

Convective controls on anvil area and thickness in analytical and km-scale models

Mathilde Ritman, William Jones, Philip Stier, Gabrielle
("Bee") Leung, Fabian Senf, Susan van den Heever

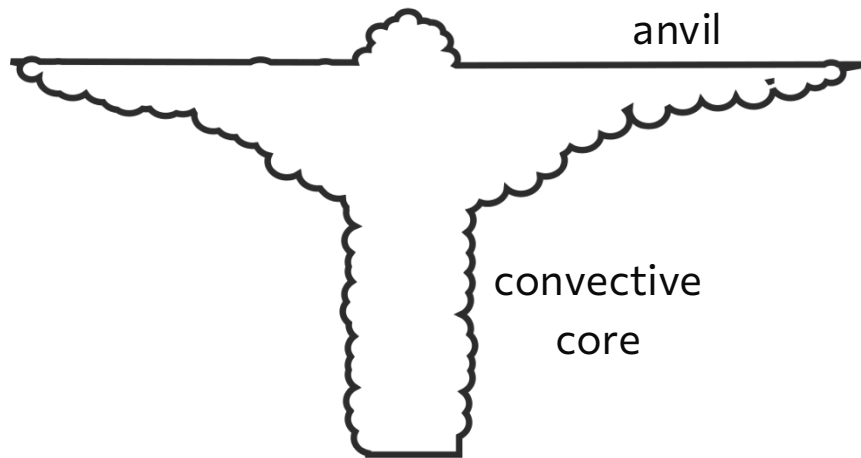


General Sir
John Monash
Foundation

Tuesday 5 May, EGU General Assembly 2026

Study motivation

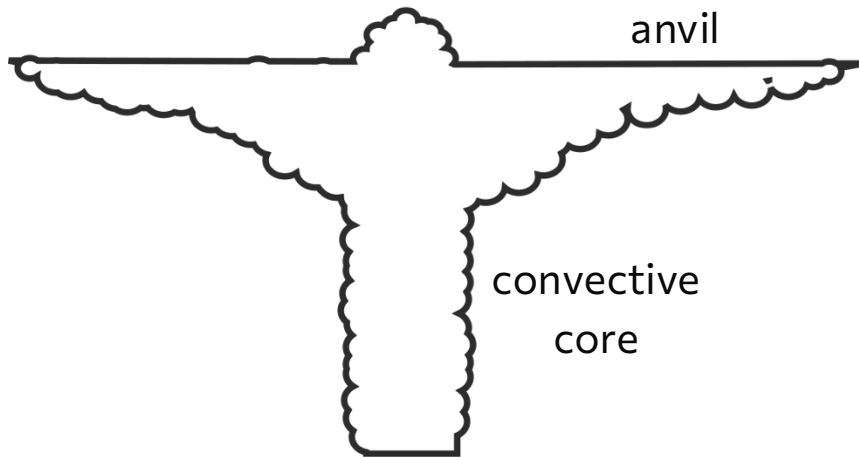
deep convective cloud



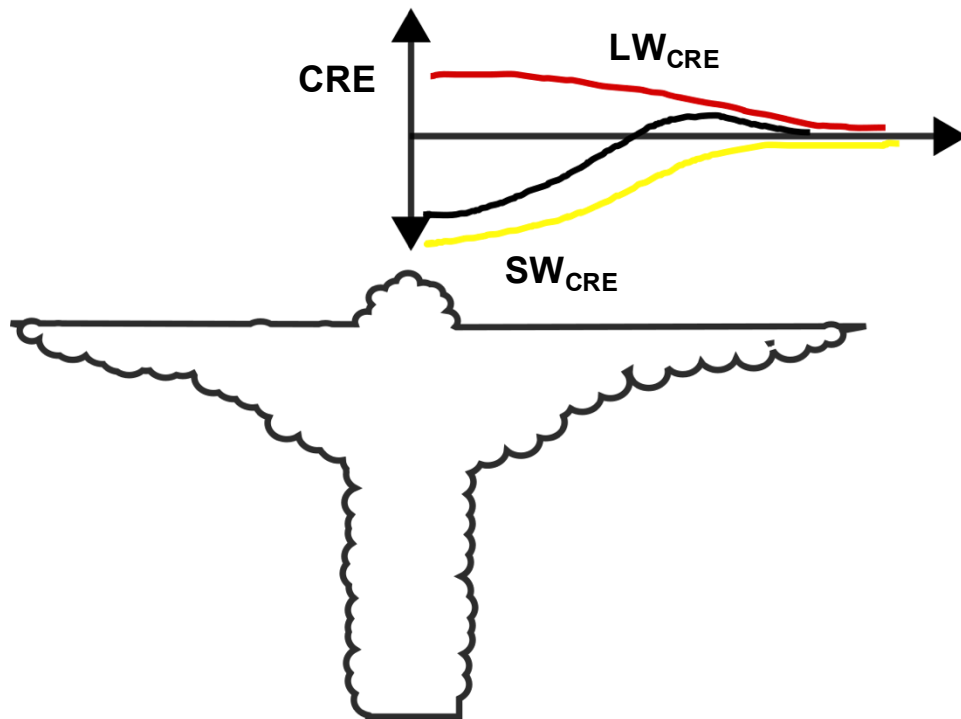
Study motivation

- Clouds matter for climate (and more)

deep convective cloud

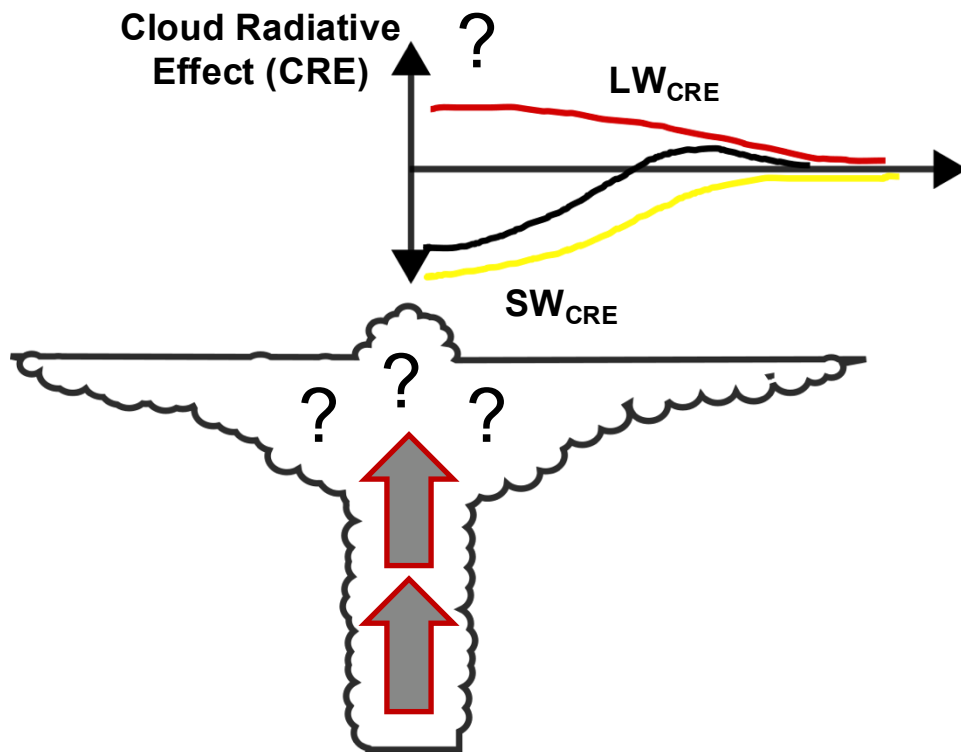


Study motivation



- Clouds matter for climate (and more)

