Mesoscale Convective Systems in the Colombian Caribbean: Insights from Convection-Permitting simulations

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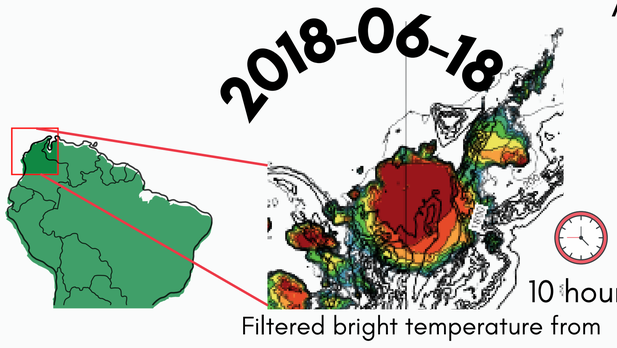
1. Introduction

Mesoscale Convective Systems (MCSs) are organized long living thunderstorms, larger than hundreds of kilometers. Over **northern Colombia (NOC)** they tend to occur more during the **nights of June to August. However**, the mechanisms behind their formation have not been totally described.

This work selected **two MCSs over NOC** from the University of Washington convective core Database, with the goal of diagnosing the low-level circulations associated with their formation.

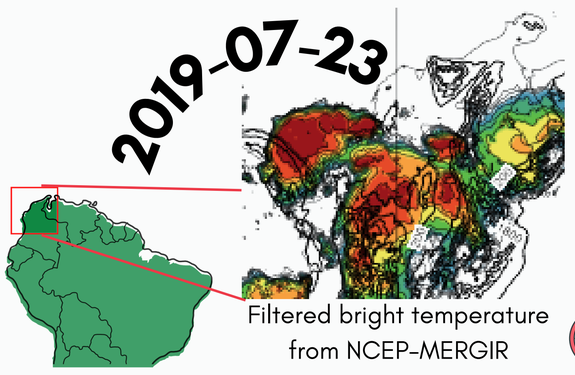
The MCS events are:

Magdalena event, characterized by southerly winds from the Amazon Basin (SM 1)



	GPM	NCEP
Area	82000 km^2	144000 km^2
Accumulated Precip.	**GPM** 40 mm	**IDEAM** 25 mm

Cordoba event, characterized by the passage of an African Easterly Wave (SM 2).

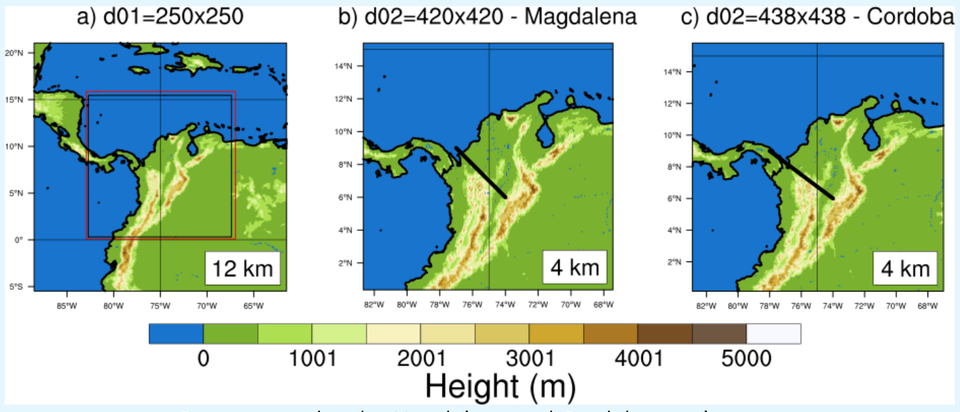


	GPM	NCEP
Area	69700 km^2	118000 km^2
Accumulated Precip.	**GPM** 38 mm	**IDEAM** 40 mm

3. Methodology

Based on data from **two simulations using the WRF model at *Convective Permiting* resolutions (4 and 1.3 km)**. Focus on the associated **precursor low-level mesoscale circulations.**

MP: Morrison **PBL:** YSU **CU (d01):** New Tiedke
Runtime: 48 h (-24h) **Levels:** 50 **BC/IC:** ERA5 (31 km)



