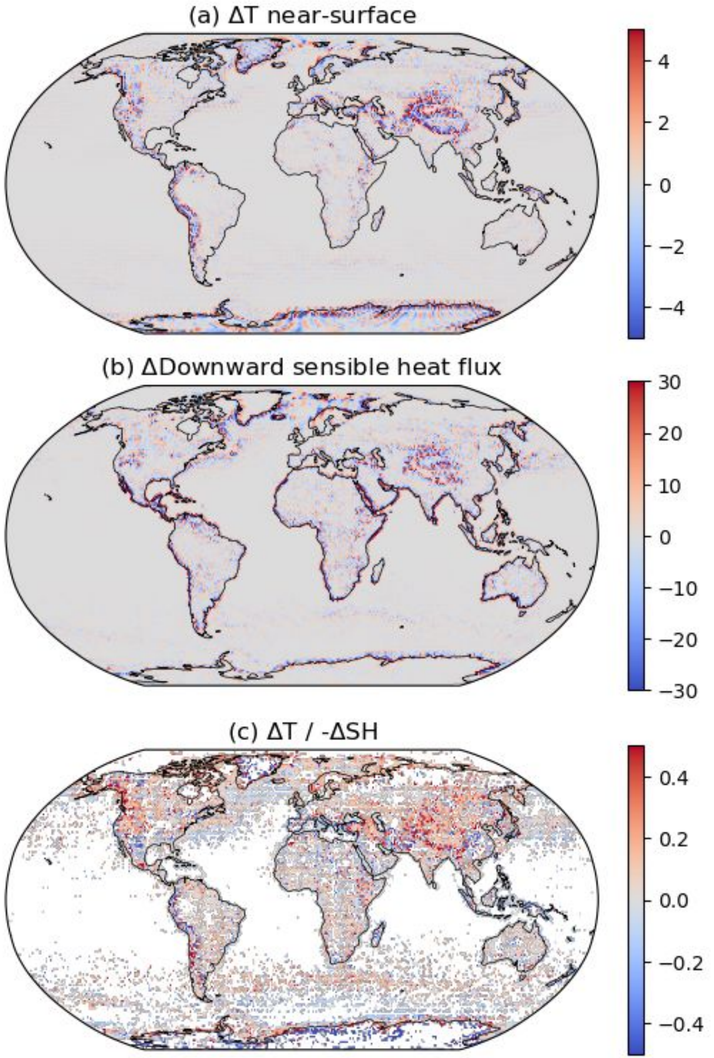
Team Land Report
May 15 (Thu 2025)

Do Ngoc Khanh, Ching-Hung Shih, Kei Yoshimura, Shuping Li,
Ryotaro Omae, Chu-Yi Chang, Jie Hsu, Ren-Jie Wu, Yen-Ting Chou

Thermal Process

- Presented question: What information is gained, or loss, when zooming in/out.

- March monthly mean result, zoom 5 vs 7 ⇒
- Little change on the ocean.
- On land, large ΔT and ΔSH around mountainous area (Andes, Himalayas, Rockies).
- -ΔT/ΔSH > 0, in general.



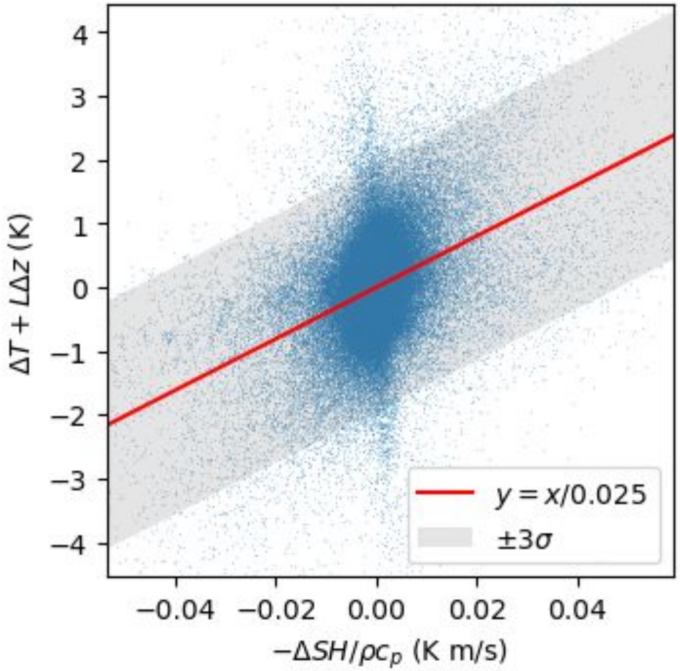
A statistical model (March)

$\Delta T = -L\, \Delta z - \Delta SH / (a\, \rho c_p)$

- Δz (m): Height difference between two zoom levels,
- ΔSH (W/m^2): Sensible heat flux difference,
- ρc_p (J/m^3 K): Volumetric heat capacity of air.

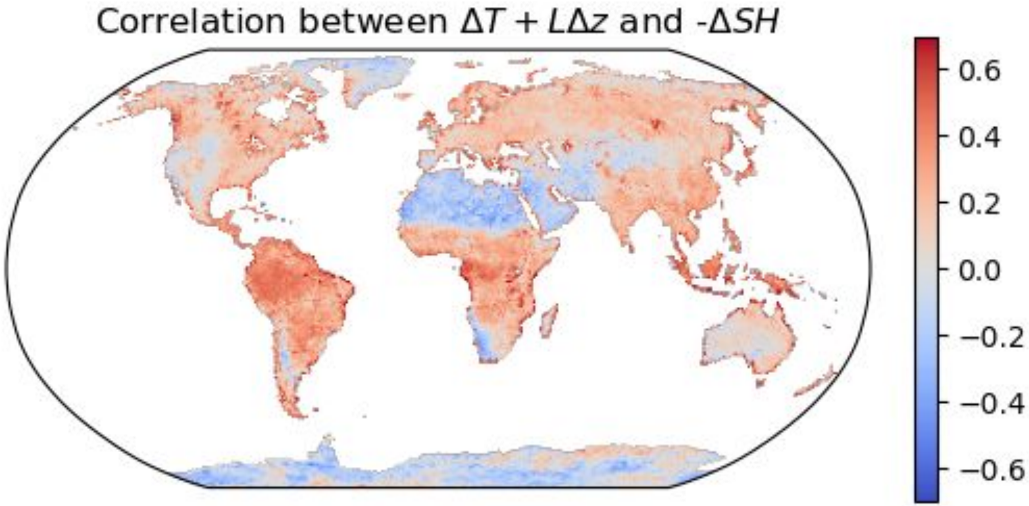
Fitted parameters

- L (K/km): temperature lapse rate.
  → L = 6.6 K/km. (Adiabatic lapse rate 9.8 K/km)
- a (m/s): some empirical parameter.
  → a = 0.025 m/s. Why?



