THE TERRITORIAL STRUCTURE OF CERTAIN STATISTICAL CHARACTERISTICS OF THE EUROPEAN TEMPERATURE FIELD

by

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Az európai hőmérsékleti mező egyes statisztikai jellemzőinek területi rendszere. A tanulmány az európai hőmérsékleti mező szórásának és ferdeségének területi rendszerét és az évi menetét vizsgálja. A szórás délnyugatról északkelet felé növekszik, évi ingása hasonló módon változik. A ferdeség értékei egész évben kicsinyek, nyáron enyhe pozitív, télen enyhe negatív aszimmetria mutatkozik.

The study examines the territorial structure of the standard deviation and skewness of the European temperature field. The standard deviations grow from south-west to north-east and their yearly oscillation alters in the same way, too. The values of the skewness are small in the whole year. There is a slight positive asymmetry during the summer months, while a slight negative one during the winter months.

The most important parameter in characterising the climate of a certain territory is the temperature, it has been continuously measured according to its importnce since the time that its observation begun, and there is a relative long time array at disposal. The temperature mean values of Europe are universally known, its plotting on a map was realized by Hungarian experts on a WMO comission [1]. As a matter of fact, the temperature distribution which was separately established on every area would cover adequately the subject, this, however, cannot be realized in practice. In this way we must accept as satisfactory the examination of parameters characterising the distribution of time arrays measured at a few stations.

In this case the European temperature field is approached with the series of monthly mean temperatures of 80 years (1881—1960) measured at 39 different stations. The standard deviation of these series was calculated as well:

$$\sigma = \sqrt{\frac{n}{n-1} \frac{\sum_{i=1}^{n} (x_i - M)^2}{n}} \qquad (1)$$

where

n is the instance number, in this case 80, x: the series number of the previous, M is the mean value. The standard deviation of the monthly series of the 39 stations is displayed on *Table 1*. The yearly line of the standard deviation is generally wellknown, it is great during winter and it is small in summer. It is important, however, to notice the characteristical change of standard deviation with the change of latitude and longitude *(Fig. 1 and 2)*, its value increases with the increment of both. If latitude is indexed with "φ", longitude with "λ", the standard deviation in February with "σ_{II}", in June with "σ_{VI}", the correlational coefficients with "r" the following is obtained: To support previously stated facts $r_{\varphi,\sigma_{II}} = 0{,}59$; $r_{\lambda,\sigma_{VI}} = 0{,}72$; $r_{\varphi,\sigma_{VI}} = 0{,}45$; $r_{\lambda,\sigma_{VI}} = 0{,}62$, with the knowledge of these parameters and the mean values of numerical

