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Characteristics of Large-scale Tropical Convective Systems

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◆ Science questions that motivate us

– How well do Cloud Regimes identify tropical convective systems?
– Can we quantify size relationships between convection cores and anvils?
– Do the precipitation properties characterize convective systems?

◆ Data

– **Cloud:**
- MODIS C6.1 daily, 1°×1°, Terra and Aqua data, 2003.6–2018.5 (15 years)
- 2D Joint histogram of Cloud Optical Thickness (COT) and Cloud Top Pressure (CTP)

– **Precipitation:**
- The Integrated Multi-satellite Retrievals for GPM (IMERG)
- V06B (30-minutely, 0.1°×0.1°) ➔ Re-sampled to match MODIS grid and time

◆ Methodology

– **Tropical Cloud Regime (TCR):**
- k-means clustering method derives TCRs using both Terra and Aqua in 15°S–15°N
- TCR1, TCR2, and TCR3 are related to convection (Fig. 1)

– **Identification of horizontal aggregates:**
- A TCR123 aggregate is defined as an area composed of adjacent grid cells with TCR1, TCR2, or TCR3 occurrence
- The existence of TCR1 (convection core) is required, but TCR2 or TCR3 are optional
- We focus on Aqua, with orbit swath gaps filled by Terra data (Fig. 2)
- The domain is extended to 25°S–25°N

– **Precipitation grid match to MODIS:**
- Spatial match: Simple average of 100 values in 0.1°×0.1° resolution
- Temporal match: Closest time to calculated UTC of each MODIS grid cell

