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A REGRESSION EVALUATION OF THERMAL CONTINENTALITY

K. Mikolášková: *A regression evaluation of thermal continentality.* – Geografie–Sborník ČGS, 114, 4, pp. 350–362 (2009). – This paper considers climate continentality from the point of view of temperature. Primary indices, developed for climate continentality, are presented and compared and a proposal is made for a new index. The newly proposed index is based on daily temperature means and considers the influence of latitude in the Earth's temperature distribution. The regression function was selected to best reflect the dependence of annual temperature mean on latitude. Several possible indices are evaluated.

KEY WORDS: thermal continentality – continentality index – Europe – temperature.

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Introduction

Continentality is one of the basic characteristics of climate. It reflects how much a particular area is influenced by the ocean or by large expanses of land. It is a result of the impact of climatic elements such as temperature, precipitation, solar radiation, cloudiness etc. There are several factors which control the distribution of climatic elements and thus influence continentality. These include latitude, distance from sea, altitude and atmospheric circulation. The general idea of continental climate is a regime characterized by a great annual temperature range (generally more than 15.6 °C) and moderate annual precipitation with a summer maximum, resulting from convectional rainfall (McBoyle, Steiner 1972).

Several attempts have been made to devise an index of continentality which can be directly measured and which would characterize the climate of a particular area. Continentality is influenced by several factors, which are not easily quantified and thus it is difficult to come up with an index, which would cover all factors and which would precisely represent continentality. That is why some simplifications are used. It is possible to quantify continentality from a number different points-of-view, including temperature, precipitation and, in some cases, even air pressure. From these, thermal continentality is the most frequently examined.

Theoretical background

Thermal continentality is primarily expressed by annual or diurnal temperature range, lag of temperature behind radiation and temperature variability. These characteristics are easily quantifiable and thus they are incorporated into most indices of continentality. The distribution of temperature over the Earth is dependent on variation in radiation, heat and humidity, which result from the distribution of solar radiation with latitude. There is a problem of seasonal variations in solar radiation, which subsequently also causes seasonal variations in temperature and must be taken into account in the indices as well (Driscoll, Yee Fong 1992). Energy fluxes across air-land and air-water interfaces are another factor which influences temperature ranges. These fluxes are controlled by thermal properties of the interfaces substances and Petterssen (1969) suggests that "temperature ranges over land should be about 50 times those over water" (p. 186). This idea suggests that there is much greater annual temperature range over land than over sea and thus the increase of annual temperature range as one moves inland is the most remarkable effect of the continental surface. In the most continental areas, in mild and sub-Arctic climatic zones in Asia, the annual range of monthly mean temperatures can reach 68 °C or more (Martyn 1992). Thermal properties of land and water, along with atmospheric circulation, also produce a lag of temperature behind radiation. This lag is longer for maritime locations than for continental areas (Prescott, Collins 1951).

Indices of thermal continentality

The basic parameter of indices of thermal continentality is annual temperature range, which is often divided by $sin(\theta)$ to compensate for summer-winter radiation differences. Conrad and Pollak (1950) state that there is a correlation between annual temperature range and latitude θ and so this range must be compensated for latitude. Such compensation occurs in most indices, but is sometimes slightly modified by a constant. Driscoll and Yee Fong (1992) maintain that "use of $sin\,\theta$ to compensate for seasonal differences in radiation is inappropriate" (p. 188). Their research shows that receipt of solar radiation does not increase equally according to latitude with increasing distance from the equator but that it reaches a maximum at about 55° N (Driscoll, Yee Fong 1992) and, consequently, the distribution of solar radiation is not equal to the distribution of sinus.

The index of continentality most often used in Europe was proposed by Gorczynski (1918). It is computed with the equation:

$$k = \frac{1.7(A - 12\sin\theta)}{\sin\theta} = \frac{1.7A}{\sin\theta} - 20.4 \qquad [1]$$

where k is the index of continentality expressed as a percent, A is annual range of temperature in °C, θ is latitude in degrees.

Gorczynski (1922) found that the expression $A = 12sin\,\theta$ corresponded well with observations over the ocean. The constant 1.7 is calculated from the assumption that Verchojansk, in eastern Siberia, is representative of 100% continentality. According to this equation, Gorczynski suggests three degrees of continentality. These are transitional maritime (k = 0 to 33 %), continental (k = 34 to 66 %) and extreme continental (k = 67 to 100 %) climates (Gorczynski 1922).

