Selected agroclimatic characteristics of climatic regions of the Czech Republic

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Abstract: The current division of the Czech Republic into climatic regions was carried out according to basic criteria which meet the assumption of similar conditions for growth and development of agricultural crops. Ten climatic regions in the Czech Republic were labelled with numbers 0 (VT, very hot) to 9 (CH, cold). In this paper we have utilized selected agro-climatic characteristics for these climatic regions, which were not considered in the original classification. Evaluation was performed according to the daily interval of agro-meteorological model AVISO with the use of technical series of meteorological elements of a regular network of 789 grid points (10×10 km) for the period of 1961–2010.

Key words: climatic region, evaporation, potential evapotranspiration, moisture balance, AVISO

1. Introduction

In the years of 1973–1980, definition of the economic performance of potential soil units (BPEJ) was carried out as the logical outcome of a completed project "Comprehensive survey of soils in the Czech Republic". Following the purpose and conditions of the realization of the survey, parameters defining the achievable accuracy of BPEJ were determined, which were later included in the second edition of the methodology in 1974 *(Mašát, 1974)*. In the conclusion of the evaluation paper, ten climatic regions were defined in the Czech Republic, based on selected criteria (sum of average daily air temperatures $\geq 10\,°\mathrm{C}$, average annual air temperature during the growing period, the average rainfall per year, consumptive water security and the likelihood of occurrence of dry vegetation periods). Processing of the data was performed for the period of 1901–1950. The overview of the selected criteria implies that for the purposes of the classification of the climatic

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regions of the Czech Republic only selected climatic elements were used and factors such as evaporation and evapotranspiration were therefore omitted especially in regards to moisture conditions in the landscape environment with the emphasis on the upper soil horizon, which would be very important particularly in relation to agriculture. Humidity of soil is, therefore, an important characteristic for soil fertility as it expresses the availability of water to plants and agricultural crops.

2. Material a methods

This paper presents the characteristics of evapotranspiration potential of graminaceous areas (hereinafter referred to as PEVA_GL) and (basic) potential water balance of soil of grassland (hereinafter referred to as PWBAL_GL) for the period of 1961–2010 with the regard to the current climate regions in the country. PEVA_GL calculation was implemented in the daily interval with the use of a modified method of calculation according to Penman-Monteith's methodology. By a characteristic of PWBAL_GL we understand the simple difference of precipitation and PEVA_GL. Basically it is a balance of climate, when the actual amount of water in the upper soil horizon is not taken into consideration. Both values are presented in mm for better comparison. Complete processing in daily interval was performed based on the technical series of basic meteorological elements for a set of 789 grid points of a regular network 10×10 km *(Štěpánek et al., 2009; Štěpánek et al., 2011).* For the purposes of the entire calculation, AVISO ("Agrometeorological Computing and Information System"), was used, which was operated in an operational regime by CHMI, branch Brno *(Kohut and Vitoslavský, 1999; Kohut, 2007).* AVISO is basically analogous to the English system MORECS ("The **M**eteorological **O**ffice for **R**ainfall and **E**vaporation **C**alculation **S**ystem"), see *Hough et al. (1997)* and *Thompson et al. (1981).* Both models are based on the combined Penman-Montei's equation for the calculation of evapotranspiration in a modified manner. The input meteorological data are "penmannic" variables (temperature and humidity in the form of water vapour, sunshine duration, wind speed and precipitation).

The grid points are further divided according to the current classification of climatic regions. For each of the regions, we elaborated not only the basic statistical evaluation but also long-term average values and PEVA_GL and PWBAL_GL (1961–2010) expressed in mm for each individual year, standard growing season, summer season, and individual months. The number of grid points with the average altitude for particular climatic regions is as follows:

- Climatic region CR_0 (VT) 28 199.3 m a.s.l.
- Climatic region CR_1 (T 1) 30 244.7 m a.s.l.
- Climatic region CR_2 (T 2) 39 271.2 m a.s.l.
- Climatic region CR_3 (T 3) 84 270.0 m a.s.l.
- Climatic region CR_4 (MT 1) 41 384.0 m a.s.l.
- Climatic region CR_5 (MT 2) 164 408.3 m a.s.l.
- Climatic region CR_6 (MT 3) 32 321.3 m a.s.l.
- Climatic region CR_7 (MT 4) 196 493.2 m a.s.l.
- Climatic region CR_8 (MCh) 107 591.8 m a.s.l.
- Climatic region CR_9 (Ch) 68 779.4 m a.s.l.

