CORRESPONDENCE

Comments on "Direct Determination of Surface Albedos from Satellite Imagery"

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Mekler and Joseph (1983, hereafter referred to as MJ) propose a method to derive surface albedos from satellite imagery that does not require any prior knowledge of either the atmospheric optical properties or those of the satellite system. They approximate the exact monochromatic solution of the radiative transfer equation for the upward radiance over a homogeneous terrain with isotropic albedo by $I^A \approx I^0 + GA + GLA^2$ [Eq. (2) of MJ]. With three known values of the surface albedo A together with the corresponding counts I^A of the satellite instrument, the atmospheric functions I^0, G and GL can be determined. Provided the atmosphere is horizontally homogeneous over the entire satellite image, the surface albedo of every pixel can be derived.

The method of MJ is based on the assumption that natural surfaces behave like isotropic reflectors. Kriebel (1979) is cited to support the theory that this assumption is valid for solar zenith angles less than 60°. This citation is correct only insofar as albedos averaged over the whole solar spectral range from about 0.3 to 3 μm are considered; only then may the different angular anisotropies at different wavelengths compensate each other. Spectral albedos vary considerably with the solar zenith angle.

Mekler and Joseph apply their method to Landsat channels that are spectral channels. Kriebel (1974) states that the relation of the spectral albedo to π times the vertically upward reflected spectral radiance differs from unity by up to a factor of 1.5 for different solar zenith angles in the case of a savannah. Kriebel (1976, 1978) shows for four vegetated surfaces that the dependence of the reflected spectral radiance on the solar zenith angle varies widely with the angle of reflection and has a mean value of about $\pm 1\%$ per degree change of the solar zenith angle. It is also shown that the dependence of the vertically upward reflected spectral radiance on the solar zenith angle is not extreme but similar to the mean value. These results are restricted to vegetated surfaces. Other surfaces may behave differently, but there is no reason to assume isotropic behavior, at least as long as small spectral bands are considered. Most natural land surfaces have some structures producing shadows and, hence, anisotropy. As a consequence, measured spectral ground albedos may differ by up to $\pm 50\%$ from π times the vertically upward reflected radiances that produce essentially the measured counts at the satellite instrument. This results in an erroneous determination of the atmospheric functions in Eq. (2) of MJ, where the error may be larger or smaller than $\pm 50\%$ depending on the sign of the error in each of the three ground albedo measurements. This uncertainty is increased up to another $\pm 50\%$ by assuming isotropic albedo for the pixels whose surface albedos are to be determined from satellite imagery by means of those atmospheric functions. The given magnitudes of error may somewhat exaggerate the real effect of the anisotropy but, in fact, neither the amount nor the sign of the difference between spectral albedo and π times the vertically upward reflected spectral radiance are usually known.

If the hemispherical–directional reflectance factor for the vertically upward radiance (rather than the ground albedo) were to be measured at sufficient solar zenith angles, the atmospheric functions in Eq. (2) of MJ could be determined correctly, provided this equation is applicable, and only the last uncertainty mentioned would remain.

In my opinion, a study is required that shows that the exact solution of the radiative transfer equation over a homogeneous terrain with isotropic albedo is applicable in realistic anisotropic situations without too much error. This should be done before the simple and elegant method proposed by MJ is applied to derive surface albedos from satellite imagery.

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