What is triggering ice in mixed-phase clouds: A process analysison the importance of ice nucleation and sedimentation with ECHAM-HAM

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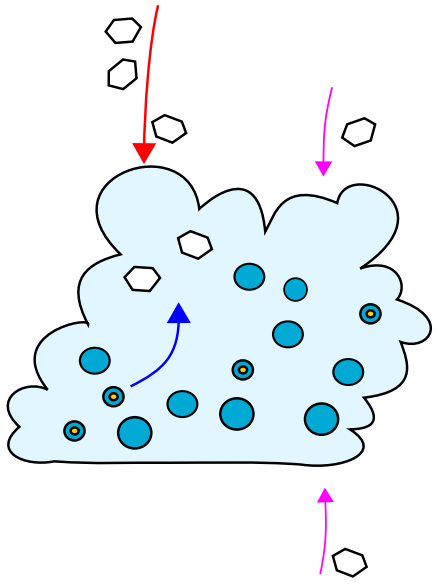


"Introducing" initial ice crystals into the supercooled cloud → triggering the phase transition:

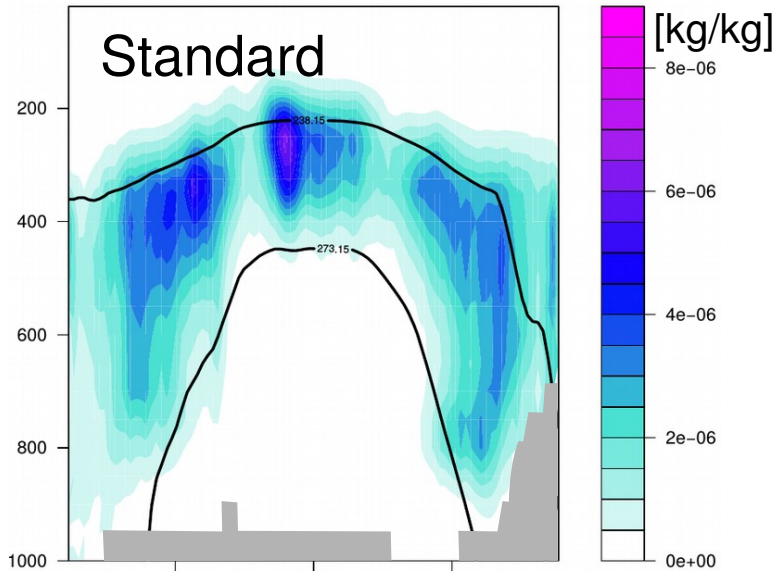
- Heterogeneous freezing of supercooled cloud droplets (mixed-phase)
- Sedimented ice from above (Cirrus or upper cloud layers)
- Vertical diffusion of ice

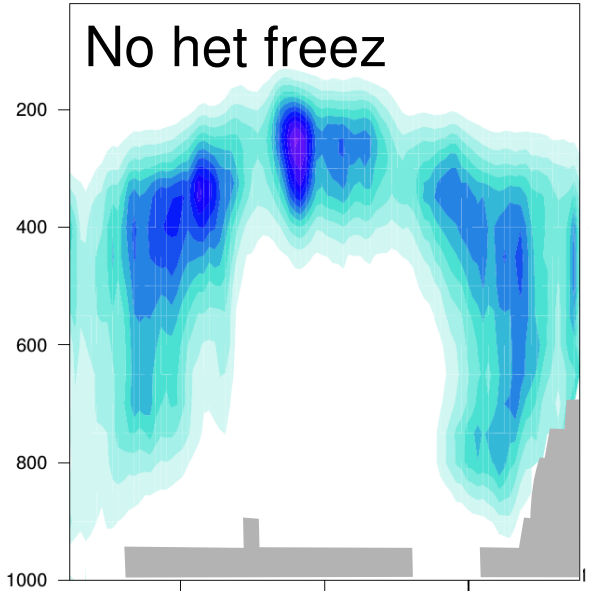
Method

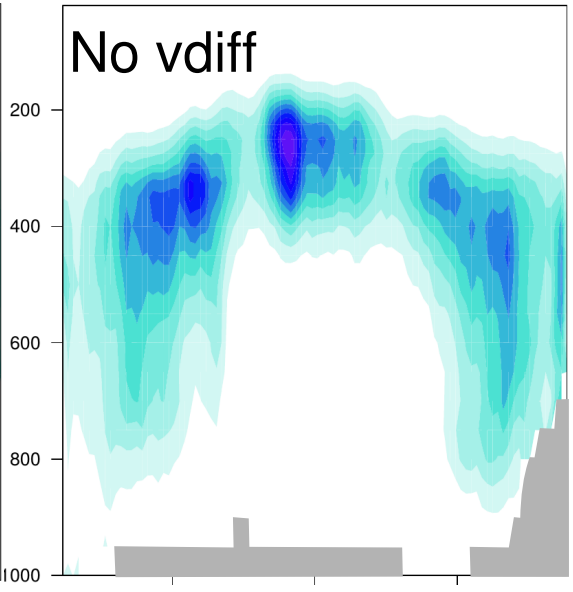
- Simulations with ECHAM-HAM: Year 2000, nudged (T63 L31)
- Different processes switched on/off
- Factorial method

