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Improved representation of stratocumulus clouds and the anthropogenic aerosol effect

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Stratocumulus clouds are important for future climate predictions as they have a strong cooling effect and the feedback of low clouds is believed to be a major cause of the model spread in climate sensitivity. Stratocumulus clouds are difficult to represent in a general circulation model because of their small vertical extent. Stratocumulus regions are also areas of a strong anthropogenic aerosol effect. Simulations of the anthropogenic aerosol effect can be expected to depend on the representation of stratocumulus clouds in climate models.

We address the representation of several of the physical processes that have to be accounted for when modeling stratocumuli in the general circulation model ECHAM6 (Stevens et al., 2013) coupled to the aerosol module HAM2 (Zhang et al., 2012). As a 'long tail' stability function can lead to excessive mixing at high stabilities we replaced it with a 'sharp' stability function. The stratocumulus cloud cover and liquid water path increase, similar to previous studies, with the 'sharp' stability function in ECHAM6-HAM2. We also study the impact of increased vertical resolution in the lower troposphere in ECHAM6-HAM2 on stratocumulus clouds. First results show improvements for the cloud height and thickness with increased vertical resolution. To simulate a realistic mixing state and size of particles released by evaporation of clouds and precipitation we include aerosol processing in stratiform clouds.

First results from multi-year simulations show that using a 'sharp' stability function decreases the anthropogenic aerosol effect from -1.5 W/m^2 to -1.2 W/m^2 and in-cloud aerosol processing to -0.8 W/m^2. This strong decrease is due to an increase in the background aerosol load. Increased vertical resolution doesn't seem to affect the anthropogenic aerosol effect in the global average.

Further results on the impact of changing the vertical resolution, a different stability function and in-cloud aerosol processing in ECHAM6-HAM2 on the anthropogenic aerosol effect will be presented at the conference.

Stevens et al., 2013, doi: 10.1002/jame.20015

Zhang et al., 2012, doi: 10.5194/acp-12-8911-2012