# The microphysical origin of tropical cirrus

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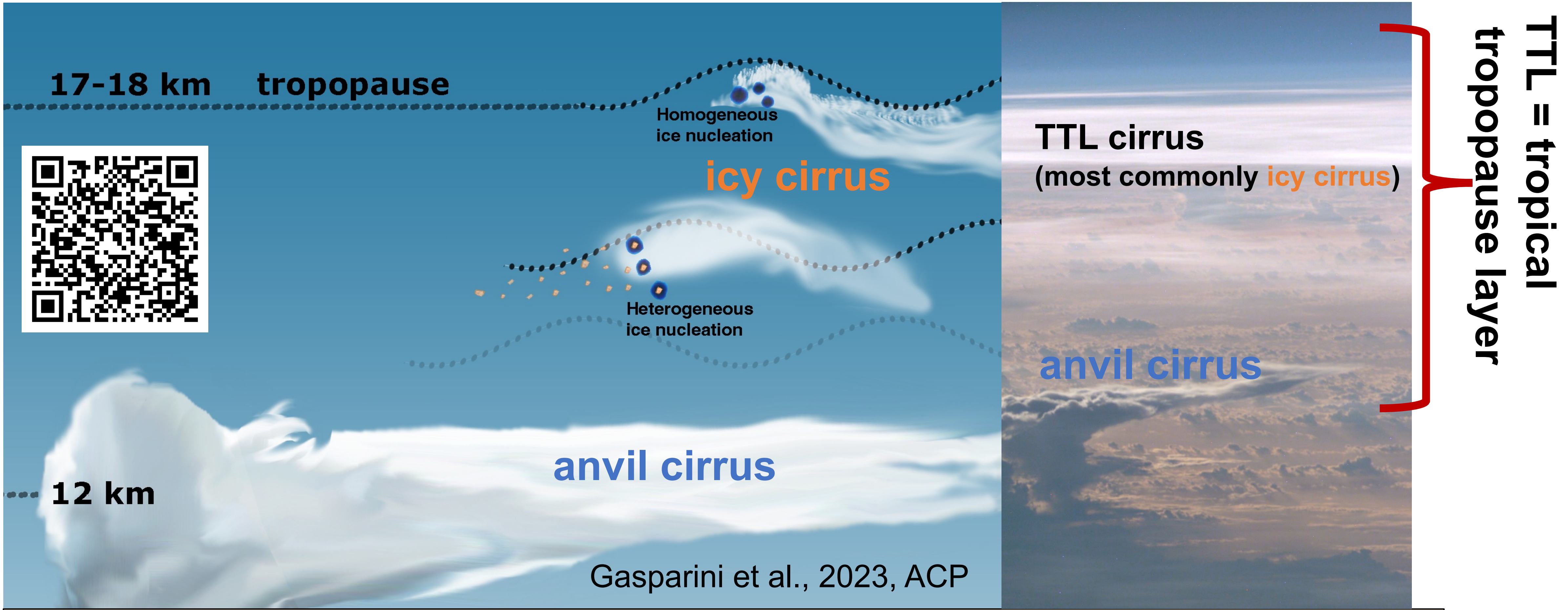
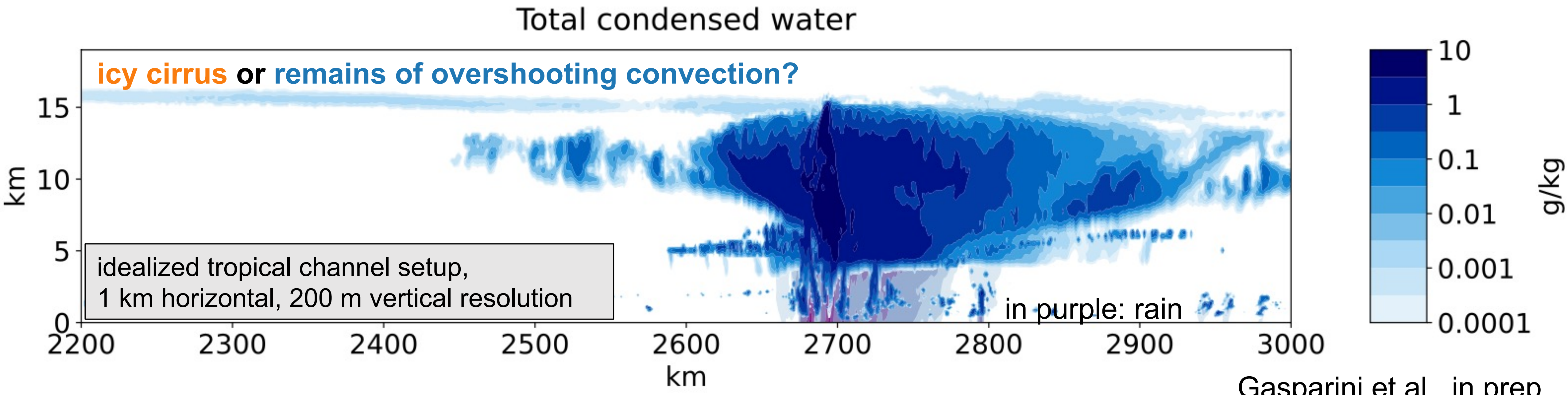
Photography encouraged

# Tropical cirrus of two sources: convection and ice nucleation




**TTL cirrus** = any cirrus in the TTL (can be of **convective origin**)
**icy cirrus** = only cirrus formed by **ice nucleation**

# SAM cloud-resolving model with improved ice microphysics has a good skill in simulating tropical cirrus



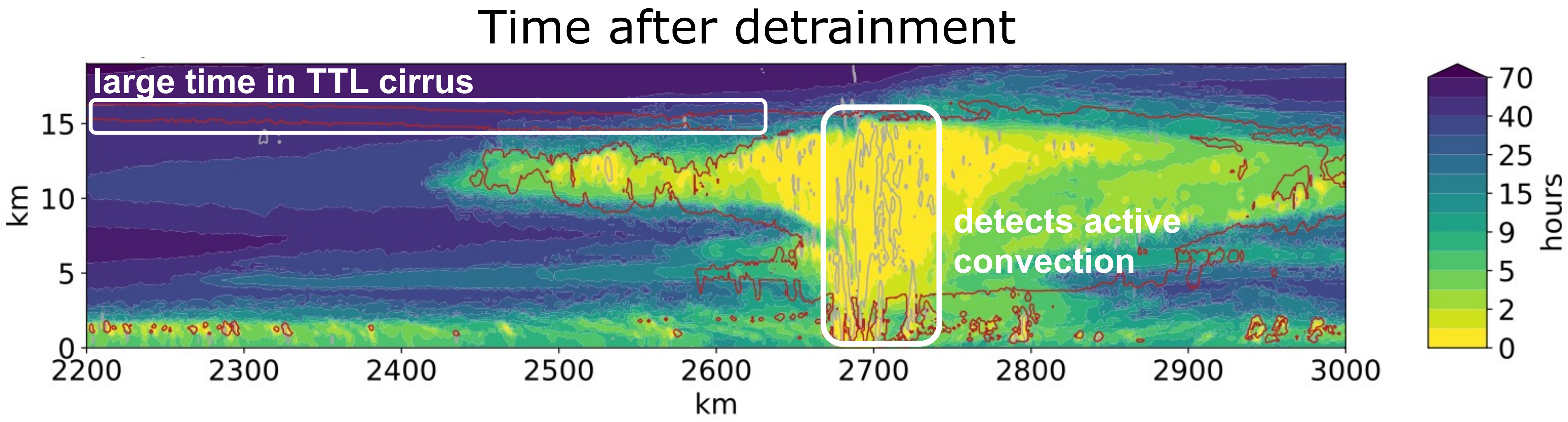

Gasparini et al., in prep.

