Cloud-radiation coupling over the lifetime of deep convective storms

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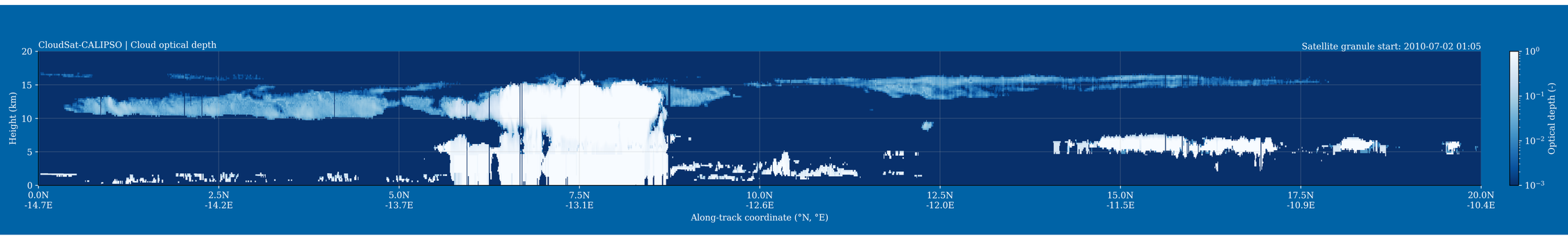
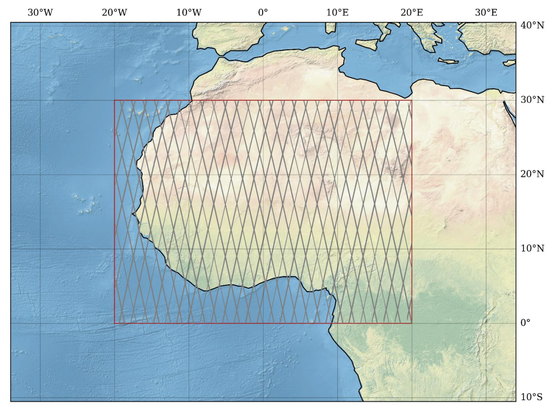


Study background and motivation

Altocumulus photographed from a research flight over the tropical Atlantic[1]

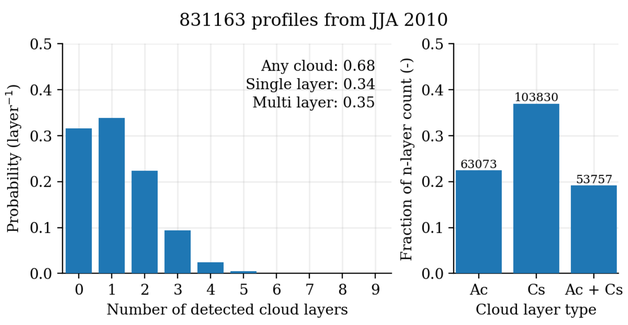
- → Clouds, through their interaction with solar and thermal radiation, influence Earth's increasing energy imbalance[2] and local atmospheric heating rates
- → Stratiform mid level clouds are often found nearby deep convection and (anvil) cirrus, possibly formed from congestus outflow[3,4,5]
- → Our aim is to understand the role of mid level clouds in the coupled cloud-radiation-circulation system
- → Our initial focus area is Western Africa, where deep convection, mid level clouds, and cirrus are often observed[3,4]



Focus area for the data presented on this poster, diagonal lines illustrate the satellite orbit tracks

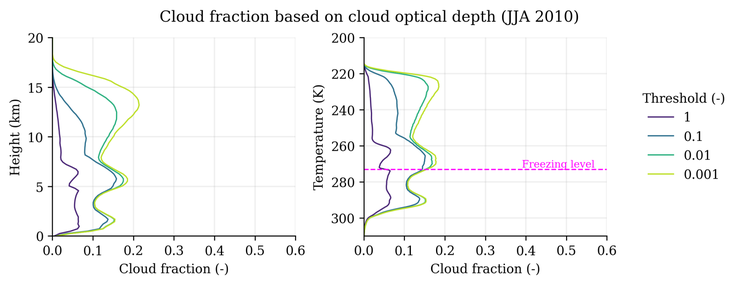
What is the observed climatology of multi-layered clouds?

CloudSat-CALIPSO satellite retrievals provide cloud optical depth, radiative fluxes, and cloud classification. We take this as our climatological reference.