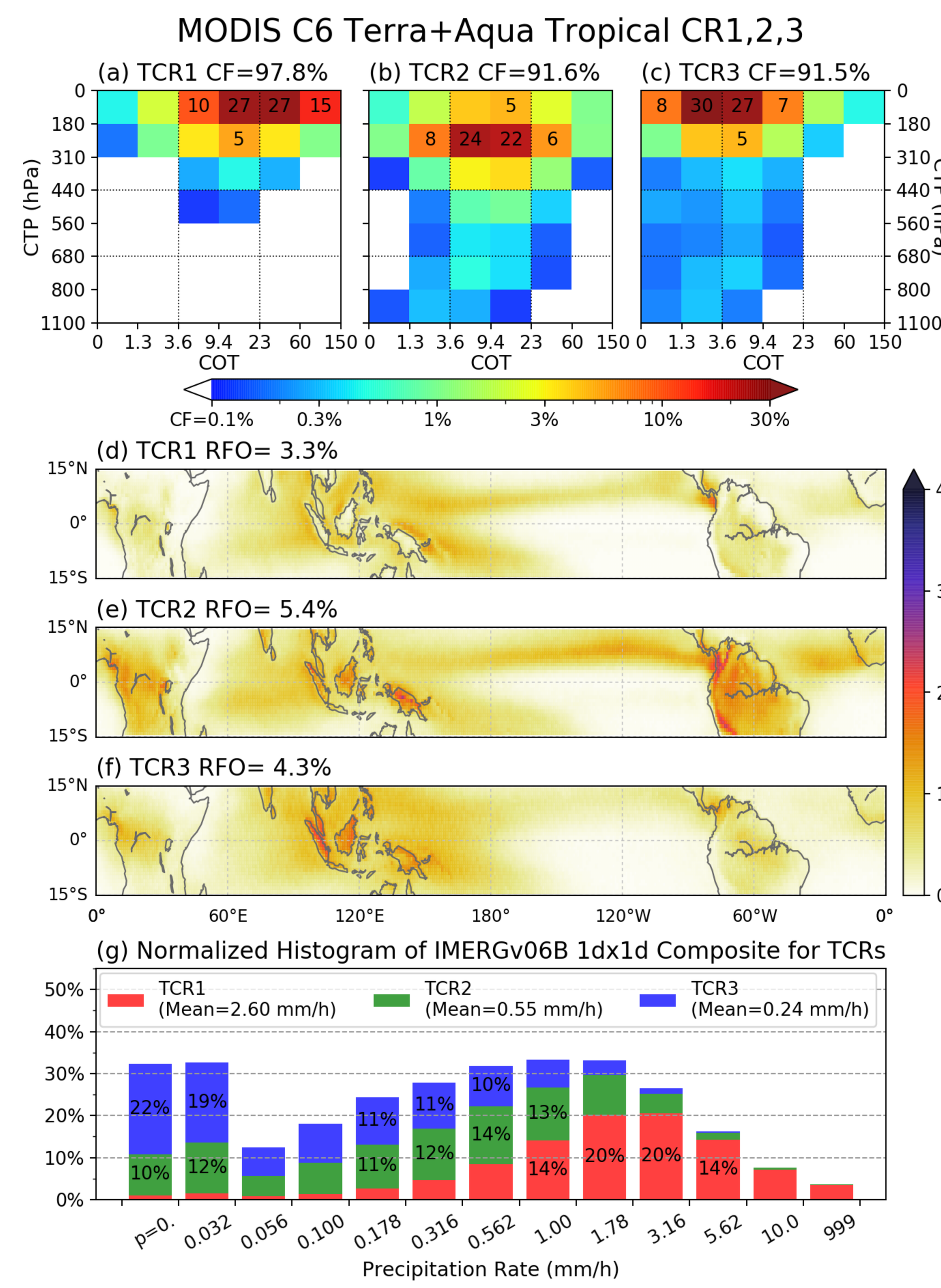


Fig. 1: Characteristics of TCR1, 2, and 3
- **TCR1: Convective Core (mostly oceanic)**
- **TCR2: Various Stages (developing, decaying, etc.)**
- **TCR3: Anvil**

(Based on Jin et al. 2019, JGR, in review)