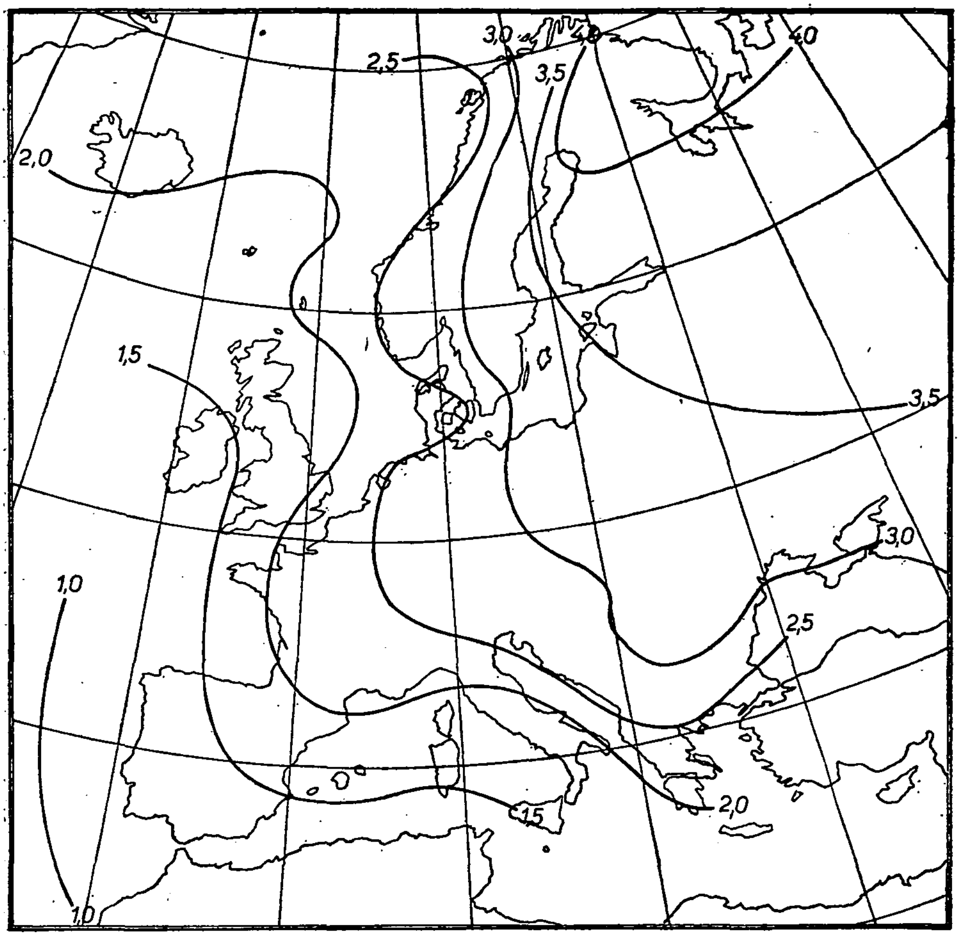

Fig. 1. Standard deviation of monthly mean temperature in February, °C

series of the respective set of datas it was possible to solve the linear, regression equitation with two variables describing the territorial structure of standard deviations:

$$\sigma_{II} = 0,046\varphi + 0,013\lambda - 1,96$$

$$\sigma_{VI} = 0,018\varphi + 0,015\lambda - 0,67$$

here with emphasising formerly established statement. These equitations are of course valid only within the examined area. In this way maximal values occur on the Scandinavian Peninsula and on the Northern part of the Eastern European Plain, while minimal values occur in the West, on the coastline of the Atlantic Ocean and in the Mediterraneum during summer and winter as well.

The extreme values of the standard deviation do not ensue on the Continent at the same time, Maximums occur in Middle and Eastern Europe in January, while in Northern, Western and Southern Europe in February. The occurance of minimums

