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RESEARCH TRANSLATION

Automation of a Sample Collector for Measuring the Liquid-Water Content of Fog by a Method Devised by V.A. Zaitsev

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AUTOMATION OF A SAMPLE COLLECTOR FOR MEASURING THE LIQUID-WATER CONTENT OF FOG BY A METHOD DEVISED BY V. A. ZAITSEV

Translation of

K avtomatizatsii zabora prob vodnosti tumana metodom V. A. Zaĭtseva

by

L. Z. Prokh

Kiev. Ukrainskiĭ Nauchno-Issledovatel'skiĭ Gidrometeorologicheskiĭ Institut, Trudy, No. 48: 121-125, 1965.

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AUTOMATION OF A SAMPLE COLLECTOR FOR MEASURING THE LIQUID-WATER CONTENT OF FOG BY A METHOD DEVISED BY V. A. ZAITSEV

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L. Z. Prokh

A trap device for taking samples of the liquid-water content of fog by a method originated by V. A. Zaitsev, used in the Ukrainian Hydrometeorological Scientific Research Institute (UkrNIGMI), is herewith described.

The Zaitsev method of determining the liquid-water content of fog [1] involves drawing a known quantity of fog into a slit trap, where the droplets are precipitated by inertia onto filter paper, forming a spot. The size of the spot characterizes the liquid-water content of the fog. A hand-held device for measuring the liquid-water content (RIV), based on this principle, is used for measurements on the ground and from balloons. Its operation under working conditions is inconvenient, however, owing to the considerable physical effort which must be expended. The observer must operate the pump 35 times in 2 min to draw approximately 100 liters of fog through the air inlet, which has a diameter of 3.4 mm. In addition, the irregular intake of the air into the apparatus introduces additional distortions into the measurement results.

The various accessories for the Zaitsev sample collector which are described below were developed and tested under field conditions, to

simplify the work of the observer and bring the sample collection into line with the required frequency.

1. The hand-operated pump of the RIV was replaced by an aspirator with a motor powered by a 12V storage battery. The aspirator permitted 100 liters of air/min to be drawn into the apparatus. The sample collection period was increased to 2-3 min for a fog with a low liquid-water content. The tape inside the RIV was advanced manually between samples.

An RIV with an electric aspirator of the above type was tested on an expedition to the steppe zone of the Ukraine in December 1962. The device was mounted aboard the gondola of a balloon. The use of such an accessory allowed samples of the liquid-water content of fog and low clouds to be collected more frequently without distracting the observer from carrying out other measurements.

The results of these measurements indicate a large variation in liquid-water content in fog from one sample to the next and an average increase with height (Table 1).

2. A new model of the RIV, incorporating remote control of the electric motor of the aspirator as well as remote control of the tape-feeding mechanism inside the RIV, was constructed in order to make the collector more automatic. The device is equipped with a relay; when a switch is closed, the relay switches on the pump motor for the necessary period of time, then disconnects it and switches on the tape-feeding mechanism, rotating a reel of tape through one half-turn. The switch is connected to the relay by a 100-meter cable, allowing remote collection of liquid-water content samples (for example, by using a balloon-borne RIV equipped with a relay).

Table 1

Results of measurements of the liquid-water content of fog and low clouds, using a balloon-borne Zaitsev RIV with motor-driven aspirator: 1 December 1962, at Zhovtnevoe (Dnepropetrovsk Region)

Moscow time	Height, meters	Wind speed, m/sec	Weather	Liquid-water content, g/m³	Temperature °C
2.29	25	0.4	Fog	0.03	3.6
2.32	60	0.4	"	0.01	3.5
2.39	75	0.4	"	0.12	3.6
2.48	100	0.6	"	0.16	3.0
2.56	150	3.4	"	0.06	3.0
3.07	200	4.8	"	0.05	2.6
3.16	250	4.0	"	0.19	2.2
3.25	300	4.0	"	0.23	1.8
3.37	350	5.6	Upper fog boundary	0.10	1.2
3.42	500	5.6	Rain from St	0.31	0.8
3.50	500	9.2	St	0.01	0.8
4.00	190	4.0	Fog	0.11	2.3

