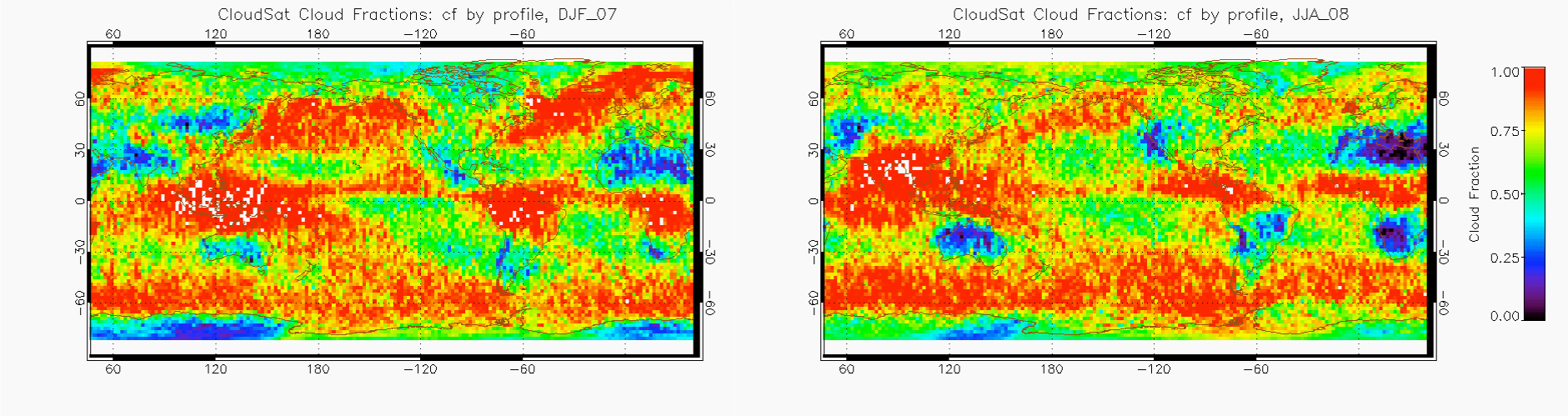
Evaluation of CAM candidates for CCSM4 with satellite cloud and radiation datasets

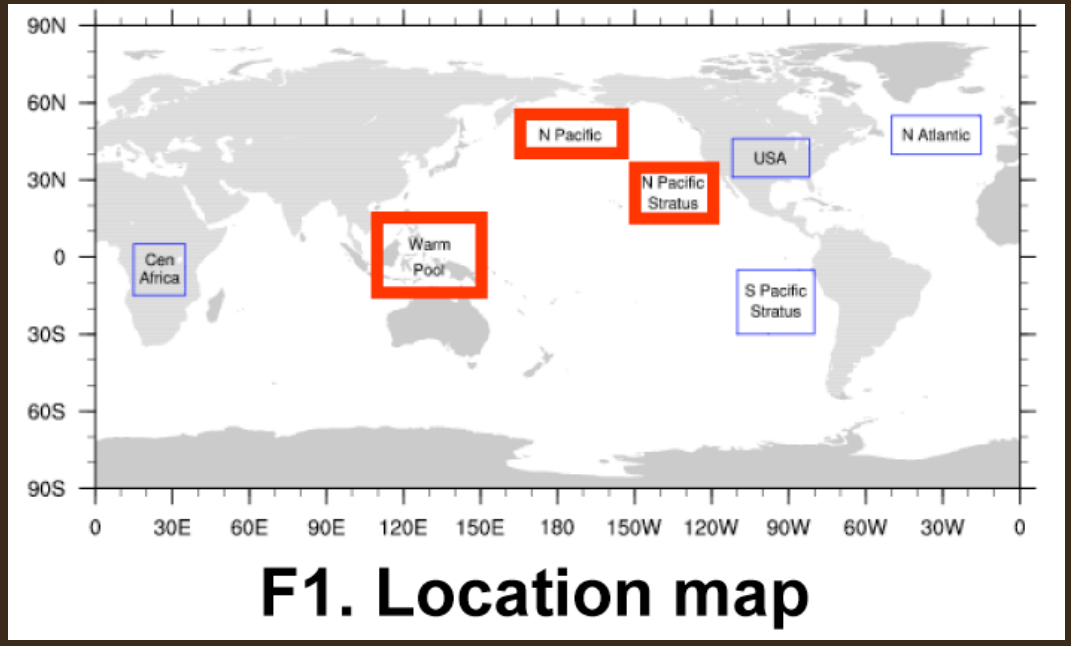
Jen Kay, Andrew Gettelman (NCAR)

Yuying Zhang (LNNL)



more plots at http://www.cgd.ucar.edu/cms/jenkay/images/CloudSatClouds.htm

Key regimes for model evaluation



F1. Location map

Observations	**Warm Pool**		**N. Pacific Stratus**		**N. Pacific**	
	DJF	*JJA*	*DJF*	*JJA*	*DJF*	*JJA*
CLDHGH	86	71	36	15	30	54
CLDLOW	44	43	58	52	78	53
CLDHGH:CLDLOW	1.9	1.7	0.6	0.3	0.4	1.0
CLDTOT	93	85	76	64	88	83
OUTLW - clear	285	286	284	289	247	263
NETSW - clear	372	350	255	410	112	395
LWCF	58	46	34	15	39	33
SWCF	-66	-56	-46	-69	-33	-136

T1. CloudSat+CALIOP cloud fractions, CERES2 TOA radiative fluxes.

Candidate models for CCSM4 from Rich/Cecile late last week

1) CAM track5

coupled run = b40.beta09_cloud.u37_b40, yrs 5-10

MG microphysics, RRTM, UW PBL/ShCu, New Macrophysics, prognostic MAM

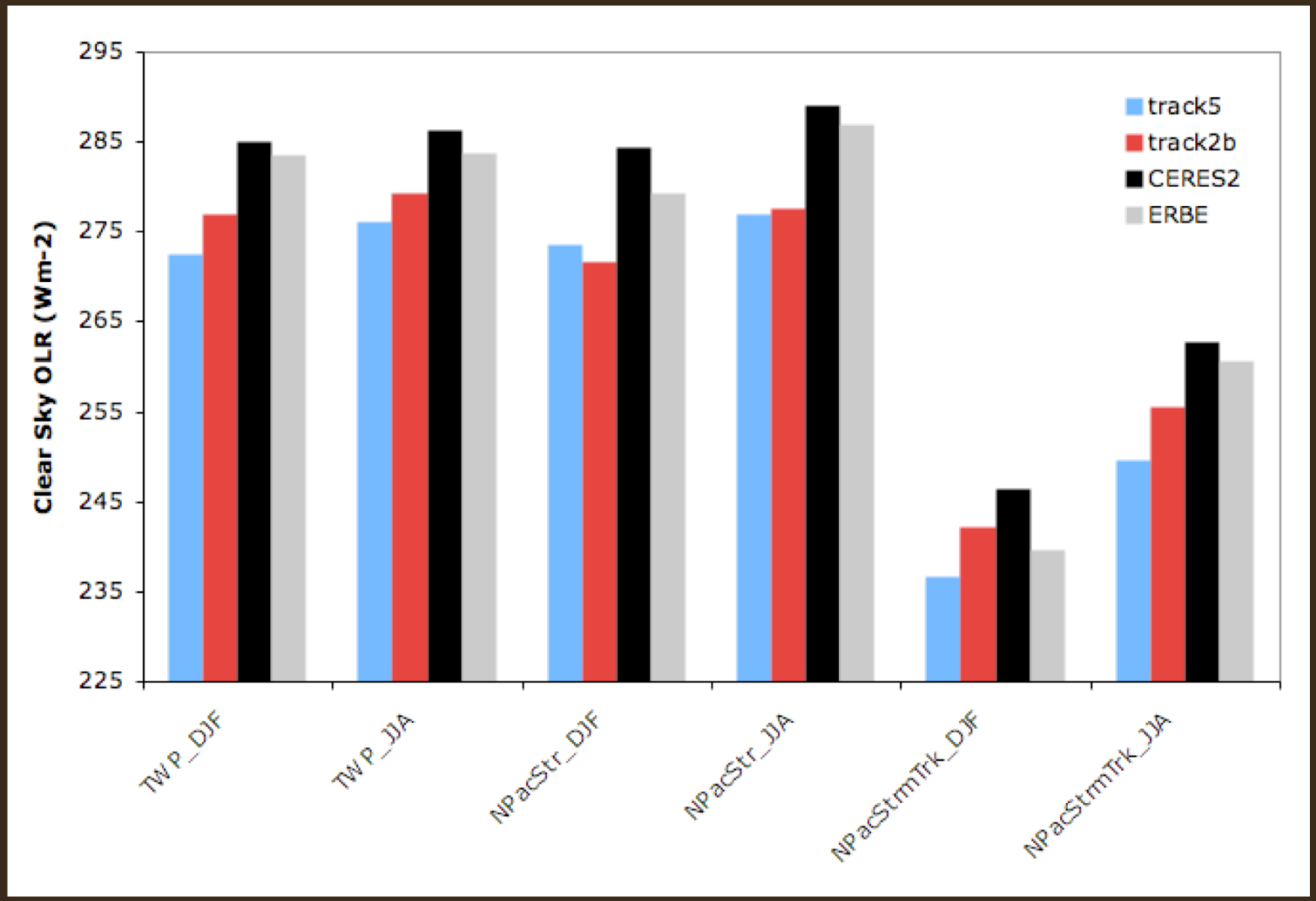
2) CAM track2b (with latest bug fix)

