ACTA UNIVERSITATIS CAROLINAE
2001 GEOGRAPHICA, No. 2, PAG. 155–167

Weather to weather links: relationships between Czech circulation pattern classification and other European regional classification schemes

JIŘÍ STEHLÍK

Charles University in Prague, Faculty of Science,
Department of Physical Geography and Geoecology, Prague

Abstract

The purpose of this paper is to answer the question whether the present Czech circulation pattern (CP) classification is dependent on other subjective classification schemes defined for different European regions (the British Isles, Germany and Greece respectively) and whether the Czech classification can be derived (predicted) from above mentioned classifications and vice versa. The intercomparison is done by using several statistical tests for the period 1965–1990. The time variations in the relationships are also investigated. It follows from the achieved results that the significance of dependence of classifications and predictability was proved. The decreasing trend of most coefficients could be assigned to the increasing variability of weather conditions over Europe which is often associated with climate change. Another explanation could be a gradual change in methology. When the strong dependence among the classifications will be confirmed also after including objective classification schemes and more classification pairs, it could serve as a basis for establishing one European CP classification instead of a lot of local ones. Such classification should explain the variability of local weather (precipitation, temperature) despite being developed for large-scale region.

Key words: circulation pattern classification, statistical intercomparison

1. Introduction

A lot of circulation pattern (CP) classifications was developed in the past for a variety of European regions and by using different methods. The common task is to characterize the daily atmospheric conditions by a discrete set of typical patterns. A circulation type can be defined following Baur et al. (1944) as a mean air pressure distribution over an area at least as large as Europe and the circulation types are classified within the area of Europe and the eastern part of the North Atlantic taking into account the general circulation pattern of the whole Northern Hemisphere.

In CP classification techniques, two main groups of methods can be distinguished (Yarnal 1984, 1993). The first type of method is the so called subjective classification. The advantage of this method is that the knowledge and experience of meteorologists is fully used in the classification. A major disadvantage is that the results cannot be reproduced and that the method can be only applied for certain geographical regions. A lot of subjective classifications have been developed for different regions at different scales: Baur et al. (1944) and Hess and Brezowsky (1969) for Germany, Lamb (1972) for the British Isles, Brádka et al. (1961) for the Czech Republic, Maheras (1989) for Greece. Also typical circulation patterns have been defined for regions on other scales: Dzerdzeevskii (1968, 1970) for the extratropical latitudes of the Northern Hemisphere, Krick (1943) and Elliott (1949) for the United States. The second type of CP-classification methods are objective techniques. They are based on automatized algorithms, and allow fast classification which is necessary especially for climate change scenarios. Objective classification methods include the k-means clustering (Wilson et al. 1992), method based on physical quantities (Jenkinson and Collison 1977), fuzzy classification (Bárdossy et al. 1995; Bárdossy et al. 2001), principal component clustering (Goodess and Palutikof 1998; Goodess 2000), principal component analysis coupled with k-means (Bogárdi et al.; 1994), and neural networks methods (Cawley and Dorling 1996).

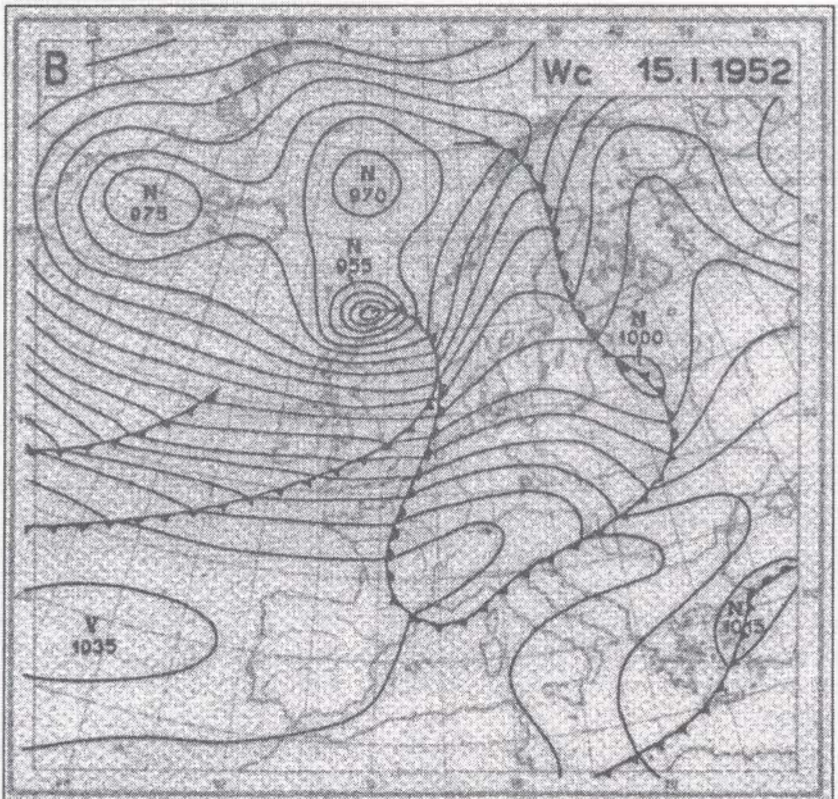

Fig. 1 A typical surface pressure contour map of the West cyclonic circulation type (Wc) for the Czech republic according to Brádka et al. (1961)

The paper is organized as follows: in section 2 different sets of CPs data are presented, section 3 consists of the description of methodology. Applications are presented in section 4. Finally, in section 5, conclusions are drawn from the present study.

