GRAVITY WAVES MODULATING THE DIURNAL CYCLE OF PRECIPITATION OVER THE RAINIEST PLACE ON EARTH

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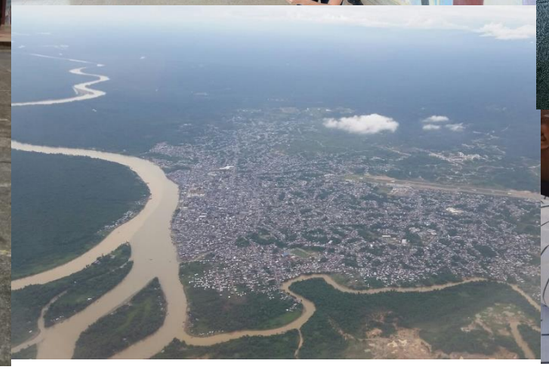
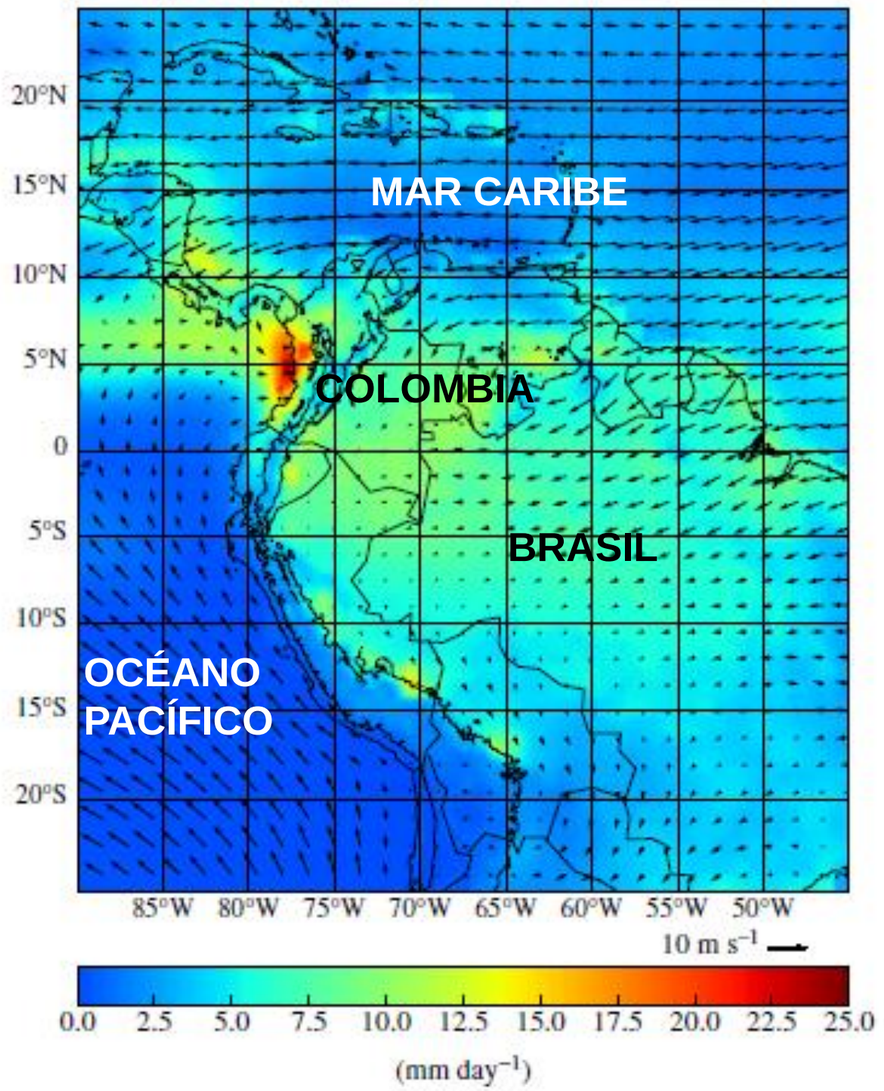


Study region

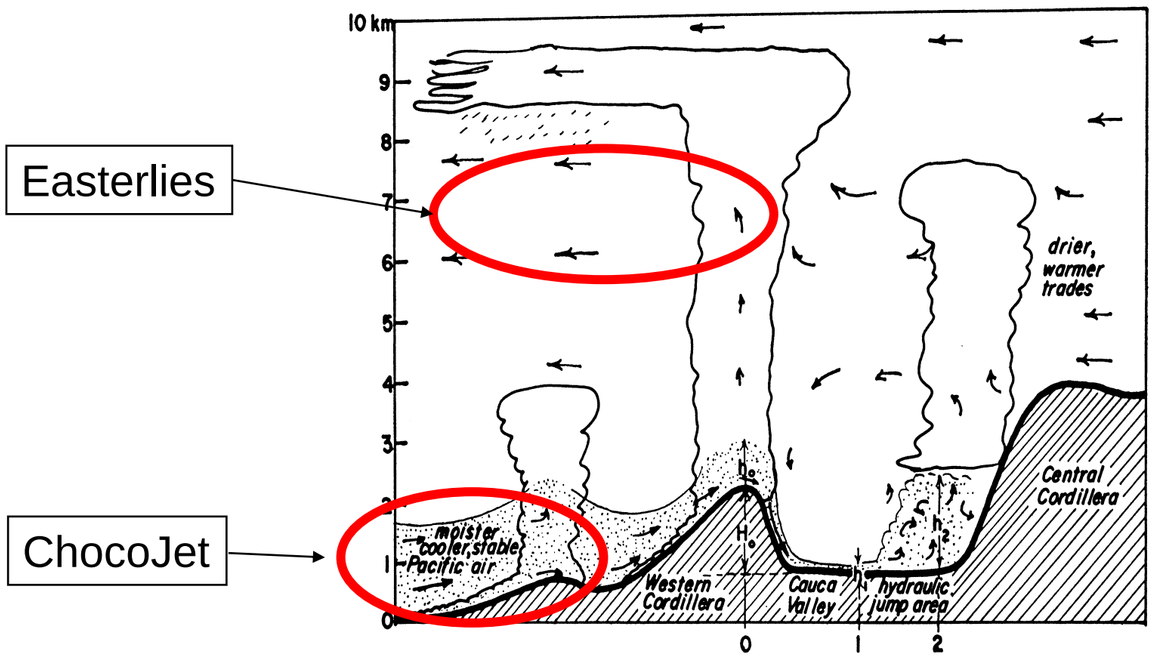
- One of the rainiest region on earth (Snow, 1976; Eslava, 1994; Poveda y Mesa, 2000).
- Ocean-atmospheric-land processes (López y Howell, 1967; Poveda y Mesa, 2000; Amador *et al*., 2006; Kessler, 2006).
- **Non-existent in-situ upper air measurements!**



Jaramillo *et al*. (2017)

Why is this one of the rainiest regions on Earth?

