SNOW COVER VARIABILITY AND TRENDS IN THE TATRA MOUNTAINS IN 1921-2006

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Abstract: Snow cover variability and trends in the High Tatras and the Low Tatras region in Slovakia in the 1921-2006 period are presented in the paper. The obtained results proved the unequal snow condition trends in the region. The most significant differences were found between the northwestern and southeastern part. It seems that variability and trends in snow cover characteristics are influenced both by air temperature and precipitation variability. This influence depends significantly on the altitude and local topography conditions. Increase of air temperature by about 1.2 °C and change of precipitation totals from –10% to +20% in the November-April season are the main reasons of obtained trends. Another reason is connected probably with the change in the atmosphere circulation patterns.

Keywords: *snow cover, statistical analysis, influence of topography, mountainous area, climate change, areal aspects*

1. INTRODUCTION

The Tatra Mountains in Slovakia consist of the High Tatras (2655 m a.s.l.), the Western Tatras (2248 m a.s.l.), the Belianske Tatras (2152 m a.s.l.) and the Low Tatras (2043 m a.s.l.). The Liptovská hollow (west) and the Popradska hollow (northeast) have the bottom altitude from 400 to 900 m a.s.l. Including the valleys and hollows, the all area is about 7000 sq km large. Because of upwind and lee effects the snow conditions are very complex there. Some of the southwestern to northwestern upper slopes have even more than 250 cm of maximum of snow cover depth with very high probability of depths above 50 cm from December to March. In the Popradská hollow (about 700 m a.s.l.) the snow cover occurrence is relatively low also in January and February.

Regular observations of daily snow cover, new snow and precipitation totals in this region have started at about 100 stations in 1921 (data from 25 stations are complete up to present). Some of stations with complete measurements have been removed after reliability testing because of worse quality. We consider the 85-year series of data as enough long for statistical analysis of variability and trends of basic snow cover characteristics also at areal consideration. Maps of snow characteristics have been designed by use of Arc View GIS software, while some grid data in higher altitudes have been prepared by the regression method. Selected graphs show a sample of trend analysis for 5 stations.

The obtained results proved the unequal snow condition trends in the region. The most significant differences were found between the northwestern and southeastern part. It seems that variability and trends in snow cover characteristics are influenced both by air temperature and precipitation variability. This influence depends significantly on the altitude and local topography conditions. Increase of air temperature by about 1.2 °C and change of precipitation totals from –10% to +20% in the November-April season are the main reasons of obtained trends. Another reason is connected probably with the change in the atmosphere circulation patterns.

2. RESULTS

2.1. Number of snow cover days ≥ 1 cm

Number of days with snow cover ≥ 1 cm is considered as a basic characteristic. The lowest values have been found in the bottom of the Liptovská hollow and in the Spiš Region. This is caused mainly by the lee effects of the round mountains. Lee effects dominate predominantly at westerly and southerly air flows. In the altitudes about 2000 m a.s.l. snow cover occurs regularly during 60% of the year, at the Lomnický štít (2635 m a.s.l.) even during 67%. The Low Tatras have nearly the same snow conditions both in the northern and the southern slopes, on the other hand the High Tatras have significanly more snow cover days on the northern slopes. More over the less windy and forested areas have higher and longer snow cover as well.