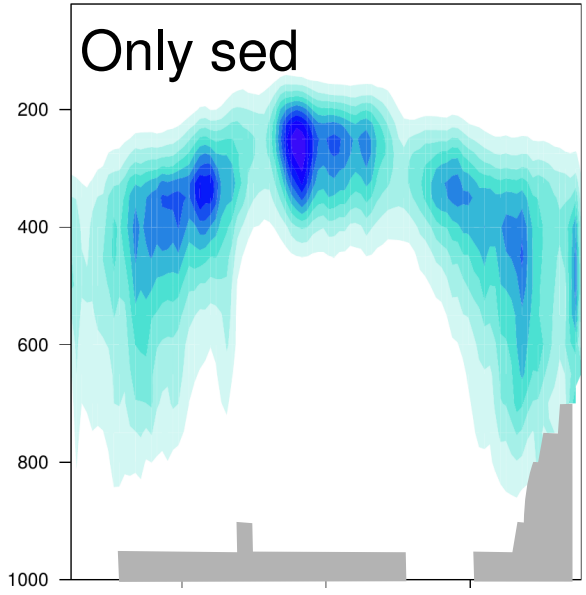
Ickes et al., 2022, in preparation

Qualitative view: Ice water content (zonal mean)

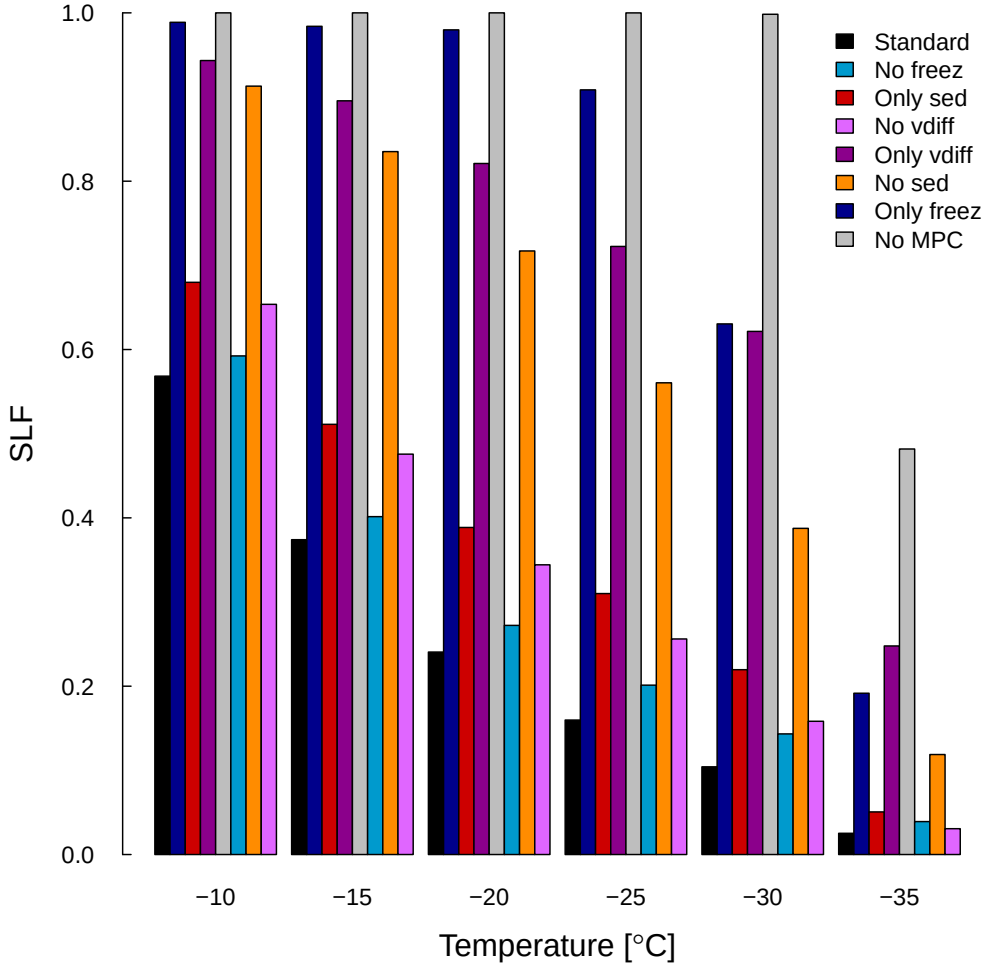








Quantitative view: supercooled liquid fraction



$$\mathrm{SLF} = \frac{\text{liquid water}}{\text{liquid water} + \text{ice}}$$

Factorial method

Impact of various **conditions** on the **outcome** of an experiment (Montgomery, 2008)

- **Conditions**: different processes (freezing, sedimentation, vertical diffusion)
- **Outcome** of experiment: SLF at a certain temperature T