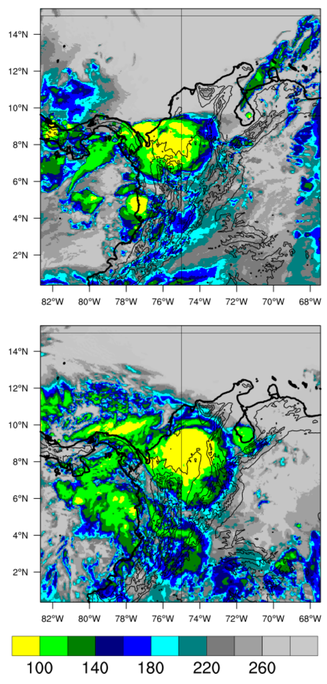
Domains used in the Magdalena and Cordoba simulations

ERA5
0.25°x0.25°
hourly
Global

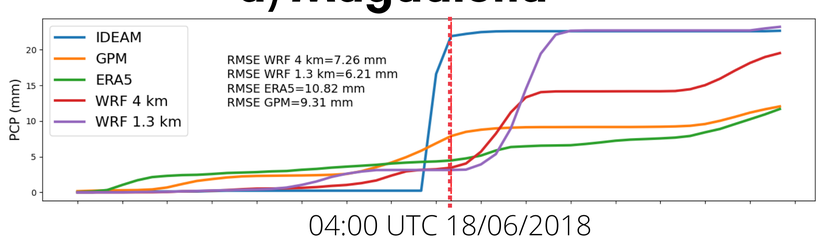
Each simulation has its own inner domain

4. Mesoscale conditions: WRF

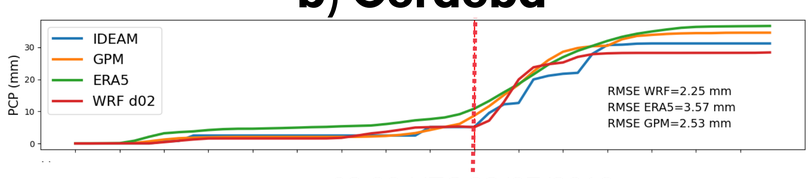
Both simulations reproduced a realistic MCS, with accumulated precipitation close to reality (IDEAM)



a) Magdalena



b) Cordoba

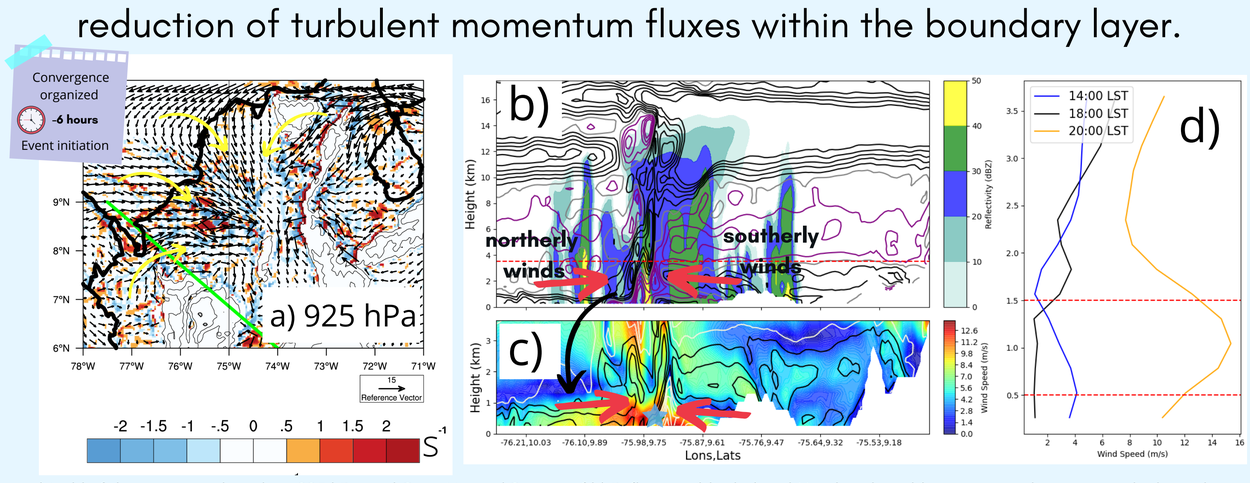


Fields of OLR and time series of accumulated precipitation for: a) Magdalena simulation, b) Cordoba simulation. Additional information in SM 3 and 4.