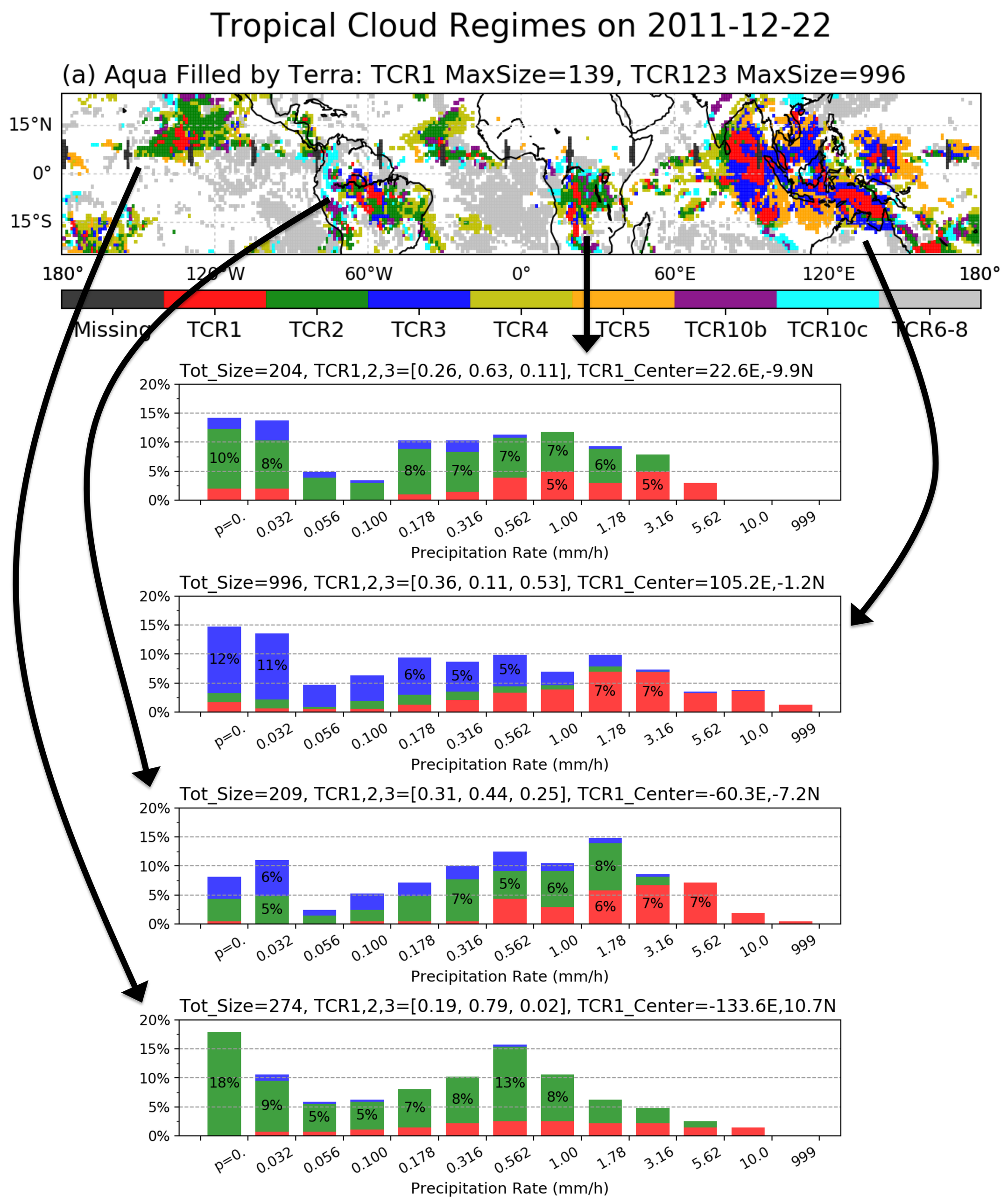


Fig. 2: Characteristics of TCR123 aggregates (snapshot on 12/22/2011; Aqua swath gaps filled by Terra)
- **Heaviest precipitation in TCR1s which are generally in 0.2-0.4 range (ratio to aggregate size).**
- **TCR2 ratios vary greatly.**

