WYŻSZA SZKOŁA MORSKA
Wydział Nawigacyjny
Katedra Meteorologii i Oceanografii Nautycznej

ANDRZEJ A. MARSZ

WSKAŹNIK OCEANIZMU JAKO MIARA KLIMATYCZNEGO WSPÓŁODDZIAŁYWANIA W SYSTEMIE OCEAN - ATMOSFERA - KONTYNENTY

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INDEX OF OCEANICITY AS A MEASURE OF CLIMATICAL INTERACTION IN THE SYSTEM OCEAN - ATMOSPHERE - CONTINENTS

SUMMARY

1. Formulation of an Issue

The main aim of the paper specified in this chapter is to find an easy index, which can define climatological interaction in the system Ocean - Atmospere - Continents in a global range. The problems of so - called "continentality indices" being in use a measure of such interaction up to the present has been outlined. The method of specifiting a climatical norm for continentality and a unit of measure (%) has been called in question.

There have been an observation made that oposing continentality to oceanity is groundless. Both above notions are just two extrems of existing on the planet differentiation of certain set of climatical features.

2. An Issue of Choosing a Climatical Element to Construct an Index Characterizing a Degree of "Continentality" and "Oceanicity" of the Climate

2.1. The most important indices, characterizing a degree of "Continentality" of the Climate, Being in Use up to Date

Analysis of indices used up to present to define continentality were carried on in the chapter. Each time it has been estimated: the climatical meaning of an element being a part of the formula, an influence of mathe-

matic shape of the formula over a result of calculations and a degree of versatility of the formula. As an universal formula such one has been recognized, which could be use on the whole globe without restraint.

In the group of indices of so-called "thermical continentality" (basing only or in decisive part on annual air temperature ranges), formulas of Zenker (1888, [1]), Gorczyński (1918, [2], 1920, [3]), Schrepfer (1925, [4]), Spitaler (1922, [5]), Johansson [6], Rindgleb (1948, [7]), Chromov (1957, [8]), Ivanov (1953, [9], 1959, [10]) and Ewert (1972, [11]) has been analysed. Analysis showed, that a lot of those formulas has uncorrect form from mathematical point ov view limitating the range of its use and/or basing on features, which have only local meaning.

In the group of "pluvial continentality" indexes basing only on distribution of precipitation of total amounts analysis shows, that all of them can find an application at the outmost on land areas of zone of moderate climate at the North hemisphere, and they do not have any global meaning.

The group of continentality indices basing on surveying the frequency of occurence of continental and maritime masses of air (for example Dinies's indices [12], Berg's [13] and Zinkiewicz [14]), in the face of disregarding a degree of transformation of atmospheric masses (maritime into continental) make this measure, against the coloure, very imperfect.

Comparition of indices calculated for a few characteristic stations (tab. 1, fig. 1) due to formulas of different authors shows, that they do not define an influence of the continent on the climate in percentage for sure, so their designation in percentage makes no physical sense. Analysis showed, that the most promising element, which can characterize climatical interactions in the system ocean - atmosphere - continents is still annual air temperature range.

2.2. Annual temperature range as a measure of climatical interaction in the system ocean - atmosphere - continents

Factors, having an influence on an amount of annual air temperature range were subjected to anlysis in the chapter. Analysis shows, that practicly a whole set of climate - formative factors with no univocal domination

of any of them has an influence on the amount of annual air temperature range. Annual temperature range is a complicated resultant of radiation and heat balance occuring in specified conditions of influence of physical compound of the ground and an atmospheric circulation. It takes macrospace elements in global scale and also mezo- and microspace into account.

It allows to considere an annual temperature range as an amount complexly characterizing effects of climatical interactions in the system. Due to this reason, to construct an index it has been decided to base on amounts of annual air temperature range only, precising and index as an amount characterizing a whole climatical complex, and not only an element of thermic.

3. Initial establishments, construction and property of oceanicity index

3.1. Initial establishments

As a result of analysis carried on refering to formation of distribution of temperatures and amplitudes over the land and sea areas, an existance of accepted (vide Chromov 1957) "typicaly oceanic amplitude" has been called, in question. An attention has been payed to the fact that zonal distribution of amplitudes over the ocean is a result of generals, and not a factual state. The generalized picture is "contaminated" by effects of oceanic circulation, which threedementionaly carry both mass (water) and energy (heat). Continentality is defined as a climatical state in which climatical influences of the ocean undergo the extiuction to moreless unclear minimum.

