RESULTS OF MEASUREMENTS OF HIGH-INTENSITY PRECIPITATION CHARACTERISTICS PERFORMED WITH THE OPTIOS OPTICAL PRECIPITATION GAUGE FOR THE WARM PERIOD OF 2024

Mirsanov. M.A

Institute of Monitoring of Climatic and Ecological Systems of the Siberian Branch of the RAS, Tomsk, Russia

e-mail: mirsanov.2014@mail.ru

The paper presents the results of measurements of atmospheric precipitation characteristics performed using the optical precipitation gauge OPTIOS for the period from 1 June to 31 August 2024. A comparative analysis of the obtained measurement results is carried out. It is concluded that the instrument is highly reliable and can be used for research in critical meteorological conditions.

When studying the impact of precipitation on the atmosphere, it should be taken into account that precipitation of high intensity is often accompanied by other unfavourable meteorological phenomena - strong gusty winds, thunderstorms, etc. At the same time, automatic meteostations supplied within the framework of the project of technical modernisation of the state observation network of Roshydromet are equipped with liquid precipitation sensors of shuttle and weight type, which have a number of disadvantages, including low sensitivity, excluding registration of low intensity precipitation; high probability of the influence of vibration, arising at high wind speed, on the readings of the device; insufficient speed of sensor operation for registration of high intensity precipitation [1].

These disadvantages are absent in the optical precipitation gauge OPTIOS, developed at IMCES SB RAS, whose design is devoid of any moving parts, provides high transparency to the wind and allows automatic measurement of a number of precipitation characteristics [2]. From June to August 2024, the optical precipitation meter underwent field tests at the meteorological site of the Geophysical Observatory (GO) of IMCES SB RAS.

In the period from 1 June to 31 August 2024, precipitation in Tomsk was observed in the form of heavy showers with intensity up to 100 mm/h, rain and hail, accompanied by intense thunderstorm activity and strong wind with gusts up to 25 m/s [3, 4], which exceeds the criteria of hazardous meteorological phenomena. The maximum amount of precipitation was 15.4 mm. This value agrees well with the amount obtained with the standard precipitation gauge O-1 (13.5 mm), also located at the meteorological site of the CS. The results of measurements for the most interesting cases, in which the intensity of precipitation exceeded 50 mm/h, as well as charges of moderate and weak rainfall, the

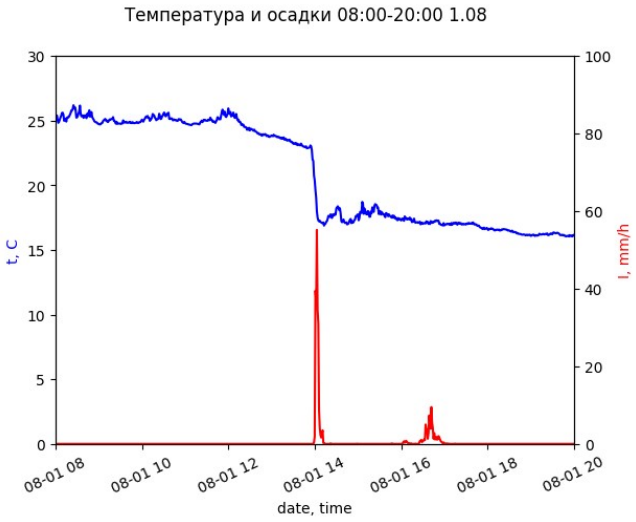
intensity of which did not exceed 10 mm/h, which allows us to classify it as moderate and weak [5], are presented in Figure 1.

The graphs show that the air temperature decreased before the onset of cases with precipitation intensity of more than 50 mm/h. This is due to the fact that during precipitation evaporation occurs, which is accompanied by energy absorption. In addition to evaporation, the temperature decrease is caused by the replacement of air masses and accumulation of clouds, which blocks solar radiation.

