Simulation of Nadir Longwave Spectral Radiance using PCRTM with MERRA Reanalysis Data sampled for a 90deg CLARREO-like Polar Orbit

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The Principal Component Radiation Transfer Model (PCRTM) (X. Liu Appl. Opt. 2006) is used to compute top-of-atmosphere nadir longwave spectral radiance at 1cm-1 resolution between 50 and 2800 cm-1. MERRA reanalysis temperature, humidity, ozone, cloud height and optical depth data for the time period 1983-2010 are used as inputs. The computations are made at thirty second intervals using the sampling pattern of a ninety degree inclination polar orbiting satellite. This is one of the proposed sampling patterns for a CLARREO mission. This precessing orbit is designed to cover the entire earth and sample the complete diurnal cycle at most locations several times a year. The control runs used fixed values for CO2 as well as other trace gasses. The simulation allows test of the *fingerprint method* (Y. Huang, JGR 2010), which will attribute of changes in TOA spectral radiance to key climate variables such as atmospheric temperature, water vapor and cloud properties.

The PCRTM code uses pre-computed quantities of reflectance and transmission based upon cloud single scatter properties dependent on phase, particle size and optical depth. Significant speed up is obtained by removing redundant spectral calculations with a subset of uncorrelated wavelengths. In this version of PCRTM 280 wavelengths and their associated principal components are used. Results compare extremely well with DISORT computations. RMS errors between PCRTM and DISORT are typically less that 0.4K with at least two orders of magnitude less CPU time (H. Li SPIE 2010).

Use of MERRA cloud data to simulate TOA radiance required some approximations to adapt to inputs for PCRTM of height dependent non-overlapped cloud profiles as seem from space. For example; a crude threshold of 260K was used to distinguish cloud phase. Also the occurrence of many very small cloud optical depth clouds was noted. However, comparisons of PCRTM nadir spectrally integrated broadband radiance compare favorably with MERRA provided TOA total-sky and clear-sky outgoing longwave flux assuming a mean longwave anisotropic factor.

Monthly zonal and global means of PCRTM spectral longwave nadir radiance output are formed. Analysis of deseasoned anomalies is performed. Correlations with MERRA; temperature and humidity, cloud properties and OLR are made. Secular trends in the computed zonal spectral radiance fields are seen and associated with MERRA input fields.

Secondary simulations using monthly mean data based upon the sampled orbit data were also made. The monthly mean based computations are compared to the instantaneous computations. Various means of computing monthly mean clouds and humidity profiles were attempted to minimize differences against the mean of instantaneous computations. Correlations of cloud property and atmospheric temperature and humidity produce on time scales of less than a month present an additional uncertainty when applying the spectral radiance fingerprint method which to date has typically been applied to monthly climate model output.

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