4.1 Cordoba simulation

This event was favored by strong convergence of low-level winds from the Caribbean and northern Pacific coasts. This pattern was observed at least since **6 hours** before the event initiation (SM 5).

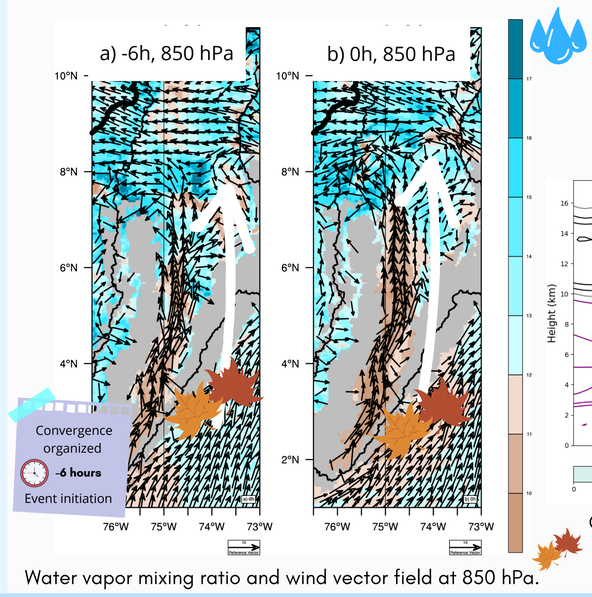
These low-level winds became stronger during the **night**, because of the reduction of turbulent momentum fluxes within the boundary layer.



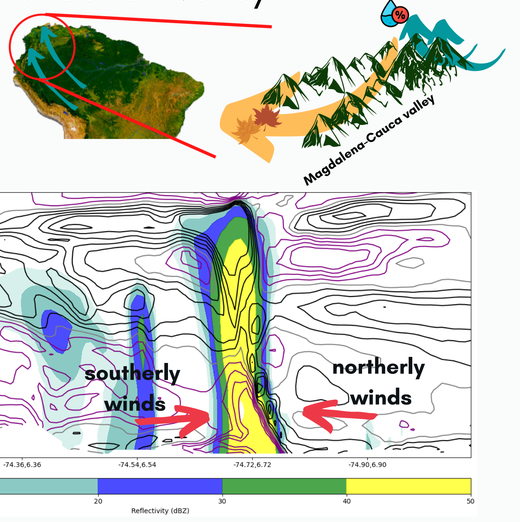
a) Field of divergence and winds at 925 hPa; and Cross Vertical Section of b) Reflectivity (shades) and Meridional wind (contours, purple means southerly winds, and black northerly).; c) Wind Speed (shades) and Meridional wind (contours; white means southerly winds, and black northerly); d) Vertical profile of Wind Speed over the star in (b).

4.2 Magdalena simulation

This event was favored by wind convergence from the Caribbean coast, and southerly winds from the Magdalena-Cauca valley (SM 6). The latter might be associated with southerly drier winds from the Amazon, which entered into the Magdalena-Cauca valley.



Water vapor mixing ratio and wind vector field at 850 hPa.



Cross Vertical Section of Reflectivity (shades) and Meridional Wind (contours), purple means southerly , and black northerly winds.

5. Conclusions

- **MCS over NOC** might happen under different synoptic conditions (e.g with or without the influence of African Easterly Wave). Sometimes mesoscale conditions might be more important than synoptic conditions.
- **The two low-level circulations** simulated by WRF (onshore winds and southerly valley winds) that favored convergence and convection, were observed **approximately 6 hours before** the initiation of each MCS.
- **The WRF model at CP resolutions** is able to reproduce the formation of organized convective events like MCSs, over a complex regions like **NOC**. However, more events should be simulated in order to better understand the possible mesoscale patterns associated with the MCSs over NOC. Currently, we are analyzing two more events.

References

Feng et al (2018)

Houze (2018)

Schumacher & Rasmussen (2020)

Zuluaga & Houze (2015)

Wang et al (2019)

Supplementary Material