Application of CAGEX for the Evaluation of Shortwave Codes and for the Testing of CERES TRMM Algorithms

T. P. Charlock
NASA Langley Research Center
Hampton, Virginia

T. L. Alberta, F. G. Rose, and D. A. Rutan
Analytical Services and Materials, Inc.
Hampton, Virginia

The Atmospheric Radiation Measurement Program Enhanced Shortwave Experiment (ARESE) currently addresses the problem of the absorption of shortwave (SW) by the atmosphere on a local scale with aircraft and ground-based measurements around the Atmospheric Radiation Measurement (ARM) Cloud and Radiation Testbed (CART) site. The following analysis with CERES/ARM/GEWEX Experiment (CAGEX) data from April 1994 (Charlock and Alberta 1996) previews some aspects of such a local scale study. The NASA Clouds and the Earth's Radiant Energy System (CERES; Wielicki and Barkstrom 1991) follow-on to the Earth Radiation Budget Experiment (ERBE) will attempt to retrieve the full vertical profile of cloud properties and radiative fluxes. CAGEX tests some of the CERES algorithms and provides access to pre-launch results needed by GCIP. Soundings and satellite retrieved cloud properties (Minnis et al. 1995), broadband fluxes calculated with a delta-4-stream radiative transfer code (Fu and Liou 1993), and validating measurements for fluxes and cloud properties from ARM are available on line for April 1994. Instructions for accessing the new CAGEX (Version 1) are on http://snowdog.larc.nasa.gov:8081/cagex.html. Some results from Version 1 are given below. Measurements of broadband surface fluxes and aerosol optical thicknesses were obtained courtesy of Dr. John DeLuisi and Dr. Joseph Michalsky. Dr. Caang Fu supplied a special version of the Fu-Liou radiative transfer code. We inserted humidity and wavelength dependent aerosol single scattering albedos and asymmetry factors from d'Almeida et al. (1991) into the Fu and Liou (1993) and Chou (1992) codes.

Table 1 summarizes the bias in CAGEX SW calculations for 26 days during April 1994. There are 18 half-hourly calculations per day. This table covers daylight conditions; the biases reported span the 24-hour day (daylight and darkness). The sample size in each column varies according to the availability of data. The incoming top of the atmosphere (TOA) insolation in W/m**^{2} corresponds to the available sample for computing the TOA net bias as calculated (from the Fu-Liou code) and measured (from the Minnis et al. 1995, conversion of the narrowband Geostationary Operational Environmental Satellite [GOES] radiance to an estimated TOA broadband flux). With the exception of the TOA insolation, all numbers in the table are biases in W/m**^{2} as calculated minus measured. Calculations in the table are based on the Fu and Liou (1993) code, except for column B, which uses the Chou (1992) code. The TOA insolation must be considered when comparing the biases in the table with those reported in global surveys that span both day and night. For example, the bias (calculated-measured) for the atmospheric absorption with column A core soundings and the Fu-Liou code is -58 W/m**^{2}. Using the associated daytime TOA insolation of 971 W/m**^{2}, the bias of -58 W/m**^{2} can be compared with a global insolation (0.25*1365 W/m**^{2}) by adjusting it as

$$(-58) * (0.25 * 1365)/(971) = -20 \qquad (1)$$

This adjusted CAGEX bias for full-sky atmospheric absorption (-20 W/m**^{2}) is similar to the global cloud forcing bias (-25 W/m**^{2}) that is expected from Cess et al. (1995) and the 45 N to 20 N domain full-sky bias (-14.7 W/m**^{2}) from the GEWEX SRB Project (Whitlock et al. 1995). Recalling that CAGEX has a very limited domain, this comparison must be interpreted carefully. The April 1994 results in the table indicate that about one half of the error in the CAGEX full-sky atmospheric absorption is due to clear-sky, rather than cloud-forcing, effects. The CAGEX bias for atmospheric absorption is robust and cannot be readily reduced by using a different radiative transfer code, making reasonable changes to sounding inputs, slightly adjusting aerosol parameters, or by using the alternate radiometer measurement for ground truth.

Table 1. CAGEX V1 shortwave biases.								
Calculated flux - Measured flux (W/m^2) 18 half-hourly steps/day (April 1994)								
All-Sky	A	B	C	D	E	F	G	H
TOA Insolation	971	971	985	971	971	971	971	971
TOA Net	-15	-11	-14	-8	-13	-18	-12	-15
Atmospheric Absorption	-58	-54	-53	-44	-53	-52	-64	-59
SFC Net	43	44	39	36	40	34	52	44
SFC Down	49	45	42	39	46	38	60	48
SFC Direct Down	14		11	7	14	-13	45	
SFC Diffuse Dow	38		33	35	35	53	19	
Clear-Sky	A	B	C	D	E	F	G	H
TOA Insolation	962	962	961	962	962	962	962	962
TOA Net	-3	9	-5	4	-1	-9	2	-3
Atmospheric Absorption	-33	-24	-33	-12	-26	-25	-40	-42
SFC Net	29	32	28	15	26	16	42	39
SFC Down	35	30	32	15	30	19	50	39
SFC Direct Down	42		37	24	41	-15	106	
SFC Diffuse Dow	-2		-3	-4	-6	38	-50	
Column A - Calculations use the core sounding data Column B - Chou SW code calculations, core soundil Column C - Calculations use the MAPS/SMOS sounding dal Column D - Core soundings, with humidity doubled Column E - Core soundings, with aerosol absorption doubled. Column F - Core soundings, with aerosol optical depth doubled. Column G - Core soundings, with no aerosols. Column H - Core soundings. comparisons are to the ARM SIROS data set.								

We have not been able to explain the excess of calculated versus measured absorption. Figure 1 indicates that the bias may have a weak dependence on the water vapor pathlength.

As shown in the CAGEX online plots and tables, the simulations of LW fluxes at TOA and at the surface, and the simulations of SW fluxes at TOA, are closer to the measured fluxes than is the case for SW flux at the surface.

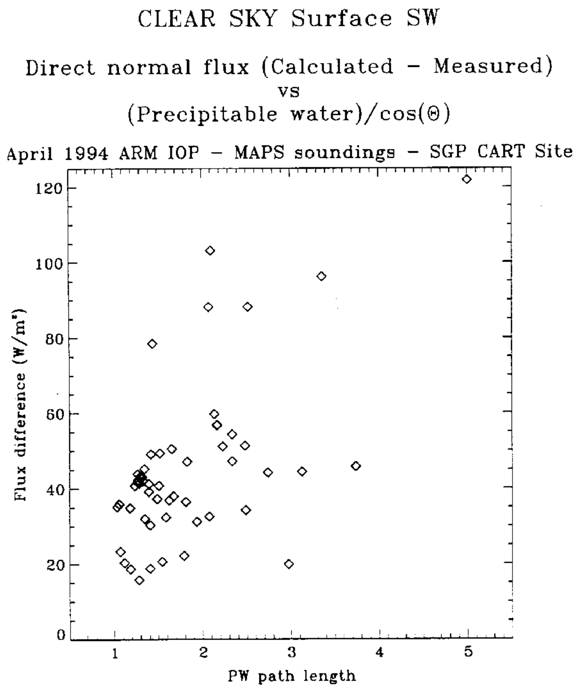

Figure 1. CAGEX Version 1.0.

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