A device of this kind was tested at a height of 2 meters. Samples were collected by remote control every 3 min, in series lasting 30 to 60 min each. Figure 1 shows the results of data from one series of ground measurements of the liquid-water content of an advection-radiation fog; 185 samples, collected at an increased frequency on 17 January 1962 in Zhovtnevoe in the Dnepropetrovsk Region, are listed. In Figure 1, the x-axis represents the liquid-water content in g/m^3 on a logarithmic scale, while the y-axis shows the time in days. In 50% of the measurements in this series, the liquid-water content fell within the limits 0.06 to 0.20 g/m^3, exceeding 0.50 g/m^3 in only 9.3% of the cases. The remaining samples showed a liquid-water content of 0.21 to 0.49 g/m^3. It is clear from Figure 1 that the liquid-water content was higher at night than in the day. In individual cases, however, the deviations of the liquid-water content from the mean, as indicated by several consecutive samples, were significant. This emphasizes the

necessity of averaging the liquid-water content over a large number of samples, collected at sufficiently frequent intervals: this is possible only with an automatic device.

3. An automatic instrument was built in order to make the collection of liquid-water content samples by the Zaitsev method completely automatic. Engineer V. P. Nekhaenko participated in its development. The device consists of the following fittings, shown in Figure 2.

a) Suction apparatus: intake slit 1 and tube 2, leading to an "Uralets" vacuum cleaner.

b) Tape-feeding mechanism: Warren motor 3, driving reel 4 which takes up the used tape of filter paper, and idling reel 6, containing a supply of clean paper tape. The tape (not shown in the sketch) travels beneath intake slit 1 through frame 5.

c) Programming apparatus: Second Warren motor 7 connected by reducing gear 9 to contact drum 8. Contact system 10, sliding along the surface of drum 8, is arranged so that the tape-feed system and the suction motor (vacuum cleaner) are switched on alternately. The length of tape feeding, time interval between successive activations of the aspirator, and the collection time for each sample are regulated by the length of contact tapes 11 and 12 on the rim of the contact drum.

The most advantageous feature of the operation of the device is the collection of samples at 3 to 4 min intervals, with the spindle of reel 4 of the tape-feeding mechanism rotating one half-turn for each measurement. The duration of the collection of each sample is determined

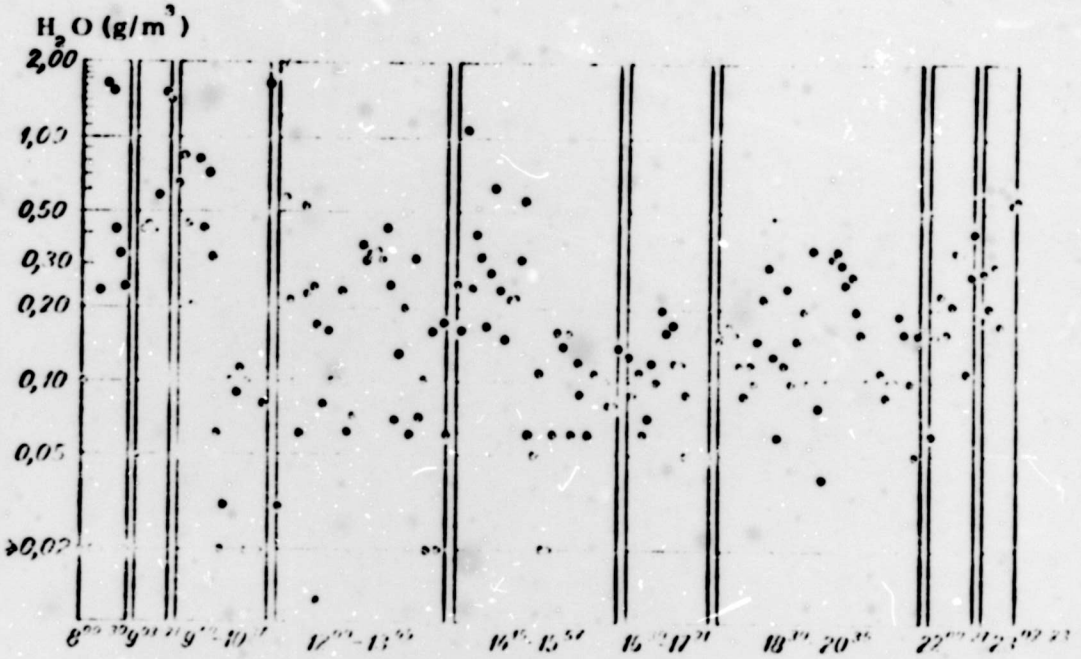

Figure 1. Diurnal variation of liquid-water content of advection-radiation fog: 17 January 1962, at Zhovtnevoe in the Dnepropetrovsk Region.

