Observed effect of Vertical Wind shear on the intensities of MCSs

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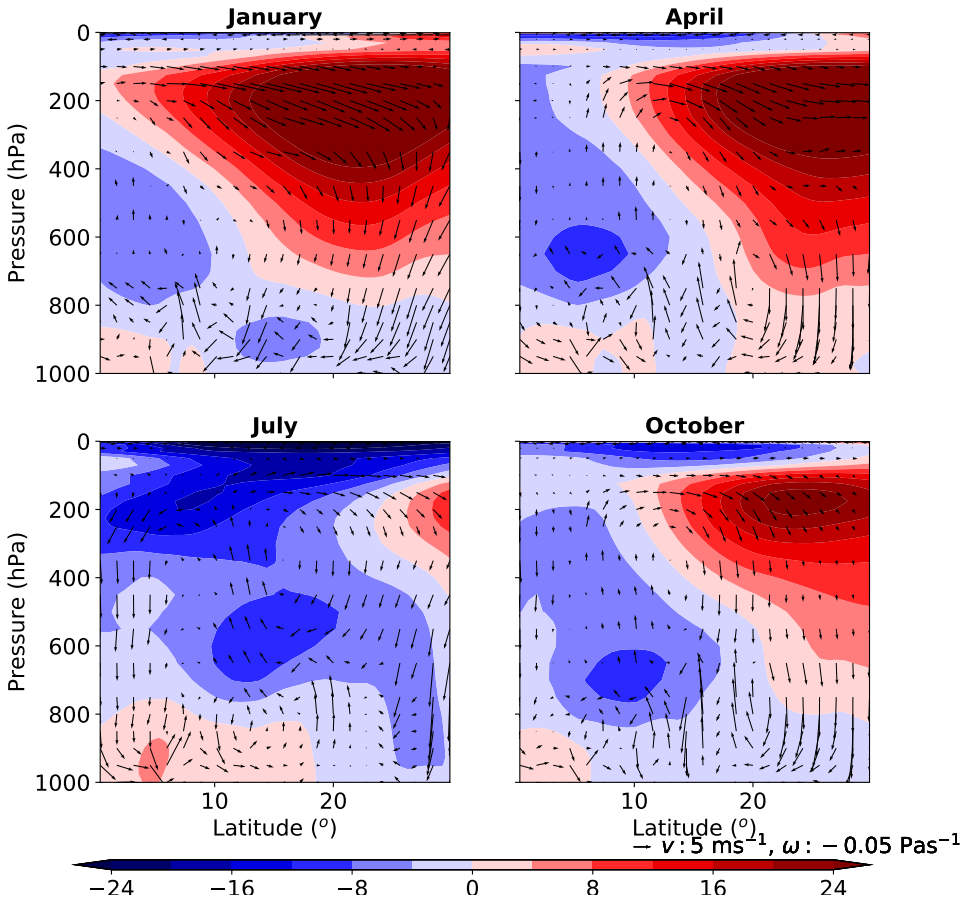
May 20, 2022

MCSs in West Africa and Vertical Wind Shear



Vertical transect along longitude 0° in West Africa of the **zonal wind** -colour, (v, ω) -arrows (1980-2010).

- Intense MCSs dominate the Sahel (∼10-20°N) during the monsoon season associated with vertical wind shear.
- An increase in the frequency of intense MCS in recent years have been found to be associated with increase in shear (Taylor et al., 2017,2018; Klein et al., 2020).

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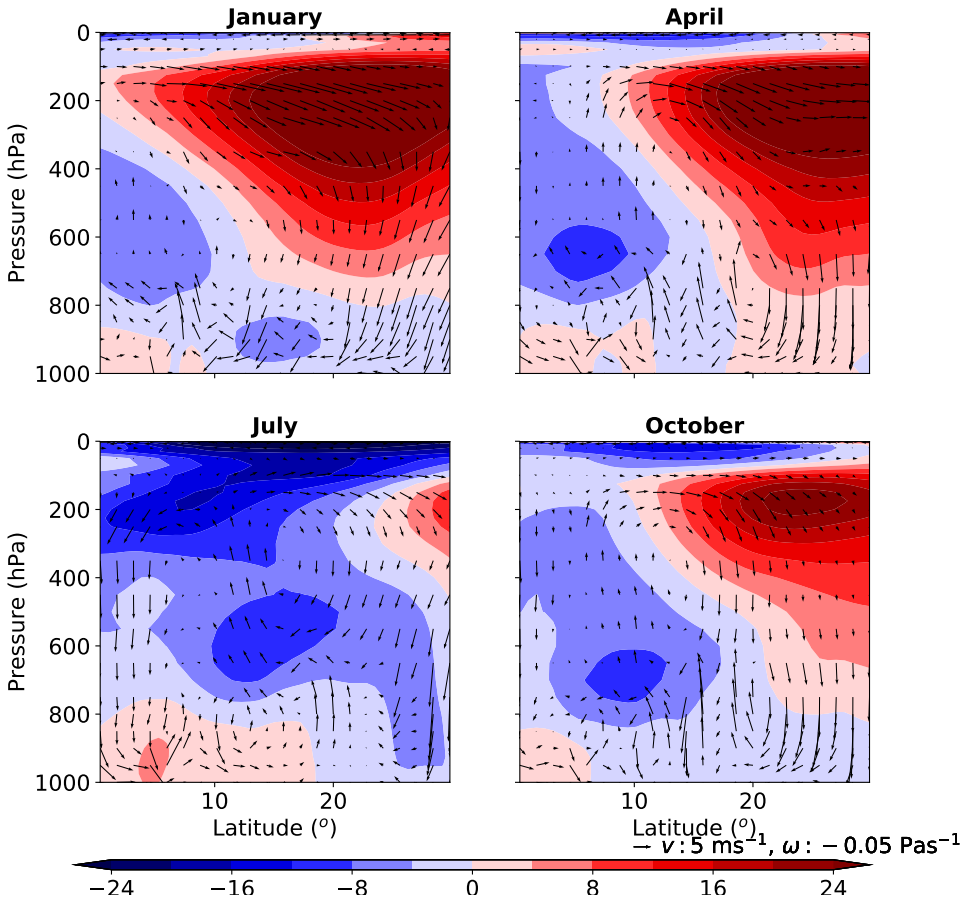

