



Met Office
Hadley Centre

Cloud simulators and CMIP6 model evaluation needs

A. Bodas-Salcedo



Met Office
Hadley Centre

Outline

- COSP
- Challenges and lessons learnt from CMIP5
- Request for DECK
- Future directions

COSP diagnostics

TABLE I. List of diagnostics from the COSP version 1.3.

Simulator	Output diagnostics
CALIPSO	Lidar total backscatter (532 nm) Lidar molecular backscatter Height–scattering ratio histograms Low-level cloud fraction (CTP > 680 hPa) Midlevel cloud fraction (440 < CTP < 680 hPa) High-level cloud fraction (CTP < 440 hPa) 3D cloud fraction Total cloud fraction
<i>CloudSat</i>	Radar reflectivity Height–reflectivity histograms
ISCCP	Mean cloud albedo Mean CTP Mean 10.5- μm T_B Mean clear-sky 10.5- μm T_B Mean cloud optical depth CTP in each subcolumn Cloud optical depth in each subcolumn CTP– τ histograms Total cloud fraction
MISR	CTH– τ histograms
MODIS	Total cloud fraction Liquid cloud fraction Ice cloud fraction High-level cloud fraction Midlevel cloud fraction Low-level cloud fraction Total cloud optical thickness Liquid cloud optical thickness Ice cloud optical thickness Total cloud optical thickness [$\text{Log}_{10}(\text{mean})$] Liquid cloud optical thickness [$\text{Log}_{10}(\text{mean})$] Ice cloud optical thickness [$\text{Log}_{10}(\text{mean})$] Liquid cloud particle size Ice cloud particle size CTP– τ histograms Cloud liquid water path Cloud ice water path Cloud area fraction
PARASOL	Monodirectional reflectance
RTTOV	Clear-sky T_B
Combined	CALIPSO cloud fraction undetected by <i>CloudSat</i> Total cloud fraction from <i>CloudSat</i> and CALIPSO



Challenges: development and implementation

- Climate models are complex, implementing new code involves effort.
- Modelling centres request a stable version
- License is important (COSPP is the first BSD code in the Met Office UM)



Challenges: promoting COSP

- Need to demonstrate utility: ISCCP ~ 170*2, CALIPSO ~ 50, CloudSat ~ 70+60, MISR ~ 25, MODIS ~ 30, COSP ~ 70
- Request by CMIP/CFMIP/TAMIP activities key. Now used for routine evaluation activities.
- Communication between communities: simulators are not a threat to the development of satellite retrievals/products.
 - Bring modelling and data experts together
 - Need for compatible observational data



Request for model outputs in CMIP6

- COSP PMC have discussed the data request proposal for the DECK
- To be send out for comments from users (mod. centres)
- Proposal will be channelled CFMIP committee
- CMIP5/CFMIP2 used as starting point. Changes proposed as 'deltas' wrt CMIP5
 - CFMIP has a strong model evaluation aspect -> decision to request CFMIP/AMIP diagnostics to be included in the DECK
 - Conservative from the point of view of new diagnostics (stable version)



DECK request

- Tried to simplify the request, sometimes at the expense of extra data.
- All COSP requests based upon COSP v1.4 (released Nov 2013).
- Diagnostics must have been used in peer-reviewed literature (not necessarily CMIP5 data).
- New capabilities in COSP. CFMIP to include AMIP experiment with extra simulator diagnostics

