Assessment of the Influence of Topography in
Extreme precipitation Events in Andean Northwestern Colombia

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Introduction

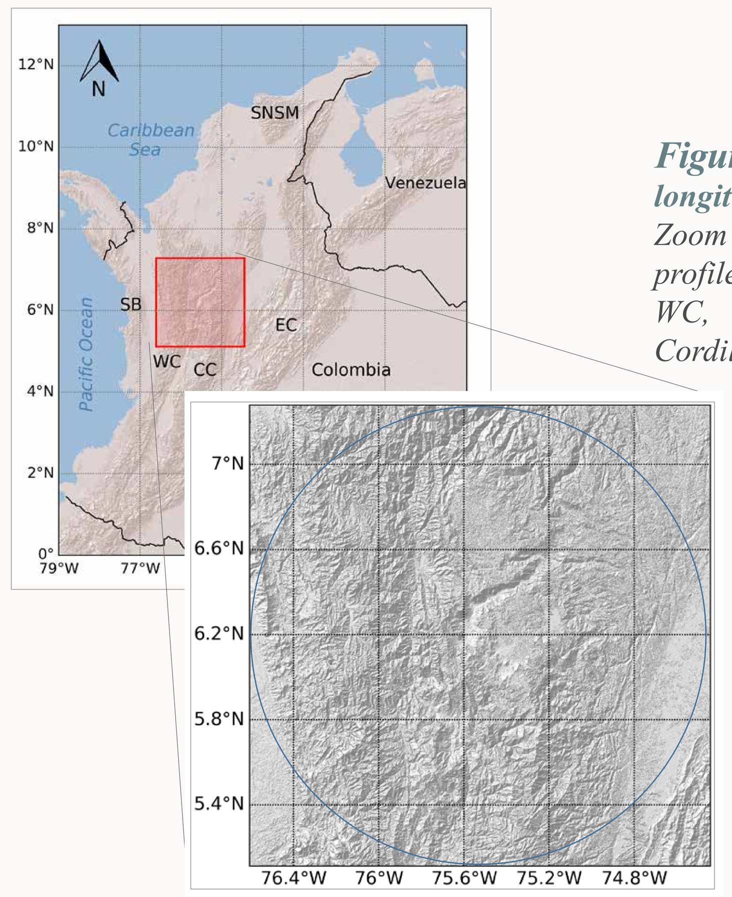
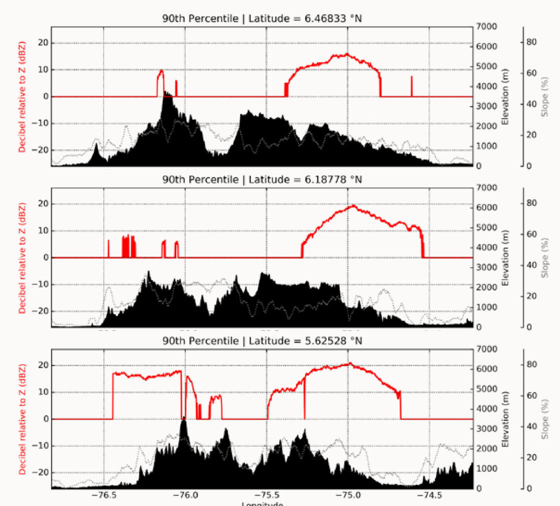


Figure 1. Zoom of the area of study with different longitudinal profiles. *Zoom of the area of study with different longitudinal profiles. Red lines show 90th percentile reflectivity of 2015. WC, CC, EC indicate the Western, Central, Eastern Cordillera.*



Colombia is an equatorial country located in the western corner of South America that stretches from 12ºN to 4ºS. The Andean Cordilleras stretch in north-northeastern direction in the western part of the country (see figure 1)

The Colombian Andes are divided into three major branches: the Western, Central and Eastern Cordillera; these are separated by two inter-Andean valleys: the Cauca and the Magdalena Valley, respectively. Its latitudinal extensión, layout and variable extensión in height and width, make Los Andes the natural scenario of a wide variety of mountain meteorological phenomena such as orographic precipitation, which in many cases is associated with extreme precipitation events and have a high relevance regarding local risk management.

Extreme precipitation events have detonated several catastrophic events. This investigation aims to identify and understand the role of orography.