What is a simple way to tell the origin of cirrus clouds?

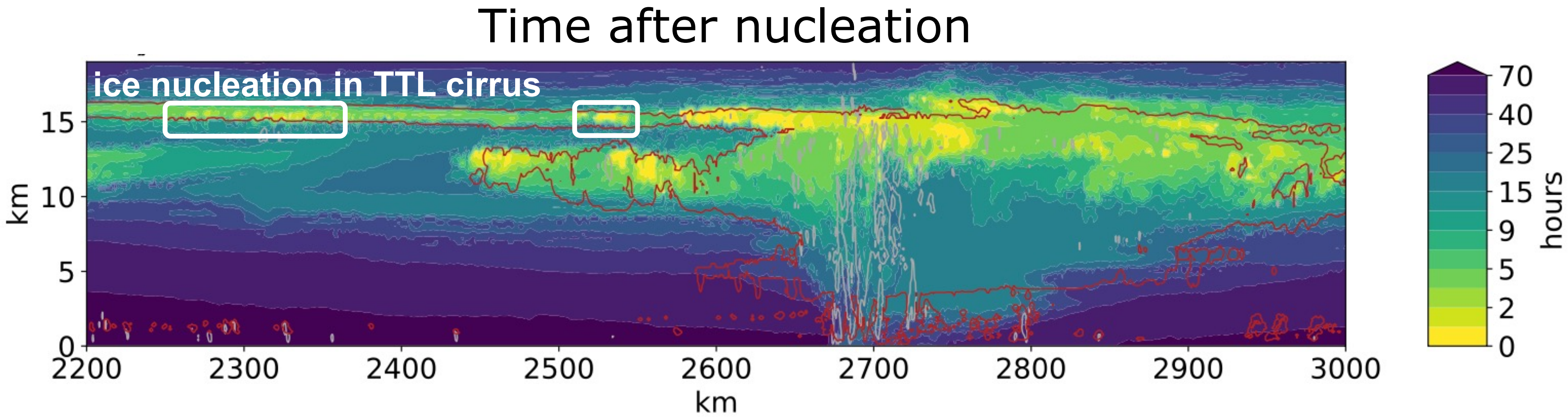
Are **icy cirrus** relevant for the radiative budget at TOA?

TOA = top-of-the-atmosphere

# Passive tracers: a simple, inexpensive method to track cloud evolution

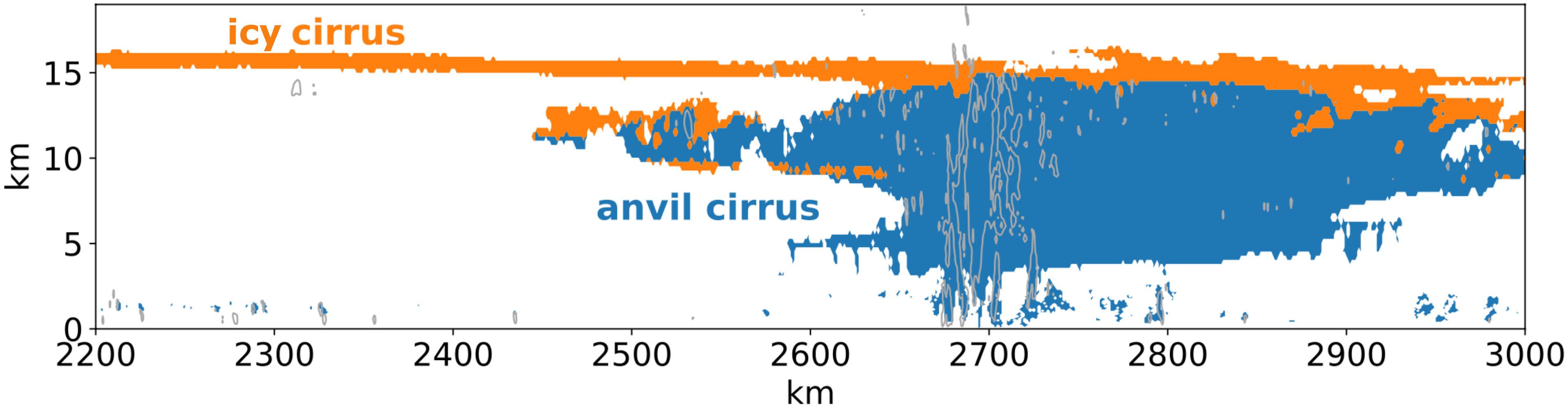



**if cloudy updraft**
tracer =1
**else:**
tracer = decay factor x tracer value




**if ice nucleation**
tracer =1
**else:**
tracer = decay factor x tracer value

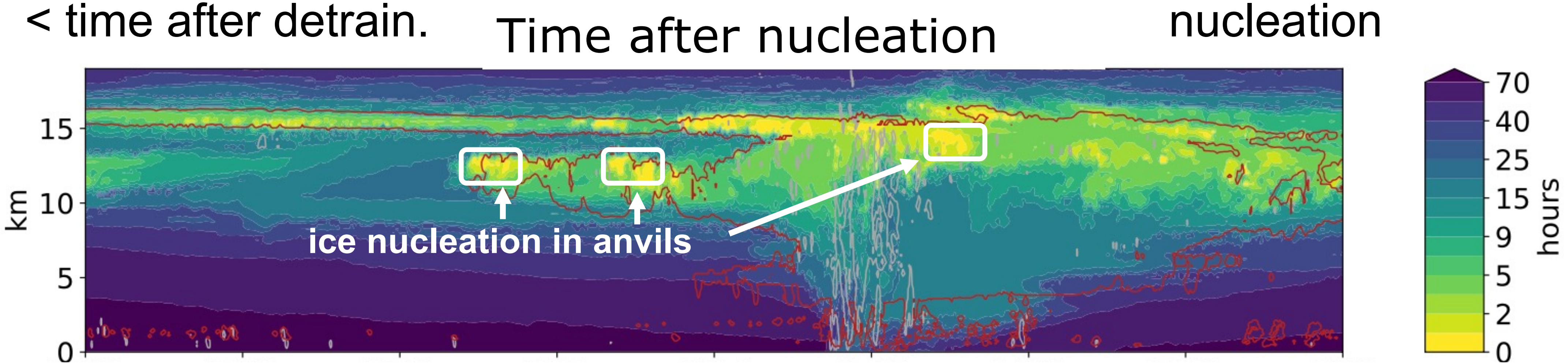
# Classifying cirrus origin with the help of passive tracers



