III. METEOROLOGICAL AND DISPERSION CONDITIONS

Apart from emissions from respective air pollution sources, air quality is significantly affected by meteorological conditions. These conditions enable, or conversely prevent, the aerial dispersion of polluting substances, influence the amount of emissions from anthropogenic or natural sources, resuspension, and affect the formation of secondary pollutants as well as their removal rate from the air. The basic meteorological variables influencing the aerial dispersion of pollutants include air temperature, wind speed, precipitation, and vertical stability of the atmosphere. One of the ways in which dispersion conditions can be expressed numerically is in terms of the ventilation index (VI), which is defined as the product of the mixing layer depth and the average air flow velocity in it[1]. However, situations with poor dispersion conditions do not necessarily lead to the occurrence of high pollution concentrations. Important factors include the duration of the situation, the starting level of pollution, distribution of sources, and emissions to the layer under an inversion (Ferguson 2001, Škáchová 2020). The effect of meteorological conditions on anthropogenic emissions from heating is determined on the basis of a calculation of heating days and temperatures that occurred during these days. Temperature conditions in the heating season (January–May, September–December) or parts thereof are characterized in terms of degree-days, i.e., the sum of differences in reference indoor temperatures and average daily outdoor temperatures on heating days. A more detailed specification of the influence of meteorological conditions on air quality is given in (CHMI 2022d).

