Paola Salio

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Overview

Motivation

Climatology of the MCS

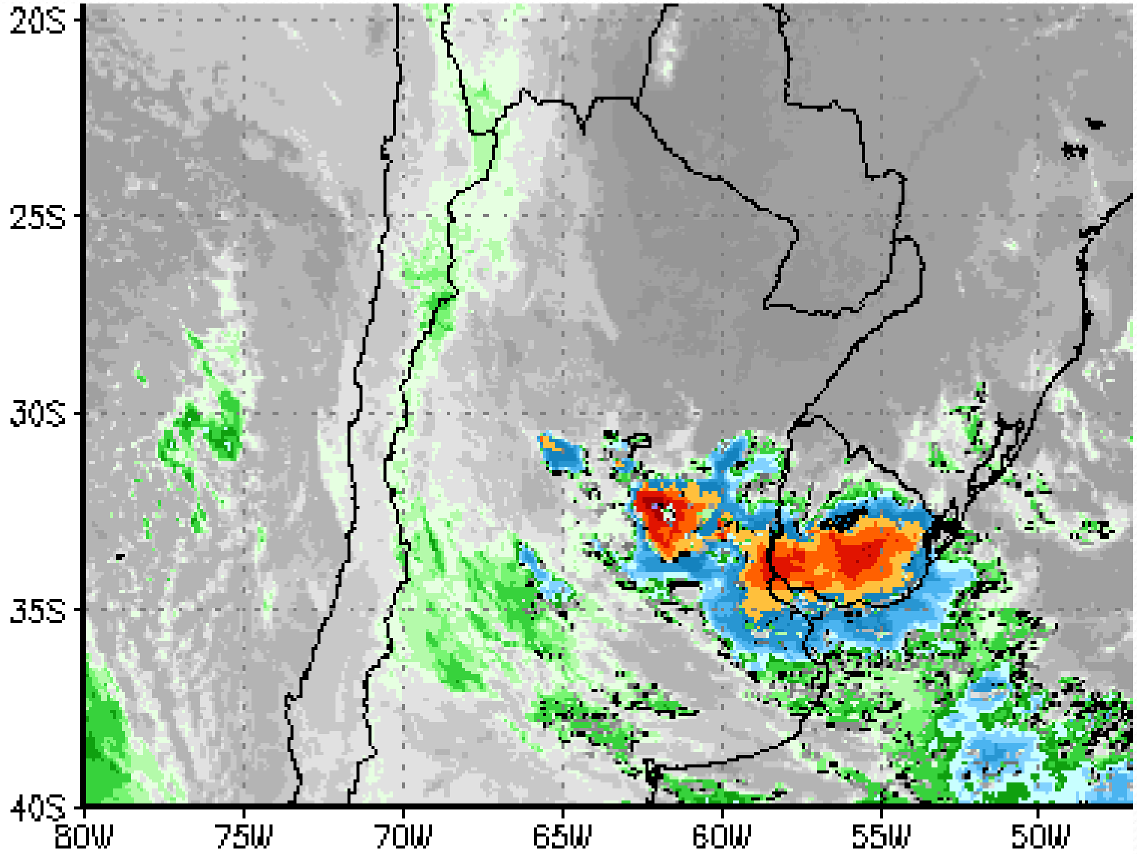
Relationship with severe weather reports

Case studies

MCS- CHUVA and Future field activities
RELAMPAGO

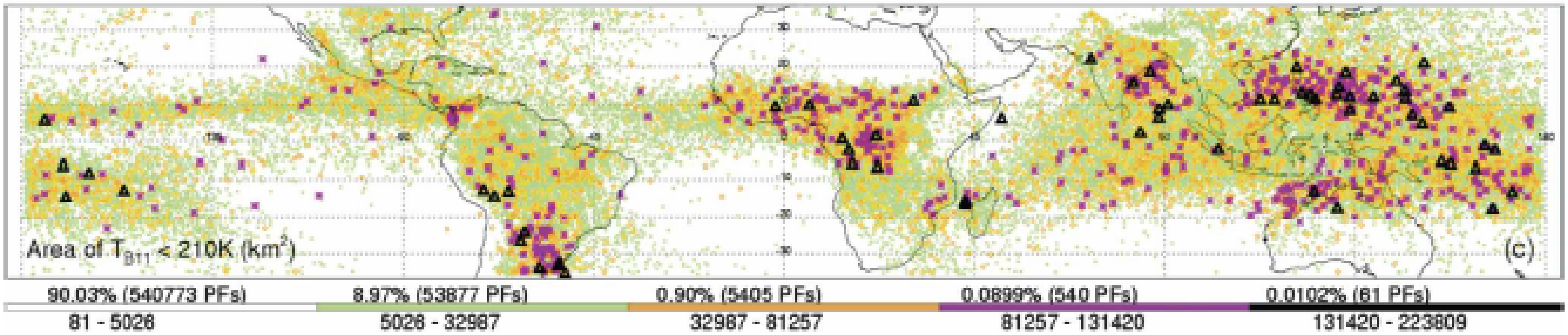
Mesoscale Convective system **definition** from Houze (1993):

"A cloud system that occurs in connection with an ensemble of thunderstorms and produces a contiguous precipitation area ~100 km in horizontal scale in at least one direction."

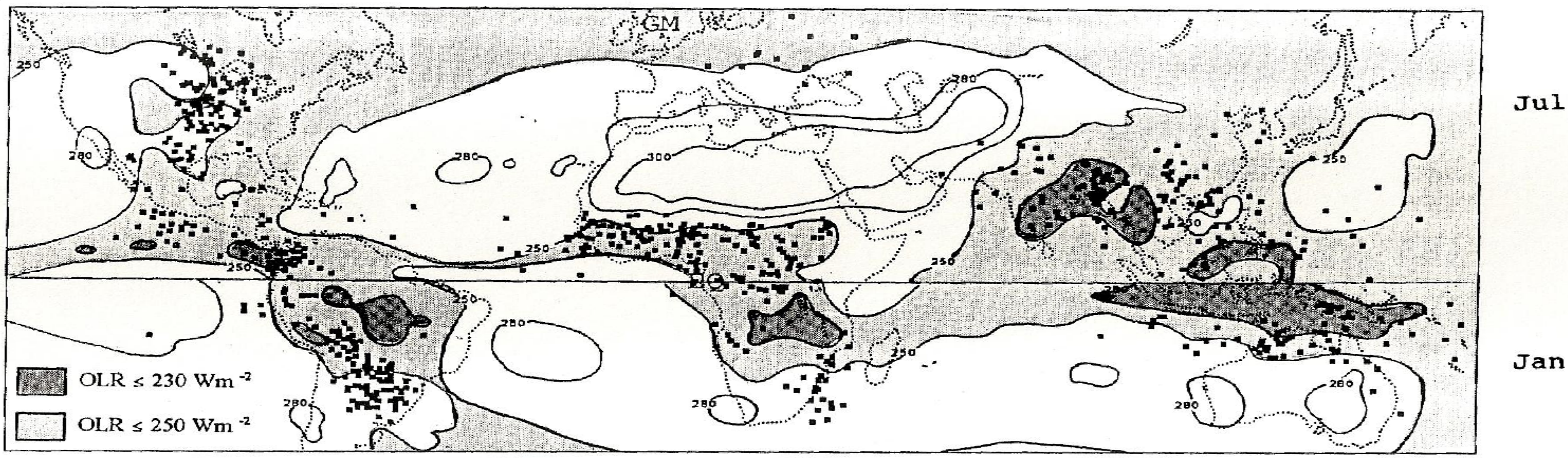


Motivation

MCSs can occur worldwide and year-round taking different sizes and shapes. Largest systems can extend ~500 km in a horizontal direction and persist for ~20 hours.



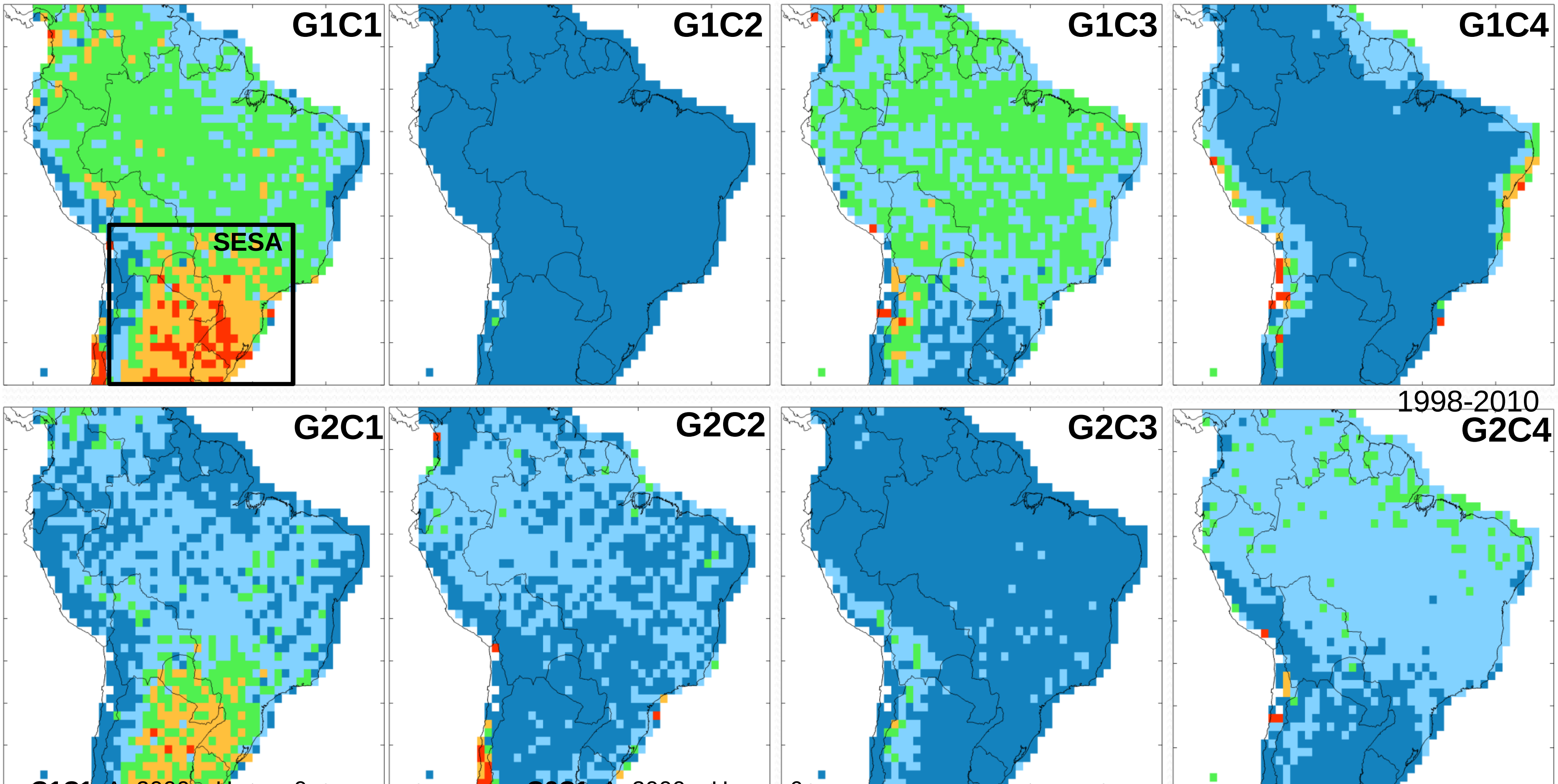
Liuct et al 2007



Laing and Fristch,1997

Why should we care about MCSs over South America?

MCSs are a significant rain producers. Large convective systems explain 90% of the precipitation over La Plata Basin and 50% over the Amazon region.



G1C1: $A>2000 + H_{40dBZ}>0$
G1C2: $A>2000 + H_{40dBZ}=0$
G1C3: $A<2000 + H_{40dBZ}>0$
G1C4: $A<2000 + H_{40dBZ}=0$

G2C1: $A>2000 + H_{40dBZ}>6$
G2C2: $A>2000 + 0<H_{40dBZ}<6$
G2C3: $A<2000 + H_{40dBZ}>6$
G2C4: $A<2000 + 0<H_{40dBZ}<6$

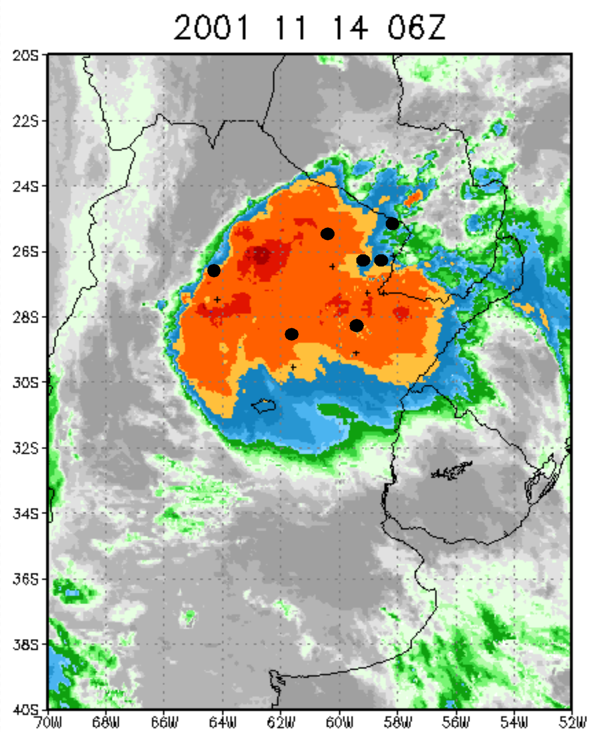
[A]: km^2
[H_{40dBZ}]: km

Vidal and Salio 2009

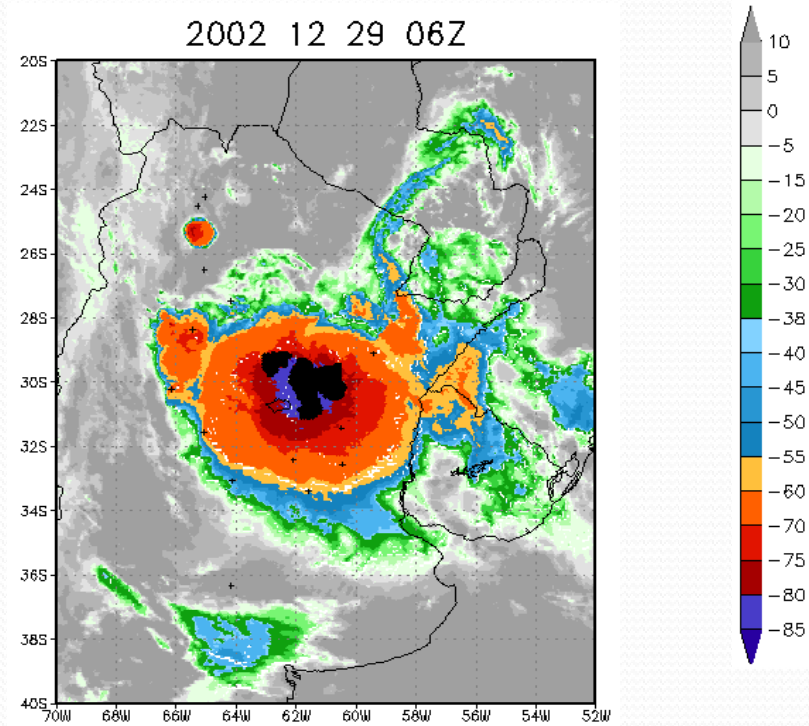
Why should we care about MCSs over South America?

MCSs produce a broad range of severe convective weather events: strong winds, hail, tornadoes, lightning, and flooding. It frequent for MCSs to result in 10s to 100s of severe weather reports.

Hail Reports



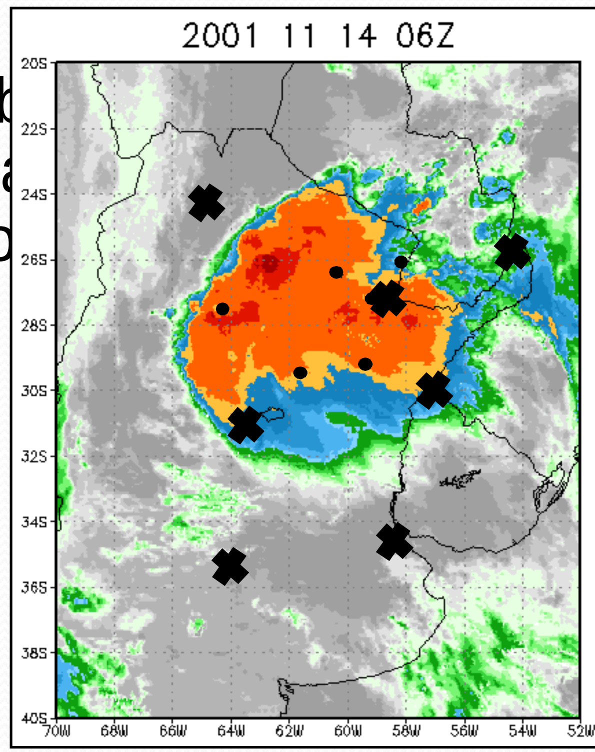
Precipitation reports higher than 20 mm/h



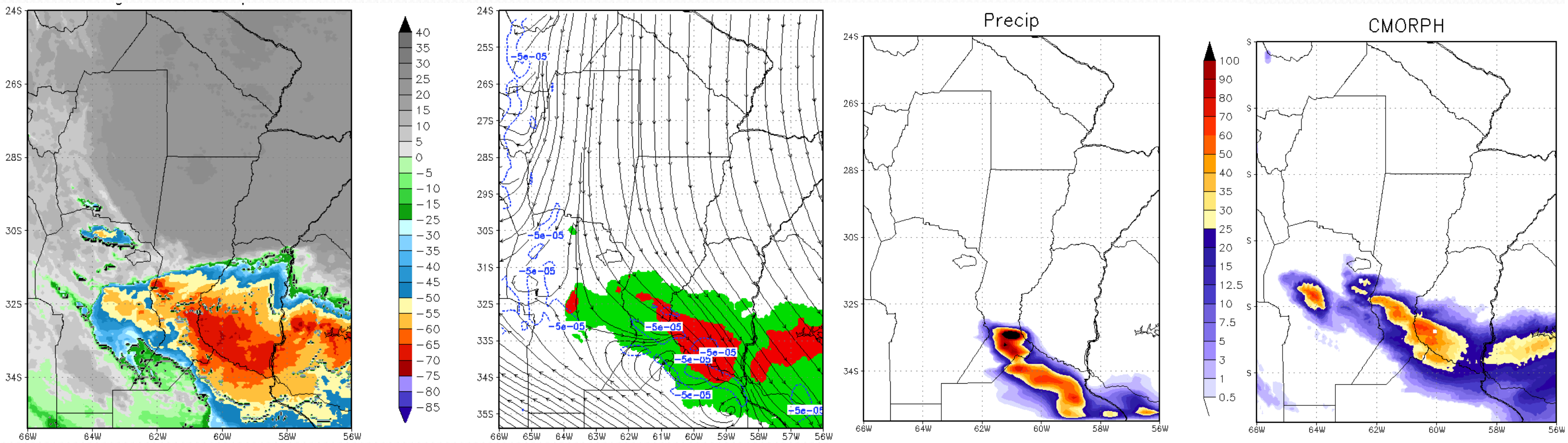
MCSs are a **real problem** in quantitative precipitation forecast (QPF).

In general, these systems are small to be captured by the sparse routine upper-air sounding network available in SA, but too large to be represented by a single point.

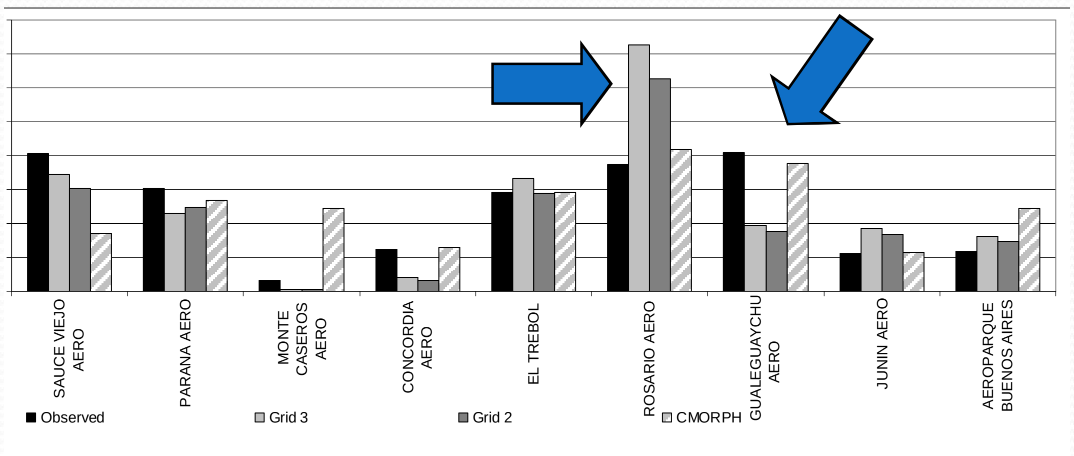
Pose a significant prob ce the systems require models with a doma ed kilometers, yet fine enough resolution to thunderstorm elements properly.



MCSs are a real problem in QPF......



27 March 2007
06UTC



Salio et al 2010

Where are Extreme storms on Earth?

