Project: 1114

Project title: Development and evaluation of cloud glaciation processes in ECHAM-HAMMOZ

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Report period: 2022-05-01 to 2023-04-30

Ice-nucleating particles can enhance droplet freezing in clouds, reducing their water content. Until now, the effect of these particles has been only studied for current climate scenarios. However, these particles are released regularly in the context of weather modification projects. Thus, we asked whether such particles could be used in the context of a geoengineering scenario. Such cloud geoengineering approaches aim to mitigate global warming by seeding aerosols into clouds to change their radiative properties and occurrence frequency.

The focus of the Project changed since the initial proposal. We now evaluated the radiative effect of mixed-phase regime clouds in ECHAM-HAM against satellite observations (Fig. 1). Aided by the increased confidence in the simulated cloud radiative effect, we quantified the effect of mixed-phase cloud thinning on climate (Villanueva et al., 2022).

Using the ECHAM-HAM climate model we showed that ice-nucleating particles could decrease the heat-trapping effect of mixed-phase regime clouds over the polar oceans during winter, slowing down sea-ice melting and partially offsetting the ice-albedo feedback. We refer to this concept as mixed-phase regime cloud thinning. We estimated that mixed-phase regime cloud thinning could offset about 25% of the expected increase in polar sea-surface temperature due to the doubling of CO2. This was accompanied by an annual increase in sea-ice surface area of 8% around the Arctic, and 14% around Antarctica. This year, we will propose this scenario for inclusion in the Geo-engineering Model Intercomparison Project (GeoMIP), partnered with DKRZ.

The last resource allocation in MISTRAL allowed us to test numerous configurations for the potential seeding of ice nuclei on a global scale. Currently, we took back on the original tasks on LEVANTE and intend to:

1) Reconcile the default two-moment microphysical scheme with the new tuned Predicted bulk Particle Properties (P3) scheme in ECHAM-HAM (Villanueva et al., 2021b), by studying the relation between sedimentation efficiency, heterogeneous freezing, and cloud top phase.

2) Translate the resulting parameters to a tuned two-moment scheme in the newly developed ICON-HAM (Salzmann et al., 2022) and compare all three configurations.

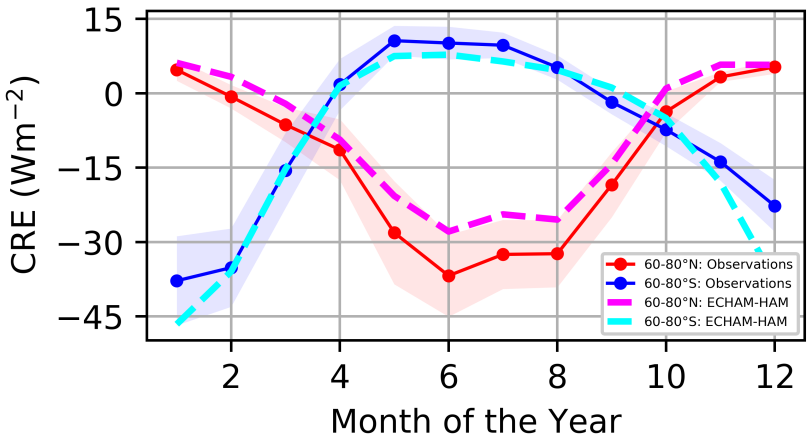

Figure 1. Simulated (ECHAM-HAM) and observed (2B- FLXHR-LIDAR) cloud radiative effect (CRE) of mixed-phase regime clouds at high latitudes over the Northern Hemisphere and Southern Hemisphere. The shaded areas corresponds to the standard deviation over the 4-years observations.

References

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