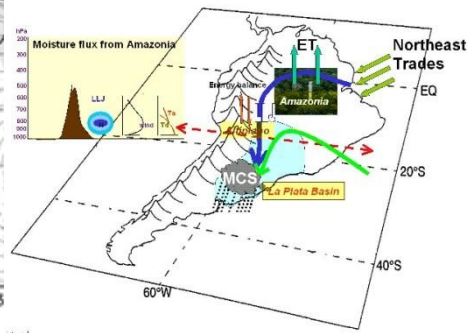
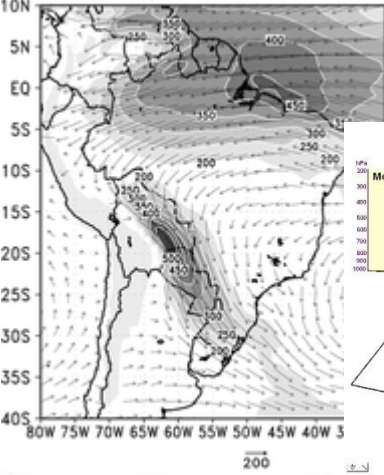


# RELAMPAGO

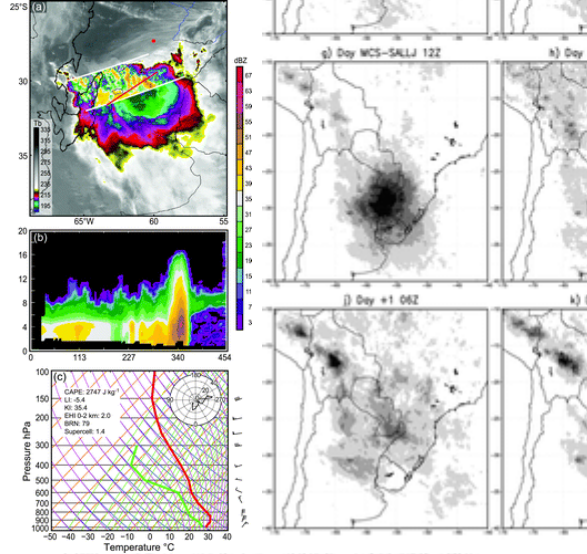
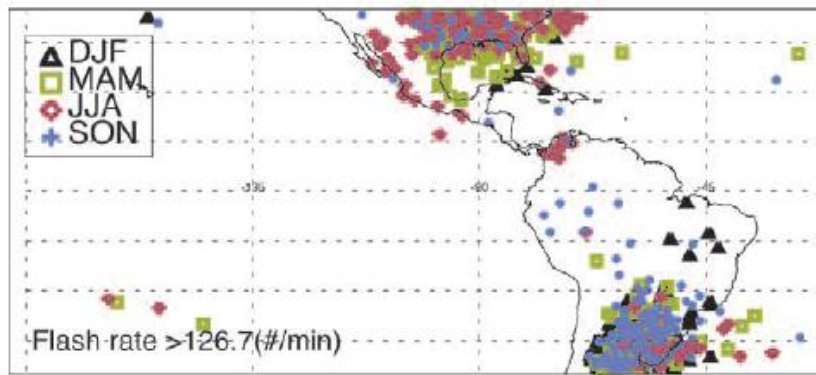
Remote sensing of  
Electrification, Lightning,  
And Meso-scale/micro-  
scale Processes with  
Adaptive Ground  
Observations



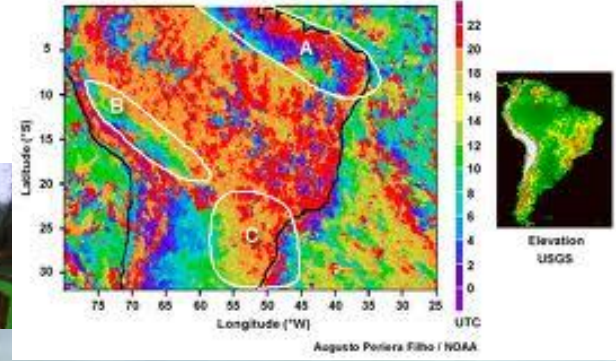
a) SALLJ 12Z



(relampago translates to lightning in Spanish and Portuguese)



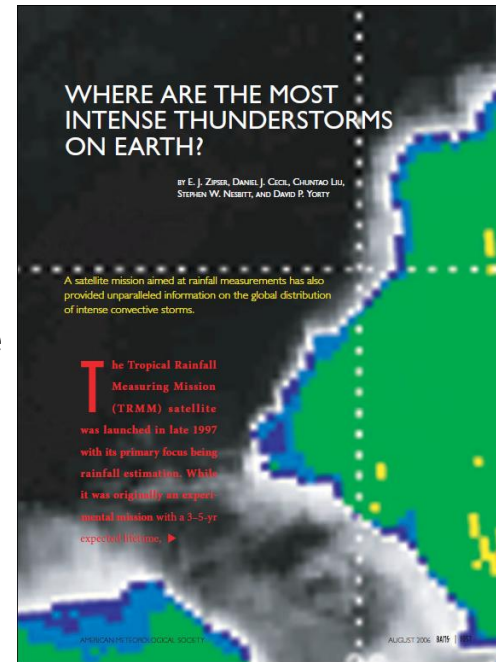
Time of Maximum Rainfall over South America, 2003 and 2004 (CMORPH analysis)