Conrad and Pollak (1950) maintain that there are some problems with constants in Gorczynski's equation because at some particular locations (such as, for instance, Thorshavn at Faeroe Islands) thermal continentality has a negative value, which has no physical meaning. The equation should take into account boundary conditions and should be in the interval of 0 to 100 percent. If continentality is zero, the climate is no longer influenced by a continental surface and in the case of 100 percent there is no influence from maritime air masses. As a result, attempts have been made to modify this equation to be more accurate even in boundary conditions.

The best known modification of the Gorczynski index was made by Conrad. He tried to reach better results in lower latitudes where was a problem with θ = 0° (*sin* 0 = 0) and so he added 10° to the latitude in the denominator (Conrad, Pollak 1950). His equation is often used for calculations in the United States and Canada. Conrad's equation is:

$$k = \frac{1.7A}{\sin(\theta + 10)} - 14 \qquad [2]$$

This equation looses its validity with latitudes higher than 80° but very few stations are located there, thus it seems to be sufficient (Conrad, Pollak 1950).

Chromov (Marsz 1995) is another scientist, who presented an index of continentality. He tried to avoid a critique of Gorczynski's index by starting with maritime climate. Chromov's equation takes the form:

$$k = \frac{A - 5.4\sin\theta}{A} \times 100 \qquad [3]$$

where $5.4\sin\theta$ should express the annual temperature range of a purely maritime climate. This temperature range should exist anywhere on Earth where there is an ocean. The highest value of this index is obtained at the equator and it seems that the growth of temperature range in lower latitudes does not matter because the value of $5.4\sin\theta$ would be too small to make any differences and the final result would be $k = 100$ (Marsz 1995). This index is not used very much because it provides minimal differentiation in continentality above the land (usually from 75 to 95 %).

There are other investigators who have tried to propose a continentality index based on parameters other than annual temperature range. Kerner (Landsberg 1958) used temperature lag behind radiation, Ivanov (1959) added diurnal range and saturation deficit to annual range. Another parameter is temperature variability, which can be used for characterizing thermal continentality based on the annual pattern of interdiurnal temperature variability (Driscoll et al. 1994).

Another aspect that can be connected with continentality is the lag of maximum and minimum temperature behind their respective solstices. According to some authors (Driscoll et al. 1994) the connection between the temperature lag and continentality is not as straightforward as in the case of interdiurnal temperature variability. The lag between solstices and daily maximum and minimum temperatures depends only on conditions around that narrow interval (the period from June to August for the summer maximum) and does not cover the whole year. Continentality is, on the other hand, an year-round factor. Nevertheless, comparison with continentality is possible and the traditional association has been that the more continental a station is, the less temperatureby Horáková (1998) who studied the lag of average, maximum and minimum temperature behind equinoxes and solstices.

In recent years, another attempt at proposing a continentality index was made in Poland, where they used an index based on annual temperature range and a linear regression of annual temperature and latitude (Marsz 1995).

This paper presents another point of view concerning thermal continentality. Thermal continentality is calculated from daily temperature means, which are not usual included in continentality indices. However, this method is better at considering year-round fluctuations in temperature than are the classical monthly means used in most common indices.

Data and methods

Data from a daily dataset of 20th century surface air temperature and precipitation were taken for the proposal of a new continentality index in this paper. The dataset was compiled for the European Climate Assessment (ECA) and is partially funded by EUMETNET. All data taken for analysis are from blended series (meaning near-complete series completed by supplementing data from nearby stations) from the period of 1961–2006 or for at least 20 continuous years during this period. Only series classified in homogeneity tests as "useful" or "doubtful" are used for calculations. Stations with an altitude higher than 600 m a.s.l. were excluded. In the end, data from 232 of 494 available stations are taken for formulating a continentality index.

This new index of thermal continentality was proposed by modifying the continentality index developed by Sládek (2005). Long-term temperature fluctuations were expressed by daily temperature means. Daily temperature means increase from a winter minimum to a summer maximum and then de-