2. Data

In this paper a mathematical comparison among the Czech CP classification scheme (Brádka et al 1961) and three other CP classifications is performed. The motivation is to answer the question whether links and possibilities of predictability between the Czech classification scheme and other regional classifications do exist. The classifications under study are: CP classification for the British Isles (Lamb 1972), Germany (Hess and Brezowsky 1969) and Greece (Maheras 1989) respectively. All the considered schemes are subjective.

The Czech CP classification is based on the classification of Baur et al. (1944) in which only large-scale features of the general circulation are induced, namely, (1)

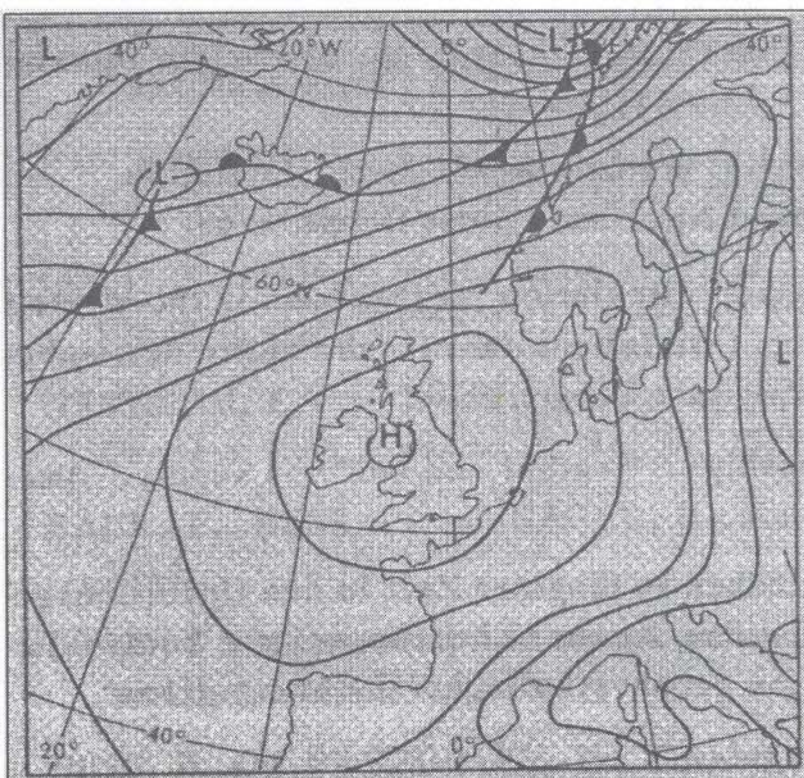

Fig. 2 A typical surface pressure contour map of the Anticyclonic (A) circulation type for British Isles according to Lamb (1972)

the location of sea level semipermanent pressure centres (e.g., Azores high/Iceland low), (2) the position and paths of frontal zones, and (3) the existence of cyclonic and anticyclonic circulation types. Baur et al. (1944) defined three groups of circulations divided into 10 major types, 29 subtypes and one additional subtype for the undetermined cases. A list of the circulation patterns with examples can be found in the work by Hess and Brezowsky (1969). The former Czech classification scheme (Brádka 1961) consists of 20 types. Since 1968 a modified version of this classification was developed in which also the daily CPs before 1968 were re-classified (Catalogue 1968). Similar methodology like in Baur et al. (1944) was used in the CP classification for the British Isles (Lamb 1972).

Two examples of circulation patterns are presented. Figure 1 shows a surface pressure distribution corresponding to the circulation pattern Wc (west cyclonic) according to the classification of Brádka et al. (1961). Typical for this circulation type is that the contour lines in central Europe are almost parallel to the latitudes. The resulting air flow is from west to east, from the Atlantic Ocean to central Europe. Three pressure centres are controlling the flow conditions, the high-pressure centre above the Azores (Azores high) and two low pressure centres near Iceland (Icelandic low). Due to the air from the Atlantic Ocean, central Europe temperatures associated with this circulation type tend to be mild in winter and cool in summer. This circulation type is often associated with rain, winter precipitation resulting from this circulation type always falls as rain. Figure 2 shows an anticyclonic (A) circulation weather type for the British Isles according to Lamb (1972). The anticyclone is usually centered over, near, or extending over the British Isles. The weather associated with this type is warm in summer and cold or very cold in winter.

3. Methods

The regional European CP classifications listed in Table 1 have been selected for analysis of intercomparison. Because a lot of computational effort is needed for getting results, only the Czech classification was compared with other ones.