Summary of changes

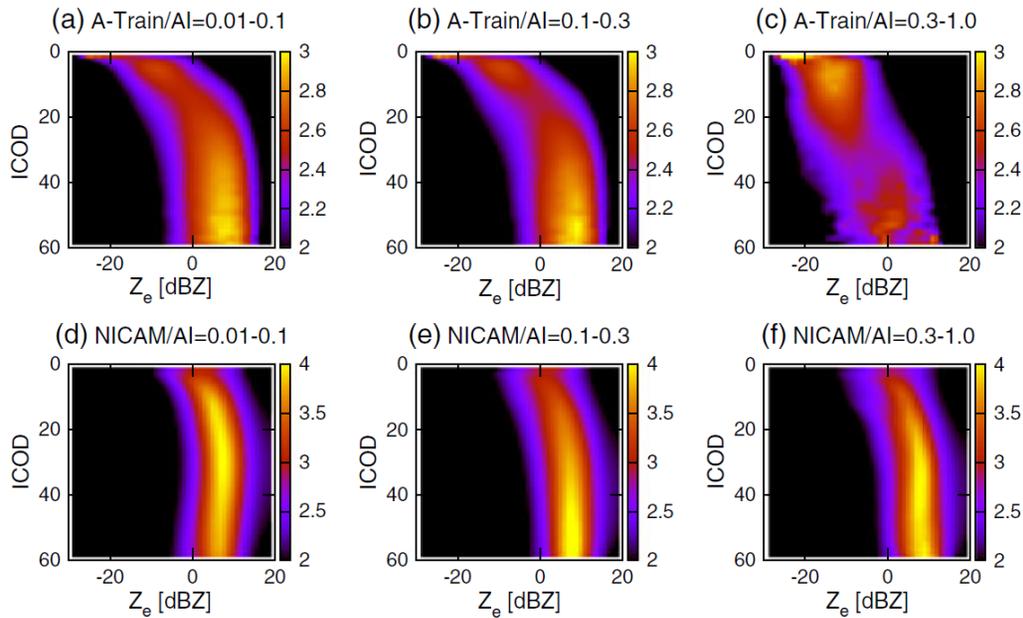
- #1: Replacement of curtain data by full 3D fields. No need for monthly gridding. AMIP run.
Evaluation/understanding.
- #2: Monthly CFADs to AMIP run. New table cfMonExtra.
Evaluation.
- #3: Standard monthly COSP and daily COSP 2D outputs in all of the DECK experiments. *Cloud trends/OSSes/cloud adjustments/cloud feedbacks*
- #4: MISR CTH-OD to cfMonExtra (~#2). MISR CTH-OD and ISCCP CTP-OD histograms to cf3hr.
Evaluation/understanding/test bed for multi-sensor diagnostics.



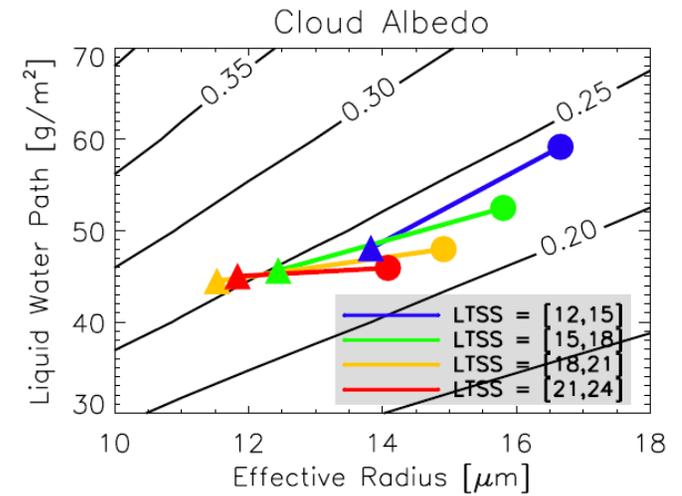
Beyond cloud properties

- Focus on satellite products that cannot be compared directly with models (that can be reasonably simulated)
- Possible extensions: precipitation, aerosols, and ground-base active sensors.
- This is an open source project, and can be forked.
- Welcoming and inclusive for new code developments (but resource-limited!)
- High frequency, multi-instrument diagnostics

