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Aerosols and clouds: numerical study for their combined radiative effect in Amazonia

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Despite their important role in Earth's radiation budget, clouds are responsible for processes that are still not understood by the scientific community, specifically because of their highly temporal and spatial variability. Reflection of solar radiation (causing surface cooling), absorption of thermal radiation (heating the atmosphere), and scattering on cloud borders (which may even increase radiation reaching the surface) are some of the cloud processes to be mentioned.

A particularity of the Amazon region is the massive cloud coverage all year round, even during the dry season, when most biomass burning activities take place. As an outcome, recent studies have demonstrated difficulty in separating aerosol and cloud radiative responses. The aim of this project is then to numerically estimate the combined cloud and aerosol effects using the libRadtran software package for radiative transfer calculations. Aerosol and cloud products from Moderate Imaging Spectrometer (MODIS) aboard Aqua and Terra satellites and Tropical Rainfall Measuring Mission (TRMM) satellite have been used as input. A relevant point to be analyzed is the representation of these cloud products. Some studies have already suggested that satellite retrieved products might represent only upper portions of clouds.

A synergy between MODIS and TRMM cloud products is proposed. MODIS provides, among other parameters, cloud fraction, cloud effective radius and the cloud water path. TRMM on the other hand, offers a detailed vertical (14 levels) profile of liquid and ice water content. Since the TRMM and Aqua/Terra overpass by the site of interest do not necessarily coincide, a synergy may be called in question due to the clouds' highly temporal variability. For this reason, its applicability and limitations are also discussed.

Downward surface global and diffuse irradiance for spectral broadband (from 350 to 1100 nm) measured with a Multi-Filter Rotating Shadowband Radiometer (MFRSR), as well as downward surface global photosynthetically active irradiance (PAR spectral band, from 400 to 700 nm) measured with a PAR sensor were used for validation and comparison with spectrally integrated numerical results. The experimental site is located in Reserva Biológica do Jaru, in southern Amazonia, a region strongly impacted by biomass burning. As an example of results, in a given day when the MODIS (Aqua) produced cloud water path of 80.277 g/m^2 and cloud effective radius of 26.14 μm and the solar zenith angle was 22 degrees, the observed global broadband irradiance was 648.3 W/m^2, whereas the numerically estimated quantity was 632.9 W/m^2, an error lower than 3%. For other situations, however, errors were larger than 30%.