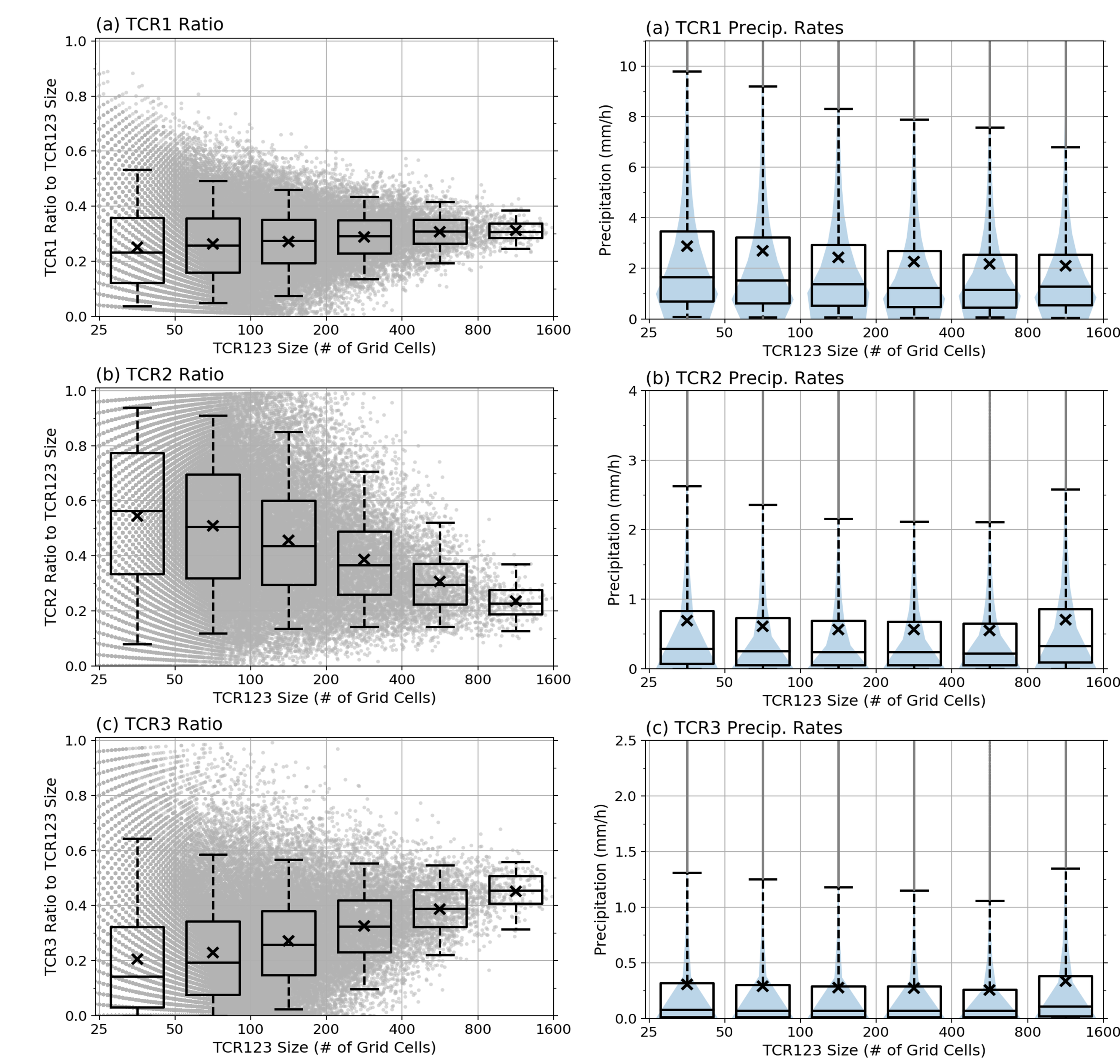


Fig. 3: TCR1, 2, and 3 ratio to TCR123 aggregate size
Fig. 4: Precipitation distribution of TCR1, 2, and 3 in TCR123 aggregates.
- **As the aggregate size increases, TCR1, 2, and 3 ratios converge to 0.3, 0.2 and 0.5, respectively.**
- **As the aggregate size increases, the probability of extreme precipitations decreases.**

How about Temporal Evolution?

