A Mesoscale Convective System over the tropical Andes: role of the Orinoco Low-level Jet and PBL schemes

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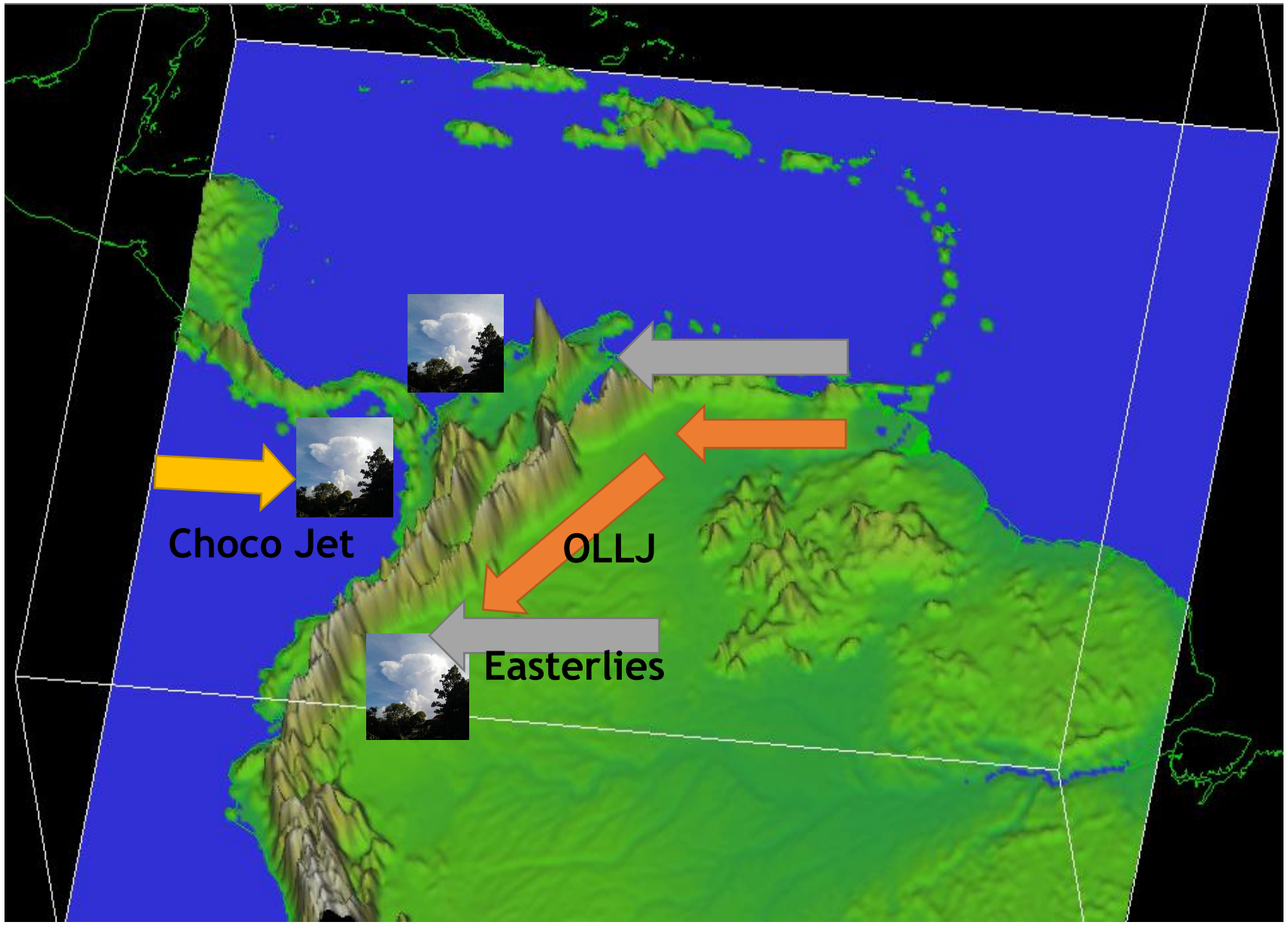
Northern South America



Tropical Andes:
Three branches in Colombia

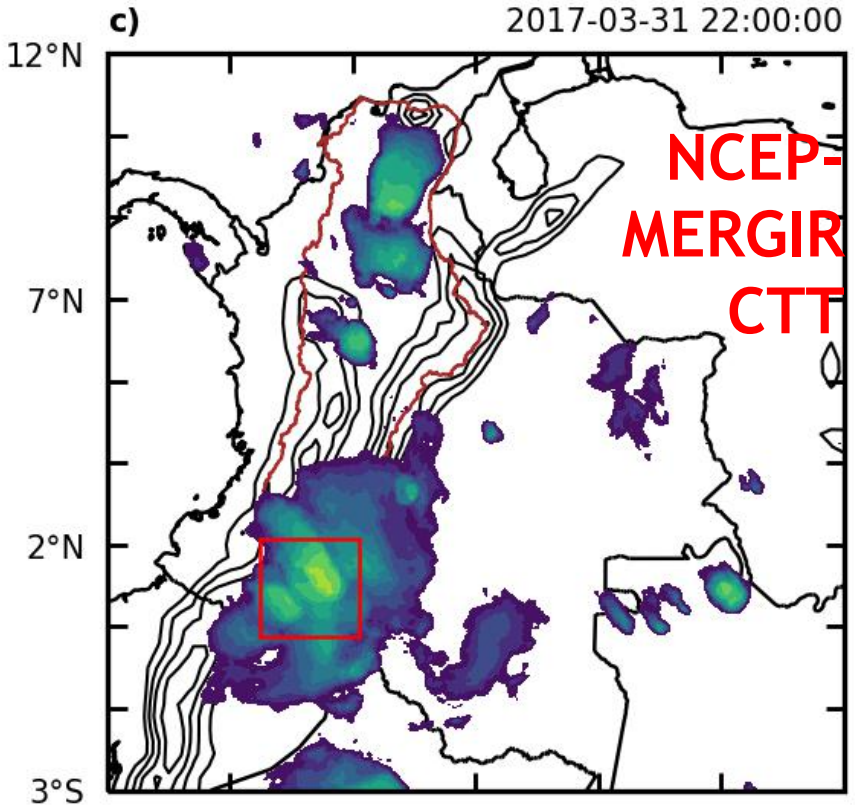
Orinoco Low-level Jet:
can provide moisture convergence

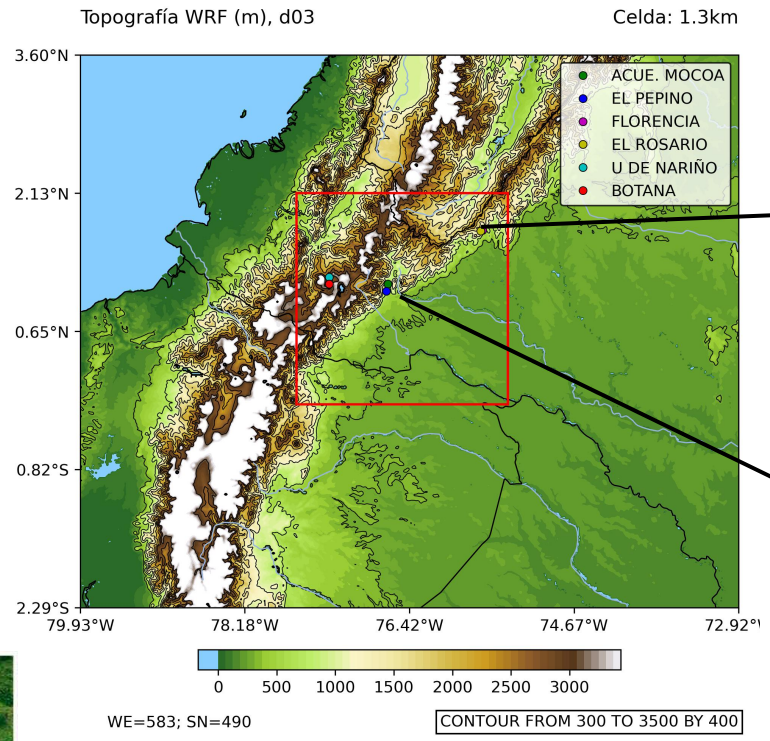
Easterlies can advect MCSs from the Amazon to the Andes

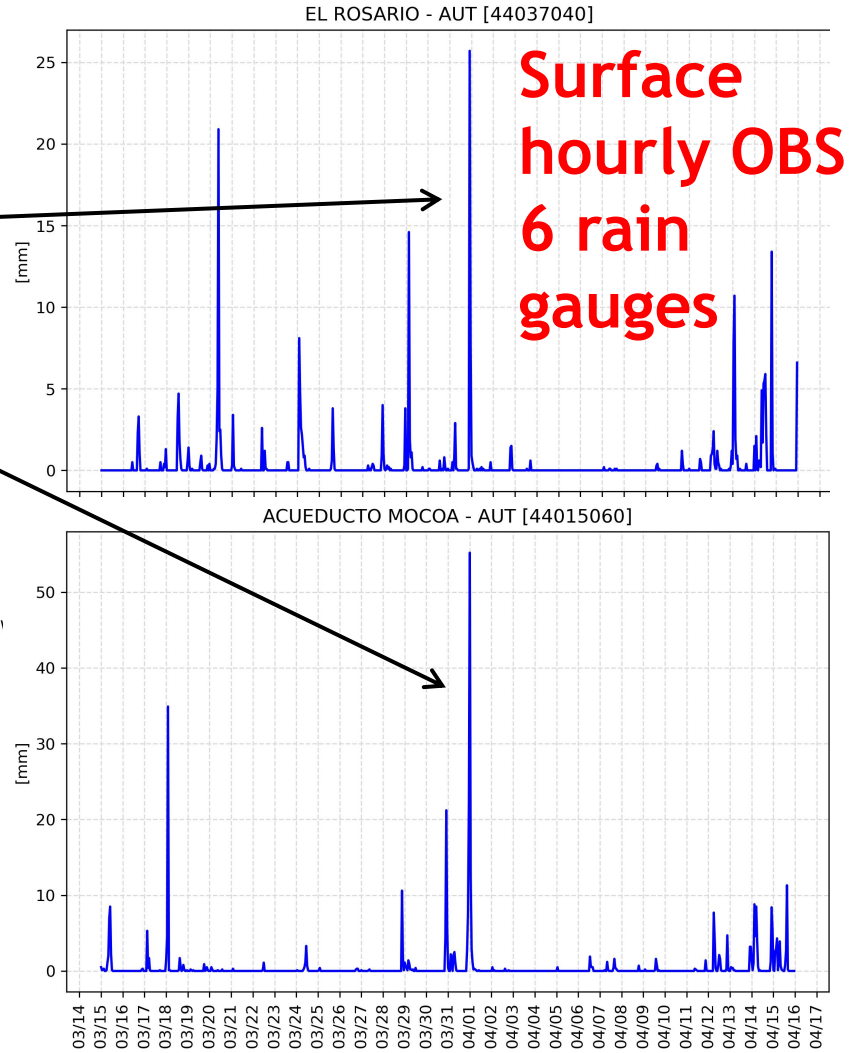
Context:
Sparse surface observations
Very few soundings over the region
Radar available only recently

General Goal:
Use CP simulations to understand and diagnose mesoscale circulations associated to topography and heavy precipitation

"Mocoa" Event (2017-04-01)



