cation work and cooperate in every possible way to secure for the biological workers of the country the form of publication and distribution which their researches deserve.

SOCIETIES AND ACADEMIES

THE WASHINGTON ACADEMY OF SCIENCES

MR. C. G. ABBOT, the director of the Astrophysical Observatory of the Smithsonian Institution, delivered before the academy, March 24, an address on "Recent Studies of the Sun."

Mr. Abbot gave a summary of the researches included in Volume II. of the *Annals of the Astrophysical Observatory of the Smithsonian Institution*, now about to be issued. Besides this he gave a brief account of the Smithsonian expedition to observe the total solar eclipse of January 3, 1908.

The mean value of the solar constant of radiation in calories per square centimeter per minute from 44 observations at Washington, D. C., 1902–6, is 2.061; from 59 observations on Mt. Wilson, California, in 1905, it was 2.024, and from 62 observations at Mt. Wilson in 1906 it was 2.020. Langley thought it necessary to add about one third to his solar constant value from Mt. Whitney observations of 1881 because of a supposed failure of Bouguer's transmission formula. This correction does not appear to be justified, and Langley's values should be as follows: For Lone Pine 2.06, for Mountain Camp 2.22, and their difference is reasonably attributed to experimental error, not difference of altitude. The fact that so good agreement between the Washington, Lone Pine, Mt. Wilson and Mt. Whitney values is found makes it most probable that the true solar constant value differs very little from 2.1 calories. It was shown from the temperature of the earth's radiating surface that the solar constant can not exceed 2.33 calories unless the reflecting power of the earth as a planet exceeds 37 per cent. The latter value was derived by measuring the reflecting power of clouds and other terrestrial surfaces.

Variations of the solar constant values were noted both in Washington and on Mt. Wilson, and these are so large and so well established by observation as to warrant the continuation of solar constant work at two observatories in cloudless regions of the earth well separated from one another. A study of the surface temperatures of the earth at 48 inland stations widely distributed over the globe indicates that general variations of temperature have occurred which may have been caused by solar variations of short period. The sun-spot cycle is clearly associated with a temperature variation; for higher temperatures occur at sun-spot minimum.

The variation of brightness of the sun's disk from center to limb has been observed for various wave-lengths of light, and on numerous days of observation. Changes of the rate of this variation have been noted from time to time, and these changes may prove to be associated with variations of the solar constant of radiation. Probably the cause of the decreased brightness near the sun's limb is the lower temperature of the sources of light near the limb, due to the fact that the scattering of light by the molecules of the gases of the sun prevents us from seeing as deep near the limb as at the center of the disk. The scattering of rays is so great in the atmosphere of the earth that, reasoning by analogy, scattering probably prevents us from seeing at the center of the sun's disk as much as 1 per cent. of the solar radius below the outer photospheric layers, and far less even than this at the sun's limb, owing to the greater length of path of the rays to a layer of given depth. This explains the apparently sharp boundary of the sun's disk, notwithstanding the necessity of admitting the gaseous nature of the sun on account of its extremely high temperature.

The Smithsonian Institution sent Messrs. Abbot and Moore to Flint Island by invitation of Director Campbell, of the Lick Observatory. They observed there, on January 3, 1908, the intensity of the rays of the solar corona at five points, and found them at brightest only 1/1,000,000 as bright as sun rays. They employed a bolometer in focus of a twenty-inch equatorial reflecting telescope. Glass was in front of the bolometer to prevent exchanges of long wave-length rays. By means of an

asphaltum varnish screen it was found that the quality of coronal and solar radiation transmitted by glass differed little in relative proportion of visible and infra-red rays. From this and other observed facts it was inferred that the coronal radiation may probably be mostly reflected sun rays. The absence of Fraunhofer lines in light of the inner corona was attributed to the bright line spectrum of hot gases in the corona superposed on the spectrum of reflection.

In the discussion that followed Mr. Abbot's address, Professor Frank H. Bigelow reviewed the difficulties of determining the solar constant and Professor C. F. Marvin remarked upon the great ingenuity and skill shown during this investigation in devising instruments and making observations in a difficult field.

Mr. J. F. Hayford expressed his ardent admiration of the research presented in Mr. Abbot's address and stated that as he had heard of the research during its progress and read the proof of the complete paper of which his address is an abridgement his view-point was intermediate between that of the expert—Mr. Abbot—and that of the audience.

According to Mr. Hayford the grand tactics of this research are especially admirable. They involve broad principles, skilfully applied, which are of general importance in any line of scientific research.

This has been a long investigation, extending over a series of years. The judgment of the investigator has had time to become mature.

The investigator has been wise in extending the effective period of his investigation backward by utilizing the work of those who came before him, by being careful to supplement their work rather than to supersede it. Similarly, he has greatly increased the forces brought to bear upon the problem by supplementing, rather than by attempting to supersede or to repeat, the work of contemporaries.

Mr. Abbot has evidently been keen and skilful in his search for the lines of least resistance, along which greatest progress may be made for a given expenditure of energy. His reward has been the unusual progress made.

These are some of the reasons for confidence in this research, for confidence that its only weak points are those pointed out by Mr. Abbot by cautious wording in the formal printed report.

It may be well to emphasize certain ideas, developed in this investigation, which help one to see the earth in proper perspective.

"The true radiating surface of the earth as a planet is chiefly the water vapor of the atmosphere at an elevation of 4,000 meters or more above the sea level." In other words, the man in the moon, when he looks at the earth, is, in general, blinded to the small contrasts in color on the surface of the earth by the light which comes to him from the air and its contents. He secures but fleeting glimpses of the outlines of the continents.

The layer of air 13,000 feet thick, with its load of other material, including water, is a great blanket of peculiar kind such that it allows the sun's radiation to penetrate downward through it more readily than it allows the radiation to return upward in the somewhat changed form in which it then exists. The result is that, while the radiating layer has a temperature of about —10° C. the surface of the earth is maintained at about 14° C.

It seems to be conclusively proved that the amount of the radiation sent to us from the sun varies 5 per cent. in each direction from its mean value. The variation is irregular, not periodic, and the intervals of marked excess or defect are only a few days or a few weeks, as a rule.

It was hoped, at the beginning of this investigation, that it might lead to the discovery of means of forecasting climatic conditions for some time in advance. The investigation shows that the 5 per cent. variation in the radiation produces only about 1° C. change in temperature at favorable inland stations and a fraction of a degree only at island and coast stations. This direct effect is, therefore, very small.

J. S. Diller,
Recording Secretary

Discussion and Correspondence

Wild Jamaica Cotton

To the Editor of Science: I send you herewith a letter from Dr. N. L. Britton, who is