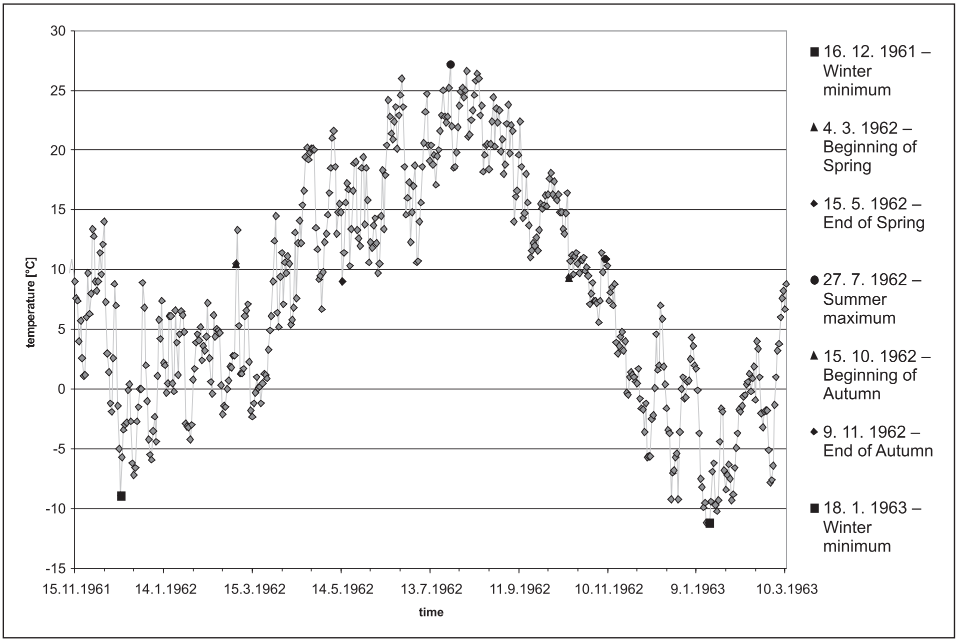

Fig. 1 – The scheme of annual temperature fluctuation in Zagreb for one cycle of rising and falling

crease to a minimum for the next winter. Thus, winter minimum and summer maximum divide the fluctuations into sections consisting of two parts – rising and falling. If the median of each part is determined, it is possible to say which days are warmer and which colder than the median and then to specify seasons of the year (one section of long-term temperature fluctuations). Spring is, in this case, defined as the period between the first warm day (a day with a higher temperature than the median) and the last cold day (a day with a lower temperature than the median) after the winter minimum. Summer is the period which consists only of warm days; autumn represents the period between the first cold day and the last warm day after the summer maximum and winter consists only of cold days (Sládek 2005; Figure 1).

In maritime climates in moderate latitudes, spring and autumn are long and summer and winter are short, while continental climates show an opposite trend. Therefore, the duration of summer and winter (days) in one section of the long-term fluctuation (expressed by the sum of days of the rising and falling parts of the annual fluctuation – it can be more or less than 365 days) can be used as a measure of thermal continentality (Sládek, personal communication):

$$Q = \frac{(summer + winter)}{(\text{rising} + \text{falling part})} \qquad [4]$$

The value 365 is not in the denominator because of rare cases of extremely long transition seasons which can occur in maritime climates, as a result, the sum summer + winter (365 – (*spring* + *autumn*)) and ultimately the Q value can be negative. Q can result in a value in the interval (0:1). Values lower than 0.5 correspond to maritime climate, values higher than 0.5 correspond to continental climate. The value of Q can be determined from each pair of rising and falling parts in the long-term temperature fluctuation. Q for a long-term period can be calculated as an average of these annual Q values. (Sládek 2005)

Demonstrating this with the example of Zagreb for one cycle of rising and falling parts of long term temperature fluctuation, the situation would be: the minimum of the 1961/1962 winter occurred on 16 December 1961 (–8.9 °C), after which the temperature starts to rise to the summer maximum on 27 July 1962 (27.2 °C). This period forms the rising part of the fluctuation and its median is equal to 9.2 °C. The first day on which temperature is higher than the median (moving from winter minimum to summer maximum) is on 4 March 1962 (10.5 °C) and this represents the beginning of spring. The last day which has a temperature lower than median of this rising part is 15 May 1962 (9.0 °C) and it represents the end of spring. It works for the falling part in similar way. The falling part of the fluctuation runs from the summer maximum to the nearest winter minimum on 16 January 1963 (–11.0 °C). The median of this part is equal to 10.8 °C and the first day which has a lower temperature than median is 15 October (9.3 °C), representing the beginning of autumn. The end of autumn is on 9 November 1962 (10.9 °C). If we sum the summer and winter days (299) and divide them by the sum of the days in the rising and falling parts (398) we will get $Q = 0.75$.

There are several possibilities concerning how to modify the existing continentality index. In all cases, the objective was to add latitude into the equation so the index would better reflect the geographical distribution of solar radiation (temperature). First, the distribution of temperature by latitude was