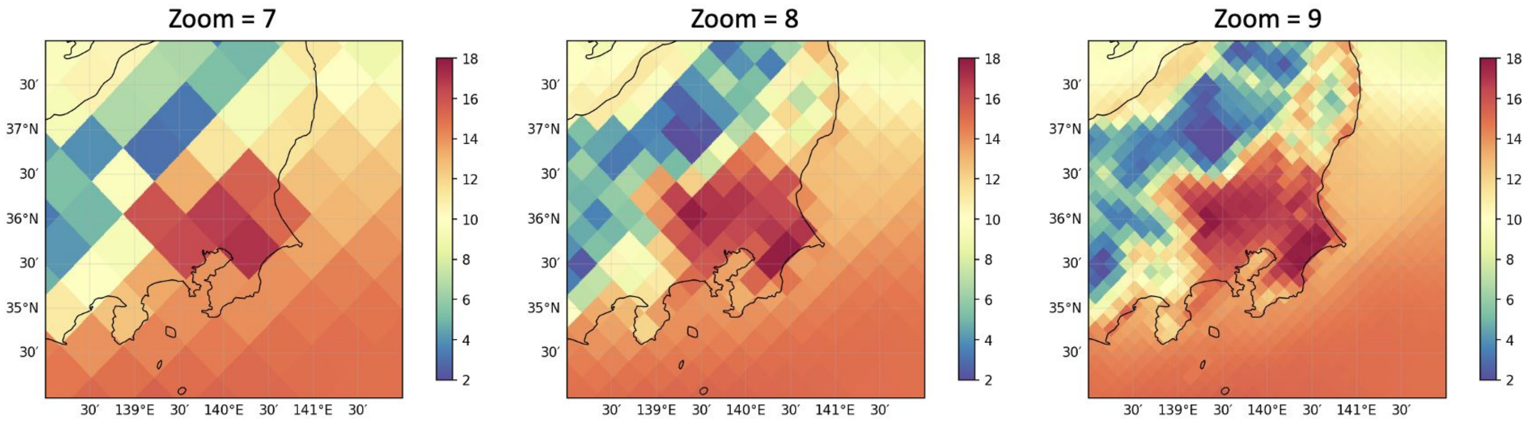
One-year correlation analysis

- Usual expectation: More SH ⇔ higher temperature.
- In dry region (e.g. Sahara), the reverse seems to be true.
- I don’t know why, but some land experts may know.
- My teammates also found similar patterns in other context.

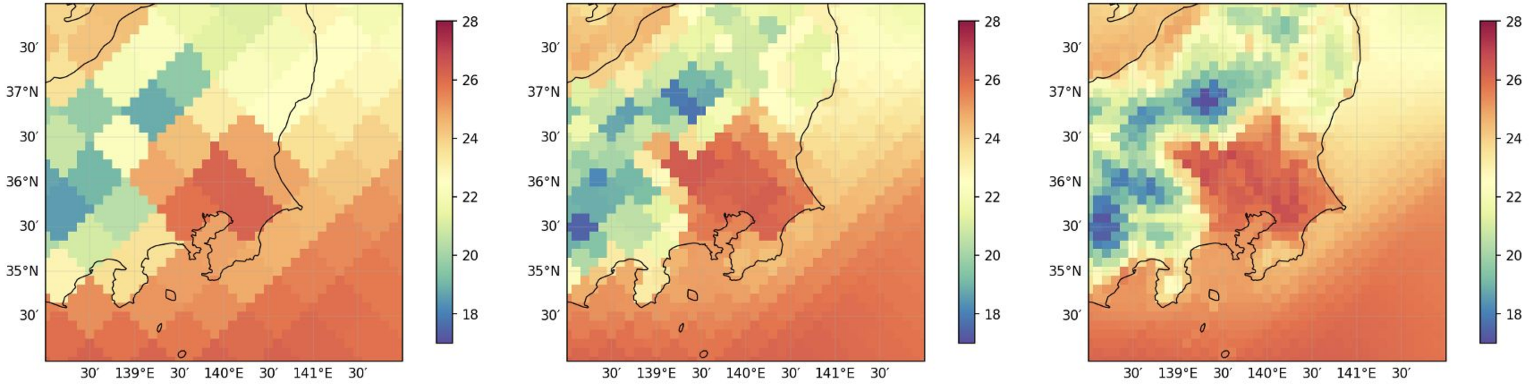


Original Healpix

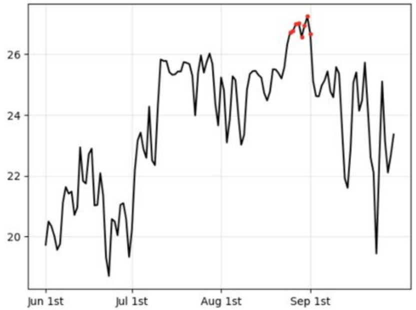
2m Air Temperature



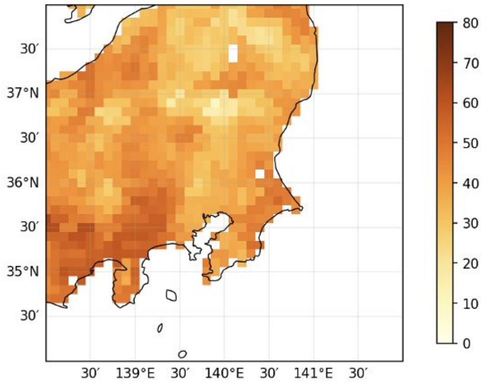
Re-grid to 0.1 deg



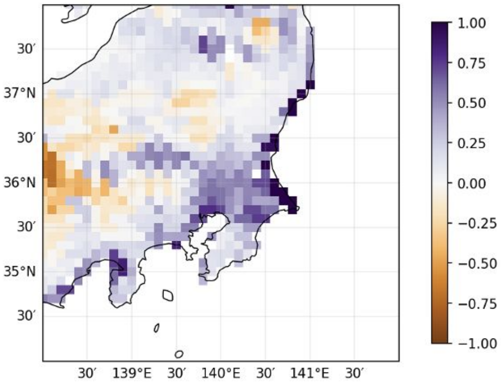
Red days average – JJA average
(to simulate response in heatwave-like events)



