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Atmospheric
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Discussions

Interactive comment on "Using aircraft measurements to determine the refractive index of Saharan dust during the DODO experiments" *by* C. L. McConnell et al.

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The authors thank the referee for their useful comments and suggestions.

Section 2.2: Calculation of refractive indices using Mie Code

In our calculations shown, we have assumed that the real part of the refractive index is 1.53 at a wavelength of 550nm. Based on the comments by the referee, we have performed sensitivity tests and recalculated the imaginary part of the refractive index, assuming different values for the real part of the refractive index.

Firstly we assumed the real part was 1.51, and secondly we assumed it was 1.56 in

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order to test the sensitivity of our results to the real part of the refractive index. We found that the imaginary part of the refractive changed by less than 0.0002i for each of these tests - a change which is significantly less than the uncertainties already shown on Figure 1, which are essentially due to atmospheric variability. We therefore conclude that it is a reasonable assumption to use a real part of 1.53, and that the sensitivity of our results to this value and its likely error are very small. We now include a brief reference to this small sensitivity in the article in Section 2.2.

Section 2.3 Calculation of Refractive Indices from Filter composition measurements

With regard to the questions about the refractive indices in Figure 1, we would like to clarify that for the filter sample data, Figure 1 shows the imaginary refractive indices for the full three component (quartz, calcite and iron oxide-clay aggregates) mixture. As stated by the referee, the Mie-derived values represent the complete aerosol mixture. Therefore the comparison between the filter technique and the Mie-derived refractive indices in Figure 1 is indeed appropriate.

We also confirm that we used a volume mixing rule to get a final refractive index from the individual refractive indices of the proportions of quartz, calcite and iron oxide-clay aggregates. The proportions of these three different components were derived from the measured elemental concentrations from the filter samples, using the technique described by Lafon et al. (2006). The article text now explains this process more explicitly.

We now include two new tables in the paper to show firstly the volume fraction of iron oxide included in the clay matrix, and secondly the volume fraction of different minerals used in determining the overall refractive index calculated from the filter samples. The tables show that the volume fraction of the different minerals does indeed change with run, as pointed out by the referee, and this additional information is intended to make this clearer.

Section 2.5: Radiative Transfer Model

Yes, an assumption of a dust-free atmosphere below 300m was used in the calculation of the surface albedo of 0.44. Although there clearly was dust below this altitude, flying restrictions prevented us from collecting data closer to the surface, so we use this value as a best estimate. The surface albedo was calculated over the four low level runs during flight b238, and varied by around ±0.1 over the course of the lower altitude runs. This value was measured over the wavelength range measured by the pyranometers (0.3 to 3 microns).

The range of these uncertainties has a very small effect on the downwelling (SWD) radiation - less than 3% difference at the lowest altitudes, decreasing to less than 1% at the highest altitude runs.

The upwelling irradiances are much more sensitive to changes in the surface albedo, and we have modified the article to reflect these uncertainties. The uncertainty in the broadband surface albedo results in an uncertainty of ±10% at the highest altitude runs, and a very large uncertainty of ±25% at the lower altitude runs. This therefore means that for the lower altitude runs the differences in irradiances due to the difference chemical composition tested are as large as the uncertainty due to surface albedo, and cannot therefore be used to help achieve radiative closure. However, the high altitude runs, where uncertainty to surface albedo is lower, can still be used for this purpose, and suggest that the best agreement is found for the Mie and GK cases, as is the case for the downwelling irradiance.

Please also see the response to referee 1 for more details on the effect of spectral surface albedo on our results.

Section 4.1: Spectral Refractive Indices

The Mie-derived refractive indices are only calculated at 550nm. Since the radiative transfer model requires a spectral refractive index, scaling the WMO ni series to the Mie-derived value at 550nm allows us to use the Mie-derived refractive indices for the full radiation calculations. We note that since the intensity of solar radiation is highest around 500nm, the importance of the imaginary refractive index at wavelengths into the infrared becomes negligible. Differences may become important at wavelengths between 800nm to 2.5 microns, where the shape of the WMO and filter-based imaginary refractive indices differ. We have added a sentence to Section 4.1 noting the necessity of the spectral extrapolation, and that it may not be physical at wavelengths away from 550nm.

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