All the following graphs clearly document the differences between the climatic regions. As opposed to the original classification, we use the shortcuts CR_0, CR_1 ... CR_8, CR_9 for the individual climatic regions.

3. Results and discussion

Potential evapotranspiration of grassland was determined as the first agro-meteorological characteristics. Figure 1 shows its long-term average values for a year, summer season and growing season (1961–2010) in the climatic regions.

The graph shows the expected trend of significant decrease in PEVA_GL with increasing altitude. In the long run, it is typical for all the analyzed periods. The highest long-term total values of PEVA_GL were measured in the very hot and dry region CR_0 (VT), while the lowest values were observed in the cold region CR_9 (Ch). The values varied at intervals from 487.8 to 713.6 mm (year), from 400.0 to 576.9 mm (growing season) and from 239.5 to 334.7 mm (summer season).

Graphs in Fig. 2 present the long-term monthly values of PEVA_GL of the individual climatic regions and their comparison with the long-term

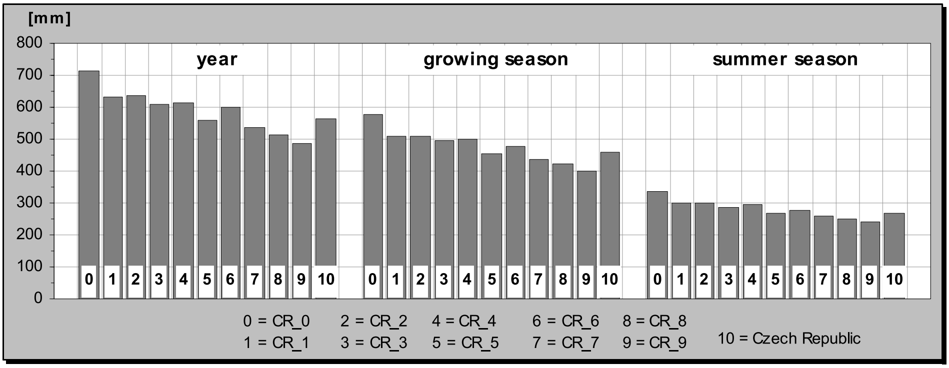

Fig. 1. Climatic regions and the Czech Republic, long-term potential evapotranspiration of grassland (1961–2010) in the individual periods [mm].

totals calculated from all grid points for the whole territory of the Czech Republic. Long-term PEVA_GL distribution is very similar in all climatic regions with the highest totals in the summer months (especially in July) and lowest in winter (especially in January). The summer months exhibit the largest relative differences between individual climatic regions, and thus the highest variability, as opposed to the winter months with the smallest variation.

Graphs in Fig. 3 show the time series of annual totals of PEVA_GL including the linear trends in the development of the Czech Republic as a whole. Annual totals in climatic regions, calculated as the average of all the grid points are shown in Fig. 3 in graphs a) and b). The last graph in Fig. 3 shows the totals for the year, growing season, and the summer period, calculated as the average of all 789 grid points located in the Czech Republic.

Annual totals of PEVA_GL calculated for the hottest (VT) and the coldest (Ch) climatic region as the average of the grid points ranged from 606.3 mm (year 1965) to 843.9 mm (year 1992) in CR_0 region (VT) and 423.3 mm (year 1980) to 584.2 mm (2003) in CR_9 region (Ch). For the Czech Republic as a whole the interval of 485.6 mm (year 1965) to 672.0 mm (2003) was calculated. According to the linear trend, the annual totals for the Czech Republic demonstrated a slight increase in PEVA_GL, it is more significant in the warmer and lower climatic regions, though.

