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Atmospheric Measurement Techniques Discussions

Interactive comment on "Measurement of aerosol optical depth and sub-visual cloud detection using the optical depth sensor (ODS)" *by* D. Toledo et al.

Anonymous Referee #1

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Review of Toledo et al.,

Synopsis: This paper provides a description of a rather innovative instrument to estimate aerosol optical depth. Readers are first reminded that this Optical Depth Sensor (ODS), was originally designed to fly on a mission to Mars. Thus, the instrument must be robust (preferably no moving parts), and must be able to account for changing calibration, such as when dust collects on windows. To a certain degree the authors appear to be successful. The ODS is based on the ratio of zenith scattered radiation at zenith to total radiation at all other geometries over the course of a day. This is performed at near UV and red wavelengths. Since their retrievals are based on this ratio, direct calibration drops out. The test this instrument for nearly a year at the Ouagadougou Africa site side by side with a Cimel sun photometer within the AERONET

program. The use of the instrument for moonlit night applications is a nice byproduct. While I give the authors for developing a simple instrument that should be able to work on a Mars lander, the instruments core methodology has many shortcomings from terrestrial applications-some of which are near fatal. These are listed below. Perhaps this paper be rewritten into a short note, specifically on the Mars applications In these cases, the authors could wave away the earth based problems. Under those circumstances I think it is publishable.

Major shortcomings: 1) Most notably, this method is based on inversions of diffuse to total radiation and thus must assume or correct for diffuse radiation from clouds. Since there are nominally no clouds on Mars, or if there are they are likely cirrus-like in nature, this is not a problem. Similarly for airborne dust over mars, spatial homogeneity is a fair assumption. But for terrestrial use, clouds are often in scenes, and we don't know based on the data when that is. From their own data "cloudy skies" have significantly more errors than clear. But a way to deal with this is not given. In fact, it is taught to tell from the paper, when there were clouds in the first place. All that is said was that for cloud conditions there were higher frequency signals in the data. This is hardly quantitative. Further, there are many cases, such as in the presence of cirrus or alto clouds where there would be no high frequency signal.

2) Second, the relationship between aerosol optical depth and the parameter of diffuse to total radiation is inherently dependent on some form of retrieval based on assumed optical properties, notably single scattering albedo and something related to phase function. Errors along their assumption is likely present in Figure 14, where there is a drop off in retrieved AOT for at higher values. This is likely a multiple scattering effect that highlights a bias in the assumed optical properties. You can see it right on que at 0.8. I think For the use of this instrument then, they used the retrievals from Dubovik. What if you don't have a retrieval side by side? If you did, you would not need ODS. Perhaps a more rigor error analysis (perhaps even assuming some Mars values) is probably in order than just a few test cases .

3) On the thin cloud detection side, there is no evidence presented that these are clouds, or what their real properties are. We are given a number of cloud detected, but no real verification analysis. Also, the authors don't seem to realize that cirrus can be inhomogeneous and relatively thick. But again, if they make a case for thin top of the atmosphere clouds on Mars, I would give them some slack.

4) In general, error analysis is a bit optimistic. First, I would prefer that they use root mean square error over chiˆ2-the later having a noise assumption built into it. With RMSE, we know what the signal is. Similarly, I would also prefer rˆ2 to r, as rˆ2 explains fractional variance. The authors could also go further on looking at the effect of shorter term variations. AERONET data is every 15 minutes, so it would be good to look at how much data do you really need in order to do retrieval.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 9611, 2015.