Standardizing the Description of Satellite Surface Albedo Products

G. Schaepman-Strub (1), J. Martonchik (2), C. Schaaf (3) and M. Schaepman (4)

(1) Nature Conservation and Plant Ecology, Wageningen University, Wageningen, NL
(gabriela.schaepman@wur.nl), (2) Jet Propulsion Laboratory, Pasadena, USA
(jvm@jord.jpl.nasa.gov), (3) Boston University, Boston, USA, (schaaf@bu.edu), (4) Centre
for Geo-Information, Wageningen University, Wageningen, NL (michael.schaepman@wur.nl)

Land surface albedo is one of the key drivers of the Earth's surface energy budget. Its importance in climate change research has been acknowledged since a long time, however recent advances in albedo related research are increasingly focusing on combined land surface processes and climate change including each others feedbacks. A recent study was giving empirical evidence that changing summer albedo in tundra regions caused by changes in seasonal length (earlier snowmelt) and vegetation composition (shrub encroachment) dramatically increases atmospheric heating (Chapin et al., 2005). Land surface albedo is a key variable in climate and ecosystem analysis and modeling through its representation of dynamic vegetation processes. Spatially continuous fields of surface albedo are usually derived from satellite observations, requiring sophisticated product algorithms. However, surface albedo is a broad term and the available operational satellite products are not consistent, resulting in physical and semantical interoperability challenges. The derivation of albedo is a multidimensional challenge, whereas the sensor-specific calculation relies not only on observation configurations representing subsamples of the final quantity, but also on angular models for inter- and extrapolation of the reflectance quantities to illumination and view angles not sampled by the satellite observations, as well as spectral conversion algorithms. While either combining albedo data from different sources or comparing studies relying on different albedo products, the above factors contribute to a bias and consequently in additional uncertainties. It is thus important to provide all relevant information of the product generation, helping users to reduce uncertainties and enabling to link the different types of albedo in a physically more consistent way. Based

on well-documented albedo products (e.g., derived from MODIS, MISR, Meteosat) we are presenting a standardized description of albedo data products. We are basing this approach on the following aspects: (1) A physically consistent description of a) reflectance input and b) resulting albedo quantities, based on the reflectance terminology by Martonchik et al., 2000. a) The reflectance input for the calculation of albedo quantities consists of top-of-atmosphere single-view angle observations corrected to the at-surface level. The standardized description contains details on the atmospheric correction of the at-surface reflectance, including the illumination geometry of the at-surface reflectance (i.e., bidirectional reflectance factor), and assumptions concerning aerosol properties (e.g., optical depth, particle size, single scattering albedo, vertical distribution) and whether these properties are inferred from the same radiance data as the albedo products or selected from climatological data. b) Description of the physical nature of satellite derived albedo products, with special emphasis on the illumination configuration of the available products (i.e., directional-hemispherical reflectance (DHR), bihemispherical reflectance (BHR), bihemispherical reflectance under isotropic diffuse irradiance conditions (BHRiso)). (2) Angular subsampling: Using empirical/semiempirical BRDF models, the atmospherically corrected observations are integrated to estimate albedo. Three main concepts for the acquisition of multiple view/sun angle configurations exist: instantaneous multiple view angle acquisition by a single instrument (e.g., MISR), daily accumulation of geostationary satellite observations (e.g., Meteosat), and multiple day composites covering the same surface under different view/sun angle geometries (e.g., MODIS). Details on the sampling design (e.g., number of used samples, time interval between samples), the sun and observer geometry of the single-angle at-surface reflectance quantities, as well as the geometry of resulting albedo products (e.g., fixed solar angle versus solar angle of observation), are part of the standardized description. (3) Spectral subsampling: A narrow-to-broadband conversion has to be performed to calculate broadband albedo from observations of a few spectral bands of the satellite sensor. The characteristics of the spectral bands (e.g., center wavelength, full width half maximum), details on the spectral conversion algorithms, as well as bandwidth of resulting albedo quantities are listed in the standardized albedo product description. (4) A priori knowledge and assumptions in the form of for example, land-surface specific constants or boundary conditions used in the atmospheric correction, angular modeling, or spectral conversion need to be described additionally. (5) Point of contact (individuals and/or organizations) for the purpose of users who may want additional information than that found in the standardized description.

The above presented standardized description is then applied to a selected set of operational albedo products (e.g., MODIS, MISR), discussing the status of the current products. This contribution forms a basis for an in-depth discussion on a standard for

albedo product description, allowing to make these products more comprehensible and reliable for the user community, e.g., climate modellers. We emphasize towards the need of a standardized definition for a suite of - application dependent - albedo products (e.g., driven by the coupling surface albedo with diffuse sky radiation in climate research (Pinty et al., 2005), the relevant time interval, or the spectral resolution, and the different angular and spectral configurations of the observing sensors), rather than asking for a standardization of the delivered albedo products themselves. In addition to the land surface albedo validation efforts by CEOS/LPV (http://lpvs.gsfc.nasa.gov/) enhancing the collaboration among satellite data producers and use by modelers, a standardized description will further reduce uncertainties based on physical product differences, increase spatial data quality awareness, and finally reduce semantic differences within the albedo terminology.

References: Chapin, F.S., Sturm, M., Serreze, M.C., McFadden, J.P., Key, J.R., Lloyd, A.H., McGuire, A.D., Rupp, T.S., Lynch, A.H., Schimel, J.P., Beringer, J., Chapman, W.L., Epstein, H.E., Euskirchen, E.S., Hinzman, L.D., Jia, G., Ping, C.L., Tape, K.D., Thompson, C.D.C., Walker, D.A., & Welker, J.M. (2005). Role of land-surface changes in Arctic summer warming. Science, 310, 657-660.

Pinty, B., Lattanzio, A., Martonchik, J.V., Verstraete, M.M., Gobron, N., Taberner, M., Widlowski, J.L., Dickinson, R.E., & Govaerts, Y. (2005). Coupling diffuse sky radiation and surface albedo. Journal of the Atmospheric Sciences, 62, 2580-2591.

Martonchik, J.V., Bruegge, C.J., & Strahler, A. (2000). A review of reflectance nomenclature used in remote sensing. Remote Sensing Reviews, 19, 9-20.