Evaluation of simulated aerosol properties with the aerosol-climate model ECHAM5-HAM using observations from the IMPACT field campaign

http://www.firstlight.cn 2010-08-19

In May 2008, the measurement campaign IMPACT for observation of atmospheric aerosol and cloud properties was conducted in Cabauw, The Netherlands. With a nudged version of the coupled aerosol-climate model ECHAM5-HAM we simulate the size distribution and chemical composition of the aerosol and the associated aerosol optical thickness (AOT) for the campaign period. Synoptic scale meteorology is represented realistically through nudging of the vorticity, the divergence, the temperature and the surface pressure. Simulated concentrations of aerosol sulfate and organics at the surface are generally within a factor of two from observed values. The monthly averaged AOT from the model is 0.33, about 20% larger than observed. For selected periods of the month with relatively dry and moist conditions discrepancies are approximately −30% and +15%, respectively. Discrepancies during the dry period are partly caused by inaccurate representation of boundary layer (BL) dynamics by the model affecting the simulated AOT. The model simulates too strong exchange between the BL and the free troposphere, resulting in weaker concentration gradients at the BL top than observed for aerosol and humidity, while upward mixing from the surface layers into the BL appears to be underestimated. The results indicate that beside aerosol sulfate and organics also aerosol ammonium and nitrate significantly contribute to aerosol water uptake. The simulated day-to-day variability of AOT follows synoptic scale advection of humidity rather than particle concentration. Even for relatively dry conditions AOT appears to be strongly influenced by the diurnal cycle of RH in the lower boundary layer, further enhanced by uptake and release of nitric acid and ammonia by aerosol water.

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