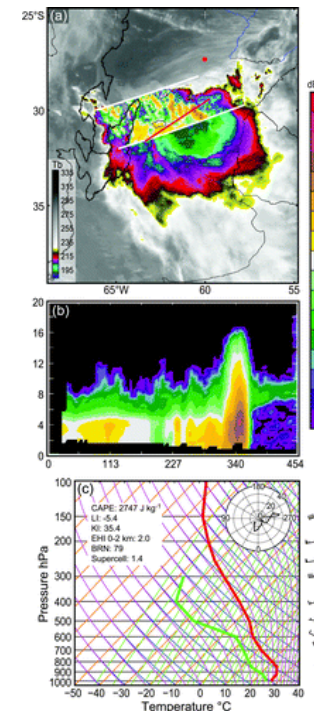
**RELAMPAGO** (a working acronym) is envisioned to be an international multi-agency field program to study multi-scale aspects of intense, organized convective systems that produce severe weather in subtropical south America

Satellite evidence, including from TRMM, indicates that the convection in this region is unique in its intense vertical structure, broad horizontal organization, and lightning production.

In this data sparse region, we do not know much about aspects of these systems including what governs their structure, life cycle, similarities and differences with severe weather-producing systems observed in the US and elsewhere, and their predictability on weather to climate timescales.



Zipser et al. 2006

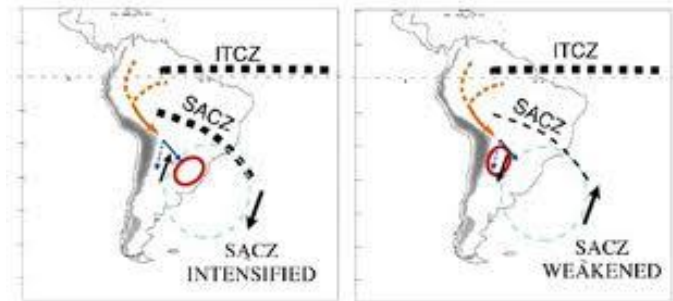


Rasmussen and Houze 2011

# Prior work

## Remote influences

Role of South American Convergence Zone (SACZ)



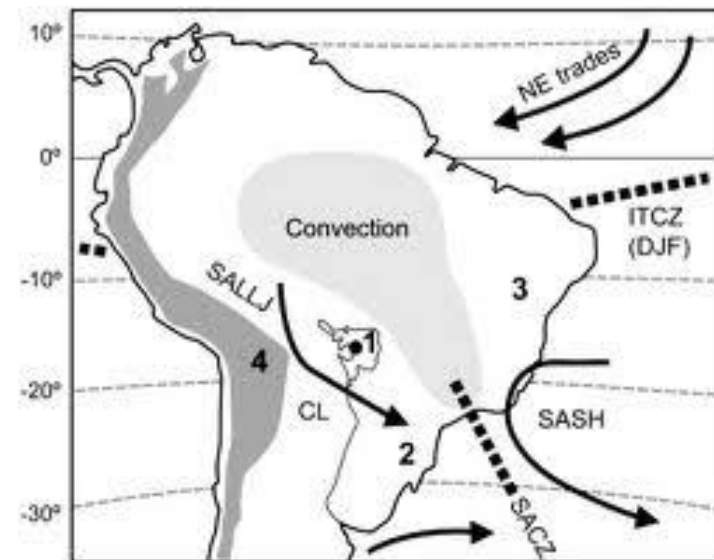
## Role of low-level jet

NOAA/NSF SALLJEX (2003)

## Mature to dying MCS structure

CHUVA-SUL (2012), southern Brazil

Northern Argentina convective systems, where MCSs initiate and reach maturity, have never been characterized by detailed ground observations (radar, radiosondes)





## **What was learned during prior experiments in the region**

### SALLJEX (2003) – La Plata Basin

- The position and intensity and internal structure of the LLJ: Internal variability over different scales, interannual to diurnal time scale, global to synoptic scale. The network deployed during SALLJEX was not enough to describe the mesoscale environment or convective initiation.
- A relationship between SACZs, Chaco Low and SALLJ was studied on the synoptic scale.
- It was possible to assure a relationship between large MCS and SALLJ, but only one WP-3 flight was concentrated on MCS and LLJ interaction. Radar operations were limited to P-3 tail radar.
- A sounding network was deployed in order to understand SALLJ, but it was not possible to clearly understand the pre MCS environment because most of the soundings were at 06 UTC (overnight).