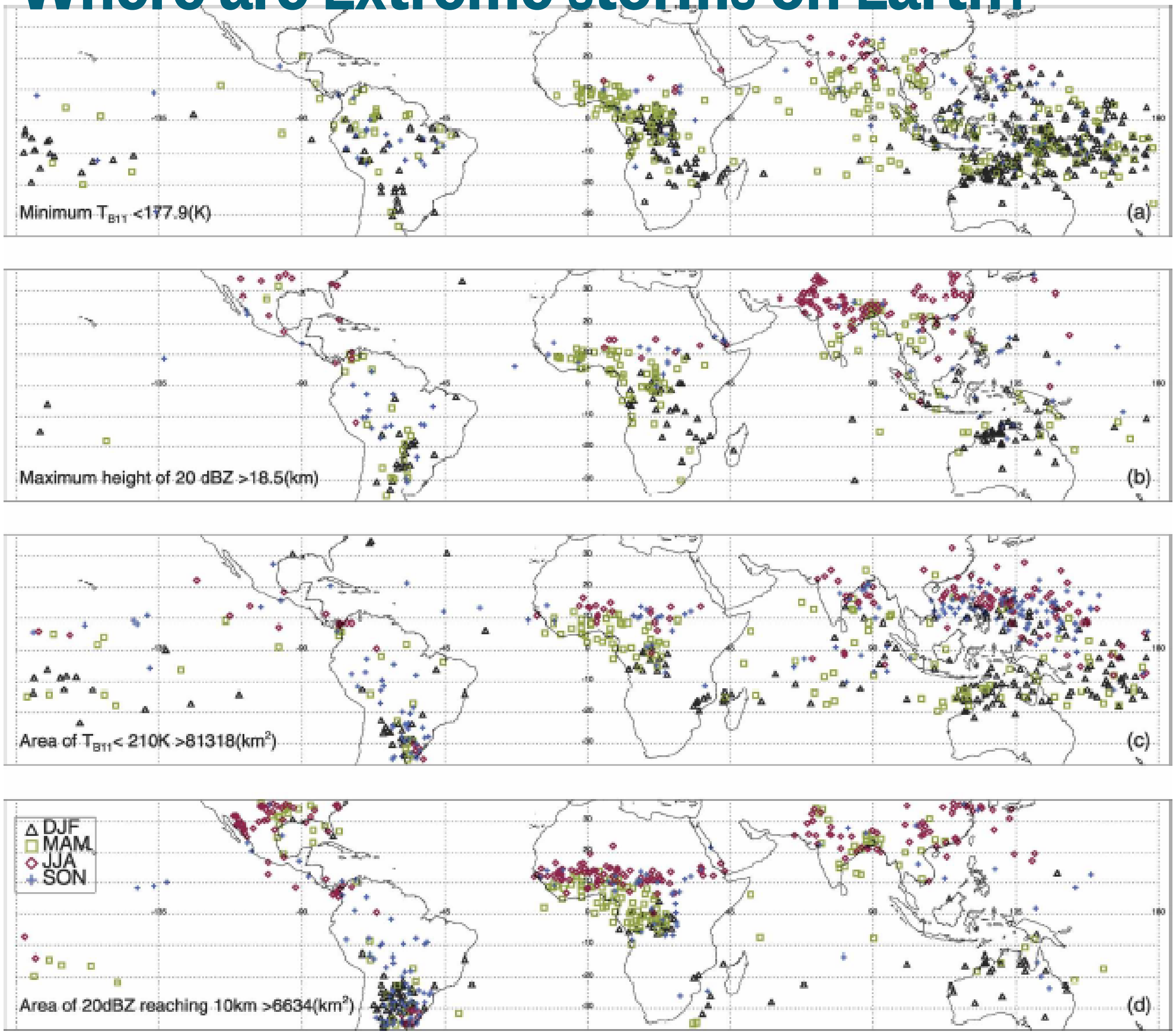
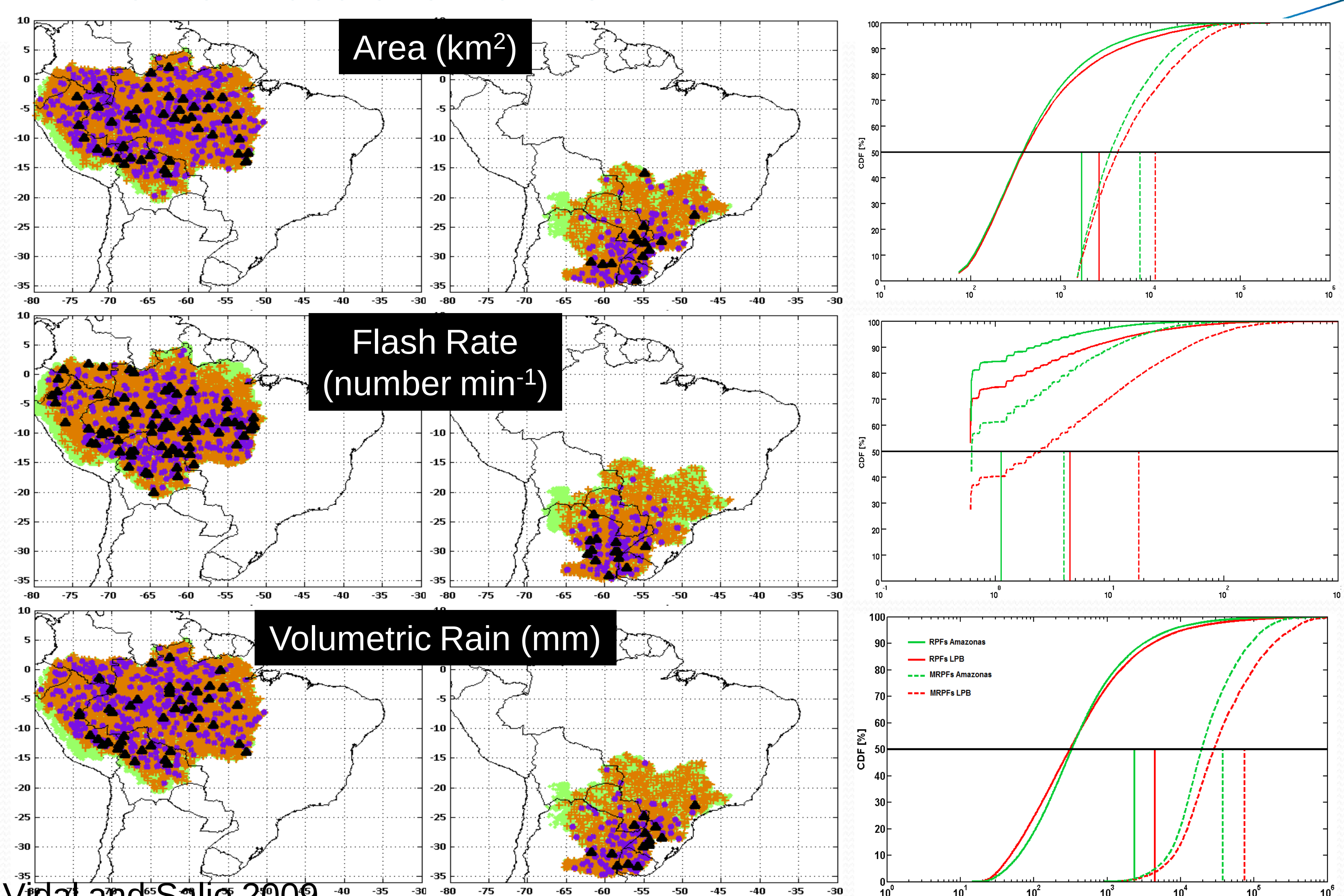


FIG. 9. Color- and symbol-coded seasonal cycle of the most extreme events (purple and black categories in Fig. 8).

Zipser et al 2006

Extreme MCSs events in SA



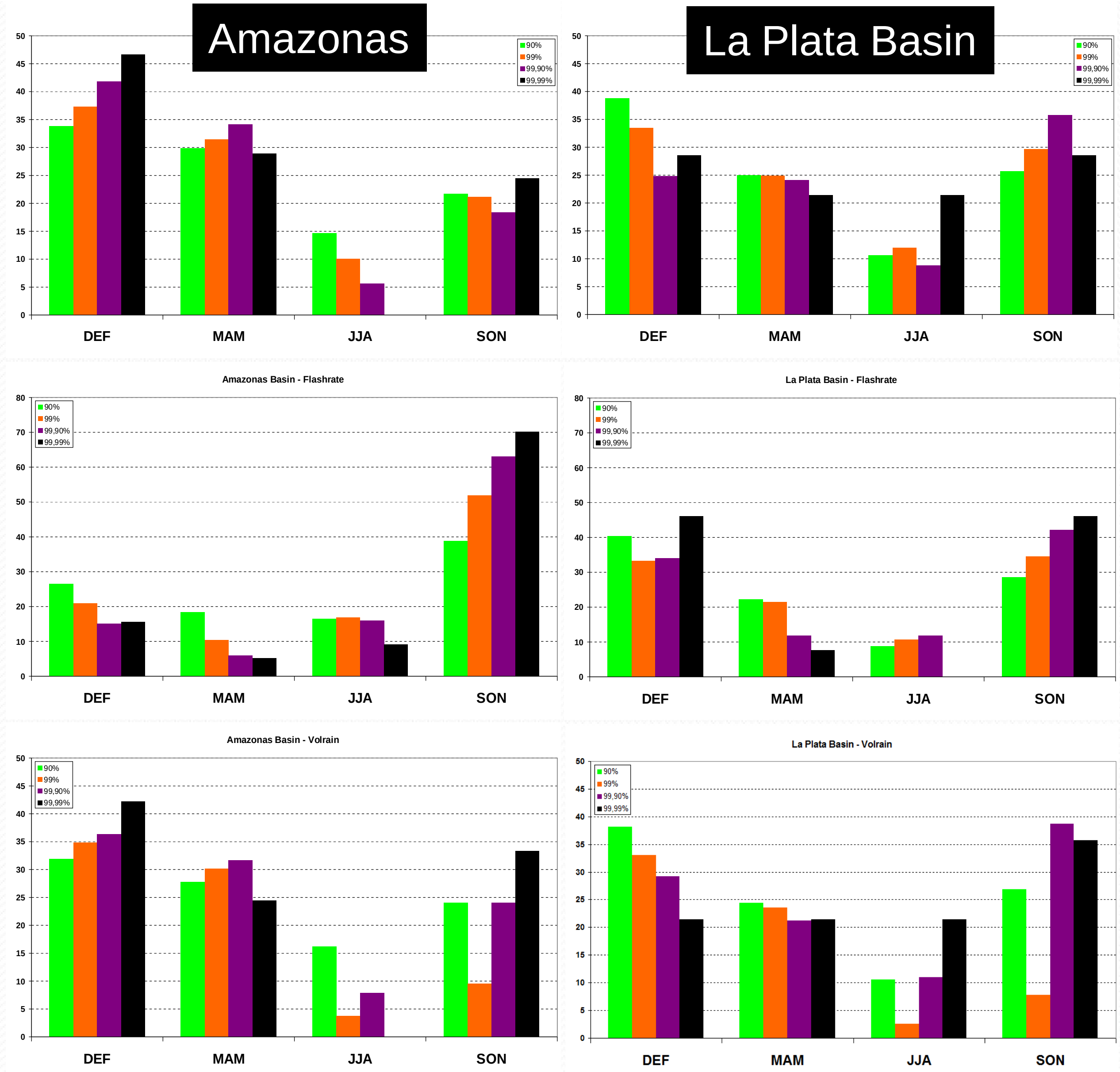
Vidal and Salio 2009

Extreme MCSs events in SA

Area (km^2)

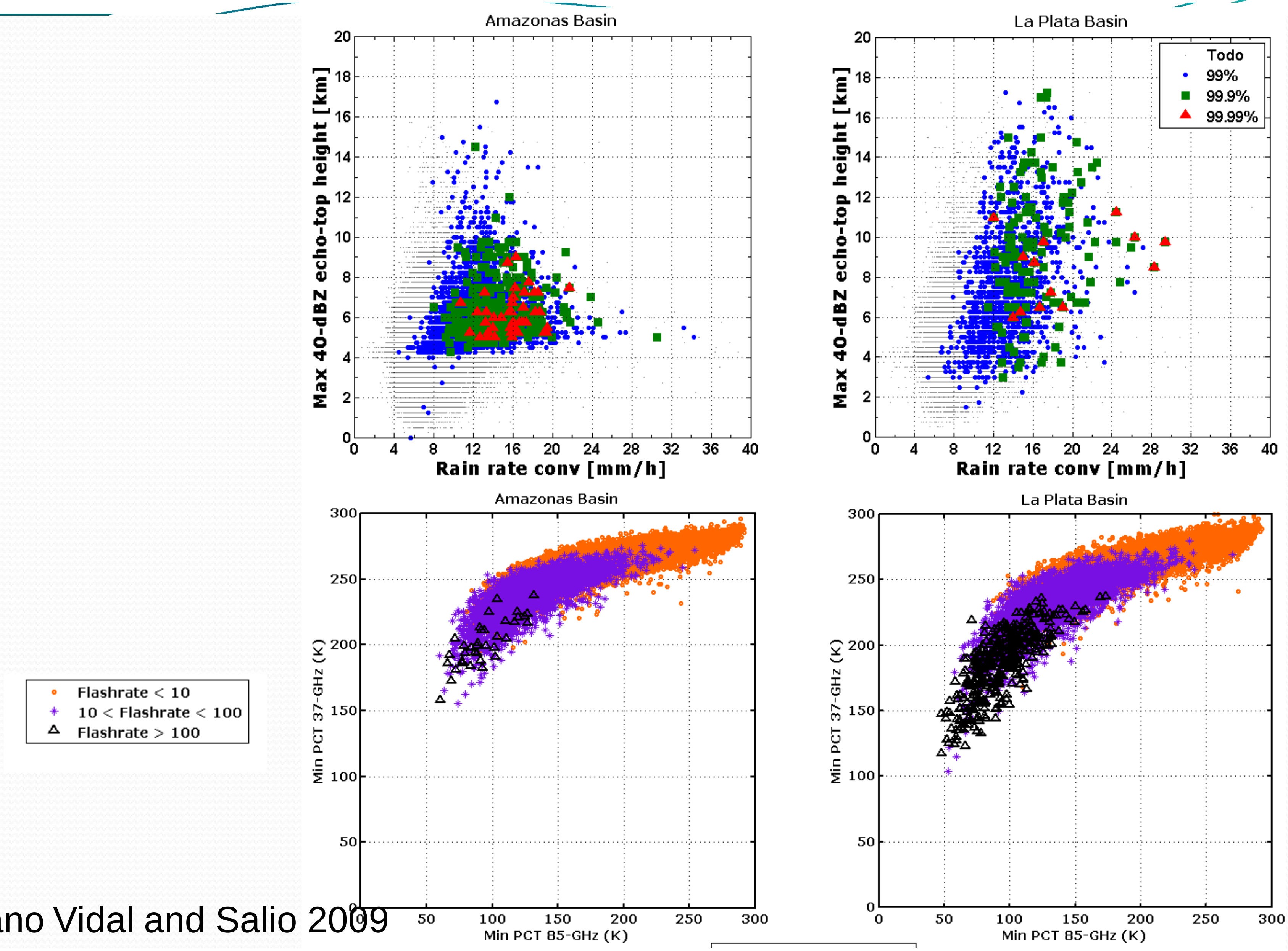
Flash Rate (number min^{-1})

Volumetric Rain (mm)



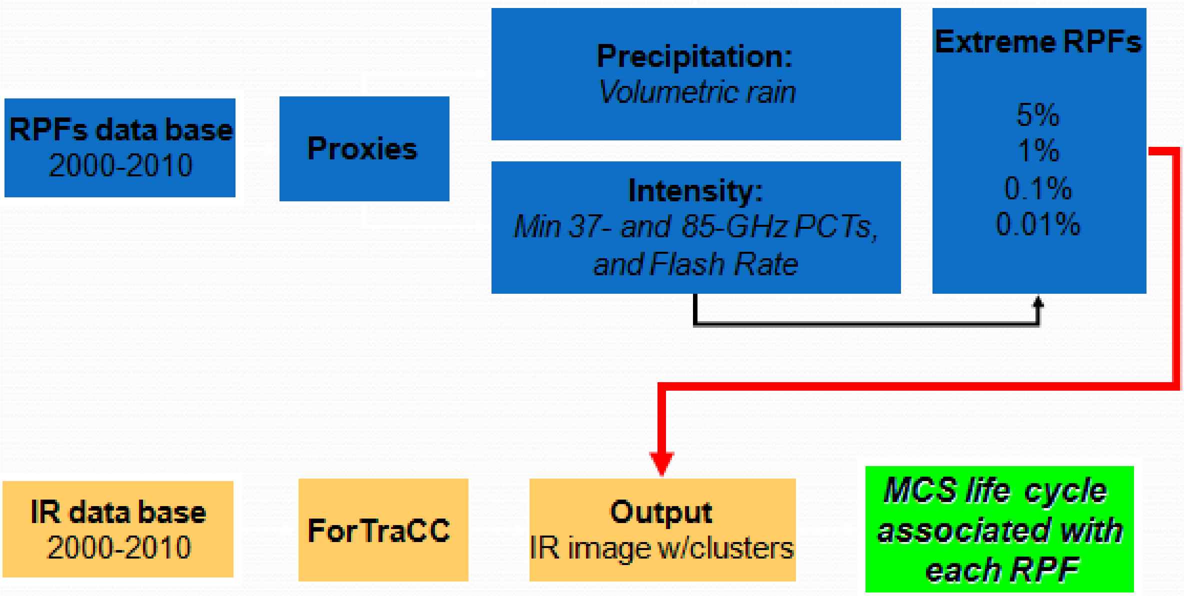
Vidal and Salio 2009

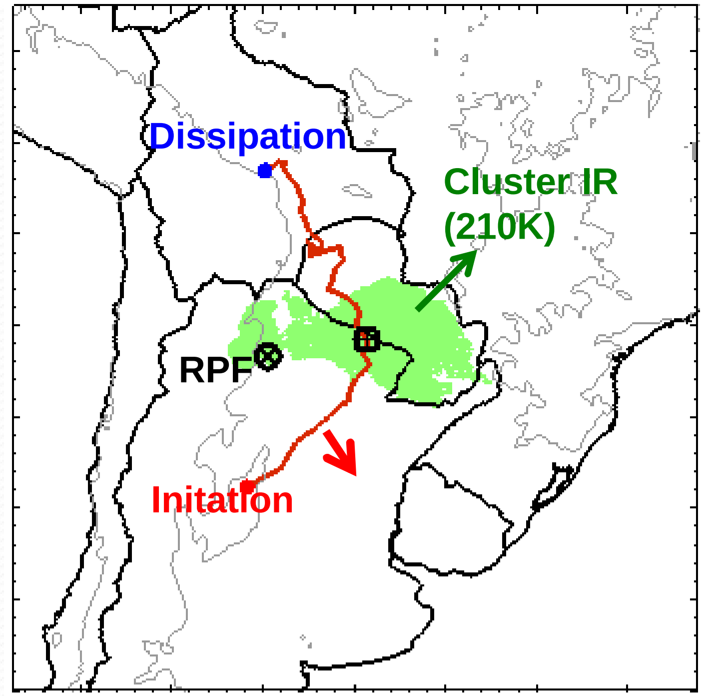
Extreme MCSs events in SA

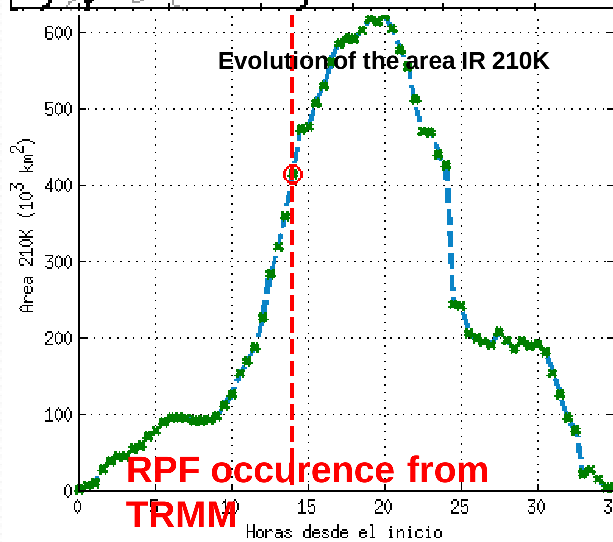


Luciano Vidal and Salio 2009

Methodology of MCS Tracking







Luciano Vidal PhD in progress

MCSs Initiation

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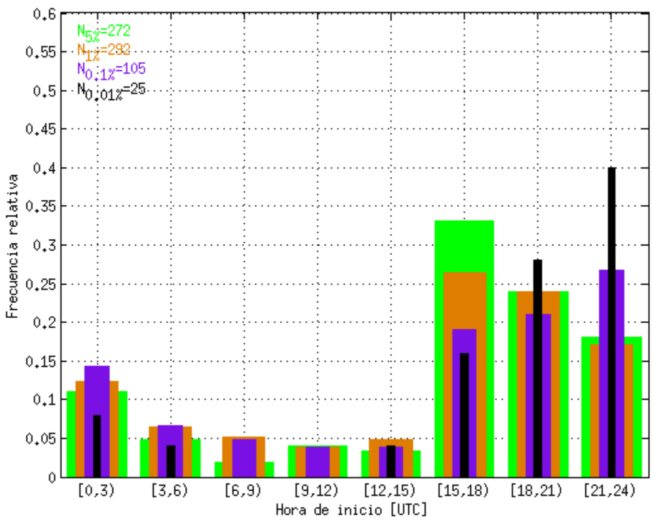

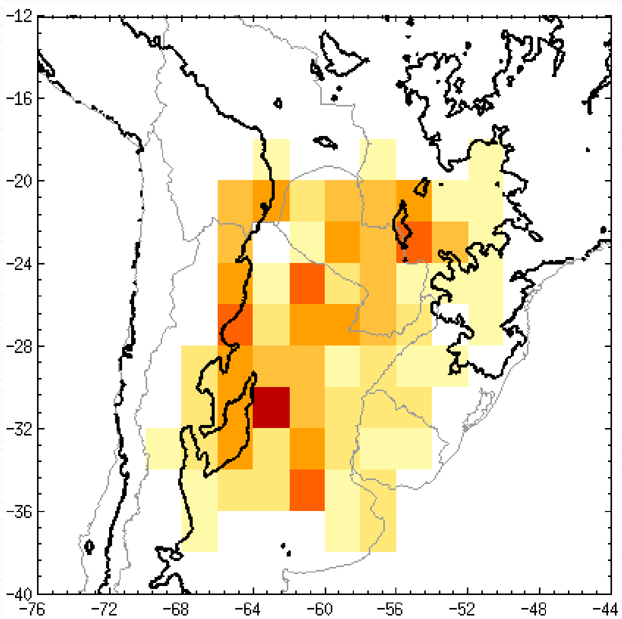

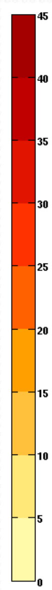

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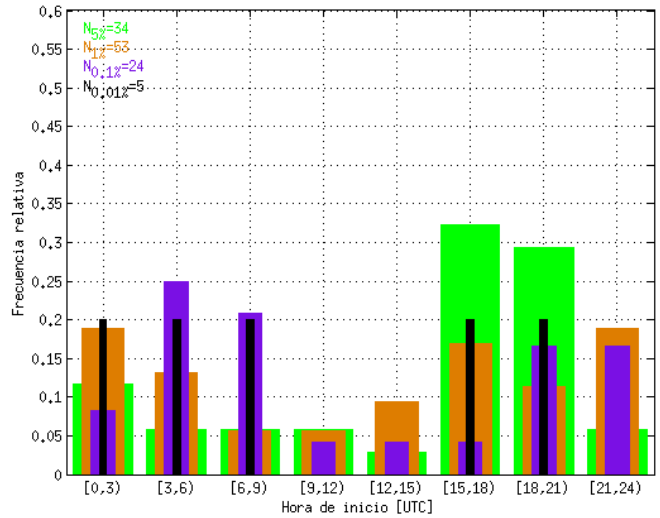

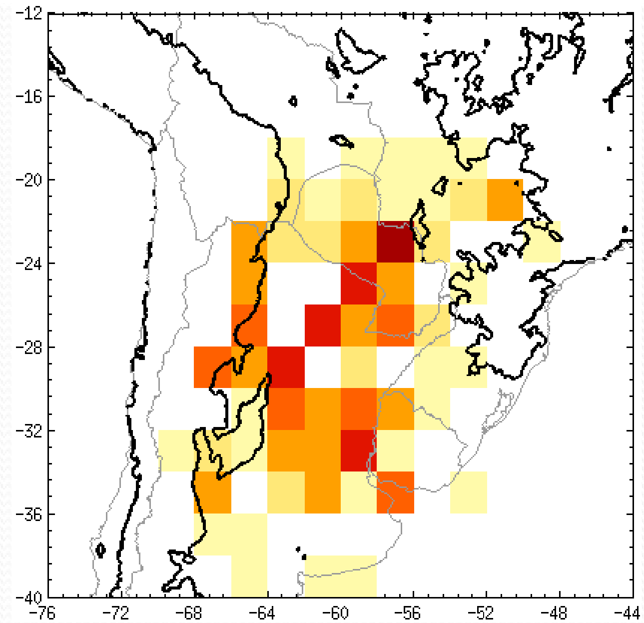

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MCSs Mature Stage

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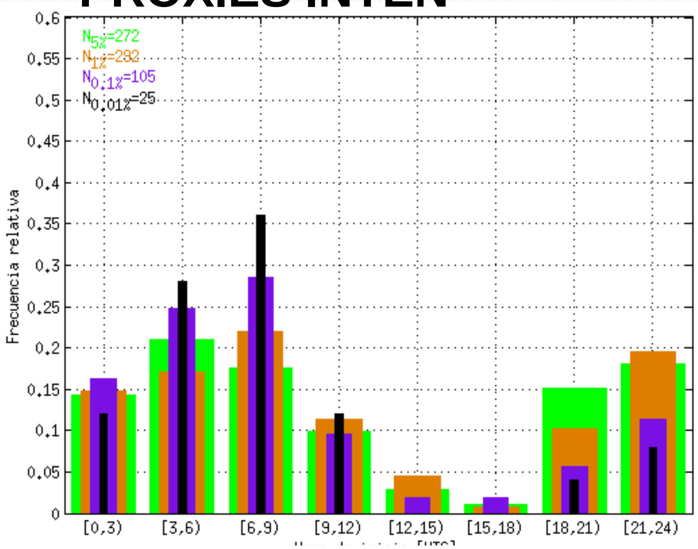

