Are Temperature Extremes of the Tibet Plateau Caused by Anomalies of Heat Advection?

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Climate: Past, Present & Future

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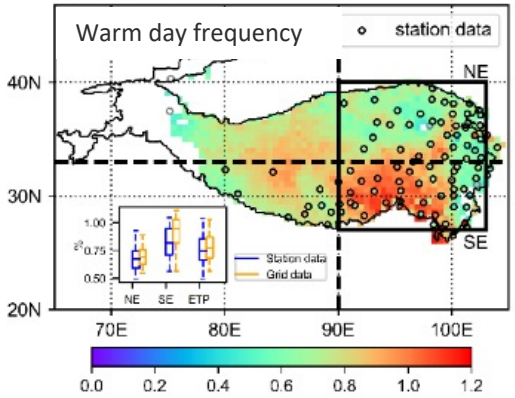
Temperature Extremes & Large-scale Circulations

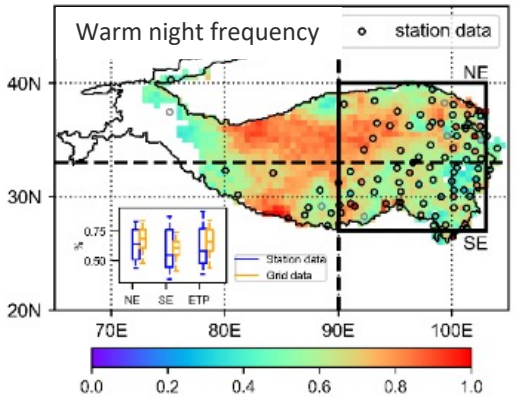
Both **extreme warm days** and **warm nights** are **more frequently occur** over **the Tibet Plateau** (the TP) during **winter**

https://eos.org/research-spotlights/tibetan-plateau-lakes-as-heat-flux-hot-spots



%/decades

https://www.nytimes.com/interactive/2018/07/11/climate/summer-nights-warming-faster-than-days-dangerous.html

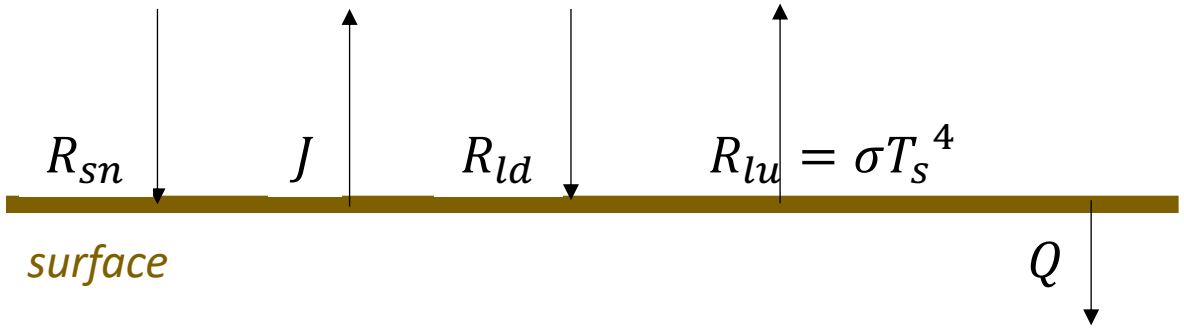


%/decades

Surface Temperature Extremes ← Large-scale Circulation Patterns

What's the connection?

Heat advection? or Radiative setting?



