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The Globally Coherent Pattern of Autumn Monsoon Precipitation

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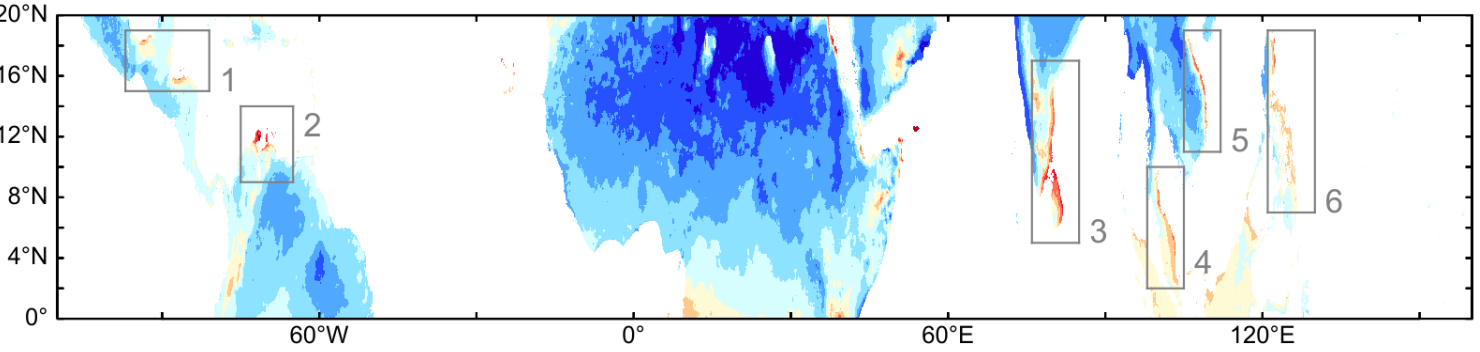
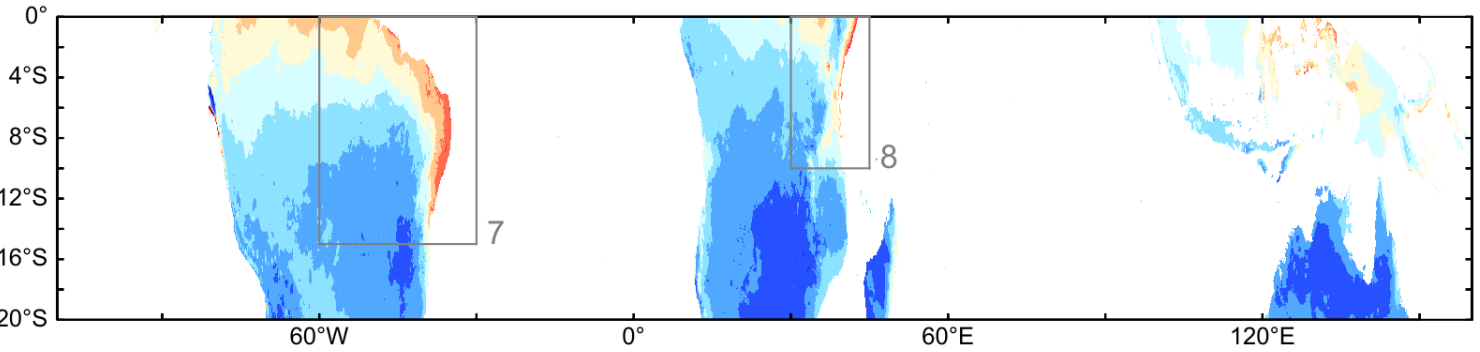
Autumn Monsoons: A Pattern over the Global Tropics

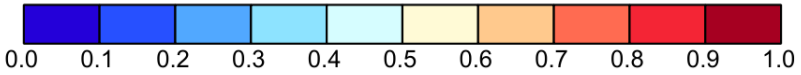
Tropical regions receiving > ½ of their annual rainfall in autumn/winter lie along eastern coastlines.

