Global estimates of Urban Surface Albedo time series with the use of cloud computing

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Abstract

The Land Surface Albedo (LSA) is a critical physical variable which influences the Earth's climate by affecting the energy transfer and distribution in the Earth-atmosphere system. Its role is highly significant in both global and local scales, since LSA measurements provide a quantitative means for better constraining global and regional scale climate modelling efforts. Similarly, in urban environments LSA is crucial for the estimation of the local scale radiation and energy budget. In the present study, the LSA was estimated in large urban areas globally, at 0.5 km × 0.5 km spatial resolution and on an 8–day basis, for the period 2001–2014. Products from the Moderate Resolution Imaging Spectroradiometer (MODIS), on board NASA's Terra and Aqua satellites were used, including the directional-hemispherical surface reflectance (black-sky albedo) and the bi-hemispherical surface reflectance (white-sky albedo), both available at 0.5 km × 0.5 km, and the MODIS-derived Aerosol Optical Thickness (AOT), at 1° × 1° spatial resolution. Since LSA also depends on Solar Zenith Angle (SZA), 8-day mean LSA values were computed as averages of corresponding LSA values for representative SZAs. The estimated LSA was analyzed in terms of both spatial and seasonal characteristics, while LSA changes during the period examined were assessed based on a linear regression approach. The effects of the Normalized Difference Vegetation Index (NDVI) and rainfall trends on LSA changes were also assessed. Urban areas were masked using the Global Urban Footprint (GUF) layer, i.e. the DLR global map of built-up areas derived by means of TerraSAR-X and TanDEM-X data acquired between 2011 and 2013. All computations were performed using the Google Earth Engine platform and the data available in its catalog, which include all the above mentioned satellite data. The Google Earth Engine is a cloud system designed to enable petabyte-scale scientific analysis and visualization of geospatial datasets. Google Earth Engine's consolidated environment, including the abovementioned data, co-located with thousands of computers for analysis, made possible the global-scale urban LSA estimation for the 14-year period and the corresponding statistical analysis. The results revealed substantial spatiotemporal variability of LSA, highlighting the great potential of Earth Observation data in combination with the power of cloud computing in supporting relevant studies.