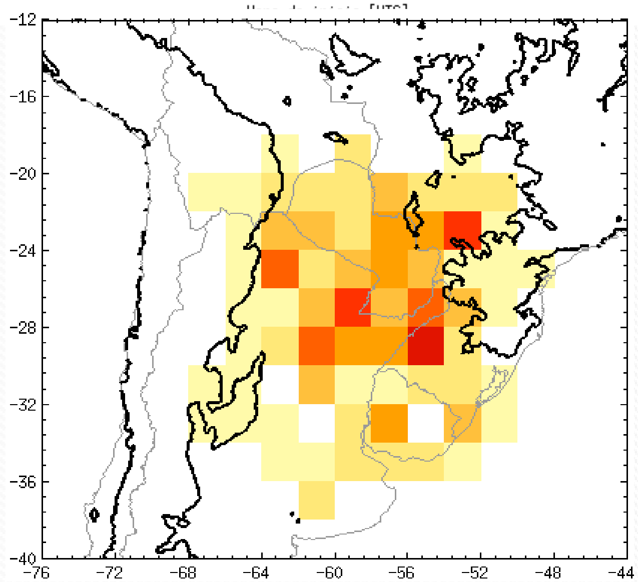

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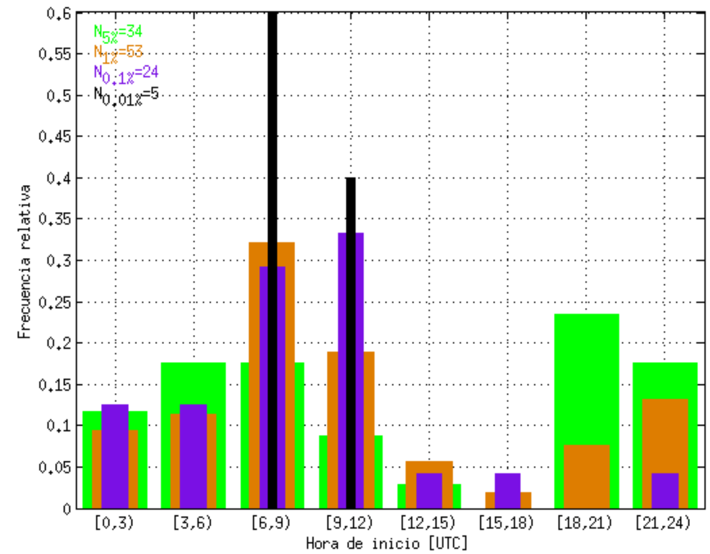

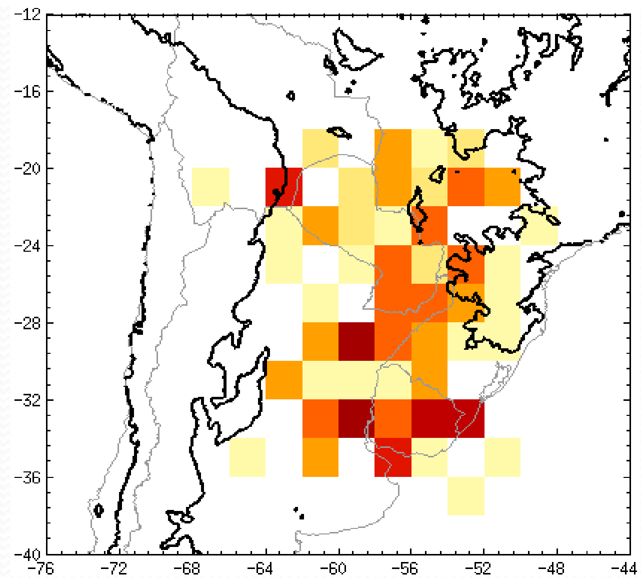

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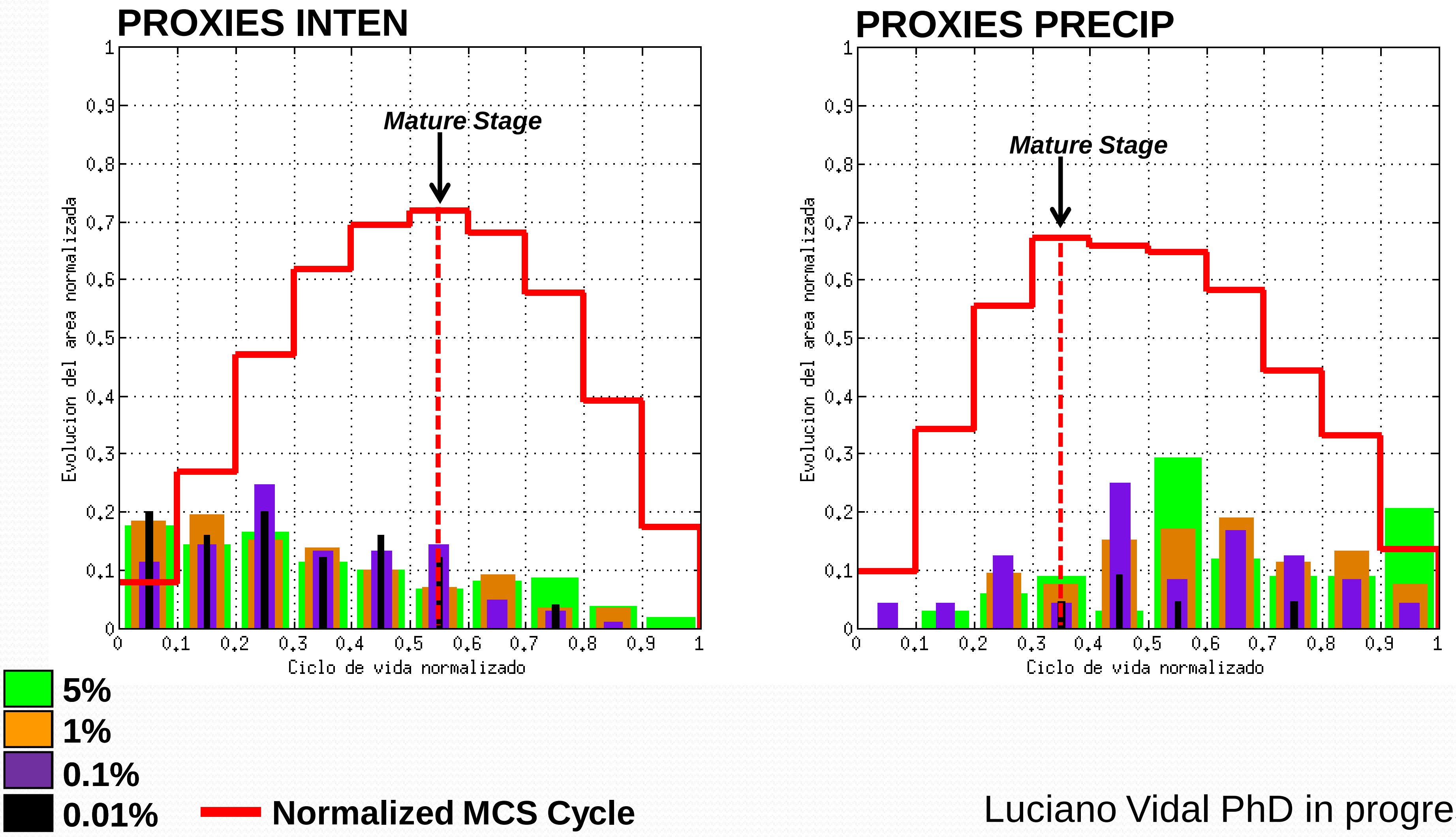
Moment of the ocurrence of RPF extreme event during the MCSs life cycle



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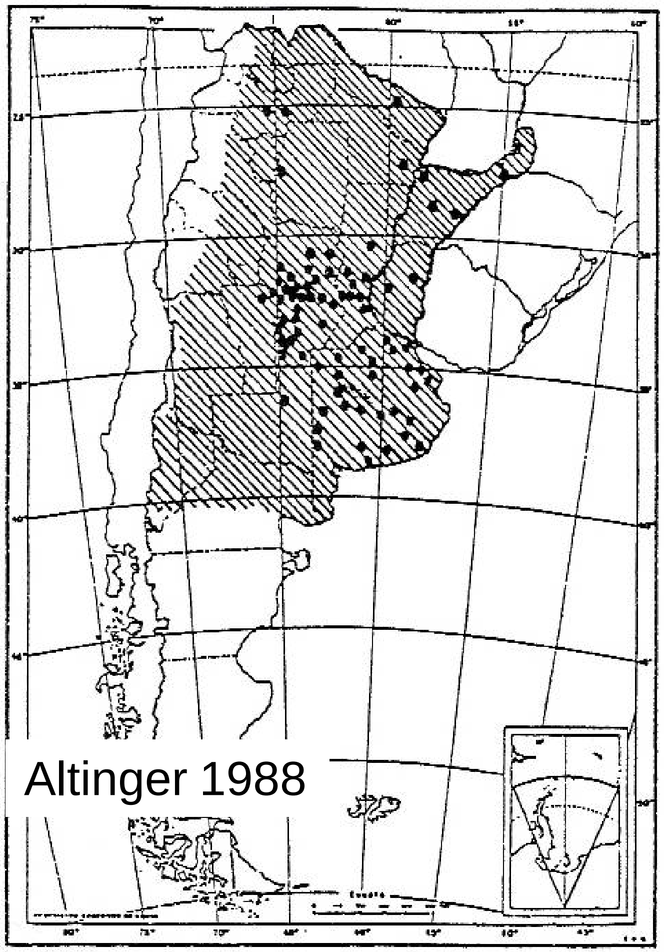
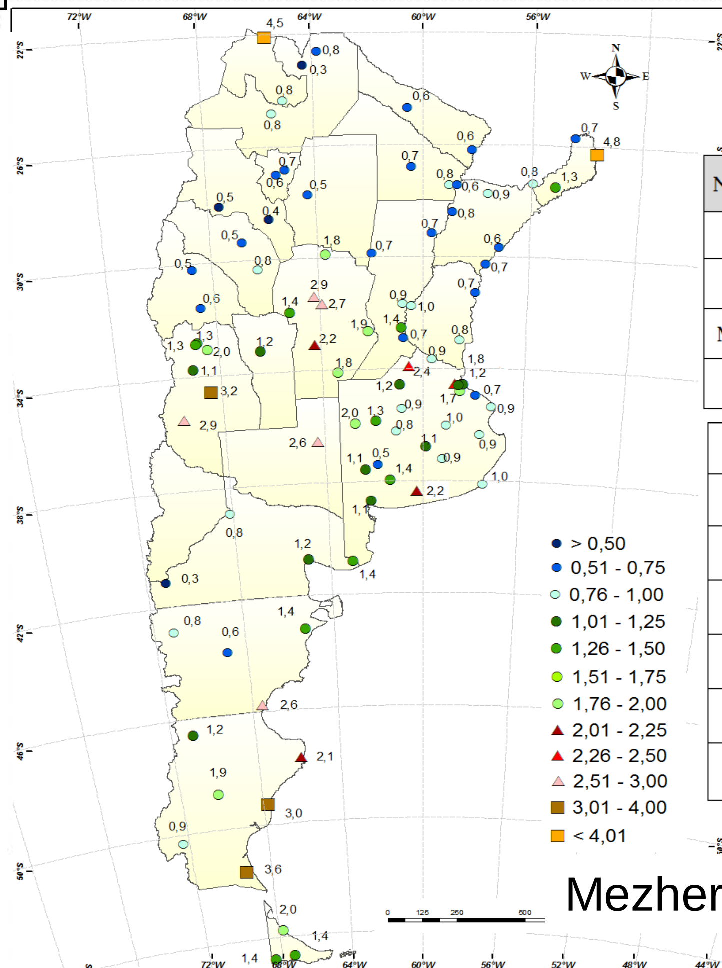
Severe weather report in Argentina

Wind F0 (1930 – 1987)



Altinger 1988

Hail (1960-2008)



Mezher et al 2012

Nombre de la estación	Promedio anual de eventos de granizo
San Rafael	3,2
San Martín	2,0
Mendoza Observatorio	1,3
Santa Rosa	2,6
Villa Dolores	1,4
Córdoba Observatorio	2,9
Pilar	2,7
Río Cuarto	2,2
Laboulaye	1,8
Marcos Juárez	1,9
San Luis	1,2

Severe weather report in Argentina

Precipitation rate > 30mm/h (1998-2010)

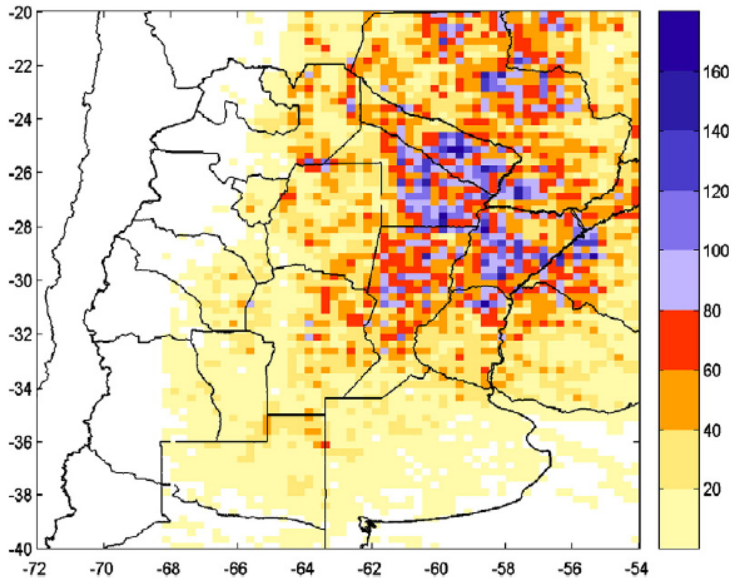
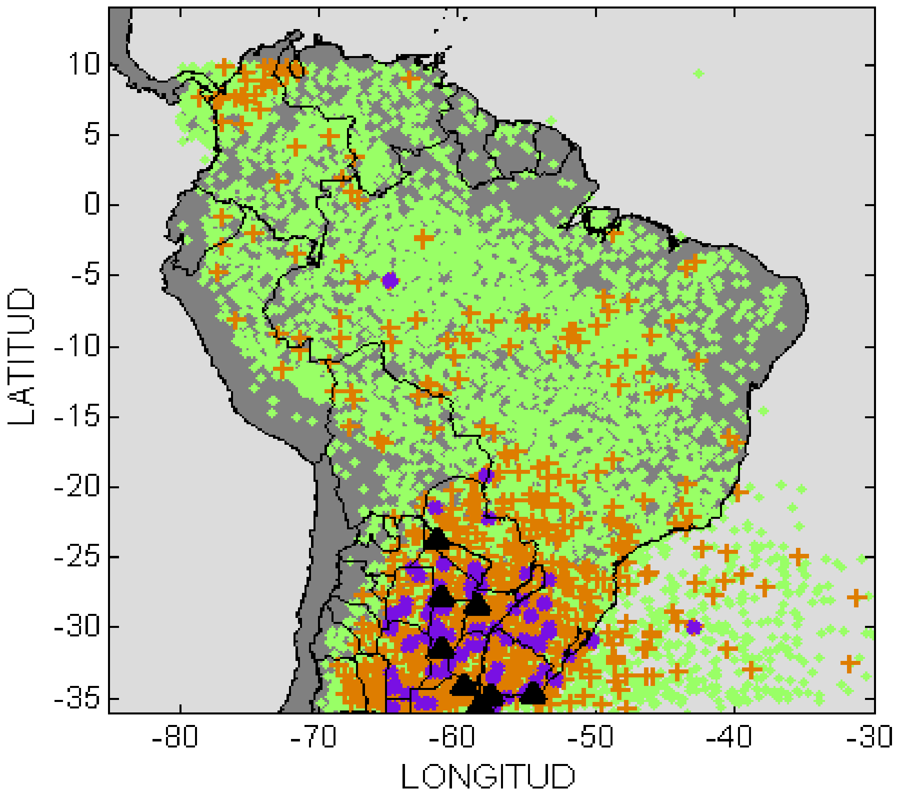


Fig. 4. Absolute frequency of heavy rainfall events (30 mm h^{-1} or greater) for 2000 to 2005 ($0.25° \times 0.25°$).

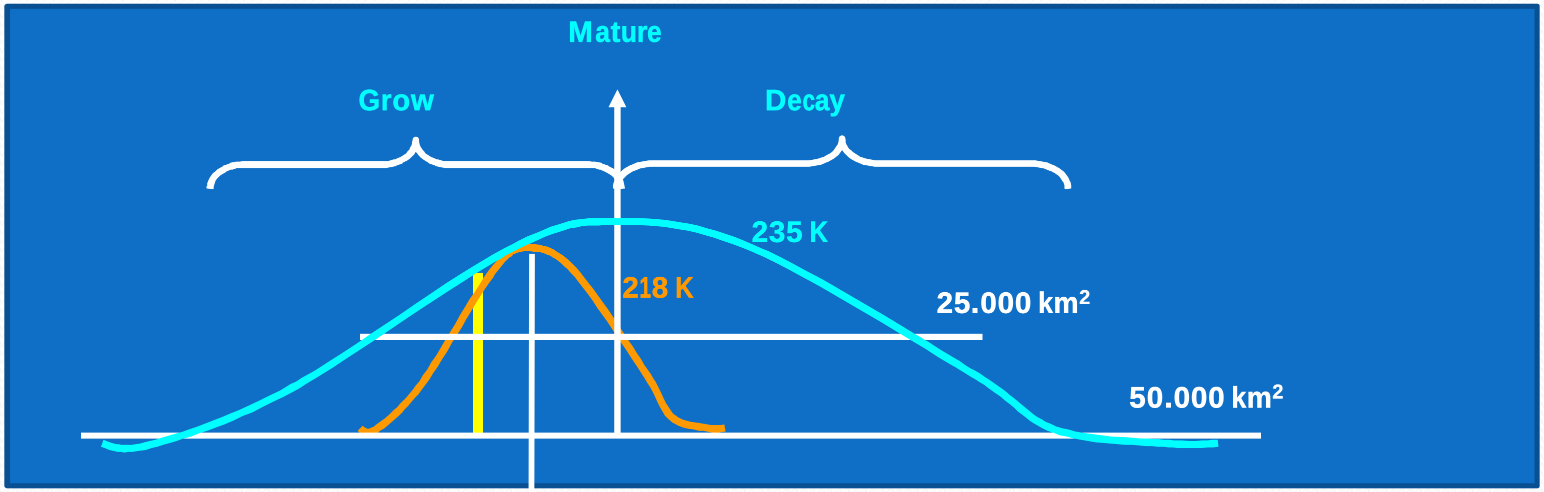
Matsudo and Salio 2010

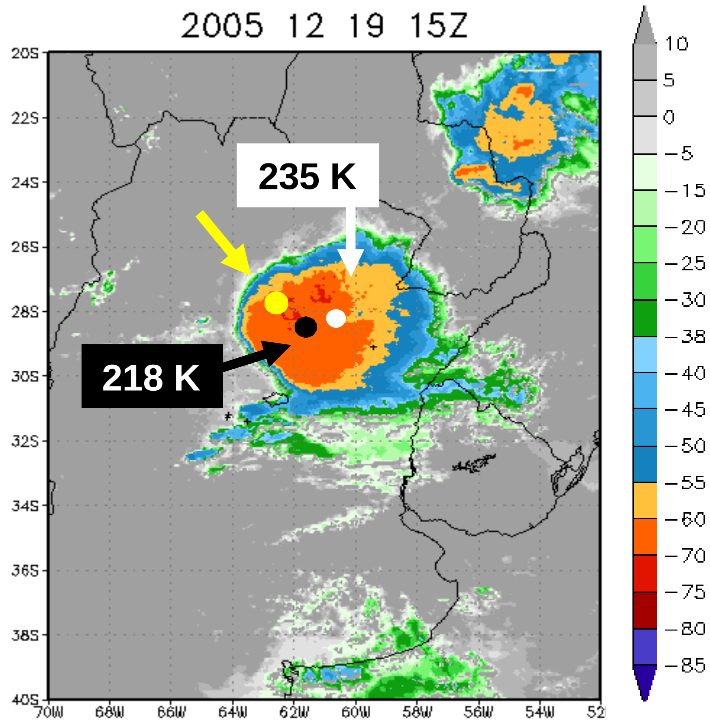
Flash Rate (1998-2012)

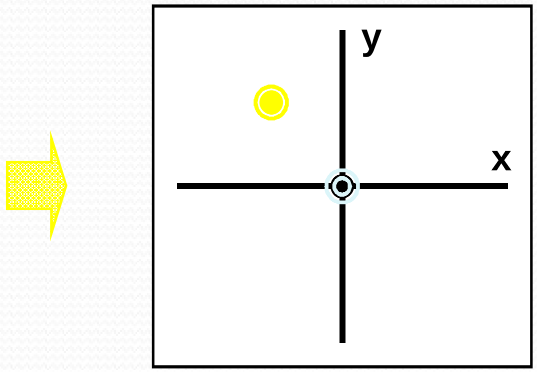


Vidal and Salio 2010

Localization severe weather report in the MCSs?



