

Clouds and climate sensitivity in two recently released versions of the Community Atmosphere Model (CAM)

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Climate sensitivity and clouds in recent NCAR climate models

CAM version	Global warming due to $2\times\text{CO}_2$
CAM4	3.2 K
CAM5	4.1 K

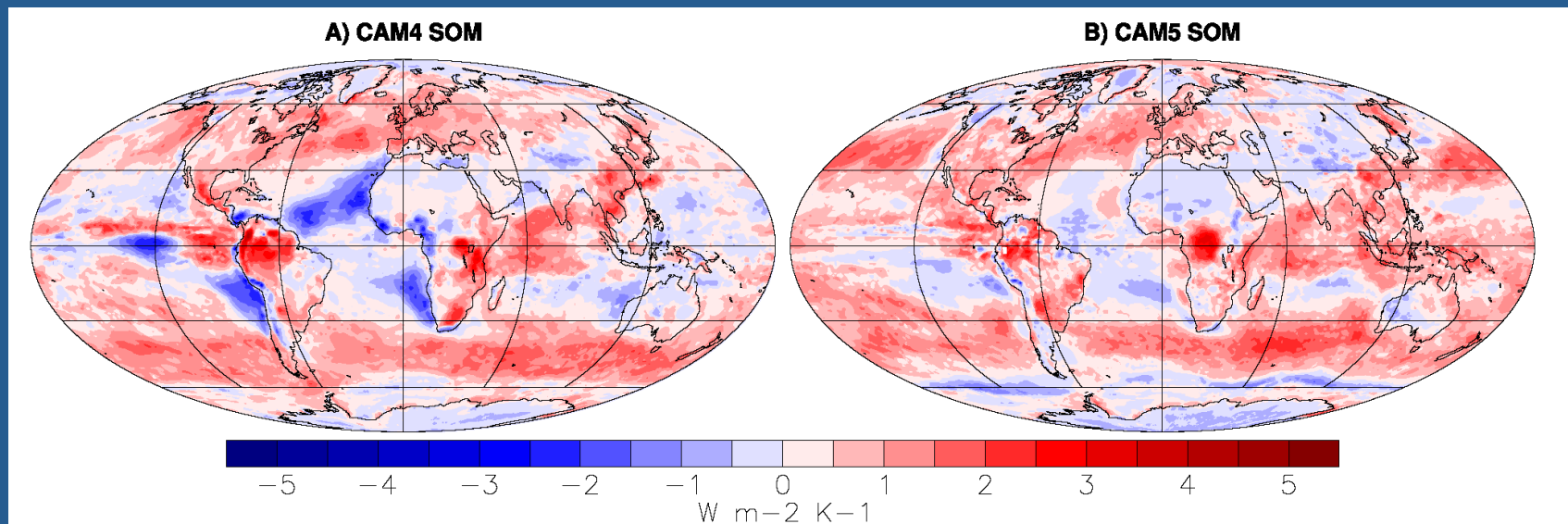


FIG. 6. Adjusted Cloud feedback ($\text{ACF} = \text{ASCF} + \text{ALCF}$) for (a) CAM4-SOM and (b) CAM5-SOM in $\text{W m}^{-2} \text{K}^{-1}$.

Gettelman, Kay, and Shell (submitted)

Area- Weighted AND Kernel- Adjusted Cloud Feedbacks in CAM4 and CAM5

Gettelman, Kay, and Shell
(submitted)

