DETECTION OF CLIMATE CHANGE IN THE SLOVAK MOUNTAINS

Lapin M. [1], Štastný P.[2], Chmelík M.[2]

[1]Div. of Meteorology and Climatology, KAFZM, FMFI, Comenius University, Bratislava, SK-84248 Slovakia, E-mail: lapin@fmph.uniba.sk, Web: www.dmc.fmph.uniba.sk
[2]Slovak Hydrometeorological Institute, Bratislava, SK-83315 Slovakia
E-mail: Pavel.Stastny@shmu.sk , Miroslav.Chmelik@shmu.sk, Web: www.shmu.sk

Abstract: This paper is devoted to detection of some expected changes in the climatological regime (means, variability, frequency distribution) at selected elements due to climate change. Very reliable time series of daily data (air temperature and relative humidity since 1951) measured by the meteorological stations at Hurbanovo, 115 m a.s.l., SW Slovakia, Poprad, 695 m a.sl., at the foot of the High Tatras mountains and Lomnický štít, 2635 m a.s.l., the 3rd highest peak in Slovakia have been utilized. More over the daily aerological data measured at the Poprad-Gánovce Observatory since 1961 (850 hPa) were elaborated for comparisons with those obtained by ground measurements. Some results are compared also with those designed as climate change scenarios for Slovakia based on the modified CGCM2 GCM outputs. The results showed very significant increase in temperature and decrease in relative humidity in the April to August season after 1990. Only selected results are presented in this extended abstract.

Keywords: *climate change, variability, temperature, humidity*

1. INTRODUCTION

The IPCC (2001) presented in Chapter 1 (WG I) three possible future changes in frequency distribution of temperature data (shift of average without change in variability and with increase of variability, no change of average with increase in variability). Considering other climatic elements a small change of average with great change in variability and skewness could be very important, mainly because of nonlinear interrelations among air temperature, air humidity and precipitation. The analyzed climatological stations are shown in the map of Slovakia (Fig. 1 left).

2. METHOD AND RESULTS

Significant trends in air temperature means can be seen in Fig. 1 right (about 1.5 °C increase in the April-August season – selected as relative homogeneous season for air humidity – Fig. 3 left). In spite of different time frame, the annual course patterns of temperature and humidity at the 850 hPa level are for the 2 h. p.m. term nearly the same as at Lomnický Štít station (2635 m a.s.l., Figs. 2-3). The data series at stations Hurbanovo (HU), Poprad (PO) and Lomnický Štít (LŠ) were without any missing values, the series for 850 hPa level measured at Gánovce (GA) contained some missing data in the individual days, or short periods. Statistical calculations eliminated differences due to data gaps in the series by the method of relative (normalized) data utilization. The normalization was calculated for each day of the year as a difference from long-term average.

As it can be seen from Figs 3 right, 4 and 5 left, the changes in temperature frequency distribution were much more significant at HU (lowland, SW Slovakia) than in the mountains (LŠ, 2635 m a.s.l., PO, 695 m a.s.l.). On the other hand, the changes in frequency distribution at the aerological measurement (GA, 850 hPa, 2 h. p.m.) was les significant comparing the periods 1971-1990, 1991-2004 and 2000-2004. Considering the relative humidity changes we suppose that it was mainly due to more intensive convective processes after 1990 and corresponding lower air temperature and higher relative humidity. This effect is less significant in the night term at 2 h. a.m. (not presented here).

