Monsoon Extremes:
Impacts, Metrics, and Synoptic-Scale Drivers

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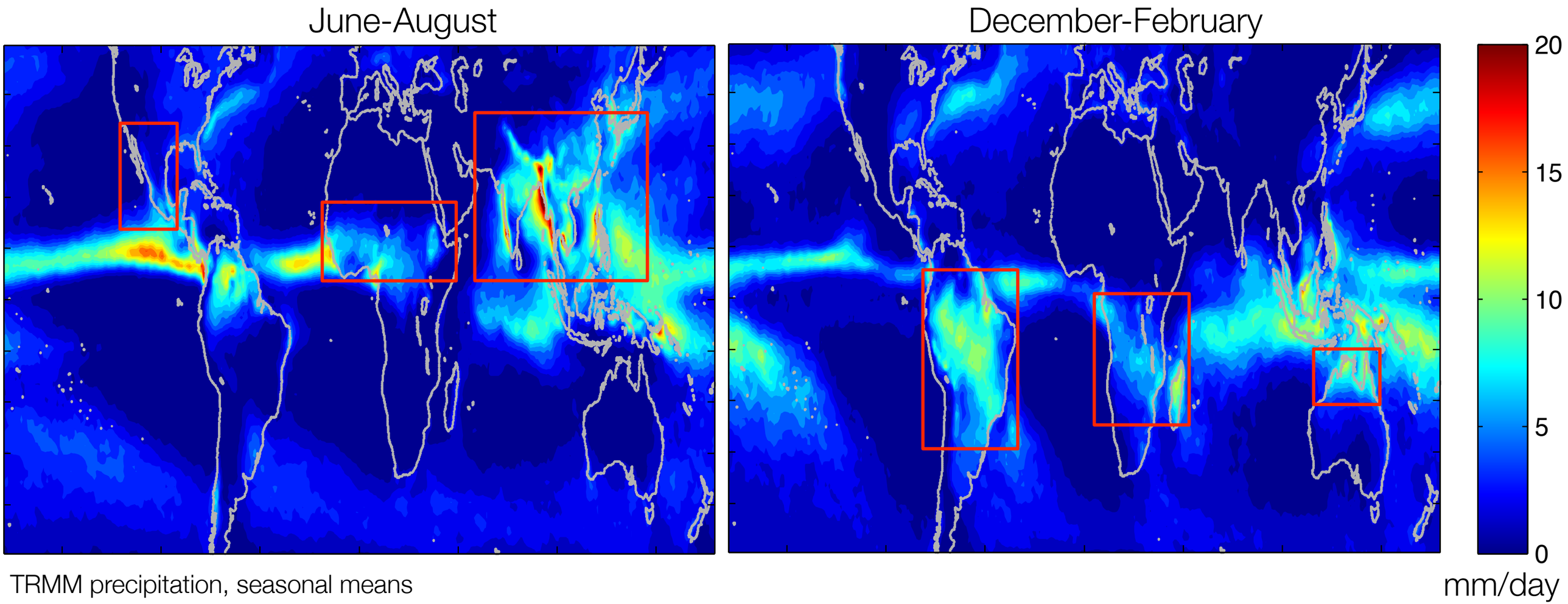
U.S. DEPARTMENT OF ENERGY

Office of Science

Berkeley UNIVERSITY OF CALIFORNIA

UCDAVIS

Motivation: Monsoons produce most rain over low-latitude land. We want to improve predictive, process-level understanding of that rainfall



TRMM precipitation, seasonal means

Project goals

- **Improve understanding of synoptic-scale vortices & waves in monsoons** and their interaction with seasonal-mean flow
- **Understand the distribution of precipitation produced by these disturbances**, and project future forced and unforced variations
- **Increase the range of states in which metrics & models can be applied** by studying both North American & South Asian monsoons

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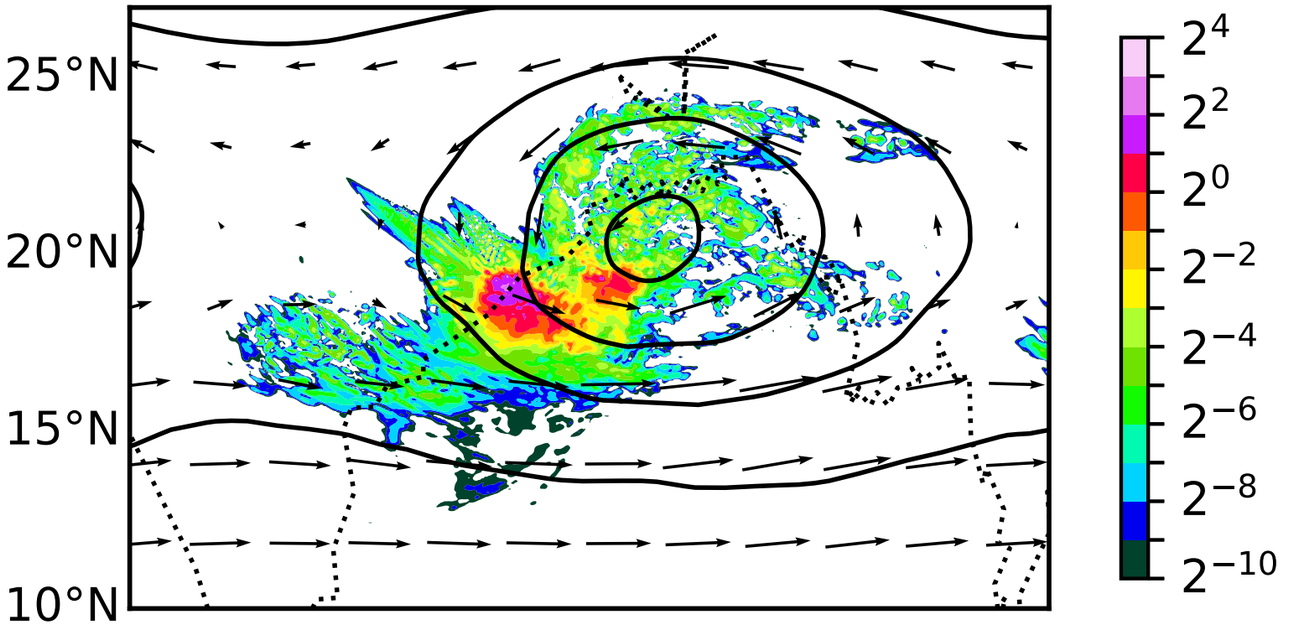
… now, 3 highlights of recent results