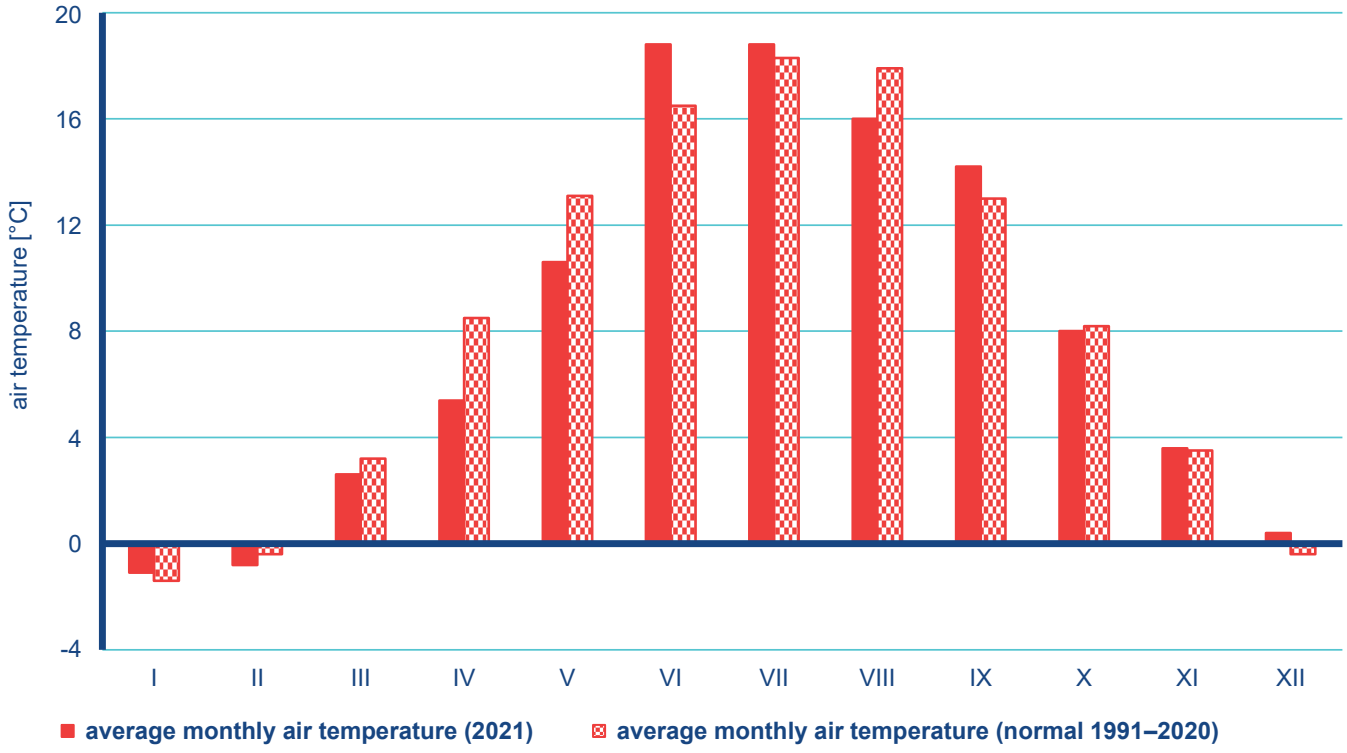

Fig. III.1 Average monthly air temperature in 2021 compared to the normal of 1991–2020

1 The mixing layer is understood as the layer of the atmosphere between the Earth's surface and the lower boundary of the lowest temperature retention layer.

Meteorological and dispersion conditions in 2021

In terms of temperature, the year 2021 was normal with the average annual temperature of 8.0 °C, being 0.3 °C below the normal of 1991–2020[2]. In the last 10 years (since 2011) only 2013 was colder with the average temperature of 7.9 °C. The previous three years were warmer by more than 1.0 °C with the average temperature of 9.1 °C (2020), 9.5 °C (2019) and 9.6 °C (2018). Majority of 2021 months were temperature normal compared to the 1991–2020 normal. However, the spring months of April and May were very cold, deviating from the normal by –3.1 °C and –2.5 °C and being rated as strongly below normal in terms of temperature. It was followed