coupled run = 40.beta05_cam36.progbam06, yrs 5-10

MG microphysics, CAMRT, HB PBL and Hack sh/cu, BAM prognostic

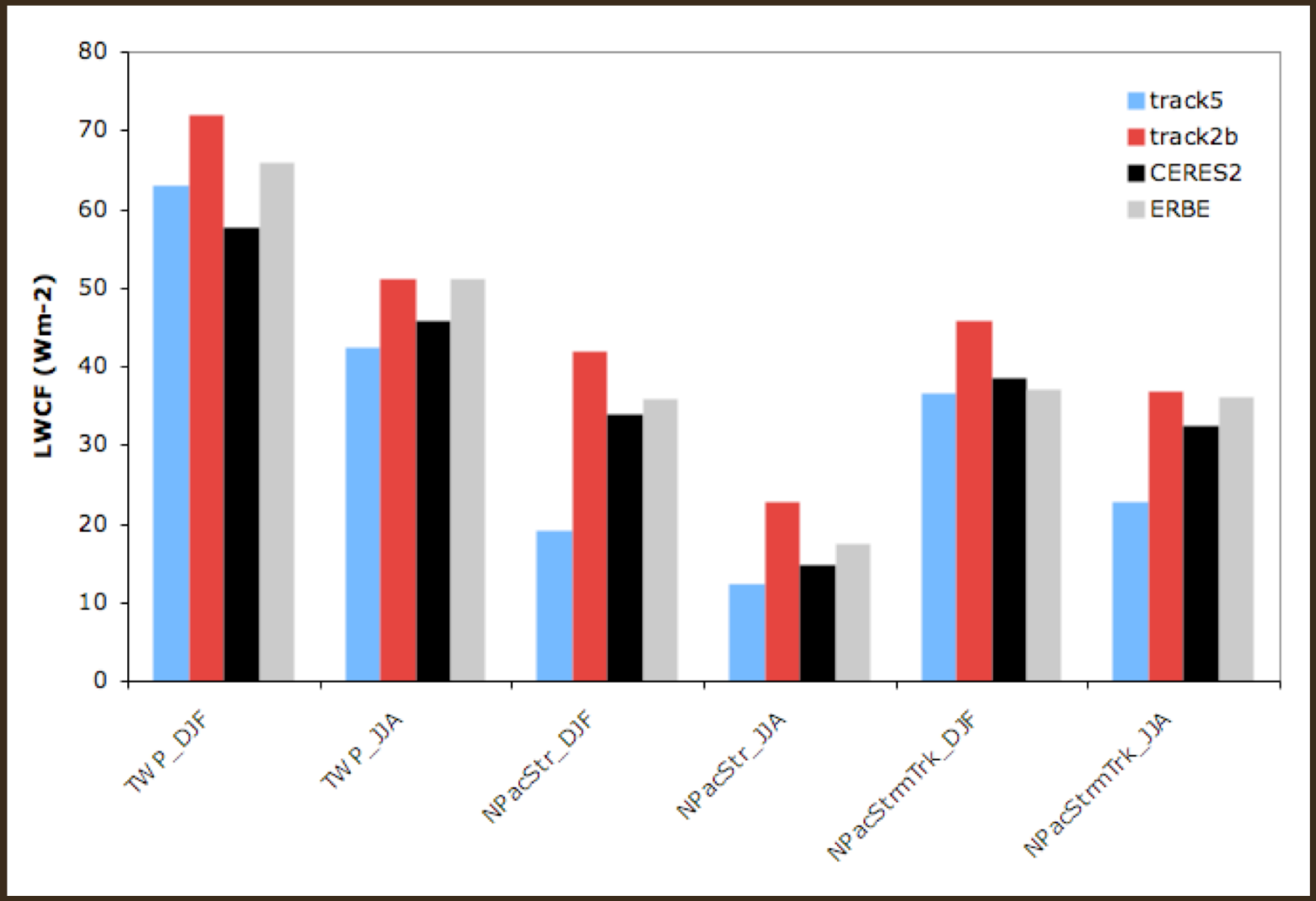
Clear Sky OLR

track5 and track2b have lower clear sky OLR than observed



Long Wave Cloud Forcing

track5 and track2b have lower LWCF than observed

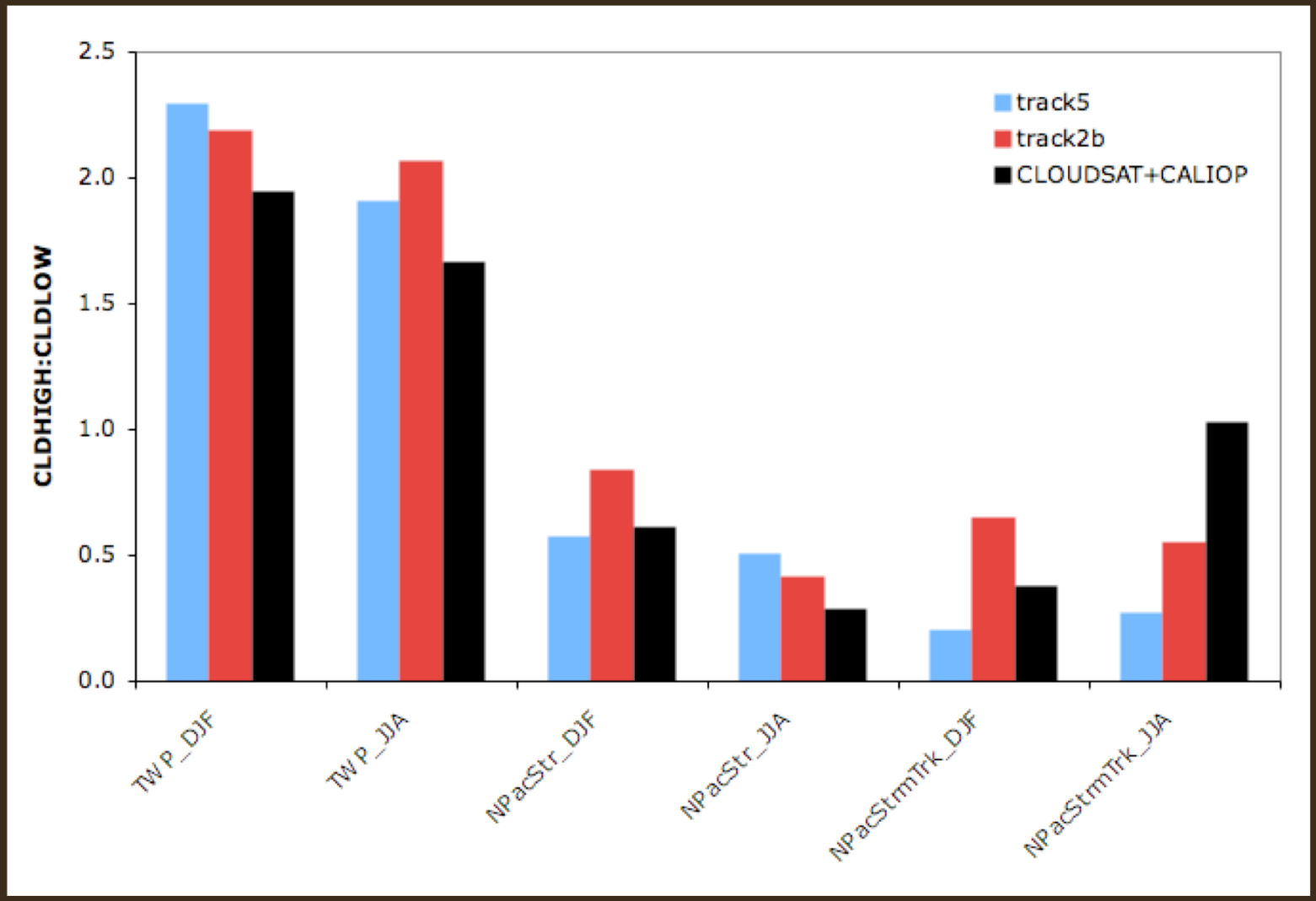


High Clouds and Low Clouds

in general, fewer clouds in track5 than track2b. exception DJF N. Pac. storm track.

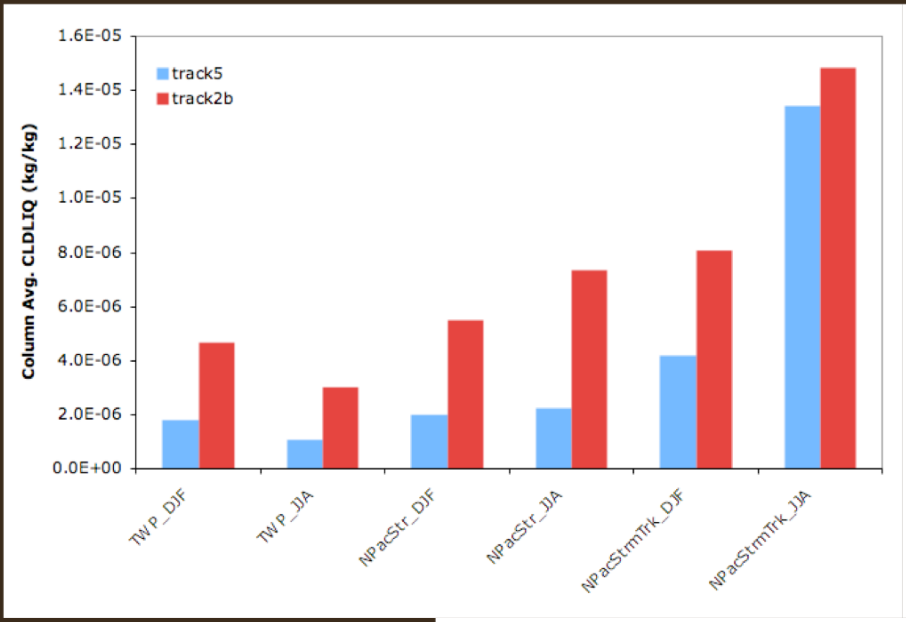
Ratio of High Clouds to Low Clouds

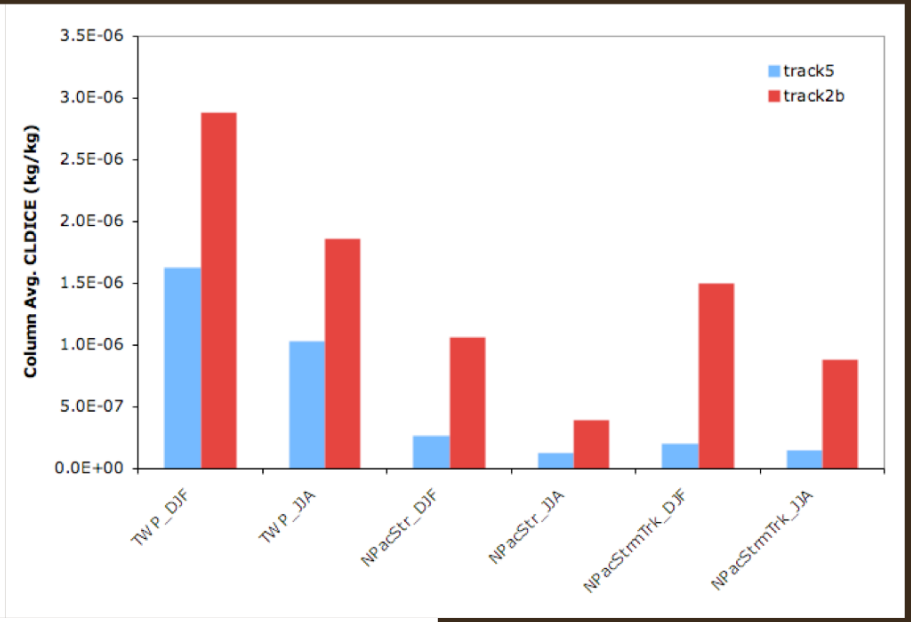
an interesting diagnostic

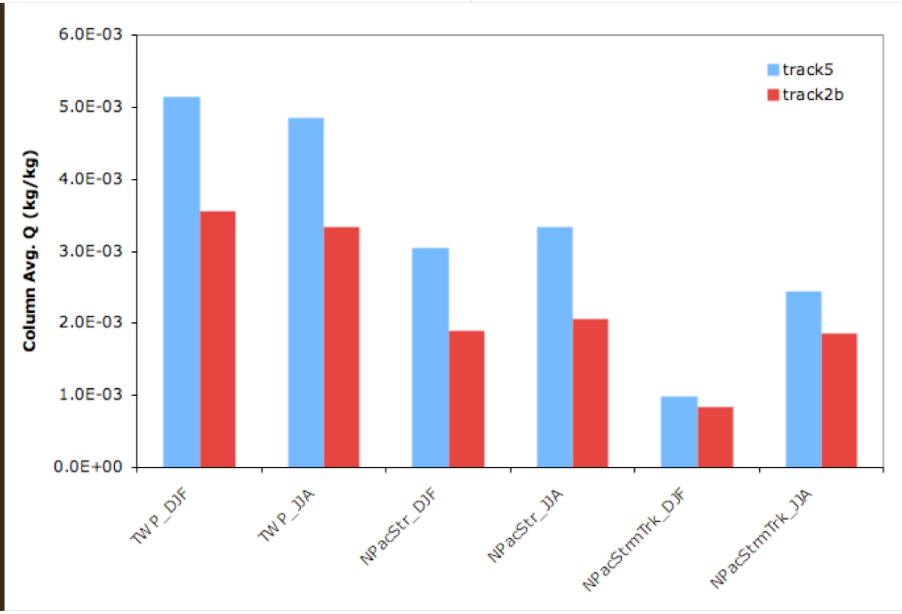


Column-averaged water contents

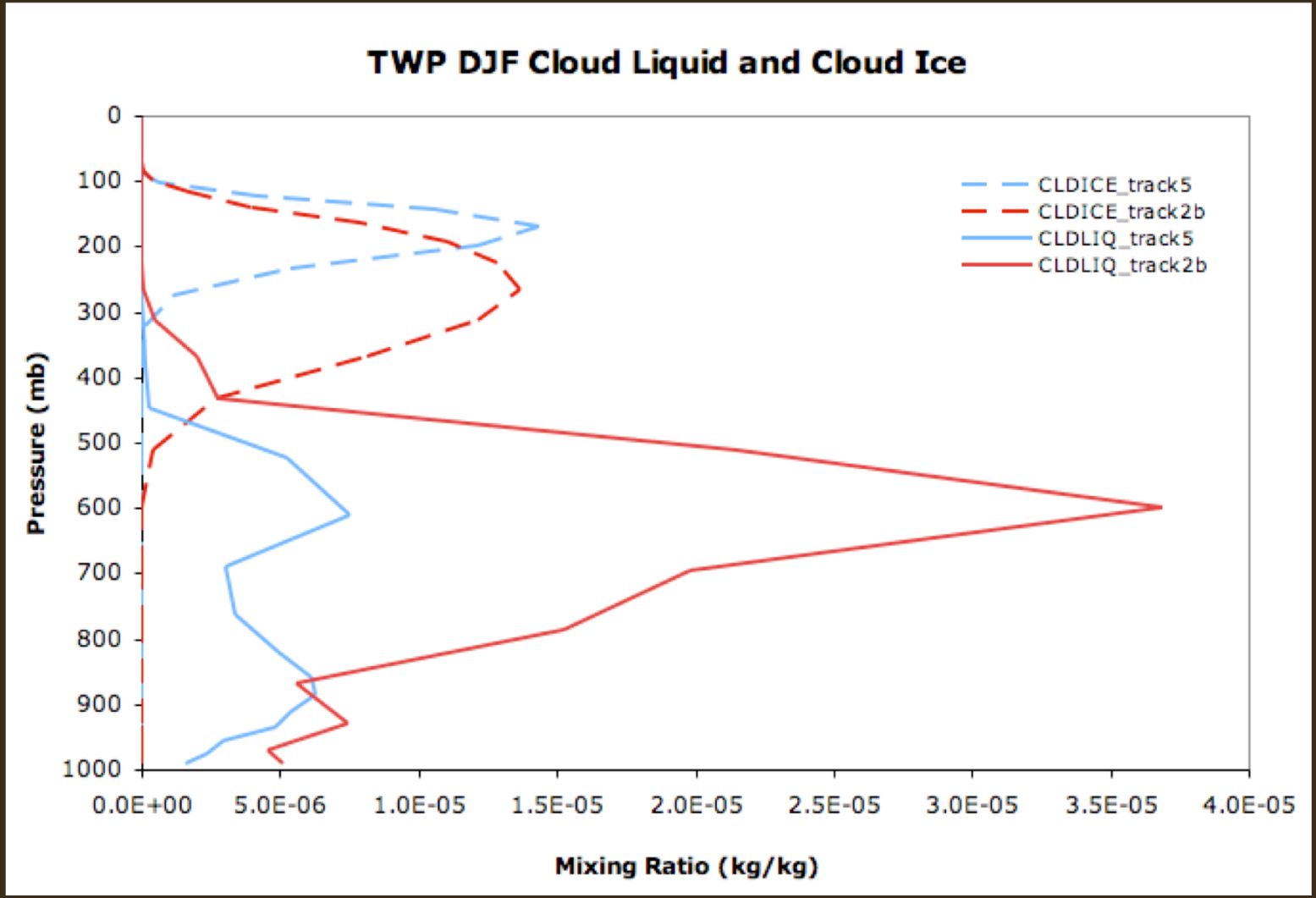
less CLDLIQ/CLDICE (more Q) in track5 as compared to track2b