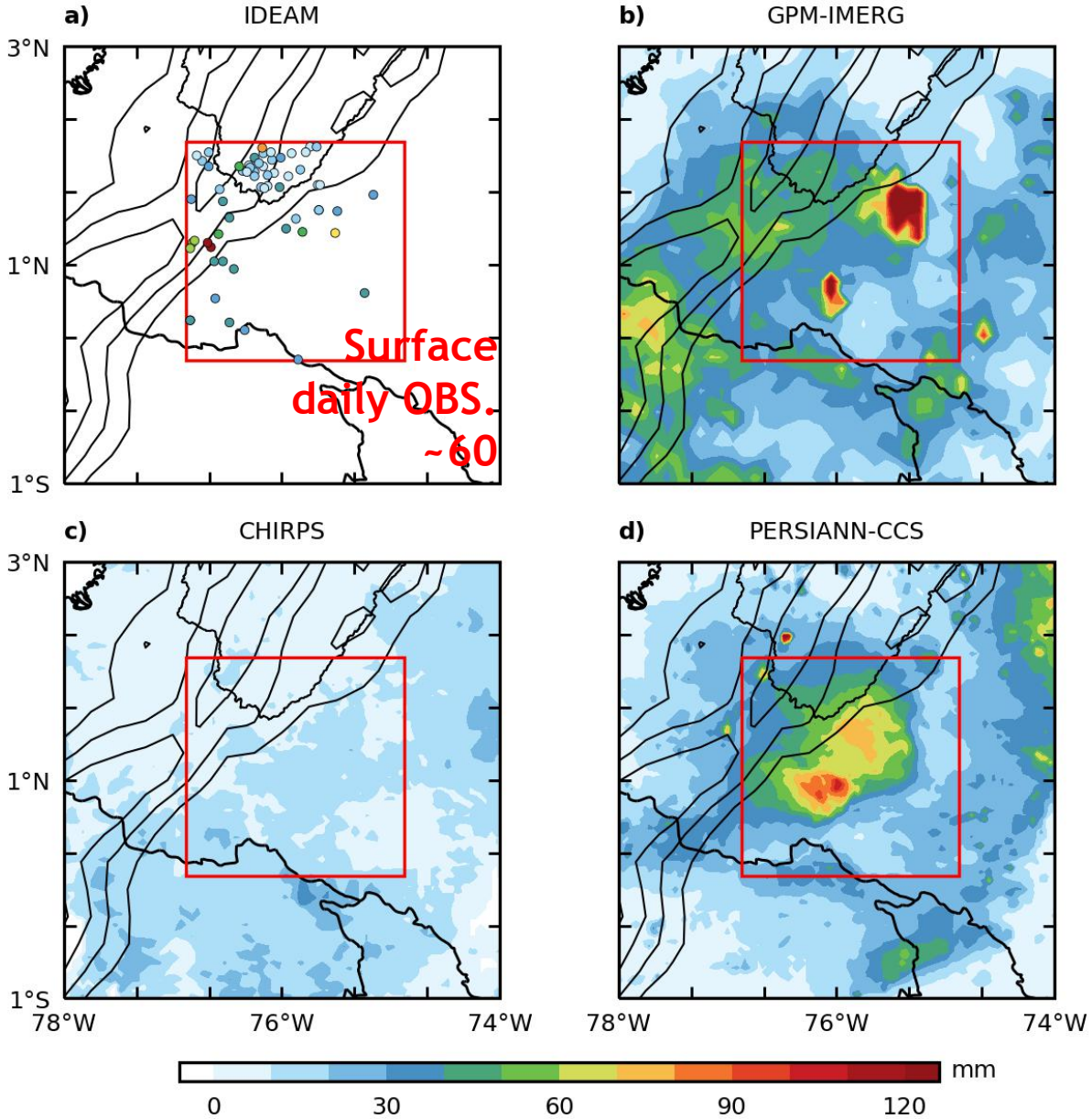




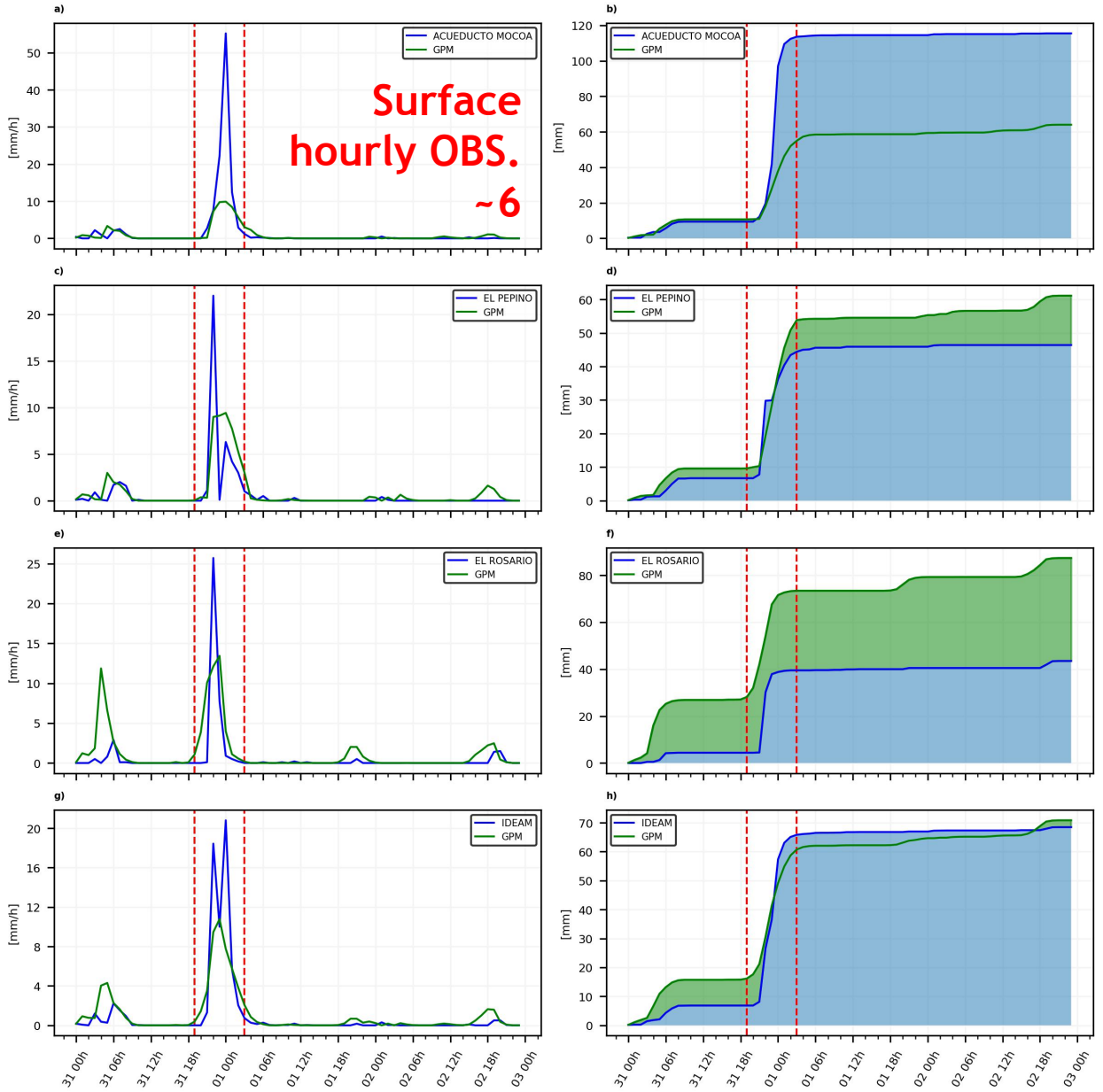
Surface hourly OBS. 6 rain gauges

- **Mesoscale Convective System formed over the Amazon, impacting parts of the Andes.**
- More than 300 casualties
- Heavy precipitation during the event.
- Other events on previous days.

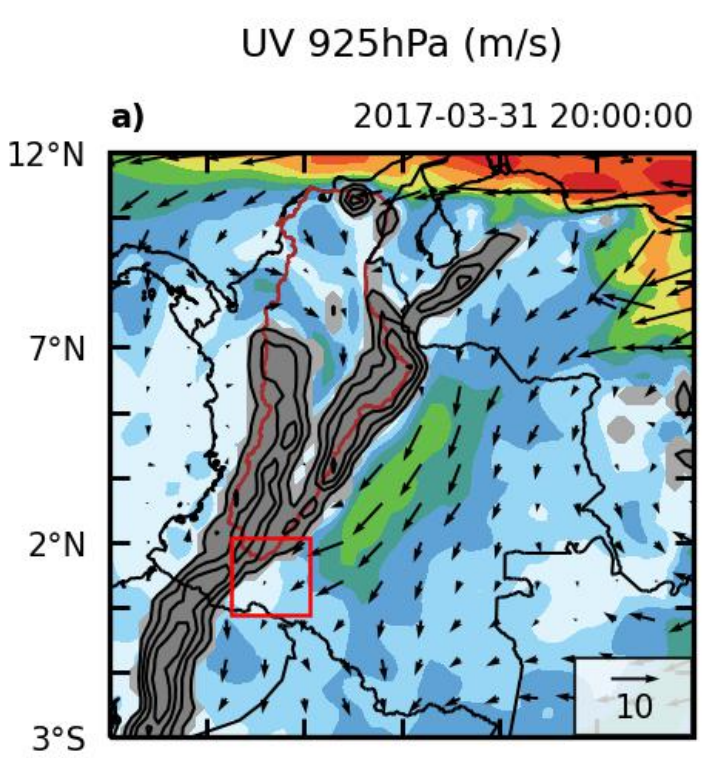
Larger accumulations over lowlands, and impacts over mountain areas

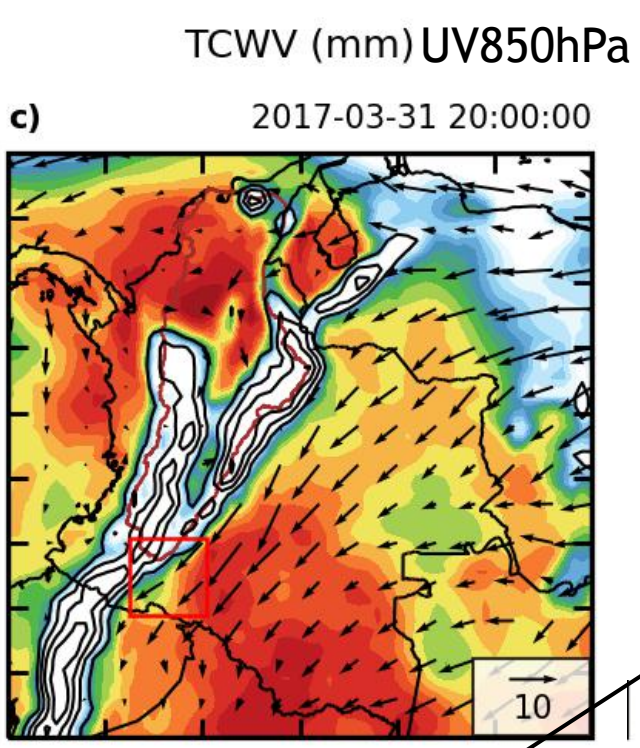


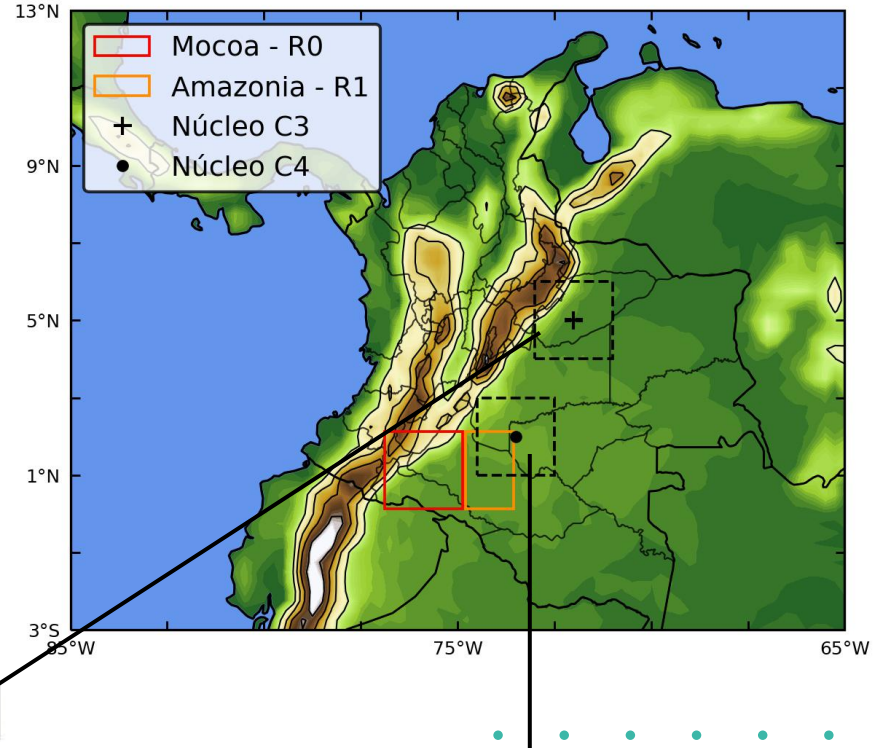
Few 1hly gauges. GPM ~ overestimates P.



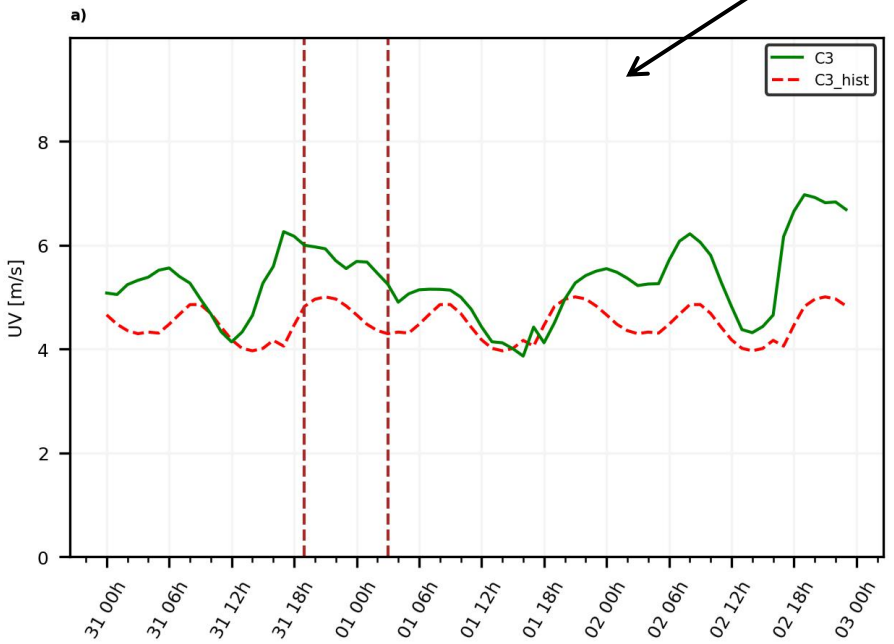
ERA5

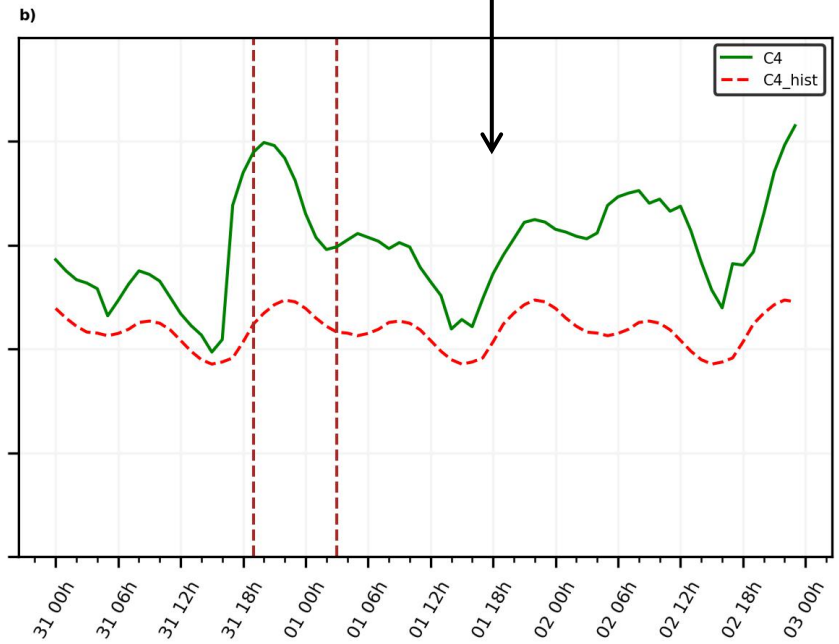




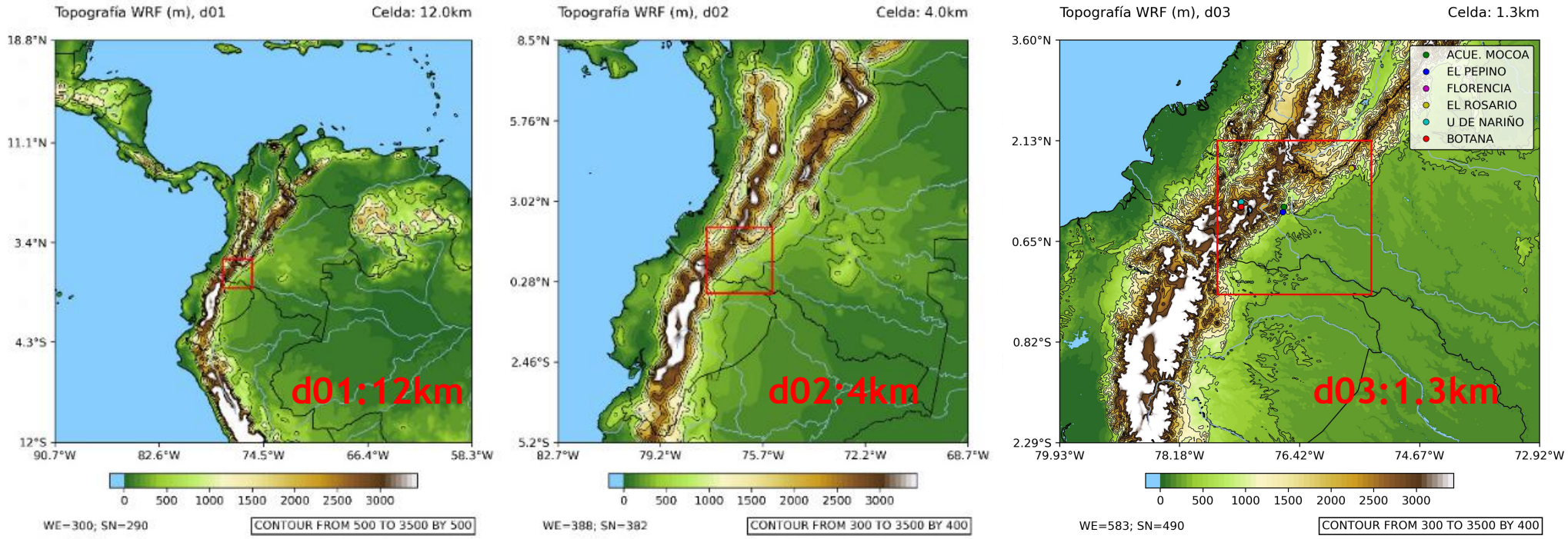


- **Strong OLLJ winds**
- Cores C3 and C4 (green lines) were stronger than normal (red lines) during several days around the event.
- Strengthening ~ 5-6 hours before the event

