Testing cloud microphysical parameterizations in CAM5 with ISDAC observations

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CAM5 Cloud Microphysical Scheme

▶ Two-moment stratiform microphysics (*Morrison & Gettelman 2008; Gettelman et al. 2010*)

- ❑ Prognostic '*cloud mass*' and '*cloud droplet number*' (Γ-function size distributions)

- ❑ Diagnostic 'precipitation mass' and 'precipitation droplet number'

▶ Cloud liquid droplet activation (*Abdul-Razzak & Ghan 2002*)

▶ Cloud ice crystal nucleation (*Liu & Penner 2005*; *Liu et al. 2007*)

- ❑ Homogeneous freezing on sulfate & heterogeneous nucleation on dust in cirrus (ice) clouds

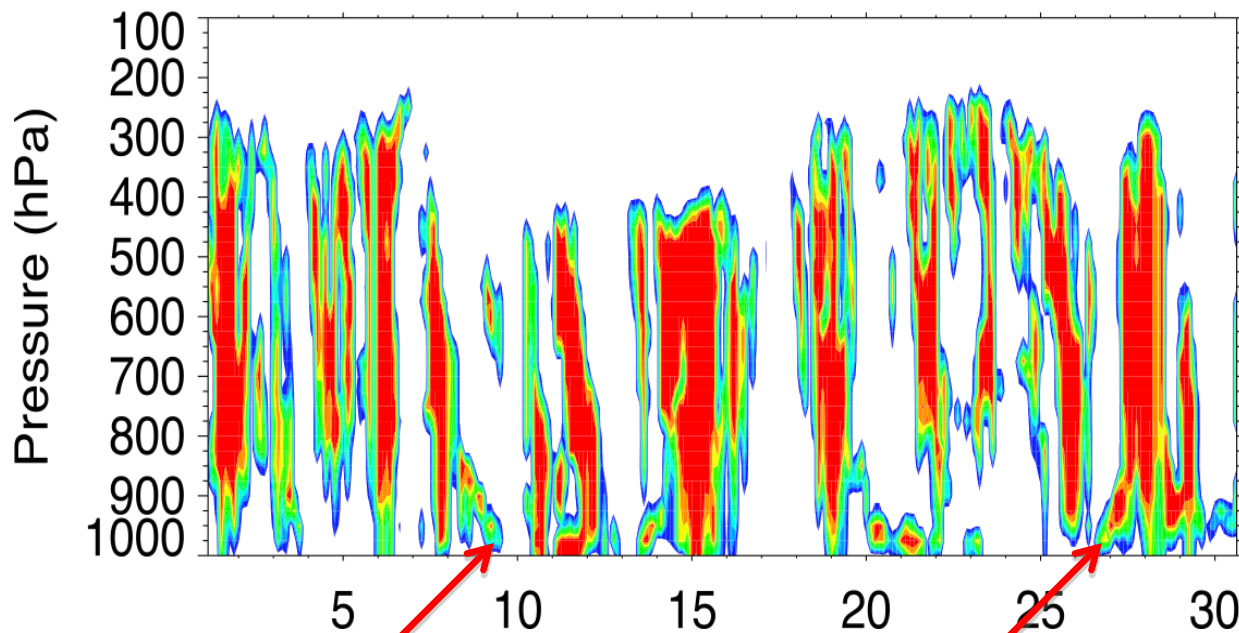- ❑ Meyers et al. (1992) for deposition/condensation in mixed-phase clouds