Study motivation



- Clouds matter for climate (and more)
- The link between convective inflow and anvil evolution is difficult to observe

Study objective



- Clouds matter for climate (and more)

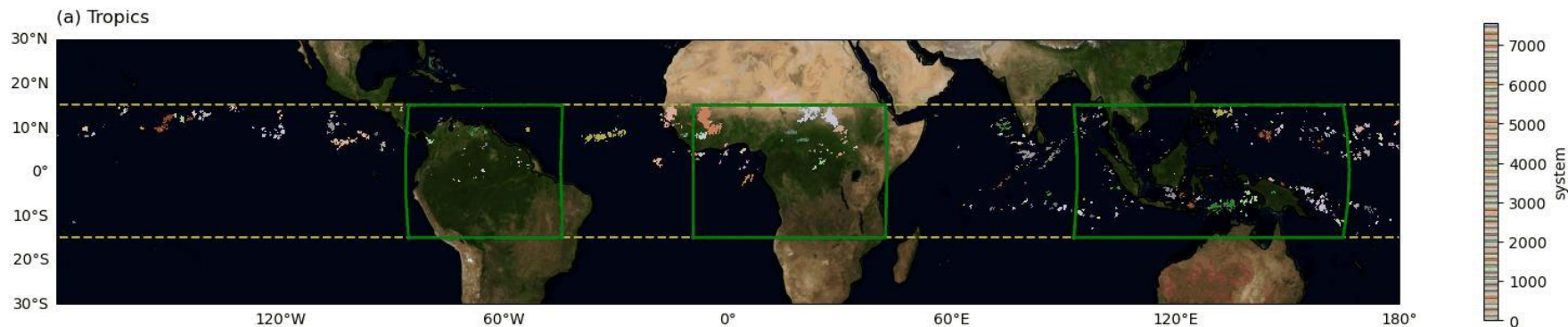
- The link between convective inflow and ... ve

How **convection** determines **anvil evolution**



Study approach

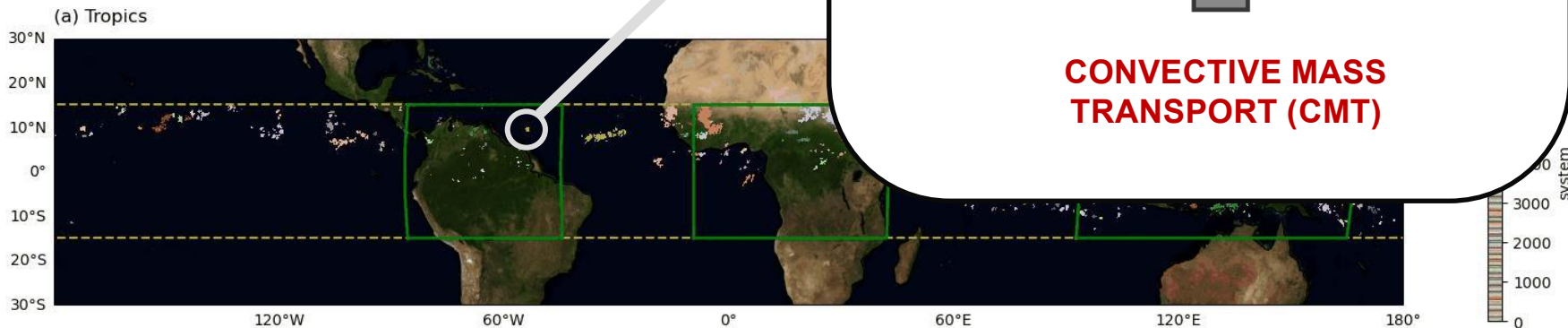
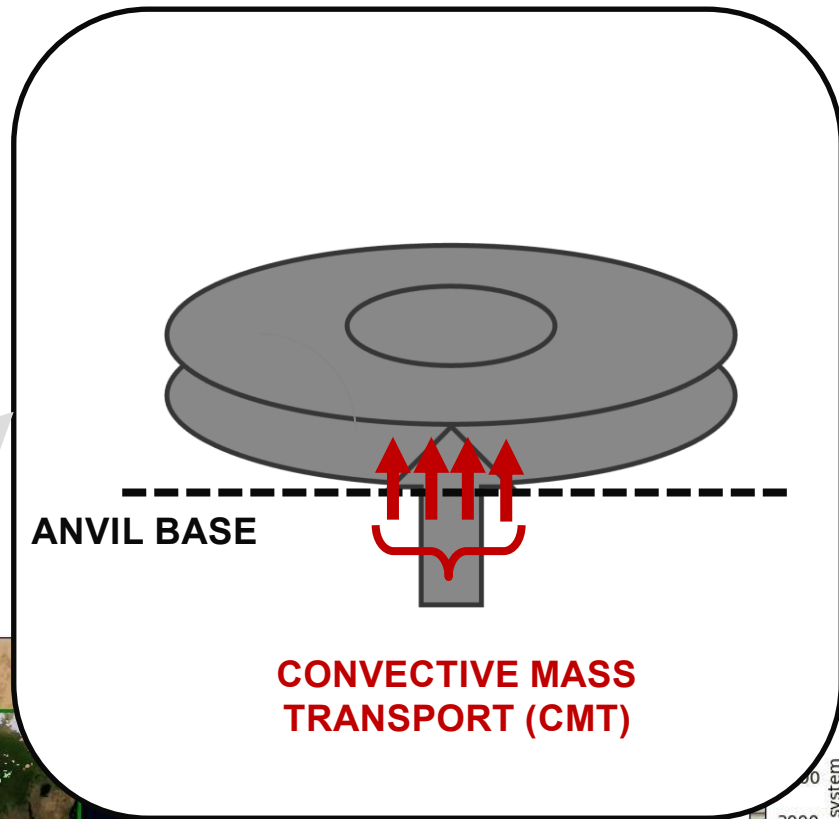
- **Track*** deep convective clouds
- ICON km-scale climate model
- Tropics-wide
- In 3D space + time



*Ritman et al., 2026 (ACP)

