An estimation of the contribution from TRMM-identified extreme storms to the total precipitation in South America

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AMS Poster S40

Introduction

- TRMM satellite observations have led to the realization that intense deep convective storms just east of the Andes in subtropical South America are among the most intense anywhere in the world (Zipser et al. 2006)

<u>South American mesoscale convective systems (MCSs):</u>

→ ~ 60% larger than those over the United States (Velasco and Fritsch 1987)

→ Larger and longer-lived precipitation areas than those over the United States or Africa (Durkee et al. 2009)

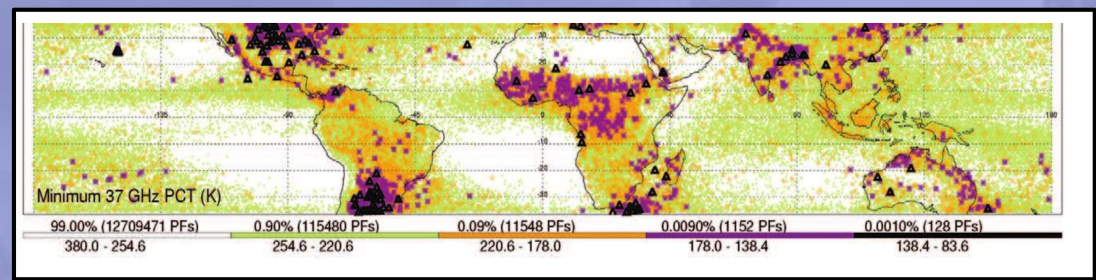
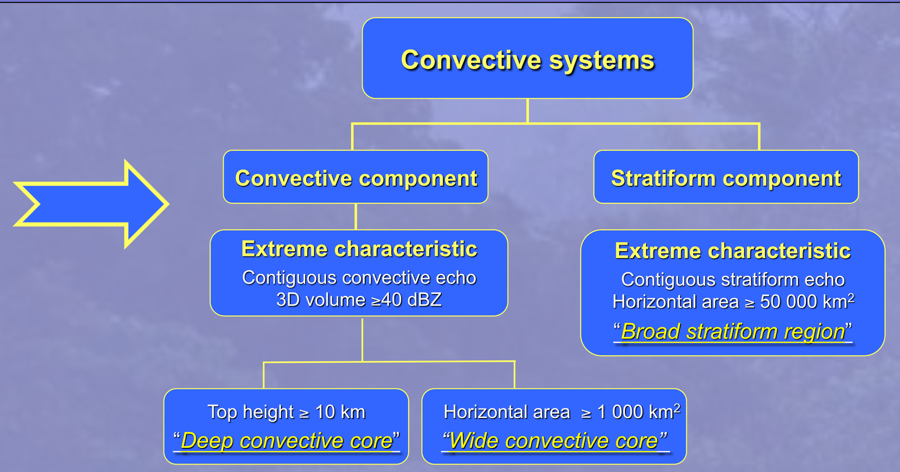


Figure 1. Locations of intense convective events using the color code matching their rarity from Zipser et al. (2006).

Background

UW methodology to separate TRMM Precipitation Radar (PR) echoes into three storm types (Houze et al. 2007): *deep convective cores, wide convective cores, and broad stratiform regions*



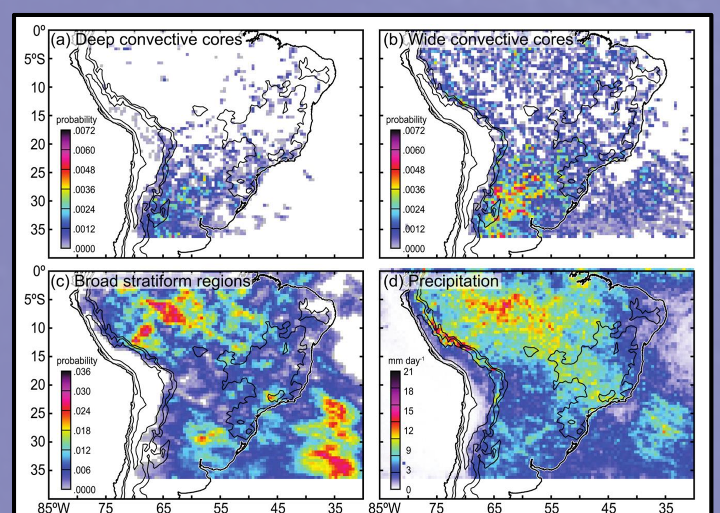


Figure 2. Locations of storm types in South America derived from TRMM PR data. From Romatschke and Houze (2010)

<u>Storm evolution hypothesis</u> :

- *Deep convective cores* initiate along Andes foothills and secondary topographical features
- Convection grows upscale, develops *wide convective cores*, and moves eastward
- Decaying convective elements move farther eastward and develop *broad stratiform regions*

