Identifying and Modelling Clear-sky Fluxes using the AMF in Niamey and GERB/SEVIRI on Meteosat 8

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1. Introduction

RADAGAST employs measurements of the Earth’s radiation, via the ARM AMF deployment in Niger and the GERB instrument on the Meteosat 8 geostationary satellite. A program of modelling using several radiation codes, including Edwards-Slingo, has been undertaken. The initial results and the consequences for modelling are presented here.

The approach described here is to model the ‘clear-sky’ profiles (cloud- and aerosol-free), with the aim of using the results for inferring forcings from the two major sources of radiative perturbation in Niger: clouds and aerosols.

The results are split into understanding and identifying the clear-sky flux at the top-of-atmosphere, and progress in modelling long-wave fluxes and radiances at the ground.

2. Identifying and comparing clear-sky fluxes

The flux modelling undertaken assumes a plane-parallel atmosphere. However, the measurements from the AMF are those of a point source on the ground, whereas satellite measurements from GERB or SEVIRI instruments cover a large, heterogeneous area.

The difficulty this can cause is demonstrated in figure 1, which shows the top-of-atmosphere short-wave flux from the product pixel covering the AMF: via the GERB ARG product (50km x 50km pixel); and via the GERB/SEVIRI HR product (10km x 10km pixel).

The difference between the two fluxes is sizeable (~20 Wm⁻²), and is explained by figure 2. This shows visible SEVIRI radiances (3km x 3km pixels) over the ARG pixel-area.

The HR pixel, however, covers a much smaller area and is thus associated with lower albedo. Compared to the ARG area, the ratio of radiances in the ARG pixel to those from the HR pixel is 1.09. The corresponding ratio of fluxes from figure 1 is 1.10±0.02. For more discussion on heterogeneity, please see the Settle et al. poster.

3. Modelling long-wave fluxes & radiances

The Edwards-Slingo radiative transfer code was used with atmospheric profiles created using several ARM instruments (including rawinsondes). Figure 5 shows both the daily mean down-welling clear-sky LW flux from the model and the measurement from the AMF, Niamey. There is a noticeable difference in the latter part of the year - a period with low column water vapour.

There is significant variation in aerosol loading during November; these changes do not, however, significantly alter the flux differences. Thus variable aerosol loading is discounted as an important factor.

An alternative measurement of LW radiation is via the AERI interferometer. Figure 6 shows a calculation from one profile in late November. It also shows the model under-representing the measured radiation. A comparison of fluxes calculated using Edwards-Slingo RT code (by the lead author) and independent calculations using LBLRTM (courtesy Eli Mlawer) is shown in figure 7. There are disagreements of ~3 Wm⁻², but the overall trend lies well to the right of the 1:1 line. The cause of all these disagreements has not yet been established.

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