Rudolf Brázdil, Oldřich Kotyza

UTILISATION OF THE LOUNY ECONOMIC SOURCES FOR THE RECONSTRUCTION OF WINTER TEMPERATURE PATTERNS IN 1518-1621

Abstract: The books of accounts of the town of Louny (north-west Bohemia) contain information about Saturday's payments of wages for work in the preceding week, some of which may be utilised as proxies of winter temperature patterns (such as cutting of ice at the mills, lining of water pipes with manure). By means of these data series of weighted temperature indices are compiled for the period 1518-1621. On the basis of calibration relations between the measured temperature anomalies and weighted temperature indices in the reference period 1901-1960, a reconstruction of winter air temperatures is carried out by two different methods for the secular station Prague-Klementinum in the period 1518-1621. The obtained results are compared with series of temperature indices of Germany, Switzerland and the series Ice Winter Index for the western Baltic.

Key words: winter air temperature, books of accounts, temperature reconstruction, Louny, Prague-Klementinum.

1. Introduction

Climate reconstruction in the pre-instrumental period is based on the most varied sorts of proxy data, among which an important position belongs particularly to written sources. They contain not only direct reports about weather, but also about events and phenomena dependent on weather and climate. Economic data usually belong to the second mentioned group. In the broadest scope data concerning the growing of vine have so far been used for climate reconstruction (e.g. Burkhardt, Hense 1985; Pfister 1988b; Glaser 1991). In an analogous sense the information about the beginning of harvest and the yields of cereals can also be used (e.g. Pfister 1988a; Fliri 1991; Tarand, Kuiv 1994). This study shows the utilisation of economic records of the town of Louny (north-west Bohemia) for the reconstruction of winter air temperatures.

2. Louny Economic Records

Many different books of accounts (LR I-V, RPV I-VI) are preserved with some breaks from 1450 to 1632 in the State District Archives (SOkA) at Louny. They contain all incomes and expenditures of the town. In the expenses there appear payments of wages for different work. As against other preserved account books, at Louny the payment was always on Saturdays, so that the wages paid express the work of the whole week. Some of payments can be taken as proxies for winter temperature patterns:
– carrying manure or straw or loopings to the pipes, through which water was brought to the town, as a protection from frost
– cutting ice between the mill wheels, at weirs, on ponds or about cutting or thawing of frozen pipes (Fig. 1)
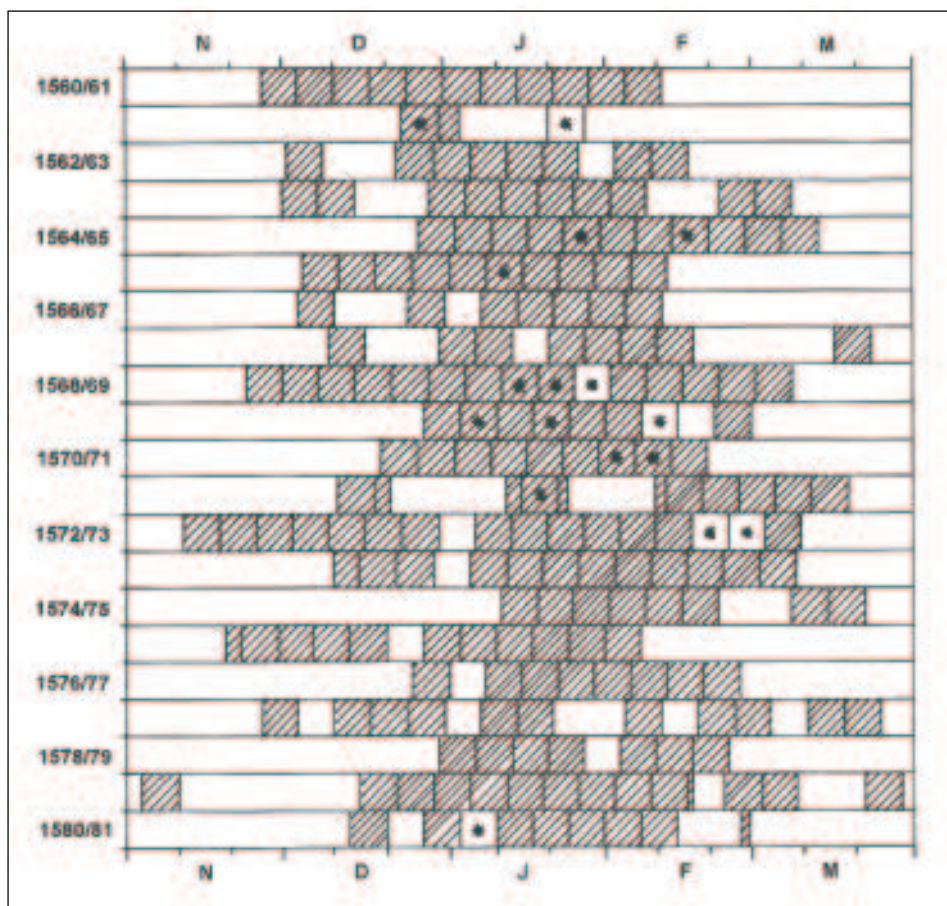

Fig. 1. The time with cutting ice at the Louny mills from November 1560 to March 1581 according to wages paid for this work (* - it was paid for clearing snow in this week).