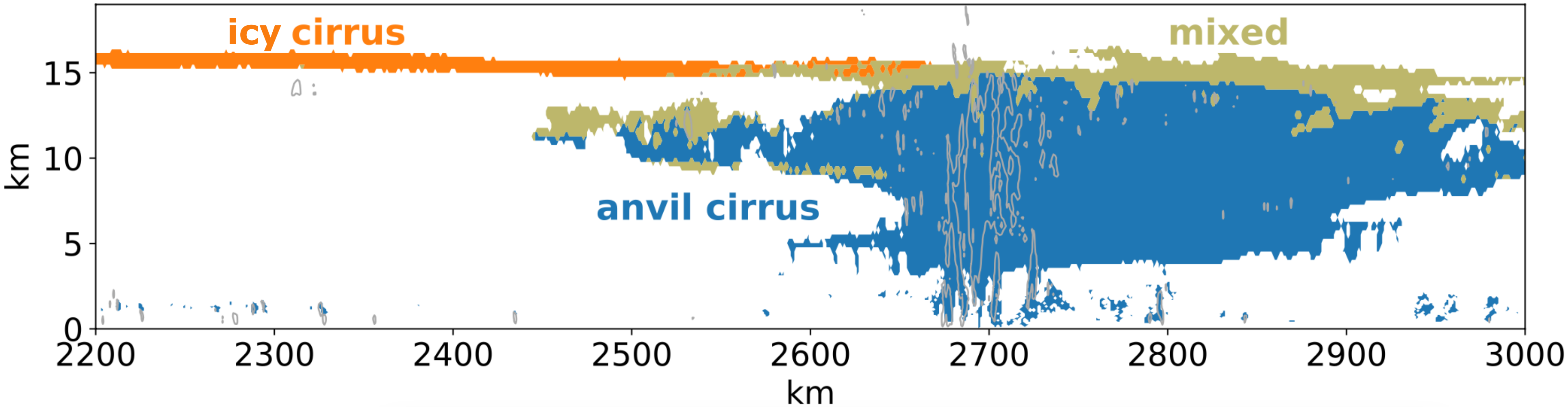

Sometimes ice nucleation occurs within anvils!

**icy cirrus** if time after nucleation < time after detrain.

**anvil cirrus**: if time after detrainment > time after nucleation



# Classifying cirrus origin with the help of passive tracers

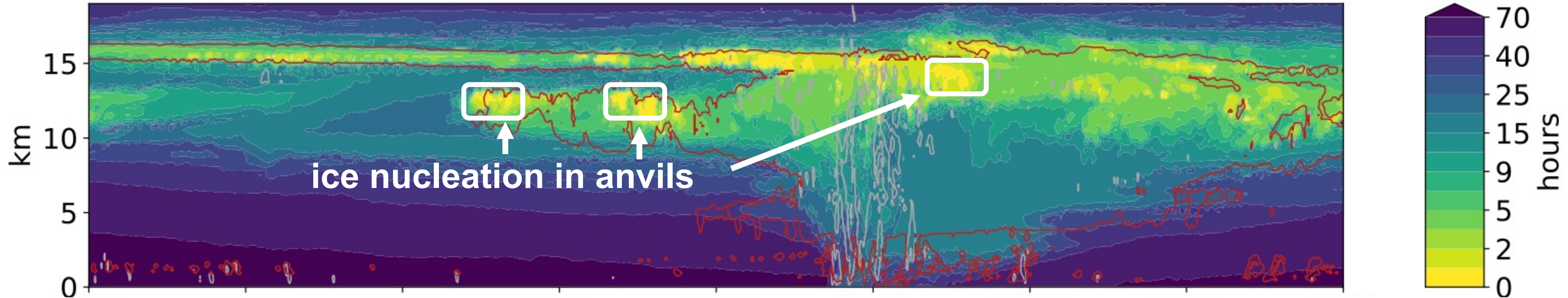



Sometimes ice nucleation occurs within anvils!

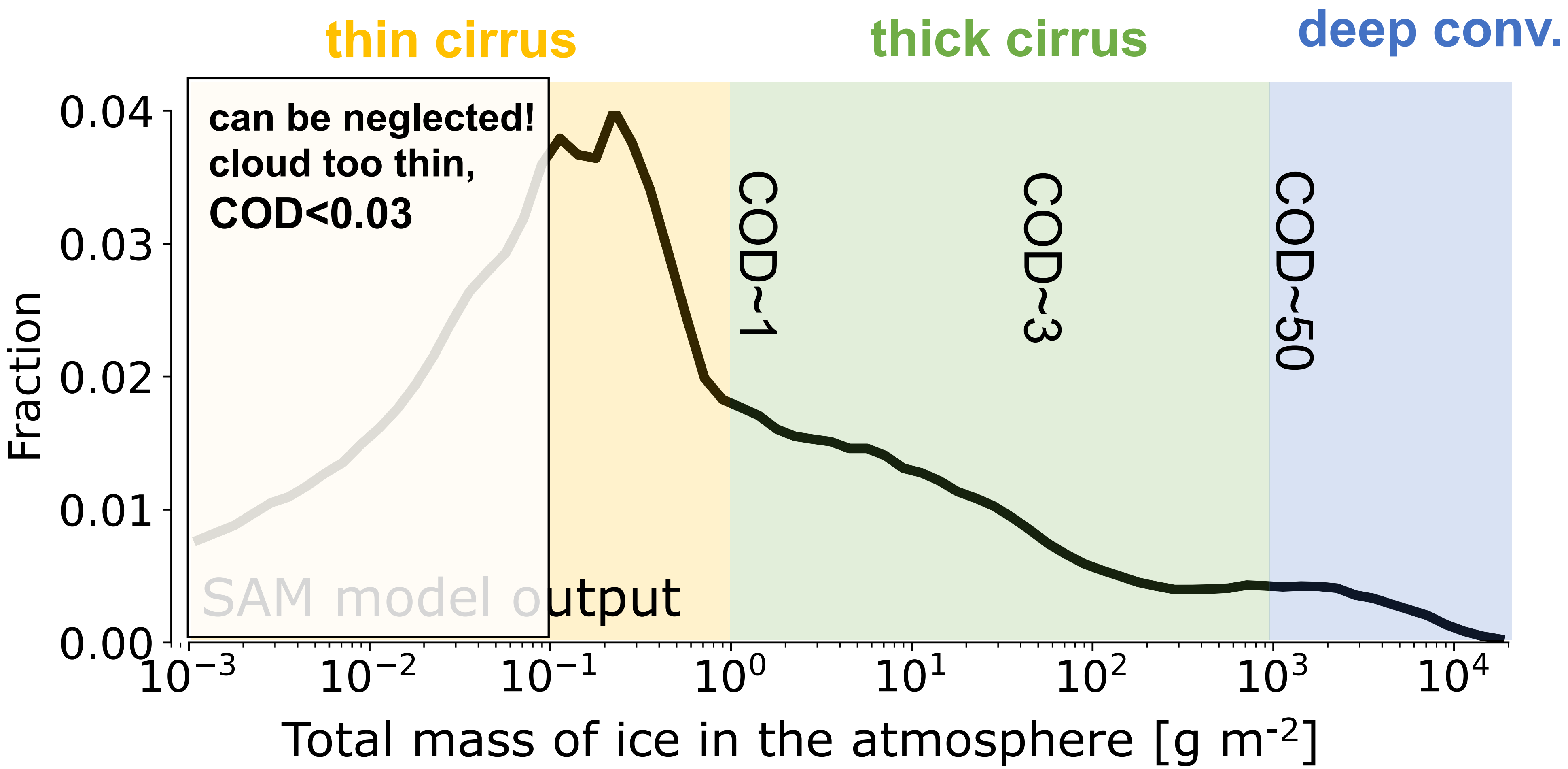
**icy cirrus** if t_nucl< t_detr & t_detr>30 h

