Ice nucleation influences the anvil lifecycle and modulates the climate in RCE

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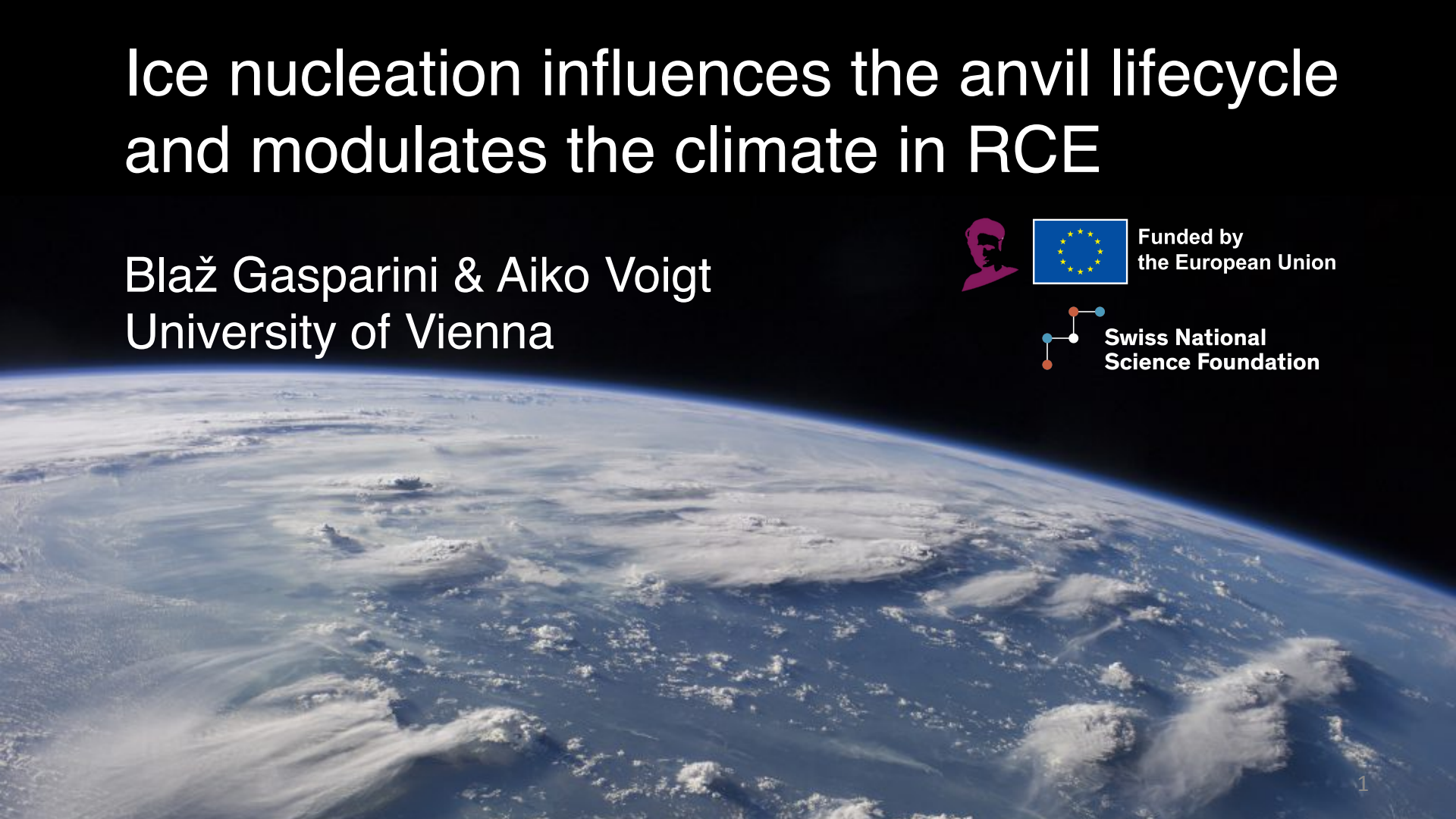

