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An assessment of radiation budget data provided by the ISCCP and GEWEX-SRB

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[1] The projects ISCCP and GEWEX-SRB compute global data sets of radiation budget components at the top of the atmosphere and at the surface. Time series range from July 1983 to June 2001, and to October 1995, respectively. Comparing monthly averages over broader zones we find that the SRB underestimates the incident radiation at TOA by more than 2–5 Wm^{-2} over the tropics and up to 40 Wm^{-2} over polar regions. The ISCCP infrared radiation fluxes near the surface and at TOA, in particular over both polar zones, are higher than those of the SRB. Clouds in the ISCCP appear optically less effective than in the SRB. Interannual and month-to-month variations are observed indicating serious errors in ancillary data. Complete reprocessing is recommended. End products need validation within this large domain in space and time with correlated radiation budget measurements at TOA and at ground. **Citation:** Raschke, E., S. Bakan, and S. Kinne (2006), An assessment of radiation budget data provided by the ISCCP and GEWEX-SRB, *Geophys. Res. Lett.*, *33*, L07812, doi:10.1029/2005GL025503.

1. Introduction

[2] Climate monitoring needs information on radiative energy fluxes within the climate system with an absolute accuracy of about 3 Wm^{-2} and better and a long-term stability of 0.5 Wm^{-2} [*Ohring et al.*, 2005]. Our study is a contribution to recent efforts of the GEWEX (Global Energy and Water Cycle Experiment) to assess the available radiation data-sets of the ISCCP (International Satellite Cloud Climatology Project), of the SRB (Surface Radiation Budget Project of GEWEX) and of others with respect to their potential for long-term studies of climate variations. Radiation fields, computed in both projects are compared here to identify major discrepancies and their possible sources.

[3] ISCCP and SRB were initiated during the years 1981 to 1983 by at that time existing relevant advisory bodies to the World Climate Research Programme (WCRP) to "determine the global cloud field characteristics from operational satellite data" (ISCCP) and to "compute from these and other data the radiation budget fields at the earth's surface" (GEWEX-SRB), respectively. ISCCP [*Rossow and Duenas*, 2004, and references therein] uses various ancillary data on the actual radiative characteristics of the atmosphere and the surface to extract information on cloud field properties from carefully normalized radiance data of operational polar orbiting and geostationary satellites. It computes [*Zhang et al.*, 2004] often with the same ancillary and cloud data all radiation budget components at the top of the atmosphere (TOA), at the surface and also at three additional levels within the troposphere for clear and cloudy skies. The SRB [*Stackhouse et al.*, 2004; *Cox et al.*, 2004] uses besides the ISCCP cloud information also ancillary data from other sources and also different radiative transfer codes to compute the same radiation quantities at the upper and lower boundaries of the atmosphere. Both projects use a mean aerosol climatology and cannot yet incorporate information on regional disturbances of the atmosphere by volcanoes or biomass burning. These data-series are available since several years as grid averages on the respective websites of both projects. They found already worldwide use to study the time and space pattern of fields of the radiation fluxes and the vertical flux divergence inclusive the effect of cloud fields on them [e.g., *Raschke et al.*, 2005a] or to validate related products computed in separated projects [e.g., *Hatzianastassiou et al.*, 2004] or by general circulation models [e.g., *Gates et al.*, 1999; *Jakob*, 2004]. The data-sets used here remained unchanged at least until about June 2005.

2. Methodology

[4] Both projects compute simultaneously for each grid point the radiation fluxes for clear and cloudy (clouds and clear atmosphere) skies to estimate the cloud effect (CE) on radiative energy transfer as the difference between both. Cloud fields are known to generally increase the planetary albedo and to lower the down-welling solar radiation at the surface. In the infrared they reduce the emission to space but enhance the radiation to ground. Exceptions occur for specific constellations.