1. Monsoon depressions intensify because of:
   - barotropic instability
   - meridional moisture advection
   - wind-enhanced ocean evaporation

rain water, pressure & wind (3 km altitude)



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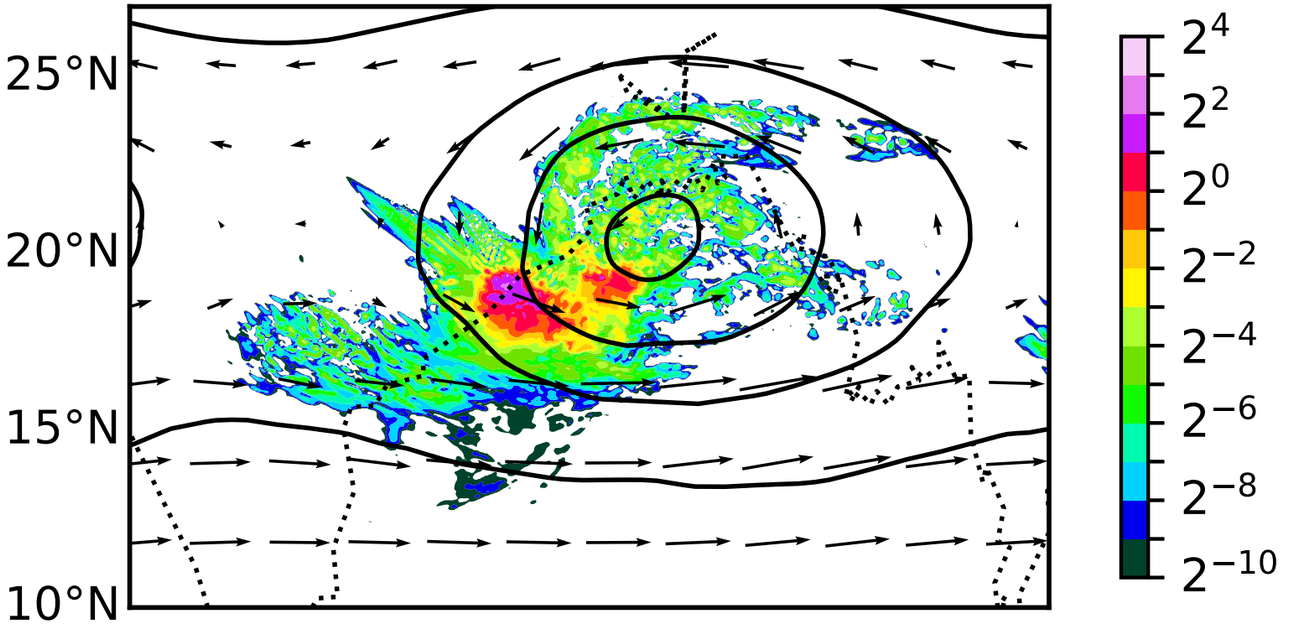

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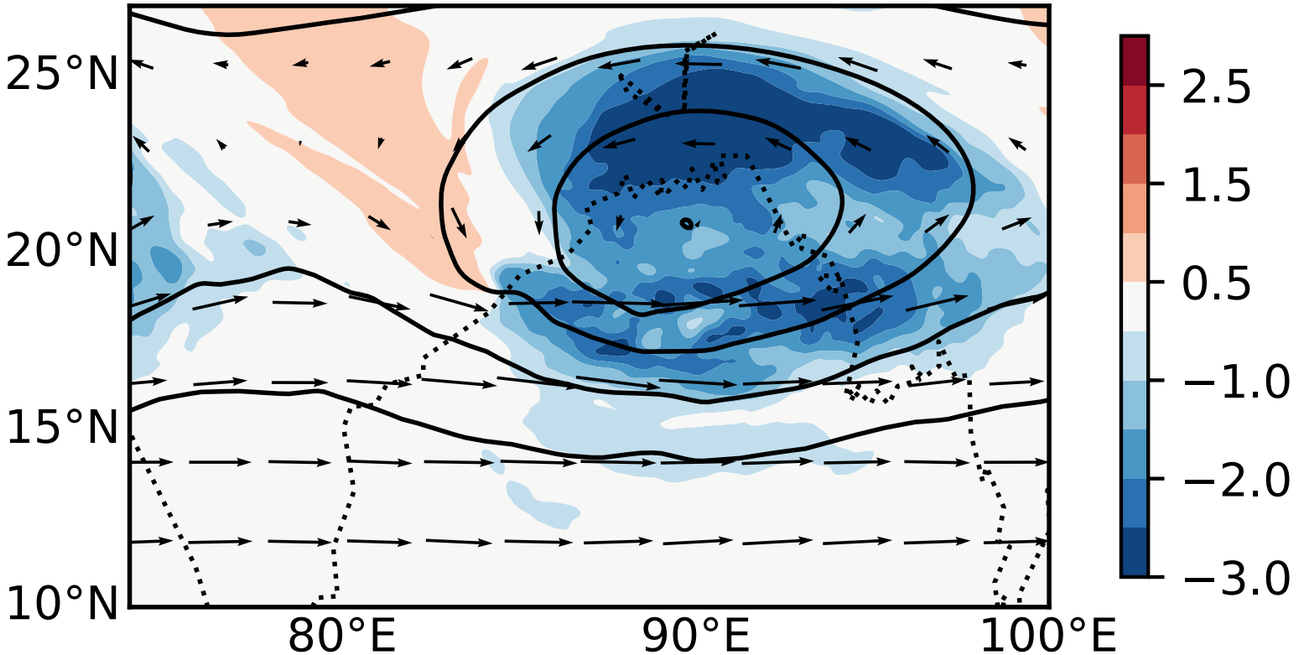