Surface energy balance

$$\sigma T_s^4 = R_{sn} - J + R_{ld} - Q$$

- **Heat advection cannot directly modulate the surface temperature**

Tian et al. (2022) in prep

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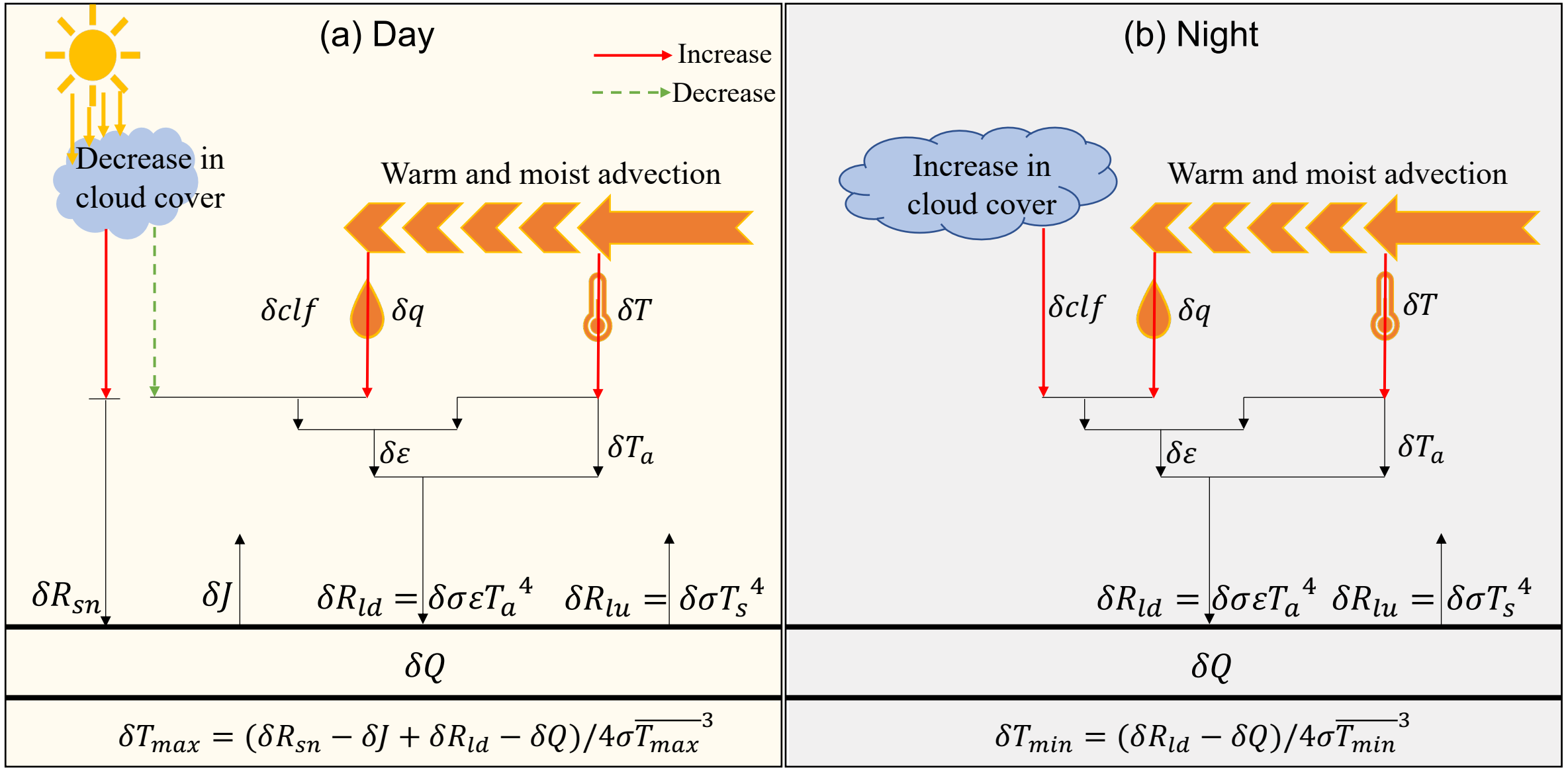
Perturbations during the Warm Extremes