Climatological norm of amplitudes for the Earth should be searched on the inner parts of continents located as far as it's possible from the coastline and circulation influence of oceanic areas only. To eliminate an influence of hypsometry (stations located as low as it is possible in one section of high should be chosen). An influence of latitude for shaping an amplitudes of inner parts of continents should be specified next.

To carry this postulate into effect ten low located in interior parts of continents stations (from 8 to 385 m asl), had been chosen for each 10-degree zone from 0 to 70° and two stations in the 70-72° zone. There had not been finded stations for higher latitudes which could be low located and interior parts of continents at the some time (tab. 3).

3.2. Construction of the index

Analysis of dependence of annual temperature range (A) and latitude [$A \approx f(\varphi)$] showed, that for collected interior continental stations (tab. 3), best fitted line, makes polynomial 4°, formula [15] with correlation coefficient (r) = 0.9798 and determination coefficient (d) = 96% (fig. 2, line 1). Run of this line gives to suppose that to make calculations easier it is possible to replace it by a method of linear fitting (formula [16]). Linear fitting (r = 0.9644, d = 93% - fig. 2, line 2) allows to extrapolation of values A to higher latitude. Value A calculated on the poles due to formula [16], (assuming the symmetry of hemispheres) figures 67.62 deg. As for low latitudes formula [16] gives physical results without sense (negative amplitudes), for equator an amplitude calculated for 10 low located interior continental stations laying in the zone of 0 - 4.3° latitudes was taken, getting the value 1.767° (with σn = 0.3299°). This value has been accepted as characteristic for the formula of equator. Through the points (A = 1.767°, φ = 0°), (A = 67.62°, φ = 90°) runs a line described by equation [17]. Above equation gives results more simmilar to the formula [15] in latitude 0 - 10° than equation [16], in the residual interval of the function differences are unimportant.

It has been recognized that the formula [17] defines theoretical value of calculated amplitude [Ao], it means mean amplitude, which should occur on low located interior parts of continents. Value Ao has been accepted as a climatical norm for given latitude. Division of calculated amplitude [Ao] for given point of the Earth by an amplitude factual existing there (A, formula [19]):

$$Oc = \frac{1.767 + 0.731 \cdot \varphi}{A}$$

where: φ - latitude,

A - annual air temperature range (amplitude),

creates an Oc index, called "OCEANICITY INDEX". It informs how many times calculated amplitude is bigger or smaller than factual amplitude. It is a nonedimention (nonominated abstract) value.

The index is an easy measure of both oceanicity and continentality of the climate. It has zonal character only, so all deflections of A from perfect zonal system are easy to find. The index should be calculated with a precision of 3 places after a decimal point and make a sum to 2 places next.

3.3. Graduation of the index

For graduation of the index, calculations of Oc for several hundred of stations laying on land or on the islands, has been counted. Indices of continentality for the same stations have been calculated due to Gorczyński & Chromov, too. Cartographic pictures of continentality indices of different authors has been also compared.

As a result of comparative procedure appeared that differentiation of value of the Oc index allows to distinguish 5 categories of the climate. Limits of categories of the climate are very much conected with integer values of Oc index. Those categories has been called:

Oc	> 3.99	-	ultraoceanic climate,
3.99	- 3.00	-	oceanic climate,
2.99	- 2.00	-	suboceanic climate,
1.99	- 1.00	-	continental climate,
Oc	< 1.00	-	ultracontinental climate.

3.4. Properties of oceanicity index

Results of investigations into features of Oc index have been shown in the Chapter. They indicates of great sensibility to even minimal local climatical changes (distance from the sea, height above sea level, change of latitude with unchanged amplitude). An activity has been also checked. There has been also activity of index in low latitudes checked.

Results of examinations show that Oc index could be used as an investigative tool in climatology, for researches both in makro- and topo-scale and studing the time series. Obtained results are easy to interpret.

As illustrations a map of distribution of the index on the area of Poland (fig. 4) and a run of changes of Oc for 2 polish stations (Szczecin - Niebuszewo, NW Poland and Tomaszów Lubelski, SE Poland) in the period 1931-1960 (fig. 5) have been inserted there.