Westerly ChocoJet, mid-level easterlies and orographic lifting (Emmanuel, 1994; Poveda y Mesa, 2000)

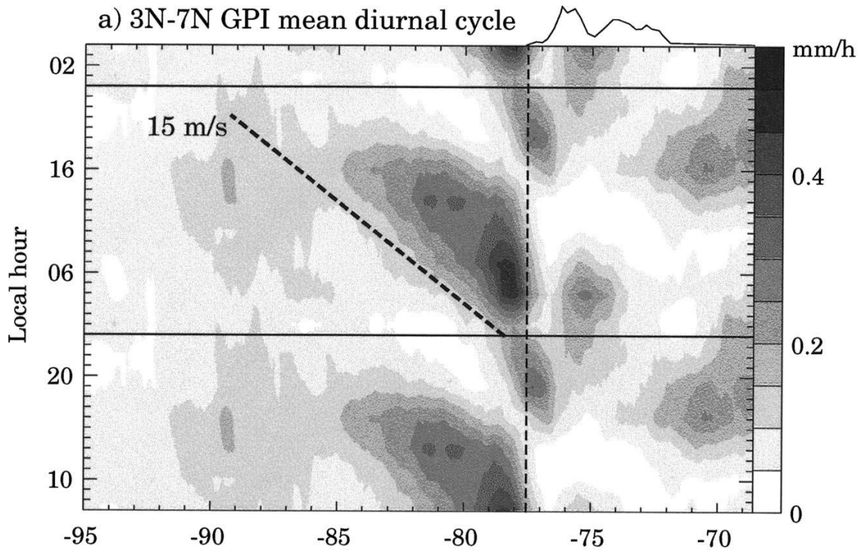


López & Howell (1967)

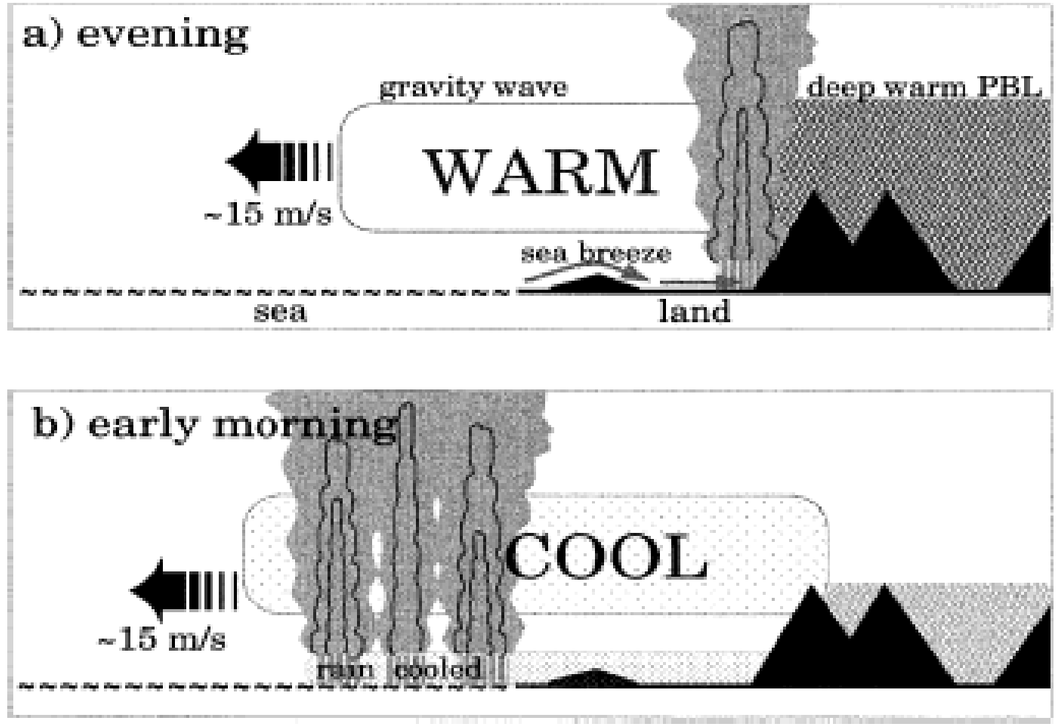
Photo by John F. Mejía

Motivation

- Observations from GPI (Mapes *et al*., 2003a)
- Simulations using MM5 at 72, 24, 8 and 2 km (Warner et al., 2003)

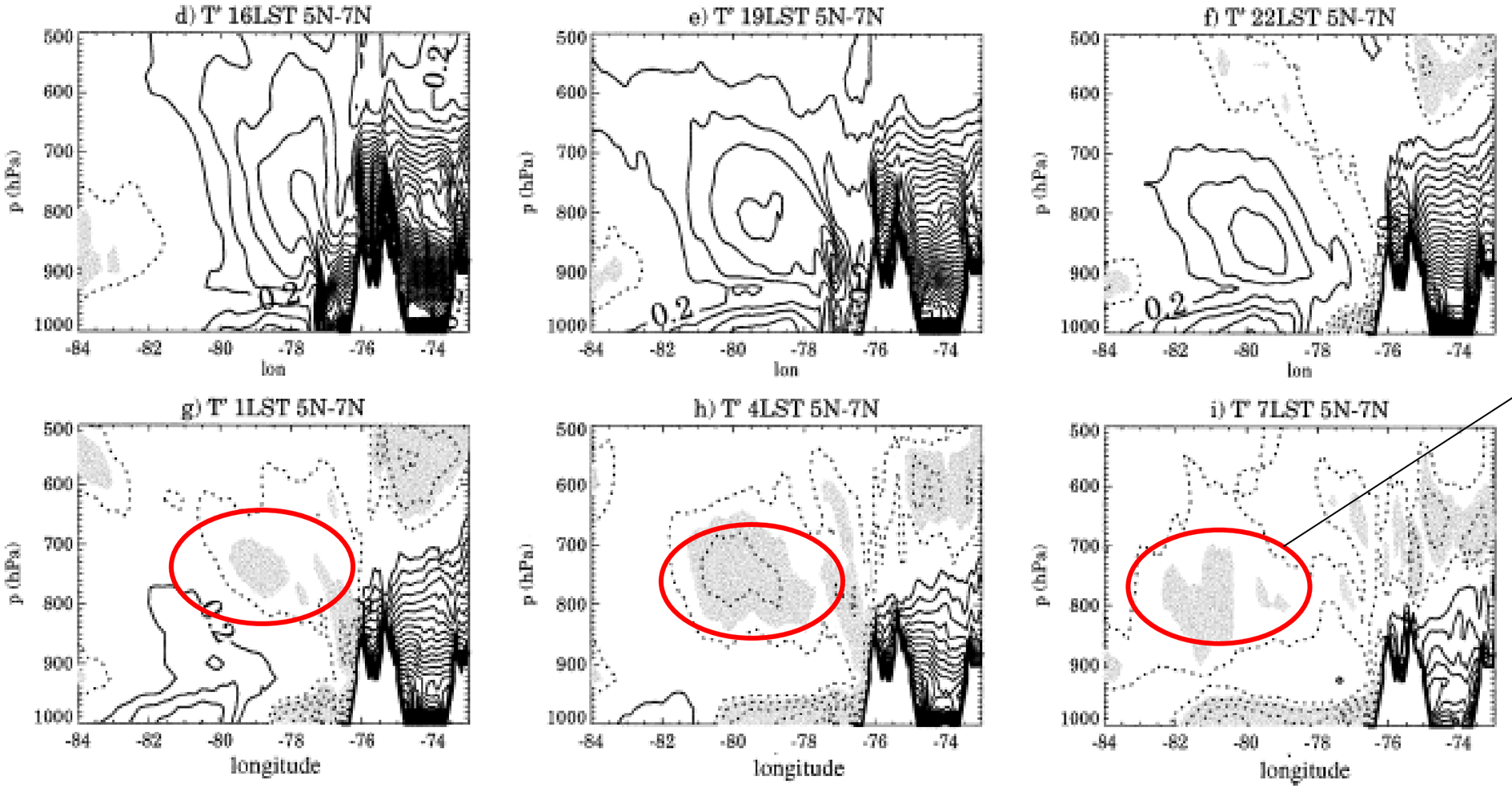


Mapes *et al*. (2003a)



Mapes *et al*. (2003b)

Motivation



Do observations show evidence of the gravity wave activity?

