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Spectral radiation balance of absorbing aerosols over clouds

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Absorption by aerosols, like smoke and desert dust, may lead to strong atmospheric warming, surface cooling, and cloud dynamical responses. Therefore, detection of absorbing aerosols and assessment of their radiative effects is important. However, absorbing aerosols are difficult to detect, especially in cloudy scenes. Here we use a satellite detection technique which can be used to determine the spectral absorption effects of smoke aerosols over clouds, using the fact that aerosols have a much stronger effect at UV and visible wavelengths than at longer wavelengths. We also analyse the shortwave radiative balance of absorbing aerosols over clouds.

We have developed a technique of measuring aerosols from their absorption effect using multi-spectral satellite data (De Graaf et al., JGR, 2012). Using a wide spectral range, from the UV (300-400 nm) up to the shortwave (SW) IR (1000-1750 nm), it is possible to distinguish the absorption by aerosols from the scattering by clouds. No microphysical assumptions are needed for the aerosols, except that their absorption must vanish at long wavelengths. With this method, called the Differential Aerosol Absorption (DAA) technique, which was applied to SCIAMACHY satellite data, we measured the direct radiative effect of absorbing biomass burning aerosols over clouds in the South-East Atlantic. We measured instantaneous direct radiative effects by the aerosols of the order of 100 W/m2 at top-of-atmosphere.

The spectral radiation balance at both top-of-atmosphere and surface is needed to estimate the amount of absorption inside the aerosol layer. We therefore perform a simulation study, using accurate spectral RT modelling, in which we compute the profile of absorption in the aerosol layer. We find that the atmospheric absorption characteristics cannot be measured only from satellite by using reflected light, also the transmission at the surface has to be measured. Therefore, field campaigns are needed in addition to satellite measurements, to clarify the process of aerosol absorption, and to quantify the heating effects of smoke.