– releasing ice gorges on the Ohře (i.e. blocking the river bed by ice floes)
– clearing snow from roofs, roof gutters and roads
– first field work or field work during the winter months, arrival of the first raft.

3. Reconstruction of Winter Temperature Patterns at Prague-Klementinum

The reconstruction of winter temperature patterns at Prague-Klementinum (no temperature measurements at Louny) is based on the compilation of temperature indices and their subsequent quantification (Fig. 2) in the following steps:

a) compilation of series of winter temperature indices

Weighted temperature indices ITD were compiled on the basis of data about cutting ice from Louny and completed for those years by information from further weather reports from the Czech Lands. The seven-step scale from –3 (extremely cold) to +3 (extremely warm) was used for individual months (i.e. for winter as a sum of indices of December, January and February from –9 to +9).

b) determination of calibration relations

The relation between the measured air temperatures at Prague-Klementinum and weighted temperature indices ITI derived from them must be found for the instrumental period. For determining ITI, measured temperature anomalies Dt in the reference period 1901-1960 were arranged in the ascending order. Then, according
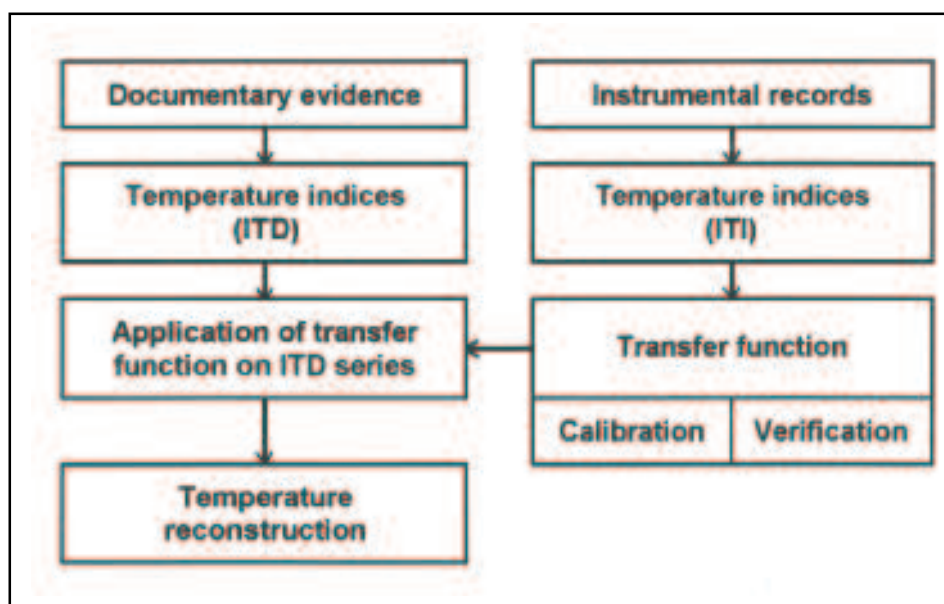

Fig. 2. A diagram of quantitative temperature reconstruction based on documentary evidence.

to Pfister (1992), index –3 was attributed to 8.3% of the lowest values, index –2 to the following 16.6% of values etc. The highest 8.3% values are then given to index +3. The methods of linear regression (LR) and of mean anomalies (MA) were used for finding the calibration relation between Dt and ITI. In the method of MA, the given value of ITI is always attributed to the mean of all Dt appurtenant to that index in 1901-1960. For example, to index -3 in February there correspond, according to LR, Dt = -4.8°C, but according to the MA method the value –7.8°C.

