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Diurnal cycle of extreme convective elements in the Andes mountains of tropical South America

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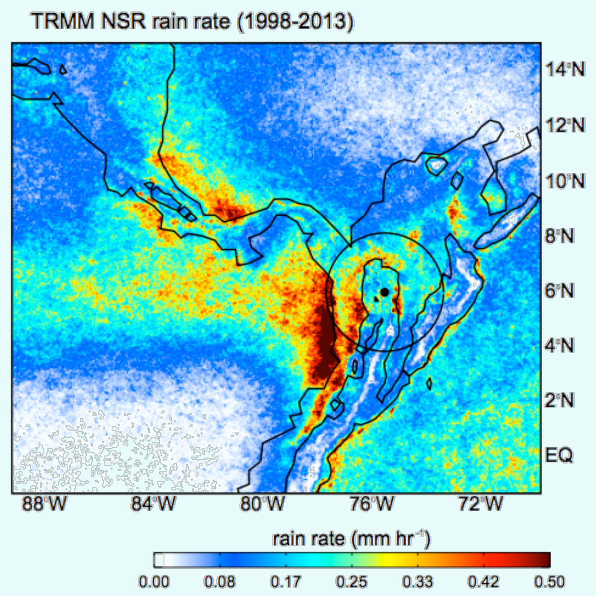
Introduction

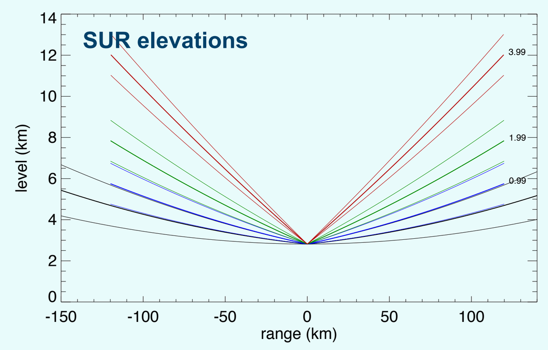
- The tropical region of South America is unique in weather related importance since it is a place where the ITCZ intersects elevated topography
- The relative warm waters of the Pacific ocean favors the region into obtain a climatological maximum in precipitation [1], and to have a large concentration of MCSs [2, 3] producing convective storms exhibiting a different variety of forms
- In this study we employ data from TRMM satellite and from a ground radar to identify and analyze the diurnal cycle of the different forms of extreme convection in this region of the world

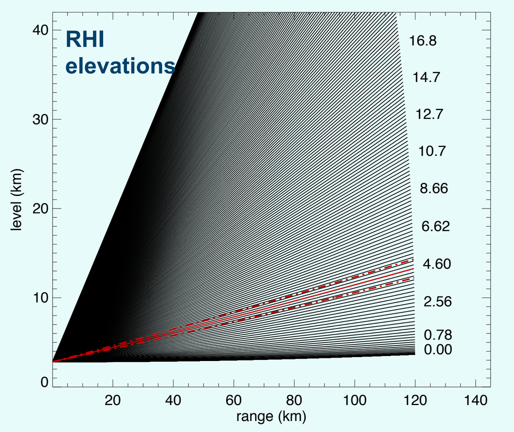


Datasets

- UW interpolated TRMM-PR database (Houze et al. 2015) and LIS data version 7 for 1998-2013
- Reflectivity fields from a dual polarization, doppler C-Band radar located in the city of Medellin (CMED, Fig. 1), and operated by the Sistema de Alerta Temprana del Valle de Aburrá (SIATA). (2013-2016)

