Observational evidence from **Calipso** for a **Stability-iris** effect

Marion Saint-Lu, Sandrine Bony, Jean-Louis Dufresne

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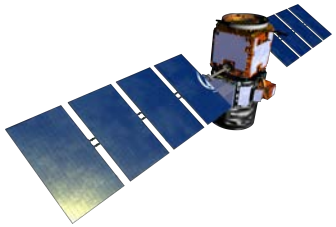
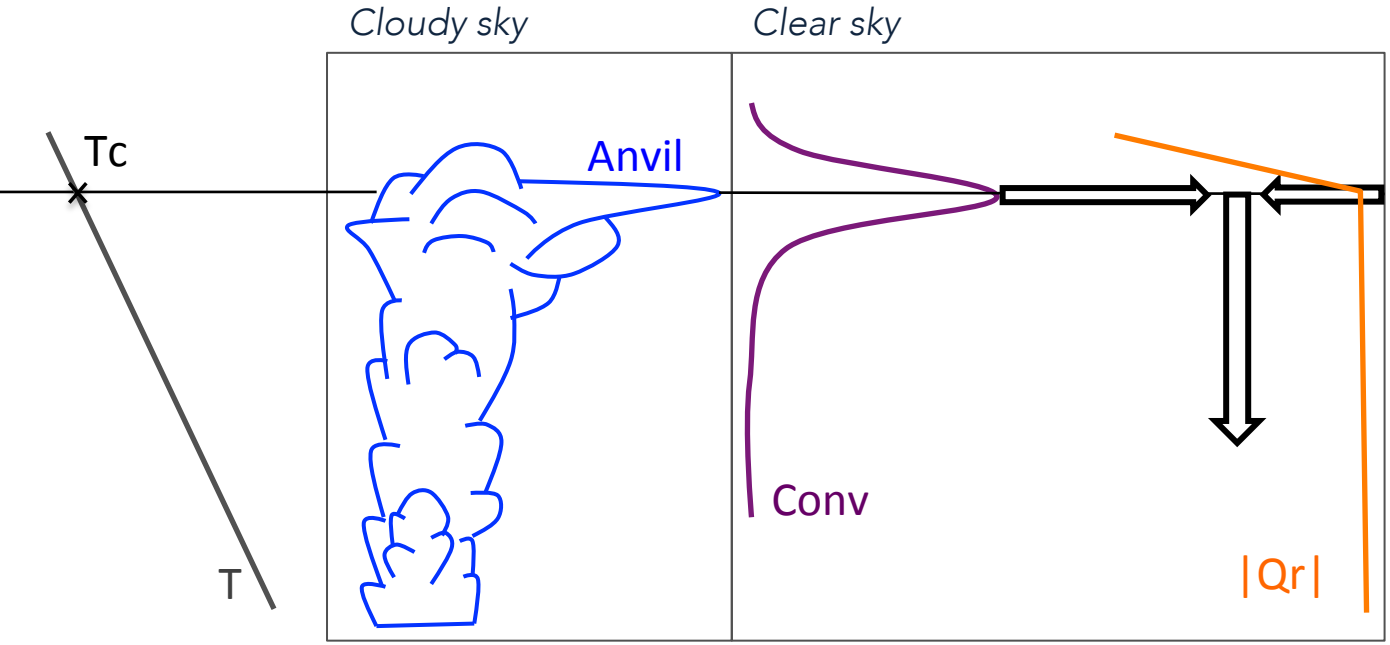


The Stability-iris effect

Bony et al. 2016



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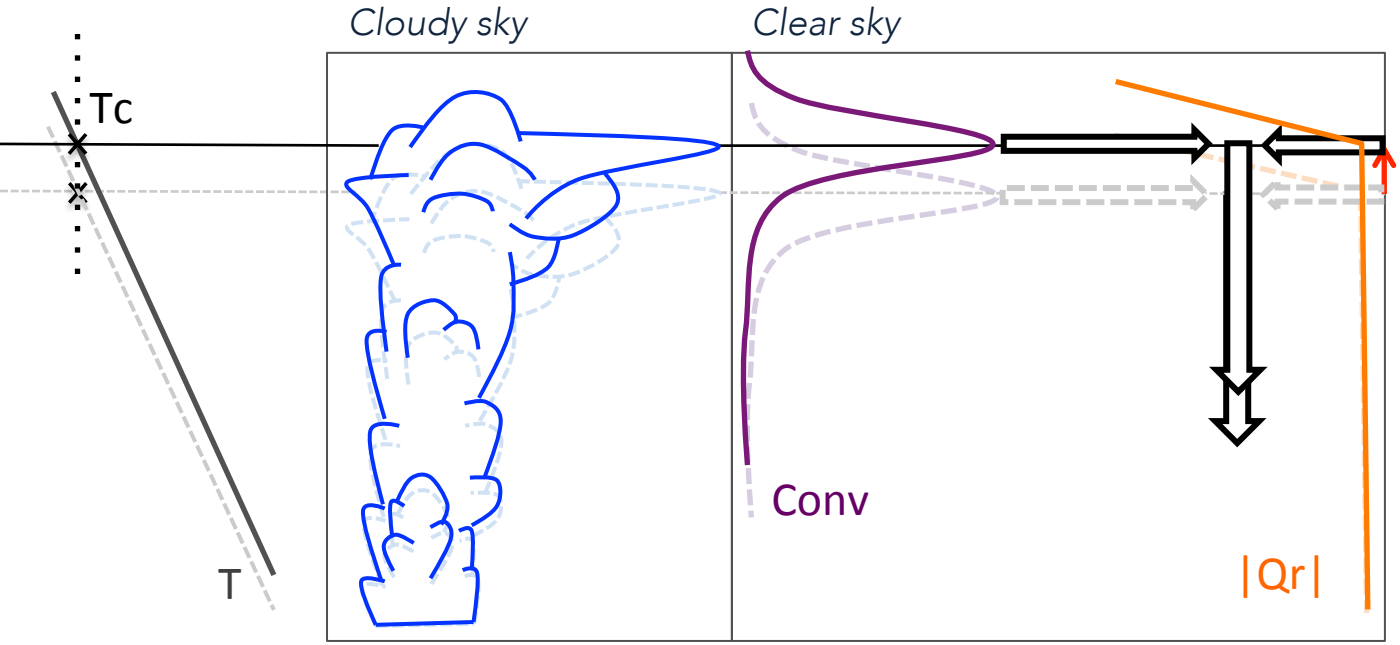

The Stability-iris effect

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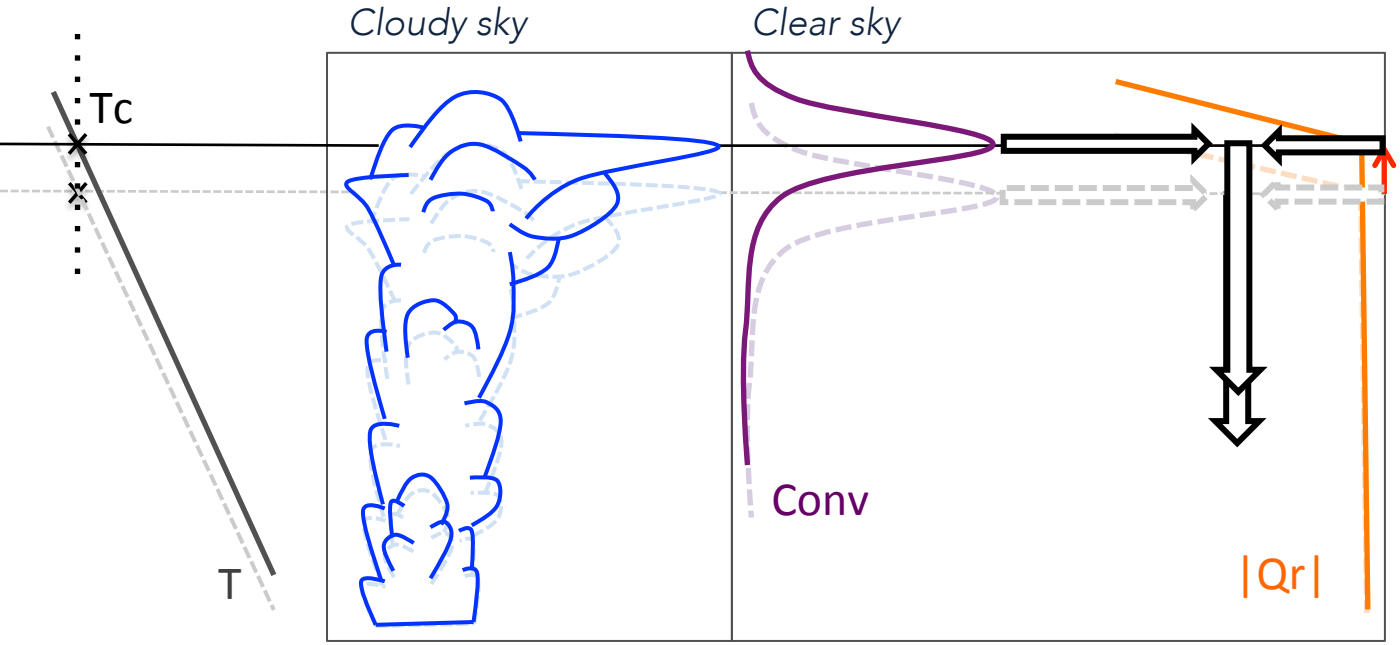
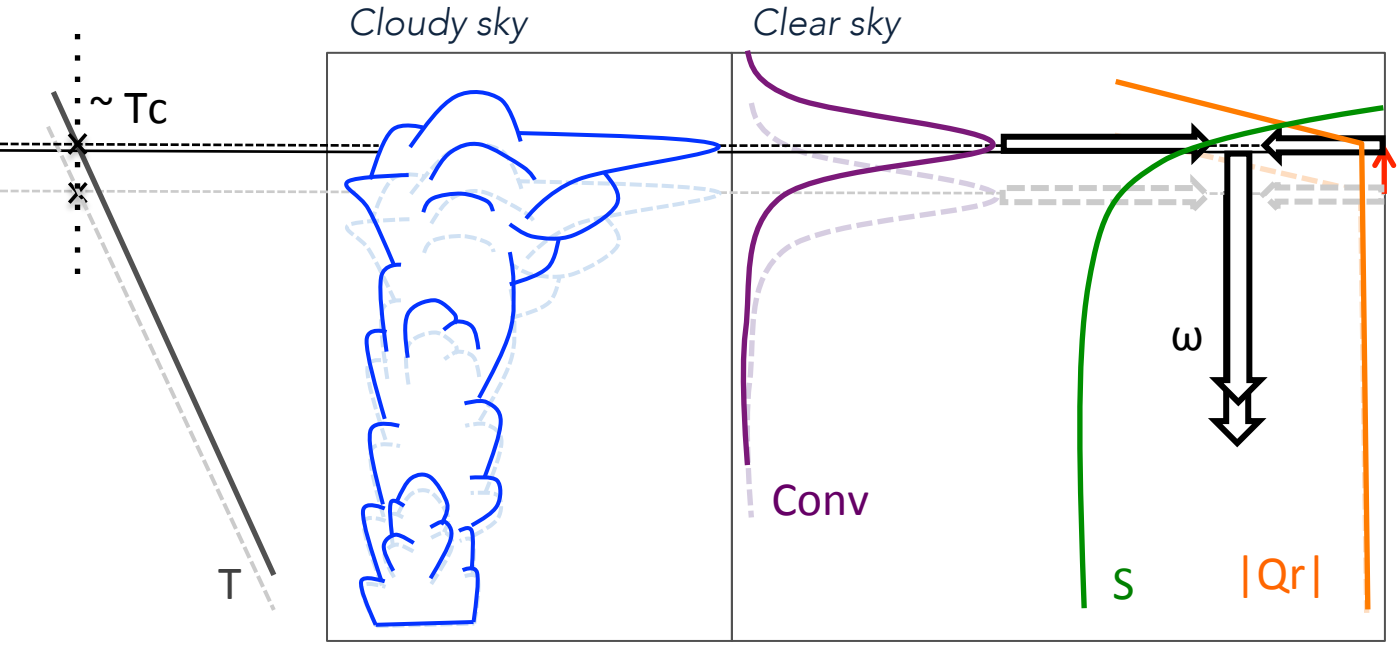


Fixed Anvil Temperature

(Hartmann & Larson 2002)

