Proyecto RELAMPAGO-CACTI Argentina 2018-9

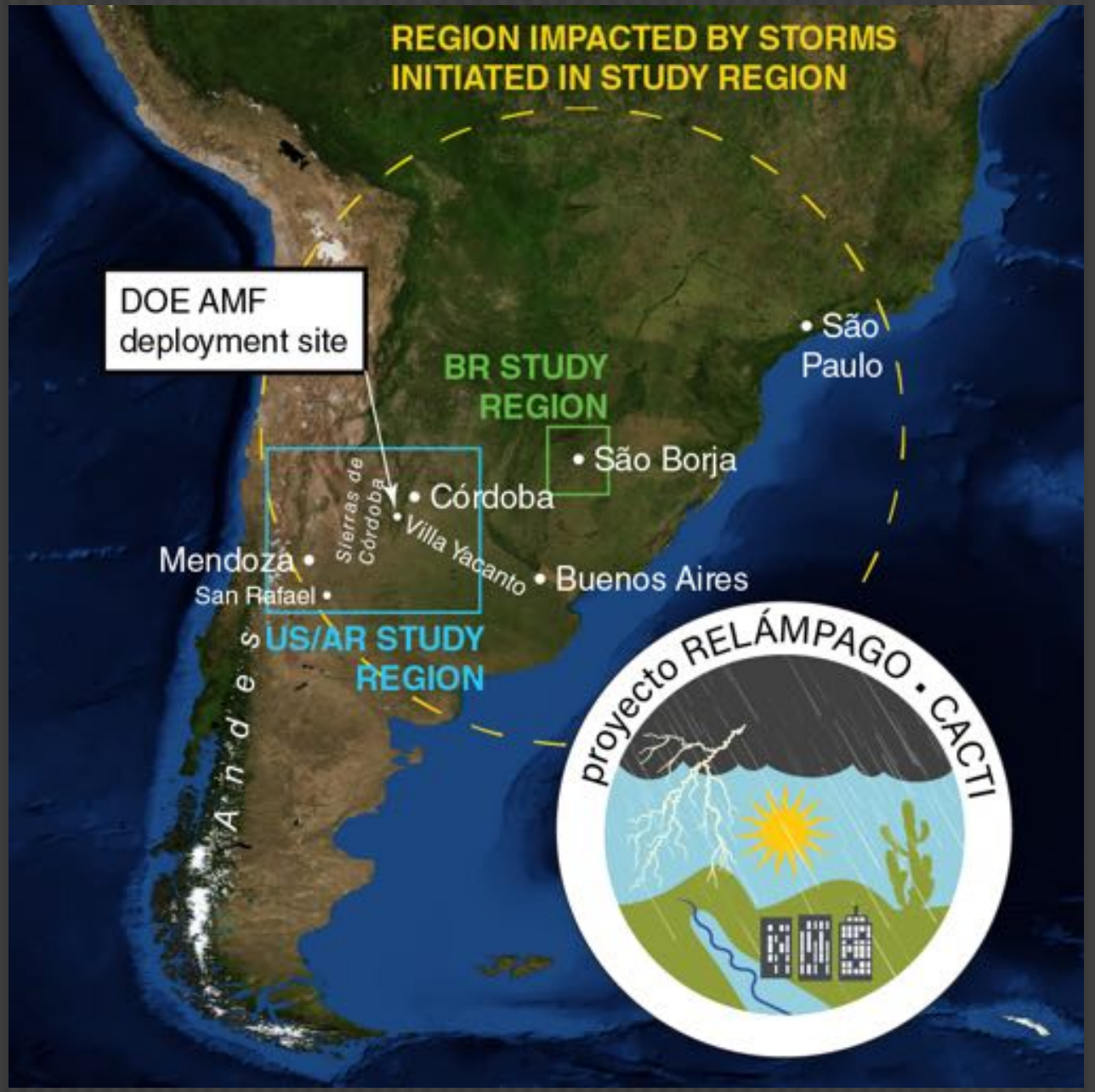
Prof. Steve Nesbitt, Department of Atmospheric Sciences, University of Illinois
and the RELAMPAGO-CACTI Team

The RELAMPAGO leadership team

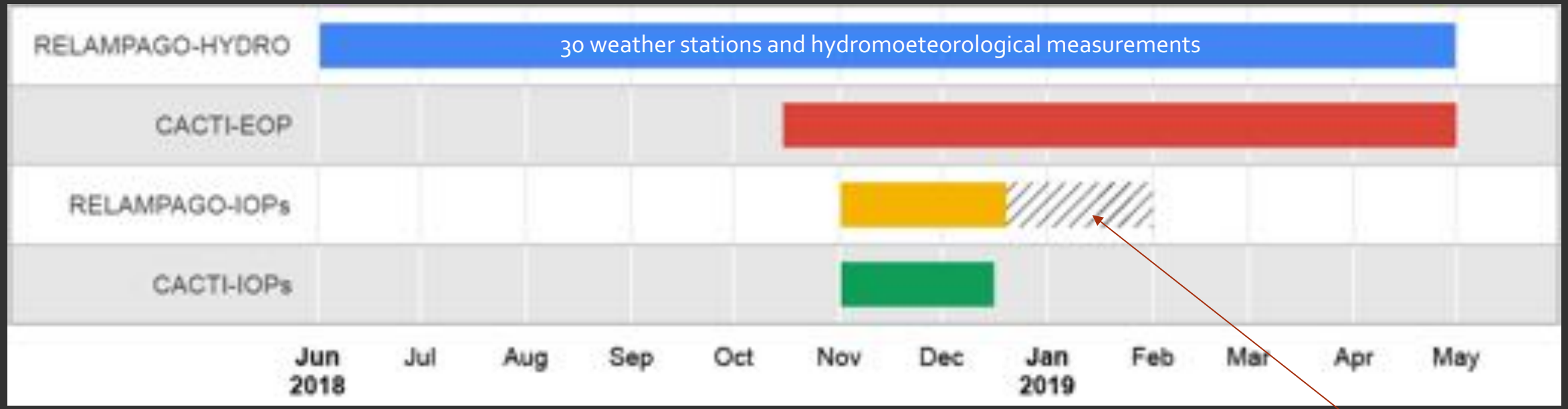
- Steve Nesbitt, University of Illinois at Urbana-Champaign (US NSF PI)
- R. Jeffrey Trapp, University of Illinois at Urbana-Champaign (US NSF Co-PI)
- Rita Roberts, National Center for Atmospheric Research (US NSF Co-PI)
- Paola Salio, University of Buenos Aires, Argentina (Argentina lead)
- Luiz Machado, INPE, Brazil (Brazil lead)
- Timothy Lang, NASA Marshall Space Flight Center (US NASA/NOAA lead)
- Rachel Albrecht, University of São Paulo, Brazil
- Larry Carey, University of Alabama-Huntsville
- V. Chandrasekar, Colorado State University
- Weibke Deierling, University of Colorado-Boulder
- Francina Dominguez, University of Illinois at Urbana-Champaign
- Carlos Marcelo Garcia, Universidad Nacional de Cordoba, Argentina
- Deanna Hence, University of Illinois at Urbana-Champaign
- Karen Kosiba, Center for Severe Weather Research
- Matt Kumjian, Penn State University
- Jim Marquis, University of Colorado-Boulder
- Ernani Nascimento, Universidad Federal de Santa Maria, Brazil
- Kristen Rasmussen, Colorado State University
- Angela Rowe, University of Washington
- Celeste Saulo, Servicio Meteorológico Nacional, Argentina
- Russ Schumacher, Colorado State University
- Adam Varble, Pacific Northwest National Lab
- Jim Wilson, National Center for Atmospheric Research
- Josh Wurman, Center for Severe Weather Research
- Ed Zipser, University of Utah

RELAMPAGO: Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations

CACTI: Clouds, Aerosols, and Complex Terrain Interactions

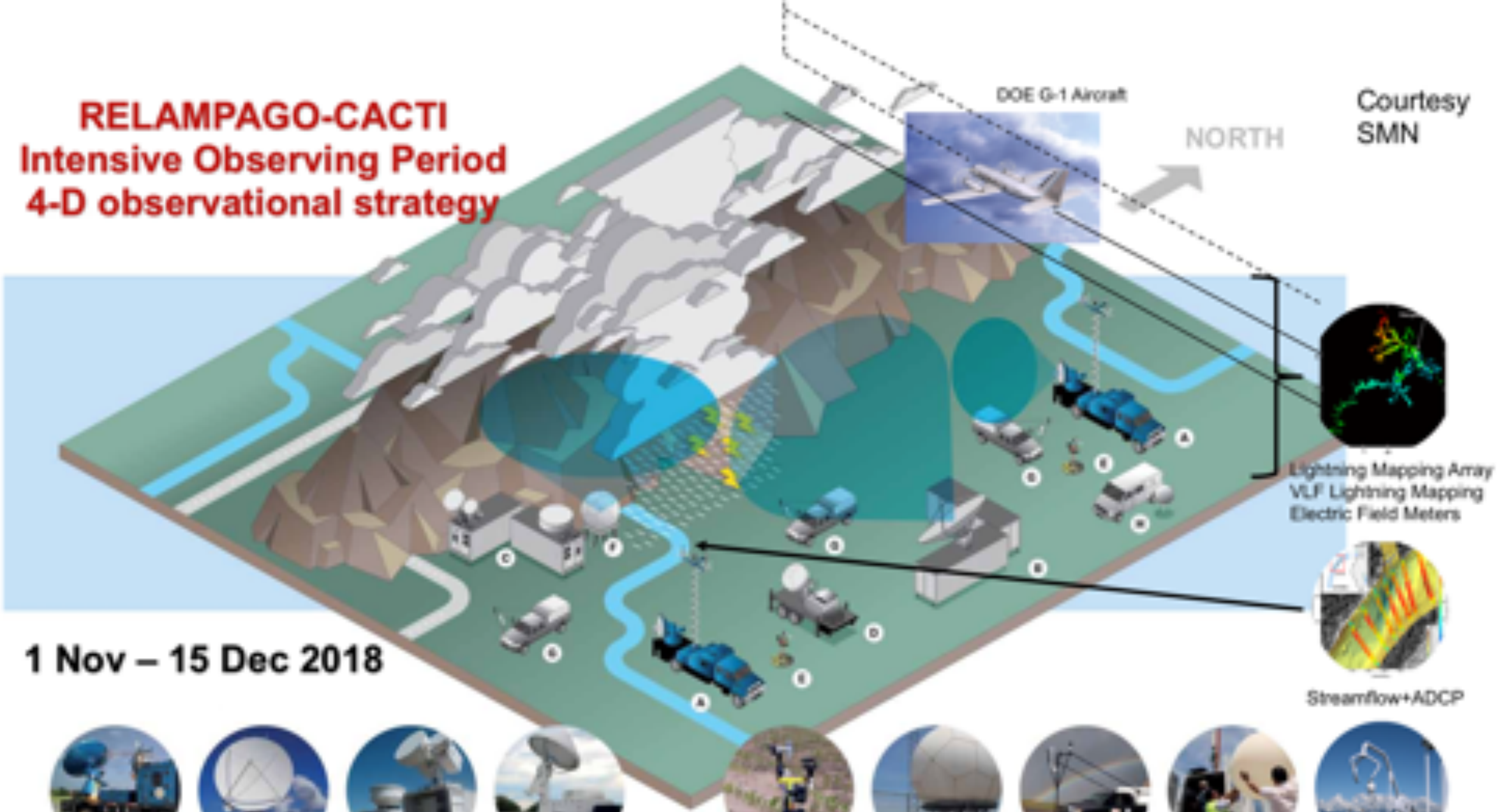


RELAMPAGO-CACTI TIMELINE



Extension of RELAMPAGO IOP with CSU C-Band, SMN Soundings at Córdoba with SPolKa logistics failure