**mixed:** anvils, where in situ ice nucleation present (but detrained ice mass dominant)

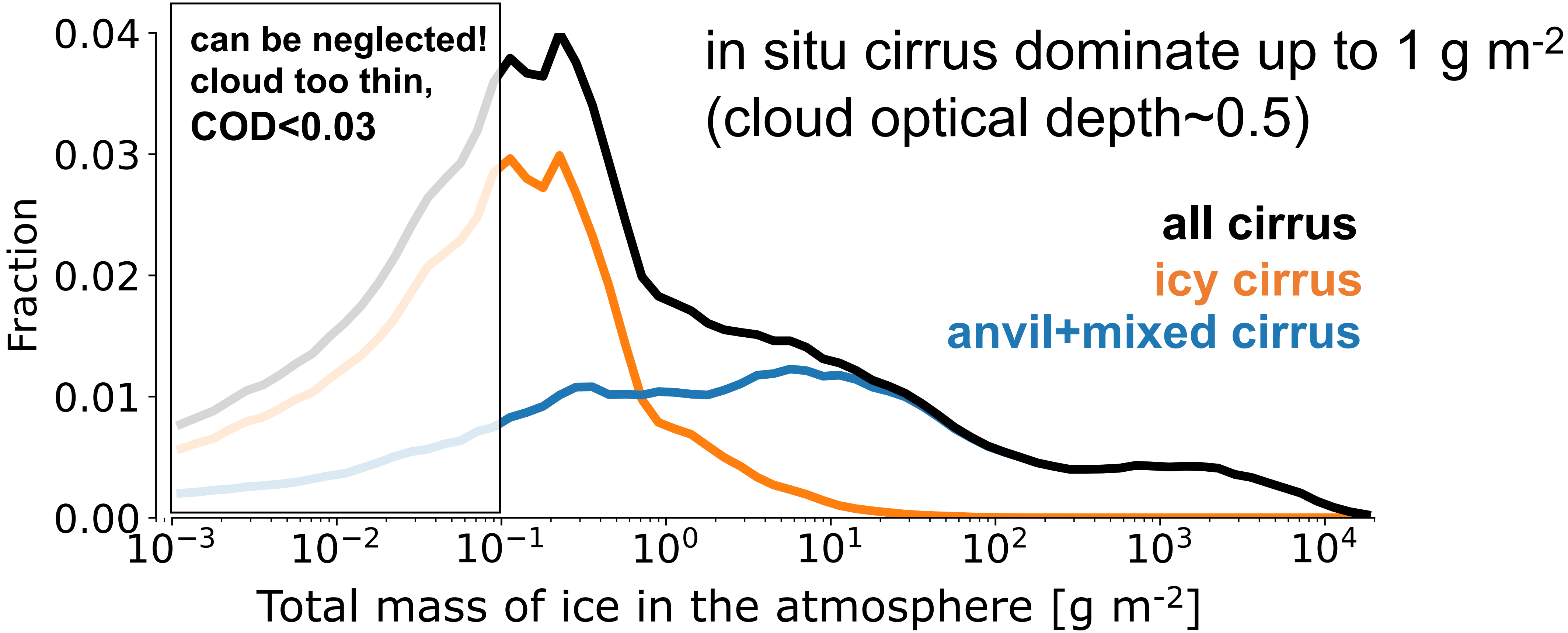
**anvil cirrus**: all within 30 h of time after detrainment with no new in situ nucleation