Tab. 1 – Selected characteristics for some stations near 23° of East longitude

Location	Country	Latitude (°)	Longitude (°)	Annual mean temperature (°C)	Annual temperature range (°C)
Sophia	Bulgaria	42.65	23.38	9.9	21.2
Vratza	Bulgaria	43.20	23.53	11.2	22.8
Galati	Romania	44.23	23.87	10.9	23.6
Cluj-Napoca	Romania	46.78	23.70	8.3	22.9
Lvov	Ukraine	49.82	23.95	7.2	21.9
Zamosc	Poland	50.70	23.25	7.2	21.6
Bresc	Belarus	52.12	23.68	7.5	22.9
Bialystok	Poland	53.12	23.18	6.7	21.9
Suwalki	Poland	54.13	22.95	6.0	21.8
Kaunas	Lithuania	54.88	23.88	6.4	22.2
Siauliai	Lithuania	55.93	23.32	6.4	21.0
Jokioinen observatory	Finland	60.82	23.50	3.9	23.4
Sodankyla observatory	Finland	67.37	26.65	–1.0	29.2

determined. Stations with similar longitude were considered for analysis to eliminate the influence of changing continentality. The meridian at 23° East longitude was taken as the main axis for the chosen stations. This meridian was selected, even though it runs close to the coastline in higher latitudes. The reason is that there are few data from stations located farther to the east and the influence of Gulf of Bothnia is not so significant. The selected stations are situated in altitudes below 600 m a.s.l. to eliminate influences of the topography. Table 1 shows the close relation between mean temperature and latitude so it is worthwhile to consider the influence of latitude on temperature in indices.

Two attempts were selected to include the influence of latitude into the equation, which would compute thermal continentality. The first attempt was to use an expression of $sin\,(\theta)$ as used in most of the indices listed above and the second was to use a linear regression based on annual temperature range.

An equation with just $sin\,(\theta)$ in the denominator did not provide reasonable results, so an equation with an added constant was used:

$$Ic = \frac{2 \times Q}{\sin\theta} - 0.75 \qquad [5]$$

where Ic is a new index of thermal continentality, Q represents Sládek's index and θ is latitude. The index can result in values from –0.75 to extremely high values (for locations close to the equator), but in the area of Europe, values generally range from –0.75 to 3.25. The index does not have a natural border such as the plain Q values of Sladek's index, so a border has to be set. The border was set at $Q = 0.5$ (the border between continental and maritime climates) and $\theta = 50°$ (representative of mid-latitude' climates; approximately the same distance to the sea to the north and to the south). The value of the border was confirmed with a subsequent map analysis. Values higher or equal to 0.55 indicate continental climate and values lower than 0.55 indicate maritime climate.

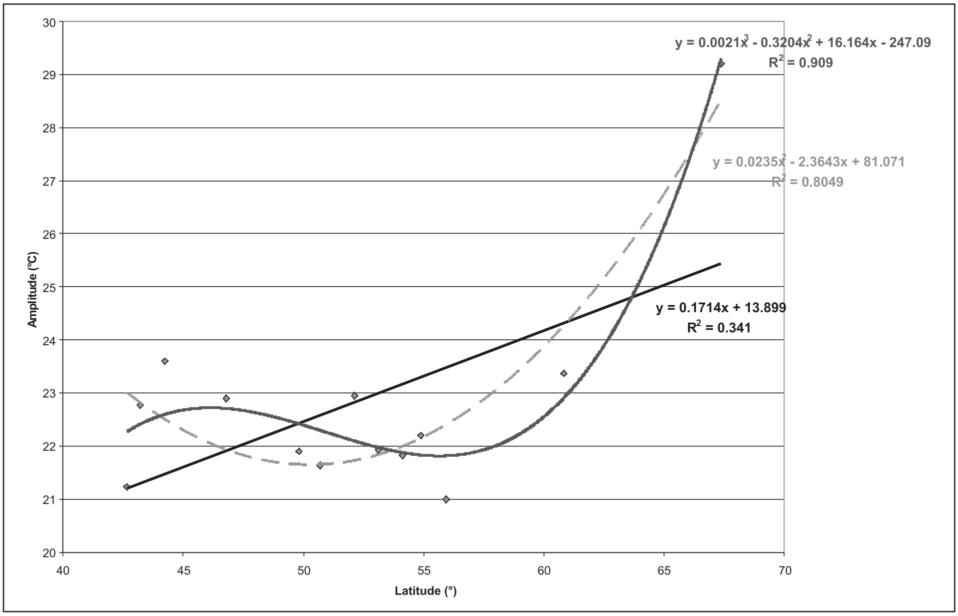

Fig. 2 – Relation between latitude and annual range of temperature along the 23rd meridian East of Greenwich

The second attempt to modify the existing index was a linear regression. The main reason for this approach was that most authors were criticized for using the expression of $sin(\theta)$ which gives errant results in high and low latitudes. There is a good relation between mean temperature and latitude and it is possible to see a trend in annual temperature range as well. The function of regression was based on the relation between latitude and annual temperature range, which is the easiest way to express seasonal and spatial variations of radiation. Both linear and polynomial regression functions were considered.

