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Atmospheric Measurement Techniques Discussions

Interactive comment on "A new method of measuring aerosol optical properties from digital twilight photographs" *by* M. Saito and H. Iwabuchi

Anonymous Referee #3

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The paper proposes a method to estimate stratospheric and tropospheric optical depths from fisheye digital photographs of twilight sky. The method consists in the retrieval of the stratospheric and tropospheric optical depths and the coarse-fine particle volume ratio from twilight sky brightness measurements at 7 solar zenith angles (SZA) from 90° to 96°, 10 viewing zenith angles (VZA) from 60° to 88° and 4 relative to the sun direction azimuths from 0° to 30°. The blue (B), green (G) and red (R) channels of the camera had a halfwidth about 80-100 nm (as can be estimated from the Fig.2). The measurement vector contained two color ratios R/G, B/G and the green channel normalized to the green channel measurement acquired at VZA 70°. The color ratios and the green channel normalization allowed to remove the calibration factor. The paper corresponds to the AMT profile and can be published with major revisions.

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Interactive Discussion
Discussion Paper

The use of the fisheye lens is attractive because it gives the possibility to measure the sky brightness at all azimuthes and VZAs by taking one image. But this technique is very sensitive to the quality of the flat field and to the presence of a stray light. The authors use the ratio of measurements acquired at two different VZAs, i.e. the measured light intensity from the different parts of the image. This means that the uncertainties due to the flat field problem should be important. Authors take the vingetting into account, but it is impossible to remove the vignetting effect absolutely perfectly. Uncertainties caused by this effect should be discussed. The most important problem which was not addressed in the paper is a stray light. The twilight sky brightness is highly nonuniform, with very bright segment near the horizon and the dark sky in the zenith area. When we take an image using fisheye lens any light scattered in the optics can cause the stray light in the darker part of the image. The stray light will affect both the normalized green channel measurements and the color ratios. The stray light problem should be investigated. Nothing has been told about the dark current. If it was not extracted it could become a significant source of uncertainty. Nothing was told about the distortion corrections. The distortion can introduce uncertainties in the VZA and azimuth estimations. One and the same exposure time 8 sec was used for all measurements (page 197 line 8). The twilight sky brightness changes significantly from SZA 90° to SZA 96°. Is the CCD dynamic range large enough to register the maximal and minimal brightnesses? At least one plot with the experimental data and the appropriate measurement uncertainties should be presented. When the measurements were carried out at the VZA=88° the signal in the blue and the green channels should be quite low. It is necessary to show that the signal is still above the level of noise. The calibration factor is considered as independent of the wavelength. This should be discussed.

The real and the imaginary parts of the refractive index (page 204, line 25) as well as the coarse-fine particle volume ratio (page 199, line 20) were taken the same for the troposphere and the stratosphere. They are essentially different.

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The authors presented the sensitivity tests (section 3.2) to show that the color ratios and the normalized green channel are sensitive to the stratospheric and tropospheric optical depths. Instead of this they should show that the proposed measurements (page 202, lines 13-14) with the associated uncertainties contain enough information to retrieve the stratospheric and tropospheric optical depth and the coarse/fine fraction aerosol ratio. They should show the appropriate averaging kernels to demonstrate that it is possible to separate the stratospheric and tropospheric aerosol optical depths. The spectral halthwidths of the channels are quite large (80-100 nm). This should reduce the altitude resolution and bring an uncertainty to the stratospheric optical depth determination. The state vector should be also reconsidered. Is it worth to try to retrieve the coarse/fine particle volume? The retrieval result does not show good correlation with the skyradiometer results (Fig.9c). The coarse/fine particle volume ratio cannot be the same for the boundary layer, the troposphere and the stratosphere. To avoid too many parameters to retrieve it is better to use climatological values. Aerosol profiles were not retrieved in this study. In the chapter 3.1 some assumptions about the aerosol extinction profile were made. It is desirable to include a figure where the used aerosol profile will be shown and to discuss what uncertainties can bring this a priory aerosol profile.

The term “chromaticity” is not correct. Better to use the term “color ratio”.

“was sensitive to twilight sky” (p. 193 line 24) should be “..twilight sky brightness” or “twilight sky light intensity”.

The measurement vector is determined only in Conclusions (p.211, line 14). It should be done earlier. Figs 3,4,5, and 9 are too small.

Are the units used in Figs 6-7 percents?

The authors propose to use the twilight measurements during the polar night (e.g. page 194, line 20). They should speak about the polar twilight because there is no twilight during the polar night. Before to claim that such observations can be useful in the polar

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regions it is necessary to show at which latitudes and how long time the solar zenith angle varies in the desirable range.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 191, 2015.