POPULAR SUMMARY:

Critical Reflectance Derived from MODIS: Application for the Retrieval of Aerosol Absorption over Desert Regions

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Aerosols are tiny suspended particles in the atmosphere that scatter and absorb sunlight. Smoke particles are aerosols, as are sea salt, particulate pollution and airborne dust. When you look down at the earth from space sometimes you can see vast palls of whitish smoke or brownish dust being transported by winds. The reason that you can see these aerosols is because they are reflecting incoming sunlight back to the view in space. The reason for the difference in color between the different types of aerosol is that the particles are also absorbing sunlight at different wavelengths. Dust appears brownish or reddish because it absorbs light in the blue wavelengths and scatters more reddish light to space. Knowing how much light is scattered versus how much is absorbed, and knowing that as a function of wavelength is essential to being able to quantify the role aerosols play in the energy balance of the earth and in climate change.

It is not easy measuring the absorption properties of aerosols when they are suspended in the atmosphere. People have been doing this one substance at a time in the laboratory, but substances mix when they are in the atmosphere and the net absorption effect of all the particles in a column of air is a goal of remote sensing that has not yet been completely successful.

In this paper we use a technique based on observing the point at which aerosols change from brightening the surface beneath to darkening it. If aerosols brighten a surface, they must scatter more light to space. If they darken the surface, they must be absorbing more. That cross over point is called the critical reflectance and in this paper we show that critical reflectance is a monotonic function of the intrinsic absorption properties of the particles. This parameter we call the single scattering albedo. We apply the technique to MODIS imagery over the Sahara and Sahel regions to retrieve the single scattering albedo in seven wavelengths, compare these retrievals to ground-based retrievals from AERONET instruments and compute error bars on each retrieval.

The results show that we can retrieve single scattering albedo for pure dust to within ± 0.02 and mixtures of dust and smoke to within ± 0.03. No other space-based instrument has achieved a retrieval of single scattering albedo that spans the spectrum from 0.47 μm to 2.13 μm and produces regional maps of aerosol absorption showing gradients and changes. Applied in a more operational fashion, such information will narrow uncertainties in estimating aerosol forcing on climate.