Morrison & Gettelman (2008)

q = mixing ratio
N = number concentration
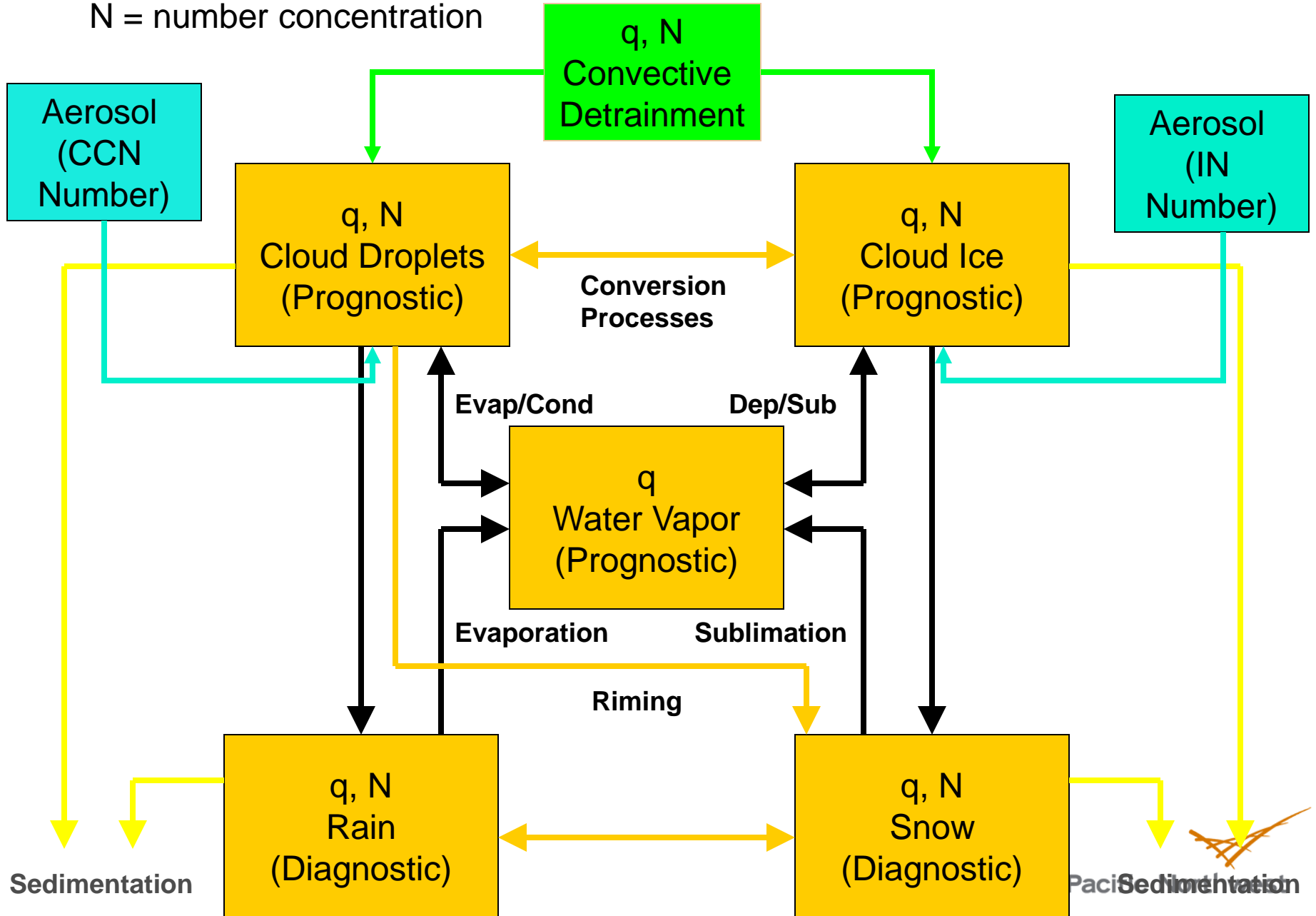
DOE Cloud-Associated Parameterization Testbed (CAPT) Forecasts

(ISDAC, April 2008)