CMED scanning strategy

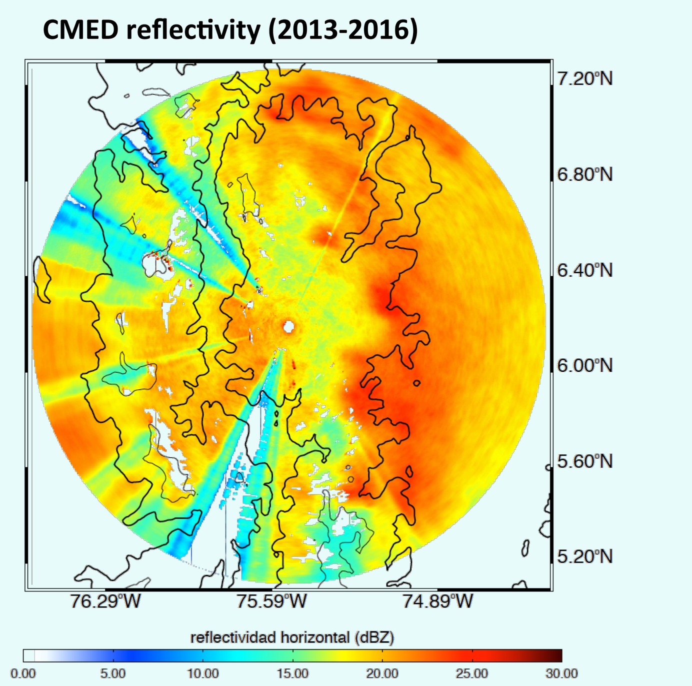


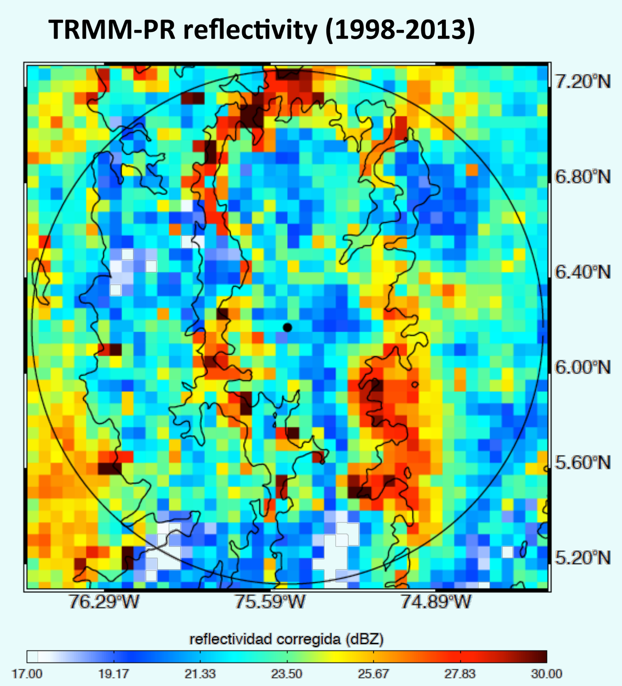


- Operationally, the CMED radar scans the volume alternating between surveillance (SUR, 0.5°, 1.0°, 2.0° and 4.0° elevations up to 120 km) about every 5 min, and elevation angle scans (RHI) in 4 fixed azimuths (N, S, E, W)
- The only polarimetric radar that has been capturing fine vertical resolution scans (RHIs) for almost 4 years!!!

- CMED data was interpolated to cartesian grid using NCAR-RadX routines.
- A Convective/Stratiform separation algorithm [4] was applied to CMED reflectivity at 3 km, and data was visually inspected and compared to match TRMM overpasses when available