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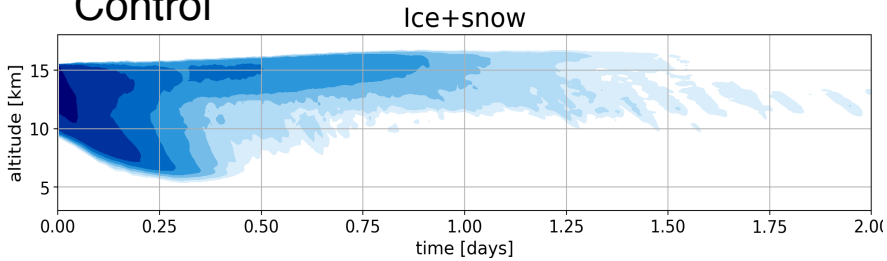
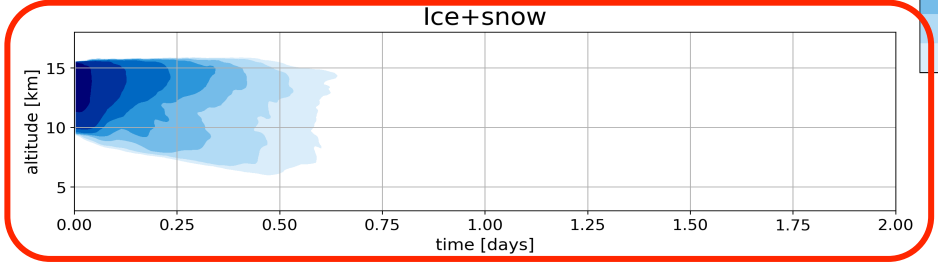
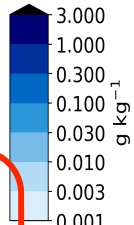
Ice nucleation can play an important role in anvil lifecycle

Control



No ice nucleation at T<-38°C

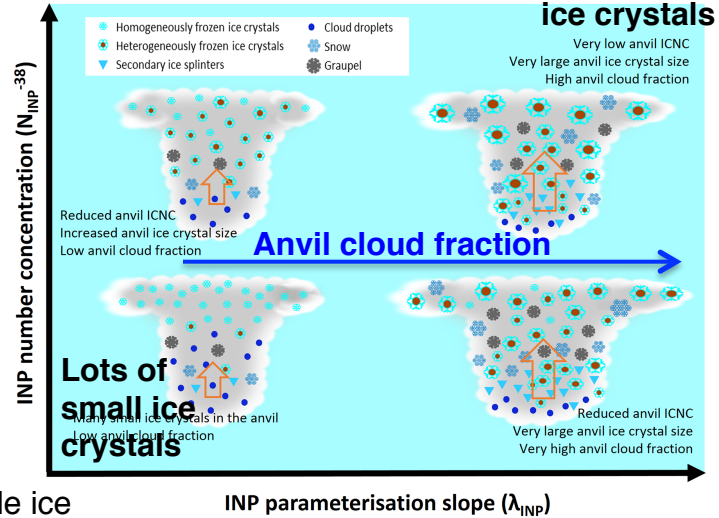




Ice nucleation (driven by radiation-generated turbulence) can be important in prolonging the anvil cloud lifetime.

Hartmann et al., 2018, JAMES
Gasparini et al., 2019, JAMES

Lots of INP at -38°C



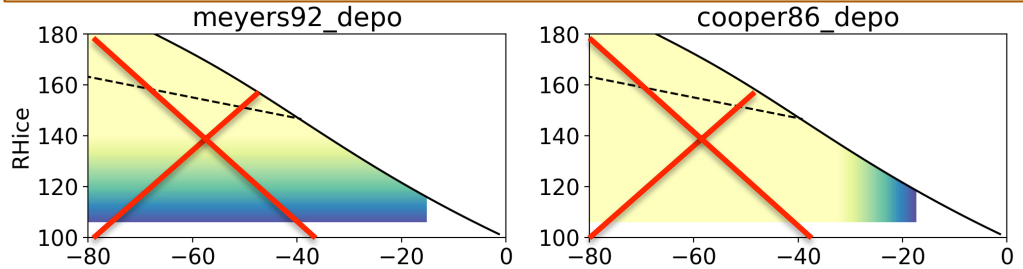
Little ice nucleating particles (INP)