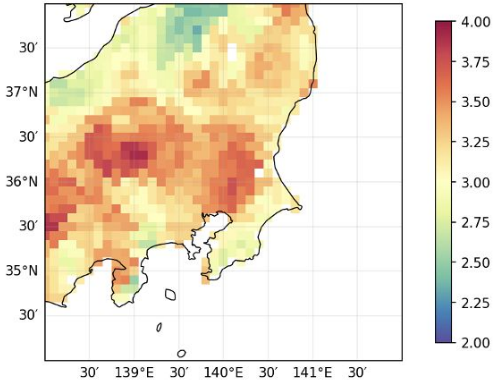
Shortwave Radiation at sfc



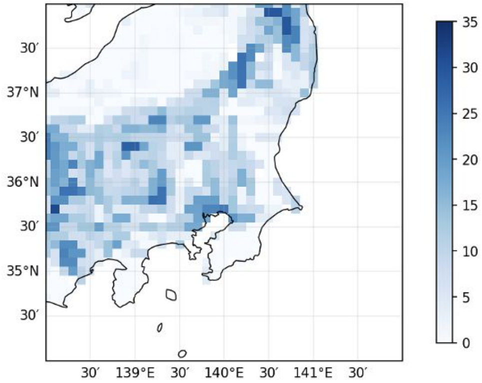
Wind Speed at 10m



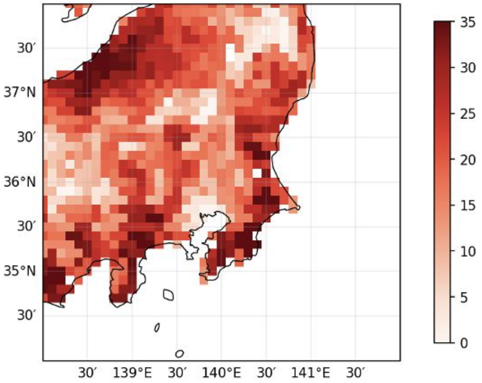
2m Air Temperature (mean)

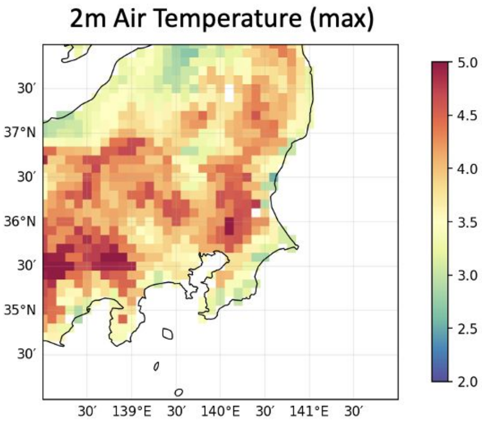


Latent Heat Flux

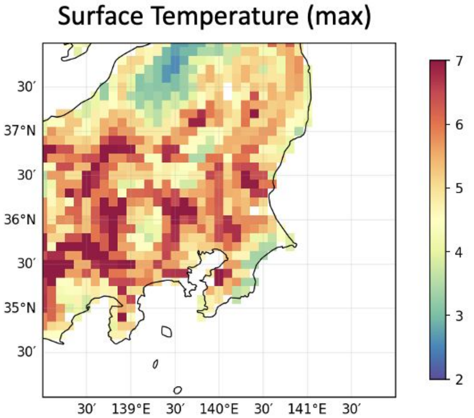


Sensible Heat Flux

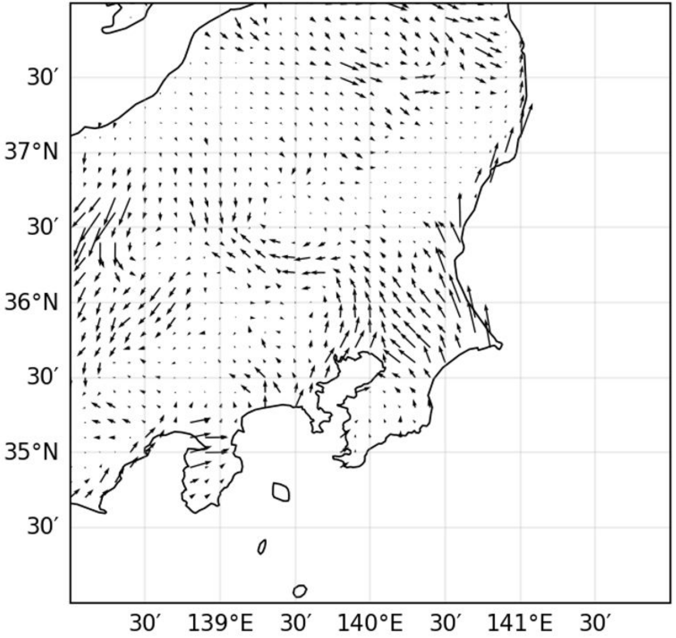




2m Air Temperature (max)
30′
37°N
30′
36°N
30′
35°N
30′
30′ 139°E 30′ 140°E 30′ 141°E 30′
5.0
4.5
4.0
3.5
3.0
2.5
2.0



Surface Temperature (max)
30′
37°N
30′
36°N
30′
35°N
30′
30′ 139°E 30′ 140°E 30′ 141°E 30′
7
6
5
4
3
2

