GEOPHYSICS

1960

SovietRxiv

Abstract

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GEOPHYSICS

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RECORDED SUMS OF HEAT OF SOLAR RADIATION IN THE OCEAN FROM 64° S. LAT. TO 60° N. LAT.

(Presented by Academician V. V. Shuleikin on 10 II 1960)

During the stay of the diesel-electric ship *Ob'* in the roadstead of the Antarctic observatory Mirny, a solarigraph of V. V. Shuleikin' s system* was connected into the pyranometer circuit. The solarigraph continuously recorded the amount of heat arriving in the form of radiant energy from the Sun and the sky. The receiving part of the solarigraph was a thermobattery mounted on a gimbal suspension. At the beginning of the voyage the thermobattery with the gimbal suspension was fastened at the top of the mainmast, at a height of about 30 m above the sea surface. Later the thermobattery was moved to a place more convenient for carrying out the necessary servicing—onto the helicopter deck, where the height of the receiver above sea level did not exceed 14 m. The place for the thermobattery was selected so that the mast shrouds and cargo booms would not shade it. To protect it from the destructive action of precipitation and wind, a hemispherical glass cap was installed over the thermobattery. The recording part of the instrument—the galvanograph—was fastened on a gimbal suspension to the ceiling of the meteorological cabin located on the deck.

As a control instrument, a Yanishevsky pyranometer was used, preliminarily checked by comparison with an absolute instrument—the Ångström pyrheliometer. The values of the total radiation intensity obtained in the control measurements with the pyranometer were used in processing the observational material to determine the conversion coefficient of the solarigraph.

At the moment of radiation measurement, the total amount of clouds and the amount of lower-tier clouds were determined visually in points. At the same time, the state of the solar disk was noted.

The conversion coefficient K was determined from the formula

$$K = \frac{P}{Sv_{\text{cp}}},$$

where P is the pyranometer reading in cal/cm$^2\cdot$min.; S is the solarigraph reading (deflection of the pointer in cm); v_{cp} is the mean speed of motion of the

Fig. 1. General picture of the latitudinal distribution of insolation

Figure 1: Fig. 1. General picture of the latitudinal distribution of insolation

tape in cm/min.

In order to obtain the amount of heat arriving at 1 cm^2 of a horizontal surface from all points of the hemisphere toward which the surface is turned, it is sufficient to integrate the area on the solarigraph tape bounded by the zero line and the curve of the radiation record over a day.

The area F, obtained by planimetry, in cm^2 is multiplied by the conversion coefficient K (the value F having first been multiplied by the planimeter coefficient R). The product FRK gives the amount of heat Q arriving as a result of insolation, in cal/cm^2 per day.

As a result of the continuous recording of heat carried out during the passage of the diesel-electric ship *Ob'* from the shores of Antarctica to the Baltic

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* For a detailed description of the solarigraph, see ([3], [4]).

···of the sea, it became possible to reproduce graphically the general picture of the latitudinal distribution of insolation, represented by the continuous curve Q in Fig. 1.

The graph clearly shows that the maximum of total solar radiation in the winter period of the Southern Hemisphere falls in the tropical zone of the Northern Hemisphere, where it reaches 850 cal/$cm^2 \cdot$ day. The minimum of insolation falls in the subantarctic region of the ocean; here the mean value of the incoming heat lies within the limits of 11-122 cal/$cm^2 \cdot$ day. A minimum is distinctly expressed in the equatorial zone, caused by the presence of powerful cloudiness formed as a result of intense evaporation of water from the ocean surface.

The curve Q_0 characterizes the latitudinal distribution of the maximum possible sums of heat from direct solar rays under an absolutely clear, cloudless sky and with the transparency of the air attainable in the corresponding regions of the globe. The values for this curve were taken according to the computations of N. I. Egorov (1) and V. V. Shuleikin (2) for the corresponding geographical latitude and season of the year. Beneath the graph are given the dates on which the vessel passed the corresponding geographical latitude.

Fig. 1. General picture of the latitudinal distribution of insolation

Comparison of the curves Q and Q_0 gives an idea of the role of cloudiness in the absorption of heat from solar radiation. To determine the most probable actual amount of heat reaching the ocean surface per day, it is necessary to know the value of the coefficient of utilization of solar energy η, the concept of which was

Fig. 2. Latitudinal distribution of the coefficient of utilization of the radiant energy of the Sun

Figure 2: Fig. 2. Latitudinal distribution of the coefficient of utilization of the radiant energy of the Sun

first introduced by V. V. Shuleikin (3). This coefficient sufficiently characterizes the overall influence of clouds on the arrival of radiation from direct solar rays:

Fig. 2. Latitudinal distribution of the coefficient of utilization of the radiant energy of the Sun

$$\eta = Q/Q_0,$$

where Q is the measured sums of heat, and Q_0 the possible sums of heat of direct solar radiation at a given declination of the Sun and under an absolutely clear sky.

It is practically impossible to cover by measurements all the belts of the Northern and Southern Hemispheres over a comparatively short interval of time. Therefore, for an objective characterization of the features of different latitudinal belts at different seasons of the year, it is essential to know the relation between lati-

of the corresponding belt and by the mean coefficient of utilization of the Sun' s radiant energy. The distribution of the utilization coefficient is shown in Fig. 2, constructed on the basis of the curves Q and Q_0 in Fig. 1. Here two minima in the utilization of radiant energy are clearly expressed (at $\sim 40^\circ$ S lat. and in the equatorial zone) and two maxima in the tropical belts of both hemispheres.

It is interesting that the mean utilization coefficient $\bar{\eta}$ in the equatorial region is less than the coefficient for the subantarctic belt. The smallest values of $\bar{\eta}$ are confined to the region of the "roaring" forties latitudes of the Indian Ocean. Evidently this is due to the presence of powerful cloudiness, which is associated with the intense cyclonic activity characteristic of these latitudes. There is reason to believe that in the zone of the sixtieth latitudes of the Northern Hemisphere, where the main track of polar cyclones passes, there is an analogous minimum in the utilization of solar energy.

In conclusion it should be noted that the results presented here for continuous recording of heat were obtained before the beginning of the International Geophysical Year, during a comparatively short interval of the year (1½ months), characterized by the maximum heat input in the Northern Hemisphere. The observations covered a considerable area from the Southern Polar Circle to the Baltic Sea. The measurements were carried out mainly in a comparatively little-studied region of the World Ocean—the Indian Ocean (its comprehensive study began only in 1959).

Taking this opportunity, I express my deep gratitude to L. G. Sobolev and A. P. Istomin for their active assistance and participation in the investigations, carried out under exceptionally difficult sailing conditions in the southern polar latitudes.

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Received
7 II 1960

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Note: Figure translations are in progress. See original paper for figures.