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Model simulation of aerosol and its radiative forcing during the IMPACT campaign (May 2008)

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A version of the coupled aerosol-climate model ECHAM5-HAM that includes a parameterization for cloud processing (i.e., aerosol activation and aqueous phase sulfur chemistry), was used for a simulation of tropospheric aerosol during the IMPACT measurement campaign, conducted in May 2008 at Cabauw (The Netherlands). The climate model reproduces actual meteorology, atmospheric transports and cloud formation through nudging with ECMWF temperature, surface pressure and divergence. During the first half of the campaign the air was relatively dry and polluted without significant cloud occurrence, while during the second half the humidity was higher and cloud formation was more prominent. Monthly averaged concentration profiles of Aitken and accumulation mode aerosol are in good agreement with observations, and also the simulated surface sulfate concentration is simulated satisfactorily. Simulated cloud droplet radii over land and over the ocean are consistent with MODIS retrievals. The model indicates that dust aerosol originating from the Sahara is processed by European pollution during transport towards NW Europe, and then acts as efficient CCN. Anthropogenic aerosol is found to contribute significantly to AOT and cloud formation, and exerts a significant radiative forcing. During the second half of the month the simulated relative humidity in the boundary layer regularly exceeds observed values so that aerosol optical thickness is sometimes severely overestimated compared with AERONET data. The impact of the uncertainties in boundary layer humidity on the calculated anthropogenic forcing will be assessed and discussed.