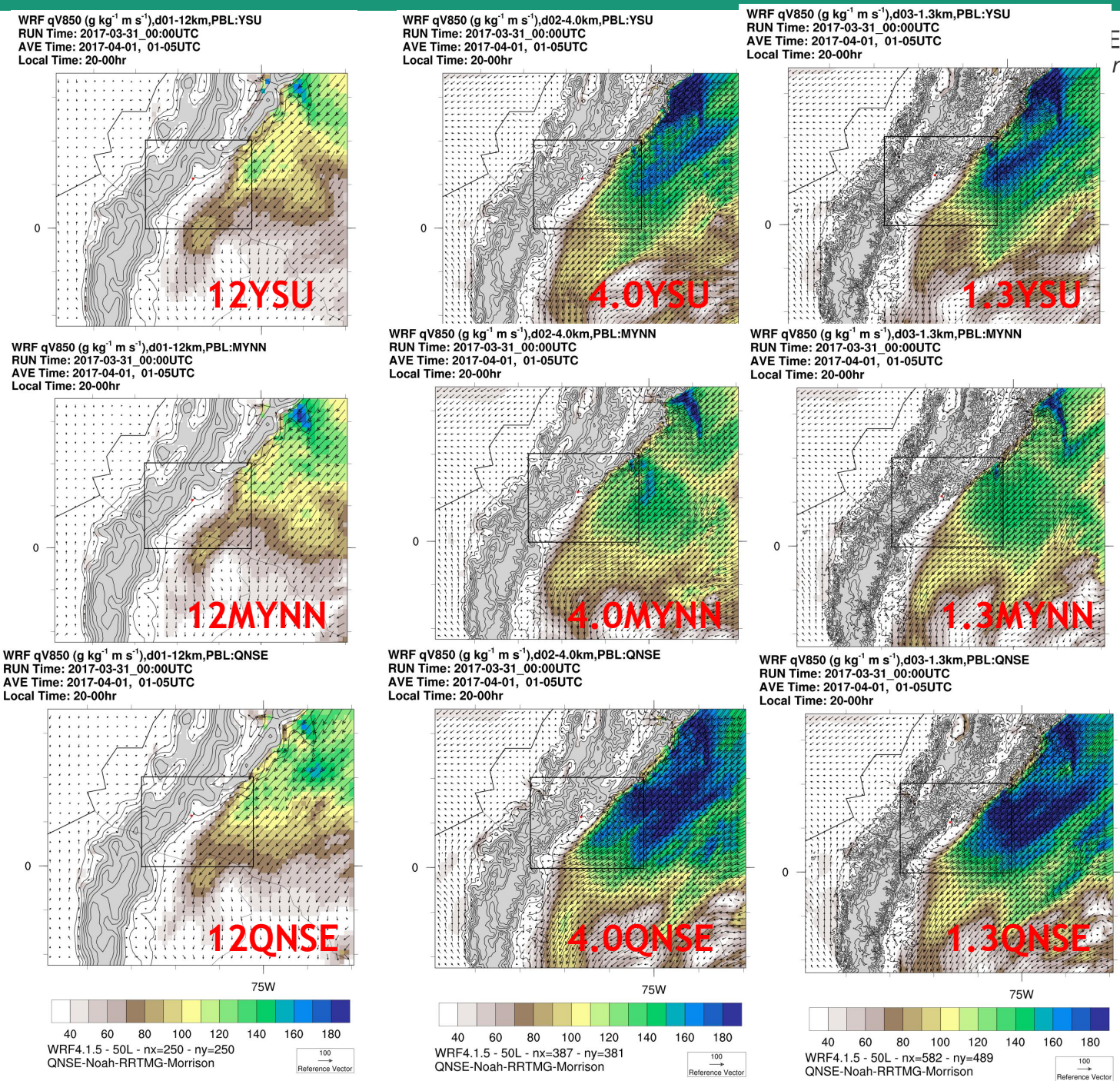




Question: which are the characteristics of low-level structures that are associated with the simulated MCS over this mountainous region?



- **WRF 4.1.5**, d01: 12km, d02: 4.0km, d03: 1.33km, 50 vertical levels, top at 20hPa
- 48 hour simulations, IC/BC from ERA5
- MP: Morrison; LSM: Noah; Rad: RRTMG, Cu-d01: New Tiedtke;
- **9 simulations**: 3 grids (12, 4, 1.3km) x 3 PBL schemes (YSU, MYNN, QNSE)



- Strong **transport of moisture (qV at 850hPa) during the 4 hours prior** to the simulated precipitation event.

- Weaker transport with dx = 12km.

- **With MYNN weaker flow near the Andes.**

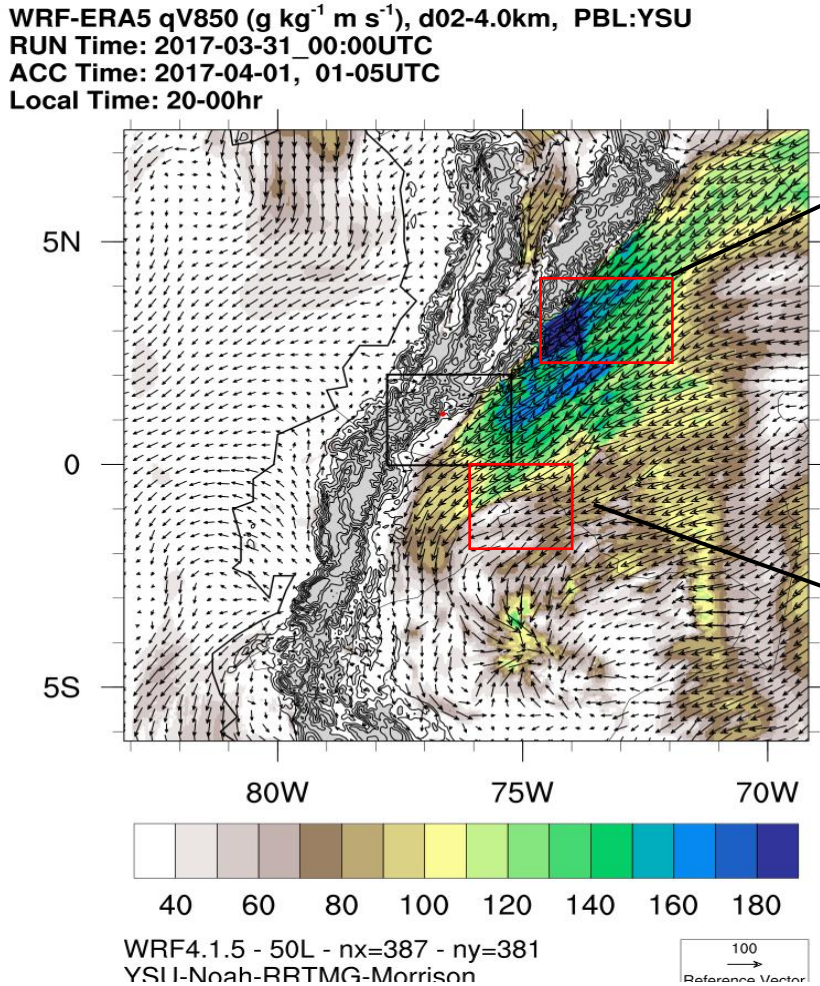
- **Stronger flow is also associated with stronger gradients**, since the Andes provide blocking in all cases.

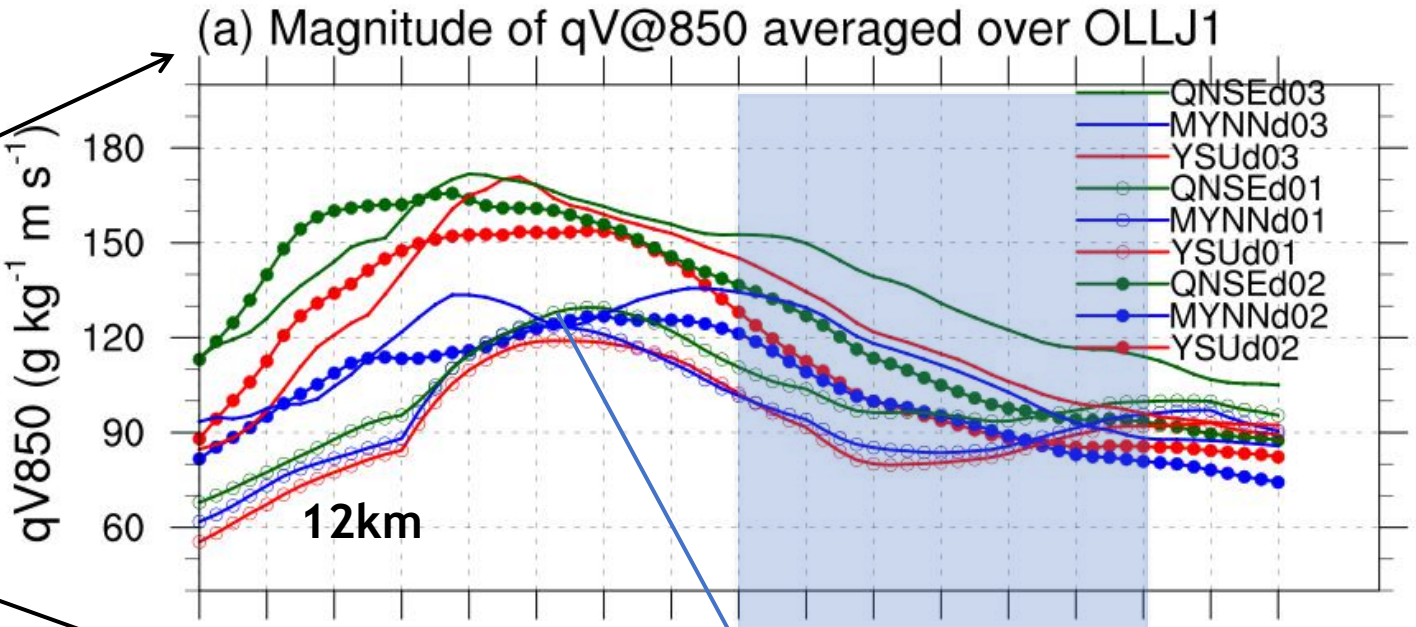
Similar to **previous work:**

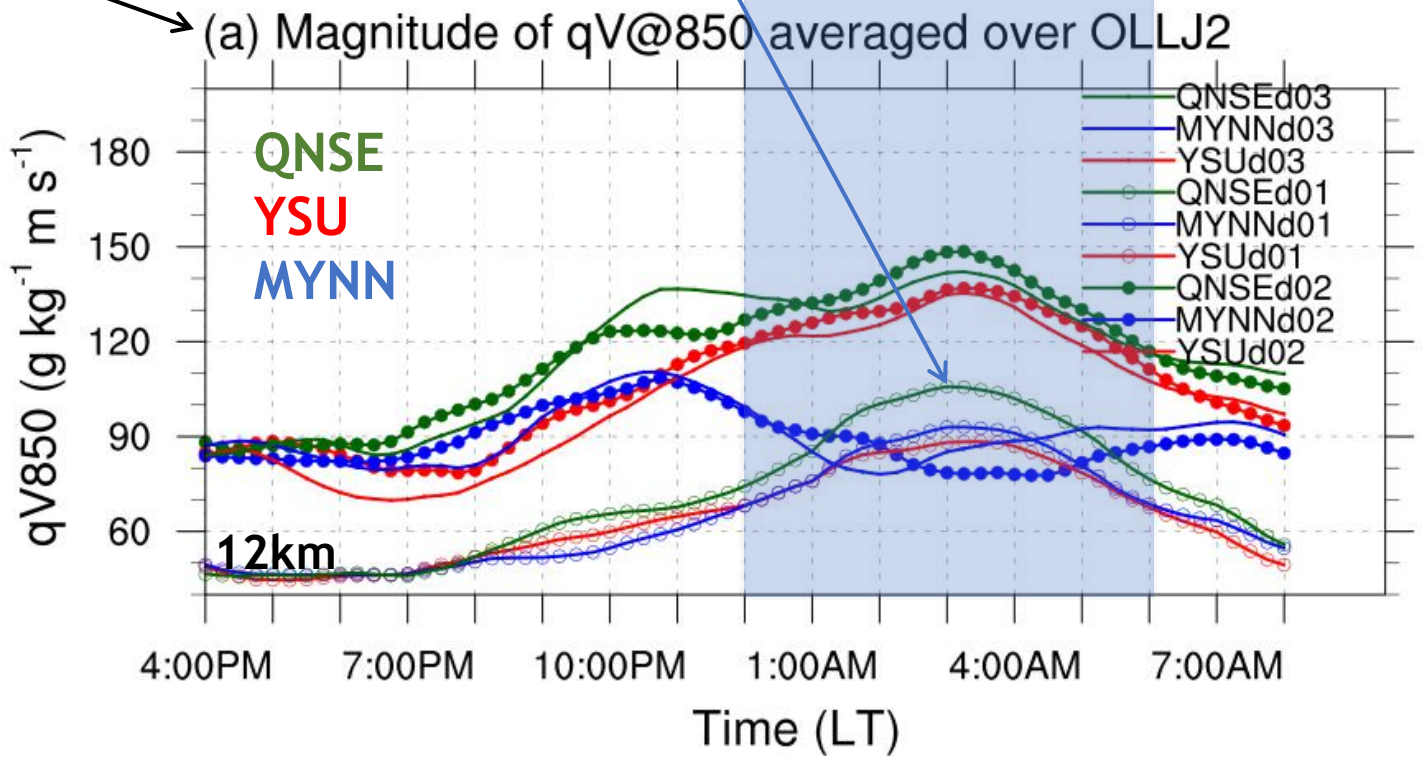
"The Orinoco Low-Level Jet and the Cross-Equatorial Moisture Transport Over Tropical South America: Lessons From Seasonal WRF Simulations"

