SCIENCE

The Solar Constant

STRICTLY defined, the solar constant is the total energy received in one minute upon a unit of surface perpendicular to the sun's rays, in free space at the earth's mean distance from the sun. It is usually expressed in langleys per minute, or the equivalent, gram-calories per square centimeter per minute.

Early in the present century the Astrophysical Observatory of the Smithsonian Institution, under the direction of the pioneer astrophysicist S. P. Langley, began a long-range study of the solar constant and its probable day-to-day variations. The classic work of Abbot and Fowle that followed—their development of instruments and methods, their search for satisfactory sky conditions, their studies of the absorption and scattering of radiation by water vapor, ozone, and dust—placed the solar constant research on a firm foundation.

In continuation of this Smithsonian project, there has now accumulated over a period of nearly 30 years a chronological record of solar constants computed from very specialized observations at high altitude stations in desert regions. The mean of these thousands of values is 1.946 langleys per minute. This mean, it should be noted, is not intended to express the absolute value of the solar constant, since the effort throughout has been to maintain a homogeneous series, preserving the original scale unchanged. The record indicates a surprisingly small, irregular variation, seldom exceeding a range of 2 per cent, with a gradual trend toward larger values. The total increase in the means of successive 5-year intervals is .3 per cent since 1925. The largest increase occurs in the 1946–50 interval, during which the number of sunspots reached a higher value than at any time since the year 1778.

The probable absolute value of the solar constant based upon this mean is largely determined by three factors: First, careful study indicates that the original arbitrary scale of radiation, which has since remained unchanged, is 1.8 per cent below the standard scale adopted by the Smithsonian in 1913. This conclusion is based upon a re-examination of all intercomparisons between pyrheliometers (instruments that measure total solar radiation at the observing station). Second, all comparisons since 1932 against the improved Smithsonian standard pyrheliometer agree in indicating that the correct scale of radiation (in true gram-calories) is 2.4 per cent below the adopted 1913 scale. Third, the corrections applied to the summation of energy in the observed region (wavelengths .34–2.4 μ) to allow for the unmeasured energy above and below this range need revision. New data from recent infrared studies and from V-2 rocket ultraviolet results indicate that the corrections applied should be increased by several per cent. One would assume that adding a percentage correction to the measured energy would proportionately increase the resultant solar constant. However, in the process of extrapolating the observations to zero air mass, there is an indirect compensatory factor that acts in the sense to diminish the effect of the increased corrections. From actual re-reductions of several typical long-method days, using a total ultraviolet plus infrared correction larger by 4 per cent of the observed energy, the solar constant is increased only .6 per cent.

Applying the three factors just mentioned (+1.8% to bring to the 1913 scale, −2.4% to reduce to true calories, and +.6% for larger ultraviolet and infrared corrections), the probable absolute value is, curiously enough, equal to the mean value 1.94. It is also identical with the solar constant that has been generally adopted in meteorological literature, based upon early Smithsonian results.

There is currently much interest in travel beyond the stratosphere. When this is accomplished, direct measurements of the solar constant, unhampered by an ever-changing and complex atmosphere, will follow.

L. B. ALDRICH
W. H. HOOVER

Astrophysical Observatory
Smithsonian Institution

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.
All correspondence should be sent to SCIENCE, 1515 Massachusetts Ave., N.W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.
Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.
The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates on request.
Cable address: ADVANCESCI.