Results from Phase I of the Continual Intercomparison of Radiation Codes

L. Oreopoulos[1], E. Mlawer[2], J. Delamere[2], T. Shippert[3], T. Charlock[4], B. Fomin[5], M. Iacono[2],
Z. Jin[4], S. Kato[4], D. Kratz[4], J. Manners[6], P. Räisänen[7], and F. Rose[4]

1.NASA-GSFC 2.AER 3.PNNL 4.NASA-LARC 5.Central Aerological Observatory (Russia) 6.UK Met Office 7.Finnish Meteorological Institute

What is CIRC again?

CIRC=Continual Intercomparison of Radiation Codes

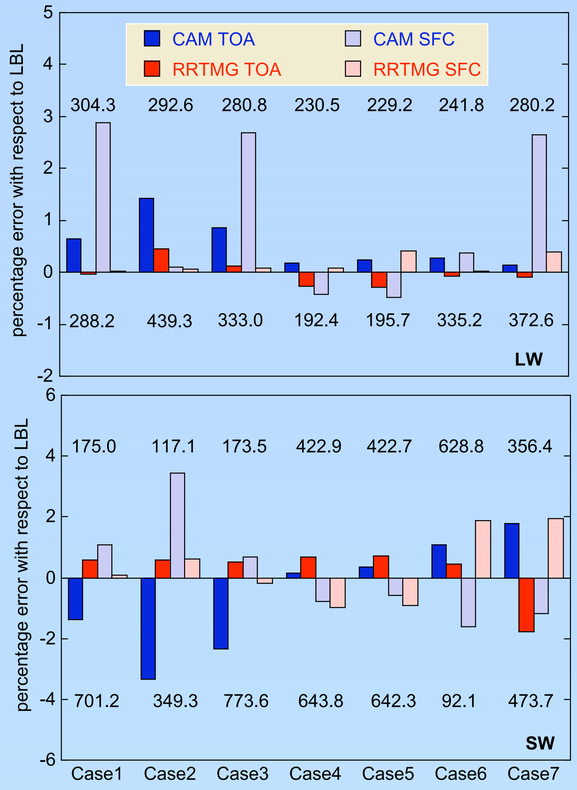
An evolving and regularly updated reference source for GCM-type radiative transfer (RT) code evaluation and improvement. Endorsed by GRP and IRC. Currently in Phase I. Please visit our website http://circ.gsfc.nasa.gov.

Phase I cases

Phase I deals with clear-sky cases (with aerosol for SGP) and overcast liquid clouds. Cases were built from ARM observations (mainly from BBHRP) with good radiative (BB and spectral IR) closure. Reference calculations come from AER LBL codes.

Case	Date (Site)	Description
1	9/25/00 (SGP)	clear, dry
2	7/19/00 (SGP)	clear, moist
3	5/4/00 (SGP)	clear, moderately moist
4	5/3/04 (NSA)	clear, very dry
5	5/3/04 (NSA)	as Case 4, 2xCO_2
6	3/17/00 (SGP)	thick cloud
7	7/6/06 (PYE, AMF)	CLOWD cloud

CAM 3.1 RT vs. RRTMG

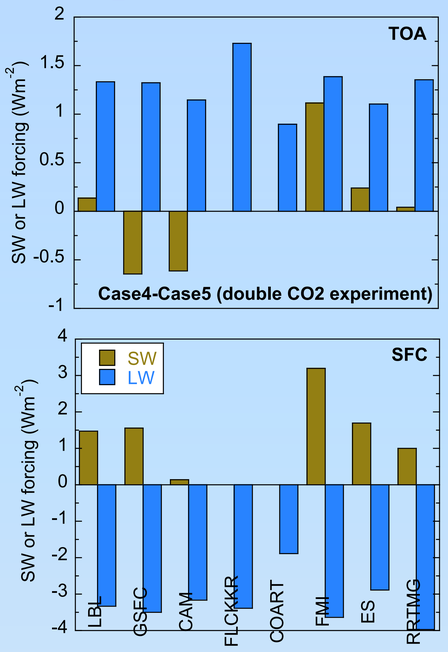


RRTMG is a candidate scheme for the next CAM. Here, it is compared with CAM 3.1 RT scheme. The numbers come from the LBL calculations, top row for TOA and bottom row for SFC.

