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The Radiative Effect in the Transition Zone of the Aerosol-Cloud Continuum: a Sensitivity Study with Radiative Transfer Models

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Previous studies have pointed towards dealing with clouds and aerosols as two manifestations of a single physical phenomenon: a suspension of particles in the air. Although the two extreme cases (i.e. pure aerosol and well-defined cloud) are easily distinguished, and produce different radiative effects, there are many situations in the transition (or "twilight") zone. The authors of the current communication estimated that about 10% of time there might be a suspension of particles in the air which is difficult to classify as either cloud or aerosol [Calbó et al., Atmos. Res. 2017, j.atmosres.2017.06.010]. Nevertheless, radiative transfer models usually simulate the effect of clouds and aerosols with different modules, routines, or parameterizations. In this study, we apply a sensitivity analysis approach to assess the ability of one-dimensional (plane-parallel atmosphere) radiative transfer models in simulating the radiative effect of a suspension of particles with characteristics in the boundary between cloud and aerosol. We simulate this kind of suspension either in "cloud mode" or in "aerosol mode", for different values of optical depth, droplet size, water path, aerosol type, cloud height, etc. Irradiances both for solar and infrared bands are studied, both at ground level and at the top of the atmosphere. We obtain that (a) optically thin water clouds and ice clouds have similar radiative effects, in the shortwave, if they have the same optical depth; (b) the dispersion of effects regarding different aerosol type/aerosol characteristics is remarkable, both in the solar and in the terrestrial bands; (c) radiative effects in the shortwave and in the longwave bands of an aerosol layer and of a cloud layer are different, even if they have similar optical depth; (d) for solar radiation, a given effect on the diffuse component corresponds to an effect on the direct component that is usually greater (more extinction of direct beam) by aerosols than by clouds; (e) radiative transfer models are somewhat limited when simulating the effects of a suspension of particles in the transition zone, as the approach to this zone as an aerosol or as a cloud produces different results.