Table 1 Regional European CP classifications used for intercomparion of classifications

Region	*Reference*	*Number of CPs*	*Classified time period*
Czech Republic	Brádka et al. (1961)	25	1946-present
British Isles	Lamb (1972)	26	1861–1996
Germany	Hess and Brezowsky (1969)	29	1881-present
Greece	Maheras (1988)	15	1950–1990

In order to answer the question whether the CP classifications differ from each other (and if yes then to what extent), the possible dependence was studied by means of contingency tables between each two CPs classifications (Table 2–4). The dependence was tested by means of the c^2 test:

$$\chi^2 = \sum_{i=1}^{n}\sum_{j=1}^{m}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} = \sum_{i=1}^{n}\sum_{j=1}^{m}\frac{(O_{ij}-\frac{p_i q_j}{T})^2}{\frac{p_i q_j}{T}} \tag{1}$$

where n ... number of rows in the contingency table (number of CPs in the first classification)

m ... number of columns in the contingency table (number of CPs in the second classification)

O_{ij}... number of observed cases in cell ij where i is the i-th row and j is the j-th column in the contingency table

E_{ij}... number of expected cases in cell ij where i is the i-th row and j is the j-th column in the contingency table

p_i ... number of cases in row i

q_j ... number of cases in column j

T ... number of all cases (equals number of classified days)

Table 2 Contingency table of two CPs classifications 1960–1995 (CP_a – Czech classification, CP_b – Lamb classification (British Isles), NC – non-classified days)

	CP_a 1	CP_a 2	CP_a 3	CP_a 4	CP_a 5	CP_a 6	CP_a 7	CP_a 8	CP_a 9	CP_a 10	CP_a 11	CP_a 12	CP_a 13	CP_a 14	CP_a 15	CP_a 16	CP_a 17	CP_a 18	CP_a 19	CP_a 20	CP_a 21	CP_a 22	CP_a 23	CP_a 24	CP_a 25
CP_b 1	0	0	0	2	7	1	20	18	5	16	4	7	0	0	0	1	8	1	13	2	1	16	4	4	1
CP_b 2	2	2	0	0	1	4	13	31	23	41	13	12	1	1	1	1	4	0	7	2	1	10	3	6	3
CP_b 3	0	1	1	1	3	5	9	15	12	9	8	1	2	1	0	1	0	0	1	1	1	1	0	20	7
CP_b 4	5	1	1	5	3	2	2	7	2	4	3	0	0	0	0	1	0	0	6	5	6	2	1	15	9
CP_b 5	9	0	9	8	9	1	4	4	4	9	4	1	2	0	0	3	2	4	2	4	4	0	1	20	13
CP_b 6	62	3	40	18	51	8	9	11	10	3	7	5	2	2	1	5	6	6	33	28	10	4	3	30	16
CP_b 7	9	1	3	2	34	4	13	6	0	2	1	2	0	1	0	1	0	0	35	14	4	7	5	2	1
CP_b 8	4	1	4	1	25	6	21	11	0	6	2	6	0	1	0	7	6	0	30	10	1	18	2	1	6
CP_b 9	49	9	59	33	184	103	111	192	94	131	96	50	13	18	8	25	43	8	134	73	35	59	37	155	101
CP_b 10	11	8	0	1	2	0	4	1	0	4	0	4	0	3	6	8	9	1	34	11	0	13	0	1	3
CP_b 11	1	2	0	0	0	1	5	7	3	8	0	3	2	4	3	5	16	1	12	0	0	21	1	1	3
CP_b 12	4	7	0	0	0	0	6	38	31	48	34	46	13	9	8	10	18	1	6	2	19	26	2	19	13
CP_b 13	3	3	1	2	2	5	4	15	14	20	21	18	6	4	4	6	10	5	1	2	8	4	3	13	22
CP_b 14	11	4	7	12	2	1	4	28	15	21	33	14	21	21	9	21	10	20	8	14	15	4	7	89	40
CP_b 15	55	5	16	20	6	1	1	12	6	8	8	6	11	9	6	19	6	46	14	15	10	0	7	42	38
CP_b 16	342	43	113	94	59	2	9	22	7	23	34	21	13	10	15	75	31	46	117	106	27	17	12	69	82
CP_b 17	62	23	8	14	74	7	3	5	2	7	5	3	0	0	1	24	9	4	114	42	2	9	0	4	8
CP_b 18	17	17	2	2	26	2	35	6	0	7	1	5	1	1	3	32	19	1	143	34	2	44	3	3	16
CP_b 19	19	11	1	1	4	0	2	1	0	3	1	1	0	3	0	6	2	0	22	3	2	1	0	0	3
CP_b 20	161	100	20	70	11	2	7	22	12	41	41	65	28	51	101	188	90	46	128	62	50	27	6	52	64
CP_b 21	1	3	0	1	0	1	0	0	0	0	0	4	1	1	5	4	8	3	4	0	2	10	0	0	1
CP_b 22	2	9	1	0	0	0	1	4	5	5	7	12	4	6	12	2	14	2	2	0	6	6	0	5	4
CP_b 23	0	1	2	0	0	0	1	1	3	3	7	2	0	2	9	2	3	1	0	0	1	2	0	3	2
CP_b 24	3	2	0	3	0	0	1	2	2	3	6	5	3	5	4	4	8	5	3	3	6	0	0	13	8
CP_b 25	7	1	1	1	0	0	1	1	0	0	0	0	3	1	1	7	1	8	3	2	2	0	1	4	8
CP_b 26	61	15	15	20	3	0	0	1	3	2	3	7	0	1	2	27	6	11	10	11	10	0	2	5	11
NC	39	12	12	13	8	8	13	19	15	24	21	18	12	15	12	23	22	9	33	23	23	19	7	32	24

Table 3 Contingency table of two CPs classifications 1960–1995 (CP_a – Czech classification, CP_b – Hess-Brezowsky classification (Germany), NC – non-classified days)

