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)

Photo by John F. Mejía

López & Howell (1967)
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

Vessel platform for offshore observations
- Campaigns developed during ERFEN

- Logistic support
- Transport of sounding system, gas and personnel

- Financial support

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Dimar
### Intensive Observing Periods (IOPs)

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

<table>
<thead>
<tr>
<th>IOP</th>
<th>Date (2016)</th>
<th>Region</th>
<th>Amount of radiosondes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 15-22</td>
<td>Ocean</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Jun 25-Jul 1</td>
<td>Quibdó</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Oct 15-21</td>
<td>Quibdó</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>Nov 21-28</td>
<td>Ocean</td>
<td>30</td>
</tr>
</tbody>
</table>

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

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

\[ S = C_p T + g z + L v q \]
Results: Moist Static Energy (MSE) – IOP2 (Inland, Jun 2016)

- Inhibition of lifting parcels at 7:00LT
- Positive boyancy at 19:00LT coherent with afternoon precipitation peak
Results: Moist Static Energy (MSE) – IOP3 (Inland, Oct 2016)

- Inhibition of lifting parcels all day long
- No apparent GW mechanisms
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

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)

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!
Conclusions

• ChocoJEX get together different institutions from Colombia and United States to address 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