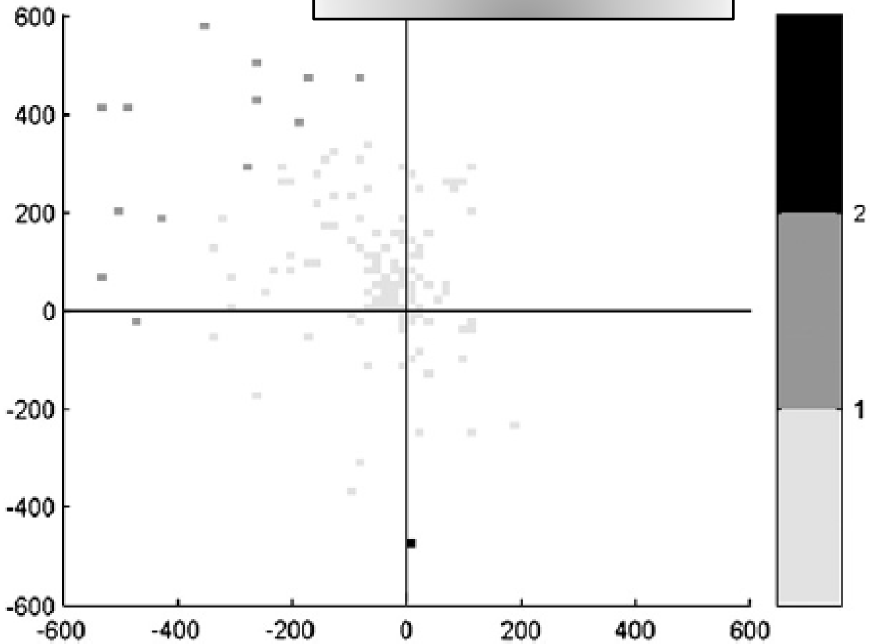




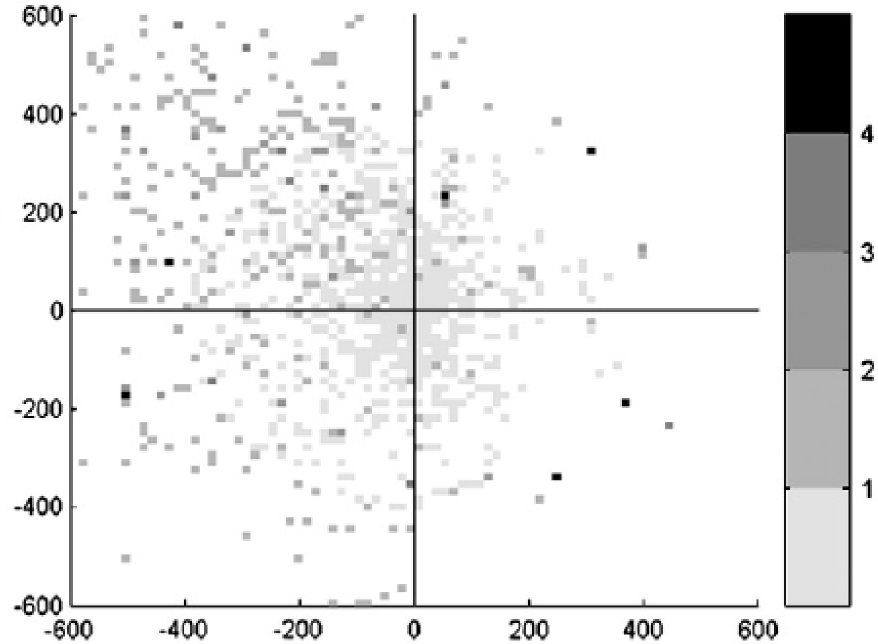
Matsudo and Salio 2010

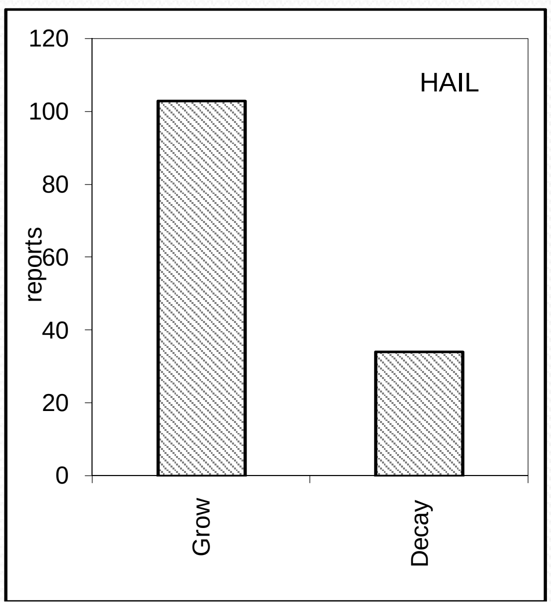
Severe Weather

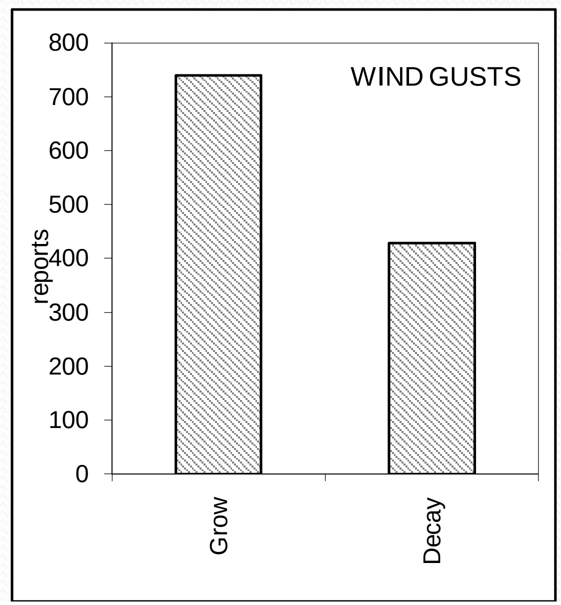
Hail



Wind gust > 25 m/s

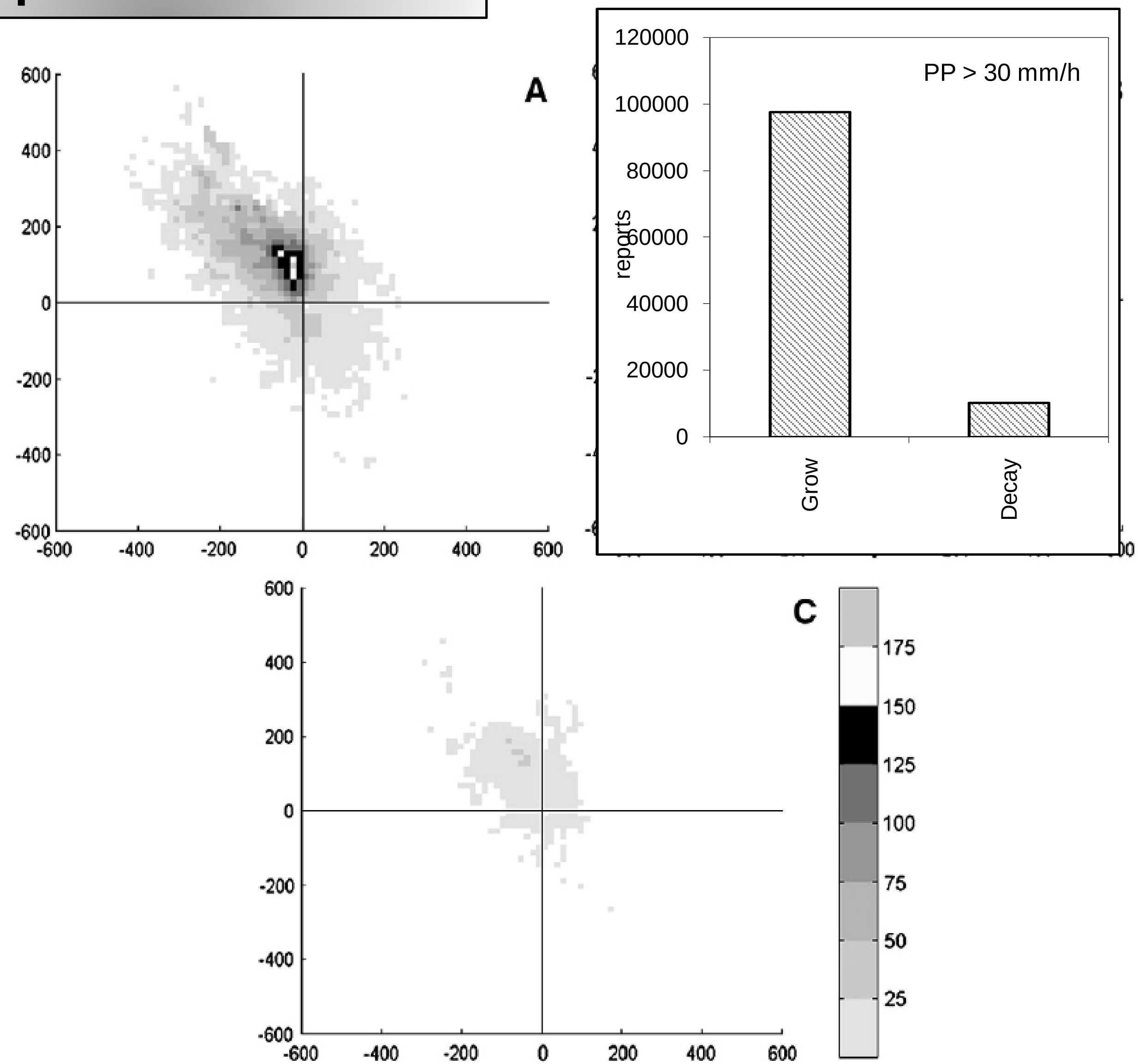






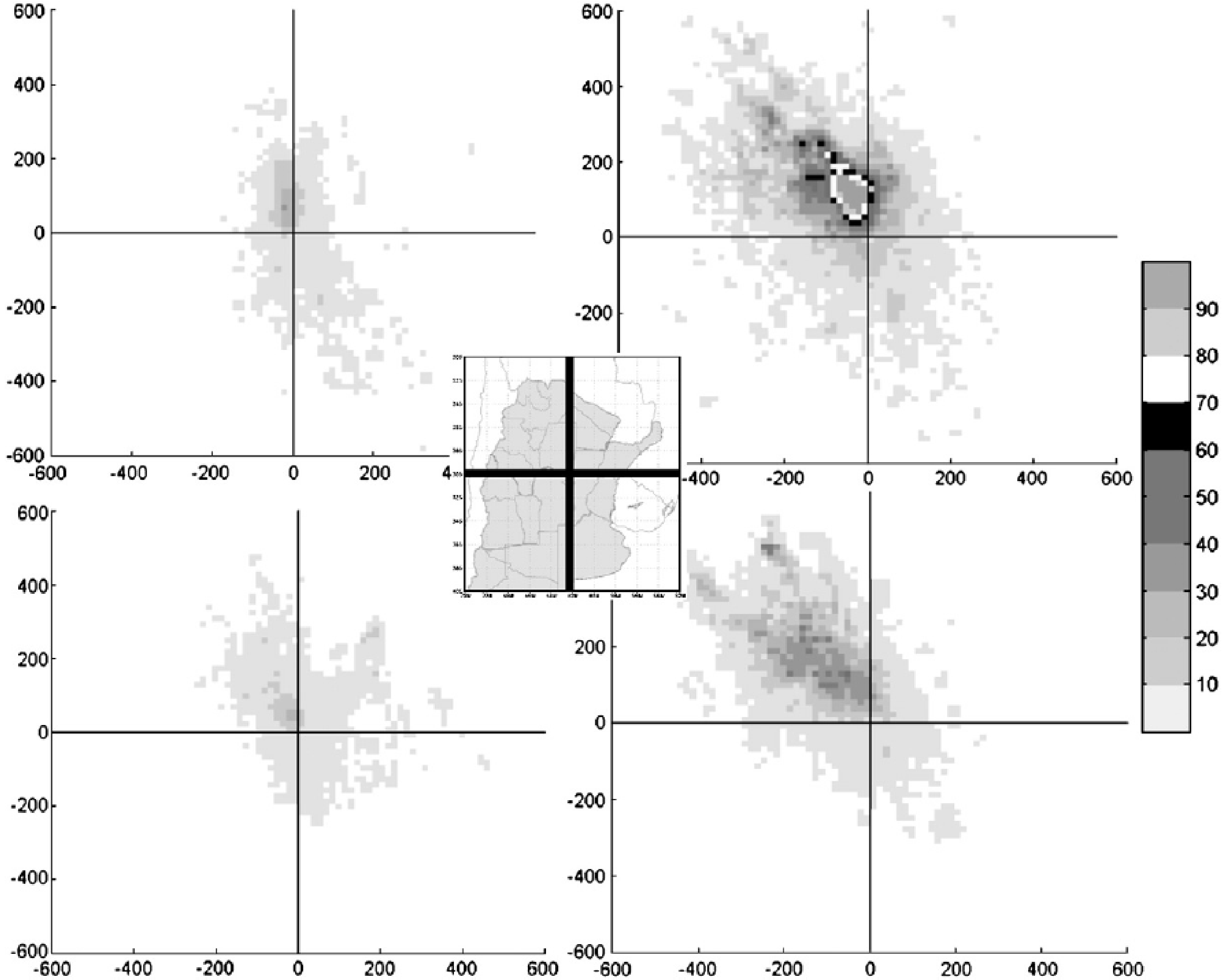
Matsudo and Salio 2010

Precipitation > 30 mm/h

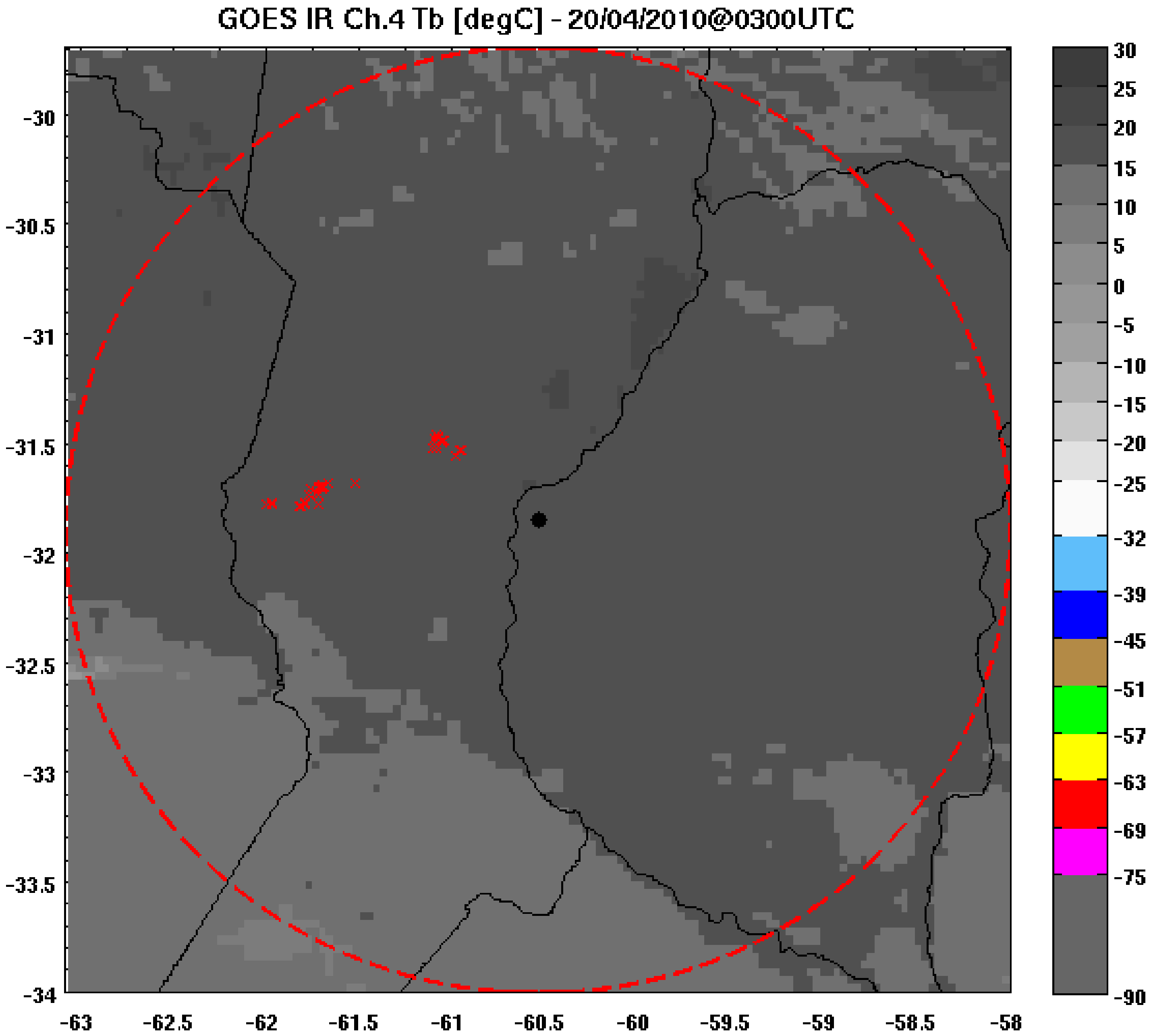


Matsudo and Salio 2010

Precipitation > 30 mm/h



Matsudo and Salio 2010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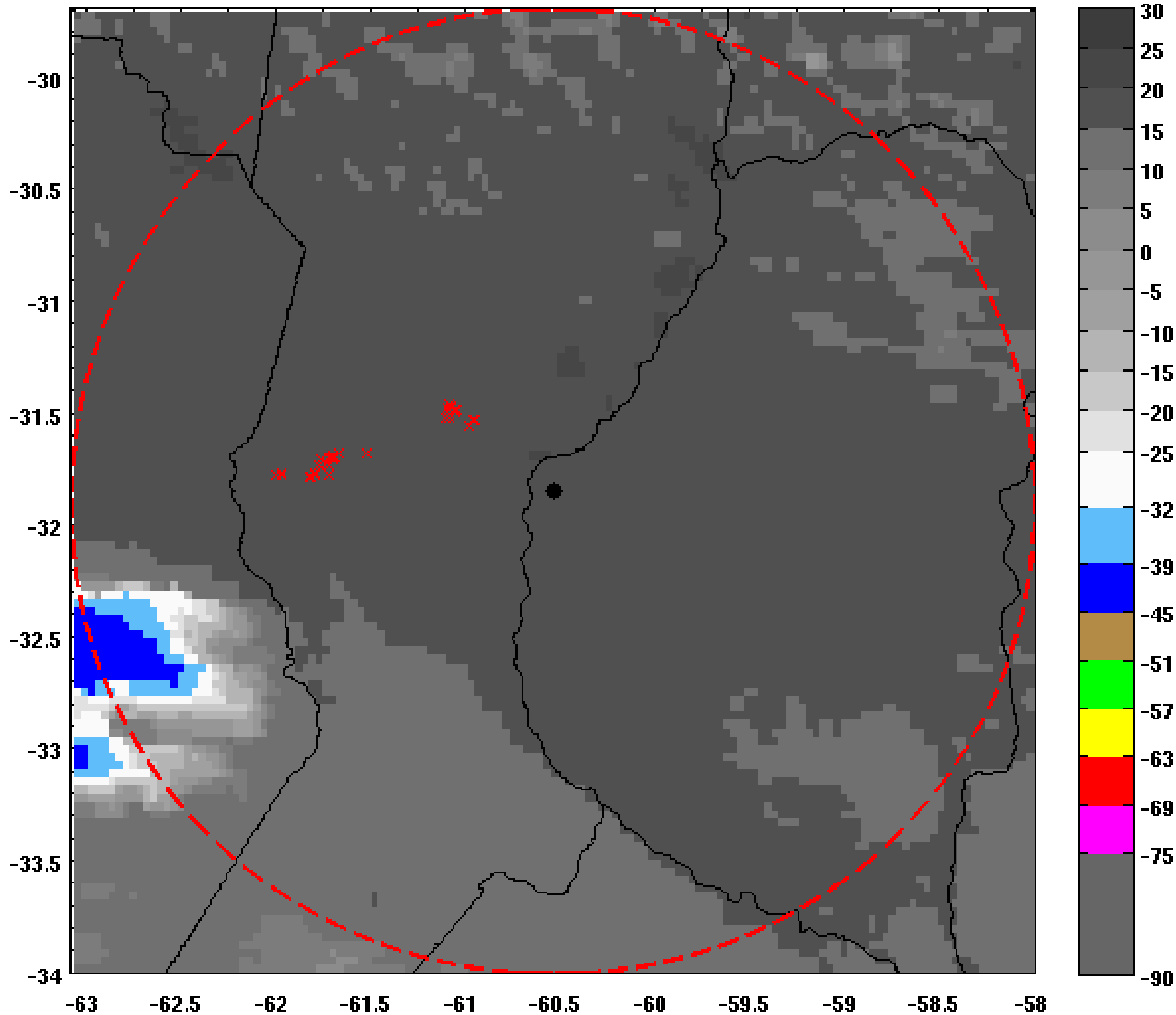

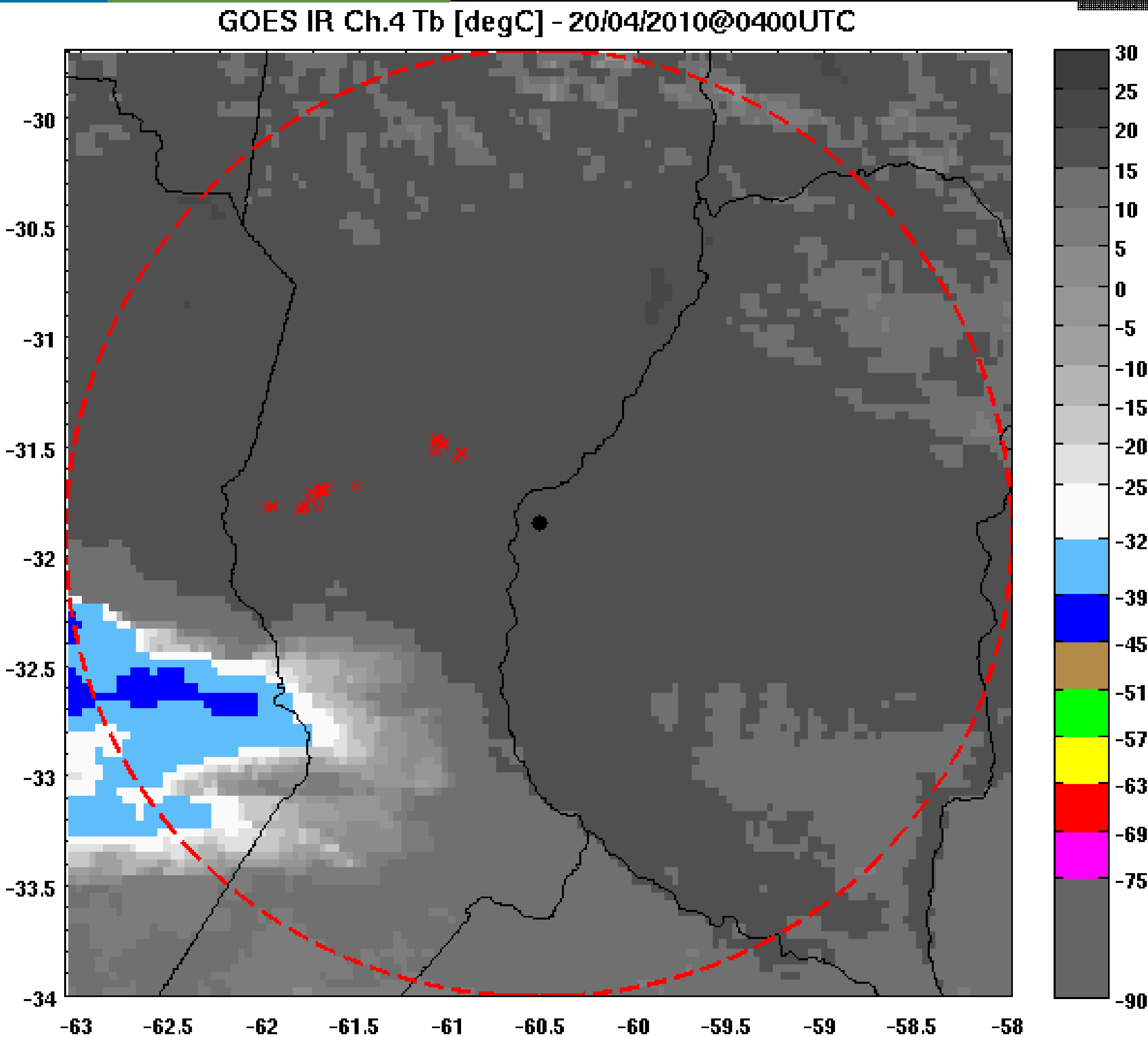
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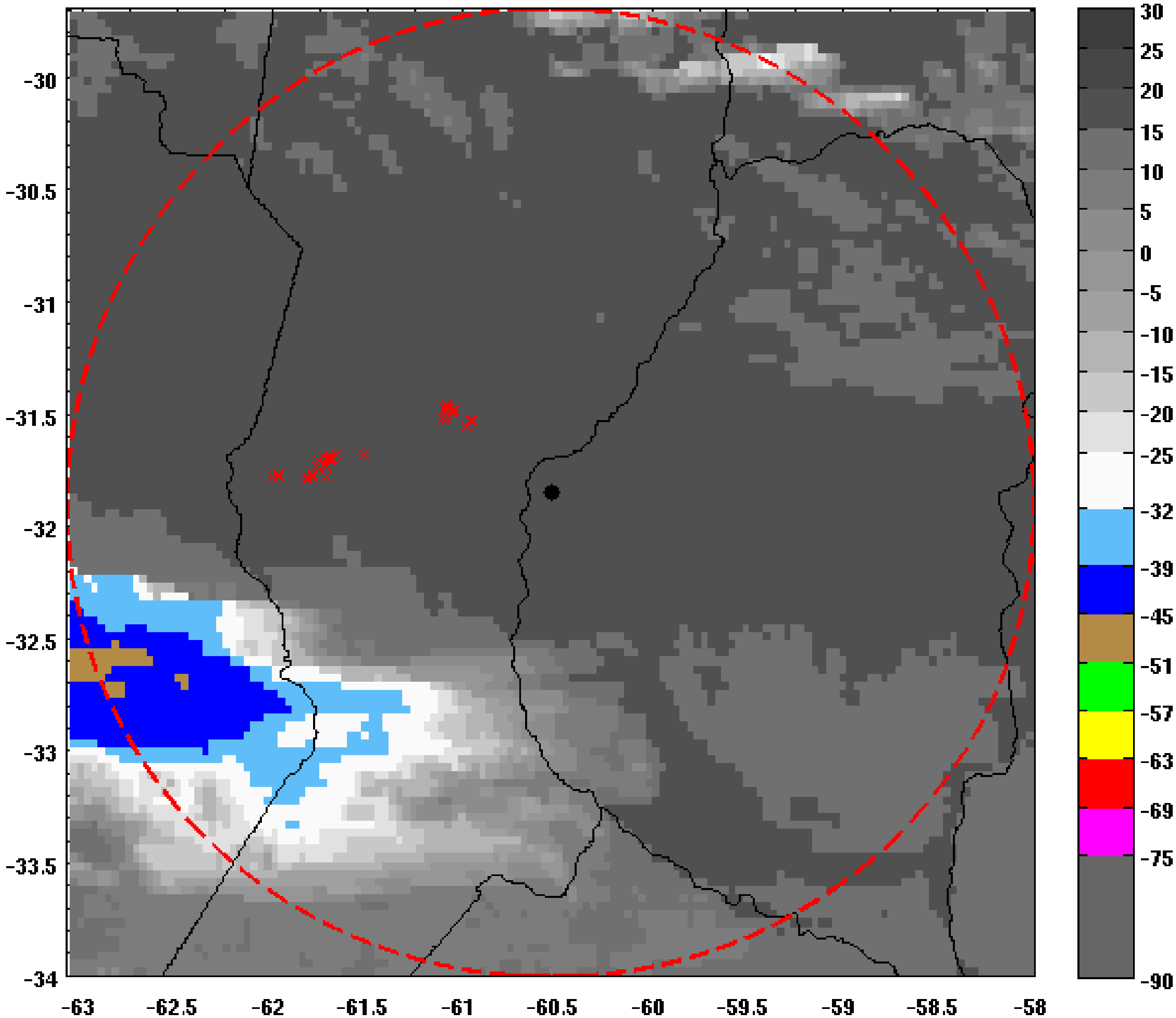