Mapes *et al*. (2003b)

Research questions

- Does observational data allow to identify the ChocoJet?
- Are there differences in the vertical structure of the atmosphere over ocean and inland?
- What mechanisms may explain the **diurnal cycle of precipitation** over the Colombian Pacific?
- Do the **gravity wave (GW) proposed by Mapes et al. (2003)** exist?

Team

- Training in observational and modelling activities
- Analysis
- HPC

- Finantial support

- Logistic support
- Transport of sounding system gas and personel

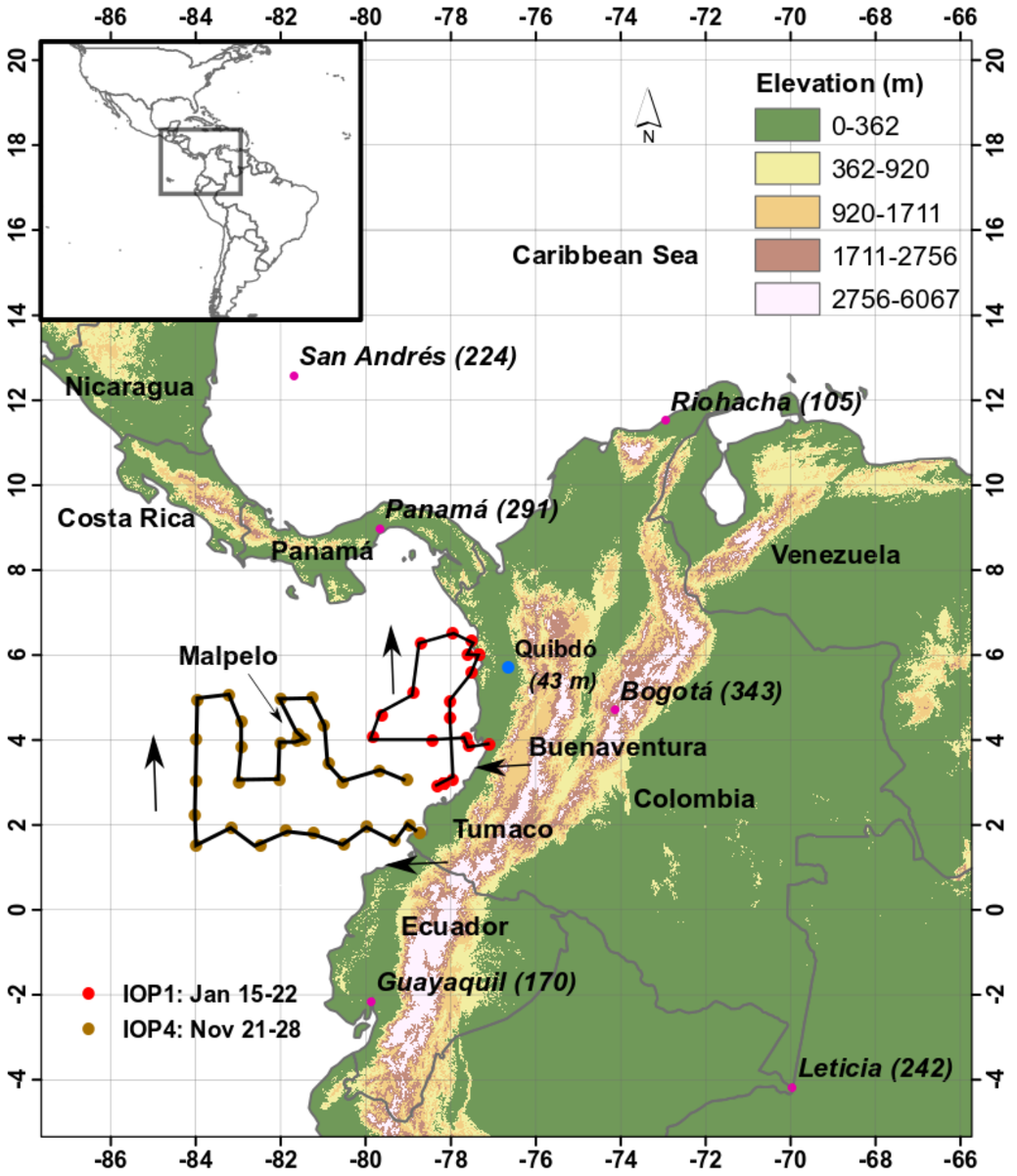
- Vessel platform for offshore observations
- Campaigns developed during ERFEN

Intensive Observing Periods (IOPs)

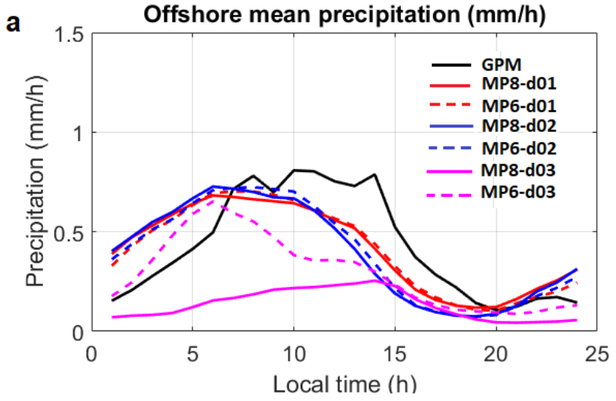
Operational sounding sites: Bogotá, San Andrés, Panamá and Guayaquil.