[5] We use here monthly averages of all radiation fluxes at TOA and at the surface. To avoid the "noise" of regional and local detail and to enhance the information on typical climate zones, this data has been averaged over large latitudinal belts (0–30, 30–60, 60–75 and 75–90 degrees over both hemispheres representing 25, 18.3, 5, 1.7% of the earth's surface). Earlier comparisons [*Zhang et al.*, 2004; *Cox et al.*, 2004] refer to smaller grid areas of 2.5 degrees and less. Uncertainties were estimated there between 10 and 15 Wm^{-2}. Our main results are summarized in Tables 1–3 as mean seasonal ranges of each quantity (fluxes and CE) as computed in the ISCCP and their difference to SRB, and also RMS-values of the deseasonalised components. The latter contain the month-to-month variability of weather and spurious inconsistencies, which are more visible in detailed plots. Most differences between ISCCP and SRB data show a pronounced seasonal periodicity. Considerable interannual

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variability and often abrupt month-to-month changes with "unusual" large amplitudes have also been found. The websites of both projects contain all data discussed here and substantial documentation. They are for ISCCP: http://isccp.giss.nasa.gov, and for SRB: http://eosweb.larc.nasa.gov.

3. Solar Radiation

[6] ISCCP and SRB compute all solar radiation fluxes with different values for the Total Solar Irradiance (TSI = 1367 Wm^{-2} in ISCCP; TSI = 1372 Wm^{-2} in SRB) and also with different values for the sun angle above horizon limiting the daylight period (ISCCP: 0.0005 degrees; SRB: about 11.5 degrees). ISCCP includes a leap day at the end of February every forth year. SRB does it not, causing an apparent 4-year periodicity in the differences between both (Figure 1). The magnitude of such differences exceeds values of more than 15 Wm^{-2} at higher latitudes due to the shorter daylight period in SRB data. Both do not include the observed natural variability of TSI [*Fröhlich and Lean*, 2004]. The shorter daylight length in SRB results affects all solar radiation fluxes at higher latitudes poleward of 60 degrees, masking there an inspection of other components of the radiation budget. Therefore we discuss here only the solar results obtained between 60S and 60N.

[7] The ISCCP solar radiation budget at TOA (row 2) is during almost all months smaller than that of SRB over the tropics and southern mid-latitudes. This might be partly due to the stronger effect of clouds, which seem in ISCCP over that belt to be optically less dense than in the SRB. Clouds generally reduce the solar budget at TOA. Between 60S and 30N this effect is smaller in SRB than in ISCCP, while the opposite occurs over northern mid-latitudes.

[8] At the surface (rows 3 and 4) the differences (ISCCP-SRB) of the downward solar radiation vary between −6 and +7 Wm^{-2} over the zone 60N to 60S. Clouds reduce the downward solar radiation but with different strength in both data-sets. The disagreement between values of the solar radiation budget ranges between about −7 to +8 Wm^{-2}. Clouds tend to decrease it. Over the tropics this effect is higher in ISCCP than in SRB data. The solar divergence (row 5) is mostly lower in ISCCP data. Clouds increase it only slightly, since they reflect a large fraction of the insolation back to space and also shield the lower moist troposphere.

4. Terrestrial Radiation

[9] In the infrared ISCCP computes poleward of 60° during most months higher emission to space (OLR) at TOA than SRB, but lower values are found over the tropics. Clouds reduce systematically the OLR less in ISCCP (up to 6 Wm^{-2}) than in SRB. Over the zone between about 60N and 60S the ISCCP cloud tops are possibly lower (warmer) and at higher latitudes higher (colder) than the SRB clouds. The ISCCP computes higher values for the downward atmospheric radiation at the surface (row 2) over all regions except over the tropical belt and the southern mid-latitudes (30–60S). SRB clouds seem to increase the downward atmospheric radiation by 4 to 8 Wm^{-2} more than the ISCCP clouds possibly due to lower base heights or lower optical

Table 1. Solar Components of the Radiation Budget at TOA and at Surface (Sfc) and of the Cloud Effects (CE) in ISCCP Data Only and of the Differences Between ISCCP and SRB Results (in Wm^{-2}): Mean Seasonal Ranges of Monthly Averages During the Period July 1983 to October 1995 and RMS of the Deseasonalised Components[a]

