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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Deriving polarization properties of desert-reflected solar spectra with PARASOL data" *by* W. Sun et al.

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This article provides what I consider an obvious first-order approach to modeling the effect of polarization of scattered sunlight over bare/desert regions. The advantages of the model are that it is simple and straightforward and physically intuitive. I consider this to be the first step in more complicated models. In addition, the model does not shy away from using advanced techniques. For instance, the authors select the agglomerated debris particles to represent their atmospheric aerosols. These particles have been demonstrated to be the most accurate at modeling the light-scattering properties of dust particles. In fact, they are the ONLY model particles that can accurately reproduce the light-scattering properties at multiple wavelengths (Zubko, 2013). As an

introductory paper to this complicated topic, the paper leaves open several lines for future research and discussion. Not only does it provide the foundation for future, more advanced modeling approaches, but leaves some research questions unanswered:

Answer: The authors of this manuscript greatly thank this reviewer for the helpful and insightful comments.

1. When more complicated surface models are incorporated, how will this effect the results?

Answer: In the Conclusion, we add "When more complicated surface models such as that considering desert as semi-infinite particle layers are considered, it may improve the total reflectance modeling, but will have little effect on polarization degree and angle of polarization calculation, since polarization is mostly determined by single scattering at the top layer of the sand particles."

2. As with any model that is composed of several distinct physical parts, what are the predominate sources of error and what observations are necessary to test these parts independently, so that we know where it is best to focus our efforts to make improvements?

Answer: For a model composed of several distinct physical parts, the predominate sources of error is from each part. We must test each part and do sensitivity studies on the error effect of each part to determine the final error of the model. When we use observation data to check the error of each part, we must consider the sensitivity study of other parts, and use the representative parameters for other parts to model the final results, which are compared with the observational data.

3. Most significant in my mind are the surface parameters f and sigma and their lack of dependence. What happens, for instance, when we consider extreme incident angles?

Answer: the surface parameters f and sigma are determined by the desert physical fact, which are fitted out by satellite data. They may have dependence on each other.

But when they work together as a pair, they can produce results close to the satellite data. They are paired quantities and must be used as a pair. They should not be significantly affected by incident angles, but since they are derived from satellite data with limited incident angles, they may have small dependence on the incident angle due to sampling issue.

My only significant criticism is that I would prefer to see the figures discussed in more depth. The authors present several of these and make broad statements. In the text, they really should state what each figure shows and why it is being presented.

Answer: There are many figures with similar natures in the manuscript to better show the results for different wavelengths/viewing or incident geometries. Since we already have detailed description of each figure in the captions, we prefer to explaining them in a very summarized way in the text, to avoid redundant statements which make the paper lengthy. We tried our best to make the text concise under the condition that the meaning of each figure can be understood. Thanks for the reviewer's recommendation, but we think we want to keep the summarized way to make the article concise.

There are some minor typographical considerations that I have transmitted to the authors.

Answer: Great thanks to the reviewer for the very detailed corrections of our errors in the text. A lot of careful corrections were made. The authors really appreciate the great help from this reviewer.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 8525, 2015.