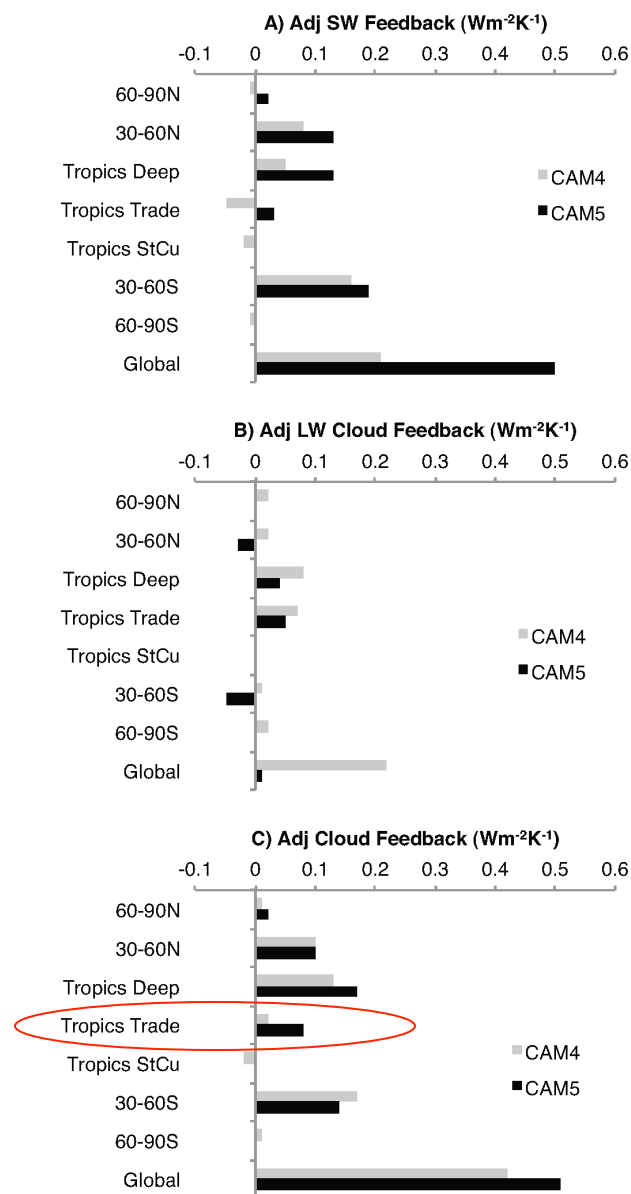


FIG. 9. Weighted Adjusted Cloud feedback by region (in $\text{Wm}^{-2}\text{K}^{-1}$) for CAM4-SOM (gray) and CAM5-SOM (black). A) Short Wave (ASCF), B) Long Wave (ALCF) and C) Net (ACF). Regions are defined in the text.

Which model has “better clouds” as compared to present-day satellite observations?

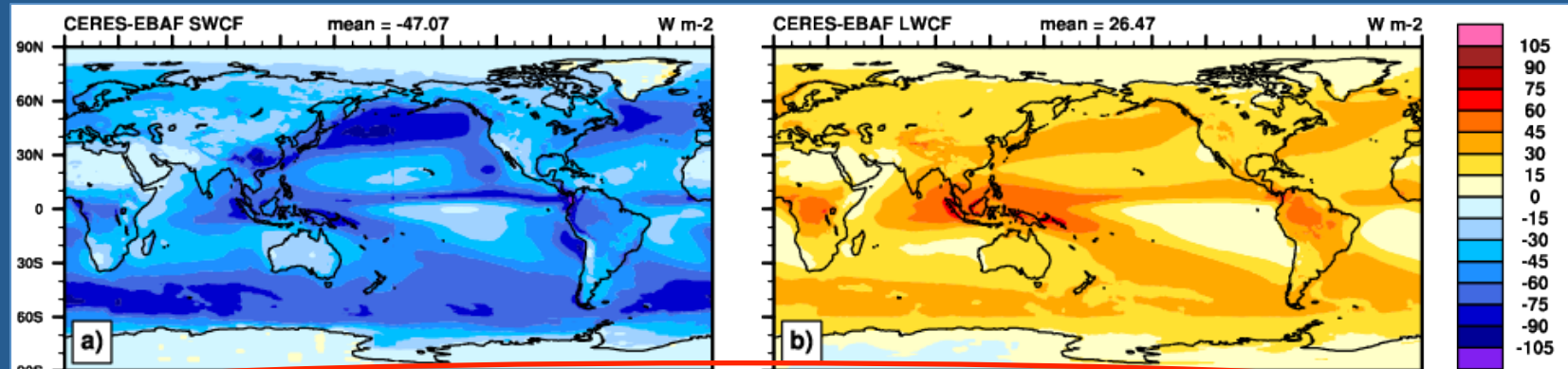
Let's analyze 2001-2010 ten-year AMIP CAM runs (prescribed SST/ice) with COSP