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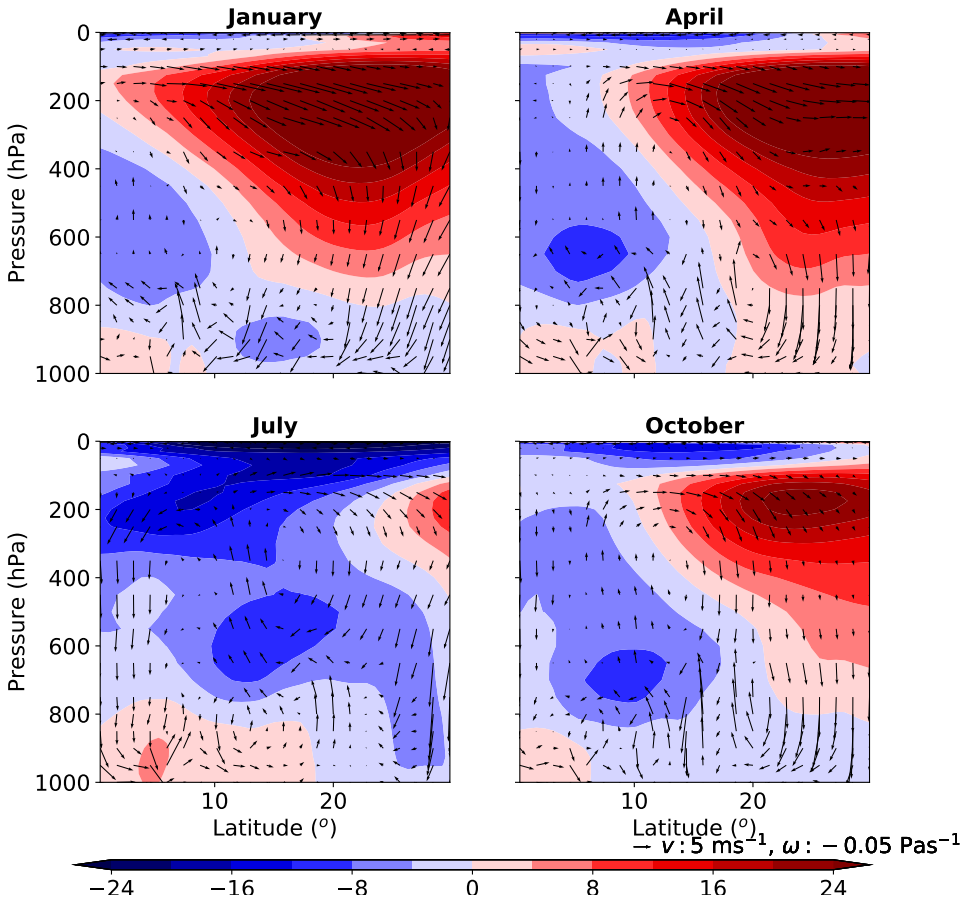

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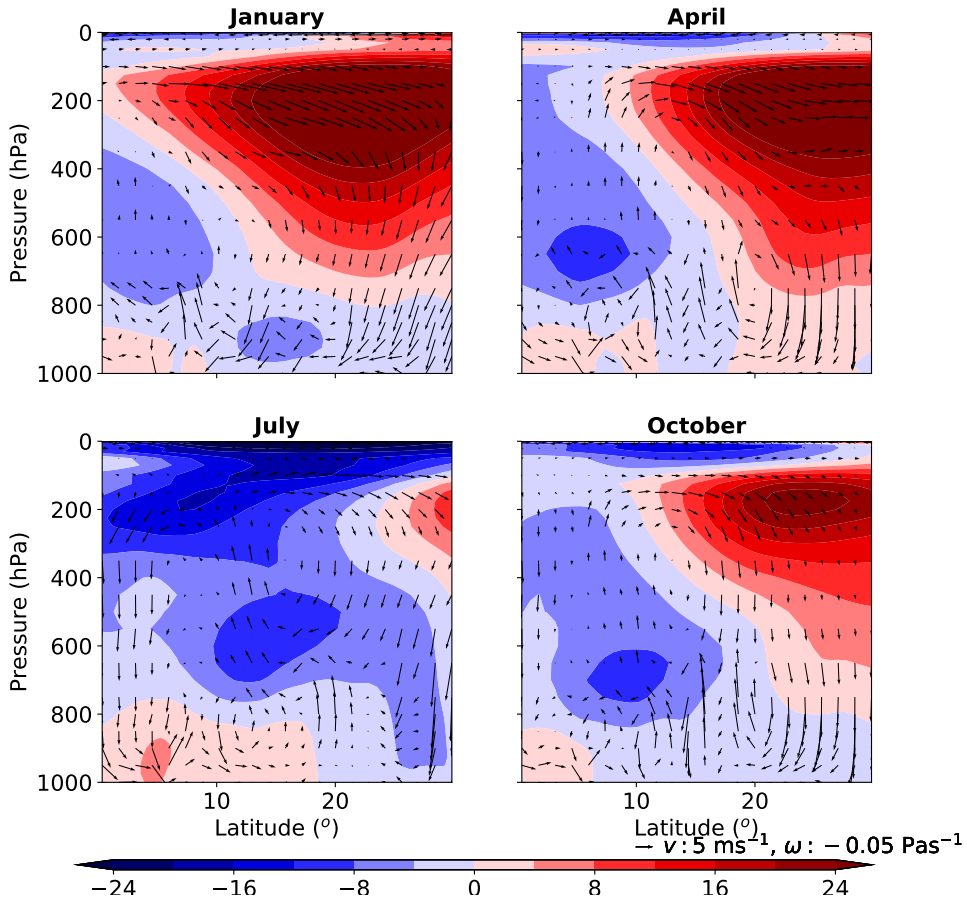

