Global assessment of longwave radiative fluxes estimated by NASA/GEWEX Surface Radiation Budget (SRB) and CALIPSO-CloudSat-CERES-MODIS (C3M)

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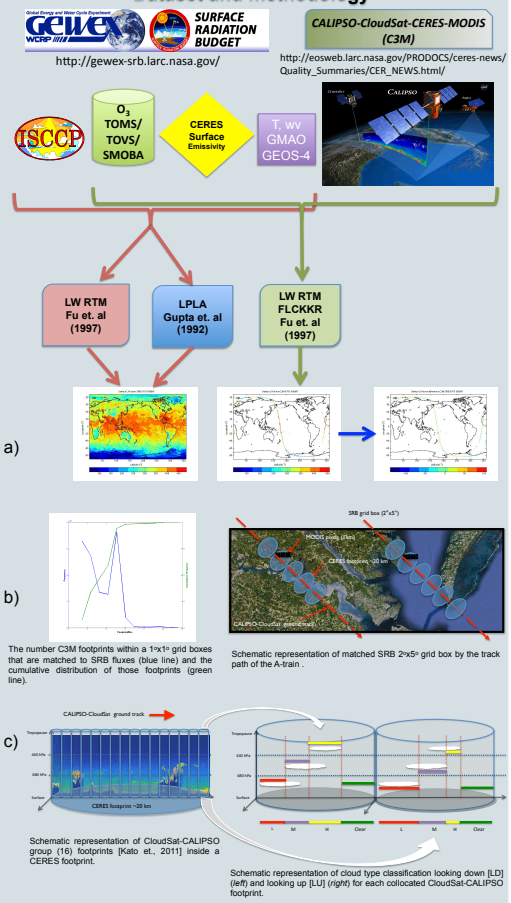
Abstract

This study shows a global assessment of the longwave fluxes by the NASA/GEWEX Surface Radiation Budget (Release 3.1) (SRB), and the CALIPSO-CloudSat-CERES-MODIS, hereafter C3M, Release B1. The origin of the differences are also analyzed and discussed. The period of time used in this study corresponds to the entire overlapping year of 2007.

Introduction

Longwave radiative fluxes (LRFs) effect and therefore with the climate change. Significant progress has been made in this field since the ground-base and satellite measurements. A better estimation of these fluxes would provide an understanding of the origin of their variability and trends. And therefore the implications in the current climate change. The results of this study quantify the. agreement and the origin of differences for the LRFs at the TOA (OLR) and surface (DLF).

Dataset and methodology



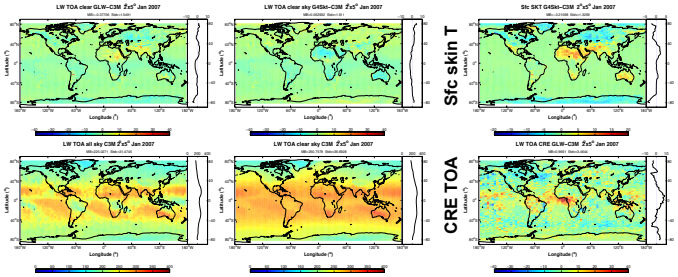
The number C3M footprints within a 1°x1° grid boxes that are matched to SRB fluxes (blue line) and the cumulative distribution of those footprints (green line).

Schematic representation of matched SRB 2°x5° grid box by the track path of the A-train .

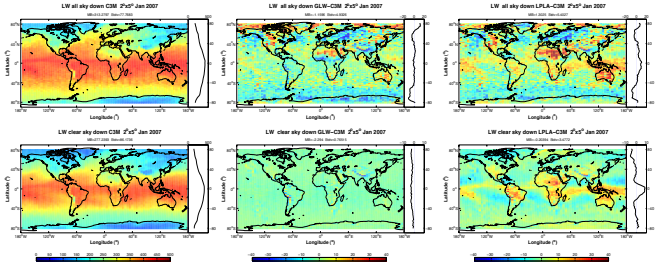
Schematic representation of CloudSat-CALIPSO group (16) footprints [Kato et., 2011] inside a CERES footprint.

Schematic representation of cloud type classification looking down [LD] (left) and looking up [LU] (*right*) for each collocated CloudSat-CALIPSO footprint.