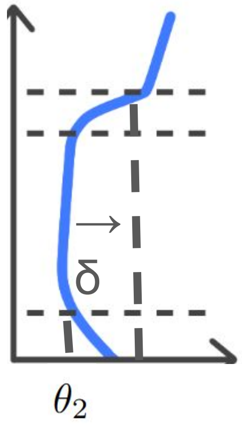


30′
37°N
30′
36°N
30′
35°N
30′
30′ 139°E 30′ 140°E 30′ 141°E 30′

Diagnostic PBL Depth

Method

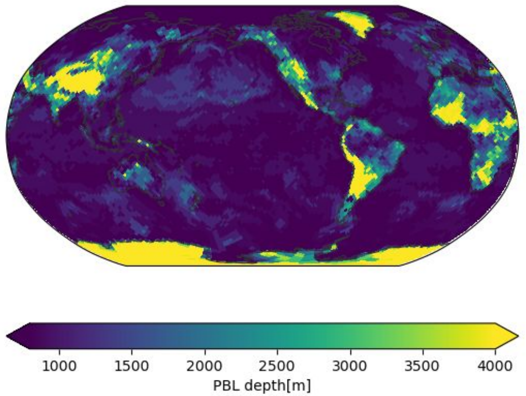
- PBL Height
  = the first layer of $\theta - \theta_2 > \delta$
  θ_2 : Potential temperature of 2nd layer from the ground
  δ : 1.25(Land), 0.75(ocean) (Olson et al.,2019)



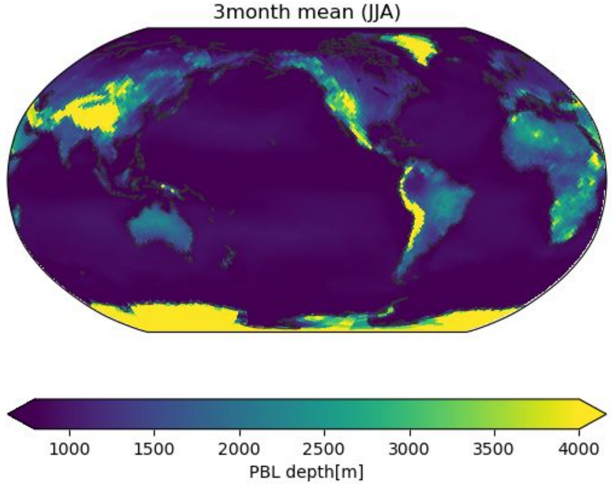
Result

- Instantaneous result : Captured the high PBL depth in the Pacific and so on
- Problem: Too large depth in Antarctica and high mountains
  → Due to the large thickness between each level in high level
  → Necessary to interporate the vertical coordinate
  (but on the way)

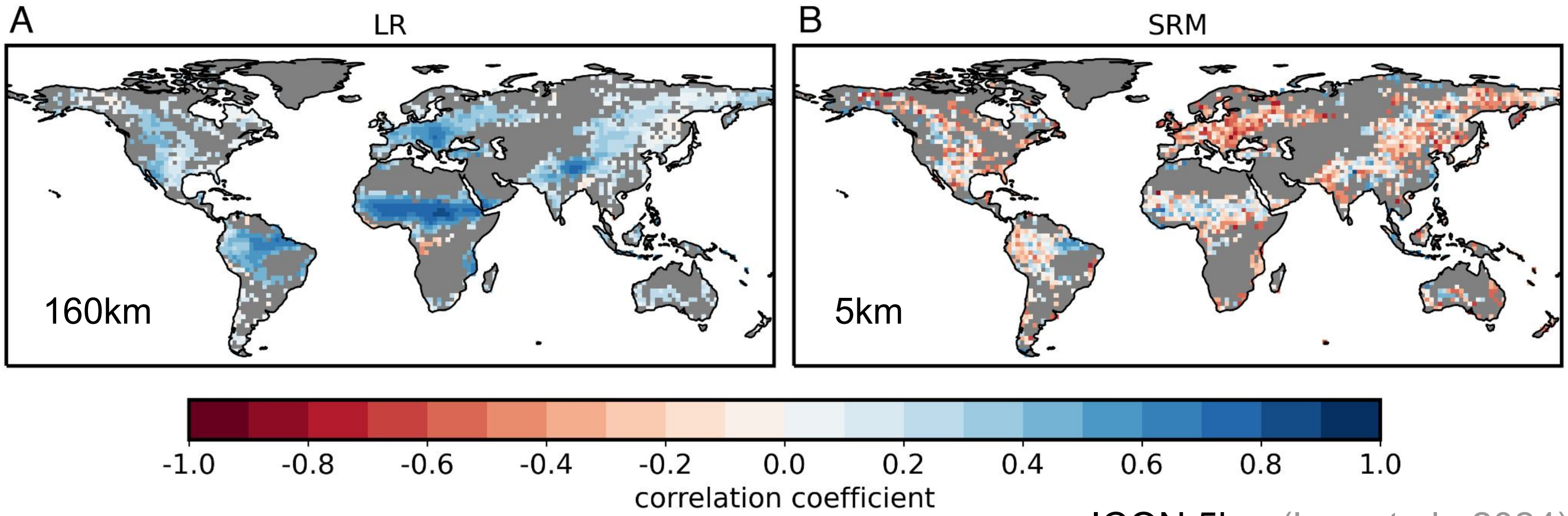
instantaneous



mean



SM-P correlation (ICON)