RELAMPAGO-CACTI
Intensive Observing Period
4-D observational strategy



A. DOW x 3

B. C-Band Scanning Radar x 2

C. KaZR + X/Ka SACR

D. Deployable INPE X-Band

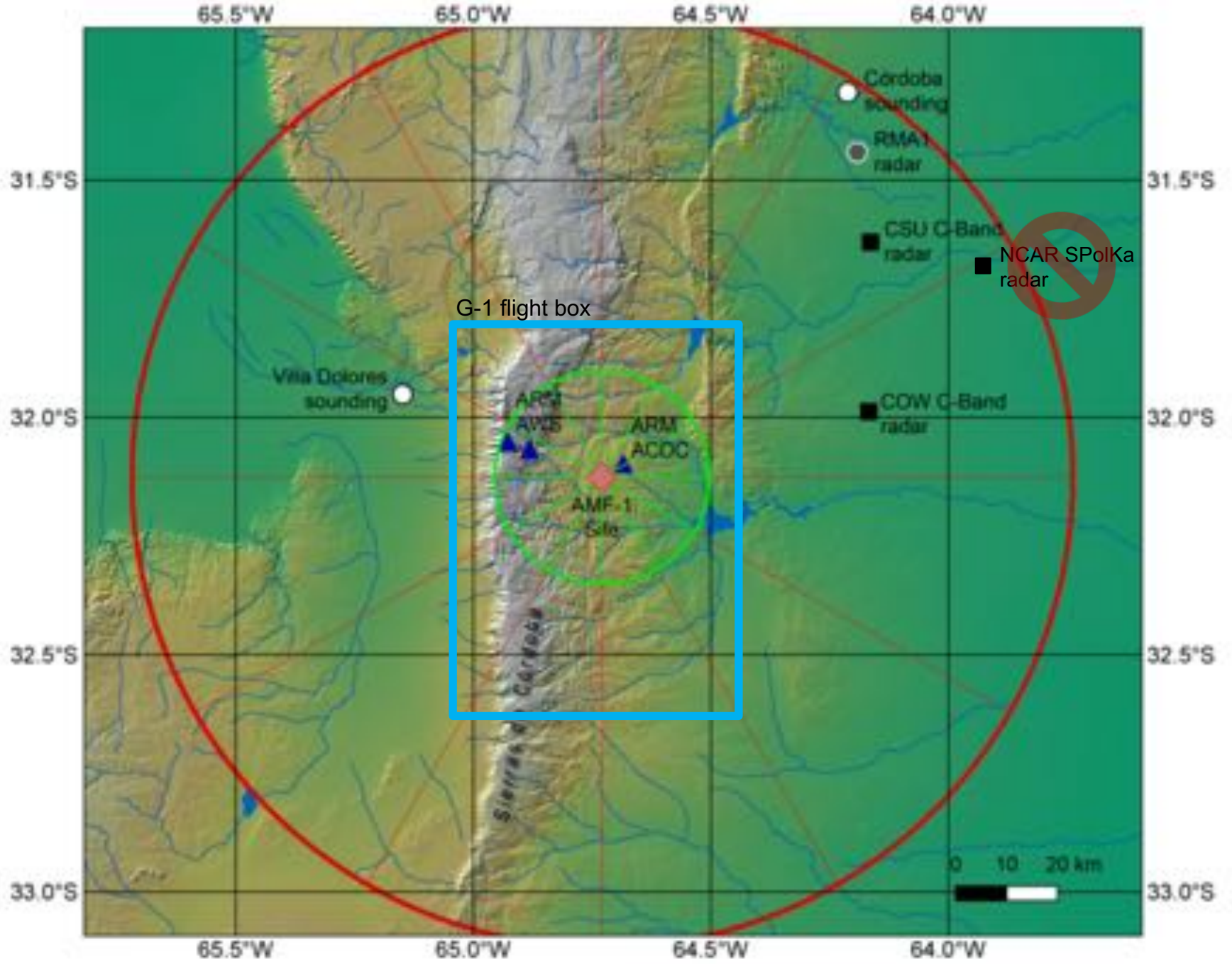
E. POD Portable Mesonet

F. CSAPR-2

G. Mobile Mesonet

H. Mobile Radiosondes

Flux towers



RELAMPAGO and CACTI collected extremely coordinated and complimentary datasets on many IOPs

The RELAMPAGO and CACTI PIs worked hand-in-hand on complimentary objectives, and the cases we collected together will be golden cases for process studies and model studies.

CSU C-BAND RADAR

- Upon directive from NSF on 26 July 2018, U. Illinois contracted to build a tower and install internet service on provincial land and operated the radar; CSU provided engineering support; Córdoba province provided power and security at no cost, and UNC provided guarantees for the temporary importation
- Operated remotely
- Collected 80 days of observations (November 10 2018 through February 1 2019), collected cases in January with extra soundings launched by SMN at Córdoba
- No technical problems other than power outages (infrequent)

COW

- Went from a truck to an operating radar in 1 month.
- Finding site was a "Hail Mary" that needed some Twitter creativity, but successful
- Leadership and engineering staff at CSWR deserve a lot of credit
- Radar worked well during the campaign despite hurried setup, hail, and some minor pedestal issues
- NCAR EOL radar engineering support of CSWR in completing the COW construction was critical
- Collected data from 12 November – 18 December 2018

RELAMPAGO had 5 Science Focus Areas

- Convective Initiation
- Severe Weather
- Upscale Growth of Convection
- Lightning
- Hydrometeorology

Each of these focus areas developed a mobile operations plan in the context of fixed SMN, RELAMPAGO, and CACTI observations

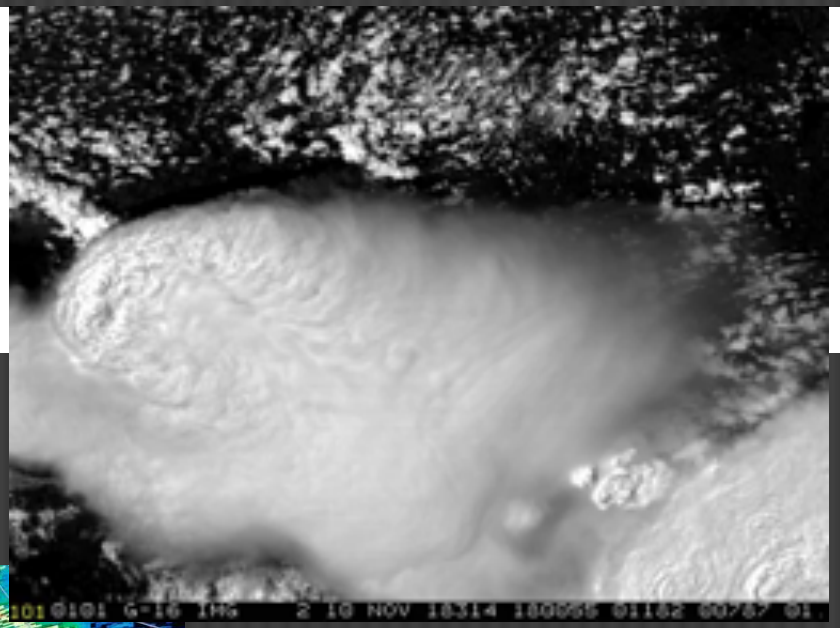
MOBILE OPERATIONS

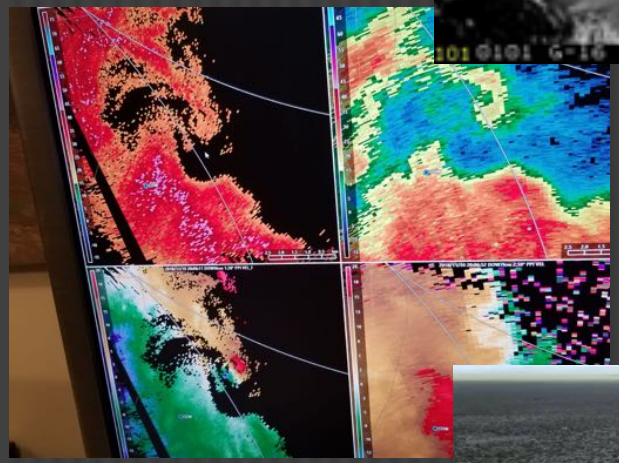
- Forecast team prepared 2x daily briefings for science planning
  - US University + SMN convection permitting WRF, MPAS
  - 60-member SMN WRF ensemble ran on NCAR Cheyenne
- Conducted 19 intensive observing periods with 3 Doppler on Wheels, 3 mobile mesonet/sonde vehicles, and 3 university sounding vehicles (U. Illinois, Colorado State University)
- Launched ~800 sondes as frequently as every 30 minutes

CONVECTIVE INITIATION

- Observed pre-convective environment at least 2 hours prior to CI with soundings, mesonets, pods, and clear-air multi-Doppler data in Cordoba and Mendoza
- Observed several "successful" events and null cases within multi-Doppler lobes
- Several cases where convection-permitting WRF runs produced deep convection and only shallow or no convection was produced


