The trend of atmospheric precipitation in the cold period of the year, according to weather stations in Kyrgyzstan, from 2017 to 2021.

Mandychev A.N., CAIAG.

In order to determine the trend of long-term changes in atmospheric precipitation during the cold period of the year (CPY) on the territory of Kyrgyzstan, according to the data of Kyrgyzhydromet (KHM) [1], an analysis of their changes over the period from 2017 to 2021 was carried out for 25 meteorological stations (MS) of Kyrgyzstan (Fig.1). In the cold period, in addition to the winter months, November was also included (N, D, J, F), since this is the month of stable accumulation of solid precipitation, especially in the high-mountain and partially mid-mountain altitudinal belt. As a result of the analysis, it is supposed to obtain an assessment of the trend of changes in the snow reserve on the territory of Kyrgyzstan for the period under review. Figure 2 shows the distribution of annual precipitation during the cold period from 2017 to 2021 for each weather station used. As follows from this figure, during the analyzed period of time, in the cold period, almost at all considered meteorological stations in Kyrgyzstan, along a linear trend, the tendency to reduce the average annual amount of precipitation prevails. According to MS "Batken", "Kara-Balta", "Gulcha" the trend of decrease in the average annual amount of atmospheric precipitation of CPY is insignificant. An exception is observed at the MS "Balykchy", where there is a slight upward trend. These cases can be interpreted as a relatively stable level of precipitation in terms of temporal variability, when precipitation changes little during the observed time. The maximum gradient of decrease in the average annual amounts of atmospheric precipitation of CPY of the order of - 12 ÷ -18.3 mm / year (Fig. 3) is observed at MS “Pacha-Ata”, “Toktogul”, “Jalal-Abad”, located in the southwest Kyrgyzstan. The territorial distribution of the amount of annual precipitation in the cold period of the year corresponds to the general pattern identified earlier for Kyrgyzstan [2,3,4]. As can be seen in Figure 3, the long-term total atmospheric precipitation of CPY for the period 2017-21 maximum in the southwestern climatic province and minimum in the western part of the Issyk-Kul depression. For other meteorological stations, depending on their location relative to the ridges that affect the circulation of atmospheric air currents, the slopes of the ridges, the height of location, there are slight variations in the values of long-term total precipitation of CPY within the general range of values.

The range of absolute heights of the location of KHM meteorological stations, for the stations under consideration, is from 596 to 2040 m above sea level. As can be seen in Figure 3, the altitudinal position of these stations not in all cases noticeably affects the value of the long-term total atmospheric precipitation of CPY. Thus, this dependence manifests itself for stations in the Chui depression, with a maximum at the MS “Baitik”, and in the southwest along the MS “Pacha-Ata” and “Ak-Terek”. In this case, the main importance is the different location of the stations and the territories characterized by it relative to the direction of movement of the main precipitation-bearing atmospheric air flows, the presence or absence of screening of these flows by mountain ranges, the location on the frontal, relative to the direction of air flows, or rear slopes of the ridges.

In this case, when analyzing data series, standard statistical criteria for evaluating random processes are not used, despite the statistical parameters used (average value, trend value), since the value of the series is small, and the preliminary analysis showed a clear presence of a

deterministic meteorological process, expressed in a general trend reduction of atmospheric precipitation during the cold period of the year for a large territory of the Kyrgyzstan.

Attention should be paid to the fact that the identified trend in the change in the annual amounts of CPY atmospheric precipitation refers to the average annual precipitation for a number of observations and does not remove the need to take into account the peculiarities of changes in annual precipitation over time in specific areas. So, as can be seen in the graph in Figure 2, for all weather stations for 5 years, the annual amount of precipitation in the cold period varies quasi-periodically, with a significant amplitude. This can be clearly seen on the upper part of the graph for MS "Ak-Terek" and "Uzgen". The quasi-periodicity of precipitation changes is manifested in the fact that a year with a large amount of precipitation is replaced by a year with a smaller amount, that is, there is no consistent decrease in precipitation year after year. The constant trend of decreasing precipitation refers, as mentioned above, to the average annual precipitation over a series of observations.