Kay, J. E., Hillman, B., Klein, S., Zhang, Y., Medeiros, B., Gettelman, G., Marchand, R., Pincus, R., Boyle, J., Ackerman, T. and B. Eaton, Evaluation of CAM4 and CAM5 clouds with satellite observations and COSP (in prep for J. Climate)

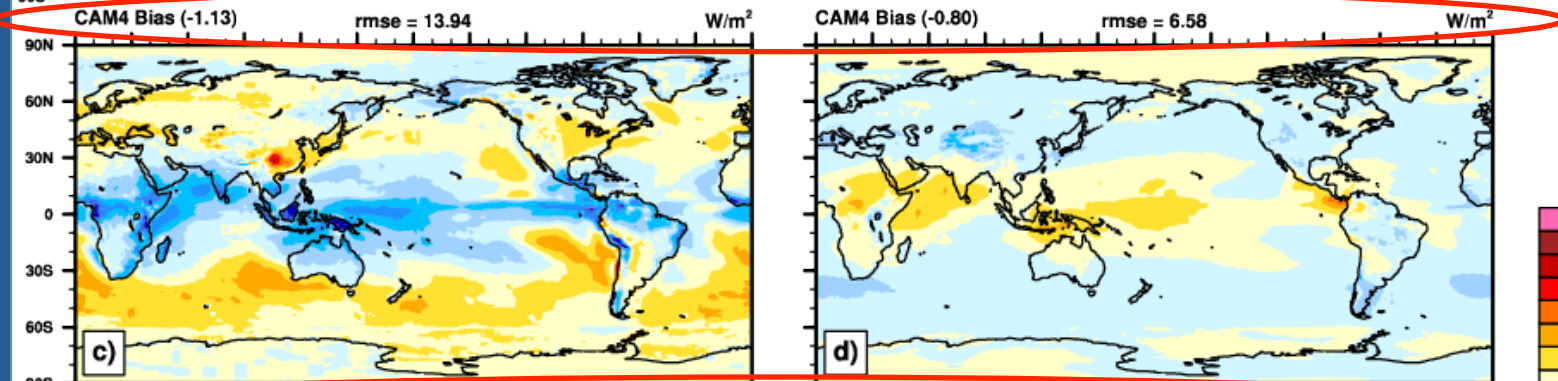
CAM Cloud Radiative Forcing vs. CERES-EBAF

(2001-2010, prescribed SST/ sea ice)