Tian et al. (2022) in prep

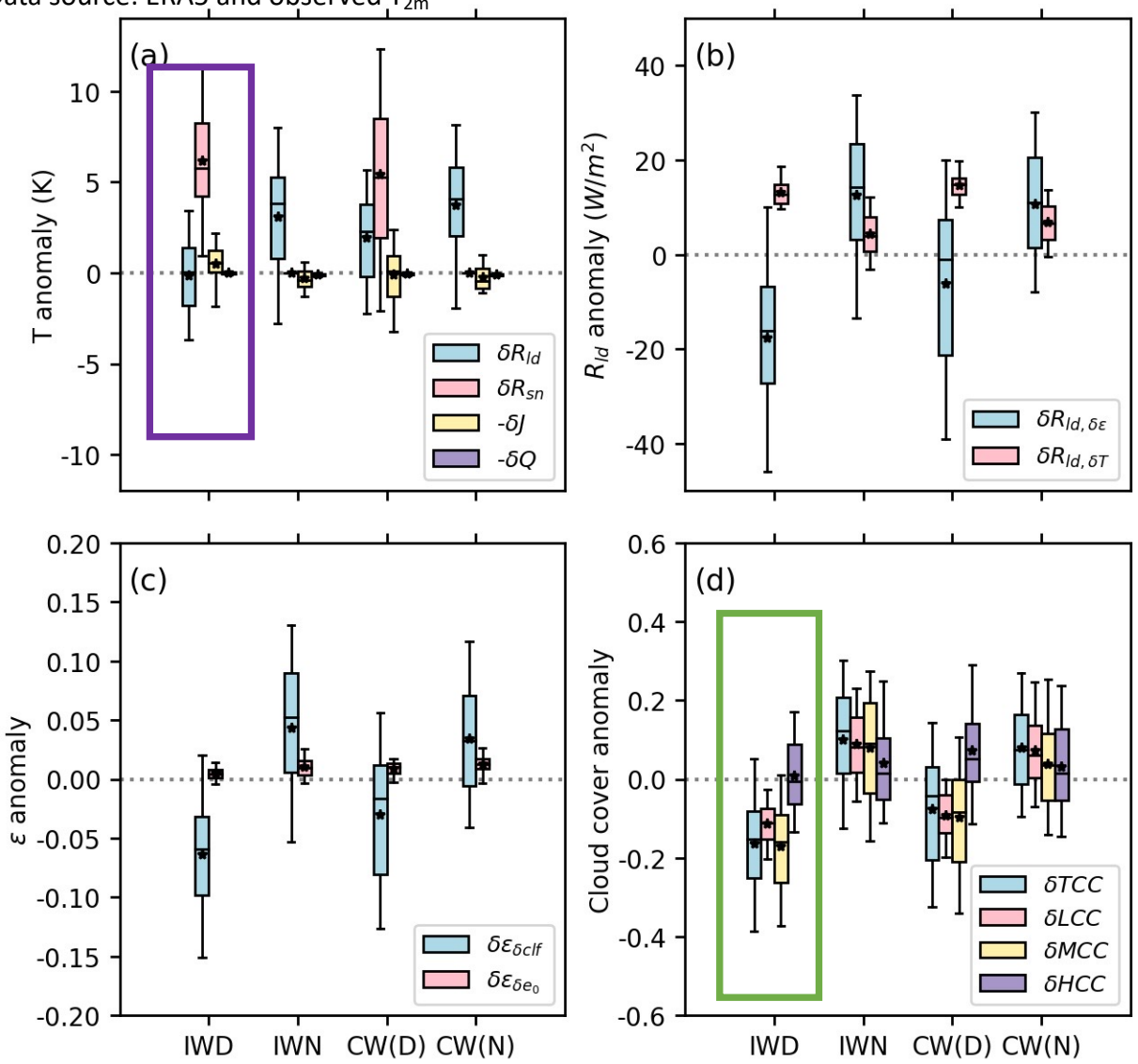


- **What caused the perturbation of surface energy balance during extremes? Heat advection or Cloud?**

Surface Energy Budget

Tian et al. (2022) in prep

Data source: ERA5 and observed T_{2m}



Independent Warm Days (IWD)

↑

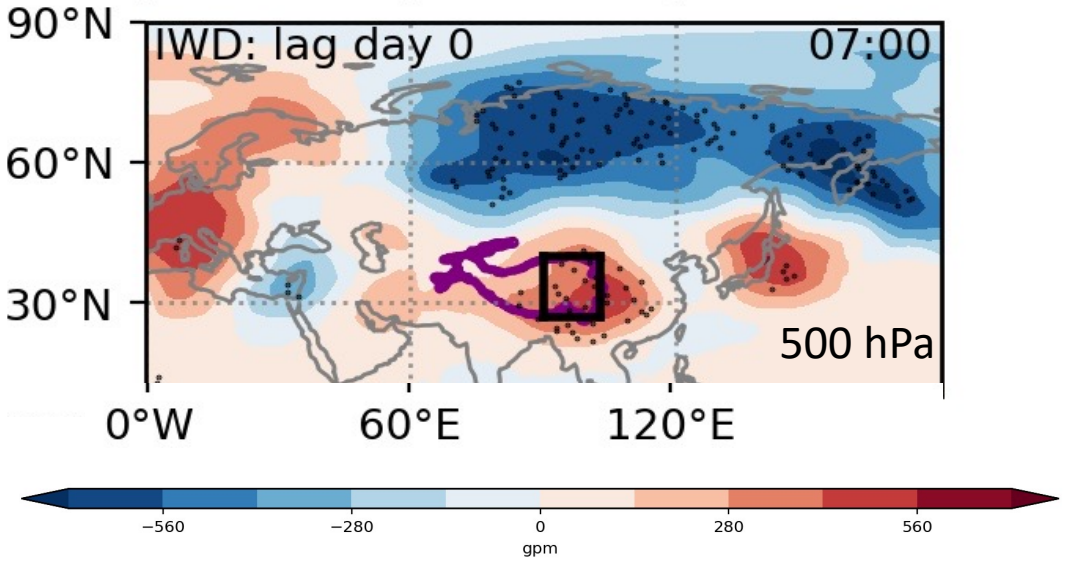
Solar radiation increase

↑

Cloud cover decrease

↑

High-pressure system and air subsidence



- **Large-scale circulations manifest themselves in cloud variation and further influences surface temperature**