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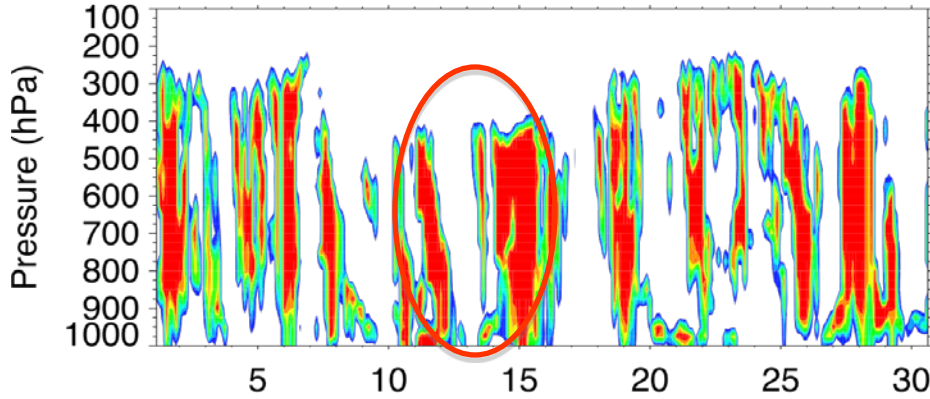# The ARM NSA Indirect and Semi-Direct Aerosol Campaign (ISDAC)
April, 2008

Radar Clouds at Barrow

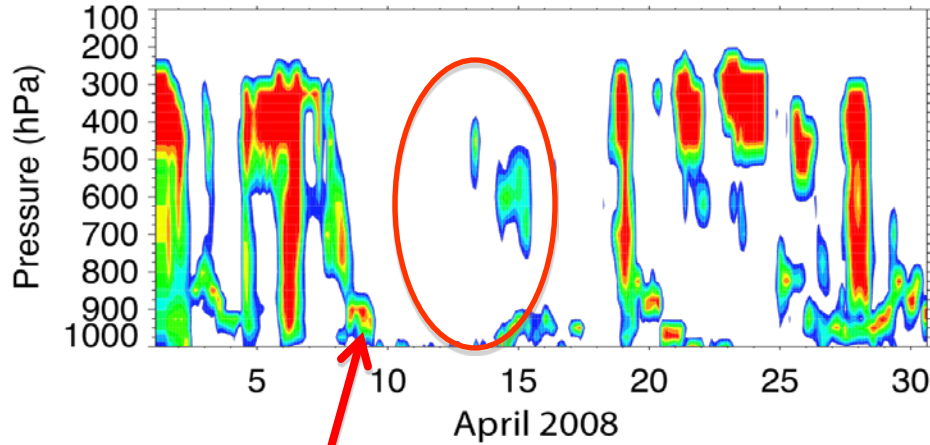April 8-9th and 26th: single-layer mixed-phase boundary layer clouds

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Cloud Fraction

(a) ARSCL (b) CNTL (c) Phillips (d) ECMWF
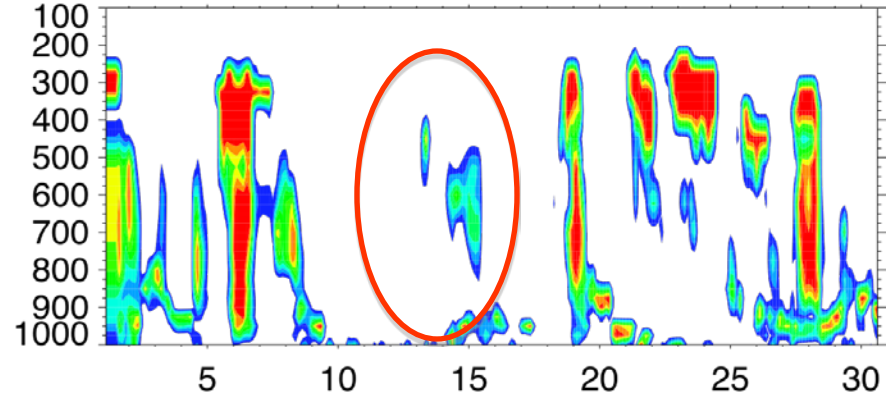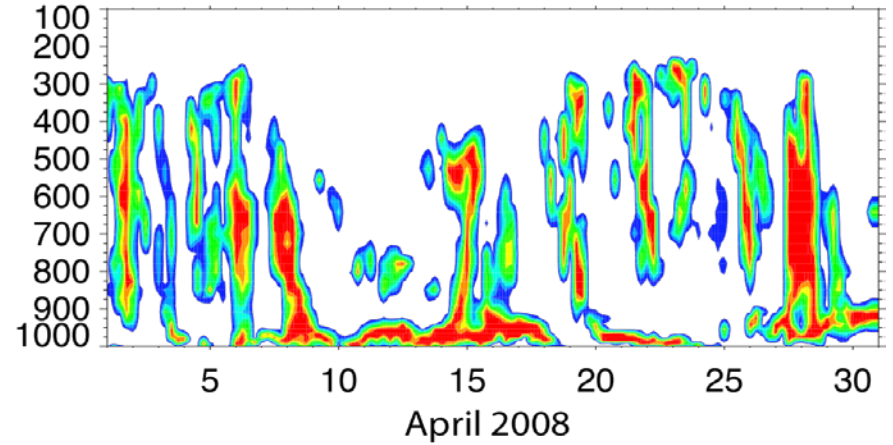
April 2008