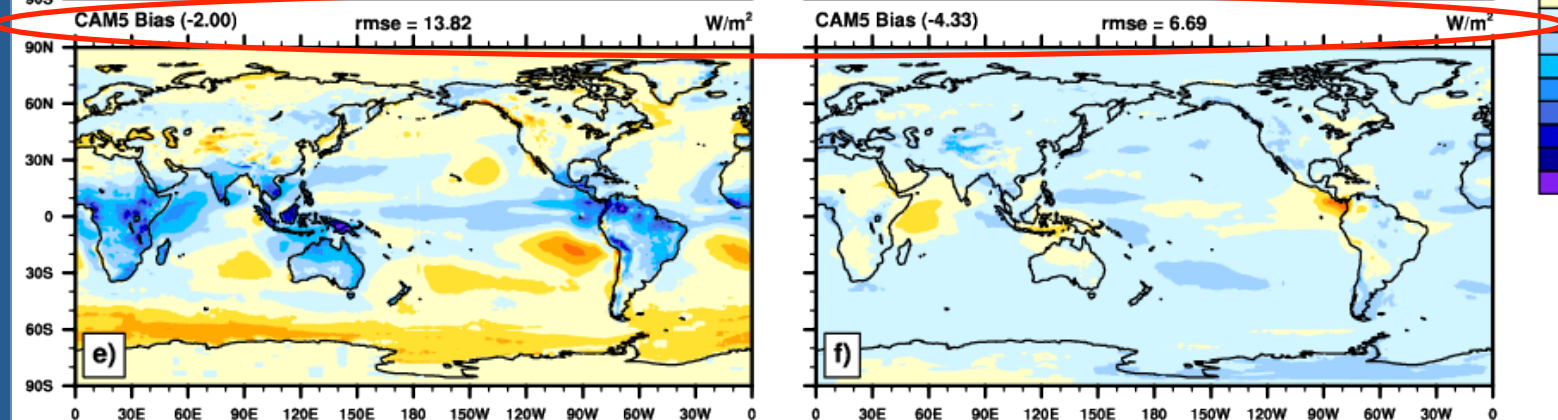
OBS



CAM4
bias



CAM5
bias





COSP and CFMIP at NCAR

**COSP in-line/on CAM trunk with both CAM4 and CAM5.
Effort began in August 2009. Code released June 2011.**

More information on COSP implementation:
<http://www.cgd.ucar.edu/cms/jenkay/cosp/cosp.htm>

Key players at NCAR:

Jen Kay (jenkay@ucar.edu), NCAR's CFMIP primary contact

- *implemented/debugging/scientific validation of COSP and CFMIP diagnostics

Brian Eaton

- *essential software engineering/design help

Steve Klein, Yuying Zhang, Jim Boyle (LLNL) and **Robert Pincus** (CU)

- *essential implementation and validation help

Ben Hillman (UW)