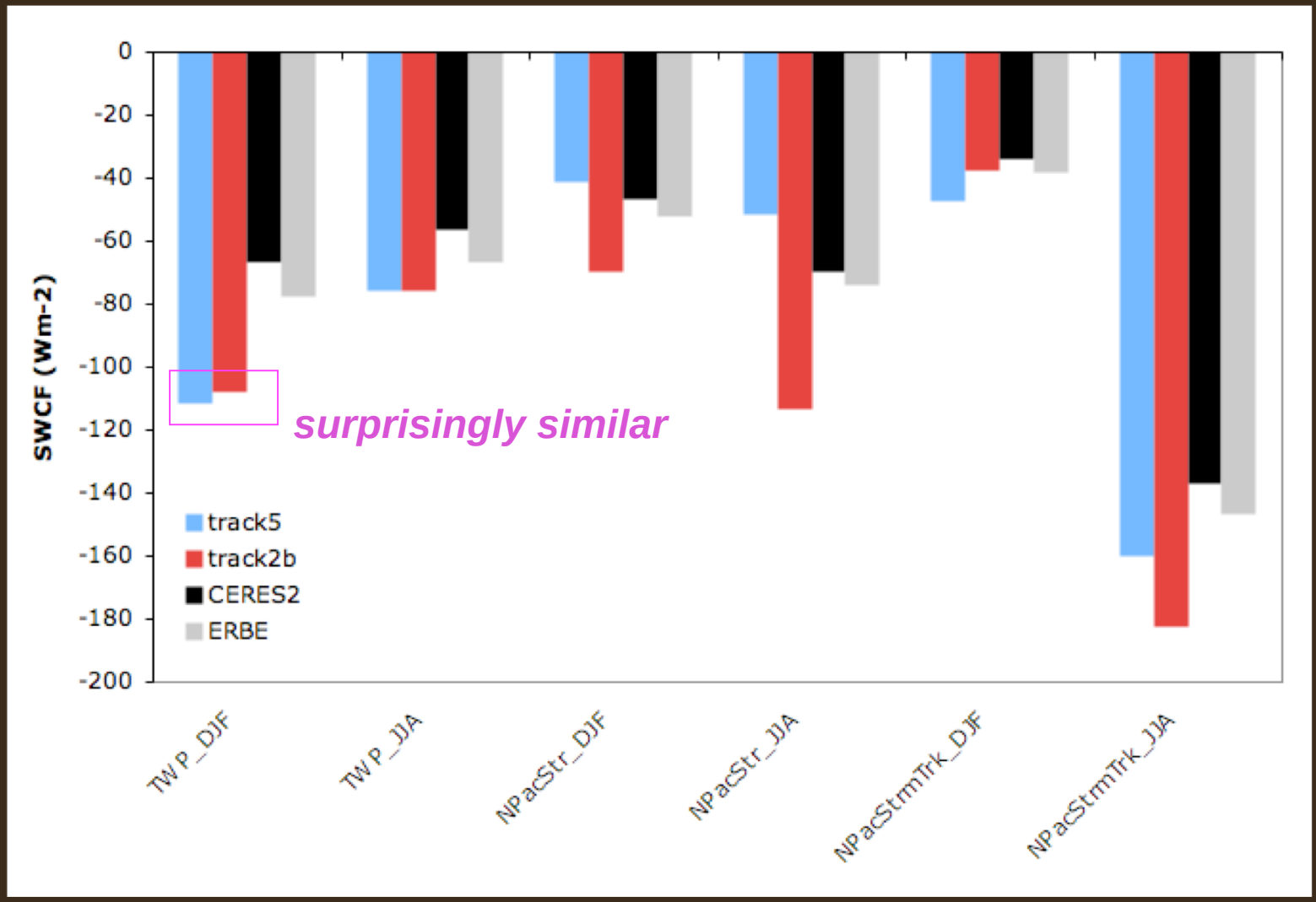
Cloud condensate vertical profile
Tropical Warm Pool DJF



Short Wave Cloud Forcing

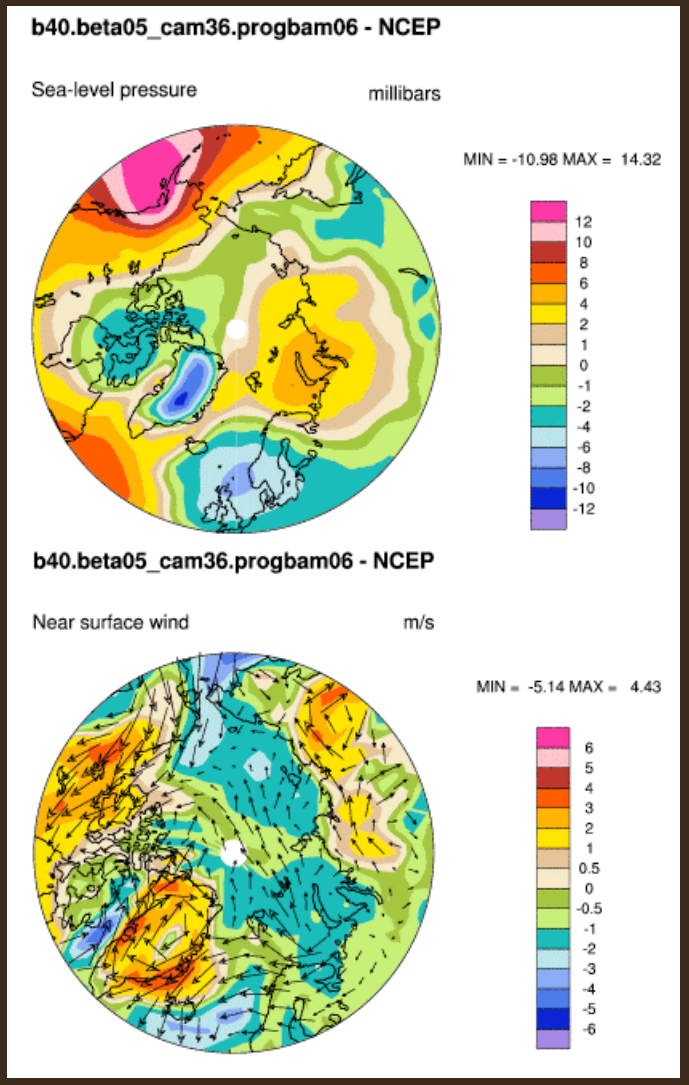
both tracks have too strong tropical SWCF

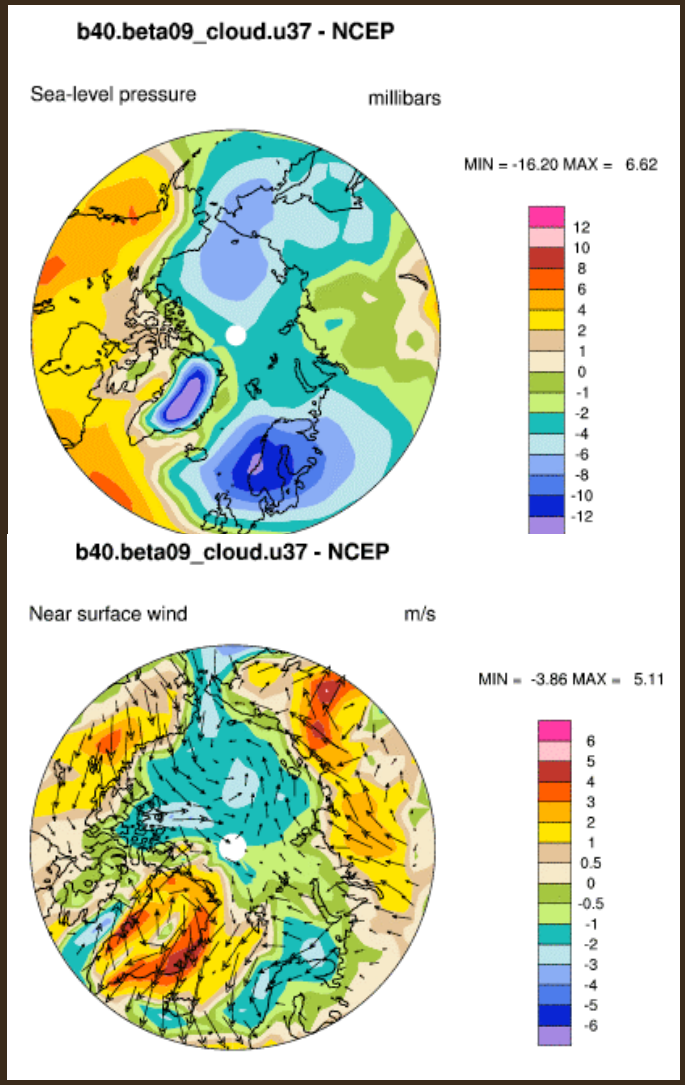
track2b has too strong SWCF in N. Pacific Stratus deck and JJA N Pac. storm track



Arctic DJF SLP/surface winds

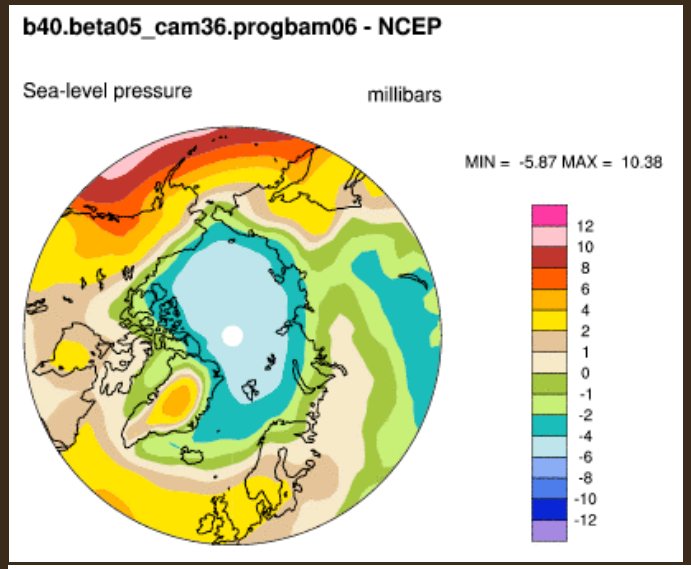
errors in magnitude and location of semi-permanent lows
(caveat: only 5 model years)

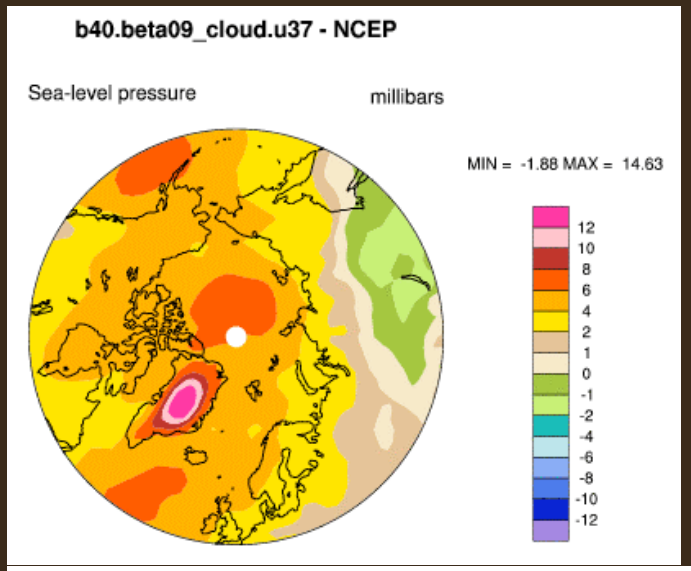


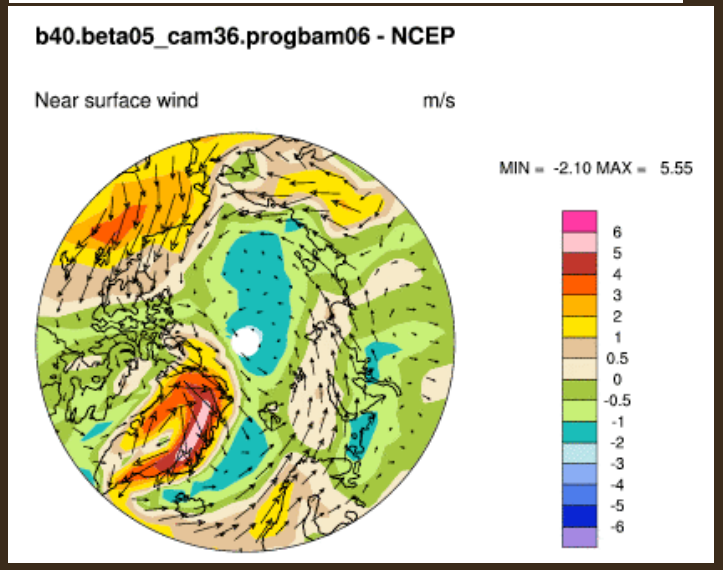


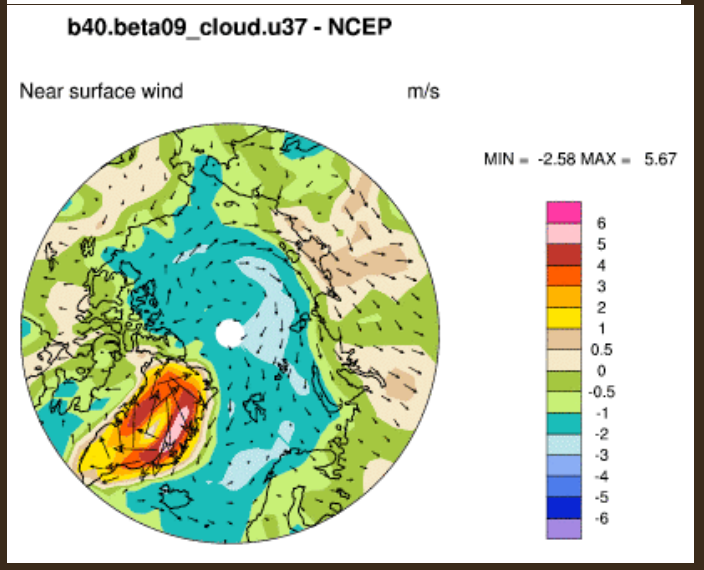
Arctic JJA SLP/surface winds

track2b cyclonic, track5 anti-cyclonic
(caveat: only 5 model years)



