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Geoscientific Model Development Discussions

Interactive comment on "SCOPE 2.0: A model to simulate vegetated land surface fluxes and satellite signals" *by* Peiqi Yang et al.

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1. Response to the comment on typical diurnal cycles of G

The (negative) night time Rn and G (shown in the Figure in our previous response) seems to be underestimated (in absolute value) compared to what has been reported in other studies (e.g. Van der Tol, 2012). We hypothesize that this is at least partly due to the turbid medium representation of the vegetation, which may lead to underestimation of the gap fraction (and thus the exposed part of the soil) and thus the night-time radiative cooling of the soil.

2. Response to the comment on FPAR of the leaves

The model outputs the APAR for sunlit and shaded leaves (per layer), by computing the spectral integration of the product of (leaf) irradiance and absorptance of the leaf, which is 1-leaf reflectance –leaf transmittance. Because the model differentiates leaves of different orientation (and exposure to the Sun) this is done for all leaf elements. The APAR for all the sunlit or shaded leaves combined is calculated by integrating the product of the individual leaf contributions and their probability of occurrence, which is determined by the leaf orientation distribution and the canopy gap fraction. Finally, the FPAR can be calculated by the user from the APAR by dividing FPAR by the incident PAR, which is also the output of the model, but for the canopy as a whole. The FPAR is for the sunlit and shaded fractions separately, in APAR/iPAR_leaf, is not output.

3. Response to the comment on the relationship between LST, Tcave and Tsave

From the energy balance routine, we obtain the temperature of each individual leaf, which is the equilibrium temperature at which the energy balance closes (radiation, sensible, latent and ground heat fluxes). Tcave represents the average temperature of all the leaves. Similarly, Tsave is the average temperature of sunlit and shaded soil. This is a simple arithmetic average, which is strictly not physically sound, but it is nevertheless a good indicator. LST is computed from Planck's law once the equilibrium soil and leaf temperature are known. First, the outgoing radiance in the observation direction is simulated with the thermal radiative transfer model. This simulation is carried out twice: - Once for thermally black soil and leaves (Lob) - Once with the actual emissivities of soil and leaves (Lo). The whole-stand effective emissivity is then calculated as: Emissivity = Lo/Lob which holds a value between the soil and leaf emissivity. The LST is then estimated by inversion of the Stefan-Boltzman equation from Lo and the emissivity. This LST is comparable to radiometric observations of temperature from proximal or remote sensing. For example, Duffour et al. (2015) compared the simulated LST with the measurements. Duffour, C., Olioso, A., Demarty, J., Van der Tol, C., and Lagouarde, J.-P.: An evaluation of SCOPE: A tool to simulate the directional anisotropy of satellite-measured surface temperatures, Remote sensing of

environment, 158, 362–375, 2015.

4. Response to the comment on bias in LST simulations in Figure 8

The figure shows that the difference in TOC SIF is around 0.1 Wm-2um-1sr-1, and around 1 degree in the surface temperature simulation. Thus the difference in radiance is minimal, while the difference in average temperature is relatively higher (compared to the natural spatio-temporal variability). This is not an error, but simply due to the non-linear relation between temperature and irradiance in the Planck law (see our response to the point of average temperature vs LST). However, the applicability of the lite option depends on specific purposes and the desired accuracy.

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