by strongly above normal June in terms of temperature (deviation +2.3 °C), which ranked as the third warmest June since 1961. August was assessed as below normal (deviation –1.9 °C) and September as above normal (deviation +1.2 °C) (Fig. III.1).

In view of precipitation over the territory of the Czech Republic (CR), the year 2021 was normal. The average total annual precipitation of 683 mm corresponds to 100 % of the normal of 1991–2020. The months of May (141 % of normal) and August (136 % of normal) were above normal. The autumn months of September and October were assessed as strongly below normal, with monthly precipitation totals being 38 % and 39 % of the normal. Other months of 2021 can be assessed as precipitation normal. However, the month of March was close to the limit of the normal and below-normal month in terms of precipitation,

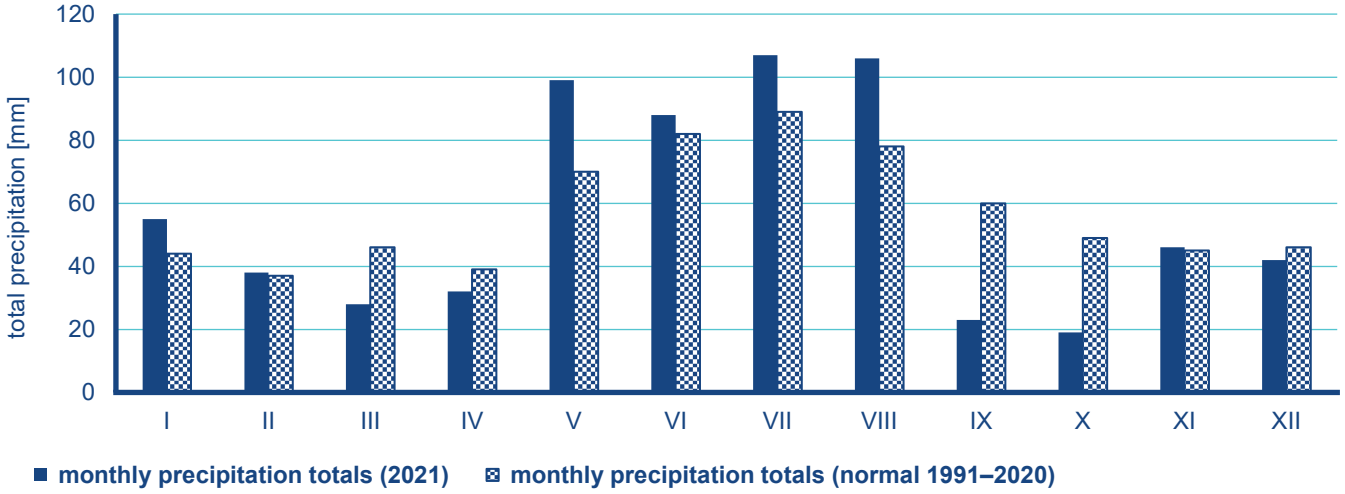

Fig. III.2 Monthly precipitation totals in 2021 compared to the normal of 1991–2020