The Stability-iris effect

Bony et al. 2016



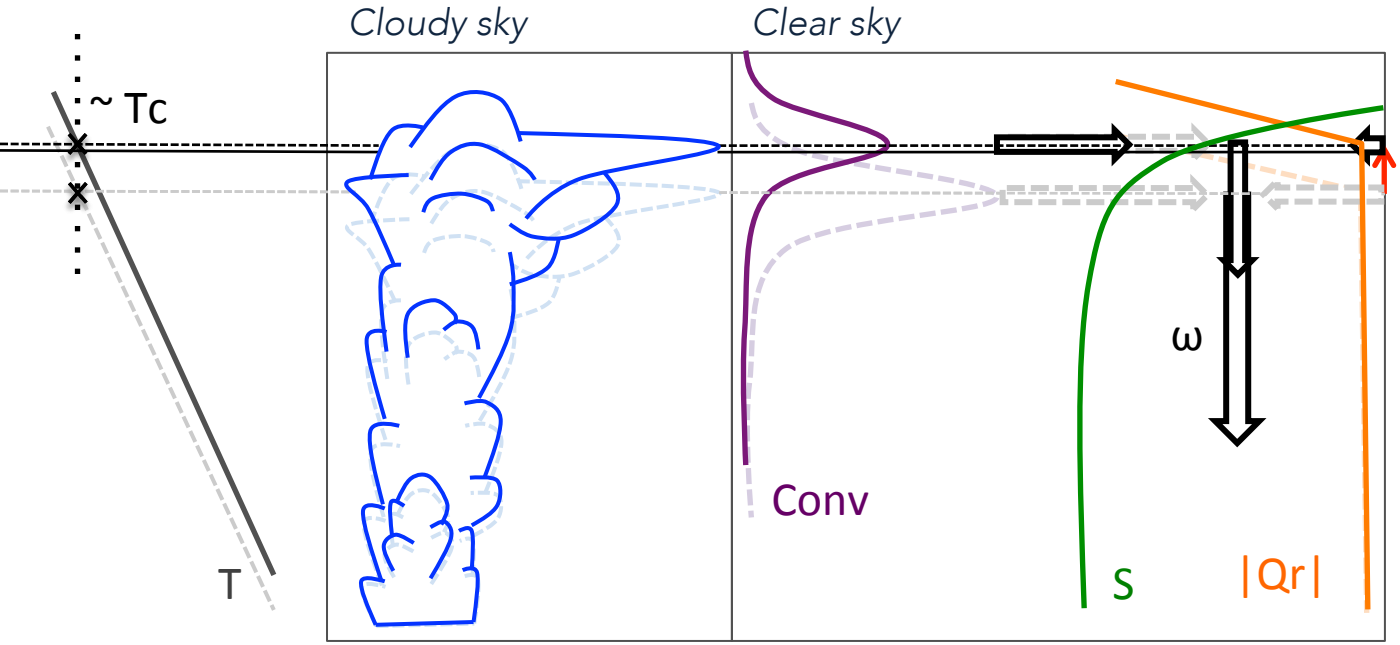
Proportionally Higher Anvil Temperature

(Zelinka & Hartmann 2010)

Conv = ∂ω/∂p
With
ω = - Qr / S

The Stability-iris effect

Bony et al. 2016



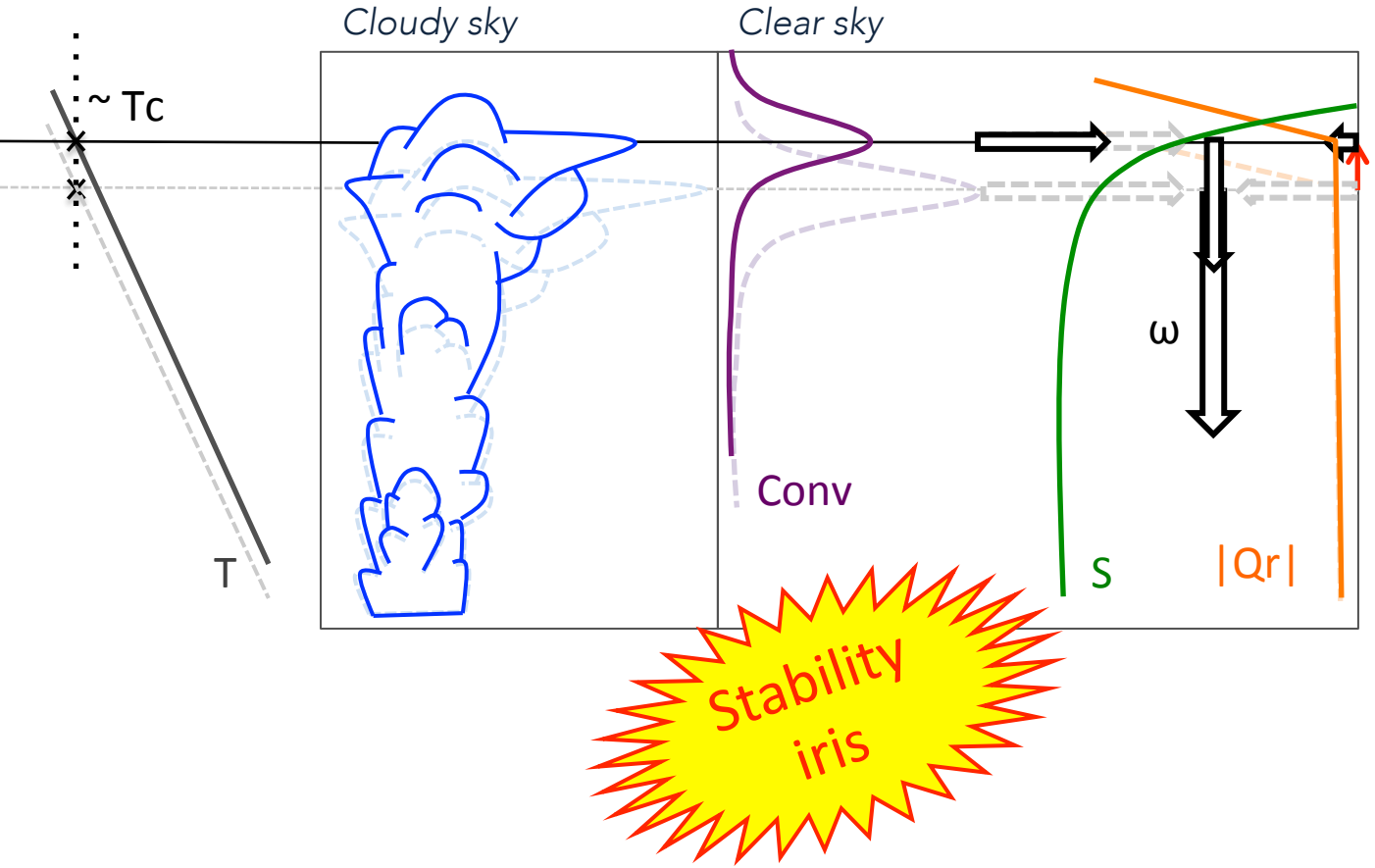
PHAT: nearly isothermal rise
+
Rise = increasing stability

⇒ Conv peak reduced

Conv = ∂ω/∂p
With
ω = - Qr / S

The Stability-iris effect

Bony et al. 2016



PHAT: nearly isothermal rise
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Rise = increasing stability

⇒ Conv peak reduced
⇒ **Anvils shrinkage**

Conv = ∂ω/∂p
With
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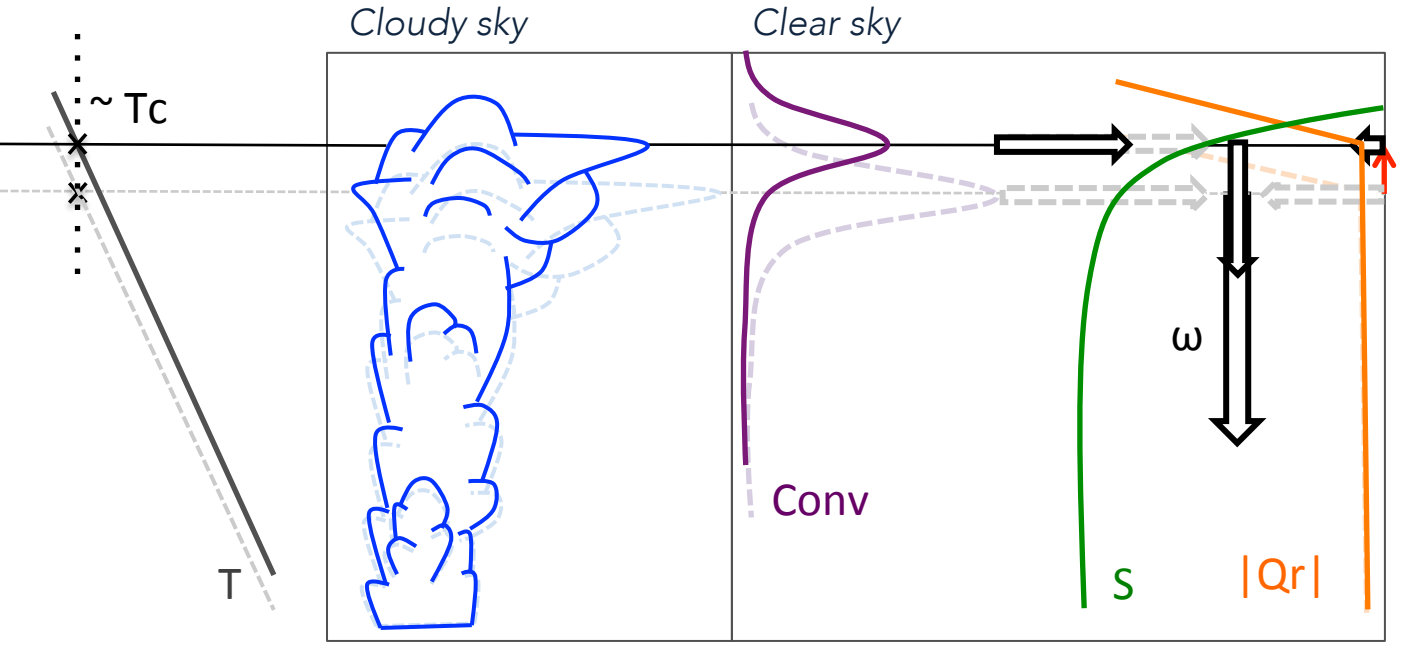
The Stability-iris effect

Bony et al. 2016



PHAT: nearly isothermal rise
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⇒ Conv peak reduced
⇒ **Anvils shrinkage**
= Stability-iris

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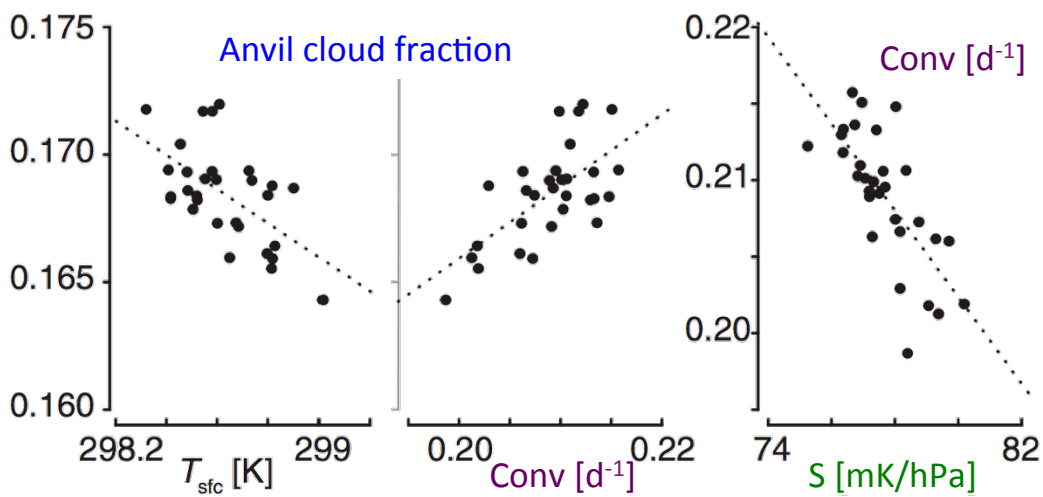
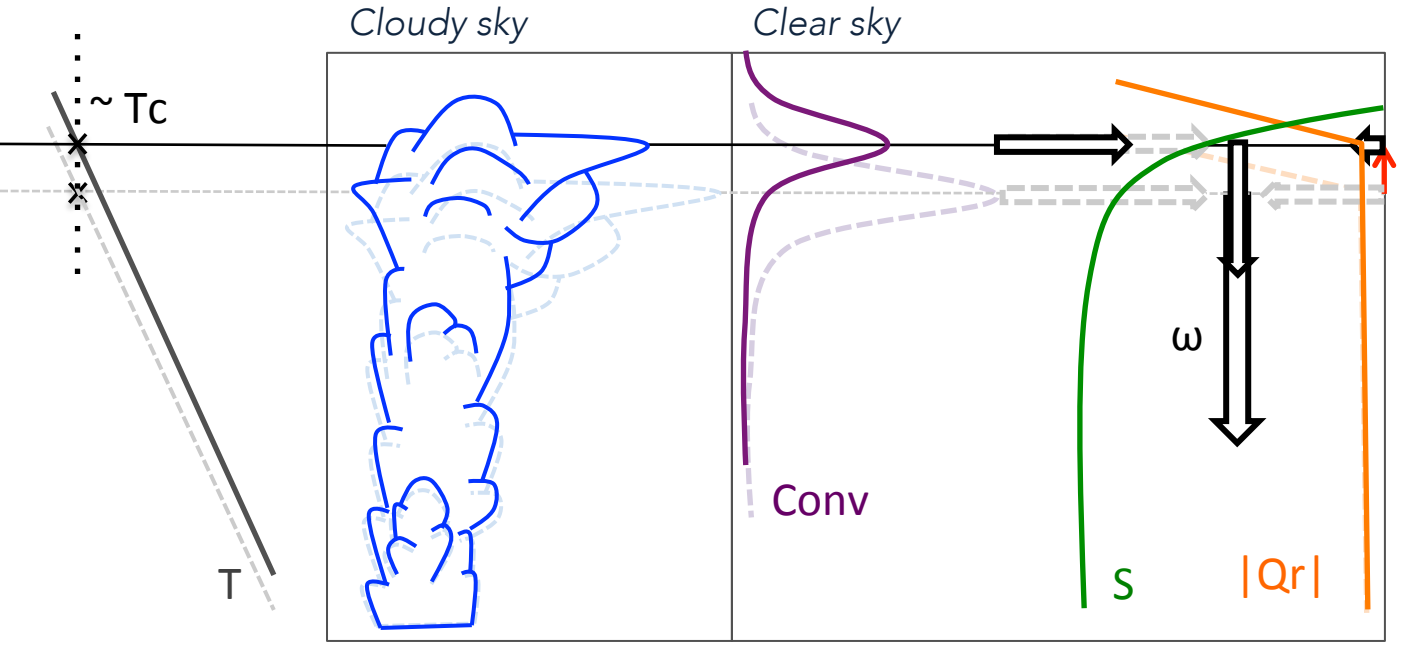
With
ω = - Qr / S