Lots of INP at warm temperatures

Hawker et al., 2021 a,b

We modified cirrus freezing in SAM-P3 CRM to enable the competition between homogenous & heterogeneous freezing

Step1: Limit the mixed-phase parameterizations to mixed-phase



Step 2: Modified Liu and Penner (2005) scheme that allows competition between homogeneous and heterogeneous freezing + pre-existing ice crystals
(Shi et al., 2015 –implemented in CAM6, E3SM GCMs)

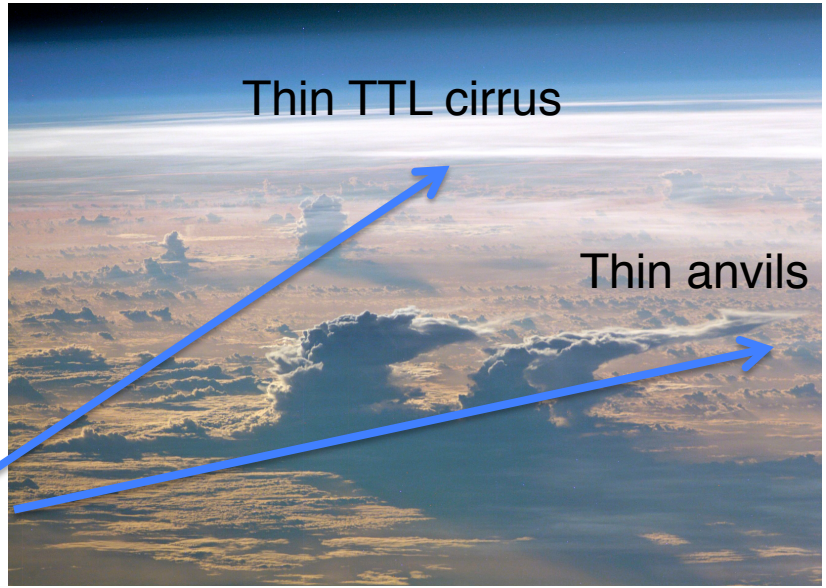
SAM-P3 doesn't interactively simulate aerosols
⇒ need to set the number of ice nucleating particles

Ensemble of 2D RCE + a selection of 3D simulations

SSTs= 26, 30, 34, 38 °C

NC	2 INP/L	20 INP/L	200 INP/L	2000 INP/L
100	**x**	**x**	**x**	**x**
300	x	x	x	x
1000	x	x	x	x

Main target: in-situ (cirrus) freezing at T<-38°C
mixed phase freezing is by construction not directly influenced changes in ice nucleating particles (INP)