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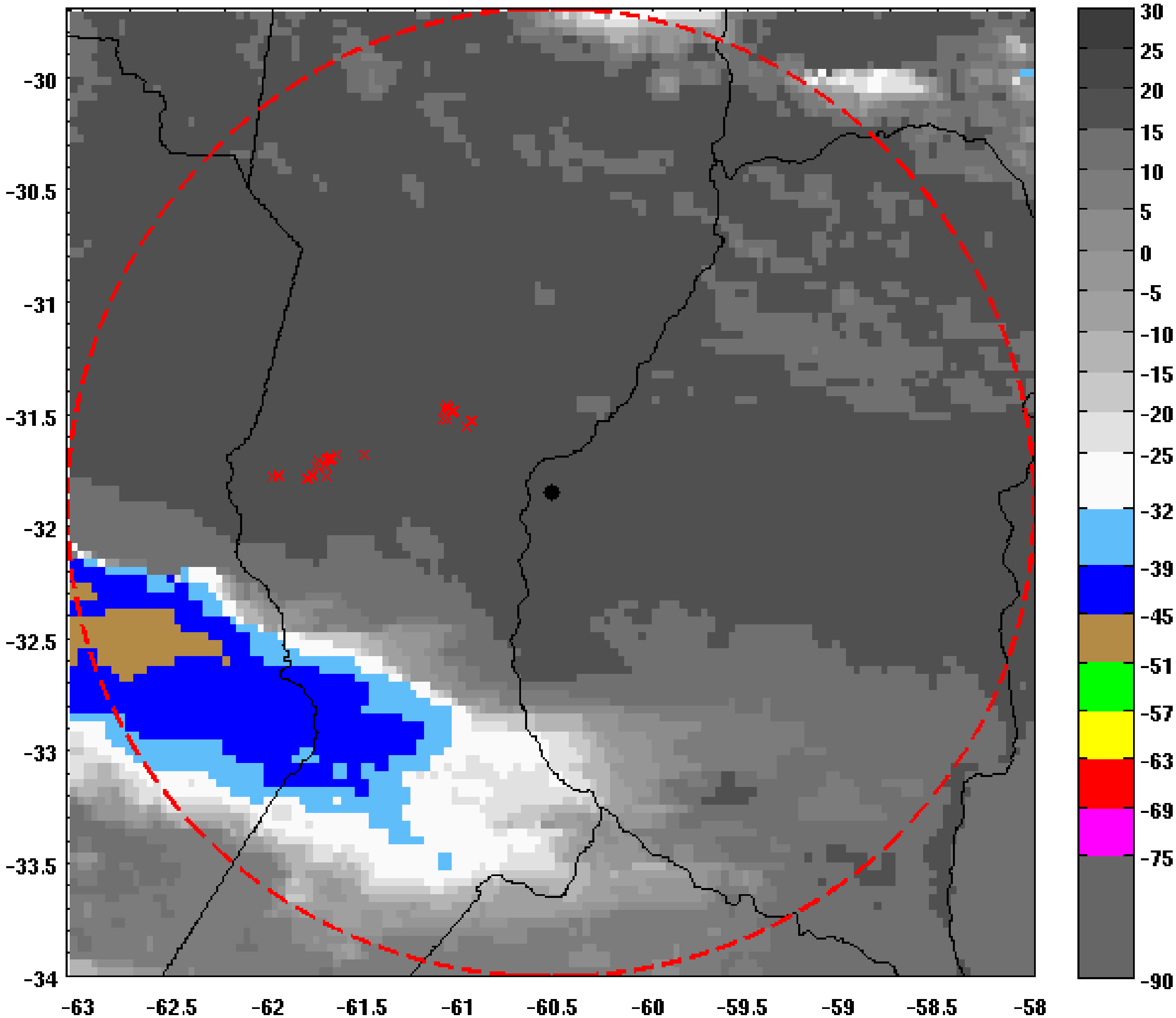

Case studies

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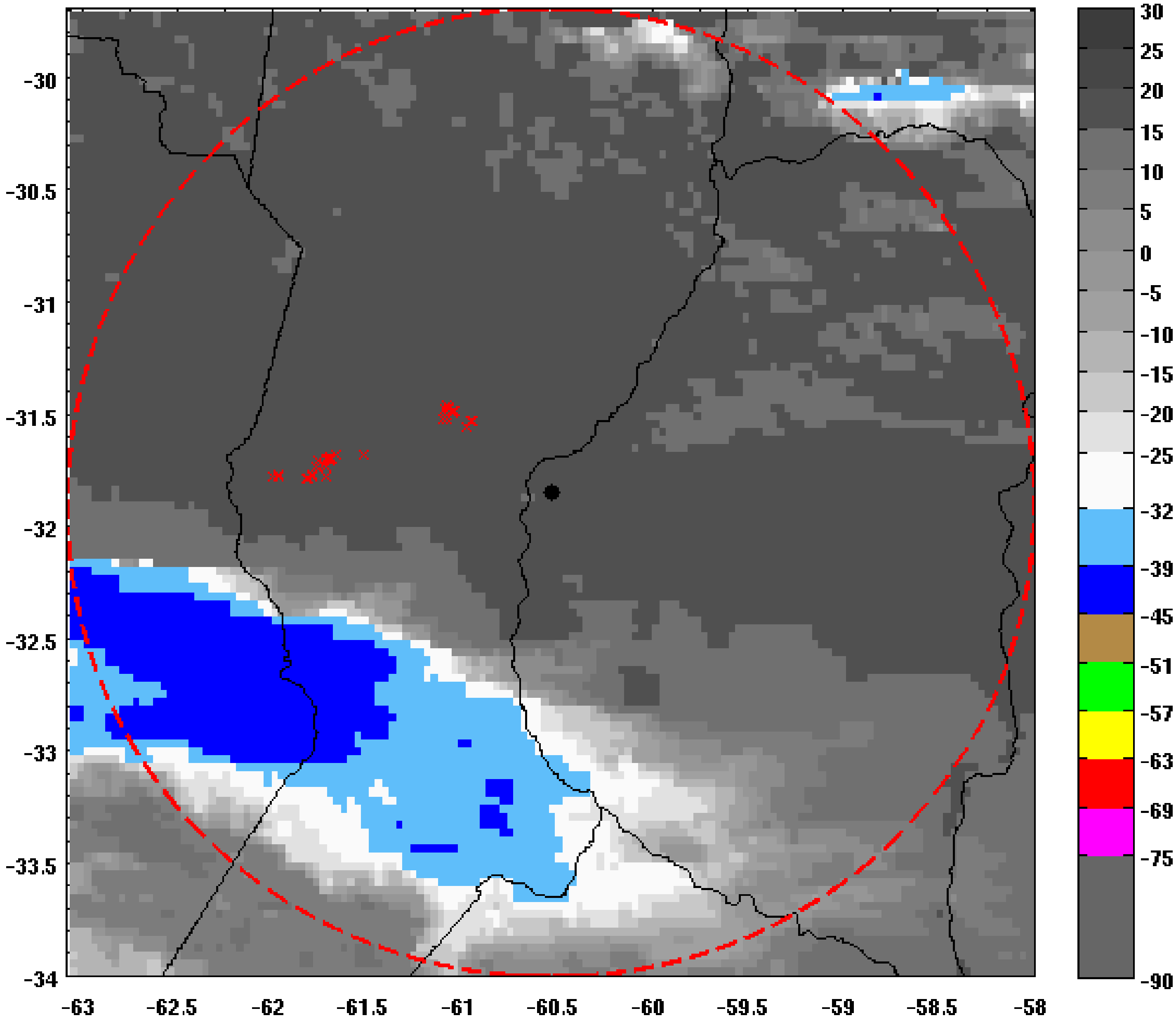

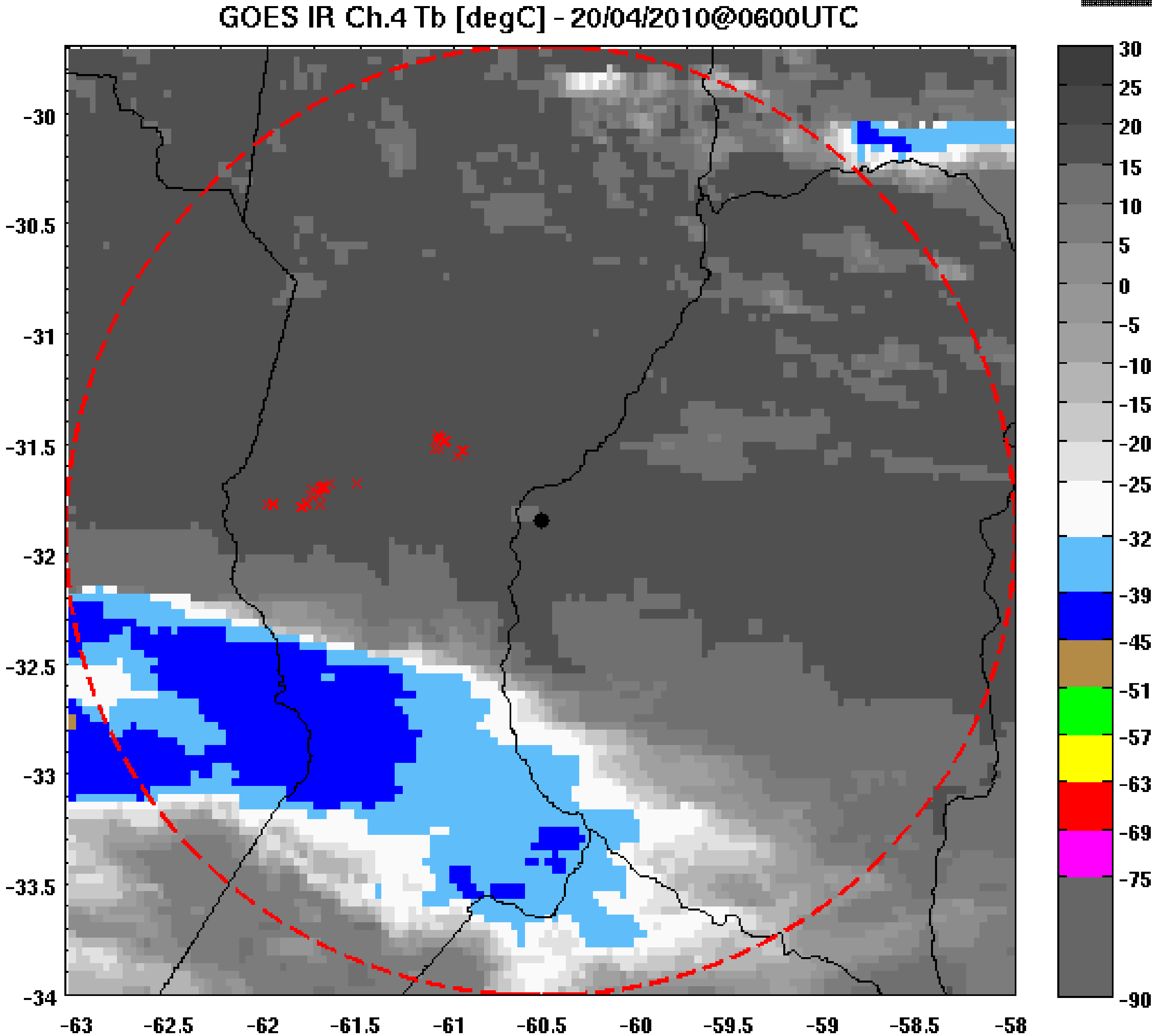
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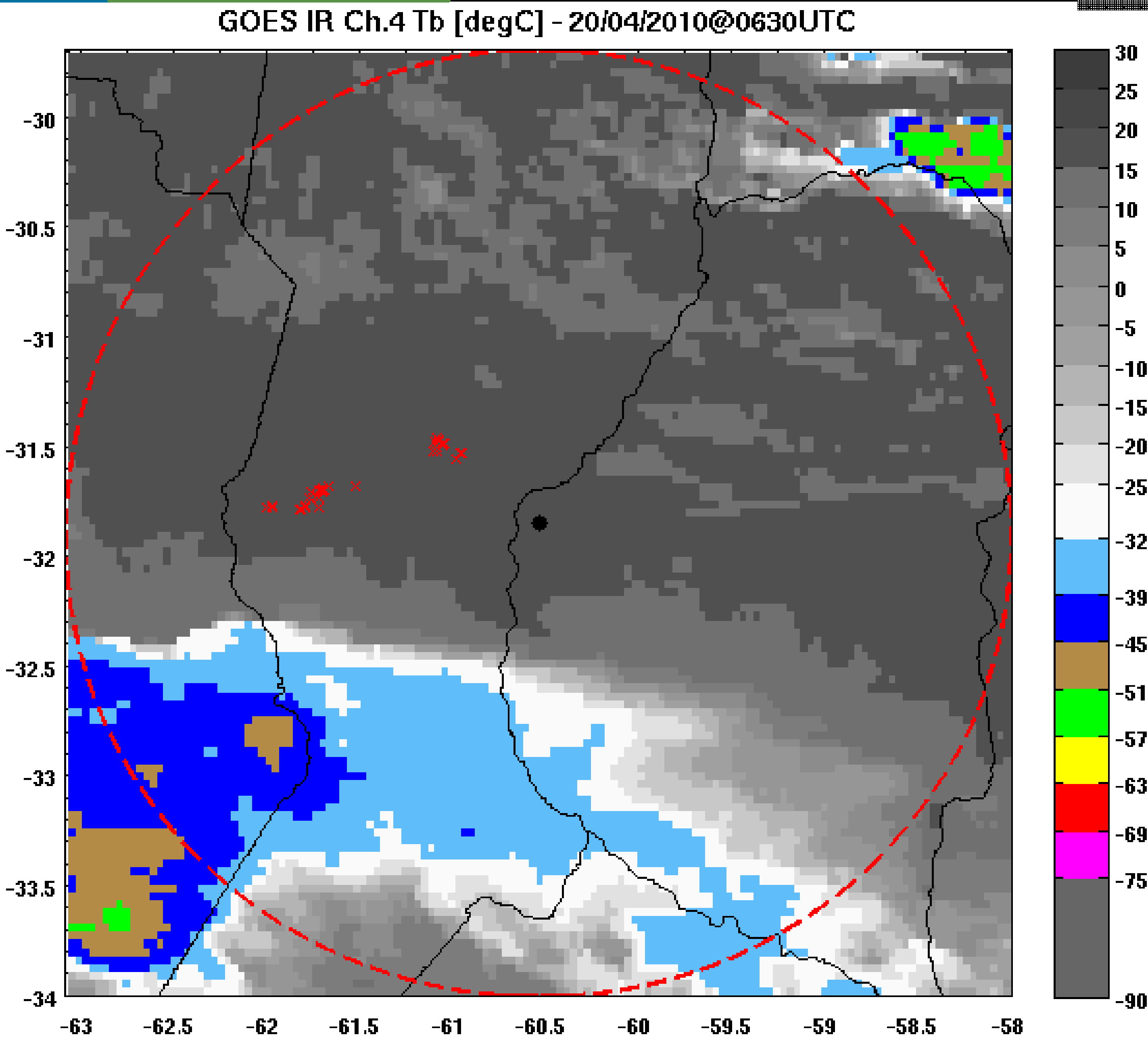
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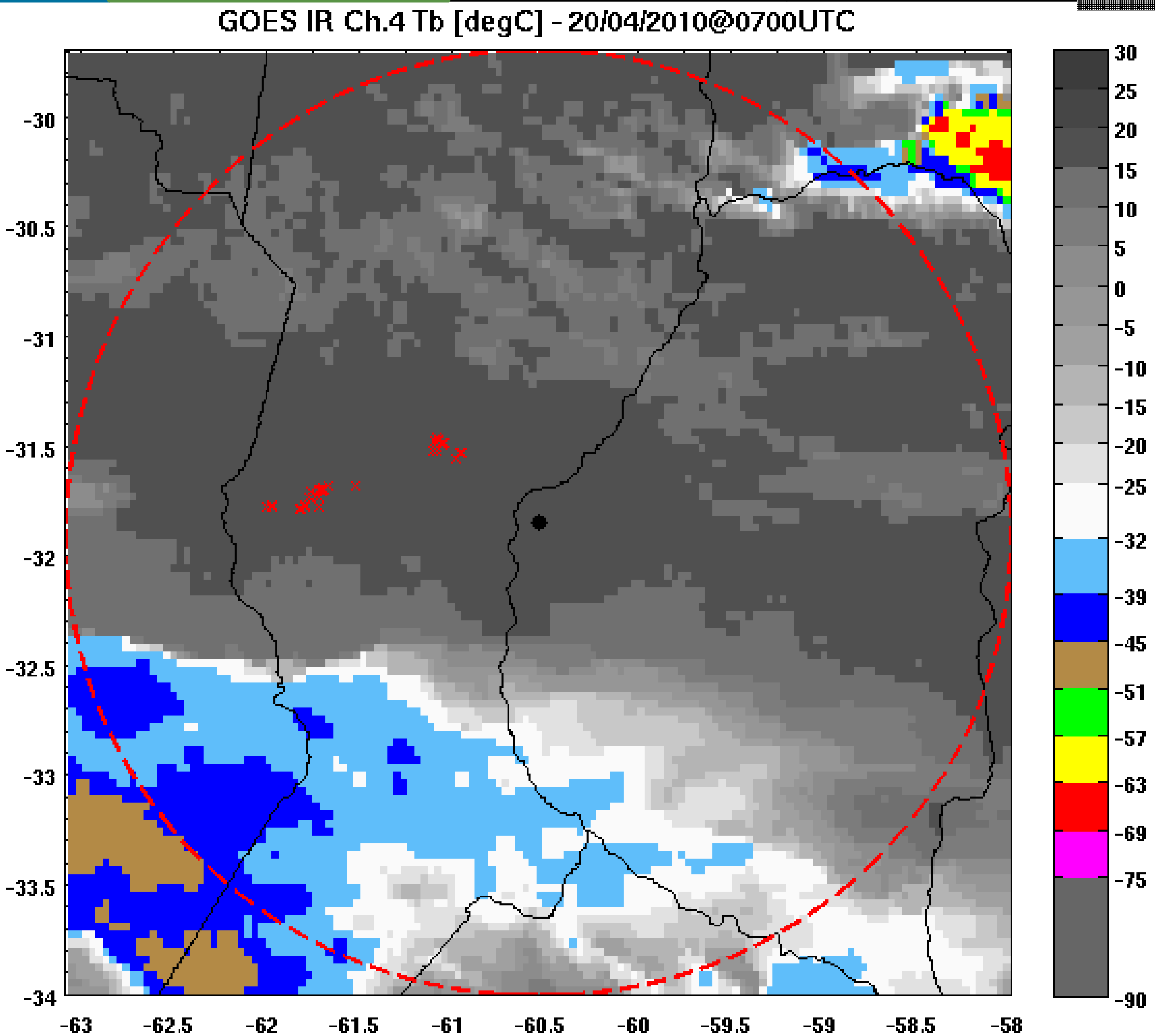
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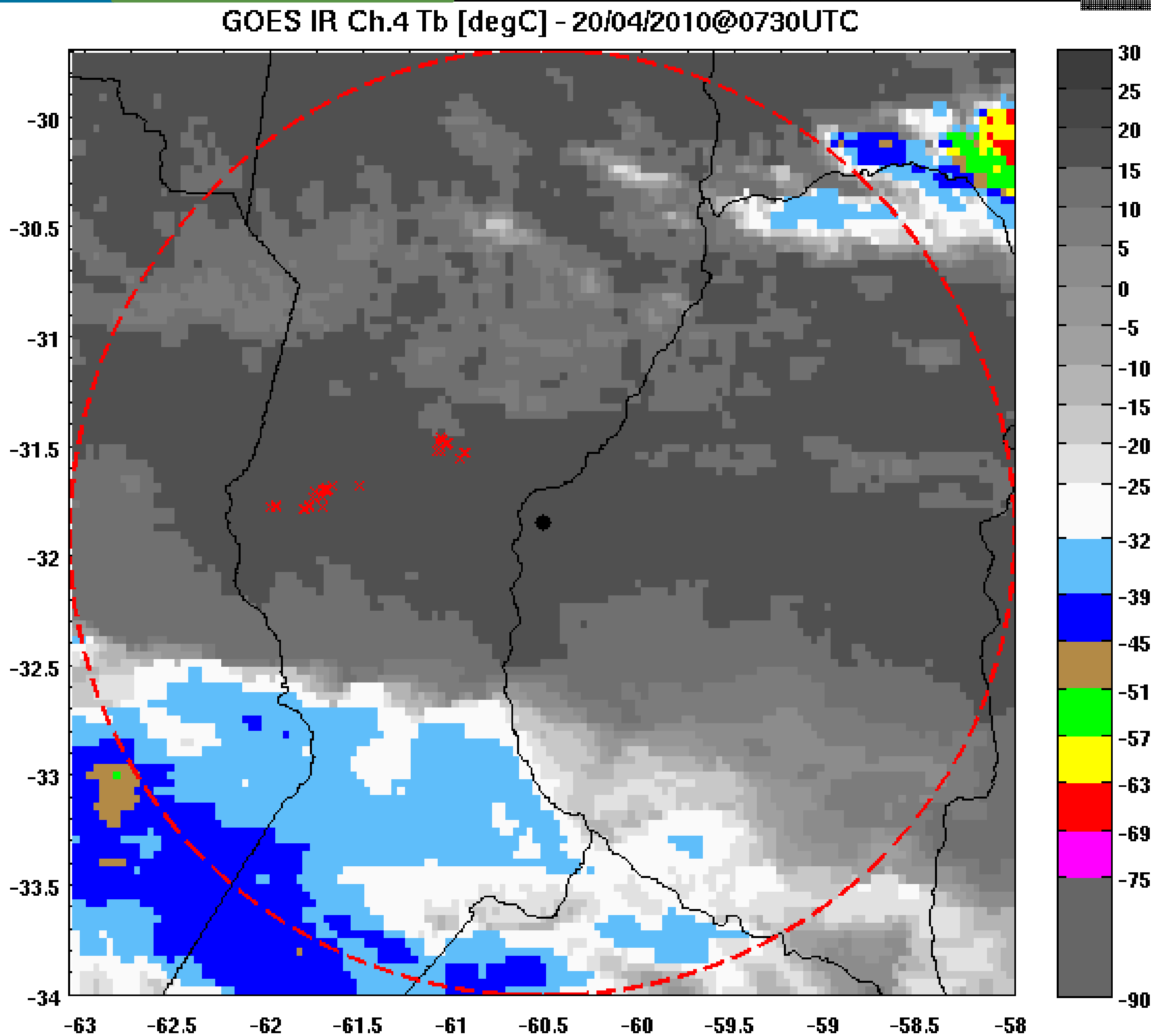
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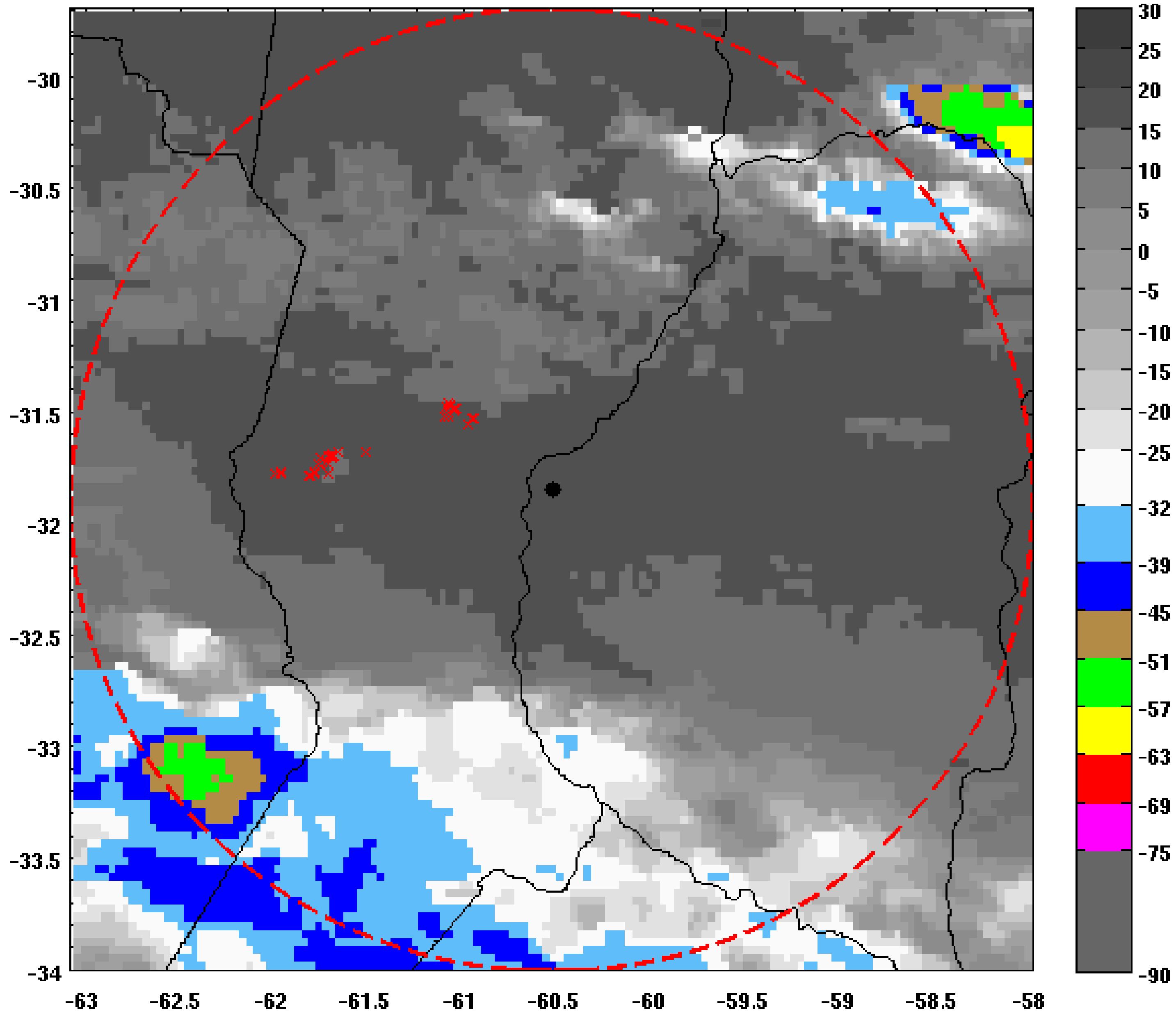