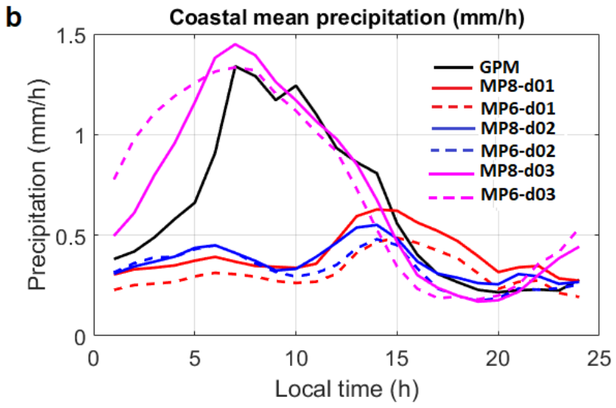
IOP	Date (2016)	Region	Amount of radiosondes
1	Jan 15-22	Ocean	23
2	Jun 25-Jul 1	Quibdó	25
3	Oct 15-21	Quibdó	28
4	Nov 21-28	Ocean	30

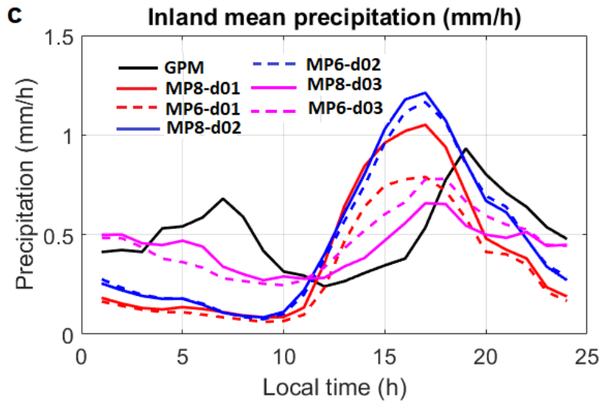
6-hourly soundings

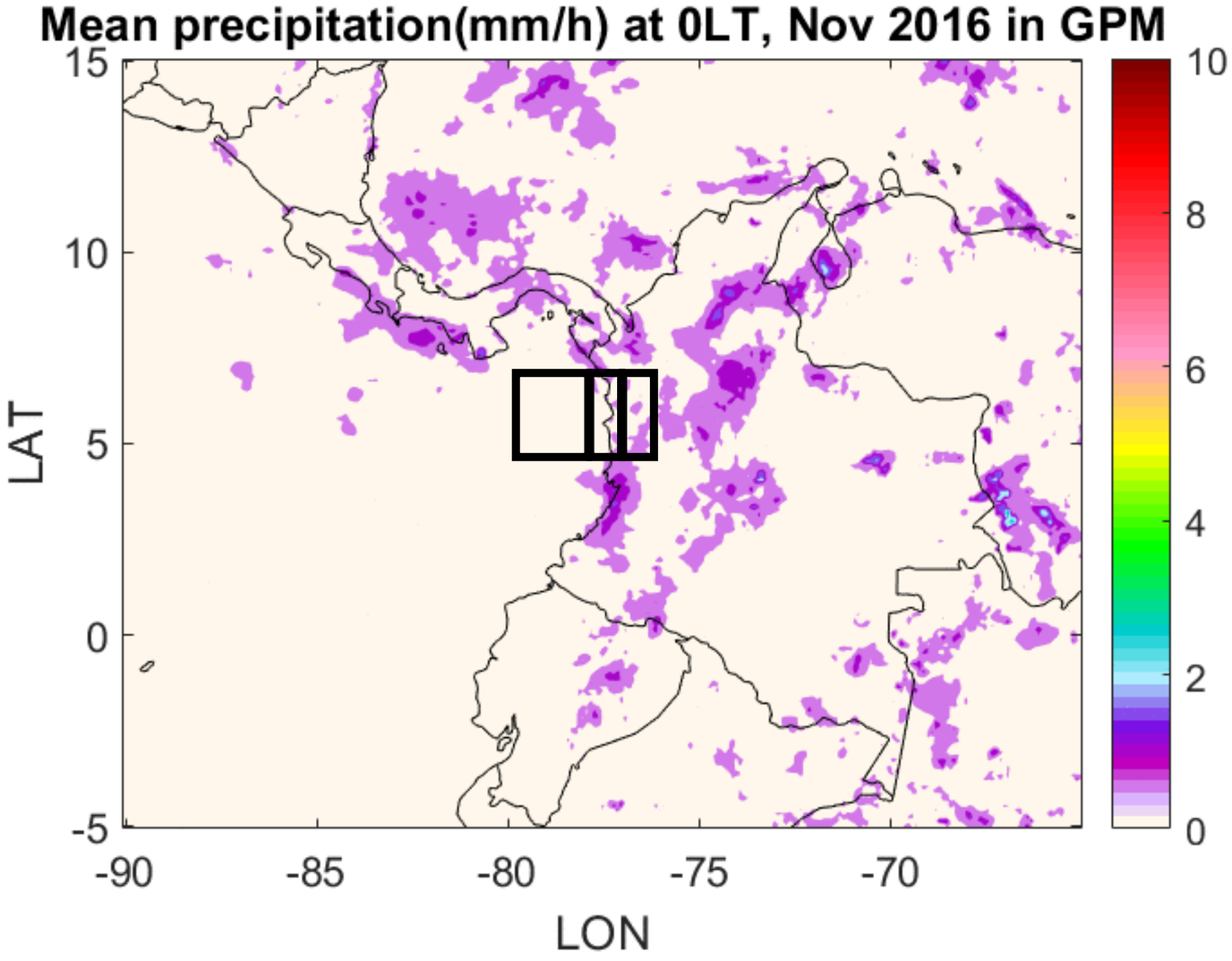


Yepes *et al*. (2019)


a
Offshore mean precipitation (mm/h)
Precipitation (mm/h)
Local time (h)
GPM
MP8-d01
MP6-d01
MP8-d02
MP6-d02
MP8-d03
MP6-d03


b
Coastal mean precipitation (mm/h)
Precipitation (mm/h)
Local time (h)
GPM
MP8-d01
MP6-d01
MP8-d02
MP6-d02
MP8-d03
MP6-d03


c
Inland mean precipitation (mm/h)
Precipitation (mm/h)
Local time (h)
GPM
MP8-d01
MP6-d01
MP8-d02
MP6-d02
MP8-d03
MP6-d03