## **What was learned during prior experiments in the region**

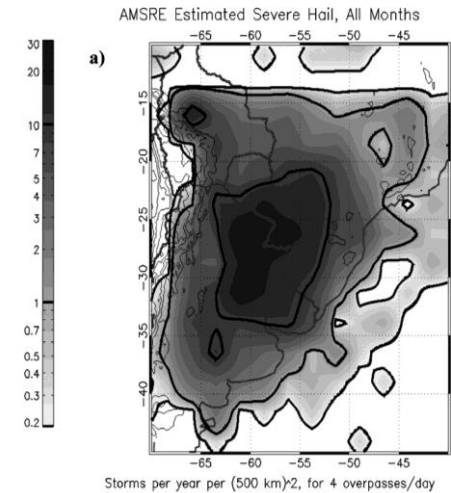
### **CHUVA-SUL (2012) – Rio Grande do Sul, Brazil**

- New regional radar networks (in regions they are currently deployed) can be useful in describing the mesoscale structure of systems, but capabilities (Doppler, dual-Polarization) vary at present.
- Large scale processes strongly control the precipitation mechanisms over the area.
- Southern Brazil region is characterized typically by organized deep convection associated with large amount of rain and some strong winds. Severe weather related with hail is located over central Argentina rather than over this region.
- NWP models have varied success in predicting the initiation, propagation speed, intensity, and organization of convective systems in Southern Brazil and Uruguay.

# **CORE RELAMPAGO SCIENCE QUESTIONS**

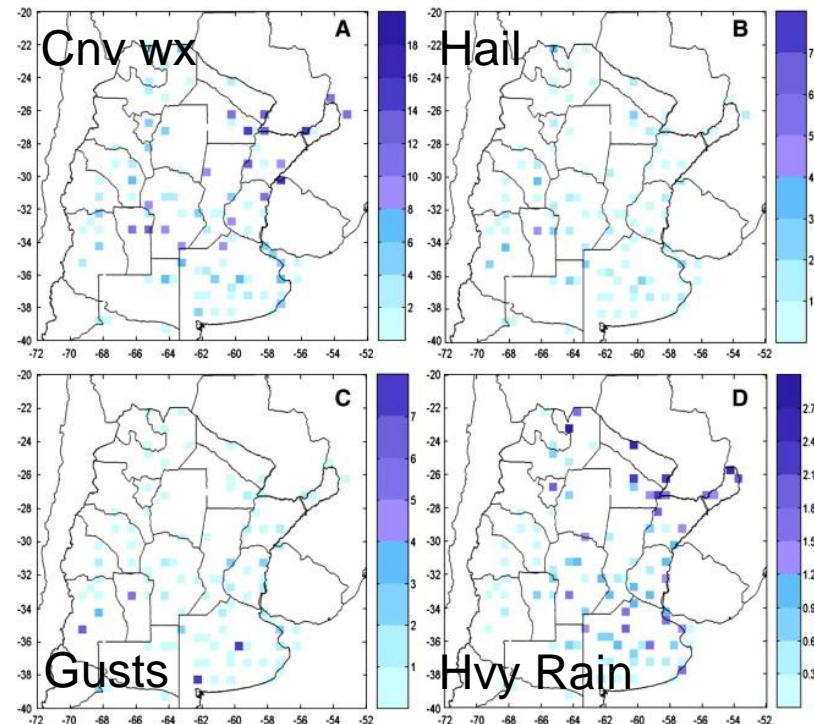
## Severe weather

- Why do many storms in Northern Argentina (north of the area indicated by surface-based reports, and more heavily studied in the past) stand out as among the strongest on earth in satellite observations, without having ground-based verification or a strong reputation about the violence of these storms?
- Does the pre-convective environment for ground-truth-confirmed severe thunderstorms in South America display a loaded-gun profile? Is an elevated mixed layer (leading to early convective inhibition) also observed over Argentina in days of severe thunderstorms? If so, is there an unobserved South American dry line triggering such storms?
- Can we improve microphysical models and forecasts with new information that might be applicable within and beyond this region?



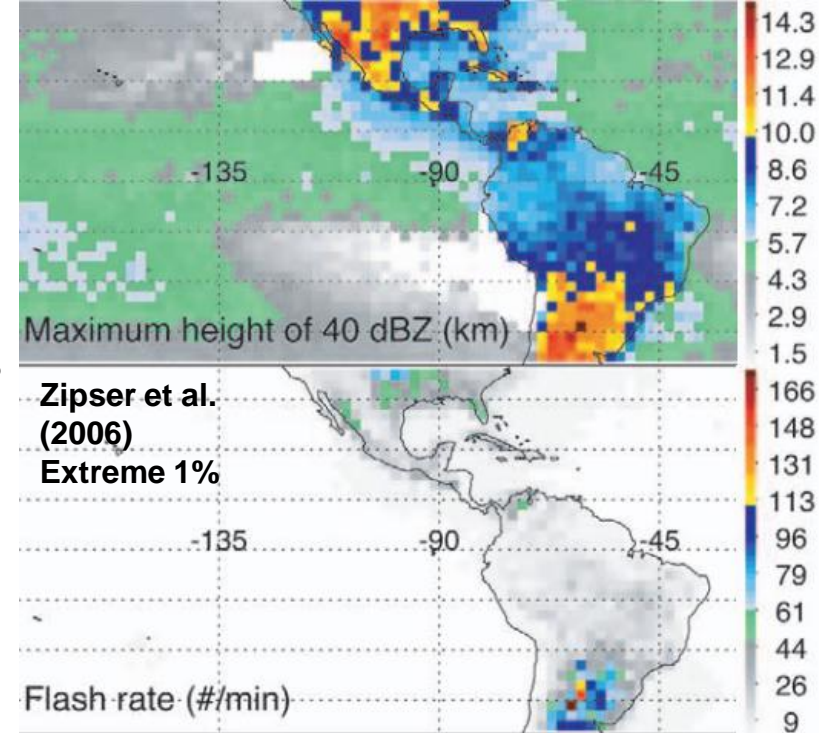
Cecil and  
Blankenship  
(2012)