Martinez et al., 2022

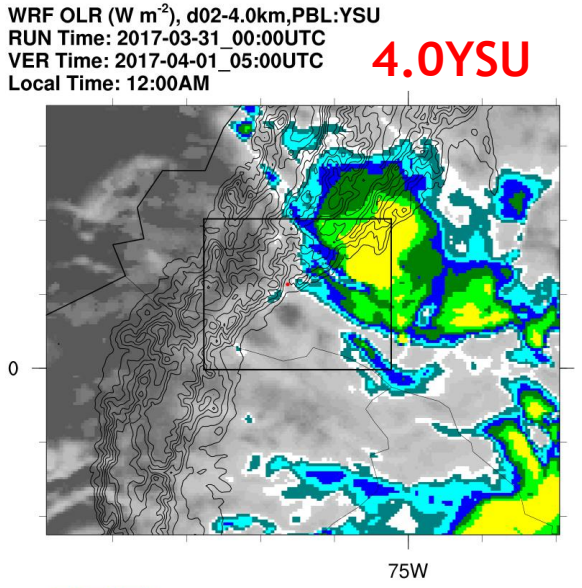
https://doi.org/10.1029/2021JD035603

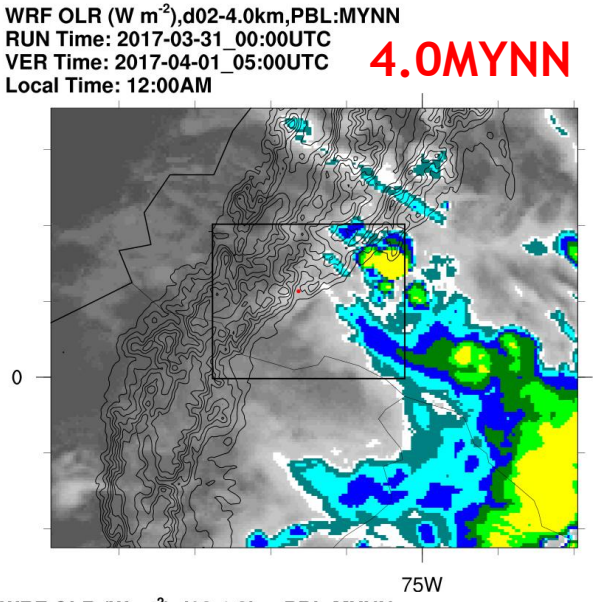


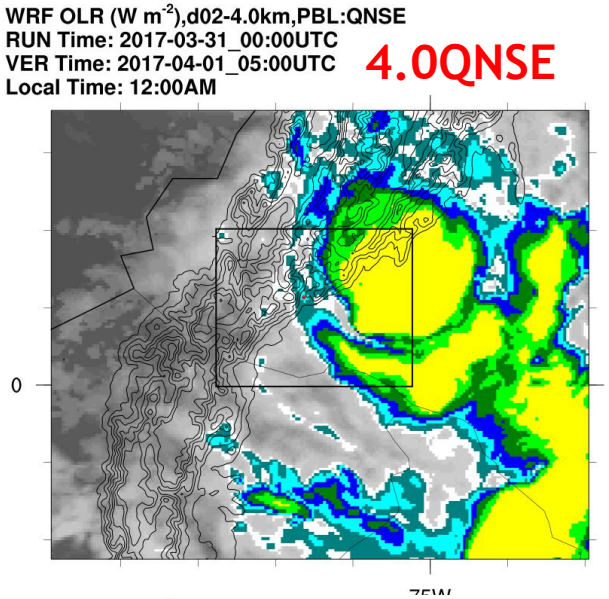


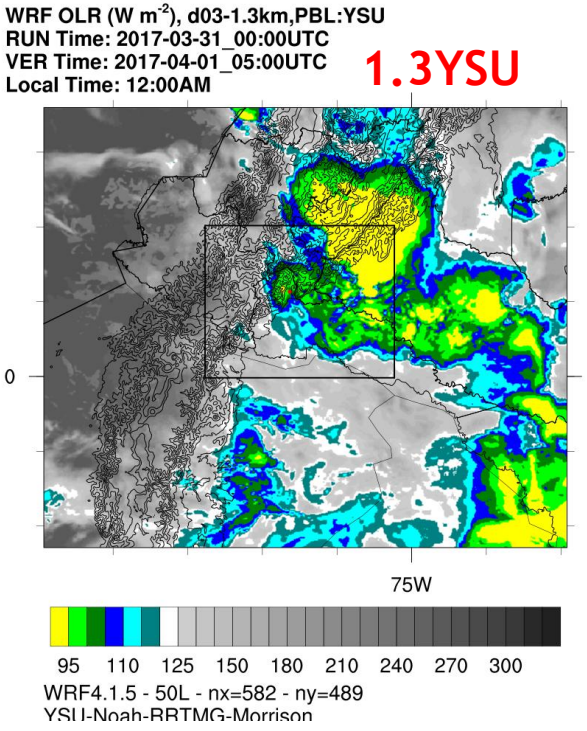


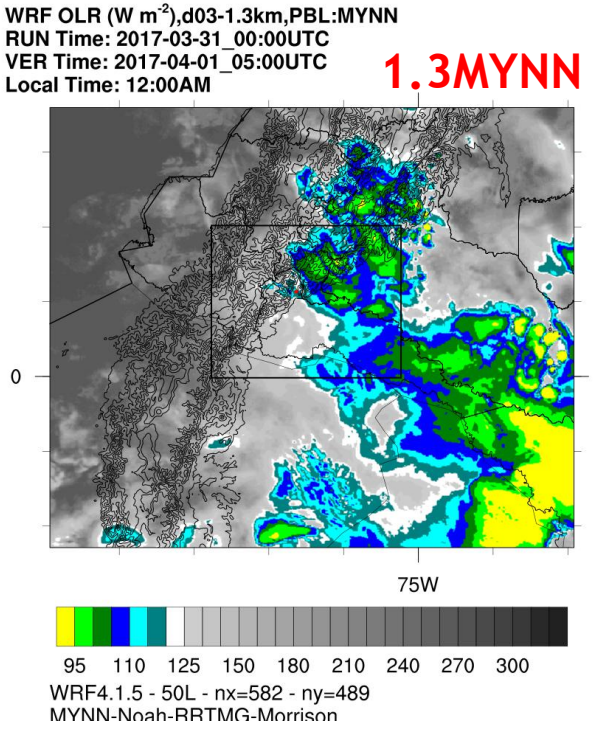
- Strong **transport of moisture 6-4 hours prior** to the simulated precipitation event.
- **Perturbation traveling southward,** contributing with formation of lines of convergence.

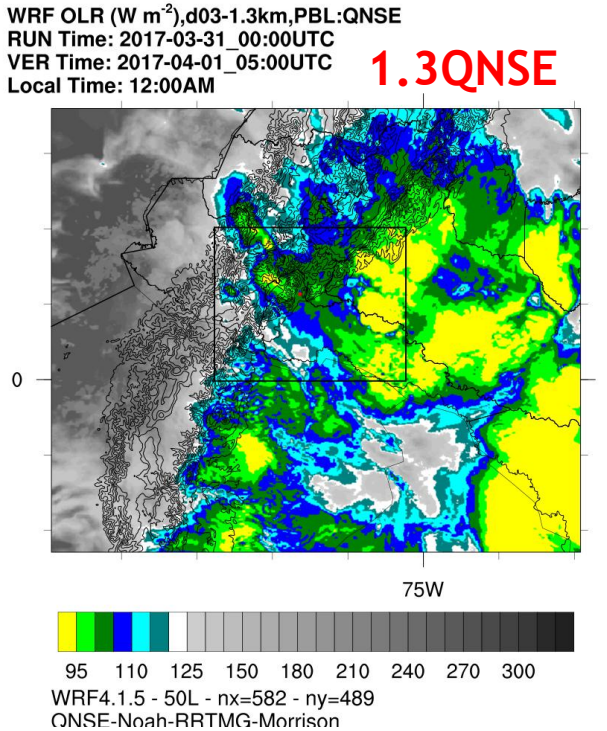








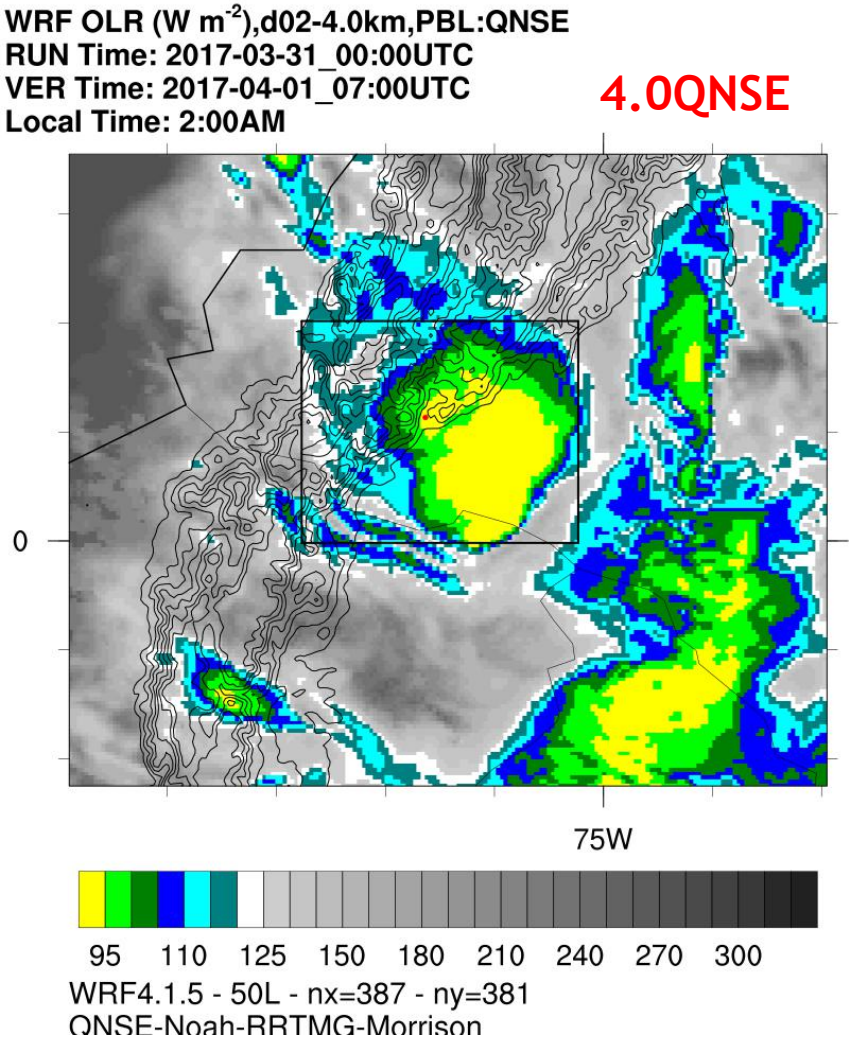




- An organized simulated convective system hit the Andes near the time of the real event.

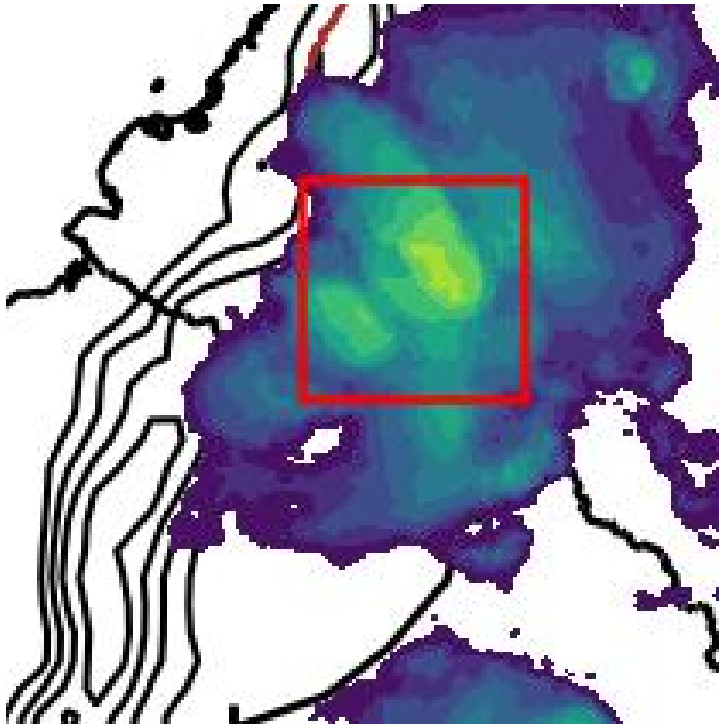
- With MYNN the system was smaller, less organized, moving less into the Andes.

- Real system moved farther into the Andes (similar to YSU and QNSE)



4.0QNSE

CTT NCEP-MERGIR



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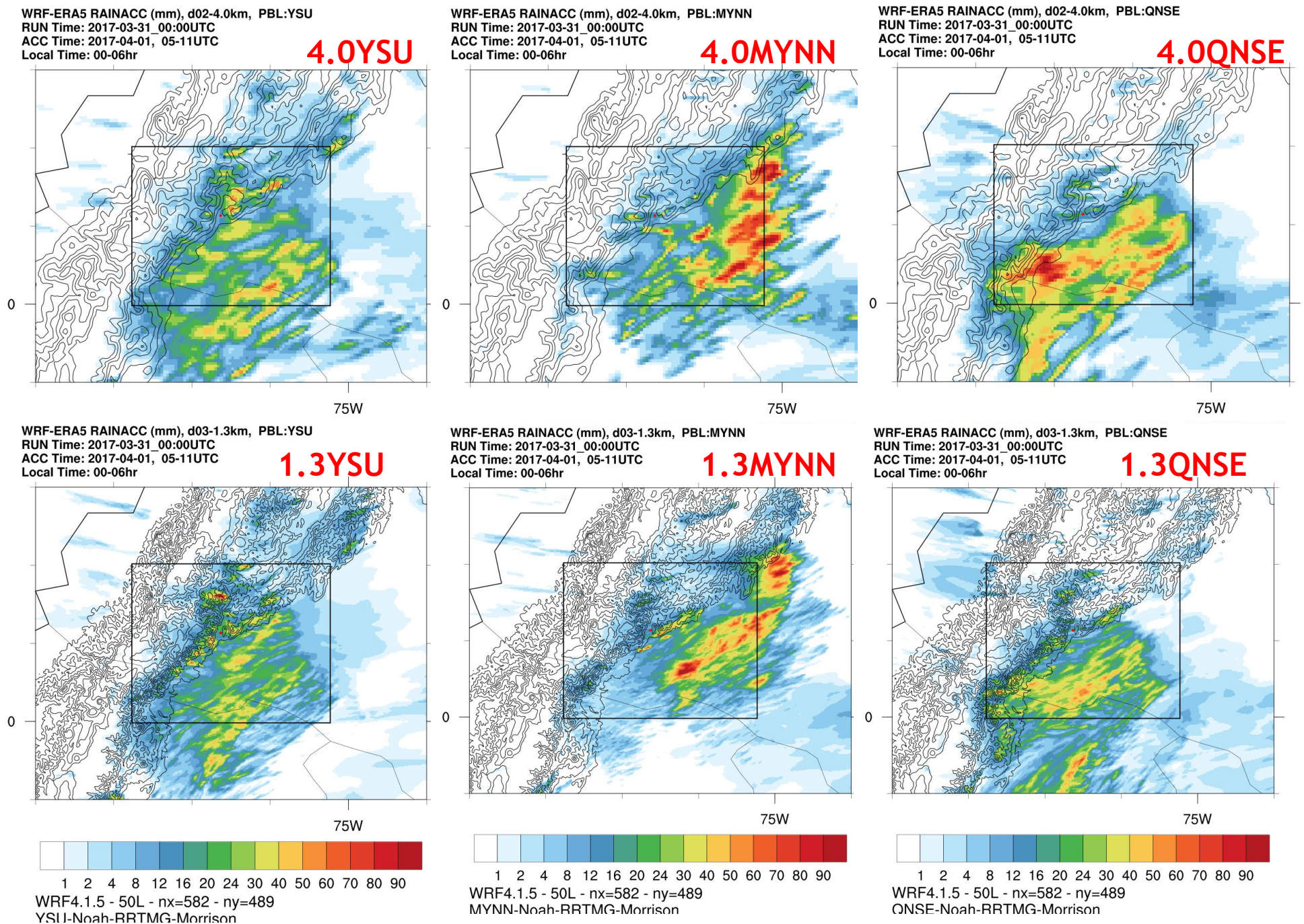
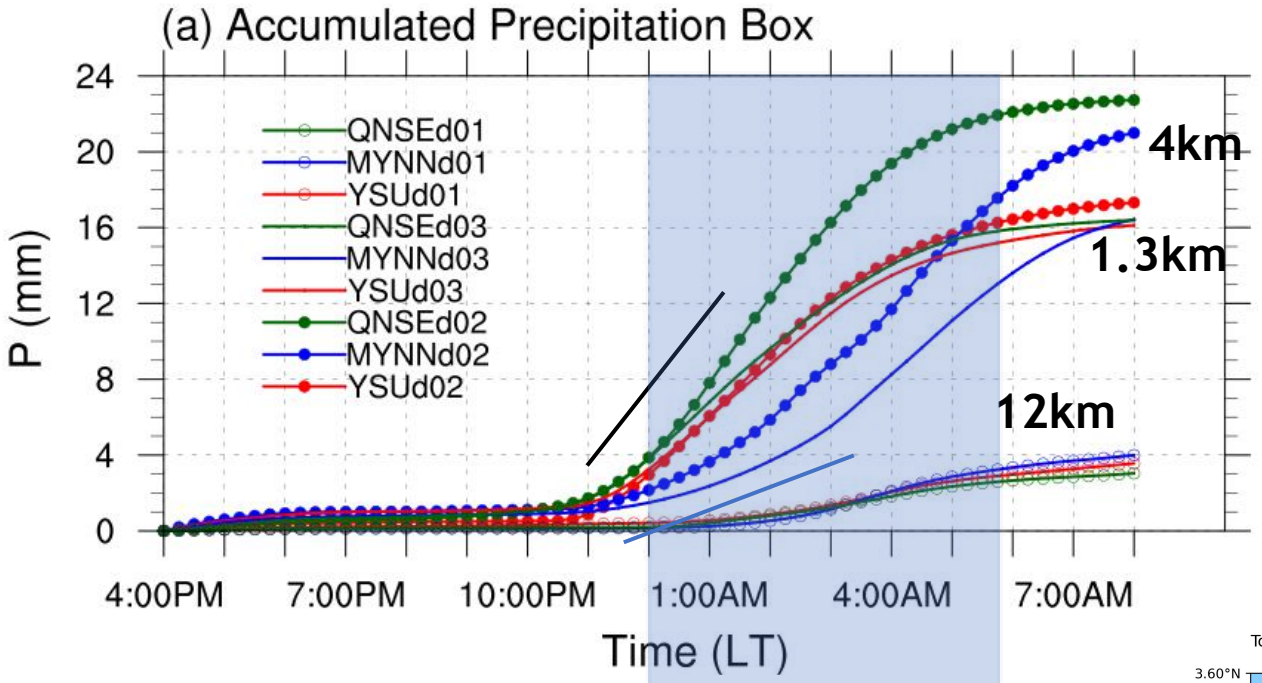
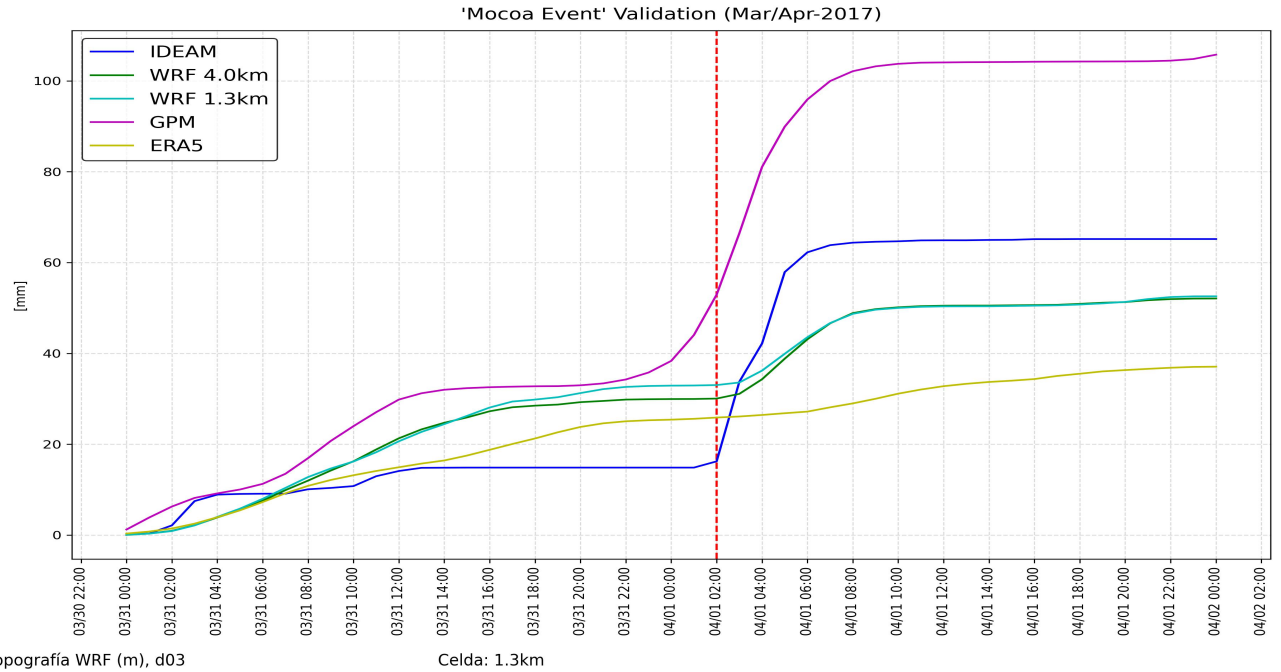