In models (at least 3 GCMs and a CRM):



The Stability-iris effect

Bony et al. 2016



PHAT: nearly isothermal rise
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⇒ Conv peak reduced
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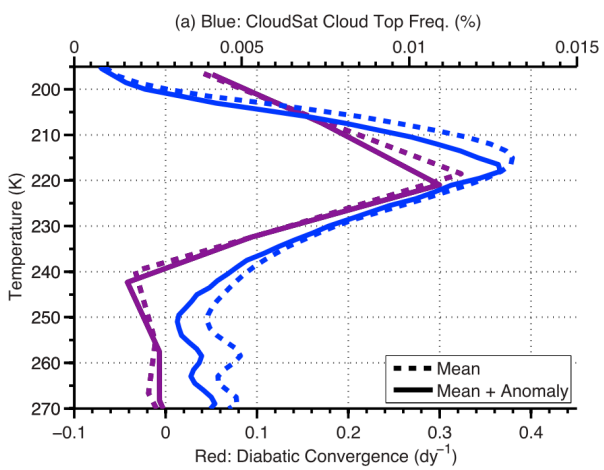
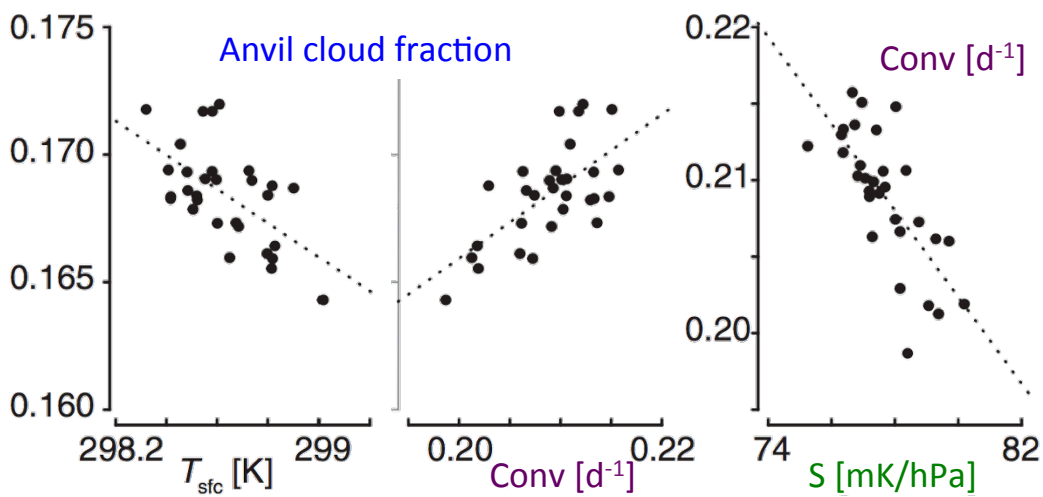
= Stability-iris

Conv = ∂ω/∂p
With
ω = - Qr / S

*In observations (**Zelinka & Hartmann 2011**):*



In models (at least 3 GCMs and a CRM):

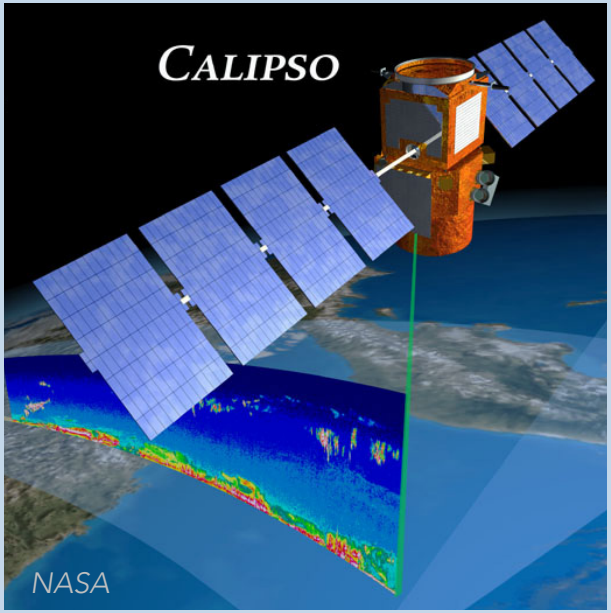


Stability-iris in observations?

- **Accuracy** of **active sensors**: lidar (Caliop) measurements from Calipso to isolate anvils and detect rise and shrinkage

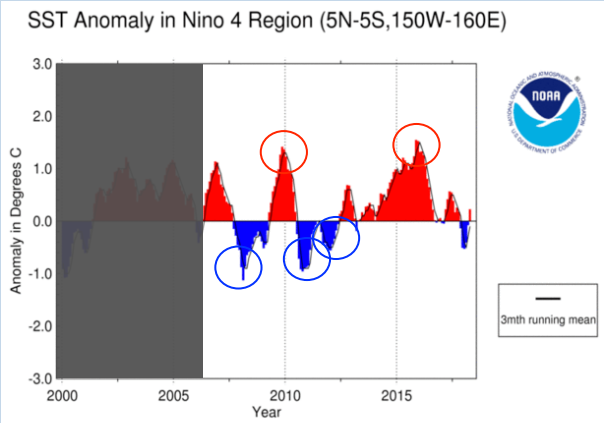
  Monthly data

  - GOCCP Caliop product (Chepfer et al. 2010) for clouds
  - ERA5 reanalyses for clear-sky properties
  - HadCRUT4 for *Ts*

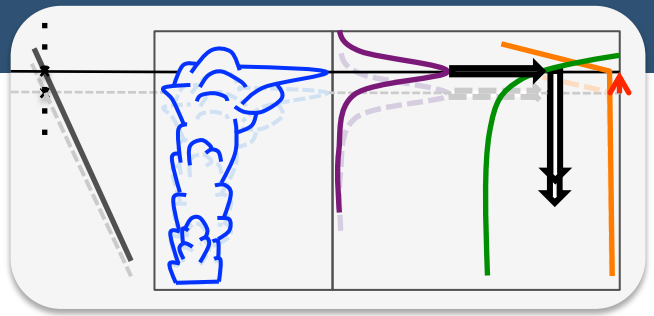


- **11 years** of data now available with **Calipso** to look at **interannual variability** (monthly data) [2006-2017]

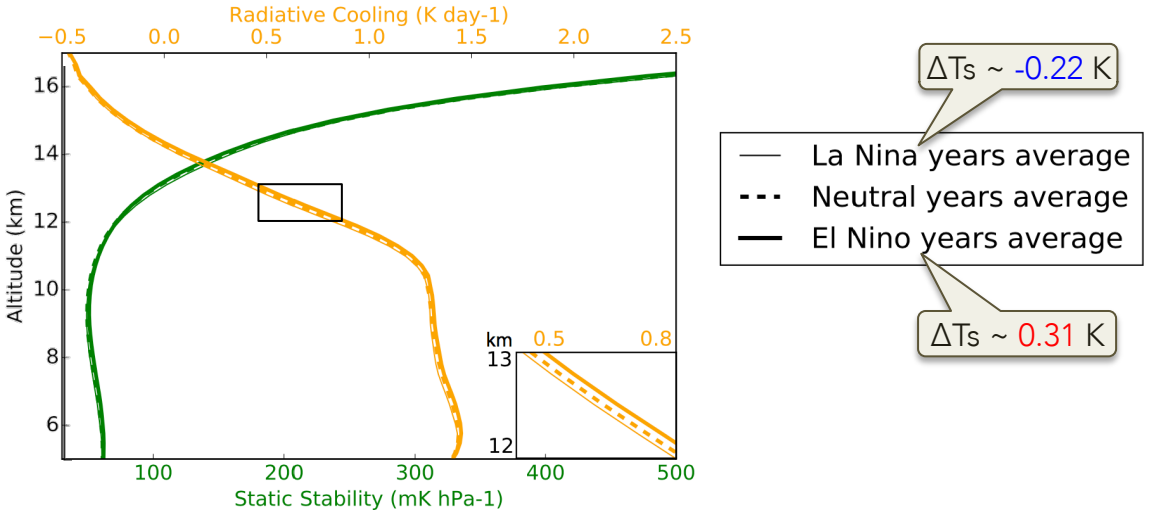
  - Analysis on the **whole tropical belt** to look at intrinsic cloud response to tropical *Ts* (not local)



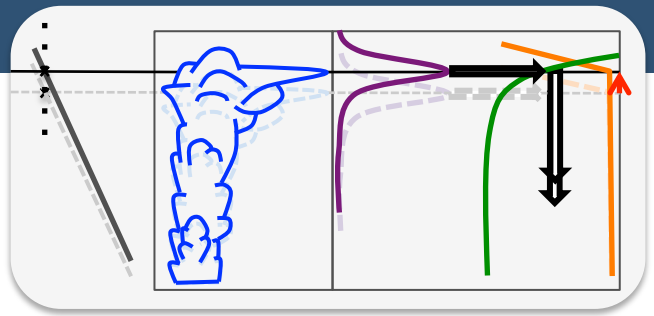
STEP 1: PHAT in observations



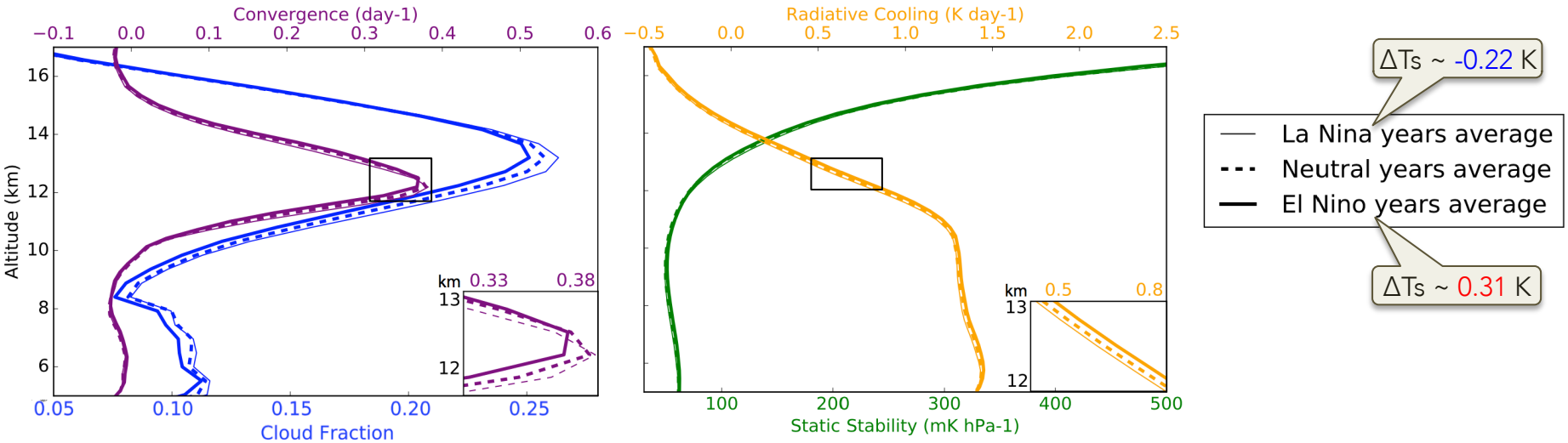
ERA5:



STEP 1: PHAT in observations



GOCCP & ERA5:



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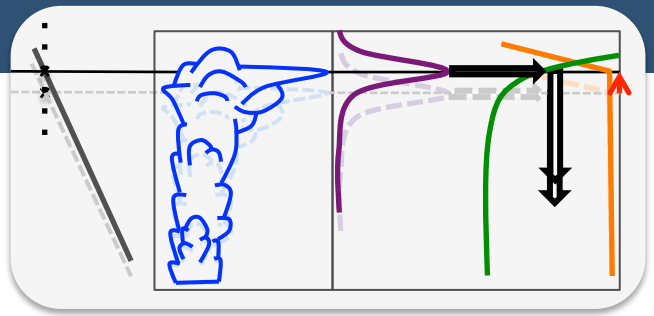

