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

Megan Chaplin, Kristen L. Rasmussen, Manuel D. Zuluaga, and Robert A. Houze, Jr.

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)
- South American mesoscale convective systems (MCSs) are ~ 66% larger than those over the United States (Velasco and Fritsch 2007)
- Larger and longer-lived precipitation areas than those over the United States or Africa (Durbin et al. 2009)

Background

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

Rainfall contribution by storm type

- 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 to understand the rainfall from extreme 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

Conclusions

- 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 rainfall contributions

Acknowledgements

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Rainfall contribution 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 (%)

<table>
<thead>
<tr>
<th>Storm Type</th>
<th>Tropics</th>
<th>Subtropics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Conv.</td>
<td>0.06</td>
<td>0.36</td>
</tr>
<tr>
<td>Deep/Wide Conv.</td>
<td>0.00</td>
<td>0.70</td>
</tr>
<tr>
<td>Wide Conv.</td>
<td>0.12</td>
<td>0.17</td>
</tr>
<tr>
<td>Broad Stratiform</td>
<td>0.68</td>
<td>0.17</td>
</tr>
</tbody>
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- Orogenographic influence of the Andes on the precipitation distribution in the subtropics
- For the La Plata Basin (red region):
  - Contribution of convective categories to the total warm season rainfall: ~ 66%
  - Including BSRR 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

- 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!

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

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<th>Rain Type</th>
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<tr>
<td>Deep Conv.</td>
<td>0.17</td>
<td>0.88</td>
</tr>
<tr>
<td>Deep/Wide Conv.</td>
<td>0.27</td>
<td>5.87</td>
</tr>
<tr>
<td>Wide Conv.</td>
<td>3.56</td>
<td>11.22</td>
</tr>
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<td>Broad Stratiform</td>
<td>6.91</td>
<td>17.15</td>
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Figure 1. Locations of intense convective events using the color code matching their rarity from Zipser et al. (2006)

Figure 2. Locations of storm types in South America

Figure 3. DJF rainfall climatology

Figure 4. DJF rain contributions from each storm type and their contribution to the total rainfall in each region, expressed as a percentage.

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

Figure 6. Map showing the Rio de la Plata drainage basin including major tributaries and cities.

“Rio 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

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