spectral bands that are transmitted by Schott glass filters OG1 (yellow) and RG2 (red):

TABLE 4.—*Transmission coefficients for different temperatures of screens*

Temperature		Transmission	
° F.	° C.	OG1	RG2
−36	−38	0.863	0.855
−18	−28	.861	.852
±0	−18	.859	.850
+18	−8	.857	.847
+36	+2.2	.855	.845
+54	+12.2	.853	.842
+72	+22.2	.851	.840
+90	+32.2	.847	.837
+108	+42.2	.844	.835

Baker (8) has made extensive measurements of the temperature of the Schott glass color filters when exposed to sunlight, as they are for 3 minutes while measuring the intensities I_y and I_r. His measurements, summarized in table 1 of the next paper in this REVIEW, indicate that the color screens have at the beginning of exposure a temperature 1.2° C. above air temperature, and that the average excess during the 3 minutes exposure is 1.4° C.; thus, there is an average total excess of 2.6° C. above air temperature. This is indicated in table 2, in the headings of columns (7) and (8), by writing in the denominator of each fraction, after the number that denotes the value of the transmission at temperature 22.2° C., the letter *c*., to indicate that a correction is to be applied to make the denominator agree with the value given in table 4 at the temperature of the screens.

Returning now to table 2, we find that the divisors throughout December 28 were 0.857 for the yellow screen and 0.847 for the red, appropriate to a midday temperature of about +17° F., or −9.3° C. for the air, and about −6.7° C. for the glass screens.

From this point on, the work in table 2 is simple: Each set of values of I_y and I_r is divided by its transmission coefficient, determined in the same manner as in the example just given. The value of I_r thus obtained is then subtracted successively from I_m and I_y; and from the results, by interpolation in figures 3 and 4, this REVIEW, March 1933, page 64, we obtain the value of β, the coefficient of atmospheric turbidity for the time at which the solar radiation measurements were made. Two determinations of β are obtained, one from the value of $I_m - I_r$ and the other from the value of $I_y - I_r$, representing intensities in different parts of the solar spectrum. (See above reference, figs. 3 and 4, for spectral limits in each determination.) It will be noted that the first pair of values were not in so close accord as those obtained later in the day; figure 1 shows that the intensity trace at the earlier time was not so steady as it was later, indicating possible momentary disturbances from local smoke, or, more probably, from thin clouds. During the remainder of the day, sky conditions were remarkably steady.

Using the mean values of β for each set of measurements, we obtain from figure 2, this REVIEW, March 1933, above quoted, the values for I_m in an atmosphere having the turbidity computed for December 28, expressed as a percentage of the solar constant, 1.94. Subtracting from this the value of I_m in table 2, column (4), expressed in the same units, we obtain the percentage loss that may be attributed to absorption by gases in the atmosphere. Deducting 0.3 from the total loss by absorption given in column (15), and dividing the remainder by $\sqrt{m}$, we obtain what appears to be a close approximation to the depth of water that would be formed if all the water vapor above the place of observation were precipitated.

The small amount of water vapor indicated by the morning observation is probably due to an overestimate of the loss by scattering; or in other words a too high value of β led to a too low value for w.

Under "Air mass type", in the last column of table 2, is given the probable source of origin of the air as indicated on air mass analysis maps.

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MEASUREMENT OF SCHOTT GLASS FILTER TEMPERATURES

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In the solar radiation program at Blue Hill Meteorological Observatory, atmospheric turbidity and water vapor content are measured by a method developed by H. H. Kimball. In this method the energy in selected regions of the spectrum, received at normal incidence, is measured by means of a thermopile. Isolation of the desired spectral regions is effected by two Schott glass filters, mounted in such a way that they can be swung in and out of the incident beam in succession.

It is a well-recognized fact that the transmission of radiation through any filter that exhibits either selective or nonselective absorption is a function of temperature. The purpose of the present investigation was to measure the temperatures which the filters assumed, in order that a temperature correction to the transmission might be applied.

The filters are circular in shape, 3 centimeters in diameter, one-half millimeter thick, and are mounted as shown in figure 4 of the preceding paper by H. H. Kimball. It is obvious that a determination of the internal temperature of the filters is impracticable. A good approximation to the internal temperature is the surface temperature, which could quite easily be measured. Accordingly the surface temperature of the filters was measured under the actual conditions of use. An instrument based on the thermoelectric effect seemed most feasible for the measurement. Thermocouples were constructed and were found quite satisfactory for the purpose.

In use the filter is swung into a position such that its surface is normal to the incident beam. This position is maintained usually for 3 minutes. Two questions present themselves: What is the temperature of the filter before exposure to direct solar radiation? What is the rise in temperature during the 3-minute exposure period?

The thermocouples were constructed of no. 34 copper wire and no. 30 constantin wire, and the junctions were soldered; the wires may be seen, in figure 4, hanging from the upper end of the thermopile tube. Current rather than emf was measured, as the conditions under which measurements were made necessitated the use of simple portable equipment. The current flowing in the thermocouple circuit is not a linear function of temperature, but this fact is of no consequence, because the thermocouple had to be carefully calibrated anyway.