As can be seen in Figure 2, the maximum amplitude of the change in the amount of precipitation in the cold period of the year in 2017-22 was observed in the south-west of Kyrgyzstan. Here, the difference between the maximum and minimum annual precipitation values of CPY at the MS “Jalal-Abad” is 104.6 mm, “Uzgen” - 99.3 mm, “Kara-Su” - 97.3 mm, “Isfana” - 90.8 mm. Also, relatively large annual values of the amplitude of precipitation CPY were determined in the Issyk-Kul depression, according to the MS “Kyzyl-Su” - 77.6 mm, “Cholpon-Ata” - 72.7 mm. Relatively small amplitudes of variations in precipitation CPY were recorded in the inner Tien-Shan at the level of 24 mm according to the MS “Naryn”, and in the Talas depression - 17 mm. A special case is the minimum, for all the considered meteorological stations, the amplitude - 10.2 mm at the MS “Balykchy”, this area is also distinguished by the minimum amount of long-term atmospheric precipitation of CPY and their positive trend.

The result of the analysis of atmospheric precipitation variations in the cold period of the year shows that the assessment of the average level of precipitation should be carried out differentiated by climatic province and regions with characteristic ranges of parameter values. The magnitude of the amplitude of the sums of annual precipitation, characteristic of individual regions, should be used for the annual forecast of the magnitude of precipitation.

In general, the analysis of changes in the amount of long-term atmospheric precipitation in the cold period, in the period 2017-21, over a large territory of Kyrgyzstan, shows a clear trend towards a decrease in their average annual value, practically for all the meteorological stations under consideration, which indicates the influence of the subglobal process of moisture transfer in atmosphere on the territory of Kyrgyzstan, which has a tendency to reduce moisture transfer during the cold periods of the years under consideration.

Accordingly, the amount of snow reserve formed during this period tended to decrease in the territory characterized by the meteorological stations under consideration, which was also reflected in the decrease in 2017-21 river flow in the respective river basins. As can be seen in Figure 3, the minimum snow reserves in the period 2017-21 formed in the basins of surface runoff in the areas of the MS "Balykchy", "Chaek", "Batken", and the maximum - in the areas of MS "Ak-Terek", "Pacha-Ata". The maximum decrease in snow stock over 5 years, in terms of the magnitude of the gradient, was observed in the south-west of Kyrgyzstan, in the areas where MS “Jalal-Abad”, “Pacha-Ata”, and “Toktogul” are located.