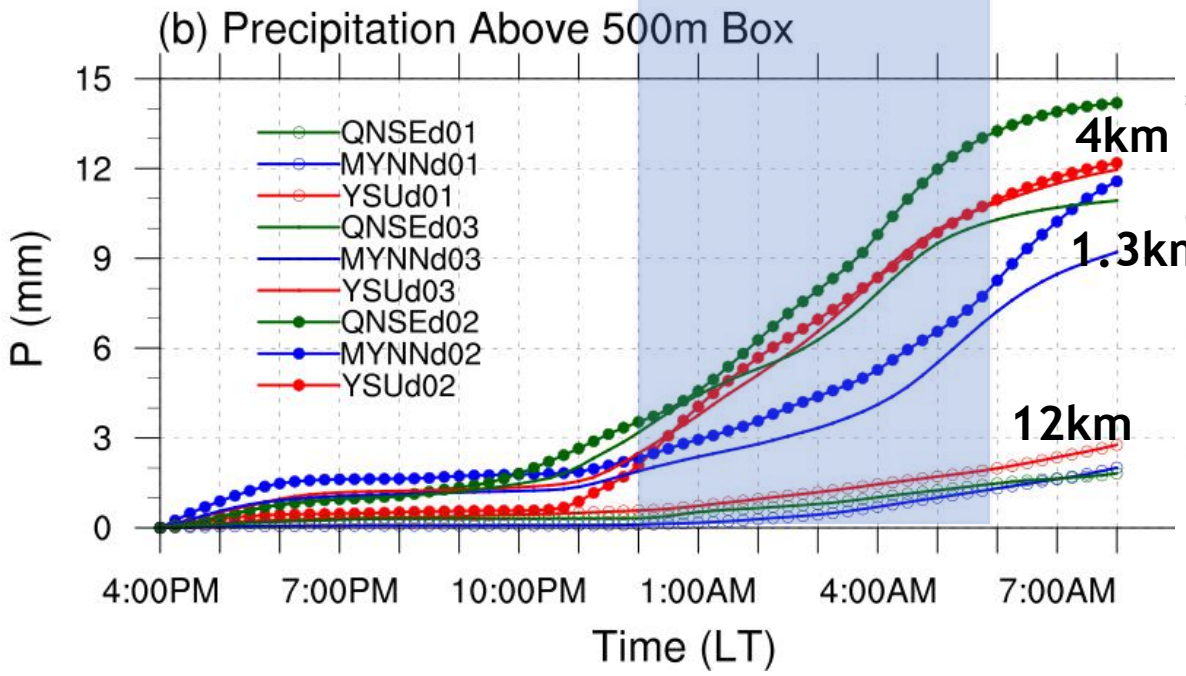
- Substantial 6-hour accumulated precipitation over Andes-Amazon region (convergence/blocking).

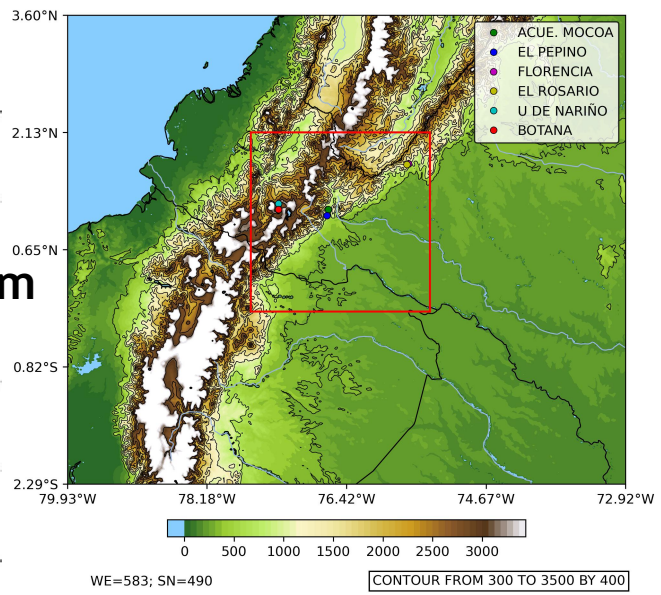
- In this case, smaller maxima of precipitation over the Andes with MYNN.

- Larger precipitation at 4km than at 1.3km for all tested PBL schemes.





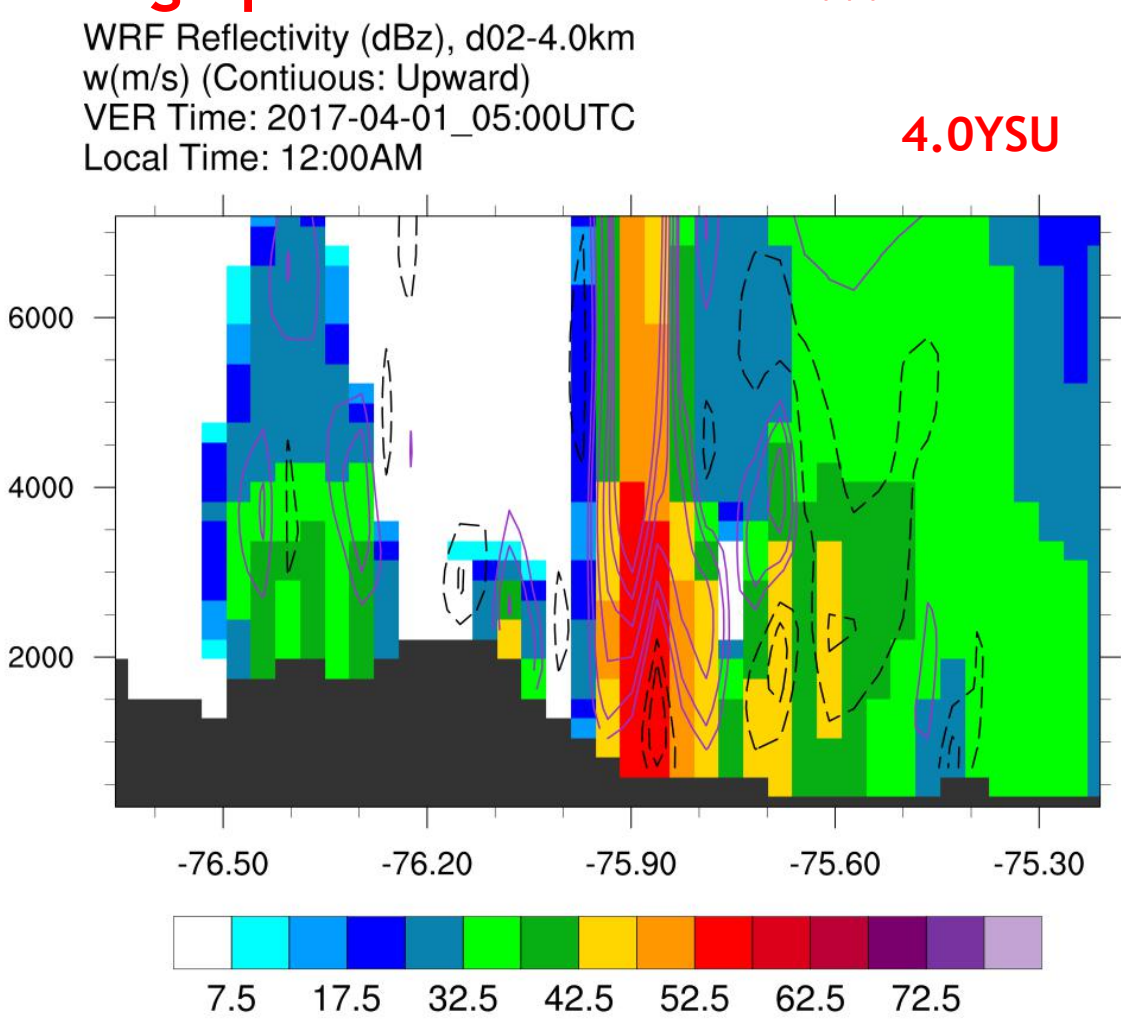




- More precipitation at 4 km than at 1.3km

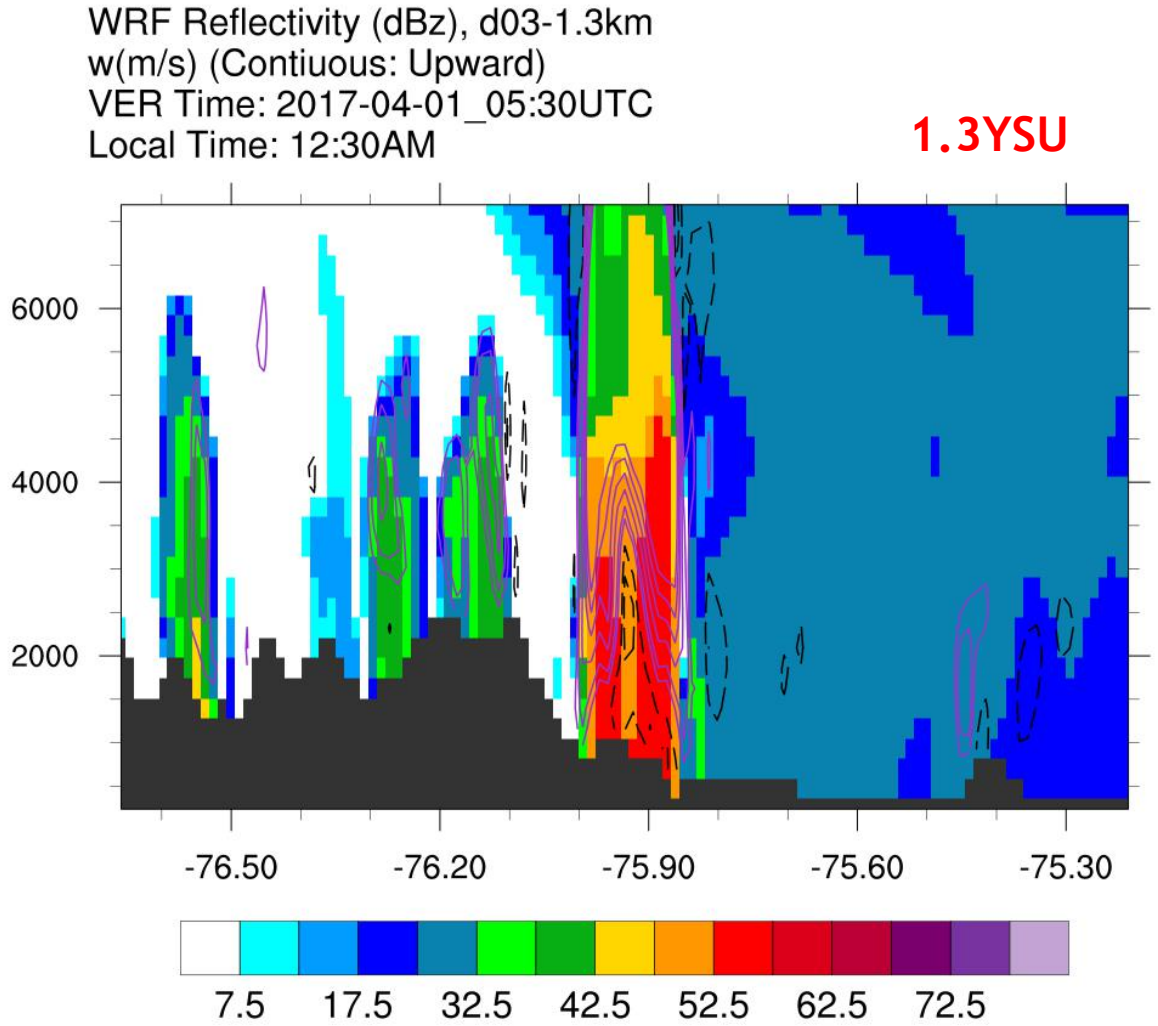
- Smaller precipitation rates with MYNN, especially above 500m.