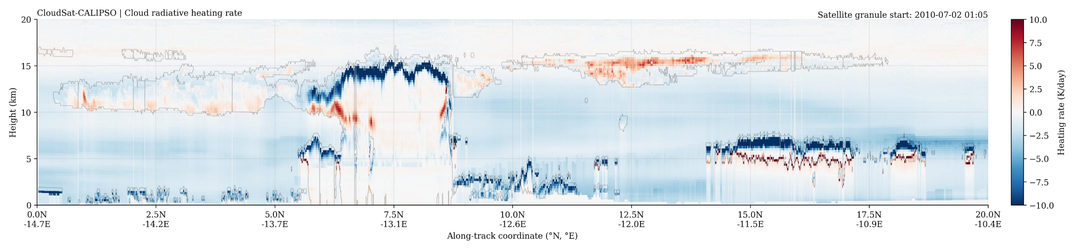


Mid level clouds are common during the convective season

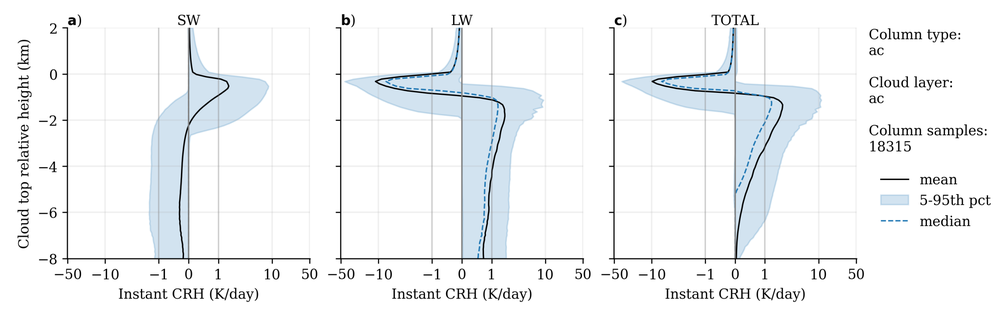
Vertical cloud climatology is tri-modal



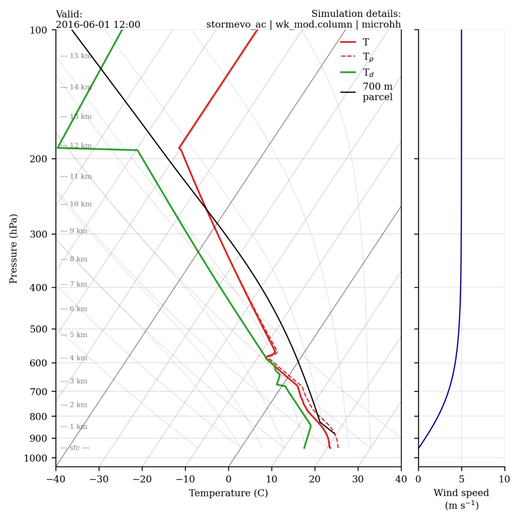
Radiative effects of mid level clouds



Cloud classification and cloud radiative heating products are combined to make **composite cloud radiative heating profiles** for selected cloud types



Does cloud-radiative heating influence deep convective storms?

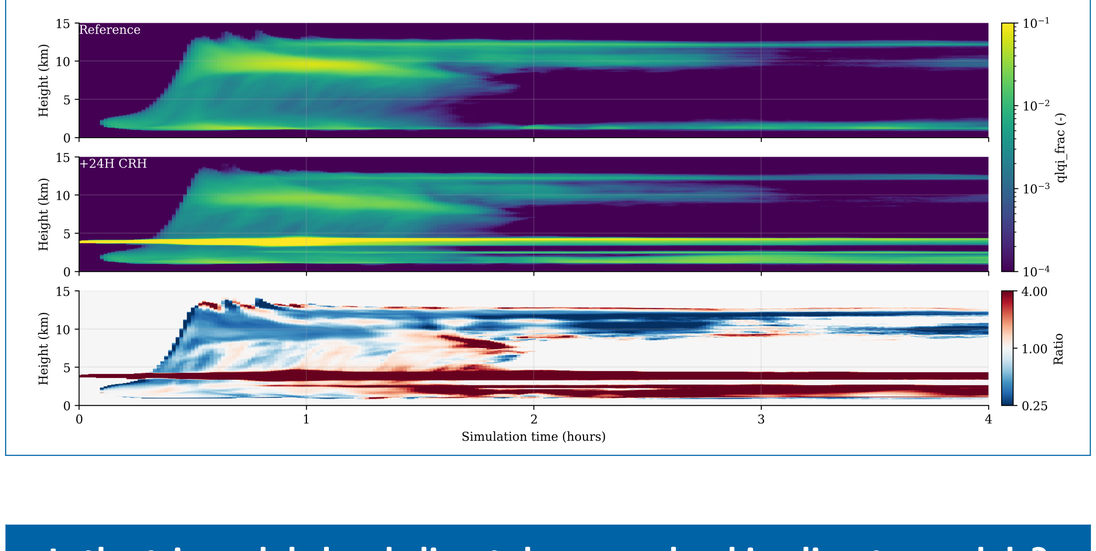


Numerical experiments designed to test the impact of the radiative effects of mid level clouds on 'next-day' deep convective events

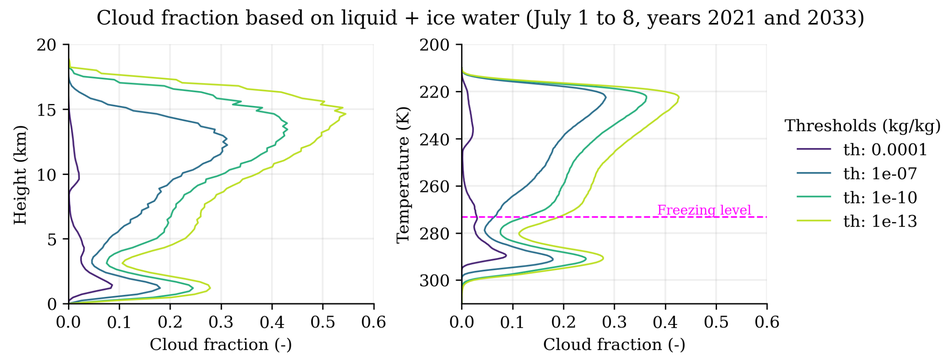
Experimental setup:

- Large-eddy simulation: MicroHH (150x150x75 m resolution)
- Modified idealized supercell setup (Weisman and Klemp) with warm bubble to initiate convection
- One reference simulation
- One simulation with 24 hours of composite cloud radiative heating applied
- CAPE in both simulations is 900 J/kg
- Experimental design is work-in-progress

Early results suggest slight reduction in updraft strength and subsequent anvil coverage



Is the tri-modal cloud climatology resolved in climate models?



Two weeks of 3D ICON data from NextGEMS[6] (ngc4008a) does not show clear tri-modal cloud climatology and overall shows higher cloud fraction than observations

References

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