What we have learned so far

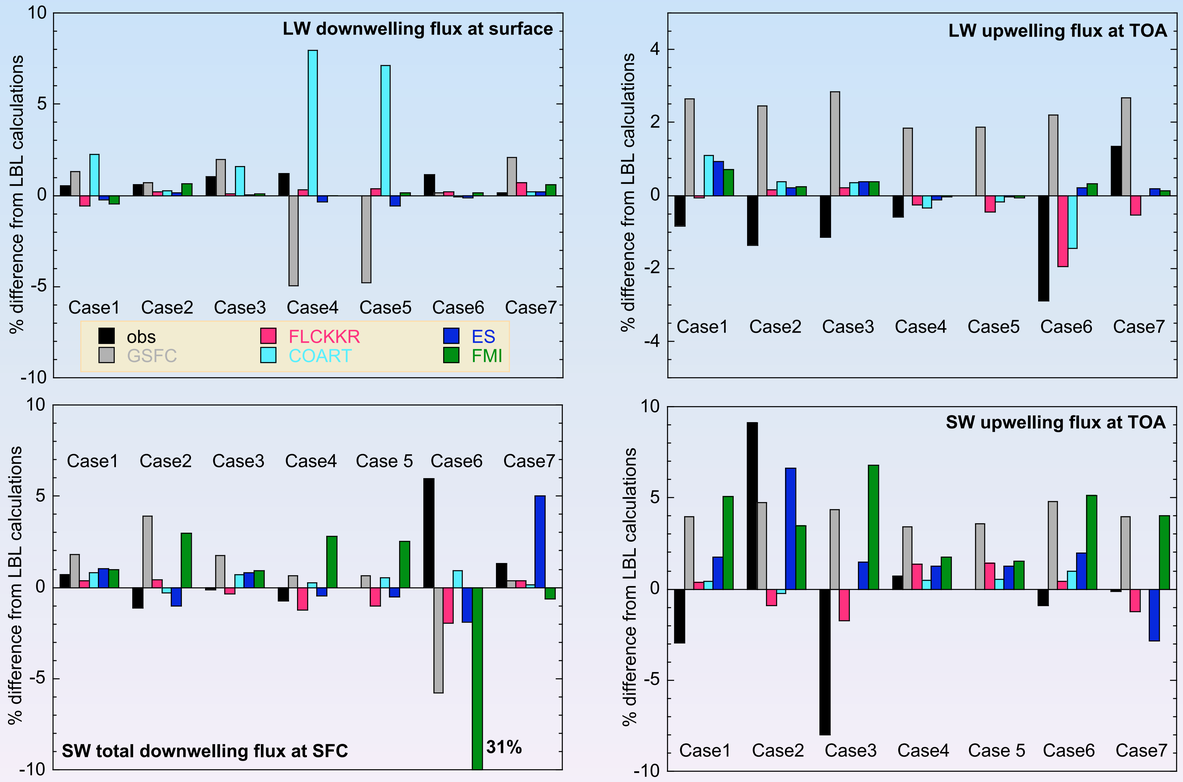
- Observations provide realism and confidence on quality of LBL runs
- RT codes can overall better simulate LW
- Surprisingly, overcast liquid clouds still create problems
- More spectral detail (as in RRTMG) can bring significant improvement
- LW and SW CO_2 forcing range wider than perhaps anticipated
- Coarse band-averaged SFC albedo may be inadequate and details (weighting method) of the spectral surface albedo function are important

CO_2 forcing in very dry atmospheres



Radiative forcing due to doubling CO_2 in an arctic (very dry and cold) environment. Note that FLCKKR and COART do not have the capability to perform the 2xCO2 experiment in the SW. Negative SW CO2 forcing for GSFC and CAM is due to spectral SFC albedo weigthing with LBL downwelling fluxes: the effective NIR albedo of Case 5 is higher than that of Case 4. See also figure below.

Modeled and observed fluxes vs. LBL

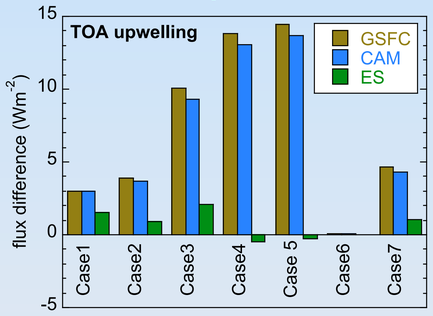


Flux deviations from LBL (in %) for several RT codes of CIRC Phase I. Deviations of observed fluxes from LBL reference calculations are also shown.

Codes participating in Phase I thus far

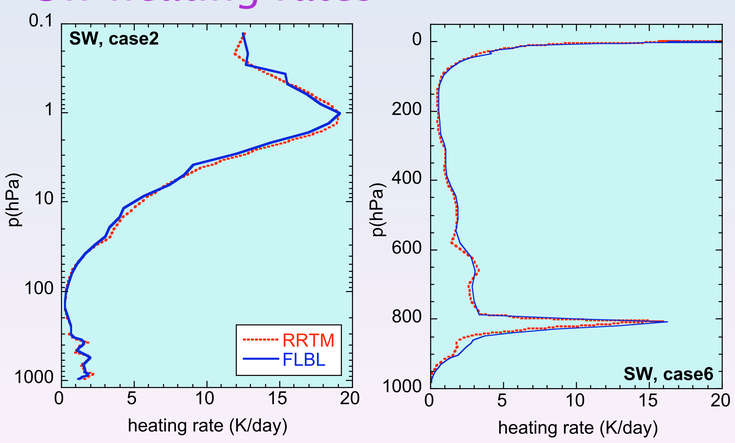
CAM (=Community Atmospheric Model), submitted by Oreopoulos
COART (= Coupled Ocean-Atmosphere Radiative Transfer), submitted by Jin and Charlock
ES (= Edwards-Slingo), submitted by Manners
FKDM (= Fast K-Distribution Model), submitted by Fomin
FLBL (= Fomin LBL Model), submitted by Fomin
FLCKKR (= Fu, Liou Charlock, Kato, Kratz, Rose), submitted by Rose and Charlock
FMI (=Finnish Meteorological Institute), ECHAM 5.4 RT code, submitted by Räisänen
GSFC (=Goddard Space Flight Center – Chou et al.), submitted by Oreopoulos
RRTM (= Rapid Radiative Transfer Model), submitted by Iacono
RRTMG (= Rapid Radiative Transfer Model for GCMs), submitted by Iacono

Role of spectral SFC albedo



The spectral surface albedo can be averaged using either TOA incident or SFC incident LBL fluxes as weights. This figure shows the impact on TOA SW flux from the two options. The smallest difference is for ES which resolves the SFC albedo into 6 bands (others resolve in two)

SW heating rates



We do not provide reference SW heating rates, but participants help fill the void with their own LBL calculations. See example above.