Accuracy assessment of snow-ice cover albedo values calculated from Sentinel-2 imagery based on ground data

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The analysis of albedo values and its dynamics is an important parameter used in the climate studies and in the analysis of energy balance components for continental glaciers. Albedo of snow-ice cover is one of the main factors determining the intensity of melting, and characterizes the reflectivity of the earth's surface in a wide spectral range (visible and near infrared). It is estimated as a result of ground-based measurements and from remote sensing data.

The disadvantage of ground-based measurements is its discrete distribution, which does not provide a continuous picture of the spatial and temporal variations of albedo values in large areas. At the same time, the use of satellite images provides a full picture of the albedo value distribution almost simultaneously for large areas. Currently, there are several methods for calculating albedo values from satellite images that still require verification based on precise ground data.

We performed the analysis of existing methods and then calculated albedo of snow-ice cover for two geographical areas with different types of snow-ice cover and anthropogenic activities.

The first area is the Ak Shyirak massif (Inner Tian Shan), where analysis was carried out for mountain glaciers with different types of surfaces (old ice, fresh snow, rocky inclusions etc.). The second area is the Kola Peninsula (near Murmansk), which is located at Russian Arctic. However, the illumination conditions and the presence of frequent clouds cause a lack of satellite images suitable for the development of the model for albedo calculation. Therefore, the main development of the model was carried out for the Ak Shyirak massif, where a large data set of ground measurements and satellite images for cross-calibration was collected over several years.

Ground-based albedo measurements were carried out across 11 glaciers during summer and autumn in 2015-2018 using Sp Lite 2 Kipp&Zonen albedometer. Using ground albedo data from 4 glaciers and satellite imagery acquired on the same days, we developed models for ground correction of albedo values obtained from satellite data and verified it. Then we analyzed seasonal dynamics of albedo values for the Ak Shyirak massif and spatial distribution of snow cover albedo for Kola peninsula (near Murmansk) using this model. Glacier albedo in the Ak Shyirak massif is driven by natural environmental factors, mostly by elevation and preceding weather conditions, but strong technogenic impact (mechanical disturbance of coal-dust) was detected for Murmansk.