Project: **839**

Project title: **Quantifying Aerosol-Cloud-Climate Effects by Regime (QUAERERE)**

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Report period: **1.1.2014 - 31.12.2015**

In the report period, we carried out several studies that aim at an improved representation of aerosol-cloud interaction processes in the ECHAM-HAM aerosol-climate model. In particular, a focus was on convective, ice- and mixed phase clouds.

In a Bachelor's (Mewes, 2013, please see the last report) and Master's thesis (the latter on-going), we improved the representation of convective (Mewes, 2013) and stratiform precipitation. The latter now makes use of the cloud subgrid-scale variability, based on the concept by Weber and Quaas (2012), but in a stochastic way, randomly sampling from the predicted cloud-water probability distribution function.

In studies evaluating the precipitation partitioning with respect to liquid- and ice phase from satellite data (Fig. 1; Mülmenstädt et al., 2015), we were able to assess the representation of mixed-phase clouds in different models, including ECHAM, and work towards improvements of the precipitation formation, including the Bergeron-Findeisen-effect (Bachelor's thesis by Sabine Hörnig; ongoing Master's thesis by Jacob Schacht).

We also made substantial progress in the observational constraint of aerosol-cloud interactions (Ma et al., 2014; Quaas, 2015). This in particular concerns the impact of aerosols on cloud cover (Gryspeerdt et al., 2015), the impact of aerosols on cloud liquid water path (ongoing dissertation by Claudia Unglaub) and the relationship of aerosol and cloud droplet number concentration (the activation parameterisation; ongoing dissertation by Karoline Block). Also first results are being processed with respect to the aerosol interaction with ice clouds (ongoing dissertation by Philipp Kühne).These observational results will now feed into improvements of the representation of aerosol-cloud interactions in the climate model.

The tendency analysis revealed the usefulness of the mid-tropospheric vertical velocity for characterising cloud processes in the ECHAM model. The tendencies relevant for changes in relative humidity are to a large extent related to the 500-hPa pressure velocity, when considering it at high temporal resolution. Moistening and cooling (drying and warming), respectively, usually work in the same sense. Largely cloud processes (condensation/sublimation) balance the large-scale advection (Bachelor's thesis Irene Heyn; Heyn et al., in preparation).

References

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Mülmenstädt, J., O. Sourdeval, J. Delanoë, and ***J. Quaas****, Frequency of occurrence of rain from liquid-, mixed- and ice-phase clouds derived from A-Train satellite retrievals, Geophys. Res. Lett., 42, 6502-6509, doi:10.1002/2015GL064604, 2015.*

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Figures

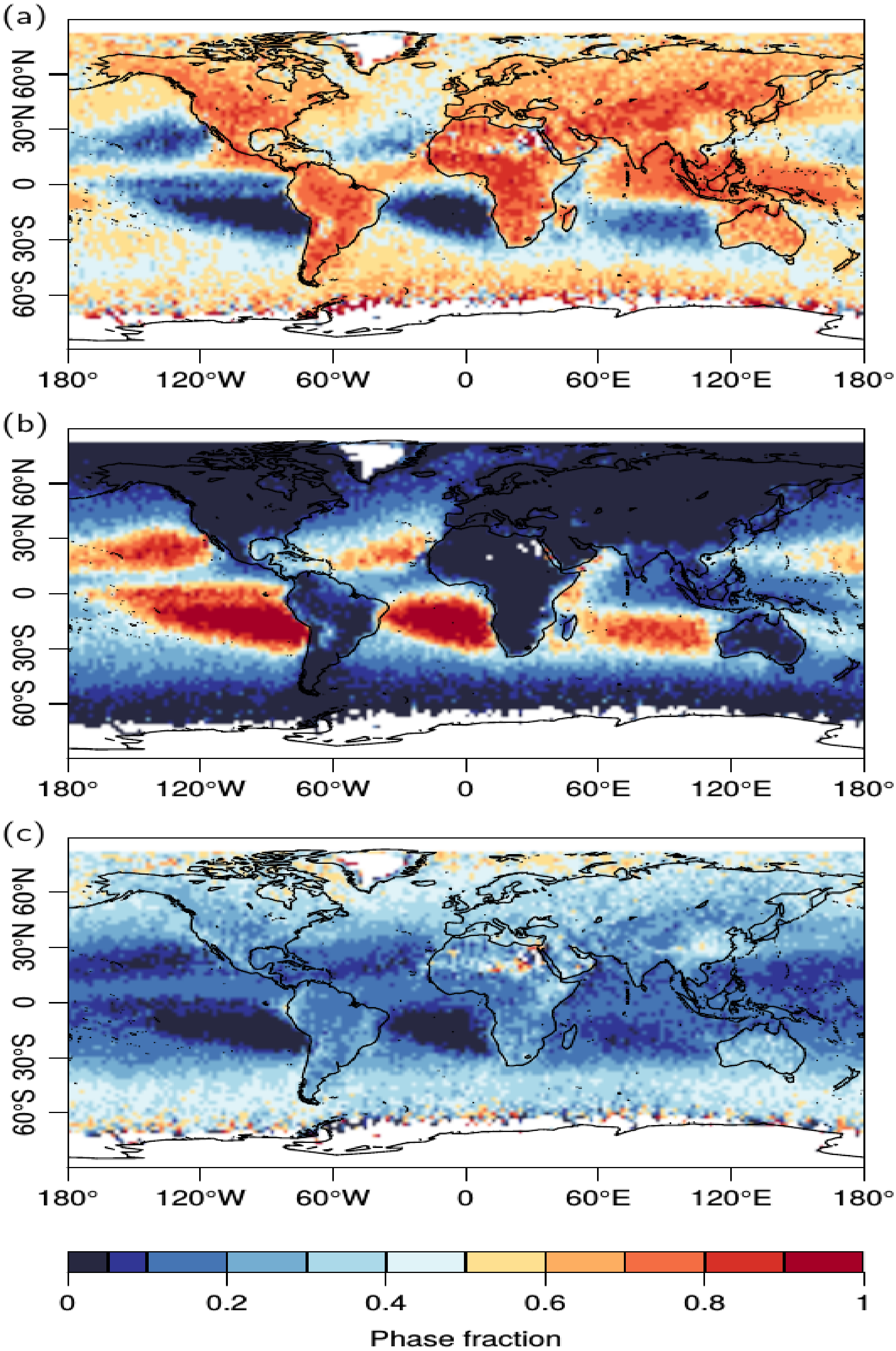

Fig. 1: Fraction of raining clouds that are (a) ice-phase, (b) liquid-phase, and (c) mixed-phase averaged over five years (2006–2011). (From Mülmenstädt et al., 2015)