Figure 2 shows a very good correlation in the case of polynomial regressions but a very low correlation in the case of a linear regression. It can be assumed, that the function which best expresses the relation between annual temperature range and latitude and which, therefore, should be included in the equation is a second or third-degree polynomial regression. Higher level polynomial regressions are precise for modelling data within a particular interval. As a result, if they are applied to data outside the interval limits where they were created they will give extreme values. Because the objective was to create a regression from data collected from stations with characteristics as similar as possible (continental, lowland stations with the same longitude) it was impossible to cover the entire area of Europe. The most southern station which was used in creating the regression function was Sophia in Bulgaria (latitude 42.65°) but the most southern station presented in the analysis is Bet Dagan in Israel (latitude 32°). In northern Europe, there is not such a big difference. The polynomial regression based on stations along the meridian 23° East longitude is:

$$Ic = \frac{Q}{(0.0021 \times \theta^3 - 0.3204 \times \theta^2 + 16.164 \times \theta - 247.09)} \times 100 \qquad [6]$$

where Q is the previous index of continentality and θ is latitude. The index can result in values from 0.86 to 16.2 and limits were set for $Q = 0.5$ and $\theta = 50°$ (for the same reasons as in the case of equation [5]) and confirmed with subsequent map analysis. Values higher than or equal to 2.21 indicate continental climate and values lower than 2.21 indicate maritime climate.

Even though linear regression shows a much lower correlation, it seems to be more suitable for the equation because it lacks extreme values. The equation for a continentality index based on linear regression would be:

$$Ic = \frac{Q}{(0.1714 \times \theta + 13.899)} \times 100 \qquad [7]$$

where Q is the previous index of continentality and θ is latitude. The fraction is multiplied by 100 to obtain higher variability in the results. The index can result in values from 0 to 7.15 and limits were set for $Q = 0.5$ and $\theta = 50°$ (for the same reasons as in the case of equation [5]) and confirmed with subsequent map analysis. Values up to 2.37 represent maritime climate and values equal to or higher than 2.37 represent continental climate.

It would be possible to add a station situated more to the south to the regression to eliminate extreme values in peripheral areas but the station would not have the same characteristics as stations along meridian 23°E. The Deir Ezzor station in Syria (latitude 35.33° and longitude 40.15°) was chosen as the most southern station with continentality characteristics and was added to already selected stations.

There are differences in the paths of the polynomial functions in Figures 2 and 3 although differences in correlation are not so big. Another equation

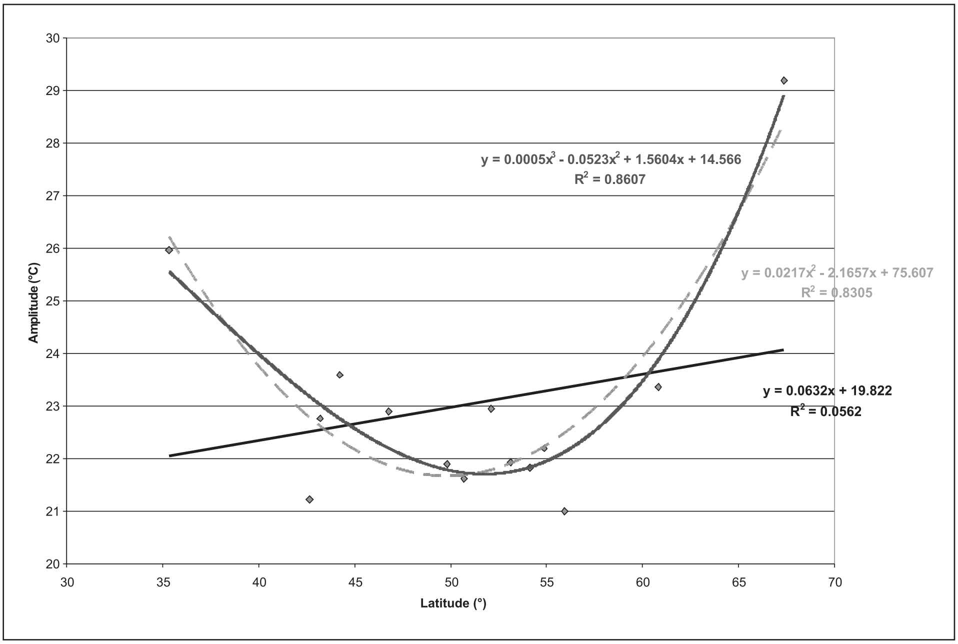

Fig. 3 – Relation between latitude and annual temperature range including Deir Ezzor, Syria

computing thermal continentality based on this new group of selected stations can be proposed:

$$Ic = \frac{Q}{(0.0005 \times \theta^3 - 0.0523 \times \theta^2 + 1.5604 \times \theta + 14.566)} \times 100 \qquad [8]$$

where Q is the previous index of continentality and θ is latitude. The index can result in values from 0 to 6.86 and limits were set for $Q = 0.5$ and $\theta = 50°$ (for the same reasons as in the case of equation [5]) and confirmed with subsequent map analysis. Values higher than or equal to 2.05 indicate continental climate while values lower than 2.05 indicate maritime climate.