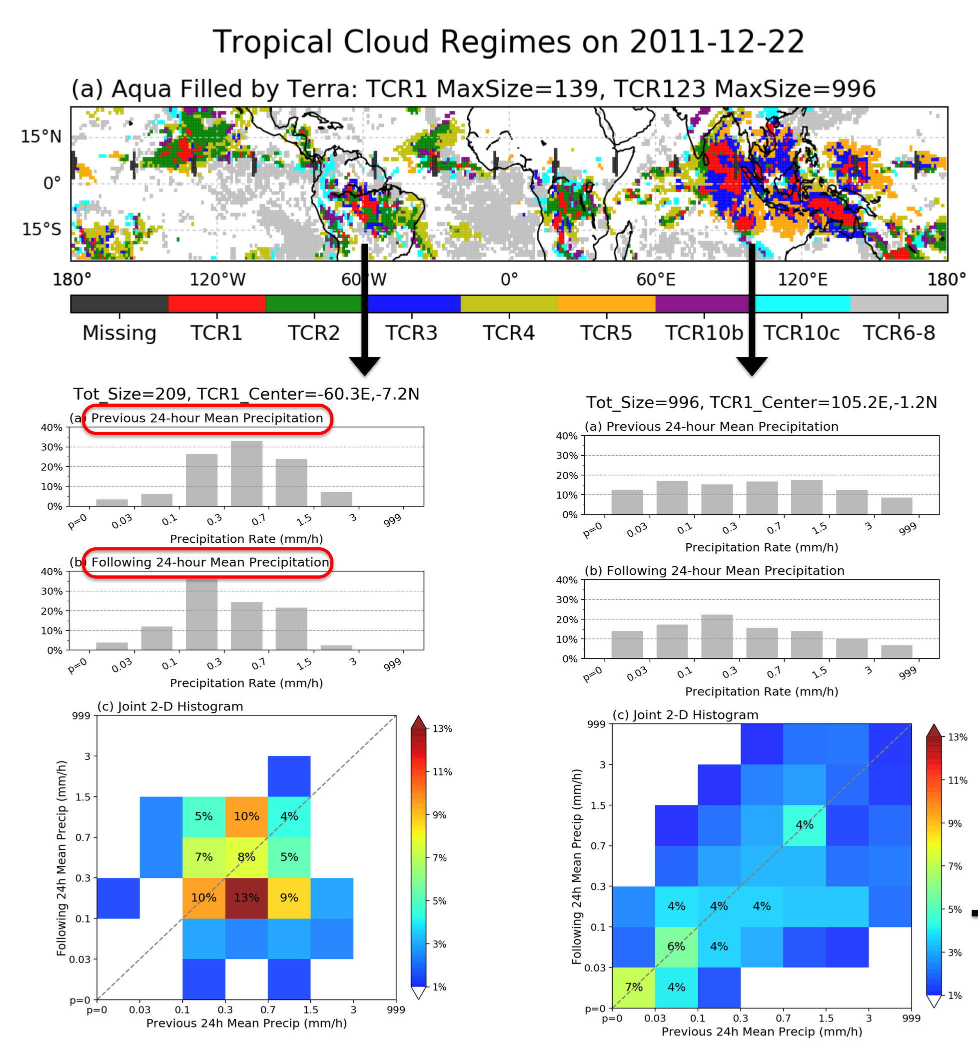
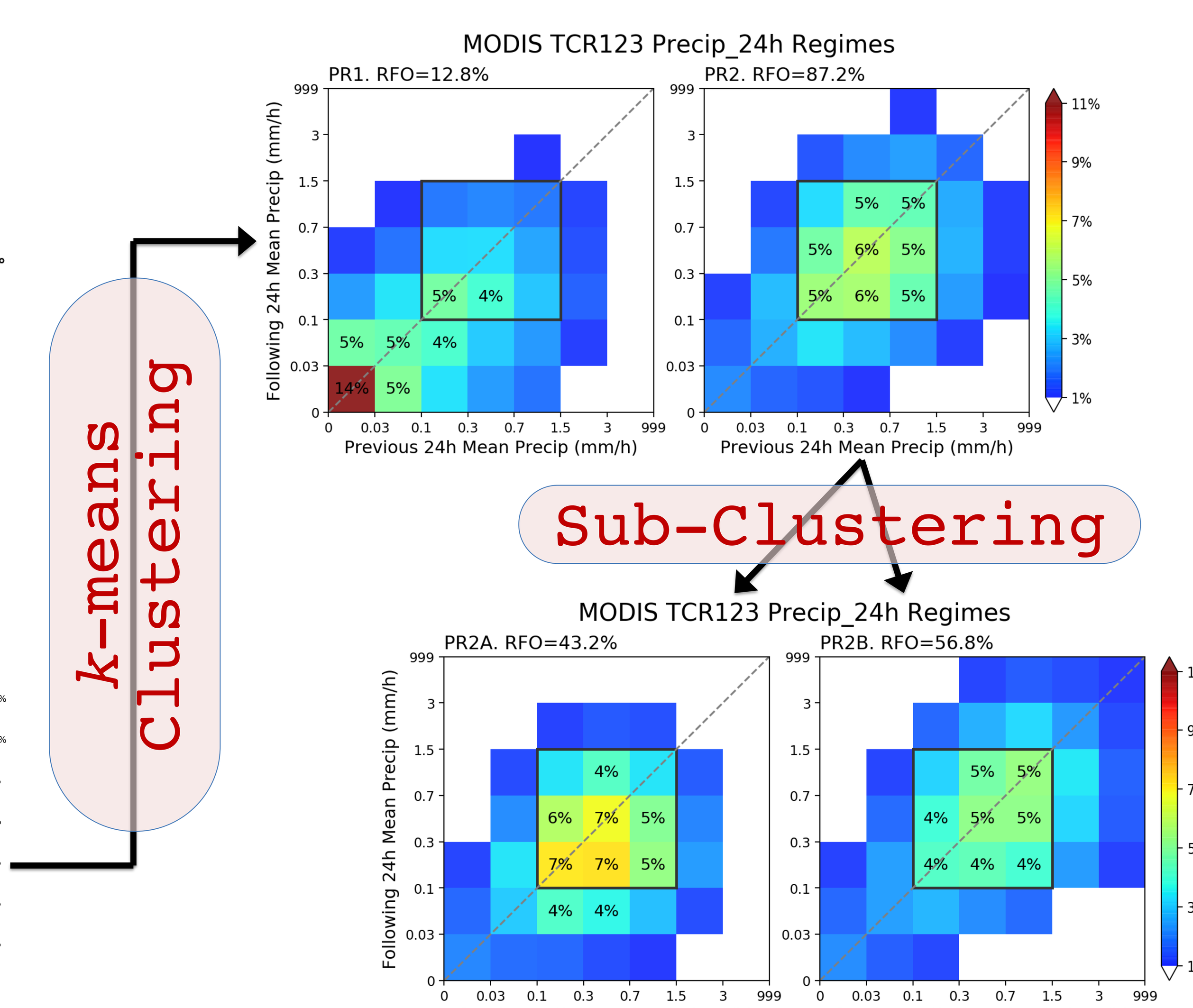


