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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Nocturnal aerosol optical depth measurements with modified skyradiometer POM-02 using the moon as a light source" *by* Akihiro Uchiyama et al.

Thomas Stone

tstone@usgs.gov

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The article "Nocturnal aerosol optical depth measurements with modified skyradiometer POM-02 using the moon as a light source" presents aerosol optical depth (AOD) measurements acquired at night using the Prede POM-02 radiometer. The exo-atmospheric lunar irradiances used in this work for AOD retrievals are obtained from an implementation of the USGS ROLO lunar model [Kieffer and Stone, 2005 (hereafter K&S)]. The approach presented in this paper utilizes the direct outputs of the ROLO lunar disk reflectance model, K&S Eq. 10, rather than using the model to generate lunar irradiance as it is intended. These direct outputs of K&S Eq. 10 are then interpolated

to the wavelengths of the POM-02 instrument spectral bands. There are significant problems with this approach, and it is not recommended to use the ROLO model in this way.

The lunar disk reflectance spectrum produced from computing K&S Eq. 10 exhibits a large amount of spectral structure, as can be seen in the example of Figure 1 of this comment. This structure is the result of the development process for the ROLO model, where the model coefficients were determined for each of the ROLO bands independently. However, the actual reflectance spectrum of the Moon is known to be smooth, with only broad, shallow absorption features [e.g. Pieters and Mustard, 1988; McCord et al., 1981]. To remove the artificial spectral structure produced by K&S Eq. 10, the USGS ROLO system fits these outputs with a reference lunar reflectance spectrum. This reference spectrum was developed from laboratory spectra of returned Apollo samples, and it is considered representative of the lunar disk as a whole in terms of spectral content (not absolute reflectance). The fitting process smoothes the results of Eq. 10 to give a realistic lunar reflectance spectrum. Figure 1 shows an example of the outcome of this process. It should be apparent from this figure that interpolating between the direct results for the ROLO bands (square symbols) generally will not produce values that align with the fitted spectrum (solid line).

The recommended usage of the ROLO model is to fit the reference reflectance spectrum to the outputs of Eq. 10, where these have been computed for the particular phase angle and librations of the instrument's Moon observation, then convolve this fitted spectrum with the sensor band spectral response and the solar spectral irradiance to give lunar irradiance, as:

$$E_{\mathsf{M}} = \frac{\Omega_{\mathsf{M}}}{\pi} \frac{\int A_{\mathsf{fit}}(\lambda)\, E_{\mathsf{Sun}}(\lambda)\, S(\lambda)\, d\lambda}{\int S(\lambda)\, d\lambda} \tag{1}$$

where E_{M} is the lunar spectral irradiance, Ω_{M} is the solid angle of the Moon, $A_{\mathsf{fit}}(\lambda)$ is the fitted lunar reflectance spectrum, $E_{\mathsf{Sun}}(\lambda)$ is the solar spectral irradiance, and $S(\lambda)$ is the sensor band spectral response. The result of Equation 1 must then be corrected for the actual Sun-Moon and Moon-sensor distances of the instrument's Moon observation. The solar spectral irradiance used in this step should be the PMOD-WRC model published by C. Wehrli (`ftp://ftp.pmodwrc.ch/pub/publications/pmod615.asc`). This is because the Wehrli solar model was used to convert the original ROLO irradiance data to reflectance for developing the disk reflectance model, and the same solar model must be used to convert reflectance back to irradiance (Equation 1) to avoid errors caused by differences in the solar spectral models.

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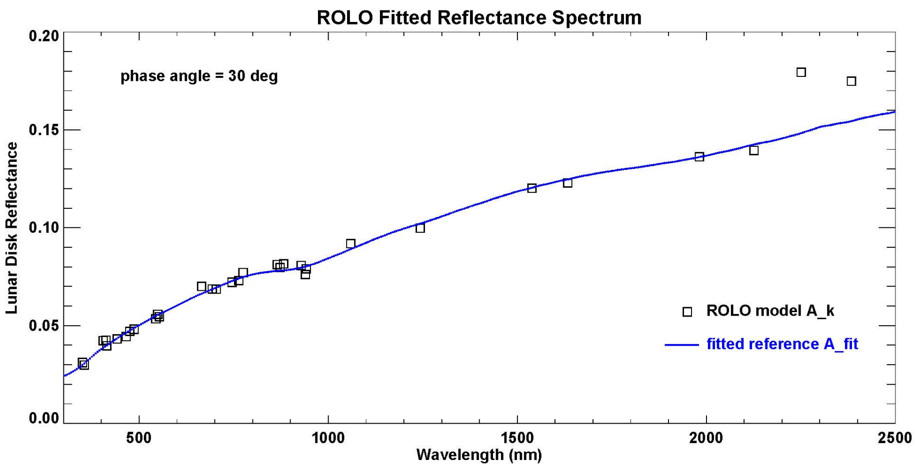

Fig. 1. Example of ROLO lunar disk reflectance model output and fitted reference lunar reflectance spectrum