Several equations for computing a thermal continentality index have been proposed and their relevance is evaluated in the next section.

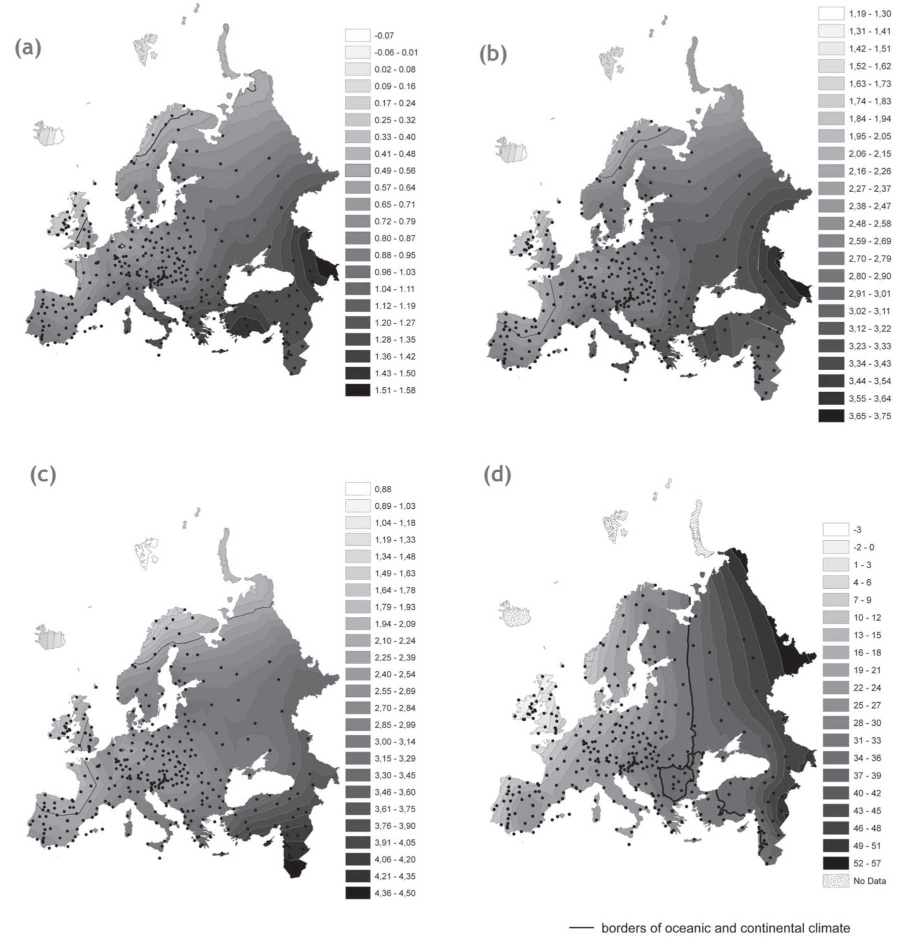

Fig. 4 – Thermal continentality of Region VI. a) using $2 \times Q/sin(\theta) - 0{,}75$ – equation [5], b) using linear regression – equation [7], c) using polynomial regression based on the relation between annual temperature range and latitude at stations along the 23rd meridian East of Greenwich – equation [6], d) using Gorczynski – equation [1]

Results

Several equations for computing thermal continentality based on Sládek's (2005) continentality index were proposed. They were tested in the area of Region VI, according to the World Weather Records, at stations from the European Climate Assessment. Figure 4 shows a map with interpolated values for each index, computed by different equation.

The first attempt to modify the previous continentality index was made by adding *sin* (θ) into the equation as a reflection of latitude (Figure 4a). It is an acceptable approximation even though some authors criticize this. *Sin* θ was used mainly to see the comparison with other indices which use it as well, such as the Gorczynski or Conrad equations. According to equation [5], most of the British Isles and the most western parts of France are classified as oceanic as well as areas of northern Europe. On the other hand, a small part of western Germany shows an oceanic character. This is caused by original Q values which are lower than neighbouring Q values. It is hard to say what causes such big differences. Daily means in western Europe are calculated differently (the average of the maximum and minimum temperature in a day) than in the countries of eastern Europe (the average of temperatures measured at 7 a.m., 2 p.m. and twice the temperature at 9 p.m.) Nevertheless, this difference would not cause different values within the same country. Southwest Turkey shows very high values which can be compared with high values in the area of the Caspian Sea. This probably does not accurately reflect reality, because there is only one station located in the area and there are no other data from Turkey available. Otherwise, equation [5] reflects continentality quite well.