Components SOLAR	75°–90°S	60°–75°S	30°–60°S	30°S–00°	00°–30°N	30°–60°N	60°–75°N	75°–90°N
Dw at TOA	0 to 545 (1.0)	6 to 511 (0.9)	126 to 510 (0.6)	310 to 460 (0.3)	330 to 440 (0.2)	134 to 480 (0.6)	6 to 481 (0.8)	0 to 510 (1.1)
ISCCP-SRB	0 to 5.1 (4.3)	−2 to +11 (4.0)	−0.4 to +4 (0.6)	1.5 to 3.6 (0.3)	1.4 to 3.1 (0.3)	−0.3 to +4.1 (0.6)	−1.5 to +9.8 (1.0)	−2 to 8.8 (1.1)
Budget TOA	0 to 184 (1.4)	4 to 236 (2.4)	73 to 343 (2.2)	239 to 350 (3.3)	240 to 330 (3.1)	75 to 325 (2.5)	2 to 274 (2.6)	0 to 212 (3.5)
ISCCP-SRB	0 to 14 (5.8)	−3 to +2.4 (4.1)	−6.5 to +1 (1.6)	−3.3 to −0.2 (1.6)	−5.1 to −1 (1.6)	−6.7 to +3 (1.4)	−10 to +3.4 (2.4)	−10 to 0 (2.3)
CE	−12.6 to 0 (1.4)	−80.6 to −0.9 (1.5)	−11.2 to −8.6 (1.9)	−65 to −3.5 (1.1)	−70 to −40 (1.9)	−75 to −23 (1.8)	−76 to −0.6 (3)	−45 to 0 (2.4)
ISCCP-SRB	2 to 7.7 (1.4)	−13 to +1.2 (1.8)	−7.4 to −2.5 (1.6)	−7.6 to −5 (1.5)	−7.1 to −4 (2.6)	0.1 to 0.6 (1)	−12 to +1.0 (1.4)	2.2 to 8.6 (1.4)
Dw at Sfc	0 to 403 (6.6)	3.2 to 88 (5.7)	59 to 260 (2.3)	185 to 274 (3.1)	188 to 265 (2.9)	58 to 249 (2.2)	2 to 244 (7.7)	0 to 280 (7.4)
ISCCP-SRB	0 to 58 (5.2)	1.3 to 40 (4.4)	−6.3 to +4.3 (1.5)	−4 to +7.5 (1.6)	−2.4 to +4.5 (1.6)	−3.3 to +7 (1.3)	−3.4 to +19 (2.6)	−5.6 to +21 (4.3)
CE	−85 to 0 (7.2)	−129 to −2 (6.1)	−127 to −30 (2.2)	−71 to −39 (2.1)	67 to −4.5 (2.2)	−96 to −28 (2.3)	−101 to −1 (4.4)	−120 to 0 (4.4)
ISCCP-SRB	−1.9 to +3.6 (1.9)	−2.7 to +16.1 (4)	−5 to +2 (1.5)	−1.6 to +4.8 (1.4)	−5 to −1 (1.4)	−3.2 to +7 (1.2)	−3.6 to +11 (2.1)	−14 to +2 (4.1)
Sfc Budget	0 to 97 (1.3)	1 to 141 (3.)	48 to 243 (2.2)	169 to 257 (3.2)	170 to 238 (3.0)	47 to 221 (2.5)	1 to 177 (2.7)	0 to 108 (3.8)
ISCCP-SRB	−3.1 to +7.1 (4.5)	−3.5 to +2.4 (3.3)	−6.7 to 3.3 (1.4)	−2.1 to +5.4 (1.4)	−2.1 to +5.4 (1.4)	−6.1 to +7.9 (1.2)	−8 to +1.2 (1.2)	−12.6 to 0 (1.5)
CE	−13 to 0 (1.4)	−70 to −1 (3.2)	−118 to −27 (2.1)	−60 to −40 (1.9)	−60 to −40 (1.9)	−77 to −1 (3.6)	−77 to −1 (3.6)	−40 to 0 (2.9)
ISCCP-SRB	−1 to +6 (1.9)	−1.6 to +22 (2.2)	−5.6 to +2.4 (1.8)	−4.6 to 1.9 (1.8)	−4 to −1 (1.8)	−2.6 to +10 (1.9)	−2.6 to +10 (1.9)	0 to 10 (1.8)
Solar Div.	0 to 87 (1.5)	1.5 to 98 (1.2)	29 to 100 (1.2)	66 to 94 (0.6)	69 to 95 (2.5)	32 to 104 (0.6)	1.6 to 103 (0.9)	0 to 104 (1.1)
ISCCP-SRB	−21 to +3 (1.7)	−3.6 to +3.7 (1.3)	−2.7 to +1.5 (0.6)	−9.1 to −0.1 (0.8)	−7.2 to −1.2 (0.8)	−4.8 to 0.2 (0.6)	−26 to 2.2 (0.9)	0 to +5 (1.3)
CE	−6.6 to +5.5 (0.9)	−0.6 to +11 (0.6)	−0.4 to +10 (0.3)	0 to 3.5 (0.2)	0.8 to 2.3 (0.2)	0 to 7.0 (0.3)	−0.3 to +6.7 (0.4)	0 to 5.6 (0.5)
ISCCP-SRB	−0.5 to +10 (1.3)	−0.2 to +14 (1)	−4.3 to −0.1 (0.9)	−4.6 to −0.1 (0.6)	−3.1 to 0 (0.6)	−1.5 to +1.5 (0.4)	−0.2 to +4.9 (0.6)	0 to 8 (0.6)