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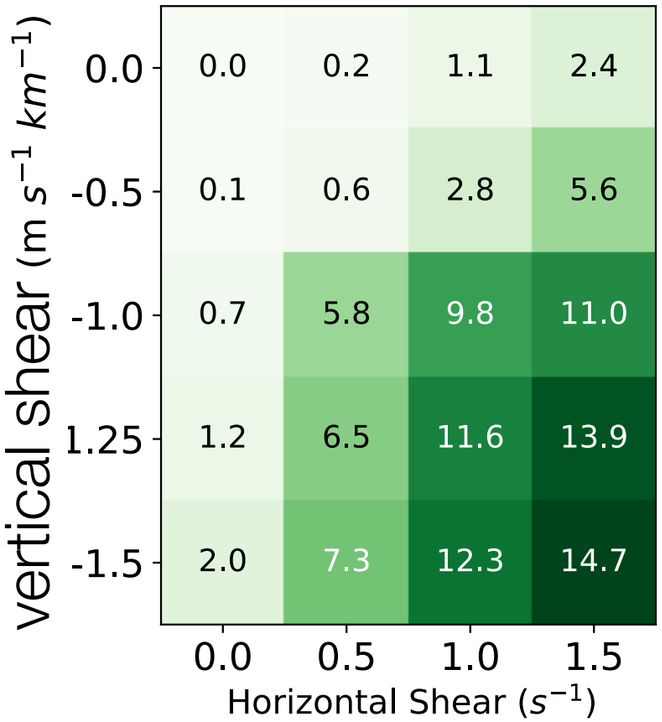

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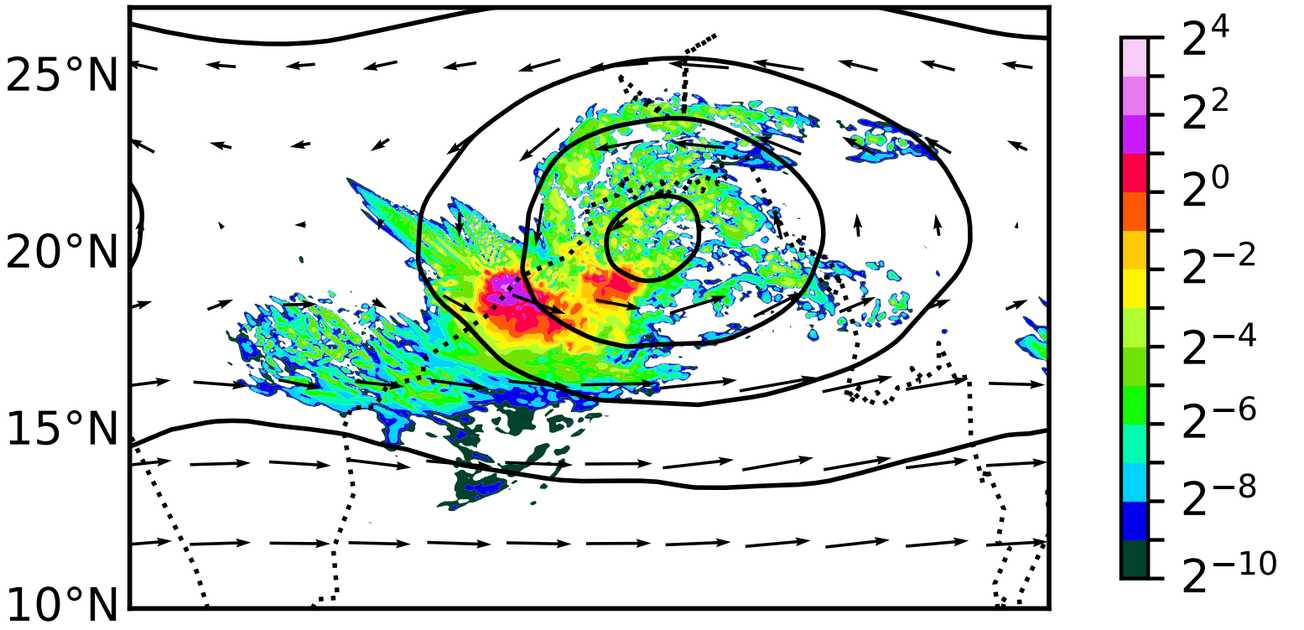