4. Distribution of Oc index on the Earth

The materials, which had served to construction maps and a spatial distribution of Oc index on the world, has been talked over there (fig. 6). Because of drawback of computer operation the picture of izopleth and coloures on this figure are removed about 3.5 mm E in comparison with geographical graticule and outlines of continents. A picture of Polar regions has been shoved in details (fig. 7 & 8).

An observation was made to the fact that the differentiation of Oc over oceans is much bigger than over areas of coninents. Leded analysis shows that Oc index could characterize something different over the land areas and something different over oceans.

5. Oceanicity index as a measure of transportation of heat humidity in the system ocean - atmosphere - continents

5.1. An index of oceanicity and frequency of occuring of atmospheric masses over the land areas

Analysis leded from the point of view of relationship of value of Oc and frequency of atmospheric masses occuring over the land areas shows, that each of conspicious categories of the climate correspond with specified structure and frequency of occurence of atmospheric masses.

In ultraoceanic climate (Oc > 3.99) occurs only or almost only untransformated maritime air masses (in subequatorial zone - equatorial air).

In oceanic climate (4.00 > Oc > 2.99) in the structure of masses during the whole year untransformated masses of maritime air dominates. Participation of other masses is unimportant - those are first of all maritime masses of air, transformating itself into continental masses, with domination of features of maritime masses. Masses of continental air are an episodic element and they do not have any strongly marking itself seasonal rhythmic. In subequatorial zone equatorial air dominates, so continental masses of air could show weak marked rhythmic of occurence there.

Suboceanic climate (3.00 > Oc > 1.99) is characterized by occurence of maritime masses of air in majority during the year, even though occurence of continental air mass is possible at any moment. Most often masses of continental air showing smaller or bigger degree of transformation (in the direction of continentality) are occuring in this climate. Participation of continental masses of air is smaller, although in could periodicly (most often during the warm season of the year) dominates. During the cold season of the year fairly transformated maritime air positively dominates.

In continental climate (2.00 > Oc > 0.99) during the whole year continental masses of air dominate over all others kinds of masses. Some of these masses are continental airs originated thanks to transformation of maritime masses, so they still have few features of their maritime origin. On some areas, against a background of positive domination of continental masses of air stronger or weaker transformated maritime or equatorial air could periodicly (especially during the warm season of the year) dominate.

Ultracontinental climate (Oc < 1.00) is characterized by occurence of continental masses only. They could come into being thanks to advection and underwent a total transformation on their way (often with cooperation of saturated adiabatic lapse-rates - orography). They could be down-rising masses from upper troposphere, which got properties from the ground.

Comparision of the frequency of occurence of masses of continental air for a few stations with values of Oc index (tab. 4, fig. 9) shows the connections [19] with big statistical significance. Theoretical dependence between the frequency of occurence of masses of continental air and Oc in section from 4.00 to 1.00 shows formula [20].

5.2. Index of oceanicity and intensivity of transmission of heat and humidity over the oceans

If the mechanism of transmission of heat from the surface of ocean to atmosphere in the shape of sensible heat and heat by evaporation [21]) is taken under consideration, the picture of distribution of Oc over the seas becomes clear. The value of Oc over areas of oceans defines relative intensivity of transmission of heat and humidity from the ocean to atmosphere. Oc reaches maximum values there, where temperature of water surface is bigger than air temperature and wind velocities are considerable. Minimum there, where air is warmer than water and a dew point temperature equals or is approximated to temperature of water. In these regions where Oc has low value (ultracontinental, continental climate) accumulation of heat by radiation in waters occurs without constant transmission of sensible heat to atmosphere. Transmission of heat on substantial way (heat by evaporation) is small and characterized by very big seasonal variability. The upper Oc is, the more intensive transmission of sensible heat and heat by evaporation to atmosphere is, in the zone of given latitudes and is characterized by bigger continuity in the function of time.