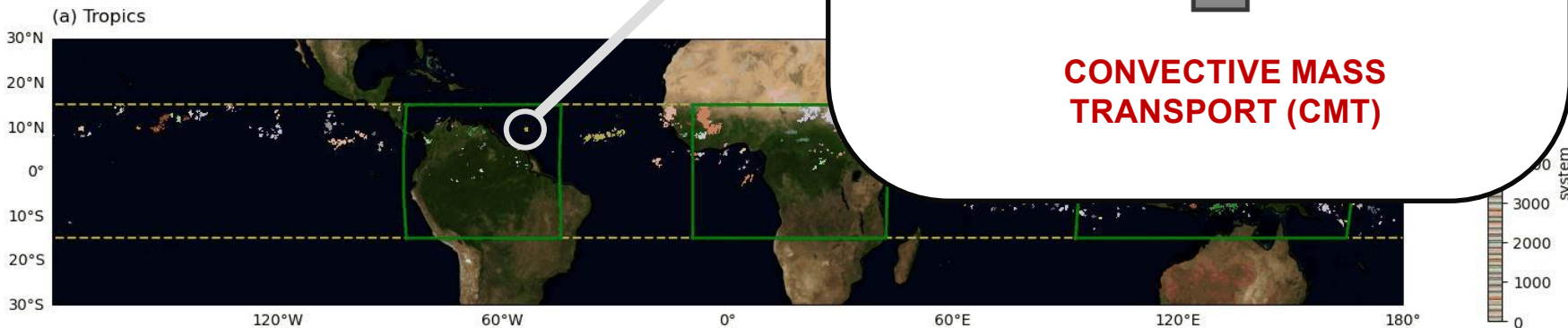
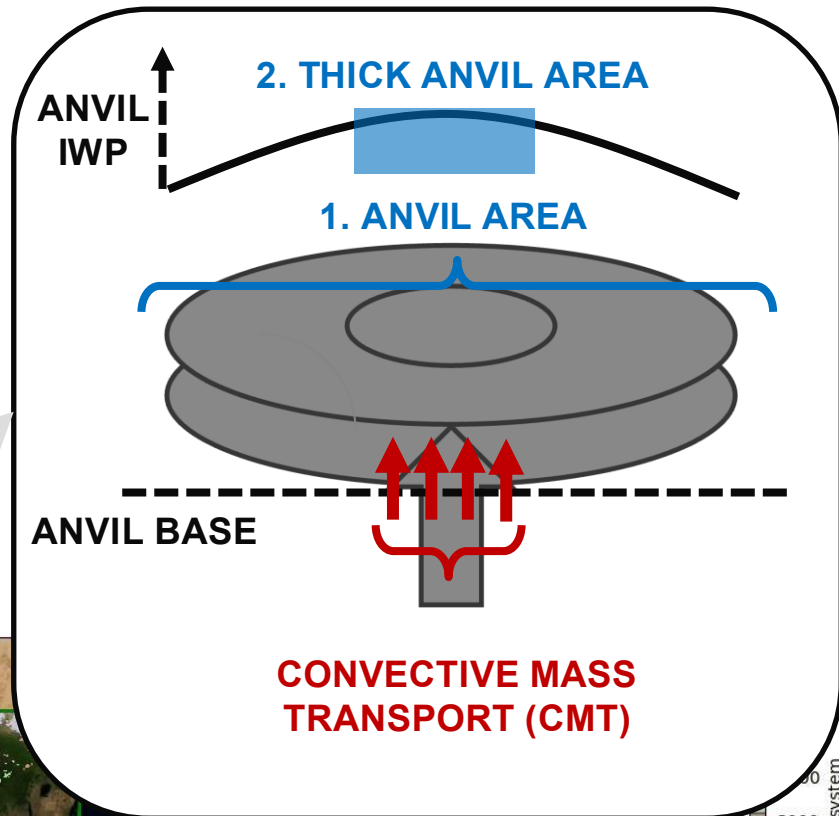
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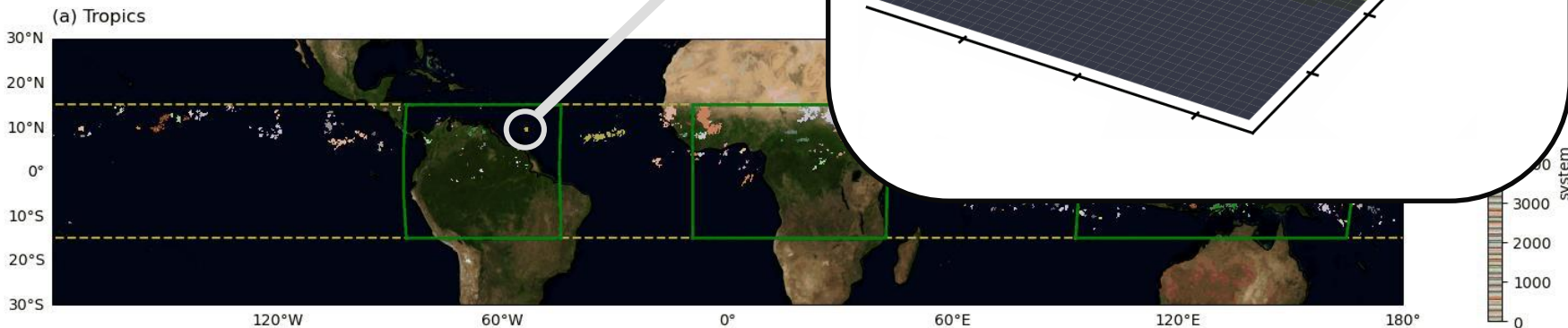
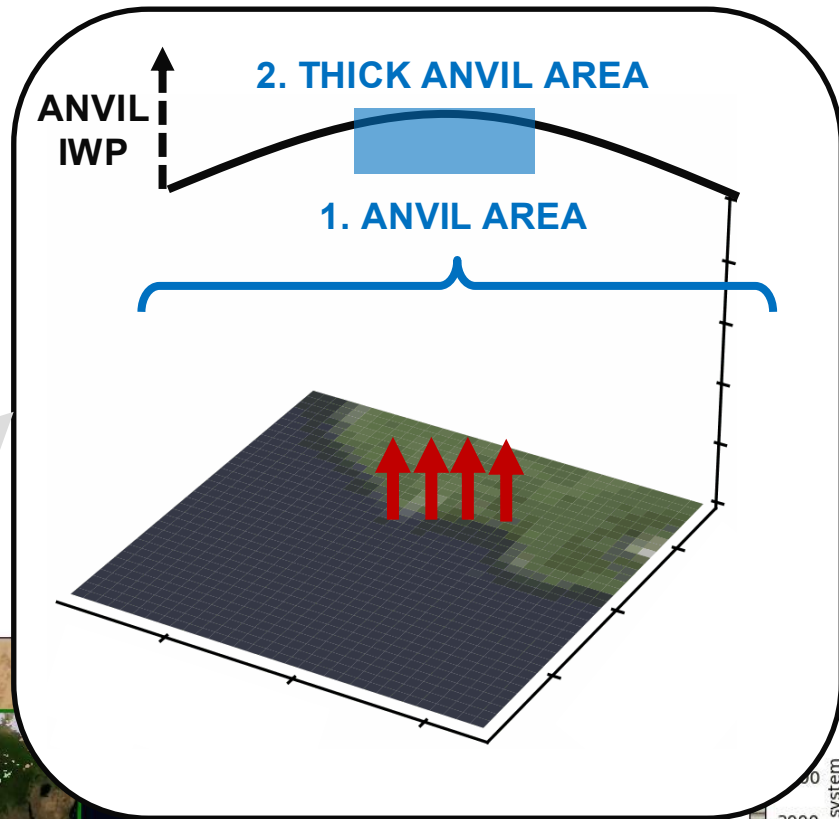
Study approach