12-36hr forecasts: fewer IN → larger cloud fraction

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Liquid water

(a) CNTL
Meyers et al. (1992)

(b) Phillips
Phillips et al (2008)

(c) ECMWF

April 2008

4   10   50   90   130   180
1   7   30   70   110   150
mg/kg
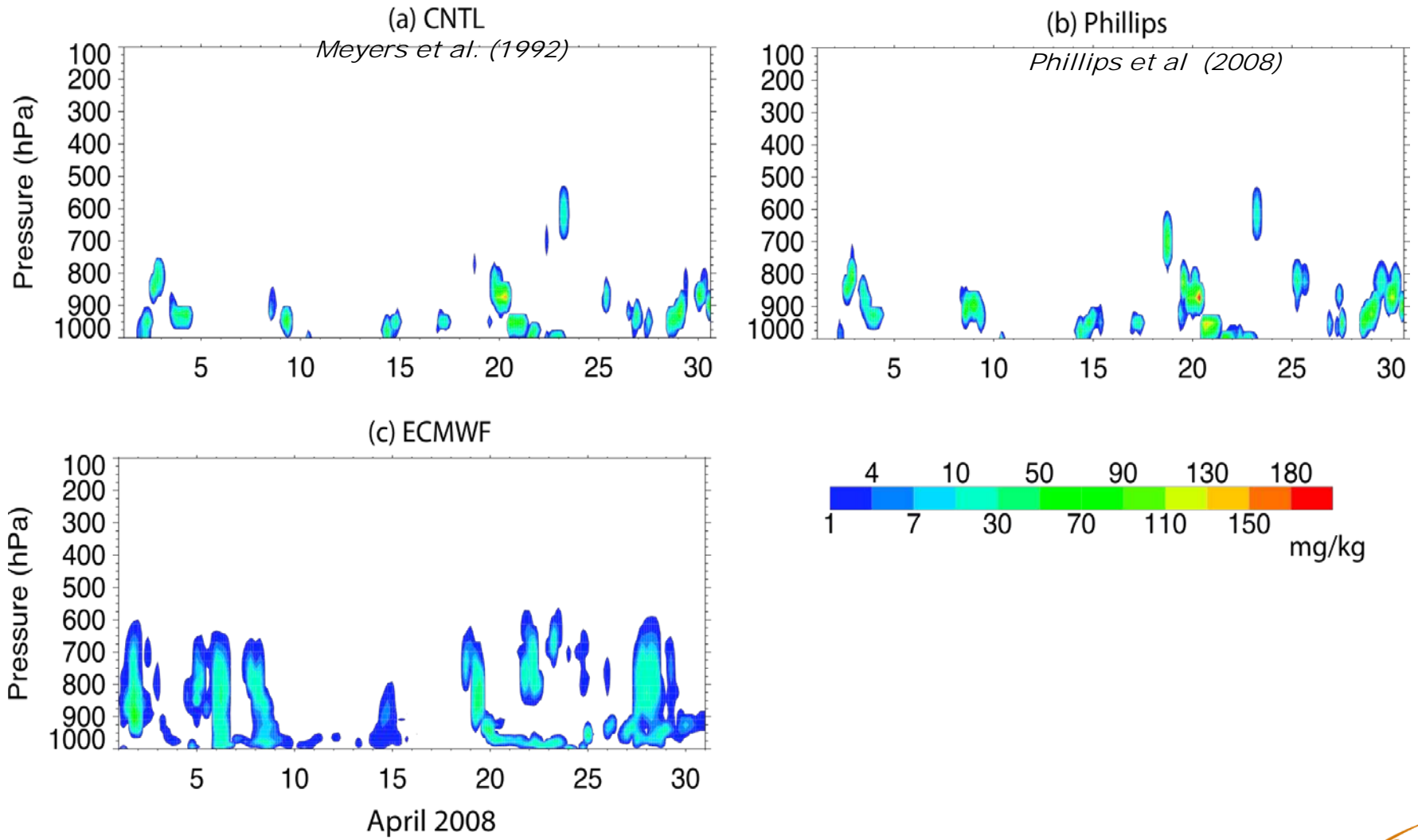