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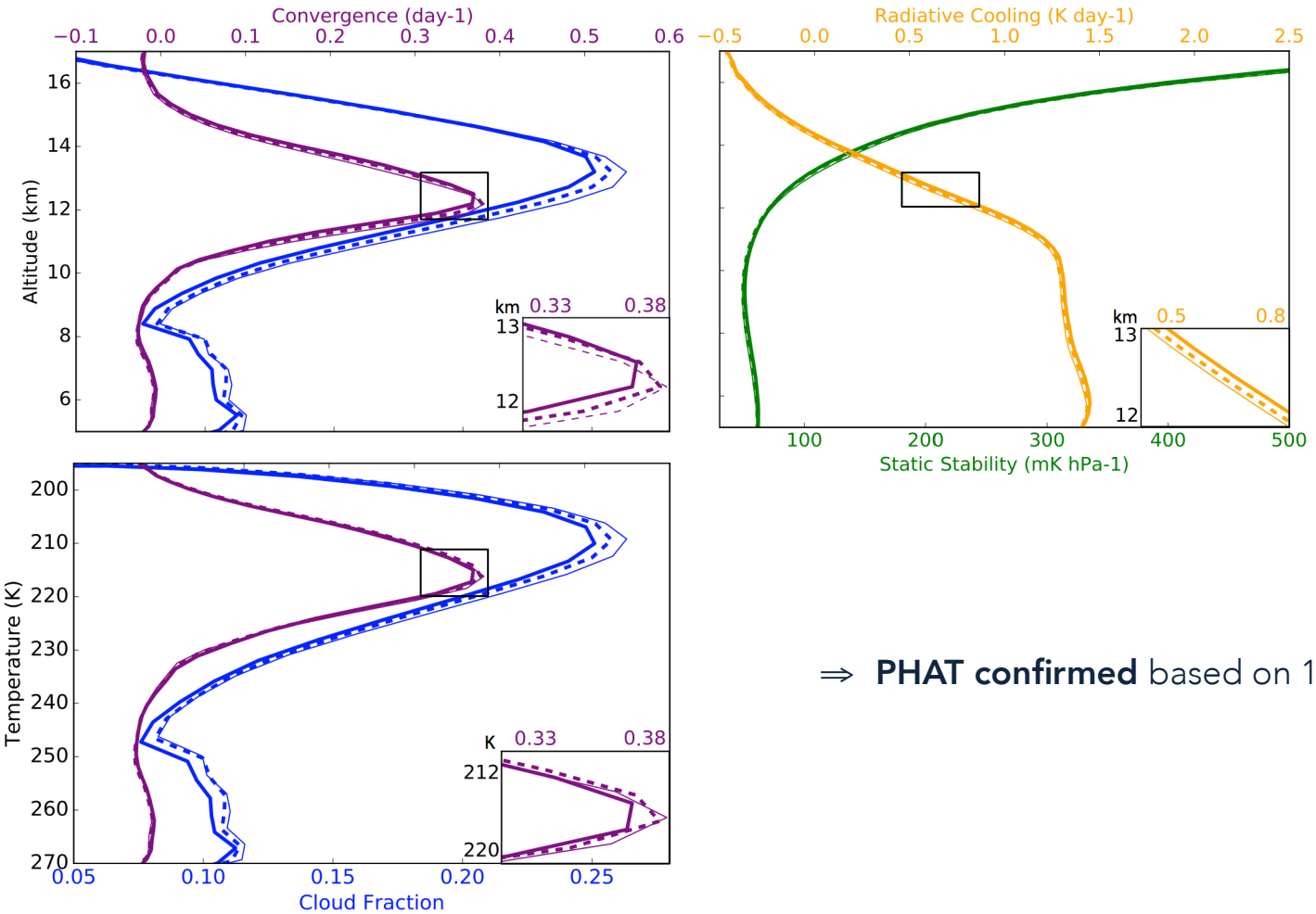


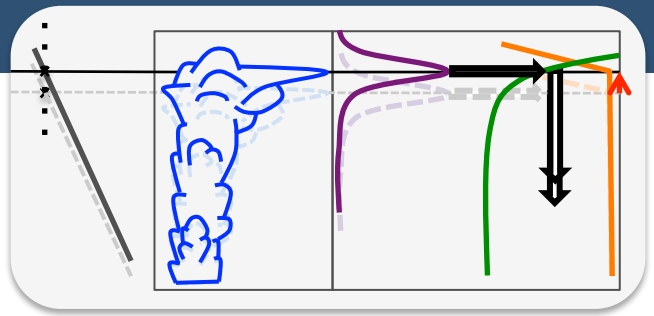
ΔTs ~ -0.22 K

La Nina years average
Neutral years average
El Nino years average

ΔTs ~ 0.31 K

⇒ **PHAT confirmed** based on 11 years of **observations**

STEP 1: PHAT in observations



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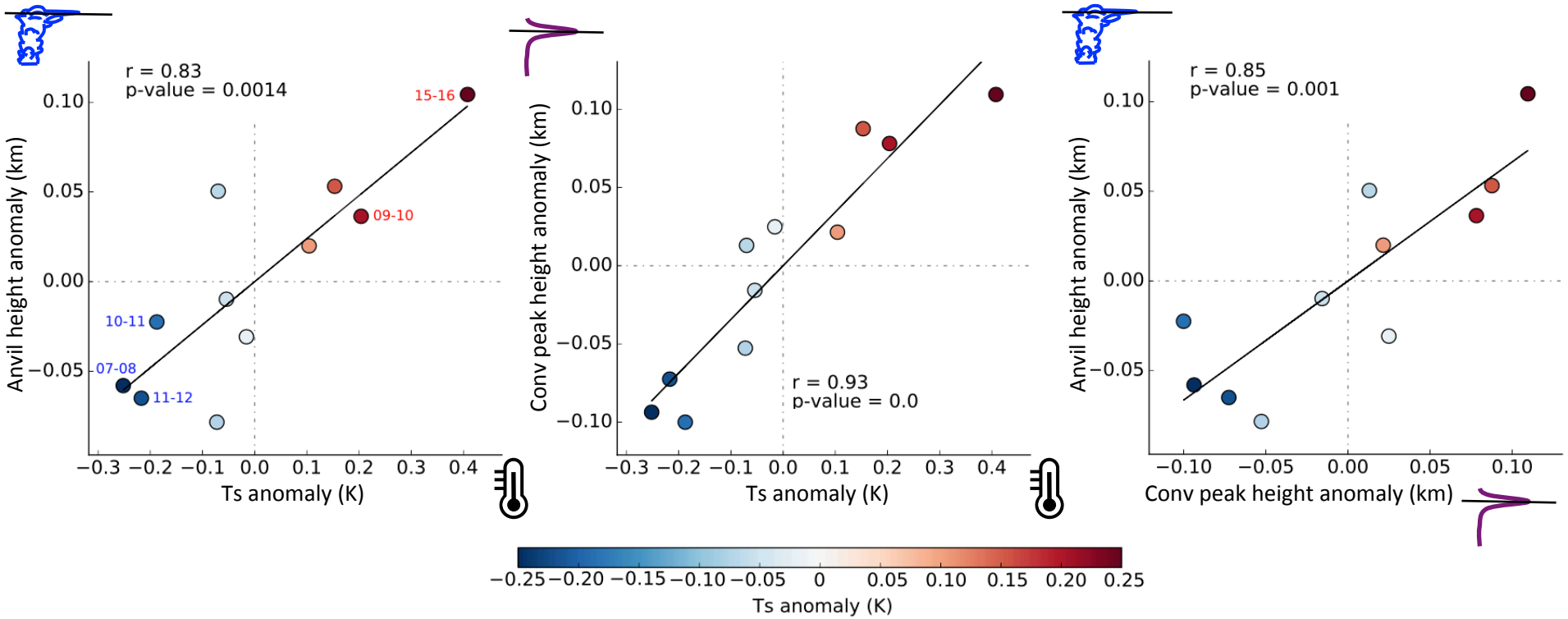

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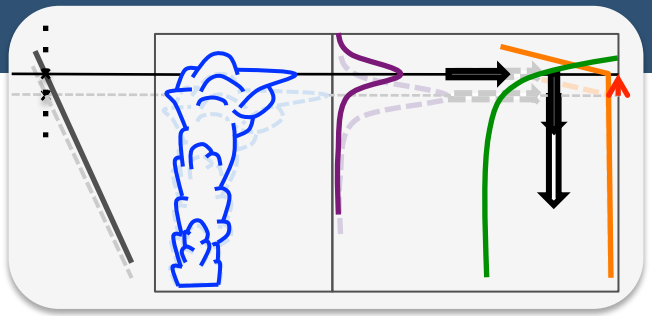
Stability-iris in observations



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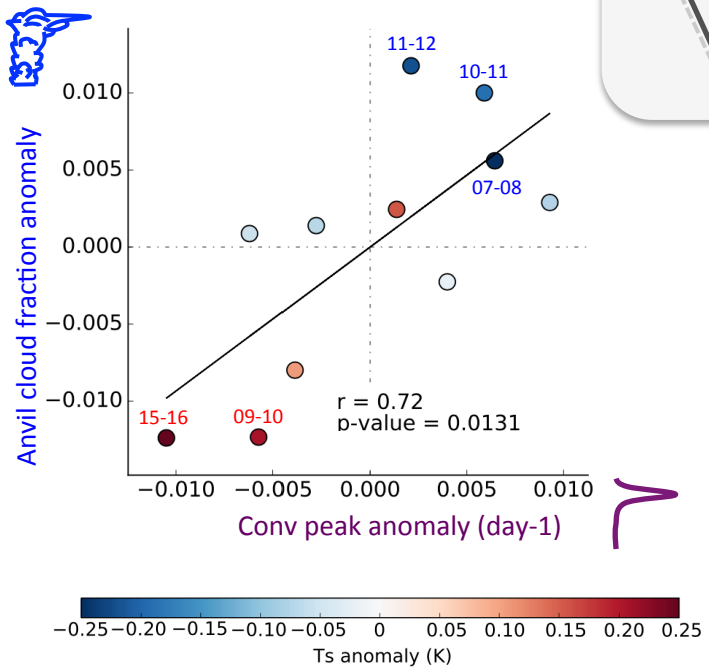

Stability-iris in observations

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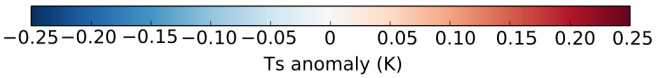
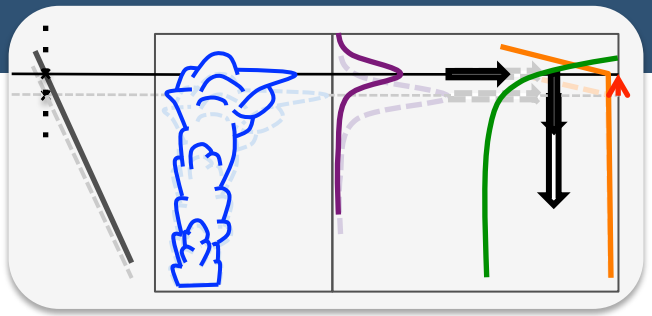
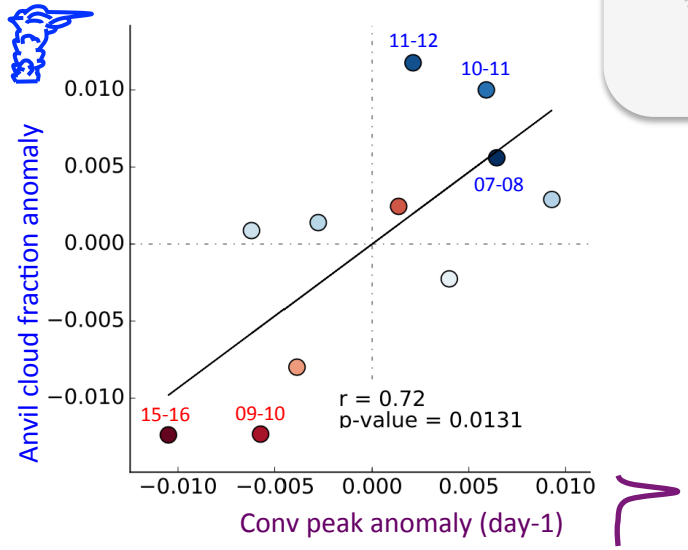
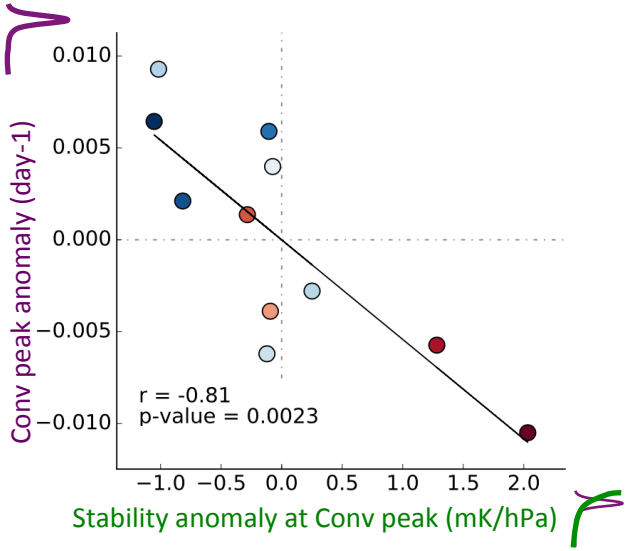