Rebecca Haacker






Josh Soderholm

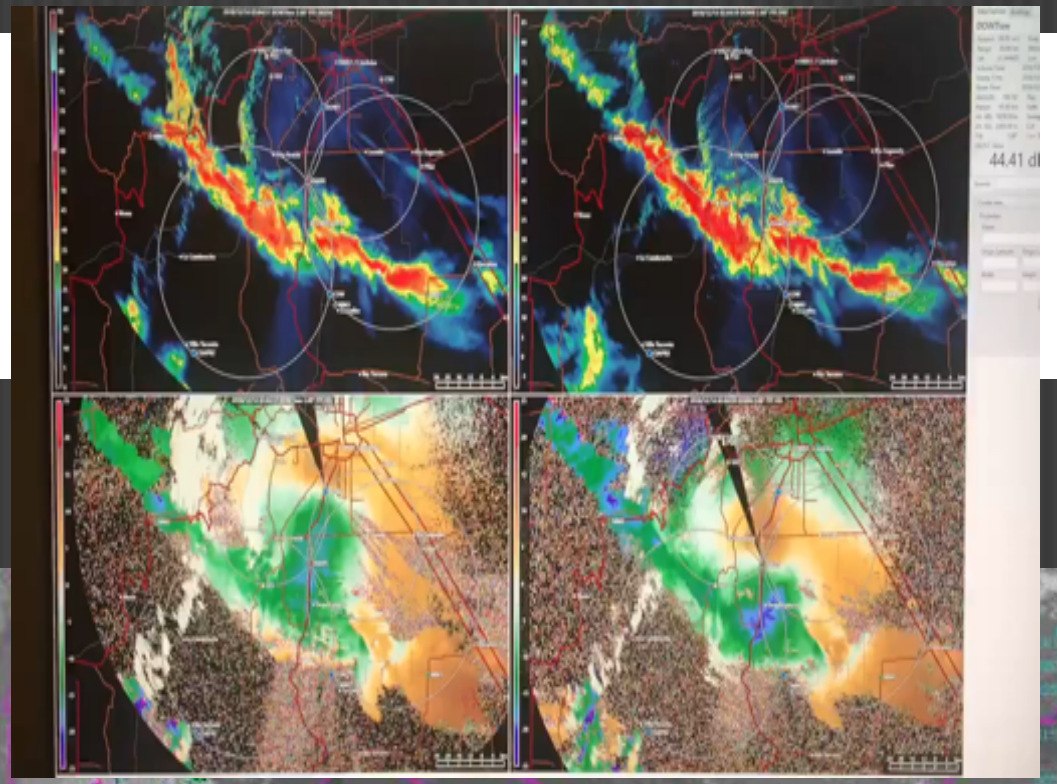
SEVERE WEATHER

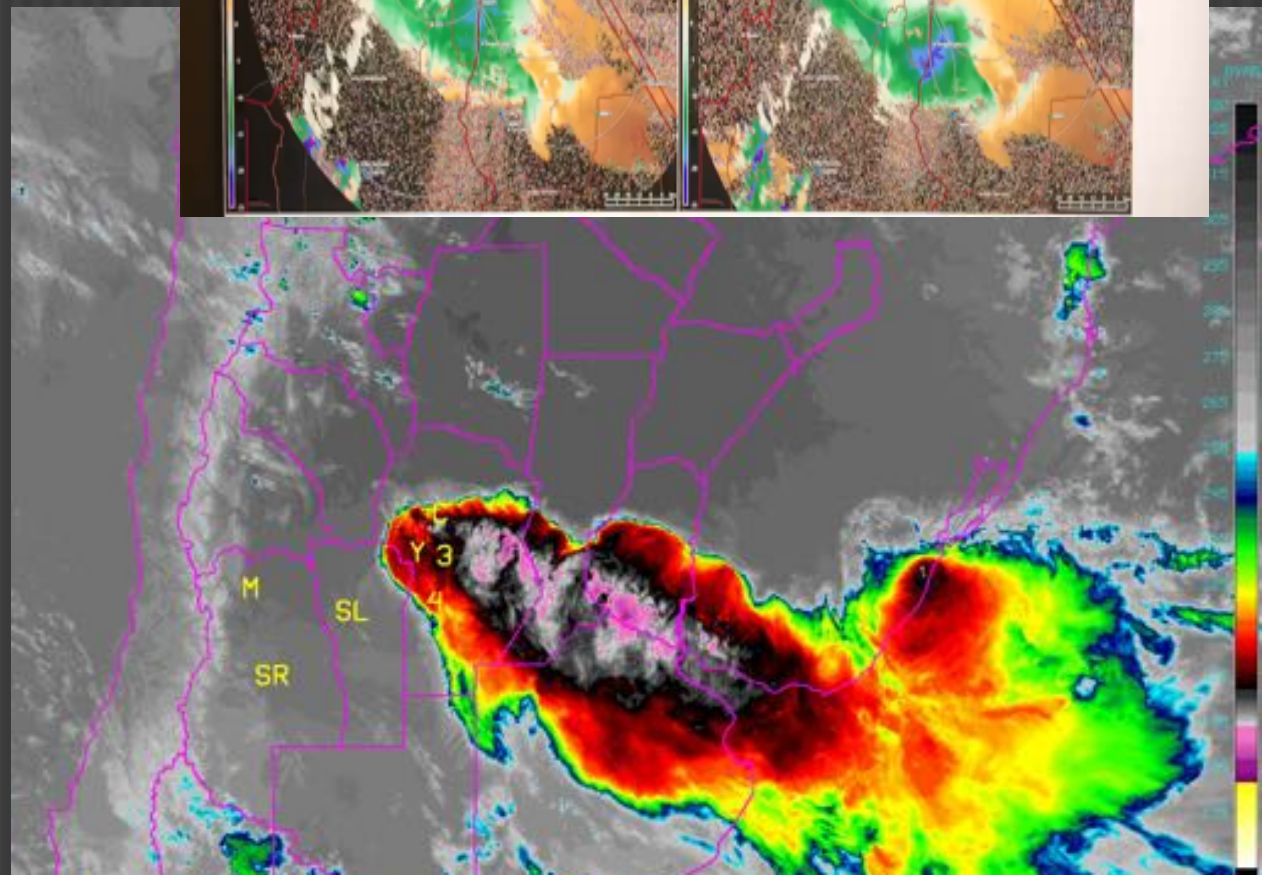
- Targeted supercells, strong winds, and hail
- IOP4 featured observations of the lifecycle of a supercell in multi-Doppler lobes in Cordoba province, produced severe hail and above-anvil cirrus plumes
- Severe observations of a hail-producing cell in San Rafael with multi-Doppler DOW coverage; hail pads destroyed and drone observations of hail swath and size distribution
- 3D hail scanning of preserved hail stones from 9 February 2018 Southern Hemisphere record hail event

UPSCALE GROWTH

- Observed 4 (+ 3 January) cases of developing mesoscale convective systems (MCSs), including a null case, including:
  - a "backbuilding" case where serial upstream propagation of new cells formed upshear of older convection
  - a case of simultaneous convective core initiation along a cold front that was part of a massive cluster of MCSs
  - diurnal orographically-forced convective cores that developed a common cold pool and grew into an MCS

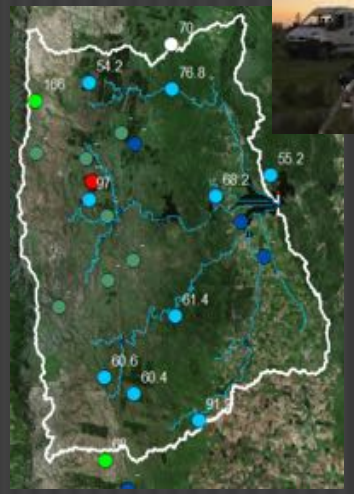
- Observations focused on the role of the terrain and cold pools in organizing new convective updrafts as observed by multi-Doppler winds



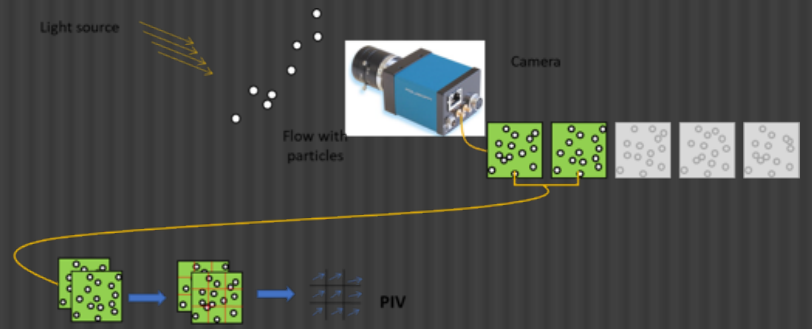


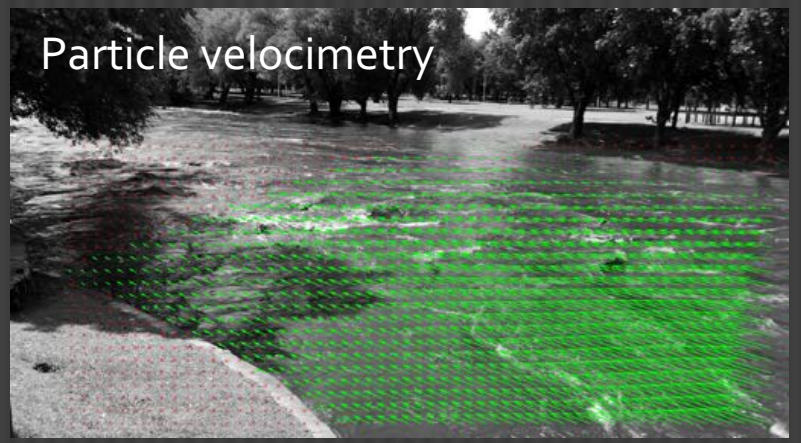
HYDROMETEOROLOGY

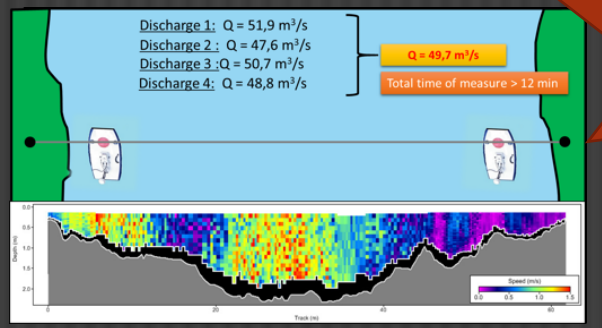
30 EOL ISFS + RAL flux stations, gauge and radar-estimated rainfall



BDHI
CIRSA-INA
EOL
MAGYA-MAASP
RAL
WU







WRF
WRF-Hydro

Improved water management

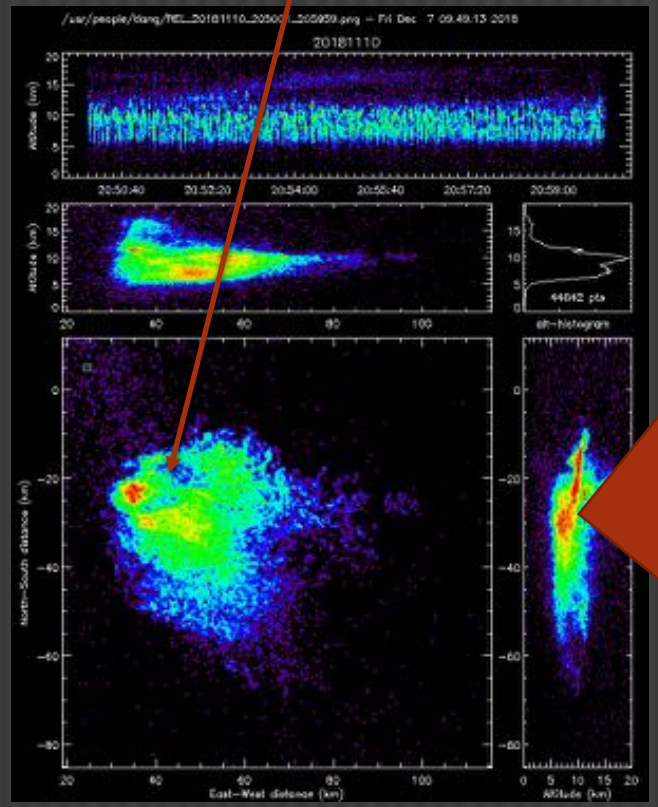
27-28 Nov 2018 case provided RELAMPAGO forecasts for improved civil protection and reservoir management

Francina Dominguez, U. Illinois, Marcelo Garcia, U. Córdoba, David Gochis, NCAR

LIGHTNING

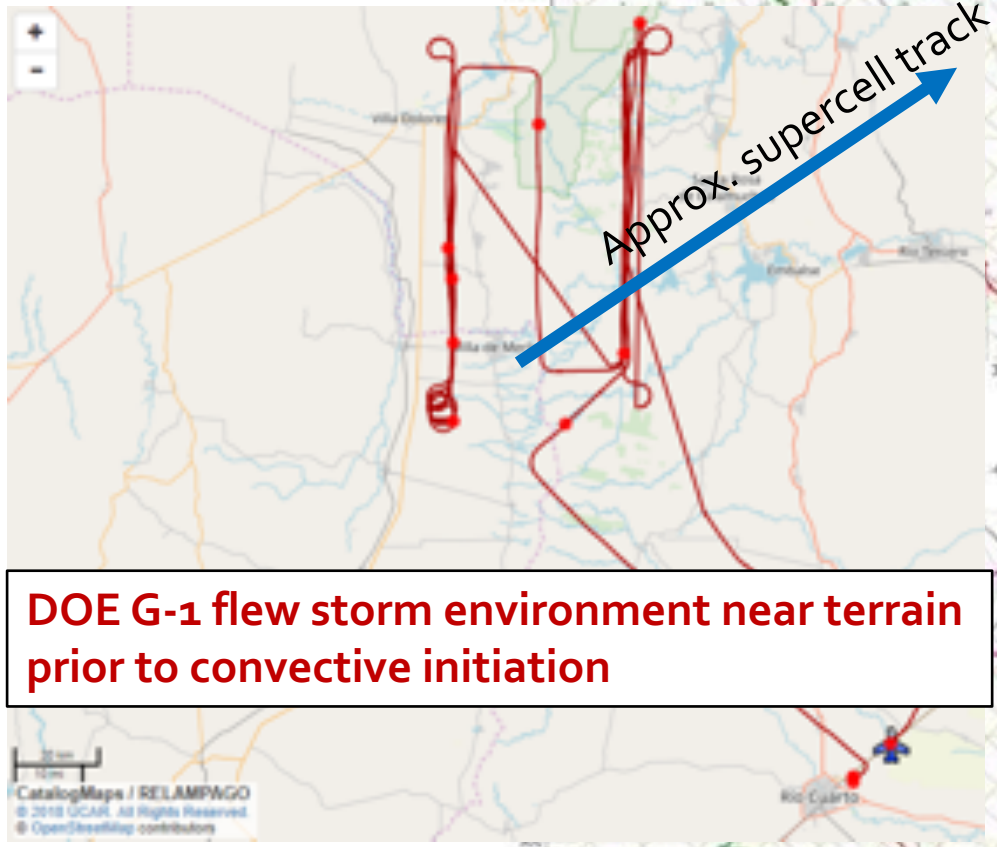
11-station **NASA/NOAA Lightning Mapping Array**
VHF sources for 10 minute periods between 1930-2200 UTC 10 November 2018 – supercell case