[a] Results over both polar regions are not discussed in the text, since they are dominantly affected by the shorter daylight length in SRB data.

Table 2. Terrestrial Components of the Radiation Budget at TOA and at Surface (Sfc) and of the Cloud Effects (CE) in ISCCP Data Only and of the Differences Between ISCCP and SRB Results (in Wm$-^{2}$): Mean Seasonal Ranges (and RMS) of Monthly Averages During the Period July 1983 to October 1995

Component	75°–90°S	60°–75°S	30°–60°S	30°S–00	00–30°N	30°–60°N	60°–75°N	75°–90°N
OLR TOA	128 to 196 (2.5)	166 to 209 (1.8)	211 to 231 (1.2)	241 to 262 (1.6)	244.to 258 (1.6)	205 to 249 (1.6)	175 to 232 (2.1)	164 to 225 (2.8)
ISCCP-SRB	1.1 to 10.2 (1.5)	−1.8 to +4.8 (1.3)	−2.5 to +2.5 (2.9)	−7 to −1 (1.0)	−6 to −3 (1.0)	−3.7 to +1.6 (0.7)	−2.1 to +22 (1.0)	−2 to +3.1 (0.9)
CE	−13 to −4 (1.0)	−22 to −15 (1.2)	−29 to −26 (1.0)	−36 to −18 (1.4)	−35 to −21 (1.4)	−29 to −23 (1.0)	−20 to −15 (1.2)	−14 to −7 (1.4)
ISCCP-SRB	−5.6 to 0.6 (1.1)	−5 to +3.6 (1.5)	3.5 to 6.0 (1.0)	0.2 to 2.1 (0.7)	0.5 to 1.7 (0.6)	2.5 to 4.0 (0.6)	−6 to + 3 (1.0)	−4.4 to 1.2 (1.0)
Dw at Sfc	143 to 179 (6.6)	208 to 261 (4.9)	300 to 337 (2.6)	376 to 405 (3.3)	377 to 415 (3.0)	271 to 369 (2.3)	212 to 312 (4.8)	193 to 283 (6.9)
ISCCP-SRB	8.4 to 25.6 (5.7)	1.6 to 9.9 (4.1)	−12.8 to −1.5 (1.9)	−3.3 to +1 (3.6)	−2.9 to +5.9 (2.5)	−2 to +3.5 (2.0)	−2.1 to +22 (3.2)	4.8 to 24 (3.3)
CE	26 to 35 (4.3)	43 to 51 (3.0)	43 to 49 (1.8)	19 to 24 (1.3)	18 to 21.5 (1.1)	28 to 43 (1.2)	37 to 45 (2.5)	40 to 51 (3.1)
ISCCP-SRB	−6 to +1.3 (3.1)	−7.3 to +2.8 (2.3)	−7.3 to −1.6 (1.6)	−7.7 to −5.1 (1.5)	−8.8 to −6.1 (1.1)	−6.9 to −3.2 (1.2)	−6 to 0 (2.4)	−2 to 3.6 (1.9)