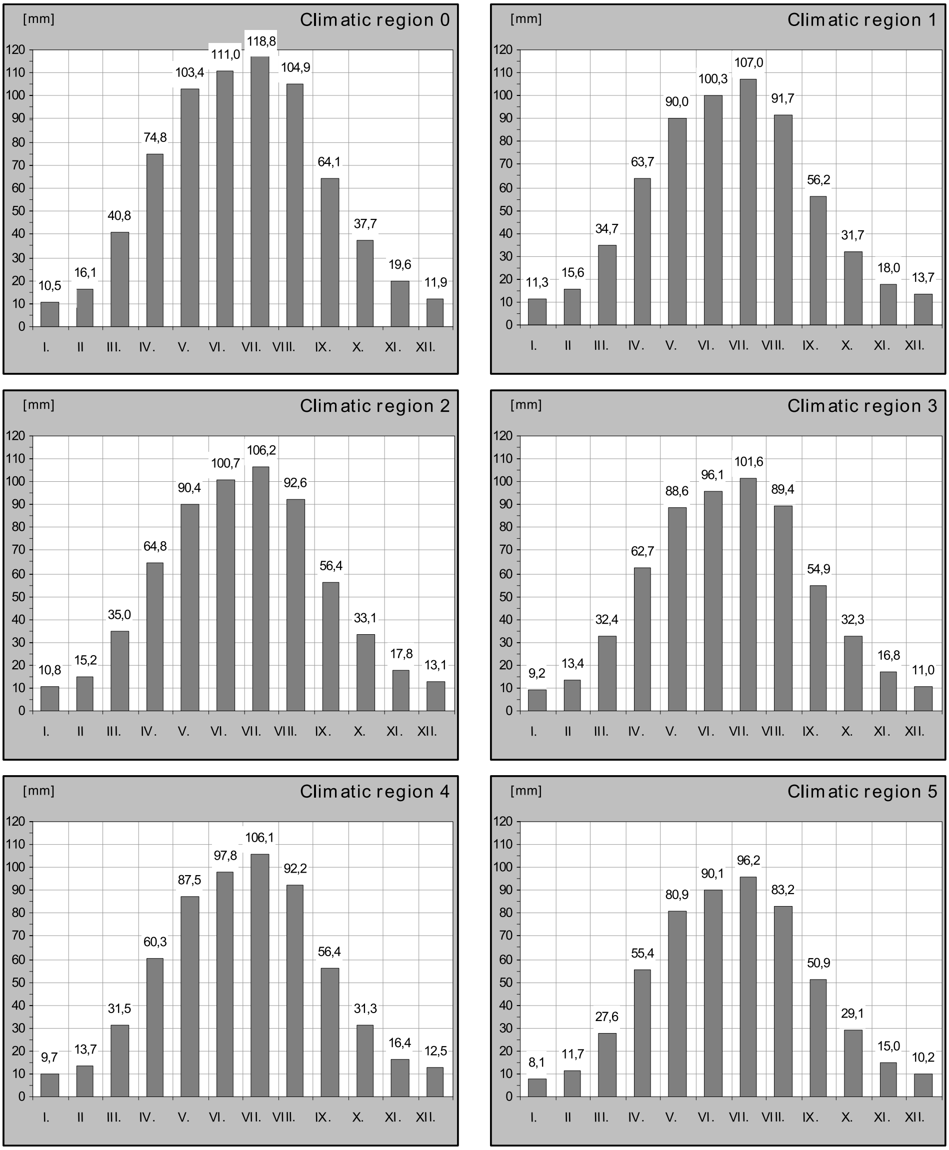

Fig. 2. Climatic regions and the Czech Republic, long-term potential evapotranspiration of grassland (1961–2010) in mm.

