



## **Space-time analysis of snow cover change in the Romanian Carpathians (2001-2016)**

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Snow cover is recognized as an essential climate variable, highly sensitive to the ongoing climate warming, which plays an important role in regulating mountain ecosystems. Evidence from the existing weather stations located above 800 m over the last 50 years points out that the climate of the Romanian Carpathians is visibly changing, showing an ongoing and consistent warming process. Quantifying and attributing the changes in snow cover on various spatial and temporal scales have a great environmental and socio-economic importance for this mountain region. The study is revealing the inter-seasonal changes in the timing and distribution of snow cover across the Romanian Carpathians, by combining gridded snow data (CARPATCLIM dataset, 1961-2010) and remote sensing data (2001-2016) in specific space-time assessment at regional scale. The geostatistical approach applied in this study, based on a GIS hotspot analysis, takes advantage of all the dimensions in the datasets, in order to understand the space-time trends in this climate variable at monthly time-scale. The MODIS AQUA and TERRA images available from 2001 to 2016 have been processed using ArcGIS for Desktop and Python programming language. All the images were masked out with the Carpathians boundary. Only the pixels with snow have been retained for analysis. The regional trends in snow cover distribution and timing have been analysed using Space-Time cube with ArcGIS for Desktop, according with Esri documentation using the Mann-Kendall trend test on every location with data as an independent bin time-series test. The study aimed also to assess the location of emerging hotspots of snow cover change in Carpathians. These hotspots have been calculated using Getis-Ord  $G_i^*$  statistic for each bin using Hot Spot Analysis implemented in ArcGIS for Desktop. On regional scale, snow cover appear highly sensitive to the decreasing trends in air temperatures and land surface temperatures, combined with the decrease in seasonal precipitation, especially at lower elevations in all the three divisions of the Romanian Carpathians (generally below 1,700-1,800 m). The space-time patterns of snow cover change are dominated by a significant decreasing trend of snow days and earlier spring snow melt. The key findings of this study provides robust indication of a decreasing snow trends across the Carpathian Mountain region and could provide valuable spatial and temporal snow information for other related research fields as well as for an effective environmental monitoring in the mountain ecosystems of the Carpathian region