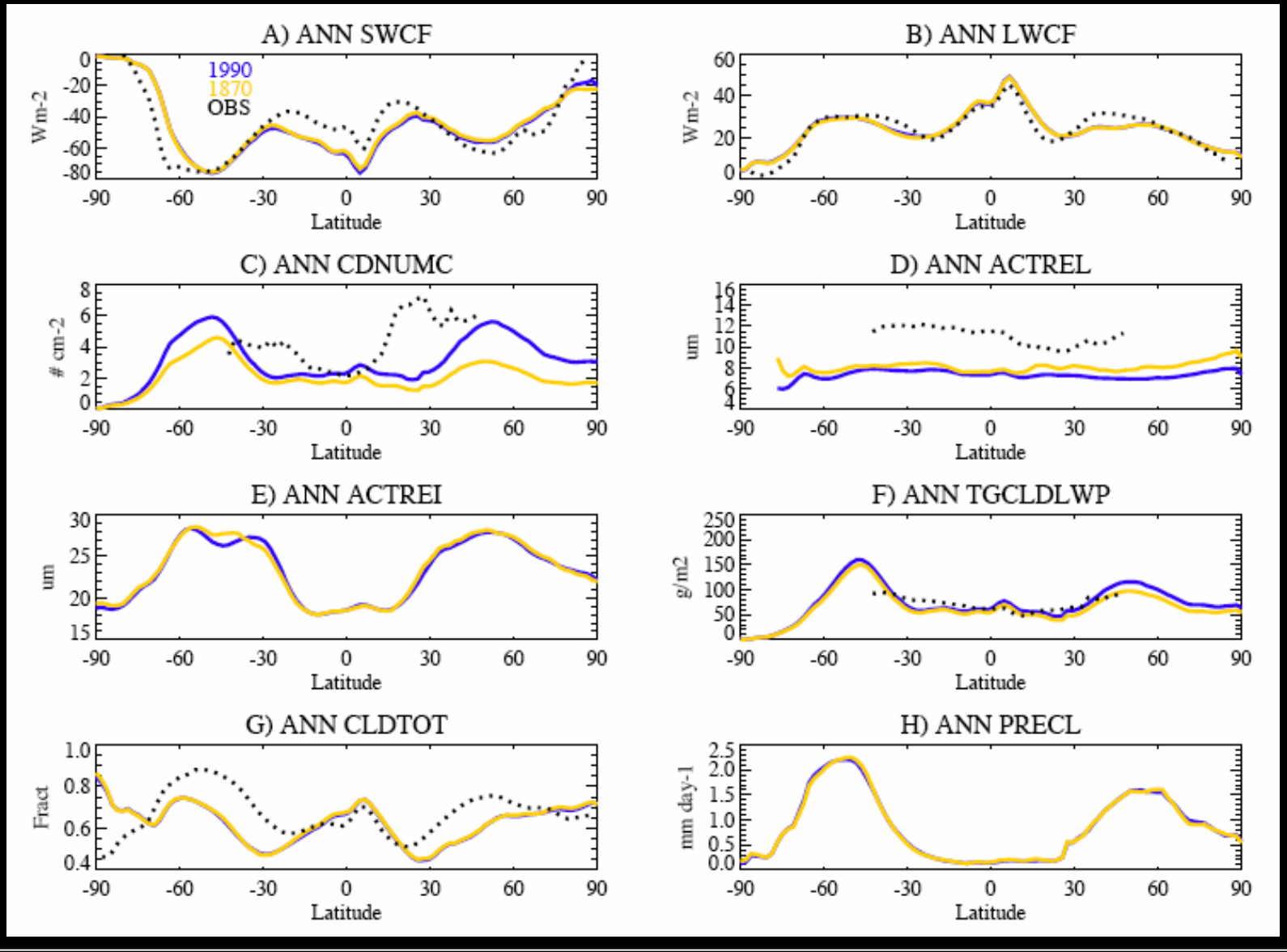
‘Indirect’ Effects

- 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

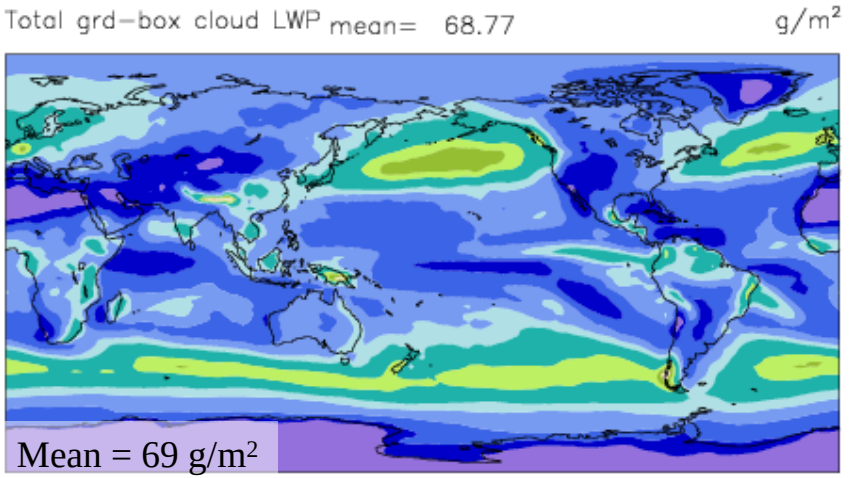


Change in Liquid water

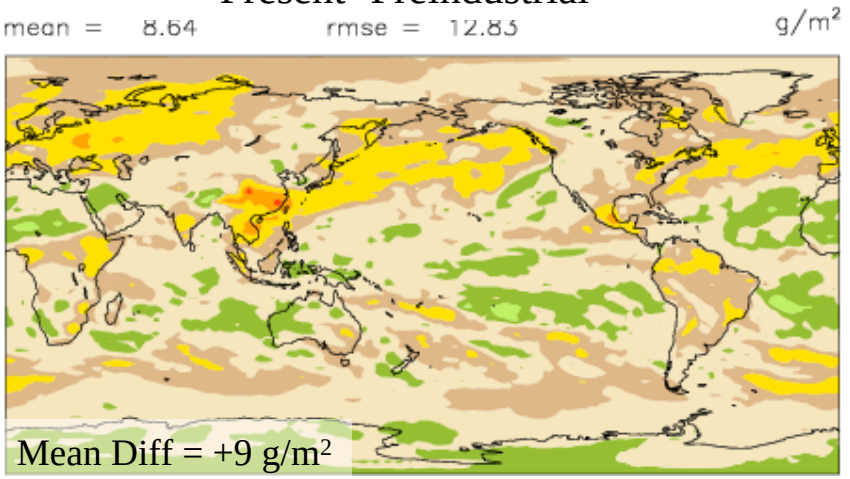
Largest changes in Storm Tracks (where LWP large)

Little change in stratocumulus regions

Preindustrial (1870)



Present- Preindustrial



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)