A CERES-Consistent Cloud Climate Record From AVHRR Data

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One of the most pressing climate issues identified by the IPCC's Fourth Assessment is the need for a long-term analysis of cloud properties to better understand the impact of cloud radiative forcing on various aspects of climate, especially surface temperature and its diurnal variation. To understand this radiative forcing over long time periods, it is necessary to measure global cloud properties using a consistent set of proven algorithms applied to a long-term record of consistently calibrated and quality-controlled satellite imager data. Knowing how clouds vary with climate change and how well climate models reproduce such variability through modeled feedbacks is critical to understanding how well the models can predict climate.

As part of the NOAA NCDC Climate Data Record (CDR) program, scientists at NASA LaRC are currently developing a Thematic CDR (TCDR) consisting of cloud amount, phase, optical depth, effective particle size, height, temperature, and surface skin temperature extending from 1978 to the present time using data from the Advanced Very High Resolution Radiometer (AVHRR) instrument. The TCDR will be consistent with cloud properties derived from MODIS for the Clouds and Earth's Radiant Energy System (CERES) program, though some modifications to these algorithms will be required to operate on the 5-channel and lower spatial resolution AVHRR Global Area Coverage (GAC) data.

Accurate and stable visible and infrared channel calibration is essential for producing a robust, long-term analysis of global cloud amount and cloud properties. If visible channel degradation is not accounted for throughout the lifetime of the AVHRR instrument, this will induce an artificial trend in the climate data record. Reliable visible channel calibration is ensured through matching modern AVHRR data with that of Aqua MODIS using the Nearly Simultaneous Ray-matched Technique, the Deep Convective Cloud Technique, simultaneous nadir overpasses, and observations of desert scenes. These calibrations are then transferred back in time through the use of time-overlapping LEO and GEO data.

Additional features of this CDR that may differentiate it from past long term cloud climatology efforts include: 1) use 2-D surface fields and 3-D atmospheric profiles from the NASA Modern Era Retrospective-Analysis for Research and Applications (MERRA), 2) retrieval of cloud properties during both day and night over all land surface types, 3) estimates of cloud base based on cloud microphysical property retrievals, 4) use of dynamically updating clear sky reflectance maps over both snow/ice covered and non-snow surfaces, 5) use of specialized bi-directional reflectance distribution functions and emissivity models with scene-, atmospheric-, and angular-dependencies to improve modeling of clear sky reflectance and brightness temperatures over ocean, sea ice, and snow surfaces, 6) improved AVHRR image navigation, 7) 3.7 μm channel noise reduction in older AVHRR data, 8) objective detection of overshooting convective cloud tops which serve as a proxy for the presence of severe storms and indicate where significant amounts of water vapor are being transported into the upper troposphere / lower stratosphere (UTLS) region.

This presentation will highlight progress to-date on this CDR effort with a special emphasis on how the CDR could be used to improve the properties of clouds present in reanalyses and the representation of clouds in climate models.

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