CMED and TRMM annual climatology

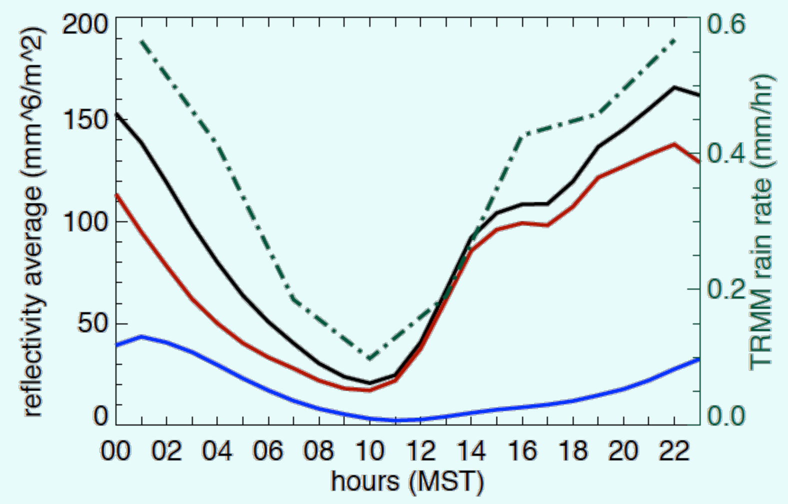




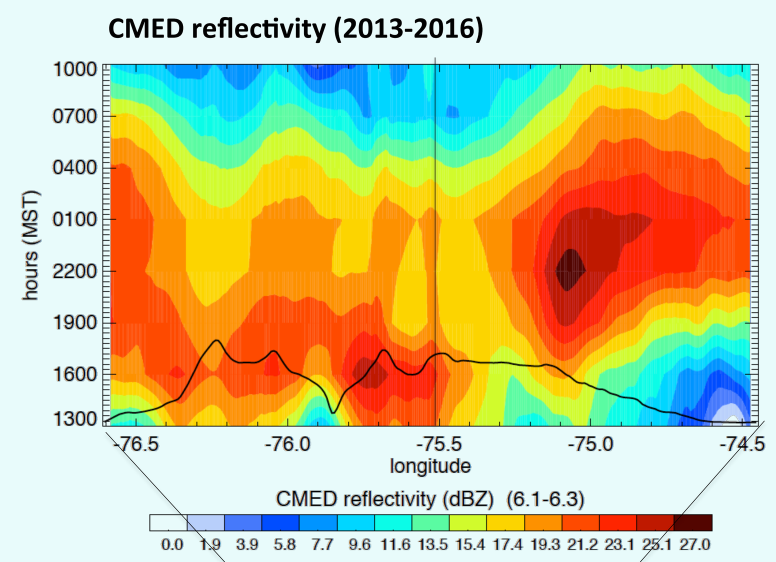
- Maxima of rainfall associated to orographic enhancement in regions of high moisture and instability. In some areas, reflectivity values comparable to maxima in the Pacific coast
- Annual climatology of reflectivity shows very similar patterns, specially for those regions with intense rainfall

Diurnal cycle of reflectivity and rain rate

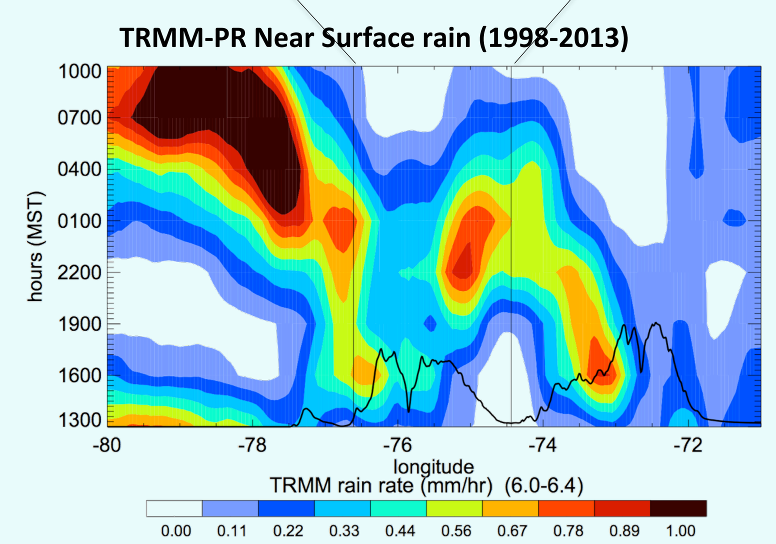
- Diurnal cycle of accumulated reflectivity at 3 km in the area of the radar for total (black), convective (red) and stratiform (blue) rain. TRMM diurnal averaged NSR rain rate in green
- Afternoon and late-night peak of rain associated with convective storms, after-midnight peak for stratiform rain
- Sequence possible associated with the translation from deep convective to stratiform rain

