Review of A. Wiacek, et al., “Absorbing aerosol radiative effects in the limb-scatter viewing geometry”

General: The article examines the effects of absorbing aerosol layers upon sun-light scattered from the limb of the atmosphere and would be measured by a space based observer. The effects of the absorbing aerosol are contrasted with non-absorbing aerosol also. A dissection of the limb scattered radiance is done by looking at light that is scattered once and that which is scattered multiple times (the sum of the two being the total limb scattered radiance). This partitioning is helpful in illustrating the limitation of simple single particle scattering to understand the effect. The paper does a fairly good job of stating what the effects are and presenting the physical basis. The punch line that limb-scatter retrievals of aerosol extinction being insensitive to external information about aerosol absorption is an important statement and tends to get lost in the various comparisons, discussion and figures in the main body of the article. In addition, a bit more work would be extremely helpful in placing this recent work in context with earlier work focused on space based nadir observations of back scattered sunlight and absorbing aerosol in the atmosphere.

Comments:

Page 1900, line 2 & 1902, line 3: I generally think of the path length being on the order of 200 km for a 1 km thick shell. The entire path through the atmosphere can be thousands of km. Additionally, the high vertical resolution is only possible if the instrument has a small Instantaneous Field of View.

Page 1904, line 3: Is 65 degrees truly a “low” solar zenith angle?

Page 1909, line 12: Herman et al., 1997 is missing from the Ref. list. I assume you mean “Global distribution of UV-absorbing aerosols from Nimbus 7/TOMS data”. You should also read Torres et al. “Derivation of aerosol properties from satellite measurements of backscattered ultraviolet radiation: Theoretical basis” (JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 103, NO. D14, PAGES 17,099-17,110, JULY 27, 1998). Especially note Fig. 3 & 6 of Torres 1998. Not all absorbing aerosol darkens the surface, for the nadir point of view. Altitude of the aerosol layer is important, as well as the total optical thickness of the layer. You need to prove that your model will produce the same results as shown by Torres for the nadir observations of lower tropospheric layers. Then transition to limb observations and gradually move the layer to larger altitudes. In addition, the optical depth of the elevated layer should be increased to see if the surface is darkened. This further analysis is needed to make an understandable connection with the nadir work.

Page 1911, line 12: should be “Scattering phase function…”

Page 1911, line 24: What do you mean by “aerosols further down”? Down what?

Page 1914 line 22: It would be helpful to include in the various tables the vertical optical depth for the various types of aerosols mentioned here.

Page 1915, line 13: What is BC?

Page 1921, line 11: Good point about the relationship between the aerosol layer height and the "radiance knee", but I wouldn't call a vertical optical depth of 0.01 "optically thick". It might be optically thick for the line of sight path, but not for other paths. Need to state this more specifically.

Table 1: Why not list SAGE I, SAGE I, SAM II?

Table 5: Caption says 20 cm^-3, but the first column ranges from 0.2 to 200. Need to change caption or alter the table.

Figures in general: It is hard to see the difference between circles and squares. Pick a different symbol or make them larger.

In figures 7-11 it was difficult to see the difference between several of the curves. I assume that they are plotted on top of each other, but that is an assumption that the reader shouldn't have to make. The location of each curve should be more obvious.