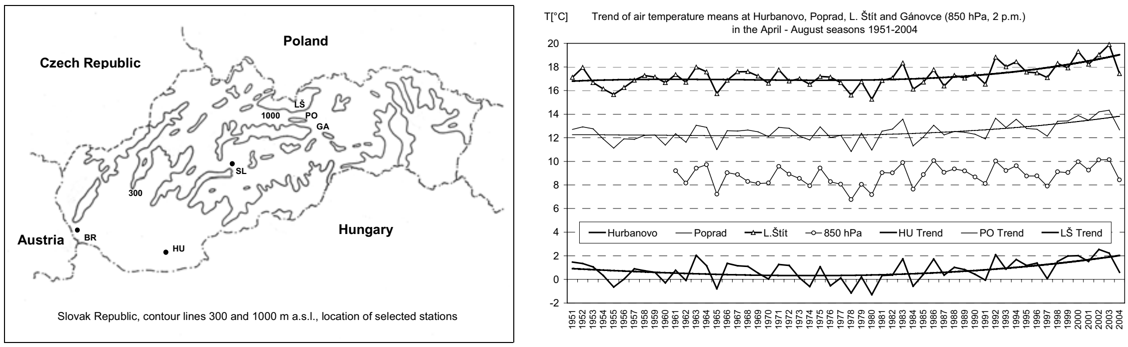

Figure 1. Left - map of Slovakia with contour lines 300 and 1000 m altitude, and selected stations HU (Hurbanovo), BR (Bratislava), SL (Sliač), GA (Gánovce), PO (Poprad), LŠ (Lomnický Štít); Right – April – August air temperature means T[°C] and trends at the stations HU, PO and LŠ, and at 850 hPa level* (2 h. p.m.) in 1951-2004 (1961-2004)*.

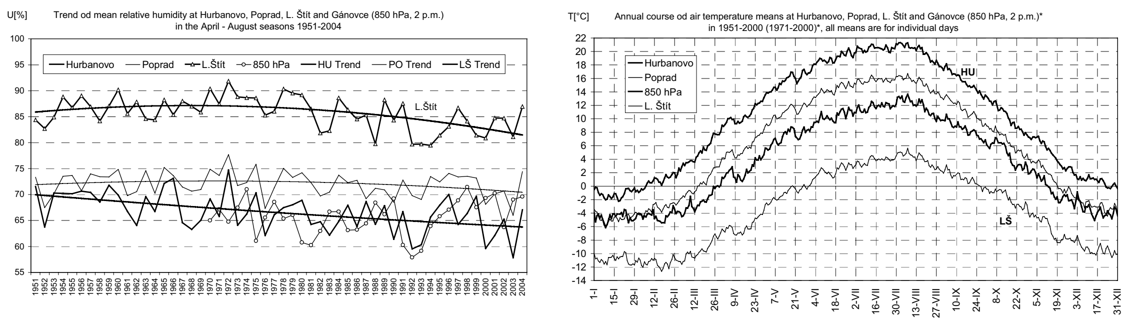

Figure 2. Left - April – August air humidity means U[%] at the stations HU, PO and LŠ, and at 850 hPa level* (2 h. p.m.) in 1951-2004 (1971-2004)*; Right – annual course of air temperature daily means T[°C] at the stations HU, PO and LŠ, and at 850 hPa level* (2 h. p.m.) in 1951-2004 (1961-2004)*.

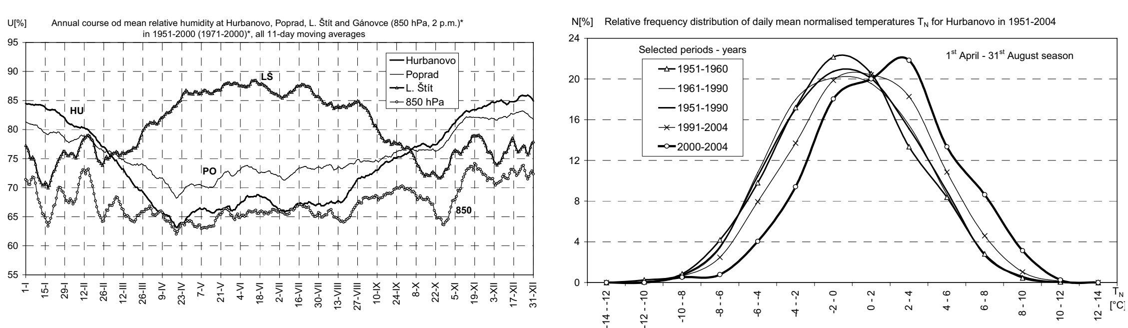

Figure 3. Left - annual course of humidity means U[%] at the stations HU, PO and LŠ, and at 850 hPa level* (2 h. p.m.) in 1951-2004 (1971-2004)*; Right – frequency distribution N[%] of temperature daily means T[°C] at the station HU in 1951-2004 (deviations from the 1951-2000 averages for each day in the April-August season).