Mesoscale circulations and Orographic Enhancement ...



4.0YSU

WRF4.1.5 - 50L - nx=387 - ny=381
YSU-Noah-RRTMG-Morrison

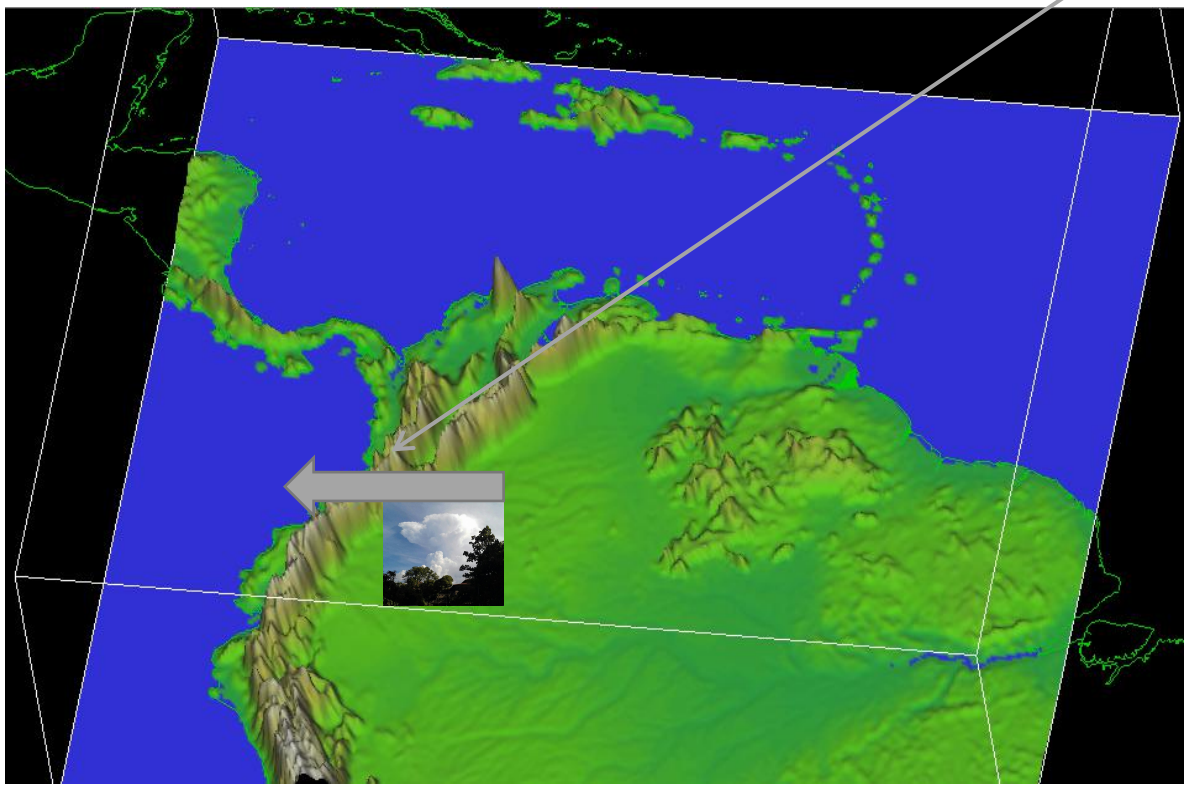


1.3YSU

WRF4.1.5 - 50L - nx=582 - ny=489
YSU-Noah-RRTMG-Morrison

Concluding remarks

1. **Heavy precipitation event over the Andes** from an MCS formed in the Amazon.



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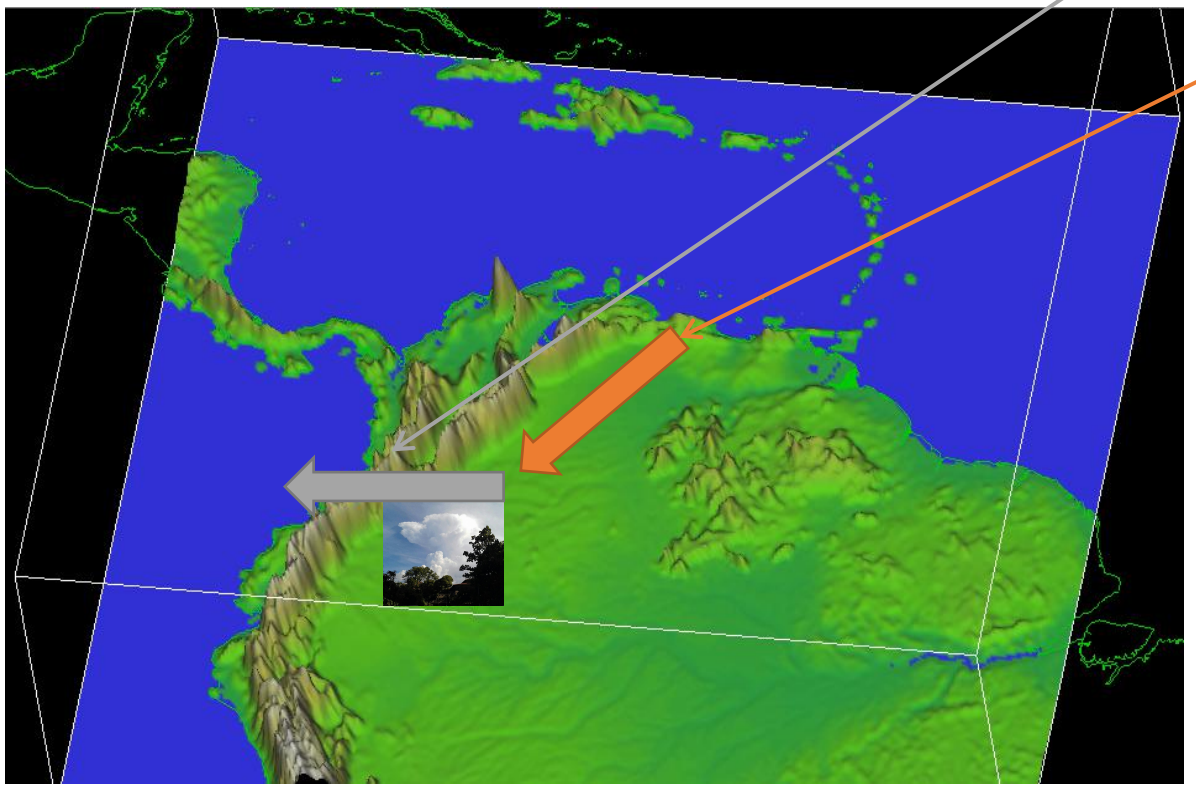

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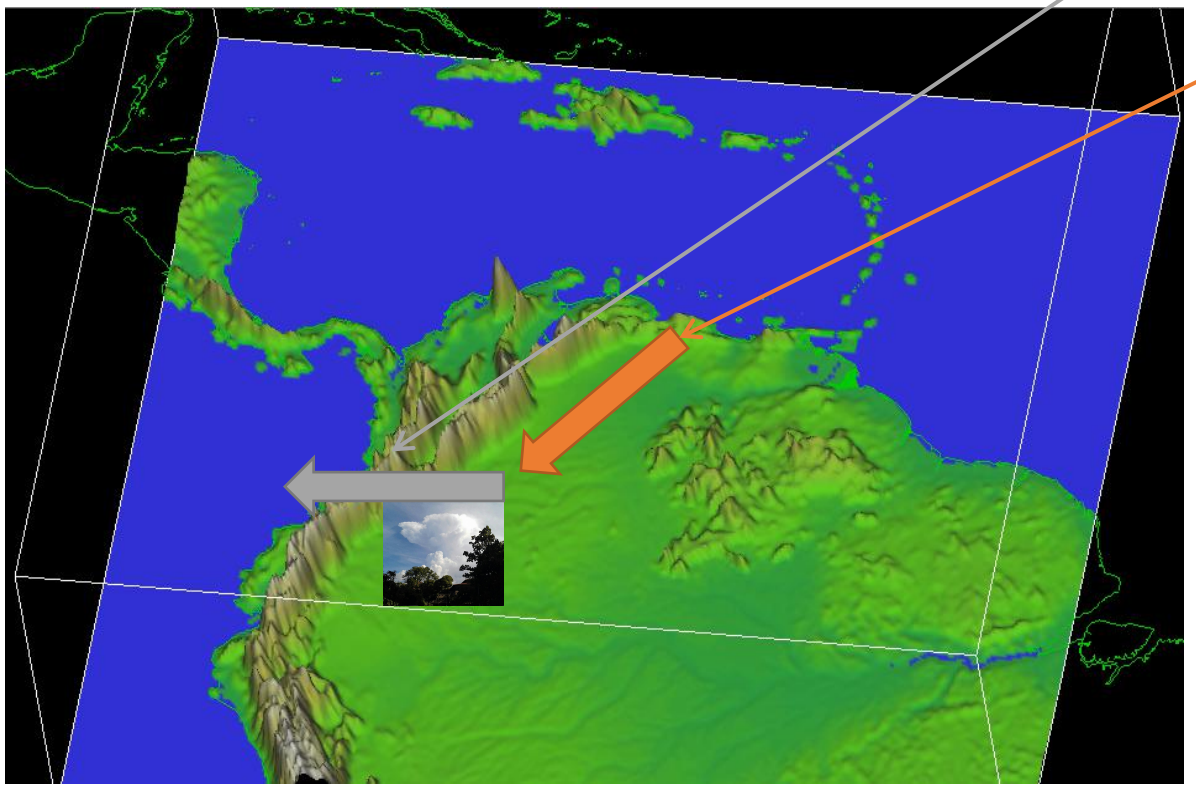

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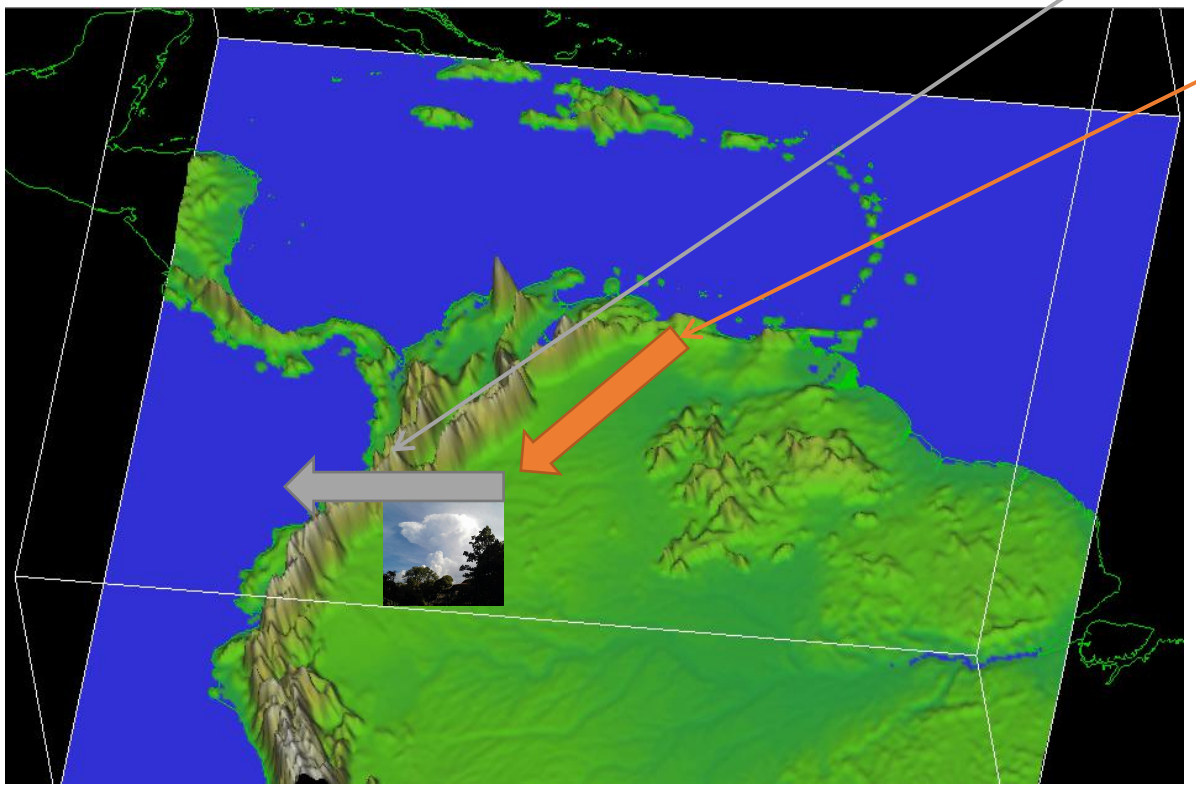

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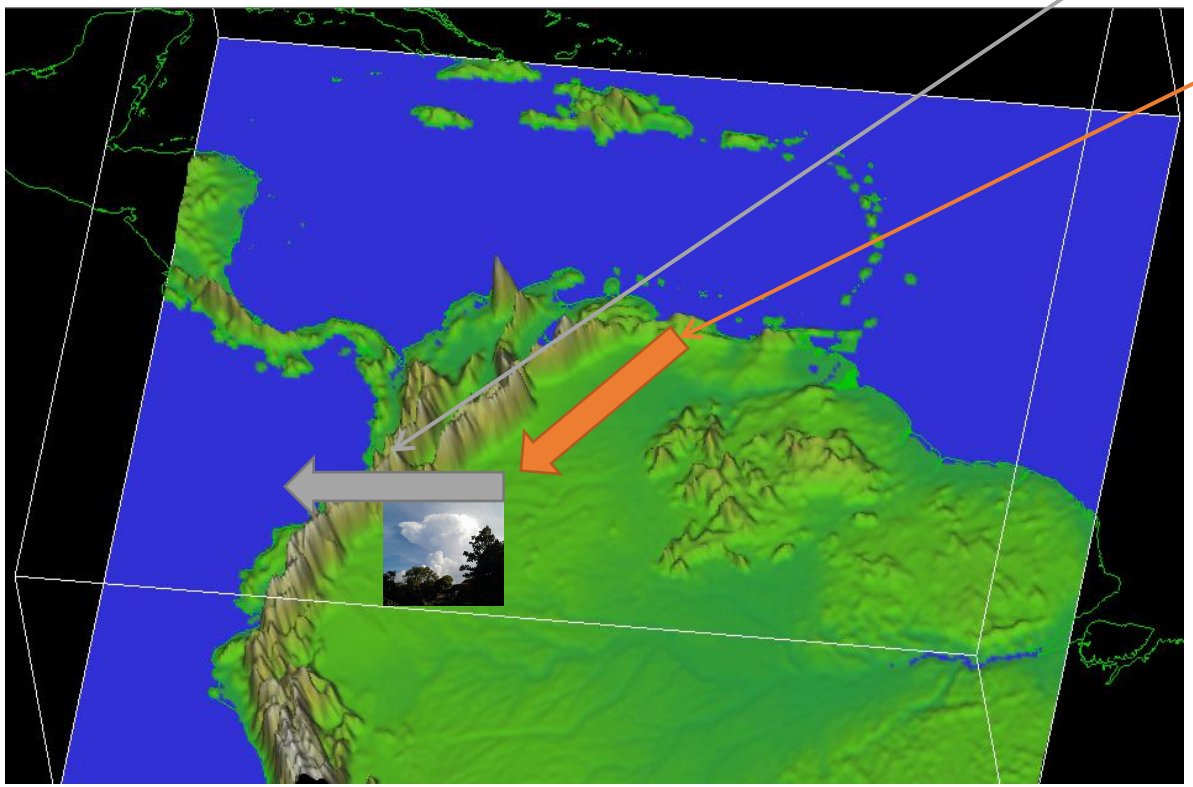