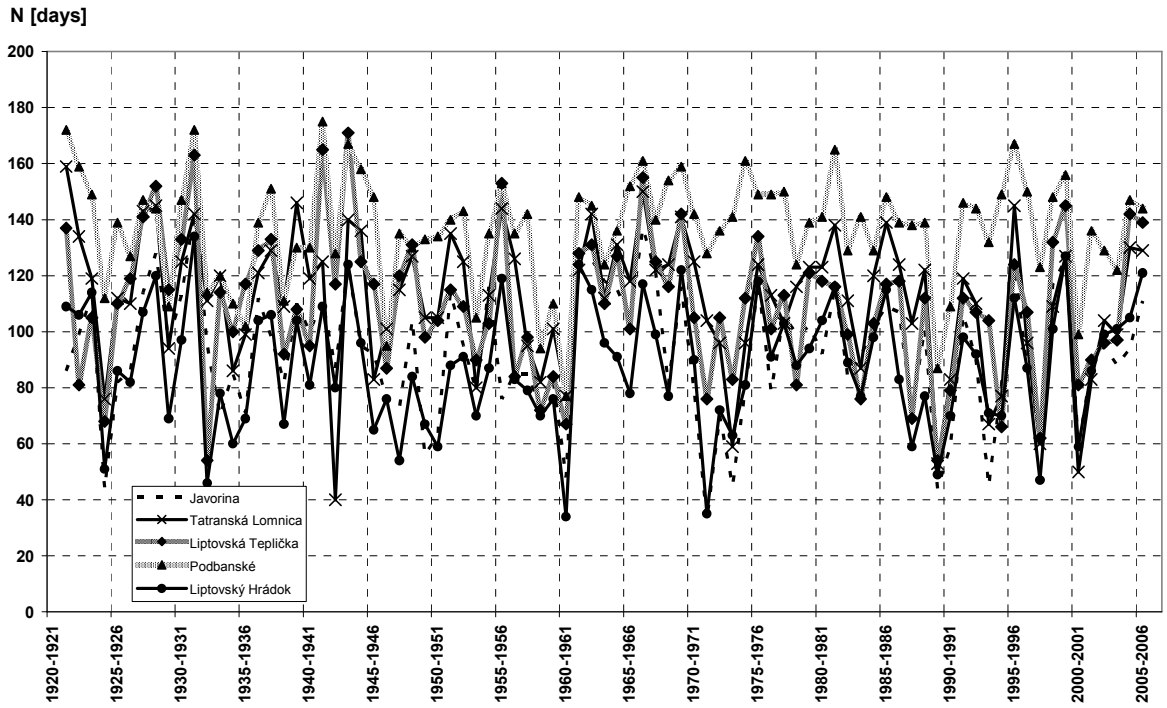

Figure 1: Number of days with snow cover (N [days]) at 5 selected stations in 1920/21-2005/06 period (July-June is considered as the snow season here; Javorina (1020 m a.s.l.) lies at the northern foot of the High Tatras, see Figure 2).

