

Traffic Bottlenecks: Predicting Atmospheric Blocking with a Diminishing Flow Capacity

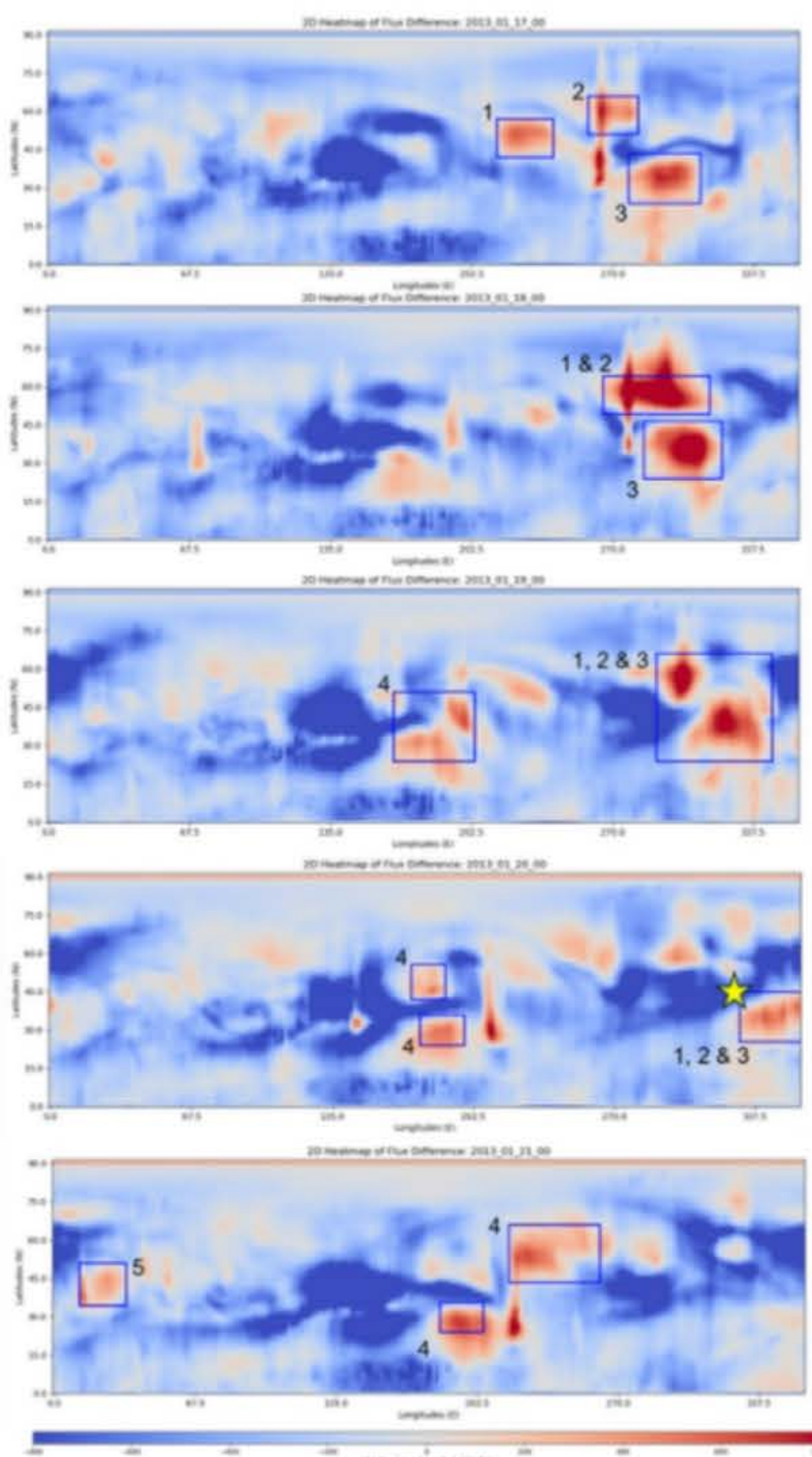
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