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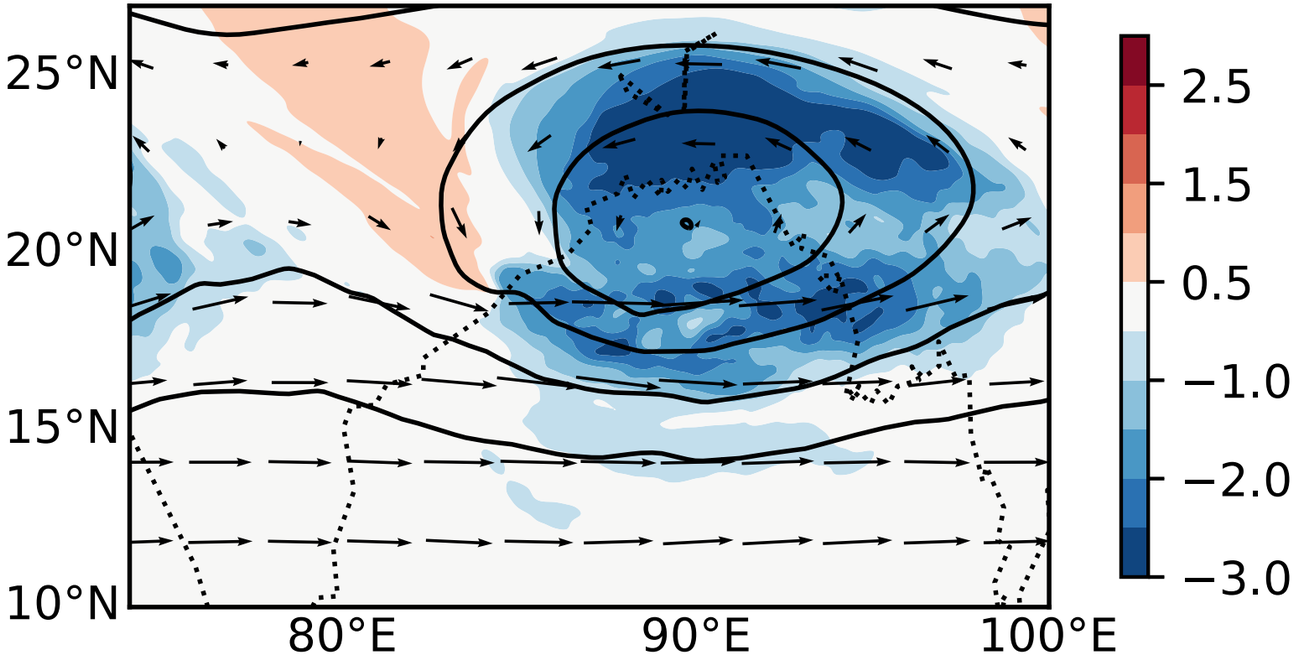
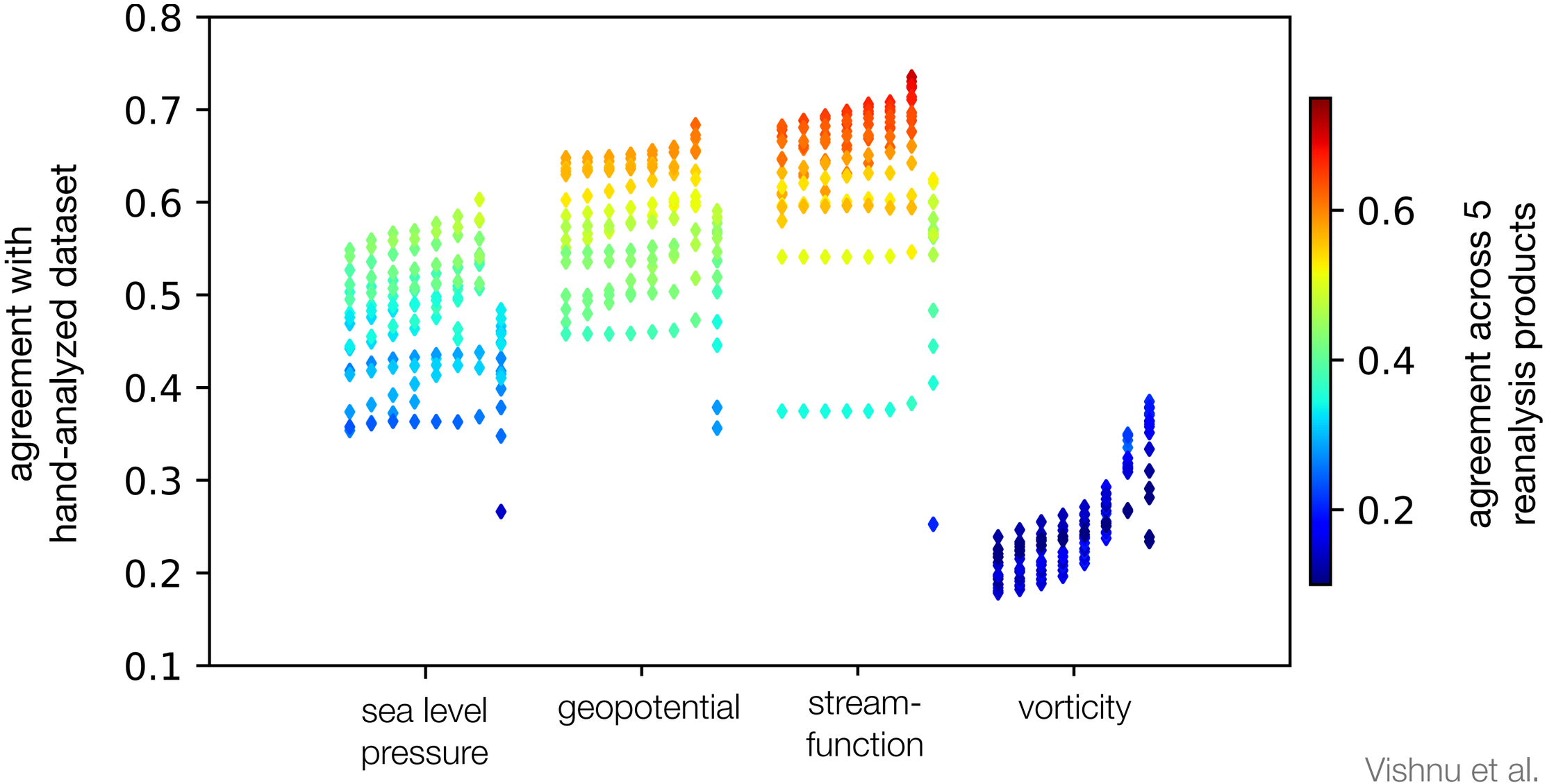


