Exploring the Link between Multi-Scale Moisture Transport Patterns and Extreme Rainfall Events in the Asian-Australian Monsoon Region

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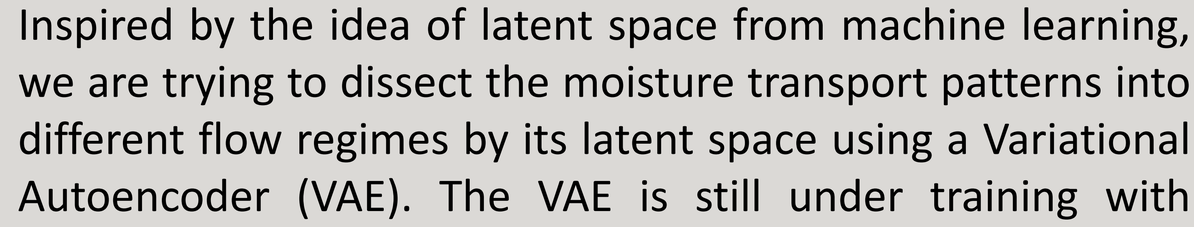
1 Introduction

In terms of the extreme rainfall events in the Asian-Australian monsoon region, many previous studies have reported their close relationship with moisture transport through synoptic environment analyses. Based on the different case studies, we have observed the local and non-local effects of moisture transport on extreme rainfall hotspots, implying a multi-scale problem. Hence, we intend to investigate the relationship between moisture transport configuration and extreme rainfall events in a larger domain incorporating the concept of flow regimes and unsupervised machine learning techniques.

2 Dataset

- ERA5 daily data for synoptic fields (resolution 0.25x0.25)
- GPM 0.5-hourly data for precipitation (resolution 0.1x0.1)
- Variables
  - **IVT** (1000-700 hPa): $-\frac{1}{g}\int_{1000}^{700} q \cdot \overrightarrow{V_h} dp$
  - $\boldsymbol{IDR_\theta}$, or **IVT coherence** *(Pan and Lu, 2019)* :
    IDR_θ stands for the inter-decile range of IVT angle, which is calculated within a radius of 500-kilometers. IDR_θ can be understood as the **IVT angle differences** within a certain area.



3 Pattern Identification

AR-like and vortex-like transports are the most dominant with extreme rainfall system occurrences in this area. (*Fig.1*)

However, the combinations are diverse when visualizing on map. Different configurations link to different precipitation hotspots, which also increases the complexity of this problem. (*Fig. 2-4*)

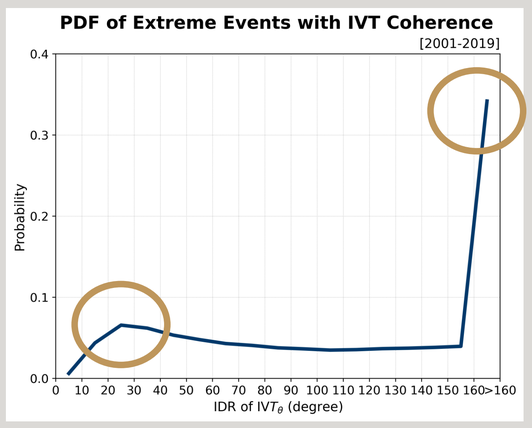


Fig.1. Two peaks in low and high coherence intervals.