Matsudo and Salio (2011)



## Cloud microphysics/electrification

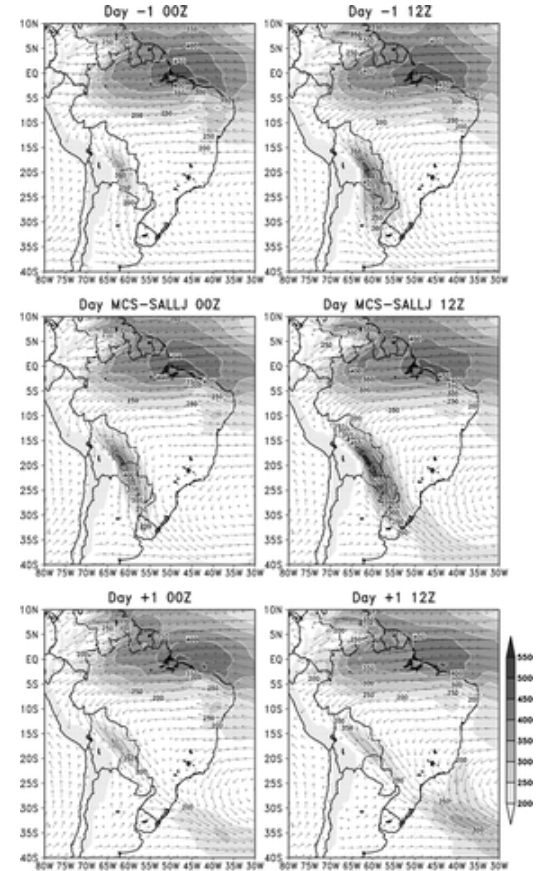
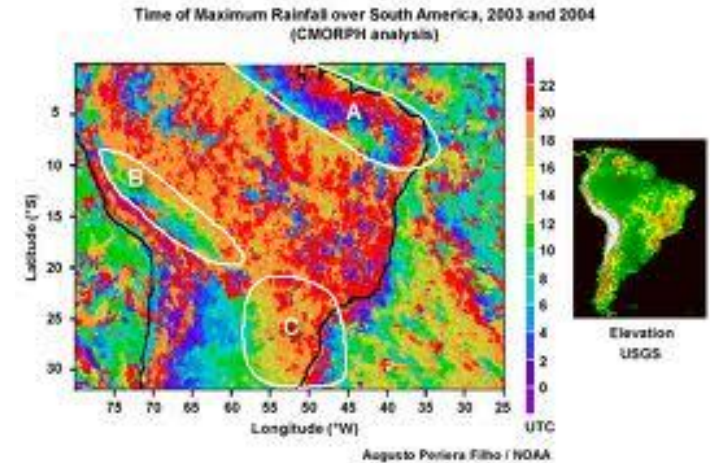
- What leads to the extremely tall radar reflectivity vertical structure (e.g. high reflectivities near the homogeneous freezing temperature) of storms in the region? Is this structure due to high conditional instability, low entrainment, aerosol environments, or strong mesoscale lift? What are the implications for charging rates in these storms?
- Does the extreme vertical structure and dense ice production in these storms lead to unique drop size distributions in these storms (i.e. large drops stabilized by ice cores)?
- Does the broad structure of the systems lead to enhanced charging and lightning in the anvil and stratiform regions of the storms?
- Does the extreme structure of these storms lead to enhanced sprites/TLE production compared with the US Central Plains?





