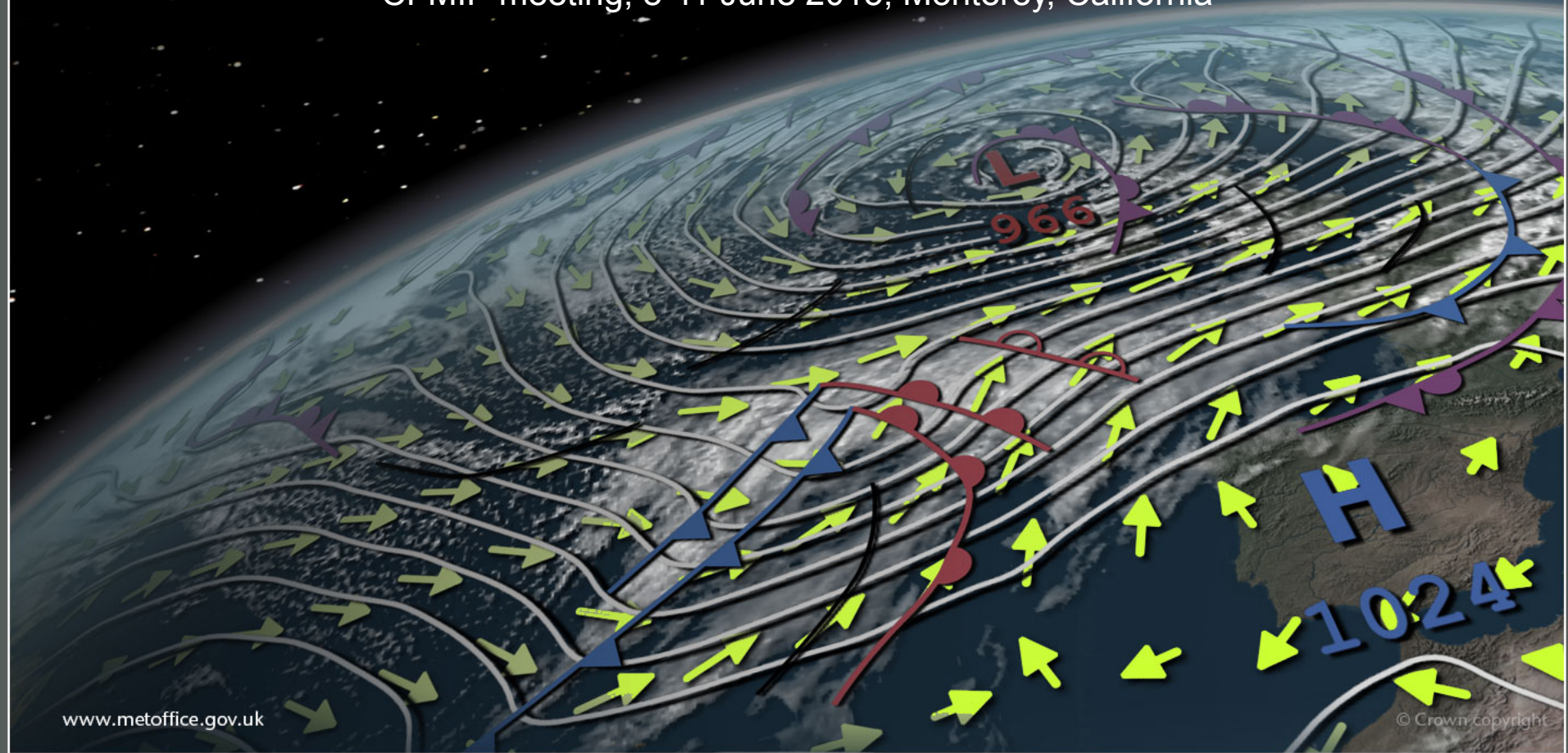# COSP: overview, CMIP6, and future plans

A. Bodas-Salcedo, R. Pincus (U. Colorado), D. Swales (U. Colorado), and the COSP PMC

CFMIP meeting, 8-11 June 2015, Monterey, California

CFMIP Observation Simulator Package

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.

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/**

Individual simulators

- **CALIPSO/CALIOP (Chepfer et al., GRL, 2008): scattering ratio, height-SR histograms, cloud fraction**

- **ISCCP (Klein and Jakob, MWR, 1999; Webb et al., Cim. Dyn., 2001): τ-CTP histograms, cloud properties**

- **MISR (Marchand and Ackerman, JGR, 2010): τ-CTH histograms**

- **MODIS (Pincus et al., J. Clim., 2012): τ-CTP histograms, effective radius, cloud phase**