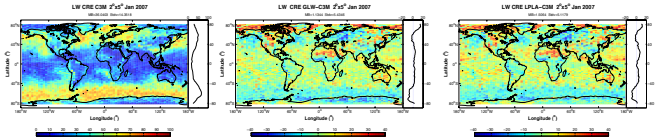
Results



Global and zonal monthly average OLR at the TOA difference for the clear SRB-GLW (blended between GEOS4 and ISCCP retrievals - *top left*) SRB-GEOS4Skt (GEOS4 surface skin temperature only - *top center*). OLR at the TOA for C3M all sky (*bottom left*) clear sky cases (*bottom center*). CRE difference between SRB-GLW and C3M at the TOA (*bottom right*) for January 2007. Surface skin temperature difference between SRB-G4Skt and C3M (*top right*). Units for fluxes are in Wm^{-2} and temperature in K.



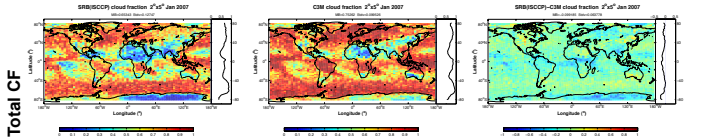
Global and zonal monthly average for the all (*top left*) clear (*bottom left*) sky downwelling longwave fluxes for C3M. DLF difference SRB-GLW (All sky – *top center, clear sky – bottom center*) and LPLA (All sky – *top right, clear sky – bottom right*) between C3M for January 2007. Units are in Wm^{-2}.



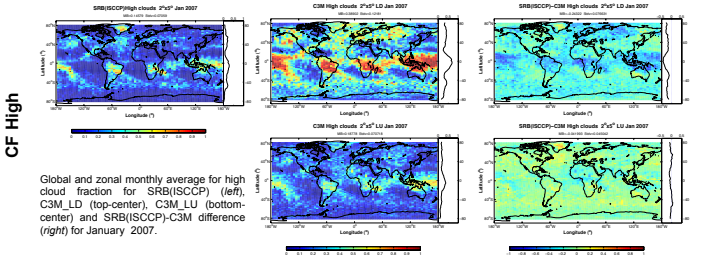
Global and zonal monthly average for the CRE for C3M (*left*). CRE difference SRB-GLW (blended between GEOS4 and ISCCP retrievals - *center*) and LPLA (using GEOS4 surface skin temperature only - *right*) between C3M for January 2007. Units are in Wm^{-2}.

	TOA			SURFACE					
				ALL		CLEAR		CRE	
	ALL	CLEAR	CRE	GLW	LPLA	GLW	LPLA	GLW	LPLA
January	0.6 ± 3.2	-0.4 ± 1.5	0.9 ± 3.4	-1.2 ± 4.9	1.3 ± 5.4	-2.3 ± 0.8	-0.2 ± 3.5	1.1 ± 5.4	1.5 ± 5.1
April	0.4 ± 3.0	0.01 ± 1.2	0.4 ± 3.2	-0.2 ± 4.1	2.0 ± 5.3	-2.5 ± 0.8	-0.5 ± 3.6	2.3 ± 4.5	2.5 ± 4.2
July	1.3 ± 2.8	0.4 ± 1.3	0.9 ± 3.0	-2.3 ± 4.1	-0.2 ± 4.3	-2.7 ± 0.9	0.2 ± 3.9	0.5 ± 4.3	-0.3 ± 3.9
October	0.7 ± 3.0	-0.2 ± 1.8	0.9 ± 3.2	-3.2 ± 4.7	-0.4 ± 6.6	-2.4 ± 0.8	-0.2 ± 2.6	-0.8 ± 5.2	-0.1 ± 5.6

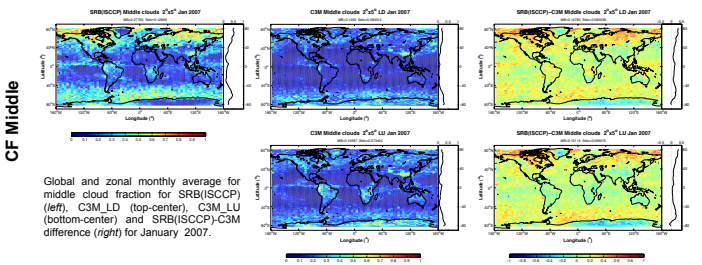
Statistics (Mean Bias ± Standard Deviation) for the Global monthly mean difference for the TOA (only GLW) and Surface (GLW and LPLA) in January, April, July and October 2007. Units are in Wm^{-2}.