Methodology

Data	ERA5 Reanalysis, Meteorological Radar and ALOS PALSAR DEM	
Methods	Cases of Study	• Reflectivity behavior for each case. • Hovmoller diagrams (longitudinal profiles). • Wind vertical profiles.
	Extreme Events	• Frequency of events >40dBZ (reflectivity values). • Scatter plots: Frequency vs Height and Slope. • 2D Spatial Histograms. • Positive and negative derivatives for events >40dBZ.
	Life Cycle	• Wind composites before, during and after extreme precipitation events. • Duration and gaps histograms. • Diurnal cycle of events for each month.

Results

Cases of Study

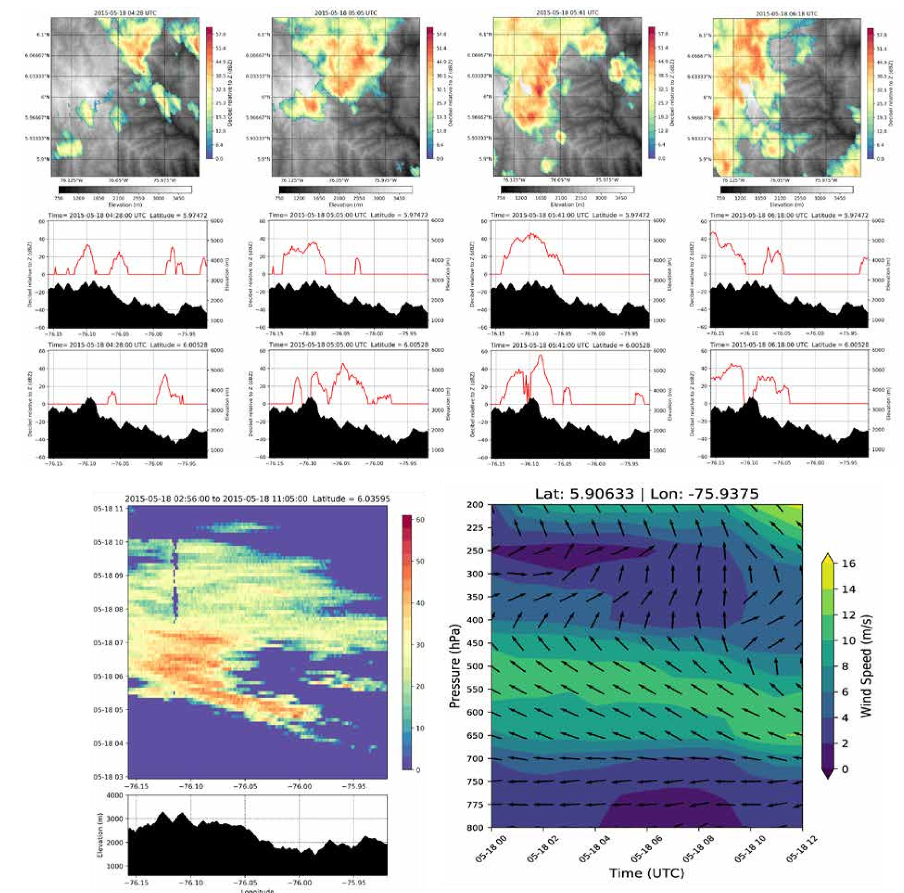
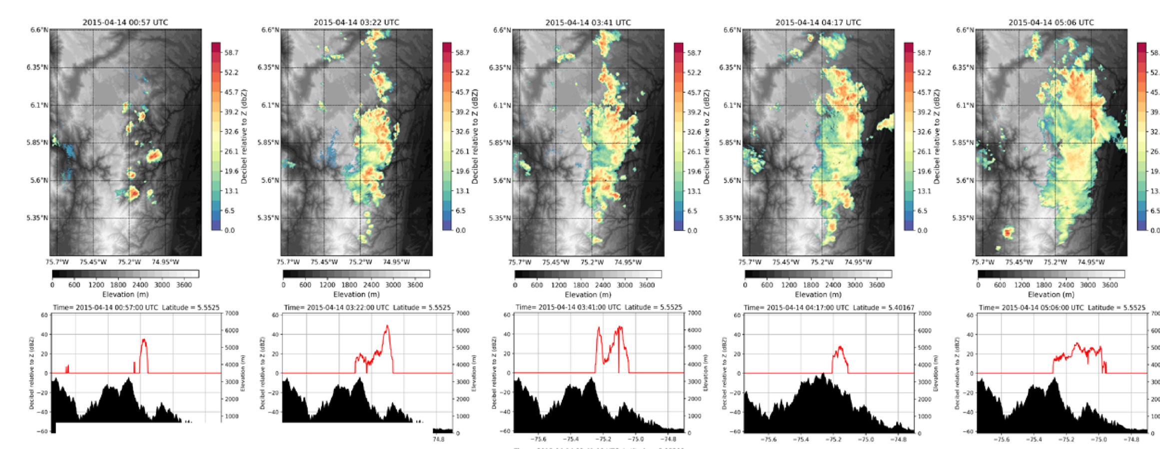