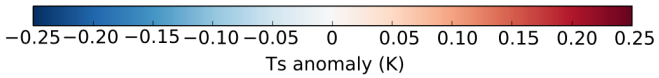


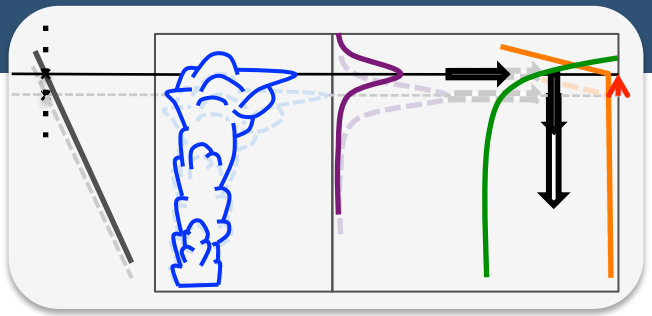


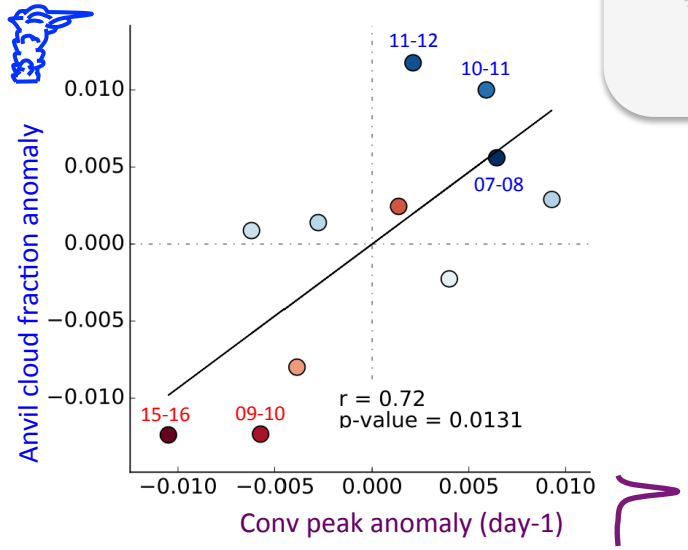


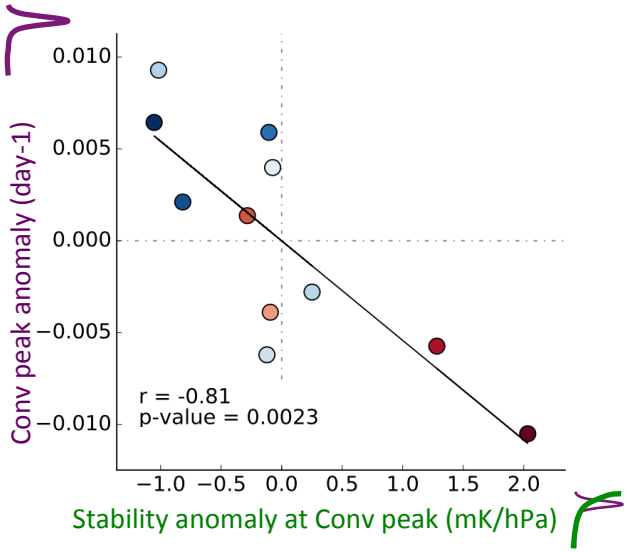
Stability-iris in observations

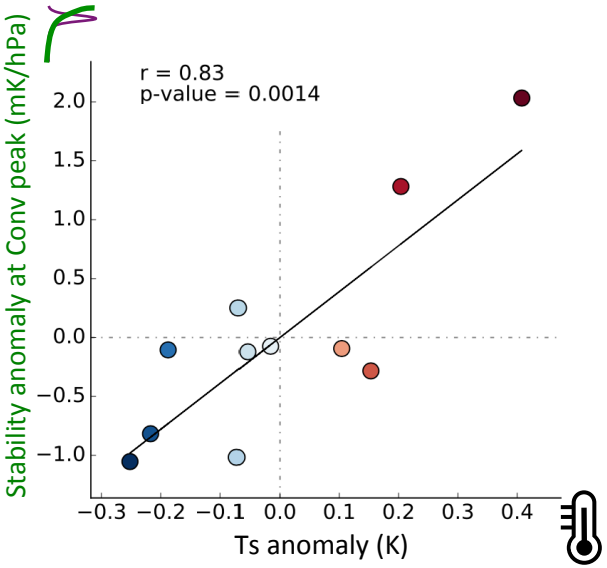
GOCCP & ERA5:











Stability-iris in observations

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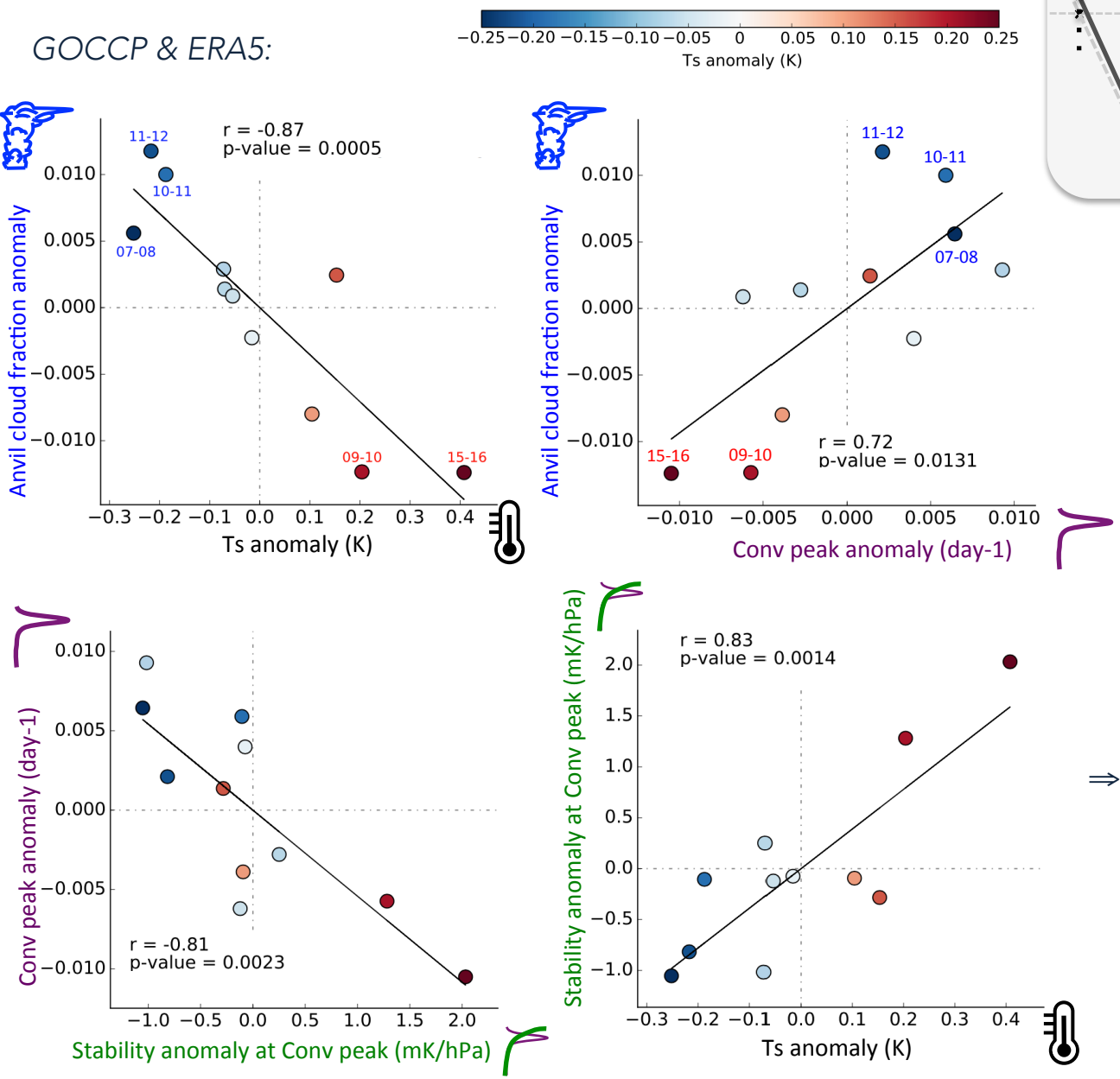
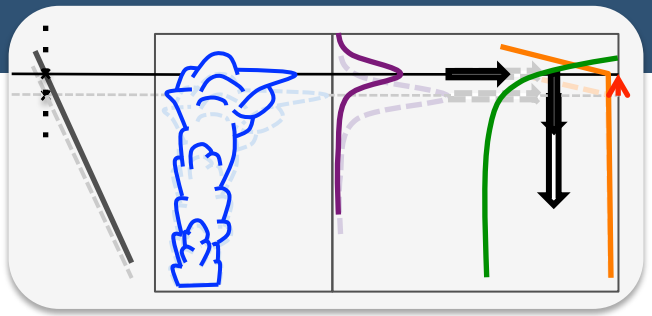
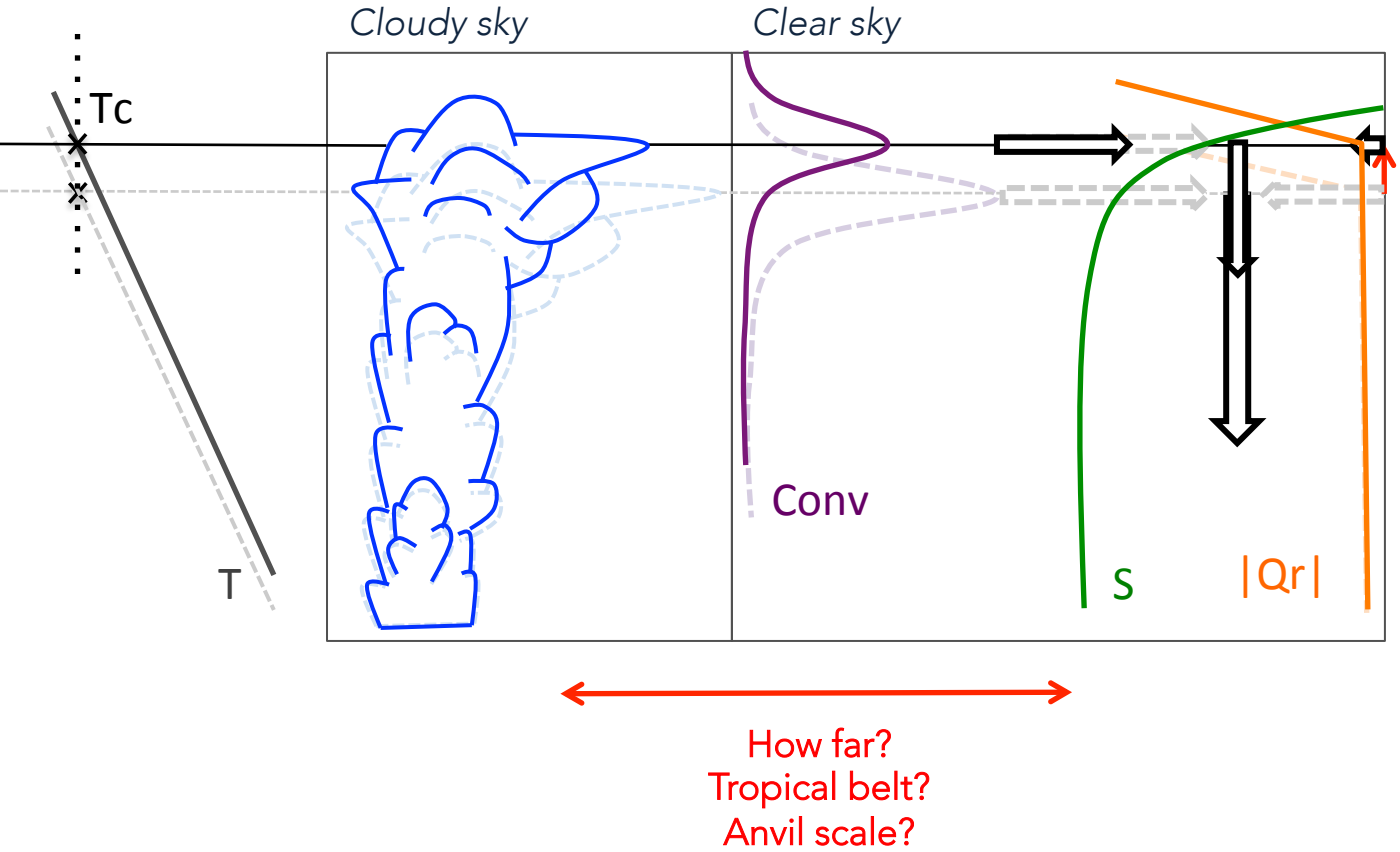




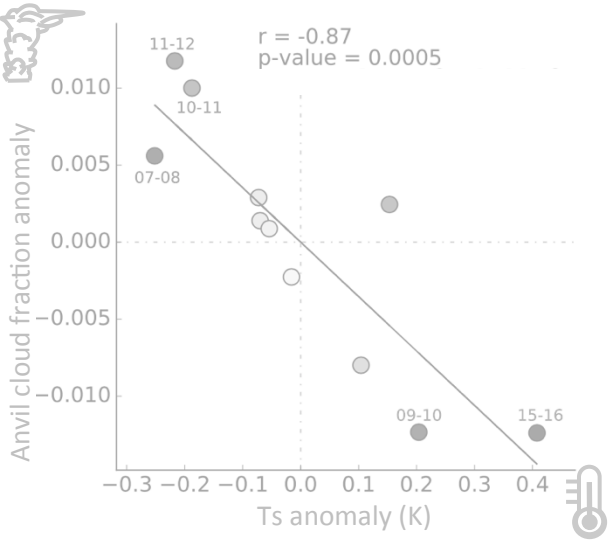
⇒ **Strong / significant relationships** supporting a **thermodynamic Stability-iris hypothesis**

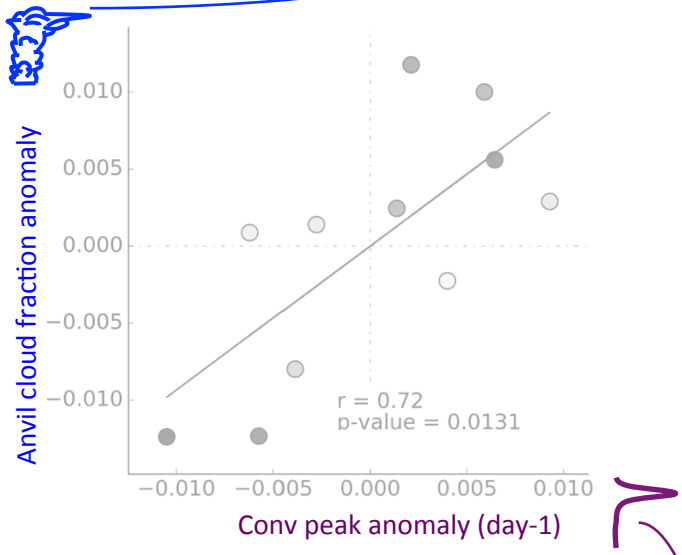
At what scale do PHAT and the Stability-iris hold?