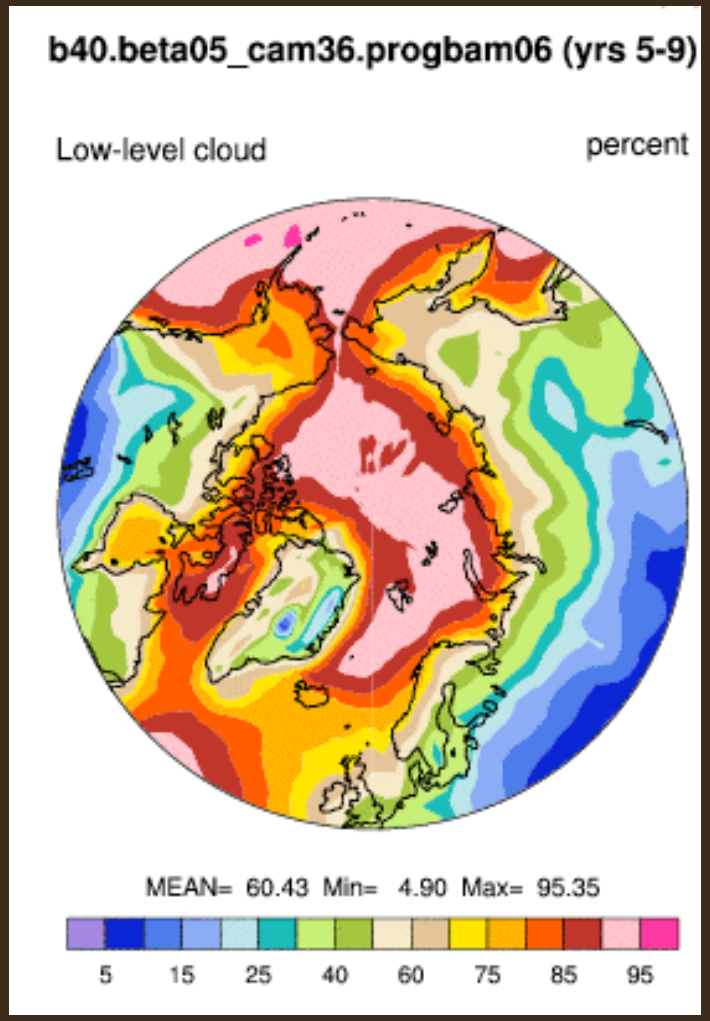


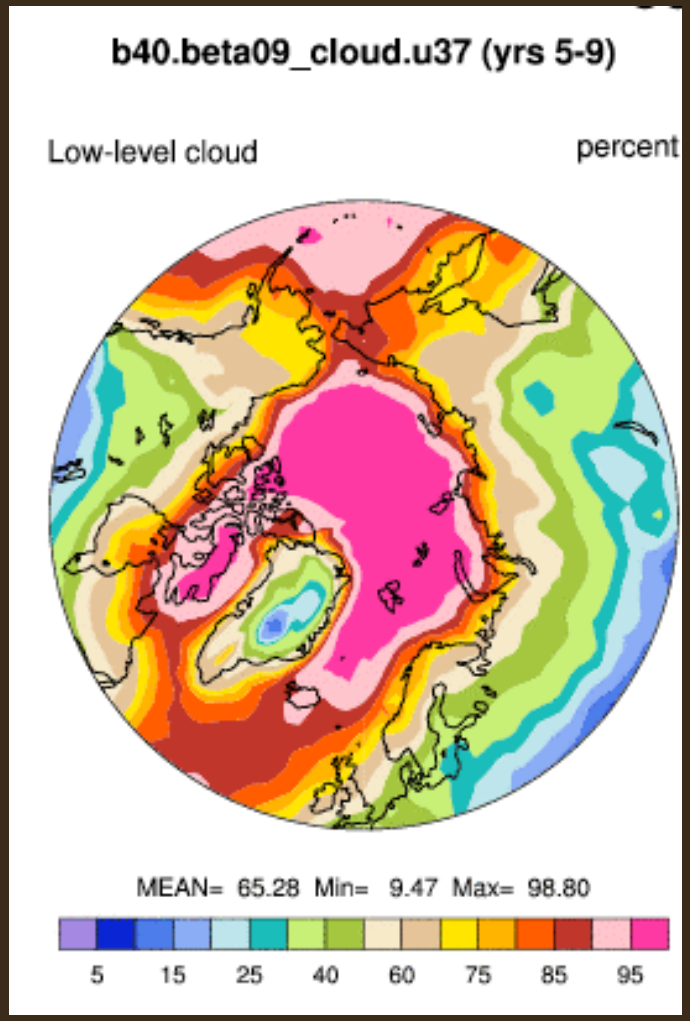




Arctic JJA Low Clouds

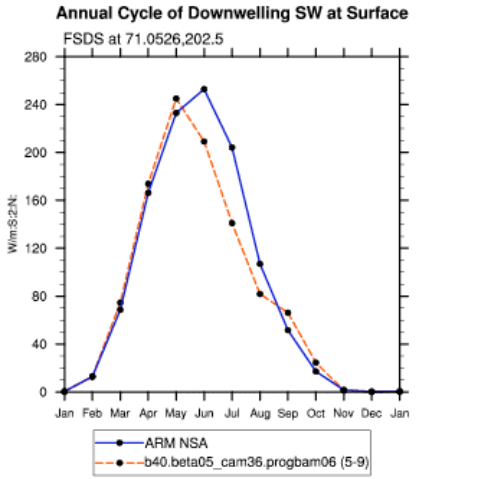
track5 has more summertime arctic clouds than track2

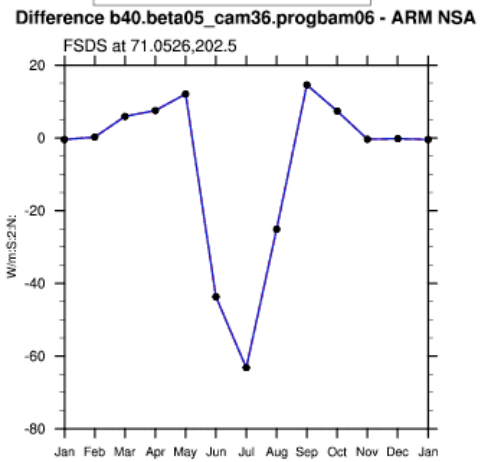


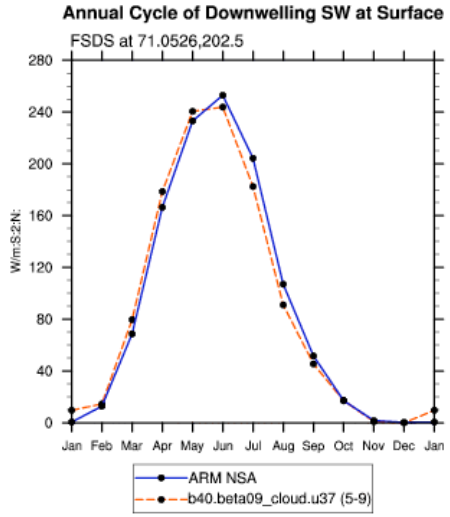


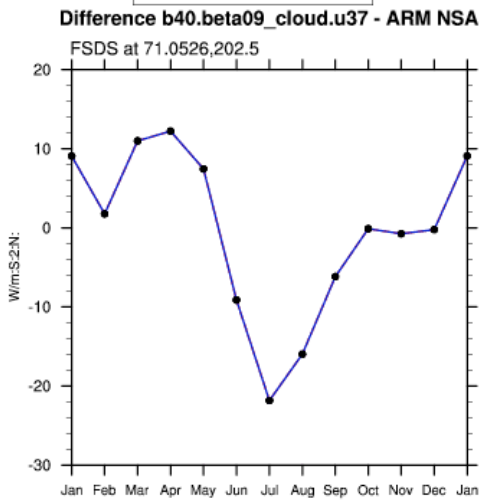
Barrow, AK Downwelling SW

track5 much closer to observed fluxes than track2b



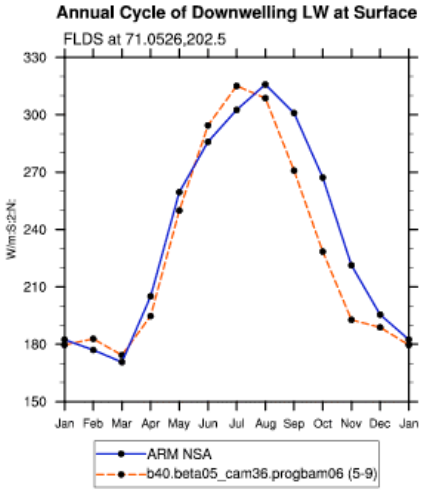


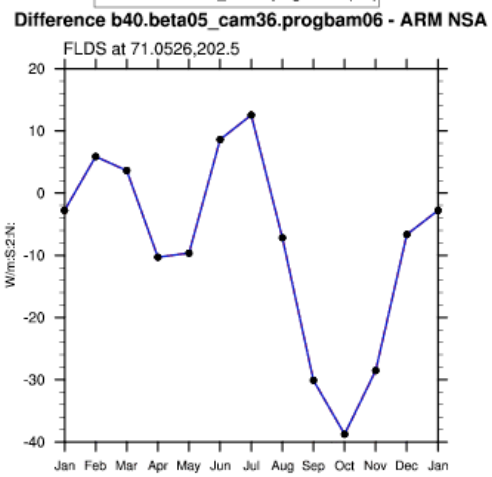


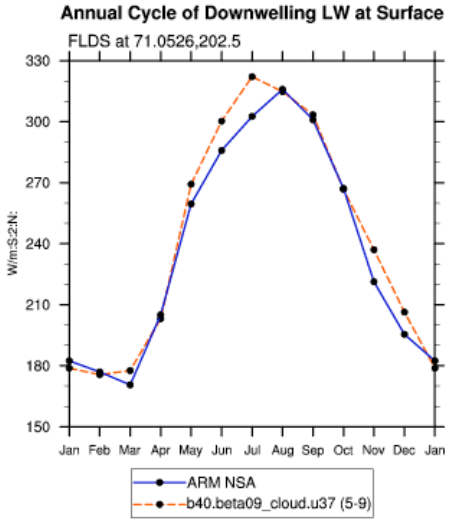


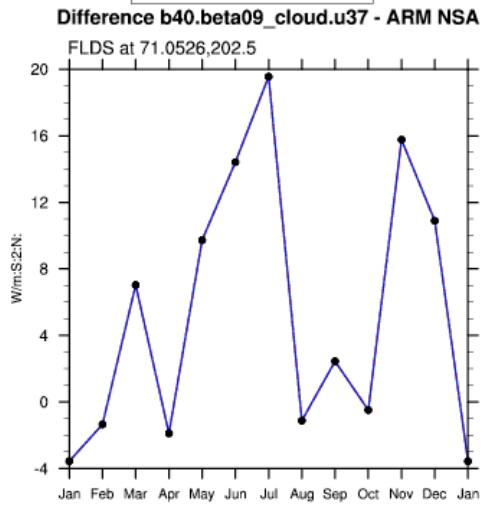
Barrow, AK Downwelling LW

track5 closer to observed fluxes than track2b









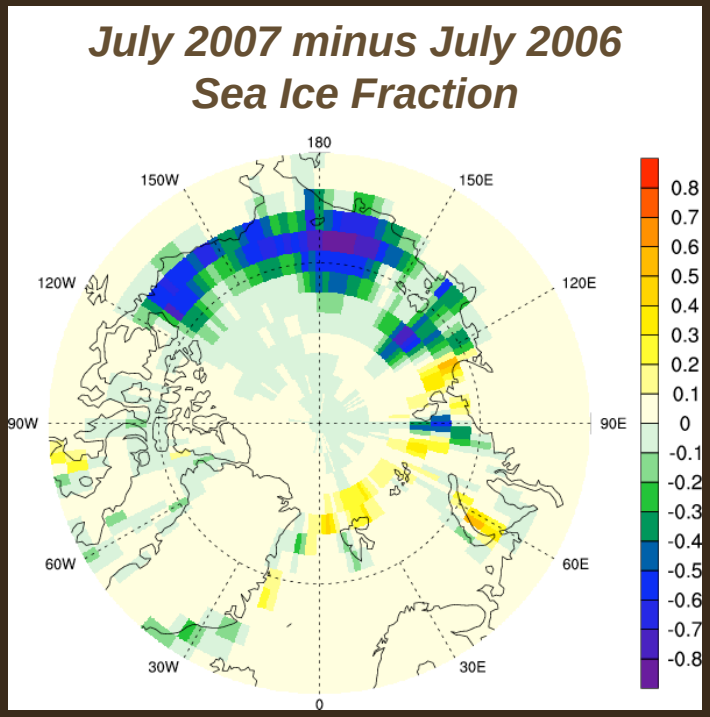
Summary

- Too little clear sky OLR: track5 worse than track2b.
- In general, track2b has larger cloud fractions/CLDLIQ/CLDICE, and less Q than track5. (exception NH semi-permanent lows and in the Arctic)
- Tropical SWCF too strong in both track2b and track5. Track2b stratus and JJA storm track SWCF is too strong.
- Both tracks have significant biases in the Arctic circulation patterns that affect sea ice.
- Both track2b and track5 have excessive Arctic cloudiness, but track5 closer to Barrow, AK-observed downwelling fluxes.
- Arctic cloud forcing and feedback evaluation and COSP simulator implementation work in progress
(not shown here, ask me later if interested).