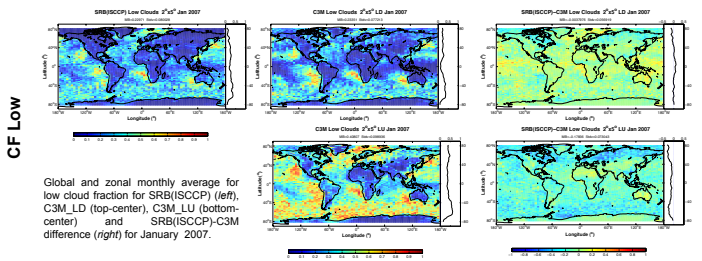
Global and zonal monthly average between the total cloud fraction for SRB-ISCCP (*left*), C3M (*center*) and SRB(ISCCP)-C3M difference (*right*) January 2007. Units are in Wm^{-2}.



Global and zonal monthly average for high cloud fraction for SRB(ISCCP) (*left*), C3M_LD (top-center), C3M_LU (bottom-center) and SRB(ISCCP)-C3M difference (*right*) for January 2007.



Global and zonal monthly average for middle cloud fraction for SRB(ISCCP) (*left*), C3M_LD (top-center), C3M_LU (bottom-center) and SRB(ISCCP)-C3M difference (*right*) for January 2007.



Global and zonal monthly average for low cloud fraction for SRB(ISCCP) (*left*), C3M_LD (top-center), C3M_LU (bottom-center) and SRB(ISCCP)-C3M difference (*right*) for January 2007.

Conclusions

Due to the different spatial and temporal resolutions of SRB and C3M, we combined all the collocated footprints from the A-train C3M footprints (20 km CERES footprint including the MODIS pixels fused with CloudSat and CALIPSO footprints) with each SRB (1°X1°) set of cloud properties (from ISCCP) and fluxes on a final global grid of 2° latitude x 5° longitude). The results of this study quantify the agreement between both projects for mean monthly differences. The origin of the clear-sky flux differences between both datasets is mainly due to the skin temperature differences between SRB and C3M for outgoing longwave fluxes (OLR) and the meteorological profiles downward longwave surface fluxes (DLF). For all-sky cases, the differences are due to the estimation of the different cloud properties, like the total cloud cover, which was 10% less (in absolute percent terms) for SRB than for C3M in January 2007, where C3M includes active measurements from CloudSat and Calipso. Comparisons of the cloud properties for high, middle and low clouds were made to illustrate their relative importance on the observed OLR and DLF differences. To illustrate the difference between an ISCCP passive cloud retrieval approach and the C3M blended active cloud profile retrievals and resulting SRB/C3M flux differences, we use a looking down (LD) and a looking up (LU) methodology. Presumably, the difference in cloud fractions for each approach will help bracket the uncertainties of the ISCCP passive retrievals. For instance, using LU, SRB shows 17% less low clouds than C3M. However, for middle clouds the LU and LD approaches give 12% more clouds in ISCCP and thus SRB than C3M. High clouds are underestimated by SRB, overall, and especially in the Polar and Tropical zones. The radiative contribution of clouds at the TOA and surface was estimated using the Cloud Radiative Effect (CRE). Difference patterns in the CRE between SRB OLR and DLF some similarities with the cloud pattern differences. At TOA, the OLR CRE global mean agreement was 0.5±3.7 and 0.9±3.4 Wm^{-2} for SRB G4Skt and GLW respectively. The only difference between these simulations is the surface skin temperature where the G4Skt uses skin temperatures most similar to C3M. At the surface, the DLF CRE agreement was 1.5±5.1 and 1.1±5.4 Wm^{-2} for LPLA and SRB respectively with C3M at the surface. Future work will more explicitly consider the cloud overlapping assumptions of SRB relative to the C3M to explain the differences more accurately.

Acknowledgments

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