c) verification of calibration relations

The two calibration relations were verified (RMSE, maximum positive and negative difference between measured and calculated values) for verification periods 1886-1900 and 1961-1975 (Fig. 3). The temperature reconstruction according to the MA method gives better results than those according to the second one, mainly in the case of extremely cold winters.
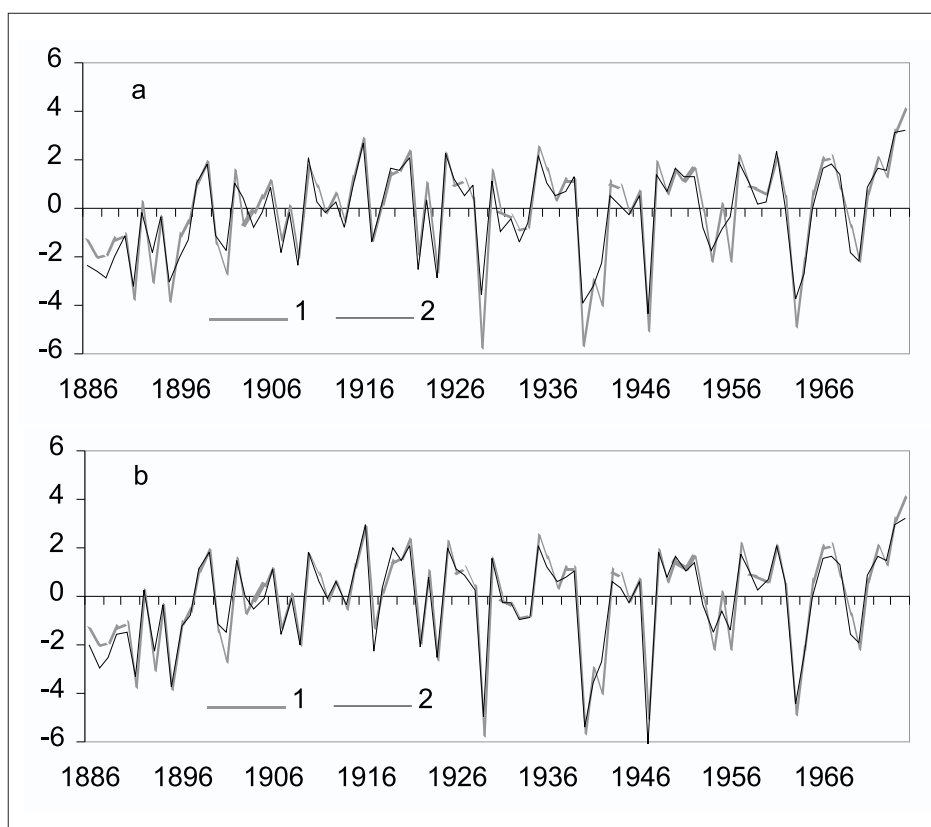

Fig. 3. Comparison of measured (1) and reconstructed (2) winter temperature anomalies (°C) at Prague-Klementinum in 1886-1975 according to the methods of LR (a) and MA (b).

d) reconstruction of winter air temperatures

The reconstruction assumes the validity of calibration relations also for the period in which the reconstruction is carried out. In the obtained relations for the reference period instead of values of ITI are put values of ITD from the individual reconstructed years.

4. Discussion of Results

The obtained reconstruction of winter temperature anomalies for Prague-Klementinum are presented in Fig. 4. In most cases the difference of reconstructed temperatures by the two methods does not exceed 0.5°C, in extreme winters, however, they can exceed as much as 1.5°C (the correlation coefficient between them is 0.96). Further, these reconstructed series are compared with ice winter index (IWI – it characterises the extent of the ice cover in the western part of the Baltic – see Koslowski, Glaser 1999) and winter temperature indices for Switzerland (a new corrected version of indices from Pfister 1988a) and Germany (Glaser 2000) (Fig. 4). The reconstructed series of Prague reach the highest correlation coefficients with the series of Switzerland (0.64, 0.67), whereas the correlation with the series of Germany (0.60, 0.62) and the IWI series (-0.43, -0.46) is somewhat worse. Differences among several series follow from the natural spatial variability of winter temperature patterns given above all by a different expression of circulation patterns, but also from problems with the compilation of the presented series (such as subjectivity of records and the interpretation of indices, different density and character of records).