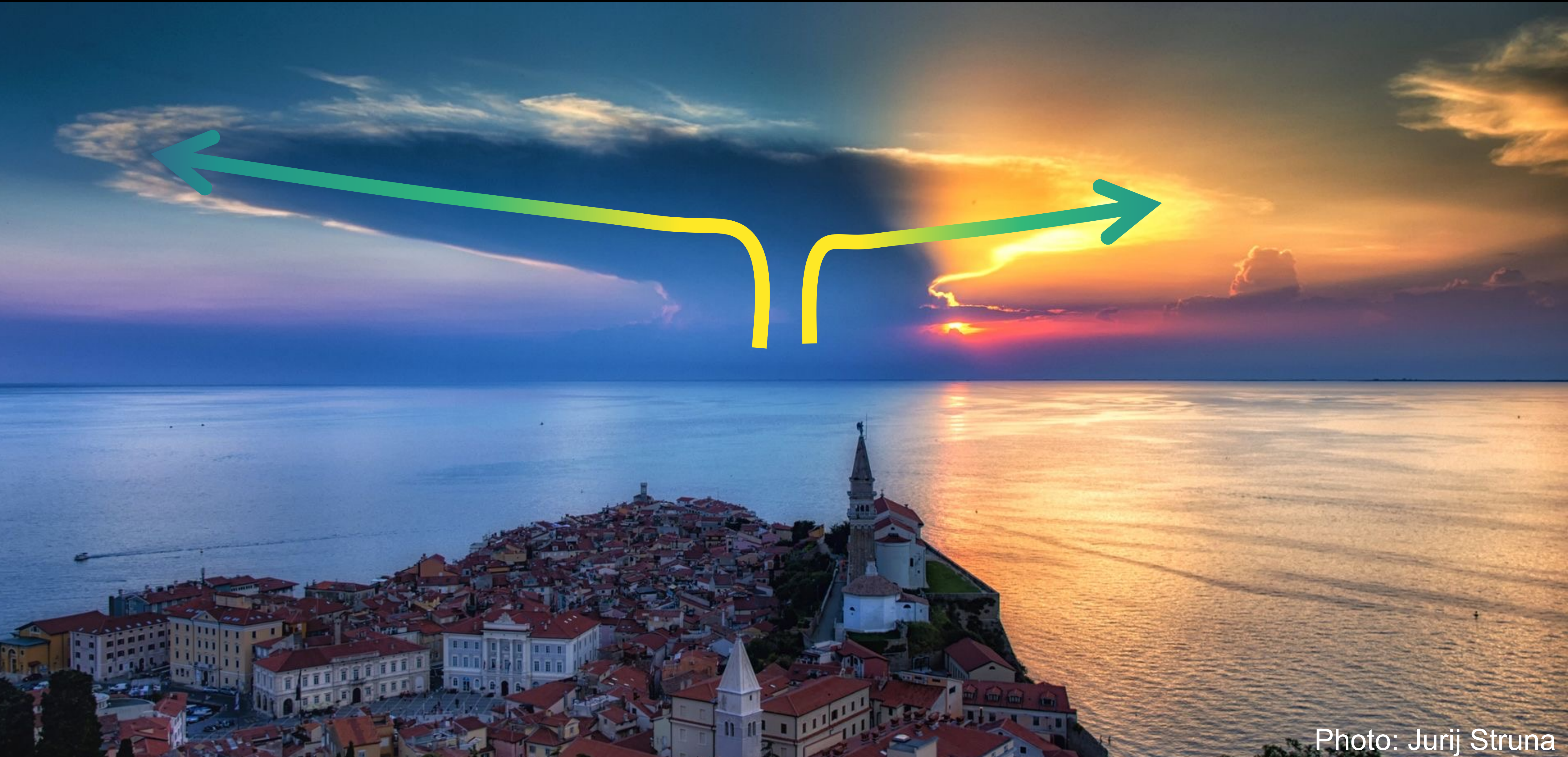
# Do we need to consider icy cirrus to represent the tropical TOA energy balance?