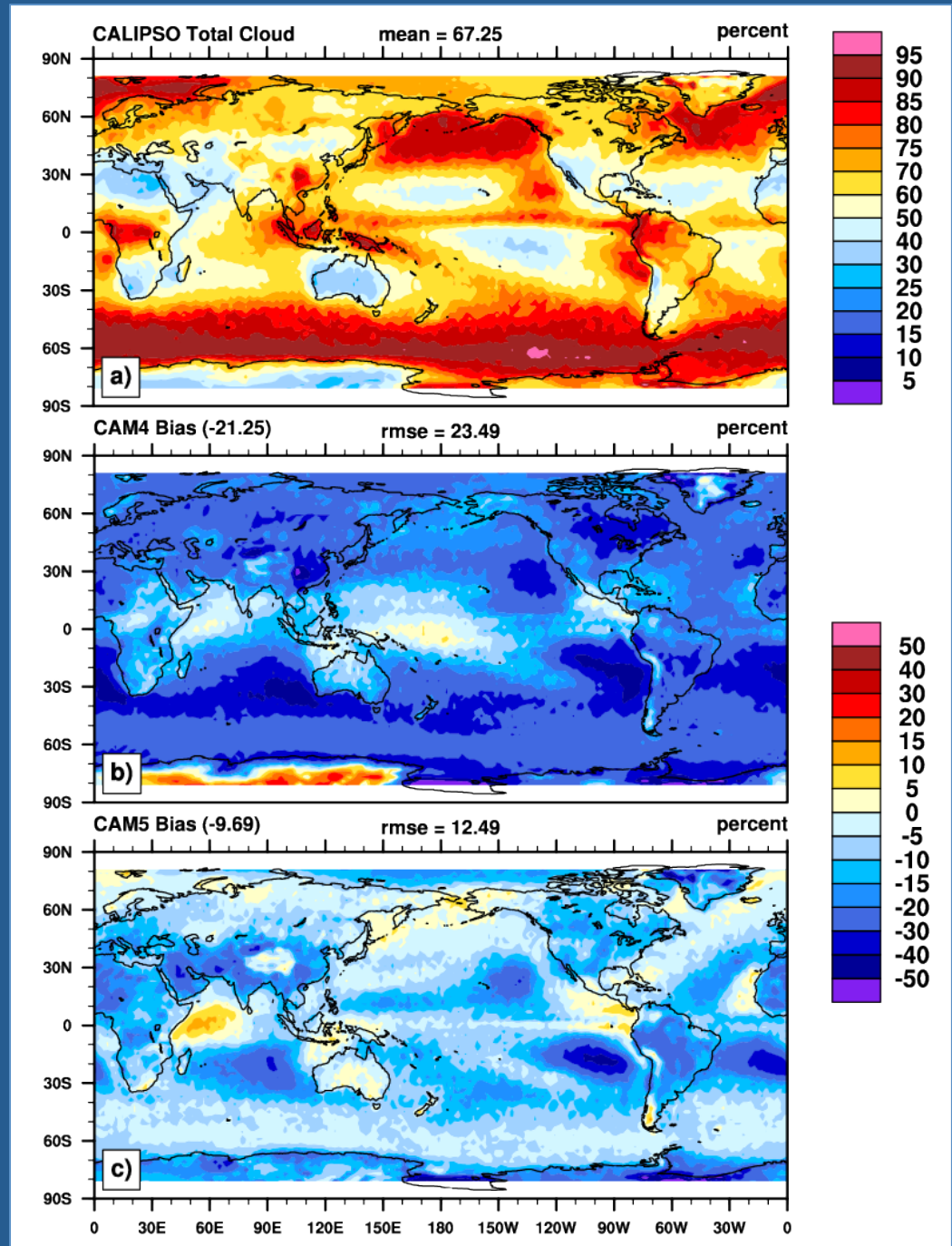
- *adding COSP outputs and CFMIP observations to AMWG diagnostics package

Ben Sanderson (bsander@ucar.edu)

- *coordinating CFMIP runs

Total Cloud (vs. CALIOP)