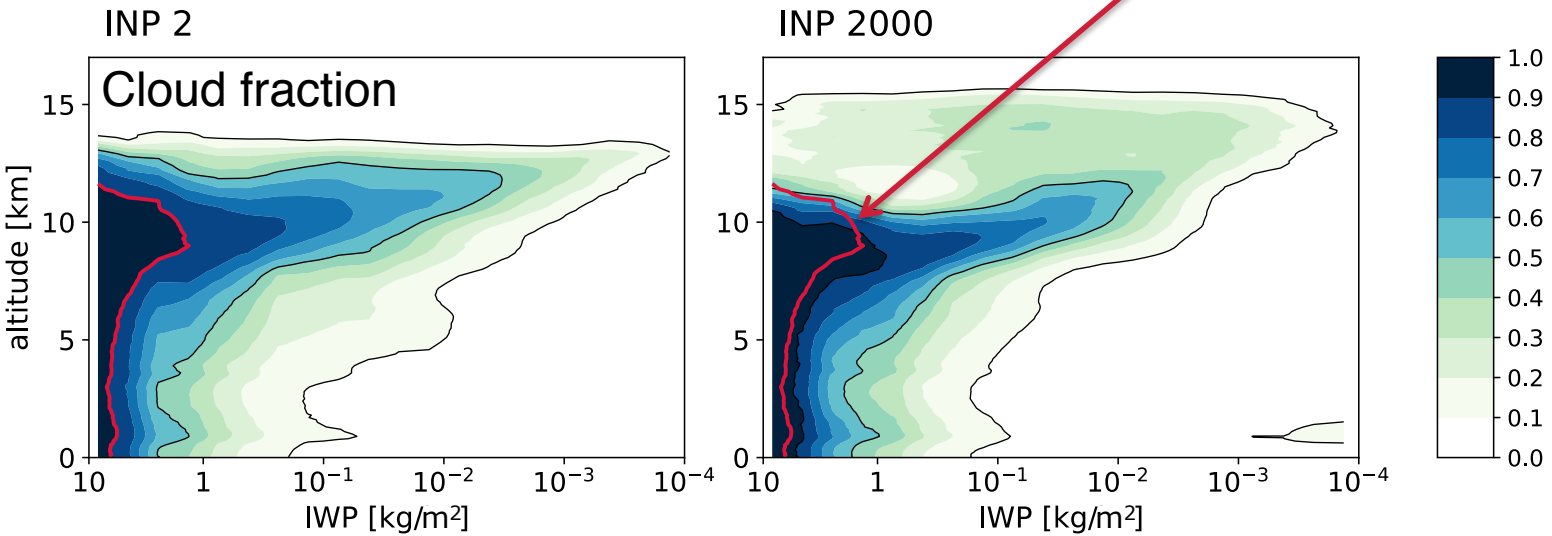


Enhanced ice nucleating particle number lead to more upper tropospheric cirrus and a decreased detrainment level

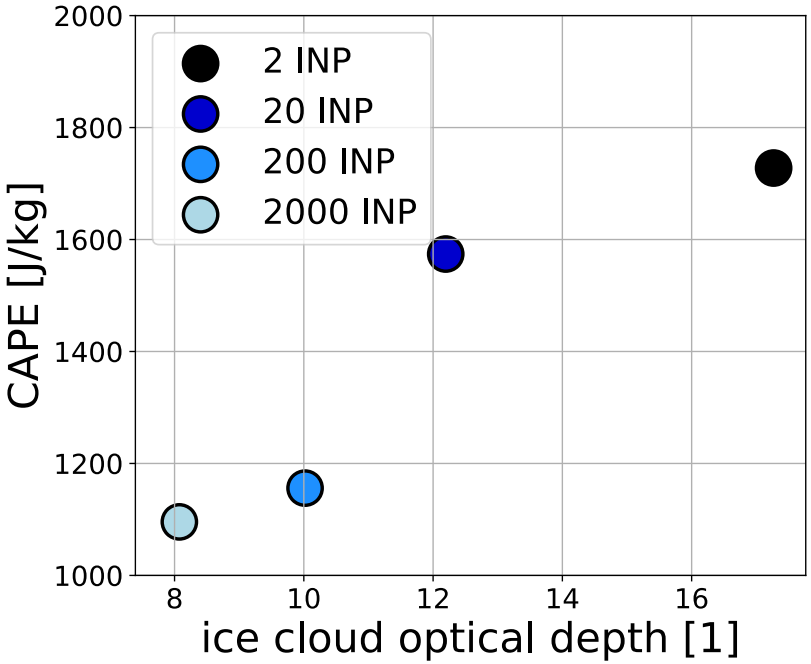
SST= 26°C

NC	2 INP/L	2000 INP/L
100	x	x

Cloud fraction = 0.9 from the INP 2 simulation



Enhanced ice nucleation dampens deep convection



Targeting cirrus (in-situ) freezing

RCE simulations:
Increase in INP at T<-38°C:

- more thin high clouds
- smaller high cloud COD
- Large spread in CRE responses

Only small (insignificant?) changes in cloud feedbacks
possible role of changes in convective aggregation

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