Convective lifecycle insights from RELAMPAGO observations near the Sierras de Córdoba

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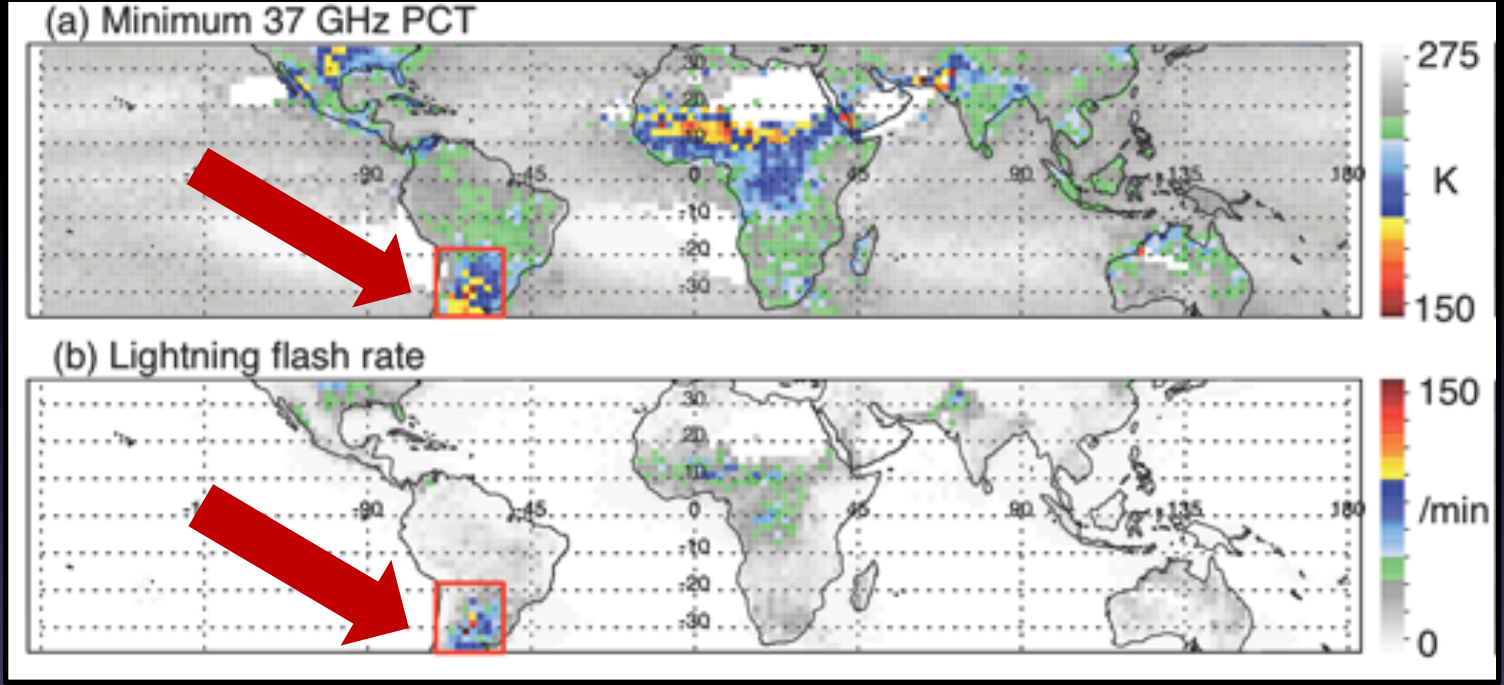
Motivation – Why Argentina?

From satellite snapshots:

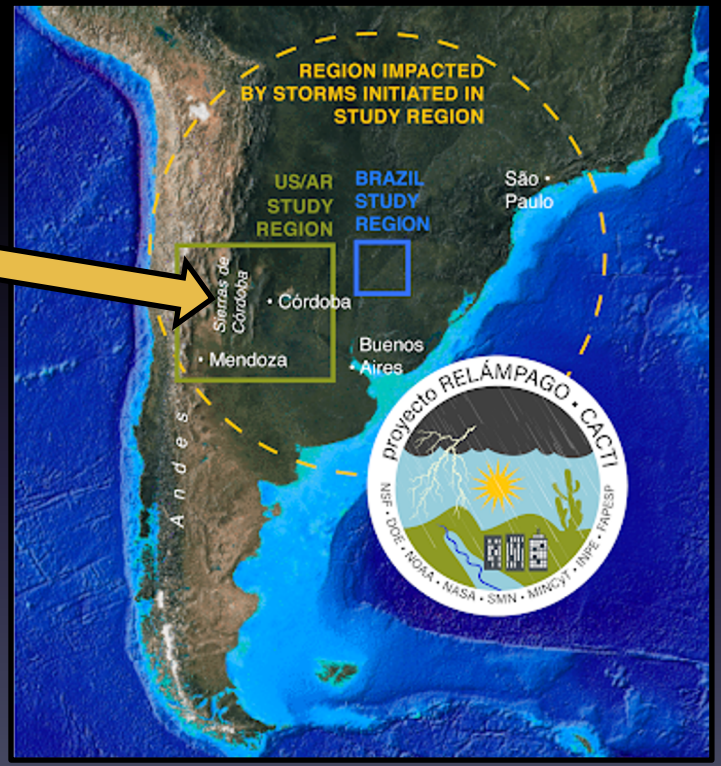
Deep convection with strong updrafts, frequent lightning, hail in Argentina