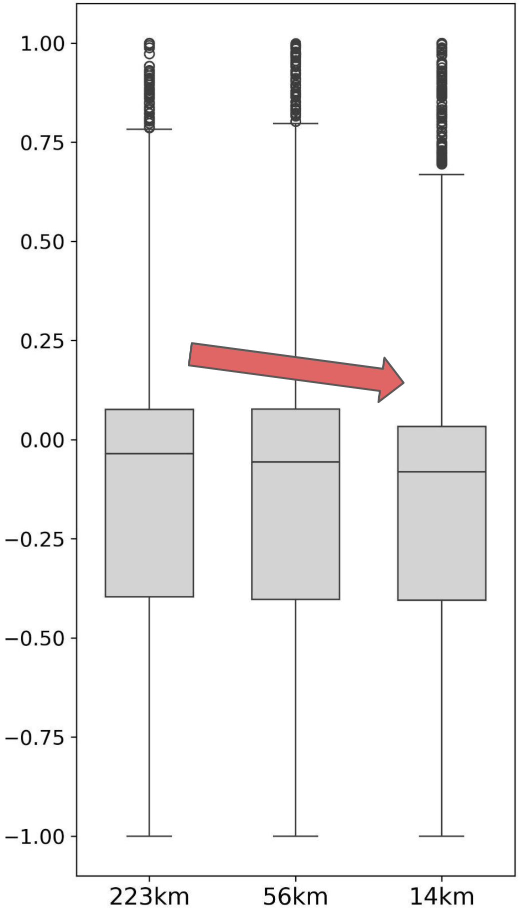


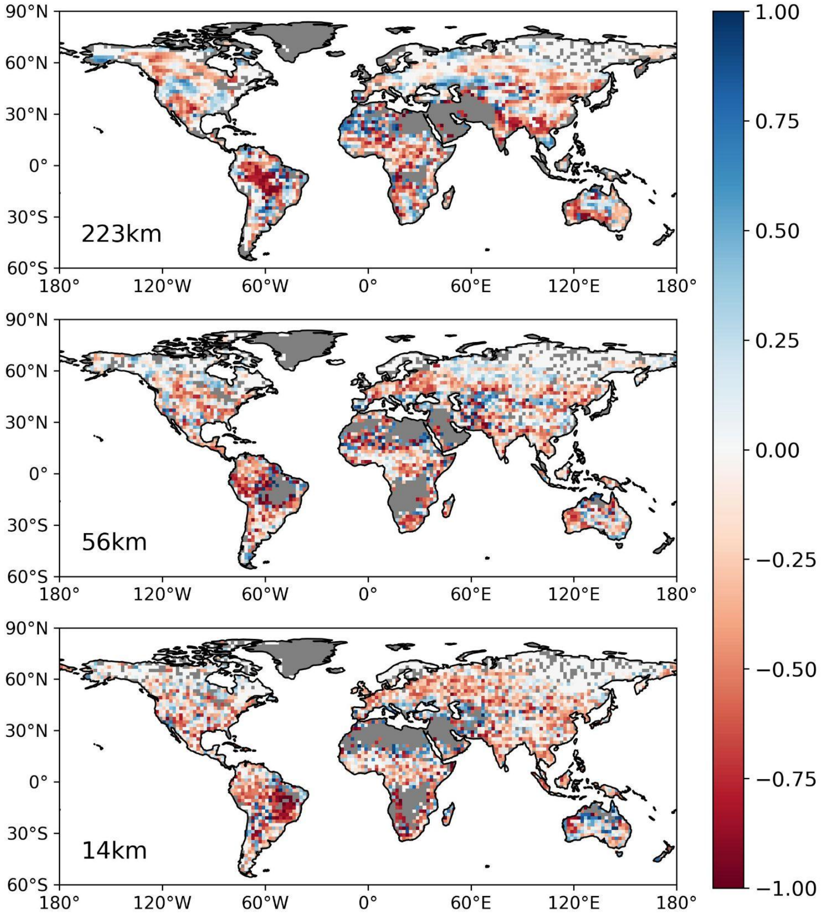
ICON 5km (Lee et al., 2024)

coarse resolution (LR, 160km) fine resolution (SRM, 5km):

homogeneous positive **wide spread negative**

SM-P correlation (NICAM)





1.Not as homogeneously positive in coarse resolution (223km).

2.From coarse to fine resolution:

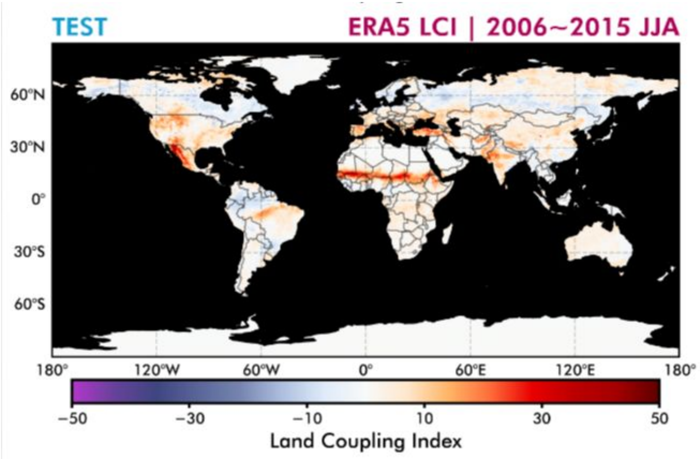
- more discrete spatial distribution pattern.

- overall more negative.

Land Coupling Index

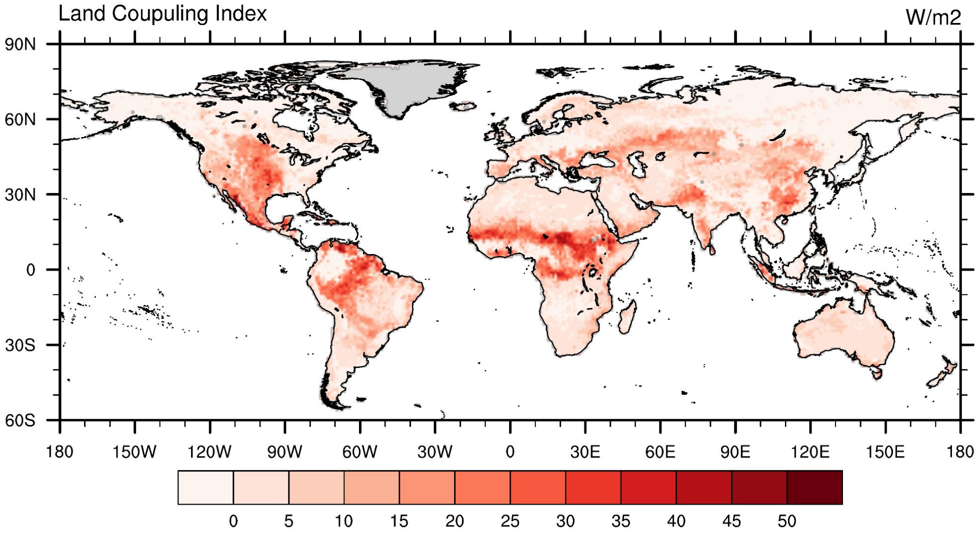
Land Coupling Index = Reg(SM, ET) * std(SM)

