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On the Use of Geostationary Satellites for Climate Feedback Study

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Climate feedback has recently been estimated using satellite data to validate the behavior of current climate models. In order to extract climate feedback strength from data, previous studies have commonly used simple regression of monthly variations in sea surface temperature (SST) with outgoing energy flux anomalies from sun-synchronous satellites. This common methodology needs to be revised when using the observed data with cloud variations. This is because cloud variations occurring independently of SST should not be included as feedbacks to SST. Namely, only pure cloud responses to SST changes should be taken into account as feedbacks to SST. With the sun-synchronous satellite's global energy flux data and SSTs, however, the extraction of cloud response to SST changes is basically limited; the sign of the cross-correlation coefficient between the observed outgoing radiation and SST changes greatly between negative and positive lags between the two time series, and estimation of climate feedback is just subject to selection of the lag. This variable cross-correlation according to lag occurs only in the presence of non-feedback cloud variations. Therefore, estimates of climate feedback will be satisfactory if the significant non-feedback cloud effect on SST is effectively removed. Here we suggest that highly time-resolved data from geostationary satellites are of great use to remove this non-feedback cloud effect. The hourly geostationary data were used to obtain daily SSTs averaged for clear-sky pixels only, so that the non-feedback cloud effects on SST was largely minimized. The clear-sky SSTs, therefore, are only the forcings to cloud variations, but are not the responses to them. To investigate longwave climate feedback to SST, the clear-sky SSTs were compared with outgoing longwave radiation (OLR) values retrieved from recent (January 2008–June 2010) geostationary window channel imagery over tropical western Pacific (TWP; 20°N–20°S, 130°E–170°W). The cross-regression analyses between the domain-averaged values of anomalous OLR and clear-sky SST (deviations from their 90-day centered moving average values) reveal the highest significant correlation at zero lag, and the corresponding regression slope (i.e. change rate of OLR per SST) is about 10 W m-2 K-1. This value is much higher than that for the all-sky SSTs. This result implies that strong negative longwave feedback may be present over TWP.