Zipser et al. (2006), BAMS

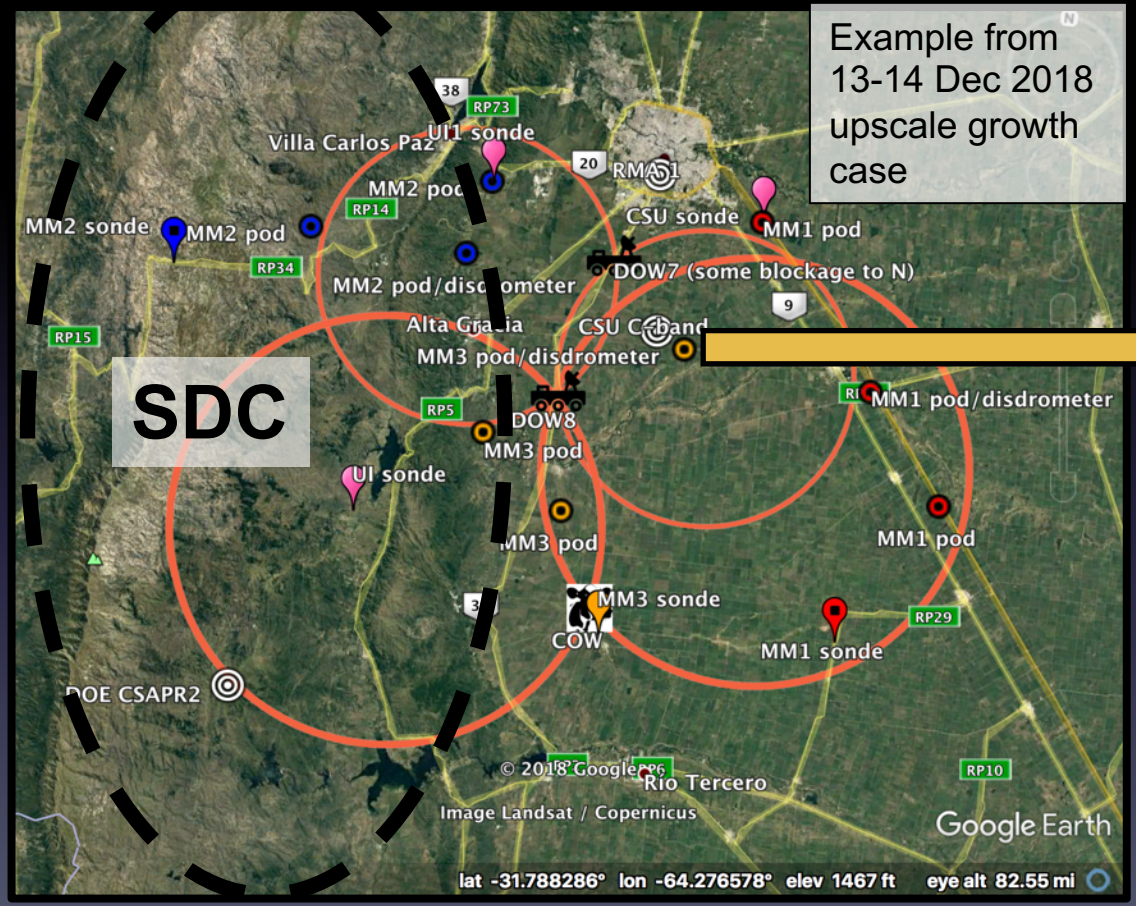
RELAMPAGO: Remote sensing of Electrification, Lightning, And Mesoscale/microscale Processes with Adaptive Ground Observations

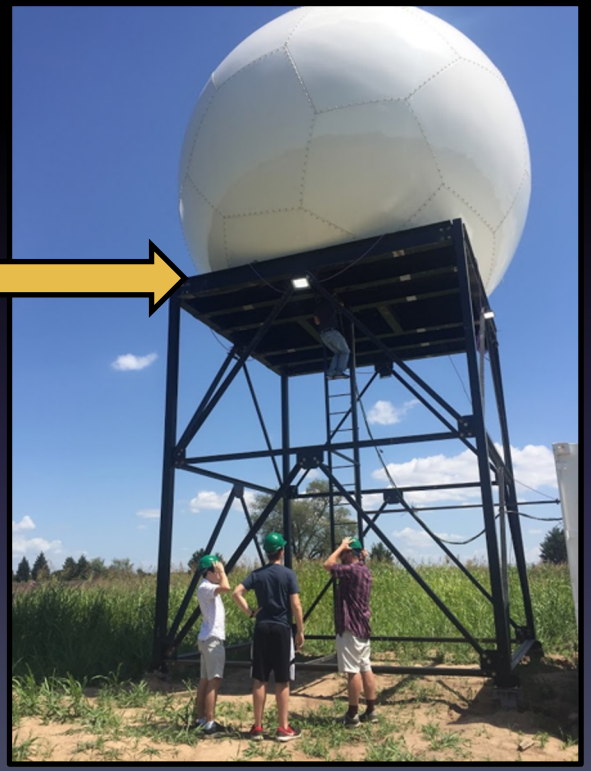
- Sierras de Córdoba (SDC): Frequent initiation of deep convection, rapid upscale growth of convection
- Unique opportunity to observe and understand complex interactions between terrain, environmental conditions, and convective characteristics



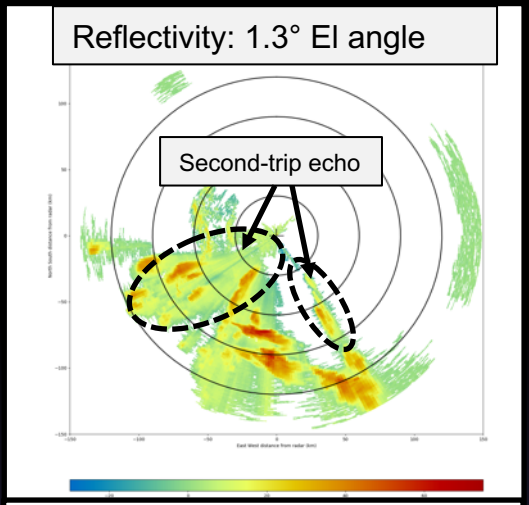
Intensive Observing Period: 1 Nov 2018 – 15 Dec 2018