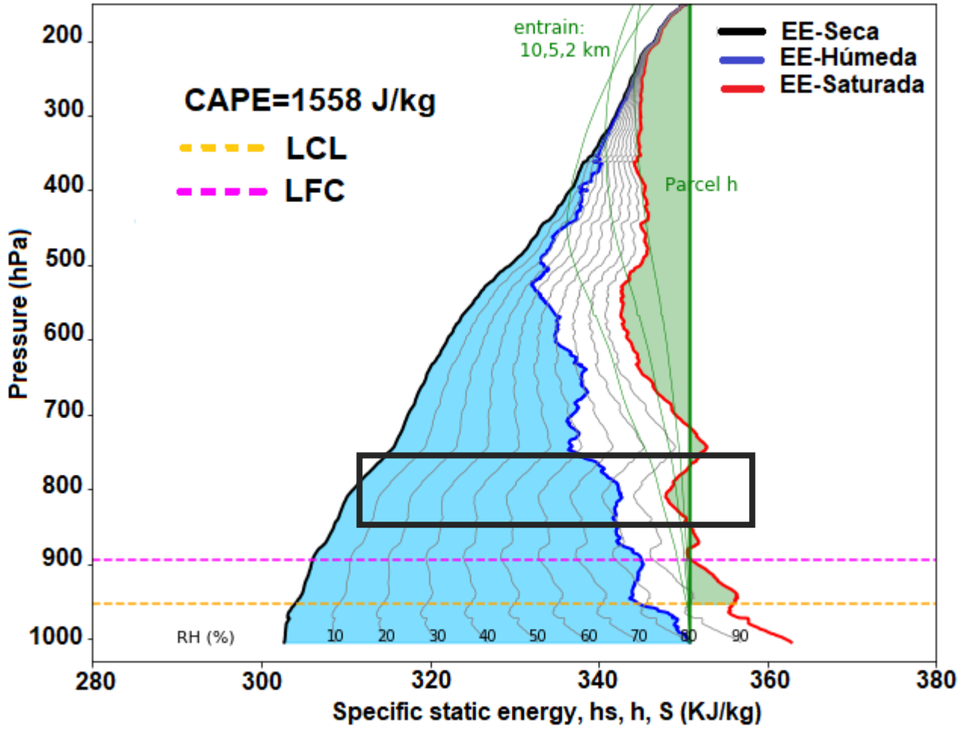

Mean precipitation(mm/h) at 0LT, Nov 2016 in GPM
LAT
LON

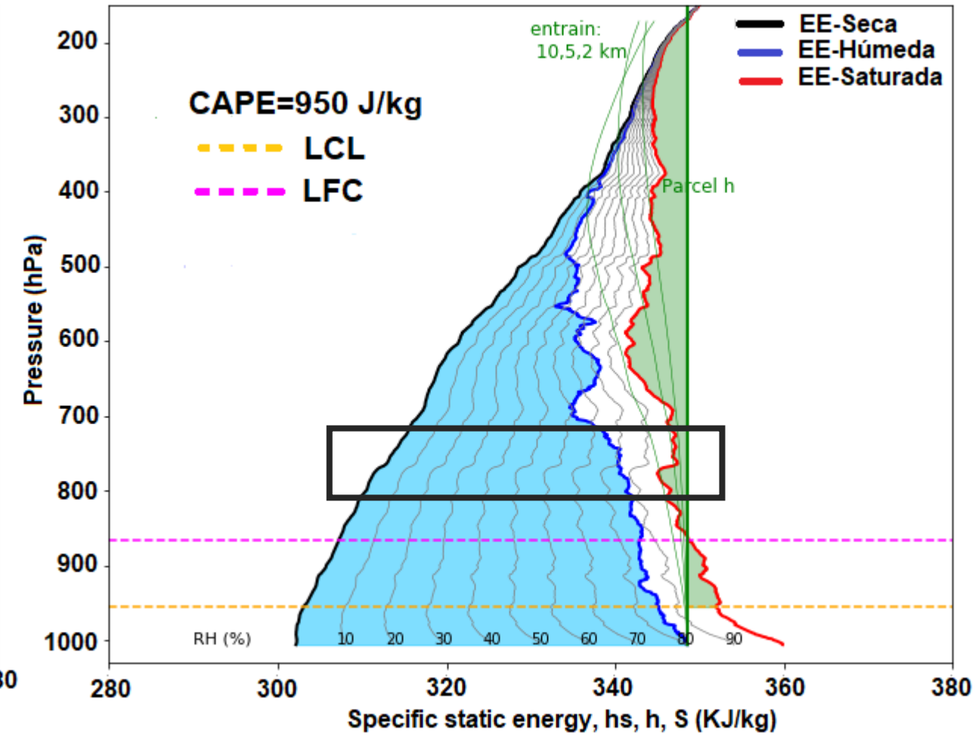
Results: Moist Static Energy (MSE) - IOP1 (Ocean, Ene 2016)

- Inversion layer between 700-800 hPa at 19:00 and 1:00LT
- **Positive boyancy at 7:00LT** coherent with morning rainfall peak and Mapes *et al*. (2003b)

