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Erroneous variations of cloud cover obtained from the ISCCP data caused by satellites replacement

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This study examines variations in the Equivalent Black Body Temperature (TBB) and cloud cover during 1983-2008. These data were obtained from the International Cloud Climatology Project (ISCCP) D-series data. The ISCCP can observe cloud almost globally with using geostationary and polar orbiter satellites. The ISCCP calibrate the values of the TBB observed by each satellite with using those of NOAA-Afternoon (NOAA-A) polar orbiter satellites series for the purpose of dealing equally with observed values of each radiometer which has a different sensitivity. However, it has been found that the calibrated TBB has erroneous variations at a temperature of about 280K or higher. Shown in Fig.1 are the differences between the averaged TBB at a high temperature range obtained from ISCCP-calibrated GMS which are geostationary satellites series of Japan and that from non-calibrated GMS. Note that although Figure.1 shows the TBB of GMS, the differences clearly change as NOAA-A series (NOAA-7, 9, 11, 14, 16, 18) change from old one to new one. The erroneous effects of the inter-calibration show only at two temperature range which are higher than about 280K, or lower than about 220K.

Next it has been found that the erroneous variation of the TBB leads to erroneous variations of cloud cover. The difference between monthly averaged cloud cover from GMS and that from NOAA-A clearly changes from plus to minus while NOAA-A series change from NOAA-11 to NOAA-14, whereas differences of cloud cover between METEOSAT series which are another geostationary satellites and NOAA-A don't show such a sudden change through that time. In addition, the TBB of NOAA-A doesn't clearly change at a high temperature range from this term. These results suggest that the sudden change of cloud cover differences is regarded as the result of changing cloud cover of GMS. Since the decrease in the TBB at a high temperature range leads to decreases in the estimated clear sky TBB, in which case it becomes more difficult to detect cloud fractions from differences between the TBB of cloud and that of clear sky. The remarkable decrease of GMS cloud cover is believed to be due to the above mechanism. These analyses are carried out in such a way that the satellite from which we obtained data doesn't change its monthly averaged view angle for the period of the 25-year observation. This is because cloud cover observed from satellites is much larger near the edge than that in the center of their view areas. This error is called 'view angle dependence'.

The ISCCP inter-calibration lead to a decrease by 1.8K in the averaged TBB of GMS at a high temperature range in GMS region from the TBB averaged before the time which NOAA-A series change form NOAA-11 to NOAA-14 to the TBB averaged after the time. This leads to decreases in GMS Cloud cover to 3.0%, in which case long-term variations of GMS cloud cover show -2.2% per decade in the same period and area. As it is considered that a trend of NOAA-A cloud cover shows +0.5% per decade in the same situation, the inter-calibrations is thought of leading a considerable decreasing trend into GMS cloud data. Moreover it is predictable that the inter-calibrations will affect more severely on cloud height data because they are estimated directly from the TBB on the cloud top.

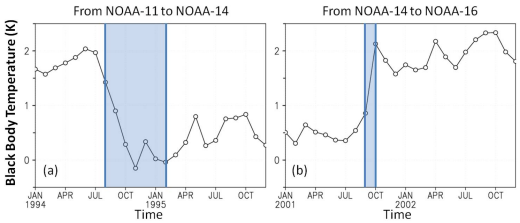

Figure 1. Differences between TBB obtained from ISCCP-calibrated GMS and those from non-calibrated GMS over the ocean close to GMS footprint. TBB are averaged monthly within higher temperatures than 280K. Blue lines represent time of NOAA-A series changing and blue shade in Fig. (a) express a term of data missing of NOAA-A. Intervals of the time axis are 3 month.

Keywords: cloud cover, satellite observations, ISCCP, satellite zenith angle, climate change