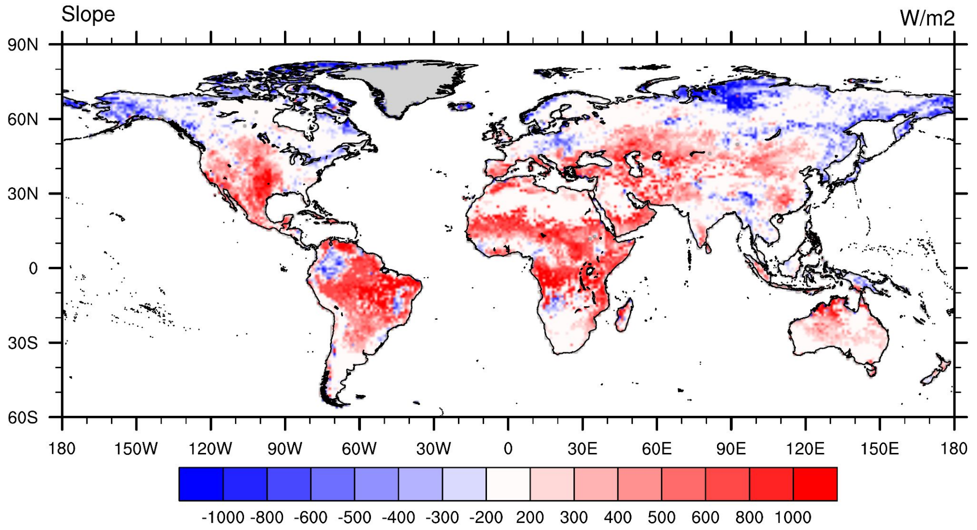
- Strong land coupling in Mid-US, Mid-Africa, and Amazon (hot spots)
- May have strong SM-LH-P feedback



Interesting findings

- negative SM-P: Northern SA
- positive SM-P: Mid-US and Mid-Africa

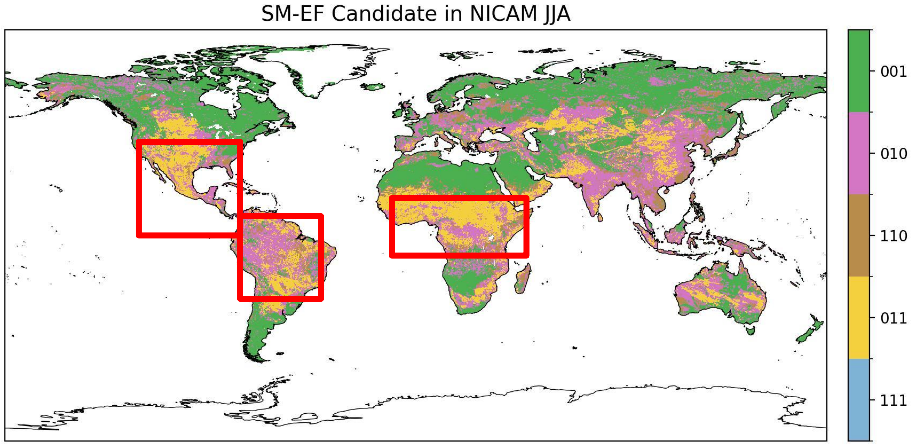


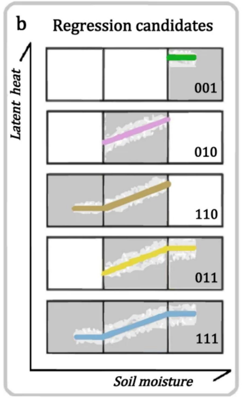


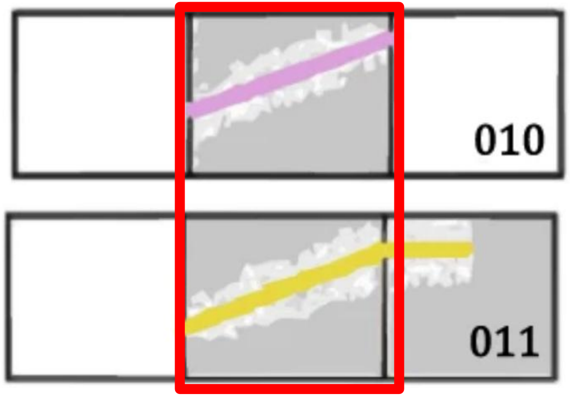
SM–EF Relationship in NICAM JJA

In regions with strong LCI:

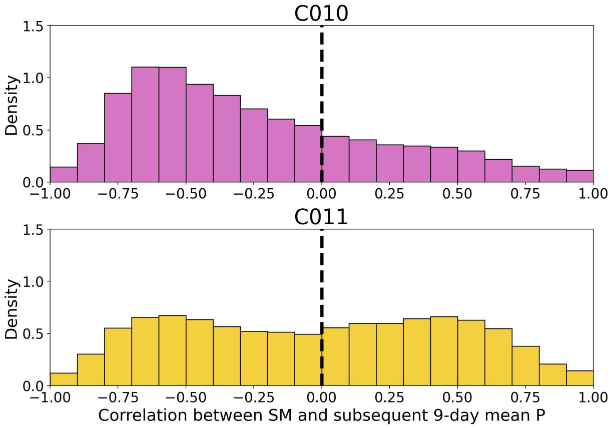
- C010: negative soil moisture–precipitation (SM–P) feedback
- C011: negative SM–P feedback, when more days are within the transitional regime

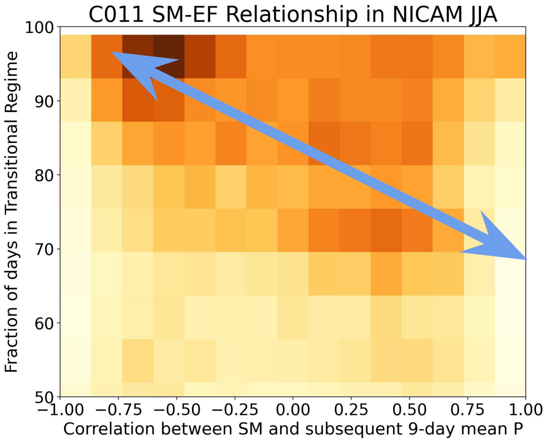






transitional regime

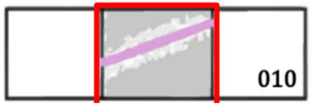




SM-ET in Transitional Regime

- What happens (SM-ET slope) in the transitional regime between **Positive** / **Negative** SM-P feedback.