October 2, 2008 MODIS image

DART-CAM Assimilations

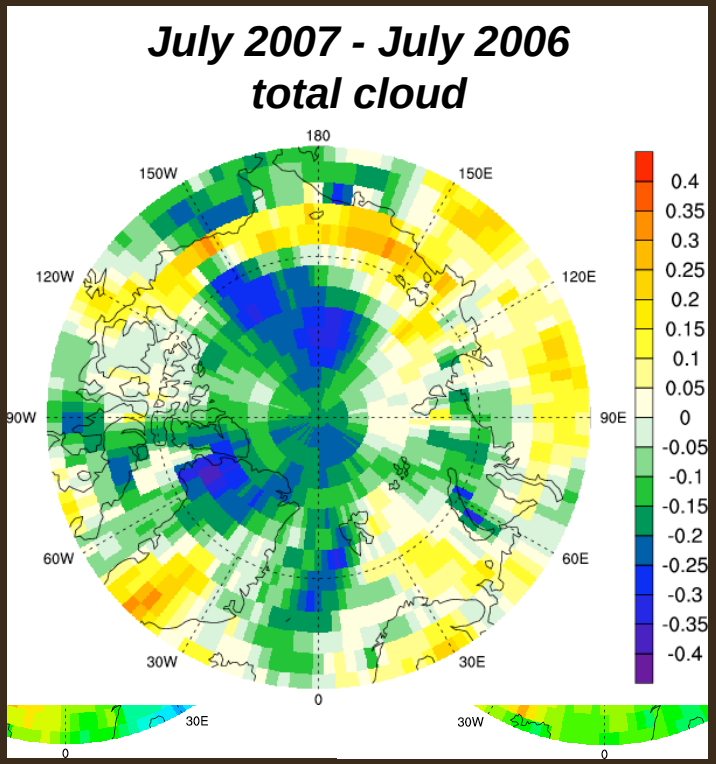
CAM = Community Atmosphere Model
DART = Data Assimilation Research Testbed

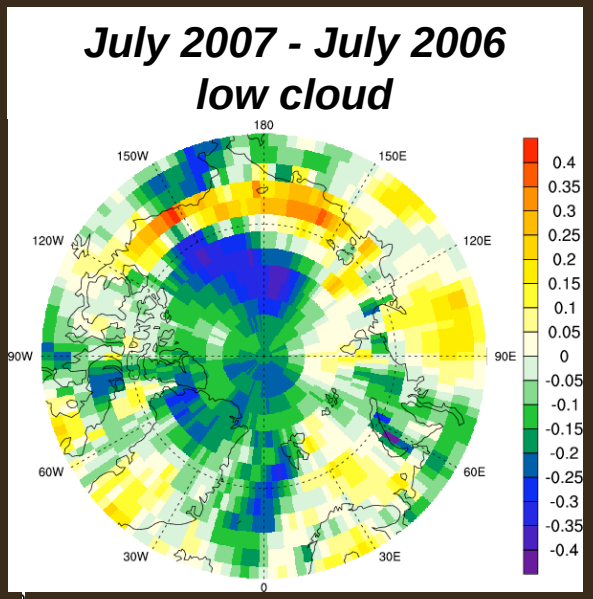


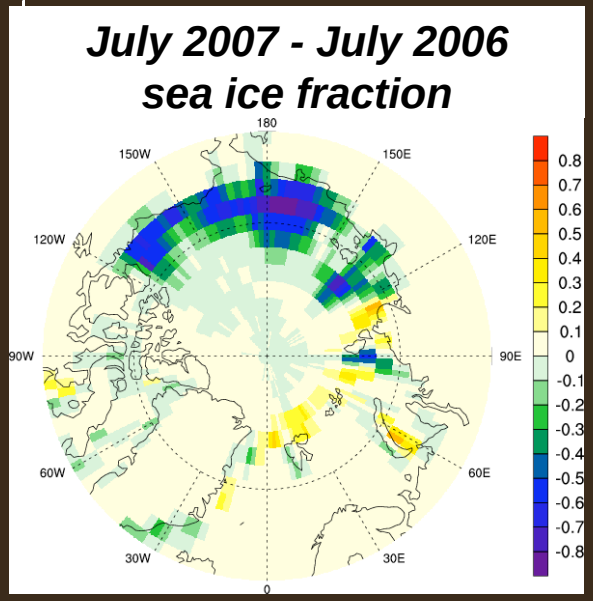
Month	Surface boundary condition
July 2006	observed (Hurrell et al., 2008)
July 2007	observed (Hurrell et al., 2008)

Does CAM capture observed cloud forcing and feedbacks in the Arctic?

CAM3.5-forecasted clouds

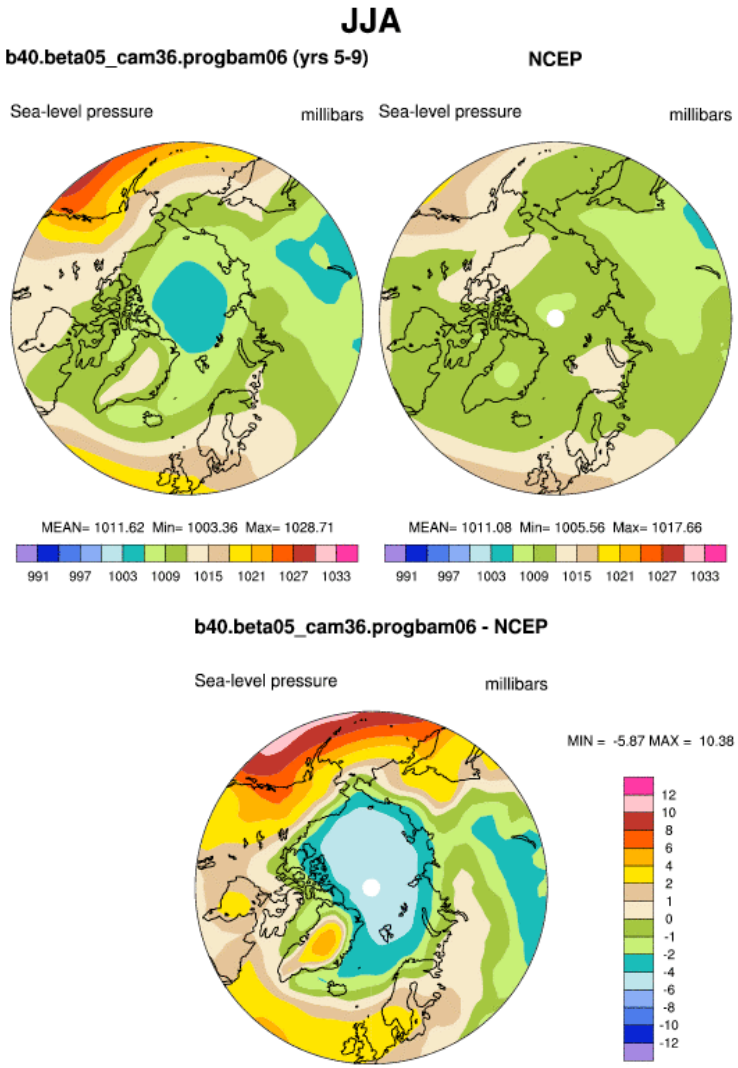


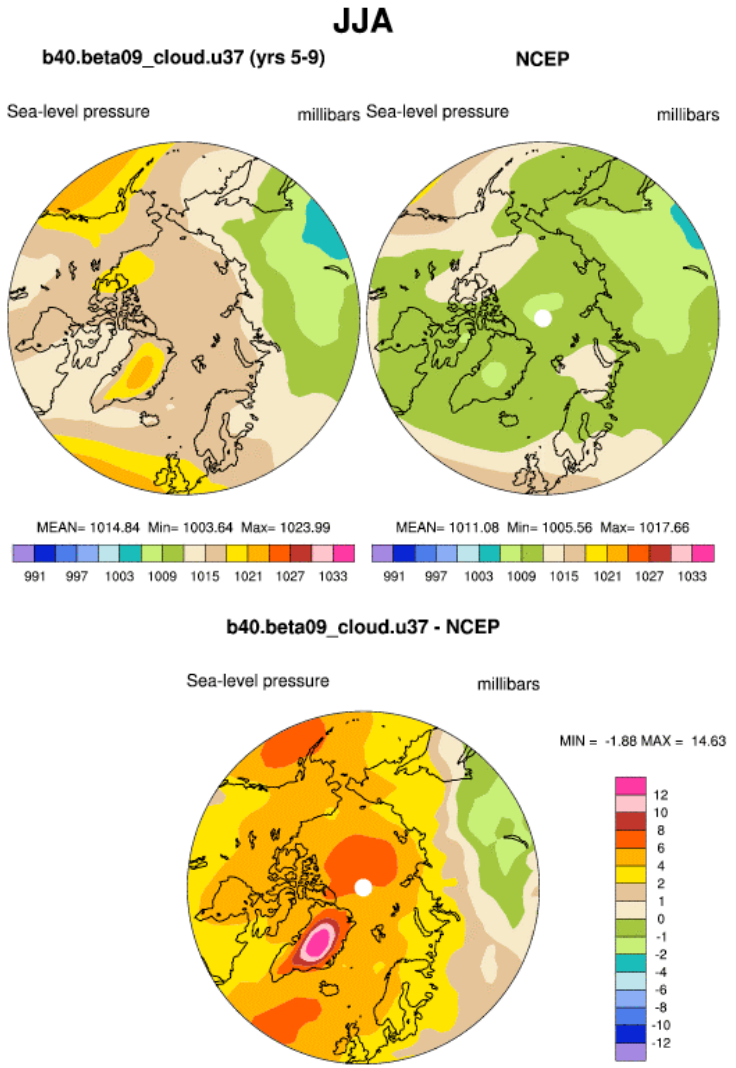




July 2007 had cloud decreases under high SLP, but cloud increases over the newly ice-free ocean. Cloud increases over open water are a negative feedback on sea ice loss not seen in observations.