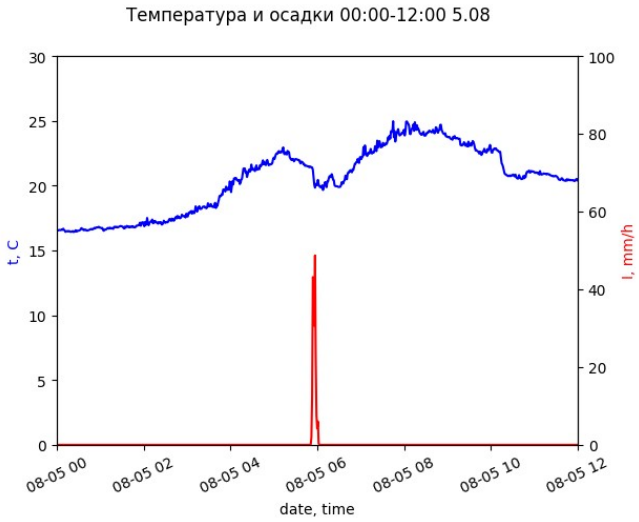
After heavy precipitation (more than 50 mm/h) during night and morning hours, the course of temperature flattens out, and vice versa during the day. If solar radiation becomes more intense after rainfall and rapidly heats the surface, this causes a sharp increase in air temperature. If clouds continue to trap heat, the temperature is more stable. In any case, convective mixing of air occurs after heavy daytime precipitation. Note that high humidity after a rainstorm hinders the change in air temperature because moist air cools more slowly than dry air.

Thus, the measurements of high-intensity precipitation accompanied by thunderstorms and strong gusty winds demonstrated high reliability of the OPTIOS optical precipitation gauge and the possibility of its application for any level of research in critical meteorological conditions.

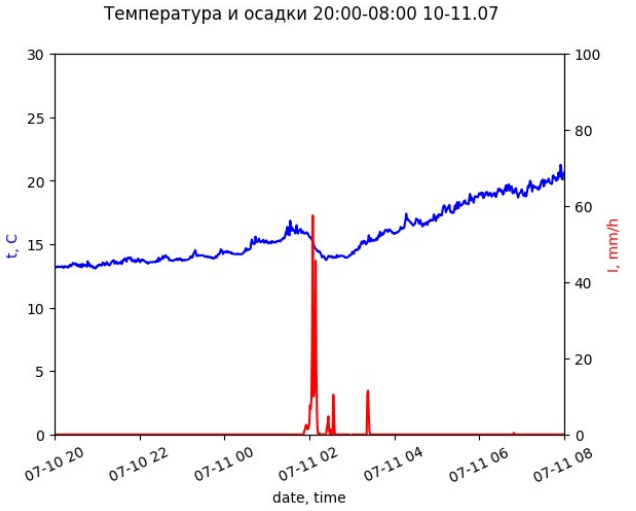
Funding. The research was supported by the Russian National Foundation (grant № 25-27-00376, https://rscf.ru/project/25-27-00376/).


Температура и осадки 08:00-20:00 1.08
t, C
I, mm/h
date, time
08-01 08
08-01 10
08-01 12
08-01 14
08-01 16
08-01 18
08-01 20

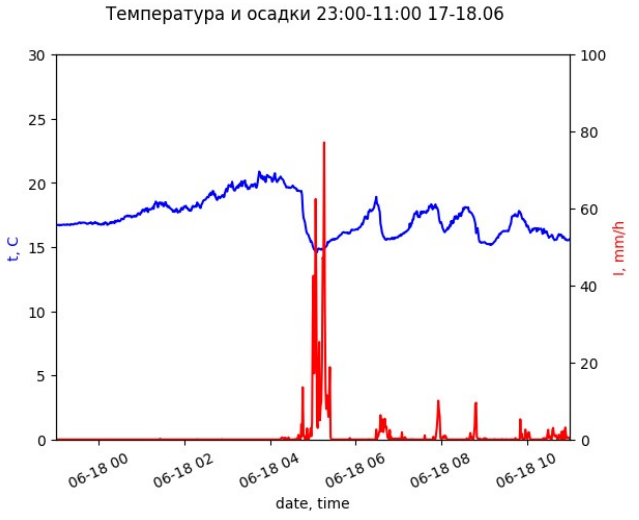
a


Температура и осадки 00:00-12:00 5.08
t, C
I, mm/h
date, time
08-05 00
08-05 02
08-05 04
08-05 06
08-05 08
08-05 10
08-05 12