12-36hr forecasts: fewer IN → more Liquid
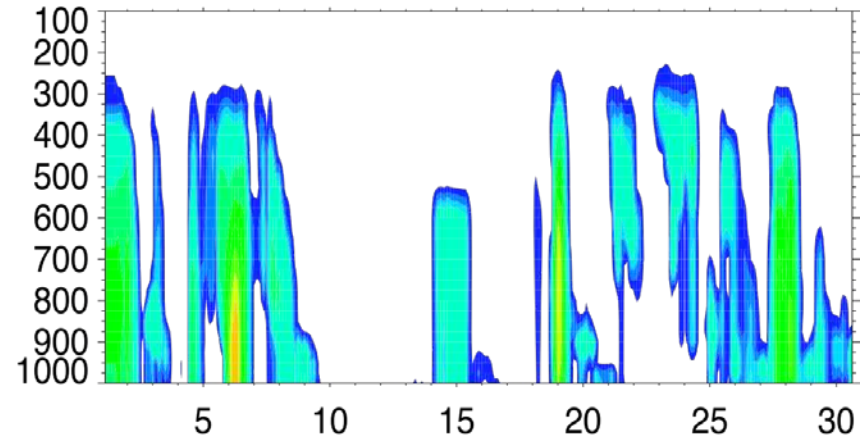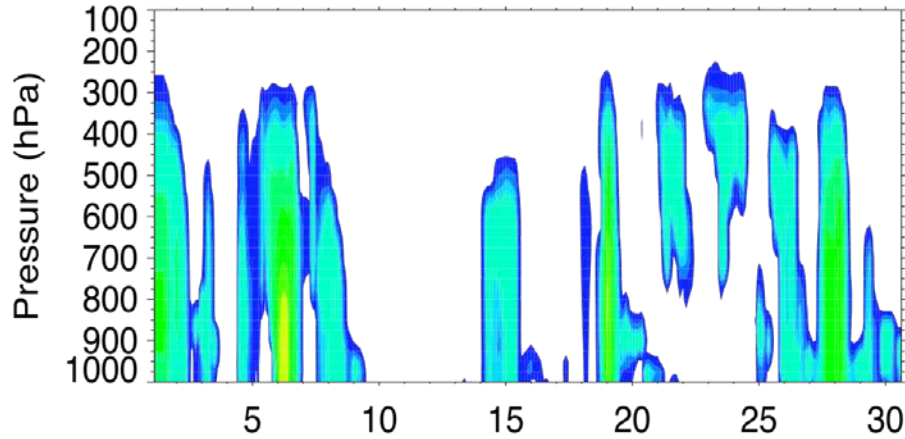
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Cloud Ice (+ Snow) Water
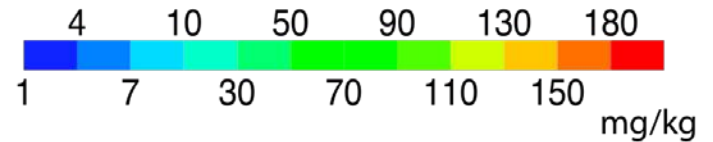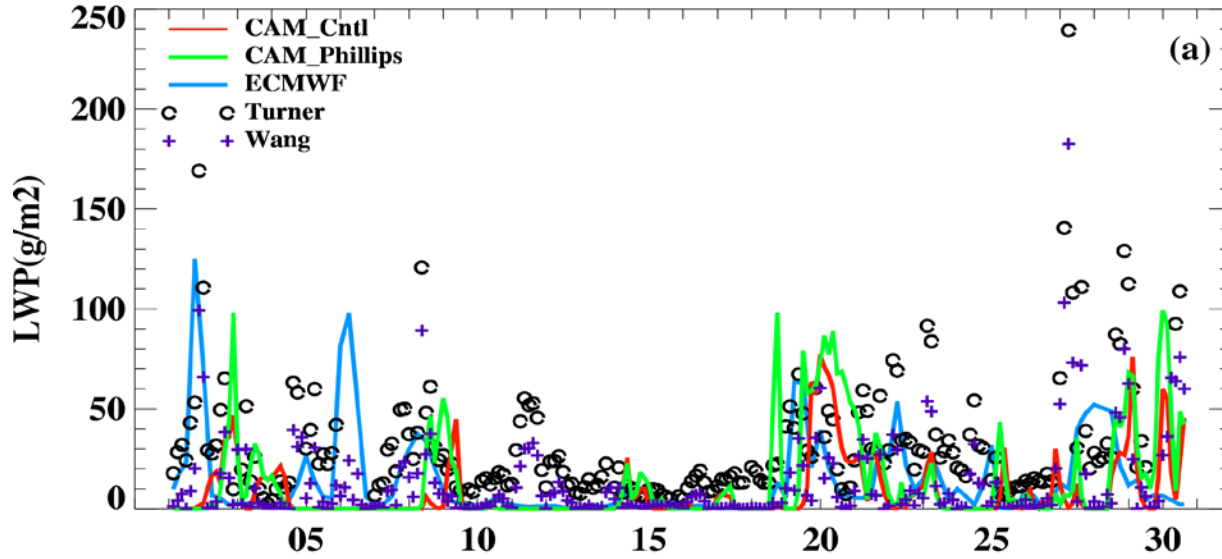