Figure 2. Salgar case

Salgar

As seen in figure 2, an event of medium intensity (20-30dBZ) approaches the upper part of the basin, its interaction with the highest slopes force a significant increase in intensity: the cores of maximum intensity exceed 60dBZ.



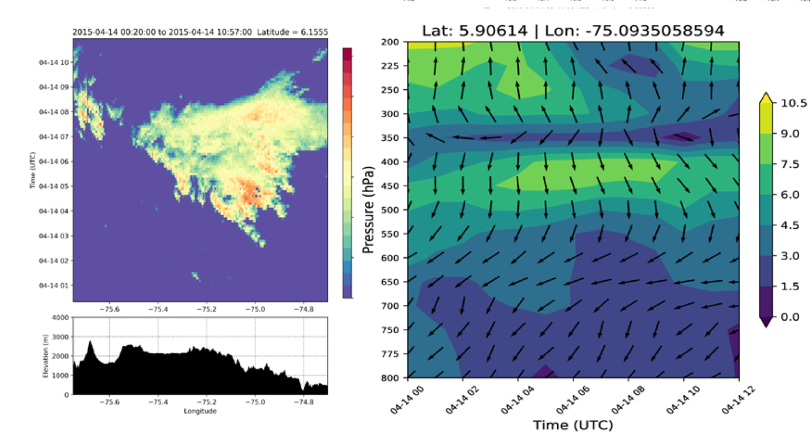


Figure 3. Magdalena Valley case

Magdalena Valley

Most of the study cases develop in this zone; they usually begin with the appearance of high intensity scattered cores (see figure 3).