	CP_a 1	CP_a 2	CP_a 3	CP_a 4	CP_a 5	CP_a 6	CP_a 7	CP_a 8	CP_a 9	CP_a 10	CP_a 11	CP_a 12	CP_a 13	CP_a 14	CP_a 15	CP_a 16	CP_a 17	CP_a 18	CP_a 19	CP_a 20	CP_a 21	CP_a 22	CP_a 23	CP_a 24	CP_a 25
CP_b 1	96	2	150	79	19	3	3	6	2	0	3	2	2	1	4	22	11	12	13	21	7	2	0	62	35
CP_b 2	581	111	44	96	67	1	2	13	0	7	1	8	3	4	10	139	58	23	83	118	25	7	8	13	64
CP_b 3	31	108	0	2	4	0	5	4	0	8	3	11	0	3	2	15	35	4	24	22	21	10	2	0	8
CP_b 4	23	8	0	11	0	0	1	1	2	10	8	15	5	3	8	16	11	7	33	25	36	0	2	6	4
CP_b 5	16	2	6	19	1	0	0	2	2	1	9	0	11	6	13	17	2	90	4	10	1	0	3	53	28
CP_b 6	21	0	2	19	0	0	0	0	0	3	0	5	5	7	20	118	43	36	8	8	11	0	1	9	21
CP_b 7	15	0	10	9	79	30	11	7	0	1	1	0	0	0	0	1	0	1	2	8	5	0	0	0	24
CP_b 8	60	6	0	0	159	9	32	8	0	6	3	0	0	2	3	7	0	1	81	52	7	4	0	0	8
CP_b 9	9	6	22	15	14	19	10	27	22	3	34	1	4	1	7	5	5	1	5	12	9	0	1	233	73
CP_b 10	37	0	67	53	39	32	5	30	21	76	93	36	15	14	9	18	11	8	65	45	10	3	30	109	99
CP_b 11	1	0	0	0	2	0	2	11	1	15	1	19	1	1	1	0	12	0	50	5	4	123	4	1	0
CP_b 12	1	0	0	2	12	5	15	15	0	1	0	0	0	0	0	1	1	0	4	5	0	3	0	2	2
CP_b 13	4	3	0	1	36	6	89	14	2	0	0	0	0	0	0	2	8	0	57	13	3	16	0	0	4
CP_b 14	6	3	0	0	6	8	23	31	27	4	12	2	2	1	0	5	0	0	9	2	8	1	4	6	18
CP_b 15	4	4	0	0	8	0	11	23	0	4	0	5	2	0	3	12	17	1	27	4	18	21	2	2	9
CP_b 16	1	0	2	1	50	46	72	54	33	8	9	5	0	0	0	2	0	0	12	3	0	4	13	5	3
CP_b 17	10	13	0	1	8	0	6	13	0	8	0	12	2	2	0	3	14	0	217	45	6	18	3	2	6
CP_b 18	0	1	3	0	1	1	1	67	22	37	0	1	0	0	0	2	0	0	1	1	2	3	2	0	2
CP_b 19	0	0	1	0	0	0	3	48	14	35	4	4	1	0	0	0	2	0	22	2	1	29	7	1	1
CP_b 20	1	1	0	3	0	0	3	50	79	43	47	10	6	4	4	2	0	0	3	1	7	5	4	7	18
CP_b 21	0	5	0	2	0	0	0	6	7	69	20	22	0	5	10	3	3	0	5	2	7	14	3	1	1
CP_b 22	1	0	0	1	0	0	2	16	11	29	7	11	0	6	0	1	0	0	2	1	3	2	0	1	10
CP_b 23	0	0	0	0	0	0	0	18	4	46	10	17	2	0	4	8	18	0	7	3	18	23	6	3	2
CP_b 24	0	0	0	0	1	0	0	0	10	9	52	16	30	7	0	1	1	3	1	0	3	1	0	13	6
CP_b 25	0	0	0	0	0	0	0	0	1	13	3	67	15	5	2	1	1	0	6	0	1	6	6	2	1
CP_b 26	0	0	2	0	0	0	0	3	4	1	20	6	23	22	12	5	2	3	0	1	0	0	1	50	9
CP_b 27	1	2	0	2	0	0	0	0	0	0	1	8	5	14	8	5	8	9	5	3	0	0	0	5	5
CP_b 28	4	4	0	1	1	0	0	2	0	2	6	6	3	16	61	26	39	4	17	6	17	5	1	2	11
CP_b 29	5	3	5	6	2	1	3	3	0	7	9	20	0	44	29	63	43	23	130	40	10	16	1	12	21
NC	12	2	2	1	5	3	0	8	4	2	4	9	1	2	1	8	6	3	22	11	8	4	3	8	14

Table 4 Contingency table of two CPs classifications 1960–1995 (CP_a – Czech classification, CP_b – Maheras classification (Greece), NC – non-classified days)