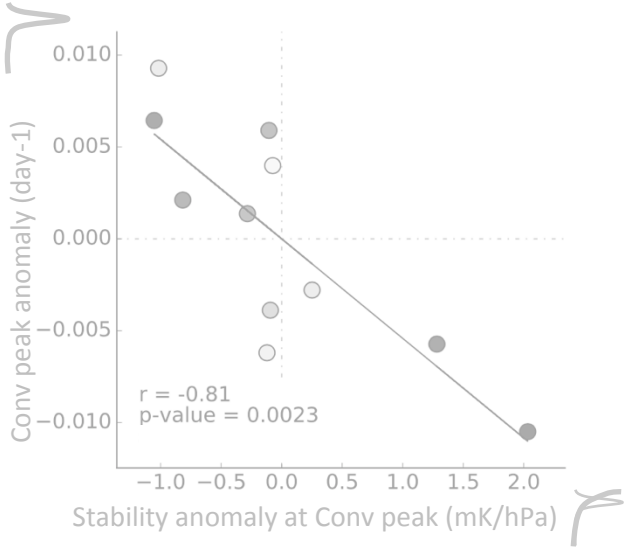


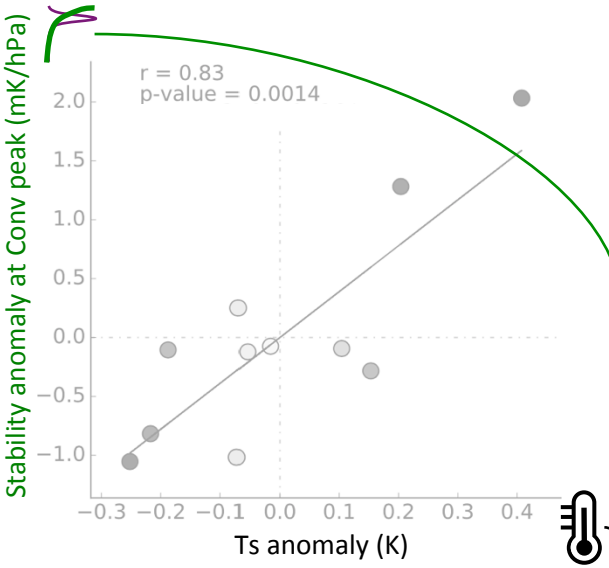
Spatial scale of Stability-iris?

Anvil scale

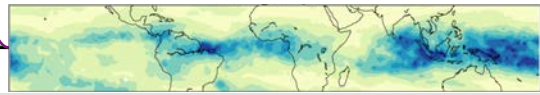




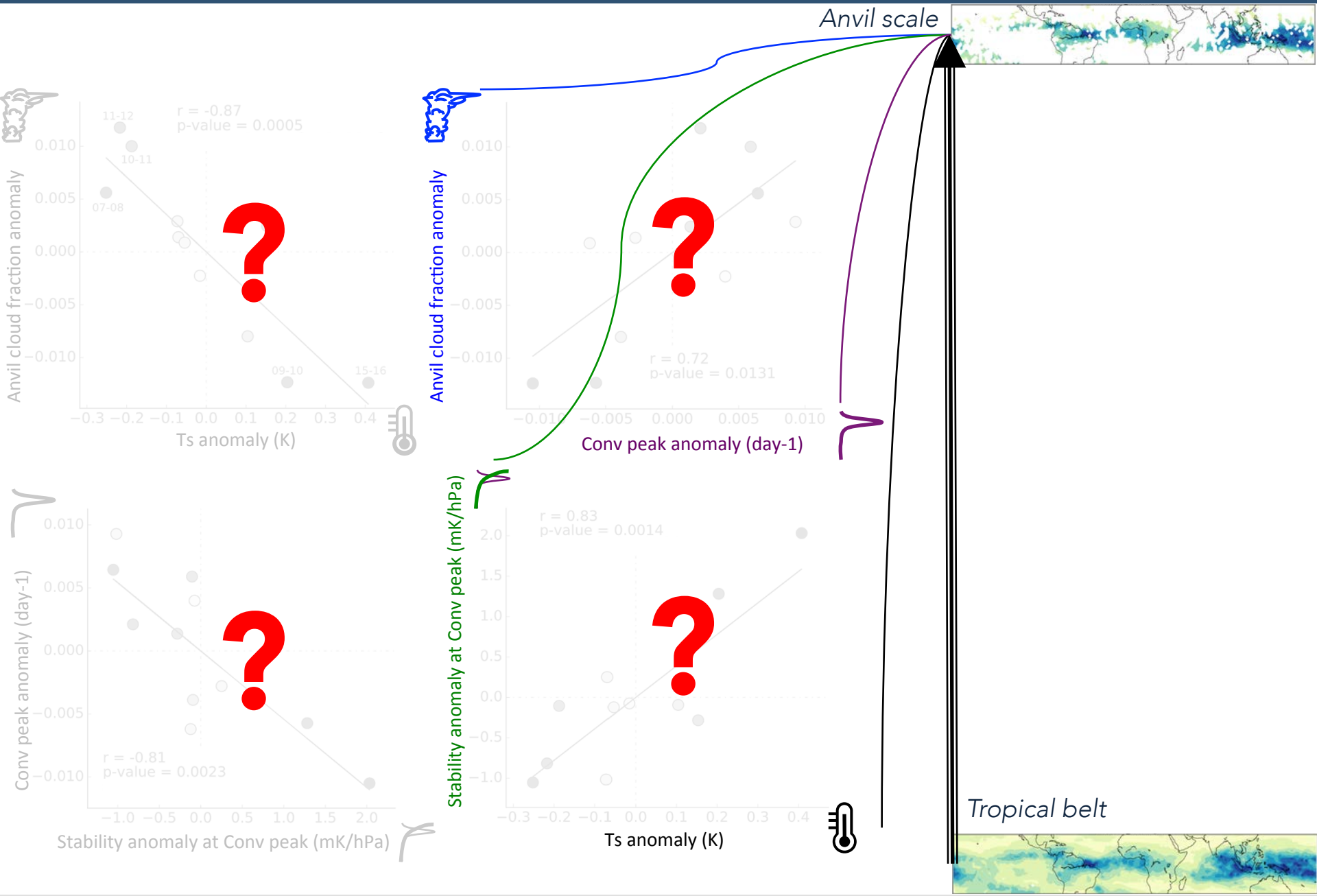




Tropical belt



Spatial scale of Stability-iris?



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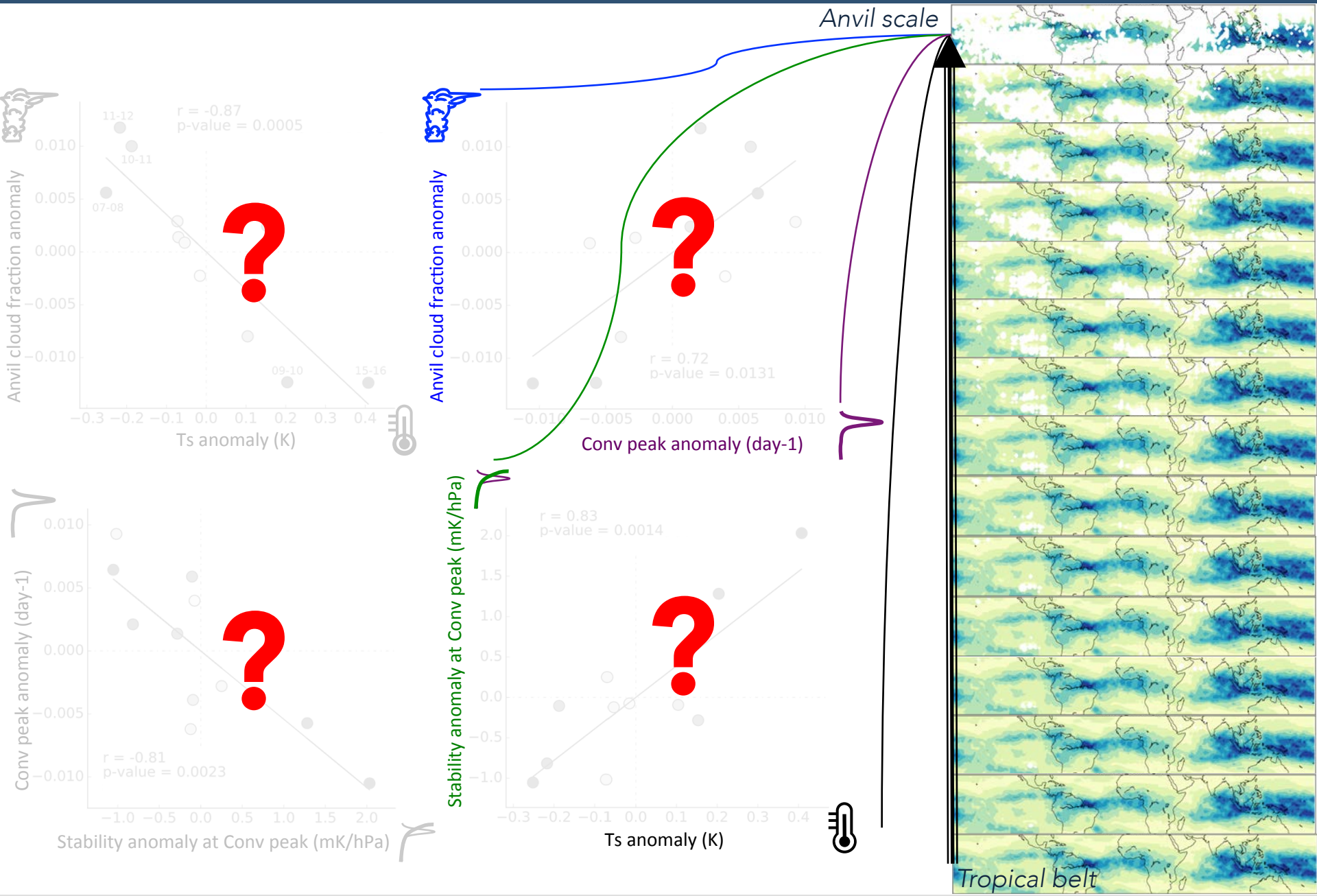
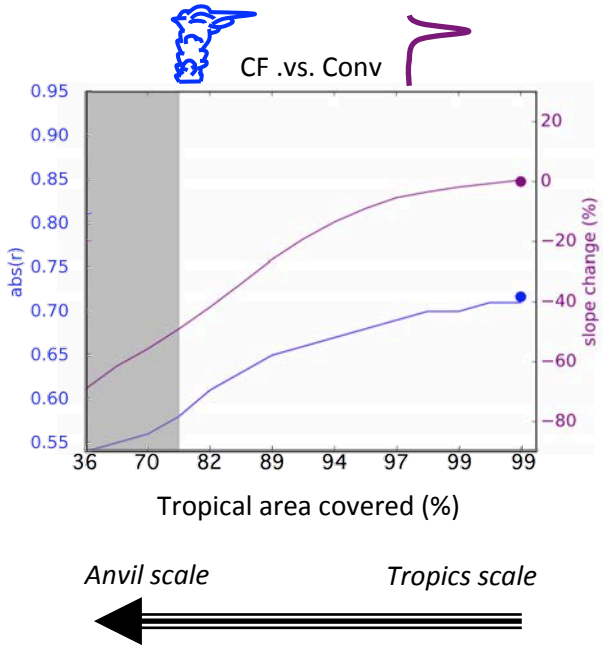
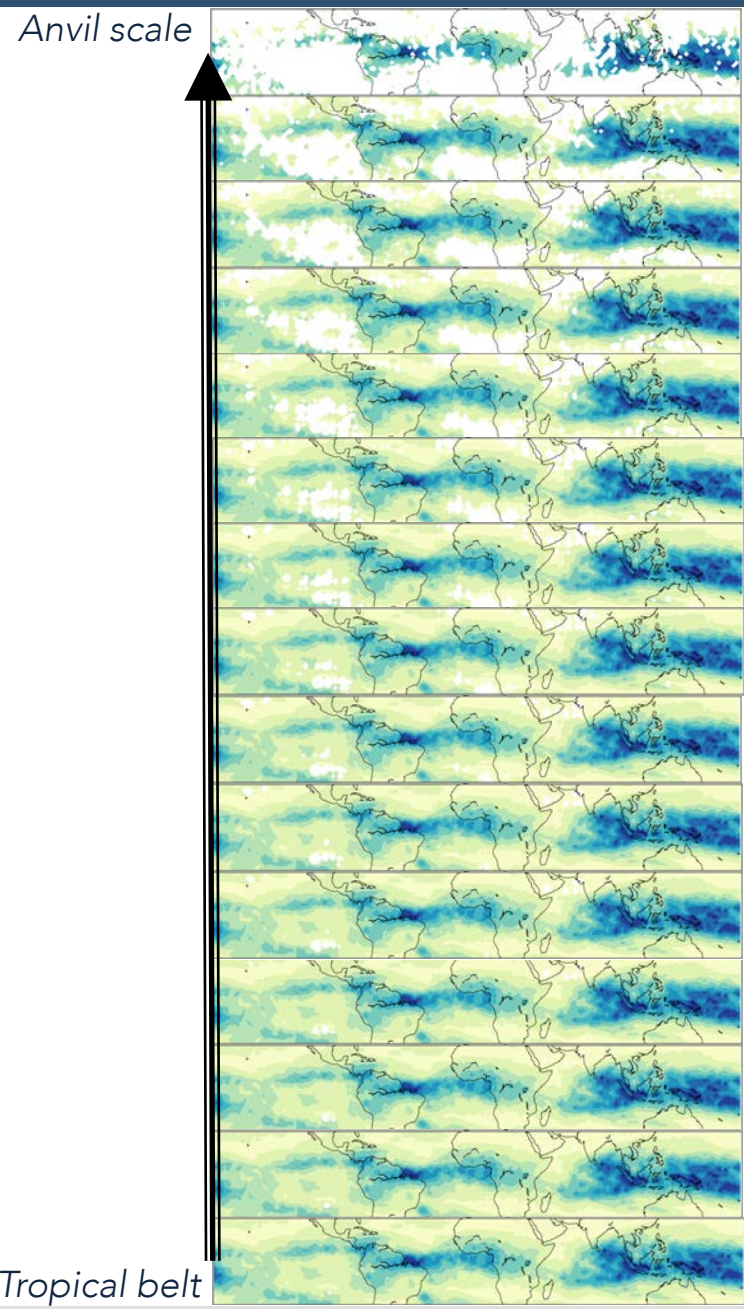