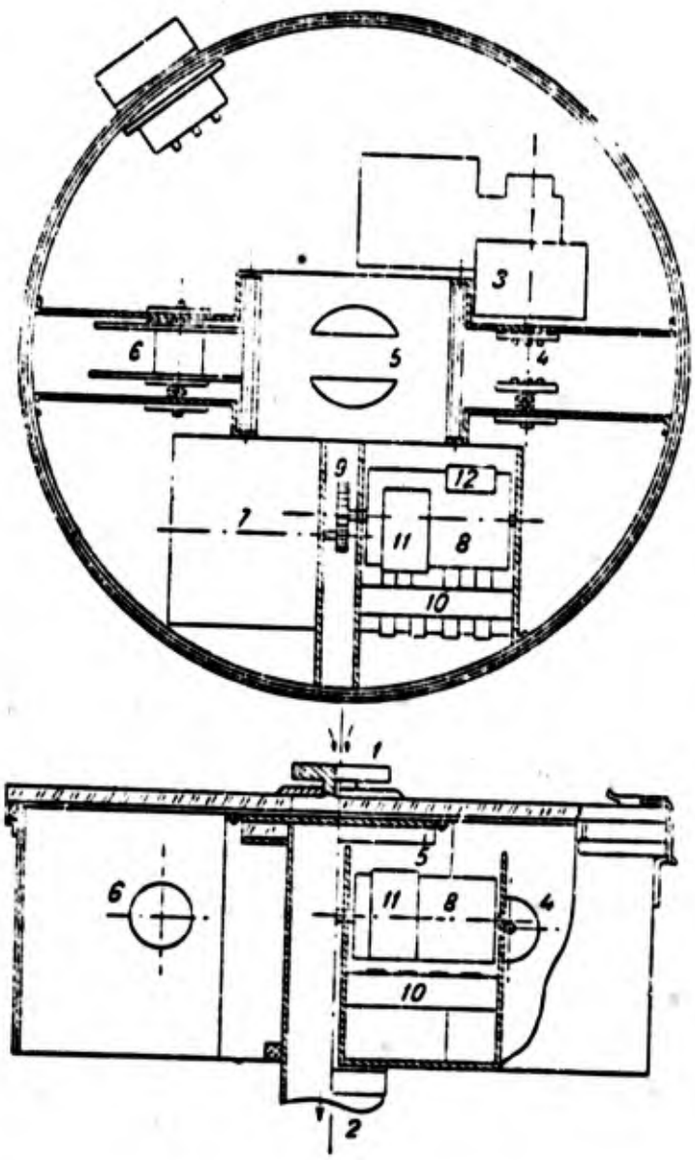

Figure 2. Diagram of automatic device used by the Ukrainian Hydrometeorological Scientific Research Institute (UkrNIGMI) for remote control measurement of the liquid-water content in fog by the Zaitsev method.

by the necessity to average the liquid-water content for a volume of more than 100 to 200 liters. With a highly efficient suction apparatus,

the samples can be collected continuously instead of individually. In this case, a continuous trace, whose width corresponds to the liquid-water content, will be left on the filter paper tape. The device is hermetically sealed, and the intake slit has the same parameters as in the RIV. This ensures a sufficiently complete entrapment of drops even in a lateral wind of up to 4 m/sec. For operation at below $0^{\circ}C$ air temperatures, an electric coil to heat the samples is mounted below frame 5.

A test of this device showed that the continuous variation of the liquid-water content with time causes the individual samples collected at intervals of several minutes to differ by a magnitude of more than 10 times. Therefore, the fog samples must be collected as frequently as possible from large volumes of air in order to obtain the characteristics of the variation of the liquid-water content with time. The Zaitsev method is completely suitable for this purpose, when the collector is fitted with an automatic aspiration device of the type described in this paper.

Reference

1. Zaĭtsev, V. A. and A. A. Ledokhovich. Instruments and Methods of Investigating Clouds from Airplanes (Pribory i metodika issledovaniia oblakov s samoleta). Leningrad, Gidrometeoizdat, 1960. 175 p.