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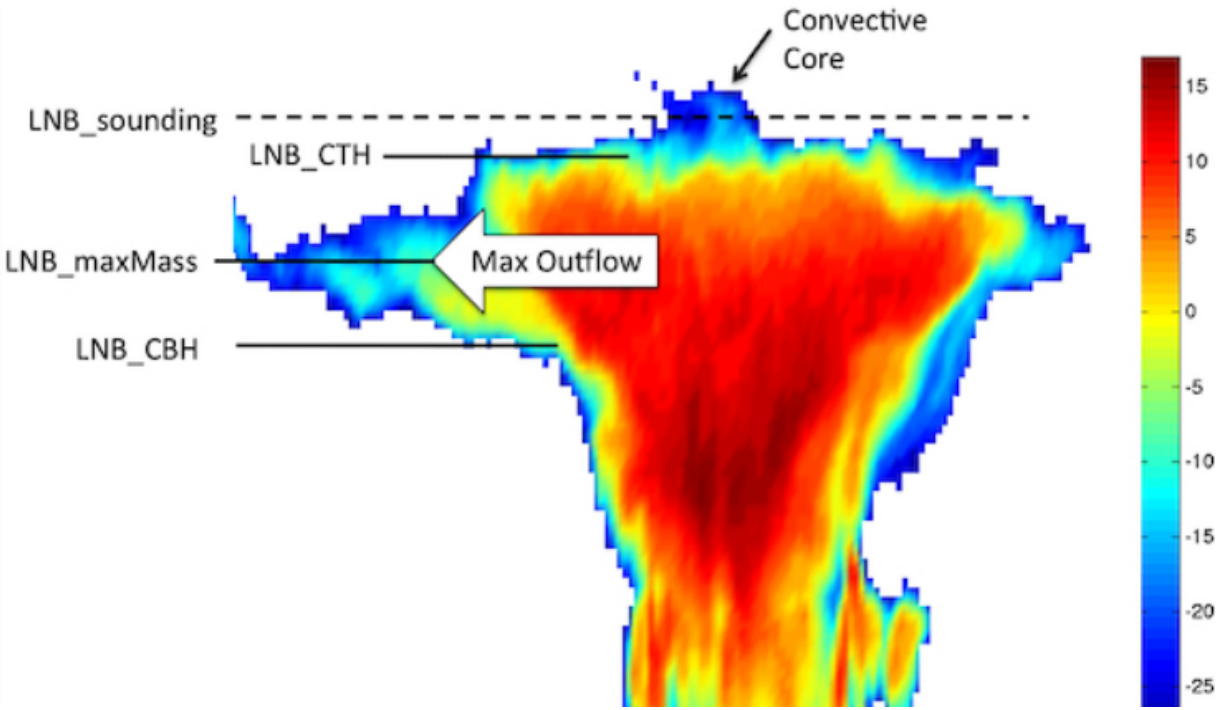
- This may happen by decreasing entrainment. (Mulholland et al., 2021).
- However even convection permitting climate models struggle to represent these effects (Fitzpatrick et al., 2020; Senior et al., 2021).
- The exact mechanism through which shear affects an MCS hasn't been thoroughly understood.

Relationship between Cloud top height (CTH) and the level of neutral buoyancy (LNB)



CloudSat radar reflectivity profile of tropical deep convective cloud on 24 Feb., 2007 (unit: dBZ) (Takahashi and Luo, 2012).

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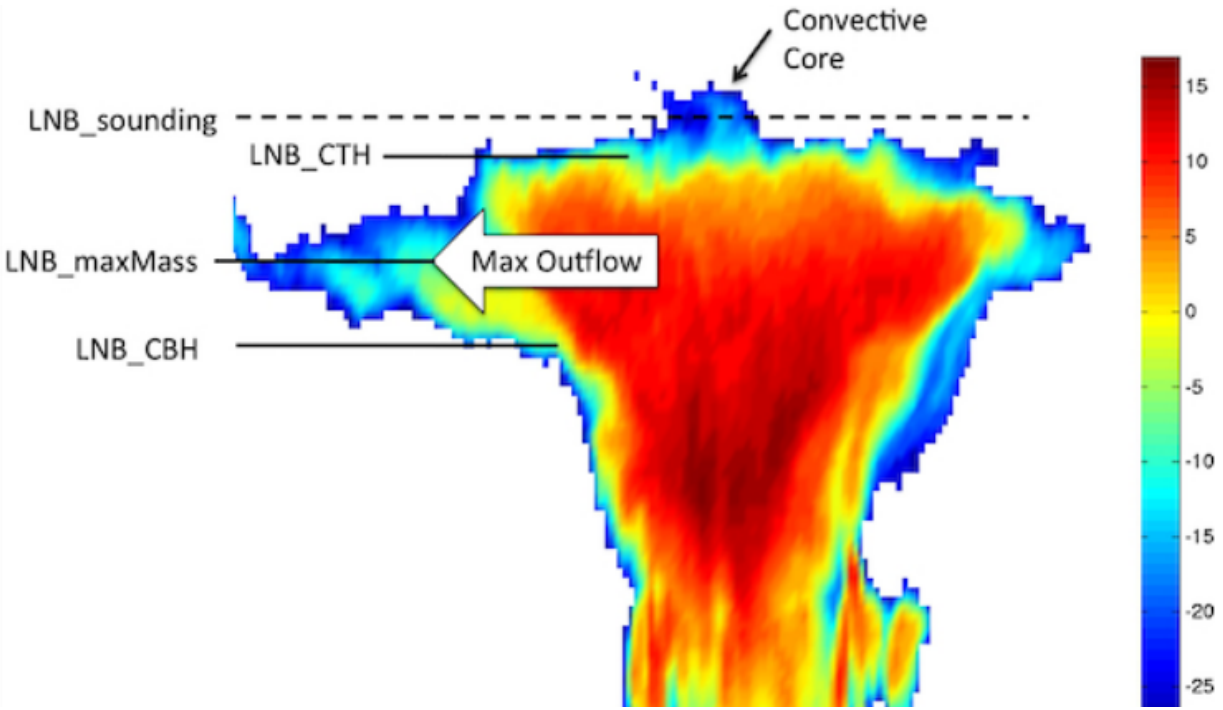