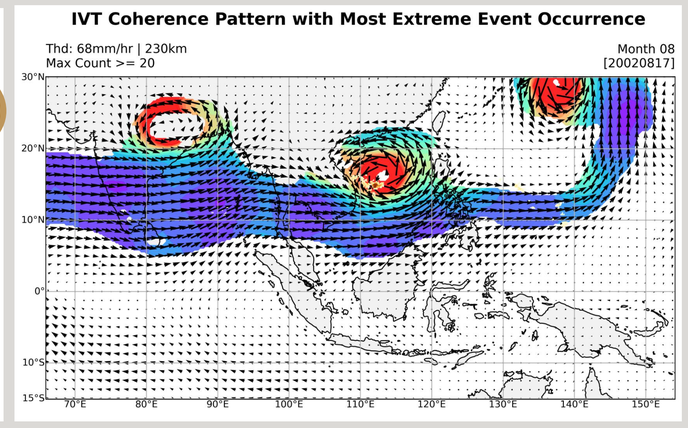
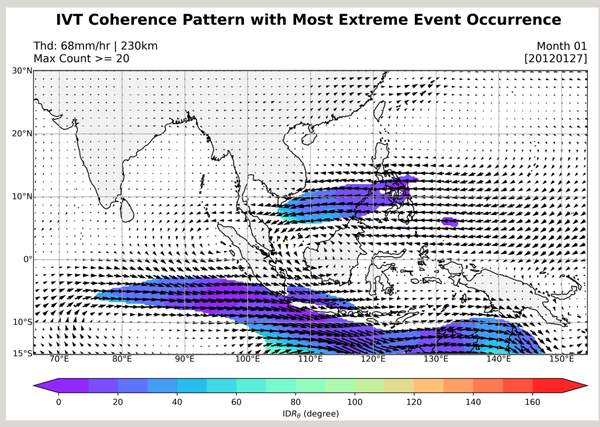
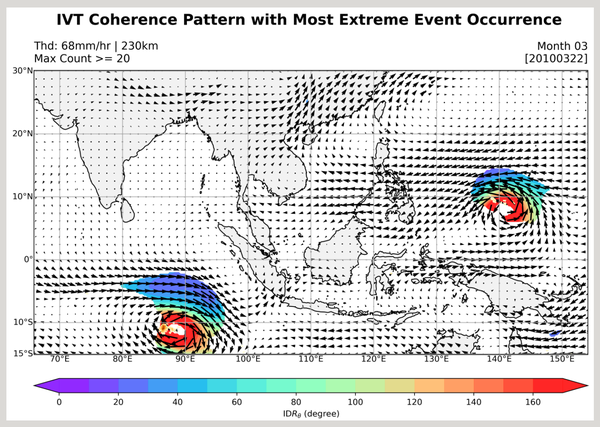


Fig.2, 3, 4. The display of IVT coherence in different days.





4 Remote Connection

We want to explore how sensitive is the extreme precipitation in one region to moisture transport in other regions by using *regression analysis*.

- Split the domain into smaller regions (yellow box)
- Regress regional P99 daily accumulative precipitation with daily IVT over whole domain, from 2001-2019, summer (Apr. – Sep.) and winter (Oct. – Mar.) separately.

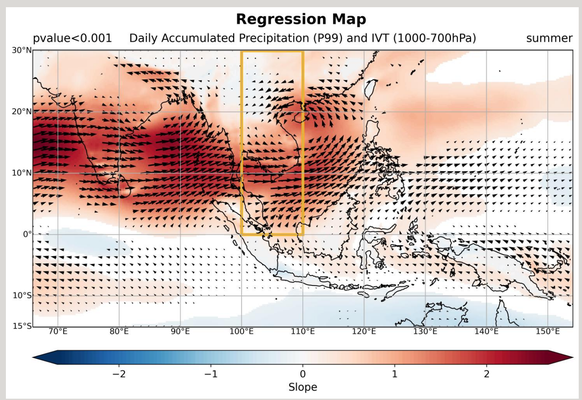


Fig.5. Indochina Peninsula in summer.
Strong moisture transport is present in the upstream region. The transport can be AR or its combination with the monsoon flow.

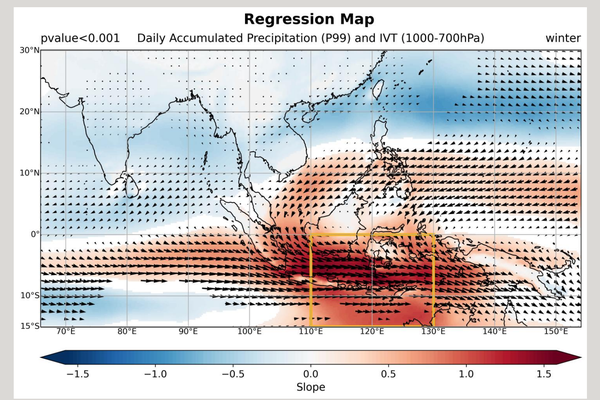


Fig.6. Maritime Continent in summer.
Two apparent passages of moisture supply are present, and the coherent flow has AR-like features.

The result implies EREs can be well related to moisture transport in remote areas.

5 Ongoing Work

Inspired by the idea of latent space from machine learning, we are trying to dissect the moisture transport patterns into different flow regimes by its latent space using a Variational Autoencoder (VAE). The VAE is still under training with different inputs and architecture for better reconstructive performance to ensure a meaningful latent space.

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Reference:

- Pan, M., & Lu, M. (2019). A novel atmospheric river identification algorithm. Water Resources Research, 55(7), 6069-6087.