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Surface Energy Budget

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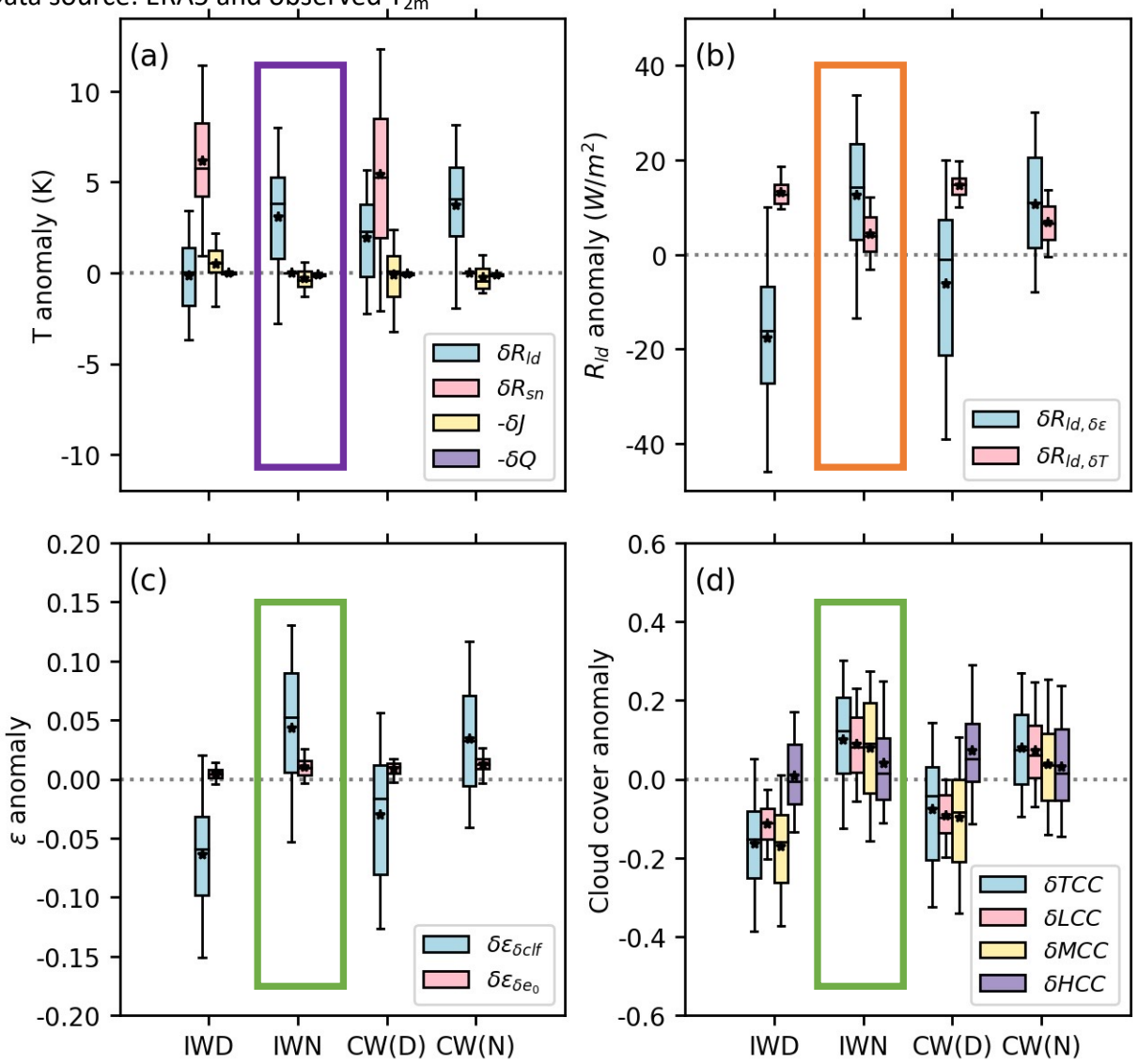


Independent Warm Nights (IWN)

↑

Downward longwave radiation increase

↑

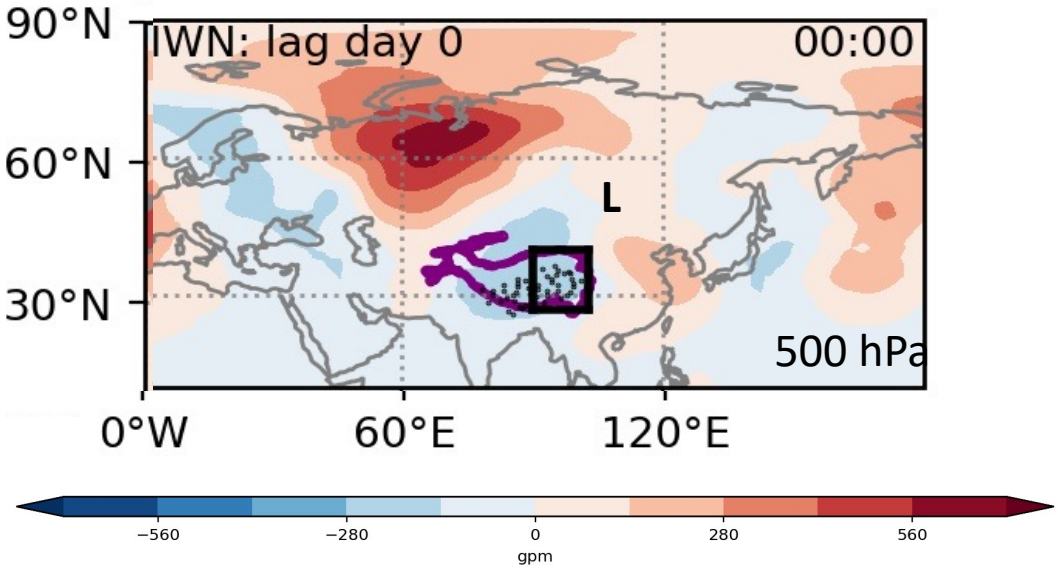
Emissivity increase

↑

Cloud cover increase

↑

Low-pressure system and air ascent



○ **Large-scale circulations manifest themselves in cloud variation and further influences surface temperature**