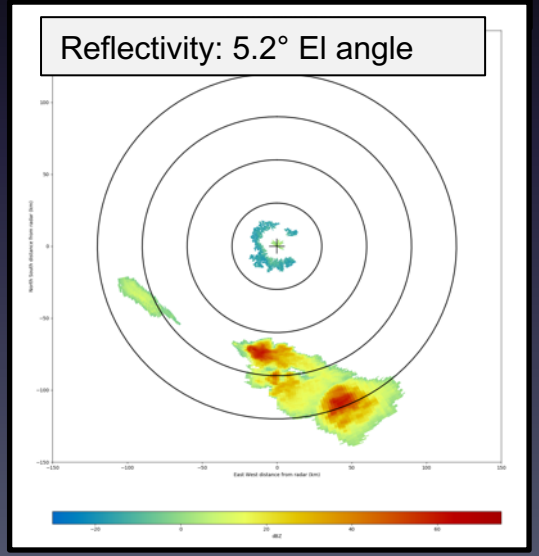
REI AMPAGO Observational Strategy





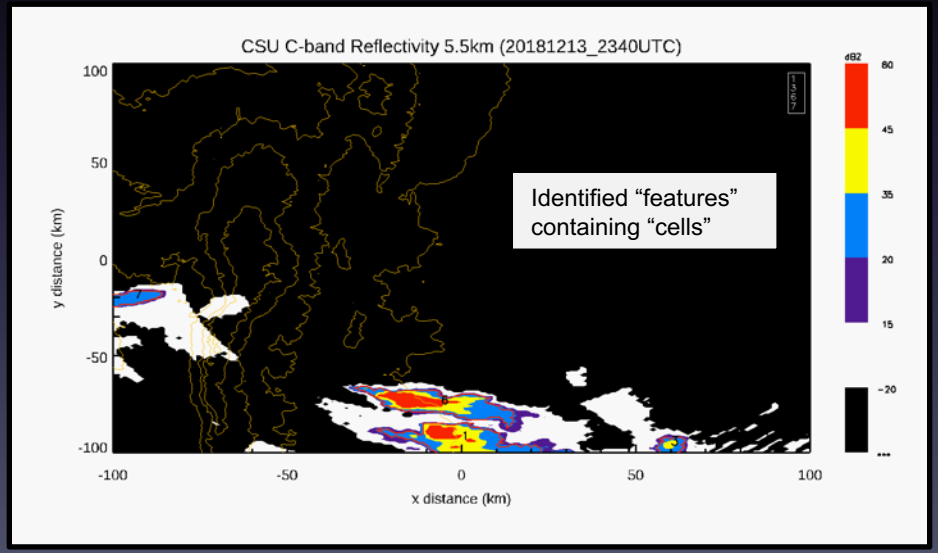
CSU "CHIVO" radar



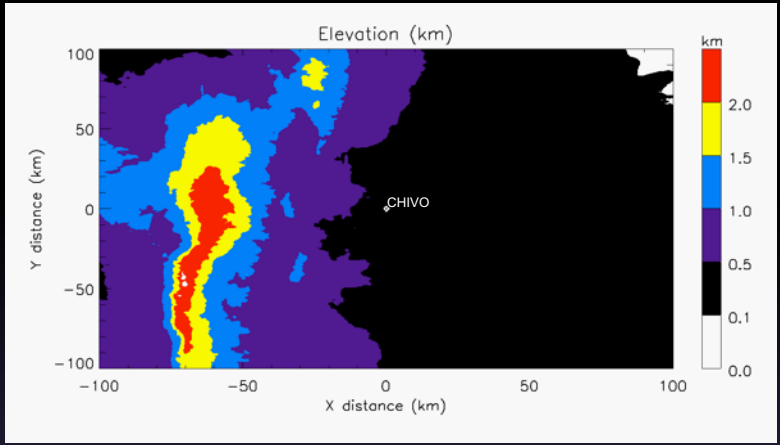


CHIVO Cell Identification

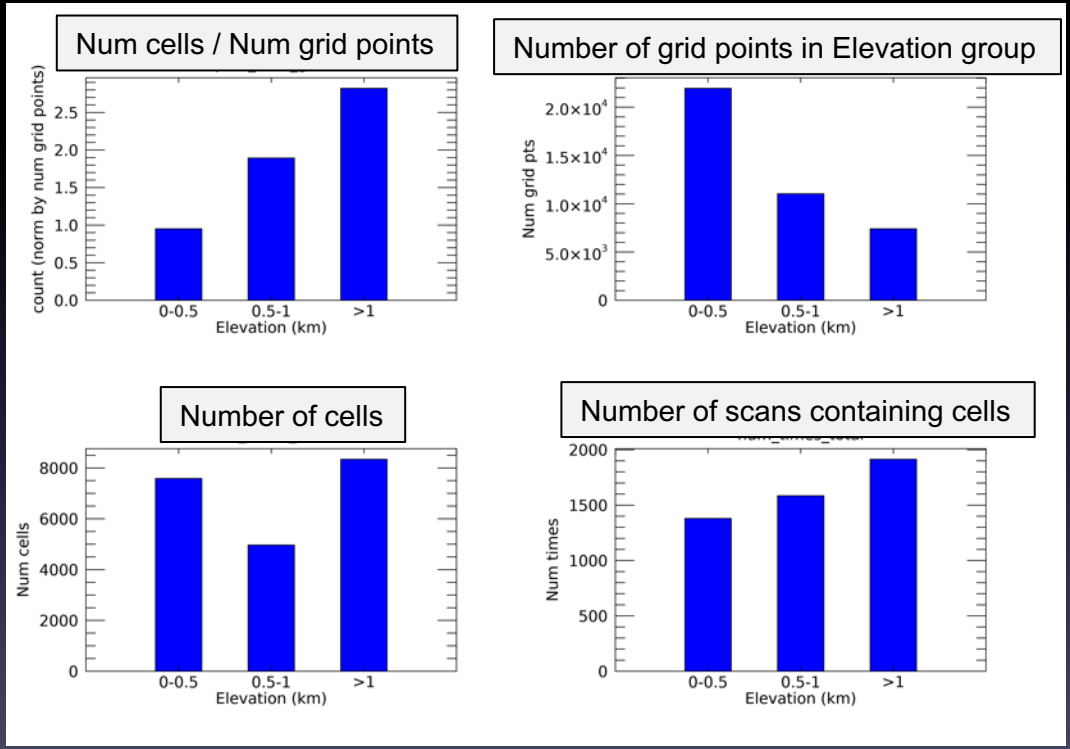
- Gridded (1 km horizontal, 0.5 km vertical), 100-km distance from radar
- Search for 20-dBZ contiguous echo at 5.5 km height (“feature”)
- Within “feature”, identify “cells” with 35- and 45-dBZ at 5.5 km
- Search within cells through vertical column for characteristics (e.g., echo-top height) with respect to cell’s centroid position w.r.t. terrain