Relative air humidity in the April to August season plays an important role mainly in the potential evaporation calculation. As a consequence of precipitation decrease in the south of Slovakia and air temperature increase in all Slovakia after 1990, relative humidity decreased more significantly in the south.

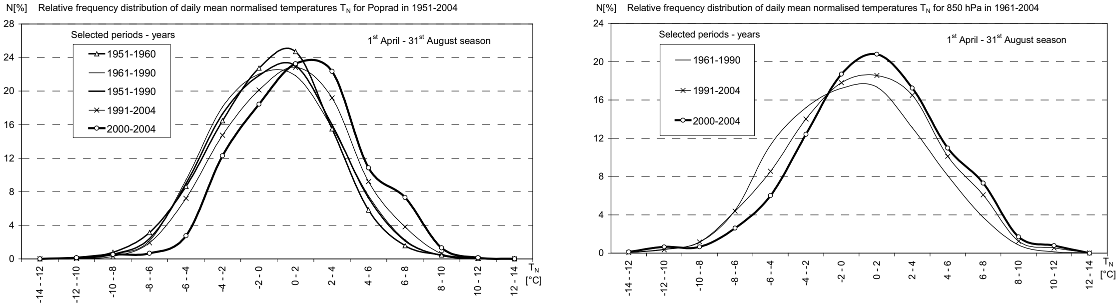

Figure 4. Left - frequency distribution N[%] of temperature daily means T[°C] at the station PO in 1951-2004; Right – frequency distribution N[%] of temperature daily means T[°C] at the 850 hPa level* (2 h. p.m.) in 1961-2004 (deviations from the 1951-2000 (1961-2000)* averages for each day in the April-August season).

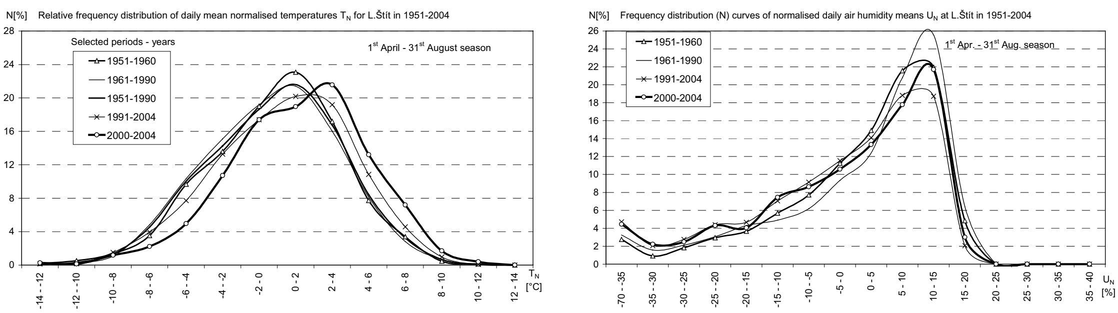

Figure 5. Left - frequency distribution N[%] of temperature daily means T[°C] at the station LŠ in 1951-2004; Right – frequency distribution N[%] of humidity daily means U[%] at the station LŠ in 1951-2004 (deviations from the 1951-2000 averages for each day in the April-August season).