# The contribution of **icy cirrus** is for the TOA budget is not negligible



# The journey of  ice crystals from deep convection to thin cirrus



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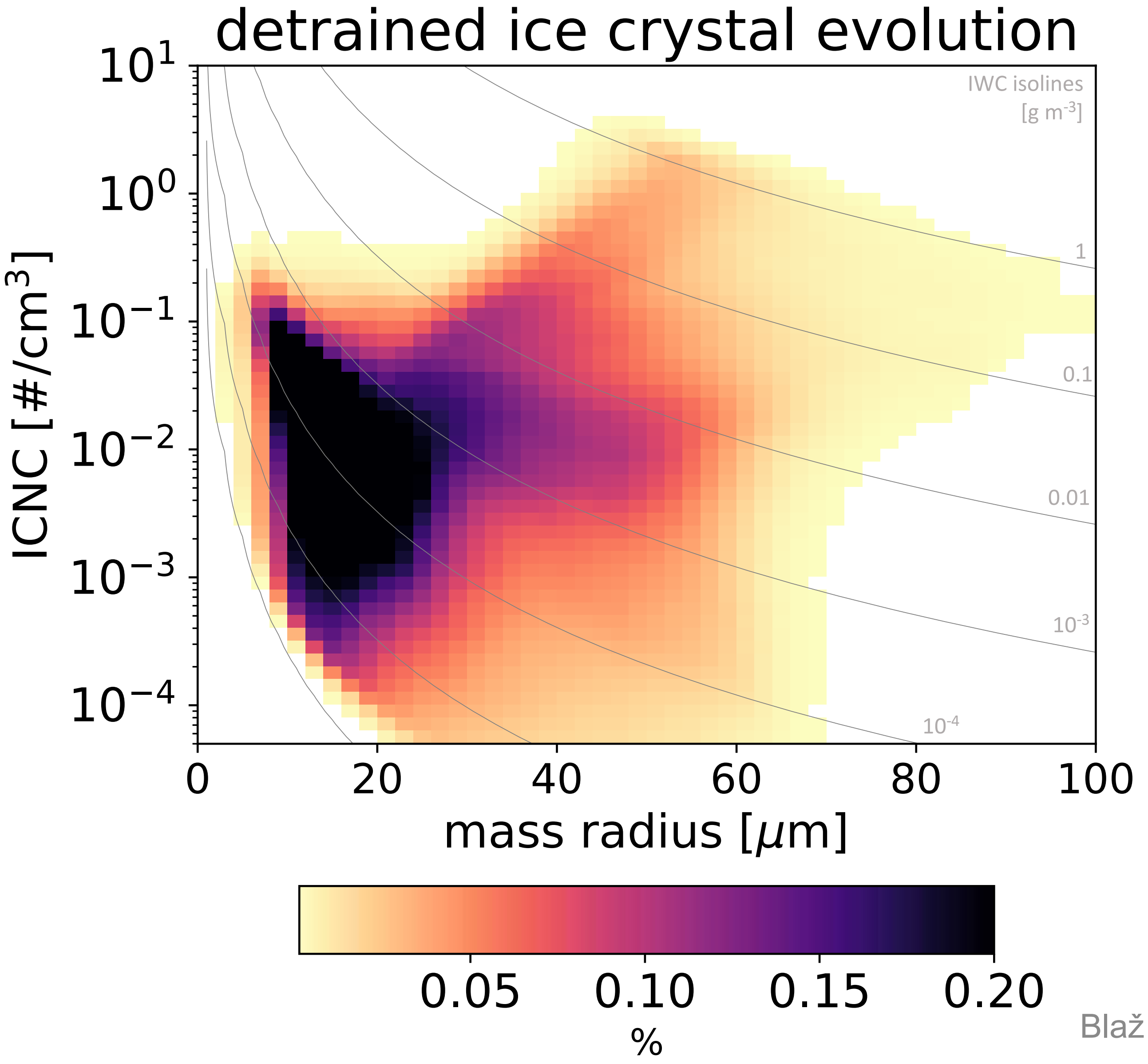
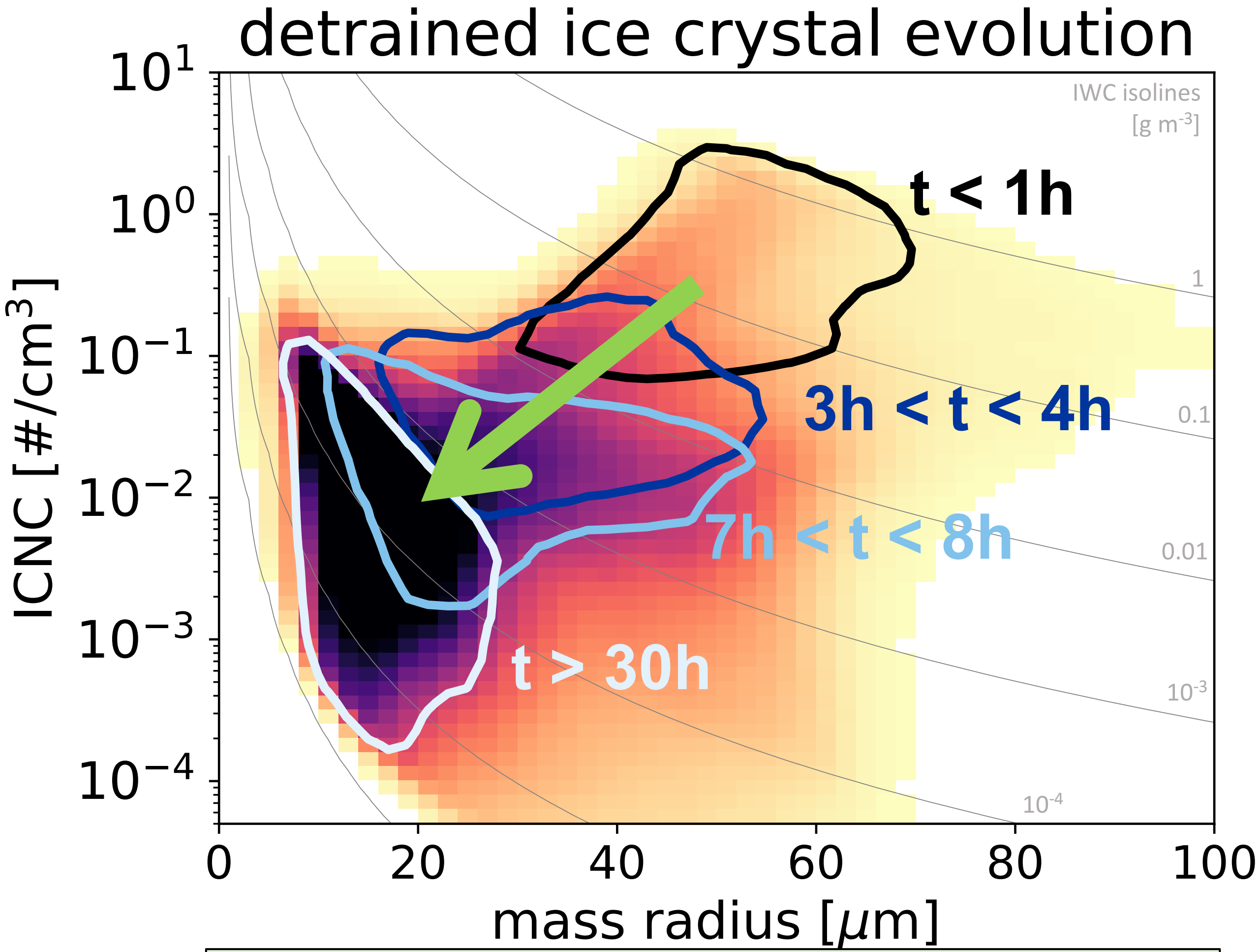
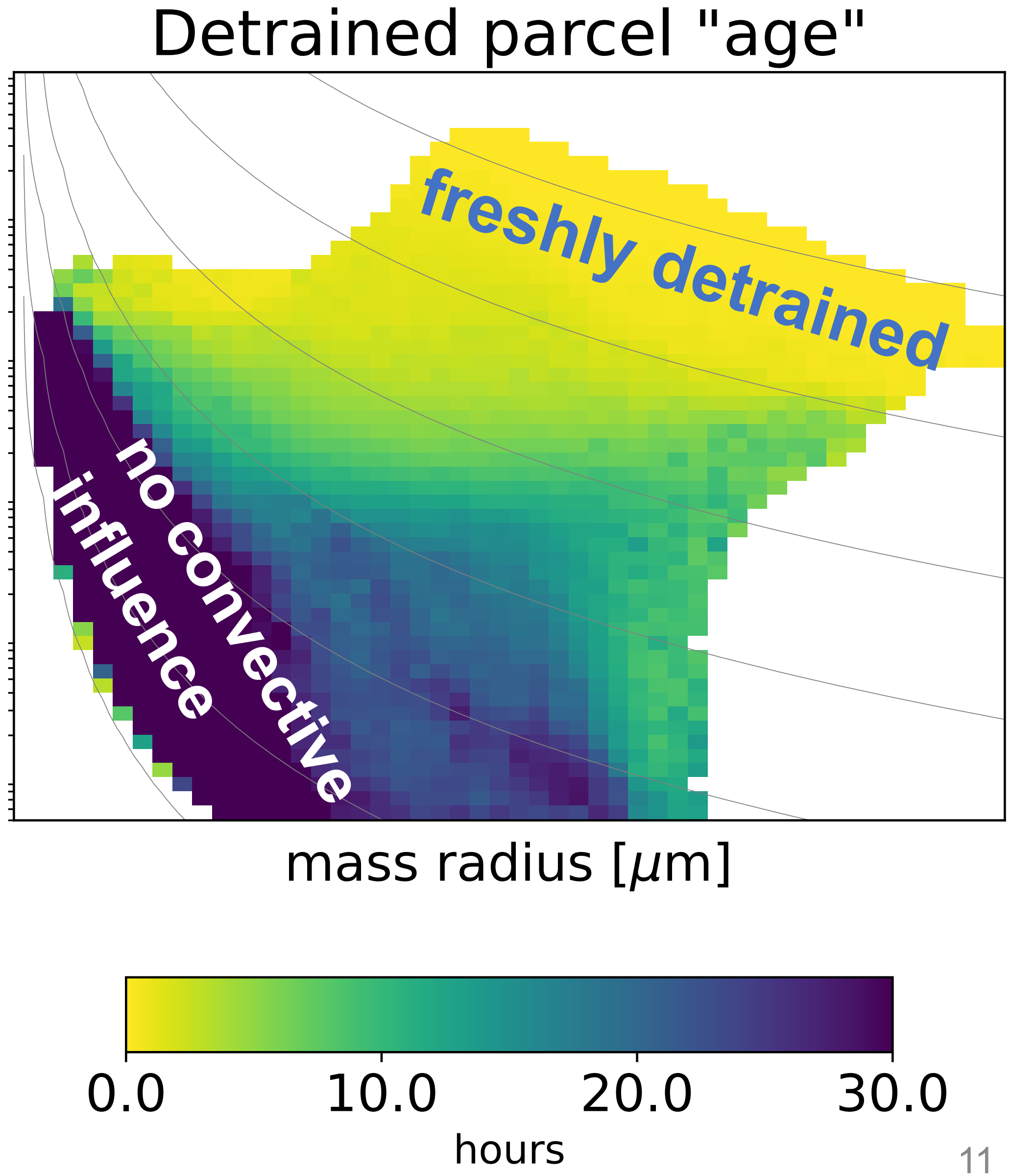



occurrence frequency for all tropical cirrus at T<-40°C

# The journey of ice crystal from deep convection to thin cirrus




During anvil lifetime we observe

- a decrease in ice crystal number
- a decrease in ice crystal size

# Summary

1. **Icy cirrus** should not be neglected in the radiative budget at the top-of-the-atmosphere
2. Tracers are an easy way to track evolution of cloud properties