Meyers et al. (1992)
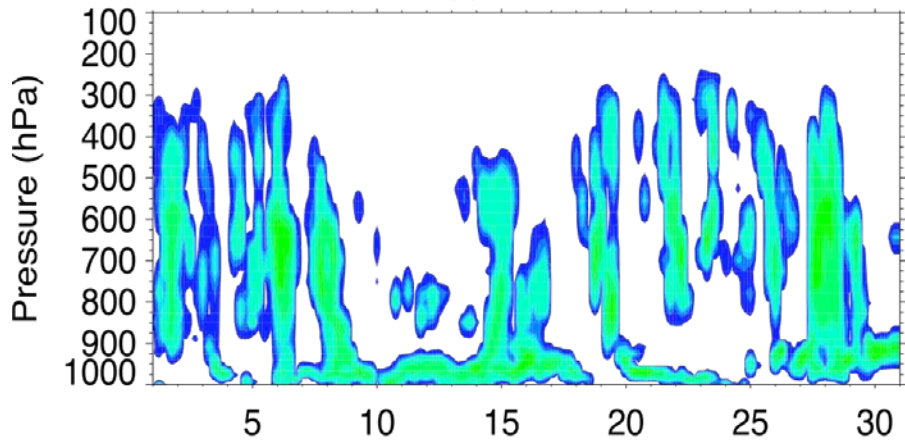
Phillips et al (2008)