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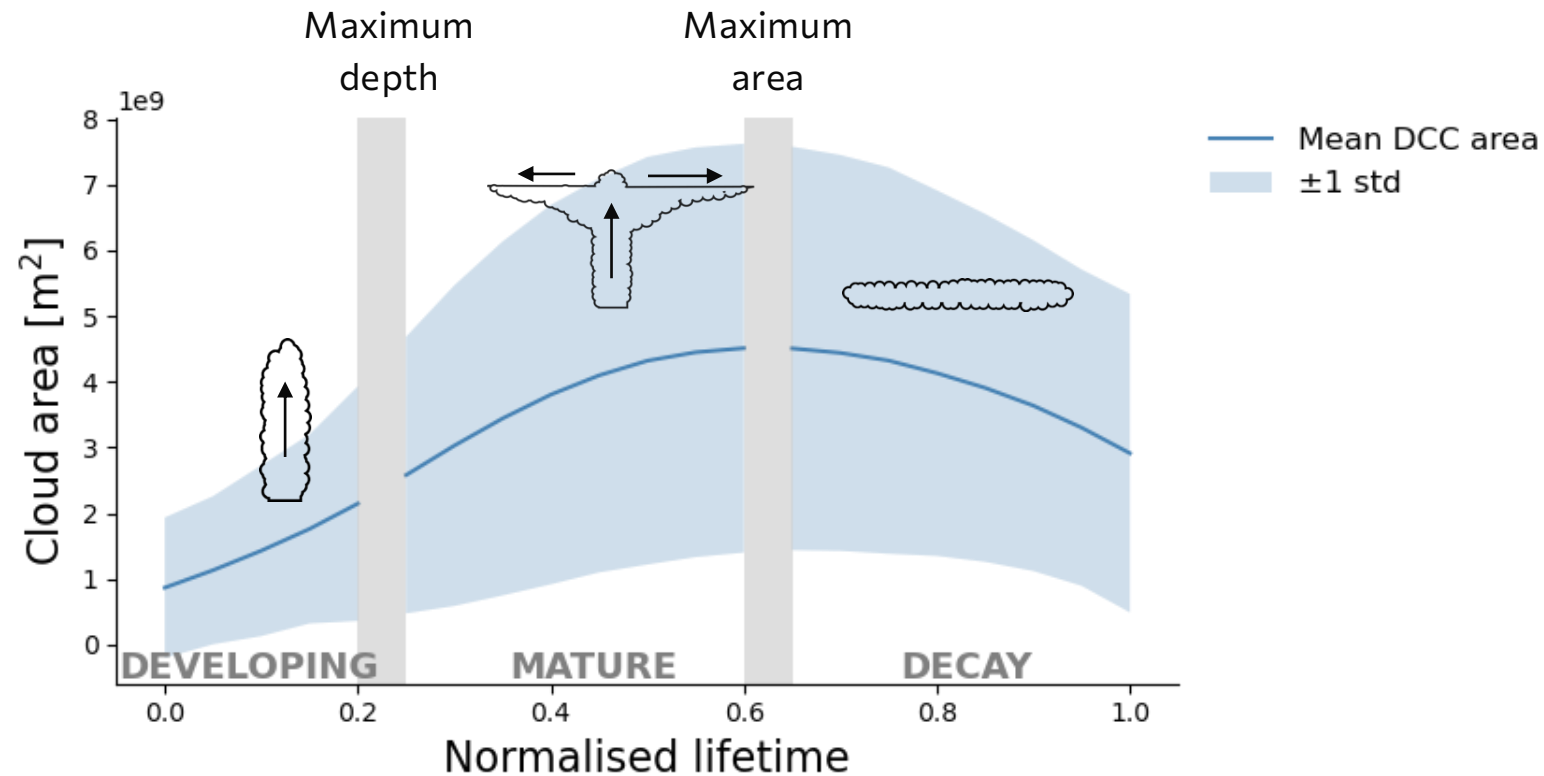