Temporal and Spatial distribution of Extreme Precipitation Events

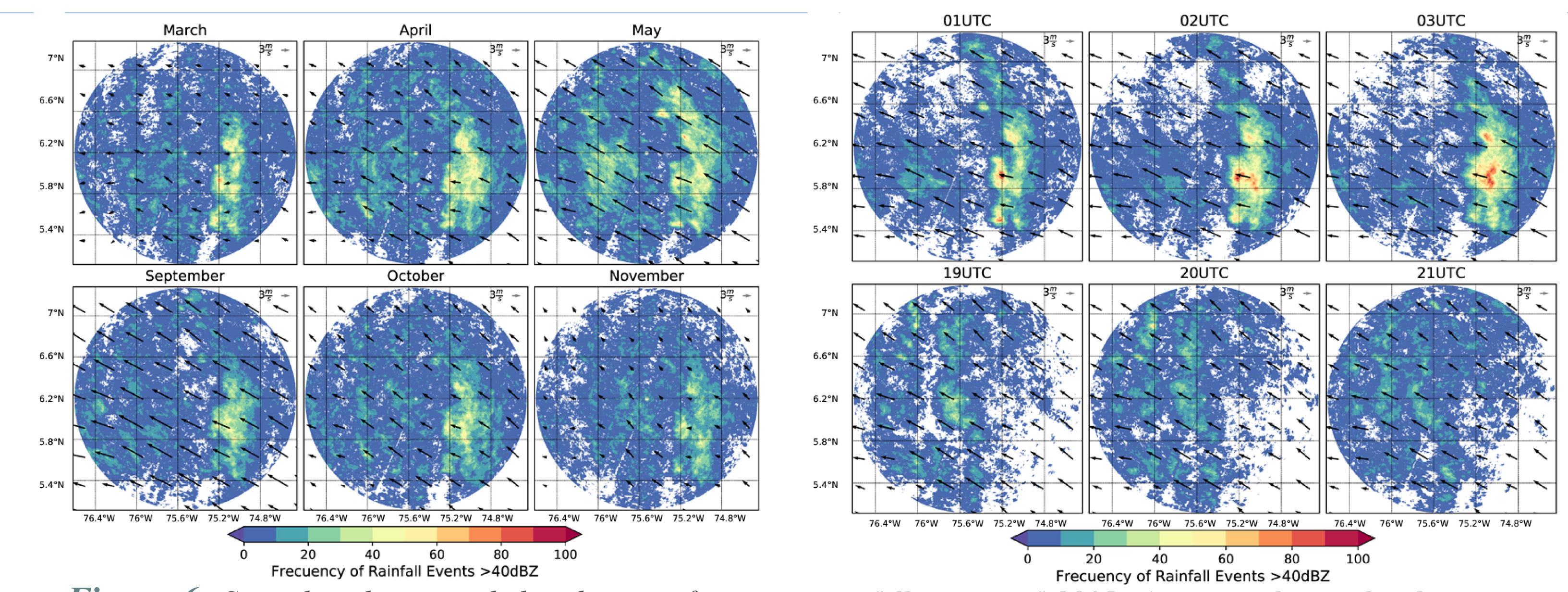


Figure 6. Spatial and temporal distribution of extreme rainfall events of 2015. Arrows indicate the direction and magnitude of the wind at 600hPa.

According to figures 4 and 5, the highest values are mainly distributed latitudinally towards the Eastern slope of the Central Cordillera and near Cauca Valley. Magnitudes vary according to diurnal and annual precipitation cycle; the maximum values occur in MAM and SON trimester. In the hourly scale highest frequencies arise near 2UTC in Samaná and Samaná Norte river basins *(towards the Magdalena Valley)*, and near 20UTC in the Cauca and Atrato valleys. The intensification of the events also occur in the mentioned zones *(see figure 6)*.

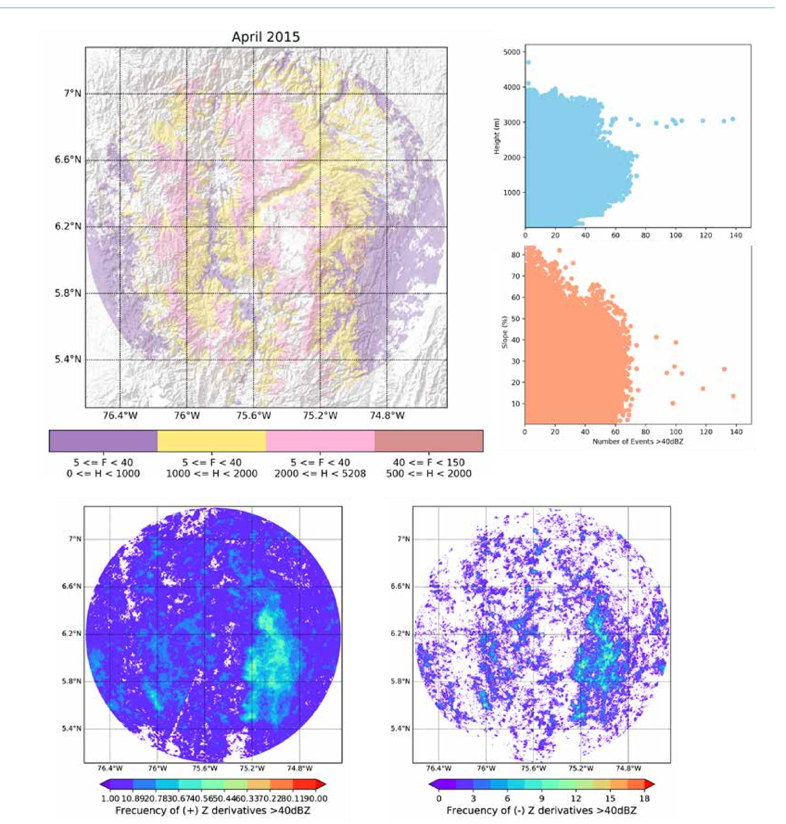


Figure 6. 2D histogram and positive-negative derivative of extreme events for April 2015.

