The comparison of differences in check-readings on the staff effected three times daily, with differences of readings for the same moments on the mareogram, showed insignificant discrepancies, not exceeding 1.5 cm., i.e. were also within the limits of accuracy of reading on the staff.

TIDE-POLE OBSERVATIONS DURING THE WINTER SEASON.

by

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(Translated from *Problemy Arktiki*, 5-6, Leningrad, 1938, p. 163).

All the instructions and text-books on making tide-pole observations in winter deal only with the installation of the ice tide-pole of standard type (i.e. on installations in which the staff is secured to a frame made fast on the ice, the readings being effected from an index on a cable), but do not mention the inadequacies of such an installation. Yet the observations thus obtained are viciated by considerable errors, which cannot ordinarily be foreseen. In hydrological practice at the polar stations, various modified types of such installations are used, but, again, without allowing for these detrimental influences.

In this article, we shall touch upon the method of installation of the tide-pole in the presence of an ice sheet, and shall treat as fully as possible the question of tide-pole observations in winter.

The sources of error in the indications of the ordinary ice tide-pole may be summarized as follows :

1. Uplifting of the upper side of the ice, and consequently of the zero of the staff, with the growing of ice above sea level; if the specific weight of the ice be assumed equal to 0.9, then one-tenth of the thickness of same will rise above the water; if, during the observations, the ice grows by 50 cm., the upper side of the ice will rise by 5 cm. above sea level.

2. Sinking of the ice due to the weight of the snow which has fallen on it.

3. Joining up of the ice with the shores.

4. Horizontal displacement of the ice. (1)

5. Sinking into the ice of the staff, or of the frame on which the latter is fixed. This sinking is especially great in spring, and when the tide-pole is housed in a heated hut in which hydrological observations are being carried on simultaneously; besides, the frame sinks into the ice under the influence of its own weight, the depth of the sinking may thereby attain a few centimetres.

6. Deflection of the cable, which runs from the bottom weight to the staff, due to strong currents (especially with a great length and great thickness of the cable).

Almost all the sources of error are produced by the ice cover, which serves in principle the purposes of a float, and communicates to the index the oscillations of sea level with respect to the staff installed on the ice. It is obvious from the above that the only way of avoiding errors in the observations is by eliminating the ice as the basis of the appliance. The device hereunder described exactly satisfies the last requirement (Fig. 1).

The principle of this device is similar to that of the ordinary pile-work tide-pole. The difference resides in that, here, the staff is held in a fixed position in space, not by a solid base, but by a "base" formed by the cable running from the bottom-weight to the lower end of the staff. The cable is kept taut by means of a counterpoise of sufficient weight, connected to the upper end of the staff; the readings of the sea level are effected directly

on the staff. The ice cover and the pulley connected to it play, here, an absolutely subordinate role in stretching the cable (and consequently the preservation of one and the same distance from the zero of the staff to the bottom), and, cannot, therefore, alter the indications in the slightest.

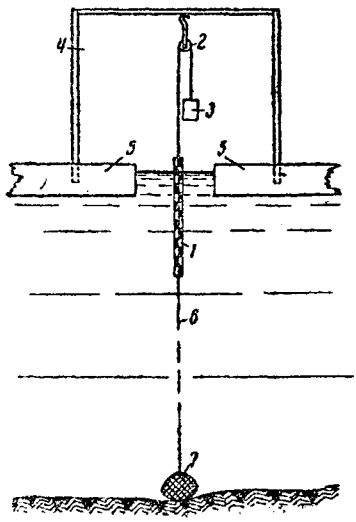

FIG. 1.

1. Tide-Pole Staff.
2. Pulley.
3. Counterpoise.
4. Hut.
5. Ice.
6. Cable.
7. Bottom Weight.

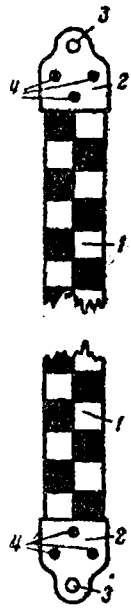

FIG. 2.

1. Staff.
2. Metal platings.
3. Openings for the Cable.
4. Screws.

The only sources of error in the indications of this appliance may be the curvature bending of the cable and the shifting of the whole appliance with respect to the ice.

The errors of the first kind may be eliminated, or, at least considerably lessened by suspending a heavy weight as counterpoise (not less than 25 kg.) and the use of a thin cable (ordinary cable, 1.8 mm. in diameter). The bottom weight must, of course, be much heavier than the counter-poise, and not less than 50-60 kg.

Far more difficult is the elimination of the errors of the second kind, i.e. those due to the horizontal displacement of the floe, and with it of the whole appliance.

As a method which considerably diminishes the errors from drifting, the following is recommended. The bottom weight is lifted, from time to time, to a certain height, and dropped again as soon as the cable has assumed a vertical position. Readings are effected on the staff immediately before the lifting, and at once after the dropping of the weight; the difference in the indications is (according to sign), either added to, or substracted from, the next reading on the displaced staff. One obtains a reduction of the error from drifting, in this case, by the fact that the angle of inclination of the cable to the vertical will remain constantly in the vicinity of zero.

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(1) MATVEEV, "*On the measurement of sea level by means of an ice tide-pole*". Sovietskaya Arktika, N° 1, M., 1938.

The only way of eliminating these errors is the deduction of the angle of inclination of the cable from the vertical and subsequent multiplication of the "length of the cable to the zero of the staff + reading on the staff" by the cosine of such angle; for obtaining the corrected quantity it is indispensable to substract from the product the length of the cable.

A staff of such an appliance may be made from an ordinary tide-pole, by fitting loops to the ends of same for fastening the cable (Fig. 2). For preference, the staff should be rather thin, so as to offer only a slight resistance to the currents, and take, at the same time, a less inclined position under their influence.

An appliance of this type was used by the Hydrologists V.A. LESITSIN in 1933 and B.I. DANILOV in 1934. B.I. DANILOV added to same a second staff installed in the ordinary way on the ice; the readings of the latter were carried out on the index. But there is no absolute necessity for this additional staff with ordinary observations; it is required only in determinations of a theoretical character, for the elucidation of the numerical characteristics of the viciating influence of the ice cover on the indications of the ordinary tide-pole.

The above described appliance gives a positive solution of the problem of sea-level observations in winter, and, for this reason, may be recommended to all polar stations.