Global Energy and Water Cycle Experiment

GEWEX NEWS

WCRP World Climate Research Programme · WMO · IOC · ICSU

Vol. 19, No. 1 February 2009

Changes in Leadership of the GEWEX Scientific Steering Group

Thomas P. Ackerman

After many years as a member of the GEWEX Scientific Steering Group, Prof. Thomas Ackerman has assumed leadership of this important advisory group. GEWEX welcomes him as the new SSG Chairman (see page 3).

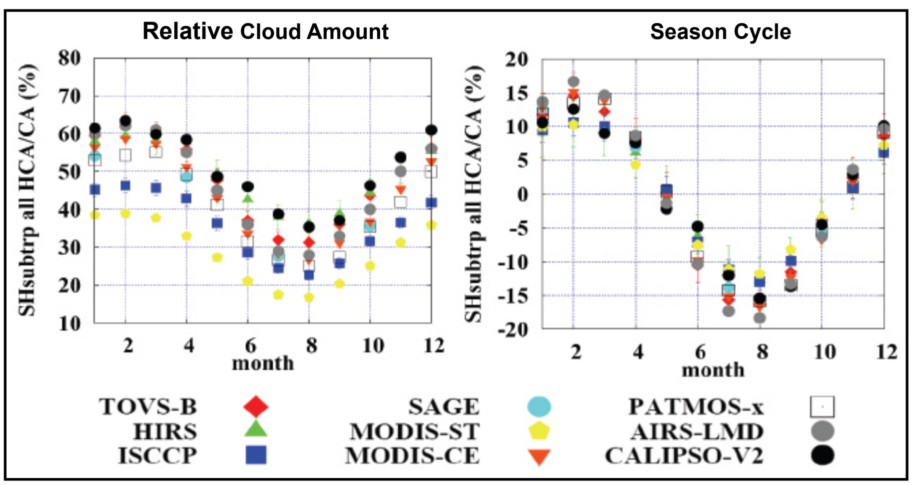
After 9 years as Chairman of the GEWEX Scientific Steering Group, Prof. Soroosh Sorooshian has stepped down. Two former IGPO Directors give tribute to the man whose exceptional leadership and guidance have shaped the science and direction of GEWEX (see pages 4 and 5).

Soroosh Sorooshian

GEWEX Radiation Panel Providing Key Contributions for Improving Models and Climate Prediction

Evaluation of Global Cloud Data Products (see figure below and article on page 6)

Intercomparisons of GCM Radiative Transfer Codes (see page 8)



Climatological monthly averages of high cloud amount are given for the latitude band 0° to 30°S. Whereas the absolute values depend on instrument sensitivity (as well as retrieval method), the seasonal cycles are very similar. The large seasonal cycle can be explained by the shift of the Inter-Tropical Convergence Zone. The seasonal cycle is smallest in the southern hemisphere mid-latitudes. See article by C. Stubenrauch et al. on page 6.

CIRC to Provide Key Intercomparisons of GCM Radiative Transfer Codes Prior to Next IPCC Assessment

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The Continual Intercomparison of Radiation Codes (CIRC) Project was initiated to evaluate the performance of radiative transfer (RT) codes used in global climate models (GCMs). Such an undertaking has not been attempted on a systematic scale since the GRP Intercomparison of Radiation Codes in Climate Models (ICRCCM; Ellingson and Fouquart, 1991) that took place over 15 years ago. The motivation for CIRC is the current routine availability of radiation data measured simultaneously with important radiative properties of the atmosphere like temperature and humidity by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Program and similiar initiatives, such as Europe's Cloudnet Project. The significance of continuous measuring programs for improving RT parameterizations has been advocated for many years (Ellingson and Wiscombe, 1996), but the necessary level of maturity in understanding instrument capabilities, retrieval algorithms and analysis techniques needed to take full advantage of the wealth of data produced by these programs has only recently become a reality.