$$S=Cp*T+g*z+Lv*q$$

19:00LT



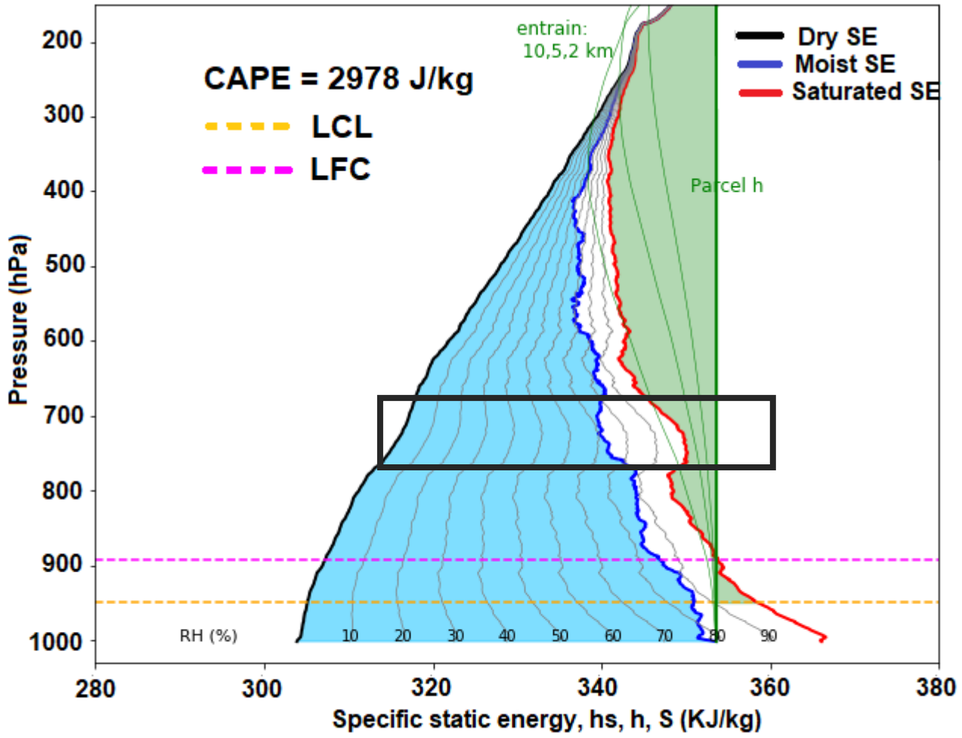


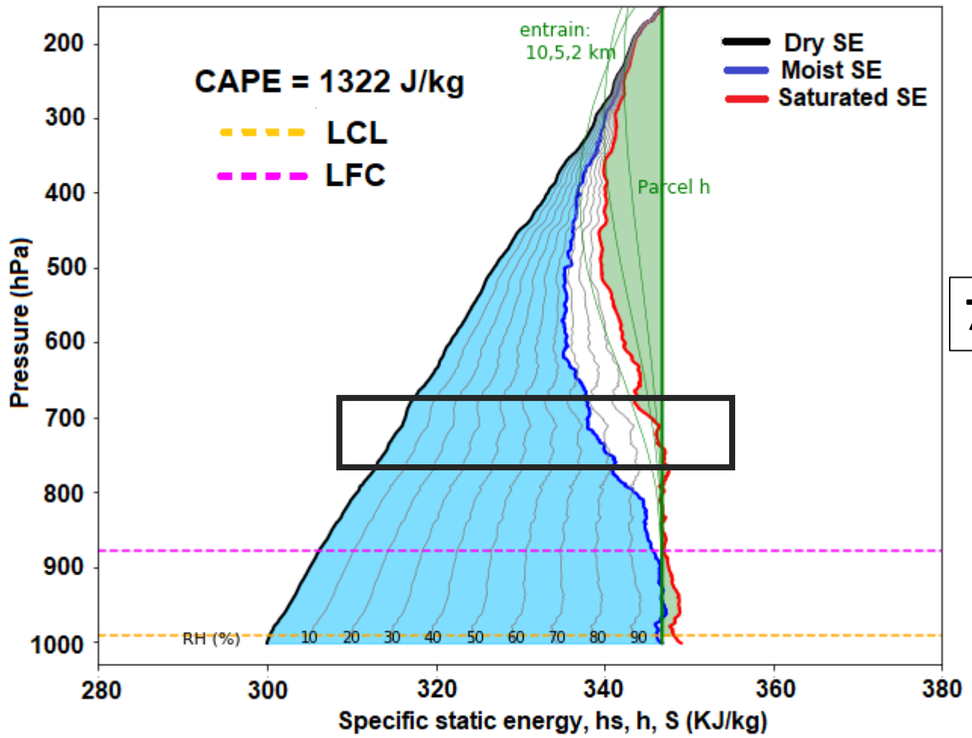
7:00LT

Results: Moist Static Energy (MSE) – IOP2 (Inland, Jun 2016)

- Inhibitation of lifting parcels at 7:00LT
- **Positive boyancy at 19:00LT** coherent with afternoon precipitation peak

19:00LT



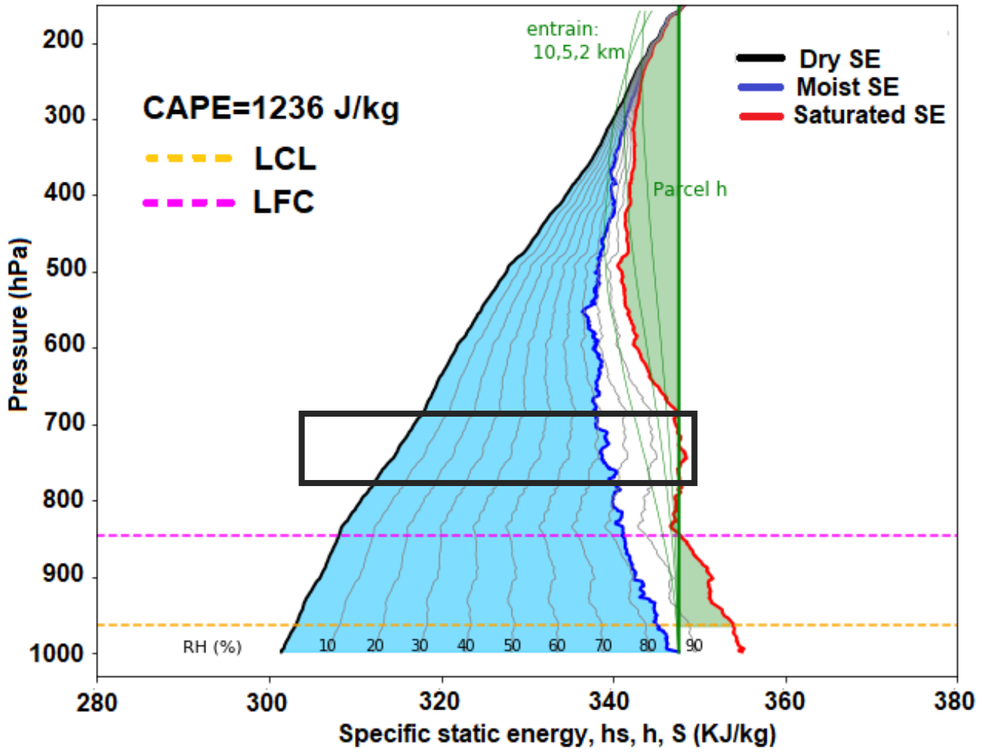


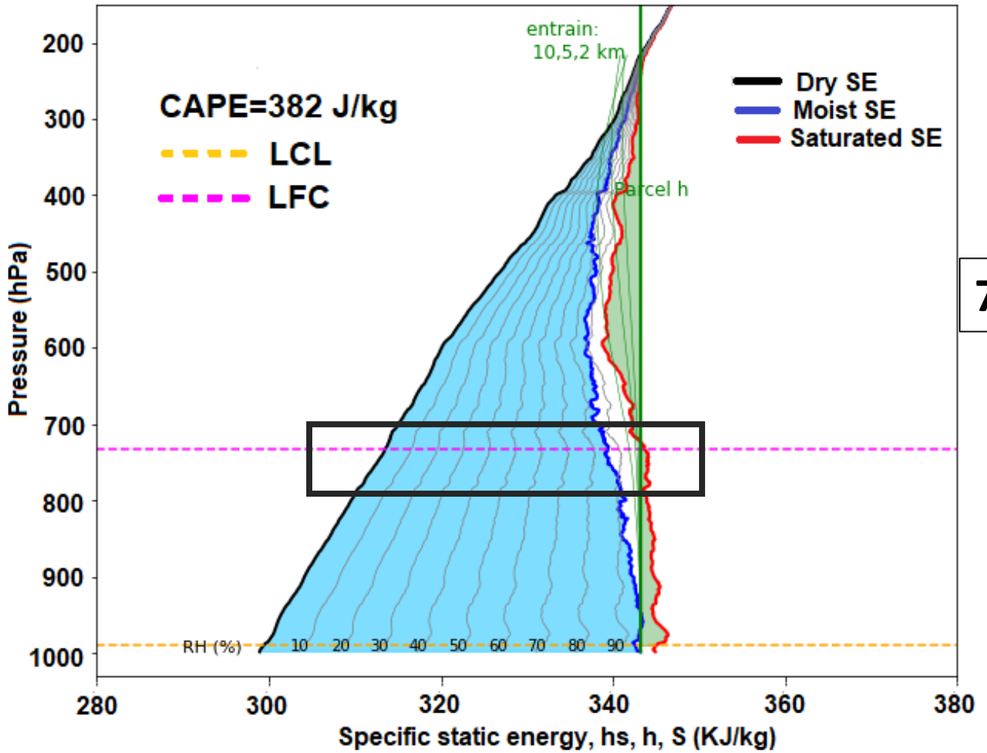
7:00LT

Results: Moist Static Energy (MSE) – IOP3 (Inland, Oct 2016)

