Climate change and variability in Poland from Copernicus's time to present

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1. Introduction

In recent years, the issues of climate change and variability, and their consequences for the environment (be it natural or anthropogenic) have become dominant themes in research above all espoused by climatologists and meteorologists. The direct cause of this is global climatic warming observable since the second half of the 1970s, and constituting the so-called second phase to contemporary warming, the first having taken place in the years 1920–1940.

Knowledge on climate change in Poland over the last centuries is fullest in respect of the period of instrumental observations. In the last 25 years it has been possible for various workers to compile, and then engage in the homogenisation of, ten or more air temperature series for Poland. The most important of these are the longest series, which relate to Warsaw (from 1779 on), Wrocław (from 1791) and Cracow (from 1792). Furthermore, high levels of correlation observed for air temperatures across the country allow for the use of these temperature series in characterizing thermal conditions throughout Poland.

In the last several decades there has also been a marked increase in the level of knowledge on the Polish climate from the so-called pre-instrumental period. Nonetheless, this does not extend back before the start of the last millennium (Przybylak et al. (eds), 2010; Przybylak 2011). Relatively better climate information is available since Nicolaus time and onwards.

The main aim of this paper is to sum up the current state of knowledge on changes and variability in Poland's climate from Copernicus's time to present.

2. Results

Information about the climate in Poland in Nicolaus Copernicus's time (1473-1543) is limited, in particular for the end of the 15th century. We have no reconstructed temperatures for particular years, only for certain decades of that time. Additionally, almost nothing is known about the precipitation levels then. Knowledge of the climate becomes markedly better in the first half of the 16th century (see Fig. 1, Limanówka 2001 and Przybylak 2011).

During Copernicus's childhood and in his youth, the climate was either within – or even slightly warmer than – present norms, especially in summer. Reconstructed mean values for air temperature in the January–April period, based on the width of tree rings, also point to the occurrence of a period of cooling at that time (Fig. 1 in Przybylak 2011). More in line with the reconstruction data, based on historical sources, are the newest reconstructions of mean temperatures in February and March obtained on the basis of dendrochronological data from northern Poland (Koprowski et. al. 2010) and southern Poland (Szychowska-Krąpiec 2010). According to Maruszczak (1991), precipitation was probably above normal in this time.

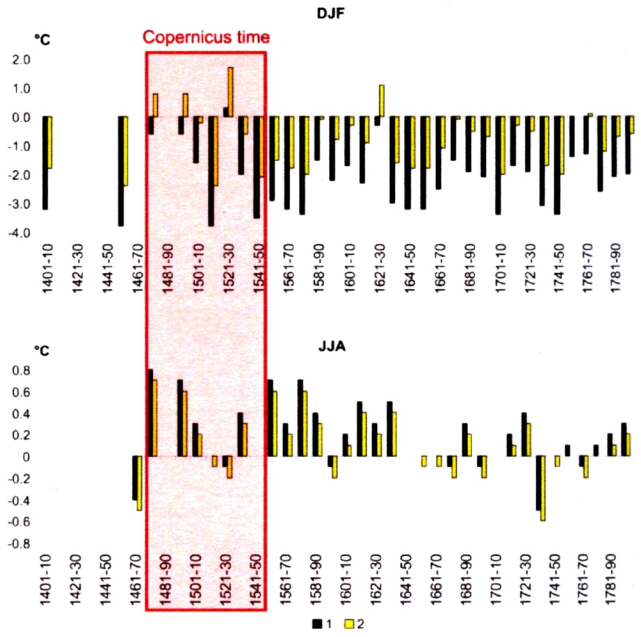

Fig. 1. Reconstructions of mean 10-year air temperatures (°C) in Poland from 1401 to 1800: a) winter (DJF) and b) summer (JJA). 1 and 2 – anomalies with respect to 1901–1960 and 1789–1850 means, respectively (after Przybylak 2011)

The climate during Copernicus's adult years was more continental than in present times. On average, winter temperatures were generally 1-3°C colder than they are today, while summer temperatures were slightly warmer (Fig. 1, see also Limanówka 2001). The coldest winters occurred in the second decade (an anomaly of almost -4°C compared to present times), while the warmest were in the third decade, reaching temperatures even slightly warmer than today. The warmest summers were noted in the fourth decade (an anomaly of about 0.4°C), while the coldest occurred in the second and third decades (Fig. 1). Mean annual values for air and ground-surface temperatures were most probably lower than current values by some 0.9–1.5°C. Ground-surface temperatures were reconstructed for this period using the geothermal method (Majorowicz et al. 2004).

In first two decades of the 16th century, the climate was much wetter than in the following three decades. In particular, the decade of 1531-40 was probably dry, with three extremely dry summers noted (Fig. 2). In contrast, on the basis of an analysis of the numbers of days with precipitation, Limanówka (2001) found that the first half of the 16th century had far less precipitation than it does today. However, it would seem that the notes compiled by the university professors of Kraków did not take account of the lightest precipitation, which they may well have missed altogether.

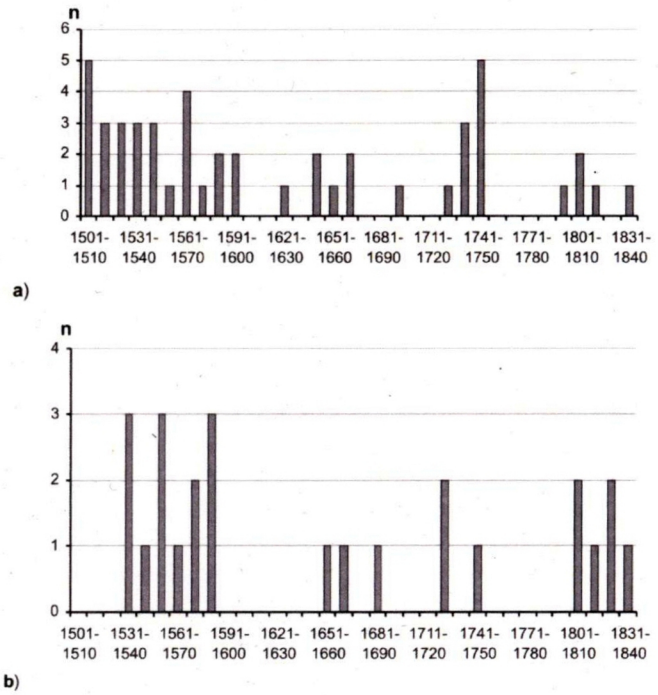

Fig. 2. Decadal frequencies of occurrence of summers (JJA) that were: a) extremely wet and very wet and b) extremely dry and very dry in Poland between 1501 and 1840 (after Przybylak et al. 2004)

According to Przybylak et al.'s (2004) studies, the climate in the first half of the 16th century was most unstable and extreme in the entire analyzed period of 1501-1840.

3. Conclusions

The climate of Nicolaus Copernicus's lifetime can be considered to be transitional between the Medieval Warm Period, which probably ended in Poland at the beginning of the 15th century, and the Little Ice Age, which began in the middle of the 16th century. As a result, extreme situations (including both air temperature and precipitation) were most frequent and most changeable in winter (temperature) and summer (precipitation). The climate in Copernicus's time was more continental than it is today, mainly due to the very severe winters occurring in the later stages of his life (1-3 °C colder in reference to the mean for 1901-1960). The summers he experienced were slightly warmer and wetter than today, while mean annual air temperatures and surface-ground temperatures were lower, on average, by ca. 1.0-1.5°C than contemporary values

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