Lightning hole evident at 2050 UTC

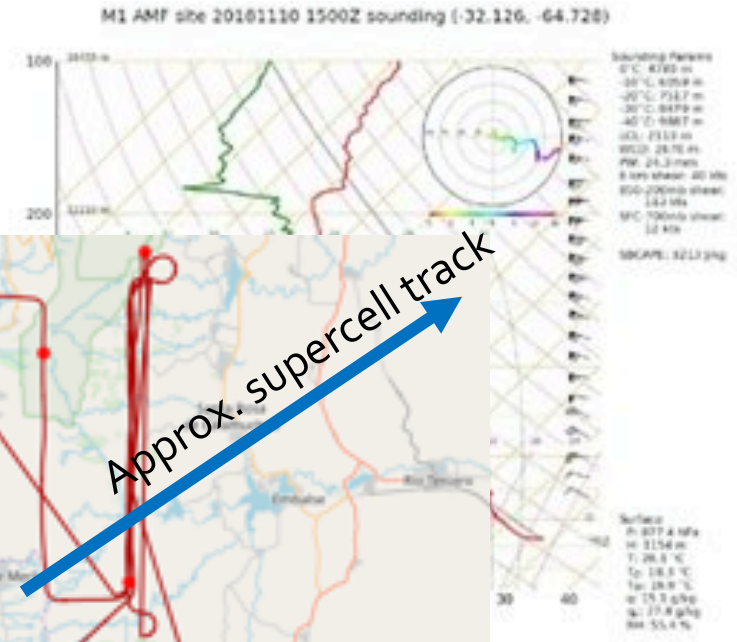


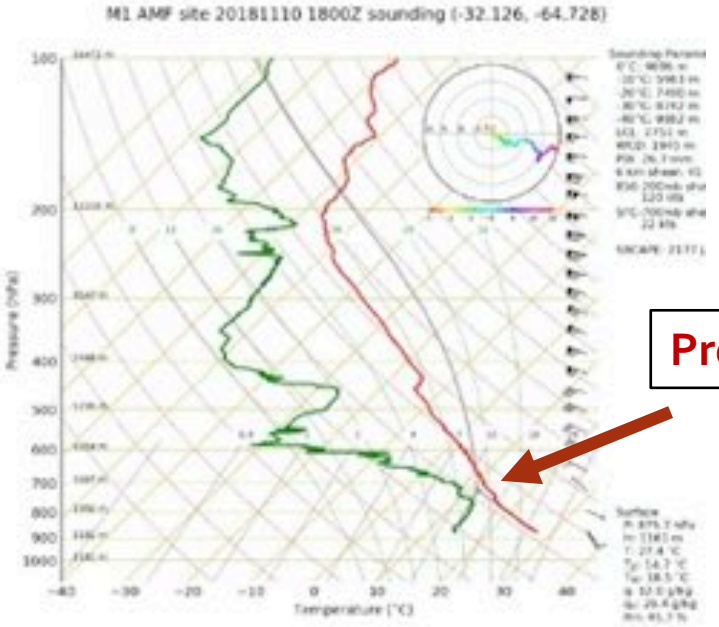
Courtesy Timothy Lang and Wiebke Deierling

IOP 4 – severe storm example

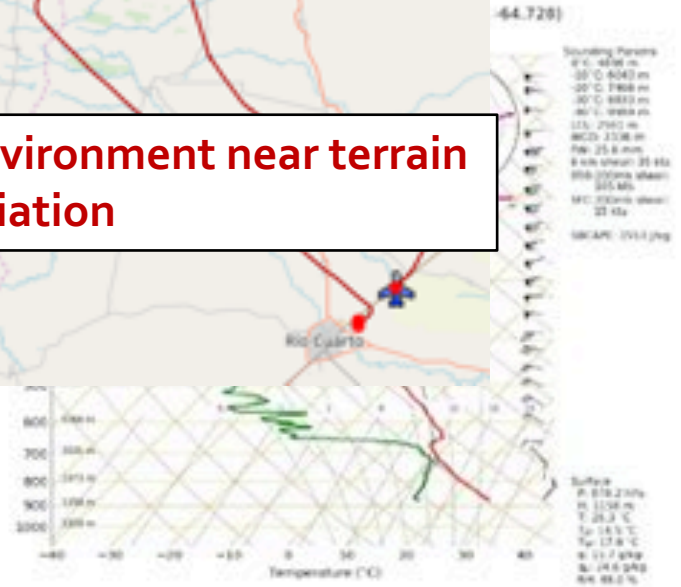


DOE G-1 flew storm environment near terrain prior to convective initiation

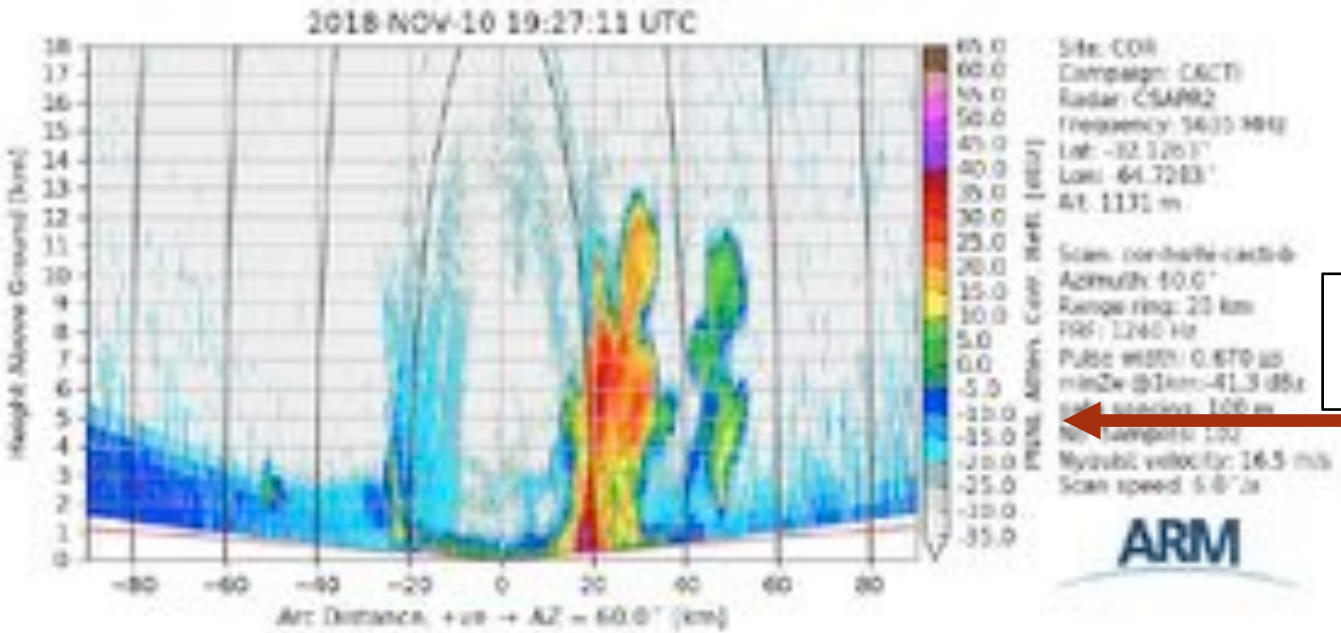


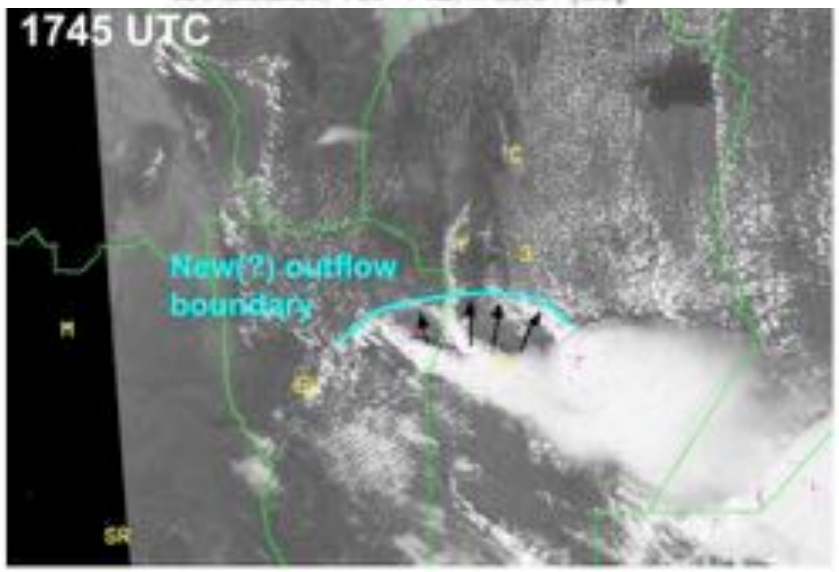


Pre-CI sounding at AMF1

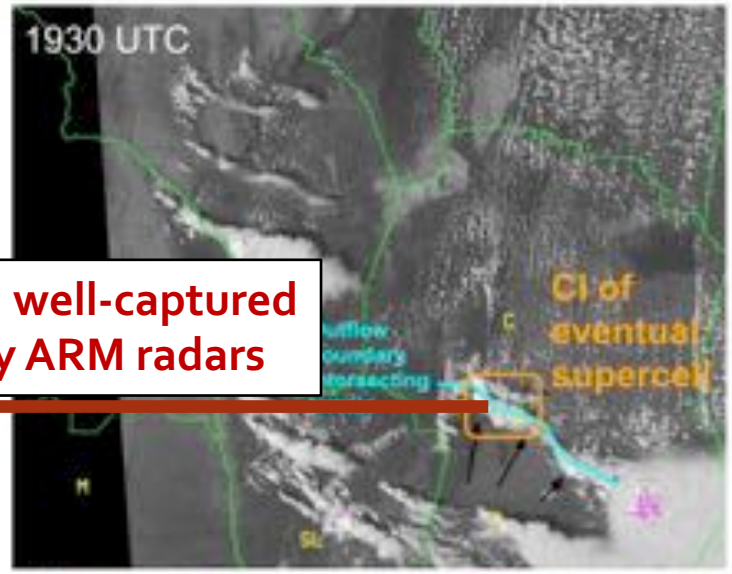


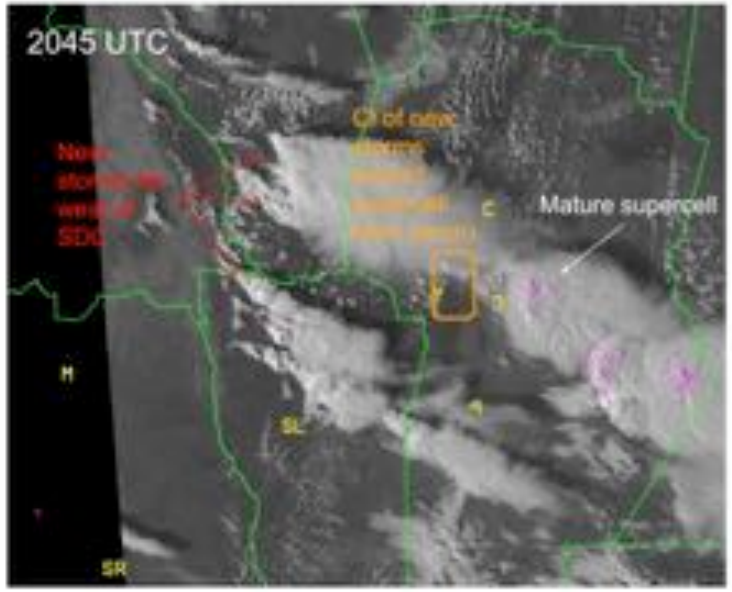
AMF1
Villa Yacanto
15, 18, 21, 00 UTC
10 Nov 18





