Testing cloud microphysics schemes in CAM5 During M-PACE and ISDAC

Xiaohong Liu[1],S. Xie[2], J. Boyle[2], S. Klein[2], X. Shi[1], S. Ghan[1], P. DeMott[3], A.J. Prenni[3] [1]PNNL, [2]LLNL, [3]CSU (email: xiaohong.liu@pnl.gov)

Pacific Northwest NATIONAL LABORATORY

Objectives

- Evaluate cloud microphysics schemes in NCAR Community Atmospheric Model version 5 (CAM5) with ARM M-PACE and ISDAC data
- Investigate effects of ice nuclei (IN) parameterization on mixed-phase clouds and climate forcing in CAM5

Conclusions

- CAM5 successfully reproduces mixed-phase cloud microphysics structures in the Arctic. Predicted liquid amount is too small and total ice amount is dominated by snow.
- IN number can significantly impact mixed-phase cloud microphysics, cloud radiative forcing and global climate.

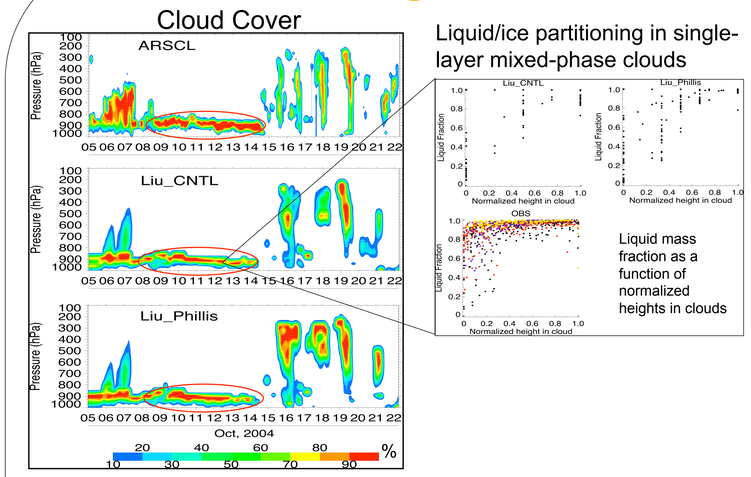
M-PACE vs. ISDAC

- M-PACE: The ARM NSA Mixed-Phase Arctic Cloud Experiment in October, 2004 (Arctic clean season)
- ISDAC: Indirect and Semi-Direct Aerosol Campaign and ISDAC in April, 2008 (Arctic polluted season)
- ARM data: Cloud fraction – ARSCL; Radar/lidar retrievals; in-situ aircraft

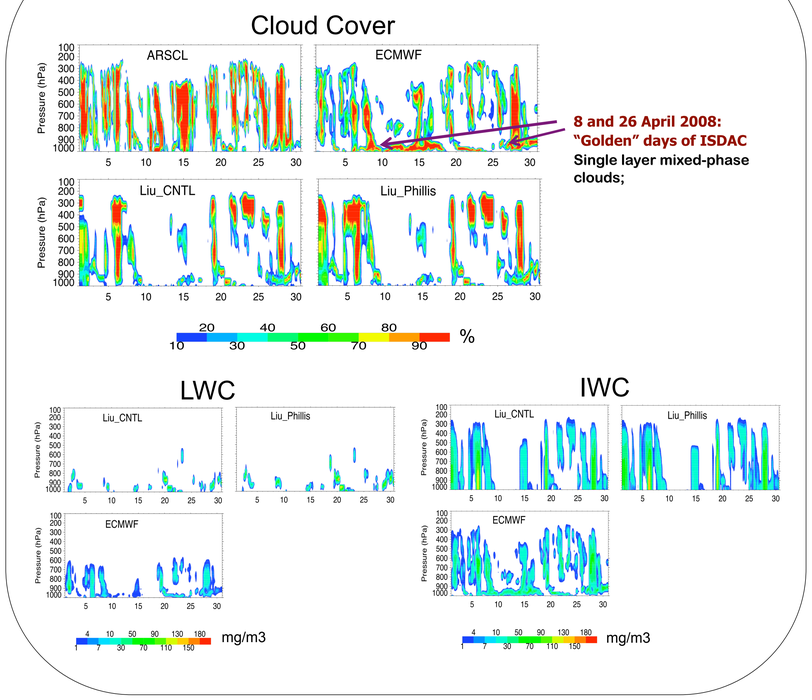
CAM5

- New Physics: MG cloud microphysics; PNNL modal aerosol module (MAM); UW shallow cumulus and cloud macrophysics; RRTM radiation.
- Test CAM5 (camdev32_cam3_6_57) under DOE CCPP-ARM Parameterization Testbed (CAPT) and under single column model (SCM)
- Test different IN parameterizations:
  - Liu-CNTL: Meyers et al. (1992)'s
  - Liu-Phillips: Philips et al. (2008)'s
  - Liu-DeMott: DeMott et al. (2009)'s