The second attempt to add latitude into the equation was done with regression. The results are shown in Figure 4 (b, c). Linear regression (Figure 4b) seems to have the best results, although the correlation between annual temperature range and latitude is not very good in this case. It gradually increases eastward. According to the majority of maps which take Q values into account, the Arctic Ocean seems to have greater significance than in reality. The Arctic Ocean's coast in northern Europe has an oceanic character, but the influence of the maritime air penetrating inland is much smaller than in the case of the Atlantic Ocean. This is evident from all maps, as the distance of maritime or less-continental areas penetrate much farther inland from the Atlantic Ocean than from the Arctic Ocean.

The map in Figure 4c shows the results of equations where a third-degree polynomial regression was used. As stated above, higher level polynomial regressions are precise for modelling data in a particular interval. If the function is then applied to data outside the interval, where it was created, it will give extreme values. Europe has a high degree of segmentation, so it was problematic to find representative stations, which would meet all the criteria (continental lowland stations along one meridian) and which would be distributed across the entire latitudinal range. Continentality in Figure 4c was computed according to equation [6]. The expression of the first polynomial regression (Figure 4c) was determined from the relation between latitude and annual temperature range at stations along the meridian 23°E. Thus, all of southern and a part of northern Europe are located outside the interval of the function. This difficulty affects results in the south-eastern part of Region VI. Continentality increases southward and isolines there are nearly zonal. A similar effect is evident in the northern part of Europe although it is less significant. There is only a very small area located outside the interval in northern Europe, so the impact of this on the results is minimal. Nevertheless, values at Svalbard and in the most northwestern part of Norway are slightly overestimated. To eliminate this overestimation a new regression (equation [8]) was proposed. It was based on same stations with the addition of one more station. Deir Ezzor situated inland and farther south, in Syria, was the station selected. The distribution of thermal continentality values is different with this equation. The highest values are in the east and not in the south as they were before. On the other hand maritime climate occurs in the south at place that was previously subject to the highest continentality values, which is obviously incorrect. This is caused by the only station in this area which is, again, located outside the interval limits of the function.

The final map (Figure 4d) represents thermal continentality according to the Gorczynski index. It is clear that continentality arises more evenly to the east and that isolines have a more meridional flow. The border between oceanic and continental climate is shifted eastward in comparison with other indices and most of Europe is classified as oceanic.

From the proposed indices, linear regression in the computing equation seems to be the most suitable solution. It shows maritime climate in the west and it gradually increases towards continental climate in the east. Maritime climate in the north is reasonably distributed. It reflects the influence of the Arctic Ocean, which is present but does not penetrate deep inland. In the area of Scandinavia, the isolines are more meridional than in indices with polynomial regression and they follow the direction of the Scandinavian mountains. The influence of the Atlantic Ocean penetrates deep inland in the area of central Europe. Although continental climates exist here, the increase of values eastward is rather slow. One disadvantage of this equation is that it does not show any influence from the Mediterranean Sea and considers the whole area to be continental. However, this could also be caused by the Mediterranean climate in general. Another disadvantage is the possible range of values which make it difficult to determine simple limits between maritime and continental climate.

Conclusion

This paper shows that it may be possible to use the regression function and daily temperature means to create a continentality index. Several attempts at proposing a new continentality index were made in this paper. From all the proposals, use of linear regression in the computing equation seems to be the most suitable solution. Choosing a linear regression as opposed to a higher-degree, polynomial regression is, in this case, reasonable, even though the correlation factor is low. There are not enough stations in border areas and so higher-degree regressions would give extreme and unreal values while a linear regression does not. The equation with linear regression shows maritime climate in the west which gradually increases towards continental climate in the east. Oceanic climate in the north is reasonably distributed. This reflects the influence of the Arctic Ocean, which is present but does not penetrate deep inland. In the area of Scandinavia, the isolines are more meridional than in indices with polynomial regression and they follow the direction of the Scandinavian mountains. The influence of the Atlantic Ocean penetrates deep inland in the area of central Europe. Although continental climates exist here, the increase of values eastward is rather slow. Values of continentality indices computed in different ways are shown in the map (Fig. 4). A comparison shows discrepencies in several areas.

