

## THE SEVERITY OF THE WINTER IN THE CZECH REPUBLIC IN THE PERIOD FROM 2005 TO 2010

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**Abstract.** The paper deals with the analysis of positive and/or negative anomalies of air temperature during the last two extreme cold winters (2005/2006; 2009/2010) and two extreme warm winters (2006/2007; 2008/2009) occurred at territory of the Czech Republic. Assessment of winter severity is based on the daily air extreme temperature and monthly mean temperature from 100 weather stations since 2005 in the Czech Republic. The highest negative temperature deviation ( $\sigma = -6.6$  °C) in January 2006 in South Moravian region was occurred. Contrastly, the highest positive temperature deviation ( $\sigma = +6.3$  °C) in January 2007 in Ustí nad Labem and Pardubice regions was occurred. The severe cold periods of the observed season were accompanied by synoptic situations NEa, SEa, and Ec, these occur with significantly lower frequency during winter season.

### Introduction

Central Europe lies far away from the main centres of atmospheric activity, i.e. high pressure centre of Azores and the Icelandic low pressure centre. According to the Köppen climate classification system the most of the territory of the Czech Republic belongs to the humid region of the warm temperate zone (Cfb), while medium and higher location belong to the humid region of the cold temperate zone (Dfb and Dfc). The cold zone (ET) can only be found on the crests of the Krkonoše Mts. and the peaks of the Hrubý Jeseník Mts. (Tolasz et al., 2007).

The severity of winters varies in a large range from year to year and is also strongly influenced by the synoptic patterns. The Western Cyclonics (Wc) are responsible for the occurrence of moderate winter season in the Czech Republic. Another most occurred synoptical situation is low-pressure trough over Central Europe (B). This situation brings distinct clouds, numerous of snow-showers and maximum air temperatures close to 0.0 °C with possible occurrence of inversion.

The greatest negative anomalies of air temperature ( $\sigma = -6.0$  °C) during winter are recorded during the eastern zonal circulation represented by various situations, including Eastern anticyclonic (Ea), Northeastern anticyclonic (NEa) and Northeastern cyclonic (NEc). The negative anomalies of air temperature occur during zonal circulation are less frequent in the Czech Republic (winter of 1928-1929; 2005-2006). Contrary, in winter the greatest positive anomalies of air temperature ( $\sigma = +6.0$  °C) occur during the western zonal circulation (such as Wc, Wcs).

The main objective of the study was to assess the positive and/or negative anomalies of air temperature during the last two extreme cold winters (2005/2006; 2009/2010) and

two extreme warm winters (2006/2007; 2008/2009) occurred at territory of the Czech Republic.

### Material and methods

The study drew data from two data sets. (1) The monthly mean air temperature records of 100 climatological stations from December 2005 to February 2010 were used. (2) The average, maximum and minimum of daily temperature series for 100 of the same stations for the period 2005–2010 were also available. Altitude of climatological stations ranged at 159 to 1324 m a. s. l. with mean annual temperature between 8.7 °C (Doksany) and 2.6 °C (Lysá Hora). Daily weather types over the Czech Republic were obtained from winter 2005 to 2010 using the objective weather typing system by HMÚ (1972). Long-term average temperature series (1971-2000) were taken from the Czech Hydrometeorological Institute.

Evaluated winter period was defined by consecutive months (DJF). There were evaluated winters 2005/2006, 2006/2007, 2007/2008, 2008/2009 and 2009/2010. As a criteria of determination severity of winters has been calculated deviations of average monthly air temperature against from the long-term average (1971-2000) for defined month. Spatial distribution of deviations for average monthly air temperature in the Czech Republic has been processed by program Arc GIS 9.3 as a performance of maps.

### Results and discussion

The severe cold winter during observed period was winter of 2005/2006. In January the temperature deviation from long-term average temperature series has been -3.2 °C. The large temperature deviation was recorded in the followed regions: Zlin ( $\sigma = -4.3$  °C), Olomouc ( $\sigma = -3.8$  °C), South Moravian ( $\sigma = -3.5$  °C) and Liberec ( $\sigma = -2.2$  °C) (Fig. 1a). In respect of distribution of regionally temperature deviation, there has been measured the lowest deviation of January air temperature ( $\sigma = -6.6$  °C) at Stražnice station in South Moravian region between all observed stations.

Thereby, a strong continental weather pattern was expressed by Eastern anticyclonic (Ea), which resulted inflow of extraordinary cold air from East to Northeast. Next synoptical patterns was Northeastern (NEa) and followed by Southeastern (SEa) anticyclonic and was caused massive anticyclone over the Norway and the North Sea resulted in the inflow of Arctic air over Sweden and Finland on Czech territory. Subsequently, the anticyclone shifted toward the Ukraine and inflow continued inflow of cold air. In this period, there were recorded the lowest temperatures, mainly in the north Moravia. On January 23, 2006 the daily minimum air temperature ranged from

