Constructing an AIRS Climatology for Data Visualization and Analysis to Serve the Climate Science and Application Communities

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Abstract

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) is the home of processing, archiving, and distribution services for sounders: the present NASA Aqua Atmospheric Infrared Sounder (AIRS) mission and the succeeding NOAA SNPP* Cross-track Infrared Sounder (CrIS) mission. The AIRS mission is entering its 15th year of global observations with the Atmospheric Infrared Sounder (AIRS) and the succeeding CrIS. Our presentation will show the impacts to this climatology project by different averaging methods. This climatology can serve the climate science and application communities in data visualization and analysis, which will be demonstrated using a variety of functions in Giovanni, such as climatology plots and anomaly analysis.

Weighted vs Unweighted Monthly Climatology

The AIRS monthly standard retrieval product (AIRX3STM) is a weighted average of the daily AIRS temperature, humidity, and other products, from 1 x 1 degree cells for each day, and then the monthly average of these retrievals. The AIRS temperature retrieval retrieval succeeds in conditions with cloud cover less than 50%. The daily means are weighted with the unweighted values (for Surface Air T and Skin T) or climatologies that are unbiased towards cloudy conditions. The weighted monthly product is technically an estimator that is slightly biased toward fair weather conditions.

The simplest way to alleviate this problem is to produce unweighted averages instead, where all days and months have equal weight. For the purposes of this analysis, we use the "Time Averaged Map" function in Giovanni to produce unweighted monthly and multi-year monthly climatology estimates, and compare them against the standard monthly and derived weighted climatology estimates.

Datasets and Variables

The datasets used for this work are AIRS Version 6 standard retrieval monthly product (AIRX3STM) and daily product (AIRX3STD) over 14 years: from September 2002 to August 2016. The surface air and surface skin temperatures for each day serve as weights. However, AIRS temperature retrievals succeed in conditions with cloud cover less than 50%. The daily means are weighted with the unweighted values (for Surface Air T and Skin T) or climatologies that are unbiased towards cloudy conditions. The weighted monthly product is technically an estimator that is slightly biased toward fair weather conditions.

Weighted vs Unweighted 14-year Mean of Monthly Surface Temperature

• There is a consistent, notable, difference between the unweighted and the weighted monthlies, with the largest differences for Surface Skin T around 8 K and for Surface Air T around 5 K. The root mean square difference over global is up to 0.72 K.
• The global mean of arithmetic difference (unweighted – weighted) is always negative, with most values between -0.1 K to -0.2 K. It shows the weighted monthlies are warmer than unweighted ones, which is likely because the weighted averaging gives more weight to clear days, which are generally warmer than cloudy days.
• The Surface Skin T maps overall show higher temperature differences than the Surface Air T maps, which might be explained by the higher heating rate that land has compared to air.
• Even though the unweighted monthlies are colder than the weighted ones globally, they are consistently warmer near the winter polar regions (July: South Pole, January: North Pole).

Weighted vs Unweighted Monthly Surface Temperature

• Differences between the climatology created as 14-year means of unweighted and weighted monthly products show similar regional differences when compared to the monthly maps. With confidence larger than 95%, the differences are within +/-0.5 K.
• The weighted climatology is warm-biased (negative differences), which is consistently contributed mostly by Land and Tropical Oceans throughout the year. The global mean difference seems to peak during the boreal summer (-0.1 to -0.2 K for surface air and skin, respectively).
• Most values of the global root mean square difference (unweighted – weighted) are between 0.15 K to 0.25 K for Surface Air T and 0.3 K to 0.5 K for Surface Skin T.

Weighted vs Unweighted Monthly Surface Temperature

• More research needs to be done for creating the climatology product in Giovanni test server, along with their anomalies. The plots below demonstrate two use cases: the 2015-2016 El Niño event and June – August 2015 global surface temperature anomaly.

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Applications on Giovanni

The 14-year means of weighted monthly surface air and surface skin temperatures have been deployed as a climatology on the Giovanni test server, along with their anomalies. The plots below demonstrate two use cases: the 2015-2016 El Niño event and June – August 2015 global surface temperature anomaly.