Trends in Downwelling Longwave Radiation over SGP

Research Highlight

The long-term measurements that are being collected at the ARM Climate Research Facility sites provide a unique data set that can be used to look at trends in the atmospheric state or composition. While the ARM data record is too short for any trends to be considered as trends in climate, any trends do provide insight on changing atmospheric properties or processes.

Recently, a 14-year climatology of downwelling infrared radiance observed by the Atmospheric Emitted Radiance Interferometer (AERI) at the Southern Great Plains site was constructed. A detailed analysis of the data was performed to see if any trends existed in the radiance data. Two different tests were used to verify the statistical significance of the trend. Furthermore, the calibration approach used by the AERI prevents drifts in calibration and provides a measure of the sensitivity of the instrument; thus, instrument artifacts are shown to not be important for this study.

The results demonstrated that there were many significant trends in the downwelling radiance at this site over a range of time-scales (annually, seasonally, diurnally). For example, there is a significant negative trend in the all-sky radiance at 11 µm in the winter, summer, and autumn, but there is a positive trend in the downwelling radiance during the spring. As the data used in this climatology were separated into three categories based upon sky condition – clear skies, opaque low-altitude clouds, and "thin" clouds (which encompassed all other cases) – this classification can be used to understand these trends. The trends in the all-sky radiance are due primarily to changes in the cloudiness over time, with three seasons showing a negative trend in all-sky radiance having an increase in the fraction of time that the sky is clear. Different trends were also found in clear-sky, thin cloud, and thick cloud categories in different seasons and diurnally. The negative trend in the clear-sky classification is due to the decease in the precipitable water vapor over this period; this was seen in all four seasons.

Since this data set only spans 14 years, natural variability must be considered before drawing broad conclusions. However, these trends suggest that the atmospheric state (i.e., water vapor amount) and cloud properties are changing during this period, resulting in many statistically significant trends in the downwelling radiance. Given the geography of the Southern Great Plains and the use of seasonal averages, the AERI observations are representative of a large area of the central U.S., which is compatible with a gridbox of a global climate model. Thus, this data set is a valuable tool for evaluating climate models on a local scale.

Radiance trends at 11.4 µm in all-sky scenes for different seasons (left); for different sky conditions in summer and winter (center); and for clear-sky and thin-cloud conditions in the winter for day and night (right). A black "X" on the symbol indicates that the trend is not statistically significant.

Reference(s)

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Cloud Life Cycle, Cloud-Aerosol-Precipitation Interactions