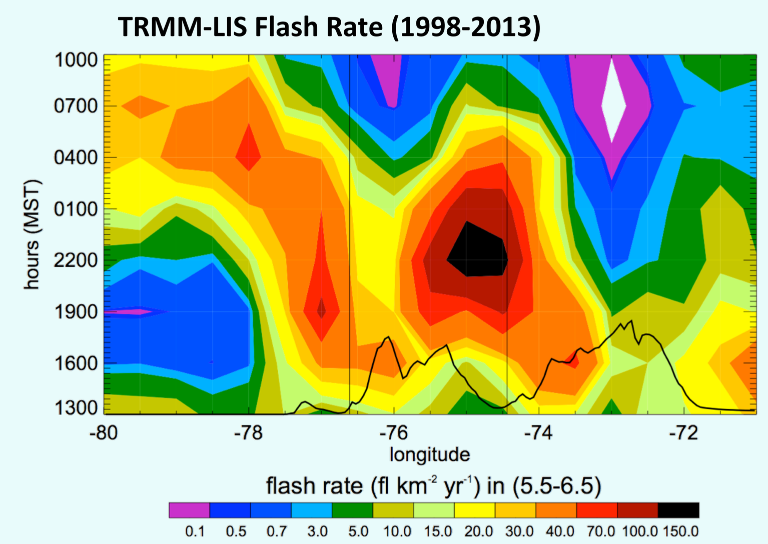


Longitudinal diurnal evolution



- Time-longitude diagrams representing the diurnal progression of the CMED reflectivity, TRMM-PR near surface rain and TRMM-LIS flash rate for the region of CMED coverage
- Two maxima of rainfall, one in the afternoon for the region close to CMED radar, the other around midnight for the region to the east
- A clearer progression from the afternoon to midnight to the west of the radar
- A midnight lighting maxima maxima at the slopes of the cordilleras, coincident with the rainfall maxima

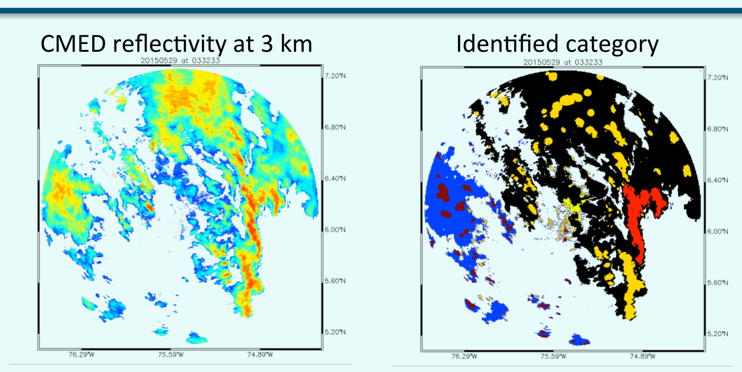




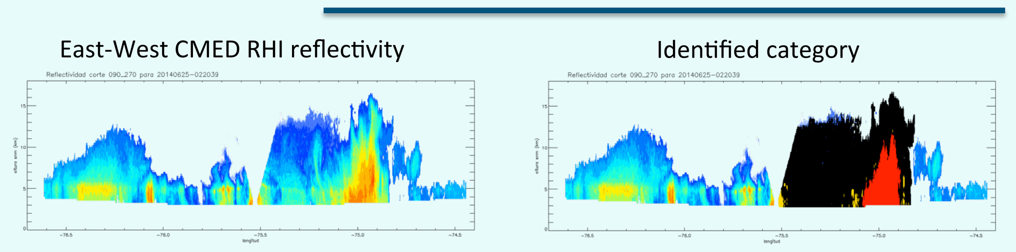
Extreme category identification

- Use the advantage of CMED scanning strategy to combine methods to identify stratiform and convective events developing extreme characteristics of intensity, height and size, similar to [5]

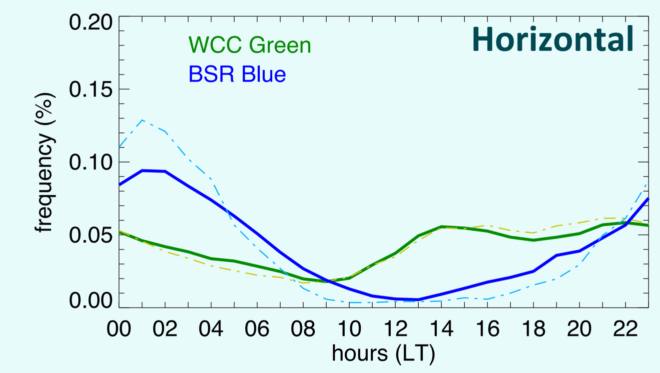
- **Horizontal method**
  - *Wide Convective Cores*
    - Refl > 40 dBZ
    - Area > 100 km²
  - *Broad Stratiform Regions*
    - Area > 5000 km²

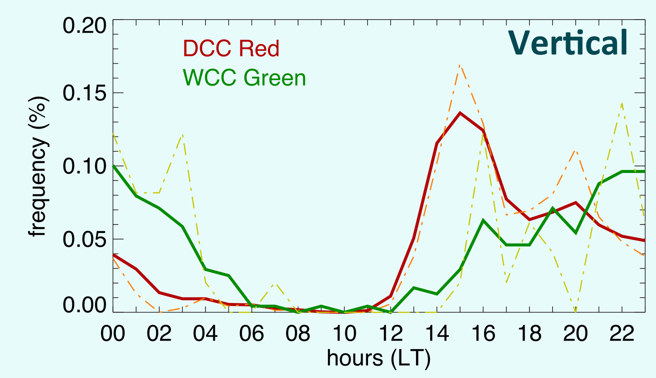


- **Vertical method**
  - *Deep Convective Core*
    - Refl > 40 dBZ
    - Z dim > 8 km
  - *Wide Convective Cores*
    - Refl > 40 dBZ
    - X dim > 8 km