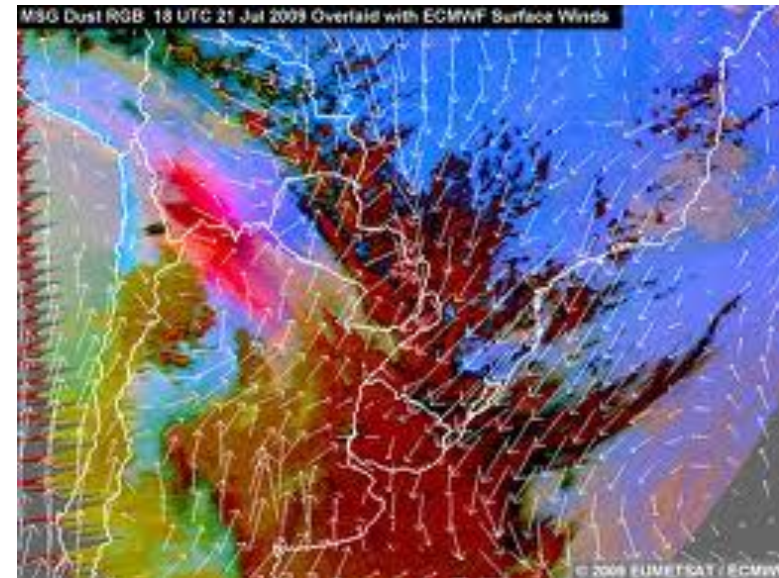
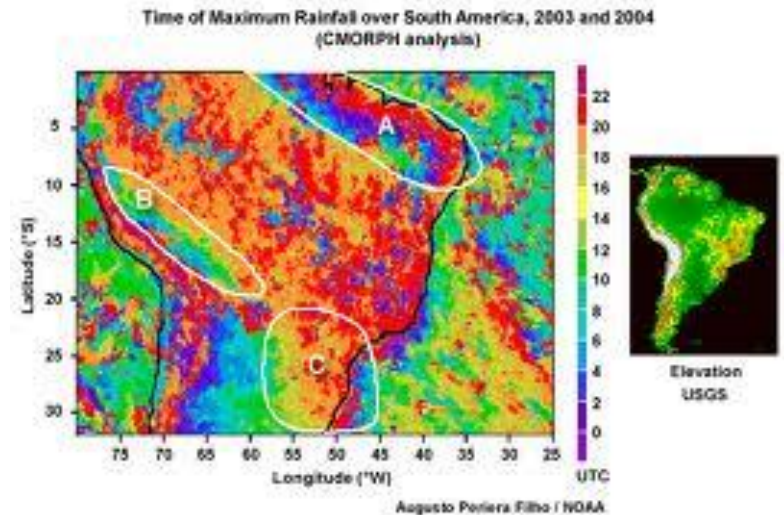
# MCS life cycle

- What controls the diurnal cycle of convective system intensity (vertical structure) and mesoscale organization in the lee of the Andes?
- What is the role of microphysical and kinematic processes in leading to the upscale growth of convective clouds into MCSs and ultimately MCCs?
- Does the extreme intensity of the convection in the region impact the morphology of the convective systems (or vice versa), and how?
- Are there inferences of predictability for these processes from observations? How well do cloud resolving models and regional NWP models represent this morphology from case study to seasonal time scales?



# MCS environments

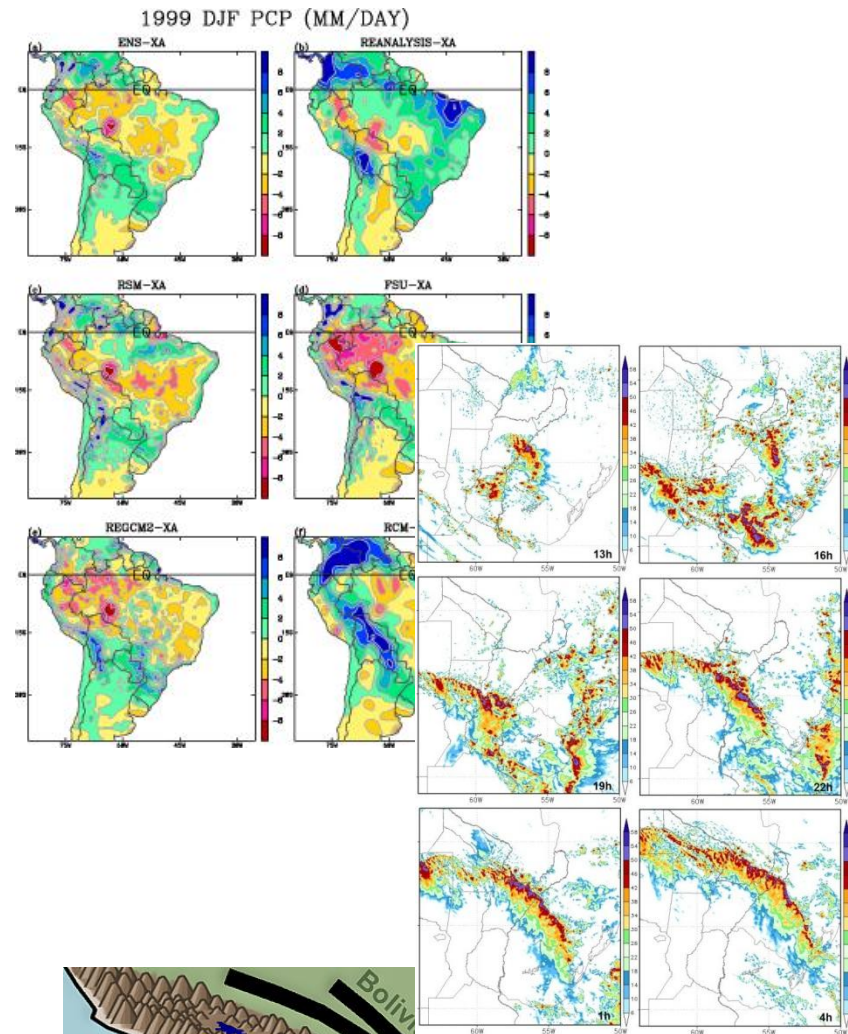
- What are the synoptic to mesoscale flow features in the region, and how do they dictate the triggering of convective systems and the environment for storms to grow upscale into MCSs?
- How the PBL control the evolution of the LLJ and the evolution of MCSs considering different initiation times?
- How do katabatic flows near the Andes evolve and generate the initiation of large MCSs over plain areas close to the mountains?
- The LLJ produces a strong transport between Amazonia, Paraguay and northern Argentina of biomass aerosols, as well as dust outbreaks from the south. How is the influence of the these aerosols on the development of large convection?