The use of ARM data for the intercomparison of radiation codes is especially attractive due to the availability of the Broadband Heating Rate Profile (BBHRP) Evaluation Product, which has generated time series of calculated atmospheric radiative flux and heating rate profiles for two ARM sites using specifications of atmospheric and surface properties by instruments deployed at the sites. The centerpiece of BBHRP is the suite of radiometric measurements associated with these sites. Comparison of flux calculations and measurements allows refinement of the methodology used for the calculations, resulting in improved quality of the calculated radiation profiles. BBHRP utilizes the RRTM correlated-k RT algorithms (one for the solar and one for the thermal part of the spectrum) developed at Atmospheric and Environmental Research, Inc. (AER) under ARM support. These algorithms are capable of accurately reproducing the fluxes computed by high-resolution (but much slower) line-by-line (LBL) calculations. Since the output quality of BBHRP's RT calculations has been evaluated and refined using radiometric observations at the surface and the top of the atmosphere (TOA), GRP postulated that a subset of BBHRP cases with good radiative flux closure could be used as a reference for evaluating GCM RT algorithms.

Given the designs and capabilities of the RT models to be evaluated and the assumptions built within the BBHRP algorithm, two essential criteria were set for identifying optimal CIRC cases: (1) atmospheric conditions must be homogeneous, and (2) flux closure for four radiative components must be achieved, namely reasonable agreement among measured and calculated shortwave (SW) and longwave (LW) fluxes at the surface and the TOA. The spectral information of the RRTM codes is insufficient for identifying and addressing discrepancies emerging in the calculations of the participating codes. Because of this, selected cases are rerun with the more exact and spectrally detailed LBL codes. An additional benefit of this approach is that, at least for the thermal portion of the spectrum, spectral closure could be assessed using radiance measurements by ARM's surface-based atmospheric emitted radiance interferometer (AERI). Achieving LW spectral closure enhances confidence in the quality of the input since it confirms the realism of the input temperature, humidity and ozone profiles. Selecting ice or mixed phase cloud cases appropriate for the intercomparison has challenges; while the single-scattering properties of liquid cloud droplets are largely well-defined, the corresponding properties of ice crystals are not, and require assumptions about the shape and habit of the crystals. BBHRP flux closure for ice cloud cases can therefore be entirely due to a particular ice crystal optical property parameterization in the RRTM codes being fortuitously appropriate for those cases. Due to this, ice cloud cases were shelved for a later phase of CIRC.

Given the above factors the cases for CIRC's first phase were selected to represent the least demanding scenarios a GCM RT code could encounter: conditions as horizontally homogeneous as possible (as indicated by a low temporal variability in measured surface radiative fluxes), and with the least ambiguous optical properties for atmospheric scatterers. For cloudy cases these conditions translate to contiguous overcast cloud layers of low horizontal cloud water variability with no ice crystals anywhere in the cloud (note that deficiencies of GCM RT codes for complex cloud structures were already documented by Barker et al., 2003). A consequence of introducing LBL calculations as the reference standard was the need to develop a more detailed specification of spectral surface albedo, but this was an effort already underway for other ARM projects. Such an albedo also provides the added flexibility for participating codes to adjust the spectral breakdown of their surface albedo in accordance with the band structure of their models.

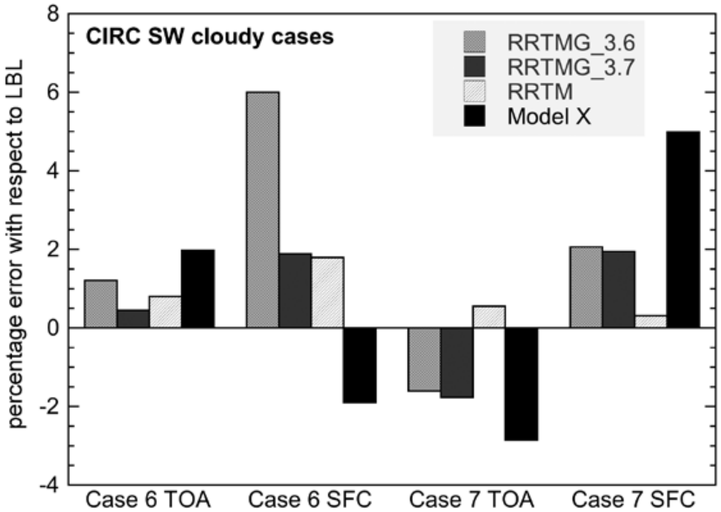
The effort to carefully screen the BBHRP data set for CIRC-appropriate cases culminated in the selection of five cases representing very dry (ARM Alaska site), dry, moderately humid, and very humid conditions (ARM Oklahoma site), and one mid-latitude (ARM Oklahoma site) overcast liquid cloud of relatively high optical thickness (~60 in the visible). A spin-off case was created by doubling the CO_2 concentration of the arctic case, as it was deemed important to evaluate model-produced CO_2 forcings under very dry conditions given the significant spectral overlap of CO_2 and water vapor absorption. The search within BBHRP for another cloud case of more modest optical thickness that would satisfy the CIRC criteria was not fruitful. Following the suggestion of ARM colleagues, such a case was eventually identified in measurements taken by the ARM Mobile Facility deployment in Pt. Reyes, California, which included most of the types of measurements used by the BBHRP effort.