	CP_a 1	CP_a 2	CP_a 3	CP_a 4	CP_a 5	CP_a 6	CP_a 7	CP_a 8	CP_a 9	CP_a 10	CP_a 11	CP_a 12	CP_a 13	CP_a 14	CP_a 15	CP_a 16	CP_a 17	CP_a 18	CP_a 19	CP_a 20	CP_a 21	CP_a 22	CP_a 23	CP_a 24	CP_a 25
CP_b 1	93	2	114	33	37	49	9	15	26	10	32	3	1	4	6	8	5	15	10	10	14	2	12	189	71
CP_b 2	51	4	23	40	4	1	1	5	21	18	47	36	50	73	41	53	26	59	44	29	6	11	10	122	42
CP_b 3	78	8	28	28	31	7	14	9	4	5	3	3	1	7	4	68	19	51	14	20	17	3	3	28	25
CP_b 4	93	9	15	6	6	3	2	8	2	4	1	0	0	7	4	26	14	15	18	6	16	12	0	11	13
CP_b 5	11	13	1	0	4	1	3	3	1	3	2	9	3	9	13	25	29	1	40	14	1	9	1	0	4
CP_b 6	58	43	1	11	11	1	13	13	10	16	4	7	2	2	3	24	30	3	44	37	30	25	6	4	14
CP_b 7	11	18	2	0	3	3	17	6	8	35	31	22	10	0	8	3	7	2	16	6	5	6	3	2	10
CP_b 8	74	50	3	4	91	2	72	40	22	51	42	28	15	2	9	19	13	3	96	70	35	21	5	17	38
CP_b 9	95	47	19	16	107	14	53	55	33	15	10	3	3	0	2	7	5	1	38	36	18	6	2	21	49
CP_b 10	17	26	13	1	20	9	27	94	23	94	24	109	2	11	10	21	57	1	308	44	7	115	18	4	28
CP_b 11	25	8	5	2	30	5	18	30	14	35	24	13	2	1	1	13	4	5	42	17	2	16	4	9	29
CP_b 12	43	3	15	6	61	6	17	25	14	4	2	1	0	2	4	7	0	7	16	6	12	1	3	21	43
CP_b 13	27	0	19	0	7	11	11	7	14	22	57	7	35	6	0	13	1	18	13	6	12	0	4	67	35
CP_b 14	47	17	14	68	18	8	7	21	9	18	16	12	1	5	18	46	9	6	21	18	7	10	5	27	15
CP_b 15	189	33	24	72	66	33	31	89	42	43	28	45	12	37	70	157	126	25	171	120	52	72	25	31	62
NC	28	3	20	37	18	11	4	60	25	75	37	20	1	4	18	18	6	17	24	30	14	11	6	55	29

The zero hypothesis assumes that the two CPs classifications are independent on each other. In case that the computed c^2 value is greater than the critical one, the zero hypothesis is rejected and the classifications are assumed not to be independent. In order to express the strength of link between each pair of CPs classifications, the Pearson coefficient *C* and the Cramér coefficient *V* were computed (Hartung 1999). These coefficients which use the c^2 value as input range between 0 (no dependence) and 1 (absolute dependence) and are defined as follows:

$$C = \sqrt{\frac{\min(n,m)-1}{\min(n,m)}} \cdot \sqrt{\frac{\chi^2}{\chi^2+T}} \tag{2}$$

$$V = \sqrt{\frac{\chi^2}{T\ (\min(n,m))-1)}} \tag{3}$$

To estimate the possibility of making predictions the l-statistics (Guttman 1941) was introduced. The l_B coefficient compares the probability of the wrong prediction of classification *B* assuming classification *A* to be unknown with the probability of the wrong prediction of classification *B* assuming *A* to be known:

$$\lambda_B = \frac{\sum_i \max_j O_{ij} - \max_j q_j}{T - \max_j q_j} \tag{4}$$

Reversing the roles of *A* and *B* (predicting *A* with and without the knowledge of *B*) the formula looks as follows:

$$\lambda_A = \frac{\sum_j \max_i O_{ij} - \max_i p_i}{T - \max_i p_i} \tag{5}$$

Considering both l_A and l_B the l_{sym} is defined as:

$$\lambda_{sym} = \frac{\frac{1}{2}\left(\sum_i \max_i O_{ij} + \sum_j \max_j O_{ij}\right) - \frac{1}{2}\left(\max_j q_j + \max_i p_i\right)}{T - \frac{1}{2}\left(\max_j q_j + \max_i p_i\right)} \tag{6}$$

In order to test the significance of the parameter's mean values, their variances have to be defined by using the following relationships:

$$n^2 \cdot \sigma^2_{\chi^2} = 4\sum_i \sum_j \frac{n^3_{ij}}{n^2_{i.} n^2_{.j}} - 3\sum_i \frac{1}{n_{i.}} \left(\sum_j \frac{n^2_{ij}}{n_{i.} n_{.j}} \right)^2 - 3\sum_j \frac{1}{n_{.j}} \left(\sum_i \frac{n^2_{ij}}{n_{i.} n_{.j}} \right)^2 + 2\sum_i \sum_j \frac{n_{ij}}{n_{i.} n_{.j}} \left(\sum_k \frac{n^2_{kj}}{n_{k.} n_{.j}} \right) \left(\sum_l \frac{n^2_{il}}{n_{i.} n_{l}} \right), \tag{7}$$

$$\sigma^2_c = \frac{n^4 \cdot \min(r,s)}{(\min(r,s)-1) \cdot 4 \cdot \chi^2 (n+\chi^2)^3} \cdot n^2 \cdot \sigma^2_{\chi^2} \tag{8}$$

$$\sigma^2_V = \frac{1}{4(\min(r,s)-1) \cdot V^2} \cdot n^2 \cdot \sigma^2_{\chi^2} \tag{9}$$

$$\sigma^2_{\lambda A} = \frac{\left(n - \sum_j \max_i n_{ij} \right) \left(\sum_j \max_i n_{i.} + \max_i n_{i.} - 2 \cdot \sum_j{}^* \max_i n_{ij} \right)}{\left(n - \max_i n_{i.} \right)^3} \tag{10}$$

$$\sigma^2_{\lambda B} = \frac{\left(n - \sum_i \max_j n_{ij} \right) \left(\sum_i \max_j n_{ij} + \max_j n_{.j} - 2 \cdot \sum_i{}^* \max_j n_{ij} \right)}{\left(n - \max_j n_{.j} \right)^3} \tag{11}$$

where $\sum_i{}^*$ denotes the summation over the columns, in which $\max_i n_{ij}$ occurs in the same row as $\max_i n_{i.}$