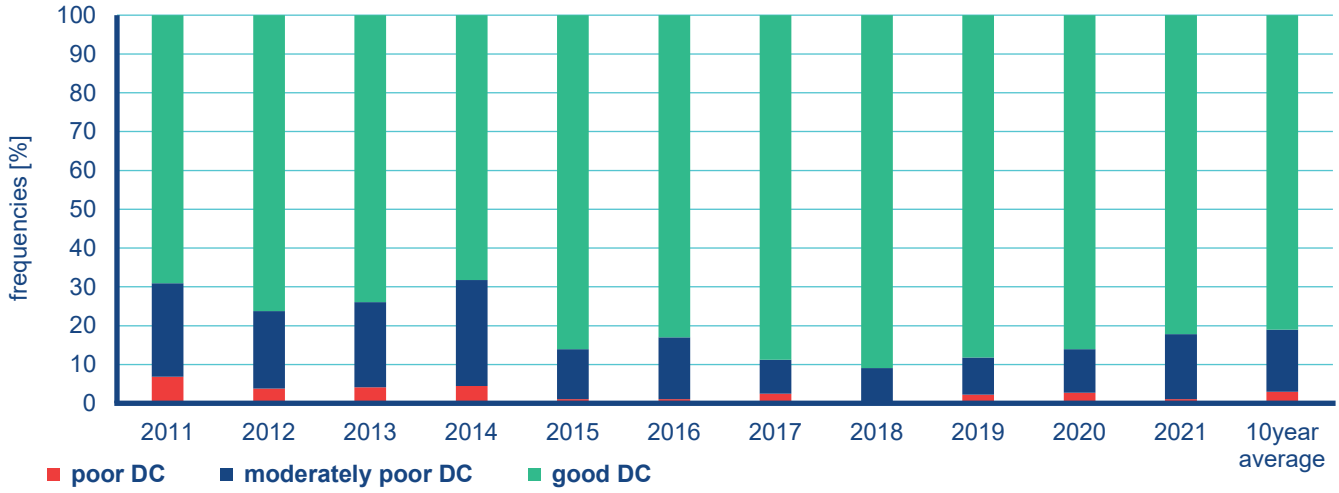

Fig. III.3 Frequency of occurrence of dispersion conditions (DC), 2011–2021

2 Based on the recommendations of the World Meteorological Organization (WMO), the CHMI has been using the most recent thirty years (1991–2020) to assess climatological characteristics since February 2022 instead of the period set for the calculation of standard climatological normals.

when 61 % of the precipitation normal covered the territory of the CR. On the contrary, January (125 % of normal) was on the limit of the normal and above-normal month in terms of precipitation (Fig. III.2).

In 2021, dispersion conditions were standard compared to the ten-year average of 2010–2020 (Fig. III.3). Good dispersion conditions, expressed by the ventilation index for the whole of the CR, were observed in 300 days (82 %) in 2021. Compared to the ten-year average (81 %), this is an improvement by 1 %. Moderately poor dispersion conditions occurred in 61 days (17 %), and poor dispersion conditions in 4 days (1 %) in 2021.

During the year, good dispersion conditions occurred the most in May (100 %), the least in February (64 %) (Fig. III.4). Poor dispersion conditions were observed in February (4 %), and January, March, and December (3 %). Compared to the ten-year average, May was assessed as a month with significantly improved dispersion conditions and February as a month with worsened dispersion conditions in 2021 (Fig. III.5). The other months (January, March, April, June, July, August, September, October, November, and December) range as standard.