- Inhibitation of lifting parcels all day long
- **No apparent GW mechanisms**

19:00LT



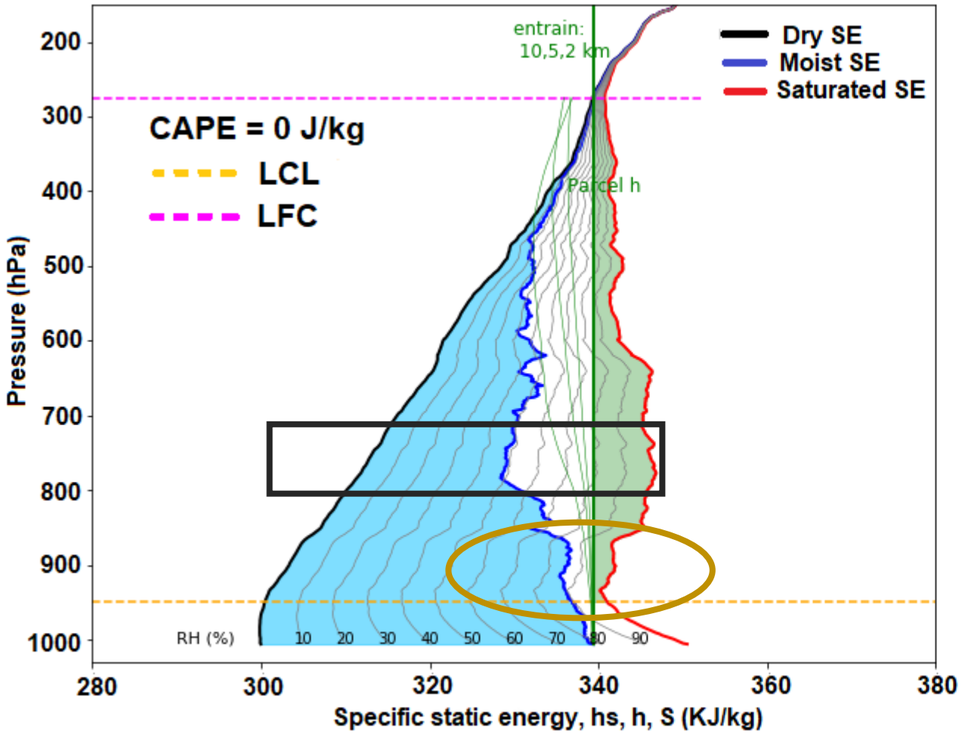


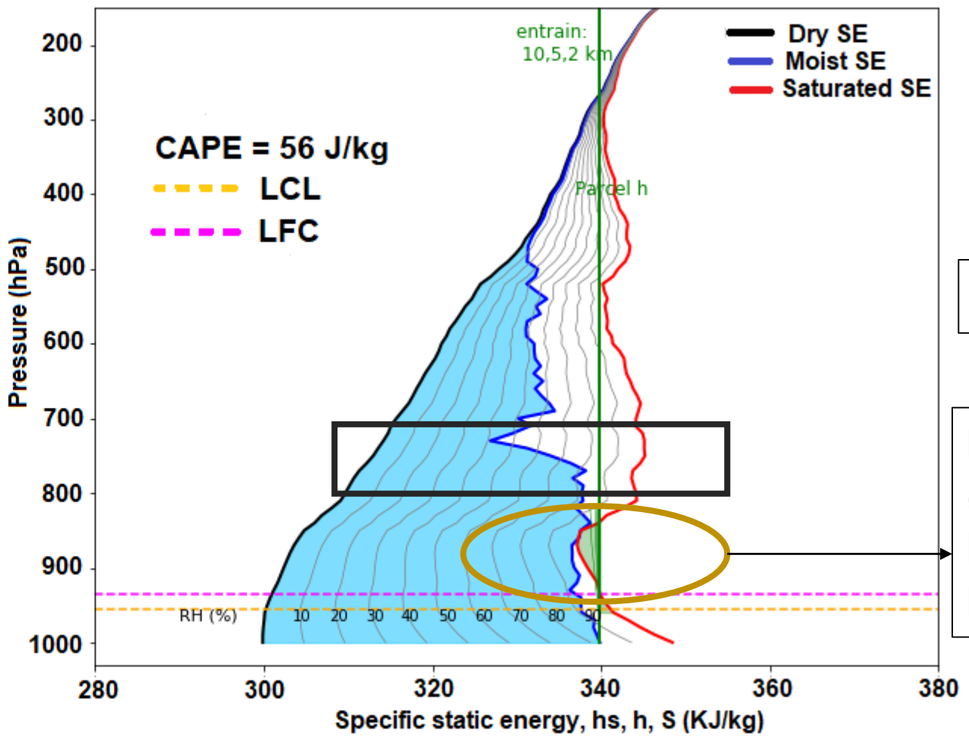
7:00LT

Results: Moist Static Energy (MSE) – IOP4 (Ocean, Nov 2016)

- It was located at southern part of the región of interest in Mapes et al. (2003)
- The most interesting campaign: hurricane Otto, La Niña conditions and **ChocoJet**