# Prediction

- Why do numerical models, at mesoscale NWP scales to climate models, have very low skill in this region? Are they missing important data for assimilation or are there missing physical processes in numerical models?
- Does the large zonal soil moisture gradient in Northern Argentina control the intensity, structure, and predictability of convective systems?
- What datasets are missing in order to provide for more accurate nowcasting and short term NWP predictions in the region?
- What are possible inferences and limits of predictability on synoptic to intraseasonal time scales for subtropical South American convection?



# **RELAMPAGO OBSERVATIONAL STRATEGIES**



# 2014 radar Network

**RELAMPAGO  
TARGET REGION**

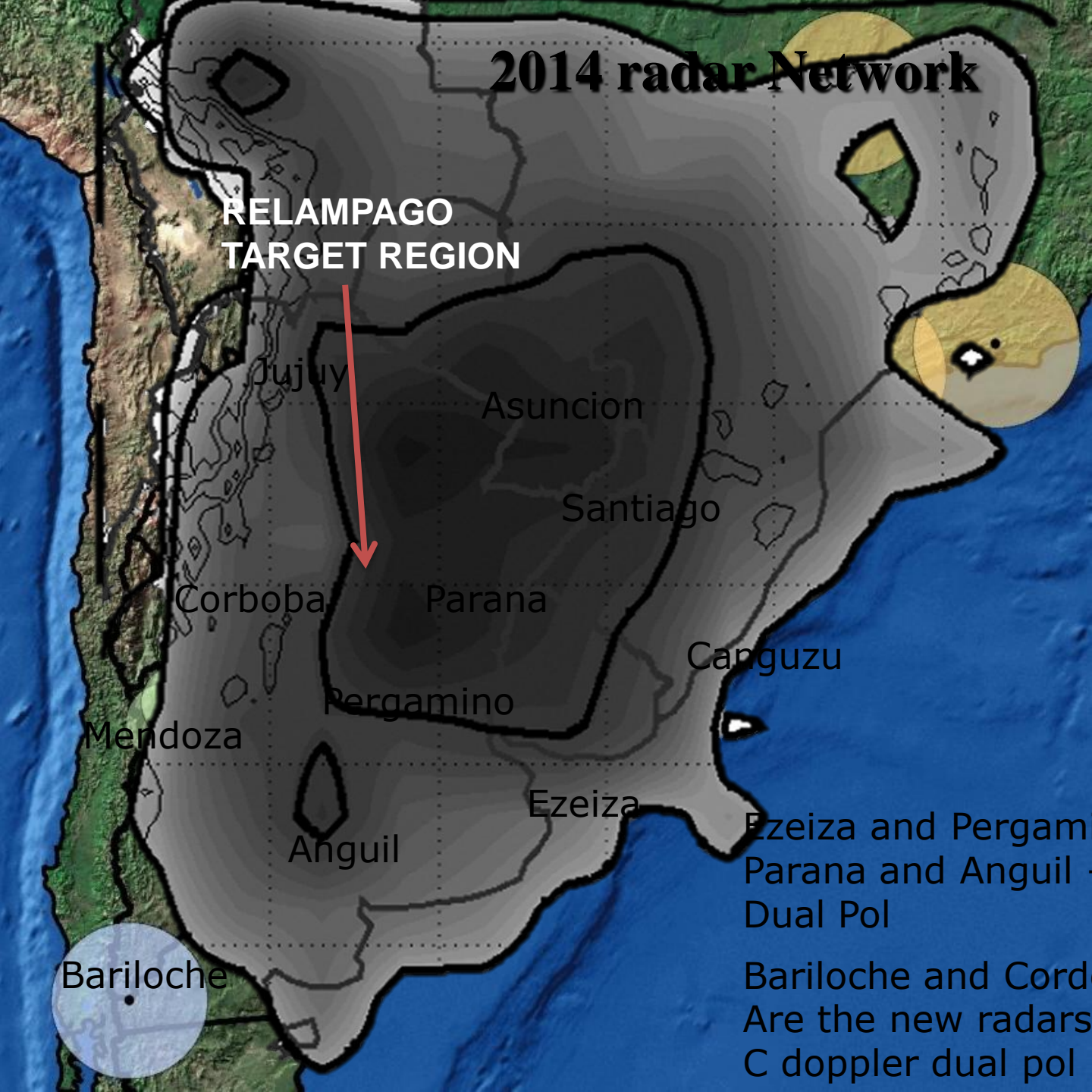


Each circle has 480km diameter

- Target region has:
- Satellite and ground based indications of severe weather
- Good roads, connectivity
- Proximity to soundings and radars

