

# Climatic Changes over the Republic of Belarus during the Period of Instrumental Observations

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## Part 1. Introduction



The Republic of Belarus is located in the geographical center of Europe. It borders Poland, Lithuania, Latvia, Ukraine and the Russian Federation.

The Republic of Belarus area: 207,600 km<sup>2</sup> (80,153 sq. miles). Belarus is approximately the size of the Utah State. Minsk (the capital) lies roughly on the same latitude as Hamburg in Germany or Churchill in Canada. From east to west, Belarus covers 650 km, north to south - 560 km.

The country's relief is predominantly flat with the average height of 160 m over the sea level. The highest point is 343 meters and the lowest area is 46-50 meters above the sea level. Agricultural lands occupy 44% of the republic's territory, forests constitute 30% of the country's area.

### The climate in Belarus



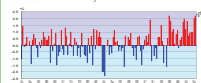
The average January temperature varies from -4°C in the south-west, to -8°C in the north-east. The average July temperature varies in the narrow range from 17°C to 19°C. The annual rainfall is 550-650 mm on lowlands and 600-750 mm on plain and uplands. The vegetation period duration on average is from 184 to 208 days.

The period with stable snow cover is 75 days in the southwest and 125 days in the northeast of the country. Average snow depth between Southwest and Northeast varies from 15 to 30 cm respectively.



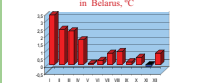
### Nationwide annual surface air temperature anomalies over Belarus (1882-2008).

The present warming has both an unprecedented duration and intensity: the mean temperature anomaly for 20 years (1989-2008) has exceeded climatic norms by 1.1 °C.



Elena V. Komarovskaya, 2009; Personal communication

### Deviation of average monthly surface air temperature during 1989-2008 from long-term mean values in Belarus, °C



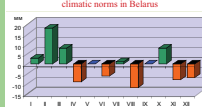
Temperature increase has occurred practically in each month, except November. The largest increase occurred in winter and early spring. E.g., January and April temperature anomaly are 1.4°C and 1.6°C respectively. Elena V. Komarovskaya, 2009; Personal communication

### Anomalies (days) of the spring dates of daily surface air temperature transition through 0°C from the mean long-term values in central Belarus



Elena V. Komarovskaya, 2009; Personal communication

### Nationwide mean monthly precipitation total anomalies in the 1989-2008 period compared to climatic norms in Belarus



Elena V. Komarovskaya, 2009; Personal communication

## Part 2. Data issues

Meteorological observations in the region were started by the Russian Empire in the end of 19th century. At the time of the First World War, the meteorological network of Belarus had 27 first order stations and 65 rain gauges. At the time of the nation independence in 1912, more than 50 first order Belarus stations were working with Belarusian meteorological program of ~30 meteorological variables. But since 2009 year meteorological data from Belarus became discontinued in the World Data Center archive in Asheville, NC, USA. The result was that many people from the international scientific community could access these data. To solve this problem, joint efforts to update and re-publish the Global Daily Climatology Network for Belarus was conducted by the Republican Hydrometeorological Centre of Belarus and the Department of Hydrometeorology of the Republic of Belarus. All-Russian Research Institute for Hydrometeorological Information World Data Center of the Russian Federation, the Hydrometeorological and Environmental Monitoring, Obninsk, Russian Federation, and NOAA National Climatic Data Center, Asheville, North Carolina, USA.

This project presents the results of this effort and first findings about climatic changes over the nation during the past two decades.

### Data availability

- The maximum period of data span in our present archive is from July 1, 1975 to June 30, 2009
- Only 5 stations have data in the 1880s and there is no digital precipitation information prior to 1890 (the year of the introduction of measurement standards). However, most of the Belarus data with daily time resolution became available in digital form after 1954 (54 stations). From the total number of 59 stations, the digital daily data set includes approximately 54 stations in the early 1990s, i.e., Fig. 10.
- In 2009, the archive contains daily data of 51 stations.

