A Supplement to "Optical Properties of a Plastic Pyranometer Head"

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1. Introduction

Schotland and Copp (1982) described the optical characteristics of a newly designed two-step pyranometer head. The percentage error in the cosine response of this head, when new, was measured to be less than 1.5% over an angular range of 85° in the spectral range 400–720 nm. The percentage error in the cosine response $C_\lambda(\Theta)$ is defined as

$$C_\lambda(\Theta) = 100\left[\left(\frac{R_\lambda(\Theta)}{R_\lambda(0)}\right)\left(\frac{1}{\cos\Theta}\right) - 1\right],$$

where $R_\lambda(\Theta)$ is the response of the pyranometer to the flux of wavelength λ incident at an angle Θ with respect to the normal of the pyranometer surface. After the head had been continuously exposed to weather for a period of 13 months, $C_\lambda(\Theta)$ was remeasured and found not to exceed 4.8% in the same angular and spectral intervals.

Recently the head was used in a measurement program which required diffuse atmospheric flux measurements in the visible and near-infrared wavelengths. The instrument was modified so that observations could be taken at 873 and 1031 nm, in addition to the original six wavelengths. Since the head had been exposed to the environment for two years, $C_\lambda(\Theta)$ was again measured using techniques similar to those described by Schotland and Copp (1982).

The purpose of this note is to show the effect of weathering on the performance of the head and to point out the limitations of this design when the head is used in the near-infrared portion of the spectrum.

2. Results

The "two-year" calibration $C_\lambda(\Theta)$ as a function of angle of flux incidence is given in Table 1. The radiation source used in this study was unpolarized, so that these results correspond to curves labeled "averaged response" in the original paper. The maximum fractional standard deviation of the data used in the computation of Table 1 was 0.003.

The data in Table 1 indicate that $C_\lambda(\Theta)$, in the visible portion of the spectrum, did not change significantly from the 13-month calibration for angles of incidence $0 \leq \Theta \leq 80°$. However, the performance

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TABLE 1. Percentage cosine error as a function of angle of incidence Θ and wavelength λ.

λ (mm)	Θ (deg)																	
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
401.8	0.0	0.1	1.0	1.3	1.6	2.0	1.8	2.1	2.1	2.1	2.4	2.9	3.3	1.0	−0.5	−2.9	−3.9	−7.3
439.5	0.0	0.1	1.0	1.1	1.6	1.6	1.4	1.3	2.8	1.6	1.9	2.7	3.4	2.8	0.4	−1.3	−2.2	−5.4
520.9	0.0	0.1	1.2	1.4	1.8	1.9	2.2	1.9	1.9	2.1	2.2	3.0	3.2	2.2	−0.4	−2.0	−1.9	−4.4
555.0	0.0	0.0	0.7	1.2	1.3	1.5	1.5	1.2	1.1	1.2	1.2	1.6	1.5	0.7	−2.0	−3.4	−3.7	−5.6
612.0	0.0	0.2	0.9	1.3	1.6	1.7	1.6	1.7	1.5	1.9	2.0	2.5	2.9	2.3	−0.5	−1.2	−1.5	−3.5
670.9	0.0	0.3	0.7	1.0	1.4	1.5	1.2	0.8	0.9	1.1	0.8	1.2	1.5	0.8	−2.3	−3.1	−4.2	−6.2
873.2	0.0	−0.2	−0.6	−0.7	−1.3	−2.4	−3.7	−4.7	−5.5	−7.1	−7.7	−9.0	−10.0	−11.0	−13.2	−14.7	−15.8	−18.3
1031.4	0.0	−1.4	−1.4	−2.5	−3.5	−4.7	−6.4	−8.7	−10.8	−12.7	−14.5	−16.4	−18.0	−20.5	−22.5	−24.2	−26.3	−29.6

of the head worsened substantially in the range $80° \leq \Theta \leq 85°$. Examination of the head showed a rounding of the edges of the steps which provide the necessary flux correction at large angles of incidence. This rounding was probably caused by scouring of the plastic by airborne particles. The effect was previously noted at the 13-month calibration, but the rounding is now more severe.

The cosine response of the head was unsatisfactory in the near-infrared spectral region. It is recommended that the head not be used in this wavelength region unless appropriate corrections are applied to the measured data or the flux is limited to relatively shallow angles of incidence. It should be noted that the present head design can be modified for use in the near-infrared, but this modified design would not be suitable for use at the shorter wavelength.

REFERENCE

Schotland, R. M., and J. D. Copp, 1982: Optical properties of a plastic pyranometer head. *J. Appl. Meteor.*, **21**, 735–739.