Ezeiza and Pergamino – C Doppler  
Parana and Anguil – C – Doppler – Dual Pol

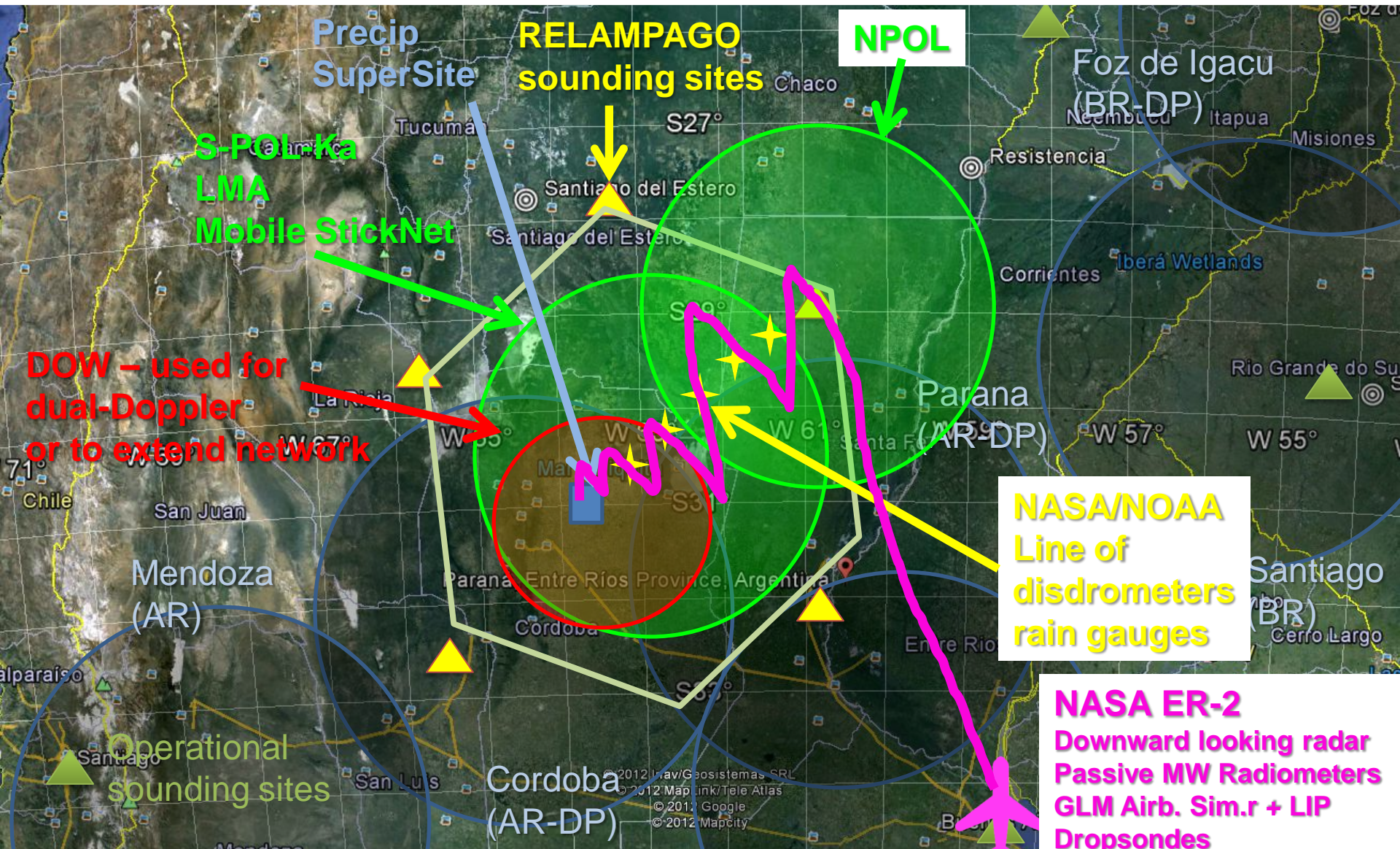
Bariloche and Cordoba  
Are the new radars for 2014  
C doppler dual pol