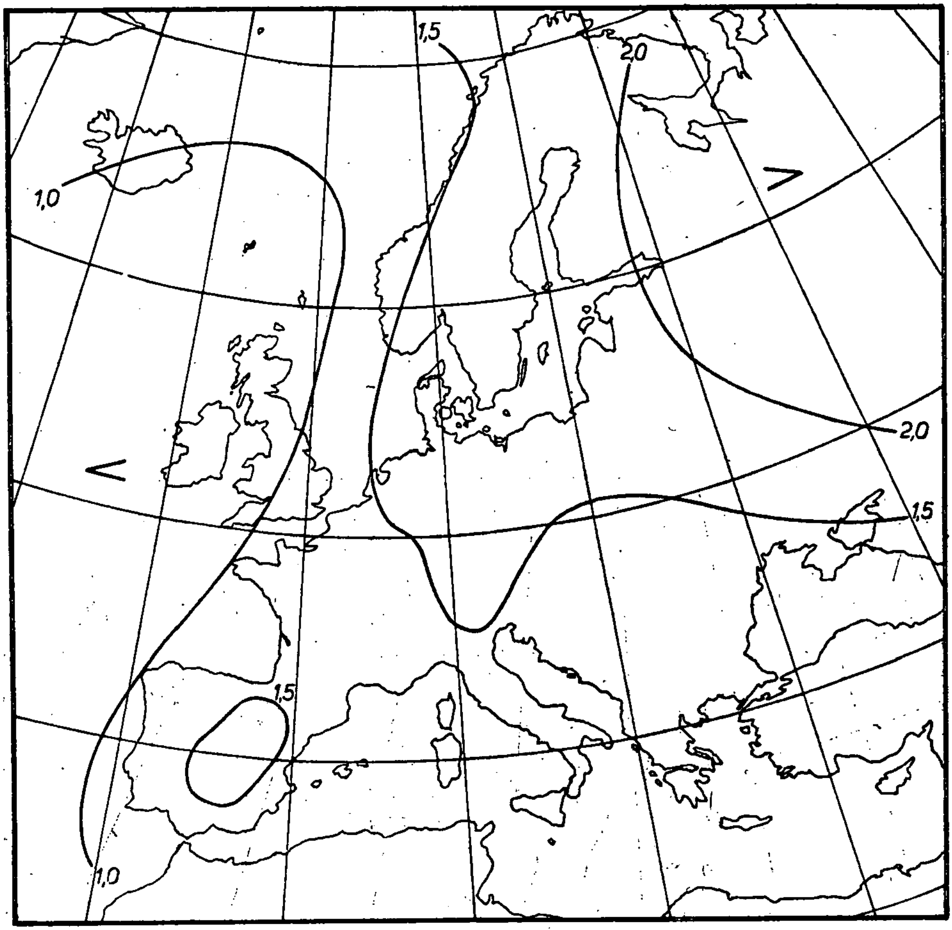

Fig. 2. Standard deviation of monthly mean temperature in June, °C

is less uniformal. On the Atlantic coastline it is in June, along the Mediterranean Sea it is in April, on the continental parts it is in July and in August, in the Eastern part of the Scandinavian Peninsula, in the territory of the White Sea it is in September. The yearly line of standard deviation is characterised by a non-recurring wave-form, but within this there are significant differences *(Fig. 3 and 4)*. The maximal values of oscillation (above 2,5°) occur on the North-Eastern part of the Continent. In Eastern and Middle Europe there are great standard deviation values and the oscillation is great as well (2,2,5°). In Western Europe, with the exception of the British Isles, the yearly oscillation of standard deviation decreases (1—1,5°), the maximal value is less, than 3 °C. In the territory of the Atlantic Ocean and the Mediterranean Sea the characteristical yearly line is hardly recognisable or it cannot be recognized at all, the oscillation is less than 1 °C, it does not even reach 0,5 °C on the South-Western part of Europe, the values of standard deviation are around 1 °C.

Summarizing what was previously written it can be stated that the yearly oscillation of the standard deviation of temperature alters according to the standard deviation on the territory of Europe.

Temperature series are generally described with normal distributional probability variables, since temperature is considered to have a normal distribution.

This supposition was several times proved in practice, but since it is about empiric distributions, normality is not fulfilled in theory, only with a certain approaching. In this way the real distributions deviate to some extent from the normal distribution. Since normaldistribution is symmetrical, the asymmetry, the skewness can be regarded as a degree of deviation. To measure skewness the following parameter was calculated:

$$\gamma = \frac{n}{n-2}\,\frac{\dfrac{\sum_{i=1}^{n}(x_i - M)^3}{n}}{\sigma^3} \tag{3}$$