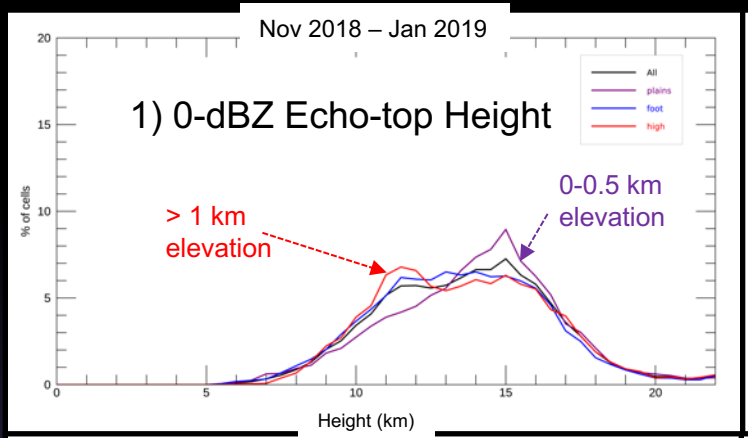
How many cells did CHIVO observe?

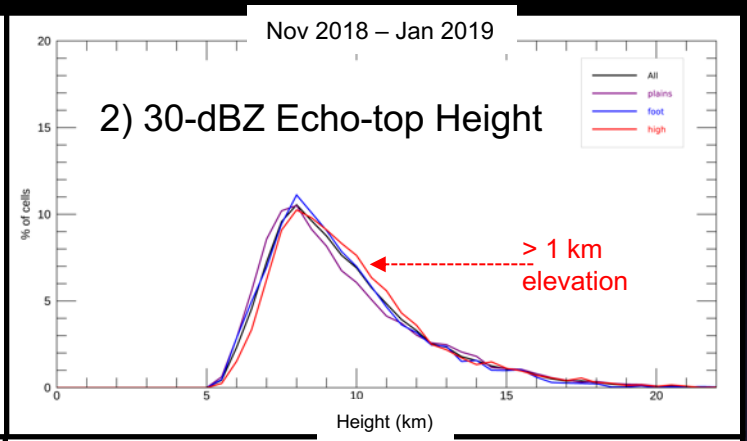


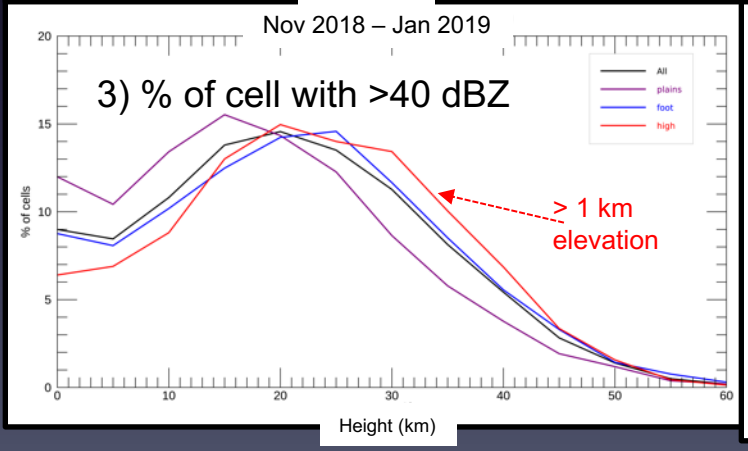
- More grid points in 0-0.5 km elevation range, but more radar scans with cells identified and more total number of cells observed over higher terrain (>1.0 km)
- ➢ Highlights frequent occurrence of convection over SDC
- ➢ Despite rapid-update sector scans focusing to west, scans included adequate coverage to east of radar

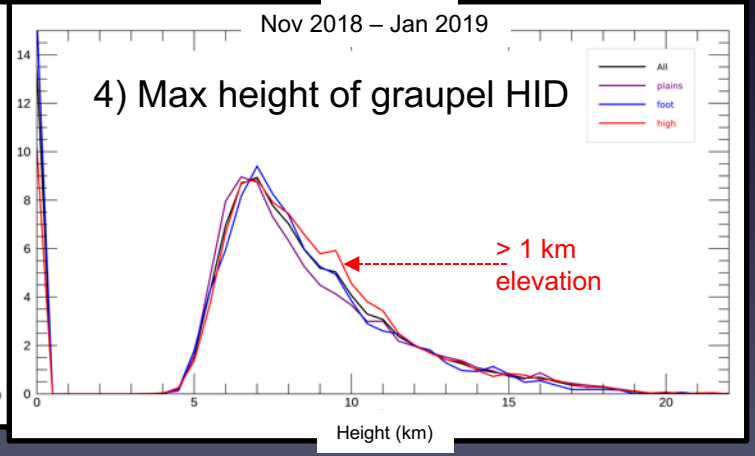


Where did CHIVO observe intense convective cells?