As the distribution of the each parameter is unknown, the significance is tested by means of the Cebysev's inequality:

$$P(|X - EX \geq k\sigma| \leq \frac{1}{k^2} \tag{11}$$

where X ... random variable

EX ... expectation

σ ... standard deviation of the parameter's mean value

k ... number (multiplicator of the standard deviation)

From the inequality equation follows that the probability that a mean value is equal or greater than k times its standard deviation s is lower or equal $1/k^2$. As a critical value the ratio $R = \frac{X - EX}{\sigma} = 4$ was chosen where $EX = 0$. When $R > 4$ than it is assumed that the tested parameter is significantly different from 0 (in this case the probability that it is 0 equals $1/4^2 = 0.0625$).

4. Results

4.1 Period 1965–1990

In order to ensure the same time span for comparison of each pair of CP classifications, the period 1965–1990 was selected. The results are summarized in Table 5.

Table 5 Statistical parameters reflecting the relationships between the Czech CP classification and other regional European CP classifications (1965–1990)

	Czech Republic, Brádka et al. (1961)				
	Pearson coefficient C	Cramér coefficient V	l_A	l_B	l_{symm}
British Isles, Lamb (1972)	0.667	0.176	0.133	0.089	0.110
Germany, Hess-Brezowsky (1969)	0.865	0.326	0.179	0.240	0.210
Greece, Maheras (1988)	0.668	0.226	0.111	0.080	0.095

The strongest dependence of the Czech classification exists on the Hess-Brezowsky classification (C = 0.865, V = 0.326). The reason is probably that a) both regions (Czech Republic and Germany) have the closest position, b) the methodology of the Czech CP classification was done with the help of Hess-Brezowsky classification. The link to the Greek classification is comparable (C = 0.668) or even stronger (V = 0.226) than to the classification for the British Isles (C = 0.667, V = 0.176).

Regarding the predictability (l_A, l_B, l_{sym}) of one classification from another, the best possibility exists again when considering the Hess-Brezowsky classification. Predictions between the Czech classification and the British Isles classification would be more reliable than between the Czech and Greek classifications.

The significance of parameters was tested by means of Cebysev's inequality (see part 3). The ratios between parameter's value and its standard deviation are shown in Table 6. The table shows that all ratios are greater than 4 and therefore the coefficients

Table 6 Test of parameter's significance (in the table there are ratios between parameter's values and their standard deviations), 1965–1990.

	Czech Republic, Brádka et al. (1961)			
	Pearson coefficient C	Cramér coefficient V	l_A	l_B
British Isles, Lamb (1972)	126.73	14.79	22.64	19.68
Germany, Hess-Brezowsky (1969)	311.94	17.99	33.34	44.51
Greece, Maheras (1988)	116.17	18.11	17.43	16.561

can be considered to be significantly different from zero, so the classifications can not be considered to be independent.

4.2 Time variations of the CPs relationsips

The time variations of the relationship between the Czech classification and other classifications were investigated by means of 11-year moving window. It means that every statistical parameter was computed for time period having 11 years and the result was assigned to the year in the middle of this period. Results are given in Figure 3. It is obvious that the closest relationship and the best possibility of predictability exists between the Czech and Hess-Brezowsky classifications during the whole investigated period. Both the lines for the British Isles and Greek classifications are comparable with the exception of Cramér coefficient (V). Based on the course of V it can be concluded that the Greek classification scheme is more closely related to the Czech classification than in the case of the British Isles scheme.