Life Cycle

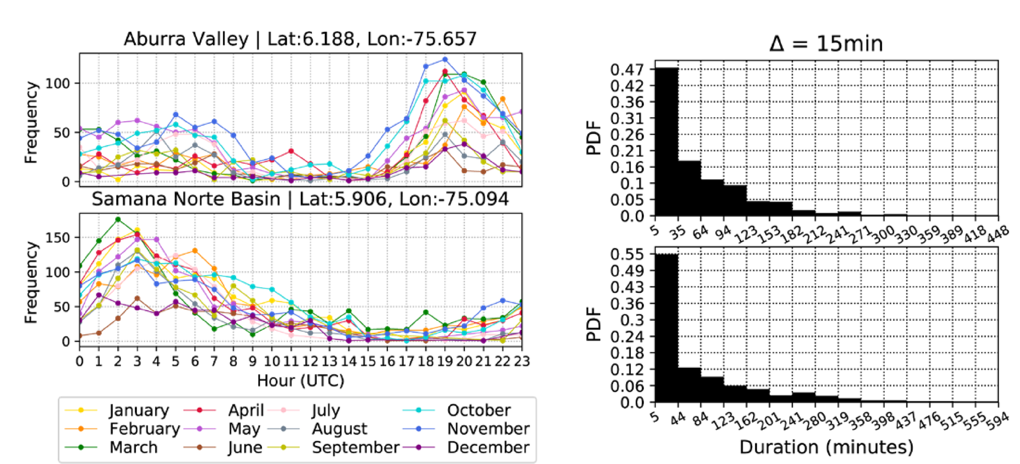


Figure 7. Diurnal Cycle of the extreme precipitation event according to every month and histograms of duration for each basin.

Most of the analyzed extreme precipitation events are of short duration. However, there is a difference between the location of them. Near Magdalena valley can be longer (see figure 7).

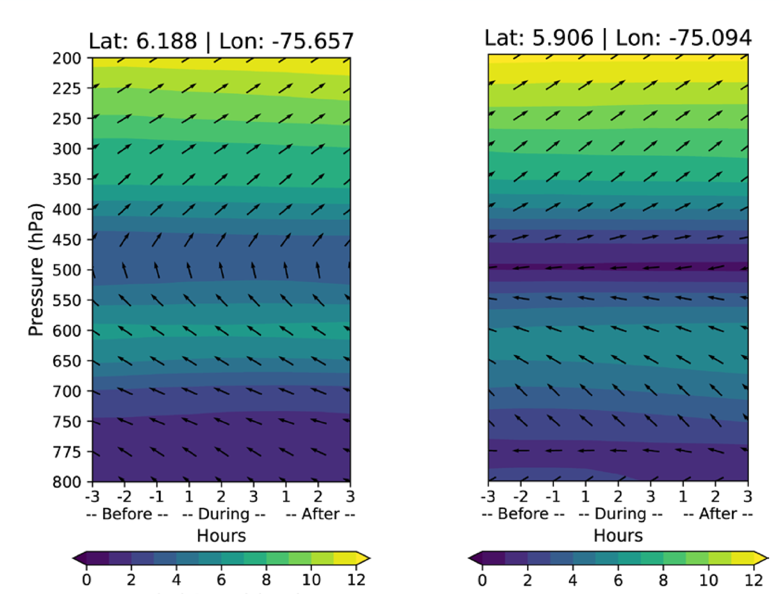


Figure 8. Wind composites of the extreme precipitation events in the Aburra Valley basin(left) and the Samana Norte basin (right).

The mid-atmosphere winds are always predominantly in the northwestern direction, during the events in the analyzed basins. This indicates that the intensification or generation of the events also depends on the geometry and orientation of these basins (see figure 8) Specific humidity is also analyzed finding that usually there are higher values before the event.

Discussion

Location of the pluviometric optimum can change depending on the diurnal and annual variability of the winds and humidity. The observations suggest that the preferential mechanisms for the development and intensication of extreme precipitation events is related to wind (moist advection) approaching mountain barriers (similar to the mechanisms shown in figure 9).

Figure 9. *Mechanisms by which mountains and hills affect precipitating clouds. Taken from Houze (2011).*

Authors suggest that the size of the mountain is relevant to determine where rainfall will occur (for example on the windward slope) but the whole distribution of the basin according to the wind direction is important in the analyzed cases.

Conclusions

Regardless of the preferential mechanisms found in orographic precipitation, height is a necessary but not sufficient condition for the development and intensification of precipitation events. Due to combination the factors described, the basins with higher frequencies of orographic precipitation and extreme events are Samaná and Samaná Norte basins. In general, extreme events seem to have a close relationship with the topographical disposition of the study area.

Bibliography

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Acknowledgements

This work was supported by Area Metropolitana de Medellín y de Valle de Aburrá, Municipio de Medellín, Grupo EPM, and ISAGEN under the contract CD511 of 2017. This work is also supported by UNiversidad Nacional de Colombia, Sede Medellín.

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