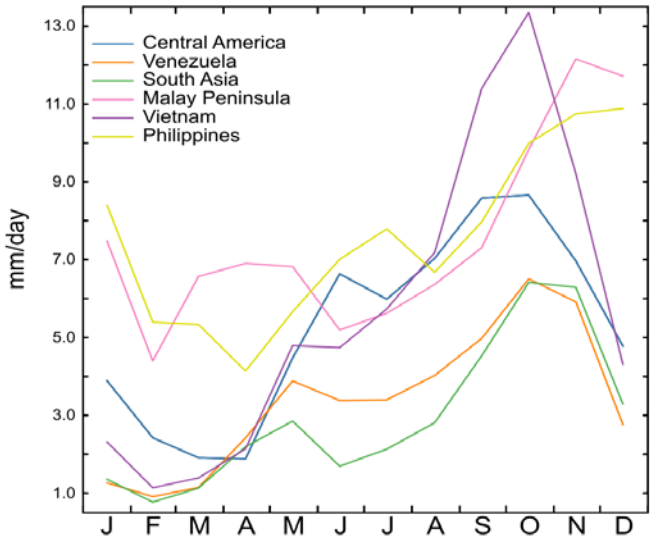
Fraction of annual rainfall in **September-February**



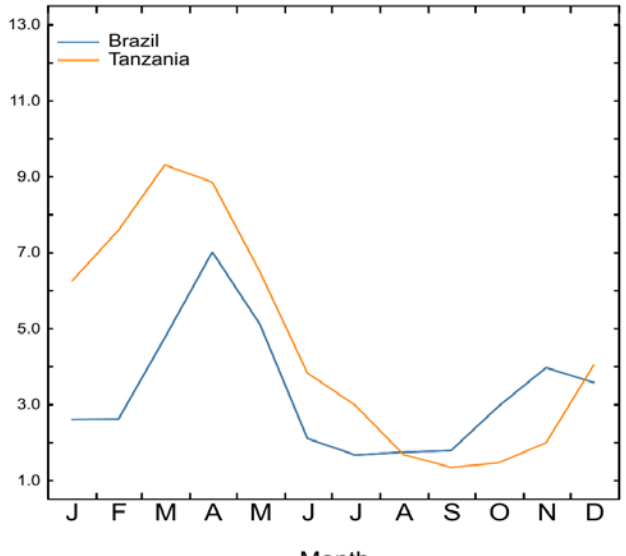
Fraction of annual rainfall in **March-August**





