Project: **839**
Project title: **Quantifying Aerosol-Cloud-Climate Effects by Regime (QUAERERE)**
Project lead: **Johannes Quaas**
Report period: **1.1.2016 - 31.12.2016**

In the report period, we assessed the cloud adjustments to aerosol-cloud interactions (formerly known as cloud lifetime effect). Simulations were conducted with varying aerosol influence on the autoconversion of warm rain. The simulations were evaluated with the help of the satellite-derived warm rain fraction, i.e. the fraction of precipitation events at the surface which form in conditions where the cloud-top is of liquid phase (vs. those rain events where the cloud top is glaciated). Satellite data (Mülmenstädt et al., 2015) showed a very low warm rain fraction over continents (Fig. 1).

We carried out several sensitivity simulations with the ECHAM5-HAM2 model (Zhang et al., 2012) to find that the autoconversion scaling has to be reduced substantially to obtain a realistic distribution (Fig. 2, Mülmenstädt et al., in preparation). This result is very interesting and in contrast to previous findings that suggested the autoconversion should indeed be scaled up, with an ideal value of 1 (Weber and Quaas, 2012) and requires further investigations.

References

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.*

Mülmenstädt, J., J. Quaas*, et al., Satellite-derived warm rain fraction as constraint on the cloud lifetime effect, Atmos. Chem. Phys., in preparation*

Weber, T., and ***J. Quaas****, Incorporating the subgrid-scale variability of clouds in the autoconversion parameterization, J. Adv. Model. Earth Syst., 4, M11003, doi:10.1029/2012MS000156, 2012.*

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.*

Figures

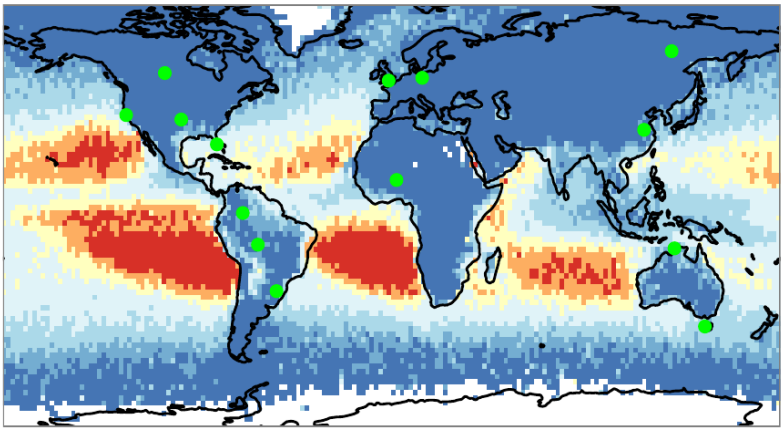

Fig. 1. Warm rain fraction (red – warm rain dominant; blue – cold rain dominant) derived from CLOUDSAT / CALIPSO active satellite data (Mülmenstädt et al., 2015) with the location of the sites where instantaneous model diagnostics are available superimposed as green dots.

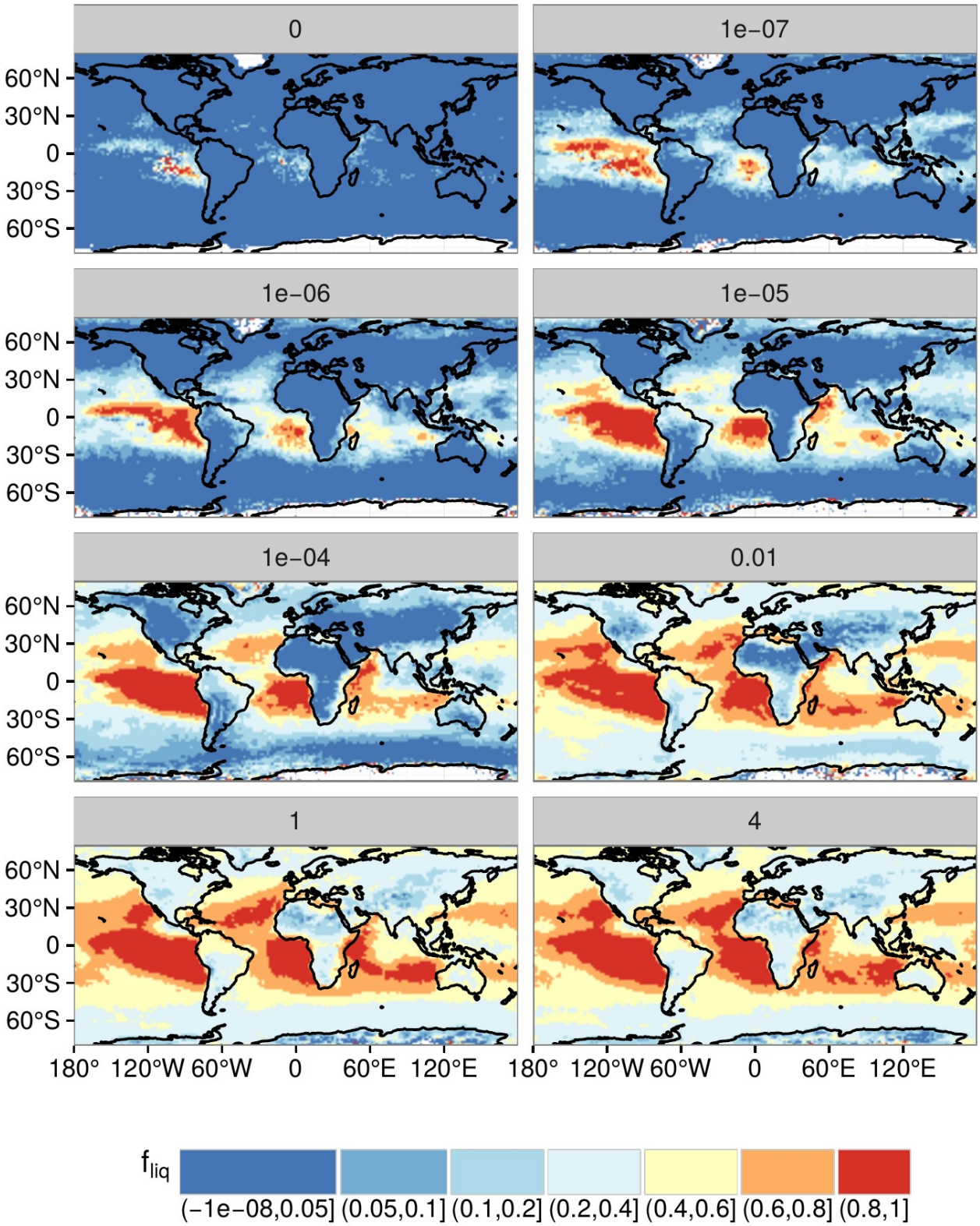

Fig. 2: Warm-rain fraction in the ECHAM5-HAM2 model using varying scaling factors in the autoconversion parameterisation (between 0 and 4). It is obvious that a reduction in scaling down to about 10^{-5} is necessary to obtain a realistic distribution (from Mülmenstädt et al., in preparation).