The CIRC web site (*http://circ.gsfc.nasa.gov*) contains all the necessary input fields and instructions on how to run the cases, output from the reference LBL calculations (TOA and surface spectral fluxes, broadband flux profiles and heating rates) and sample code to ingest the data. The web site also contains information on the goals and modus operandi of the project and will soon add documentation on participating codes and the analysis of submissions by registered CIRC participants. Currently, 17 scientists representing seven countries (Australia, Brazil, Finland, France, Russia, the United Kingdom and the United States) have registered as participants and several submissions have been received and are being analyzed. With the recent endorsement of the project by the International Radiation Commission, further expansion of the project's reach is expected.

CIRC seeks to provide standards against which radiation code performance will be documented in scientific publications, in coordinated joint modelling activities such as GCM intercomparisons, and in important international undertakings such as the radiative forcing calculations for the assessment reports of the Intergovernmental Panel for Climate Change. It may prove especially valuable to global modelling groups wishing to intercompare versions of current and future candidate schemes. An example where CIRC is used in this context is when the current Community Atmospheric Model (CAM3) GCM SW and LW RT schemes are compared with with RRTMG-SW and RRTMG-LW, which are faster versions of their RRTM siblings and candidates for future versions of CAM. As can be seen in the figure at the top of page 20, the RRTMG schemes perform better overall for the CIRC cases than the current CAM schemes.

An interesting aspect of this example is that the version of RRTMG-SW initially used for the comparison gave substantial errors for CIRC's thick cloud case (Case 6). Following a rigorous investigation with full flux and heating rate profiles involving several models, it was discovered that the culprit responsible for the disagreement was the relatively low threshold of droplet single scattering albedo for triggering an approximation with no absorption. Setting this threshold to a higher value immediately improved results (see figure on this page, comparing both versions of RRTMG-SW). Remaining discrepancies (as in Case 7) are believed to be due to inadequacies of the two-stream approximations that do not affect RRTM-SW with its multi-stream capability. The obvious advantage of performing such an intercomparison exercise through CIRC is the availability of additional RT models that share common fundamental features with the model under consideration to facilitate error analysis.

While it is understood that the CIRC reference calculations reflect current spectroscopic knowledge and may themselves



Above is the percentage of errors with respect to LBL calculations for the two CIRC Phase I cloudy cases of upwelling TOA and downwelling surface shortwave (SW) fluxes for the version of RRTMG-SW initially tested (3.6) and after modification (3.7). Errors are also shown for RRTM-SW and for another two-stream (as RRTMG-SW) RT code that participates in CIRC, but is not identified (Model X). Negative errors indicate higher LBL flux values.

be imperfect, the intent is to update them whenever algorithmic or database improvements become available. Contributions of alternate LBL calculations by participants are especially welcome and may help to identify overlooked issues or to fill gaps in our reference data set. Already LBL SW submissions that provide full flux profiles have been received, output that the CIRC LBL code (CHARTS) currently cannot produce on a single run.

The first order goal of CIRC is to document the performance of participating models relative to reference standards. Ultimately, model performance will be critically evaluated in terms of the accuracy needed to address operational GCM requirements for current and future climate simulations and comparisons with observations. Feedback and contributions from participants and users of the data set and atmospheric radiation practitioners will be essential toward enhancing and enriching the CIRC portfolio of cases and supporting the continuous nature of the CIRC effort.

For more information on CIRC, please contact *Lazaros.Oraiopoulos@nasa.gov* or *emlawer@aer.com*.