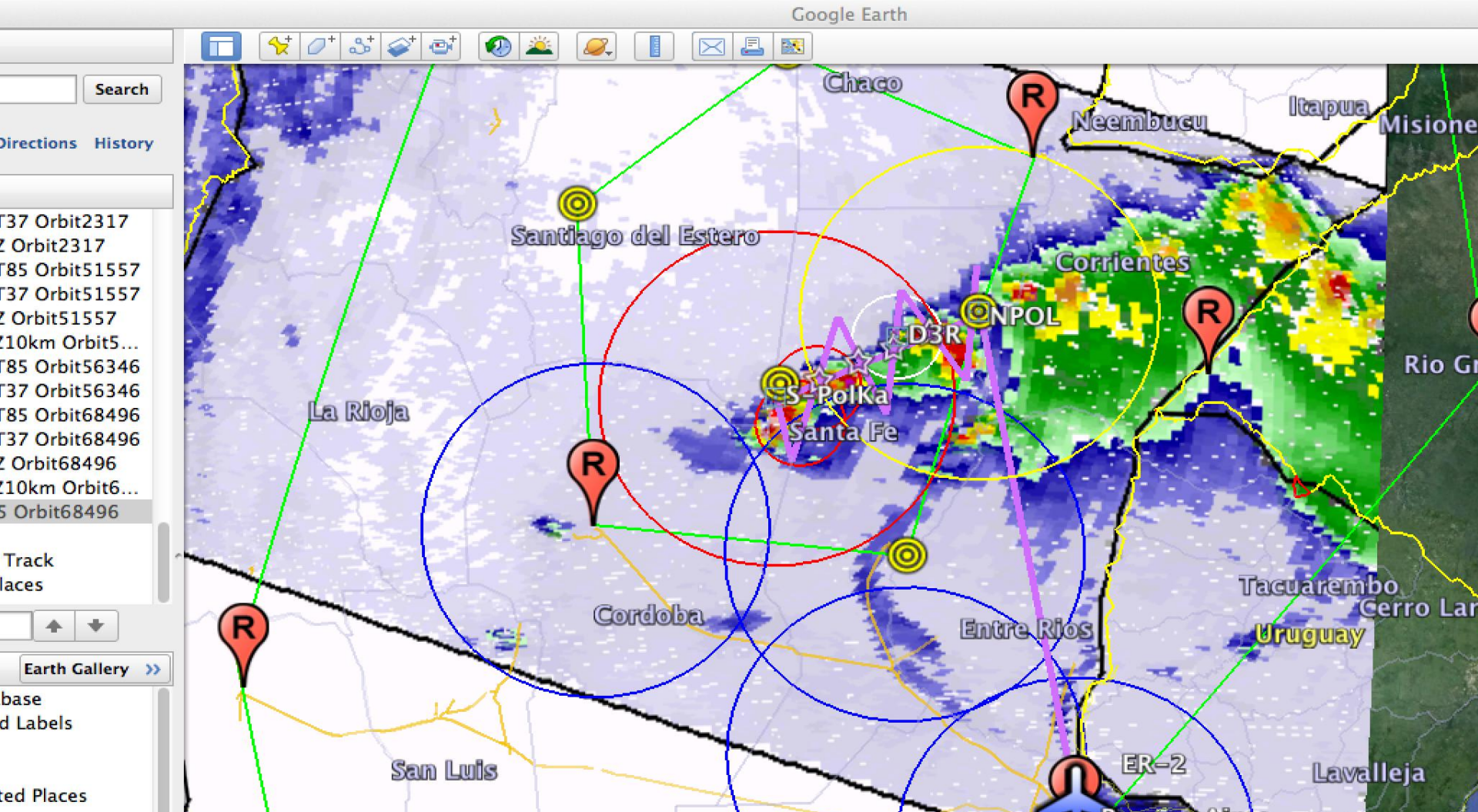


# RELAMPAGO observation network





# RELAMPAGO observation network





## **Assets.** Envisioning 6-8 week EOP with IOPs during events with enhanced sounding coverage (8 x per day)

- **NSF**
  - SPOLKa – convective structure and microphysics, refractivity moisture retrievals and cloud water retrivals
  - NCAR ISS and/or university sounding platforms (U. Alabama/U. Illinois/others?)
  - DOW for dual-doppler coverage
  - TTU StickNet or similar platform
- **Other US agencies**
  - NASA Global Precipitation Measurement (GPM) mission disdrometers, radiometers
  - Planned discussion with Wayne Higgins (CPC)
- **Brazil**
  - Sounding launch facilities
  - Sticknet (UFMS)
  - Lightning mapping array (INPE)
  - Ground-based electric field mills
  - EFM balloon profiles/video charge particle measurements (Japan)
  - High-speed (10,000 fps) video camera
- **Argentina**
  - 2 operational C-Band dual-pol radars (installed by 2014), existing dual-pol radar at Parana
  - Mobile sounding facility/PIBAL operations
  - Aerosol /thermodynamics UAV
- **Chile, Paraguay (perhaps Bolivia)**
  - Cooperation established, can host instrumentation, possible enhanced radiosonde/PIBAL ops

# Science steering group

## USA

S. Nesbitt (U. Illinois)

D. Cecil and T. Lang (MSFC)

K. Rasmussen and R. Houze (U. Washington)

D. Gochis (NCAR-RAL)

## Brazil

L. A. T. Machado and R. Albrecht (INPE/CPTEC)

E. Nascimento (U. Fed. Santa Maria)

## Argentina

P. Salio, C. Saulo (U. Buenos Aires)

G. Binimelis de Raga/D. Baumgardner (UNAM-U. Buenos Aires)

## Near term plans

Will be reaching out to other scientists with observational and modeling interests following the crafting of a white paper in 2013.

Seeking WMO World Weather Research Programme (WWRP)/World Climate Research Program (WCRP) endorsement in 2013.