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Surface Energy Budget

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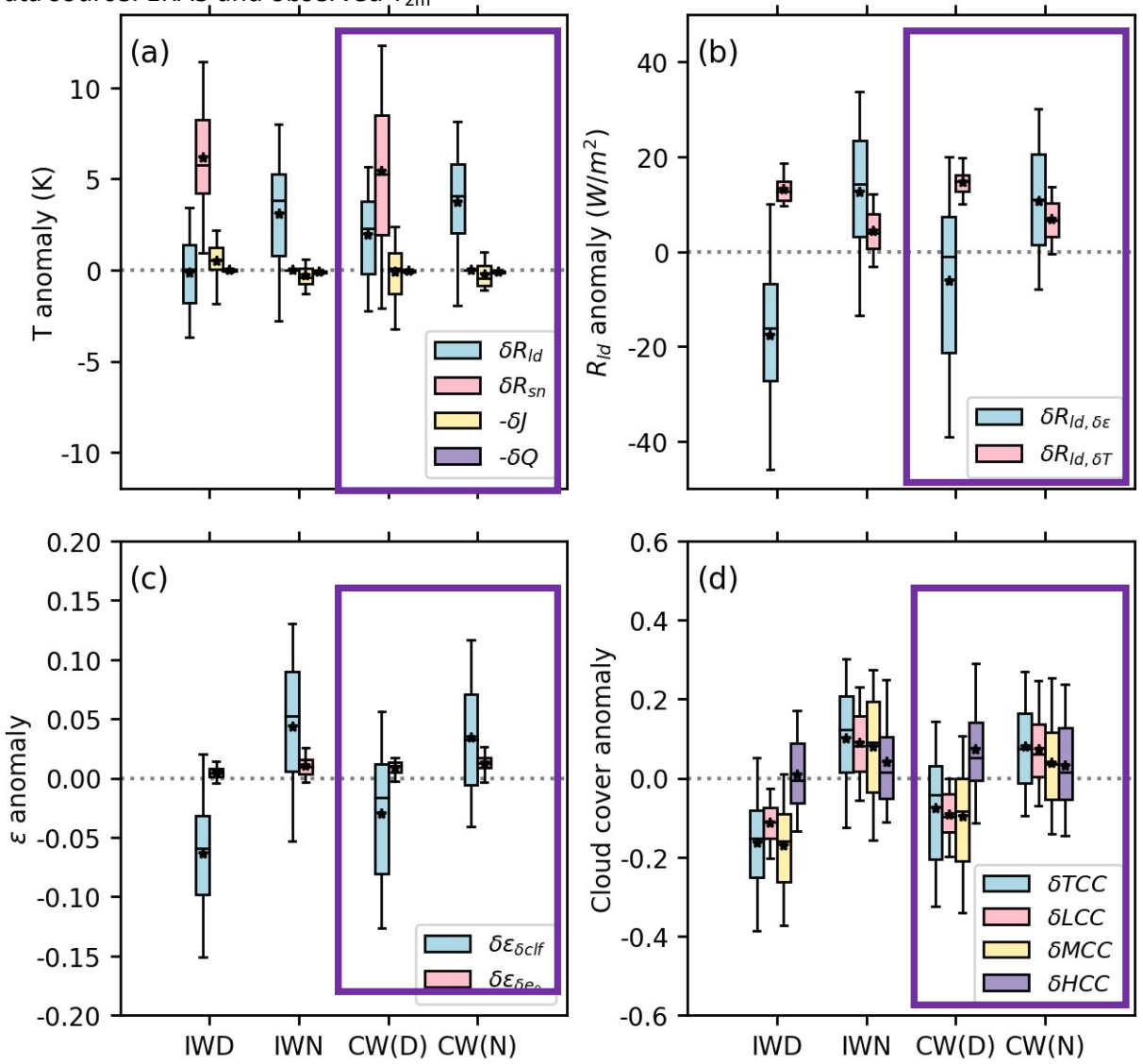
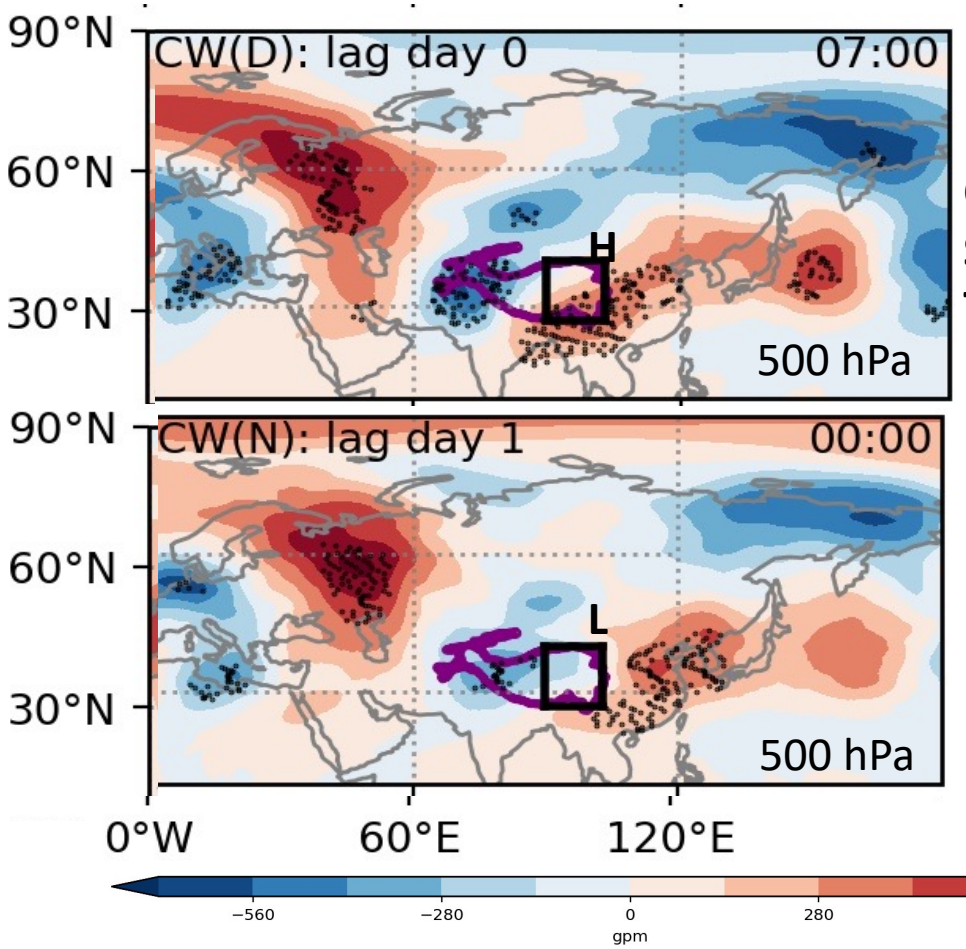