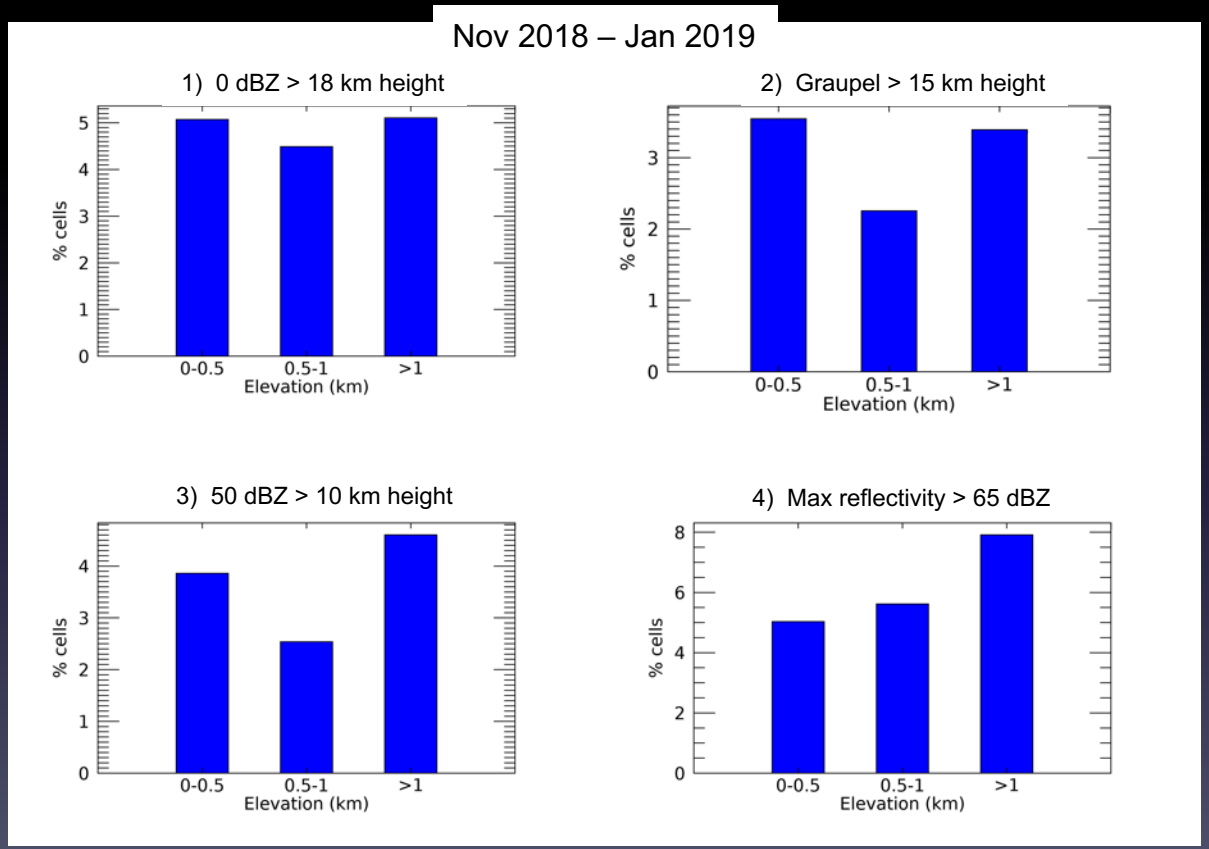






1. Similar echo-top distributions, some shallower over high terrain (likely initiation)
2. All cells have 30-dBZ echo above 5 km, many above 10 km (slightly more for high elevations), and a small few above 15 km
3. Greater overall % of 40-dBZ echo over high terrain (overall more intense)
4. Similar distribution of max graupel height (slightly more for high terrain)

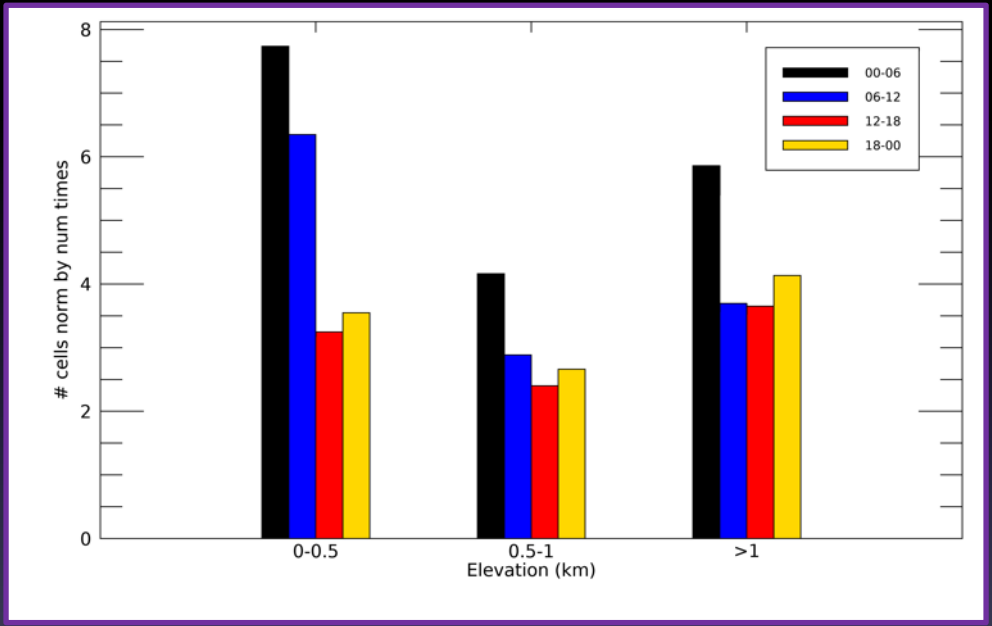
Where did CHIVO observe intense convective cells?



