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Shifts during the snow season in the Romanian Carpathians in response to winter temperature and precipitation change

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Snowpack characteristics and duration are considered to be key indicators of climate change in mountain regions, particularly during the winter season when its environmental and economic importance is notable. The present study is focused on relevant snow statistics over a 43-year period of meteorological observations at several climatological stations (15) located above 1,000 m a.s.l. in the Romanian Carpathians. Here the snow season is considered to last from the 1st of November to the 30th of April when snowpack reaches the highest stability and thickness in most of the studied locations. Winter temperature and precipitation change signals are investigated as main triggering factors of snow season changes (i.e. snow vs. rain, seasonal snowfall onset and offset, snowpack duration s.o.). The current mountain climate warming is obvious, determining a generalized decreasing trend of the snow-to-rain ratio. The alpine areas are also experiencing temperature increases and a higher frequency of positive extremes (e.g. winter heat waves). Earlier spring snowmelt was also statistically proved both at regional level and by elevation levels. Winter precipitation varies from year to year and over decades, and changes in amount, intensity, frequency, and type (e.g. snow vs rain) affect both the environment and society. Periods in which snow was abundant or not were also investigated in relation to the large-scale forcing (e.g. the winter North Atlantic Oscillation index fluctuations as a measure of strength of the westerly flow from the Atlantic and of cyclonic activity trends). The shifts observed in the Romanian Carpathians snow season are comparable to winter climate change estimated from observational data recorded also in other European mountain regions (e.g. the Swiss Alps, the French Alps and the Tatra Mts.). The results indicate that since mid-1980s the Romanian Carpathians have shown an obvious trend towards late Fall snowfall and snowpack onset (more evident below 1,700 m) and early Spring snowmelt (generalized in most areas) even if the response of the snow season length is still blurred in several mountain areas, particularly in the alpine ones.