→ **How to connect it more to observations?**

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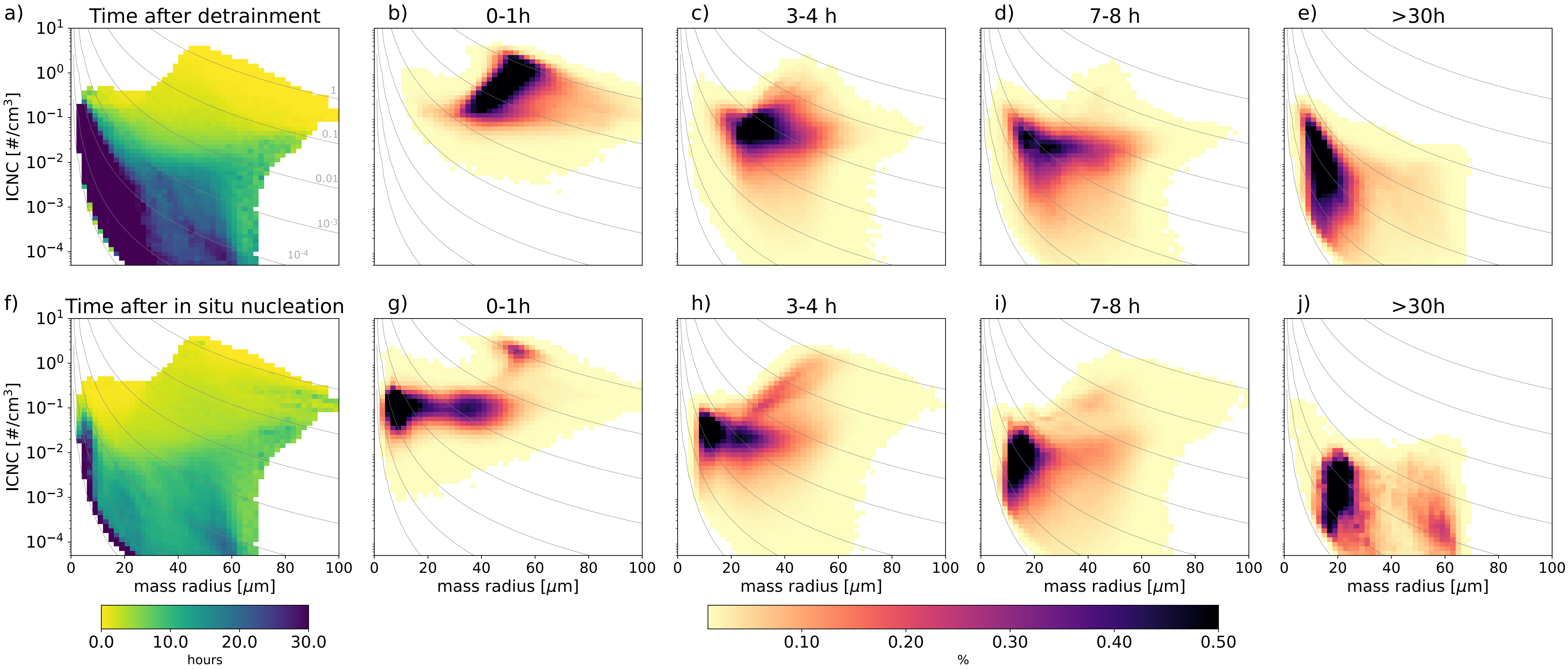
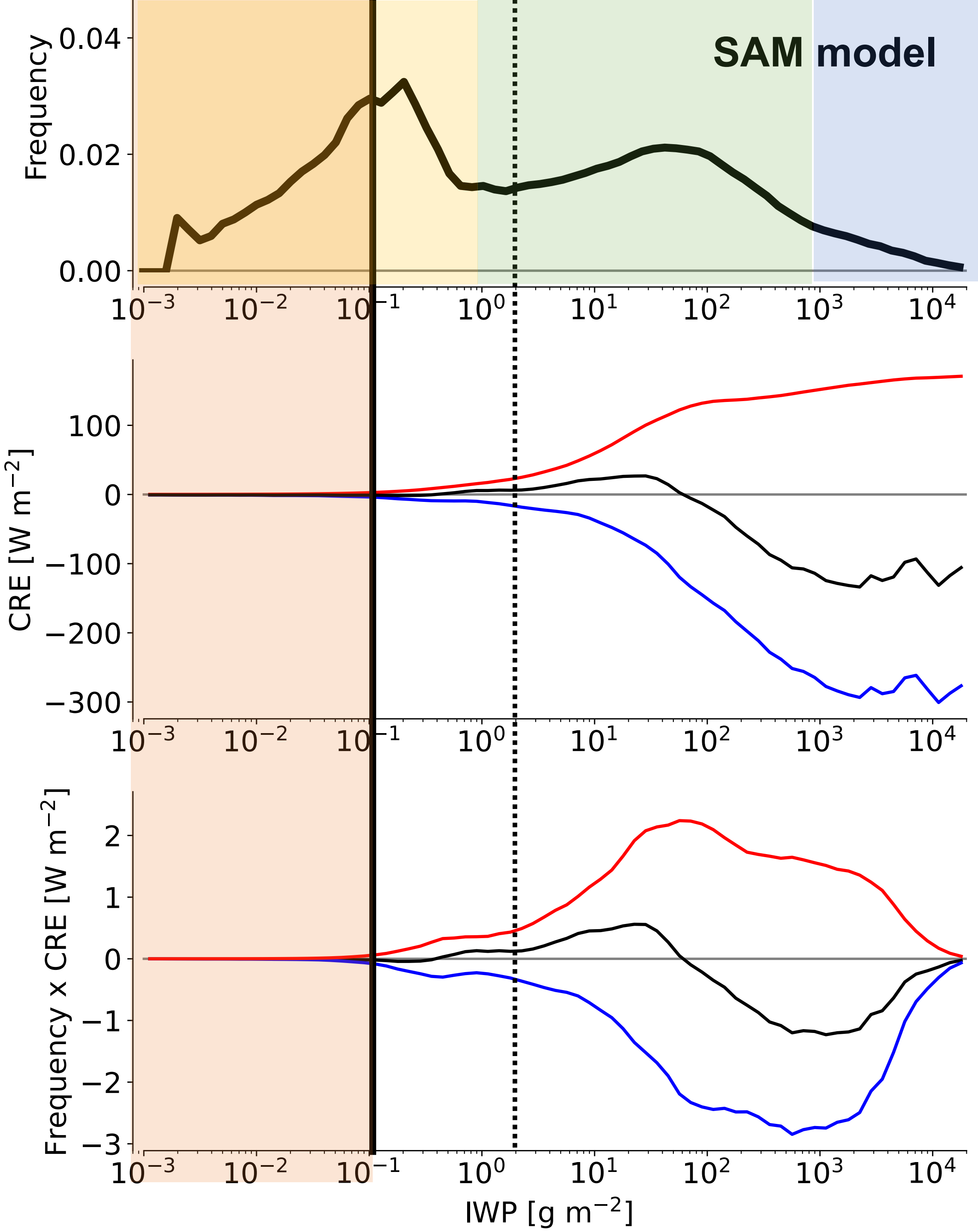
# The journey of  ice crystal from deep convection to thin cirrus