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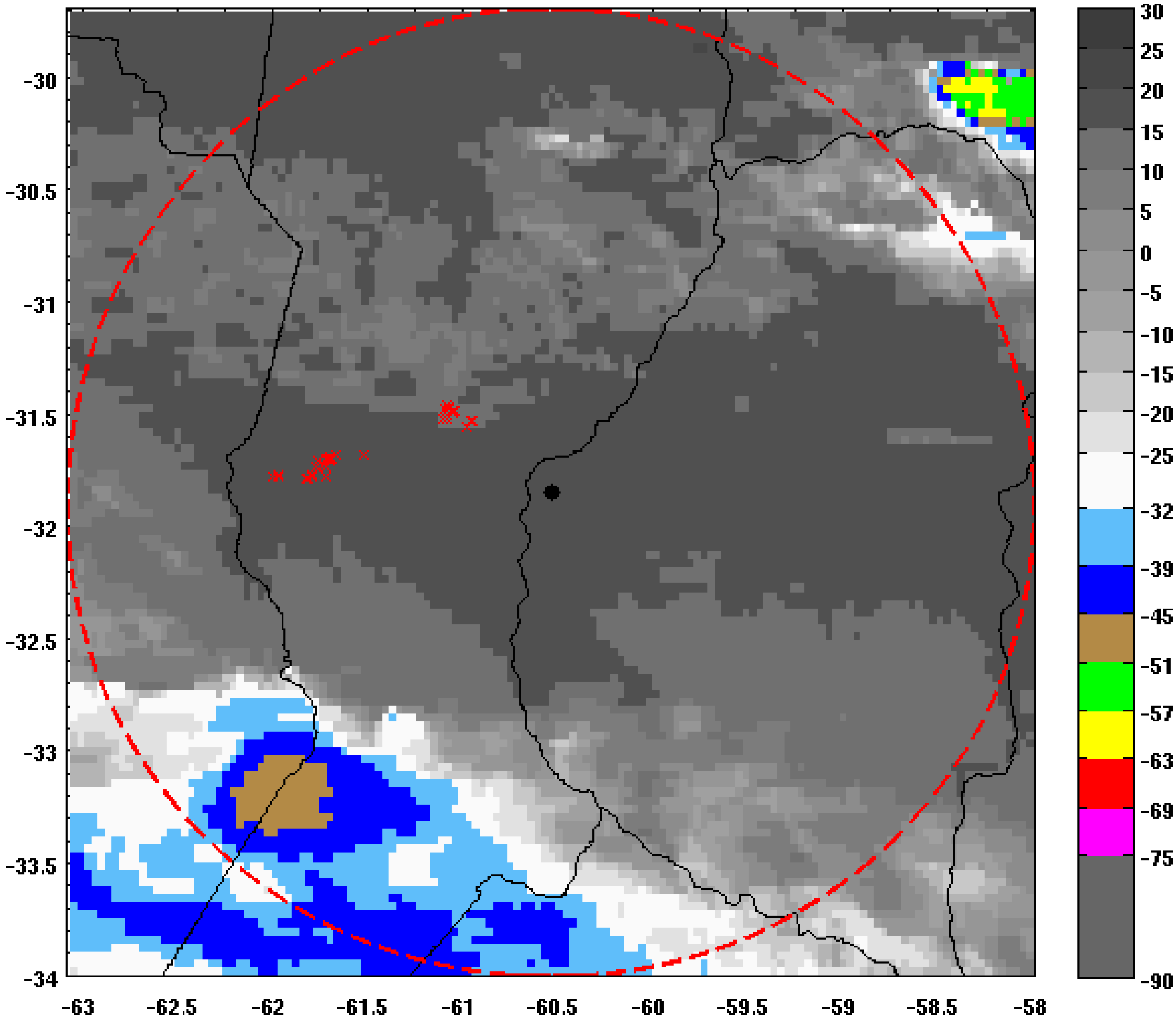

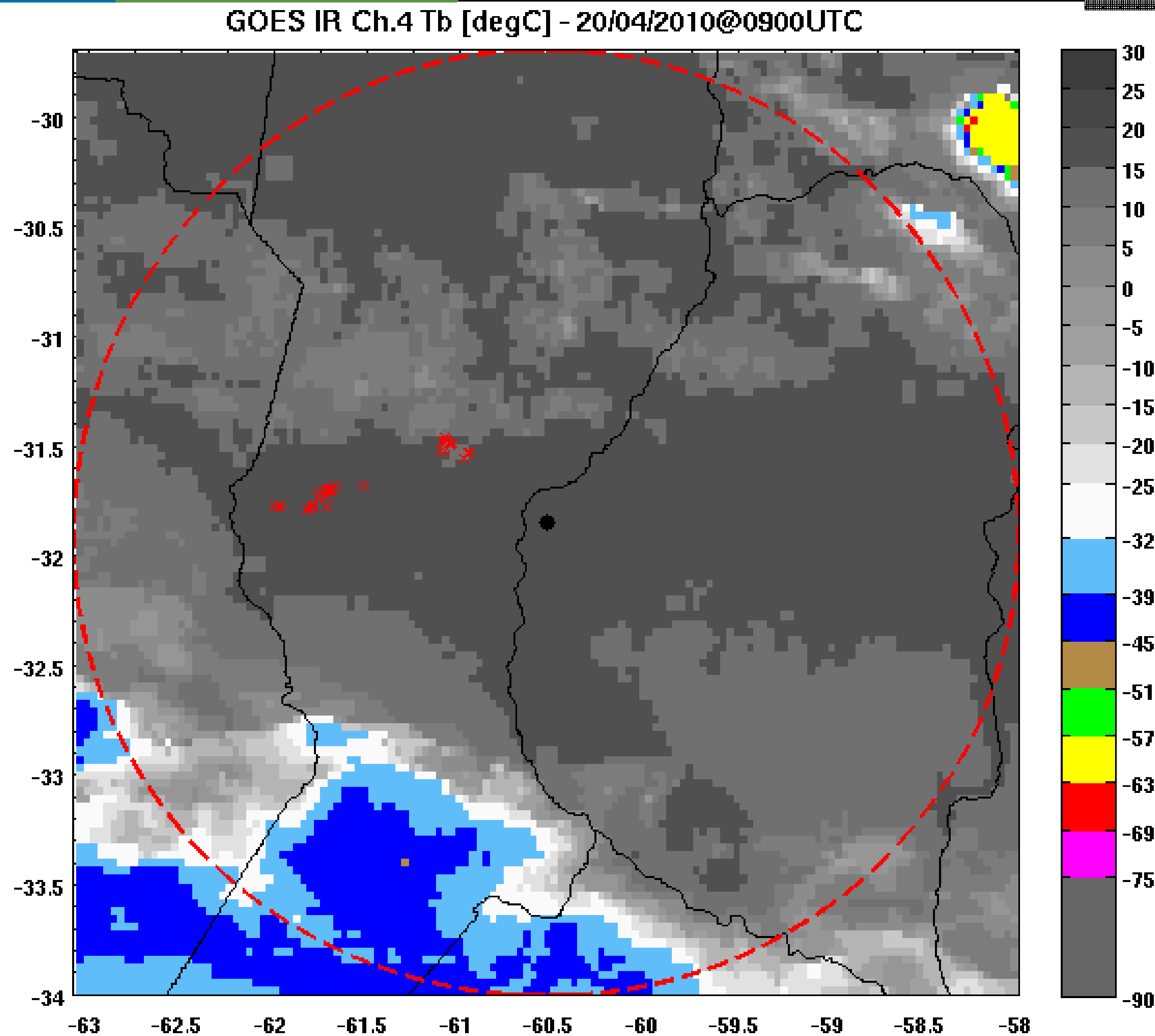
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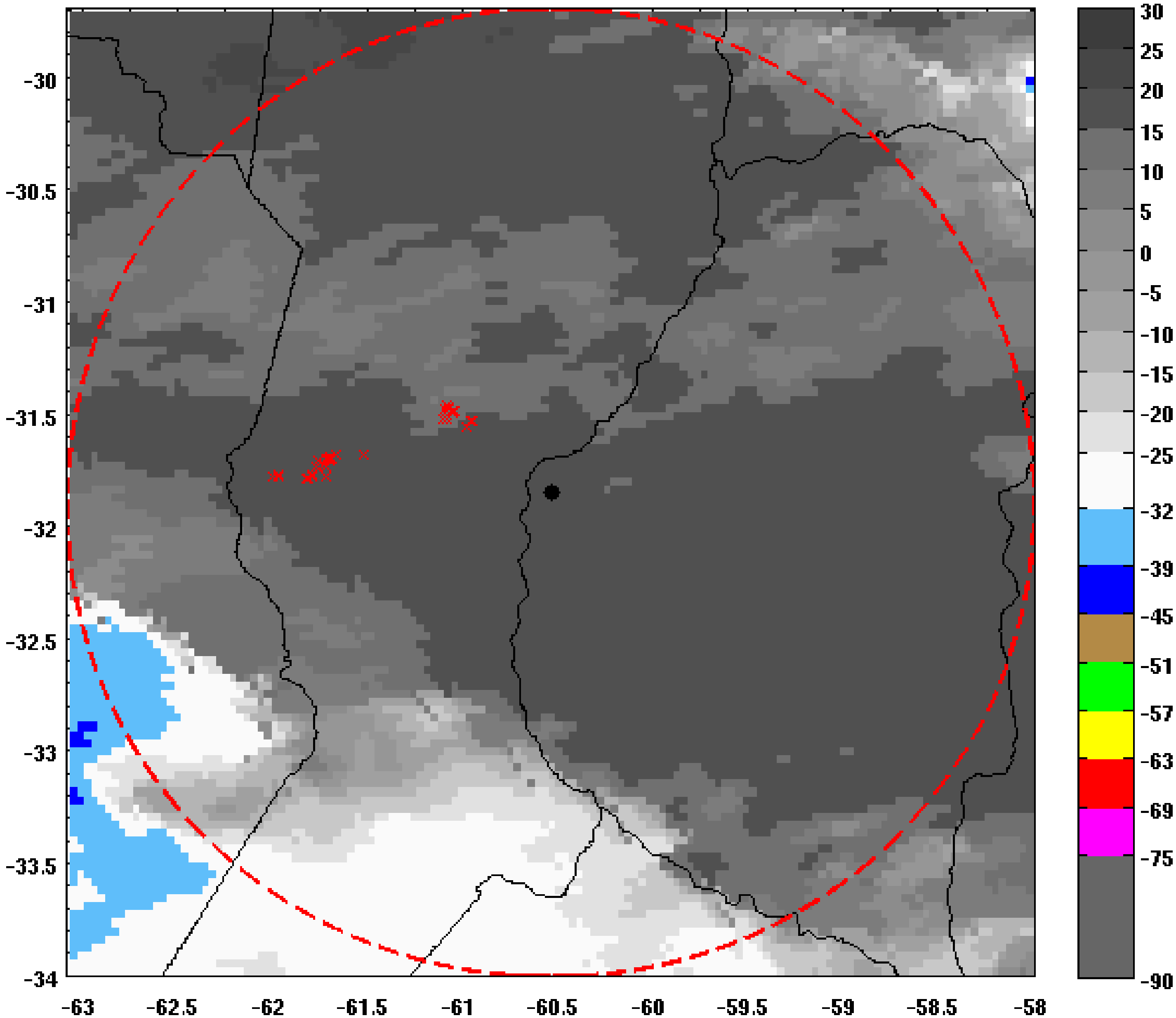
GOES IR Ch.4 Tb [degC] - 20/04/2010@0930UTC



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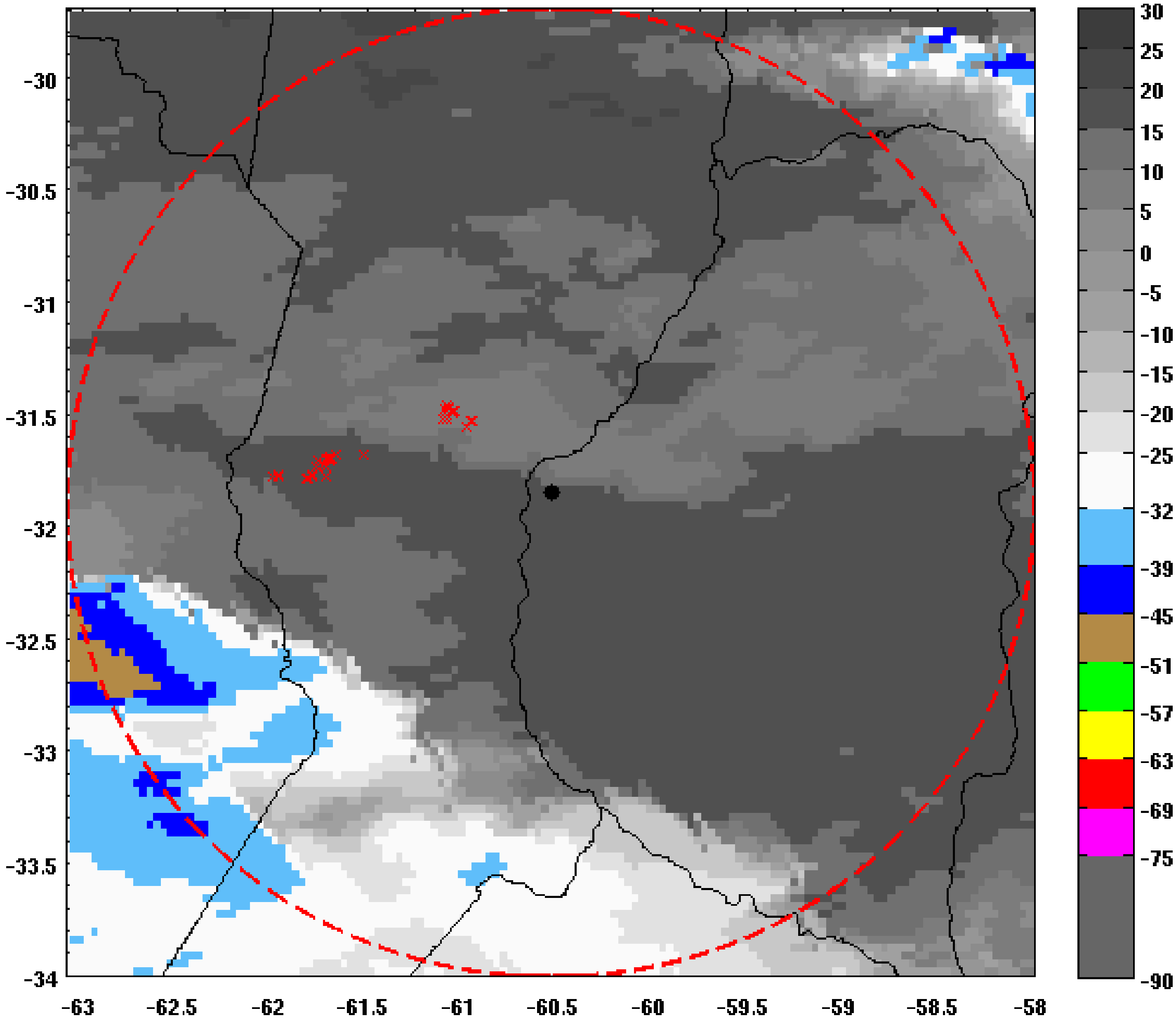