2. Synoptic-scale monsoon vortices are best tracked using the ***streamfunction*** of the horizontal wind



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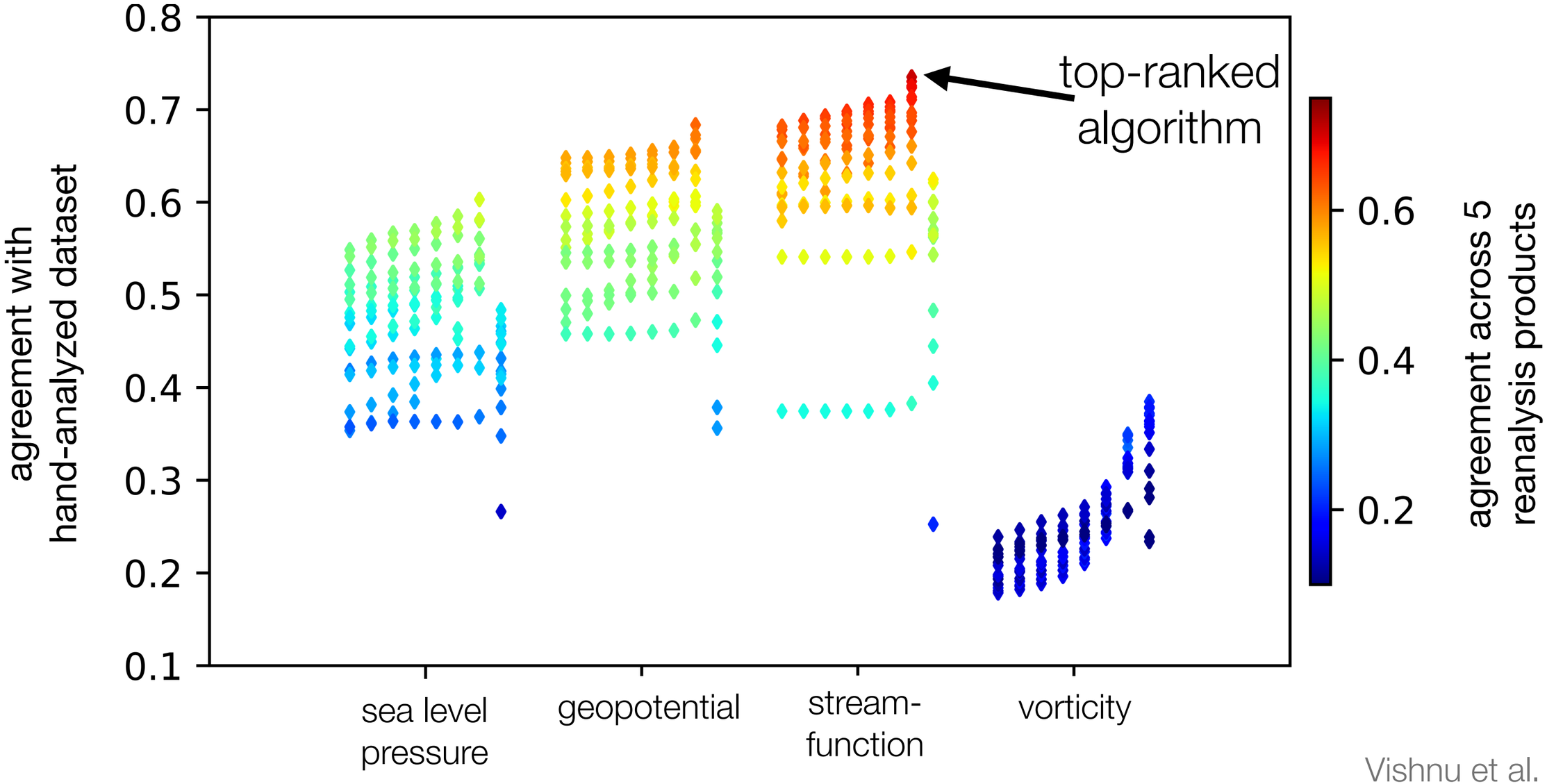

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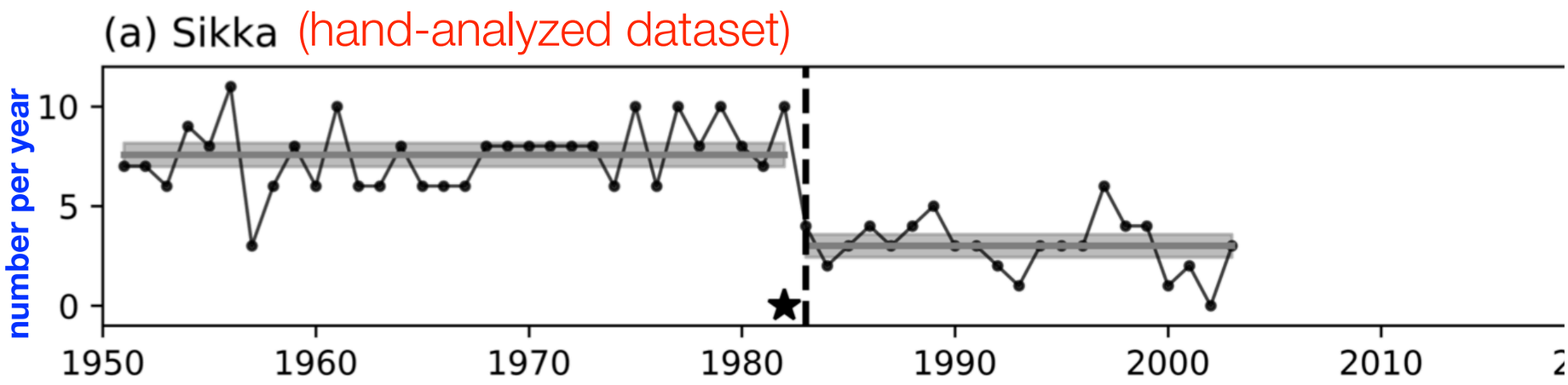
2b. Apparent large decrease in monsoon depression counts may be artifact of changes in observing network