transitional regime

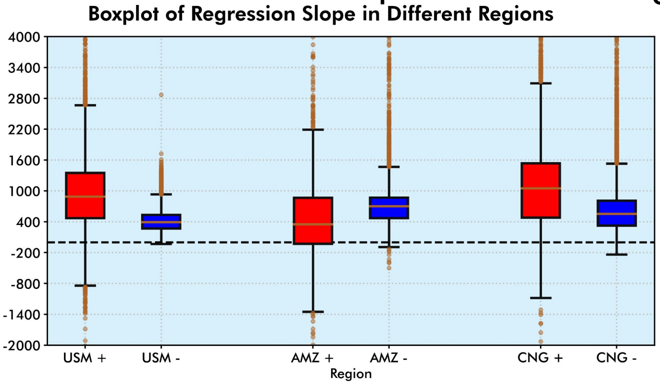


Positive: **C011**

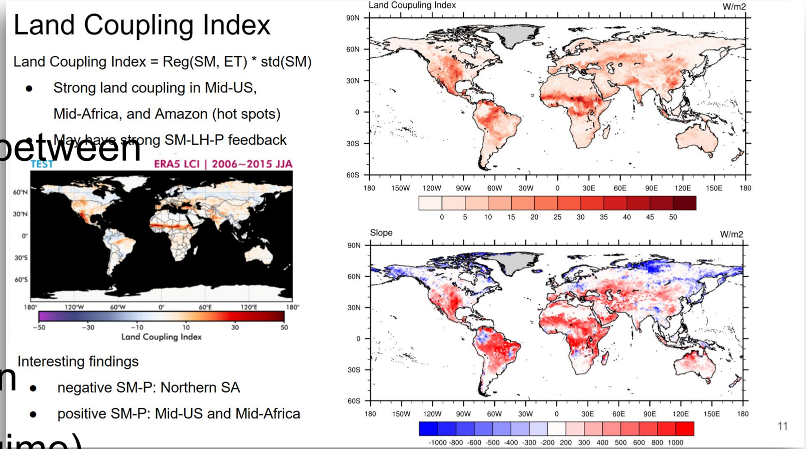
First Segment Slope of Piecewise Correlation

Negative: **C010** (more day in transitional regime)

Slope of Linear Regression

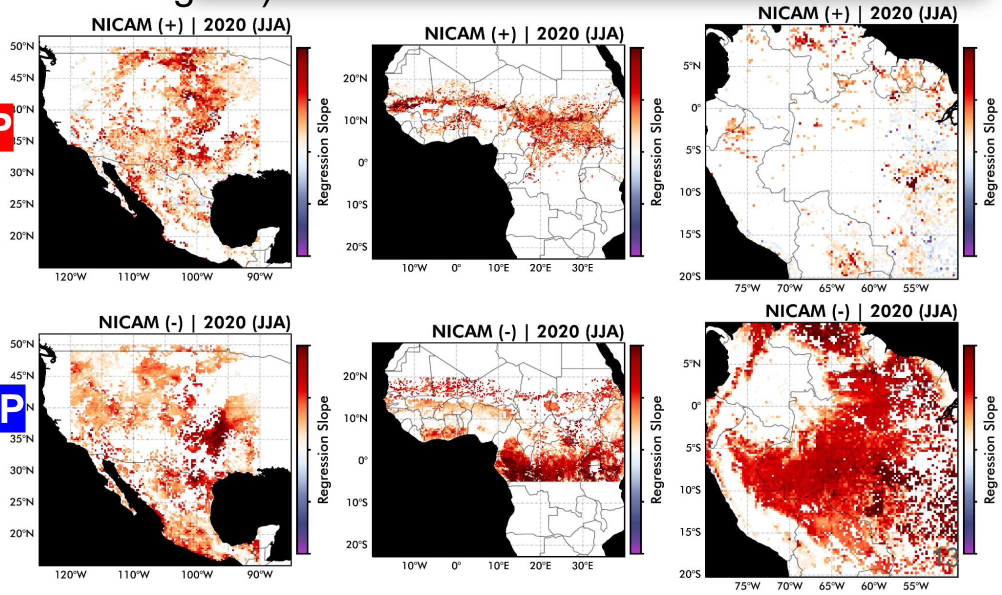


Similar SM-ET but Different SM-P? (WHY?)