Study approach

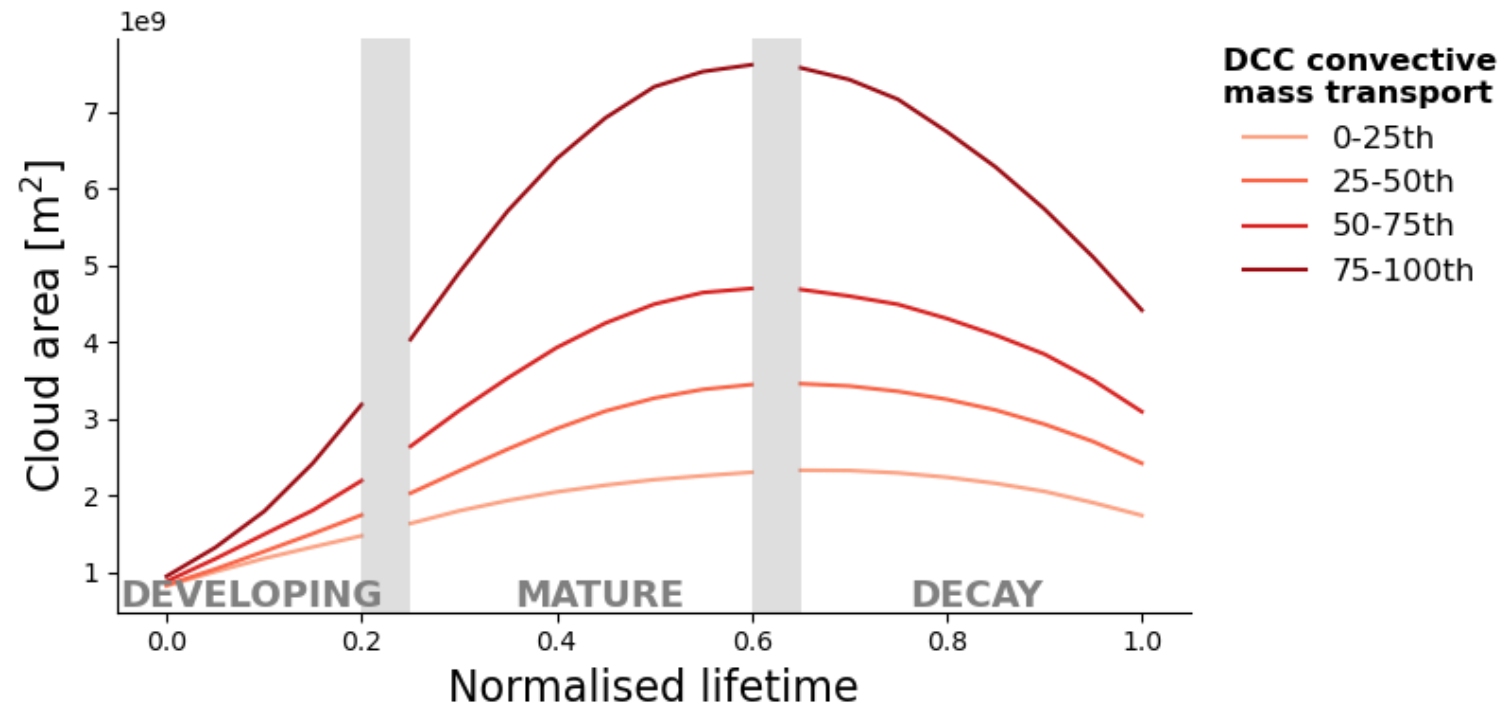
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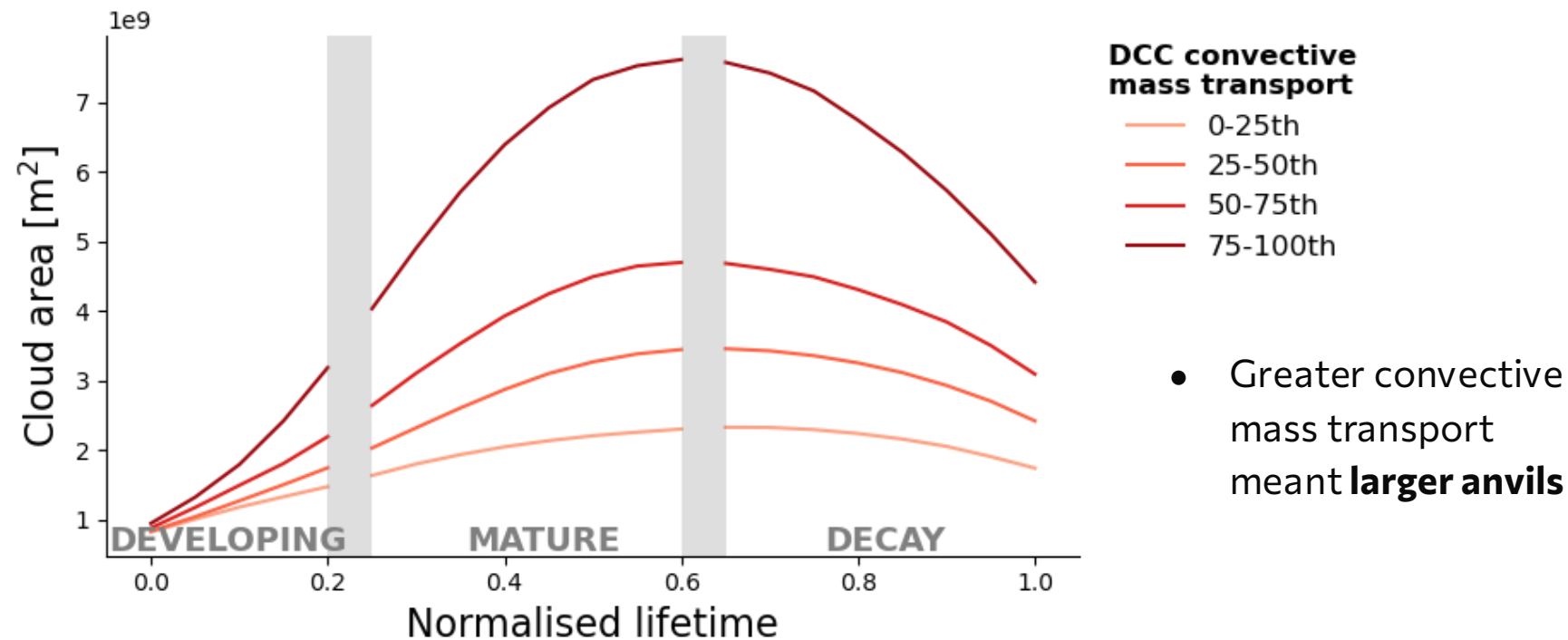
Mean anvil evolution



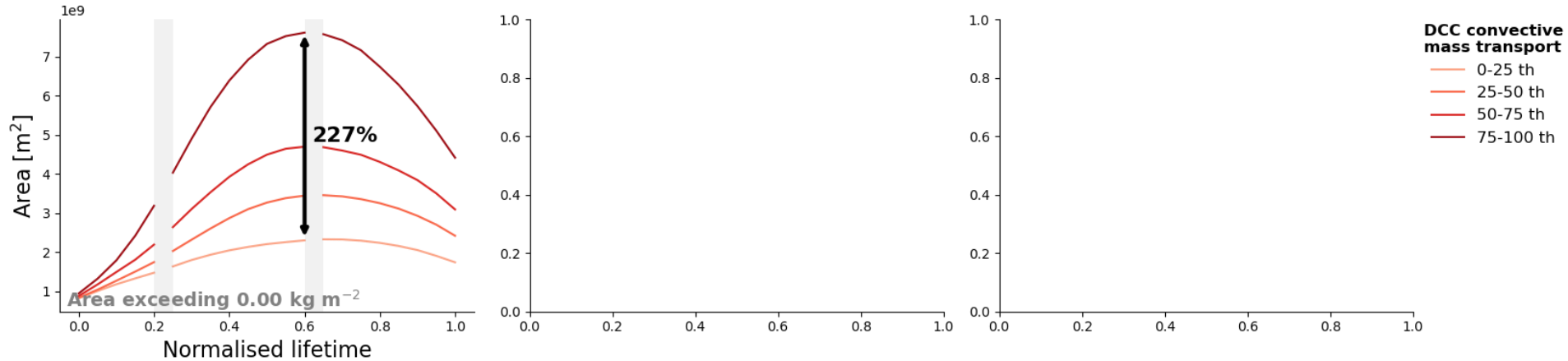
1. Anvil response to increased inflow



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2. *Thick* anvil response to increased inflow