- **PARASOL: reflectance**

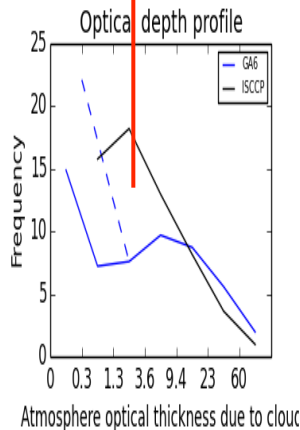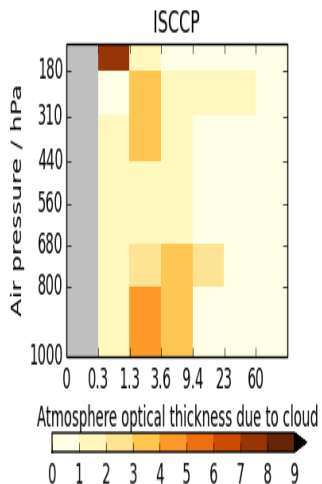- **RTTOV (Saunders et al., QJRMS, 1999): brightness temperature**

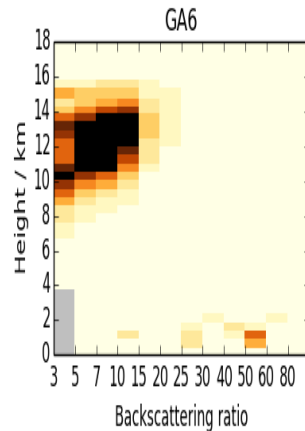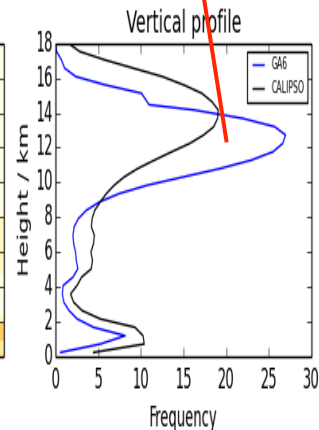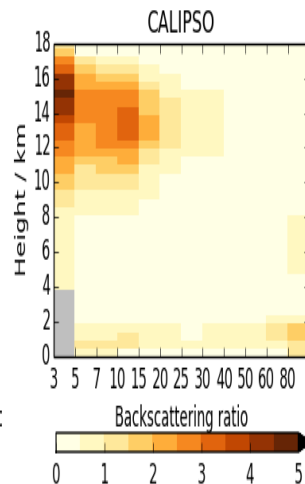# Comparison against satellite data over the tropics

ISCCP   CALIPSO   CloudSat
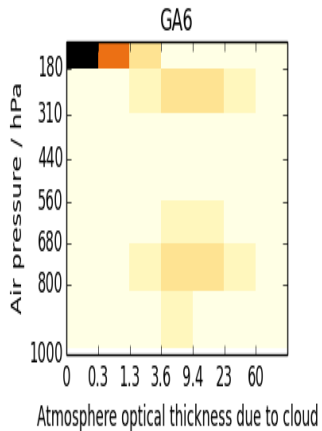
Too little medium brightness cloud

Excessive cirrus and too low
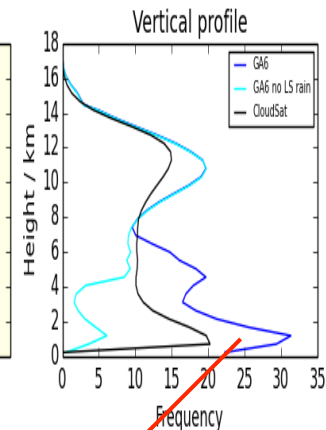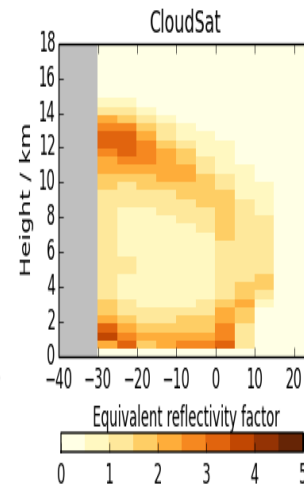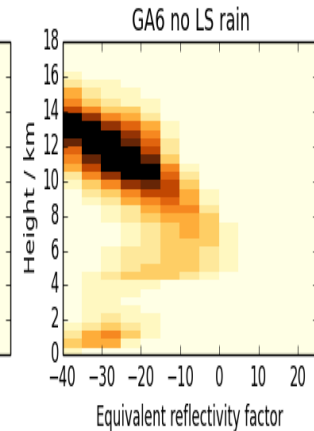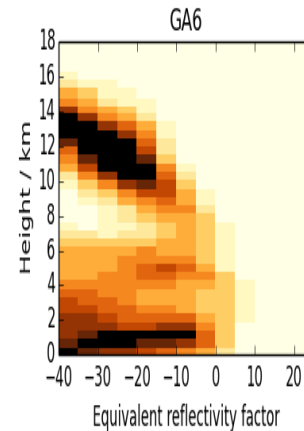
Excess "drizzle" (<0.005mm/hr)

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CMIP6 request philosophy

- Conservative from the point of view of new diagnostics: COSP requests based upon COSP v1.4.

- We have tried to simplify the request, sometimes at the expense of extra data.

- CFMIP has a strong model evaluation aspect -> decision to request CFMIP/AMIP diagnostics to be included in the DECK.