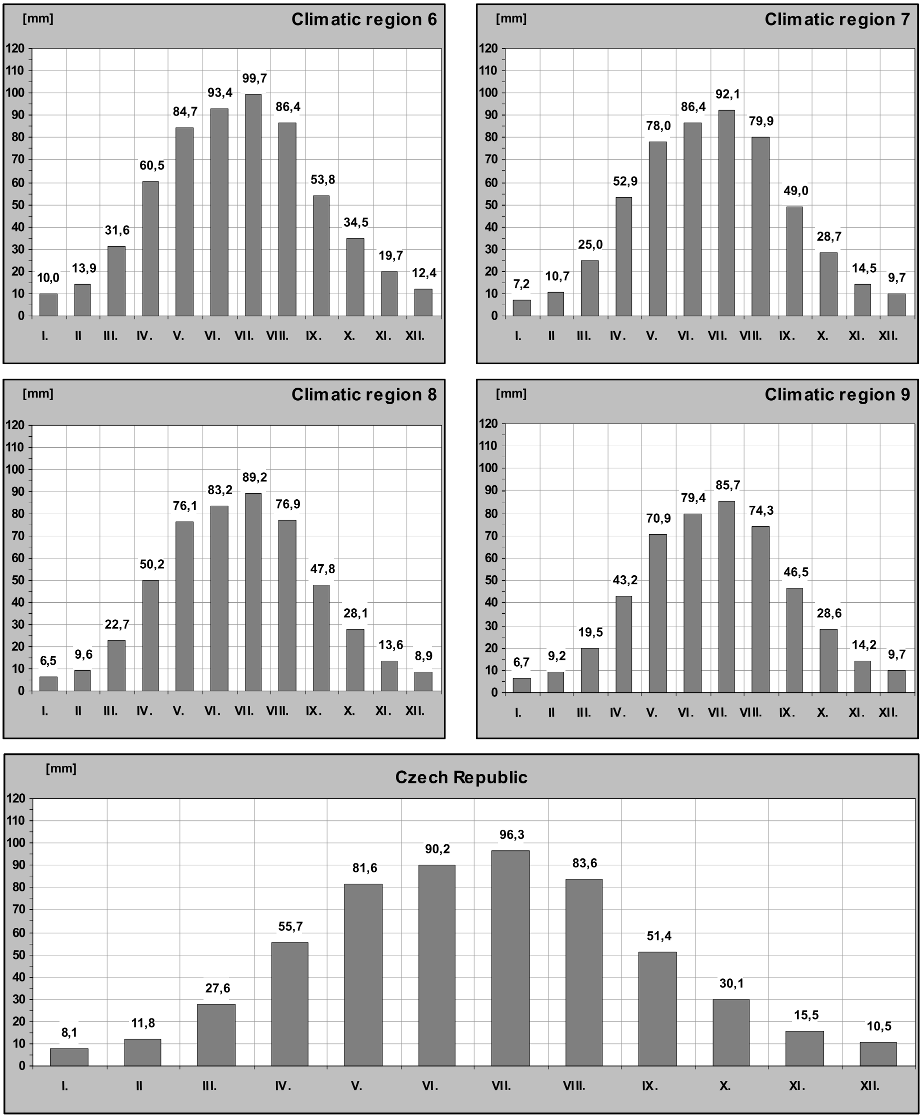

Fig. 2. Continuation.