CI well-captured By ARM radars

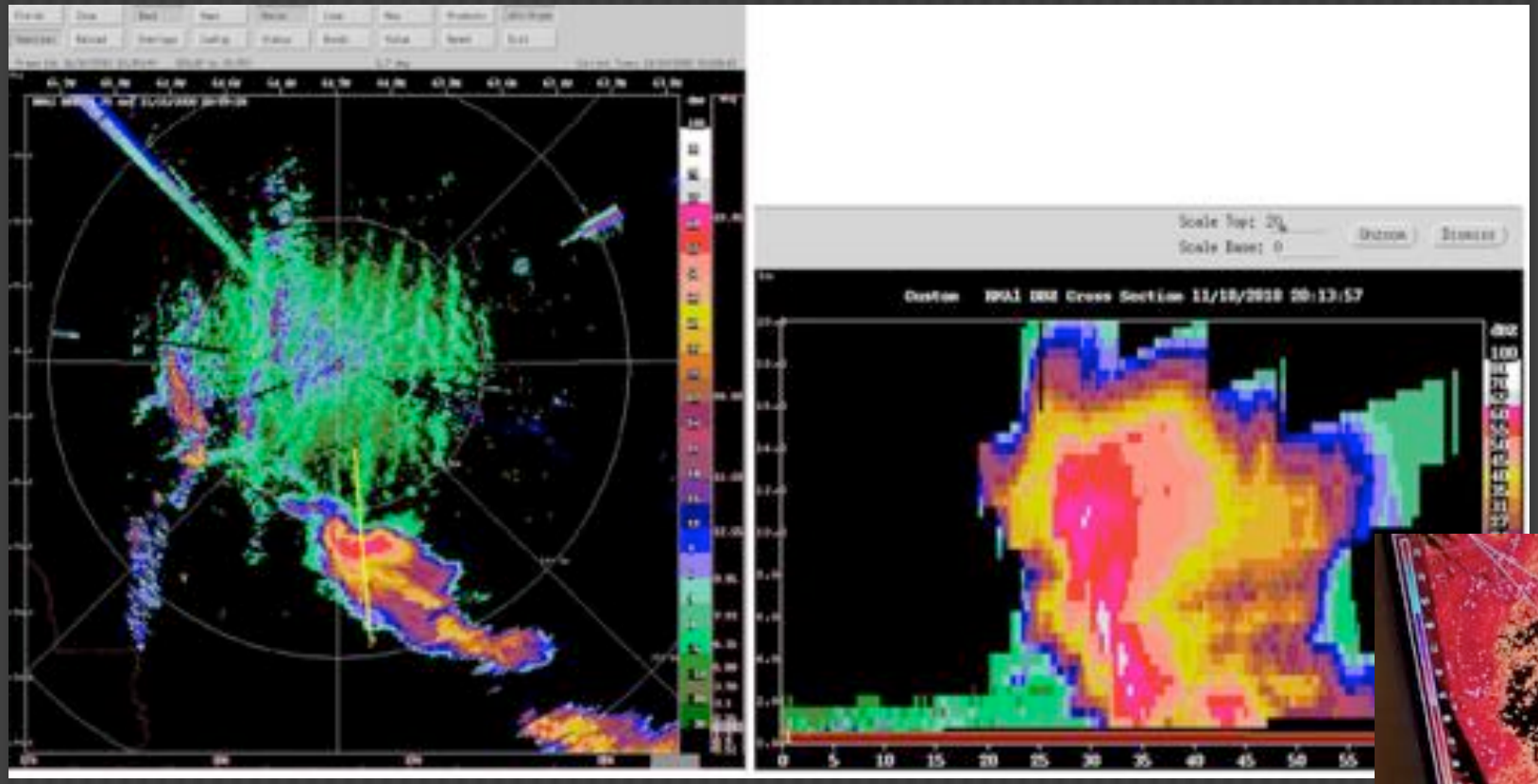




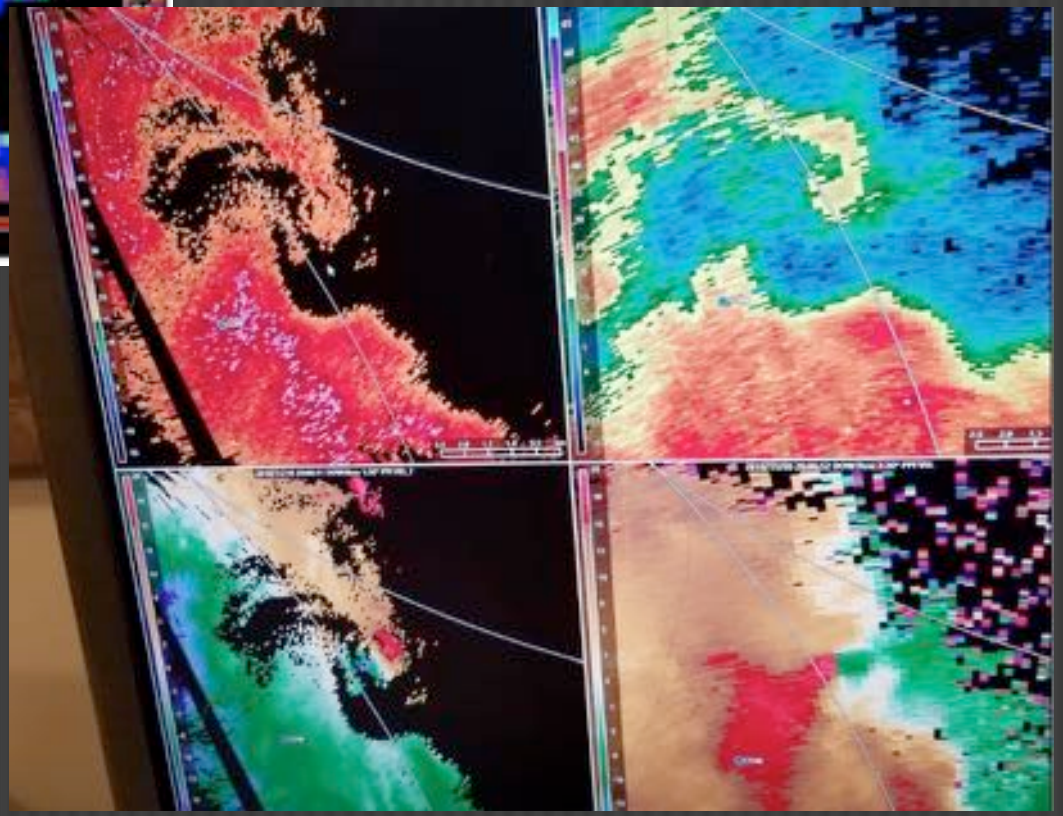
Analysis courtesy Jim Marquis

Fig. 12 - Photographic sequence of the storm that initiated near Santa Rosa de Calamuchita from the vantage point of the Amerian Hotel looking south. The first photograph was taken approximately by 1900 UTC (left, photo by Angela Rowe), the second was taken at 1937 UTC (middle, photo by Lynn McMurdie) and the third was taken 2003 UTC (right, photo by Jake Mulholland).

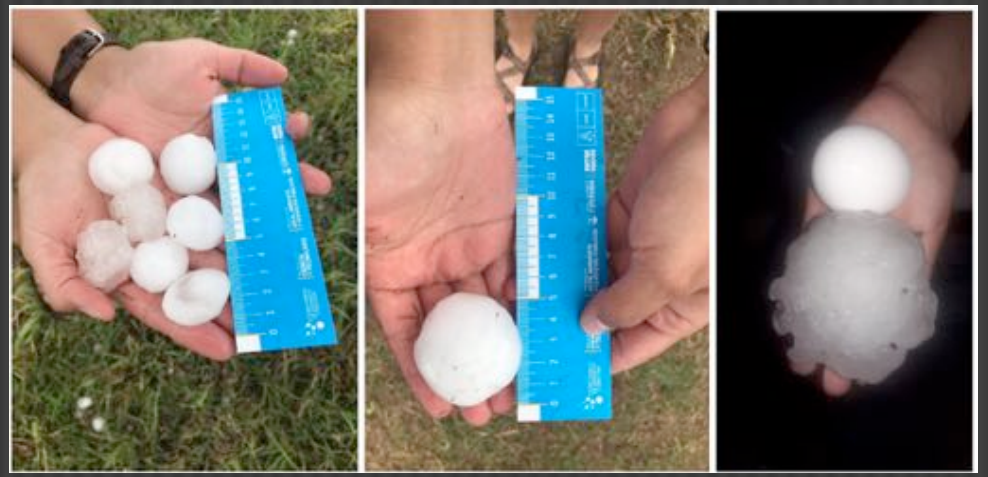
Fig. 13 - Photographic sequence of the same storm taken at the location at the sounding team stationed immediately north of Rio Tercero taken at 1938 UTC (left) and 2013 UTC (right). Photos by Stephen Nesbitt.