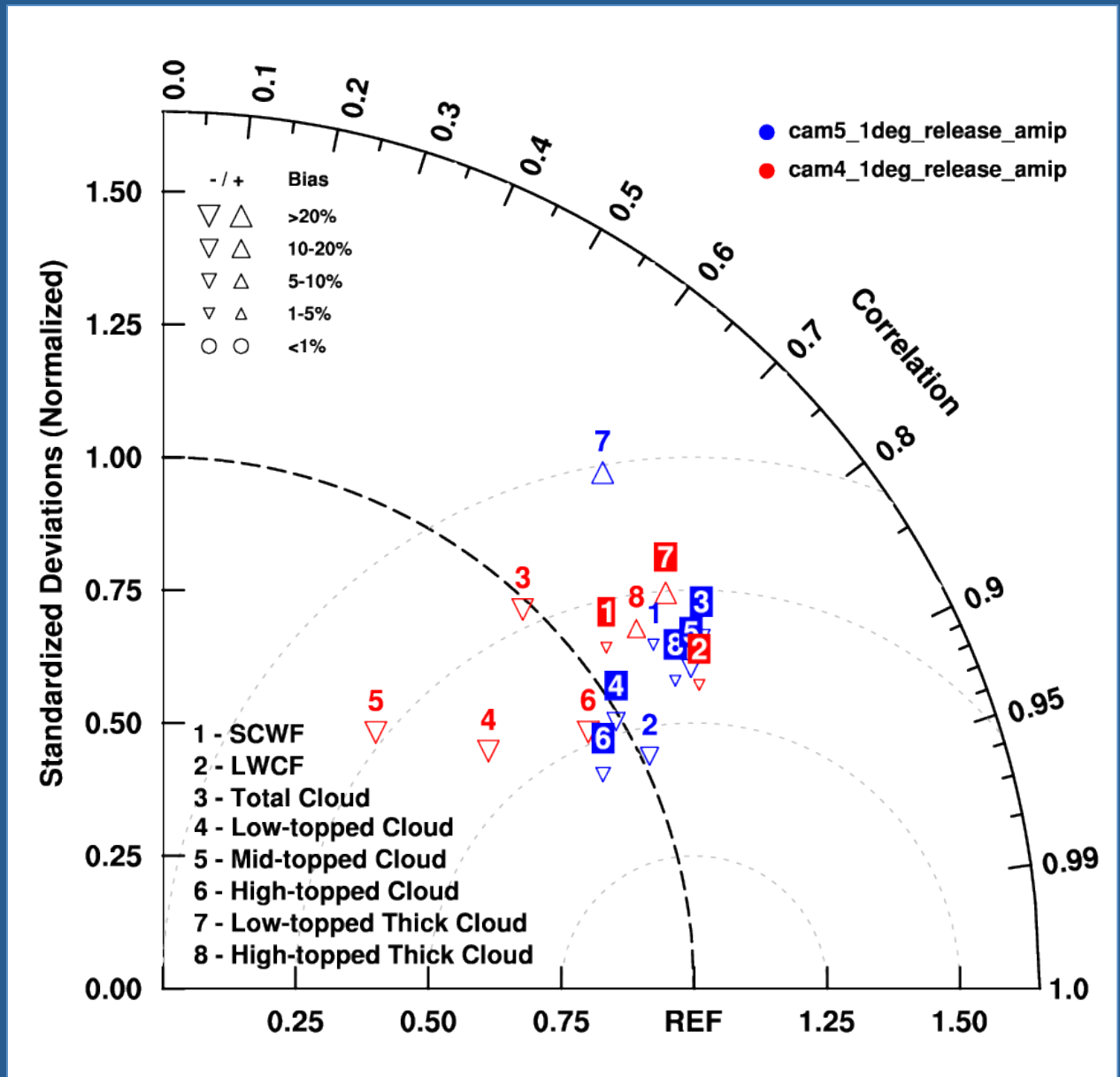
Similar results vs.
ISCCP, MISR



So many additional diagnostics...
How do we use them?
What do they mean?



What would
****YOU****
 put in a
 Taylor
 Diagram for
 Clouds and
 Radiation?