# Clouds at IWP < $10^{-1}$ g $m^{-2}$ are irrelevant for the radiative balance

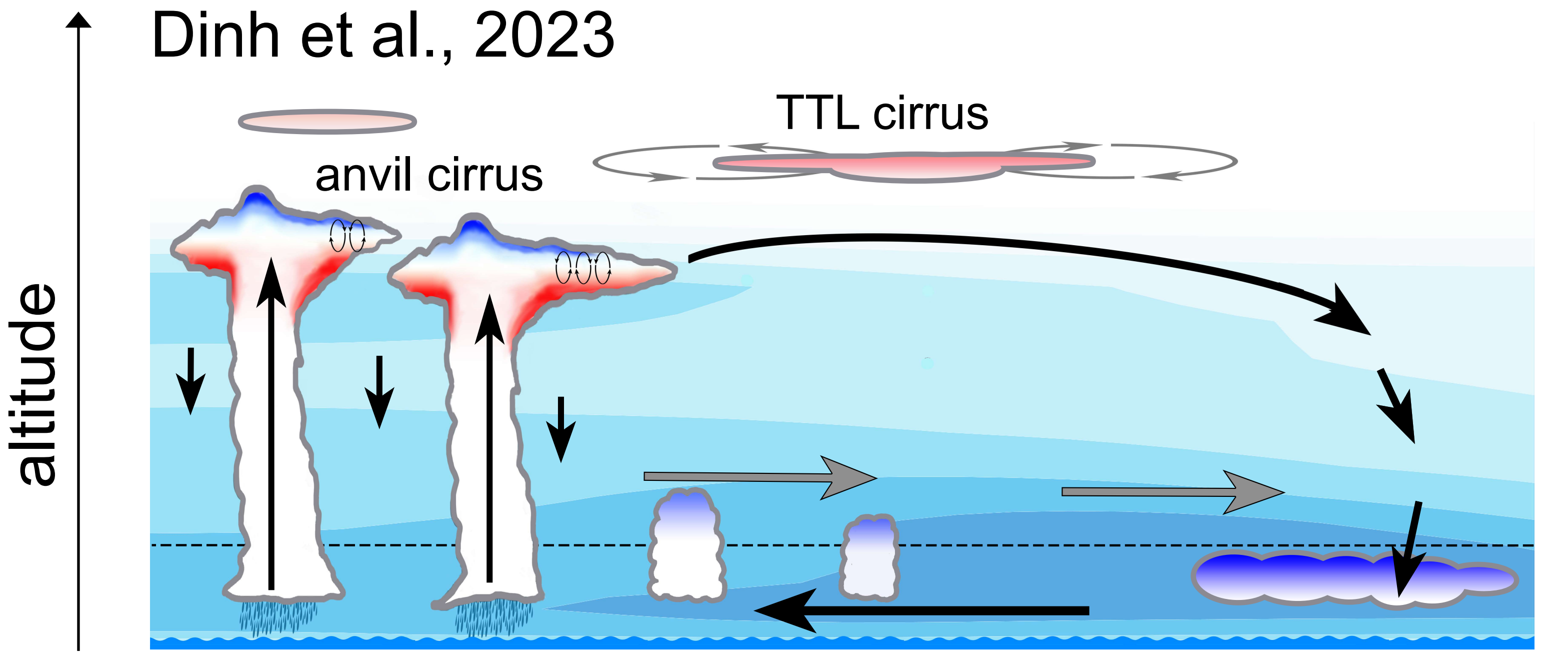


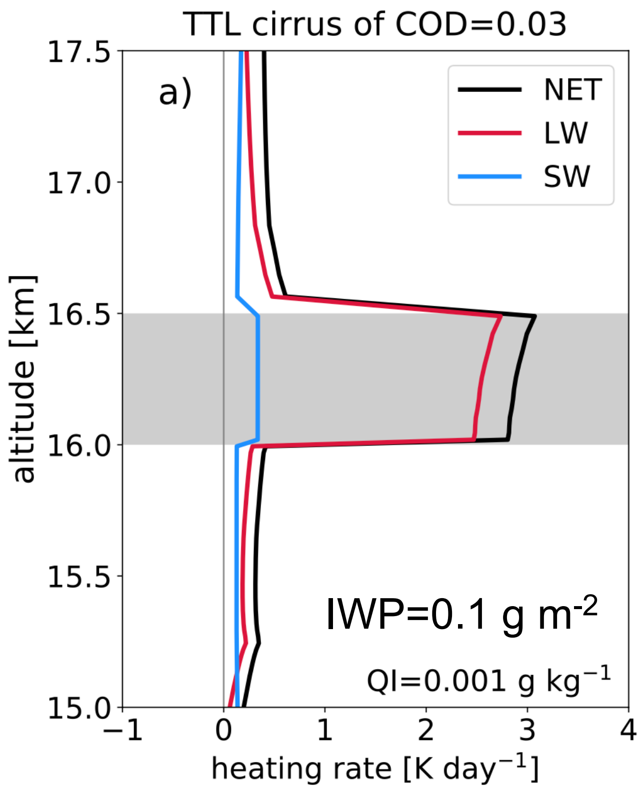

**contribution to the CRE is negligible for IWP < 0.1 g $m^{-2}$ (COD < 0.03)**

Blaž Gasparini

# Even thin TTL cirrus can substantially change CRH

Dinh et al., 2023




Cloud radiative heating drives large-scale dynamics and its response to global warming (e.g. Voigt et al., 2021, Dinh et al., 2023) and mesoscale circulations (e.g. Gasparini et al., 2022)