Acknowledgement

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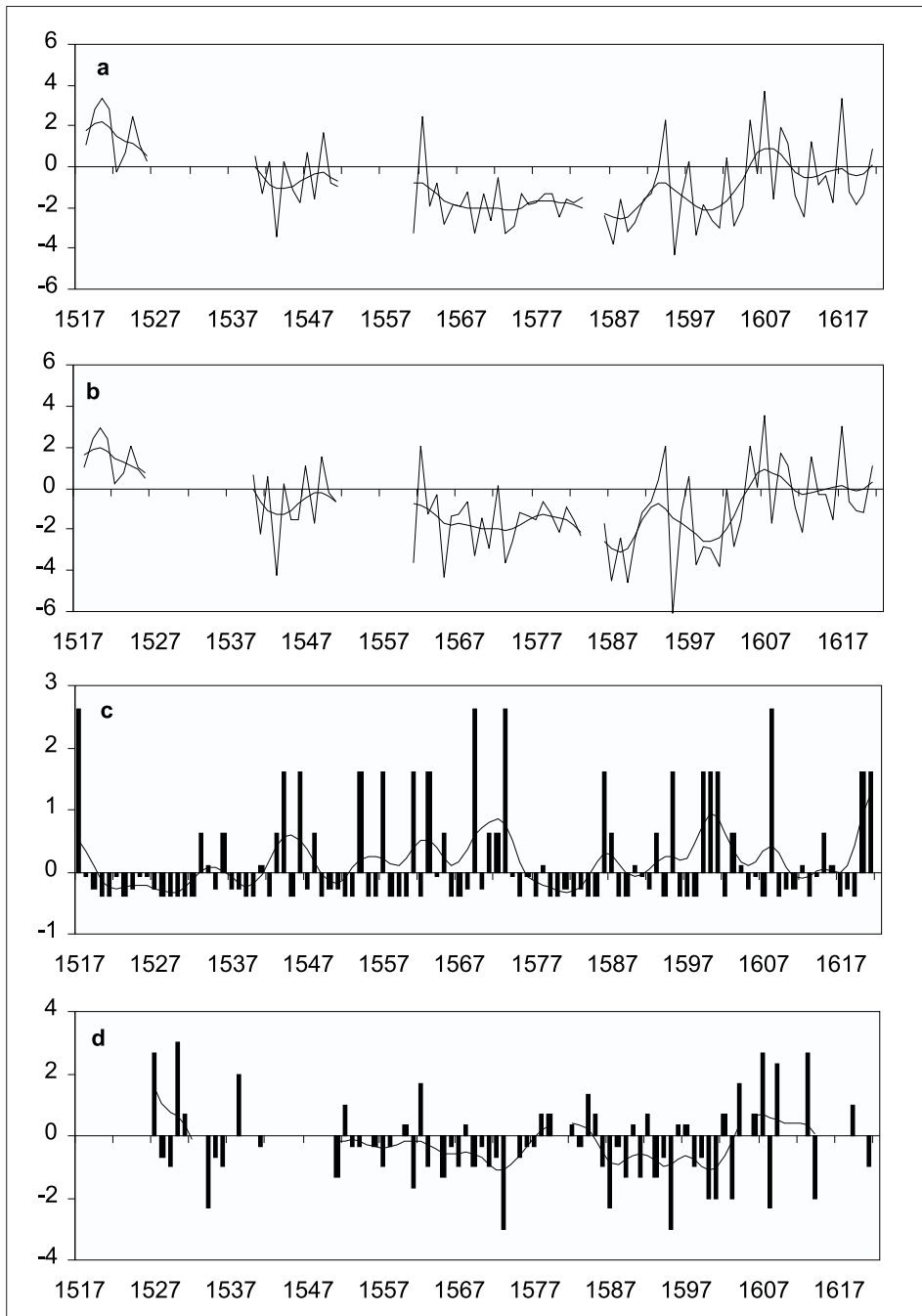
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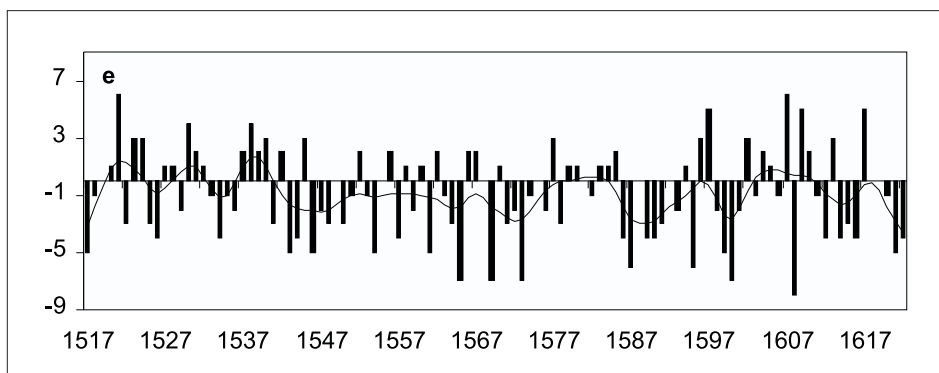

Fig. 4. Fluctuation of winter air temperature anomalies (°C) of Prague-Klementinum (a – the LR method, b – the MA method), IWI (c), winter temperature indices of Switzerland (d) and of Germany (e) in 1517-1621 (smoothed with the Gauss filter for 10 years).

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Rudolf Brázdil
Department of Geography
Masaryk University
Brno
Czech Republic

Oldřich Kotyza
The District Museum of Local History
Litoměřice
Czech Republic