Geophysical Research Abstracts
Vol. 13, EGU2011-1509, 2011
EGU General Assembly 2011

Sensitivity of aerosol retrieval to surface albedo

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Atmospheric particles are the objective of intensive research. In addition to effects on our health, they also have a significant influence on climate. Aerosols can be measured *in situ* or retrieved using optical remote sensing instruments. They are made to measure the upwelling solar radiance, reflected from the Earth's surface, scattered and absorbed by atmospheric molecules and aerosols. Separating measured upwelling radiance into its components is one of the most challenging tasks for quantitative remote sensing applications in general and aerosol retrieval in particular. The measured upwelling radiance is often dominated by the surface component and surface albedo is therefore one of the most influencing parameter to radiative transfer. Therefore, it is important to analyze and understand the impact of surface albedo on quantities derived from remote sensing data.

We present here an analysis of this influence with respect to the retrieval of aerosol optical depth (AOD) using a fast and simple model for atmospheric radiative transfer. Results show that larger AOD lead to increased reflectances R at sensor level for underlying "dark" surfaces and to decreased R for "bright" surfaces. In between, R does not depend strongly on AOD for surface albedo. It is therefore very difficult to infer AOD from measured upwelling radiances or R with such an underlying surface, which is sometimes called "critical" surface albedo. We use the derivative of R with respect to AOD for different surface albedos to understand better the relationship between R, AOD and surface albedo. Results with small derivatives show that the critical surface albedo is found typically in the range of approximately 0.2–0.4, which depends mainly on aerosol single scattering albedo and therefore also on aerosol extinction, as well as scattering angle, wavelength and other parameters.

Aerosol remote sensing relies on previously measured or estimated surface albedo, which are prone to errors. The impact of such uncertainties is also evaluated in the presented work by using the derivative of R with respect to AOD. The results confirm that the AOD retrieval at "dark" surfaces is less influenced by surface albedo uncertainties than "bright" surfaces. It is obvious that even smallest uncertainties in the surface albedo may lead to large uncertainties in AOD retrieval for surfaces close to the critical surface albedo. It was found for typical remote sensing conditions that only 0.01 surface albedo uncertainty leads to at least 0.2 AOD retrieval uncertainty. Assumed or empirically estimated surface albedo values may lead therefore to unusable AOD results.

It can be thus concluded that AOD retrieval is very sensitive to surface albedo and its related uncertainties.