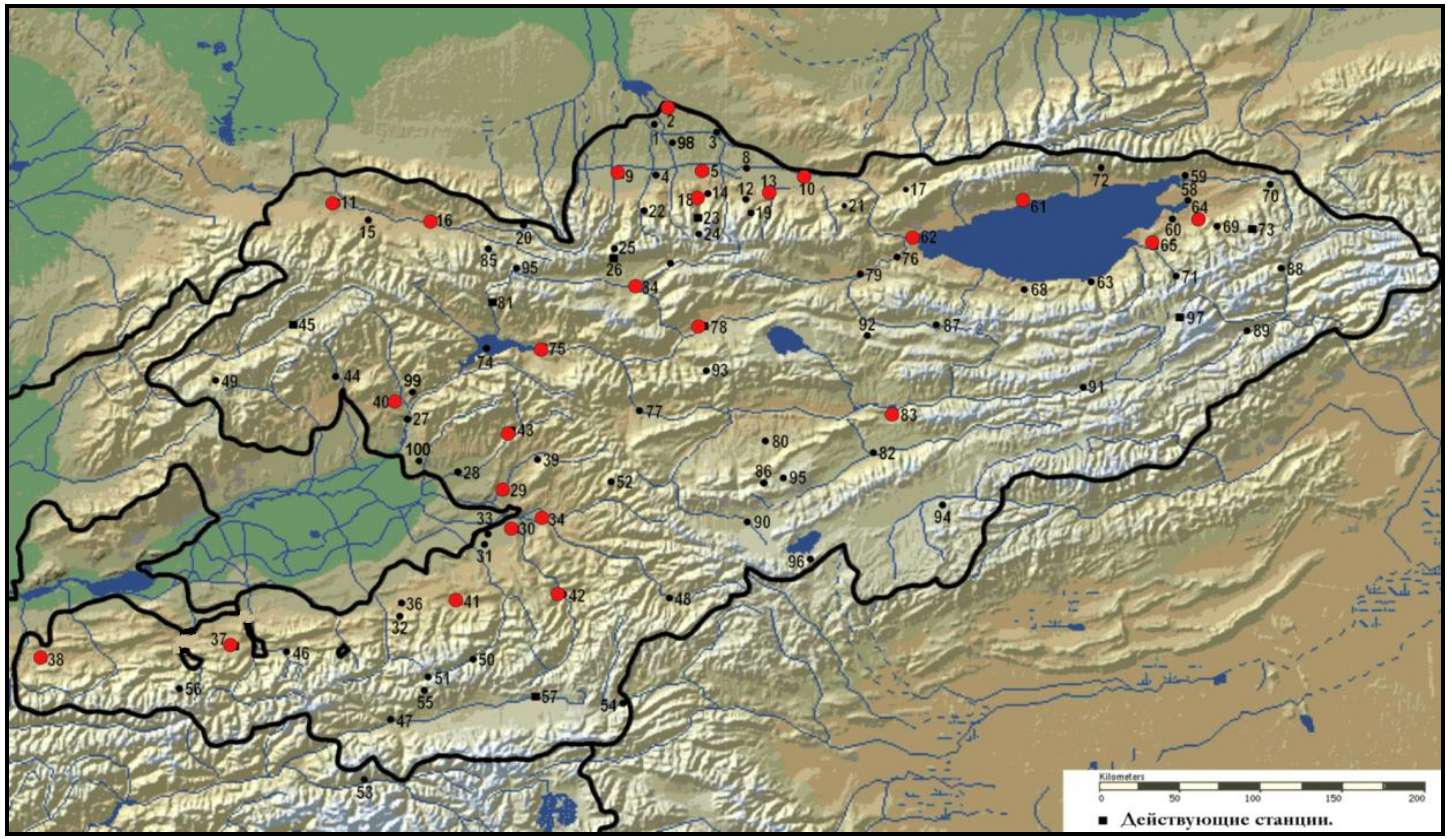

Fig. 1 KHM weather stations: 2. Zhany-Zher-596, 5. Bishkek-756, 9. Kara-Balta-770, 10. Tokmok-817, 11. Kyzyl-Adyr-858-924, 13. Issyk-Ata-1028, 16.Talas-1217, 18.Baytik-1579, 29.Jalal-Abad-763, 30.Kara-Su-860, 34.Uzgen-1012, 37.Batken-1050, 38.Isfana-1180, 40.Pacha- Ata-1537, 41.Nookat-1325, 42.Gulcha-1542, 43.Ak-Terek-1748, 61.Cholpon-Ata-1645, 62.Balykchi-1660, 64.Karakol-1716, 65.Kyzyl-Su- 1740, 75. Toktogul-821, 78. Chaek-1651, 83. Naryn-2040, 84. Susamyr-2061. The number on the right is the height above sea level in meters. Red mark - weather stations, the data for which were used for the analysis.