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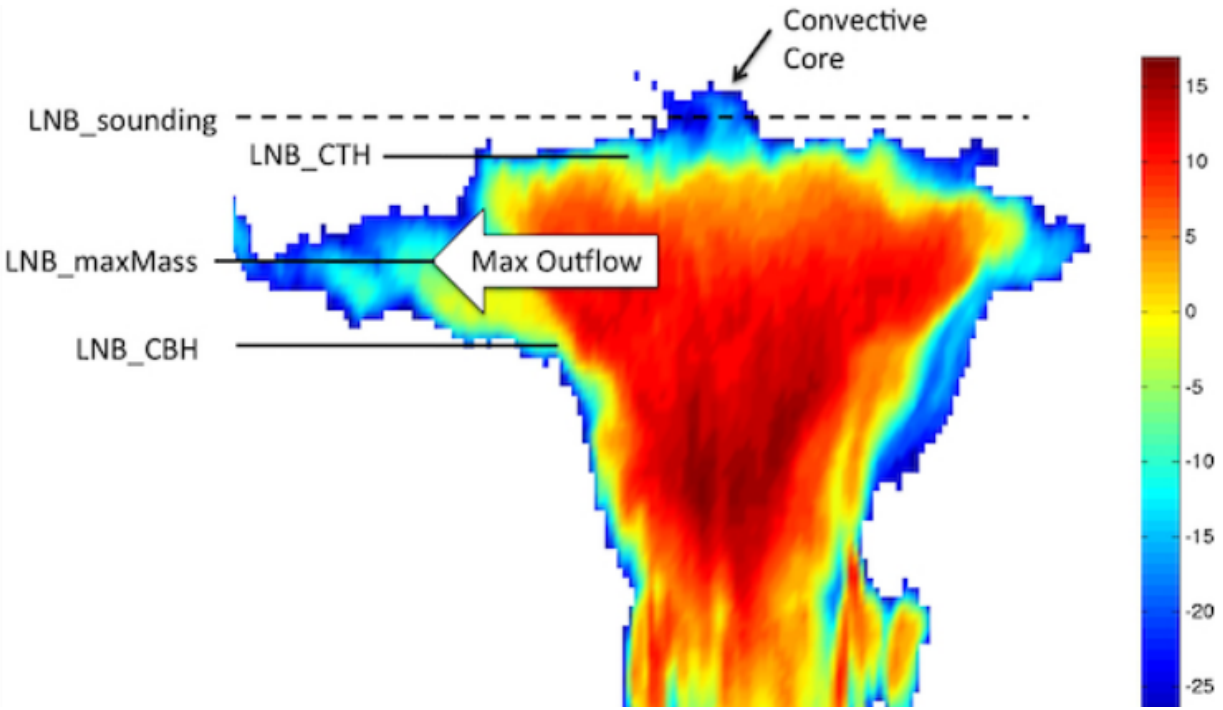

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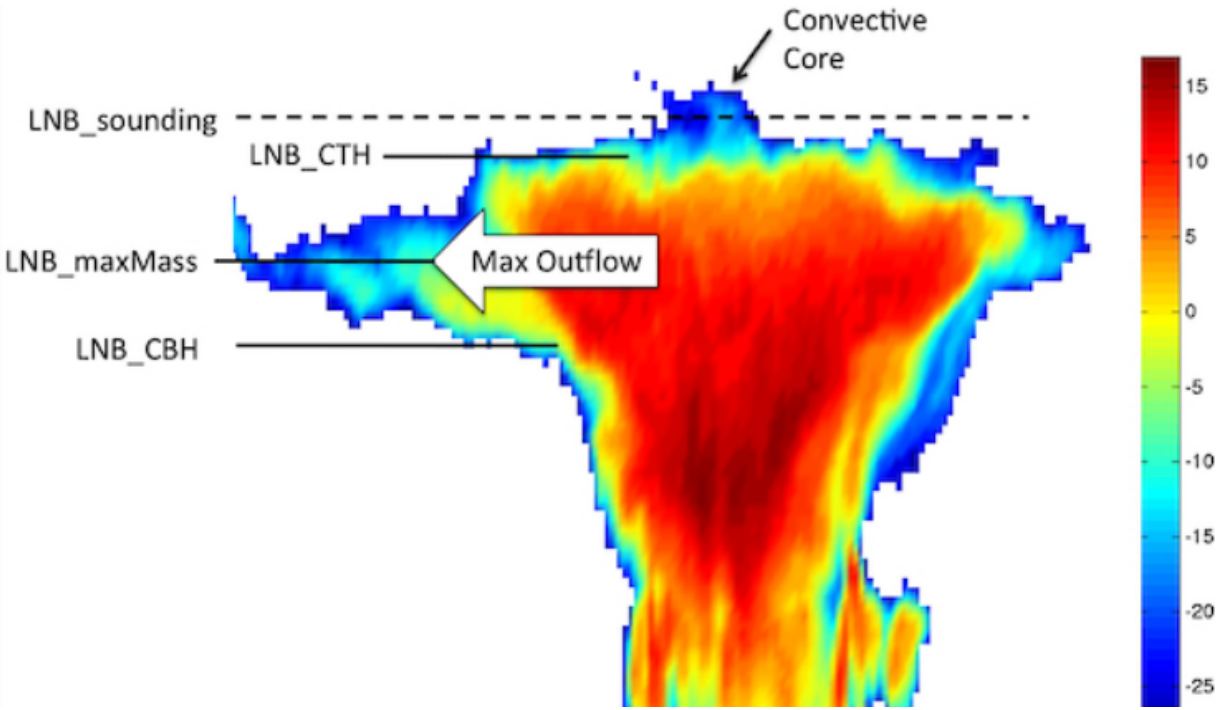

