Application of Satellite and ARM simulators to ACME Model Evaluation: Progress, Problems, and Plan

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ACME Accelerated Climate Modeling for Energy

Overview

Given the different definitions of clouds among climate models and between models and observations, the instrument simulators are developed to facilitate an "apple-to-apple" comparison of modeled clouds with detailed observations. The simulator approach accounts for observational limitations of the instruments and bridge the scale gaps between observations and climate models. In the ACME project, the simulators will be applied to perform meaningful testing for new or improved parameterizations. To facilitate the comprehensive assessment for the cloud simulations, we implemented the ACME Tier 1b cloud collection of satellite simulator diagnostics in UVCDAT through the collaboration with the workflow team. We performed an initial assessment of the candidate convection schemes for the next generation of CAM by applying these simulator diagnostics to their AMIP simulations. The results will provide useful information for ACME since these schemes are also being tested in ACME model. In addition to the comparison with satellite observations, this poster will also present initial assessment of ACME model simulated clouds with high frequency and high vertical resolution ARM data by using a newly developed ARM radar simulator for the DOE ARM program.

In this poster, we will also discuss the problems we encountered for v0.1 AMIP ensemble runs ne30 and ne120 with satellite simulators. Our future plan on how to upgrade COSP for more efficient speed, lidar cloud phase diagnostics, and aerosol diagnostics will be presented.

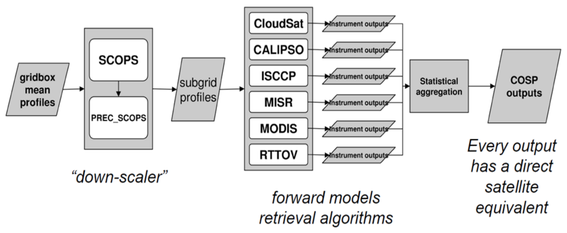
Method

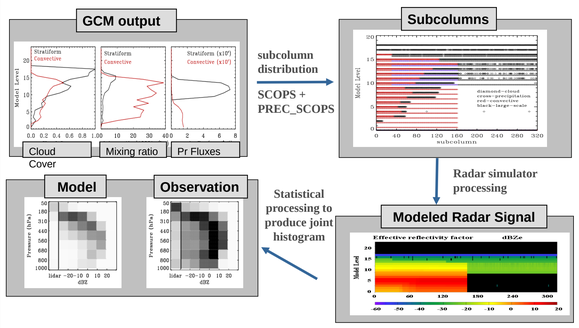
COSP – the CFMIP Observation Simulator Package

COSP development team:

- Met Office Hadley Centre
- LMD/IPSL
- Lawrence Livermore National Laboratory
- Colorado State University
- University of Washington