Up at Sfc	154 to 223 (4.4)	238 to 283 (2.5)	345 to 380 (2.5)	437 to 458 (4.6)	441 to 465 (5.2)	322 to 420 (3.0)	244 to 353 (4.4)	216 to 310 (5.5)
ISCCP-SRB	−1.8 to +18 (1.8)	−12 to +9.6 (3.1)	−3.9 to 14 (2.4)	0 to +4.3 (4.3)	−2.8 to +4.3 (4.3)	−7.5 to +6.5 (4.4)	−9.5 to +32 (2.7)	2.5 to 25.3 (2.7)
Sfc Budget	−48 to −8 (5.8)	−33 to −20 (4.7)	−48 to −38 (3.2)	−63 to −51 (4.6)	−66 to −46 (5.0)	−60 to −49 (2.9)	−46 to −31 (3.7)	−26 to −16 (4.0)
ISCCP -SRB	2.1 to 12.5 (5.7)	−2 to +2 (5.2)	−1.7 to +8.4 (3.2)	−7 to +0.2 (4.5)	−4 to +7.6 (4.7)	−3.2 to +10 (2.8)	−10 to +7.4 (3.9)	−3.8 to +11.2 (4.1)
CE	26 to 35 (4.3)	43 to 51 (3.0)	43 to 49 (1.8)	19 to 24 (1.3)	18 to 21.5 (1.1)	28 to 43 (1.2)	37 to 45 (2.5)	40 to 51 (3.1)
ISCCP-SRB	−6 to +1.3 (3.1)	−7.3 to +2.8 (1.1)	−7.3 to −1.6 (1.6)	−7.1 to −6.1 (1.5)	−8.8 to −6.1 (1.1)	−6.9 to −3.2 (1.2)	−6.2 to 0 (2.4)	−2 to +3.6 (1.9)
Vert. Div.	−152 to −117 (2.5)	−190 to −136 (5.1)	−193 to −165 (3.5)	−203 to −193 (4.9)	−199 to −191 (5.2)	−198 to −154 (3.2)	−191 to −141 (3.8)	−200 to −140 (5.1)
ISCCP-SRB	−7.7 to +20 (6.3)	−20 to +3.5 (5.3)	−7.4 to +5 (3.4)	1.7 to 12.8 (4.5)	−3.4 to +9 (4.7)	−6 to +5.8 (3.1)	−4.1 to +6 (2.9)	−11 to +0.8 (4.3)
CE	−25 to −20 (3.6)	−36 to −22 (3.0)	−22 to −14 (2.1)	−6 to +15 (2.0)	0.6 to +16.4 (1.9)	−17 to −5 (1.4)	−30 to −17 (2.2)	−39 to −26 (2.3)
ISCCP-SRB	−0.7 to +9.2 (2.7)	−5.3 to +10.8 (3.2)	−3.6 to +2 (2.3)	5.2 to 7.5 (2)	5.1 to 7.8 (1.6)	0.2 to 3.8 (0.5)	−0.3 to +7.5 (2.4)	−3.5 to +3 (2.2)

thickness. At higher latitudes this effect is masked by a stronger seasonal signal.