AREA

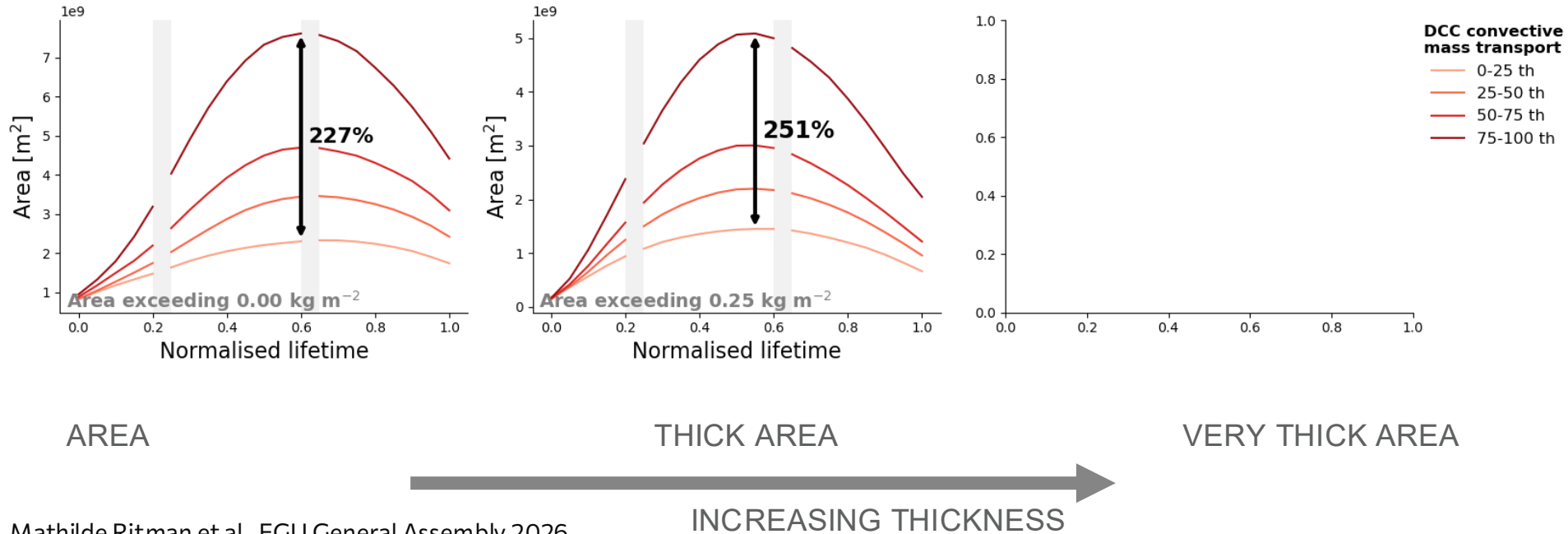
THICK AREA

VERY THICK AREA



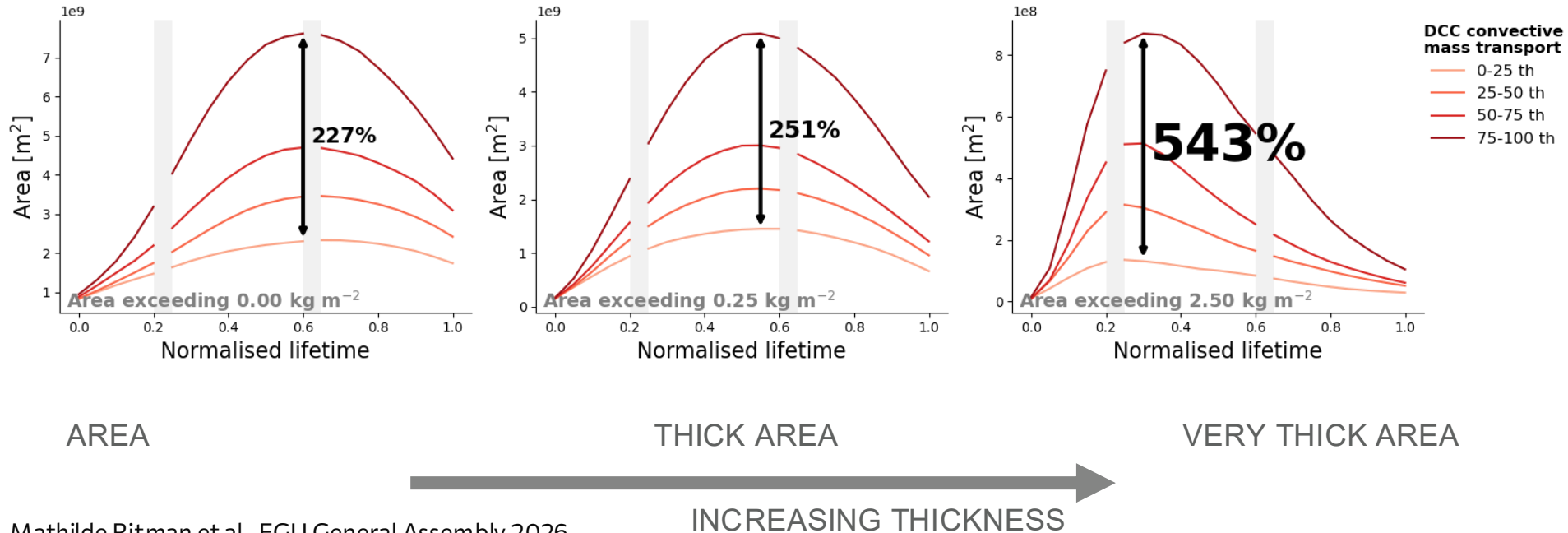
INCREASING THICKNESS

2. *Thick* anvil response to increased inflow



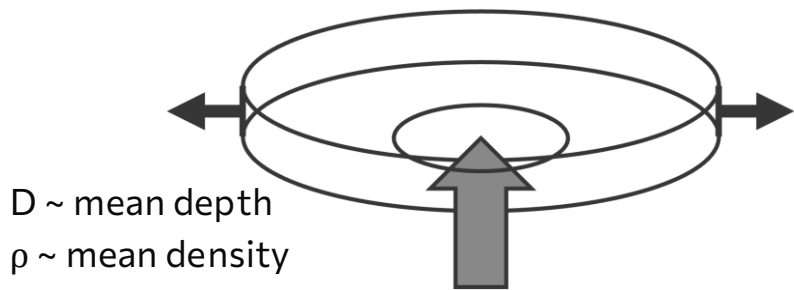
2. *Thick* anvil response to increased inflow

- Greater convective mass transport meant a **bigger increase in thick anvil area**