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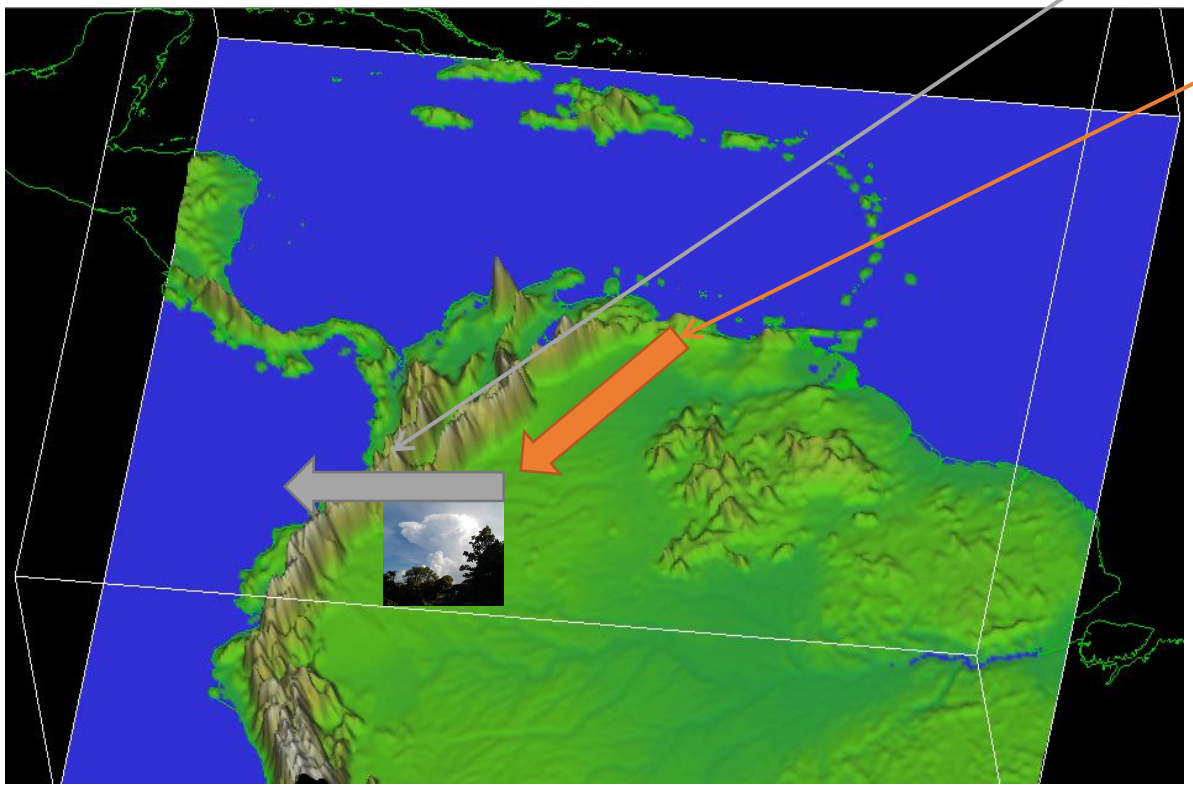

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6. **Process oriented diagnostics/evaluation** (e.g. wind-hydrometeors relationships and orographic enhancement).

Thank you!

Questions?

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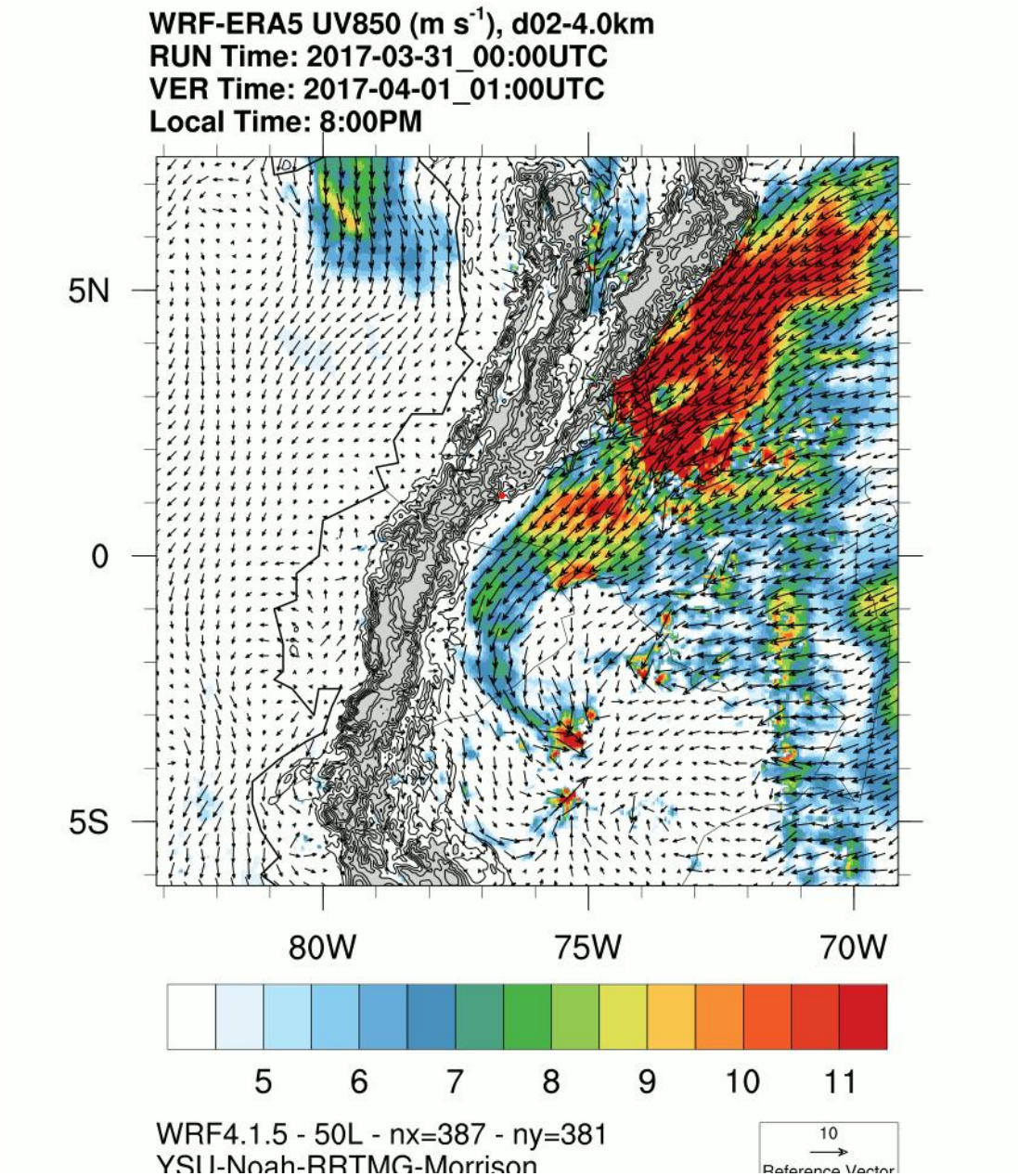

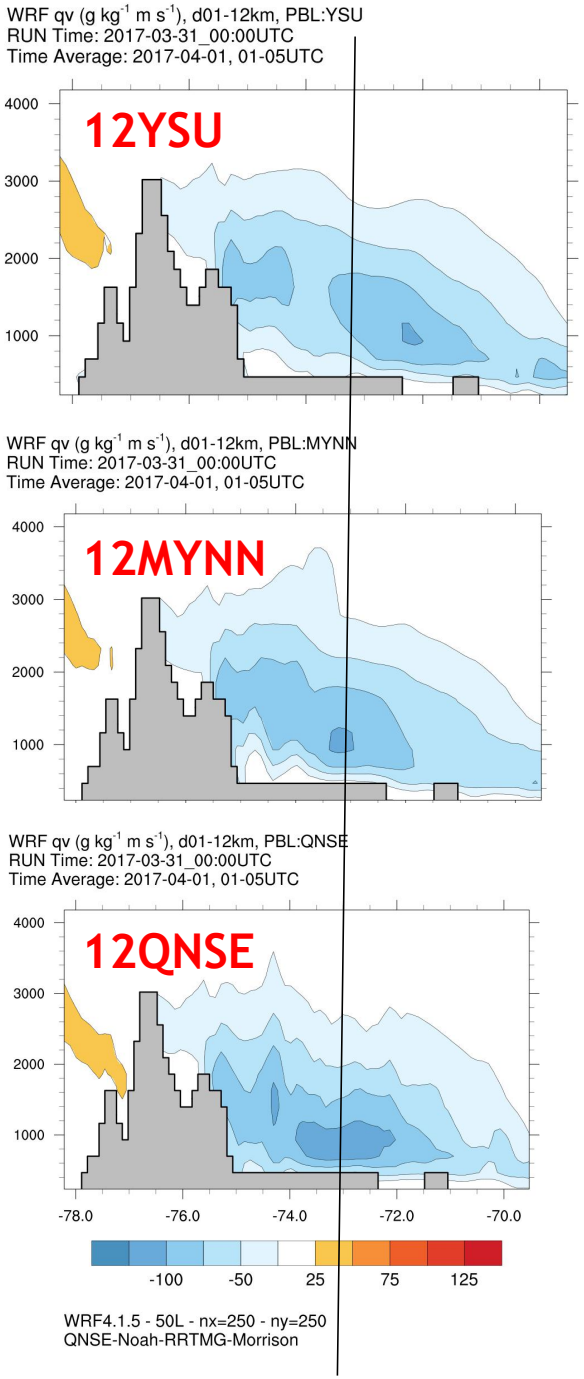

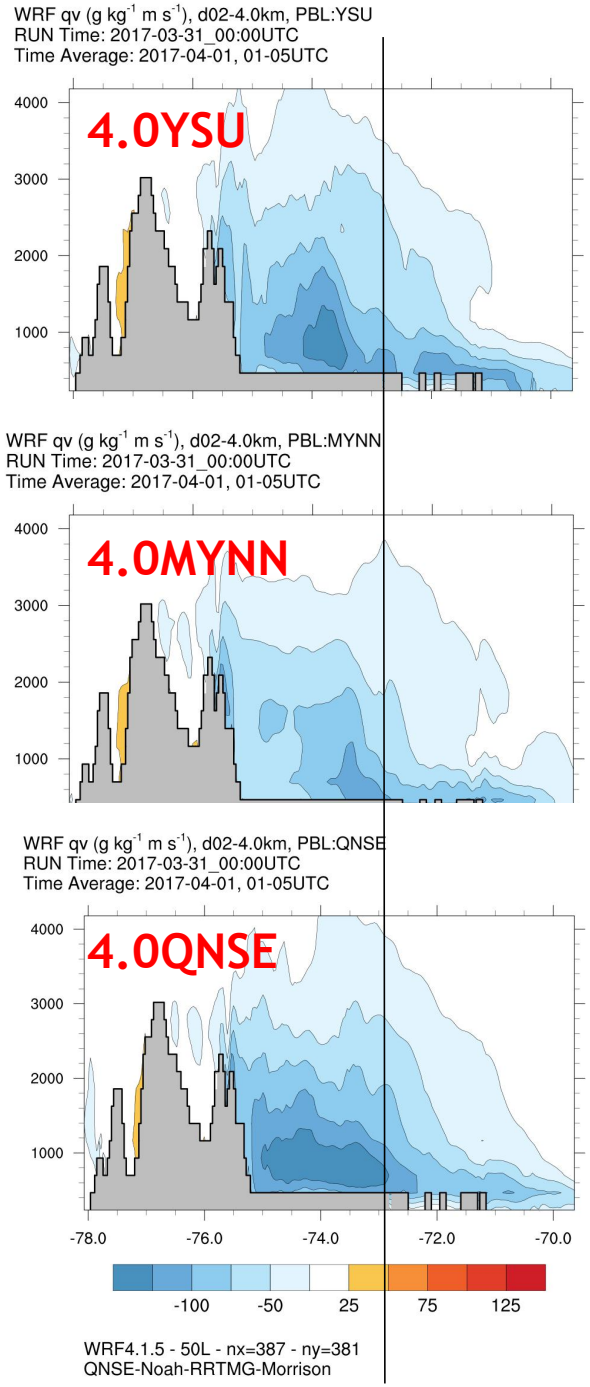

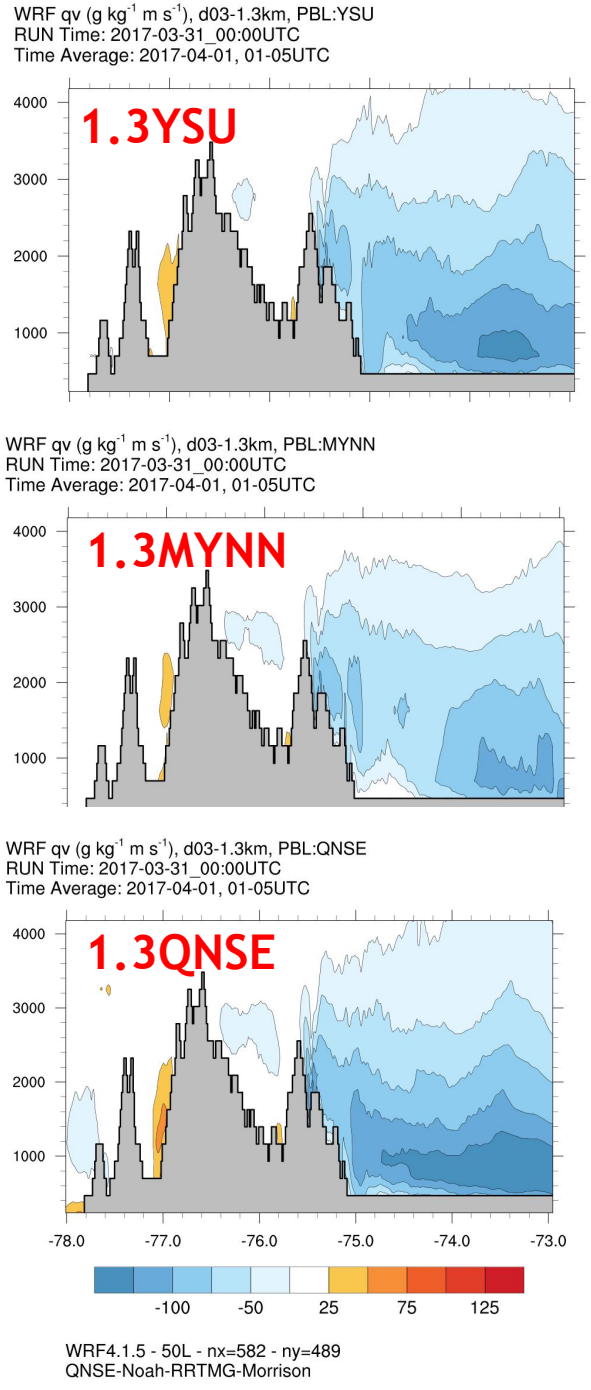

- Vertical cross-section of meridional transport accross the 2°N latitude.