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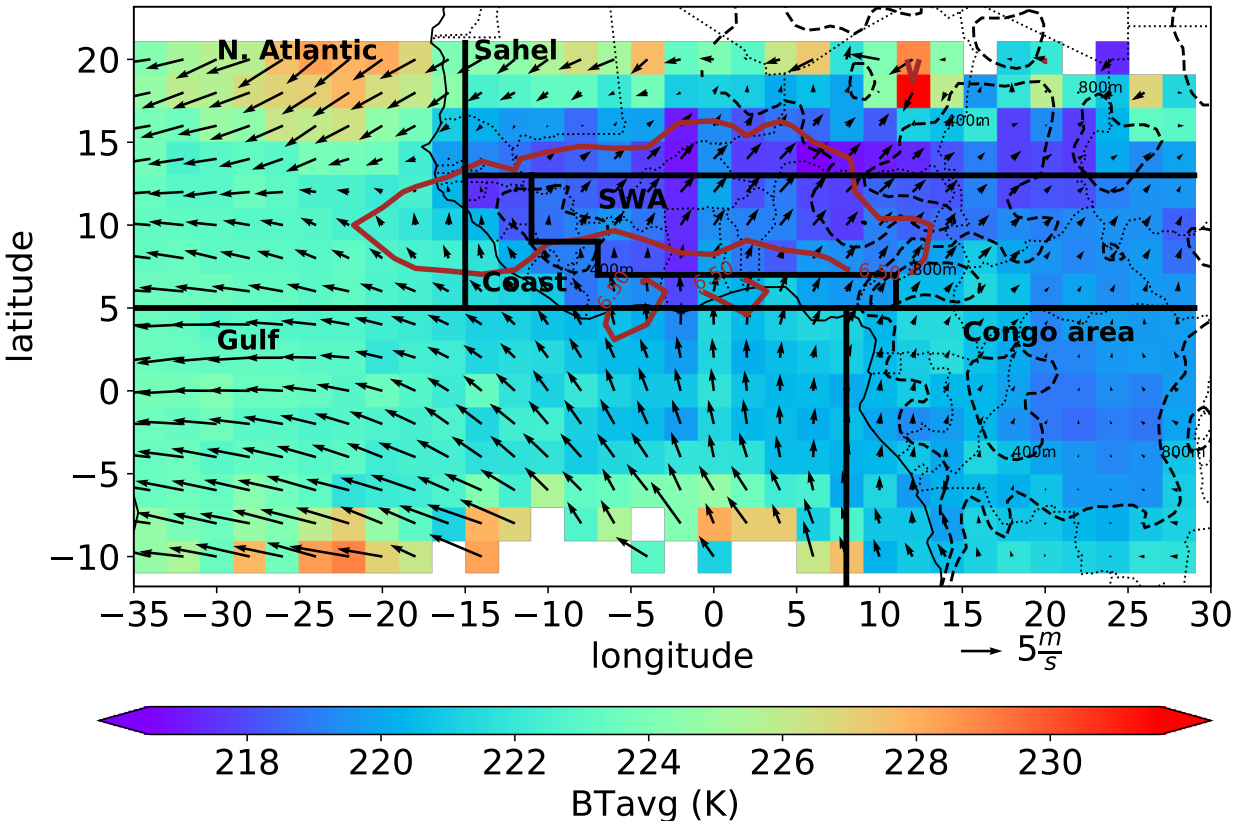
- Does shear affects the cloud top height of an MCS?
- Does shear affect the difference (CTH - LNB)?

The effect of shear on the cloud top height of an MCS



Mean brightness temperatures (BTavg) of MCSs.
shear: **925 hPa winds (arrows)** & **600 hPa wind speeds (contour)**.

