Validation of Space-based Global Albedo Products by upscaling from Ground-based Measurements

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Abstract

Surface albedo is of critical interest in land surface–climate interaction studies, since it is the key parameter that affects the Earth's radiation budget. The temporal and spatial variation of surface albedo can be retrieved from satellite observations following a series of processes, including correction for atmospheric scattering by aerosols to surface spectral bi-directional reflectance factor (BRF), followed by modelling of bi-directional reflectance distribution function (BRDF) using these BRFs, and, where required, narrow-to-broadband albedo conversions. This processing chain introduces uncertainties that are accumulated which then affect the accuracy of the final retrieved space-based global albedo products. In order to validate such spaceborne albedo, we require the exploitation of a global based network of tower-based albedometers and its upscaling to satellite resolutions.

In this study, we introduce a new method to derive the two types of surface albedo, (directional hemispherical reflectance (DHR) and bi-hemispherical reflectance (BHR)), directly from three tower-measured variables of shortwave radiation: downwelling, upwelling and diffuse shortwave radiation. The tower-measured albedo values (DHR and BHR) are then used to validate global albedo products between 2012 and 2018 at 22 tower sites. These are part of the FLUXNET, SURFRAD and BSRN networks, located over Europe, North America, South America, South-West Africa, Antarctica and Australia. A new method of upscaling tower-measured albedos to coarse-resolution albedos is described which involves the use of BRFs derived from high resolution EO such as Sentinel-2. These high-resolution BRFs are produced by the Sensor Invariant Atmospheric Correction (SIAC) atmospheric correction model (https://github.com/MarcYin/SIAC), utilising MODIS BRDF climatology from a larger area to produce high-resolution surface albedos from high-resolution surface BRFs. The main differences between SIAC and other atmospheric correction approaches include the use of an expectation of surface reflectance at coarse resolution (MODIS MCD43 BRDF kernels), the use of the Copernicus Atmosphere Monitoring Service (CAMS) data as a prior constraint, the use of spatial regularisation in atmospheric composition parameters, and the use of state-of-the-art atmospheric radiative transfer models through Gaussian Process emulators.

This atmospheric correction strategy provides uncertainties that originate from tower albedometers and propagate through the atmosphere for each satellite pixel. The upscaling process can then be used to produce validated coarse-resolution albedo products at the time of satellite overpass. The accuracy of this surface albedo upscaling method is examined over both homogeneous and heterogeneous land surfaces.

Keywords - Cross Calibration / Validation