Compound Warm Events (CW)

↑

Swift shift from high to low-pressure driven by a Rossby wave from the Arctic



Day:
H-pressure
Cloud –
Solar R +
Temperaure +

Night:
L-pressure
Cloud +
Emissivity +
Longwave R +
Temperaure +

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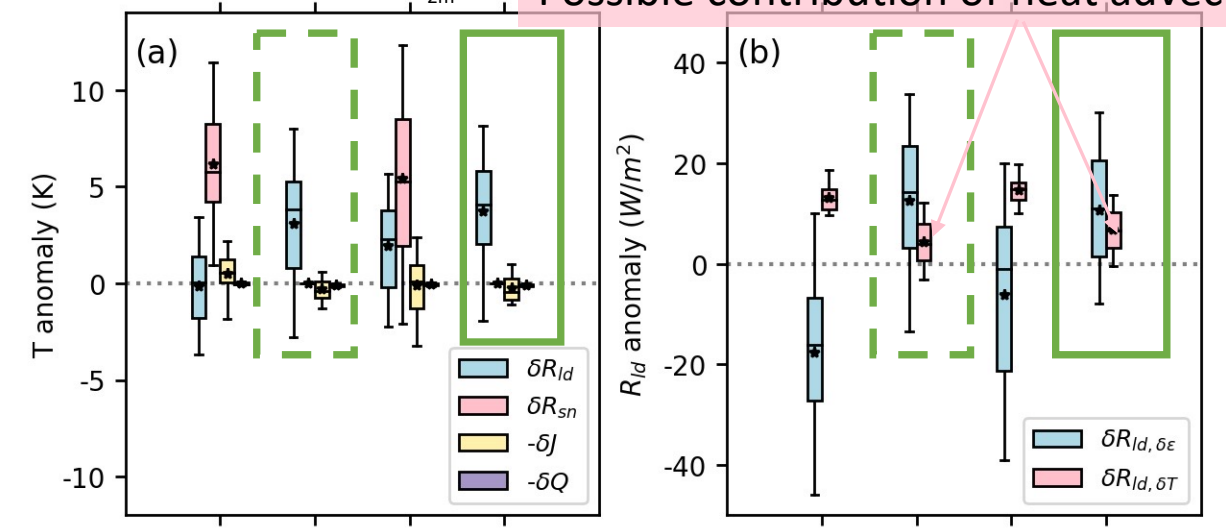
Analysis of Heat Advection