$\Rightarrow$ **Identify the contribution of each process to the variability of SLF**

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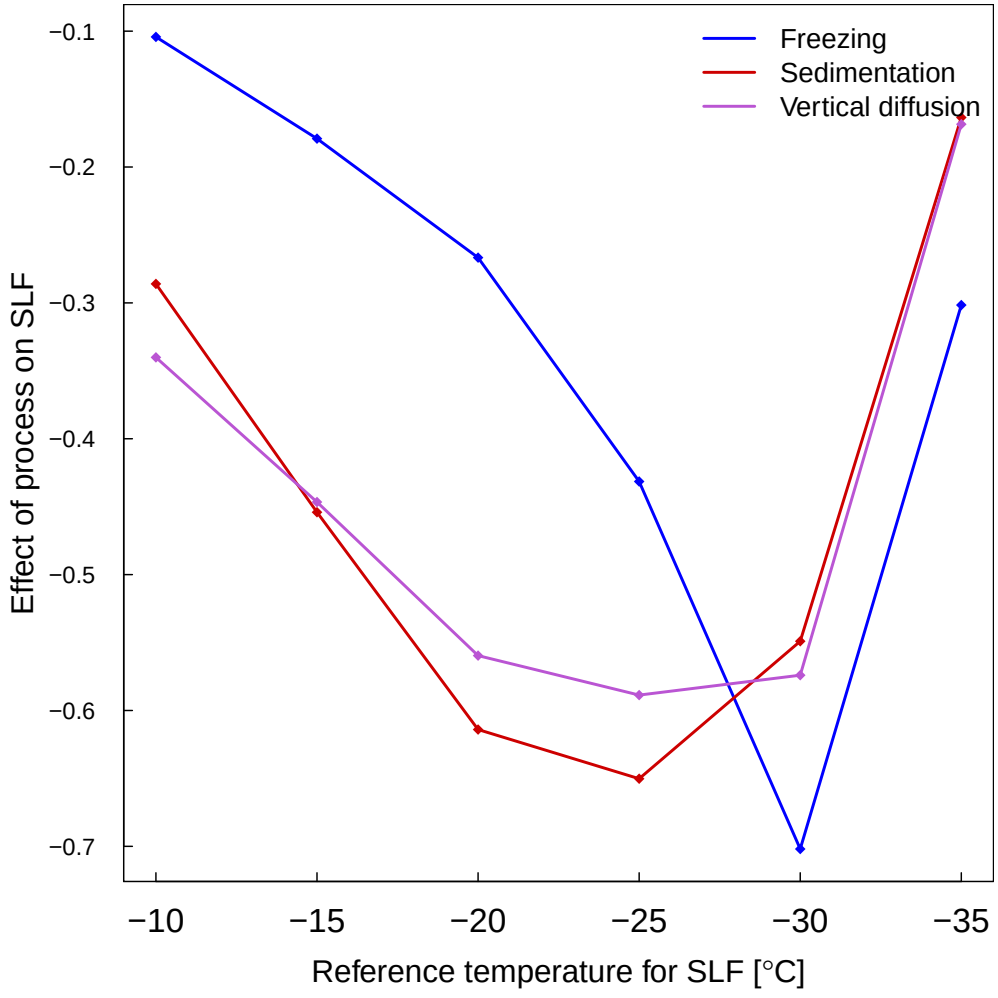
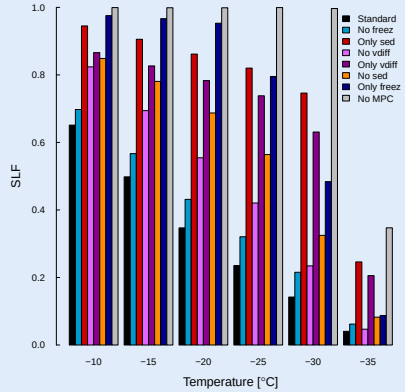
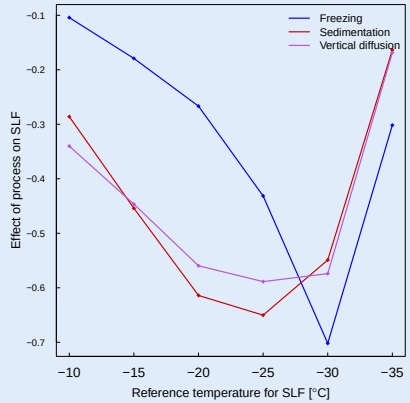
Factorial method



Conclusions

- Mixed-phase clouds seem not to be very sensitive on heterogeneous **freezing** in ECHAM-HAM (it **rarely triggers ice**)
- Heterogeneous freezing "takes over" at low temperatures (around -27°C), so there might be a dependence on the freezing scheme/INPs
- **Sedimentation is crucial** for the mixed-phase clouds in ECHAM-HAM (also as a distribution process for ice crystals)
- Different processes have an non-linear influence on SLF(T), together the relationship between SLF and temperature is linear
- Difference between all clouds vs. thin clouds





Thank you for your attention!