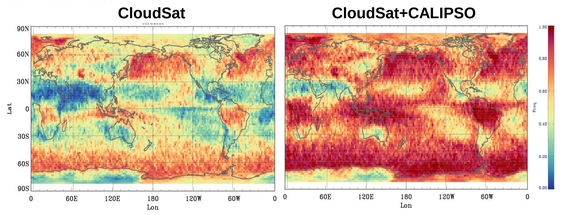
COSP Flow Chart



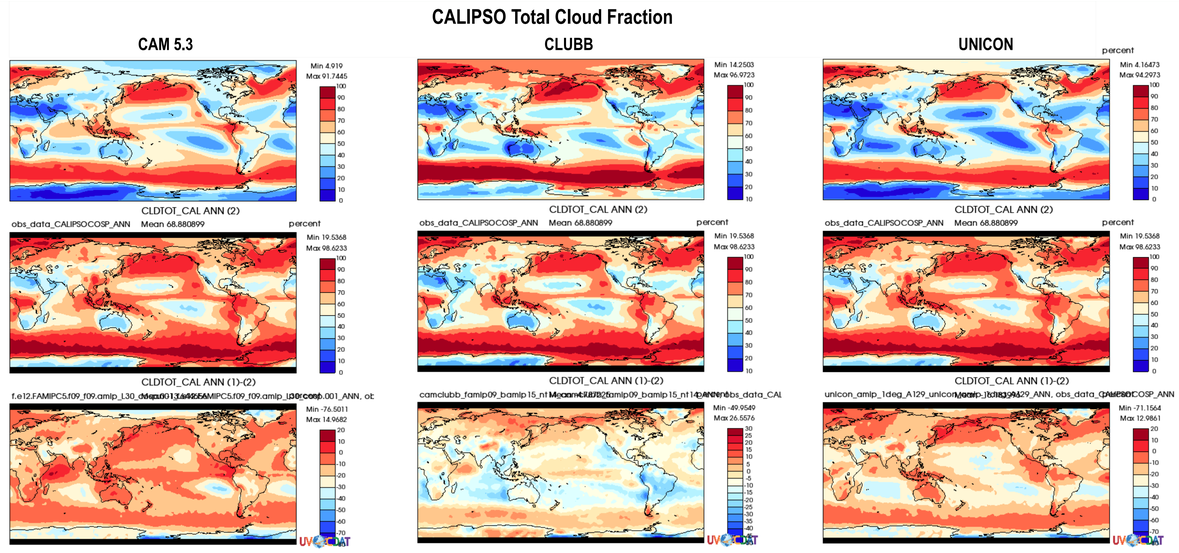


Sample: cloud properties observed by different systems can be different

Total cloud fraction :



Tier 1b Cloud Collection of COSP diagnostics in UVCDAT



CALIPSO

	CLDTOT_CAL	CLDLOW_CAL	CLDMED_CAL	CLDHGH_CAL
ANN	MEAN (RMSE)			
OBS	67.25	38.16	18.08	32.04
CAM5.3	55.01 (14.81)	31.96 (10.93)	12.14 (7.38)	26.16 (7.91)
CLUBB	60.91 (9.96)	32.27 (10.07)	20.54 (8.90)	33.19 (6.35)
UNICON	50.45 (18.97)	26.37 (15.76)	12.20 (7.98)	26.22 (7.67)

ISCCP

	CLDTOT_TAU1.3	CLDTOT_TAU1.3-9.4	CLDTOT_TAU9.4
ANN	MEAN (RMSE)		
OBS	51.96	33.22	18.74
CAM5.3	44.35 (12.47)	21.52 (13.93)	22.82 (12.65)
CLUBB	45.08 (10.81)	21.57 (14.44)	23.50 (10.61)
UNICON	39.67 (15.21)	16.41 (19.35)	23.26 (12.31)

MODIS

	CLDTOT_TAU1.3	CLDTOT_TAU1.3-9.4	CLDTOT_TAU9.4
ANN	MEAN (RMSE)		
OBS	48.12	24.60	23.52
CAM5.3	42.96 (11.57)	20.00 (7.75)	22.95 (10.00)
CLUBB	43.92 (10.15)	18.16 (9.27)	25.75 (8.72)
UNICON	33.76 (16.78)	11.18 (15.47)	22.57 (9.10)

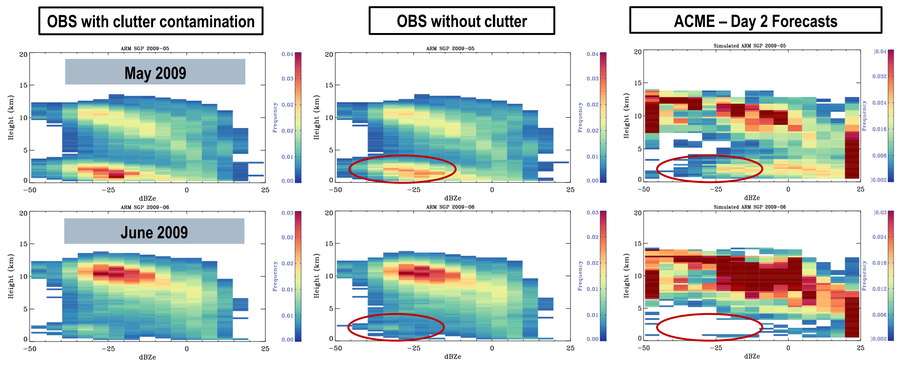
	CLDHGH_TAU1.3	CLDHGH_TAU1.3-9.4	CLDHGH_TAU9.4
ANN	MEAN (RMSE)		
OBS	20.95	10.36	10.59
CAM5.3	16.22 (7.22)	7.64 (5.00)	8.57 (3.74)
CLUBB	16.94 (7.29)	6.16 (6.19)	10.77 (3.17)
UNICON	12.80 (10.79)	5.38 (6.77)	7.41 (4.67)

MISR

	CLDTOT_TAU1.3	CLDTOT_TAU1.3-9.4	CLDTOT_TAU9.4
ANN	MEAN (RMSE)		
OBS	54.33	31.89	22.44
CAM5.3	49.14 (13.11)	25.06 (9.81)	24.07 (10.69)
CLUBB	49.65 (10.29)	24.40 (9.96)	25.25 (8.45)
UNICON	43.24 (14.50)	17.76 (16.29)	25.47 (10.17)