The frequency distribution of dispersion conditions differs from the national average in each region (Fig. III.6). All three types of dispersion conditions were observed in all regions. The highest percentage of good dispersion conditions occurred in the Moravi-

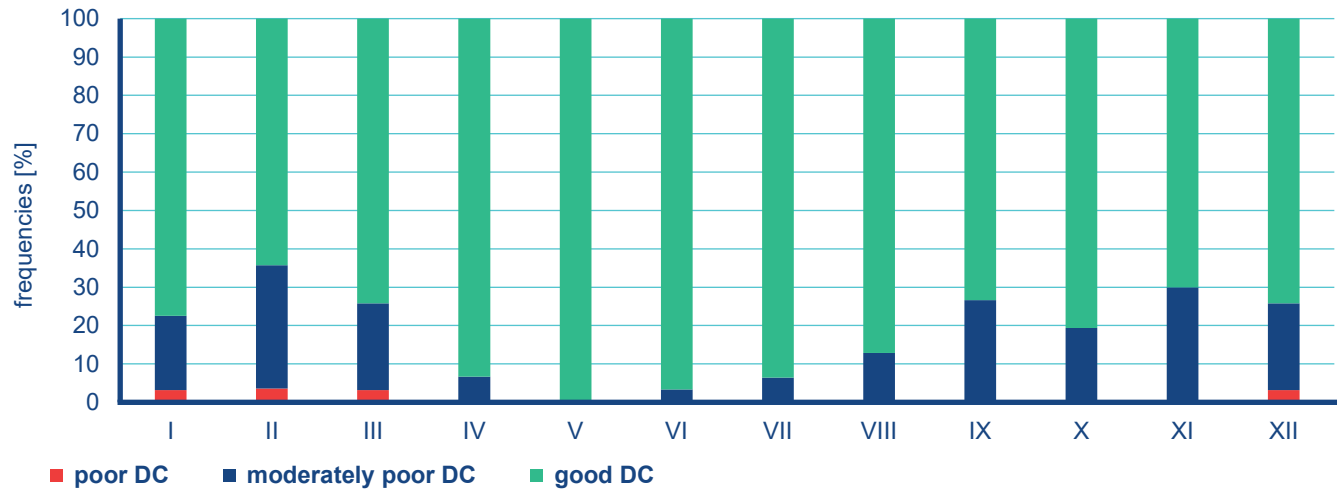

Fig. III.4 Frequency of occurrence of dispersion conditions (DC) by months, 2021

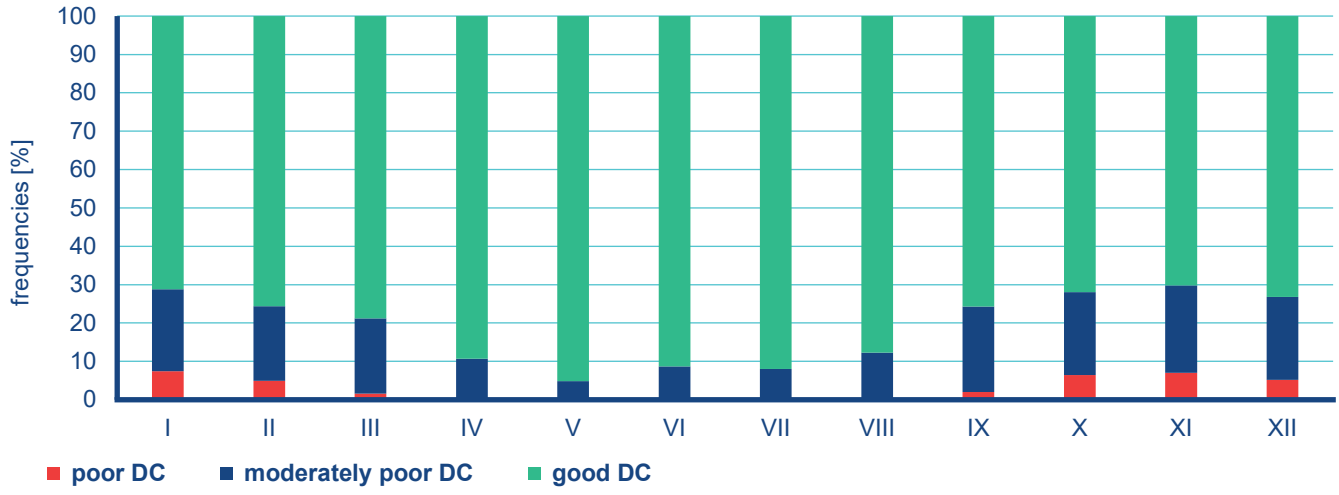

Fig. III.5 Frequency of occurrence of dispersion conditions (DC) by months, 10-year average 2011–2020

an-Silesia region without the O/K/F-M agglomeration (85 %), the lowest percentage in the Plzeň region (73 %). On the other hand, poor conditions occurred the most in the Prague agglomeration (5 %), and the least in the Moravian-Silesia region without the O/K/F-M agglomeration and the Liberec region (1 %) (Fig. III.7).

The number of degree-days during 2021 in the CR was above normal compared to the long-term average 1991–2020. The highest number of degree-days was recorded in 1996 (4 787), when the lowest average temperature on heating days was observed (2.4 °C). On the contrary, the lowest number of degree-days (3 611) was recorded in 2014, when the highest average daily temperature (5.8 °C) was reached on heating days (Fig. III.8). In five months (February, March, April, May, and October), the number of degree-days was above the long-term average, and in three months below the average (January, September, and December). The number of degree-days in November corresponded to the long-term average (Fig. III.9). The largest decrease in the number of degree-days compared to the long-term average was recorded in September, which is climatologically assessed as above normal in terms of temperature and positively affects the estimated emissions from domestic heating. On the contrary, the highest increase in the number of degree-days was recorded in April and May, which are rated as strongly below normal in terms of temperature.