Stars mark year in which **geostationary satellite data** was incorporated into the underlying datasets

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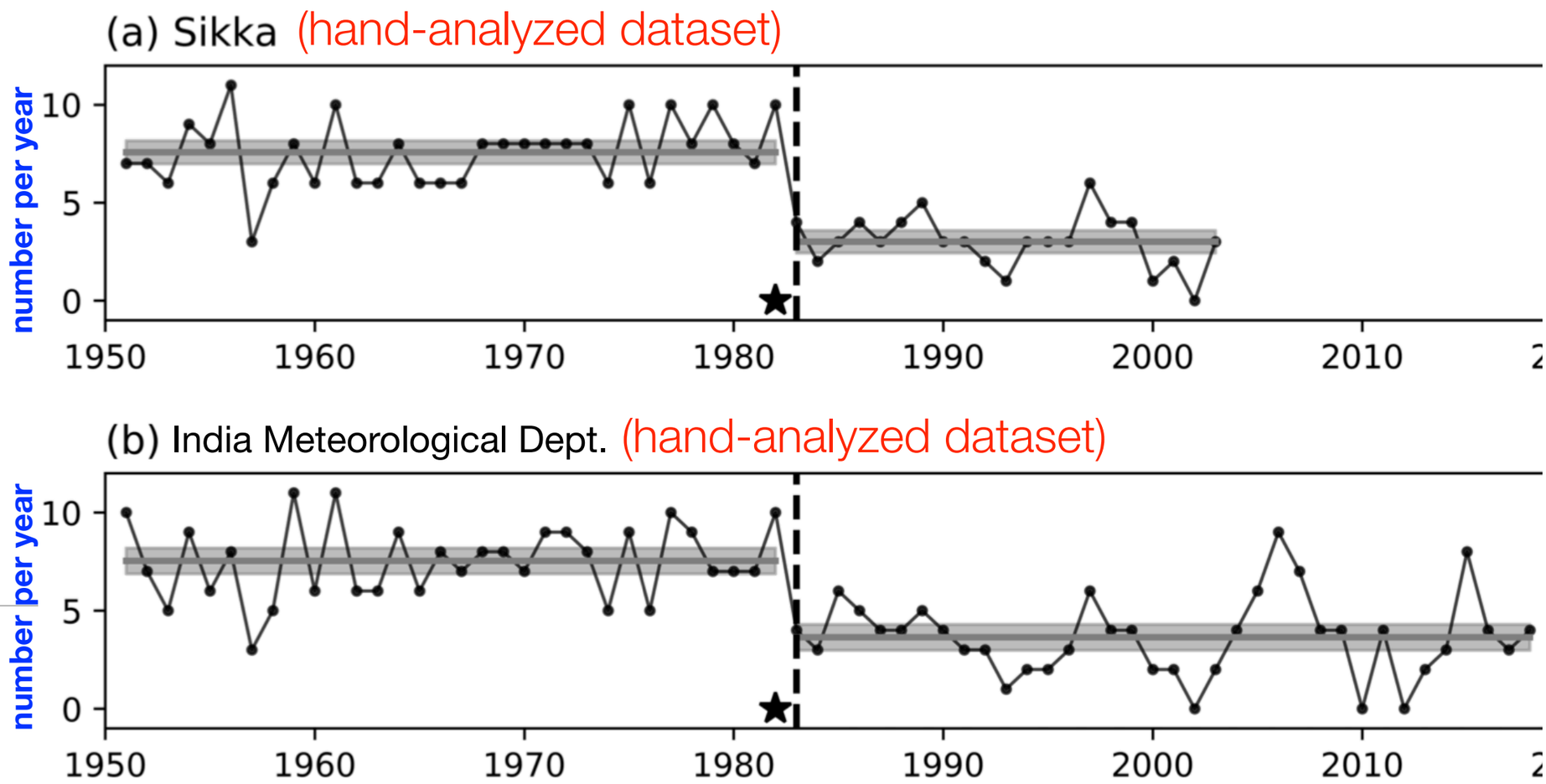