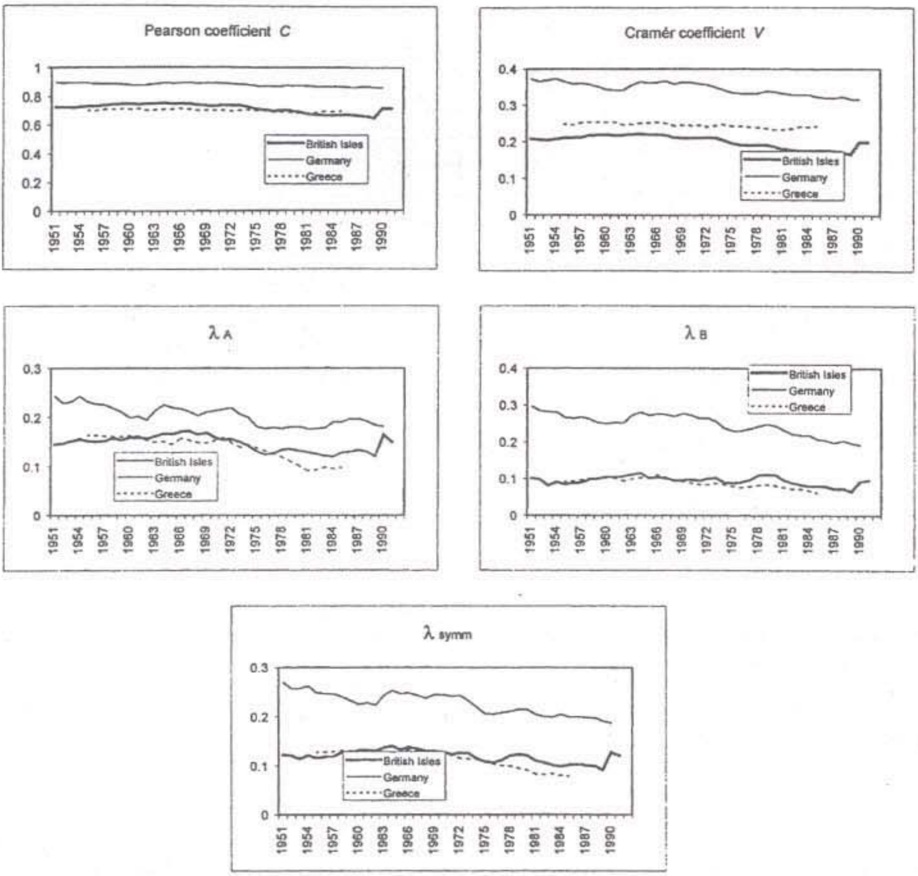

Fig. 3 Time variations of statistical parameters reflecting the relationships among different circulation pattern classification schemes

Except of the Pearson coefficient (*C*) all other coefficients reveal a slowly decreasing trend. All coefficient's courses for the British Isles classification are characterized by an increase in the end of 1980'ies and 1990'ies.

5. Discussion and conclusions

In this paper the dependence between the subjective Czech CP classification and three other subjective classification schemes (for the British Isles, Germany and Greece respectively) was studied. The motivation of the research was an investigation of the strength and the significance of the links and the possibilities of making predictions of one classification from another. The significance of dependence of all three pairs as well as the predictability possibilities were proved by means of a lot of statistical tests. From this findings follows that the CP classifications under study can not be considered to be independent on each other.

The comparison was done for the period 1965–1990. It is quite surprising to find that the links of the Czech classification to the Greek and the British Isles classifications respectively are at the same range. One would rather expect that the Czech classification would be much closer to the British one because the weather in central Europe is mostly influenced by the transport of air masses from west to east.

The time variations between the classifications were also investigated by means of 11 year moving window. The decreasing trend of most coefficients could be assigned to the increasing variability of weather conditions over Europe. This increasing variability is very often referred to be caused by changes in atmospheric dynamics at a global scale. Another explanation could be a gradual change in methodology connected with the subjective character of classifications. In order to confirm or exclude this hypothesis the relationship among various objective classification schemes have to be investigated in future research.

In the next step the relationships among all pairs of CP classifications will be taken into account – in other words, not only the dependence of the Czech CP classification on other classifications will be studied but also the dependence of the other classifications on each other. It will be also interesting to compare subjective and objective classification schemes for the same region. For example the Lamb classification for the British Isles is approximated by the objective classification based on physical quantities (Jenkinson and Collison 1977). Dittman et al. (1995) developed an objective CP classification scheme for the German region. The objective optimized fuzzy rules based method of Bárdossy et al. (2002) was applied for Germany and Greece.

When the findings regarding the interdependence of different classification schemes will be confirmed also after including the objective schemes mentioned in the last paragraph, it could be a motivation for establishing one European objective CP classification instead of a lot of local ones. The objective of the classification could be an explanation of variability of surface climate (e.g. precipitation, temperature) at defined locations spread over the Europe. The loss of explanation of variability due to the large scale should be minimised (also because of interdependence of regional classification schemes).

References

BÁRDOSSY A., DUCKSTEIN L., BOGÁRDI I. (1995): Fuzzy rule – based classification of atmospheric circulation patterns. International Journal of Climatology 15, pp. 1087–1097.

BÁRDOSSY, A., STEHLÍK, J., CASPARY, H.-J. (2001): Automated optimized fuzzy rule based circulation pattern classification for precipitation and temperature downscaling. Climate Research, in press.

BAUR, F., HESS, P., NAGEL, H. (1944): Kalendar der Grosswetterlagen Europas 1881–1939. Bad Homburg.

BOGÁRDI, I., MATYASOVSZKY, I., BÁRDOSSY, A., DUCKSTEIN, L. (1994): A hydroclimatological model of areal drought. Journal of Hydrology 153, pp. 245–264.

BRÁDKA, J., DŘEVIKOVSKÝ, A., GREGOR, Z., KOLESÁR, J. (1961): Počasí na území Čech a Moravy v typických povětrnostních situacích. HMÚ, Praha.

Catalogue of weather types for Czechoslowakia (1968): Synoptical and air service of the Hydrometeorological institute.

CAWLEY, G. C., DORLING, S. R. (1996): Reproducing a subjective classification scheme for atmospheric circulation patterns over the United Kingdom using a neural network. In: Proceedings of the International Conference on Artificial Neural Networks (ICANN–96), pp. 281–286.

DITTMAN, E., BARTH, S., LANG, J., MÜLLER-WESTENMEIER, G. (1995): Objektive Wetterlagenklassifikation. Berichte des Deutschen Wetterdienstes, 197.

DZERDZEEVSKII, B. L. (1968): Circulation of the atmosphere: northern hemisphere circulation mechanisms in the twentieth century. Institute for Geography, Soviet Academy of Sciences, Moscow.