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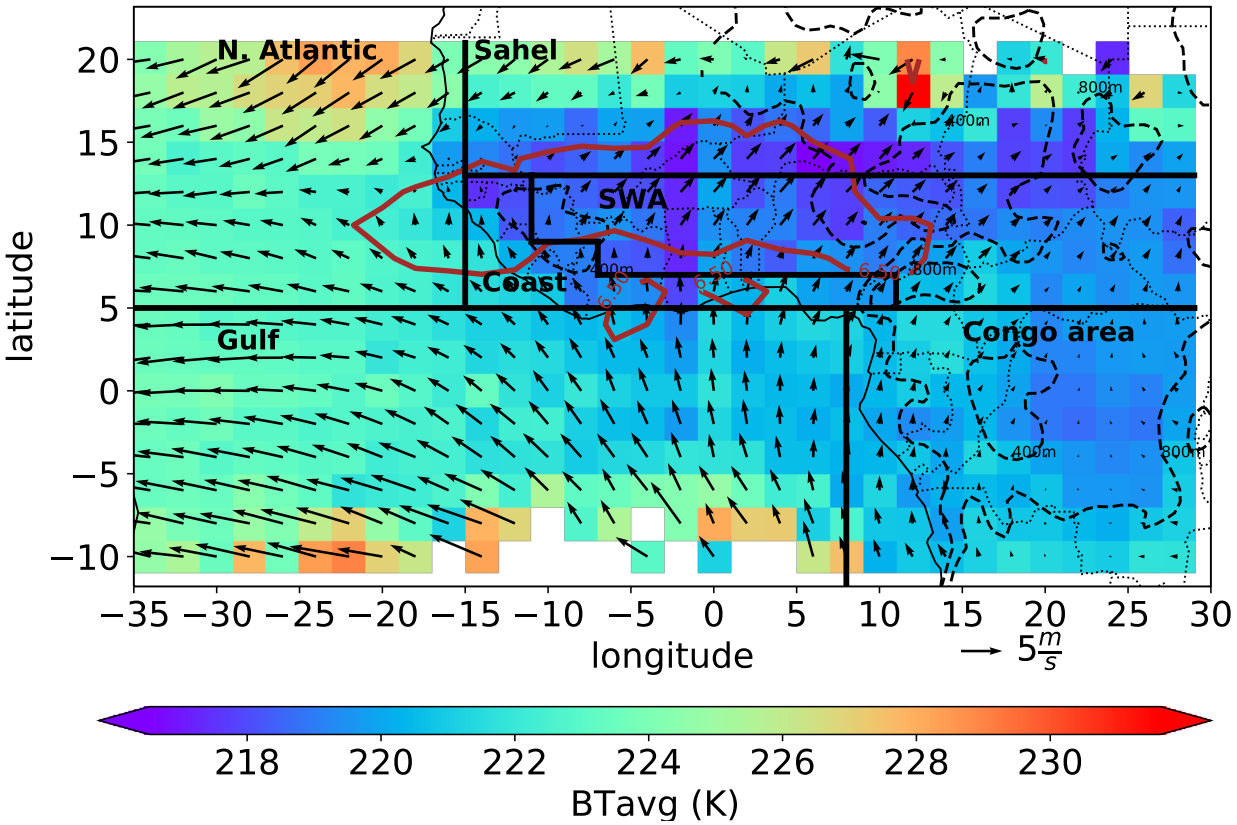

Shear is associated with colder cloud tops but how does this relate with their LNBs?

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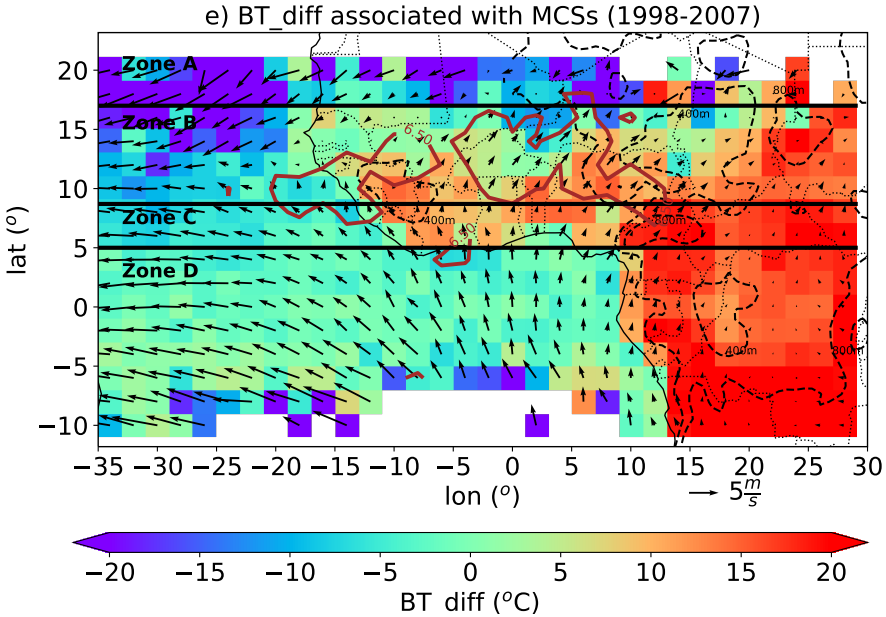
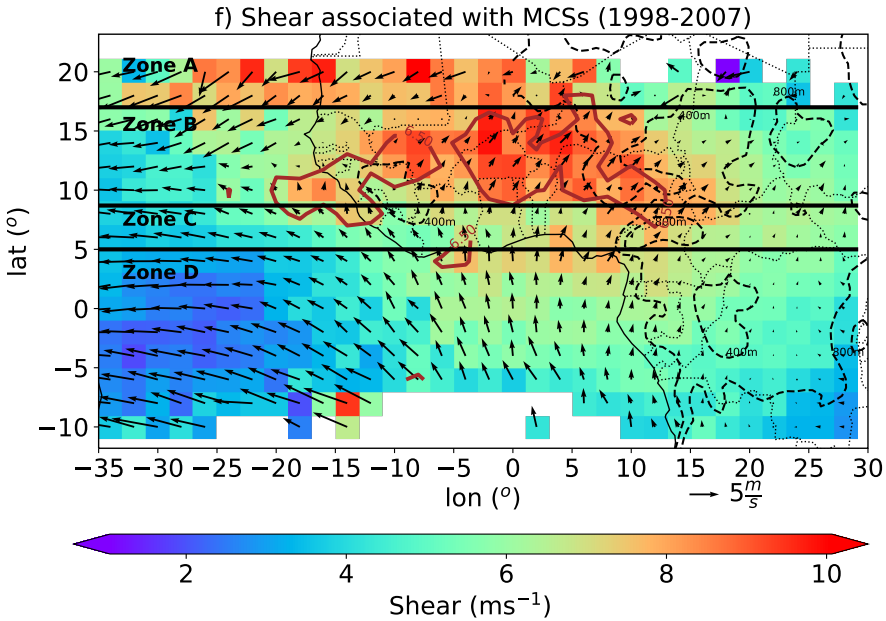
Effect of shear on brightness temperature difference

(BT_diff = CTH_temperature - LNB_temperature)

- A strong shear results in colder storms relative to the temperature at the LNB.