- Section *Proposal of request of COSP diagnostics for CMIP/DECK, CMIP6Historical and CMIP6 CFMIP experiments* in the [MIP proposal](#)*.

	cfMon_sim	cfDay_2D	cfDay_3D	cfMon_extra	cfDay_extra	cf3hr_inline
	IS CA	IS CA	IS CA	CA CL / MI MO PA	CA / MO PA	CA CL / MO PA
amip						
piControl						
1pctCO2						
abrupt4xCO2						
historical						

Legend: IS CA CL MI MO PA

cfMon_sim	cltisccp, albisccp, pctisccp, clisccp, cltcalipso, cllcalipso, clmcalipso, clhcalipso, clcalipso
cfDay_2D	cltisccp, albisccp, pctisccp, cltcalipso, cllcalipso, clmcalipso, clhcalipso, parasolRefl
cfDay_3D	clisccp, clcalipso
cfMon_extra	clcalipso_liq, clcalipso_ice, cfadLidarsr532, cfadDbze94, clmisr, jpdftaureliqmodis, jpdftaureicemodis, cltliqmodis, clticemodis, cltmodis, parasolRefl
cfDay_extra	cltcalipso, jpdftaureliqmodis, jpdftaureicemodis, parasolRefl
cf3hr	clisccp, clcalipso, clcalipso2, cltcalipso, cllcalipso, clmcalipso, clhcalipso, cfadLidarsr532, cfadDbze94, clmisr, jpdftaureliqmodis, jpdftaureicemodis, parasolRefl

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Why change COSP?

•COSP was developed as "glue" to make it easier to use a collection of satellite simulators/observation proxies.

•COSP 1.4 and prior made specific assumptions about the structure of model clouds (e.g. two internally homogeneous cloud types, precip. not visible in visible or IR, …)

•NASA funded an effort (PI R. Pincus) to redevelop COSP to make it easier to:

    •integrate into models

    •use a wider range of cloud descriptions including pre-built subcolumns

    •add new simulators and/or analyses
    build robust code

(R. Pincus)

Nothing has changed

It is possible to use COSP 2 as a nearly drop-in replacement for stock COSP 1.4

•Calls and arguments are unchanged

•"Hooks" to the model are cleanly isolated (real precision, logging/ reporting…)

•A few lines of host model code need to be modified

•Under the hood there are many changes.

•Updates and bug fixes starting (soon) will be to this code base

(R. Pincus)

Everything has changed

- The interface to the core of COSP 2 is lean

  - a derived type with grid-scale information

  - a derived type with *sub-column optical properties*
  (e.g optical thickness @ 0.67 μm, radar reflectivity @ 94 Ghz, …)

  - a (single, extensible) derived type with outputs

- We provide a general interface to the host model

  - can work on bite-sized chunks

  - draws sub-column cloud samples and converts to required optical properties

  - using *user-provided type-bound* functions including random number generation

(R. Pincus)

Some things have changed

- We provide a COSP 1.5 interface

    - uses the same information (cloud description, etc.) as COSP 1.4

    - provides the same results

    - but is arranged in two input and one output types

- We wrote this as a demystifying example. It could also be a starting point if your model uses a small perturbation on the COSP 1.4 description of clouds

(R. Pincus)

The path forward

• COSP 1.4 is the standard for CMIP6/CFMIP 2

•We are beta-testing COSP 2

• Depending on experiences with beta-testers COSP 2 may also be acceptable

• In the long run development (including bug fixes, efficiencies, new simulators, and new analyses) will be focused on COSP 2

• Google Code is shutting down, and COSP is moving to Github

(R. Pincus)

COSP statistics

- CMIP5 database lists 20 models using COSP
- 100 users registered in the users list.
- Citations (approx.):
  - COSP paper (Bodas-Salcedo et al., 2011): 100
  - ISCCP (Klein and Jakob, 1999; Webb et al., 2001): 190 each
  - CALIPSO (Chepfer et al., 2008): 60
  - CloudSat (Haynes et al., 2007): 70
  - MISR (Marchand and Ackerman, 2010): 15
  - MODIS (Pincus et al., 2012): 50

Participation in CMIP5

- WGCM recommended the use of COSP in a subset of CMIP experiments

- Data from 20 models in ESGF

- Requested in these experiments:

  - amip, amip4K, amipFuture, amip4xCO2

  - aquaControl, aqua4K, aqua4xCO2

  - piControl, historical, 1pcCO2, abrupt4xCO2

  - sstClim, sstClim4xCO2

BCC-CSM1.1 (6)
BCC-CSM1.1(m) (6)
CCSM4 (27)
CESM1(CAM5) (9)
CNRM-CM5 (41)
CanAM4 (42)
CanESM2 (63)
GFDL-CM3 (13)
GISS-E2-R (2)
HadGEM2-A (42)
HadGEM2-ES (44)
IPSL-CM5A-LR (382)
IPSL-CM5A-MR (55)
IPSL-CM5B-LR (24)
MIROC-ESM (21)
MIROC-ESM-CHEM (6)
MIROC5 (94)
MPI-ESM-LR (27)
MRI-CGCM3 (120)
NICAM-09 (9)