5.3. Connections between Oceanicity index and some climatical elements

Because Oc is nonedimentional value, some statistical connections existing between this index and values of some climatical elements has been investigated. Investigations were leded for parallelal profile in Eurasia, from Atlantic Ocean to East Syberia and for Grenland (meridional profile). Results of investigations shows the existance generally strong and with big statistical significance connections between Oc and a group of

climatical elements. It allows to use known values of Oc , for estimation of unknown values of some climatical elements. Oc index shows the connections with values of indicies of circulation, too (especially index of cyclonity).

6. Conclusion

It has been stated that Oc index is nonedimensional value and it could be treated as an easy qualitative measure, and in some cases as quantitative measure of climatical interactions in the system ocean - atmosphere - continents too. It is an investigation tool, possible to use in climatology. Its funcionating has wider range than an existing continentality index and its needs different interpretation than others indices.

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translated by Karolina Marsz

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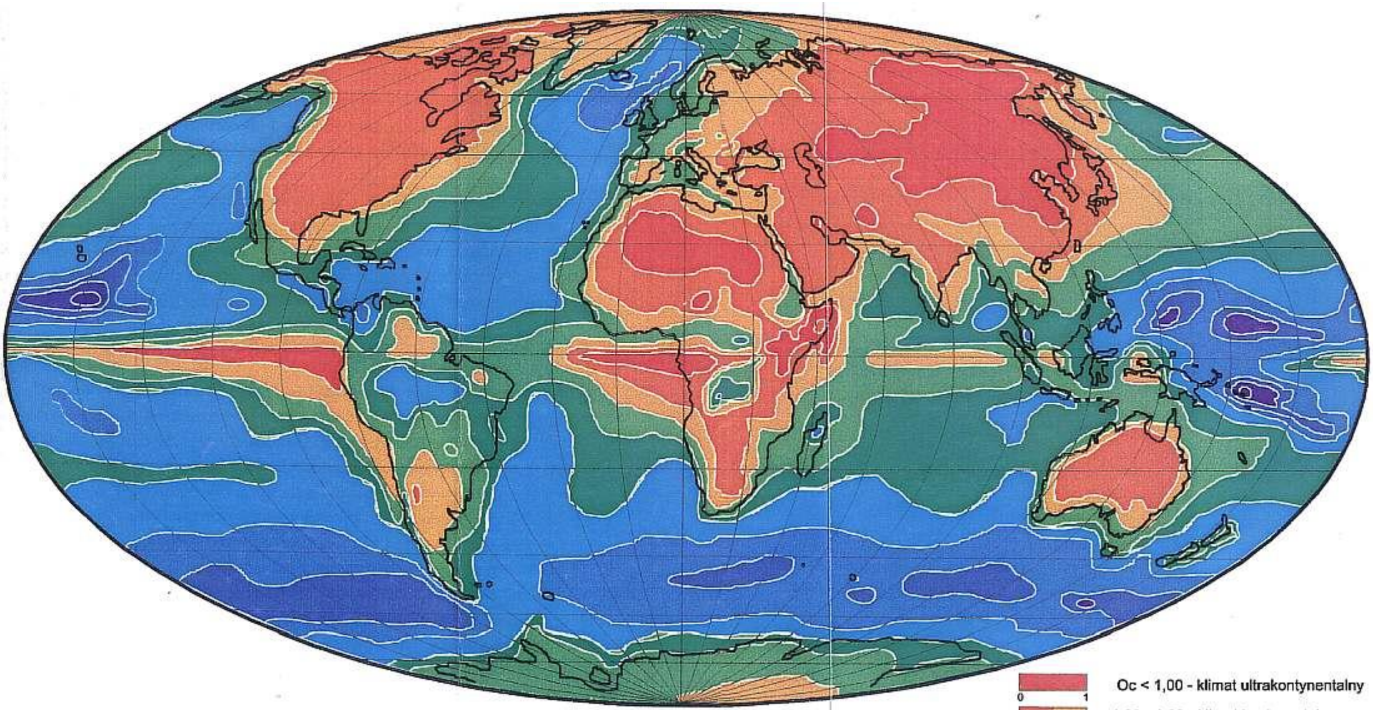