Fig. 5: Previous 24-hour and following 24-hour mean precipitation of TCR123 aggregates, and their joint histogram (snapshot on 12/22/2011).
- **Above joint histograms of large aggregates (>100 grid cells) are used for clustering analysis.**



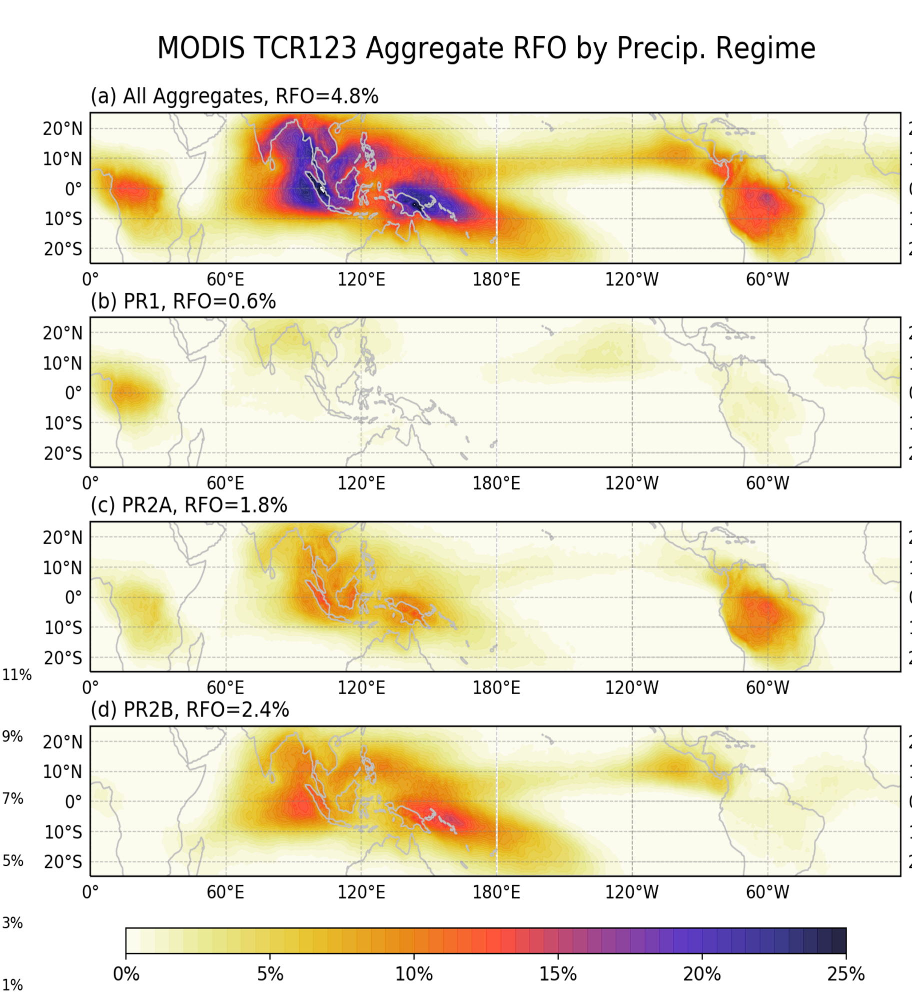


Fig. 8: Clustering of previous- and following-24hour mean precipitation results in three (3) aggregate types: **PR1(partial no-rain), PR2A(decreasing rain), and PR2B(symmetric pattern).**
Fig. 9: Geographical distribution of PR1, PR2A, and PR2B
- **Preferred regions are distinctively different: tropical Africa (PR1), Amazon basin and Maritime Continent (PR2A), and tropical warm pool oceans (PR2B).**