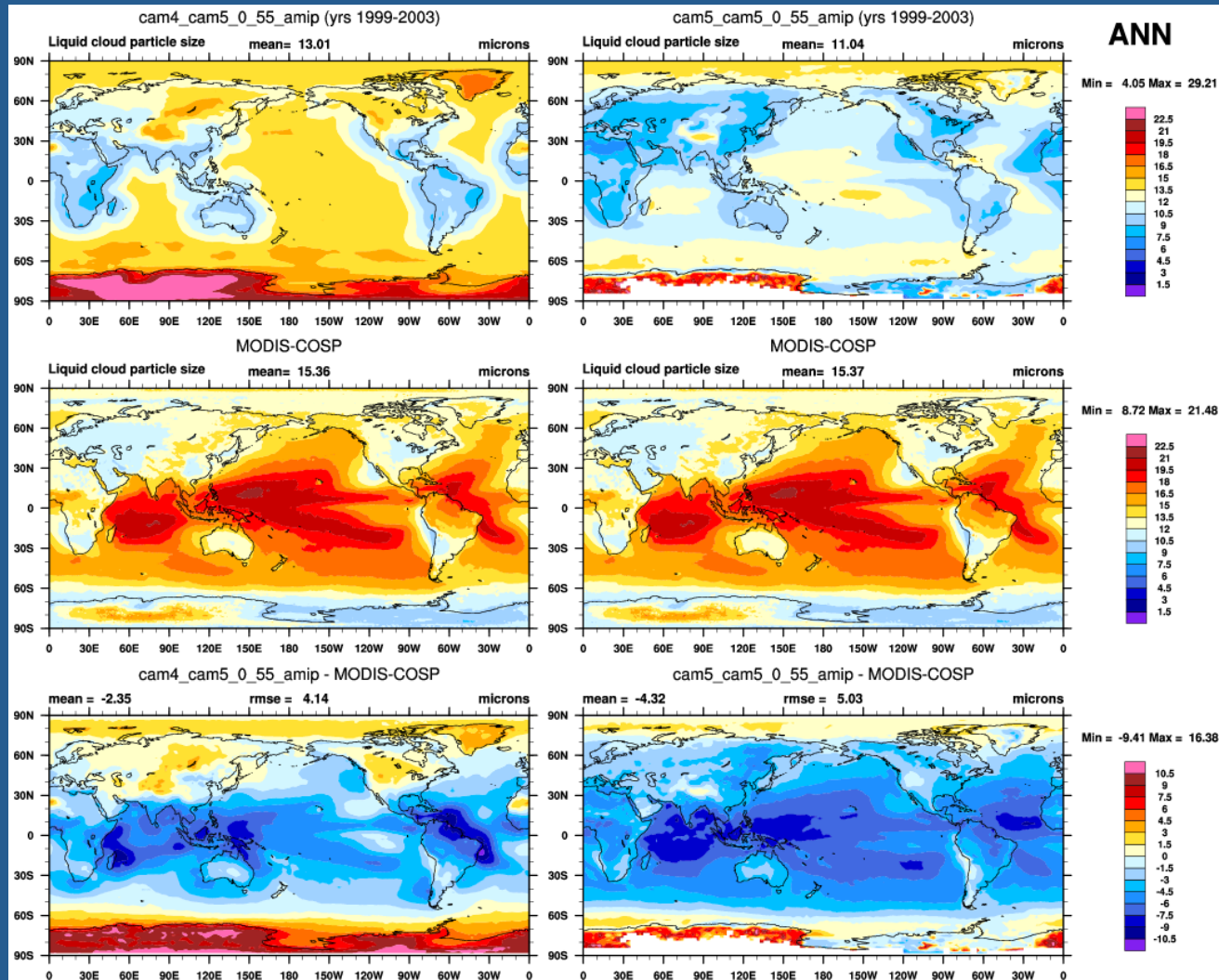
Summary

Our comparisons using COSP show that while both CAM versions have their deficiencies, CAM5, the higher sensitivity model with larger cloud fractions and smaller cloud water content, has a better representation of clouds than CAM4. That CAM5 has more realistic clouds than CAM4 when compared to present-day observations provides a necessary but insufficient evaluation for climate feedback purposes.

COSP for Liquid Effective Radius?

Are the retrievals ready? a point for discussion.

Spatial structure in CAM5 better match to MODIS...



EXTRA

Optically Thick Clouds ($\tau > 9.4$)