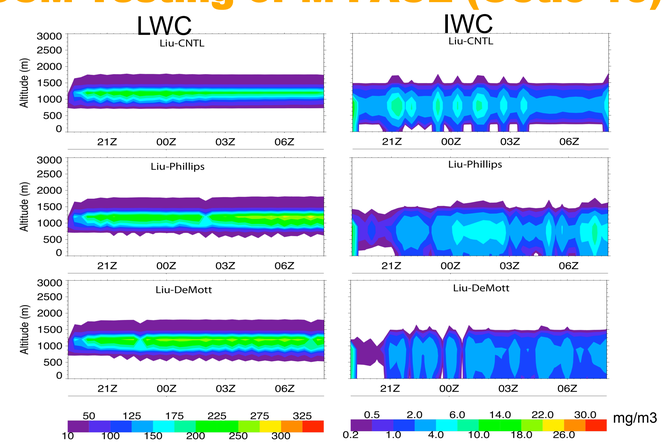
CAPT Testing of M-PACE



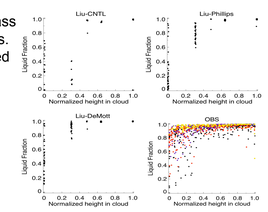
CAPT Testing of ISDAC



SCM Testing of M-PACE (Oct.9-10)



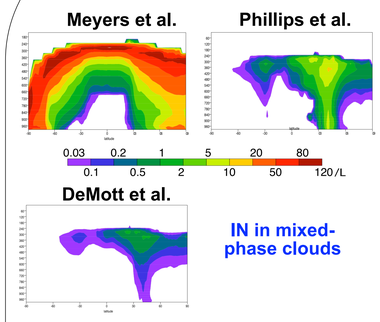
Liquid mass fraction vs. normalized cloud heights



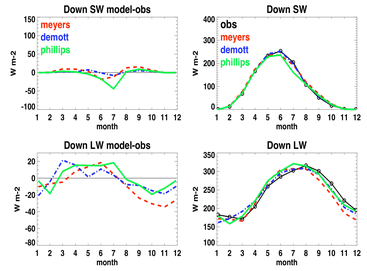
Comparison with measurements

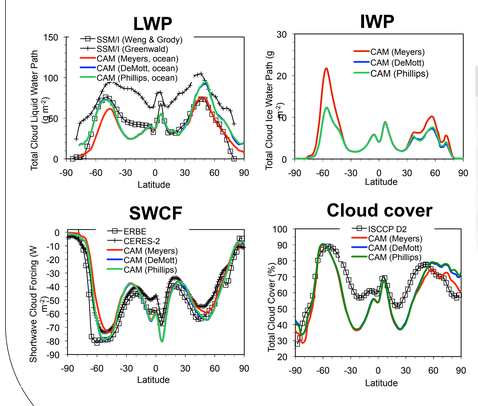
	Liu-CNTL	Liu-Phillips	Liu-DeMott	Observation
LWC (g/m3)	0.175-0.2	0.175-0.275	0.2-0.275	0.175±0.120; 0.154±0.116
IWC (g/m3)	0.002-0.01	0.002-0.006	0.001-0.004	0.015±0.032; 0.006±0.006
Ni (L^{-1})	1-5	0.1-0.2	0.05	0.16 (CFDC)
NI (cm^{-3})	30-50	30-50	30-50	30-40

Climate Forcing with CAM5



Radiative Fluxes at Barrow (ARM)





Global annual means

	Meyers	DeMott	OBS
LWP, g m^{-2}	40.5	45.6	48 (W&G, ocn) 79 (Greenwald, ocn)
IWP, g m^{-2}	5.6	4.5	
SWCF, W m^{-2}	-49.5	-51.9	-54.2 (ERBE) -47.1 (CERES2)
LWCF, W m^{-2}	19.2	20.2	30.4 (ERBE) 29.9 (CERES2)
FSDS, W m^{-2}	186.4	183.5	
CLDTOT, %	55.8	57.2	66.8 (ISCCP)

ΔCF = -1.4 W/m²

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ARM Atmospheric Radiation Measurement

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