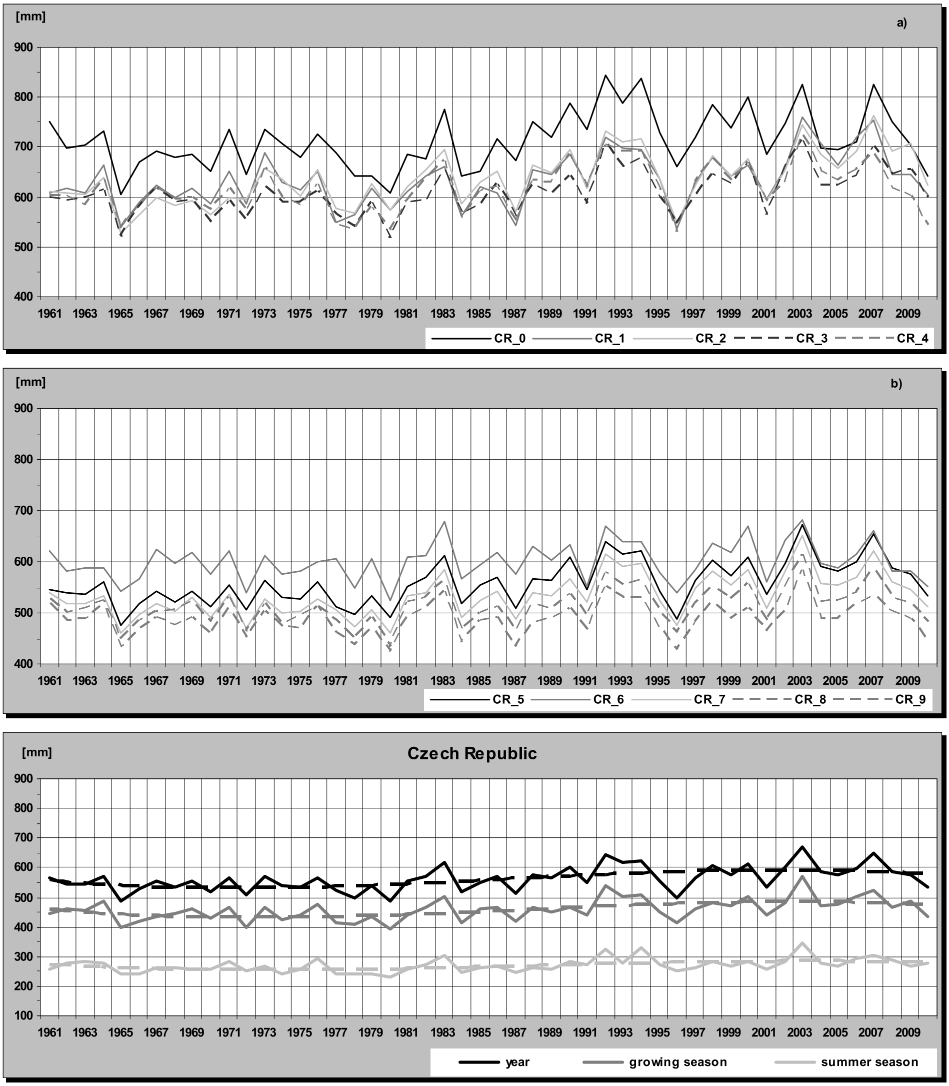

Fig. 3. Climatic regions and the Czech Republic, time series estimates of average annual potential evapotranspiration (1961–2010) in mm.

Potential (basic) soil moisture balance of grassland (PWBAL_GL) was determined as the second agro-meteorological characteristics.

Figure 4 shows the long-term average values of PWBAL_GL for individual climatic regions for a year, summer season and growing season (1961–2010). The graph below shows the expected trend of increasing moisture conditions in the landscape environment with increasing altitude. In the long run, it is typical for all the analyzed periods. The lowest long-term values (the least favourable moisture situation with prevailing evapotranspiration over rainfall) were observed in the very hot and dry region CR_0 (VT), while the highest values (the most favourable humidity conditions with a predominance of precipitation over evapotranspiration) were measured in the cold region CR_9 (Ch). The values varied in the range of −201.6 to 480.3 mm (year), −250.4 to 136.7 mm (growing season) and −143.9 to 75.5 mm (summer).

Graphs in Fig. 5 compare the long-term monthly totals of PWBAL_GL in individual climate regions with the long-term retrospective totals calculated from the 789 grid points across the country. Distribution of PWBAL_GL within one year differs in each individual climatic region and significantly depends on the altitude. Warm and rather dry regions located in places with lower altitude are generally characterized by significant negative water balance during the summer months (especially July and August), possibly in spring and autumn months. Colder regions with significantly richer

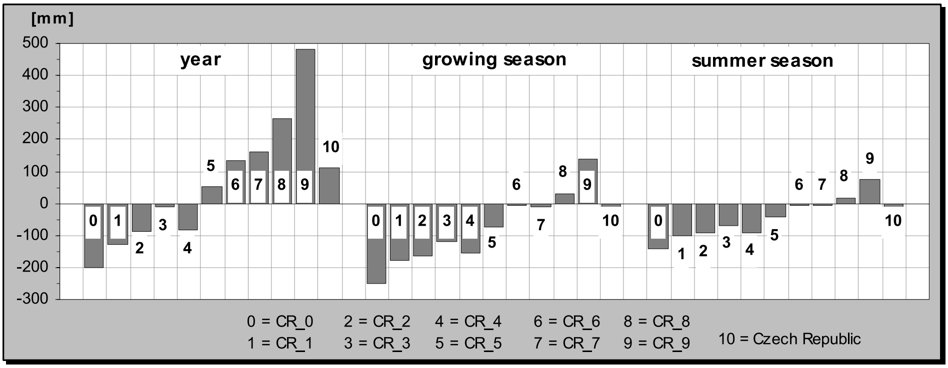

Fig. 4. Climatic regions and the Czech Republic, long-term potential soil moisture balance of grassland (1961–2010) in individual time periods in mm.