### Map of 54 hydrometeorological stations of the Republic of Belarus



### Basic data information

- The data sources are the Russian, Belarus, and the U.S. (GTS) national archives
- Synoptic measurements were made three times a day prior to 1996 and four times a day at ocean stations times during the 1996-1998 period. Since January 1, 1996, the measurements were made at hourly Moscow Standard time (UTC+3)
- Synoptic data were pre-processed according to a standard quality control routine and generation of derived variables (e.g., daily data were calculated by arithmetic averaging of a complete set of synoptic observations within a meteorological day (line starts at 9 PM of the local standard time, LST of the previous day))

### Basic data information, cont.

- Variables in the daily data set include: sea level and station pressure, surface temperature, relative humidity, wind speed, and precipitation measured for observational practice changes prior to 1984 (Gosman and Rankova 2001)
- Each data value in archive is characterized by four flags: data measurement flag, quality control flag, confidence level/visibility flag, and data source flag

### Warning for precipitation data users

- Observed precipitation for the former USSR territory can by no means be used for climate change analyses due to numerous changes in observational practice and rain gauge design (Gosman et al. 1996; Golubev et al. 1996; Gosman and Rankova 2001; Bogdanova et al. 2002a,b; NCEP, 2005; DSI 9813). The last such change occurred in 1984. Our archive uses the precipitation data that were homogenized by routine proposed by Gosman and Rankova (2007 for J. Climate).
- For bias-corrected precipitation data sets the user is advised to use homogeneity-adjusted precipitation data (e.g., DSI 9813).

### Warning for wind data users

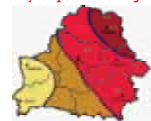
- Wind speed information in Belarus was reported first by wind vane with light beam, then with wind vane with heavy board change was completed in the 1930s and then in the early 1970s by anemometer. The switch itself does not cause significant abnormalities in mean wind speed (Bogdanova and Zaitsev, 1976). The reporting of strong gust winds was similarly affected due to a different period of time-averaging of the wind speed observations (CP by the anemometer versus 2 by the wind vane). After 1995, it appears that during field are reported "stronger" when the wind vane is used.
- The major problem with the homogeneity of the sea surface wind reporting is in the character of the measuring tool and its changes. Wind observation was always made at fixed meteorological sites (20 m to 26 m) at 10 m above the ground. However, many of these sites are not clearly reported. The anemometer surrounding has often gradually (and successfully) changed due to urbanization and/or reclamation.
- The users are warned about these changes specifically in order to avoid misinterpretation.

## Part 3. Results

### Results

Differences between mean values of meteorological variables for 1990-2009 (up to June 2009) and the previous 30-year -long period (1960-1989).

### January temperature changes (°C)



### April temperature changes (°C)



### July temperature changes (°C)



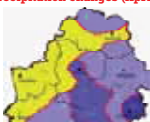
### October temperature changes (°C)



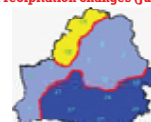
### Precipitation changes (January, %)



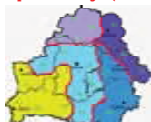
### Precipitation changes (April, %)



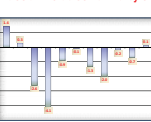
### Precipitation changes (July, %)



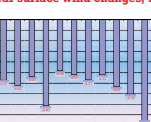
### Precipitation changes (October, %)



### Surface air relative humidity changes



### Near surface wind changes, m s<sup>-1</sup>



## Summary

- An updated archive of the Belarus daily meteorological observations (of 54 stations) provided us an opportunity to assess the recent climatic changes over the nation.
- Climatic changes over Belarus correspond well to those occurred around the world. A tendency of warming is observed during the period of instrumental observations, especially in the cold season.
- Since the last decade of the 20th century, the longest period of positive temperature anomalies has been observed in Belarus compared to the last almost 130 years of instrumental observations.
- National climatologists are concerned with the observed increase in the number of the extreme climate phenomena (droughts, wet spells, warm winters).
- Comparison of the latest period (since 1990) with the previous three decades over Belarus shows:
  - A significant increase in surface air temperatures with the largest changes (up to 3.5°C) in the cold season; Nationwide annual surface air temperature has increased by 1°C.

- Geographically, strongest warming was observed in the northern and eastern parts of the nation. Major changes occurred in winter and spring (+1.8°C and +1.1°C respectively) while the summer warming was moderate +0.9°C, and in autumn was absent. Month with the highest temperature change was January (+3.3°C) and with the lowest temperature change was November (-0.1°C).
- A significant (up to 1 m s<sup>-1</sup>) decrease in the near surface wind speed across the nation in all seasons; this is a 15% to 20% decrease.
- A sizeable increase in the surface air absolute humidity while the relative humidity remains mostly unchanged, and
- A weak increase (by 6%) of the nationwide annual precipitation
- Spring temperature increases (March-April) resulted in the earlier snow cover retreat and earlier temperature transition through 0°C. This transition is occurring now by 10-15 days earlier than in the past.

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