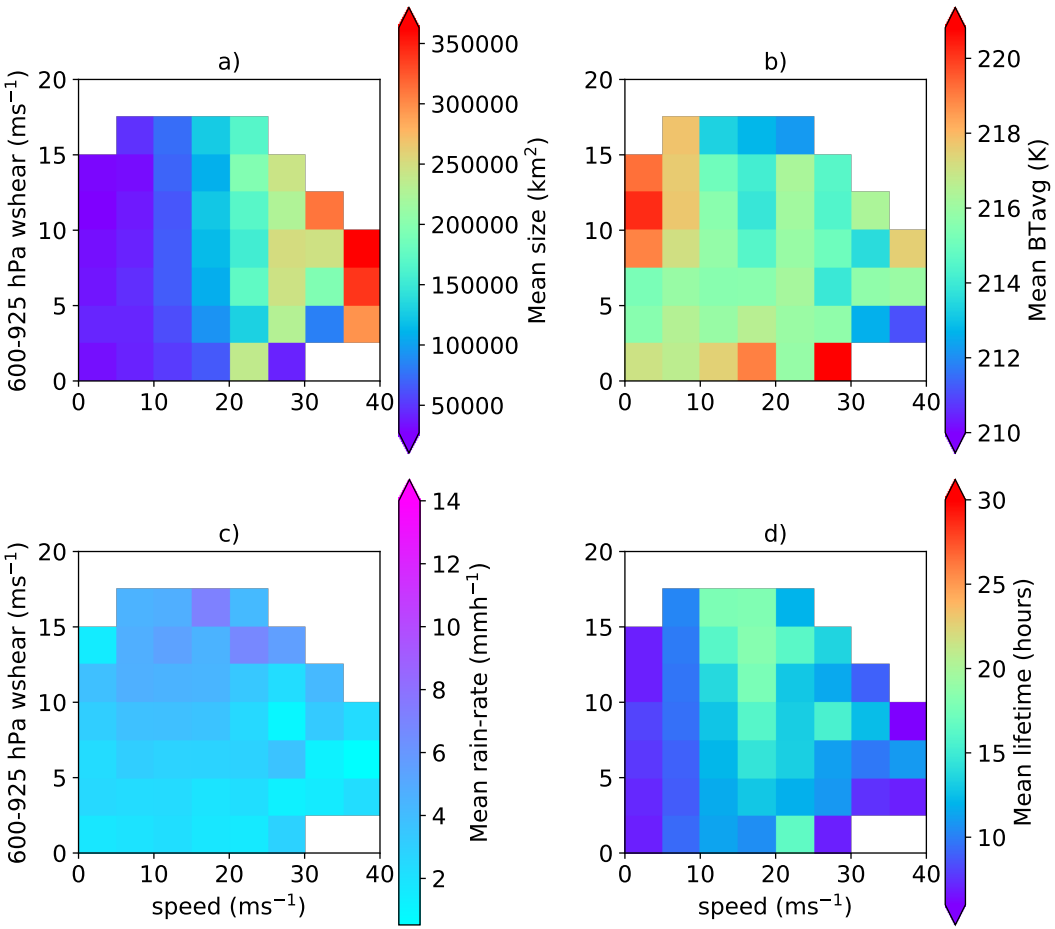


BT_diff (BT - the temp. at the LNB).
red- cloud top **low** relative to LNB. blue- cloud tops **high** relative to LNB.

shear: **925 hPa winds (arrows)** and **600 hPa wind speeds (contour)**.

Vertical wind shear and MCS properties

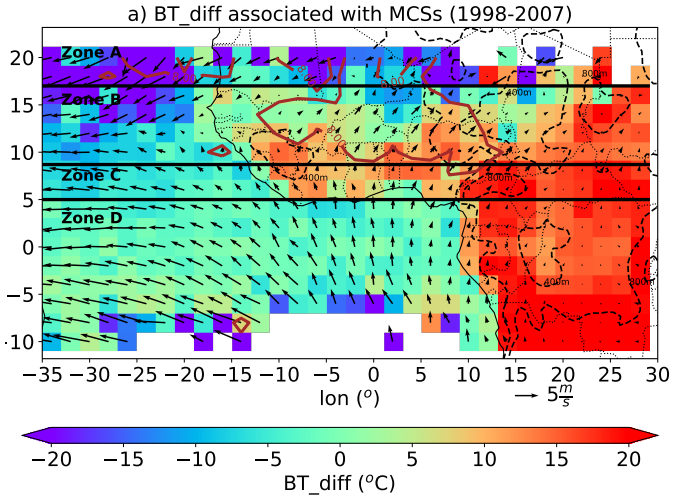
Strongest and most long-lived lived storms occur in strongly sheared environments

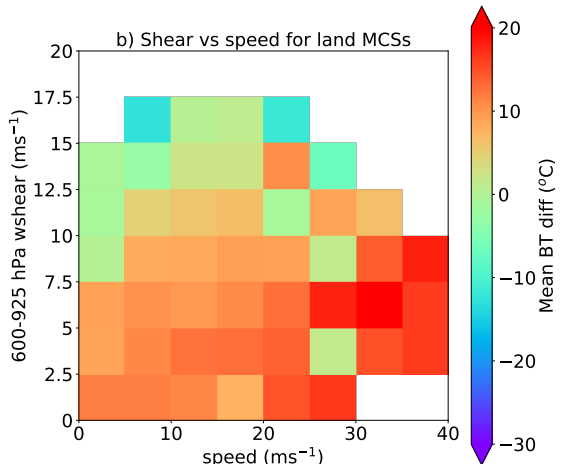


A strong shear results in:

- Large storms.
- Deep storms (coldest brightness temperatures)
- Long lived storms.
- With high rain-rates

Conclusions





a) BT_diff: contours of shear (8 ms^{-1}). b) Shear vs speed of BT_diff.