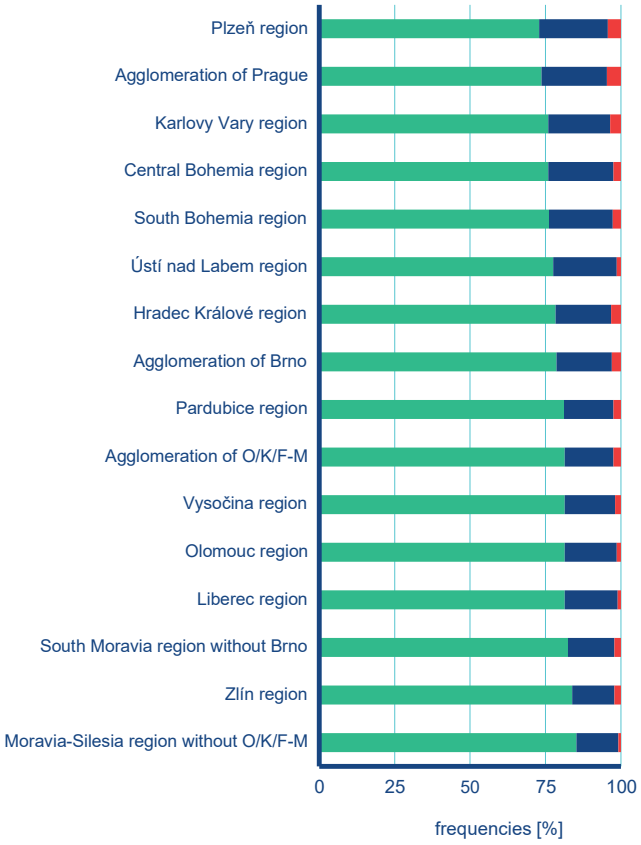

Fig. III.7 Frequency of occurrence of dispersion conditions in regions, 2021

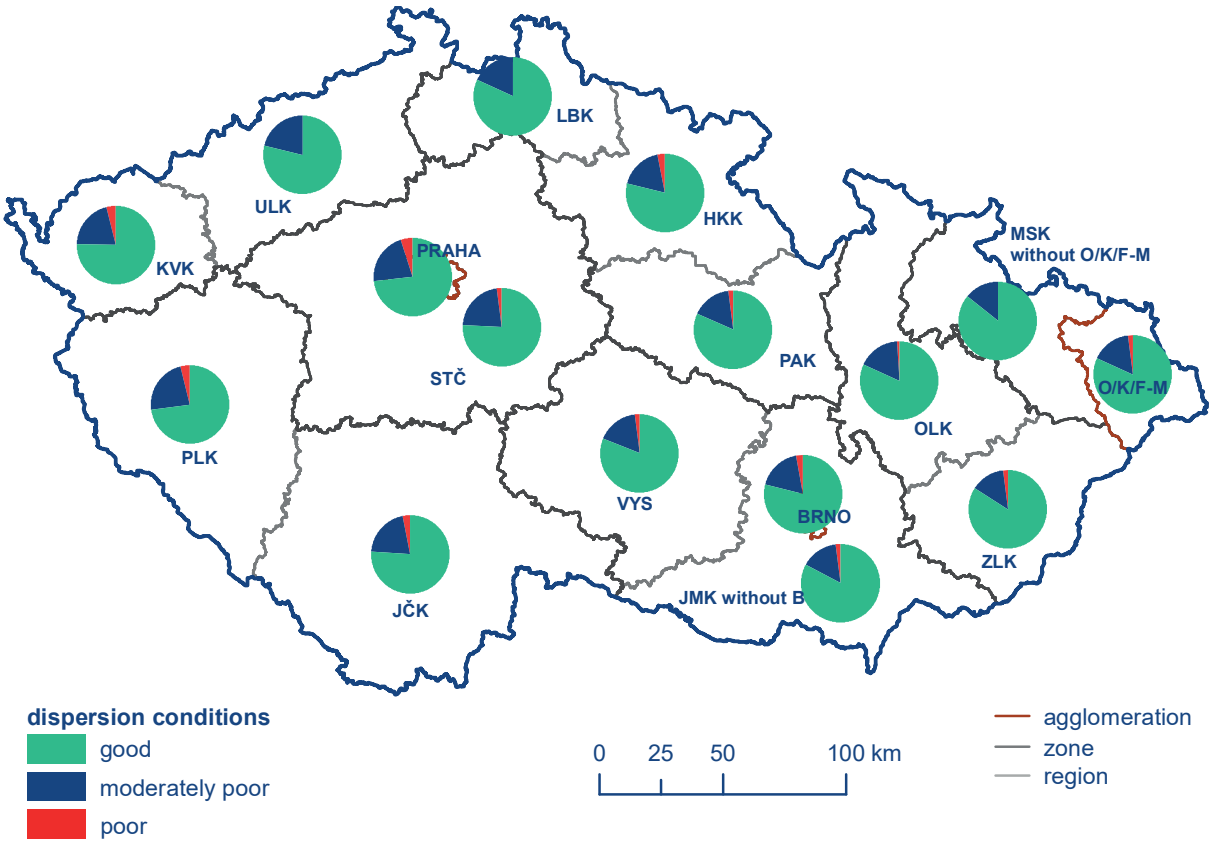

Fig. III.6 Composition of dispersion conditions in regions, 2021

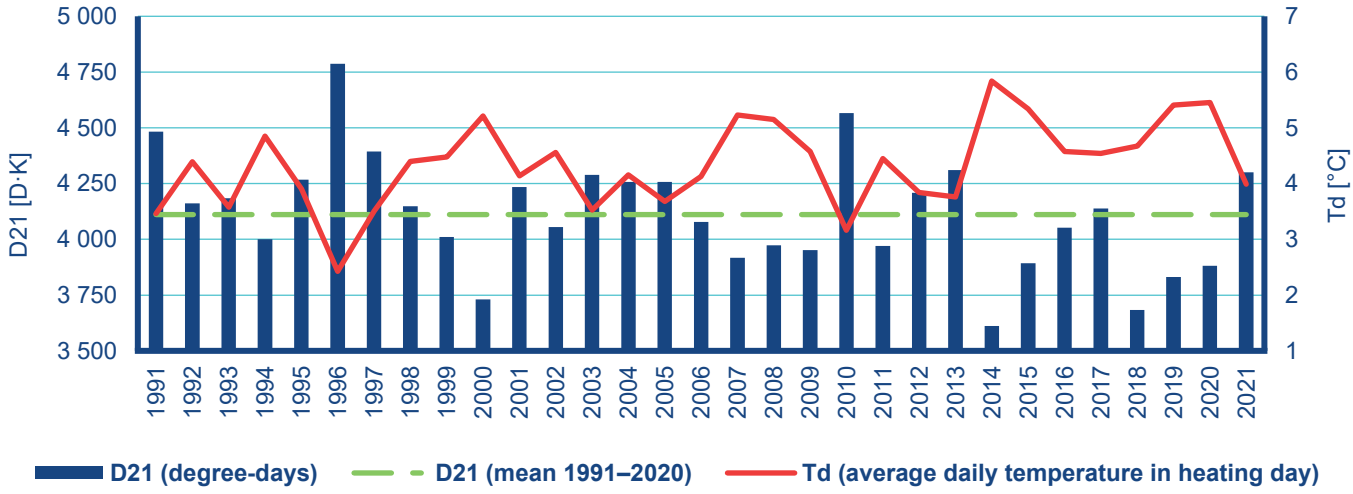