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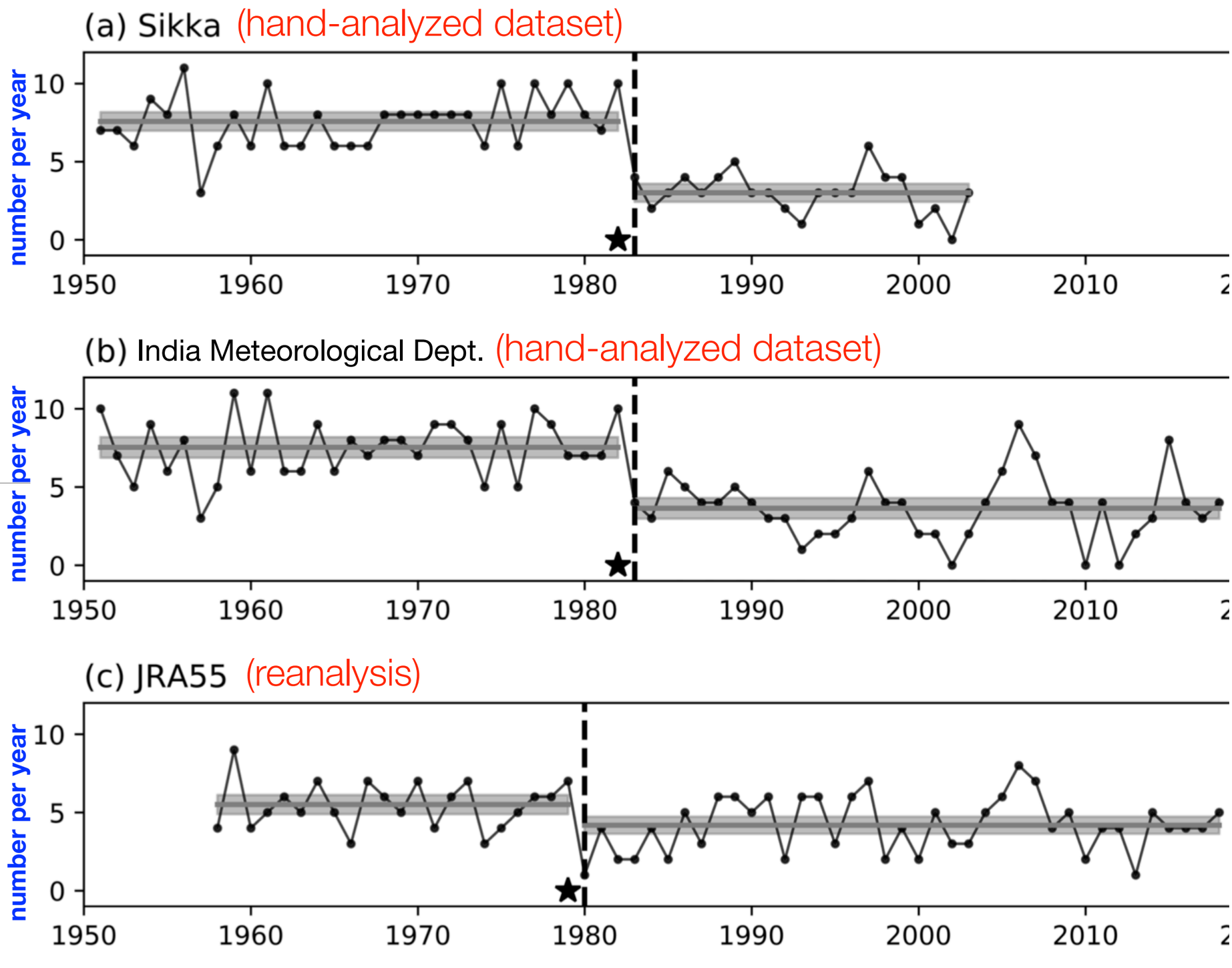

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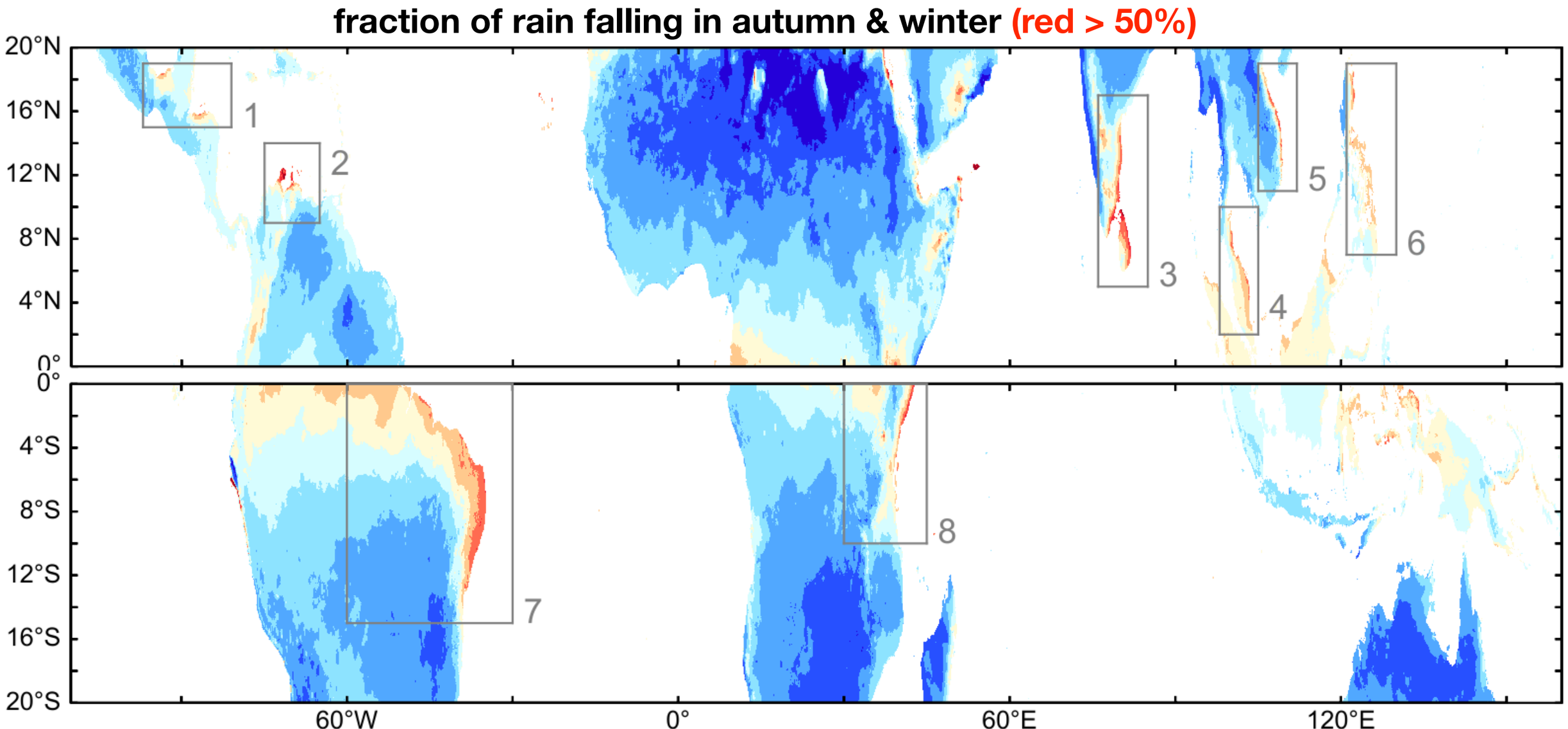