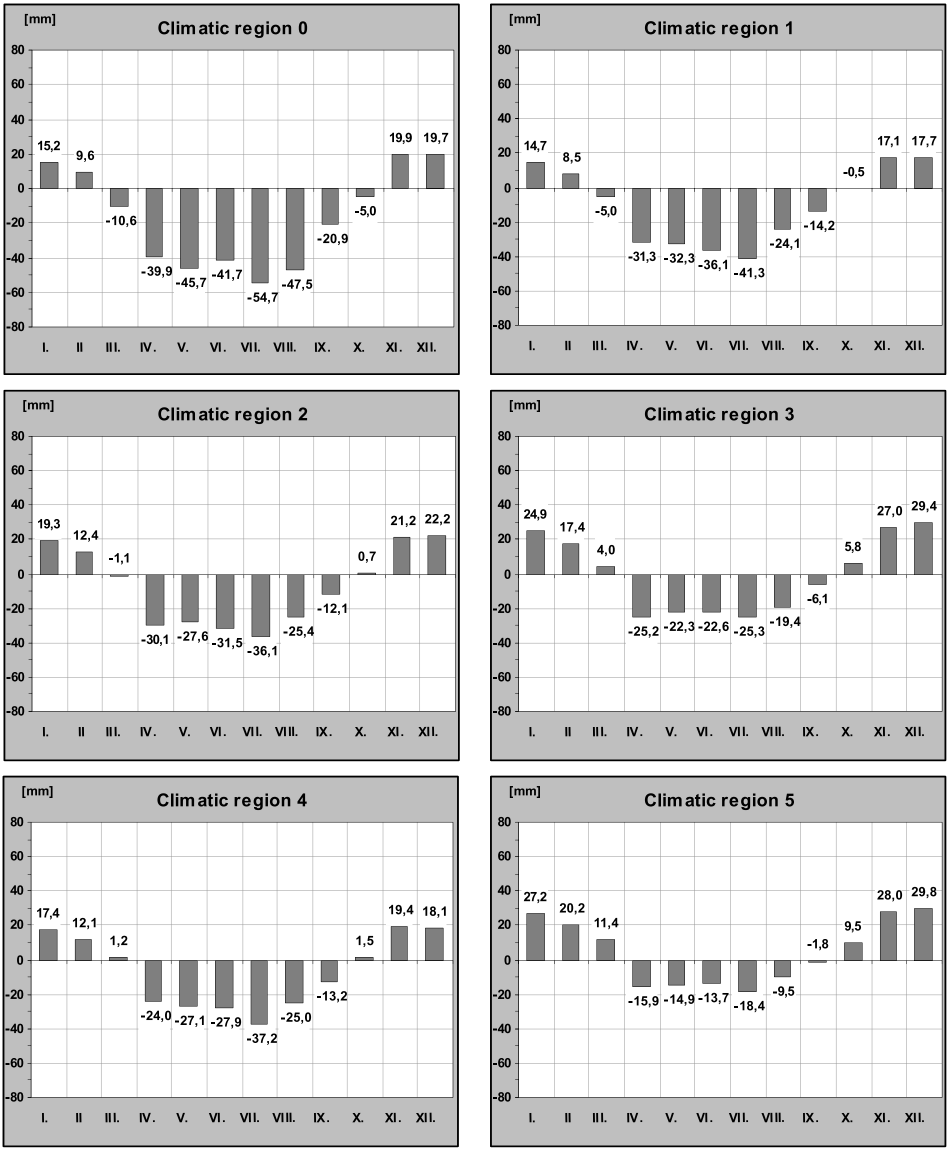

Fig. 5. Climatic regions and the Czech Republic, potential long-term monthly (basic) soil moisture balance of grassland (1961–2010) in mm.

