Global Distribution and Variability of Surface Skin and Surface Air Temperatures as Depicted in the AIRS Version-6 Data Set

Joel Susskind
NASA Goddard Space Flight Center
Code 615, Earth Sciences Division
Greenbelt, MD 20771
Joel.Susskind@nasa.gov

Jae N. Lee
Jae.N.Lee@nasa.gov

For questions or comments during AGU poster session call Joel Susskind (240) 793-6398

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Background Information

The AIRS Science Team AIRS/AMSU Version-6 Data Set

AIRS is the advanced IR Sounder flying on EOS Aqua accompanied by AMSU, an advanced microwave sounder. There are 9 AIRS 15 km x 15 km fields of view (FOV) and a single AMSU-A 45 km x 45 km field of regard (FOR). AIRS products include land/ocean surface skin temperature \( T_{ps} \), atmospheric temperature profile \( T(p) \), water vapor profile \( q(p) \), and trace gas columns, fractional cloud cover and cloud top pressure, and outgoing Longwave Radiation (OLR). Most level-2 (single retrieval) products are generated on an AMSU FOR, but cloud products and OLR are generated for each AIRS FOV. Quality Controlled AIRS soundings are generated in up to 90% fractional cloud cover. Level-3 products are gridded over the 1° x 1° grid box for both 1:30 AM and 1:30 PM orbits on a global 1° x 1° spatial grid on a daily, weekly, and monthly mean basis.

Improved AIRS Version-6 Surface Skin Parameters

AIRS Version-6 products are significantly improved over those obtained previously, especially with respect to surface skin temperature \( T_{ps} \) and surface air temperature \( T(a) \). These improvements led to the ability to conduct meaningful studies of the global distribution of the difference between surface skin temperature and surface air temperature, as observed by AIRS both 1:30 PM and 1:30 AM local time. We refer to this surface skin-air temperature difference as \( \Delta T_{ps,a} \), it is very important parameter with regard to the understanding of the sensible heat flux between the Earth’s surface skin and the atmosphere.

Data Sets Used in This Study

This study used the AIRS Science Team Version-6 monthly mean level-3 data for surface skin temperature and surface air temperature, each gridded separately for 1:30 AM and 1:30 PM. Values of \( T_{ps} \), are not contained in the Version-6 data set. Data products used extend from September 2002 (the start of the data set) to August 2014. Twelve month climatologies were generated for each 1° x 1° grid box by averaging monthly mean data for all twelve months. Similarly, we generated seasonal climatologies for each season. Separate climatologies were generated for 1:30 PM and 1:30 AM. The annual anomaly for each grid box is the difference of the value for that month from that month’s climatology, and the seasonal anomaly is the difference of the values for that season from its climatology.

Version-6 Generation of \( T_{ps} \) and \( T(p) \)

AIRS radiances are very sensitive to changes in \( T_{ps} \) which is defined in Version-6 multimonthly with shortwave spectral emissivity \( \varepsilon_{ps} \), and shortwave spectral surface bi-directional reflectance \( \rho_{ps} \), using AIRS channels between 2306 cm\(^{-1} \) and 2665 cm\(^{-1} \). On the other hand, AIRS radiances are not sensitive to changes in \( T(p) \) very near the surface. \( T(p) \) retrievals are generated by adding relative humidity profile structure \( \Delta T(p) \) to the surface skin temperature \( T_{ps} \). The vertical structure of \( T(p) \) comes primarily from the fine structure in \( T(p) \). AIRS Version-6 generates for the first time reasonable values of \( T(p) \) because the Version-4 Neutral-Net first guess \( T(p) \) contains very accurate fine level temperature profile structure. This was not the case in Version-5, which used a regression guess formula for \( T(p) \).

Summary

We computed level-3 values of surface skin minus surface air temperature, \( \Delta T_{ps,a} \), by subtracting level-3 values of \( T_{ps} \) from level-3 values of \( T_{ps} \). Level-3 values of \( \Delta T_{ps,a} \) appear to be of high quality with regard to both their climatology and interannual variability. We encourage researchers to study the characteristics of \( \Delta T_{ps,a} \) to evaluate if it is currently accurate enough for their research purposes.

Interannual Variability of Surface Skin and Surface Air Temperature Difference (\( \Delta T_{ps,a} \))

The figures in the panel to the right show the variability of \( \Delta T_{ps,a} \) in terms of the behavior of its anomaly time series, as depicted by ARCs and ENC. The Average Rate of Change (ARC) of a product is the slope of the linear least squares fit to the anomaly time series. The El Niño Correlation (ENC) is the correlation of the anomaly time series with that of the El Niño Index (ENI), which is given by the NOAA Niño-4 SST minus its climatology as computed over the same 12 consecutive years. Results shown are for the average of the 1:30 AM/PM observations, as computed over the period September 2002 through August 2014.