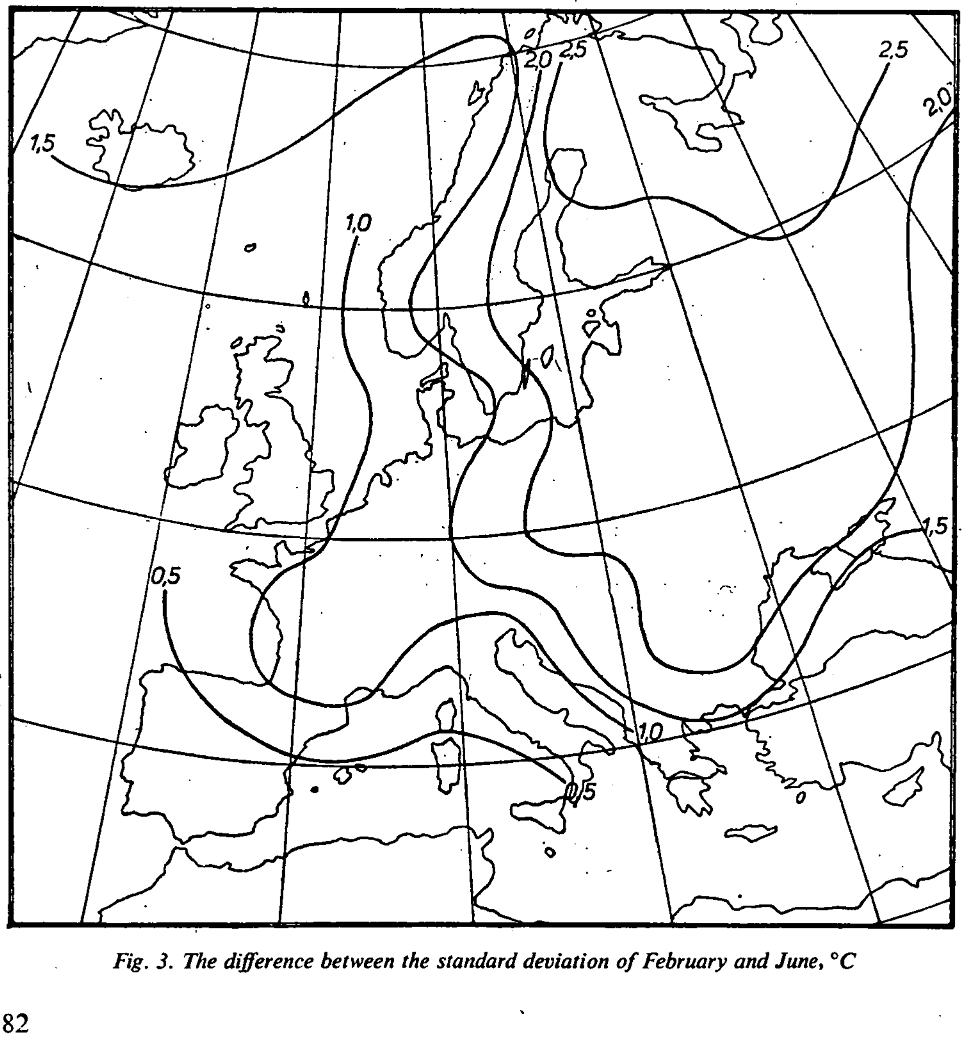

Fig. 3. The difference between the standard deviation of February and June, °C

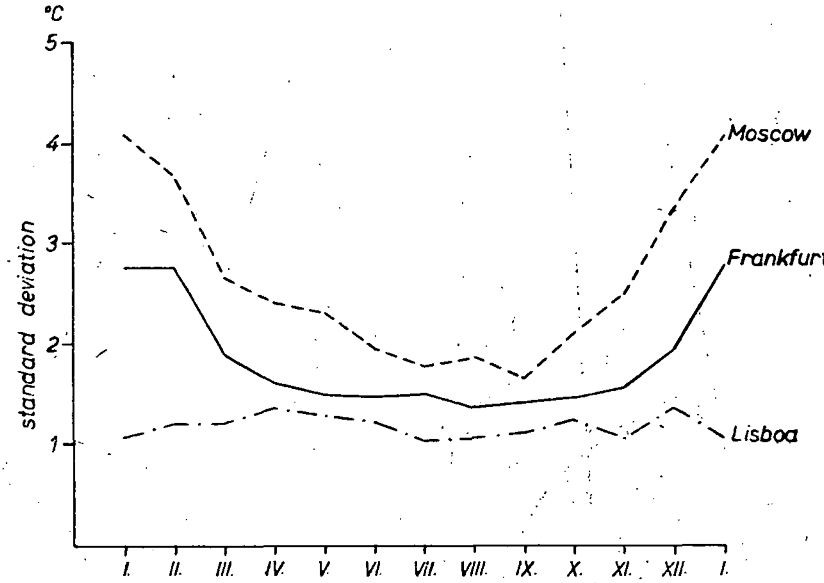

Fig. 4. The yearly line of standard deviation in Moscow, Frankfurt and Lisboa

which is the third central momentum outlined in standard deviation cubic units. The values of skewness can be read in *Table 2*. Generally it can be stated that the values of skewness are small so normaldistribution with a close approaching can be accepted in the examined territory. The territorial structure is less uniformal than in the case of standard deviation, the yearly line is less characteristic, too, but it is still discernable. During the interim seasons the sign of skewness changes without set rules and its absolute value is small as well, in this way this phenomenom can be mostly explained with the deviation between empiric and theoretic momentums. This time principally the normal distribution is fulfilled in this way. During the summer months there is a slight positive asymmetry, while there is a somewhat greater but still unsignificant negative asymmetry during the winter months *(Fig. 5 and 6)*. Maximal values occur in both cases in the middle of the territory, in Middle and Western Europe. Both Atlantic and Continental territories are characterised with small values. Since the degree of third central momentum depends on the single directional extreme anomalities, it can be stated, that the territories with greater skewness during summer and winter are those, where Oceanic effects are prevalent, but continental effects can be expected as well. In this way the territories with relatively greater asymmetry — these are more or less the same during winter and summer — can be regarded as an interim territory between the Oceanic and Continantal type temperature distributions.