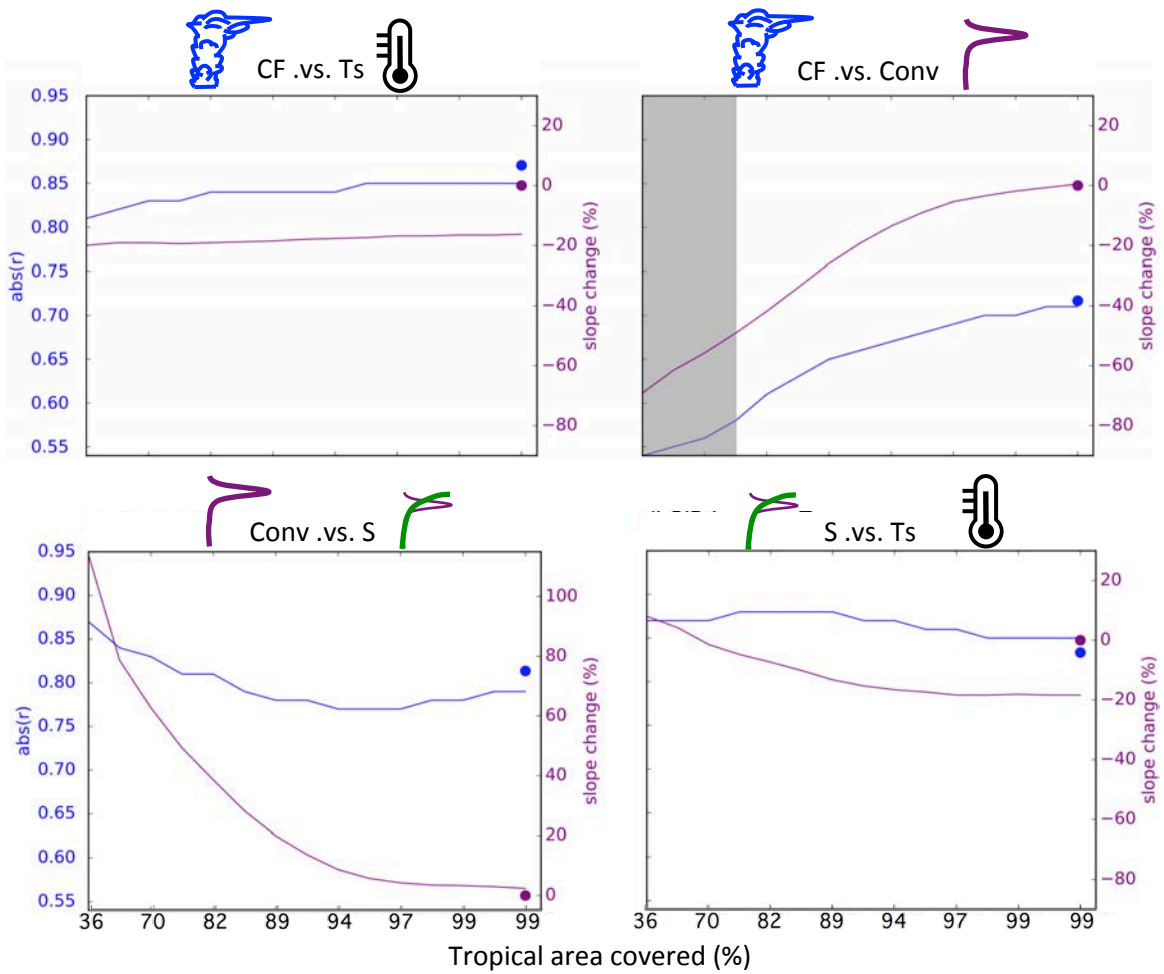
Spatial scale of Stability-iris?





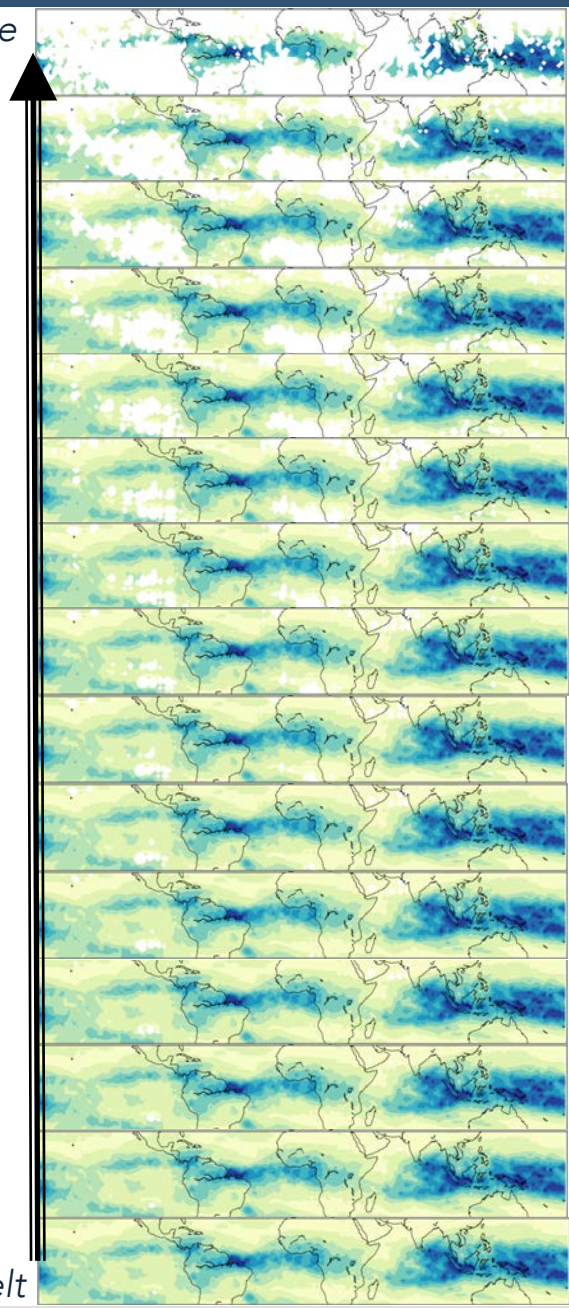
⇒ **Stability-iris** mostly holds at the **tropics-wide scale,**

Spatial scale of Stability-iris?



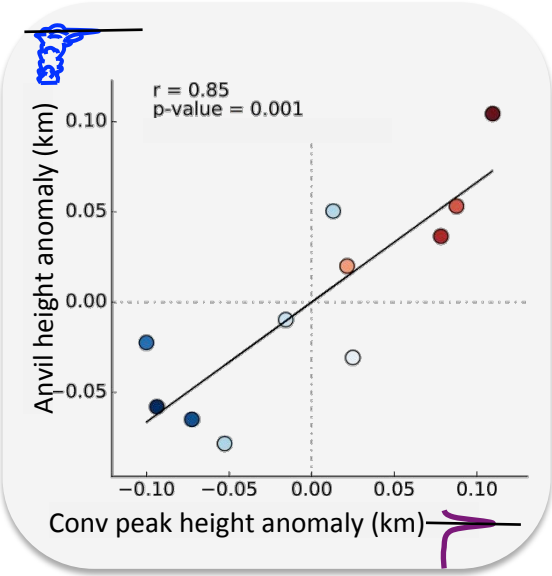
Anvil scale ⟵ *Tropics scale*

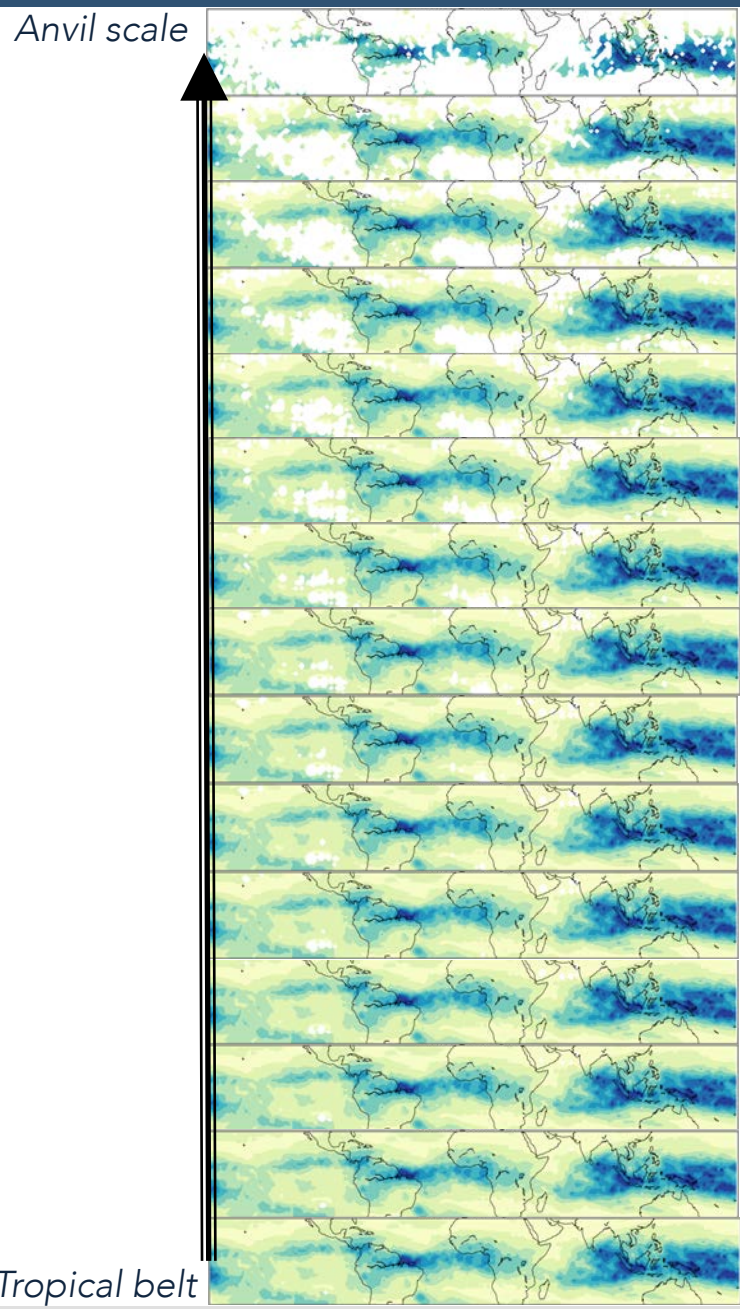
Anvil scale ⟵ *Tropics scale*



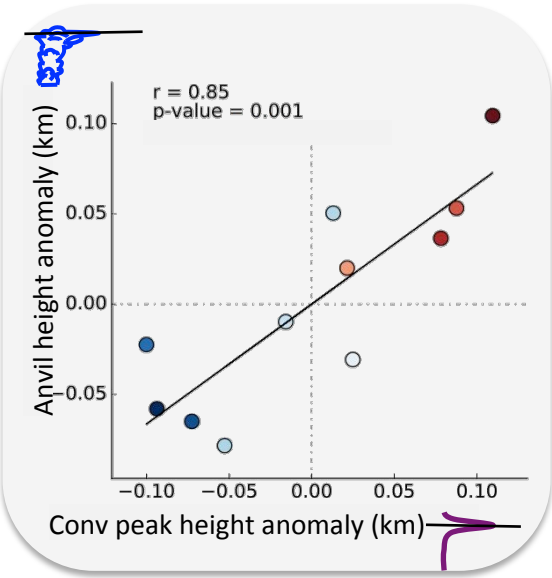
⇒ **Stability-iris** mostly holds at the **tropics-wide scale,**
Possibly has a **local component** too