- Generally storms over the oceans could reach their level of neutral buoyancies (LNBs) compared to storms over land.
- We speculate that higher entrainment rates over land compared to the ocean prevents storms from reaching their LNBs (Becker and Hogenegger, 2021).

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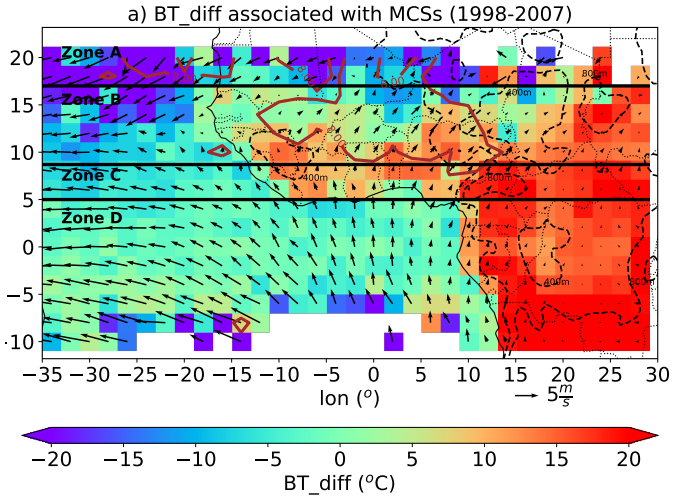

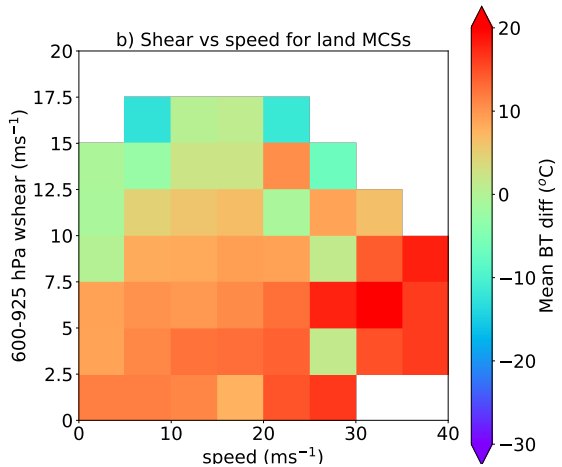

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- The difference between observed CTHs and the LNBs of land MCSs is minimised over regions of strong vertical wind shear.
  - **Strong vertical wind shear results in higher CTHs relative to their LNBs.**

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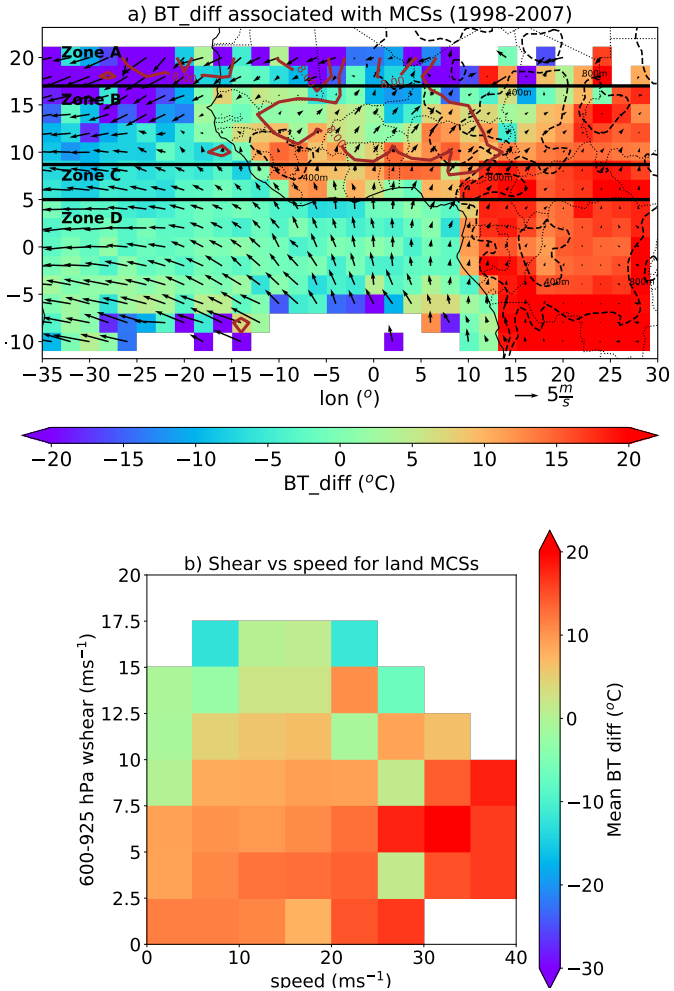

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  - **Strong vertical wind shear results in higher CTHs relative to their LNBs.**
- We hypothesize that this happens by increasing updraughts and minimising entrainment