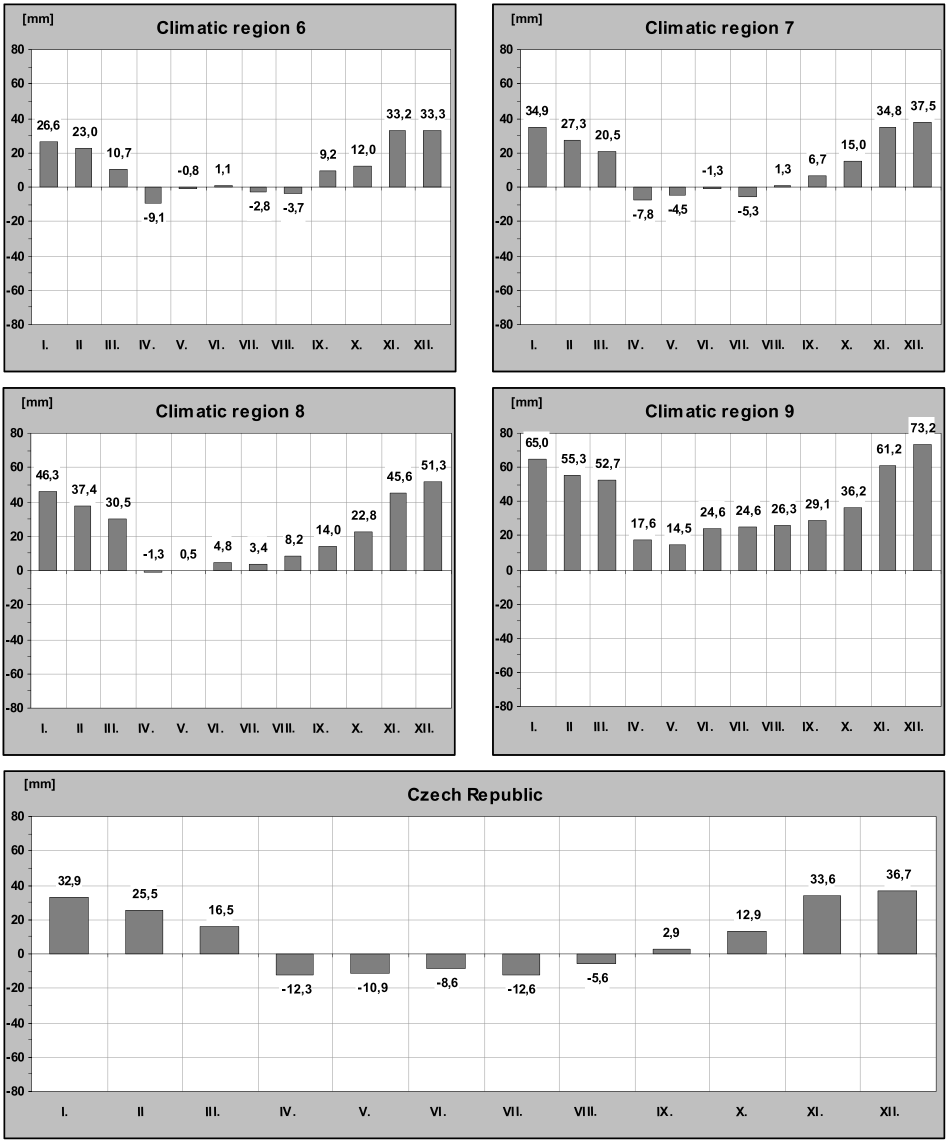

Fig. 5. Continuation.

precipitation located at higher places are characterized by predominantly positive water balance. Starting with CR_6 region (MT 3), rather positive moisture balance is already prevalent within the monthly balancing. The coldest and highest region CR_9 (Ch) is characterized by a positive moisture balance typical for each month, which is most pronounced in winter months or transitional periods. Practically the same can be said of the cold region CR_8 (MCh).

Time series of annual totals of PWBAL_GL including their linear trends of development in the Czech Republic as a whole are shown in the graphs in Fig. 6. Annual balance totals in climatic regions, calculated as the average of all grid points, can be seen in Fig. 6 in the graphs a) and b).

The last graph in Fig. 6 shows PWBAL_GL totals for the individual year, growing season and summer season calculated as the average of all 789 grid points in the Czech Republic. Annual totals of PWBAL_GL calculated for selected regions as the average of the climatological stations ranged from −442.7 mm (year 2003) to 89.4 mm (year 2010) in region CR_0 (VT) and 169.9 mm (2003) to 749.7 mm (2002) in region CR_9 (Ch). The Czech Republic as a whole reached interval ranging from −169.2 mm (2003) to 343.7 mm (2010). Considering the linear trend for the Czech Republic, no increasing or decreasing trend has been found. In case of regions with colder temperatures and richer precipitation at higher altitudes, a slight increase of PWBAL_GL was measured, while warmer regions with poorer precipitation and lower altitude are characterized by a very slight decrease in annual totals of PWBAL_GL.