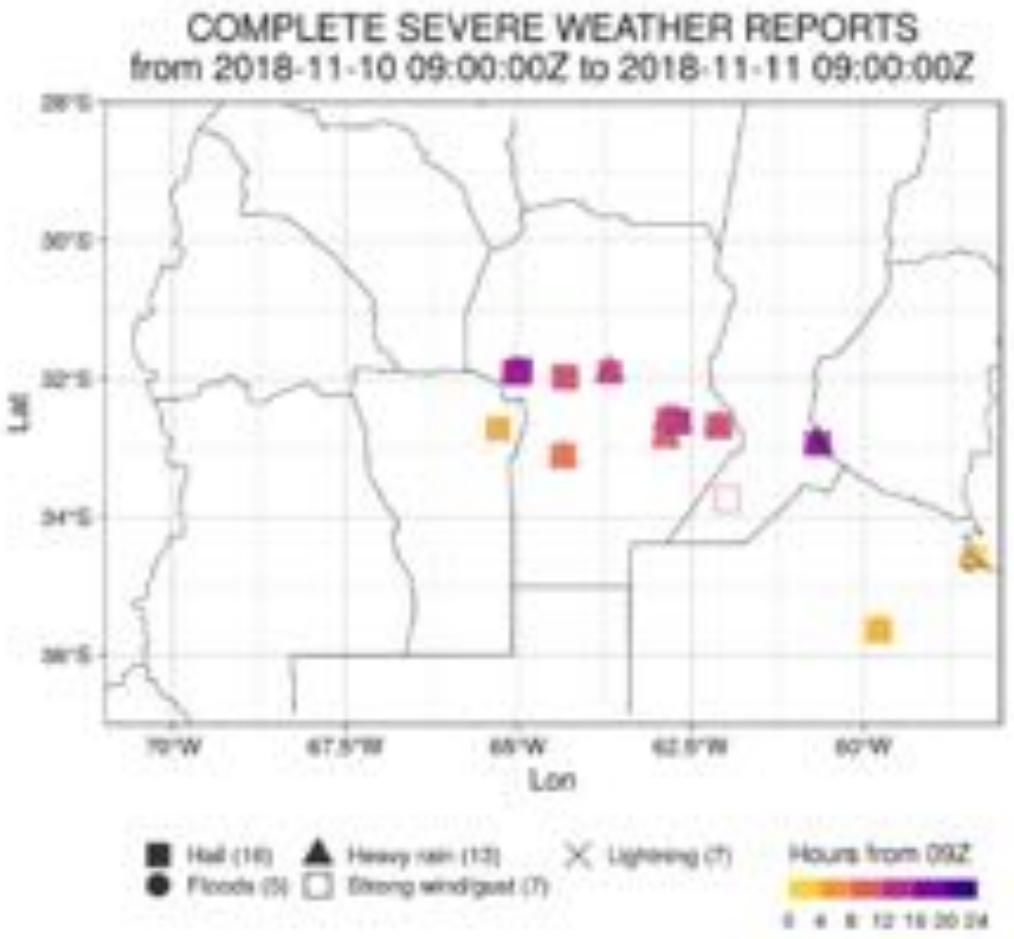
DOW 6 + 7 – 2006 UTC

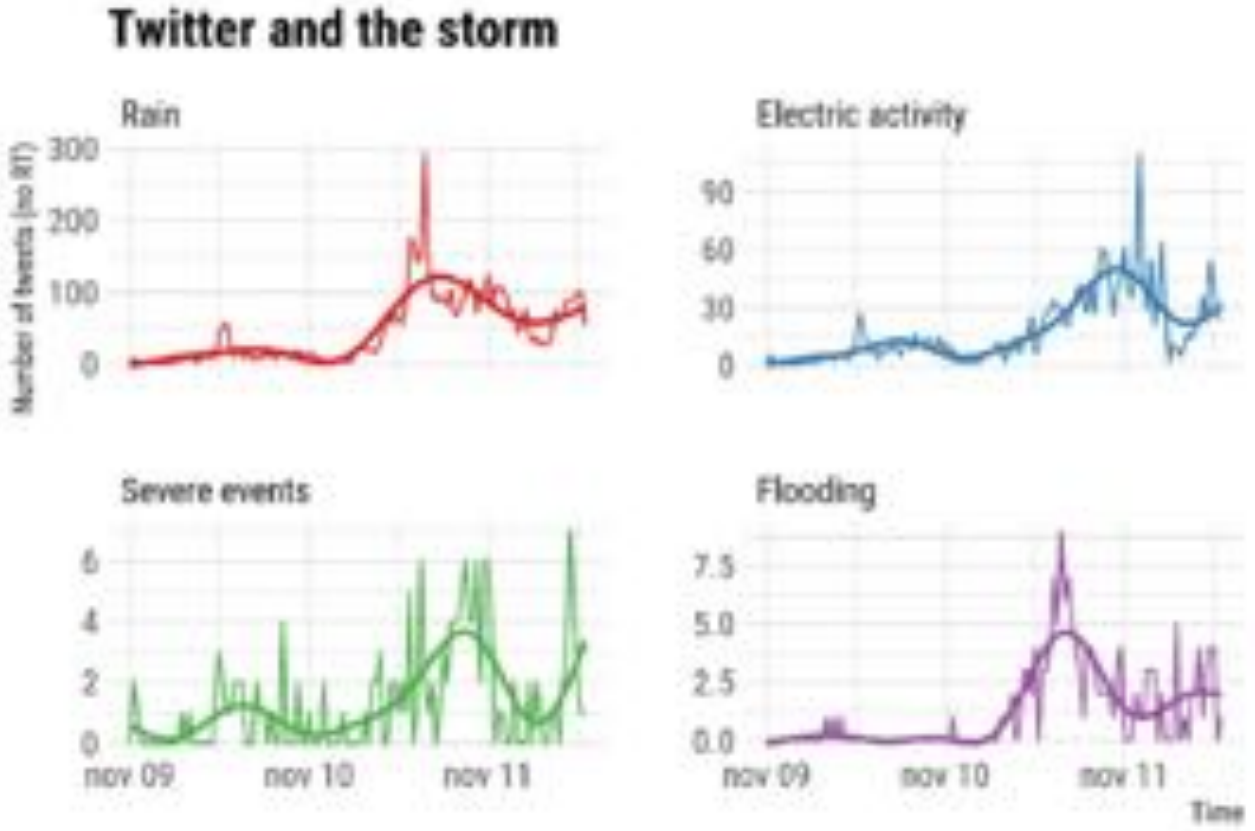


Cordoba – 2009 UTC



IOP 4 Twitter Severe Weather Reports

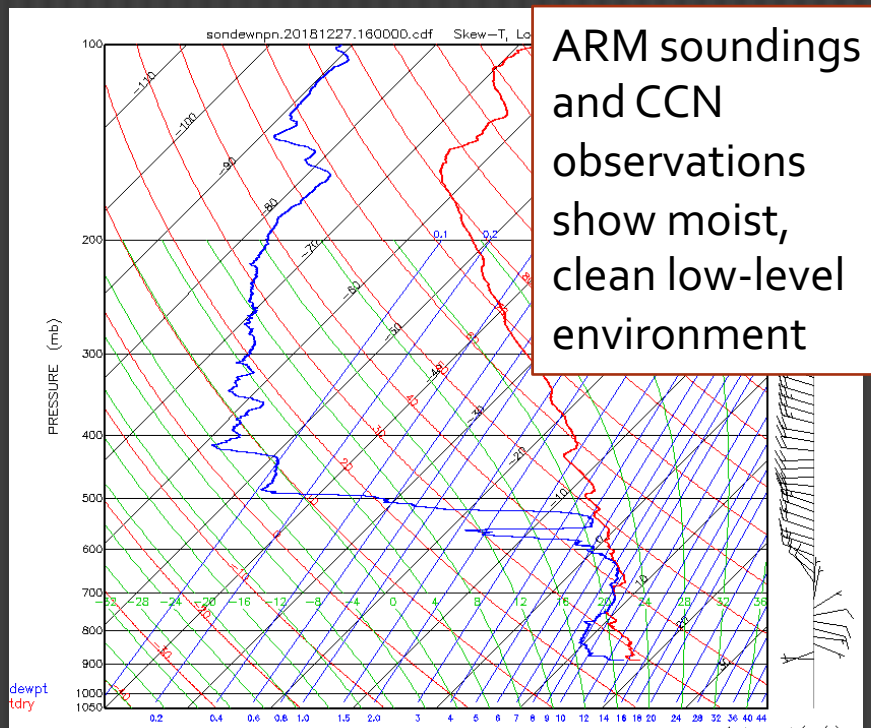




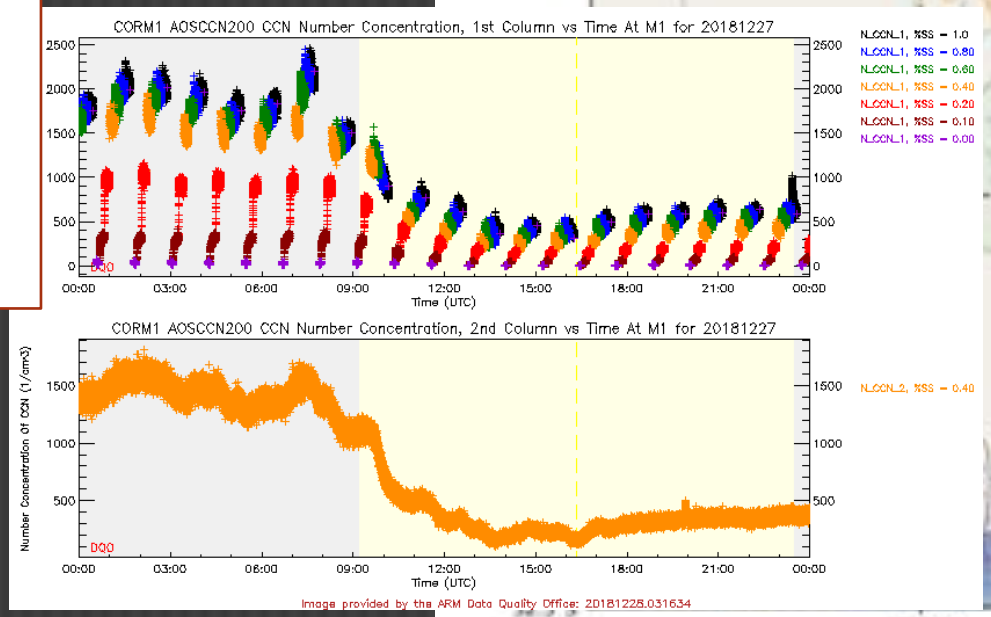
Courtesy Universidad de Buenos Aires

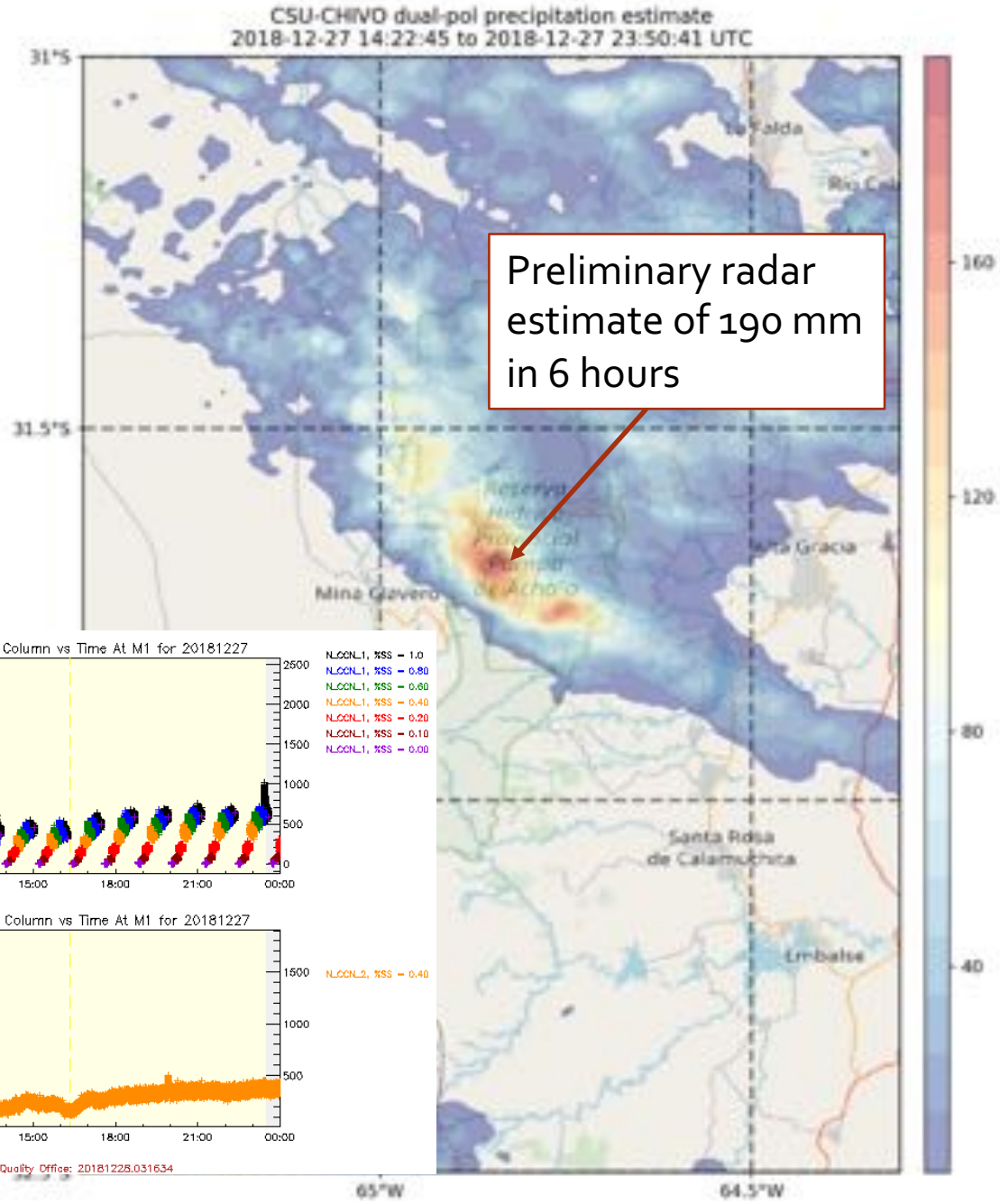
Flooding – 27 Dec 2018 during extended RELAMPAGO OPS