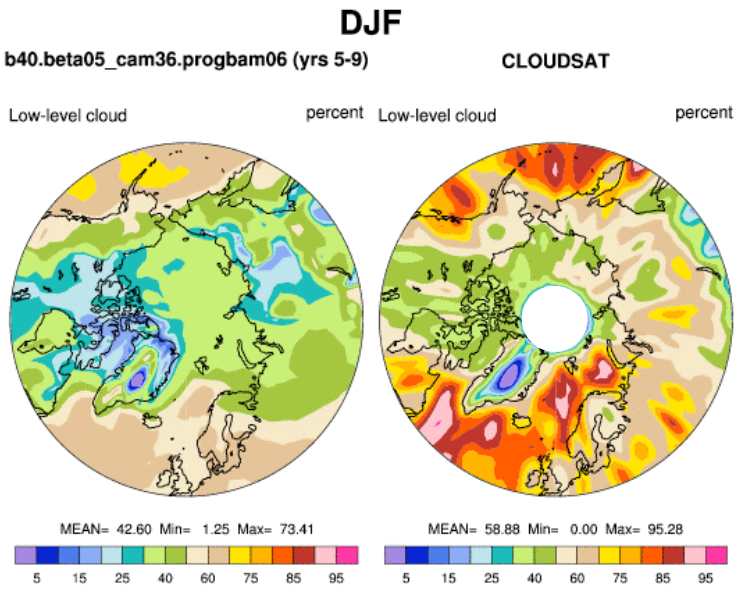
Arctic JJA SLP

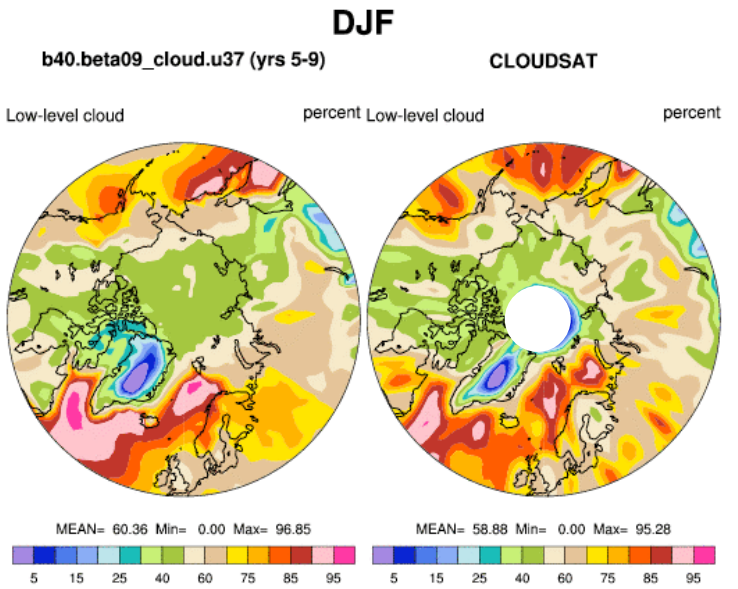


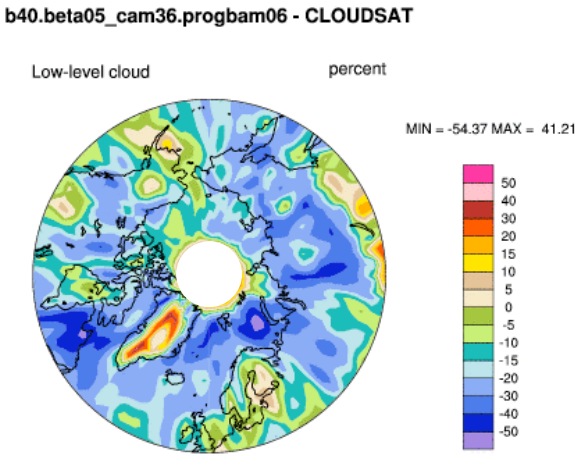


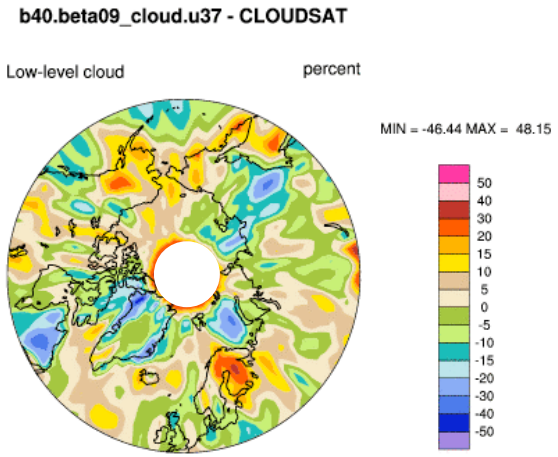
Arctic DJF Low Clouds

track5 has more clouds in semi-permanent lows than track2

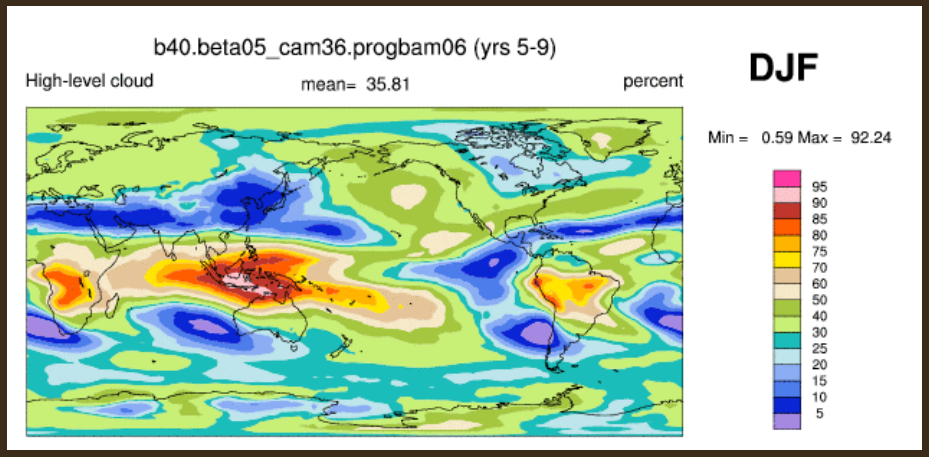


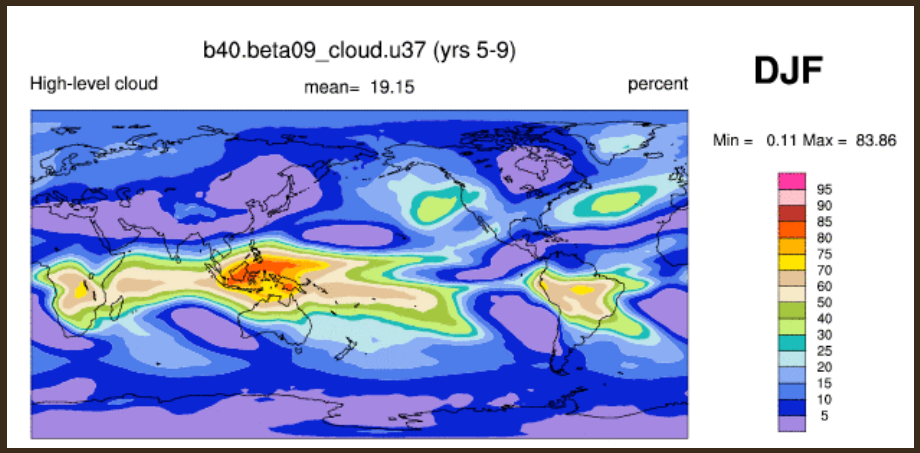


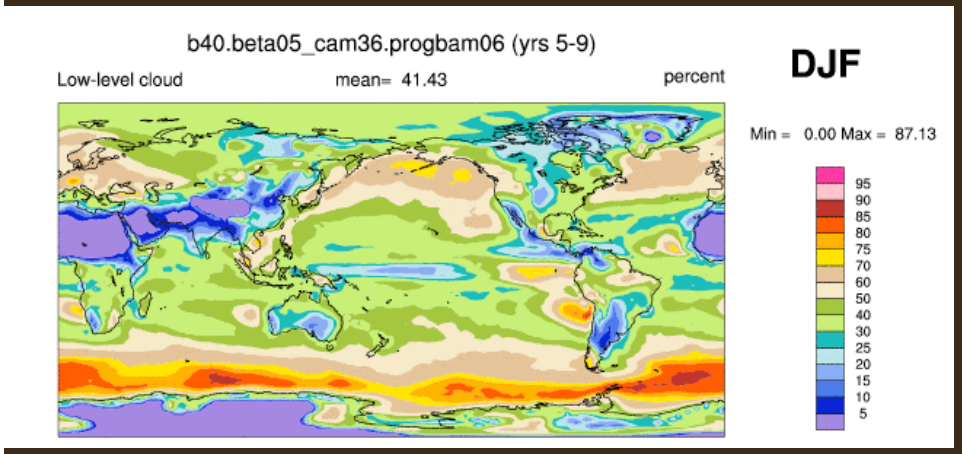


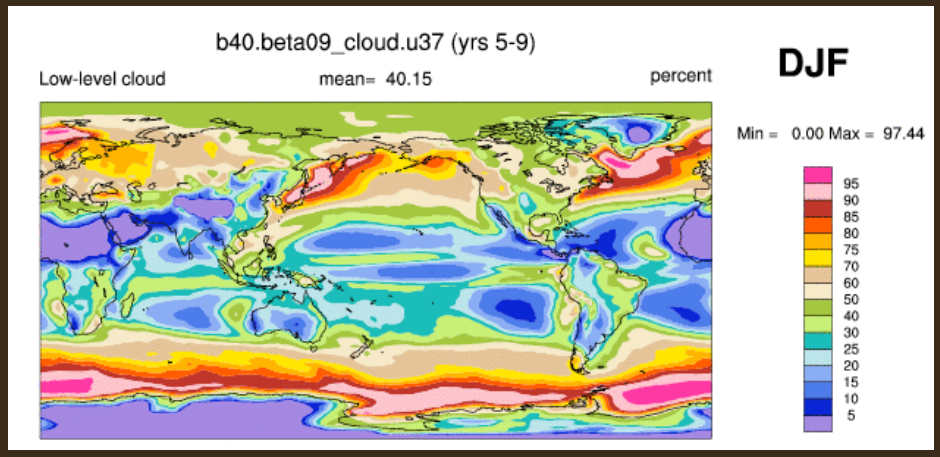


High Clouds and Low Clouds





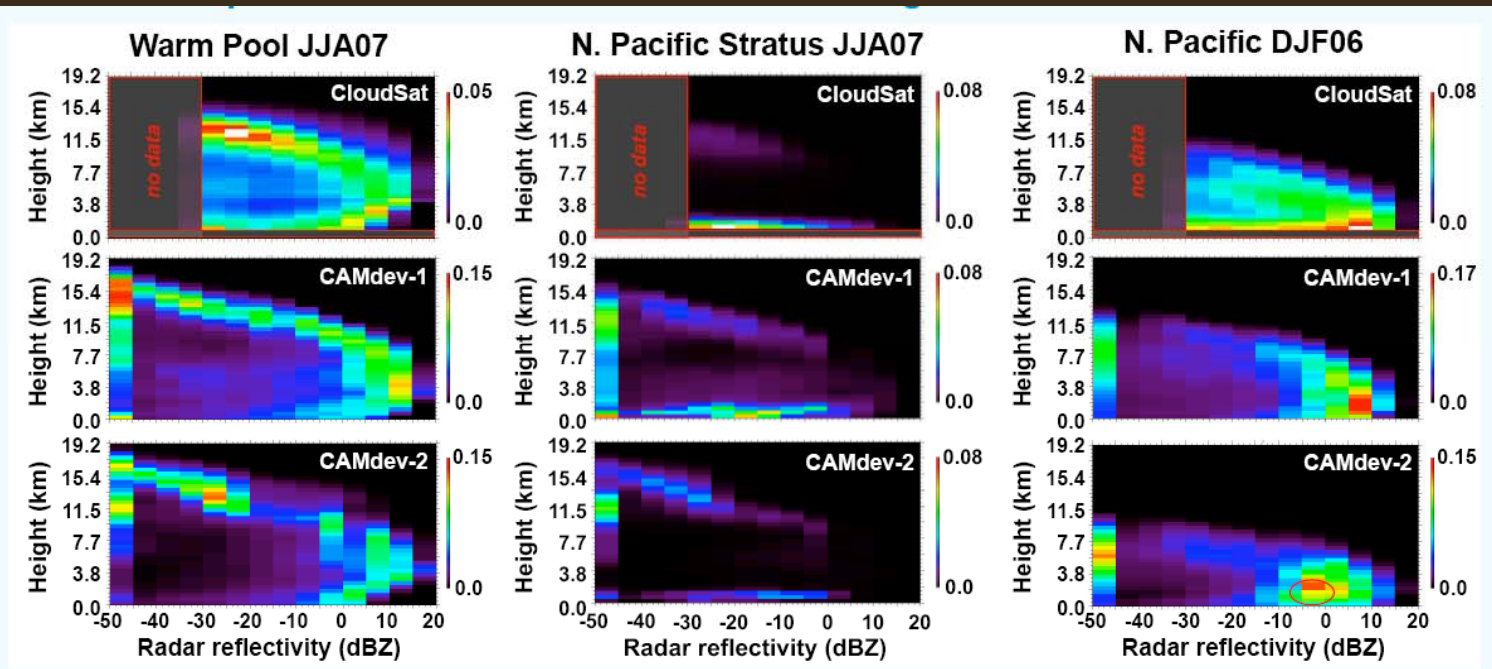




track2b

track5

Simulator Package (COSP) Comparisons

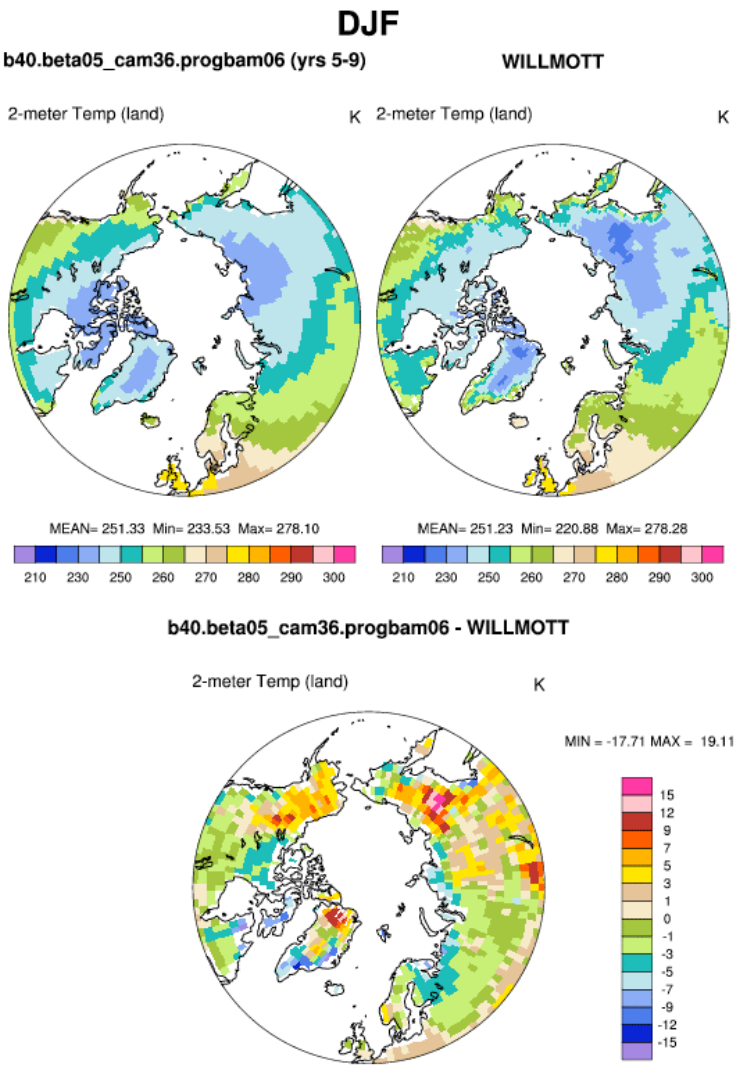


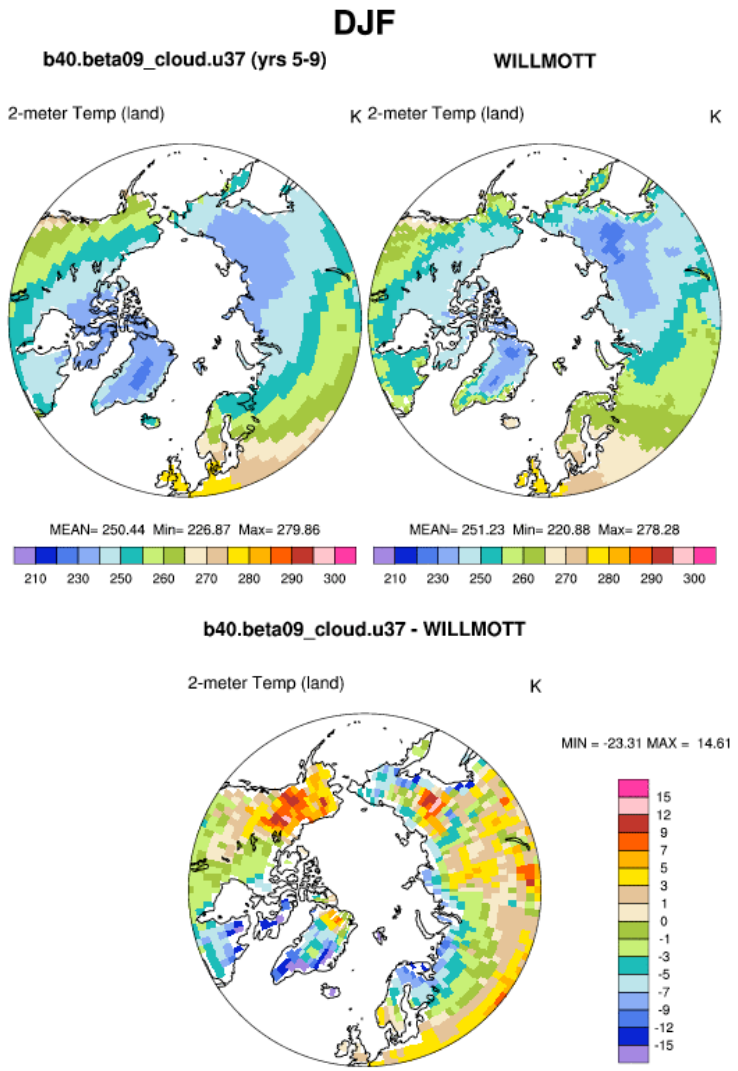
F3. CloudSat-observed and CAM-simulated 2D cloud fraction histograms