[10] The upward emission at the surface (row 3), is during almost all months in particular over the poles, higher in ISCCP than in SRB. This bias in ancillary skin temperatures is also contained in the lower tropospheric temperatures and is possibly due to a bias in the ISCCP retrieval of surface temperatures. Over the tropical belt the ISCCP surface temperatures show a tendency to decrease of about 2K over 19 years (not shown here) with a sharp increase between 1992 and 1994, which is an artifact (Pinatubo dust ?). Both changes need urgent correction. Clouds dominate the terrestrial radiation budget at surface again somewhat less in ISCCP than in SRB data except over the poles. Indeed the retrieval of skin temperatures [*Emery et al.*, 2001] might be possible only within a limit of ±0.3K over ice-free oceans and with a much wider uncertainty over continents. Cloud fields, which are not correctly recognized in the retrieval, cause major errors.

[11] In the infrared component of the total flux divergence (last row), the disagreement between ISCCP and SRB ranges between about ±20 Wm^{-2}, corresponding to often more than 5% of the individual components. Clouds tend to decrease the net cooling over all extra-tropical regions, while they seem to enhance it over the tropics (positive CE). But, this cloud effect in ISCCP is 5 to 8 Wm^{-2} lower over the tropics. It shows a large seasonal variability, which might be due to low quality of ancillary data and also some real variations.

5. Radiation Budgets

[12] These various errors in the individual fluxes propagate into the total (solar + terrestrial) budgets at TOA and also at ground. Partial cancellations keep the magnitude of differences of ISCCP and SRB data between about ±20 Wm^{-2} with strong seasonal variability at all latitudes. At both boundaries the ISCCP computes mostly higher values than the SRB. Clouds dominantly reduce the TOA budget except at high latitudes. This effect seems to be stronger in ISCCP than in SRB results. Differences between the net fluxes at surface range between about −10 and +18 Wm^{-2}. Clouds reduce both budgets over the tropics only, they enhance it over the poles. Here again the SRB computes higher values of CE over the belt between 60S and 60N.

6. Final Comments

[13] This comparison of two data sets shows several systematic errors, which need to be corrected before a further and more detailed assessment may start. The uncertainty ranges in monthly means averaged over large fractions of the earth are too large and cannot be accepted for global monitoring of radiation budget components [*Ohring et al.*, 2005]. We obtained quite complex results with a strong seasonal component.

[14] The following major uncertainties could be identified, whose correction should lead to a stepwise reprocessing:

[15] a.) Individual differences in values of the incoming solar radiation at TOA (Figure 1) and at ground reach values of more than 40 Wm^{-2} over high latitude regions. They

Table 3. Total Radiation Budget at TOA and at Surface (Sfc) and of Cloud Effects (CE) in ISCCP Data Only and of the Differences Between ISCCP and SRB Results (in Wm^{-2}): Mean Seasonal Ranges (and RMS) of Monthly Averages During the Period July 1983 to October 1995

Components	75°–90°S	60°–75°S	30°–60°S	30°S–00	00–30°N	30–60°N	60–75°N	75°–90°N
Tot Net TOA	−144 to −12 (3)	−177 to 23 (3.1)	−140 to 42 (2.2)	−26 to 100 (3.1)	−14 to 80 (3.1)	−133 to 86 (2.3)	−175 to 46 (2.8)	−183 to −13 (4)
ISCCP−SRB	−1 to −22 (6.3)	−8.4 to +4.2 (4.0)	−0.6 to +5.2 (1.6)	−0.8 to +5.5 (1.4)	−1.2 to +2.9 (1.4)	−8 to +6.7 (1.4)	−10 to 0.4 (2.4)	−8.2 to +3 (2.2)
CE	−9 to +12 (1.5)	−64 to +26 (2.8)	−86 to +0 (1.9)	−33 to −13 (1.8)	−25 to −16 (1.9)	−53 to +2 (1.7)	−56 to +5 (2.8)	−31 to +14 (2.5)
ISCCP-SRB	0.7 to 7.8 (1.8)	−3.2 to +9 (2.4)	−12.2 to −7 (1.8)	−8.7 to −5 (1.7)	−8.7 to−5 (1.7)	−1.6 to −0.3 (1.1)	−4.5 to +9 (1.8)	1.7 to 8.6 (1.8)
Tot Net Sfc	−15 to +49 (5.6)	−30 to +116 (4.5)	2 to 203 (3.1)	108 to 206 (4.2)	109 to 180 (4.8)	−2 to +170 (2.9)	−33 to +136 (4)	−25 to +82 (4.3)
ISCCP-SRB	−0.3 to +15 (7.2)	−2 to +18 (6.1)	−8.5 to +8 (3.5)	−7.7 to +8 (4.5)	−5.6 to +11(4.8)	−8.5 to +18 (2.8)	−8.8 to +6.6 (4.6)	−10 to +4.4 (4.3)
CE	14 to 38 (3.3)	−18 to +43 (2.5)	−71 to +18 (2.2)	−43 to −15 (1.7)	−42 to −19 (1.5)	−51 to +19 (1.5)	−40 to +44 (3.5)	−1 to +48 (3.2)
ISCCP-SRB	−3.7 to 2.9 (2.7)	−11 to +10 (3.1)	−11 to −3 (2.1)	−12 to −9 (2.1)	−11.8 to −9 (1.9)	−6.8 to −2.8 (1.5)	−7.8 to +8.1 (2.4)	−3.9 to +6 (2.2)