19:00LT



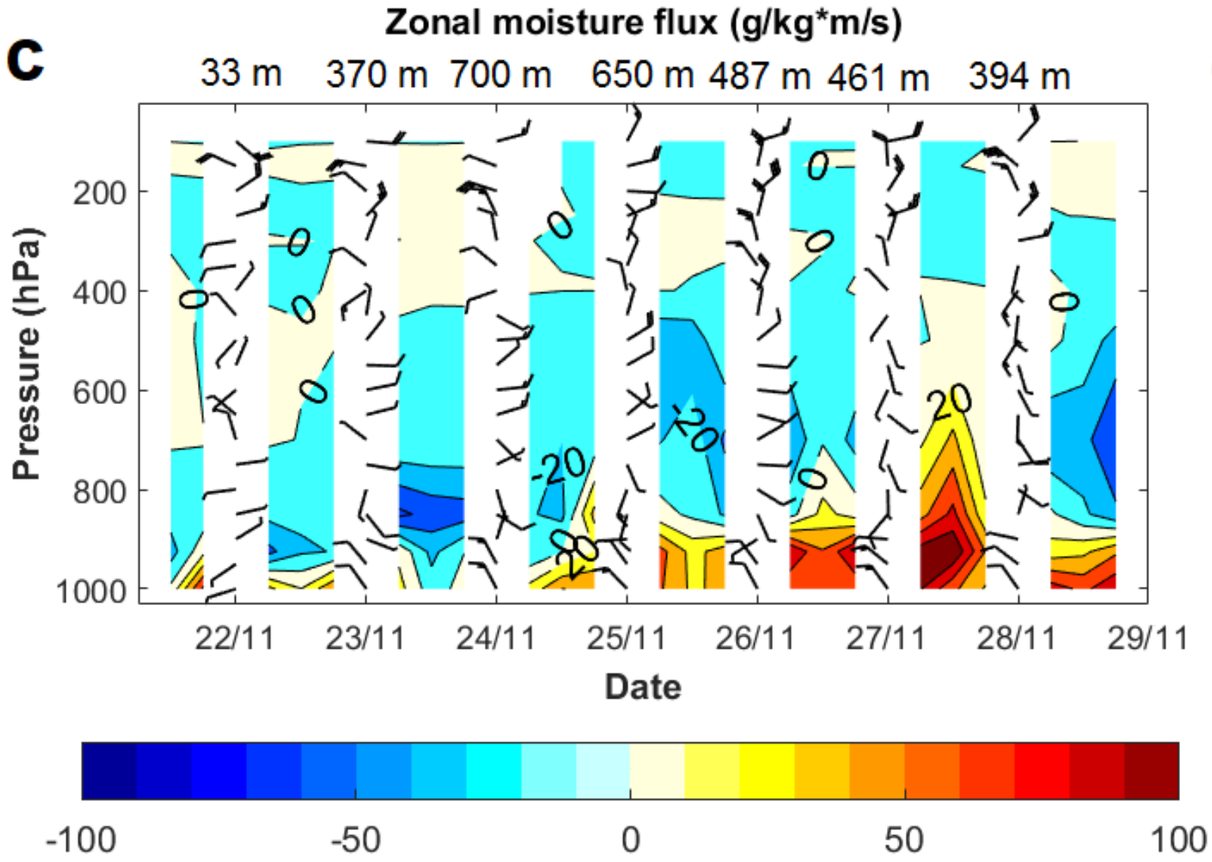


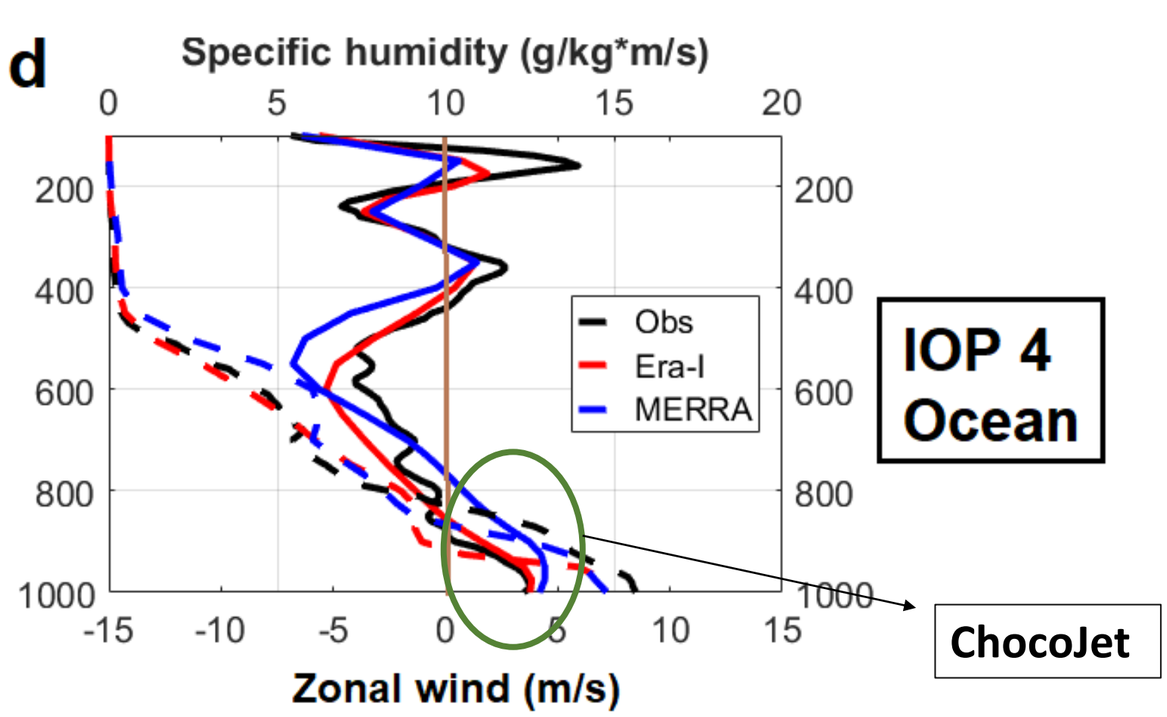
7:00LT

Positive boyancy during morning hours at 800-900 hPa

Results: ChocoJet

- Synoptic conditions influenced by hurricane Otto
- First observational evidence of ChocoJet (4-5 m/s)



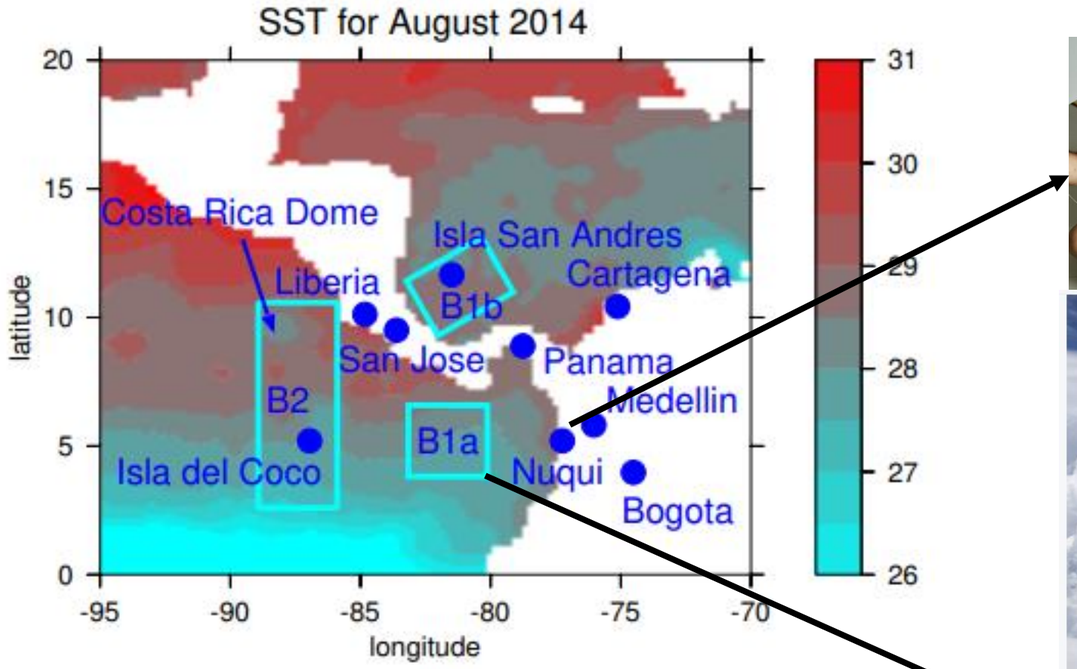


ChocoJet is deeper in the inland campiagns

Yepes *et al*. (2019)

OTREC - ChocoJEX II (http://catalog.eol.ucar.edu/otrec)

The Organization of Tropical East Pacific Convection (OTREC) Project funded by NSF (5.4 million dollars) is led by Dr. Fucks and Raymond. The main interest is in the vertical structure and spatial distribution of deep convection over an area with strong SST gradient, the far Eastern Pacific. **Happening right now!**



OTREC-Nuquí team

NSF/NCAR Gulfstream-V aircraft

Conclusions

- ChocoJEX get together **different institutions** from Colombia and United States to adress relevant research questions for the region climate.

- Diurnal variations in mid-level temperature during **IOP1 and IOP2 evidence the gravity waves** mechanism proposed by Mapes et al. (2003b), which in turn supports the diurnal cycle of precipitation over Colombian Pacific coast.

- The gravity waves activity was not evident during IOP3 and IOP4, reasons for include:
  - Rather large synoptic activity (e.g. TS Otto during IOP4)
  - Relative distance from shore during IOP4.

- **First observational evidence of the ChocoJet** during IOP4, with winds of 4-5 m/s

Acknowledgements

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