



Detection of changes in snow line elevation from MODIS imagery in the Romanian Carpathians

Mihai Micu (1), Dana Micu (1), Ionut Sandric (2), and Sorin Mihalache (1)

(1) Romanian Academy, Institute of Geography, Bucharest, Romania, (2) University of Bucharest, Faculty of Geography and Esri Romania, Bucharest, Romania

Mountain snow cover is particularly sensitive to the observed shifts in the regime of its two determinants (air temperature and precipitation), in response to climate warming. The climate of the Romanian Carpathians became warmer particularly in winter, spring and summer, exhibiting an increasing frequency of hot extremes and a decrease of freezing days. There is also an obvious trend towards a late snowpack onset in Autumn, more evident in the areas below 1,700 m, and towards an earlier Spring snowmelting, generalized across the entire region. The observed changes in the timing of snowmelt due to milder winters, are explaining most of the decline of snow cover duration in the areas below 2,000 m. Snow line, separating snow covered from snow free areas, is considered a key indicator for monitoring the changes in snow coverage under the changing climate behavior. This study aims at deriving and analysing the changes in snowline elevation (SLE) using the multi-temporal Moderate-resolution Imaging Spectrometer (MODIS) reflectance products (MYD10 and MOD10 daily and 8-day composite) and a high-resolution Digital Elevation Model (DEM) of the Romanian Carpathians (30 m). The changes in SLE were analyzed in relation to the shifts in freezing height (FH) across the Romanian Carpathians, derived from MYD11A1, MYD11A2, MOD11A1 and MOD11A2 daily and 8-day composite products, available at a spatial resolution of 1 km. Python batch scripts using Esri ArcPy were developed and applied to download, subset, reproject and mask each MODIS product. The analyses were focused on producing and using daily and 8-day composites time series from both Terra and Aqua MODIS products for a period of about 12 years, starting from 2002 up to present day. The variability of snow cover persistence was investigated at both monthly and seasonal time steps, allowing to identify the trends in SLE and FH, as well as the changes in the timing of snow melt across the region. The paper is revealing the inter-seasonal changes in snow cover depletion behaviour, with a special focus on the February-June interval (the snow ablation active interval), as well as the regional spatial differences between the three regional units of the Romanian Carpathians. The regional changes in SLE are discussed in relation to the observed temperature and precipitation changes in winter and spring, derived from in situ meteorological measurements in the areas above 1,000 m of the Romanian Carpathians. The results are explaining partially the difficulties that winter tourism industry in Romania has been facing in the mild winters with poor snow coverage, particularly in the low elevation ski domains of the Carpathians, located below the snow reliability line.