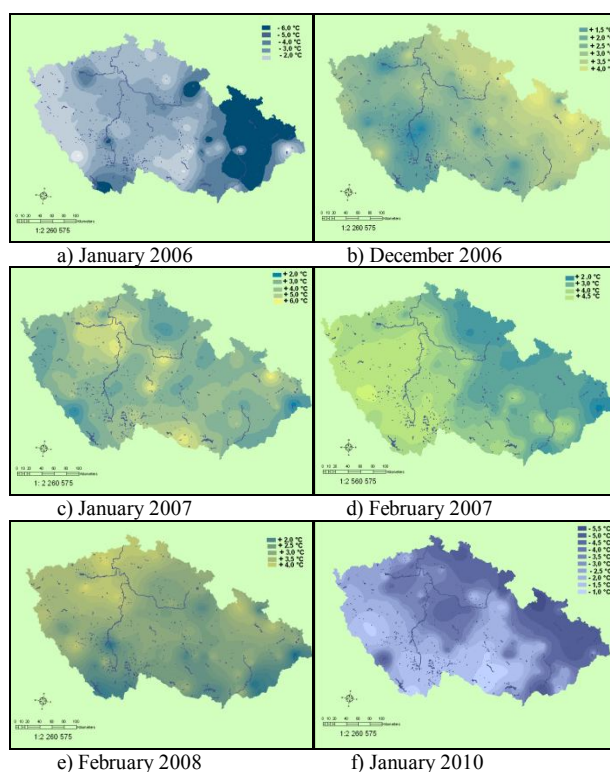
-29.2 °C (Šumperk) to -27.1 °C (Olomouc). Very cold weather patterns continued in Moravia region during February.

The next moderate cold winter was occurred in 2009/2010. Practically the entire territory of the Czech Republic was affected by severe cold winter of 2009/2010. The deviation of the average monthly air temperature in January 2010 was -2.2 °C in the Czech Republic (1f). The coldest regions were Karlovy Vary region ( $\sigma = -3.1$  °C) and Moravian - Silesian region with deviation -3.0 °C (Fig. 1f). The coldest day of this month was on January 26, when the daily maximum air temperature did not exceed 0.0 °C at all monitored stations with exception at Doksany and Brno stations. At all monitored stations, the daily minimum air temperature reached the values lower than -10.0 °C. The daily minimum temperature in this day was -27.9 °C at Broumov, -26.9 °C at Jevíčko, -25.8 °C at Brod nad Dyjí and -25.4 °C at Opava stations. All these stations have lower altitude than 500 m. The reason of such weather patterns was the East cyclonic (Ec), when low air pressure was kept above the Mediterranean and high air pressure above Northeast Europe. It caused very cold east flow.

Extreme warm winter occurred in 2006/2007 and followed by another very warm winter in 2007/2008 for the whole Czech territory. The average monthly air temperature was 2.3 °C in the Czech Republic in December, which is 3.3 °C above the long-term average, then 3.2 °C in January 2007 ( $\sigma = +6.0$  °C) and 2.8 °C in February 2007 ( $\sigma = +3.9$  °C) (Fig. 1d). According to monthly average deviation of air temperature, the warmest regions were Moravian-Silesian and Liberec regions in December 2006 ( $\sigma = +4.2$  °C) (Fig. 1b), and followed by the January of 2007 ( $\sigma = +6.3$  °C) in Ustí nad Labem and Pardubice regions (Fig. 1c). By the more detailed analysis of the temperature ratio at each particular station was interesting, that for any of station (except of high-altitude stations: Labská Bouda, Lysá Hora, Churáňov, Desná – Souš, Pec pod Sněžkou and Červená u Libavé) wasn't recorded negative average monthly air temperature. In January of 2007, the highest average monthly air temperature had Žatec (5.3 °C), Čáslav – Chotusice (5.2 °C) and Pardubice (5.1 °C) stations. The warmest days were recorded on January, 10, 2007 and January, 18, 2007, in which the daily maximum air temperature reached above 15.0 °C at majority stations.

For the whole January and partially in December and in February of winter 2006/2007 are dominated Western (Wc) and Northwestern (NWc) cyclonic at territory of the Czech Republic. At the same time, extreme warm and dry winter occurred in South-Eastern Europe, as result of high atmospheric pressure belt, which sometimes hovers in winter over Central and Eastern Europe, and brings into contact the ridge of the Azore Anticyclone with the East –European Anticyclone, usually facilitating an eastern circulation with severe winter phenomena, was positioned farther south, enabling the west winds to advection to carry warm oceanic (Atlantic) air currents and back (Bogdan et al., 2008, Potop, 2011).

The second warm winter occurred in 2007/2008. The warmest months were January ( $\sigma = +4.1$  °C) and February ( $\sigma = +3.4$  °C) in the Czech Republic (Fig. 1e). Whereas December was normal month ( $\sigma = +0.1$  °C), when the mean air temperature did not decreased by -0.9 °C. The warmest day in this winter was on February 24 when the daily maximum air temperature exceeded 20.0 °C at both Ustí nad Labem and South-Bohemian regions (+21.0 °C at Nové Hradý – Byňov, +20.9 °C at Husinec, +20.8 °C at Kopisty and +20.5 °C at Žatec). On February 24, the daily maximum air temperature exceeded 15.0 °C at 81 stations from 100 stations observed. Consequently, very warm weather lasted all the last third-period of the February 2008 and was associated with previously described Western cyclonic (Wc).



**Figure 1 a-e.** Spatial distribution of deviations of the average monthly air temperatures ( $\sigma$ ) from long-term average (1971-2000)

## Conclusions

During observed period of 2005-2010 occurred two significantly warm and two significantly cold winters.

- (1) The highest negative temperature deviation ( $\sigma = -6.6$  °C) in January 2006 in South Moravian region was occurred. Contrastly, the highest positive temperature deviation ( $\sigma = +6.3$  °C) in January 2007 in Ustí nad Labem and Pardubice regions was occurred.
- (2) The warmest day was on February 24, 2008 when the daily maximum air temperature exceeded 20.0 °C at both Ustí nad Labem and South-Bohemian regions.

- (3) The coldest day was on January 23, 2006 when the daily minimum air temperature ranged from -29.2 °C (Šumperk) to -27.1 °C (Olomouc).

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