All indices increase eastward and, therefore, inland, but the border between maritime and continental climate causes differences between “maritime” and “continental” areas in the case of each index. According to the widely used Gorczynski index, most of Europe is subject to maritime climate. On the contrary, newly proposed indices classify the enitre region, with the exception of a small western part, as continental. This creates a problem regarding where to place limits in the case of newly proposed indices, which do not have a symmetrical distribution or a distribution from 0 and 100, such as for example Gorcyznski. On the other hand, climate does not have any distinct borders, in general, so it is impossible to mark a distinct border. On the contrary, transitional areas, where the climate is changing, should be designated.

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Shrnutí

HODNOCENÍ TERMICKÉ KONTINENTALITY S POUŽITÍM REGRESNÍ FUNKCE

Kontinentalita je jednou ze základních charakteristik klimatu. Odráží, do jaké míry je klima dané oblasti pod vlivem oceánu nebo pevniny, a je výsledkem působení mnoha klimatických prvků. V minulosti bylo navrženo několik indexů, které by mohly sloužit k přímému měření míry kontinentality daného území. Vzhledem k tomu, že je kontinentalita výsledkem několika faktorů, není jednoduché ji kvantifikovat. Většina používaných indexů je proto do velké míry zjednodušena a často se zaměřuje jen na jeden klimatický prvek, podle kterého kontinentalitu hodnotí. Nejčastěji se využívá teploty prostřednictvím roční amplitudy.

Roční amplituda teploty je ve většině vzorců dělená sinem zeměpisné šířky, aby byl zohledněn rozdílný příjem radiace v létě a v zimě v dané zeměpisné šířce, a to i přes to, že někteří autoři (Driscoll, Yee Fong 1992) tvrdí, že distribuce solární radiace se zeměpisnou šířkou neodpovídá funkci sinus, ale že vrcholí na 55°.

Nejpoužívanějším indexem pro měření termické kontinentality je index Gorczynského. Ten dělí klima do tří stupňů – oceanické (k = 0–33 %), kontinentální (k = 34–66 %) a extrémně kontinentální (k = 67–100 %; Gorczynski 1922). Podle tohoto indexu však v některých oblastech (např. Faerské ostrovy) vychází kontinentalita záporná, což je fyzikálně nesmyslné.

Cílem této práce je navrhnout nový index termické kontinentality, který vychází z denních průměrů teploty a zvažuje i vliv zeměpisné šířky. Vstupními daty pro analýzy byly denní průměry teplot z období 1961–2006 z 232 stanic z databáze denních dat 20. století, kterou sestavil European Climate Assessment, a která je podporována sítí EUMETNET. Základem pro nově navržený index byl Sládkův index kontinentality (2005).

V analýzách byl Sládkův index modifikován dvěma odlišnými způsoby. V obou případech bylo hlavním cílem zahrnout do něj vliv zeměpisné šířky a promítnout tam tak geografické rozložení solární radiace a potažmo teploty. V prvním případě byl použit výraz $sin(\theta)$, stejně tak jako ve většině používaných indexů, a v druhém případě šlo o použití lineární regrese vycházející z roční amplitudy teploty.

Index kontinentality s použitím lineární regrese má tvar:

$$Ic = \frac{Q}{(0.1714 \times \theta + 13.899)} \times 100$$

kde Ic je index kontinentality, Q výsledek Sládkova indexu a θ je zeměpisná šířka. Zlomek je vynásoben 100, aby bylo dosaženo většího rozpětí hodnot. Index nabývá hodnot od 0 až po 7,15 a hranice mezi kontinentálním a oceanickým klimatem byla určena pro $Q = 0{,}5$ a $\theta = 50°$ (viz rovnice [5] v textu) a potvrzena po vynesení indexu do mapy. Hodnoty vyšší nebo rovné 2,37 reprezentují kontinentální klima a hodnoty nižší oceanické klima. Rozložení indexu kontinentality na základě tohoto vzorce je zobrazeno na obrázku 4b.

Obr. 1 – Schéma ročních výkyvů teploty v Záhřebu pro jeden cyklus vzrůstající a sestupné větve. Osa x – čas, osa y – teplota.

Obr. 2 – Vztah mezi zeměpisnou šířkou (osa x) a roční amplitudou teploty (osa y) podél 23° v. d.

Obr. 3 – Vztah mezi zěměpisnou šířkou (osa x) a roční amplitudou teploty (osa y) se zahrnutím stanice Deir Ezzor, Sýrie.

Obr. 4 – Termická kontinentalita v Regionu VI s použitím rovnice a) $2 \times Q/sin(\theta) - 0{,}75$ – rovnice [5], b) lineární regrese – rovnice [7], c) polynomické regrese vycházející ze vztahu mezi zeměpisnou šířkou a roční amplitudou teploty u stanic podél 23° v. d. – rovnice [6], d) Gorczynského – rovnice [1]

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