Cloud Liquid Water Path

Liquid Water Path

Cloud Ice Water Path

Ice Water Path

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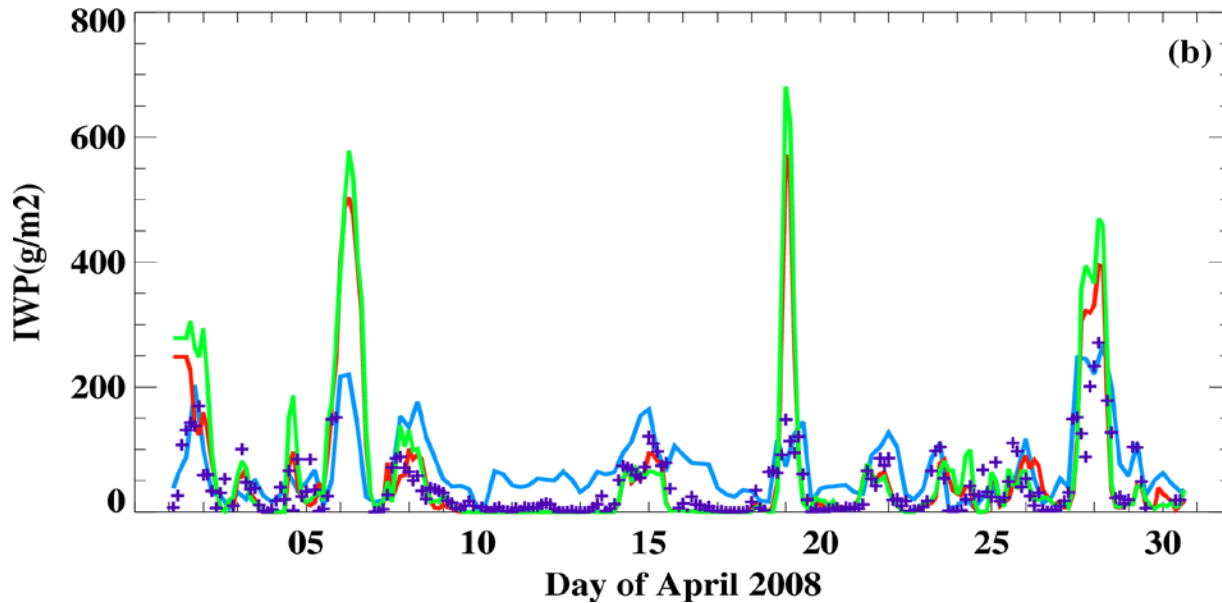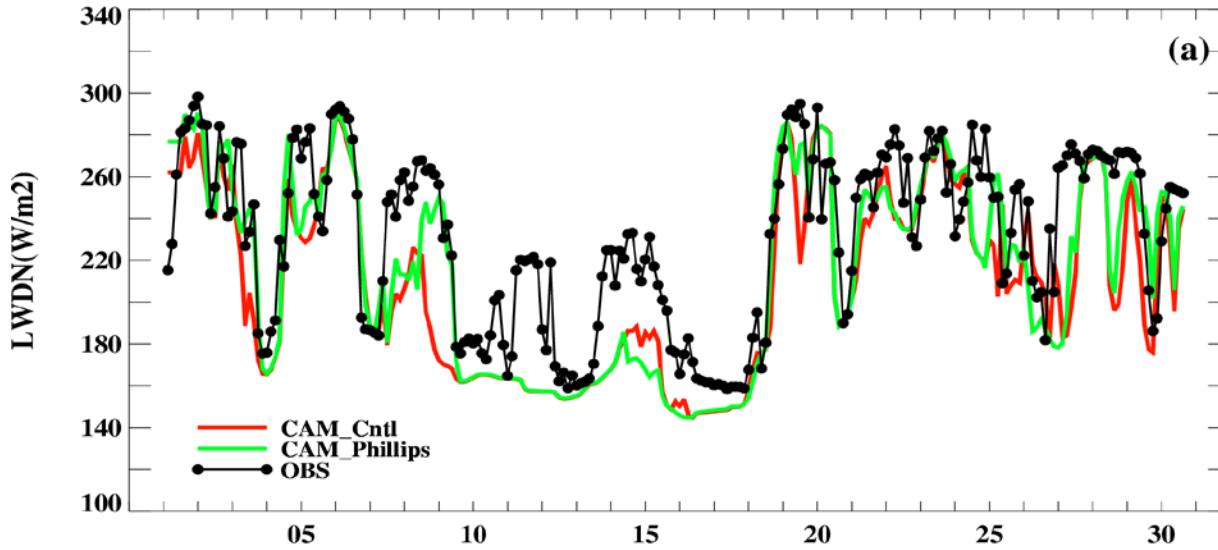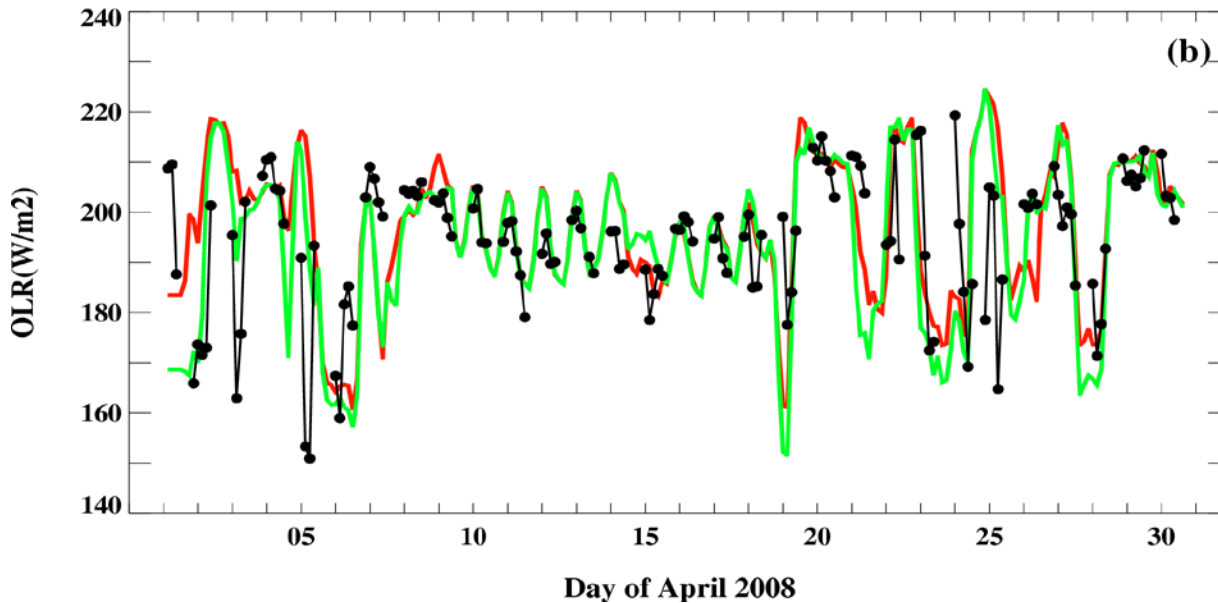
Impact on LW radiation

Surface Downward Longwave Radiative Fluxes

Downward LW

TOA Outgoing Longwave Radiative Fluxes

Outgoing LW

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Summary

- **CAM5 simulates single-layer boundary-layer cloud fraction reasonably well. However, it may underestimate multi-layer clouds.**

- **CAM5 underestimates LWC and LWP, while total ice water content and IWP relatively well predicted.**

- **CAM5 underestimates downward LW flux at surface by 20 W/m2.**