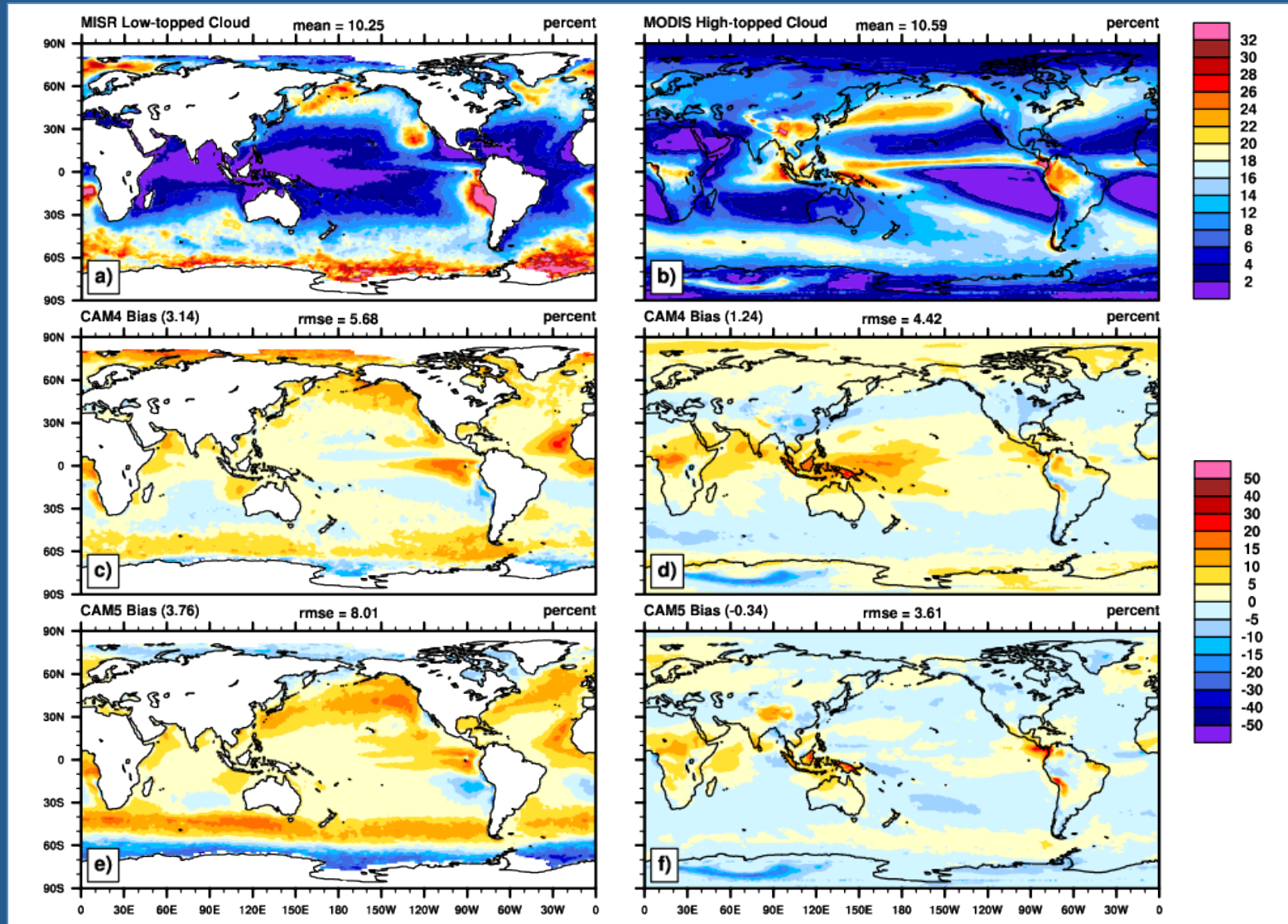
LOW (vs. MISR)

HIGH (vs. MODIS)

OBS

CAM4
bias

CAM5
bias



What does COSP cost?

	CAM	CAM + COSP passive (MODIS, MISR, ISCCP)	CAM + COSP passive + COSP lidar	CAM + COSP
CAM4 1 deg	19 minutes 35 GAU	28 minutes 52 GAU	34 minute 63 GAU	49 minutes 73 GAU
CAM5 1 deg				123 minutes 183 GAU
CAM4 2 deg				16 minutes 21 GAU
CAM5 2 deg				34 minutes 45 GAU

For 1-month of simulation on bluefire (2 nodes, 64 virtual processors)

Approximate Rules of Thumb:

$\text{CAM5} + \text{COSP} = 2.3 * \text{CAM4} + \text{COSP}$

$\text{CAM} + \text{COSP} = 2.6 * \text{CAM}$

$\text{CAM1deg} + \text{COSP} = 3.3 * \text{CAM2deg} + \text{COSP}$