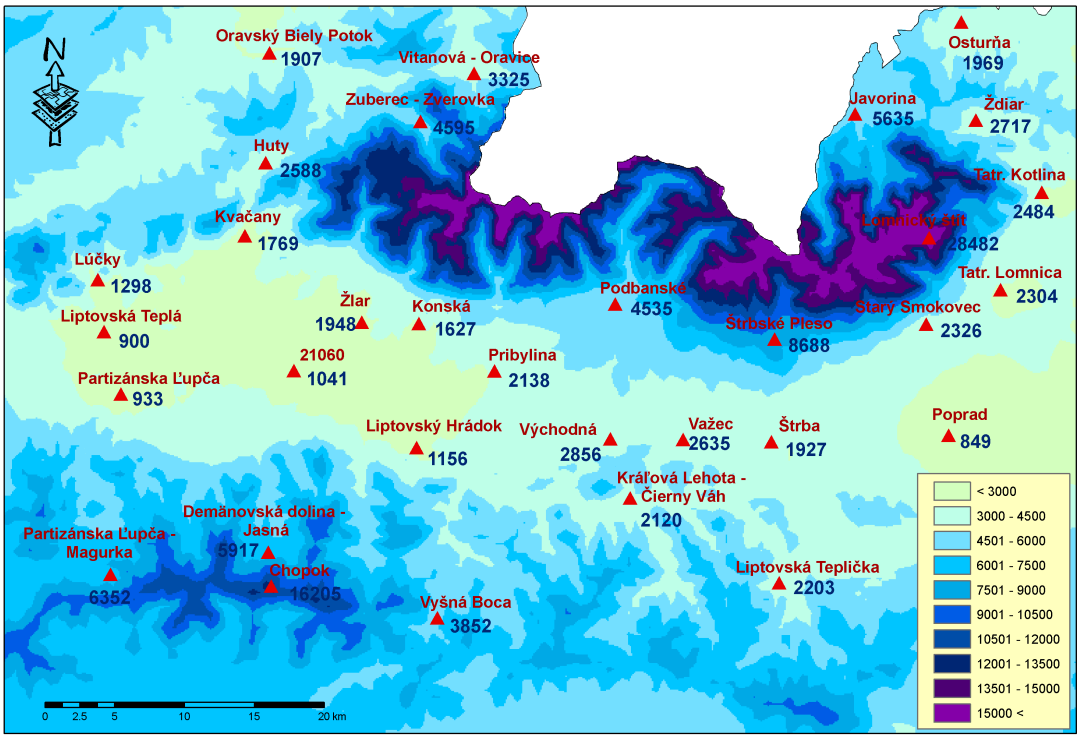

Figure 2: Sum of daily snow cover depths [cm] during the whole July-June snow season in 1920/21-2005/06 period and location of all considered stations in the region (the mean snow cover dept can be obtained by dividing of this values by mean number of snow cover days; the station 21060 lies near to Liptovský Mikuláš city).

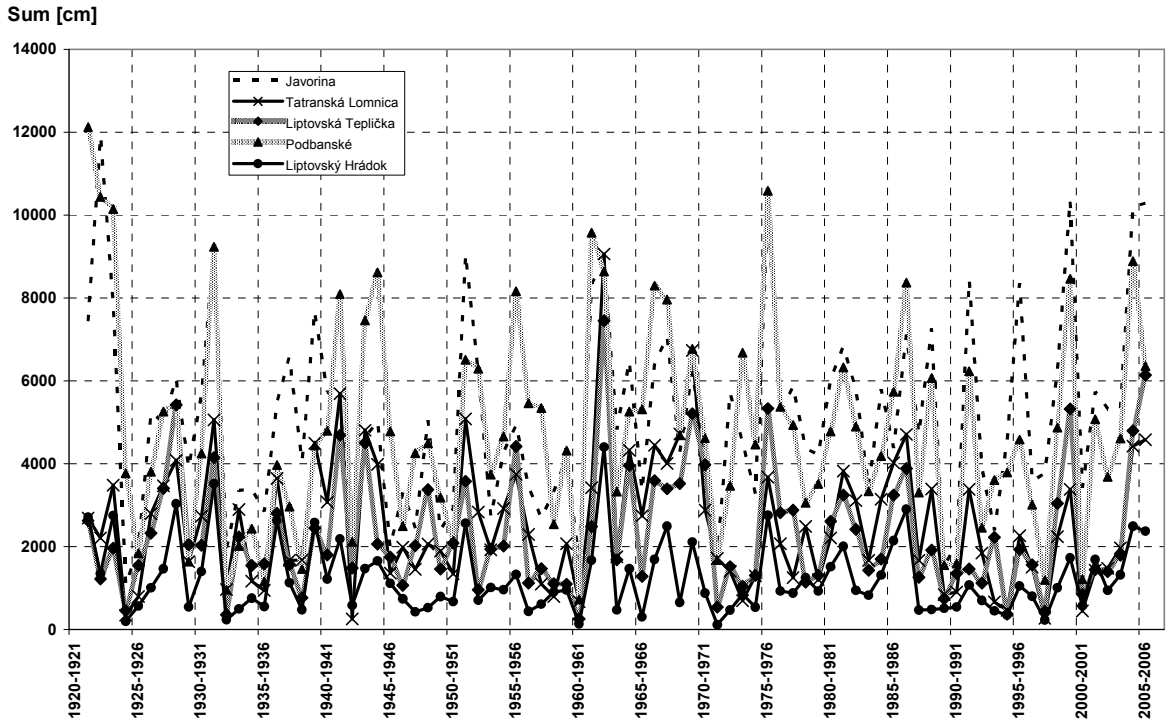

Figure 3: Sum of daily snow cover depths (Sum [cm]) at 5 selected stations during the whole July-June snow season in 1920/21-2005/06 period.

