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Analysis of tropical clear sky OLR variability with CERES products and METEOSAT data: sensitivity to water vapor and surface conditions.

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Determining accurately the dependences of the Clear-sky Outgoing Longwave Radiation (OLRc) is a key factor for the Earth's energy budget. It is of particular interest over the tropics where most of the energy of the globe is lost through Infrared (IR) radiation. Within the tropical belt, it is essentially the Surface Temperature (Ts) and the tropospheric humidity variations which explain the seasonal and short inter-annual variability. Our study starts with defining a simple clear-sky OLR statistical model for the tropics with two parameters which involve Ts and the atmospheric Relative Humidity (RH). This was achieved with satellite data coming from two different instruments and platforms: CERES on board of AQUA and the water vapour channel, retrieving the Free Troposphere Humidity (FTH), from two METEOSAT satellite. First, we estimate the tropical OLRc by night with as much information as we can get by measurements, that is, using information on the vertical structure of the atmosphere coming from radiosondes, and with a radiative transfer model (Modtran) to do the calculation. Then, based on physical arguments, we propose a simple two-parameter statistical model for the night tropical OLRc who's accuracy is going to be compared to the spectrally and vertically resolved OLRc. The model works well for all kind of tropical surfaces except for the low-emissivity ones, namely the deserts. To further investigate this, we focus on the errors caused by the surface emissivity on OLRc.
In the second part of our work, we study the magnitude of the errors over OLRc estimates when the BlackBody (BB) approximation is used in computing the surface emission. These estimations are based on computations with idealised atmospheres and low-emissivity surfaces. We use Modtran which allows us to easily modify the surface emissivity parameter and the RH profile. We conclude from a first experiment that errors due to emissivity can be non-negligible for a 300K surface and become larger for higher surface temperatures. The spectral differences appear essentially in the window part of the IR spectrum, where the emissivity is less than 0.9 for deserts and where the most intense part of the surface irradiance is emitted. The sensitivity of OLRc to RH perturbations is analysed as well. The jacobian with low-emissivity surface becomes less negative than the BB one while getting closer to surface and becomes even positive for the lower layers of the atmosphere. Finally, we study the influence of the surface emissivity on OLRc for a few key variables identified before: reduced window emissivity, RH and Ts. We create simplified desert surface emissivity spectra inspired by different studies on this topic. We call "reduced window" the portion of the IR spectrum between 8 and 10μm, where emissivities can reach values as low as 0.7 around the 9μm wavelenght. We observe a linear dependence of OLRc to the reduced window emissivity. The sensitivity of OLRc to this emissivity is stronger for higher temperatures as was suggested previously. This shows us how critical is to estimate accurately the surface conditions to have a good estimate of OLRc over the desert like surfaces.