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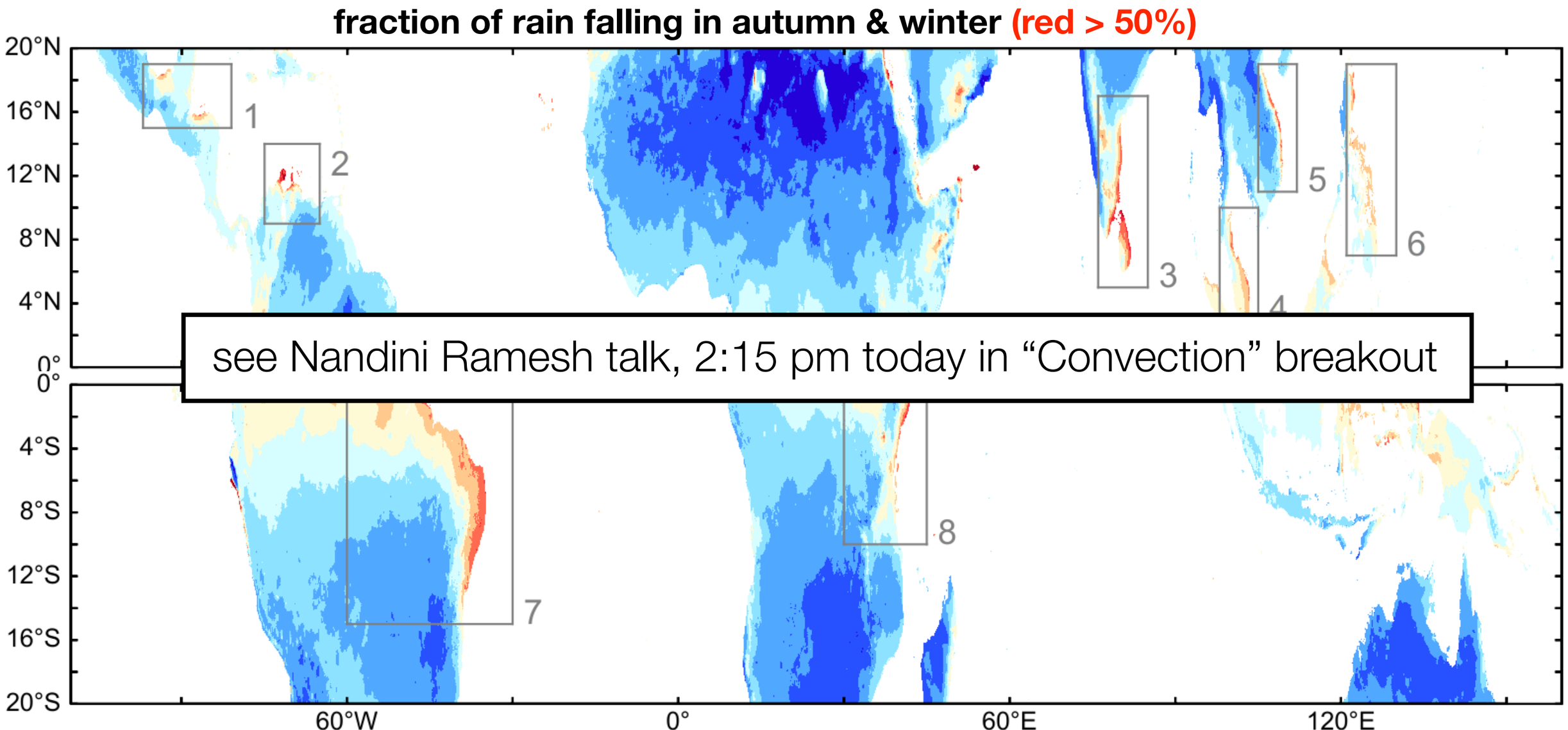

Summary: Monsoon Extremes project

Results to date:

1. Fundamental dynamics of monsoon depressions
2. Identification, tracking & analyses of
   - monsoon depressions
   - tropical upper-tropospheric troughs
   - moisture surges
3. Influence of fine-scale orography on precipitation
4. Assessing model bias: atmospheric moist energy budget

Some products:

Global ensemble dataset of tropical low pressure system tracks

First track dataset of tropical upper-tropospheric troughs in North American monsoon

Idealized cloud-resolving model that is easily linearized & used with imposed basic states

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