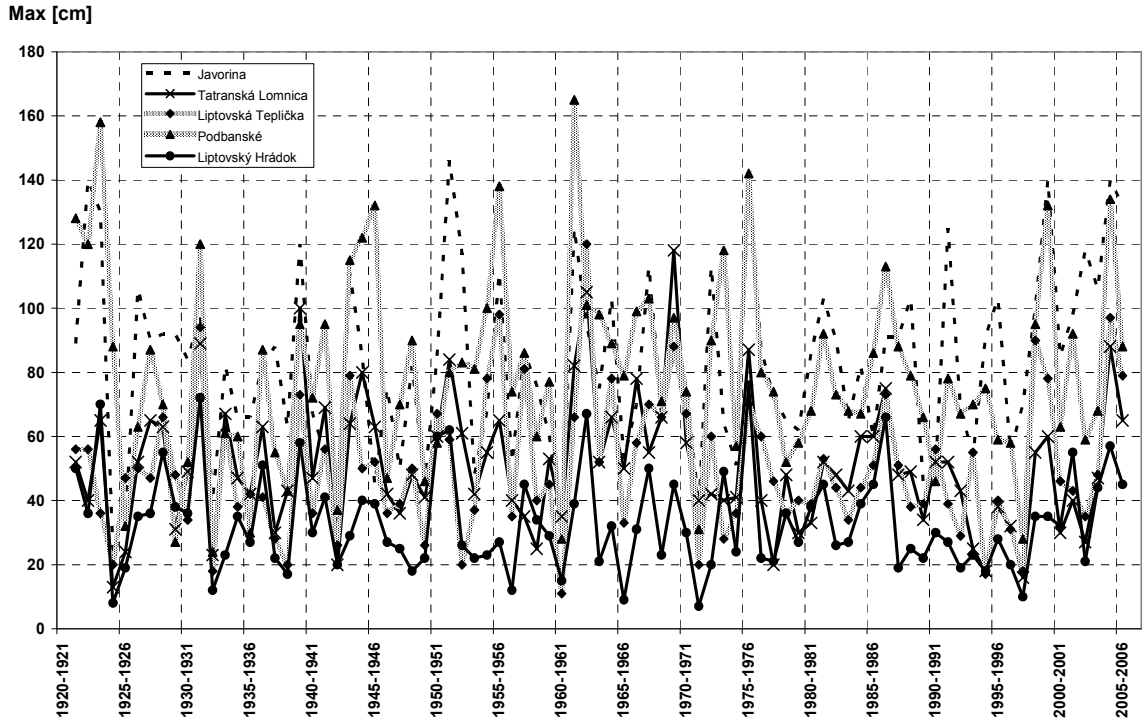

Figure 4: Maximum of daily snow cover depths (Max [cm]) at 5 selected stations during the whole July-June snow season in 1920/21-2005/06 period.

2.2. Number of snow cover days ≥ 50 cm

In comparison with above mentioned snow cover characteristic number the differences in number of snow cover days ≥ 50 cm between the regions with higher and lower altitude are much more obvious. The lowest annual number of these days occurs generally in the bottom of Liptovská hollow while at the altitude of about 1000 m a.s.l., in the Low Tatras (e.g. Ďumbier massive) the number of snow cover days ≥ 50 cm comes up normally to 60 days in average.

2.3. Sum of daily snow cover depths

Sum of daily snow cover depths is very useful characteristic for snow cover condition analysis in studied region. By analyzing of this characteristic we can realize the quantity of total snow cover accumulation during the wintry season. Its temporal and spatial variability is considerable because of substantial influence of the meteorological, climatologic and geographical factors. We can comprehend widely a relevant role of relief morphological parameters for snow cover accumulation patterns at particular weather stations by means of snow cover sum analysis. In addition It is possible to derive an average snow cover depth from the above mentioned snow cover characteristic.

2.4. Maximum of daily snow cover depths

Maximum of daily snow cover depths is important snow cover characteristic for climatologists in context with existing weather extreme events. It is especially desirable snow characteristic in cases when we need to estimate the snow cover loading limits for technical practice requirements For example the snow cover depth maximum is necessary for the preparation of standard technical norms used in building industry.

2.5. Long-term changes of the snow cover characteristics

By means of the long-term snow cover time series analysis we have identified a significant decrease of selected snow cover characteristic values in many parts of Slovakia. The northern and mountainous regions departure from this rule because the general snow cover trend is rising there. The results presented in the contribution are in expected accordance with the rising precipitation trends (identified also during the wintry season) in the northern regions of Slovakia.

3. CONCLUSIONS

Only selected results are presented in this extended Abstract. More detailed results will be published in 2007, including maps of all characteristics and tables of all stations in the region. These climatic values are of very frequent interest in Slovakia recently. It is mainly due to significant increase of ski resorts activities and winter recreation in the Slovak mountains.

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