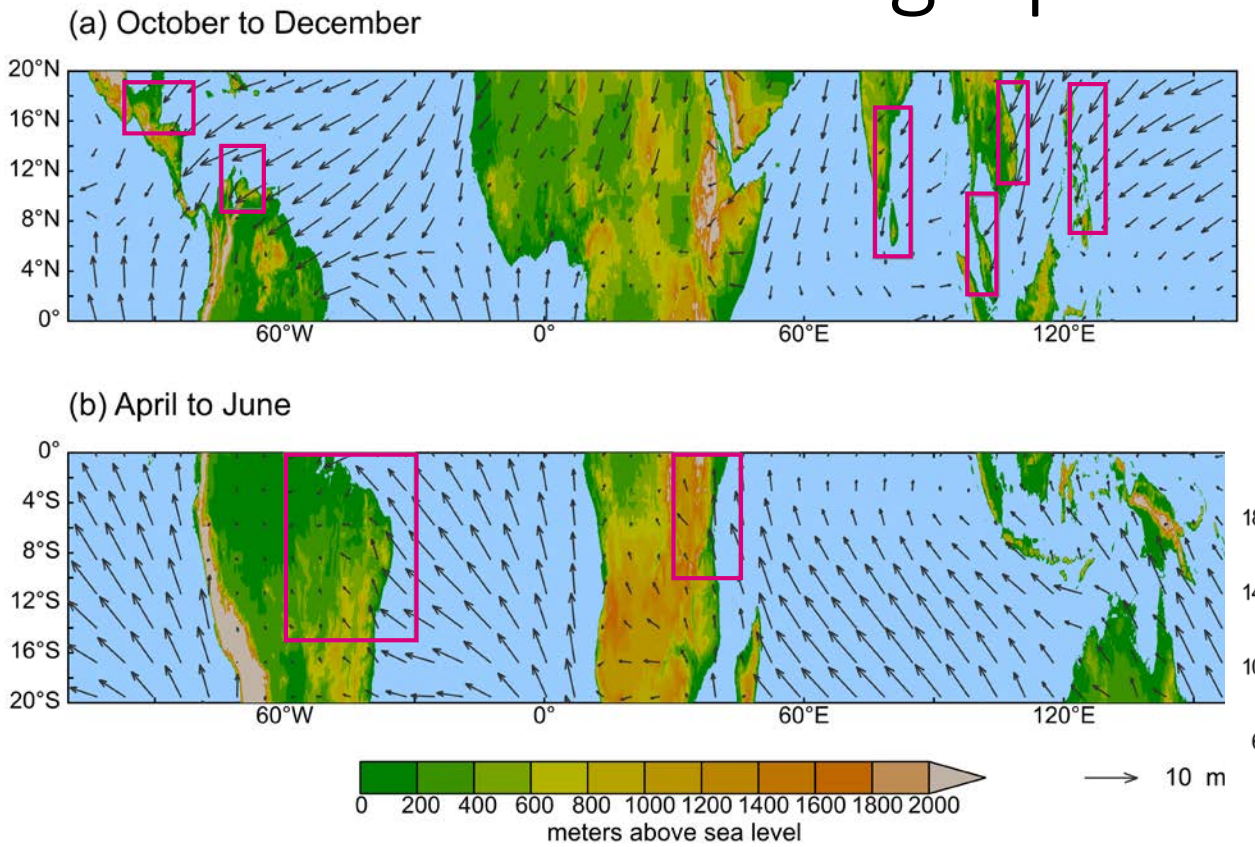


The precipitation peak in 8 east-coast regions occurs in late autumn.



They **don't** receive much summer monsoon rainfall.

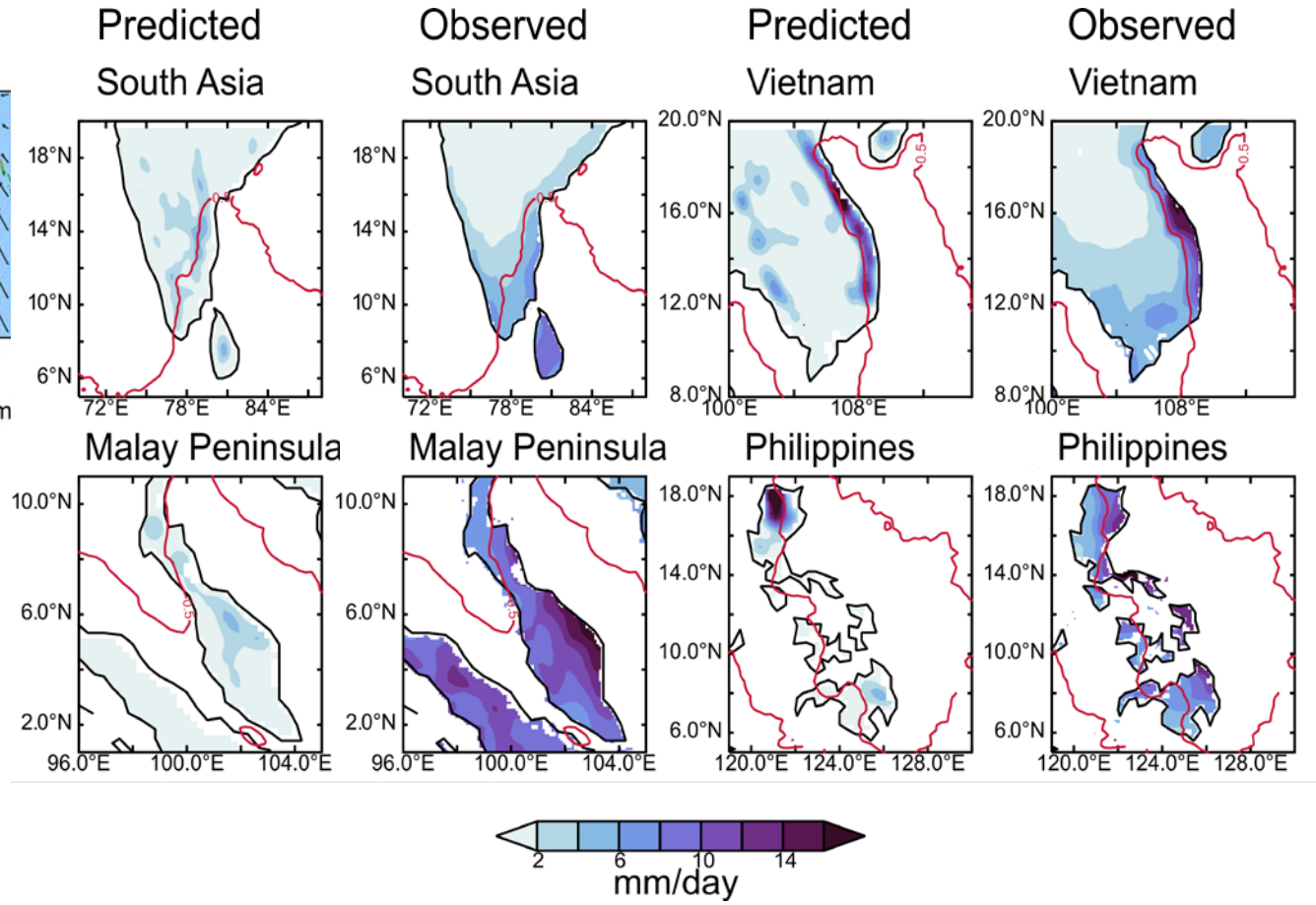
Orographic Precipitation?



Easterly, upslope winds at this time of year.

A simple scaling for orographic precipitation (Roe 2005):

$$r = \rho_0 q_0 (\mathbf{u_0} \cdot \nabla z_s)$$

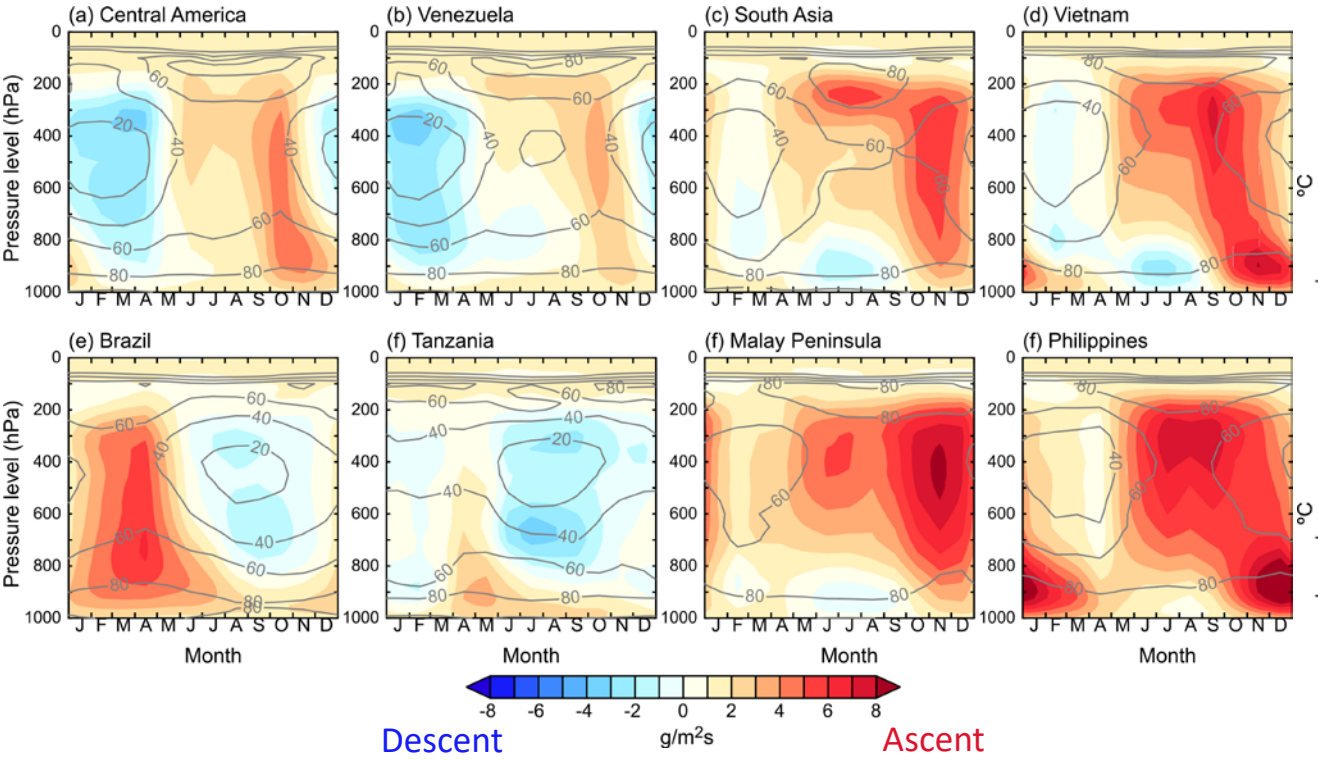


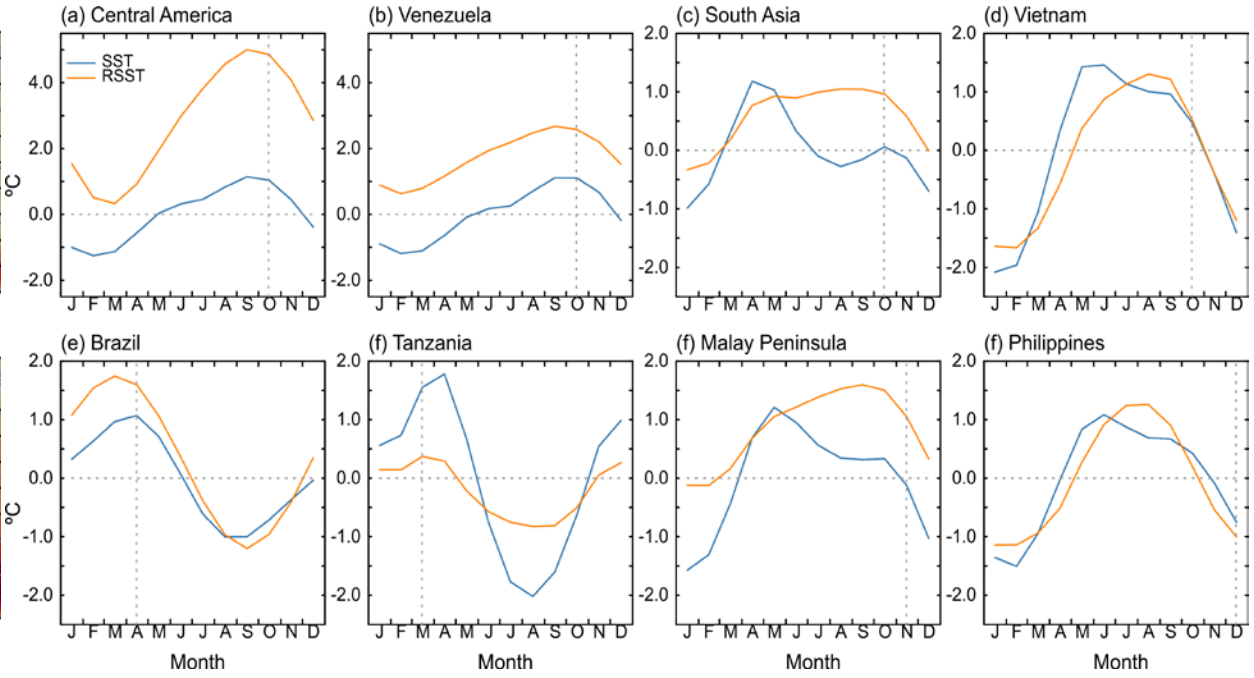
This underestimates the rain rate in most cases.

