Characteristics of Mesoscale Convective Systems in the Philippines

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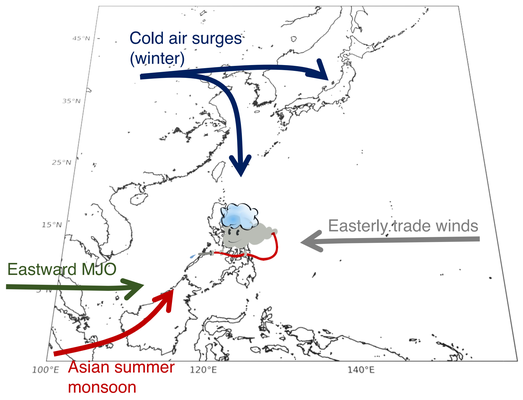
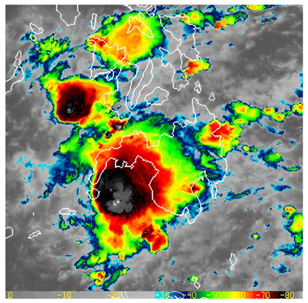
Introduction

Overview of Philippine Climate



→ Mainly influenced by monsoon systems, trade winds, MJO, etc.

What is MCS?



From Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison

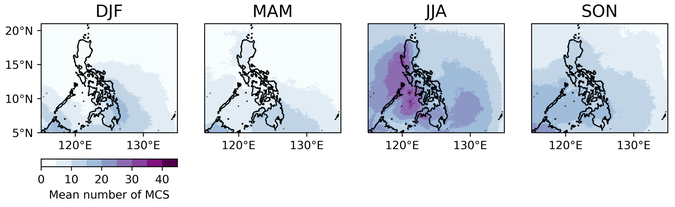
→ Mesoscale convective systems (MCSs) are thunderstorms that grow and organize into a larger convective system
- >100-km in length, lasts 3 hours longer (Schumacher and Rasmussen, 2020)

Why study MCSs?

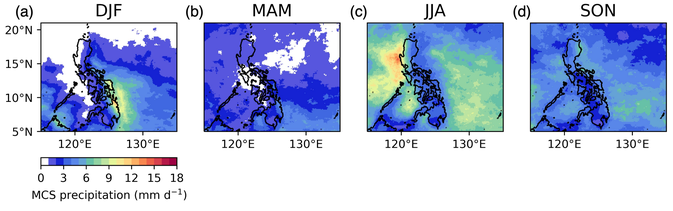
- In the tropical belt, MCS contributes **more than 50%** of the annual total precipitation with high concentration in the Indo-Pacific warm pool (Feng et al., 2021).
- However, MCSs over the Philippines remain understudied.

What are the climatological characteristics of MCSs in the Philippines?

MCS Occurrences



MCS Precipitation amount



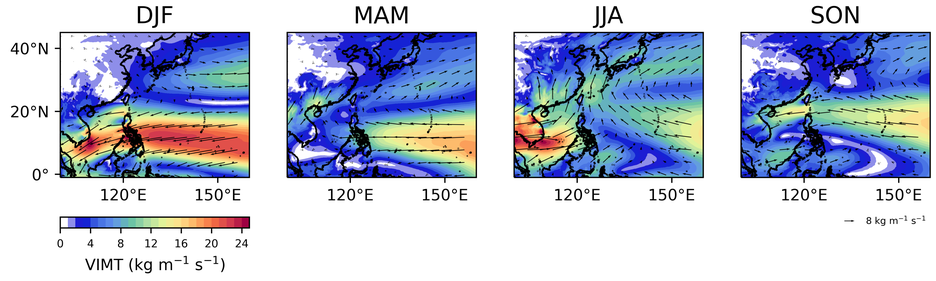
- High MCS rainfall amounts during peak of monsoon seasons
- Large-scale flows (e.g., monsoonal flows) largely influence the development of MCSs
- MCSs occur more during Asian summer monsoon (JJA) peak
- Interestingly, fewer but stronger systems during DJF

Large-scale environments during MCS events

Vertically integrated moisture transport

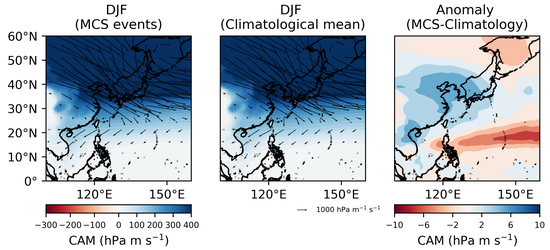
$$VIMT = \frac{1}{g}\int_{psurface}^{850hPa} q\boldsymbol{v}\, dp\,,$$

q: specific humidity, $\boldsymbol{v}$: vector wind, p: pressure, and g: gravitational acceleration



How strong are the cold surges during DJF?

→ Identified using Iwasaki et al (2014) with θ_T of 298 K



Objective and Methodology

Research Question

→ What are the characteristics of the long-term climatology of MCS over the Philippines?

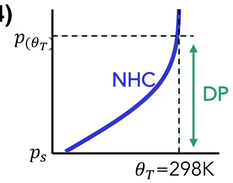
Datasets and Methods

→ **MCSs identified** - Subset of the updated global MCSs dataset of Feng et al. (2021) based on tracking method that uses geostationary satellite brightness temperature (Tb) from NASA Global Merged IR V1 and precipitation data from IMERG V06B. Covering 2000-2019

→ **Large-scale environments**
- ERA5 hourly data with 0.25° x 0.25° grid resolution
- JRA-55 6-hourly data with 1.25° x 1.25° grid resolution

○ **Isentropic analysis of cold air masses (Iwasaki et al., 2014)**

Diagram of DP and NHC based on Fig. 1 of Iwasaki et al. (2014)



Cold air mass is $DP \equiv p_s - p(\theta_T)$
p_s: surface pressure,
$p(\theta_T)$: pressure on isentrope $\theta = \theta_T$

Cold air mass flux uses horizontal wind $\boldsymbol{v}$

$$\overrightarrow{\boldsymbol{MF}} \equiv \int_{p(\theta_T)}^{p_s} \boldsymbol{v}\, dp$$

Conclusion

- ✓ Monsoonal flows influence the seasonal development of MCSs
- ✓ Fewer but stronger MCSs during DJF
  - → Interaction of large moisture supply (easterlies) and cold air (northerlies) favored the enhancement of MCSs over the eastern Philippines during DJF
  - → Complicated interaction of multiple large-scale flows

Remaining questions

- ✓ What are the influence of intraseasonal oscillations (MJO and BSISO) on tropical MCS development?
- ✓ Question remains on why does DJF have fewer MCSs but large rainfall amount (could be answered by simulations)

Acknowledgement

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References

- Feng, Z., Leung, L. R., Liu, N., Wang, J., Houze Jr, R. A., Li, J., ... & Guo, J. (2021). A global high-resolution mesoscale convective system database using satellite-derived cloud tops, surface precipitation, and tracking. *Journal of Geophysical Research: Atmospheres*, 126(8), e2020JD034202.
- Iwasaki, T., Shoji, T., Kanno, Y., Sawada, M., Ujiie, M., & Takaya, K. (2014). Isentropic analysis of polar cold airmass streams in the Northern Hemispheric winter. *Journal of the Atmospheric Sciences*, 71(6), 2230-2243.
- Schumacher, R. S., & Rasmussen, K. L. (2020). The formation, character and changing nature of mesoscale convective systems. *Nature Reviews Earth & Environment*, *1*(6), 300-314.