TRMM Precipitation Bias

- Our aim is understanding the rainfall from <u>extreme</u> convective storms globally
- TRMM PR rainfall algorithm underestimates precipitation from deep convection over land (Iguchi et al. 2009)
- Mitigate bias using a traditional Z-R Method (Rasmussen et al. 2013)

Climatological Rainfall Contribution

- A quantitative approach is employed to investigate the role of the most extreme precipitating systems on the hydrological cycle in South America
- TRMM-identified storms approximate the MCS lifecycle
- Hotspots of total precipitation along the tropical Andes foothills

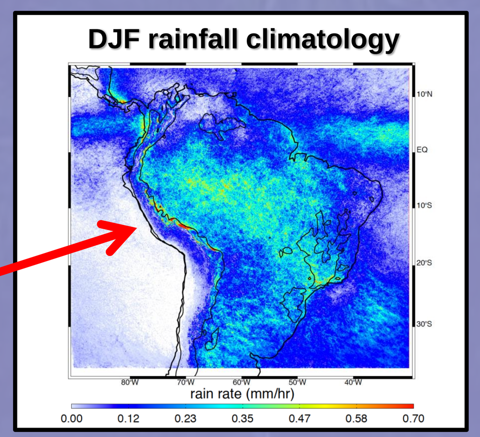


Figure 3. Climatological DJF rain rate (mm/hr) for all events.

- Subtropical S. America receives significant rainfall from mesoscale convective systems (MCSs)
- Hot spots of total precipitation along tropical Andes from non-extreme storms
- Wide Convective Cores are most frequent and contribute highest rainfall

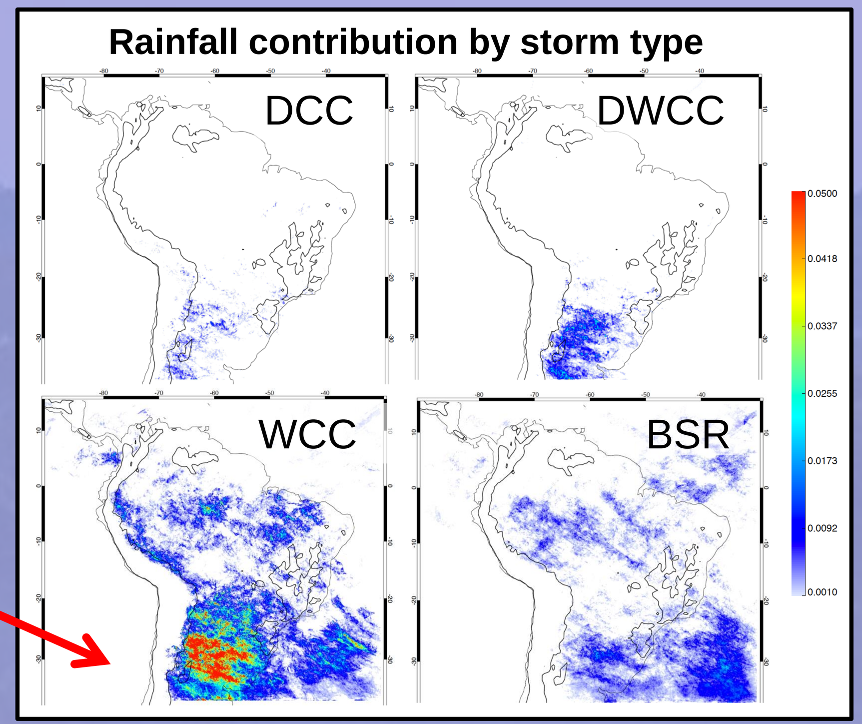


Figure 4. Filtered spatial maps of total rain contribution by each extreme storm type. *(precip_stormtype/precip)*(nRain_stormtype/TRMMpixelcount).*

★ Precipitation from wide convective systems dominates the relative contribution to the total rain ★

- Extreme storms make up less than 1.5% of the total storm counts in each region
- Notably low and similar extreme convective rain contributions in the tropics (Amazon and North Foothills)

Table 1. Ratio of the number of extreme cores to the total TRMM storm counts (%).

	Alti Plano	Amazon	Atlantic	Brazilian Highlands	La Plata Basin North	La Plata Basin South	North Foothills	Sierra Cordoba
Deep	.44	.05	.01	.18	.4	.33	.04	.93
Deep Wide	.17	.01	.01	.1	.4	.48	.01	.65
Wide	.43	.32	.25	.52	1.4	1.4	.27	.97
Broad Stratiform	.04	.08	.24	.17	.21	.42	.06	.07