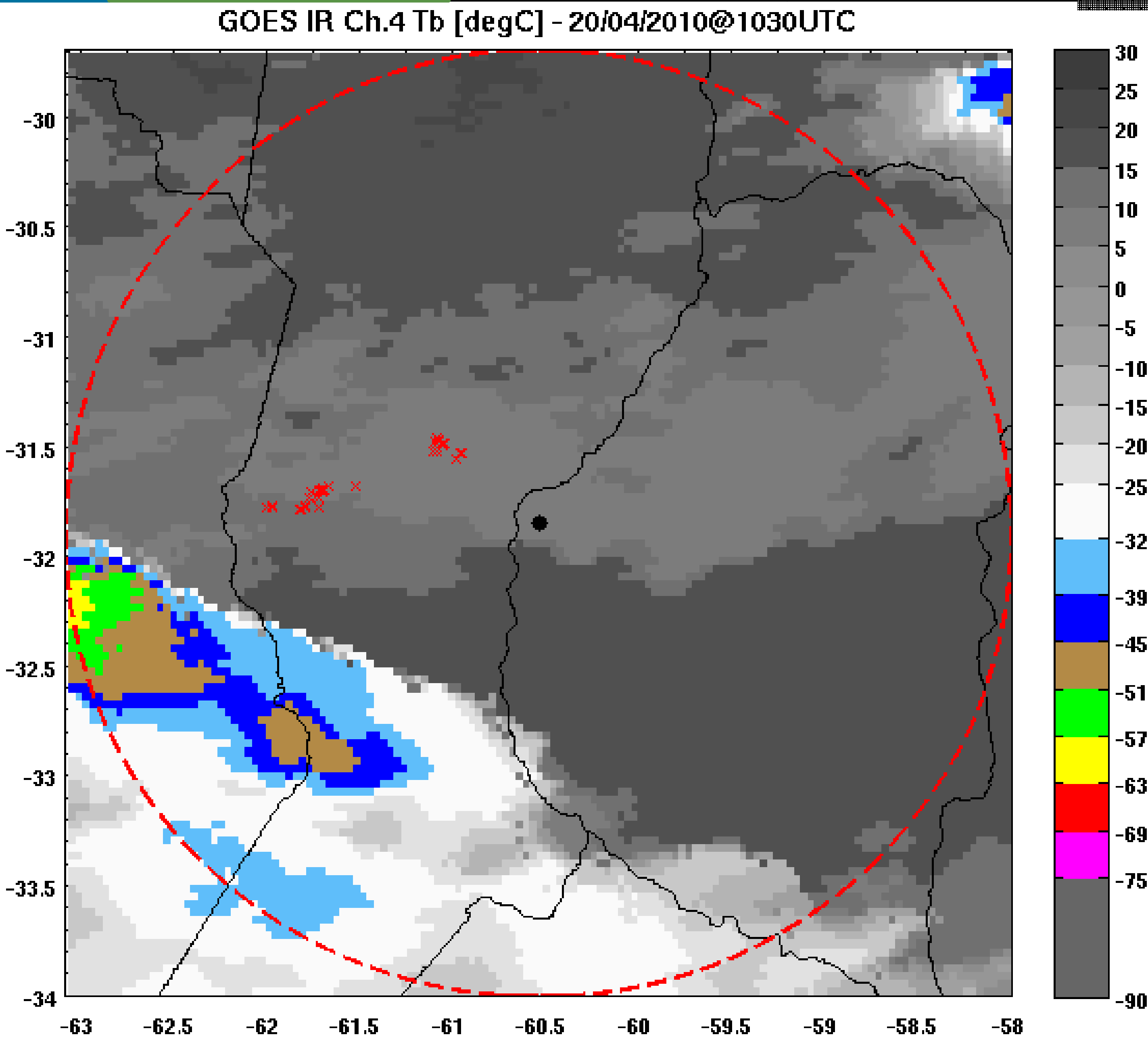
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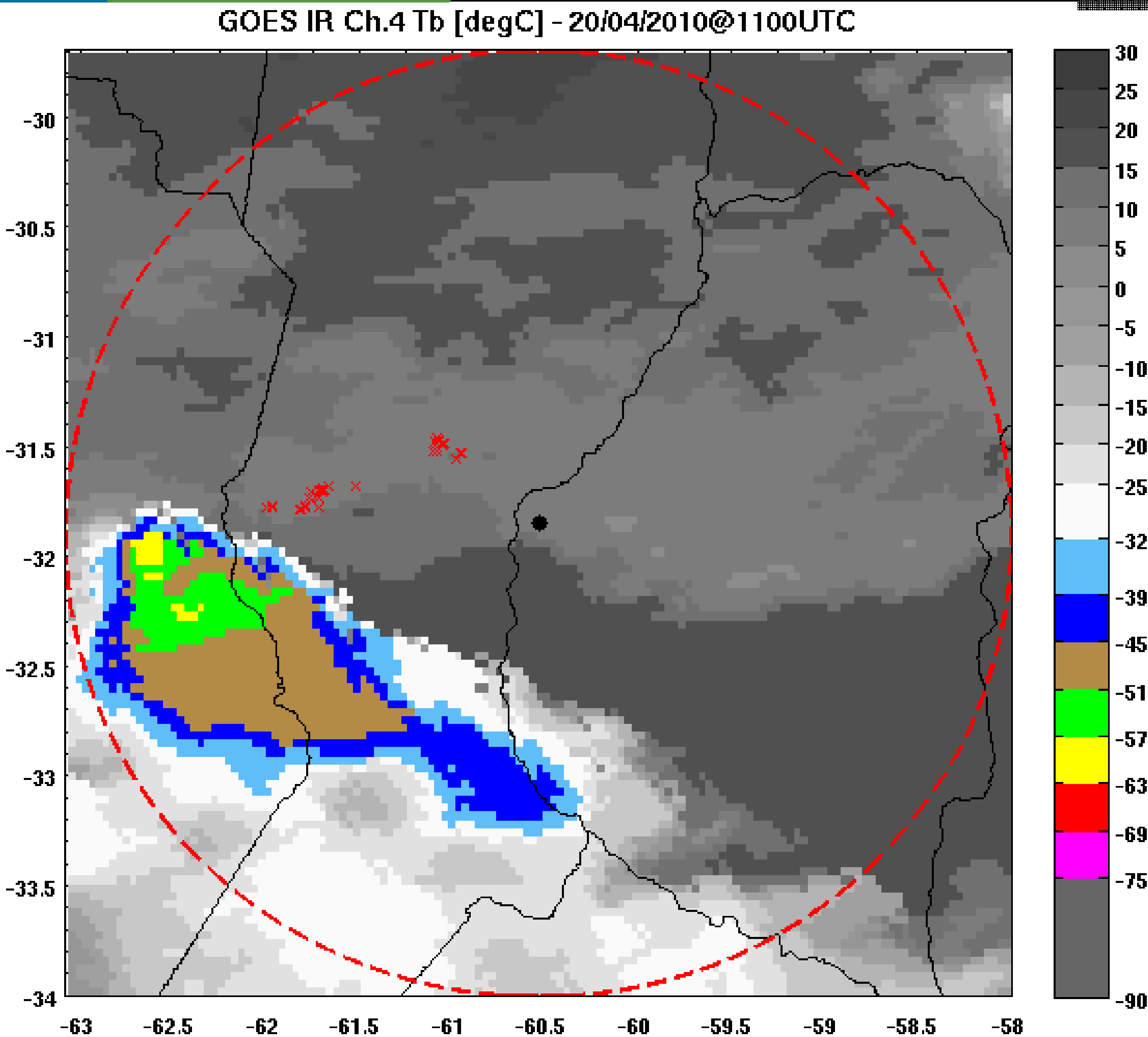
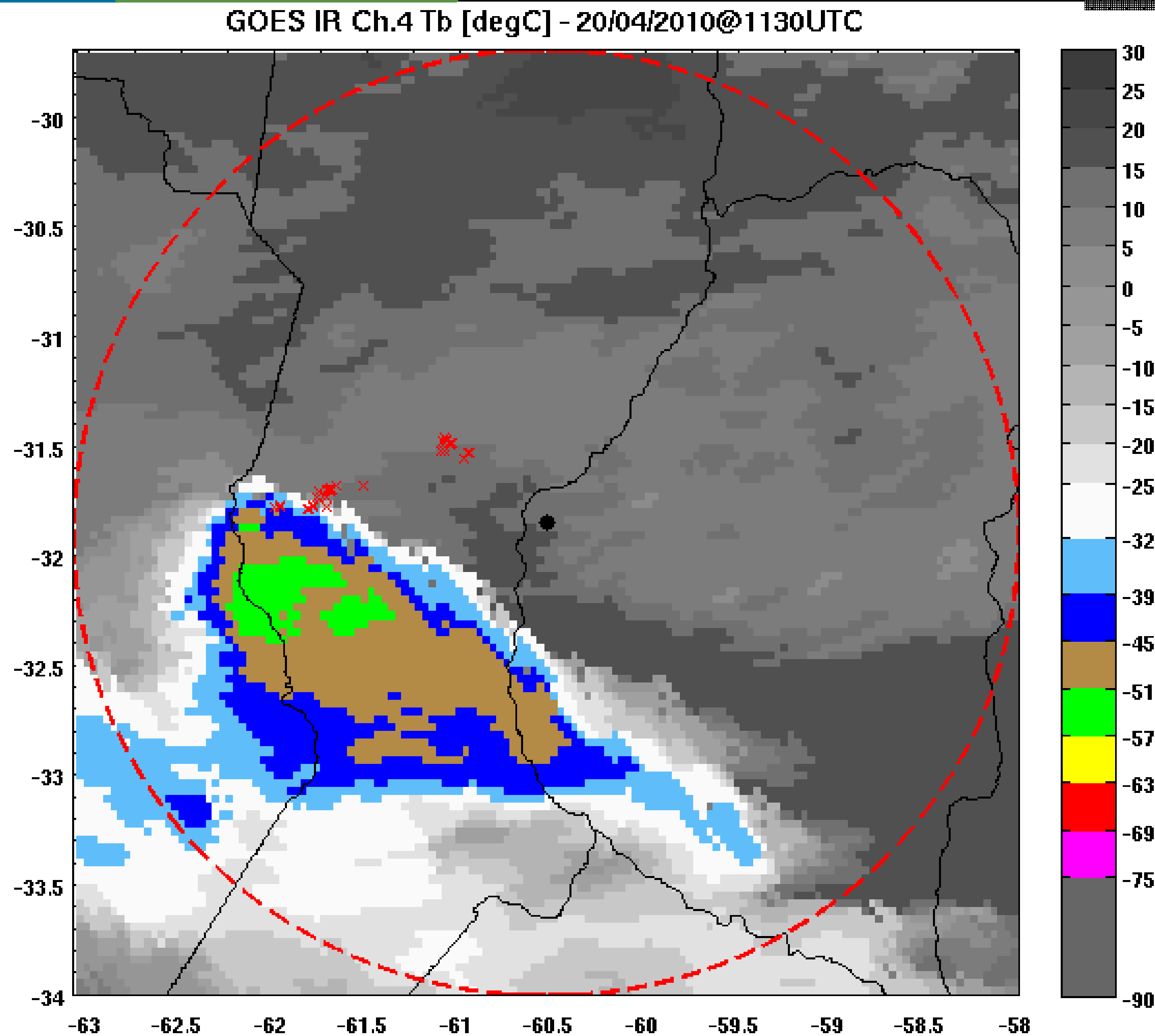
Case studies

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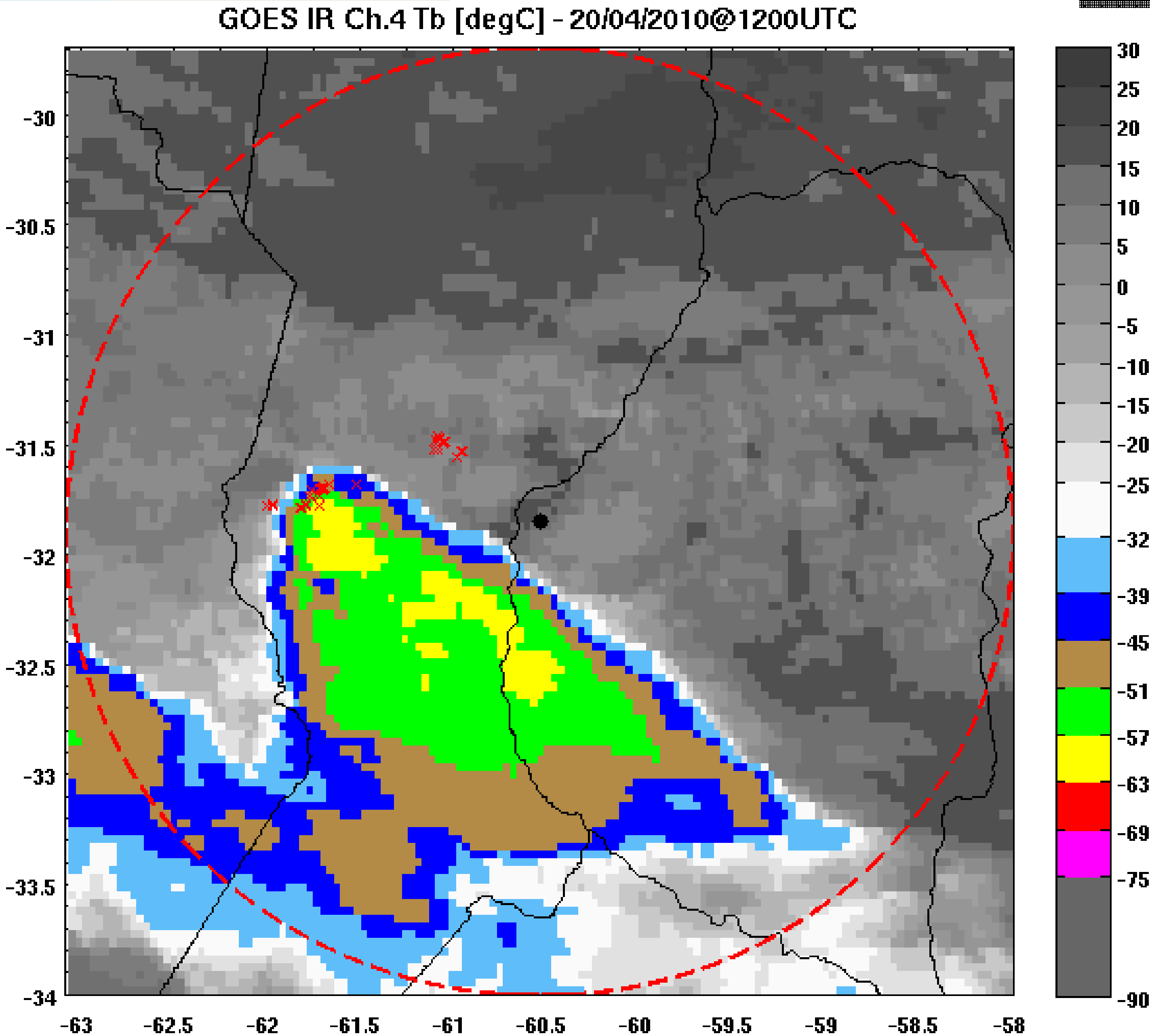
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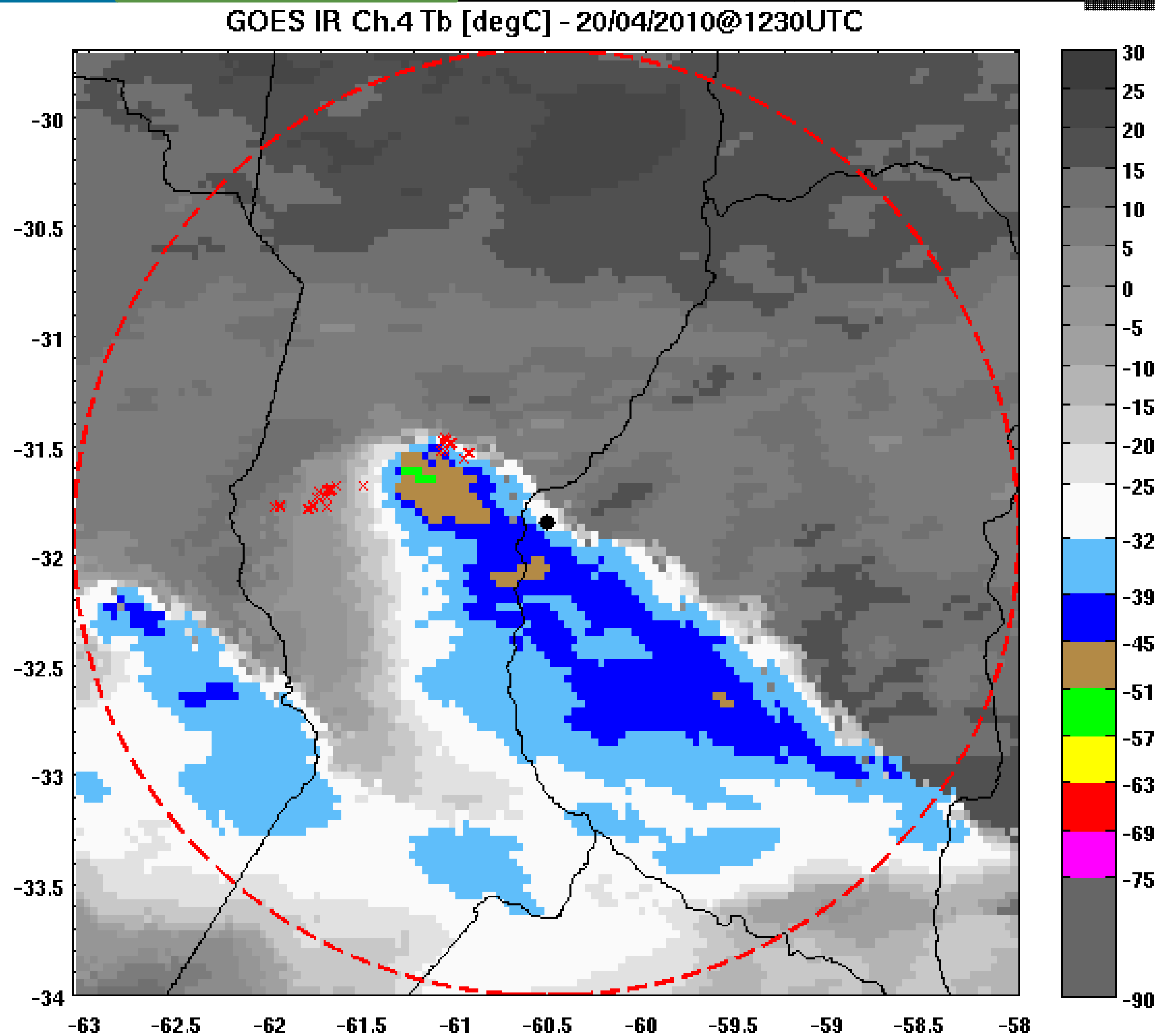
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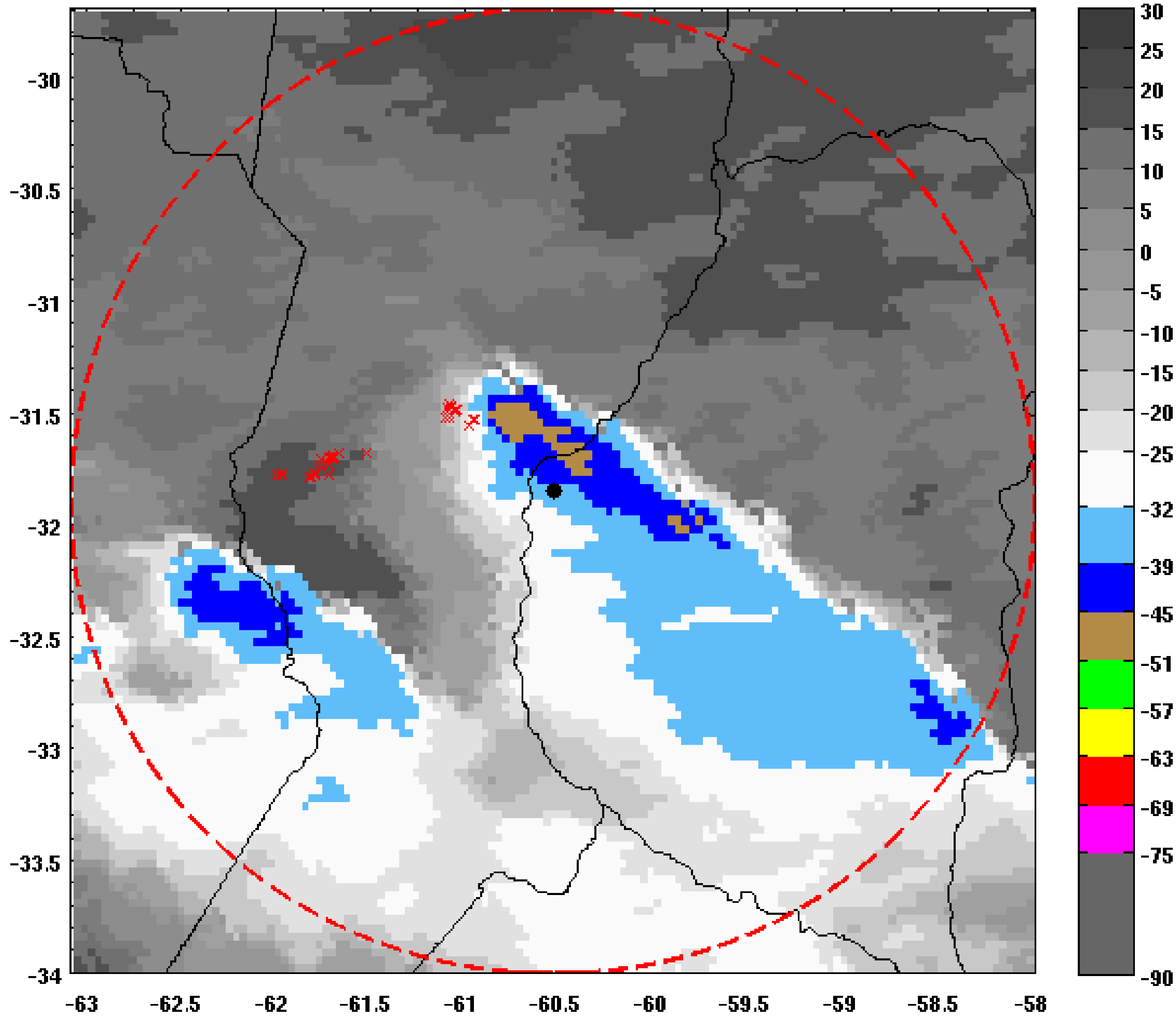
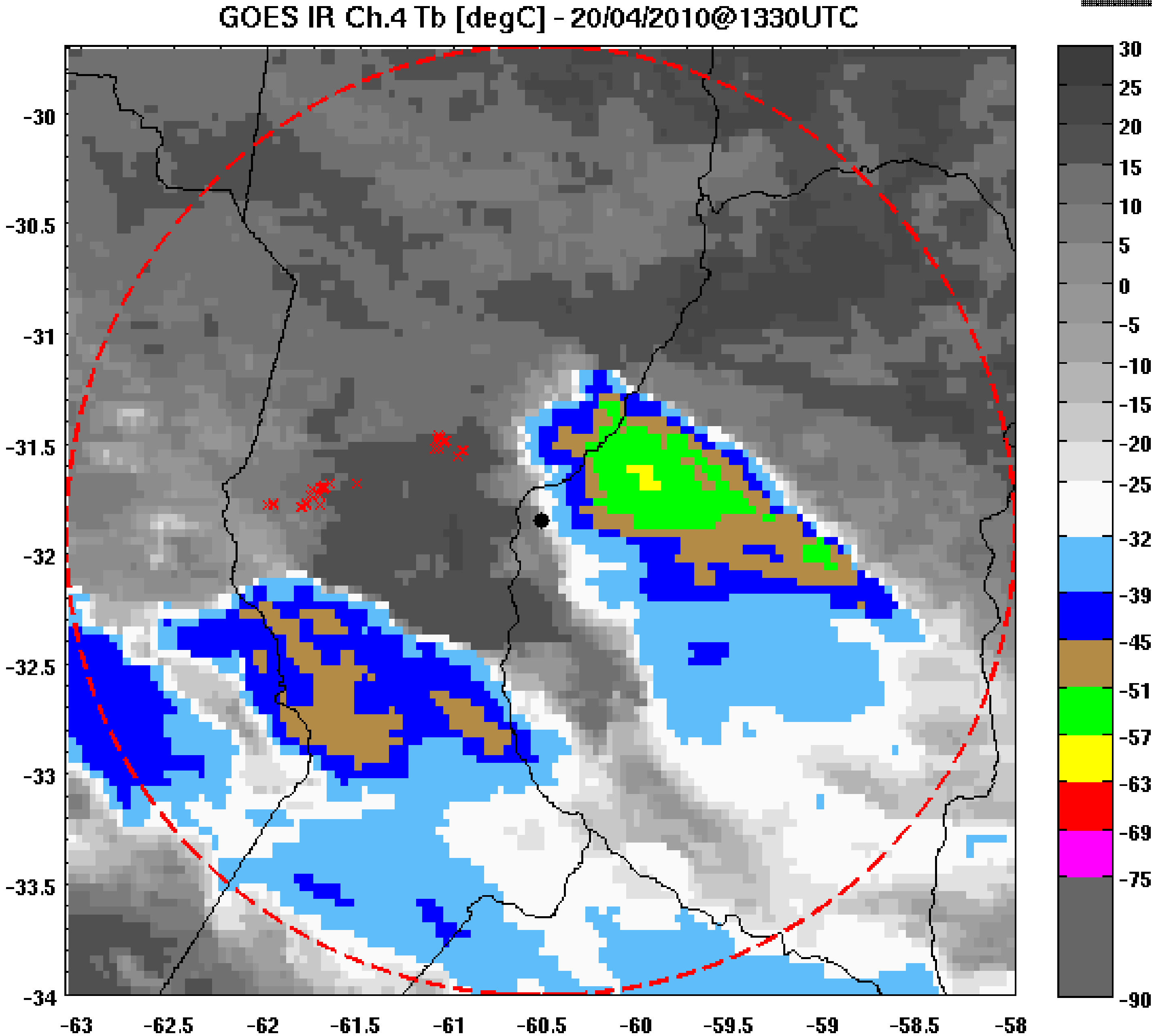
GOES IR Ch.4 Tb [degC] - 20/04/2010@1300UTC