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Similar to **previous work:**
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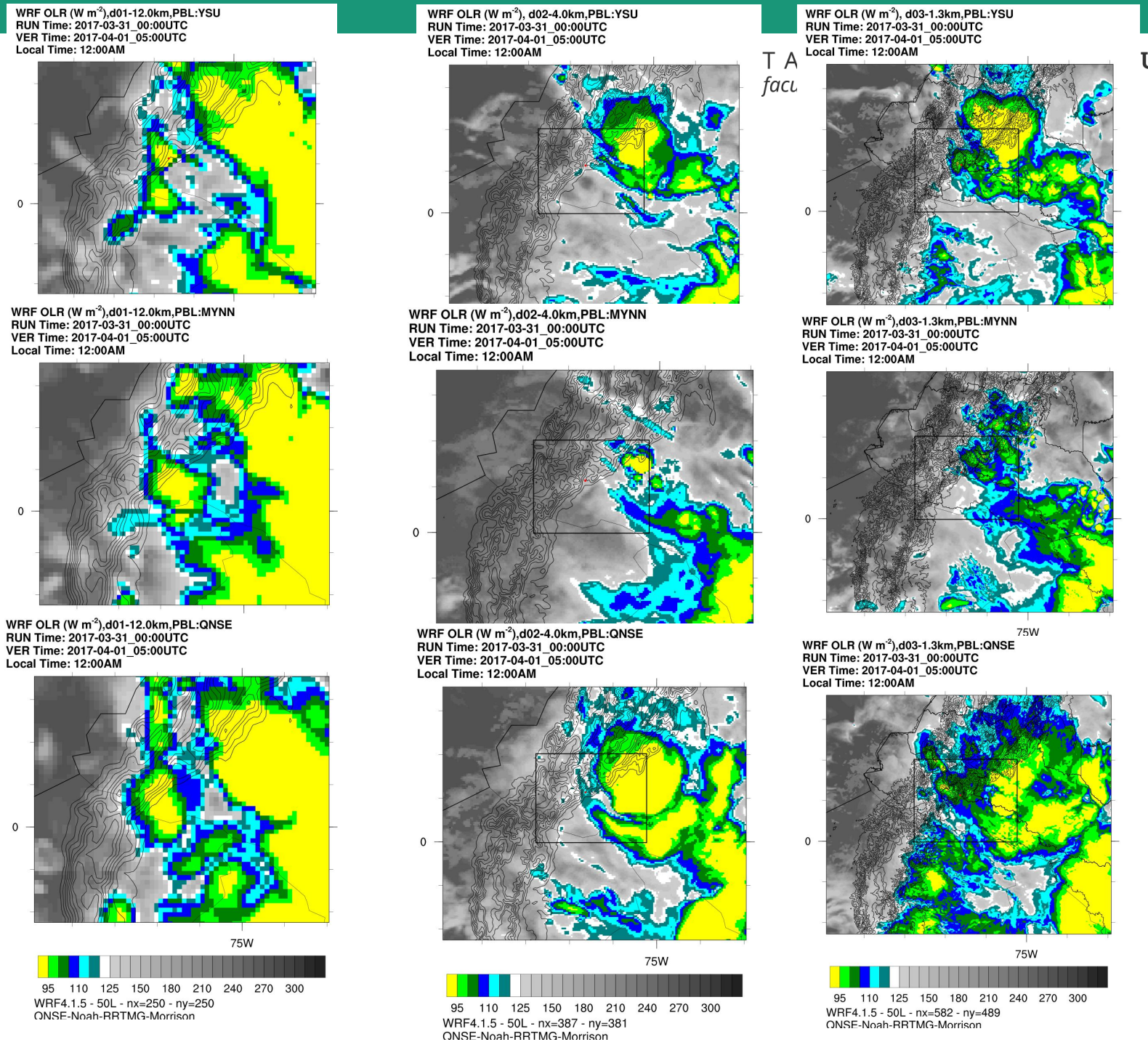

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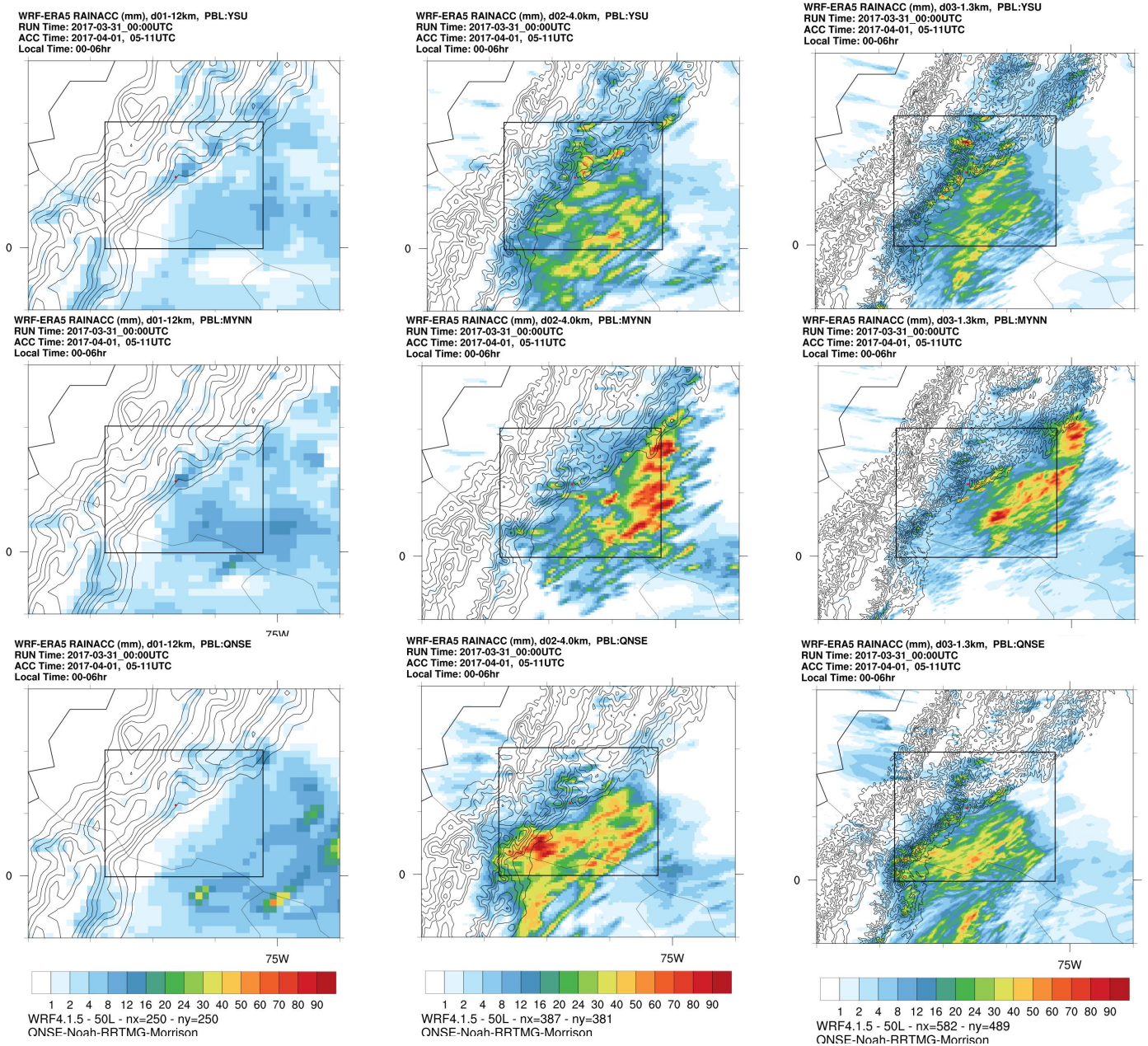

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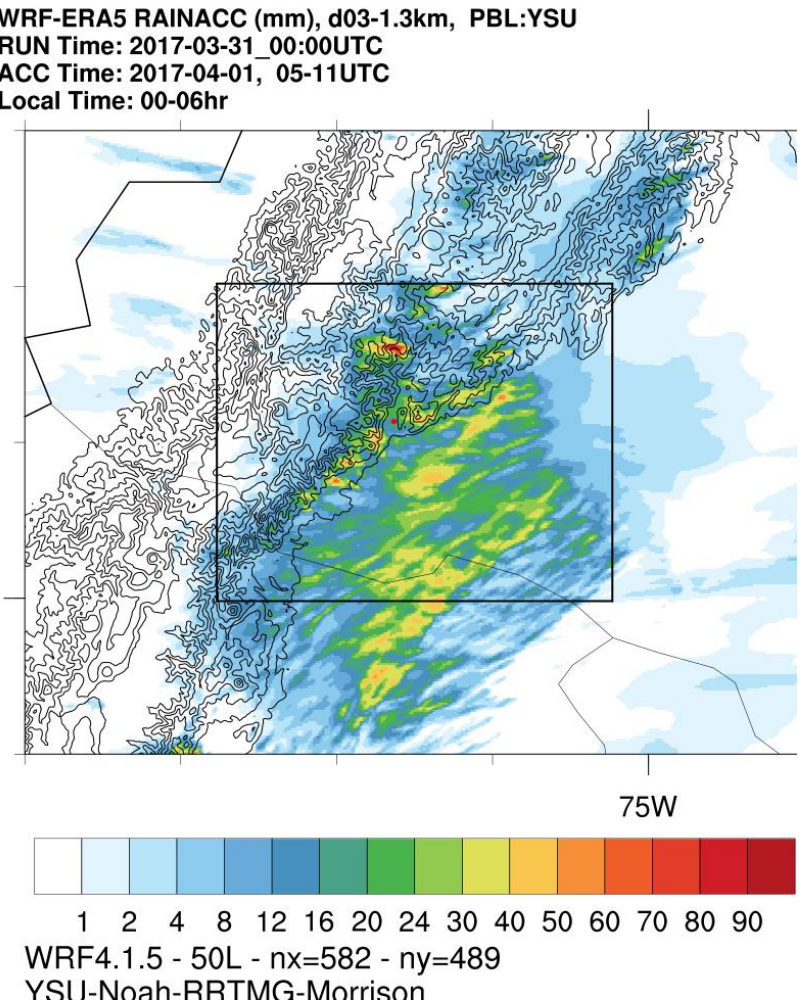

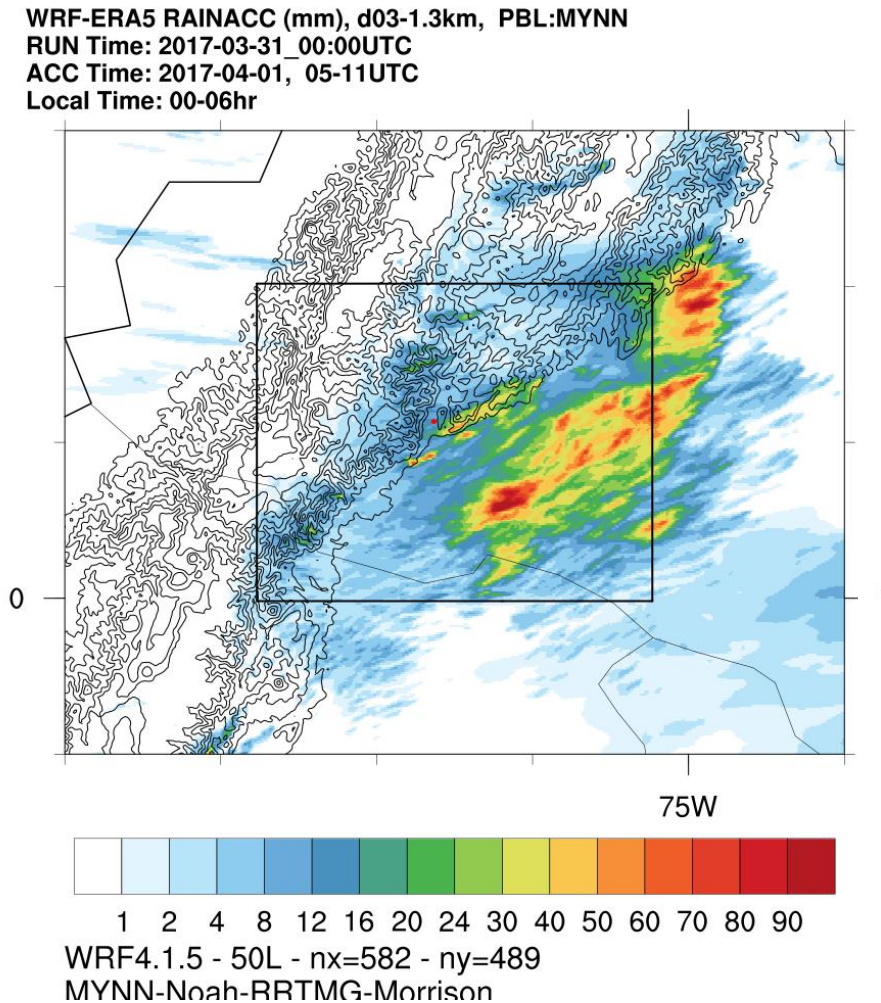

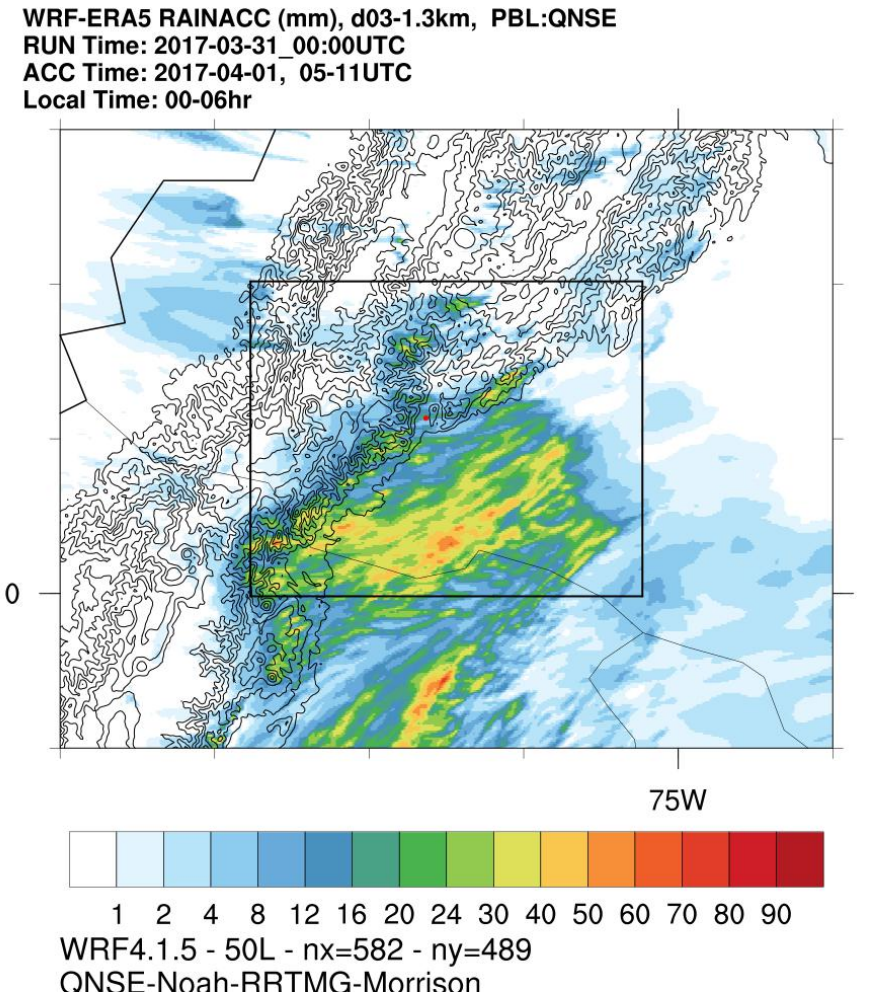

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