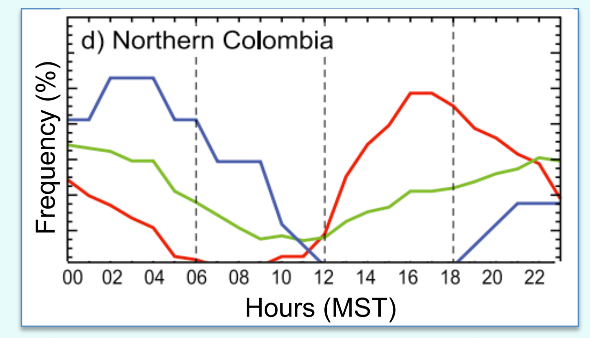


Diurnal cycle of extreme categories





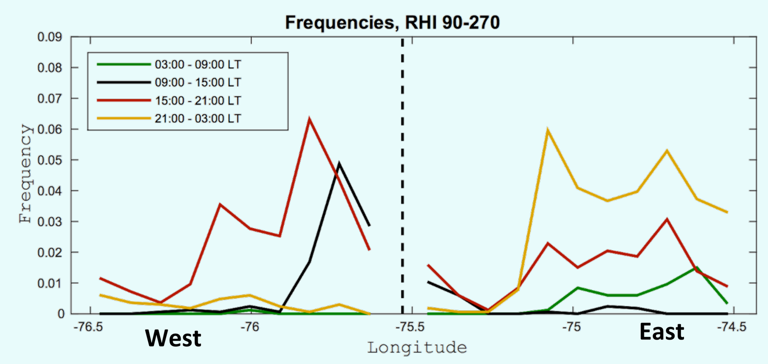
- Frequency of Deep Convective Cores (red) maximizing in the afternoon, Wide Convective Cores (green) in at midnight, and Broad Stratiform Regions (blue) after midnight
- Sequence associated with the life cycle of convective events
- Similar results using TRMM based convective categories as in [3]

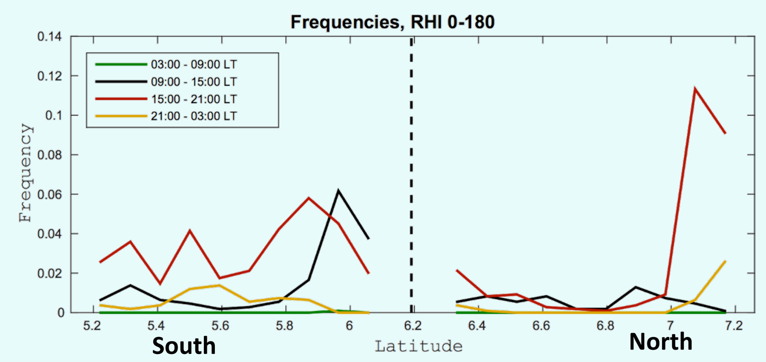


Diurnal cycle of the frequency of occurrence of DCC (red), WCC (green), and BSR (blue) using TRMM radar reflectivity data (adapted from Zuluaga and Houze 2015)

Longitudinal and latitudinal location of DCC occurrence

- Longitudinal and latitudinal profiles of the relative frequency of occurrence of Deep Convective Cores identified using the Vertical (RHI) method
- Each line represent the time of occurrence during the day
- In the West-East profile, DCC maximizes in the afternoon (to the west) and night (to the east)
- In the North-South profile, DCC maximizes in the afternoon





Conclusions

- This study uses de advantage of two different radars to analyze the distribution of extreme convective elements that occur in a mountainous region of the tropics
- Rainfall distribution during the day show a maximum peak at midnight and a secondary peak in the afternoon, related to the type of convective elements and the location with respect to the radar
- Sequence of extreme convective elements changing from intense and deep convective cells, to horizontally wide convective elements, and then to mature and broad stratiform regions
- These stages are analogous to the life-cycle of an individual MCS and represent the changes in the convective cloud population relative to the maximum of rain

References

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