4. Conclusion

In this contribution we aimed at evaluating selected agro-climatic characteristics (Potential evapotranspiration of grassland and Potential (basic) soil moisture balance of grassland) in connection with the current division of the Czech Republic into climatic regions. Both characteristics presented were processed with the use of AVISO model in daily intervals for the period of 1961–2010, through the use of technical series of basic meteorological elements in a regular grid network 10×10 km. Each climatic region is represented by the average value calculated from the respective grid points for

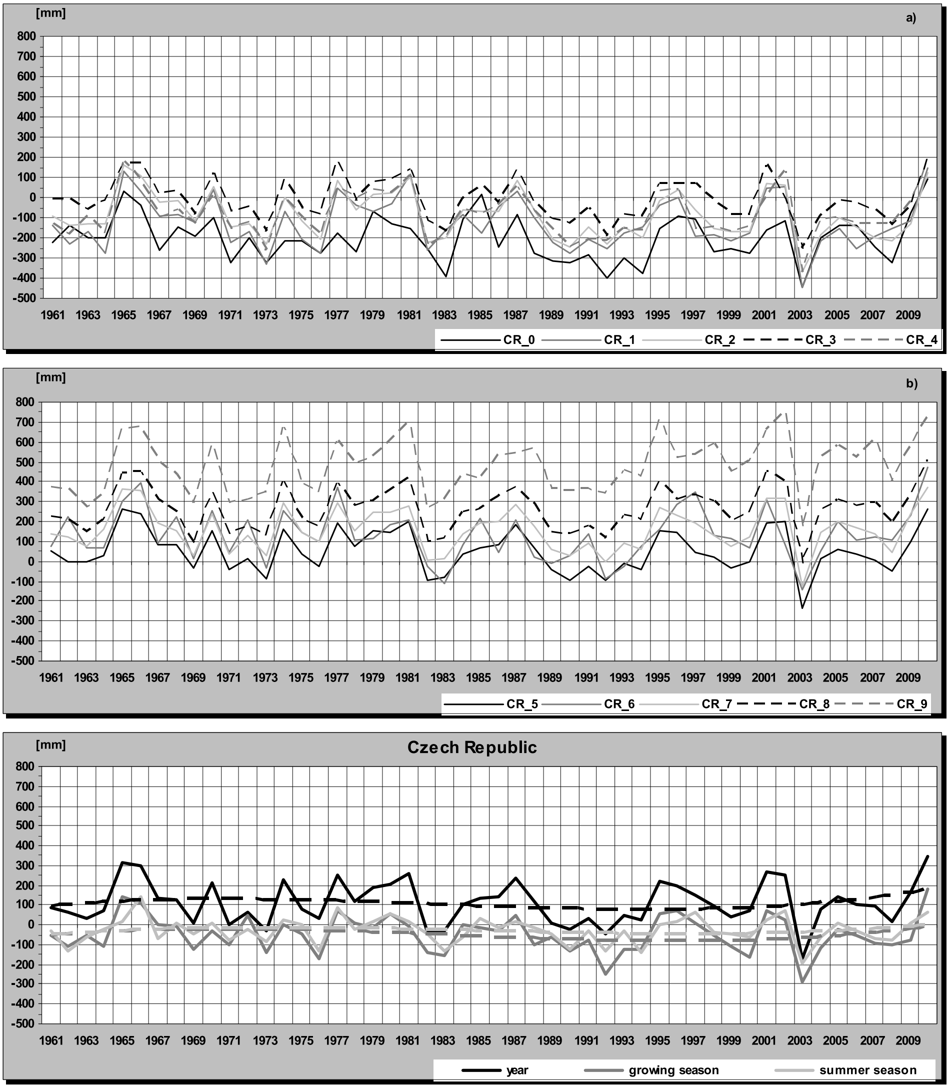

Fig. 6. Climatic regions and the Czech Republic, time series of average annual totals of potential soil water balance of grassland (1961–2010) in mm.

the selected time period (year, growing seasons, summer season, individual months). Based on the results calculated for each individual region, there was observed, demonstrated and quantified a decrease of PEVA_GL with increasing altitude and vice versa, and an increase of PWBAL_GL which improves the humidity conditions in the region.

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