Mina Clavero, Argentina



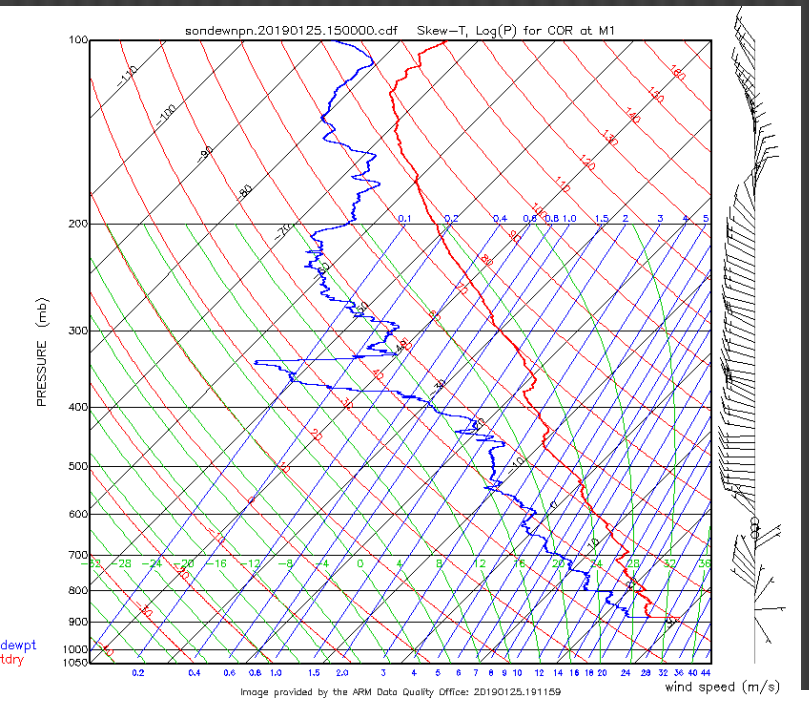
ARM soundings and CCN observations show moist, clean low-level environment



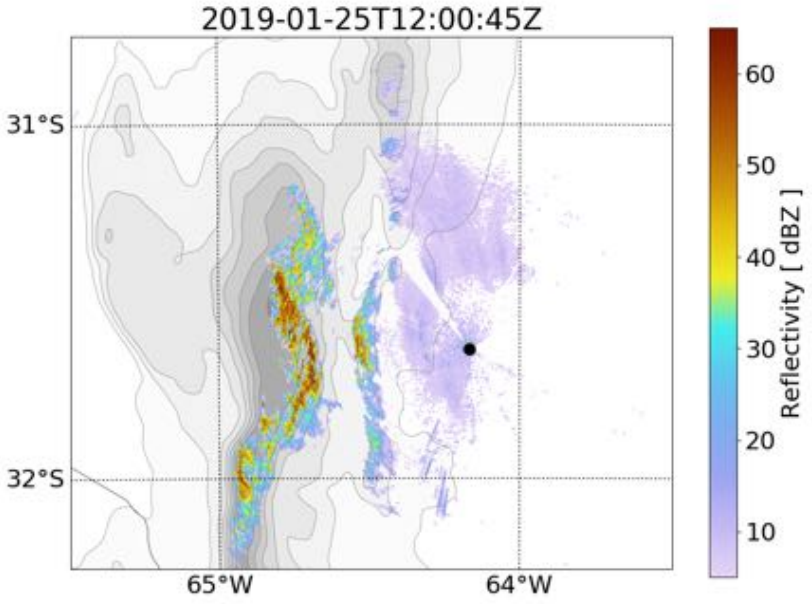


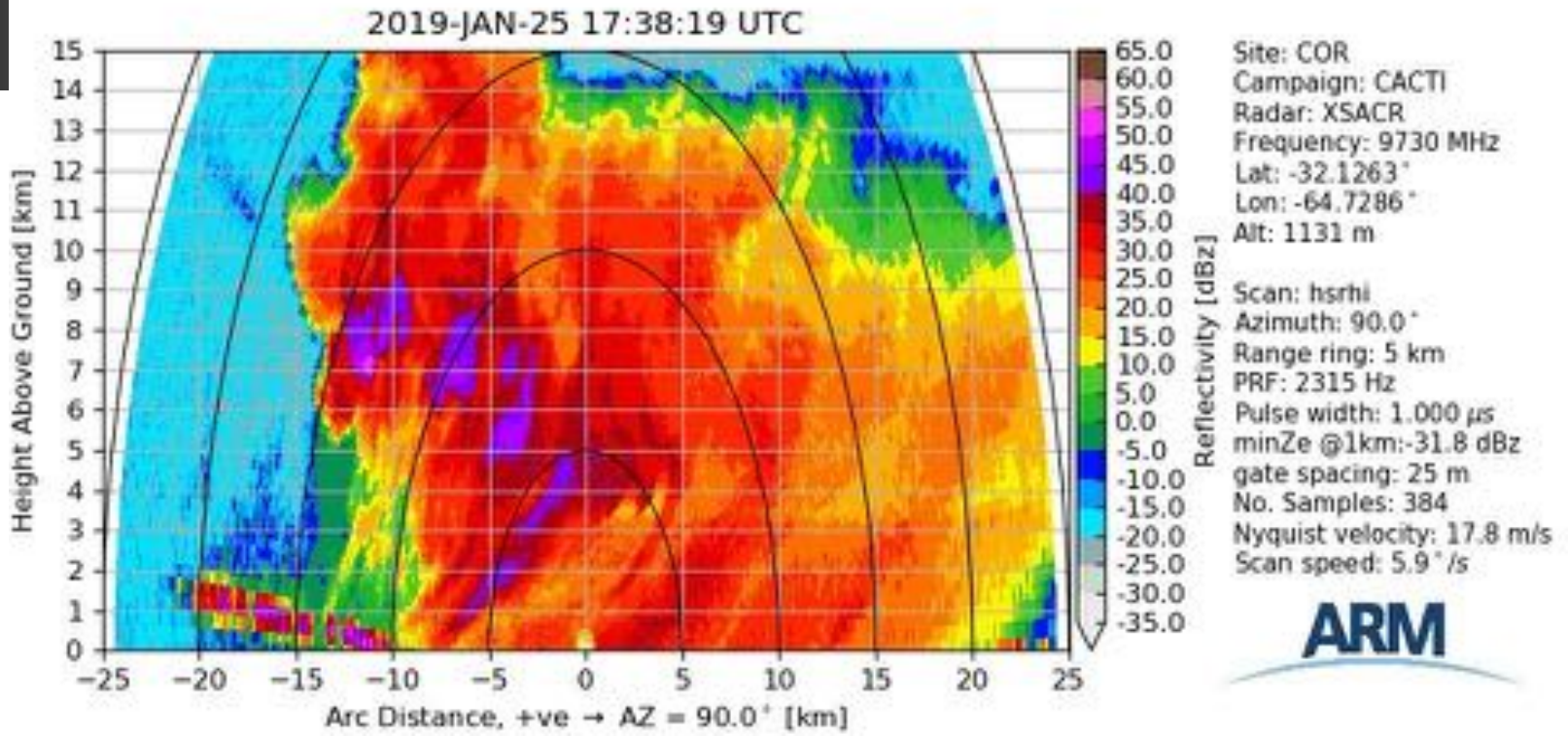
Preliminary radar estimate of 190 mm in 6 hours