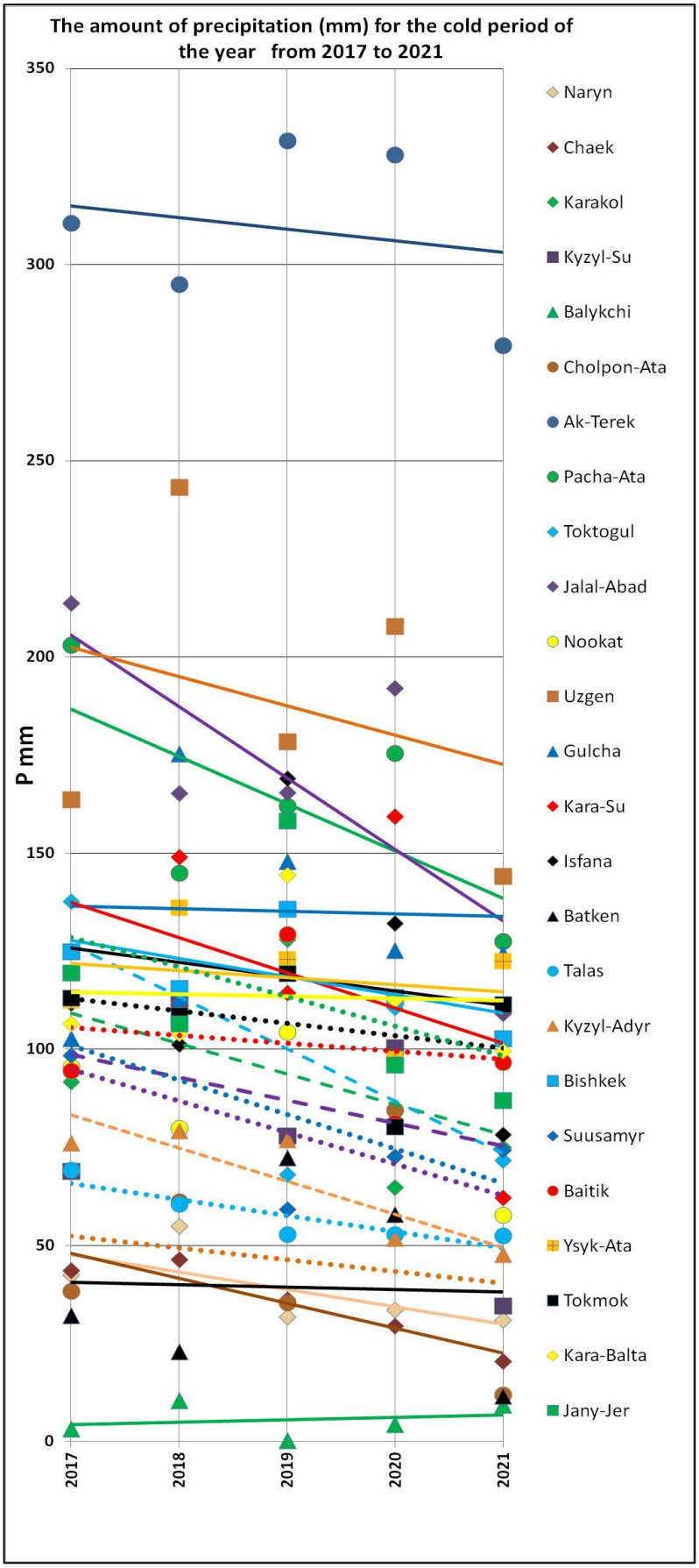

Fig. 2 Change in the amount of precipitation during the cold period of the year for 2017-21, on 25 MS.