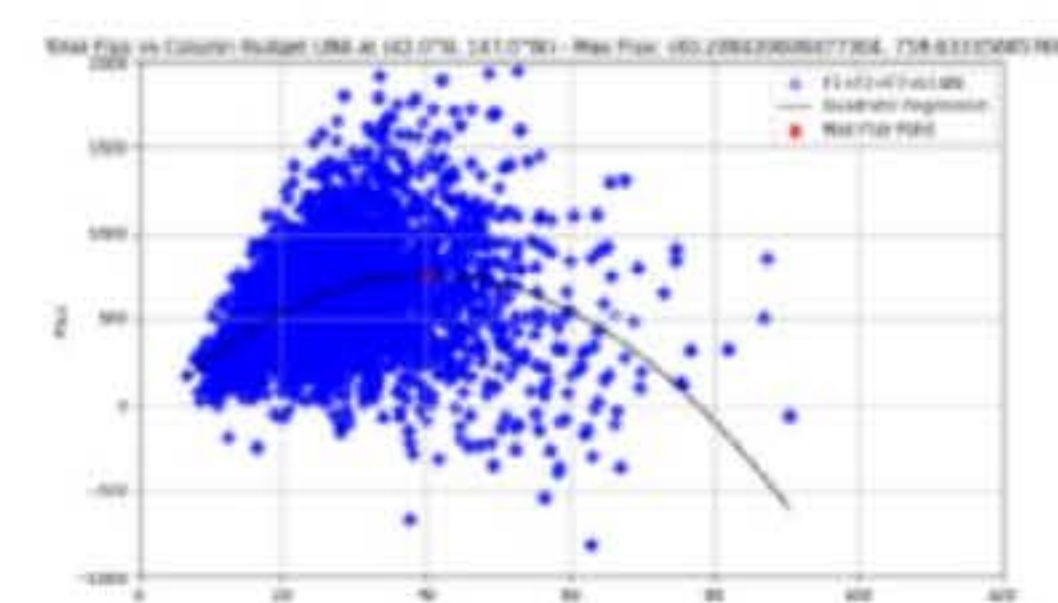
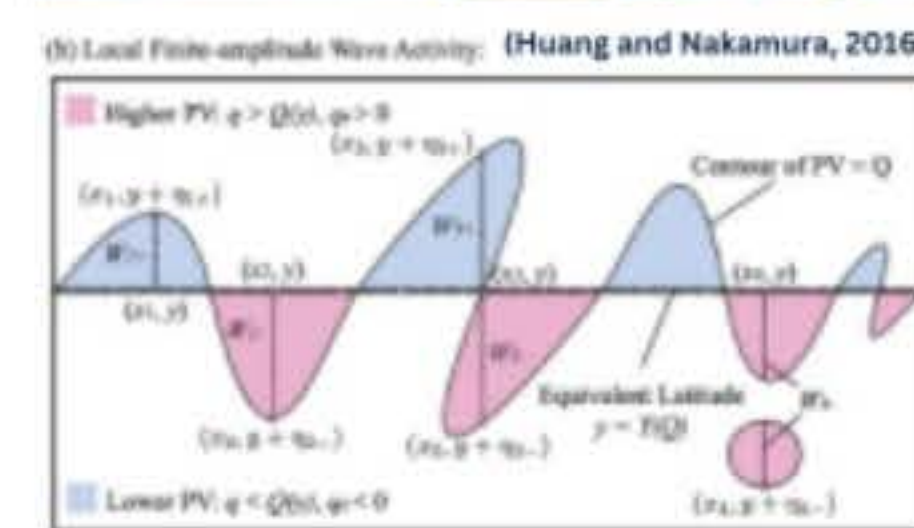
New York University, Courant Institute of Mathematical Sciences, New York, NY, United States