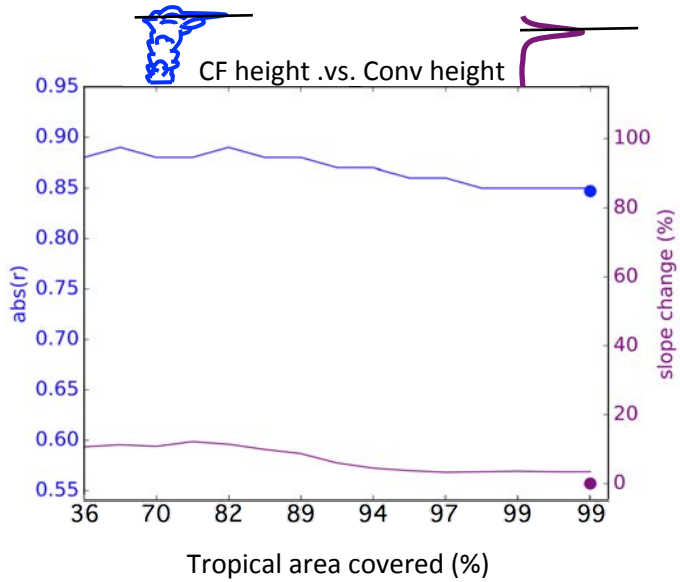
Spatial scale of PHAT?



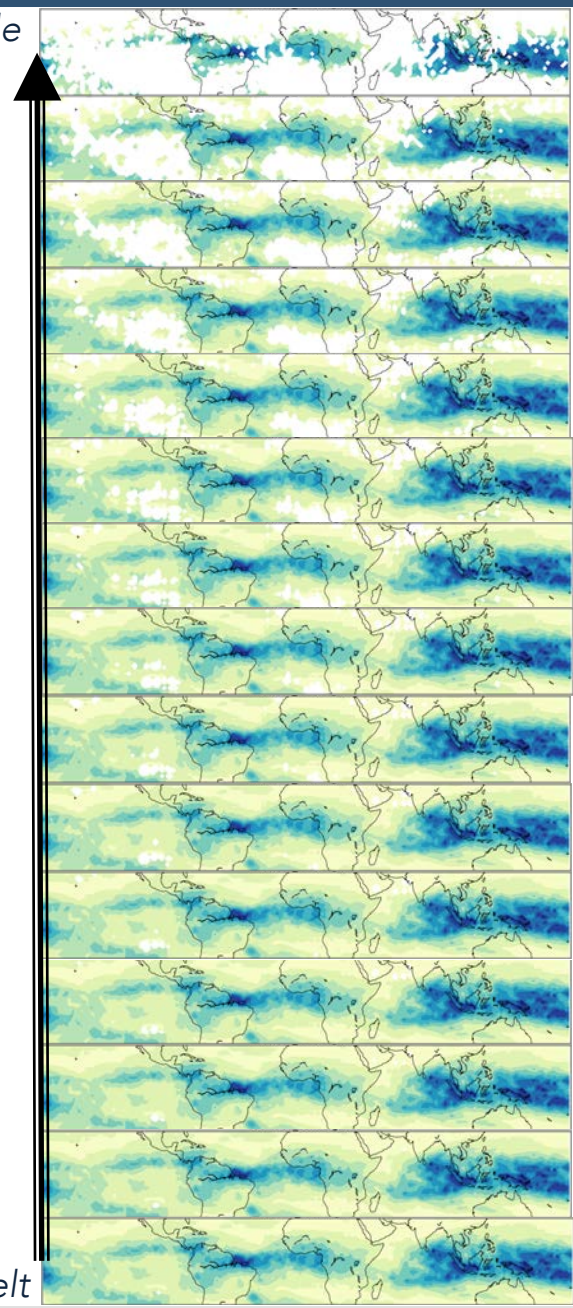


Spatial scale of PHAT?





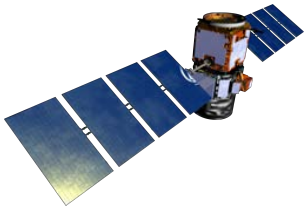
Anvil scale ⟸ *Tropics scale*

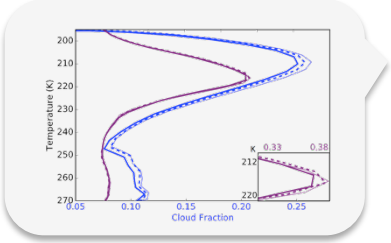


⇒ **PHAT** at play at **both** the **Anvil and Tropics scale,**

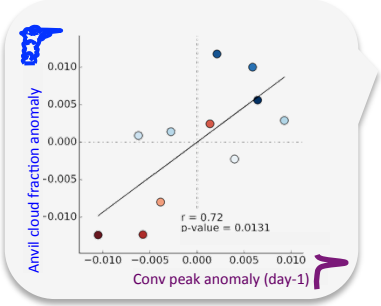
Conclusions

*Analysis of **interannual** variability with*
11 years of active lidar** measurements from **Calipso:

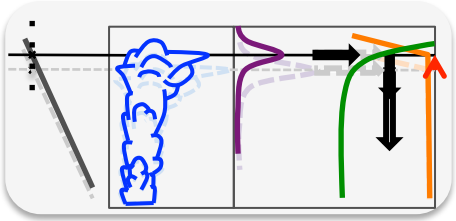


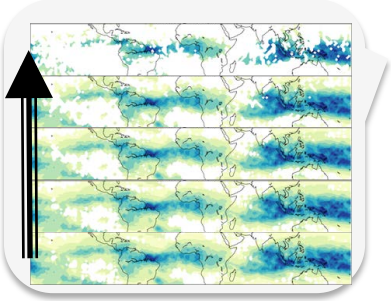


- **PHAT confirmed** on 11 years of **observations**



- **Observational support for the stability-iris effect on the interannual scale**





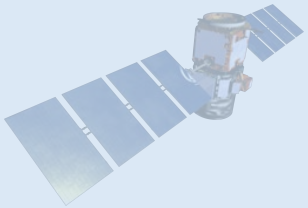
- **Stability-iris** mostly holds at the **tropics-wide scale**

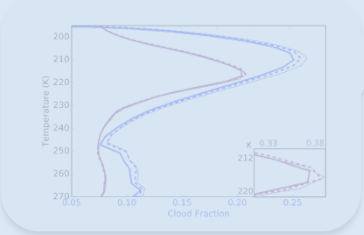
⇒ *At play on long timescales? (Climate change)*

⇒ *Radiative impact?*

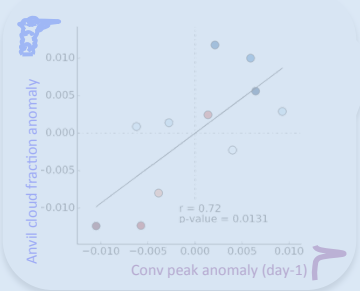
Conclusions

*Analysis of **interannual** variability with*
11 years of active lidar** measurements from **Calipso:

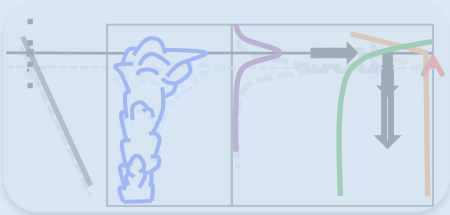




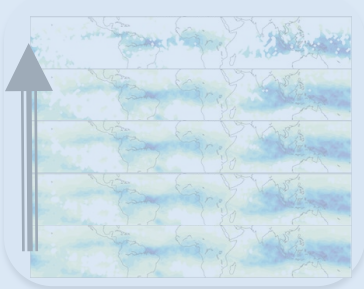
- **PHAT confirmed** on 11 years of **observations**



- **Observational support for the stability-iris effect on the interannual scale**



Thank you!



- **Stability-iris** mostly holds at the **tropics-wide scale**

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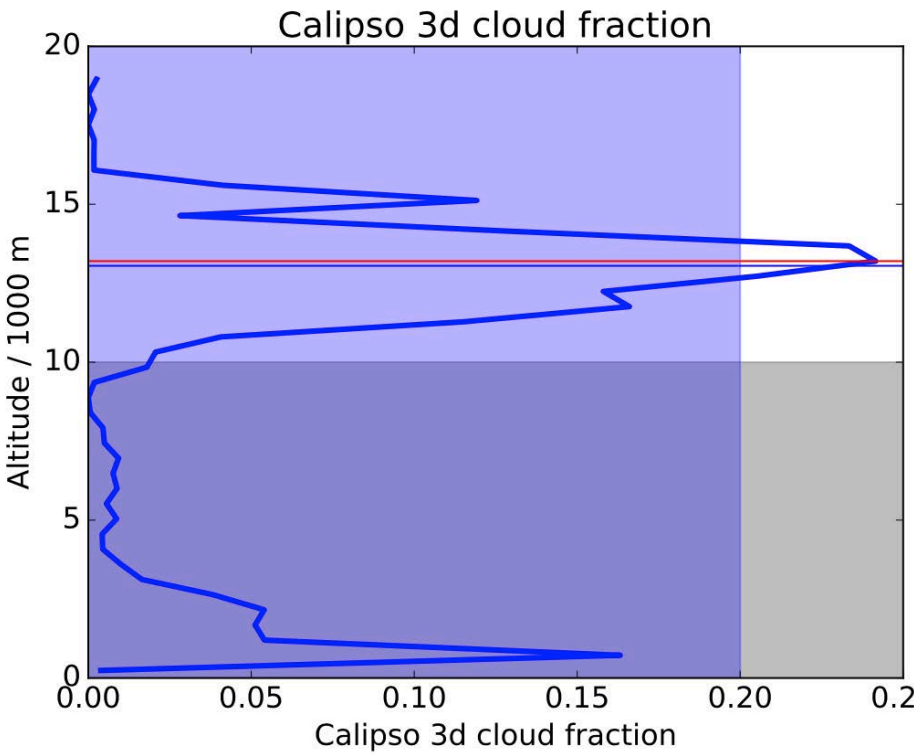
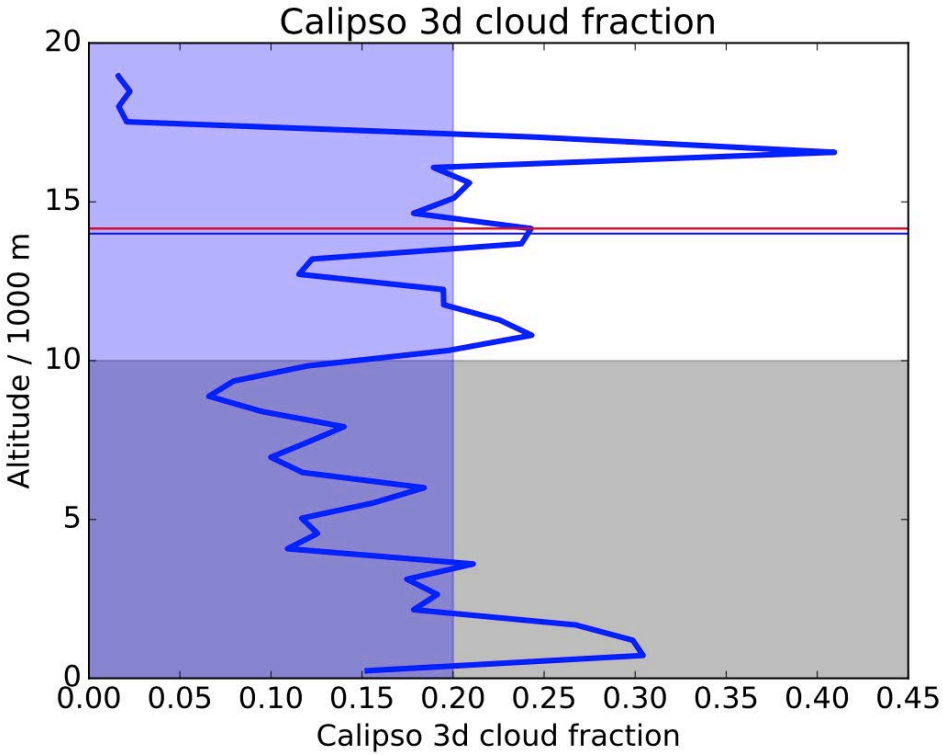
Anvils selection

Examples of two monthly grid-points: