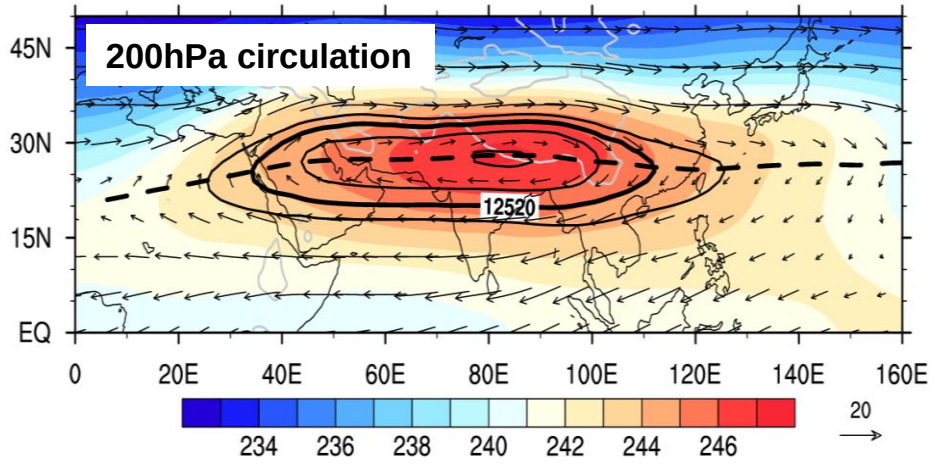
Interannual Variation of South Asian High Intensity by East Asian Summer Monsoon Heating

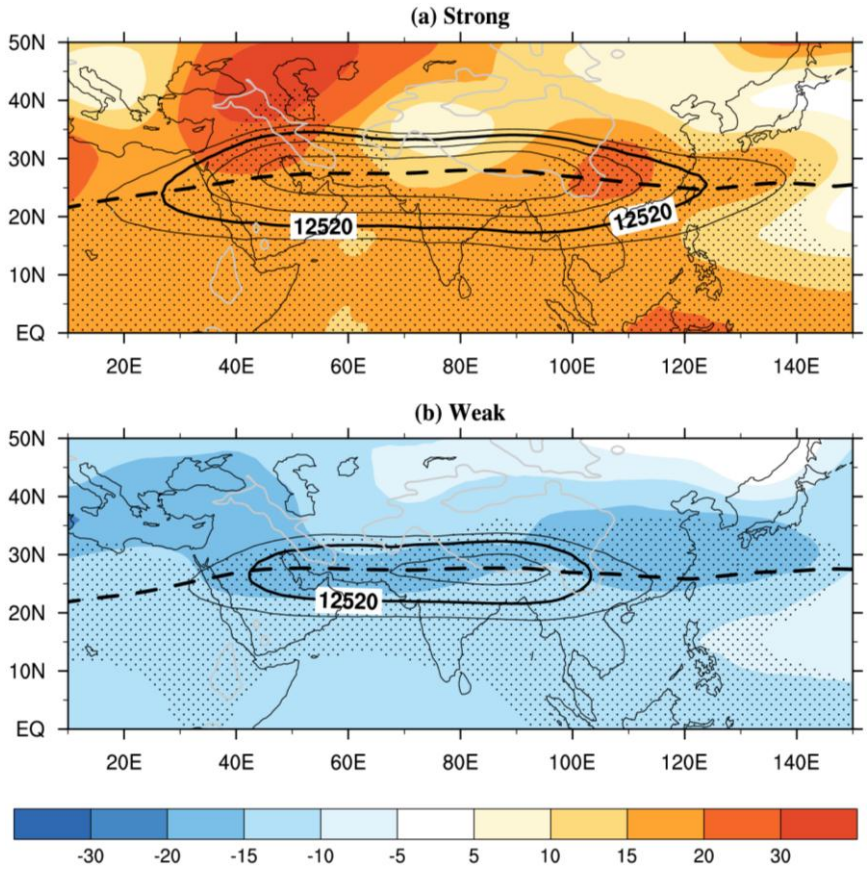
Pengfei Zhang
Purdue University

Yimin Liu and Bian He
Institute of Atmospheric Physics, Chinese Academy of Sciences



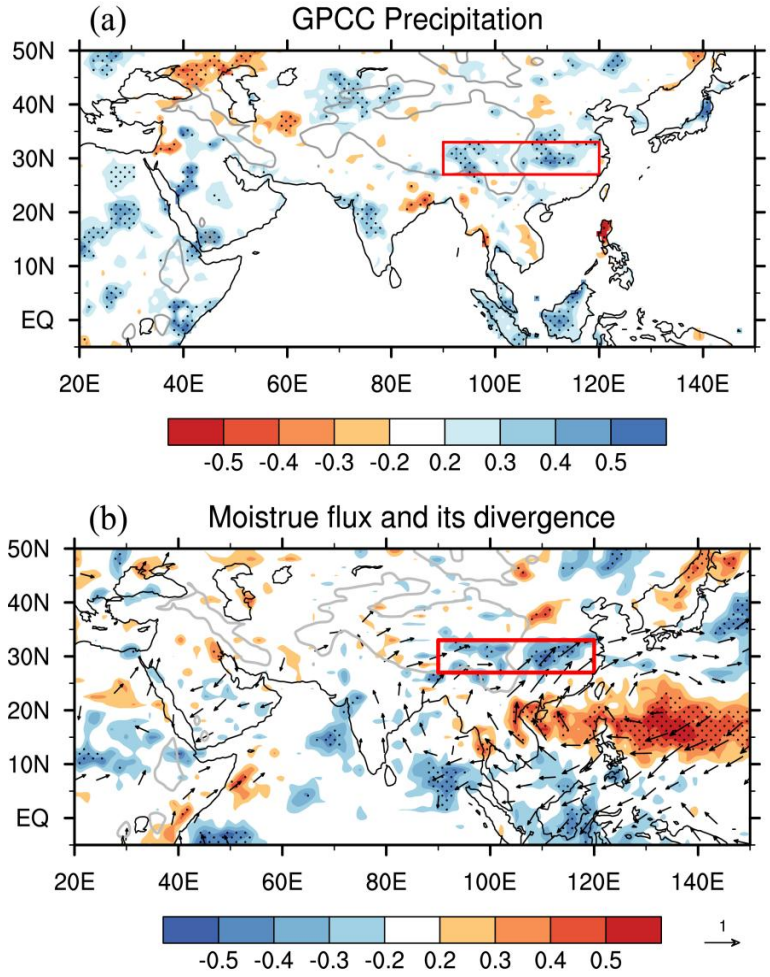
Asian Monsoon UTLS Workshop
Boulder, March 2016

1.Interannual Variation of SAH Intensity



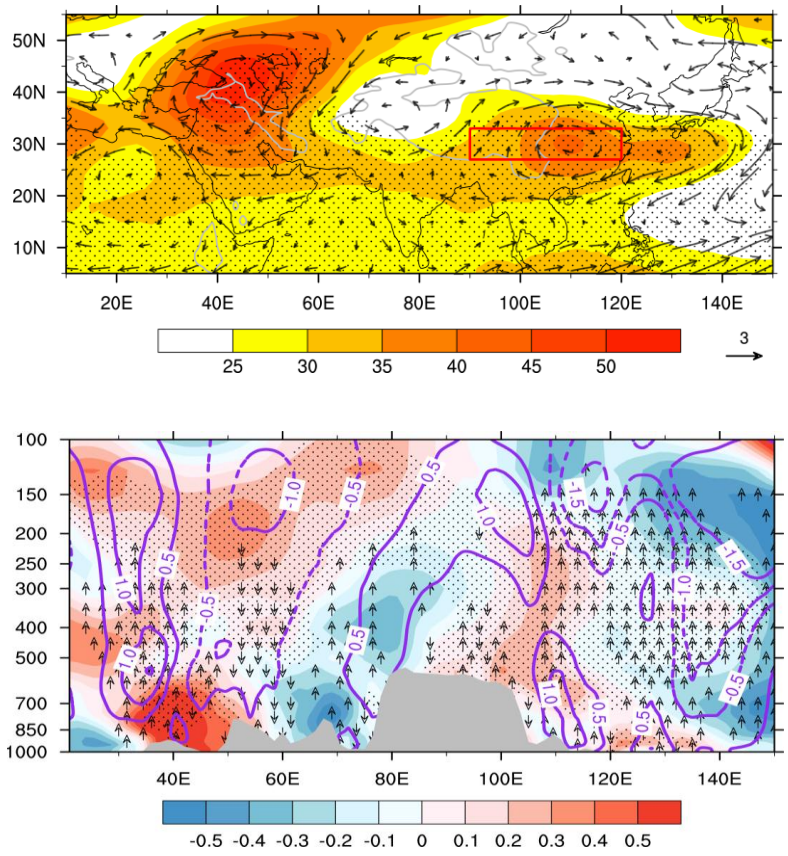
2.Related to East Asian Summer Monsoon

Regression analysis



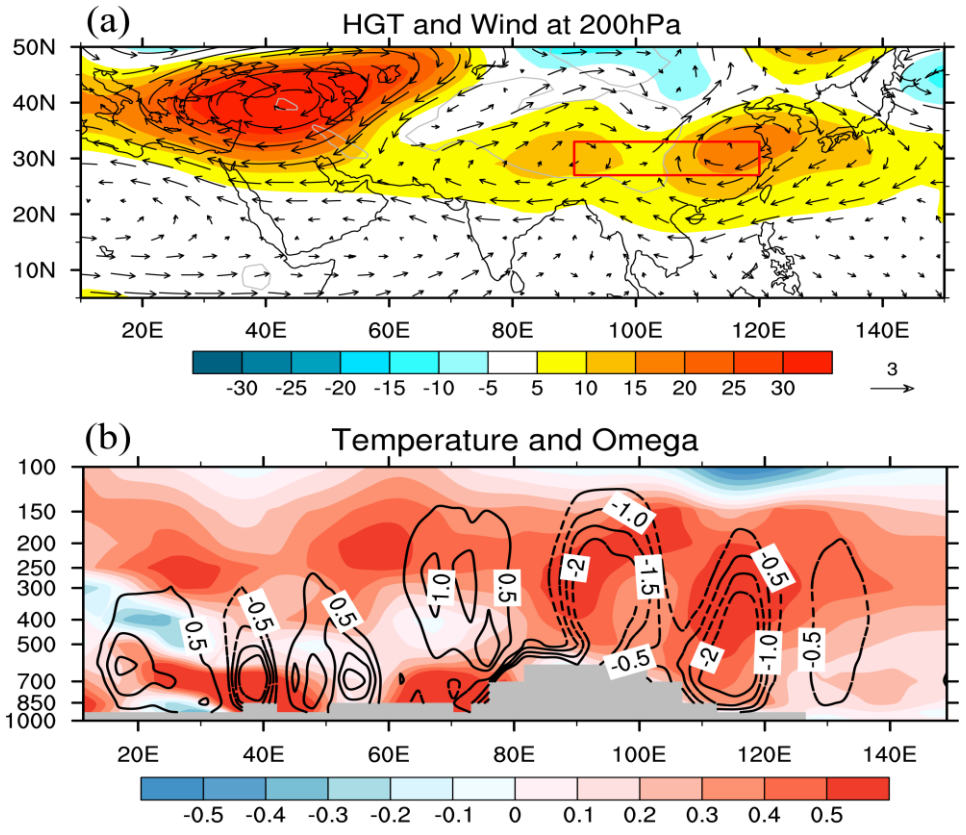
Partial Cor. SAHI .VS. EASMI (Tropical Indian Ocean, Nino3.4) = 0.38, 0.37 (95% confidence)

3.SAH Variation influenced by EASM Heating – PV Balance



4. Model Experiments

AGCM Run



The monsoonal heating over TY region excites a local anticyclone in the upper troposphere and a westward propagating Rossby Wave to increase the upper HGT and warm the upper troposphere.

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Impact of Eastern Asian Summer Monsoon Heating on the Interannual Variation of South Asian High

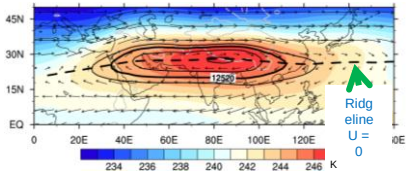
Pengfei Zhang[1], Yimin Liu[2] and Bian He[2]

1 Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, 2 Institute of Atmospheric Physics, Chinese Academy of Sciences

1. Introduction and Data

Occupying the upper troposphere over the Eurasia during boreal summer, the South Asian High (SAH) in the upper troposphere is thought to be a critical regulator of East Asian Summer Monsoon (EASM) and precipitation. However, the EASM influence on the variation of the SAH is still unclear. Present study aims to elucidate the feedbacks of EASM precipitation anomalies on the SAH intensity in the interannual time-scale.

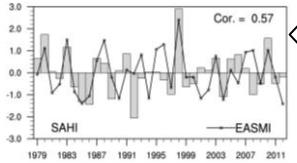
Three datasets (ERA-Interim analysis, GPCC precipitation and ERSST) are adopted in this study. The least squares linear trend is removed from each variable to emphasize the interannual variation. All indices in this study are normalized.



Climatological (1979-2012) South Asian High in boreal summer : 400-200hPa Temp (shaded), HGT (contour), Wind (vector) at 200hPa

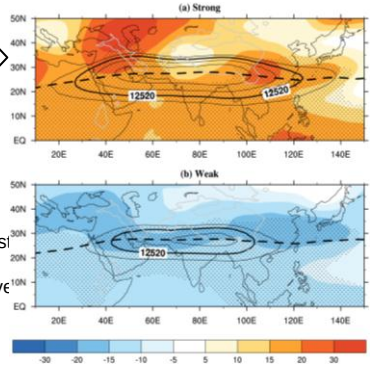
Definition: The intensity of the SAH is defined as the weighted sum of geopotential height (HGT) at all grid points greater than 12520-gpm, physically equivalent to the index defined by Qian et al. (2002) and Qu and Huang (2012) at 100hPa

2. Interannual Variation of SAH Intensity



Normalized intensity index of South Asian High (SAHI, gray bars) and the East Asian Summer Monsoon Index (EASMI, black line with star symbol)

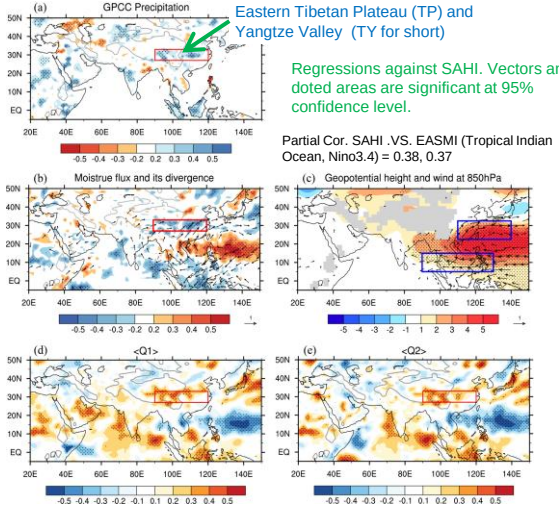
Composite 200-hPa geopotential height (contour) and its anomalies (shaded)



Positive SAHI cases:

- ✓Center HGT is >30gpm higher than negative SAHI cases
- ✓The SAH covers a larger areas from east North Africa to the East China Sea
- ✓Two regions of significant positive anomalies: East China and Iranian Plateau (IP)

3. Relationship with EASM



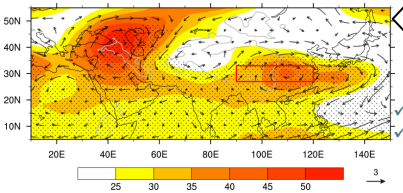
Eastern Tibetan Plateau (TP) and Yangtze Valley (TY for short)

Regressions against SAHI. Vectors and doted areas are significant at 95% confidence level.

Partial Cor. SAHI .VS. EASMI (Tropical Indian Ocean, Nino3.4) = 0.38, 0.37

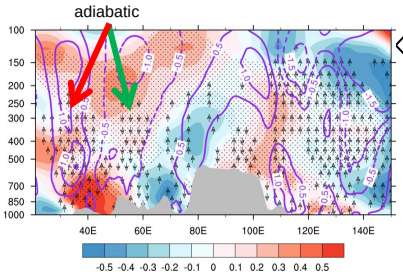
The SAH intensity is closely correlated with precipitation anomalies over TY (red box) and the lower tropospheric circulation over East Asia, which is highly consistent to the leading EOF mode of EASM (Wang et al. 2008).

4. SAH Variation influenced by EASM Precipitation



Composite anomalies HGT and wind at 200hPa

- ✓Upper anticyclonic response
- ✓Rossby wave pattern

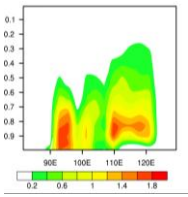


28-31N averaged cross section for anomalies of:
Temperature (shaded)
Meridional wind (contour)
Vertical motion direction (vector)

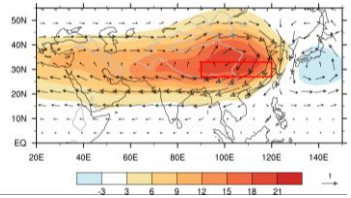
- ✓Diabatic heating at the east of SAH
- ✓Adiabatic heating at the west of SAH

5. Model Experiments

Forcing Profile



Linear Baroclinic Model (LBM) Run

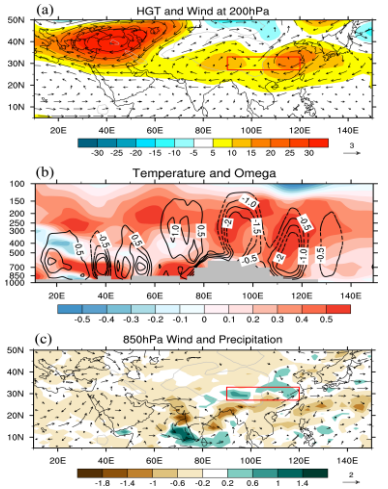


Responses of HGT and wind at 200hPa

- ✓Condensational heating excites upper layer anticyclone and stationary Rossby wave
- ✓HGT anomalies sub-maxim appearing at Iranian Plateau after day-20 is induced by adiabatic process and west-propagating wave. However, its intensity is weak compared to observation.

AGCM Run

- ✓AGCM run confirms the results in observation and LBM run.
- ✓Including the physical processes (interaction between adiabatic descent and diabatic surface sensible heating and longwave radiation), the circulation anomalies over Middle East are comparable with observation.
- ✓Interaction between Rossby wave and westerly (Rodwell and Hoskins 1996)



6. Summary

Instead of the being sole a passive response to SAH, the EASM also modulates the interannual variation of SAH intensity by the following mechanisms. The monsoonal heating over TY region excites a local anticyclone in the upper troposphere and a westward propagating Rossby wave to increase the upper HGT and warm the upper troposphere.

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zpengfei@purdue.edu