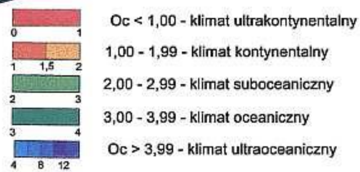

Rys. 6 ROZKŁAD WSPÓŁCZYNNIKA OCEANIZMU NA ZIEMI
DISTRIBUTION OF OCEANICITY INDEX

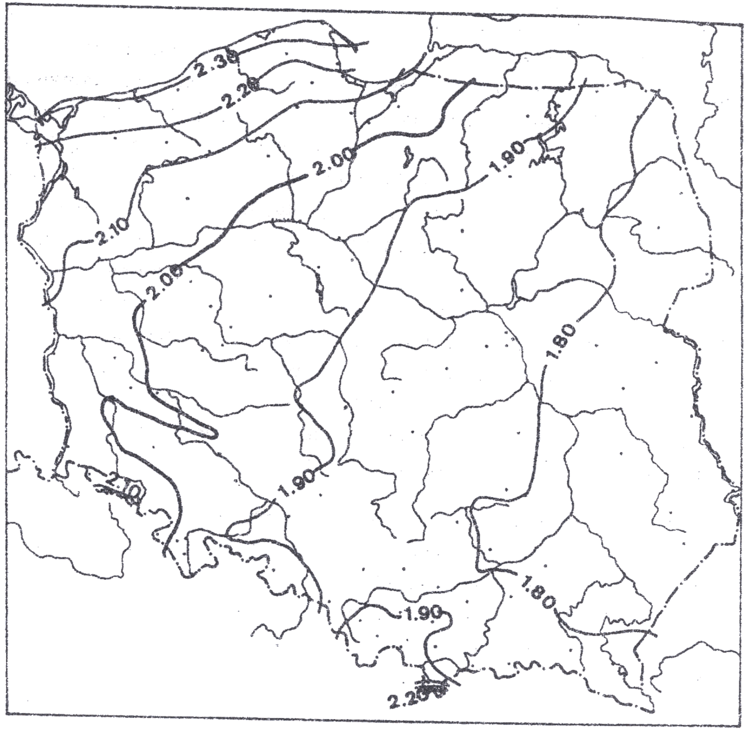

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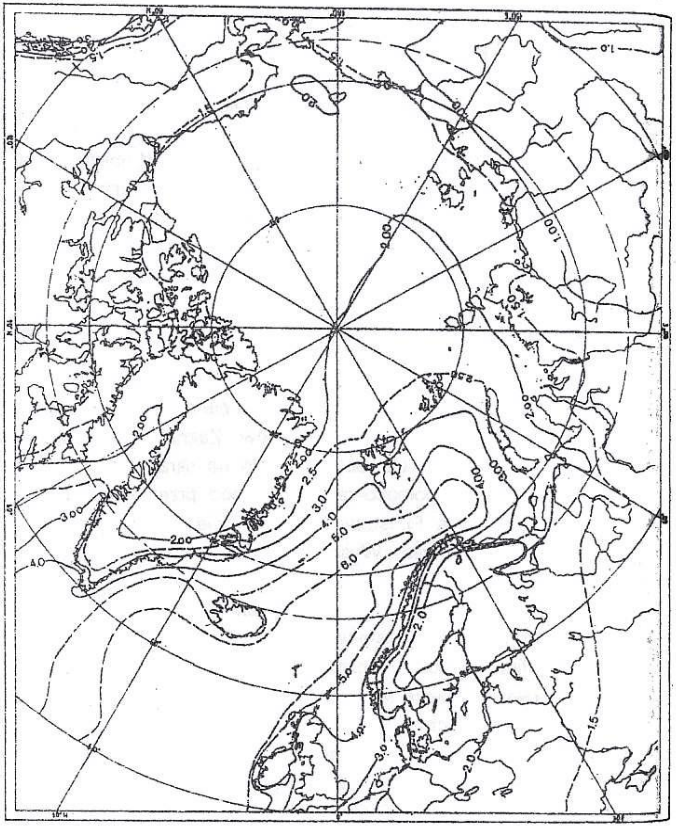
Fig. 4. Spatial distribution of oceanicity index in the area of Poland (due to mean amplitudes from 15-years; 1951-1965, Chomicz's data 1977)



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(from Marsz A.A. – The distribution of the value of the thermal oceanity index in the area of Arctic (Rozkład wielkości wskaźnika oceanizmu termicznego na obszarze Arktyki). Problemy Klimatologii Polarnej, 5, 11-19

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