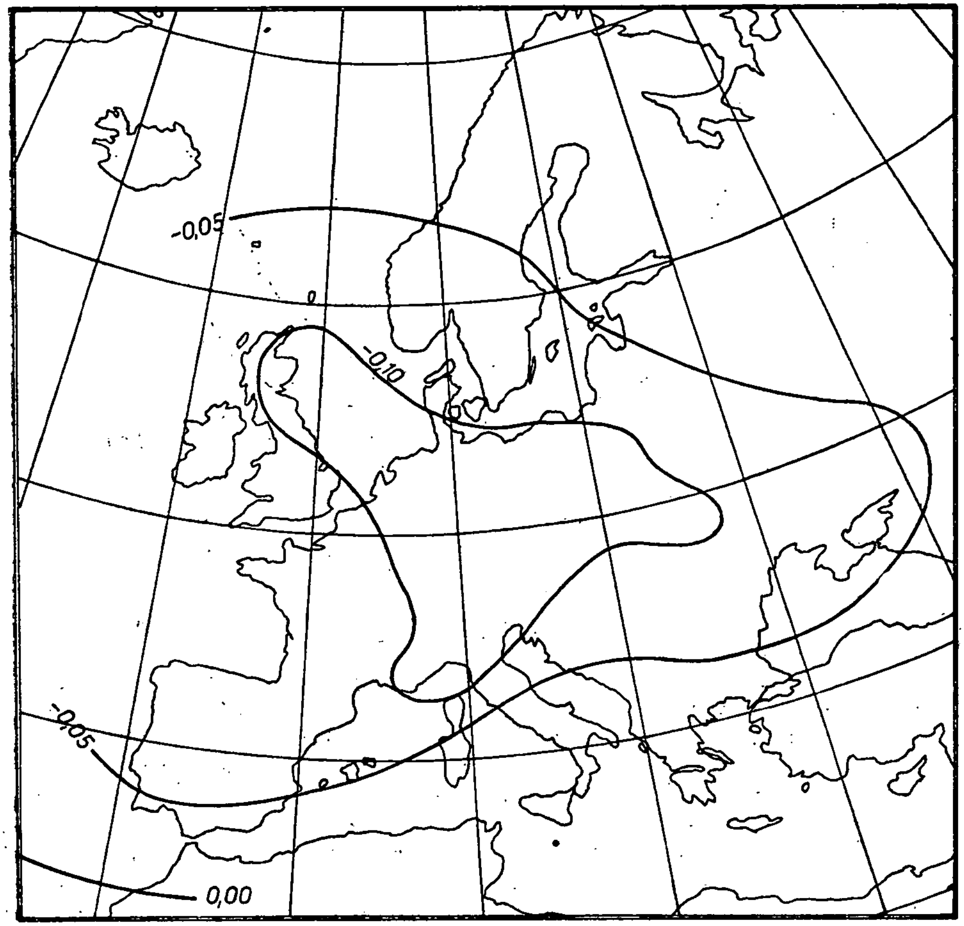

Fig. 5. Skewness of monthly mean temperature in February

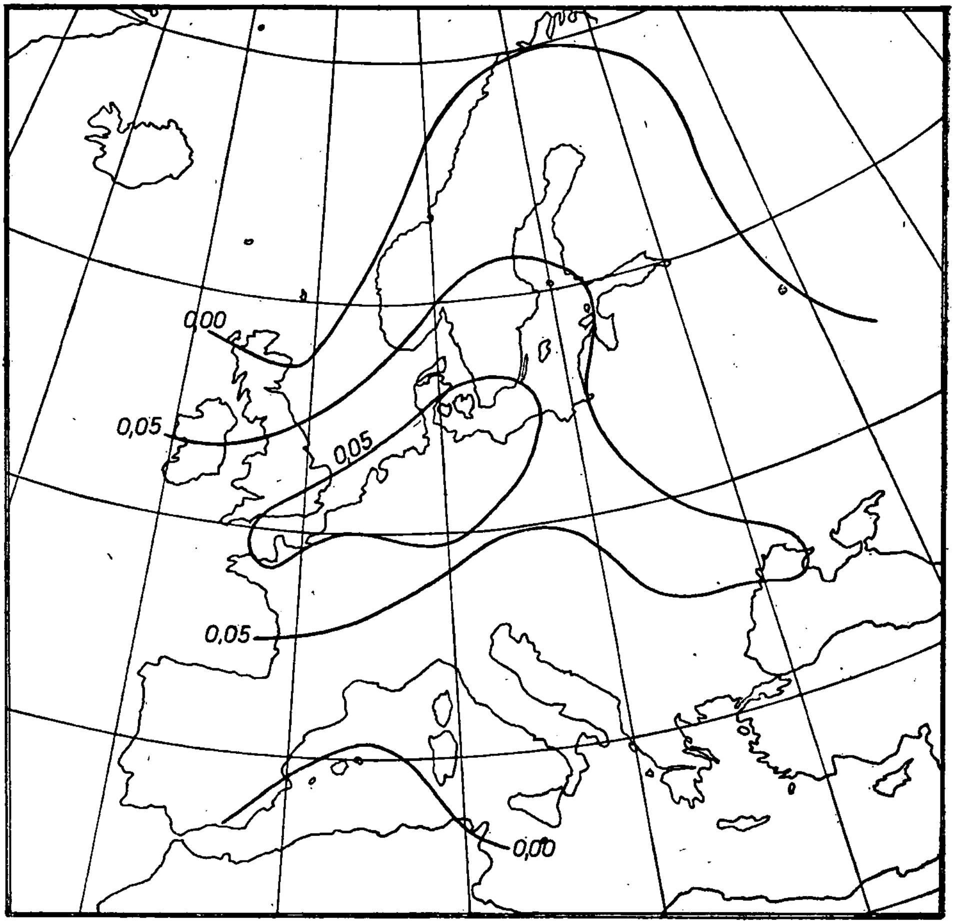

Fig. 6. Skewness of monthly mean temperature in August

References

[1] Climatic Atlas of Europe WMO, UNESCO, 1970
[2] World Weather Records Smithsonian Institution, Washington

