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Effect of non-sphericity of mineral dust particles on AERONET aerosol retrievals

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Comparative analysis of diurnal variability of aerosol retrievals obtained in dust and non-dust dominated locations revealed differences that can be clearly attributed to the difference in particles shape. For example, strong decrease in single scattering albedo (SSA) with decrease of solar zenith angle (SZA) is generally observed at dust dominated sites. At the same time no such trend is observed for spherical aerosol. One of the possible reasons explaining the observed SSA behavior for dust is bias in the model of randomly oriented spheroids employed by AERONET in the sense of non-perfect modelling of light scattering by non-spherical particles.

To check this possibility new retrieval algorithm which skips aerosol modeling stage by retrieving scattering phase function and SSA was developed. The advantage of this technique is that the accuracy of aerosol modeling is not an issue anymore. However due to the limited range of scattering angles extrapolation of phase function is required and reliable retrievals are restricted to the large values of SZA.

The new algorithm was applied to the almucantar observations collected at dust dominated site Hamim in United Arab Emirates (UAE). Comparison with the standard AERONET retrievals showed that spheroid model underestimates scattering by dust in the range of small scattering angles, 5-15 degrees and overestimates in the range of 15-50 degrees. The effect of (5-15) bias became more pronounce with SZA decreasing leading to SSA decrease. Also the difference in the range of scattering angles from 100-150 was observed for phase functions retrieved in the morning and in the evening for the same day which could be explained by the difference in shape distribution of dust aerosol for the two dust events. SSAs from both (new and AERONET standard) retrievals were very close to each other.

To better understand the dynamics of dust retrievals with SZA, phase functions and SSAs retrieved at Hamim by new algorithm were used to generate synthetic measurements which then were inverted using model of randomly oriented spheroids. The results of numerical tests showed a good agreement with operational AERONET retrievals. They also showed that not only SSA but also refractive index and size distribution are affected by this modeling bias. One of the ways to improve the situation is to use measurements protocols with wider ranges of scattering angles, like hybrid which was recently developed at AERONET with the aim to maximize the range of scattering angles.