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Land surface albedo in Northern high latitudes - MODIS satellite-inferred albedo trends for a NE Siberian tundra area

G. Schaepman-Strub (1,2), M. Claverie (2), M.E. Schaepman (2)

(1) Nature Conservation and Plant Ecology, Wageningen University, NL (gabriela.schaepman@wur.nl), (2) Centre for Geo-information, Wageningen University, NL

Major changes are expected to occur in Northern high latitudes under a warming climate, affecting the land surface albedo with a potential positive feedback (e.g., Chapin et al., 2005). We present land surface albedo results achieved within a larger Dutch-Russian effort and linked to IPY to determine the greenhouse gas and energy fluxes of a Northeastern Siberian site, located at 71 deg N, 147 deg E, about 100 km South of the arctic ocean. The aim of this substudy is to analyze land surface albedo changes throughout the past few years (2000-2007) for an area of approx. 9000 km2 and establish a reliable reference data set for vegetation and regional climate modeling. Observational limitations during the springtime period result in data mostly relying on the back-up algorithm of the MODIS albedo processing chain before DOY 153. The yearly averaged bias of backup algorithm data in the shortwave broadband albedo for a homogeneous site was found to be lower than +-0.002 (sensitivity threshold as published for climate models). However, snow-covered area backup algorithm data may show much higher biases for a specific DOY, exceeding 0.1 absolute value. The MODIS albedo product contains two different quantities, namely the DHR (directional-hemispherical reflectance) and the BHRiso (bihemispherical reflectance under the assumption of isotropic illumination distribution), which may be linearly combined according to the atmospheric conditions to approximate the actual BHR (bihemispherical reflectance under ambient illumination conditions). The analysis of the DHR and BHRiso products in the shortwave broadband for 2000 and 2002 showed a temporally averaged relative difference of 0.028. The actual difference is

mainly a function of the solar zenith angle (determined by the BRDF model), reaching values of up to 0.1 for high solar zenith angles for this tundra site. This highlights the necessity of combining the two products when the albedo quantity under ambient illumination conditions is required to meet climate model sensitivity requirements. For an absolute validation of the albedo data, in-situ pyranometer measurements performed at the eddy covariance flux tower site during summer 2003 (van der Molen et al., 2007) were compared to BHR data computed based on MODIS DHR and BHRiso products, showing a RMSE of 0.0238. The main seasonal pattern of the land surface albedo of this tundra area is driven by the snow cover, confirmed by a correlation coefficient of 0.87 with snow height data of the Chokurdah meteorological station. Further, the influence of the growing vegetation on the albedo in summer can be tracked in the red/NIR spectral bands, including spatial differences in the N-S transect of the selected test site. The analysis of the albedo of the two main spatial components, namely thermokarst lakes and shrubland, shows a temporal pattern which seems to be sensitive to actual climatic conditions. Icemelt on thermokarst lakes is delayed from snowmelt on vegetation-covered surfaces. Albedo changes at the landscape scale are expected to be a non-linear process due to the differing changes in the area (e.g., snowmelt advance, shrub enlargement and encroachment, hydrological changes, including potential thermokarst lake drainage). The quantification of the above processes and their contribution to land surface albedo changes is of outmost importance, e.g., when relating longterm NDVI data to vegetation changes in Northern high latitudes and inferring their potential feedback to the climate system.