Tall Storms – 25 Jan 2018

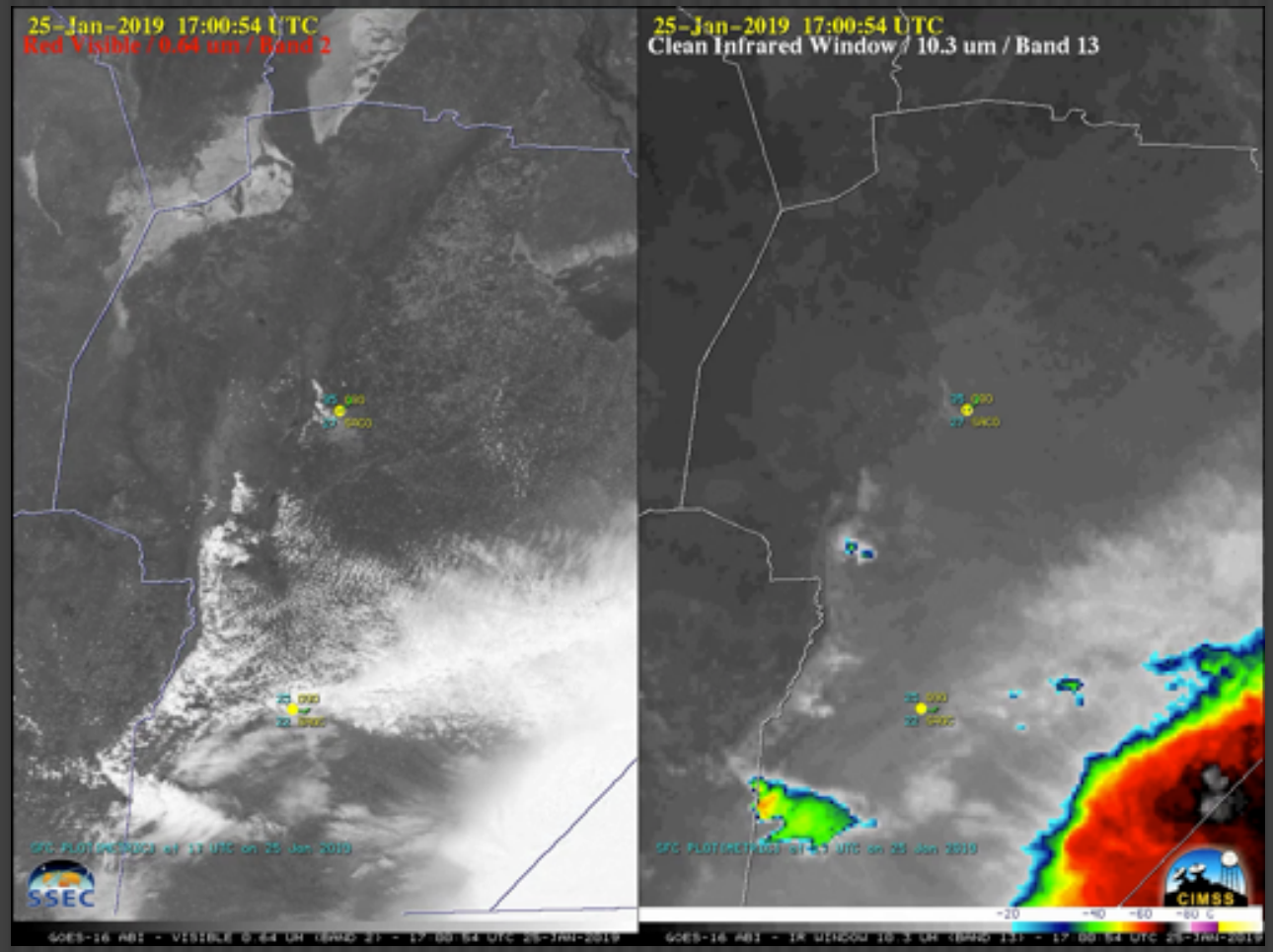


Nearly 5500 J/kg
MUCAPE

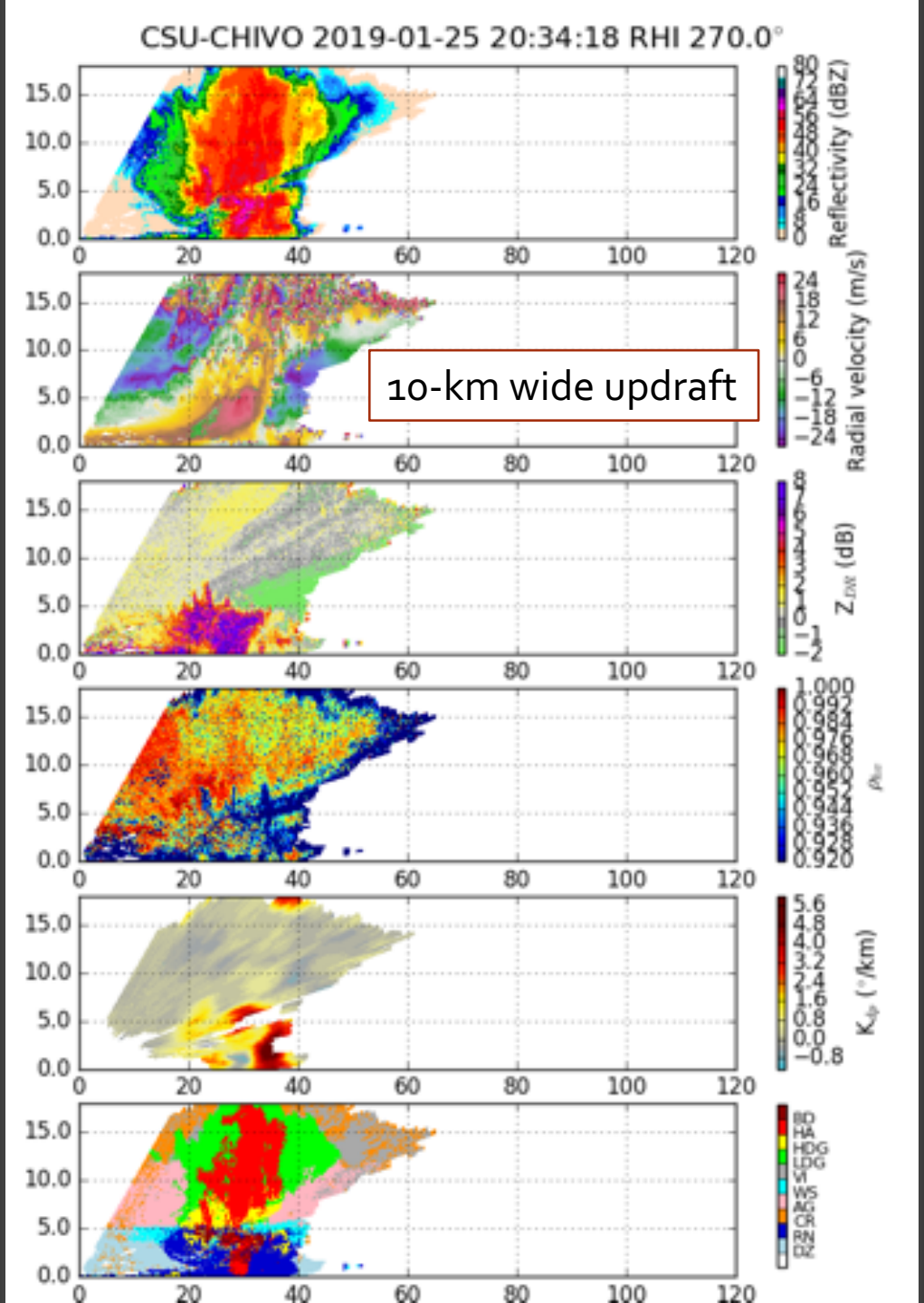




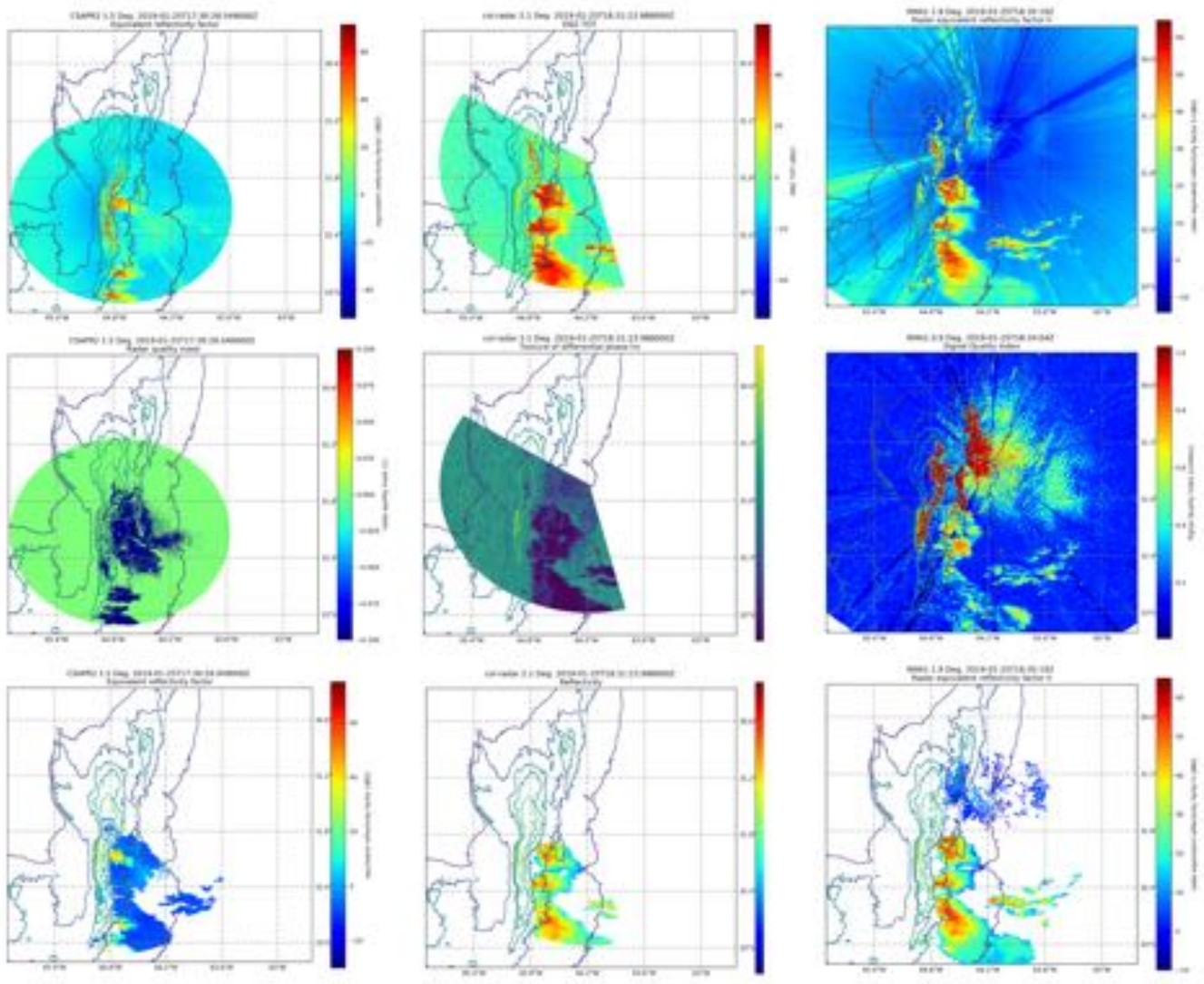
25th January 2019

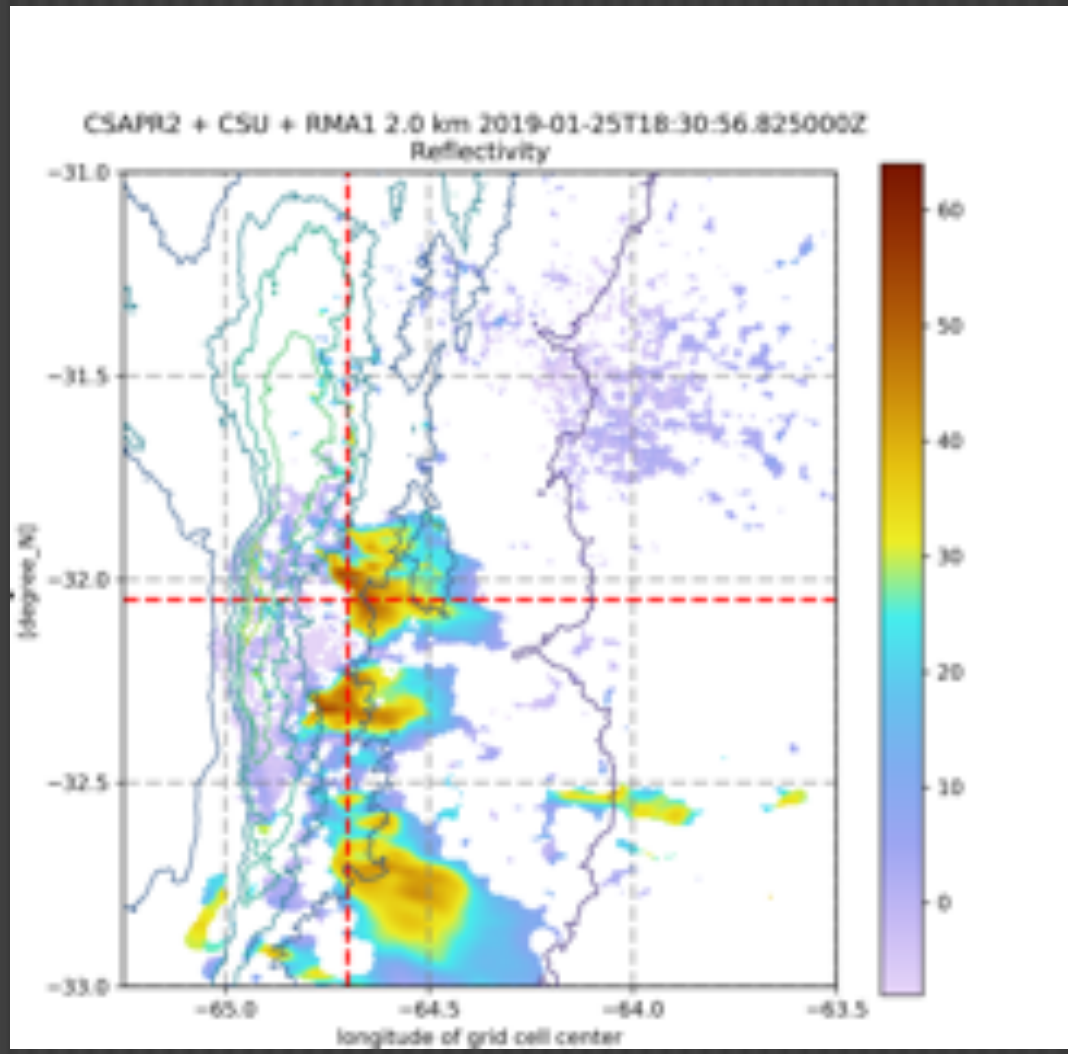


CSU investigating dual-pol time series signatures



Ongoing radar QC efforts (pointing angle, Z and Zdr and intercomparisons among radars)
C-Band attenuation and differential attenuation techniques need to be evaluated with local disdrometer data.
Generation of unified gridded products (current work by Nesbitt and Dixon) and QPE estimates from all fixed radars.
Eventually, multi-Doppler synthesis and data assimilation is a goal. ARM's help will be critical.





3 radar composite - pyart 'map_grid_from_radars'

EDUCATION AND OUTREACH

- Worked with ARM outreach (Hannah), NCAR, and local authorities. NCAR produced a series of videos, including a video about CACTI (available on YouTube)
- Engaged more than 1,000 students in the K-12 level
- Open houses hosted more than 2,000 local residents
- Formal outreach to schools installed weather stations with Proyecto MATTEO
- NSF Advanced Study Institute hosted 15 graduate students in RELAMPAGO

BROADER AND OTHER IMPACTS

- Collaboration for the improvement of operational radar information; Use for “nowcasting”, model verification and data assimilation
- Unprecedented evaluation and improvement of forecasts with data for data assimilation, model evaluation (NWP, global, mesoscale, S2S, seasonal, climate models)
- Understanding of flash flood risks and development of tools for forecasting / "nowcasting” in Subtropical South America
- “Testbed” GOES-16 & 17 for prediction using image data and lightning (with many applications)
- Development of life-long collaborations

SUMMARY

- RELAMPAGO has provided the most comprehensive observations of convective processes, orographic convective precipitation, and high impact weather to date in a meteorologically unique region
- RELAMPAGO-CACTI has and will have significant societal impact in Southeast South America
- Facilities played a key role in the ultimate shape of the project and what we were able to accomplish
- RELAMPAGO Data will be available to the community 1 January 2020

Gracias!
(sorry I couldn't make it)