1. Nearly 5% of all identified cells reach at least 18-km height (based on 0 dBZ), including over plains and high terrain
2. Over 3% of cells have graupel inferred above 15-km height, with slightly less in 0.5-1-km range
3. More cells over high terrain have 50 dBZ over 10 km (most intense cells over high terrain)
4. Cells with their max reflectivity exceeding 65 dBZ more frequent over high terrain

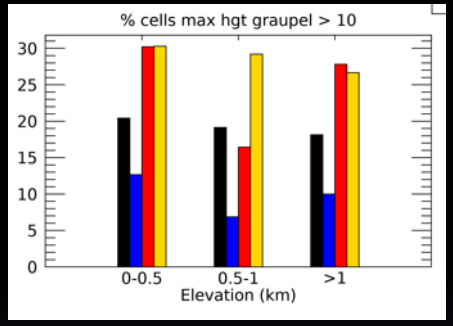
Percentage of cells meeting threshold

When did CHIVO observe intense convective cells?

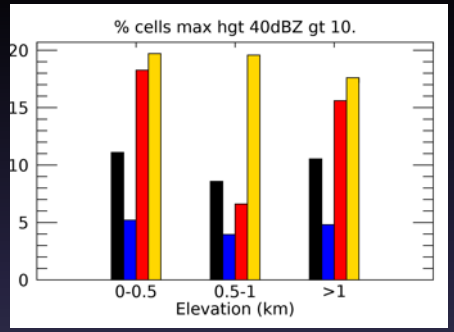


When normalized by the number of scans with cells identified, cells are observed most frequently overnight (LT=UTC-3) and into the morning (especially for lower elevations for the latter). During the afternoon/evening, more cells over highest terrain.

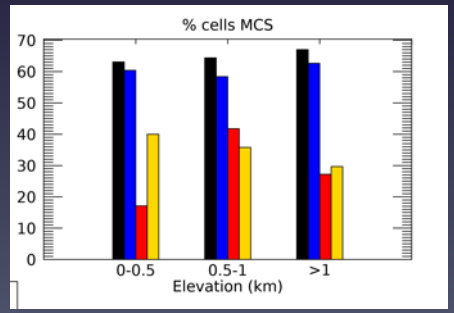
% of cells with graupel reaching > 10 km height most frequent afternoon/evening



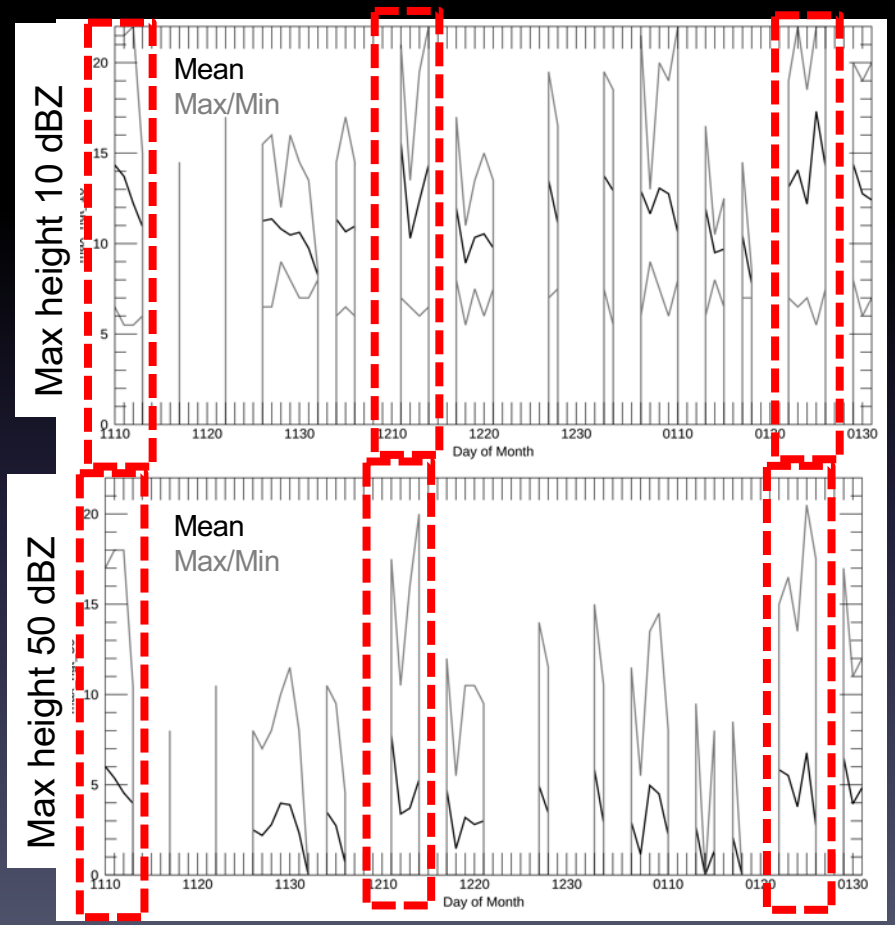
% of cells with 40 dBZ > 10 km height most frequent afternoon /evening



% of cells part of MCS peaks at all elevations overnight into the morning



When did CHIVO observe intense convective cells?



