Project: **1001**
Project title: **Marine Stratocumulus Cloud Cover and Climate (MSCCC)**
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As a first step for achieving the MSCCC goals we preformed feasibility simulations to test whether the aerosol-climate model ECHAM-HAM (Zhang et al., 2012) is able to simulate the Marine stratocumulus clouds (MSC) regime transition (closed to open cells) in terms of cloud life time effect. Because clouds cannot be resolved in the model, we assumed that MSC form in a binary cloud regime of high and low cloud fraction, and that they cover extensive areas, corresponding to many GCM grid cells. These assumptions are supported by observations. Following this, a MSC sheet that covers, e.g., 1500x1500 km² (~50 grid cells), can be considered as one single cloud that covers many grid cells.

We used ECHAM6-HAM2 to simulate the case study that is documented in Goren and Rosenfeld (2015). The model was run for a month, first in a nudging mode until the time when the MSC cloud sheet started to form, then in a forecast mode. Figure 1 (left) shows the simulated time evolution of the cloud fraction and droplet concentrations along a 4-days trajectory for a run with 10 time more anthropogenic emissions. A sudden decrease in the cloud fraction occurs together with a decrease in the droplet concentration. This decrease in droplet concentrations allows the formation of stronger precipitation (Figure 1, right) and thus depletion of the cloud water and a reduction of the cloud cover. The cloud Fraction in simulations with no anthropogenic emissions decreased much faster. The results indicate that ECHAM6-HAM2 can simulate the delayed closed to open cells transition under polluted environment in terms of longer cloud life time effect.

The above results were presented and discussed in the International Commission on Clouds and Precipitation conference (July 2016, Manchester) and in the HAMMOZ workshop (March 2017, ETH, Zürich). Additional simulations and sensitivity studies are needed before we can estimate how well GCMs are able to capture the large scale effect of anthropogenic aerosols on the lifetime and cloud cover of closed cell stratocumulus. These are expected to be preformed in the coming year.

**References**

**Goren, Tom**, and D. Rosenfeld, Extensive closed cell marine stratocumulus downwind of Europe, J. Geophys. Res.: Atmos., 120, 6098-6116, doi: 10.1002/2015JD023176, 2015.

Zhang, K., D. O'Donnell, J. Kazil, P. Stier, S. Kinne, U. Lohmann, S. Ferrachat, B. Croft, **J. Quaas**, H. Wan, S. Rast, and J. Feichter, The global aerosol-climate model ECHAM5-HAM, version 2: sensitivity to improvements in process representations, Atmos. Chem. Phys., 12, 8911-8949, doi:10.5194/acp-12-8911-2012, 2012.

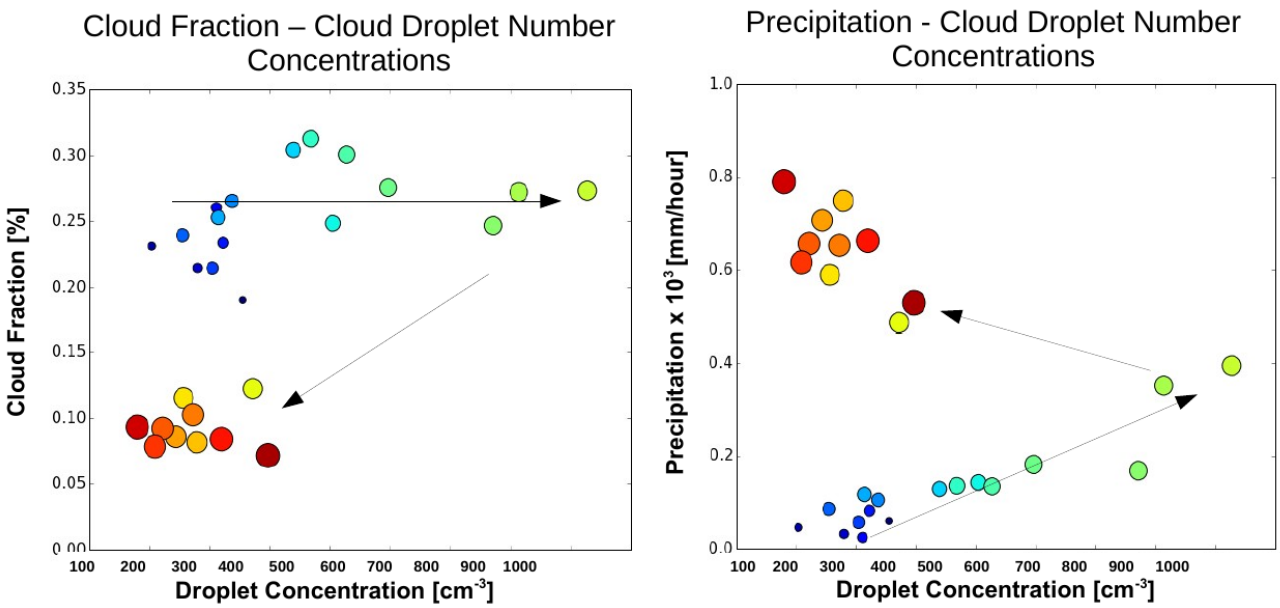


Figure 1: Lagrangian trajectory of Marine stratocumulus along 4 days. Anthropogenic emissions are set to be 10 times the present day emissions. The markers size and colors represent the progress in time (3 hour intervals), following the arrows. Left: The change in cloud fraction and droplet concentration. Right: The change in precipitation intensity and droplet concentration.