	CLDLOW_TAU1.3	CLDLOW_TAU1.3-9.4	CLDLOW_TAU9.4
ANN	MEAN (RMSE)		
OBS	30.75	20.34	10.41
CAM5.3	31.75 (9.61)	17.67 (6.78)	14.07 (8.13)
CLUBB	31.39 (7.84)	17.85 (6.38)	13.54 (7.31)
UNICON	25.06 (10.01)	9.21 (13.36)	15.84 (9.12)

ACME Model Evaluation Through ARM Simulator



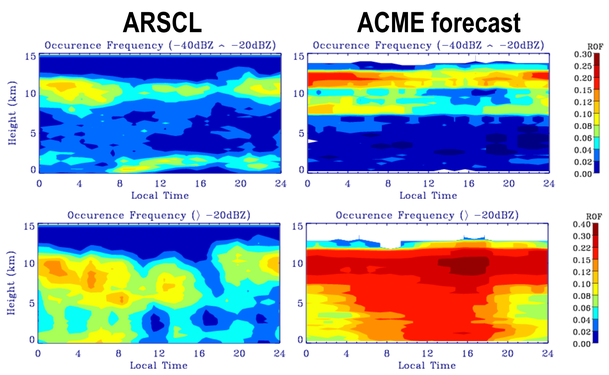
Groud-based radar data contain uncertainty from clutter

Two datasets give a range of uncertainty. Model clearly underestimates hydrometeor at middle and low levels even consider the uncertainty except for drizzle and rain.

The millimeter-wavelength radars operated at the ARM sites measure clouds and precipitation with high frequency and high vertical resolution. These observations provide detailed information on vertical structure of cloud systems and unique opportunity for model evaluation on diurnal cycle of cloud systems.

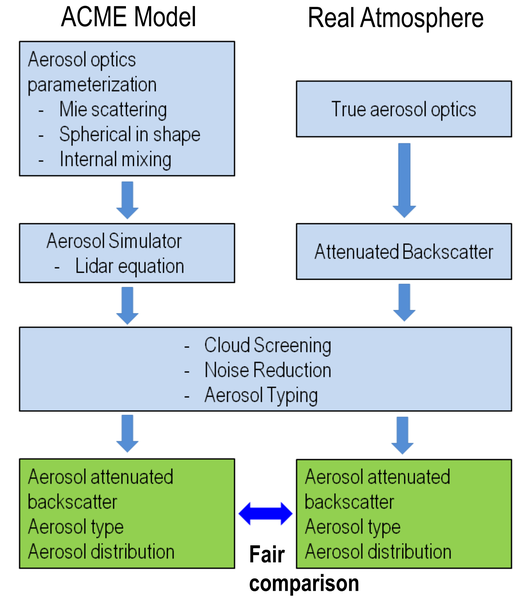
Cloud simulations from Day-2 forecast of ACME model are compared with observed radar reflectivity in ARSCL dataset.

Diurnal Cycle at ARM SGP site (May~July 2009)



Aerosol lidar simulator

For aerosol simulator, the 180-degree backscatter at 532nm will be written out by RRTMG as a new radiation diagnostics, using the pre-generated look-up table. The attenuated backscatter (ATB) can then be computed by solving the lidar equation. Cloud masking is considered for each subcolumn.



Problems

Task R1, AMIP ensemble runs with ACME v0.1 at ne30 and ne120 resolutions is the first major simulation campaign conducted by ACME. COSP v1.3 is already in the model and we tried to turn on the COSP for cloud output.

- COSP + OpenMP works fine on Titan and LC, but specifically has problems on Miran.
- Without OpenMP slows the model down by a factor of 2-5.
- The memory requirements in COSP are too large for ne120 resolution. (sub-column number has been reduced to the minimum at 10.)

Plan

- ❖ Upgrade COSP in ACME model
- ❖ Implement aerosol lidar simulator for ACME
- ❖ As part of Metrics Activity in tuning and evaluation task, make cloud collection of COSP diagnostics functioning and perform the testing for the AMIP ensemble runs of ACME model v0.1
- ❖ As part of Convection task, examine the cloud simulations from the candidate convection schemes through simulator diagnostics and using global and field observations.

Acknowledgment

This research was conducted by the Accelerated Climate Modeling for Energy (ACME) project, supported by the Office of Biological and Environmental Research in the DOE Office of Science. The work on the ARM simulator is supported by the DOE ARM program.

This work is supported by the Regional and Global Climate and Earth System Modeling programs for the Office of Science of the United States Department of Energy. This work was performed under the auspices of the U. S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. LLNL-POST-670104