CAM-dev1 = CAM3.0 (Collins et al., 2006) + deep convection (Neale et al., 2008) + double-moment microphysics (Gettelman et al., 2008)
CAM-dev2 = cam-dev1 + RRTM radiation + UW boundary layer (Bretherton/Park) + cloud ice and macrophysics

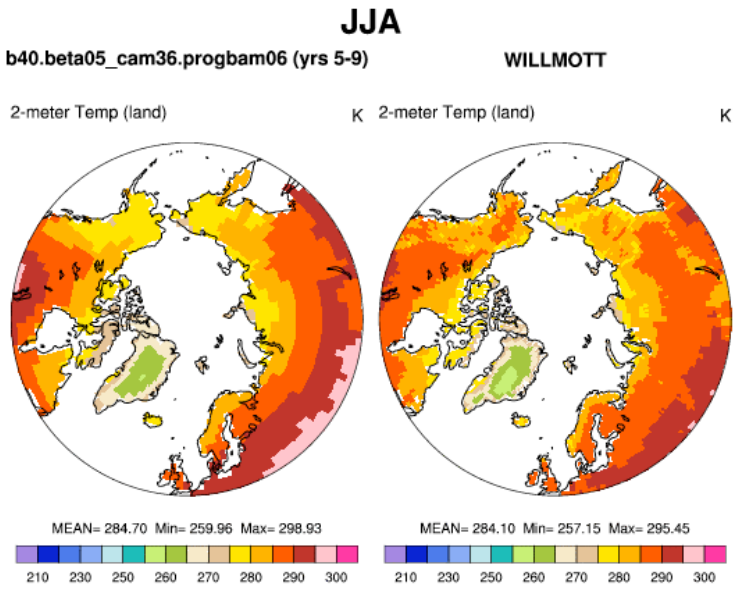
EXTRA

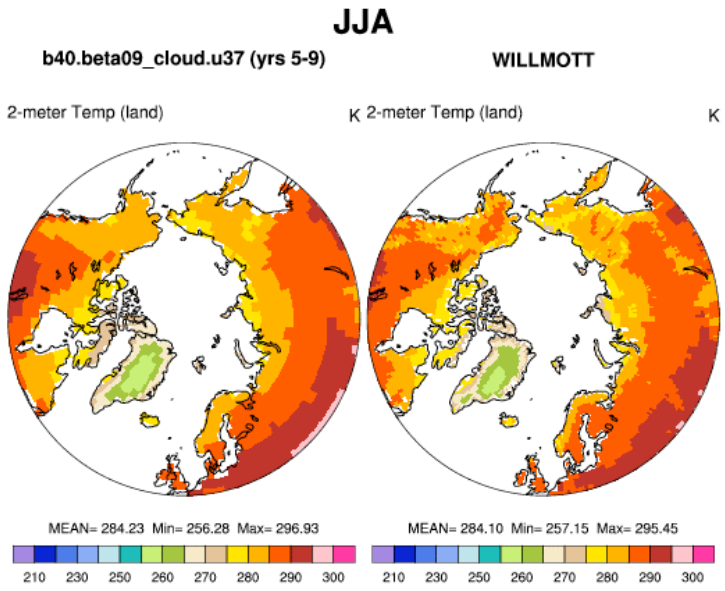
Arctic DJF Land Tempertures

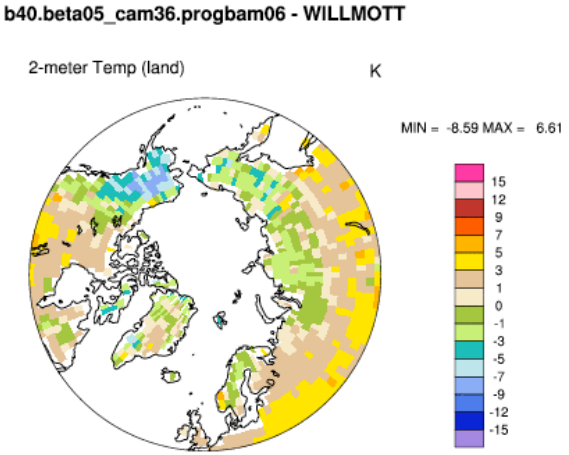


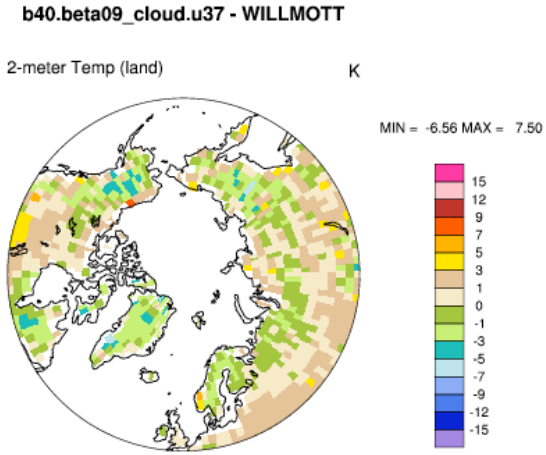


Arctic JJA Land Temperatures

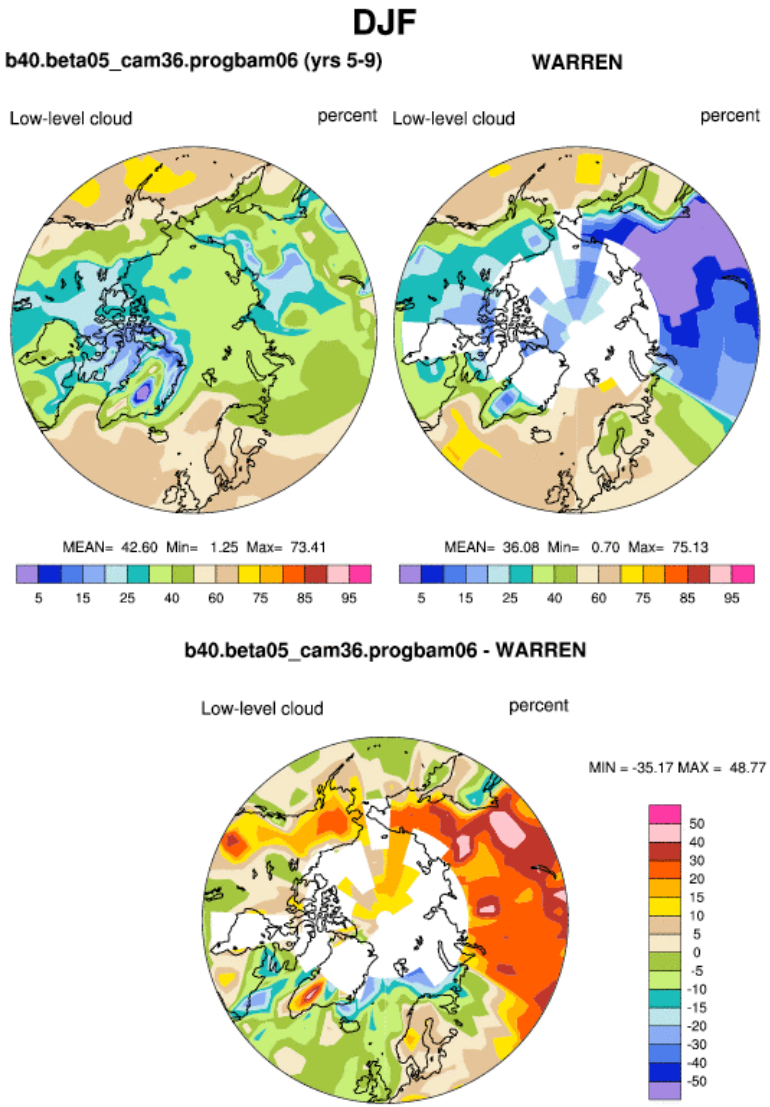


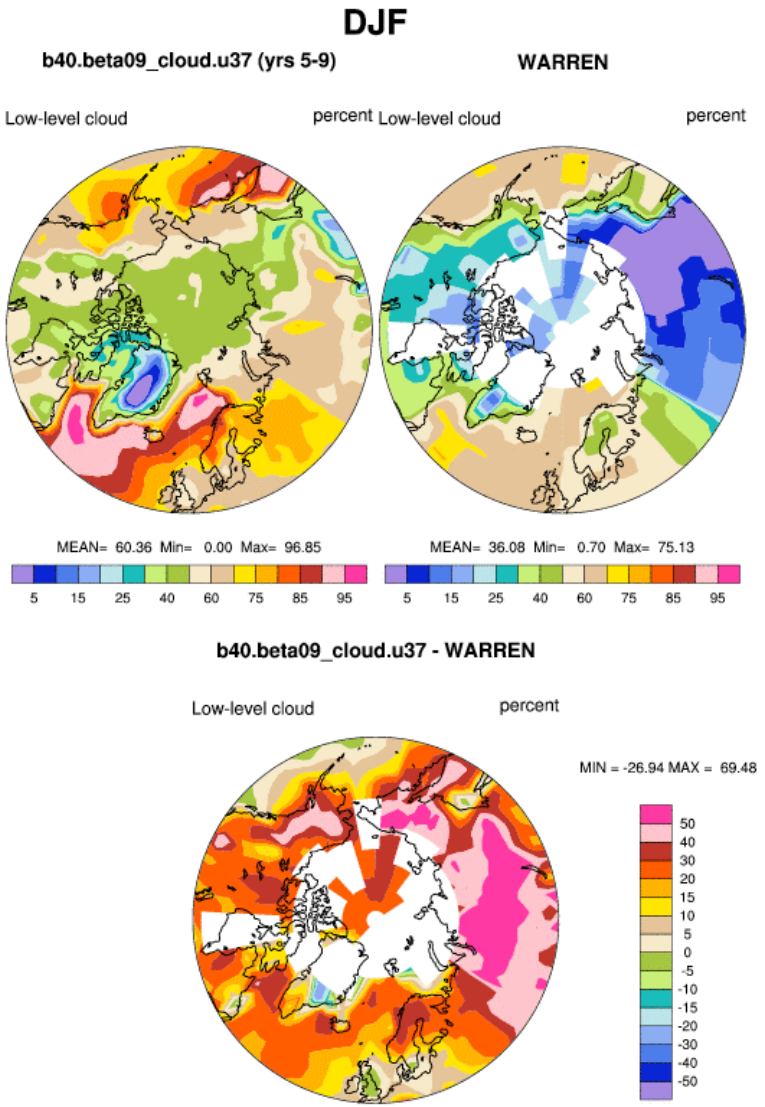




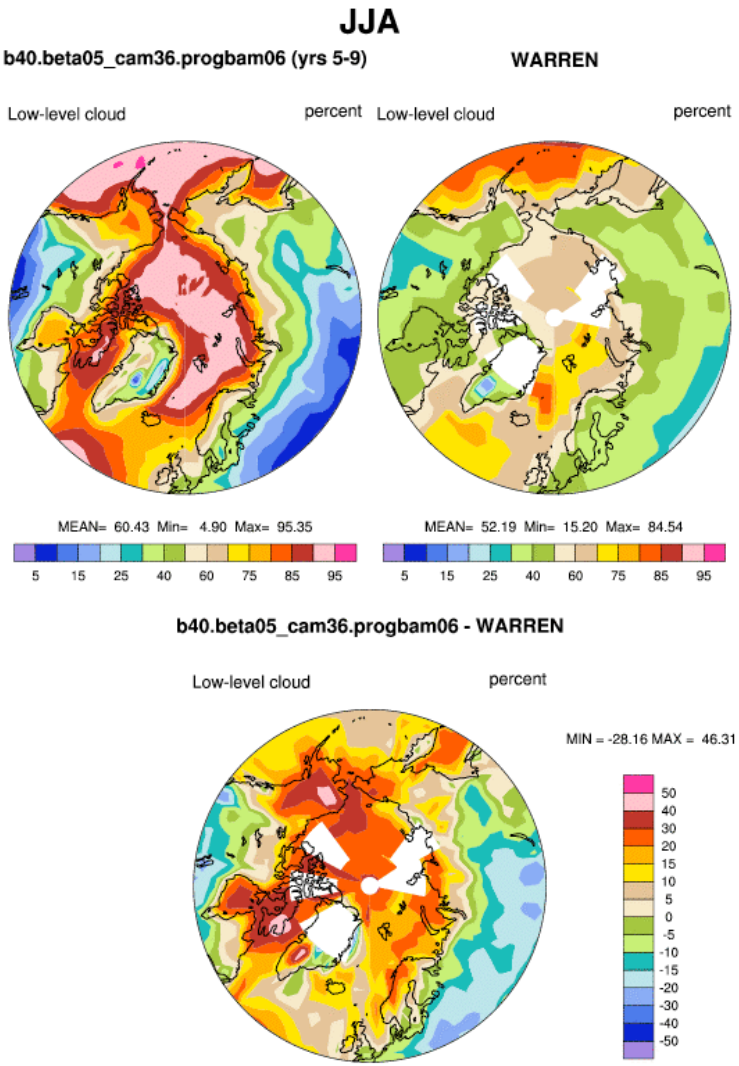


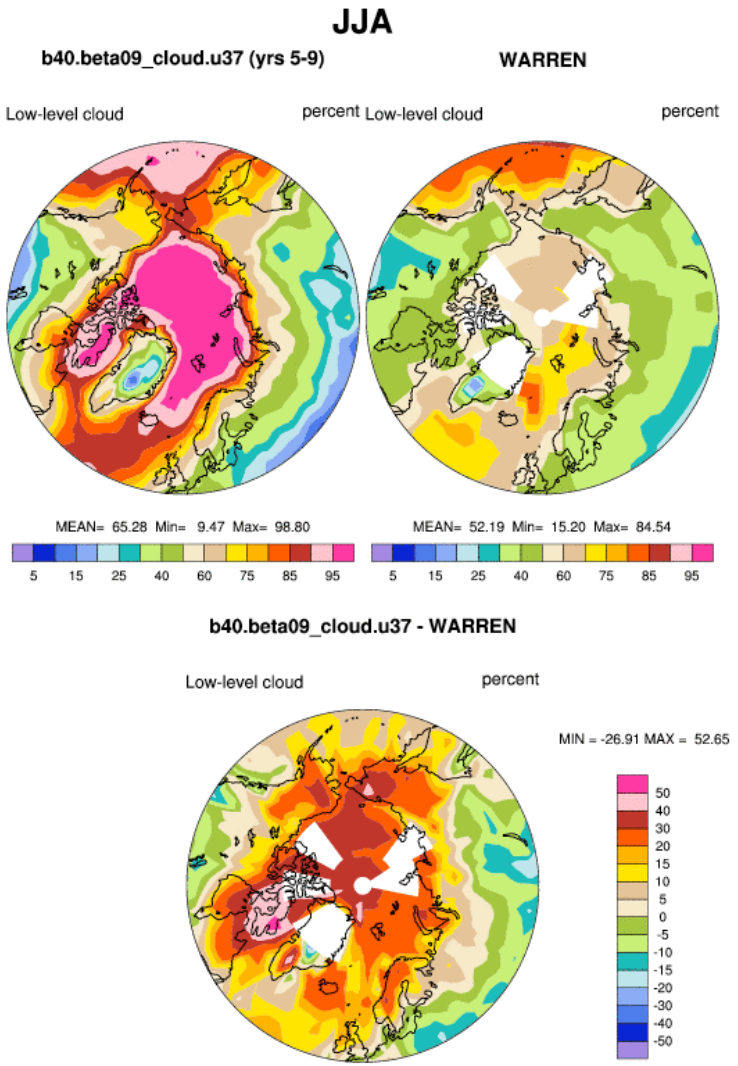
Arctic DJF Low Clouds



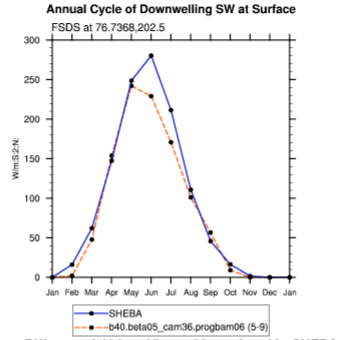


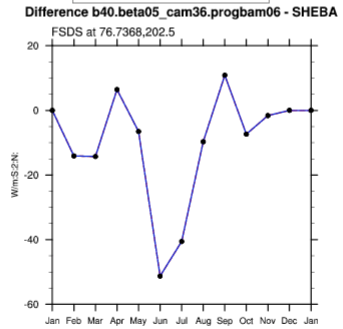
Arctic JJA Low Clouds

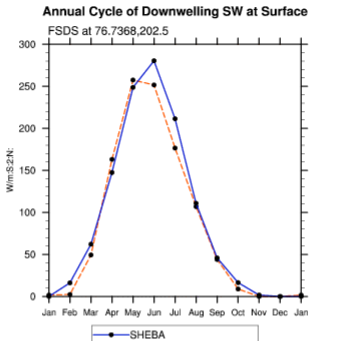


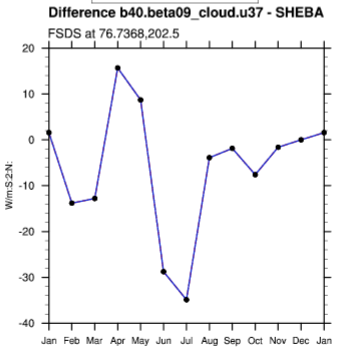