Predicting Blocking with LWA Flux Capacity Exceedance

An Exceedance Event Associated with the 2013 Jan. 20th Blocking Event



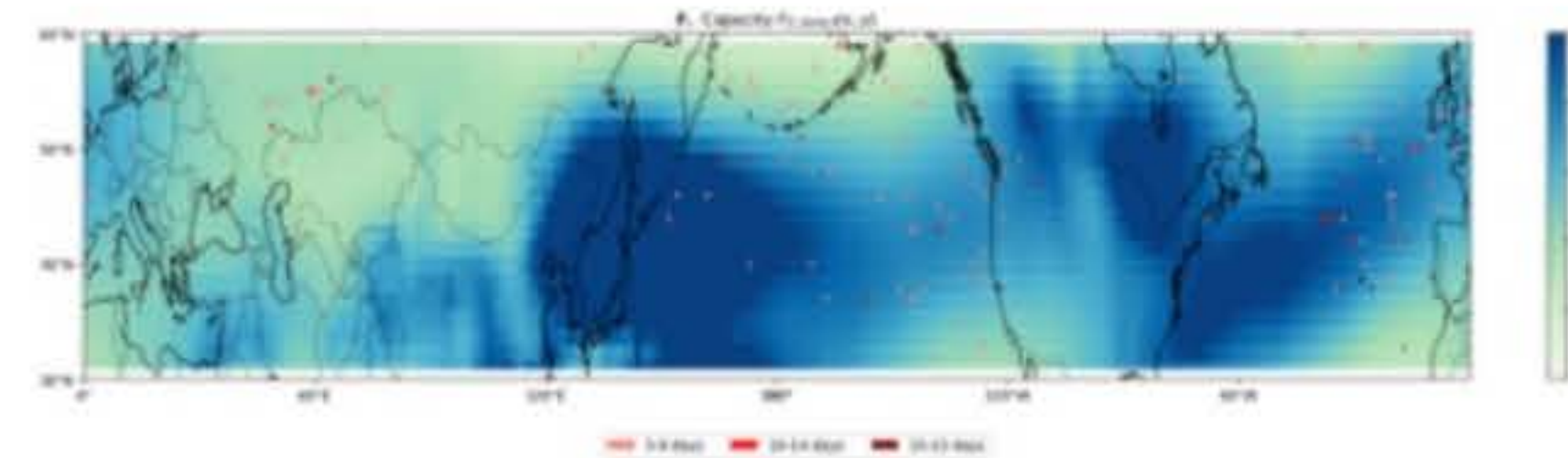
- This is a 4 day evolution of tracked exceedance events:
- Day 1 (Jan. 17th) is the genesis of 3 individual events
 - Day 2 finds the merging of event 1 & 2
 - Day 3 is the genesis of event 4, and event 3 predicts the North Atlantic blocking 24 hours ahead of time
 - Day 4 finds the split of event 4, and the yellow star marks the blocking event
 - Day 5 starts a new round of exceedance events



An atmospheric block is a large, persistent high pressure system that "blocks" the jet stream. It causes **stagnation** of typically eastward propagating Rossby wave packets and causes extreme weather events in the **mid-latitudes**. Its first order dynamics are still not fully understood.

Using **Local Wave Activity (LWA)** framework, Nakamura and Huang (2018) proposed a traffic jam theory to predict blocking onsets:

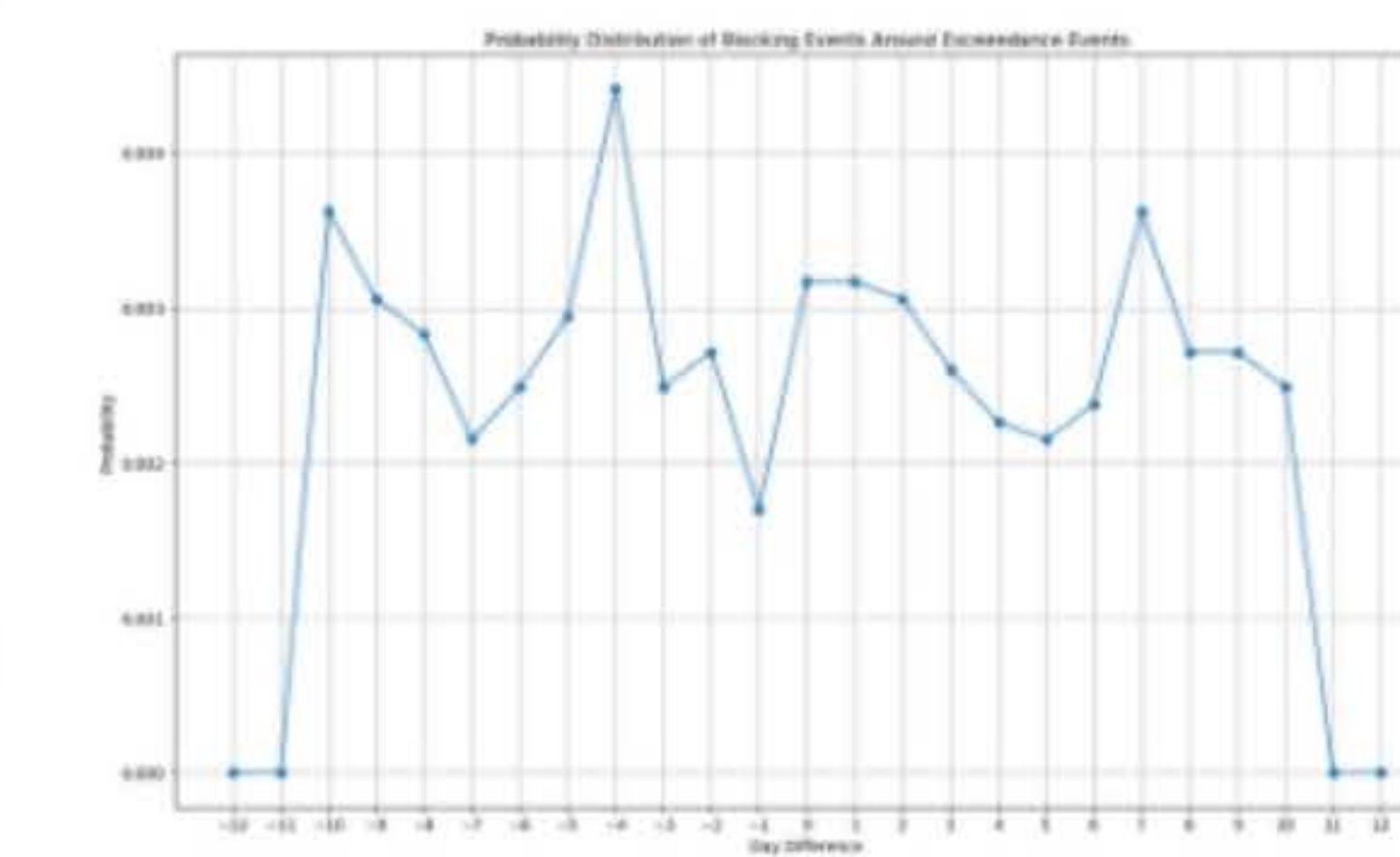
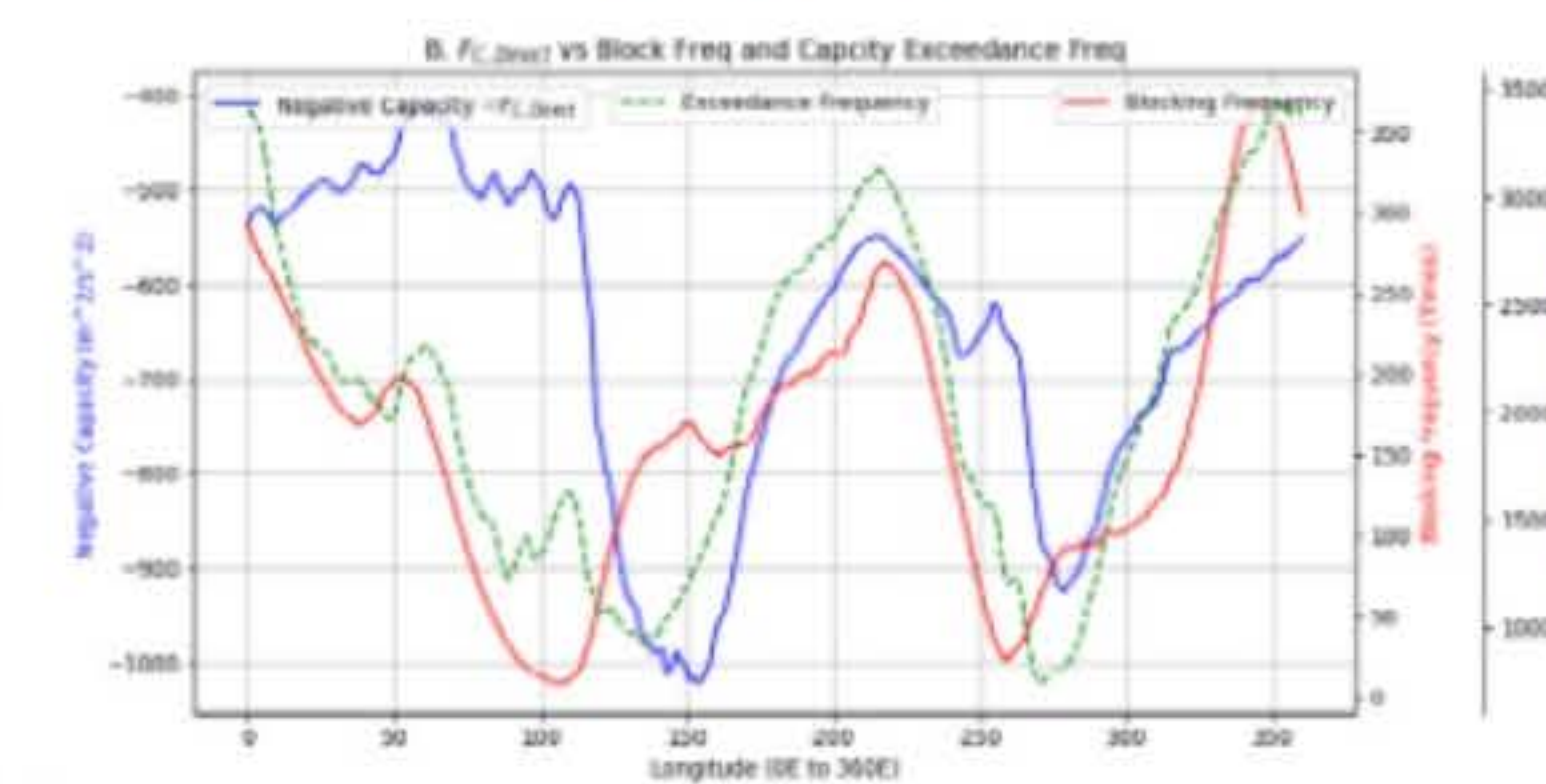
- Jet stream has a capacity for the LWA Flux
- When the capacity is exceeded, blocking manifests as congestion.