It is essential that the hot junction be in intimate contact with the glass. Various modes of fastening were tried. The most satisfactory method was to bind the junction to the glass with a strip of transparent Scotch cellophane. A possible source of error lies in absorption of radiant energy by the hot junction itself—with consequent rise in temperature. This effect proved to be negligible however, because of the high thermal conductivity, low specific heat, and small cross section of the hot junction. The cellophane had the effect of shielding the glass surface and the hot junction from the moving air. Since the air would have a cooling effect and tend to reduce the rise due to absorption of radiant energy, this shielding effect was not altogether undesirable, since the greatest possible temperature change was wanted as well as the mean. The position of the hot junction proved not to be of critical importance; both front and back surfaces were used, with no difference greater than 0.5° C. found between the two.

The change in transmission with temperature as determined for these filters at the National Bureau of Standards is such a slowly changing function of temperature that the filter temperatures do not need to be known, for purposes of correction, closer than 1.0° C. The thermocouples give temperature readings which are good to 0.1° C. The lower limit of accuracy here is of course imposed by lack of galvanometer sensitivity. The thermocouple was calibrated in the usual way, using water baths of known temperature and making suitable correction for the temperature coefficient of resistance of the wire.

RESULTS

The data are collected in table 1. Comparison of columns I and IV shows that the surface temperature of the shaded screen is on the average about 1° C. higher than the free air temperature. There seemed to be no detectable characteristic difference between the temperatures of the red filter and those of the yellow filter, under comparable conditions, so no distinction has been made between them in table 1.

Most of the data were obtained in August. Observations in midwinter (January) gave comparable results, both qualitatively and quantitatively, as might be expected.

From column VI, the average rise in surface temperature of the filter in 3 minutes is 2.8° C. For correction purposes the average rise in 3 minutes is the more significant quantity, and may be taken as 1.4° C.

Under all normal conditions, the shaded filter temperature may be taken as 1° C. higher than the current air temperature.

It is obvious that the rise in temperature is a function of two independent variables, radiation intensity and wind velocity, and would be represented graphically by a surface in three dimensions. One interesting property of this surface may be noted—namely that it shrinks to a point at the origin. No attempt has been made to sketch this surface from experimental data, as the range of intensities is not sufficient to fix the shape of the surface with any accuracy.

TABLE 1

I	II		III			VI	VII
	Galvanometer deflection in equivalent degrees			"Hot" junction			
Air temperature ° C.	Shade	Sun	"Cold" junction	IV Shaded	V 3 minutes in sun	Rise in 3 minutes	Excess of screen temperature over air temperature
August	° C.	° C.	° C.	° C.	° C.	° C.	° C.
21.1	−1.5	+1.4	23.2	21.7	24.6	2.9	0.6
21.7	−1.5	+1.5	23.5	22.0	25.0	3.0	.3
21.9	−.5	+2.5	23.5	23.0	26.0	3.0	1.1
22.2	−1.5	+1.6	24.0	22.5	25.6	3.1	.3
22.2	−2.4	+.3	26.5	24.1	26.8	2.7	1.9
22.2	−3.5	−1.0	26.0	22.5	25.0	2.5	.3
23.9	−5.3	−2.2	31.0	25.7	28.8	3.1	1.8
23.9	−4.8	−2.2	31.0	26.2	28.8	2.6	2.3
23.9	−6.3	−.8	31.5	25.2	30.7	5.5	1.3
23.9	−3.5	−1.8	31.5	28.0	29.7	[1] 1.7	[1] 4.1
23.4	−1.7	+.5	25.8	24.1	26.3	2.2	.7
23.4	−1.2	+1.4	26.0	24.8	27.4	2.6	1.4
24.1	−1.6		26.7	25.1	26.7	1.6	1.0
24.1	−1.2	+.7	26.2	25.0	26.9	1.9	.9
19.4	−4.7		25.2	20.5			1.1
19.4	−4.0		25.2	21.2			1.8
21.6	−1.5	+3.1	25.2	23.7	28.3	4.6	2.1
21.1	−1.5		25.2	23.7			2.6
21.0	−2.2	1.2	23.8	21.6	25.0	3.4	.6
21.2	−2.5	+1.3	25.0	22.5	26.3	3.8	1.3
January							
+2.0	−16.9		20.0	3.1			1.1
−0.8	−10.4		11.2	0.8			1.6
−0.7	−8.0		8.0	0			.7
−1.0	−6.8	−3.8	7.2	.4	3.4	3.0	1.4
−0.7	−6.2	−3.9	7.4	1.2	3.5	2.3	1.9
+0.5	−1.7		3.7	1.5			1.0
+0.5	−8.1		8.7	.6			.1
+1.0	−5.5	−3.9	6.9	1.4	3.0	1.6	[2] .4
+5.0	−2.5		8.6	6.1			1.1
+5.0	−2.7		8.1	5.4	6.4	1.4	[2] .4
Mean						2.8	1.2

[1] Only 1 minute after previous observation. [2] Low radiation intensity.