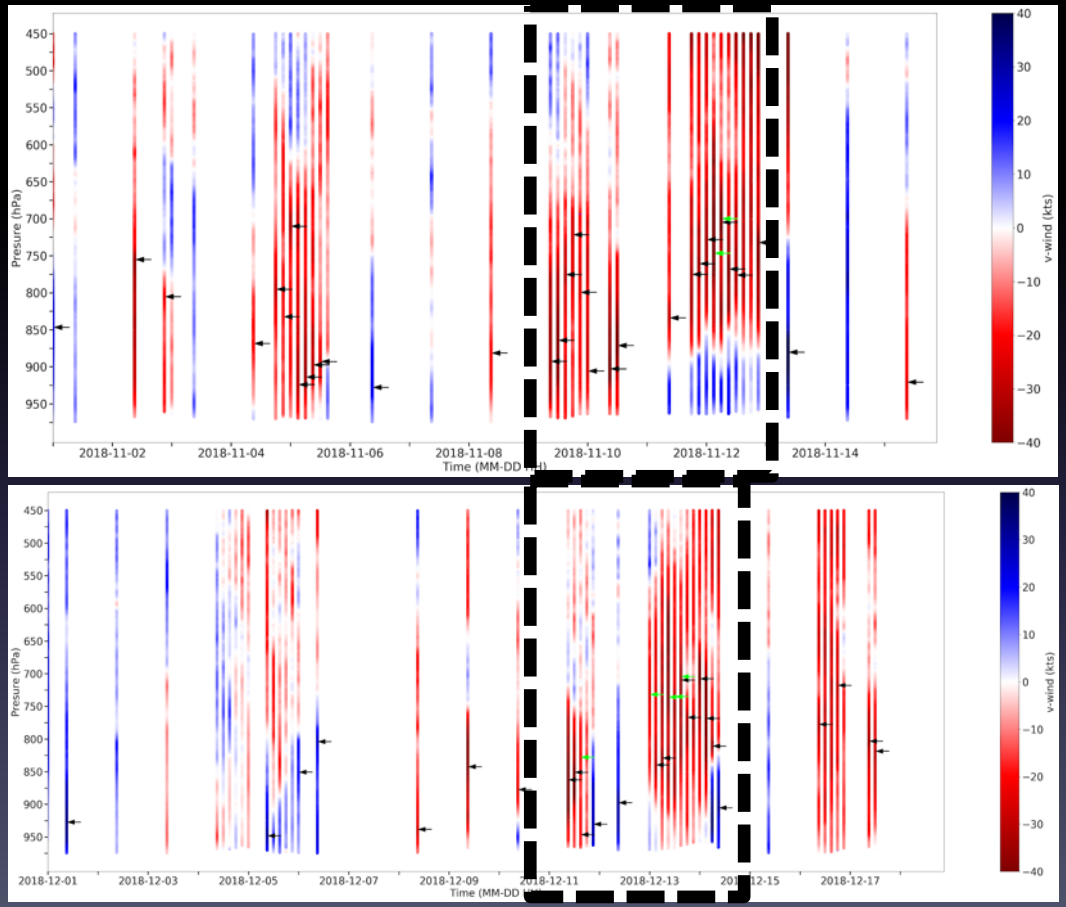
Timeseries for entire CHIVO operations (Nov 2018 - Jan 2019)

~12 multi-day convective events observed (containing deep and wide convective cores - 2.1 Rasmussen et al.)

Several events stand out with not only deep (10 dBZ > 20 km height), but intense (50 dBZ > 15 km height):

- ✓ 10-13 November (2.2 Piersante et al.)
- ✓ 12-14 December (2.4 Arias et al.)
- ✓ 22-26 January

Deep convective events coincide with South American Low-Level Jet



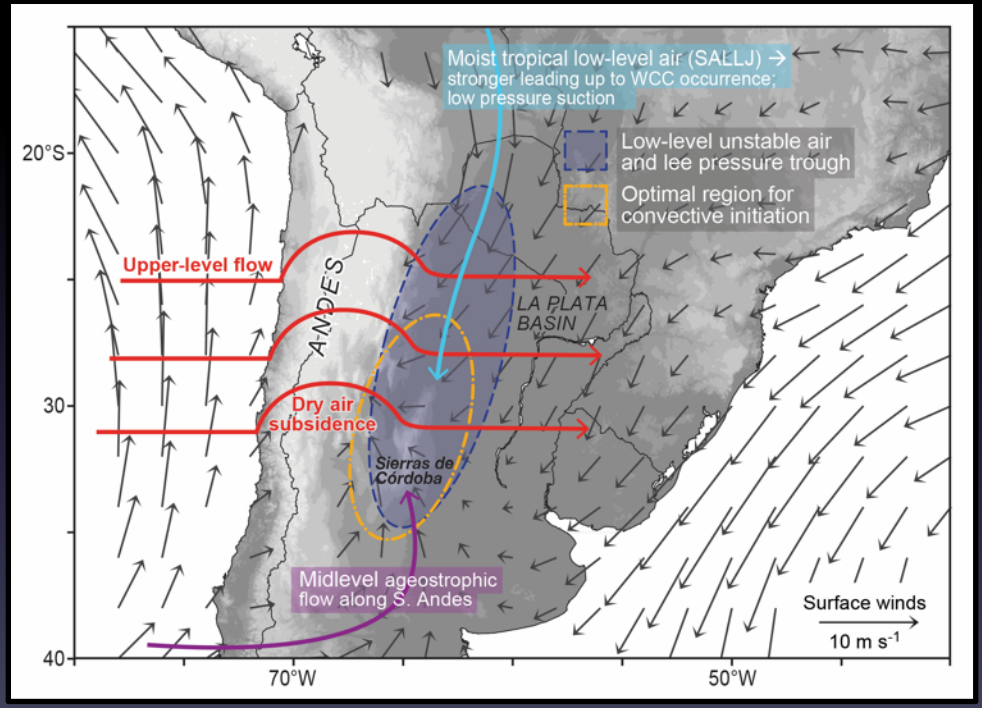
Sasaki et al. (Poster Session 1, Tuesday, #9