Postive SM-P feedback

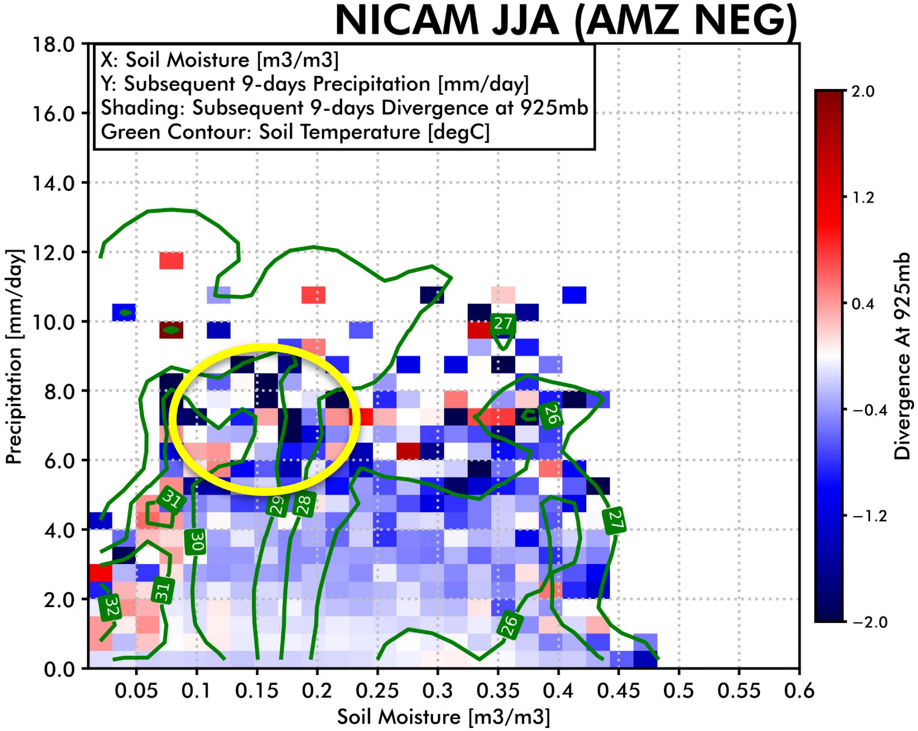
Negative SM-P feedback

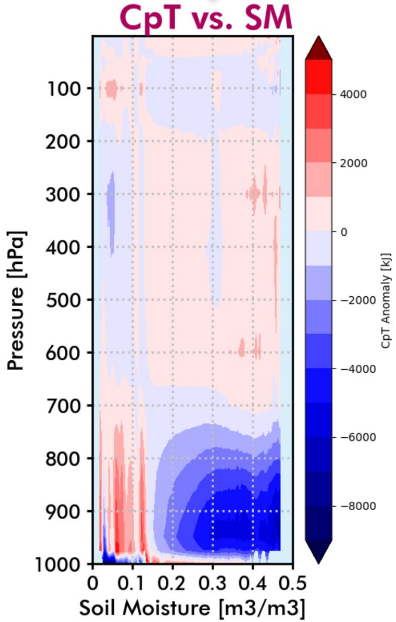


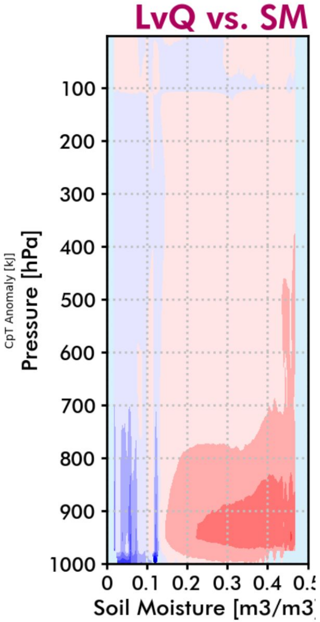
Negative SM-P Feedback

$$MSE = \underbrace{C_P \boldsymbol{T}}_{\text{enthalpy}} + \underbrace{L_v \boldsymbol{q}}_{\text{latent energy}} + \underbrace{g\,z}_{\text{potential energy}}$$

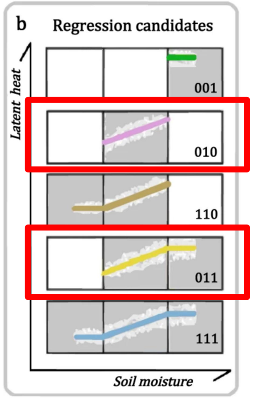
- Strong land coupling region and negative SM-P feedback: **Amazon.**
- SM slightly dry region with higher soil temperature prefers to having convergence and precipitation.
- Warmer ground over the dry SM region tends to increase low-level enthalpy and moist static energy.



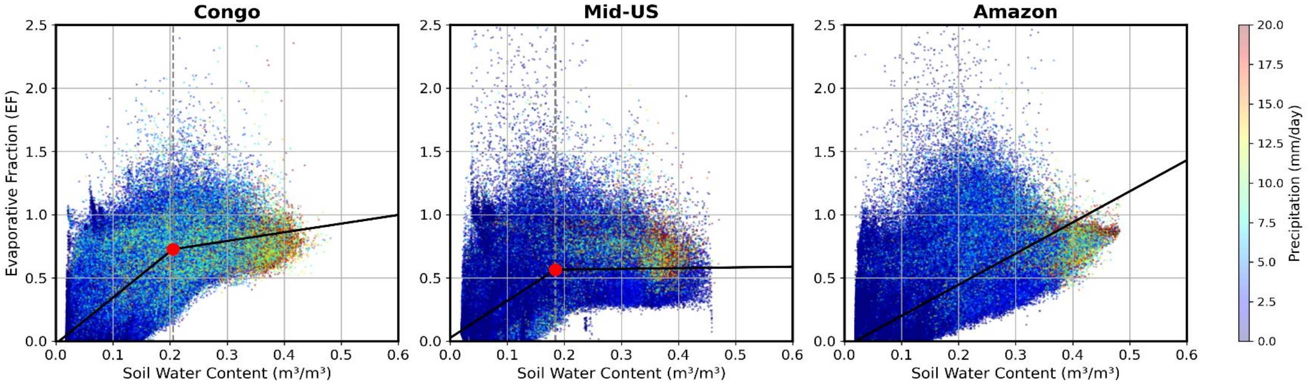




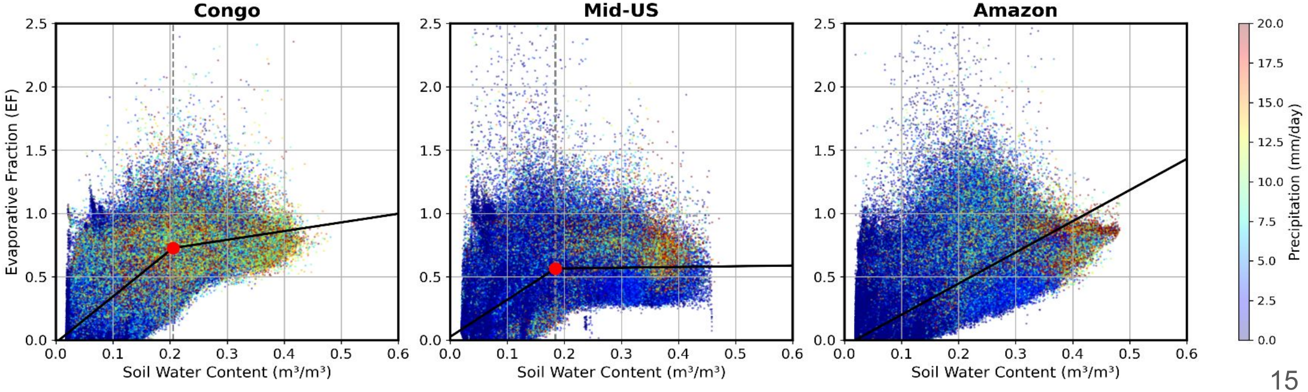
Strong coupling induced extreme precipitation



Subsequent 9-day **mean** Precip.



Subsequent 9-day Precip. variability **(STD)**



- Extreme precipitation could occur under wet soil moisture conditions.
- The Congo exhibits strong day-to-day variability, indicating both water and energy limitations.