SHEBA FSDS - similar story to Barrow

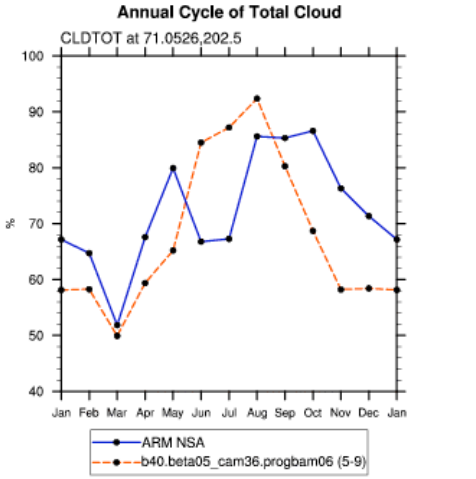


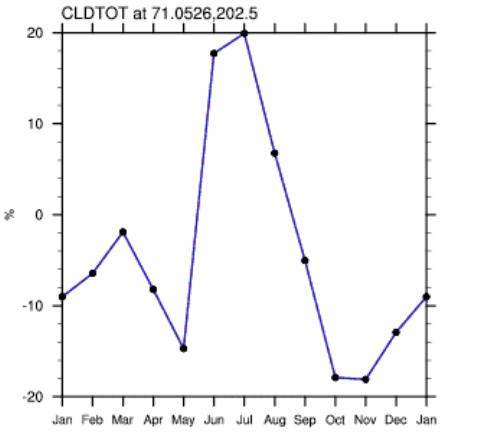


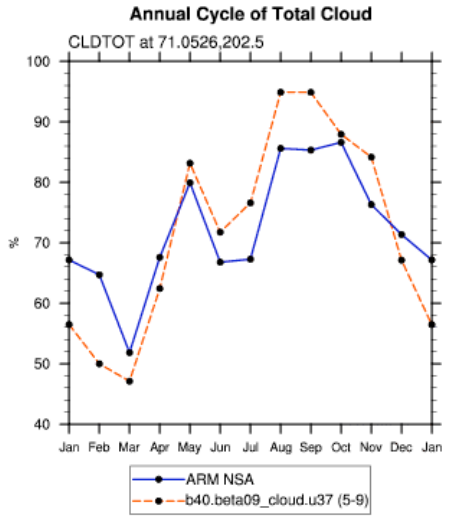


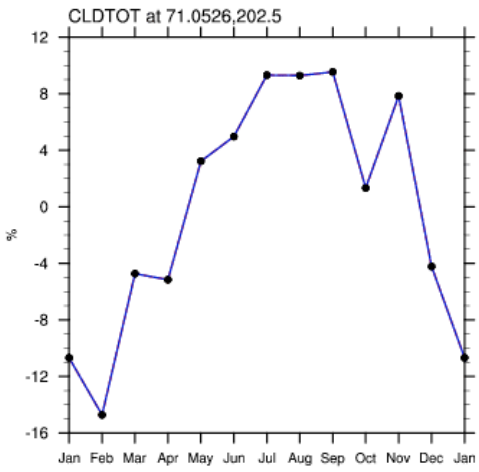


Barrow, AK total cloud

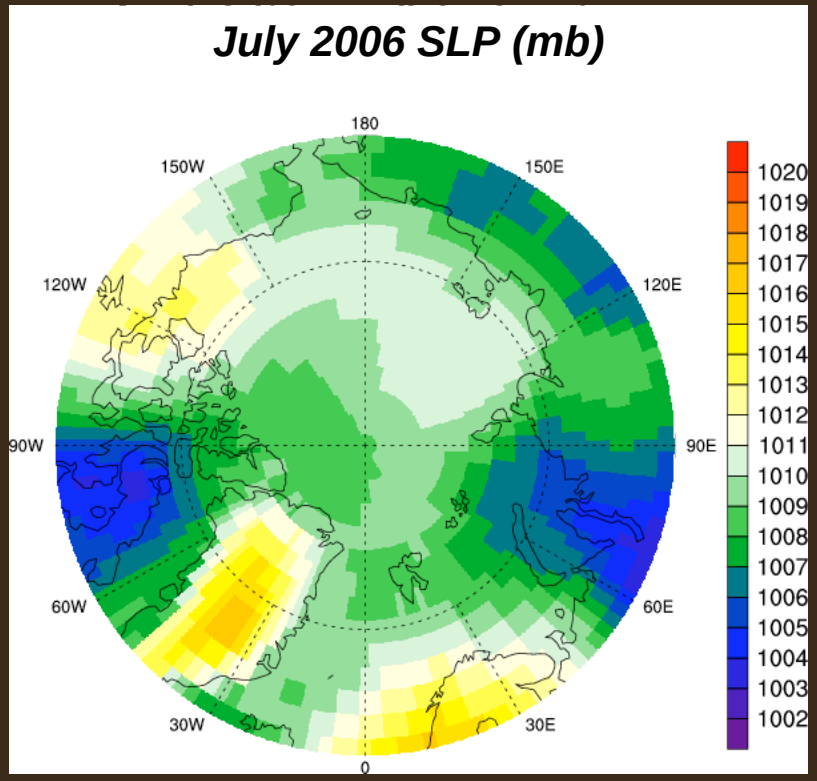


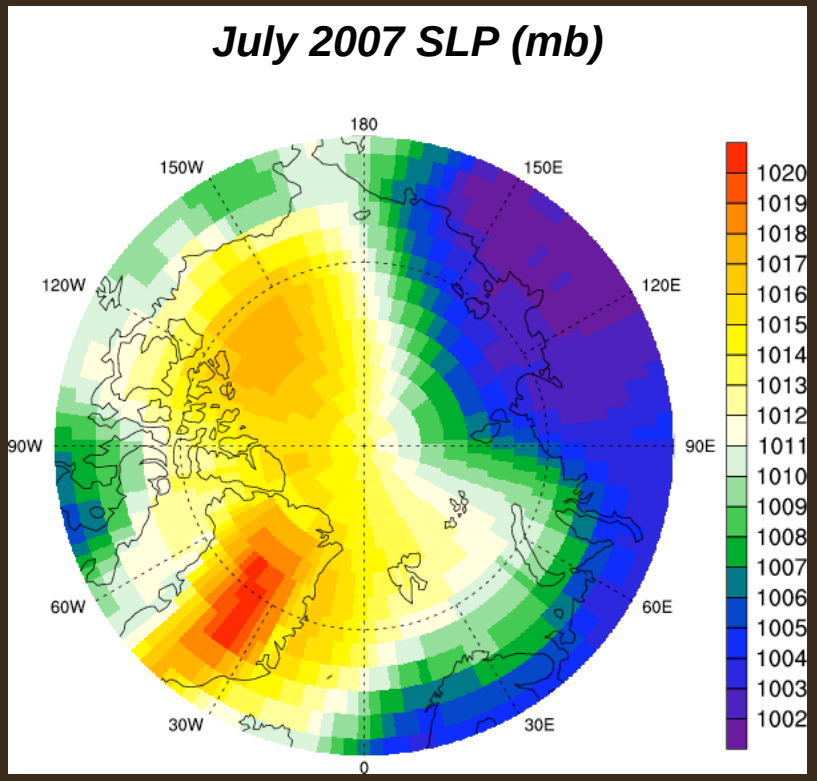






CAM-forecasted Sea Level Pressure





CAM forecasts show large differences in mean sea level pressure fields.

Simulator Package (COSP) Regime Comparisons

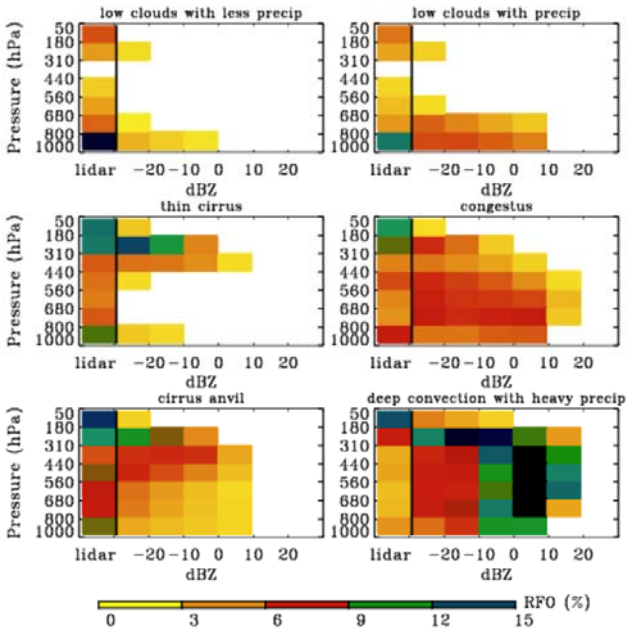


Figure 3. Joint histograms of atmospheric pressure and signal strength for the centroids of the six tropical clusters from the CloudSat and CALIPSO observations collected in June-September 2006. These clusters are named by the primary cloud morphology.

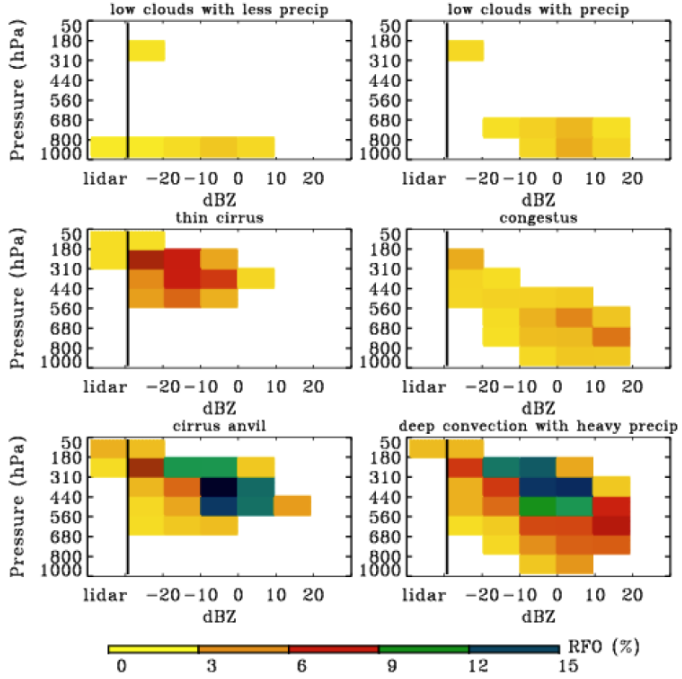


Figure 7. As in Fig. 5 but from CAM3.5.

Figures from Zhang et al. (in prep)