Warm rain processes

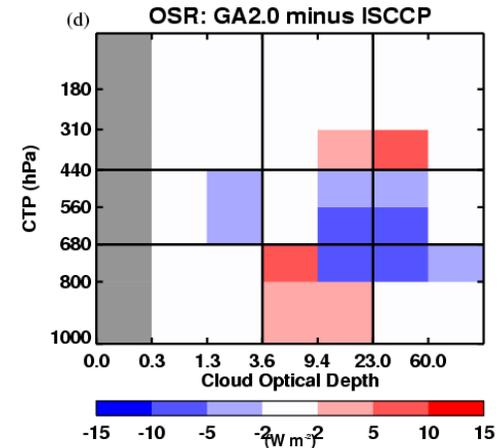
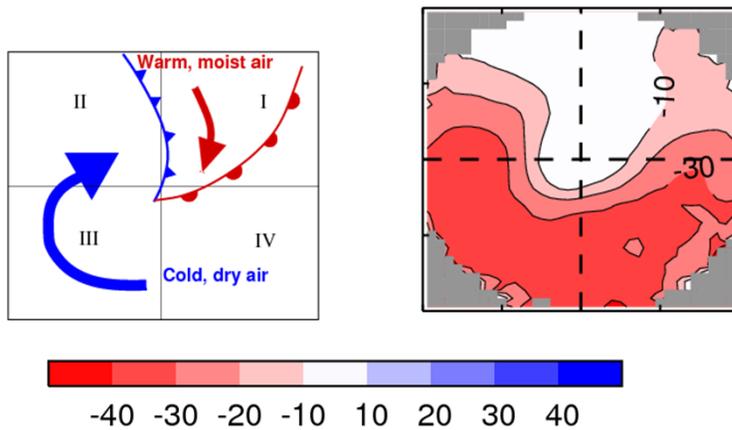
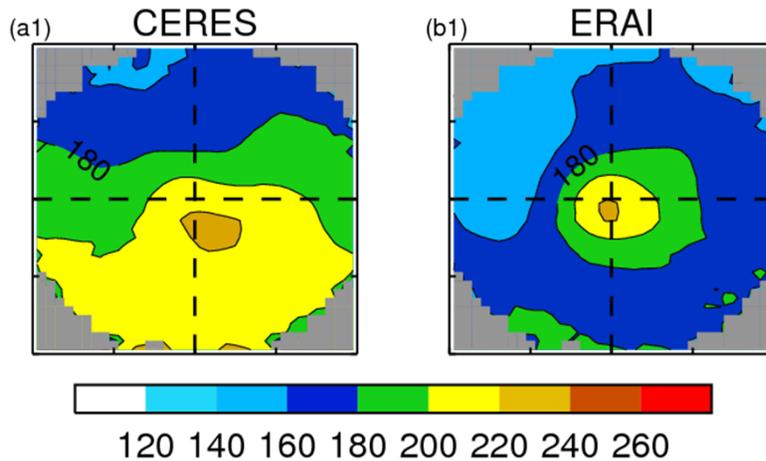


(Suzuki et al., JGR, 2013)

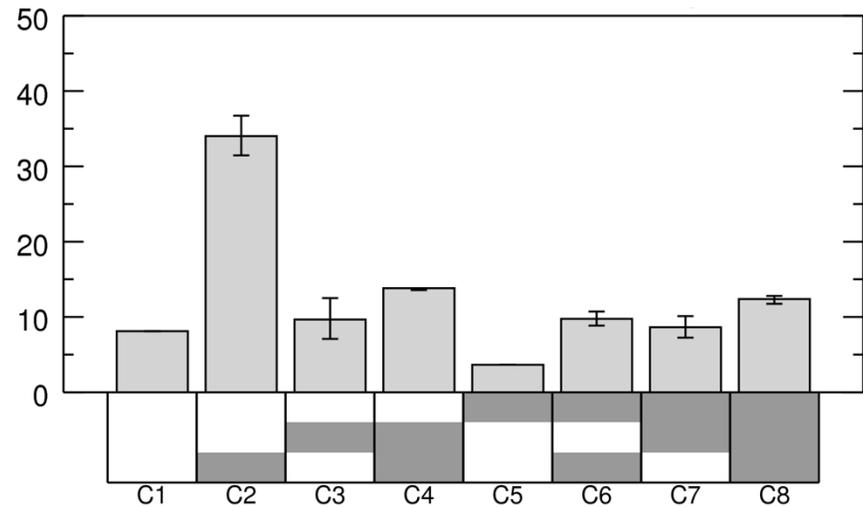


(Lebsock et al., JGR, 2008)

Cloud/radiation interactions



(Bodas-Salcedo et al., J. Clim., 2012)



(Bodas-Salcedo et al., J. Clim., 2014)



Thanks!

COSP

Satellite simulation software for model assessment

BY A. BODAS-SALCEDO, M. J. WEBB, S. BONY, H. CHEPFER, J.-L. DUFRESNE, S. A. KLEIN, Y. ZHANG,
R. MARCHAND, J. M. HAYNES, R. PINCUS, AND V. O. JOHN

By simulating the observations of multiple satellite instruments, COSP enables quantitative evaluation of clouds, humidity, and precipitation processes in diverse numerical models.

Bull. Am. Meteorol. Soc., 92(8), 1023-1043, 2011. DOI:10.1175/2011BAMS2856.1.

CFMIP web: <http://www.cfmip.net/> -> COSP

User group: <http://groups.google.com/group/cosp-user>

Code: <http://code.google.com/p/cfmip-obs-sim/>