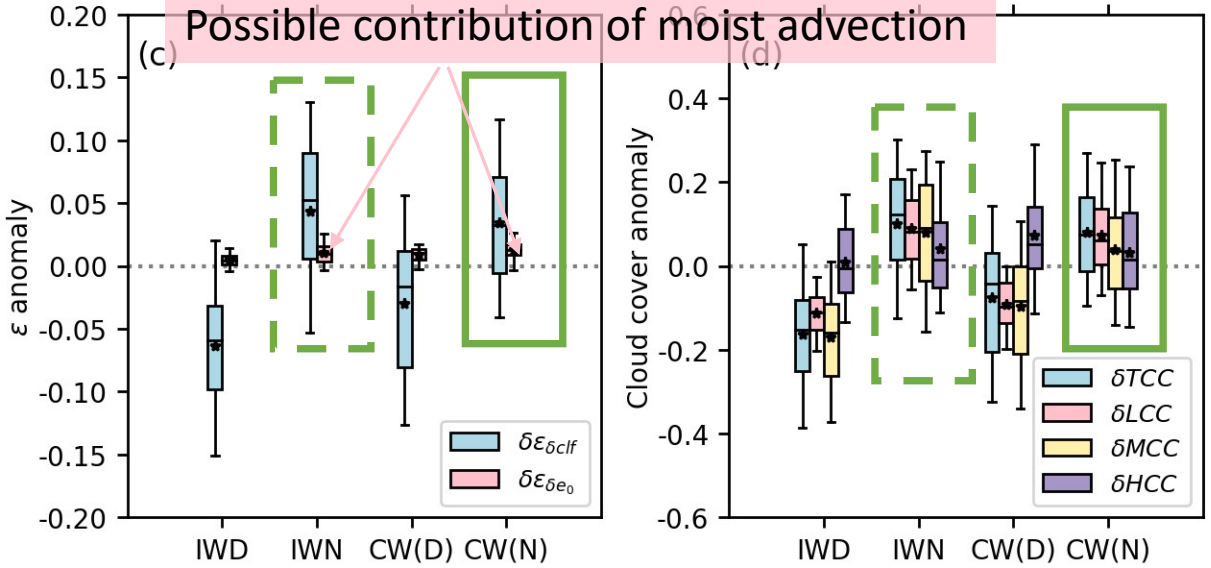
Tian et al. (2022) in prep

Data source: ERA5 and observed T_{2m}

Possible contribution of heat advection



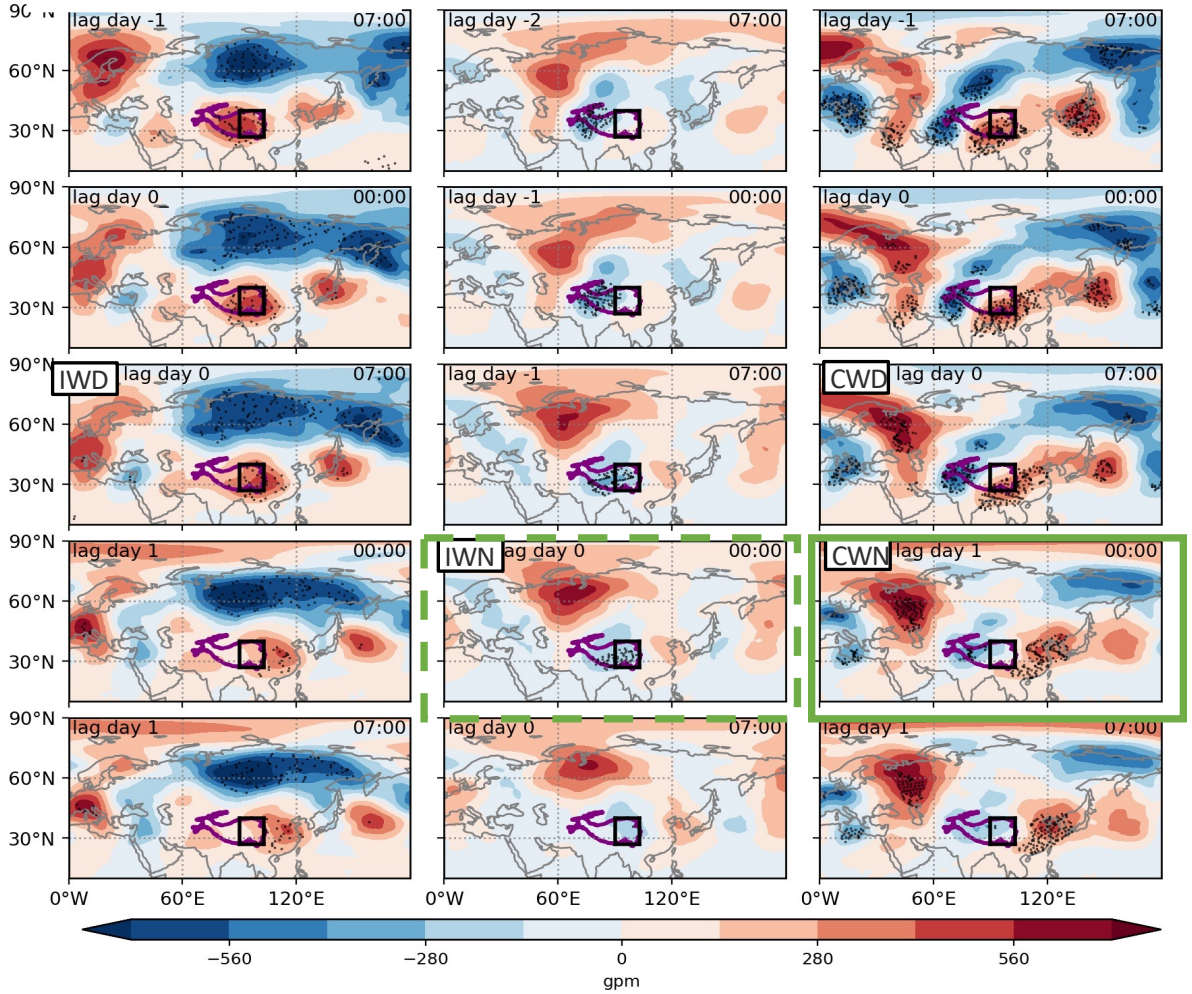
Possible contribution of moist advection