Understanding the results

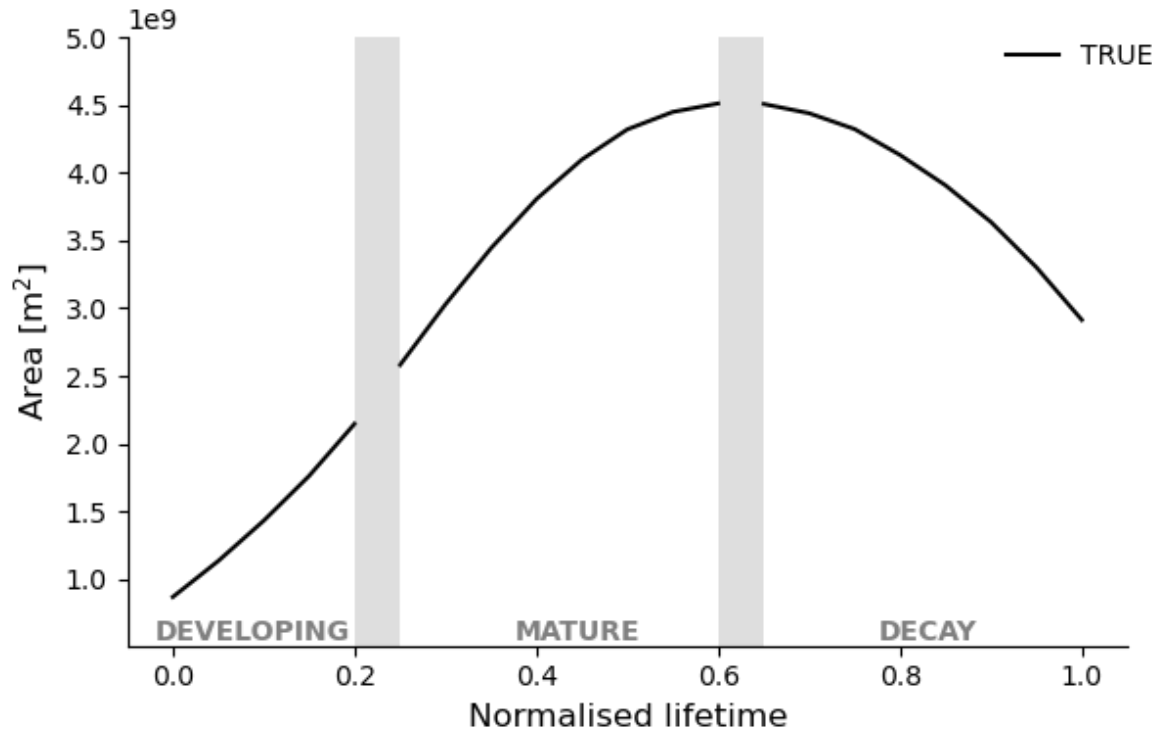
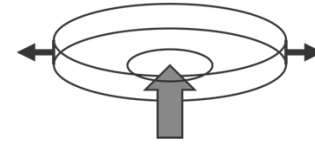
1. Anvil area: $A(t) = \frac{1}{\rho D} \int CMT dt$



$$CMT = \max_t \left(\int_{A_{core}} \rho w dA \right)$$

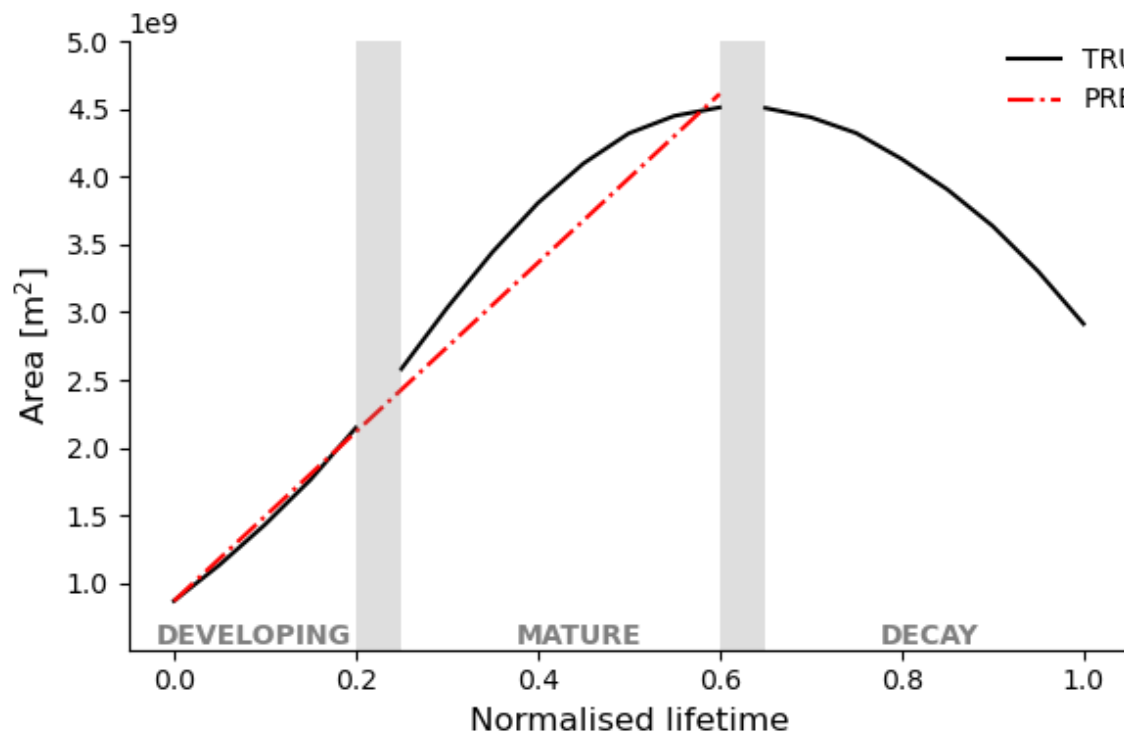
- **Conservation of mass** links convective inflow to anvil evolution
- We test how well an idealised analytical model can explain the results

1. Predicted area evolution

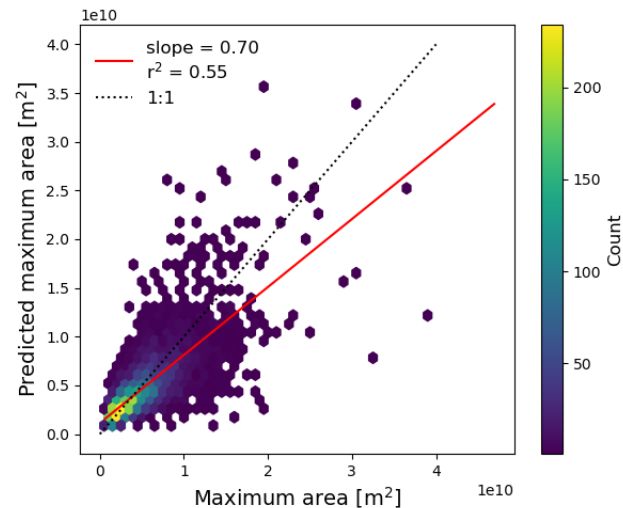


- Using the mean anvil depth and density
- Maximum CMT predicts anvil area evolution

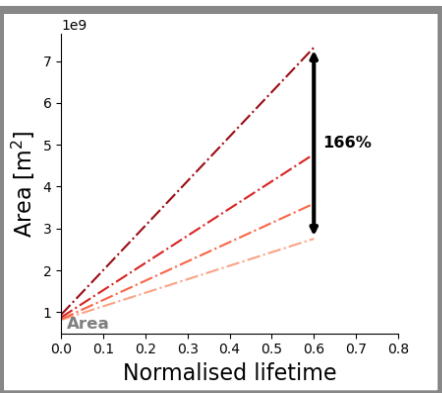
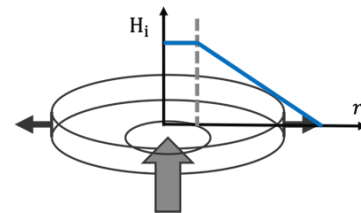
1. Predicted area evolution