DZERDZEEVSKII, B. L. (1970): Circulation of the atmosphere: circulation mechanisms in the atmosphere of the northern hemisphere in the twentieth century. (Statistical data for the entire hemisphere and for its six sectors.) Institute for Geography, Soviet Academy of Sciences, Moscow.

ELLIOTT, R. D. (1949): The weather types of N. America. Weatherwise, 2, pp. 15–18, 40–43, 64–67, 86–88, 110–113, 136–138.

GOODESS, C. M. (2000): Links between circulation and changes in the characteristics of Spanish precipitation. Submitted to International Journal of Climatology.

GOODESS, C. M., PALUTIKOF, J. P. (1998): Development of daily rainfall scenarios for southeast Spain using a circulation-type approach to downscaling. Iternational Journal of Climatology, 18, pp. 1051–1083.

GUTTMAN, L. (1941): An outline of the statistical theory of prediction. Supplementary Study B-1. In: Horst, P. (ed): The prediction of personal adjustment. Bulletin 48, Social Science Research Council, New York, pp. 253–318.

HARTUNG, J., BÄRBEL, E., KLÖSENER, K. H. (1999): Statistik. R. Oldenbourg Verlag, München.

HESS, P., BREZOWSKY, H. (1969): Katalog der Großwetterlagen Europas. 2. Neu bearbaitete und ergänzte Aufl. Berichte des Deutschen Wetterdienstes 113, Selbstverlag des DWD, Offenbach a. Main.

JENKINSON, A. F., COLLISON, F. P. (1977): An initial climatology of gales over the North Sea. Synoptic Climatology Branch Memorandum, No. 62, Meteorological Office, Bracknell

KRICK, I. P. (1943): Synoptic Weather Types of North America. Calif. Inst. of Techn., Pasadena, CA.

LAMB, H. H. (1972): British Isles weather types and a register of daily sequence of circulation patterns, 1861–1971. Geophys. Mem. 110, Meteor. Office, London.

MAHERAS, P. (1988): The synoptic weather types and objective delimitation of the winter period in Greece. Weather 43, pp. 40–45.

WILSON, L. L., LETTENMAIER, D. P., SKYLLINGSTAD, E. (1992): A hierarchical stochastic model of large scale atmospheric circulation patterns and multiple station daily rainfall. Journal of Geophysical Research, 97, ND3, pp. 2791–2809.

YARNAL, B. (1984): A procedure for the classification of synoptic weather maps from gridded atmospheric surface pressure data. Comput Geosci, 10, pp. 394–410.

YARNAL, B. (1993): Synoptic Climatology in Environmental Analysis. Studies in Climatology Series, Belhaven Press, London.

SOUVISLOSTI MEZI TYPIZACEMI POČASÍ:
VZTAHY MEZI ČESKOU KLASIFIKACÍ POVĚTRNOSTNÍCH SITUACÍ
A NĚKTERÝMI EVROPSKÝMI KLASIFIKAČNÍMI SCHÉMATY

Résumé

Za účelem typizace počasí v denním kroku byly v minulosti v různých geografických oblastech vypracovány metody klasifikace povětrnostních situací. Povětrnostní situace je obvykle definována jako průměrné rozložení tlaku vzduchu nad evropským kontinentem a přilehlou západní částí Atlantického oceánu, které způsobuje typické počasí v regionu, pro který byla klasifikace vypracována.

V předložené práci je studována závislost mezi klasifikací povětrnostních situací platnou pro území České republiky (Brádka et al. 1961) a třemi systémy, které jsou používány v jiných geografických oblastech: v prostoru Britských ostrovů (Lamb 1972), v Německu (Baur et al. 1944, Hess a Brezowsky 1969) a v Řecku (Maheras 1989). Cílem výzkumu je vyšetřování stupně závislostí mezi českou klasifikací a ostatními klasifikacemi, jejich statistickou významností a možnostmi vzájemné předpověditelnosti. Statistická významnost závislostí a předpověditelnost byla prokázána několika testy. Z výsledků vyplývá, že klasifikace není možné považovat za vzájemně nezávislé.

Testování bylo provedeno pro jednotné období 1965–1990. Je zajímavé, že závislost mezi českou a britskou klasifikací je přibližně stejně vysoká jako závislost mezi klasifikací českou a řeckou. Spíše by bylo možné očekávat větší stupeň příbuznosti mezi českou a britskou klasifikací, jelikož počasí ve střední Evropě je převážně ovlivňováno transportem vzduchových hmot ze západních směrů.

Časový průběh závislostí byl vyšetřován pomocí jedenáctiletého klouzavého průměru. Jako přirozená interpretace klesajícího trendu většiny statistických koeficientů se nabízí vzrůstající proměnlivost počasí. Ta je často považována za jeden z důsledků změn v dynamice proudění atmosféry souvisejících s klimatickou změnou. Jiným možným vysvětlením jsou změny v metodologii v rámci některé (některých) ze zkoumaných klasifikací spočívající právě v jejich subjektivitě. K objasnění příčin klesajícího trendu by měly přispět plánované analýzy závislostí zahrnující i objektivní klasifikace.

Pokud by se potvrdila vysoká míra závislosti mezi klasifikacemi i pro více párů klasifikací (včetně klasifikací objektivních), bylo by možné uvažovat o vytvoření objektivní klasifikace typizující počasí v různých lokalitách v rámci kontinentálního měřítka.