Fig. III.8 Annual heating seasons in the CR expressed as degree-days (D21) in 2021 and their average for the 1991–2020 period

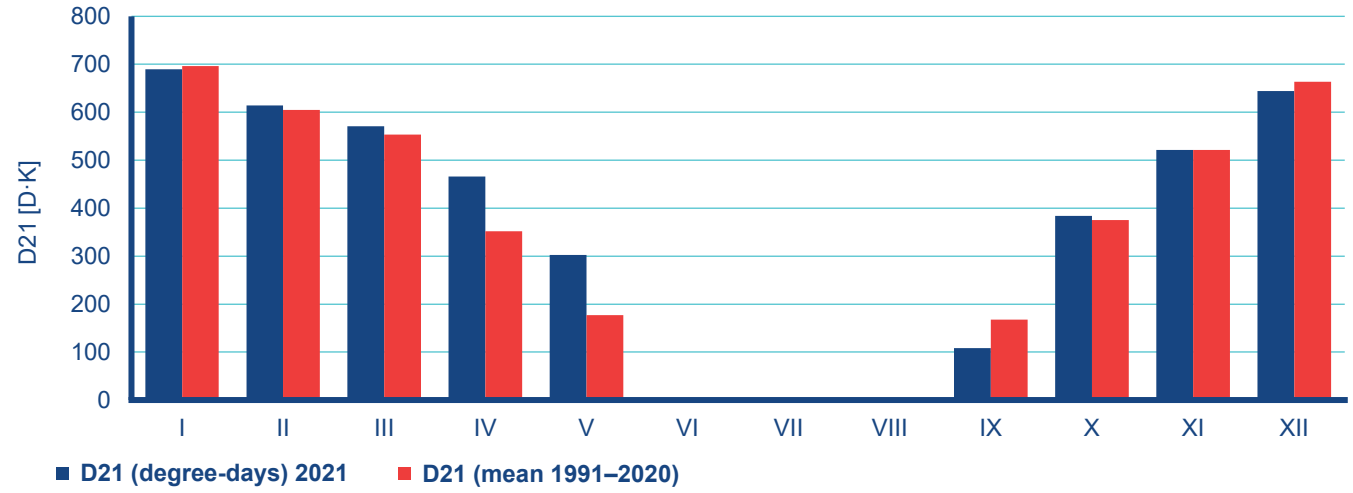

Fig. III.9 Annual variation of degree-days in the territory of the CR in the heating season 2021 (I–V, IX–XII)