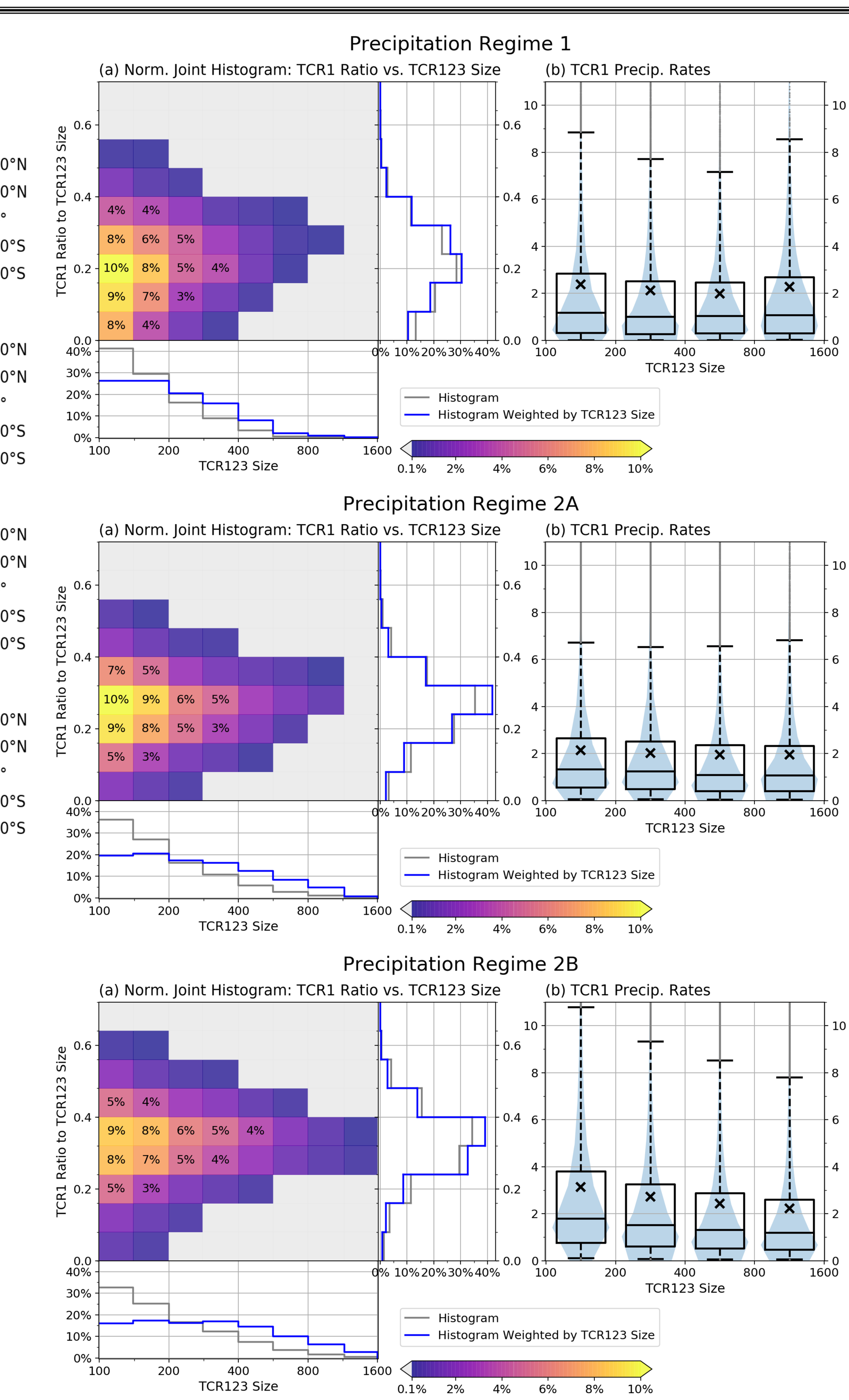


Fig. 10: TCR1 ratio histogram (left) and TCR1 precipitation distribution (right), for each PR.
- **TCR1 ratio to TCR123 total size: PR2B > PR2A > PR1**
- **Extreme Precipitation in smaller aggregates (<200 grid cells): PR2B > PR1 > PR2A**
- **Extreme Precipitation in largest aggregates (>800 grid cells): PR1 > PR2B > PR2A**

Conclusion

❖ The concept of "**Cloud Regime**" enables us to **quantify** the area occupied by **large-scale convective systems.**
❖ **Precipitation** data complements **temporal evolution information.**
❖ Next step is to **predict** future of **large systems** based on past information (cloud and precip).

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