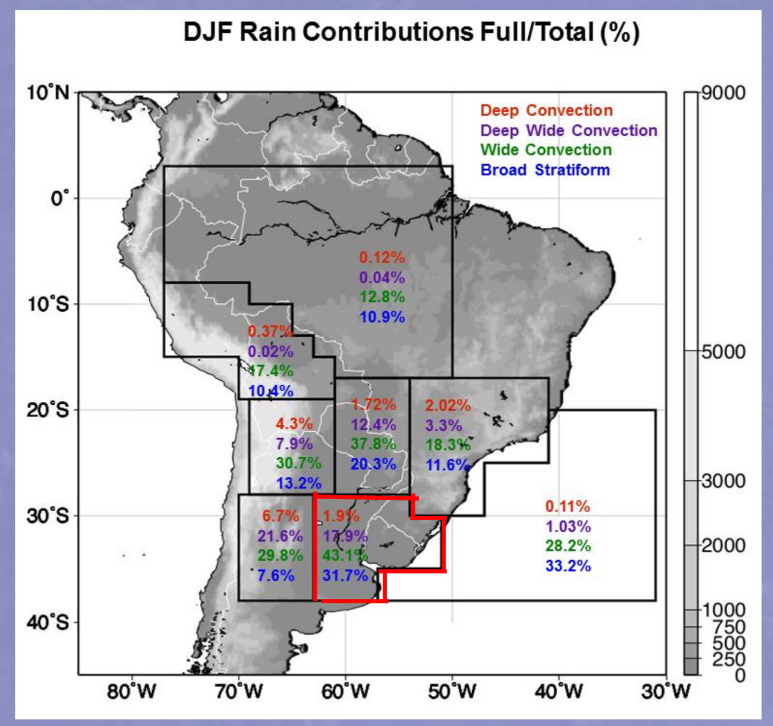


Figure 5. The rainfall contribution from each storm type (indicated by color) to the total precipitation in each region, expressed as a percentage.

- Orographic influence of the Andes on the precipitation distribution in the subtropics
- <u>For the La Plata Basin</u> <u>(red region):</u>

→ Contribution of convective categories to the total warm season rainfall: ~ 60%

→ Including BSR precipitation, all extreme echo types contribute ~ 95% of the total warm season rainfall in the La Plata Basin

- However, all extreme storm types are ~3% of total storm counts

Table 2. Climatological DJF rain contribution in the tropics and subtropics of S. America

	Tropics (%)	Subtropics (%)
Deep Conv.	0.17	0.88
Deep/Wide Conv.	0.27	5.87
Wide Conv.	3.56	11.12
Broad Stratiform	6.91	17.15

- Overall, the tropics receive more rain than the subtropics
- HOWEVER, the climatological contribution from extreme storms identified by TRMM is significantly larger in the subtropics!

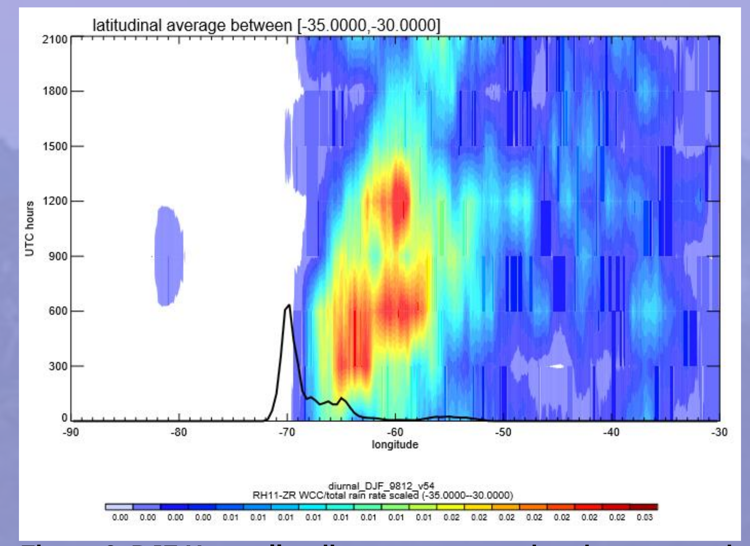


Figure 6. DJF Hovmoller diagram representing the progression of Wide Convective storms in La Plata South, averaged over latitudes [-35,-30].

- Increase in rain rates downstream of the Andes
- MCS initiation and propagation evident from the diurnal cycle of precipitation
- Highest rain rates directly over the La Plata Basin, which is expected from the rain contributions

Figure 7. Map showing the Río de la Plata drainage basin including major tributaries and cities.

Río de la Plata Basin
"One of the largest river basins on Earth"

- Main location of MCS propagation and highest rain contribution
- Precipitation is collected by multiple rivers and used to operate hydroelectric dams

★ Precipitation from extreme storms plays a crucial role in the hydrological cycle of the La Plata Basin ★

Conclusions

- Amazon and North Foothill precipitation is affected by smaller non-extreme echoes
- Rain contributions from storms containing extreme echo elements are much greater in the subtropics than the tropics because of more frequent intense convection
- Extreme cores are relatively rare in occurrence, but significantly contribute to the climatological rain in all regions
  - In La Plata Basin extreme cores represent ~3% of the total storm counts, but <u>contribute ~95% of the total rain</u>

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