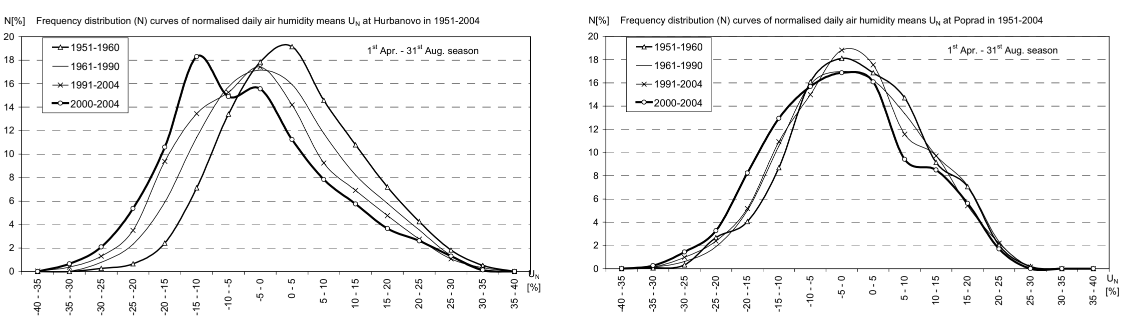

Figure 6. Left - frequency distribution N[%] of humidity daily means U[%] at the station HU in 1951-2004 (deviations from the 1951-2000 averages for each day in the April-August season); Right – frequency distribution N[%] of humidity daily means U[%] at the station PO in 1951-2004 (deviations from the 1951-2000 averages for each day in the April-August season).

Similar elaboration has been done also for the station Sliač, 303 m a.s.l., in central Slovakia (Fig. 1) and for aerological data measured at the terms 2 h. a.m. and 2 h. p.m. in the isobaric levels 850 hPa and 700 hPa. Because of limited space here, full paper will be presented in the Slovak Meteorological Journal in 2005. There will be offered more space also to analytical description of the method.

The main aim of presented elaboration is an attempt to detect possible climate change observed as the shift of distribution curves in the recent decades. This can be compared also with the curves obtained from regionally modified GCMs (General circulation models) output. In Slovakia we utilized Canadian CCCM2000 daily time series (coupled atmosphere-ocean CGCM2). Daily data from the Hurbanovo station in the 1961-1990 were used as baseline. Comparing Figs 3 right and 7 right it can be seen that shift of distribution curve for the 1991-2004 period is in accordance with the projected scenarios for the 30-year timeframes in 2051-2100.

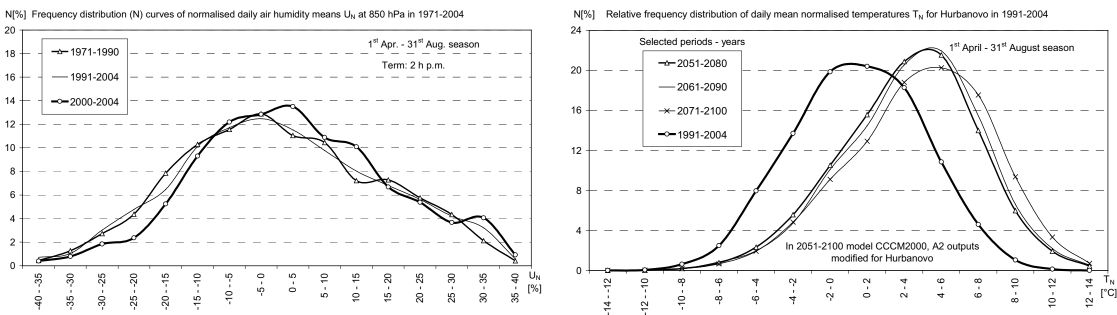

Fig. 7. Left - frequency distribution N[%] of humidity daily means U[%]at the 850 hPa level (2 h. p.m.) in 1971-2004 (deviations from the 1971-2000 averages for each day in the April-August season); Right – frequency distribution N[%] of temperature daily means T[°C] at the station HU in 1991-2004 and in 2051-2100 (regionally modified CCCM outputs; all deviations are from the 1951-2000 averages for each day in the April-August season).

3. CONCLUSION

Presented paper shows only a brief study on climate change detection in Slovakia using daily data frequency distribution analysis as some continuation of paper presented by Lapin (2004). It is very probable that in the 1991-2004 period such regime of weather has been occurred in Slovakia that is very unusual. Some statistical values of weather conditions obtained from the 2000-2004 period have not been registered in all observing history since 1871 at Hurbanovo, or even since 1775 (considering measured data at Vienna-Hohe Warte, or Prague-Klementinum).

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