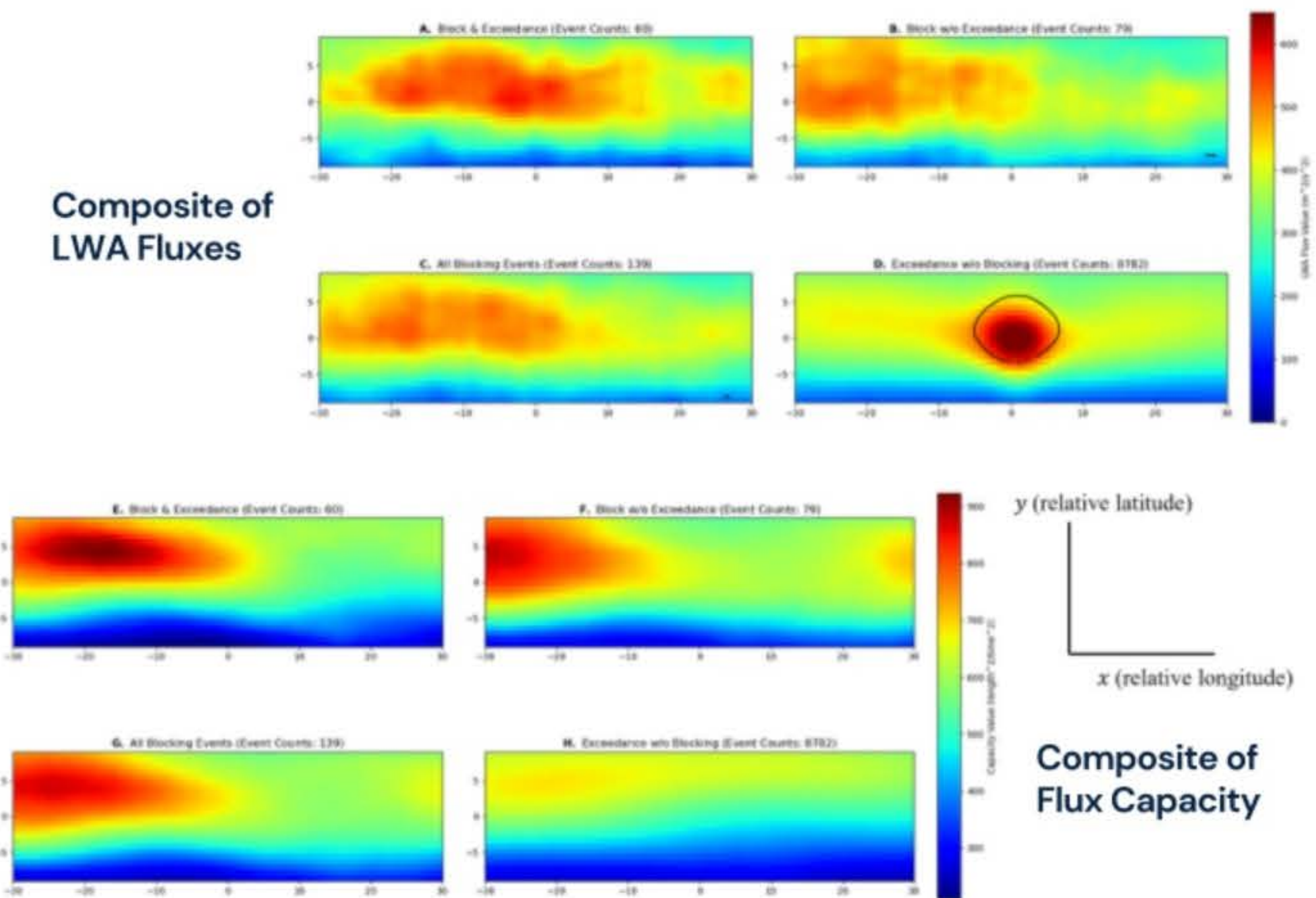
- The traffic jam theory captures the **blocking climatology**: most blockings lie within the regions of low capacity.

- Yet, it **over predicts** individual events: 8,782 false positives (flux exceedance is captured, but no blocking event is associated), which is around 2.6 times a day, in contrast to real blocking frequency of 0.04 times a day.

- The probability of a blocking happening around an exceedance event is of $O(1\%)$



Regional Features: Traffic Bottleneck



Composite of LWA Fluxes

Composite of Flux Capacity

Key Points

- Predictors for the onset of blocking based on the novel traffic jam mechanism are evaluated in atmospheric reanalysis.
- The theory captures the spatial structure of the blocking climatology, but not individual events, vastly overpredicting blocking onset.
- Using regional features improves predictors: a decrease in capacity favors blocking, as lane closures increase the chance of a traffic jam.