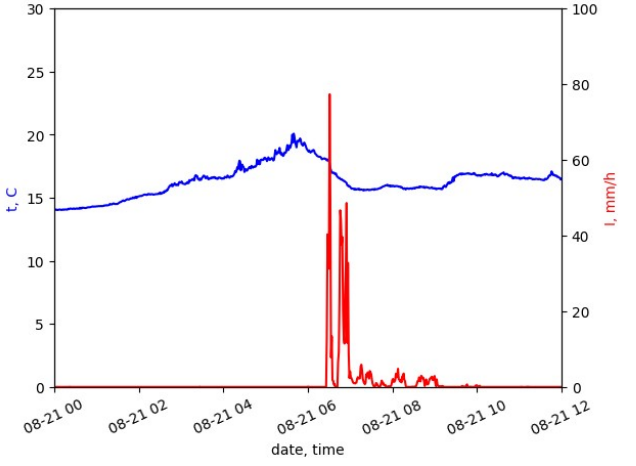
b


Температура и осадки 20:00-08:00 10-11.07
t, C
I, mm/h
date, time
07-10 20
07-10 22
07-11 00
07-11 02
07-11 04
07-11 06
07-11 08

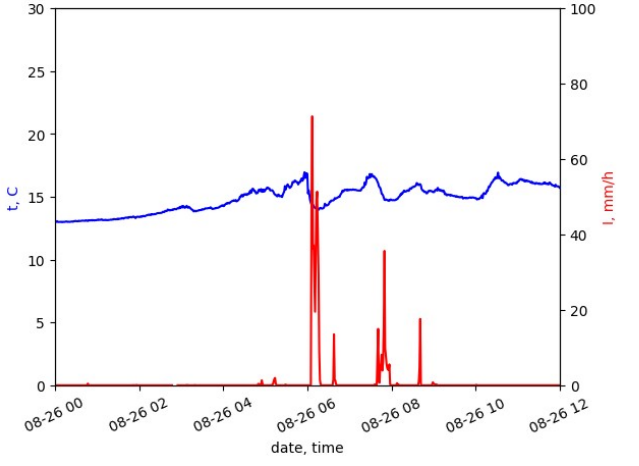
c


Температура и осадки 23:00-11:00 17-18.06
t, C
I, mm/h
date, time
06-18 00
06-18 02
06-18 04
06-18 06
06-18 08
06-18 10

d


Температура и осадки 0:00-12:00 21.08
t, C
I, mm/h
date, time
08-21 00
08-21 02
08-21 04
08-21 06
08-21 08
08-21 10
08-21 12

e


Температура и осадки 00:00-12:00 26.08
t, C
I, mm/h
date, time
08-26 00
08-26 02
08-26 04
08-26 06
08-26 08
08-26 10
08-26 12

f

Figure 1 - Progress of rainfall intensity over 50 mm/h: a) 1 August; b) 5 August; c) 11 July; d) 18 July; e) 21 August; f) 26 August.

List of references used

1. P 52.04.818-2014. Recommendations for the operation of automated meteorological complexes in observation units. SPb.: Gidrometeoizdat, 2014. 48 c.

2. *V. V. Kal'chikhin, A. A. Kobzev, V. A. Korol'kov, A. A. Tikhomirov. Determination of the Rate of Fall of Rain Drops in Measurements of Their Parameters by an Optical Rain Gauge // Measurement Techniques. 2017. V. 59. №. 11. P. 1175-1180. DOI: 10.1007/s11018-017-1111-9.*

3. Forecaster Svetlana Ryukhtina: five-day norm of precipitation has fallen in Tomsk - News of Tomsk and Tomsk region [Electronic resource].URL: https://ngs70.ru/text/summer/2024/06/19/73725473/?ysclid=m9sha4ctyt417869623 (date of address 20.04.2025).

4. Thunder, lightning and hail expect Tomsk in the coming hours - News of Tomsk and Tomsk region [Electronic resource]. URL: https://ngs70.ru/text/summer/2024/06/17/73714898/?ysclid=m9slyvy46j152178645/ (date of address 20.04.2025).

5. Guidelines for automatic meteorological observation systems at aerodromes (Doc 9837). ICAO, 2011. 116 c.