Table 1
Standard deviation of monthly averages of temperature °C

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stykkisholm	2,27	2,34	2,55	1,82	1,66	1,04	0,95	1,11	1,30	1,63	1,43	1,64
Bodó	2,11	2,42	2,05	1,56	1,49	1,52	1,84	1,50	1,34	1,85	1,79	2,25
Haparanda	3,72	4,11	2,91	1,61	1,69	1,75	1,82	1,48	1,37	2,12	2,94	3,85
Arkhangelsk	3,86	3,89	2,91	2,31	2,45	2,26	2,24	2,04	1,50	2,07	2,82	4,33
Wroclaw	3,14	3,42	2,31	1,81	1,55	1,49	1,12	1,24	1,41	1,67	1,85	2,23
Aberdeen	1,39	1,77	1,53	1,09	0,94	0,89	0,91	0,97	0,96	1,13	1,25	1,30
Oslo	2,99	2,96	2,19	1,31	1,57	1,59	1,53	1,46	1,07	1,52	1,78	2,35
Uppsala	2,70	3,43	2,88	1,77	1,65	1,58	1,57	1,49	1,29	1,72	2,00	2,50
Helsinki	3,31	3,68	2,59	1,57	1,76	1,60	1,64	1,56	1,45	1,90	2,17	3,08
Leningrad	3,67	3,80	2,83	2,13	2,40	2,40	2,60	2,42	1,90	1,98	2,18	3,25
Valencia	1,18	1,43	1,25	0,91	0,79	0,80	0,87	0,94	0,84	1,14	1,24	1,12
Basel	2,64	2,85	1,80	1,54	1,46	1,36	1,59	1,40	1,59	1,52	1,50	2,06
Moscow	4,07	3,69	2,66	2,39	2,31	1,95	1,76	1,84	1,66	2,08	2,49	3,34
Kasan	3,72	3,77	2,58	2,52	2,80	2,65	2,88	2,61	2,35	2,32	2,93	3,54
Sibin	3,59	3,20	2,30	1,76	1,59	1,28	1,25	1,47	1,60	1,80	2,60	2,62
Greenwich	1,80	1,96	1,55	1,26	1,13	1,05	1,40	1,30	1,29	1,41	1,39	1,64
De Bilt	2,37	2,68	1,71	1,54	1,50	1,59	1,54	1,47	1,40	1,33	1,55	2,04
Berlin	2,32	1,93	1,84	1,68	2,27	2,64	2,33	2,16	1,87	1,40	1,61	1,94
Kiew	3,49	3,29	2,57	2,20	1,84	1,91	1,60	1,65	1,77	2,16	2,32	2,76
Nantes	2,03	2,26	1,51	1,22	1,18	1,15	1,44	1,43	1,39	1,40	1,57	2,01
Paris	2,34	2,34	1,74	1,51	1,31	1,29	1,57	1,43	1,49	1,55	1,56	2,05
Frankfurt	2,77	2,77	1,88	1,62	1,48	1,46	1,49	1,34	1,42	1,44	1,63	1,95
Zürich	2,41	2,70	1,94	1,70	1,60	1,45	1,60	1,36	1,63	1,52	1,45	1,89
Wien	2,92	2,88	2,11	1,65	1,52	1,31	1,22	1,14	1,46	1,43	1,81	2,16
Budapest	2,89	2,71	2,13	1,68	1,59	1,34	1,23	1,34	1,62	1,58	1,98	2,19
Odessa	3,34	3,06	1,97	1,44	1,58	1,41	1,34	1,39	1,69	2,06	2,50	2,82
Marseille	1,96	2,13	1,27	1,12	1,19	1,10	1,42	1,25	1,37	1,63	1,39	1,70
Geneve	2,10	2,36	1,61	1,41	1,44	1,26	1,60	1,31	1,54	1,32	1,32	1,74
Milano	1,70	2,05	1,61	1,39	1,57	1,45	1,43	1,31	1,43	1,34	1,49	1,31
Szeged	3,24	3,20	2,25	1,75	1,66	1,39	1,33	1,51	1,67	1,74	2,07	2,51
Bukarest	3,34	3,07	2,45	1,72	1,56	1,11	1,20	1,39	1,60	1,87	2,39	2,56
Sulina	3,06	2,64	1,93	1,32	1,27	1,15	1,09	1,03	1,50	1,91	2,41	2,46
Tbilisi	2,09	1,91	1,74	1,51	1,31	1,26	1,07	1,14	1,58	1,57	1,58	1,66
Funchal	0,82	0,80	0,85	0,77	0,59	0,55	0,62	0,70	0,55	0,70	0,85	0,77
Lisboa	1,05	1,22	1,21	1,36	1,27	1,20	1,03	1,04	1,09	1,24	1,05	1,35
Madrid	1,25	1,54	1,60	1,53	1,60	1,61	1,15	1,41	1,34	1,48	1,20	1,35
Palma	1,27	1,59	1,18	1,15	1,16	1,20	1,26	1,25	1,21	1,32	1,25	1,22
Róma	1,52	1,60	1,17	1,00	1,18	1,28	1,25	1,02	1,25	1,30	1,32	1,31
Taskent	3,46	3,32	2,46	1,66	1,43	1,29	0,97	0,96	1,07	1,70	2,38	3,23
Köbenhavn	2,15	2,48	2,04	1,40	1,21	1,38	1,28	1,36	1,18	1,44	1,57	1,62