Independent Warm days (IWD)

Independent Warm nights (IWN)

Compound Warm day and nights (CWD & CWN)



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- **Contribution of heat advection is absent during extreme warm days and limited during warm nights**

Conlusions and Implications

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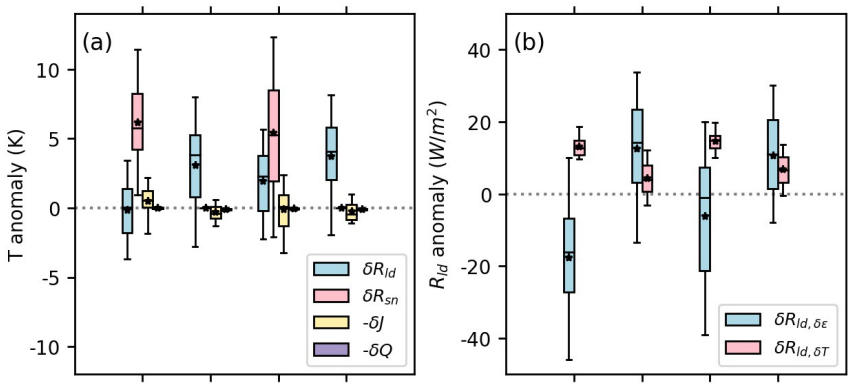

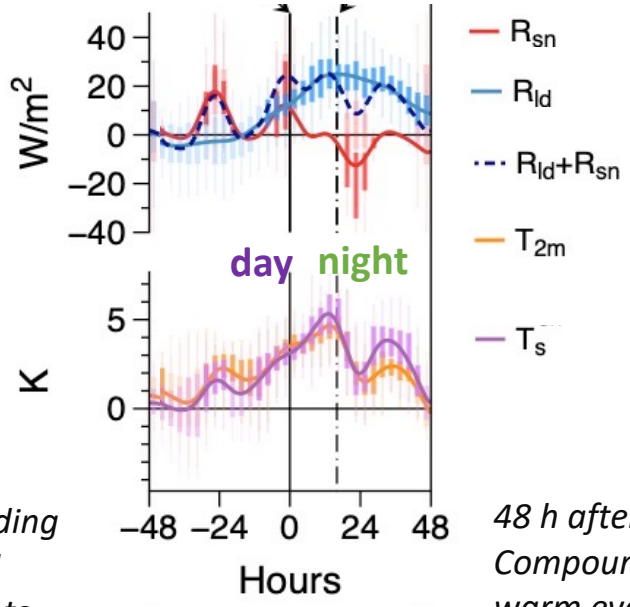

48 h preceding Compound warm events

48 h after Compound warm events

- Extreme Warm **days** <<<< + **shortwave radiation**
- Extreme Warm **nights** <<<< +**longwave radiation**
- **ΔRadiation** <<<< **Δcloud cover** <<<< **Δcirculation**
- **Heat advection** might just **play a limited role** in extreme temperature events
- *The mechanisms are **similar** during **summer seasons** and **cold events***
- ***Night extremes** are more sensitive to global warming*

- **Extremes are directly controlled by radiation and indirectly by clouds, but not heat advection**

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Thank you for your attention !

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