References

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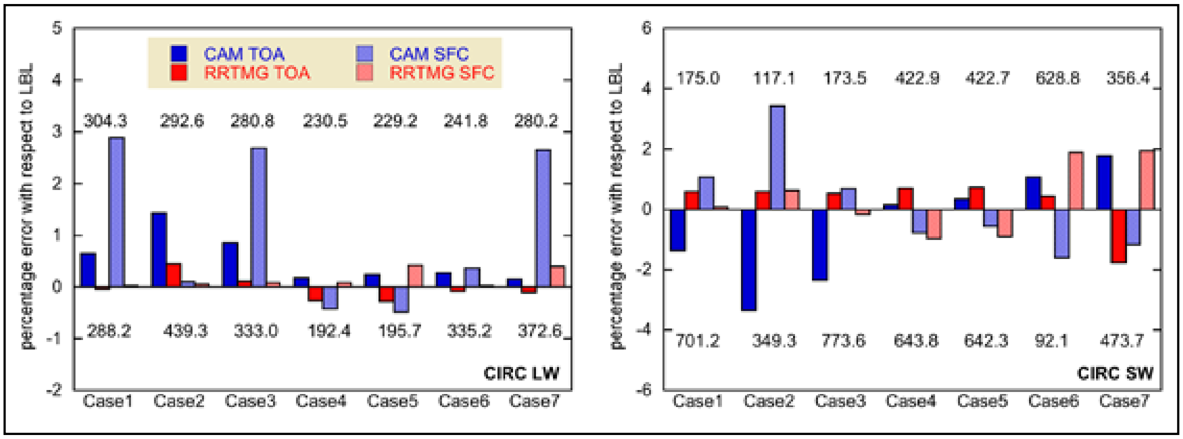
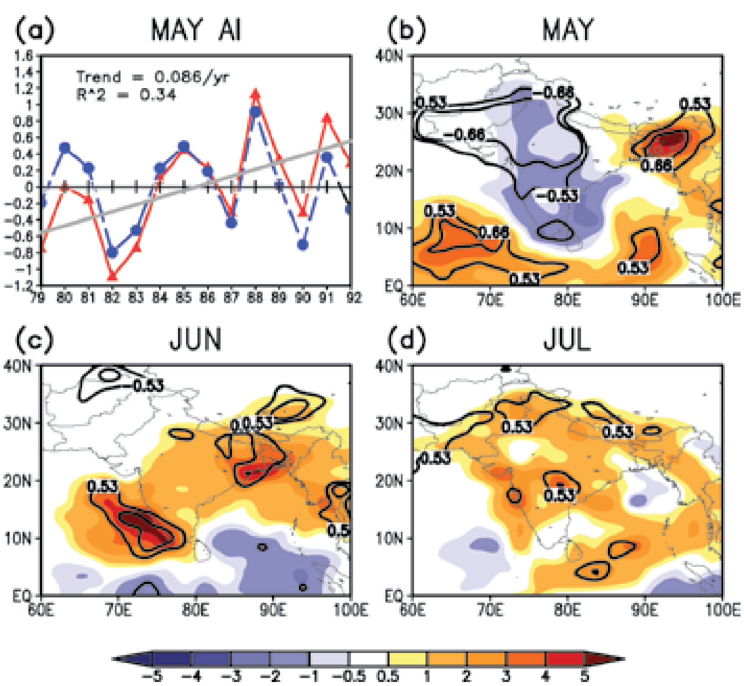
Continual Intercomparison of Radiation Codes (CIRC) Project Improving GCM Radiative Transfer Codes



For the seven CIRC Phase I cases, percentage errors are given with respect to line-by-line (LBL) calculations of the current Community Atmospheric Model (CAM) RT schemes and the shortwave (SW) and longwave (LW) rapid RT for GCMs (RRTMG) codes. Negative errors indicate higher LBL flux values. Top values are for upwelling flux at top of the atmosphere and bottom values are for downwelling flux at the surface. See article by L. Oreopoulos and and E. Miawer on page 8.

High Spring Indian Aerosol Concentration and Associated Low Precipitation Leads to Strengthened Summer Monsoon



RRTMG schemes perform better overall for the CIRC cases than the current CAM schemes. (a): Time series of May Aerosol Index (AI) anomalies over the Indo-Gangotic Plain (red line: original data; blue line: original data after removing trend; grey line: least square fit to original data). The trend is 0.086 yr^{-1} (significant at the 95% confidence level), with $R^2 = 0.34$. (b) – (d): GEWEX Global Precipitation Climatology Project precipitation (mm day^{-1}, shaded) regressed on the May AI time series [blue line in (a)] for: (b) May, (c) June, and (d) July. The ±0.53 and ±0.66 contour lines show the 95% and 99% confidence levels, respectively. See article by M. A. Bollasina and S. Nigam on page 10.