Skewness (x 10)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stykkisholm	−14,7	−3,9	−11,9	−1,4	−0,1	−5,8	−0,5	−3,3	3,3	1,9	−0,2	−1,3
Bodó	0,0	−1,9	−1,9	3,6	0,8	1,7	1,5	4,4	2,1	0,7	−1,7	−3,3
Haparanda	2,5	−1,7	−3,4	−4,4	3,7	5,3	0,9	3,8	1,9	0,8	−2,8	−3,3
Arkhangelsk	−0,6	−2,9	−3,8	−3,0	5,4	2,4	3,3	−1,3	0,0	−4,0	−6,7	−7,0
Wroclaw	−6,6	−15,8	−1,5	0,3	2,2	1’2	−4,2	6,7	−3,5	0,1	−0,1	−7,0
Aberdeen	−3,0	−12,3	0,7	3,5	−0,8	−0,7	0,5	−1,6	−0,5	−3,6	−4,3	−2,0
Oslo	−2,6	−6,8	−3,5	−2,1	5,1	4,1	8,7	8,4	−2,3	2,2	2,2	−0,5
Uppsala	−7,2	−5,7	−3,9	−2,1	−0,3	4,6	5,1	5,1	2,5	2,1	−4,5	−7,7
Helsinki	−5,7	−2,7	−2,7	0,5	2,2	1,8	1,5	5,0	3,4	1,4	−5,4	−7,1
Leningrád	−2,3	−3,4	−2,9	0,4	3,0	1,0	2,2	4,1	5,6	−0,5	−3,5	−6,3
Valencia	−3,8	−8,1	0,5	2,6	−0,2	7,8	4,8	5,3	3,1	−3,3	−3,5	−0,9
Basel	−3,8	−12,2	−1,1	2,0	−3,1	−4,8	2,4	5,7	−2,1	−6,0	2,2	−3,8
Moscow	−5,1	−3,3	−3,7	3,1	−0,6	2,1	4,1	1,3	1,6	−0,4	−2,4	−1,9
Kasan	−2,2	−3,0	−3,9	1,0	−0,8	2,7	4,5	1,8	2,2	0,1	−3,1	−2,1
Sibin	−3,2	−1,9	−3,6	−1,0	−2,2	−1,0	2,8	5,0	−2,1	0,4	−1,6	2,4
Greenwich	−3,8	−9,1	0,8	1,6	−1,6	−3,6	−0,4	3,2	0,6	−3,3	−3,5	−0,2
De Bilt	−5,8	−12,7	−0,2	−1,5	−1,6	1,0	−2,3	4,2	4,6	−2,8	−1,4	−8,2
Berlin	−10,4	−7,1	−0,3	5,0	7,7	6,9	4,0	3,7	4,4	−1,9	−2,5	−5,9
Kiew	−4,0	−6,9	−1,9	0,6	−0,2	−0,9	7,7	4,7	3,1	0,2	−2,3	−4,6
Nantes	−1,7	−8,7	−1,0	4,7	−2,3	−0,3	3,3	5,1	3,4	−3,4	1,4	−7,3
Paris	−3,5	−8,6	−1,5	2,5	−2,7	−1,7	1,8	5,1	2,6	−4,7	−0,5	−5,6
Frankfurt	−6,2	−14,0	−3,1	0,5	−2,7	−2,2	−0,4	4,4	0,3	−2,1	0,5	−0,9
Zürich	−1,4	−10,4	−2,5	2,1	−4,1	−1,2	1,3	6,2	−1,4	−4,5	2,3	−4,8
Wien	−3,5	−12,1	−1,8	0,9	0,8	1,7	−1,8	0,7	−1,5	−3,1	0,3	−5,5
Budapest	−4,2	−9,7	−2,7	1,9	−0,5	2,1	0,0	2,3	−2,1	−0,7	−2,2	−5,5
Odessa	−2,4	−9,5	−2,0	−3,7	0,3	2,4	5,7	5,6	2,4	−1,6	−2,6	−3,5
Marseille	−5,0	−10,0	−2,4	5,0	2,5	0,7	2,8	1,5	−0,6	1,6	1,8	−4,2
Genéve	−2,4	−8,9	−1,3	2,2	−3,0	0,0	3,0	4,3	−2,8	−6,8	1,2	−2,5
Milano	0,6	−10,4	−2,0	3,0	−4,3	−1,6	5,6	0,7	−2,4	0,1	1,8	0,0
Szeged	−4,6	−9,0	−3,4	2,6	0,8	1,3	2,5	3,3	−3,7	−1,5	−2,9	−5,7
Bukarest	−0,9	−5,9	−3,5	−1,2	2,4	1,4	2,3	0,3	1,1	2,0	−2,6	−3,4
Sulina	−1,2	−8,5	−1,5	−4,3	1,1	3,5	3,5	3,6	0,6	−0,3	−2,7	−1,5
Tbilisi	−1,5	−2,2	0,5	6,6	−0,3	−0,1	0,5	0,3	3,4	1,1	−5,9	−6,9
Funchal	2,0	2,3	1,2	0,6	0,7	−1,3	−3,9	5,0	0,9	4,6	2,7	0,9
Lisboa	4,7	−5,7	3,1	3,0	1,5	−1,3	−1,7	1,6	3,9	−0,8	0,9	5,5
Madrid	3,0	−6,3	0,7	4,9	−0,7	−1,6	−3,1	1,6	1,8	−2,0	2,4	2,2
Palma	−1,7	−5,1	1,4	5,6	−0,4	−3,6	8,0	−13,5	−8,7	−0,8	−1,4	−3,7
Róma	0,7	−4,7	−3,7	−4,6	−1,6	−2,4	−1,9	1,6	−1,6	−3,0	0,2	2,9
Taskent	−2,6	−6,9	0,3	0,1	−1,5	−0,9	0,4	−1,4	0,7	−1,4	0,0	−7,1
Köbenhavn	−9,1	−9,5	−2,9	−1,9	−2,0	3,6	−0,2	3,4	1,7	−2,0	−1,9	−3,7