- ✓ 10-13 November
- ✓ 12-14 December

Black and green arrows = LLJ identified, peaking at that height

Soundings north of Cordoba, east of the SDC

13-14 December 2018

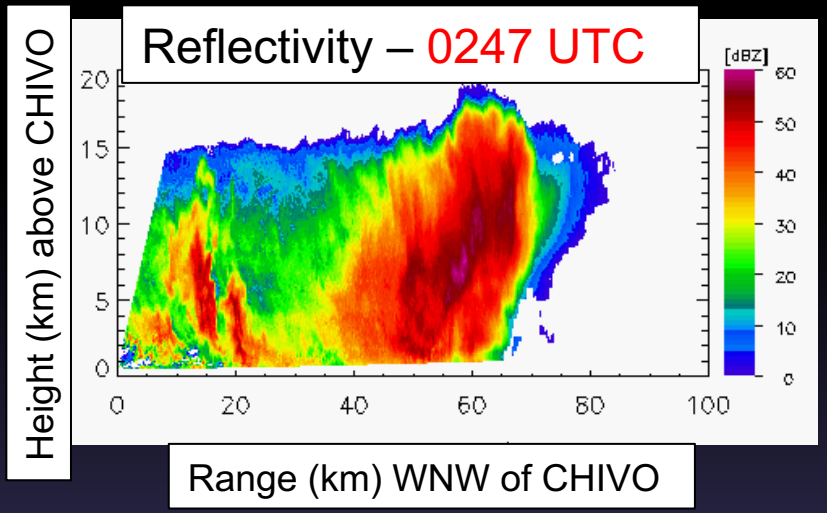


Rasmussen and Houze (2016) – Model terrain experiments reveal factors contributing to deep convective events near the SDC

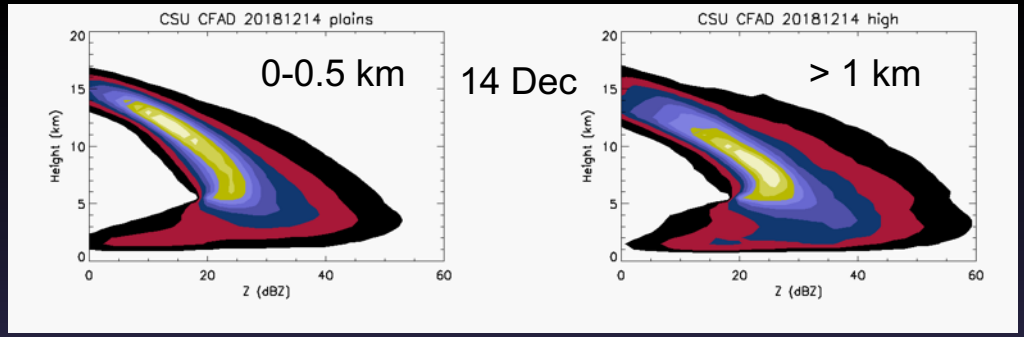
- ✓ Trough moving over Andes
- ✓ Lee cyclogenesis with cold front south of RELAMPAGO domain
- ✓ Dry air off Andes: Capped
- ✓ Northerly low-level jet ushering in moisture

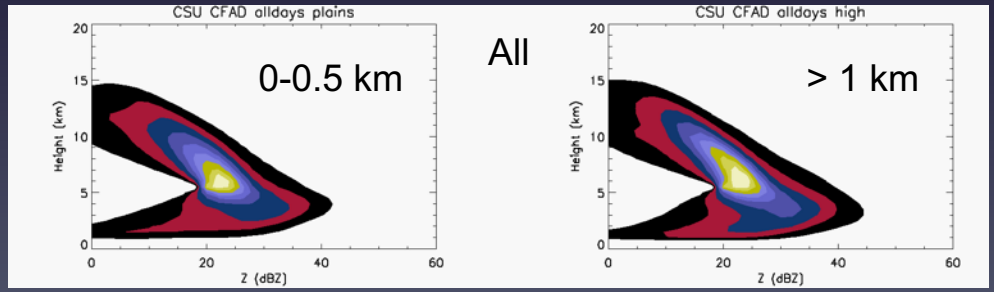
22 UTC 13 Dec – 03 UTC 14 Dec

14 Dec: Deep, intense convection (plains and terrain)



Contoured Frequency by Altitude Diagrams of CHIVO Reflectivity (normalized by max frequency)





14 December stands out as intense for convective cells both over the plains (0-0.5 km) and at high elevations (> 1 km)

Conclusions and Future Work

- ✓ Deep, intense convective cells occurred at all elevations during RELAMPAGO CHIVO operations, with greatest frequency during the afternoon/evening, especially over the higher terrain
- ✓ Convective cells as part of MCSs most often overnight into the morning
- ✓ Most intense cells occurred over terrain, but also over plains, especially during multi-day episodes of convective activity (times coinciding with SALLJ)
- ❑ Ongoing analysis of upscale growth events will focus on ingredients associated with cell characteristics with respect to terrain
- ❑ Detailed analysis of 13-14 Dec case includes cold pool and SALLJ soundings, terrain-modification experiments, and analysis of dual-polarization data of this rapid upscale event near the SDC

Thank you!

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PyART

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