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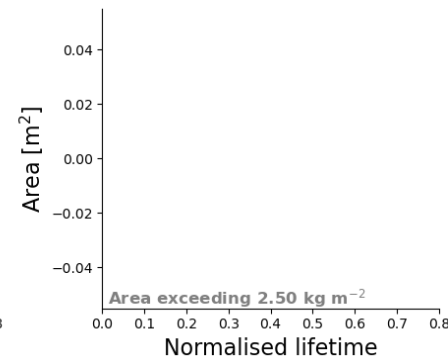
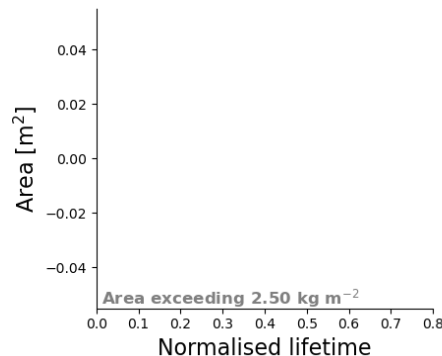
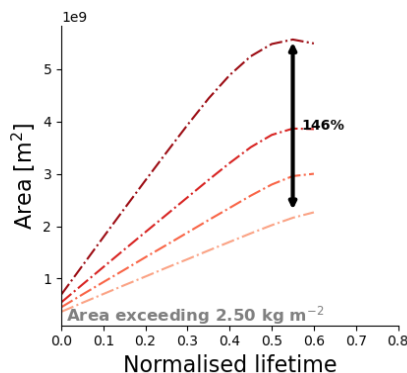


2. Predicted *thick* anvil evolution



AREA

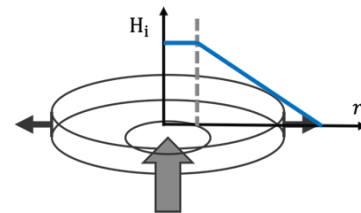
Fixed depth &
Fixed initial ice density



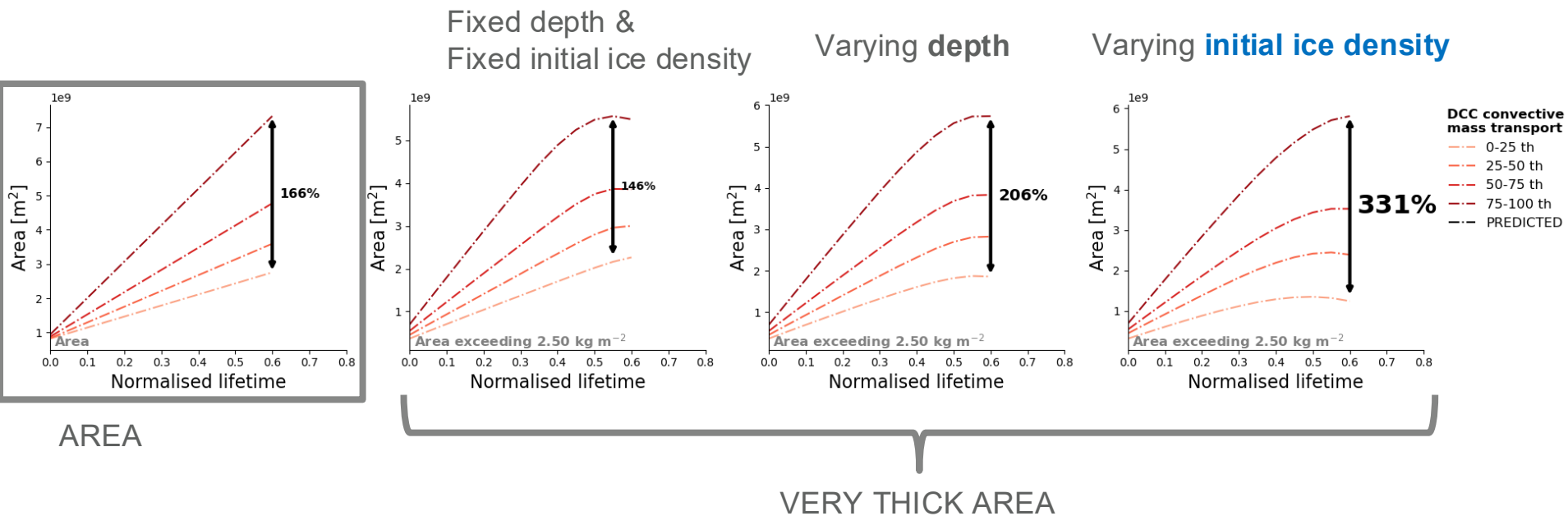
- DCC convective mass transport**
- 0-25 th
 - - 25-50 th
 - · - 50-75 th
 - 75-100 th
 - · - PREDICTED

VERY THICK AREA

2. Predicted *thick* anvil evolution



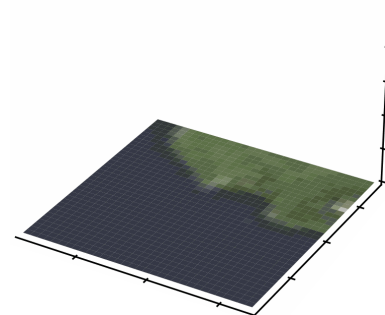
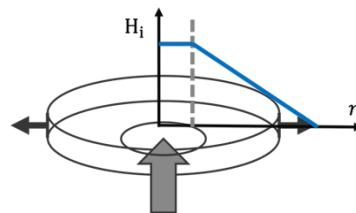
- **Varying initial ice density** reproduces the greater dependence of *thick* anvil



Summary

1. Greater **convective mass transport** meant **larger anvils**
2. There was a **greater dependence of *thick* anvil area** on inflow than total
3. Varying **initial ice density** reproduces the greater dependence of *thick* anvil on inflow

Using:

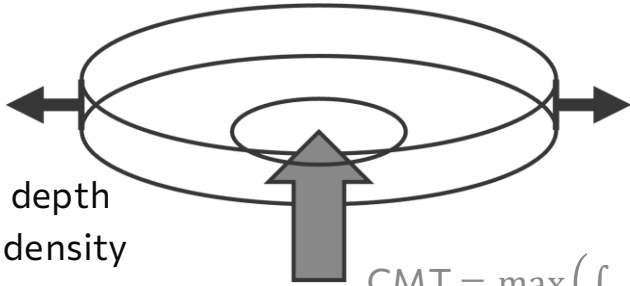


Presented by: Mathilde Ritman, mathilde.ritman@physics.ox.ac.uk

Extra slides

Extra slides

1. Anvil area: $A(t) = \frac{1}{\rho D} \int CMT dt$



$D \sim$ mean depth
 $\rho \sim$ mean density

$$CMT = \max_t \left(\int_{A_{core}} \rho w dA \right)$$

- **Conservation of mass** links convective inflow to anvil evolution
- We test how well an idealised analytical model can explain the results

2. Anvil IWP: $H_i = \rho_i(t, r) D$