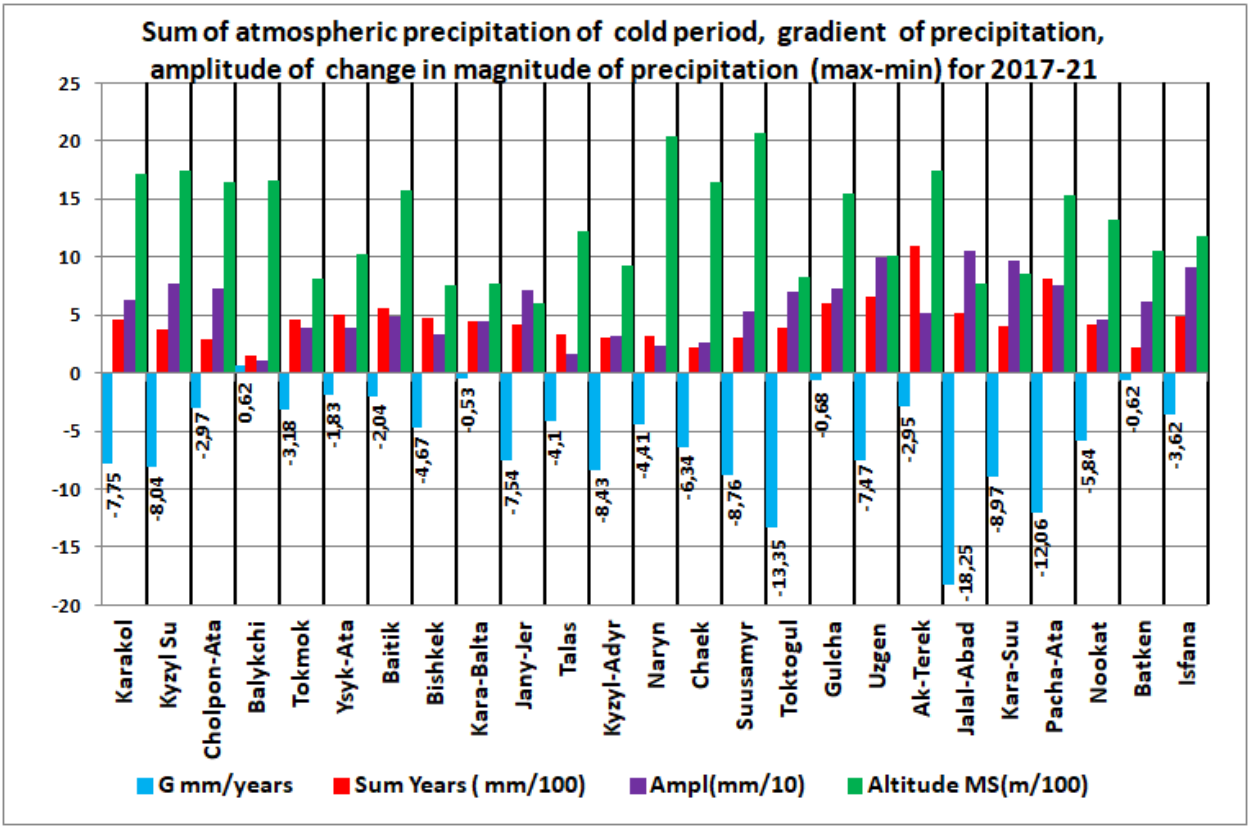

Fig. 3 Values of the gradient of change in annual total precipitation CPY(G) and relative values (for ease of comparison, divided by 10 and 100) of the total long-term, for the entire period of 2017-21, precipitation CPY(SY) at 25 weather stations, relative values of the amplitudes (Ampl) changes in the annual total precipitation of the cold period and altitudes (Altitude MS) of weather stations.

Reference:

1. Kyrgyzhydromet data, electronic resource: http://upload.meteo.kg/attachment/76_85_ee248cff39666405248f35762447d304.pdf

2. Climate of the Kirghiz SSR. Ed. Z.A. Ryazantseva. Frunze: Ilim, 1965. - 292 p.

3. Atlas of the Kirghiz SSR. GUGK. - M., 1987. – 86p.

4. Scientific and applied reference book on the climate of the USSR. Series 3. Issue 32. Parts I - VI., 1989. 374 p. https://www.vo-da.ru/book/climat-32