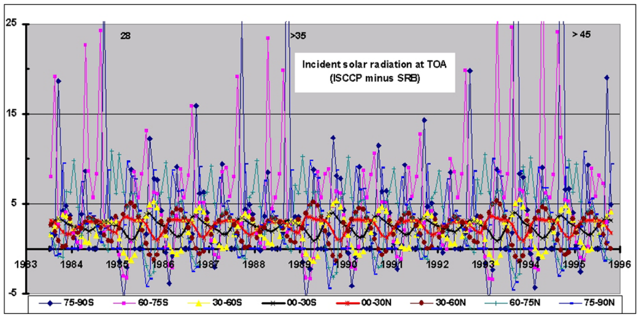

Figure 1. Differences between monthly zonal averages of incoming solar radiation at TOA (in Wm^{-2}); global annual averages of the TSI are recomputed for the ISCCP 1367 and for the SRB 1357.5 Wm^{-2}, respectively. Each year begins at its number.

make a further assessment of all other solar products, which are computed over higher latitudes, useless.

[16] b.) There is a significant discrepancy in surface and lower atmospheric temperatures causing higher emission in the ISCCP over higher latitudes and somewhat lower emission over the tropical and mid-latitude belts, with a small tendency to decrease there with time. The ISCCP is significantly "colder" than the SRB over the belt between 30 and 60S.

[17] c.) ISCCP clouds appear to be optically thinner in the solar range than the SRB clouds, although both projects use cloud characteristics as provided by the ISCCP. Also the upper and lower cloud boundaries need a closer inspection.

[18] d.) The large interannual variations of all differences between ISCCP and SRB, suggest, that various other ancillary data vary in their quality over the time period of this intercomparison.

[19] We recommend, that in a first step both projects must reprocess their solar radiation components agreeing in the same insolation at TOA and in the same onset and offset of the daylight period over each area. Similarly also other radiation budget projects (e.g., CERES [*Wielicki et al.*, 1996]; not shown here) and also all climate models should adjust their insolation to same values for the same time periods [*Raschke et al.*, 2005b]. Both projects need to correct their ancillary skin temperature values. They also must reconsider their cloud characteristics. ISCCP clouds are known for their low accuracy over both poles. Further also all other ancillary data of both projects should be inter-compared and if necessary corrected. Final results must again be validated with independent data sets on the radiation budget at TOA and at the surface [e.g., *Ohmura et al.*, 1998; *Cox et al.*, 2004].

[20] Both data-sets are at present not suited for conclusive analyses to identify slow changes. But their scientific value is high for qualitative studies of regional pattern and for the development of methods to monitor globally most or all components of the energy budget at ground. Future data sets require in particular more accurate information on cloud and aerosol characteristics and on the surface properties and its variability with cloud cover over continental surfaces. Of particular concern are cloud and temperature retrievals over both polar regions.

[21] A report with more details in pictorial form is available from the authors.

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