X This model predicted peak rainfall in spring or winter instead of autumn (except Vietnam and Philippines).

X The ITCZ is equatorward of these regions during the precipitation peak.

The Role of Moist Convection

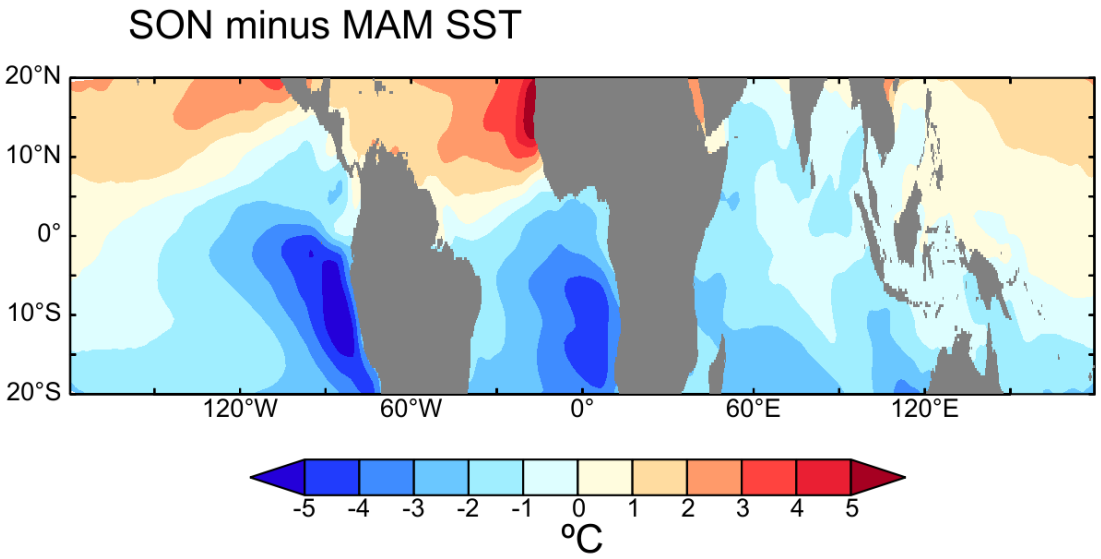




- Using a moisture budget decomposition, we found **convergence** (and therefore **ascent**, **convection**) plays a key role.
- Vertical mass flux is **upwards in autumn** through most of the column, suggesting deep convection.
- Strong ascent at **lower levels** in Vietnam, Philippines.

- In many of these locations, **RSST** (local SST – tropical mean SST) is at its **peak during autumn**, even though SST is not.
- Where RSST does **not peak** during autumn, **orography** plays a stronger role.
- Tropical-mean SST is **highest in MAM**, stabilizing the tropical atmosphere and suppressing convection.

Summary and Future Work



1. Identified a **new climate regime** over the global tropics.
2. Eliminated hypotheses: ITCZ movement, stable upslope flow (orographic).
3. Explained the observed rainfall peak in terms of RSST (i.e., **local atmospheric stability** in autumn).

Short-term goals:

- Assess the **representation** of autumn monsoons in **CMIP6** models.
- Test these **hypotheses** using a **GCM** (e.g., by perturbing the seasonal cycle of global-mean or local SST).
- Analyze past and future **trends** in autumn monsoon rainfall.

Long-term goals:

- Analyze **drivers of variability** in autumn monsoon regions.
- Assess **contributions of** synoptic-scale/mesoscale **storms** or tropical cyclones to autumn monsoon rainfall.
- Develop statistical **prediction schemes** for these regions.