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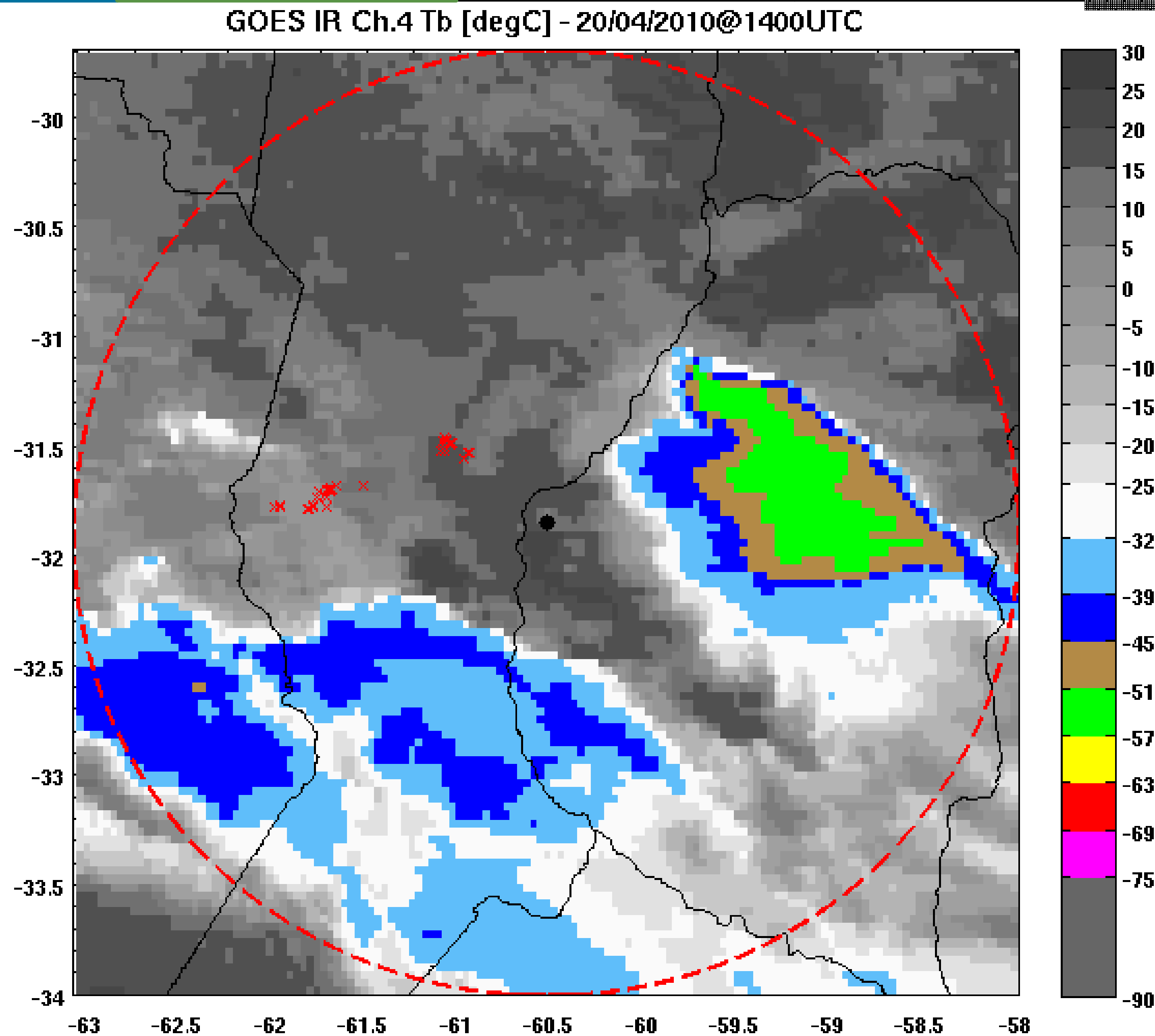
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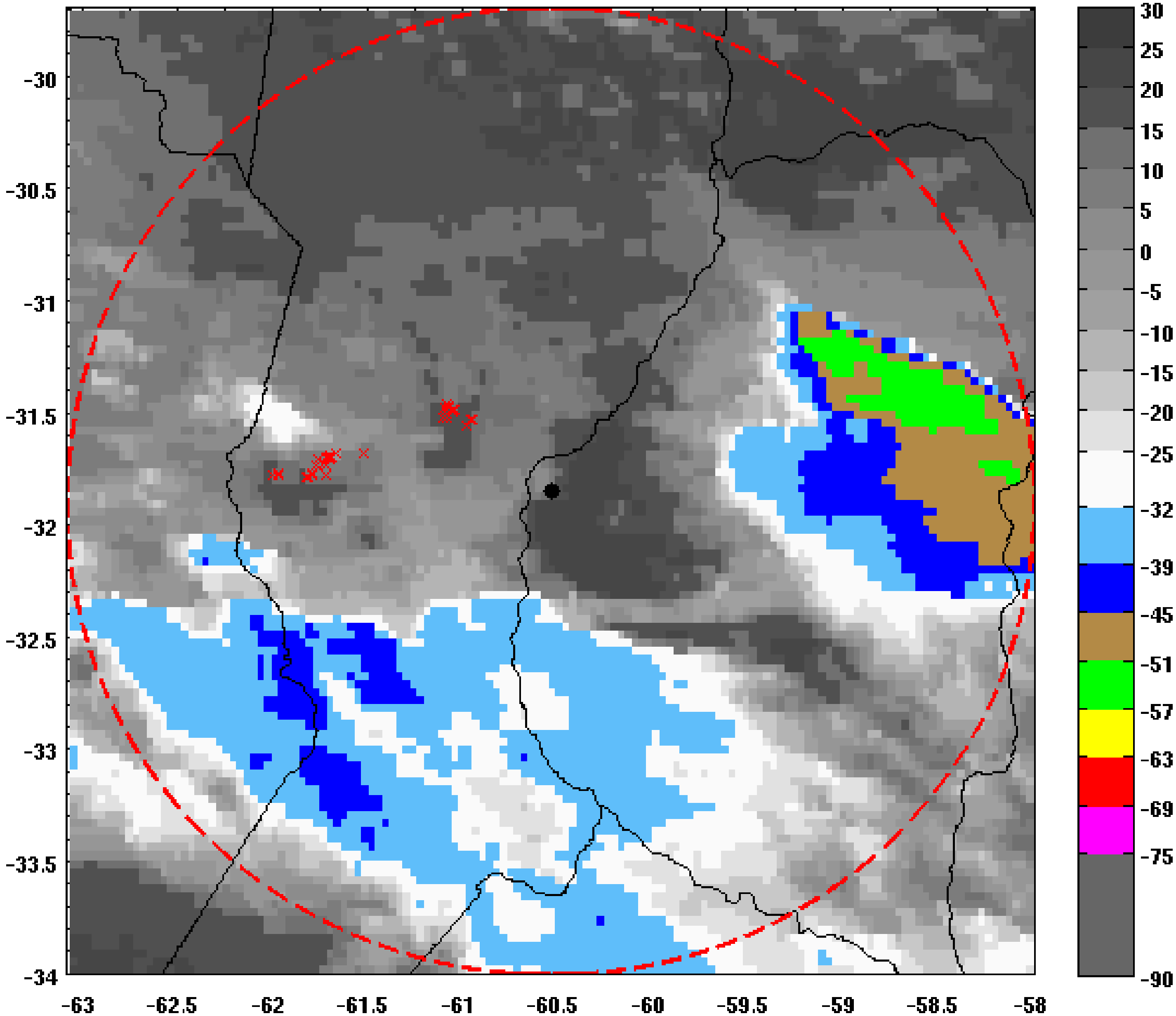

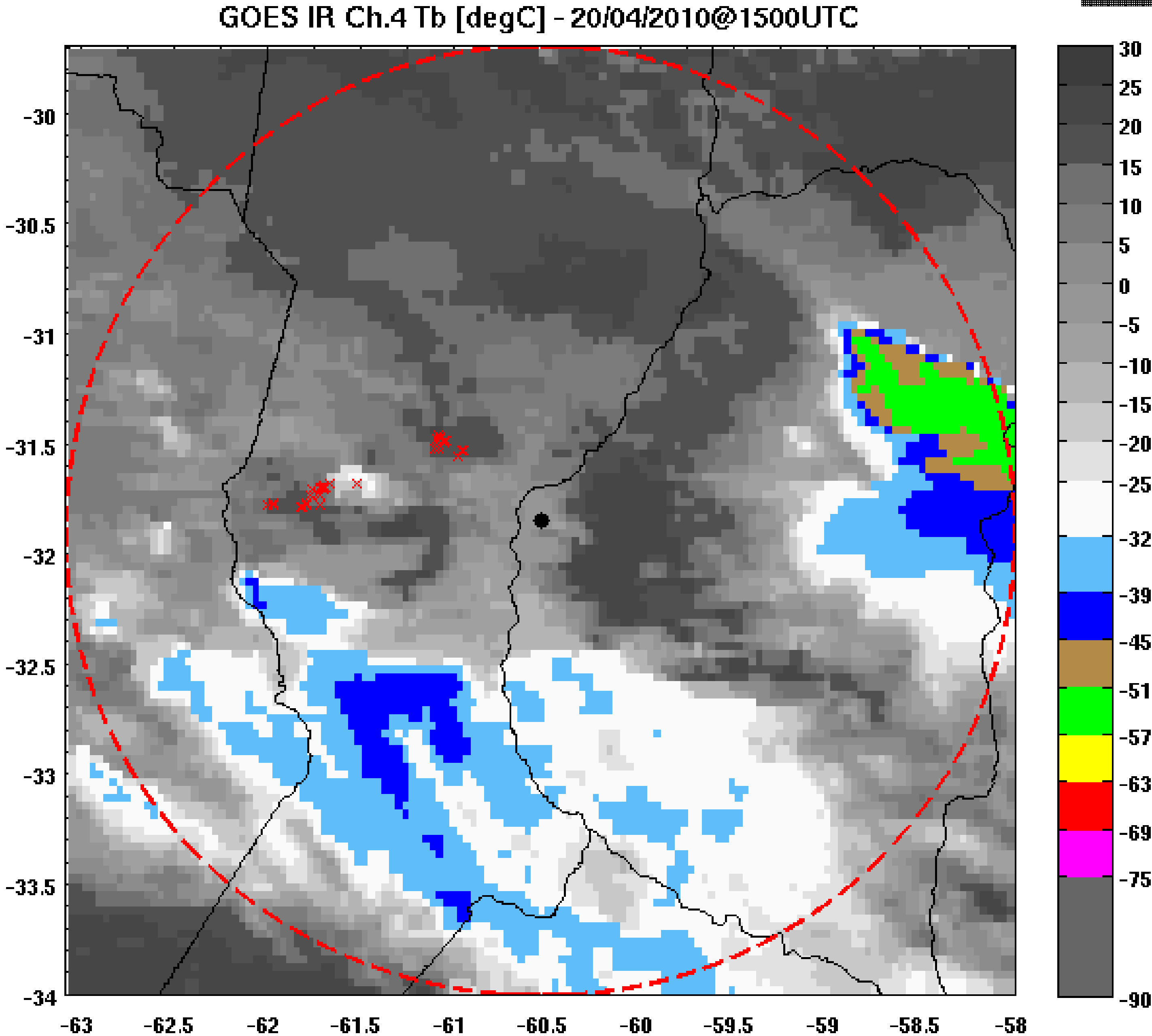
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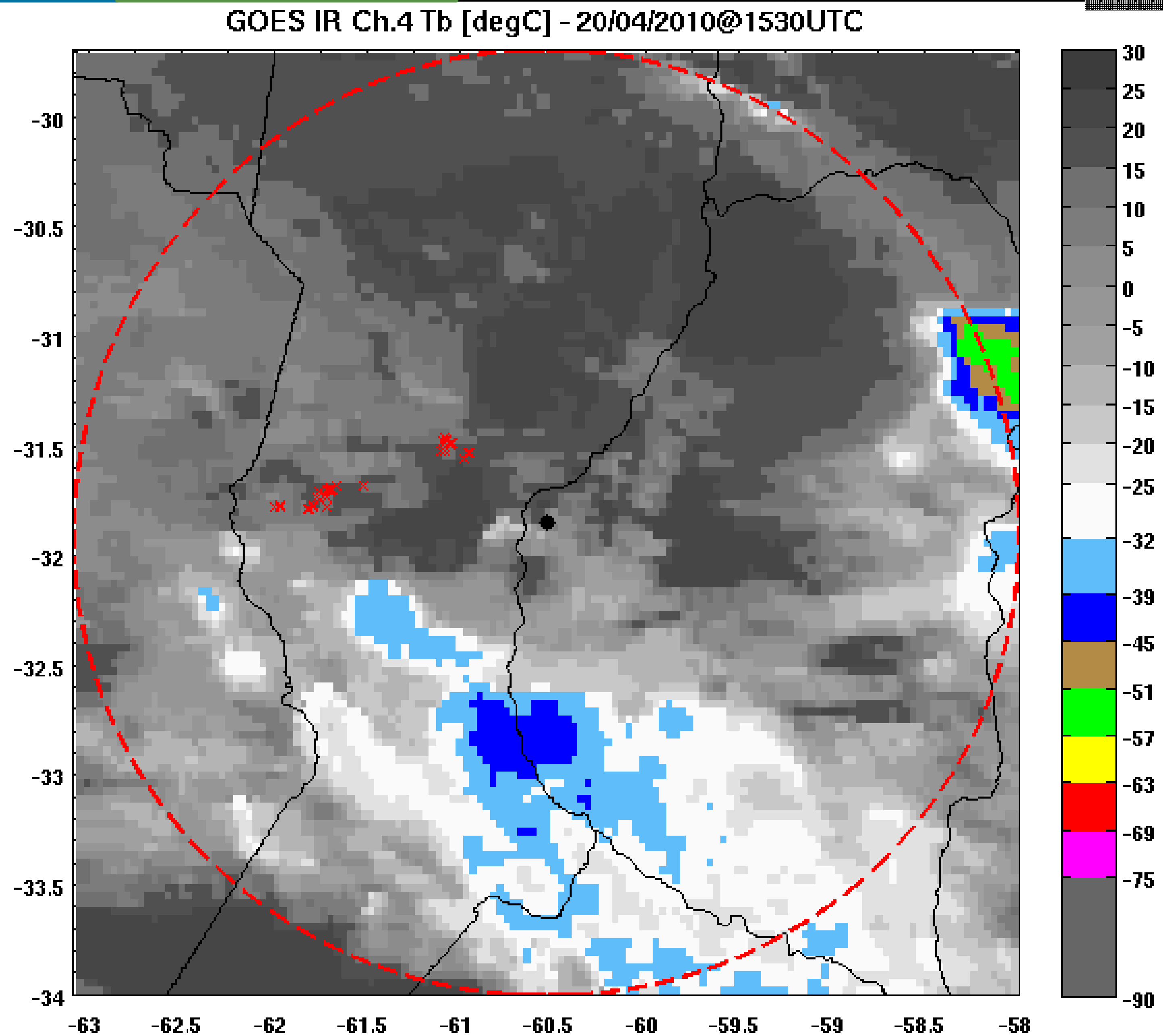
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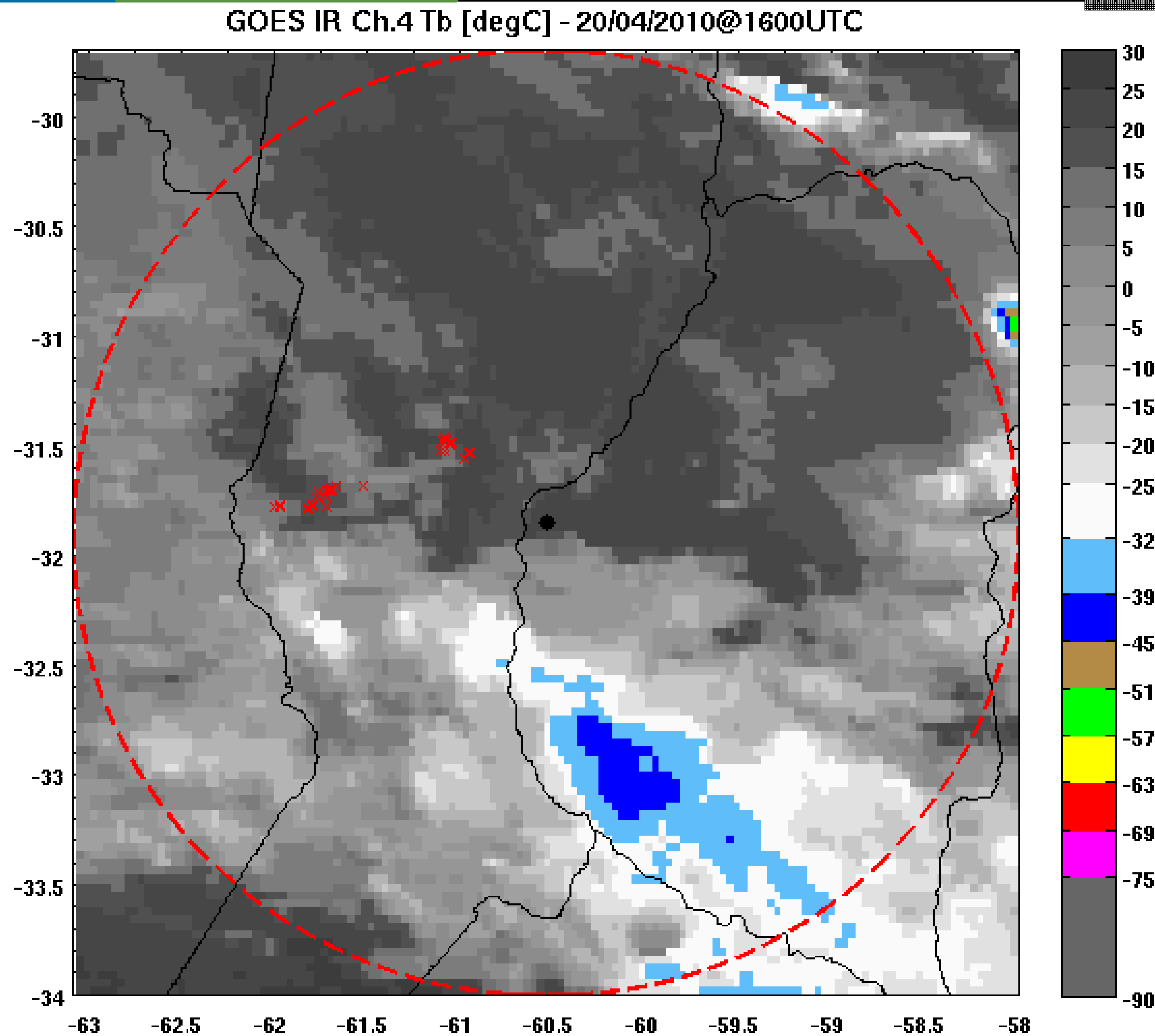
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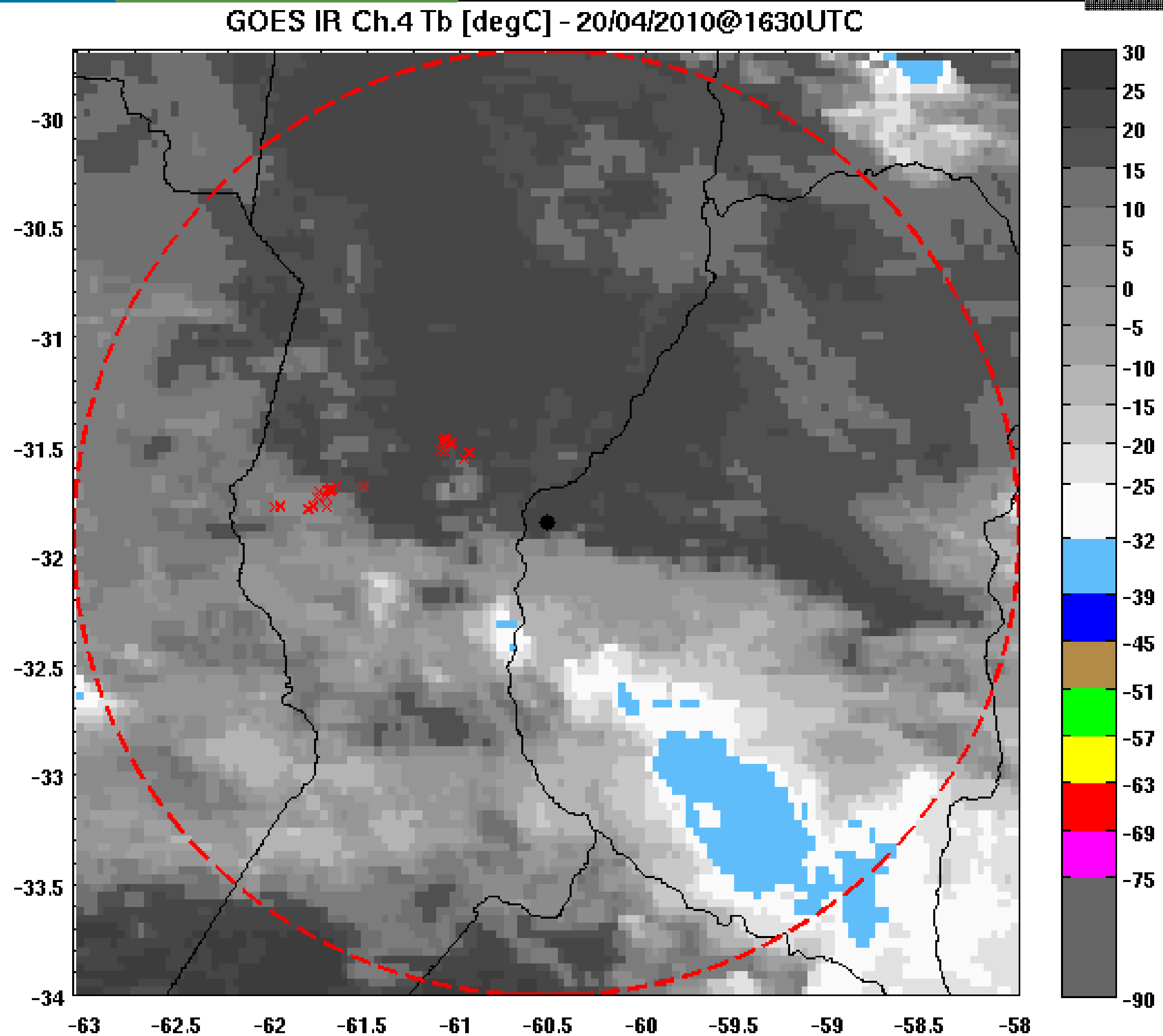
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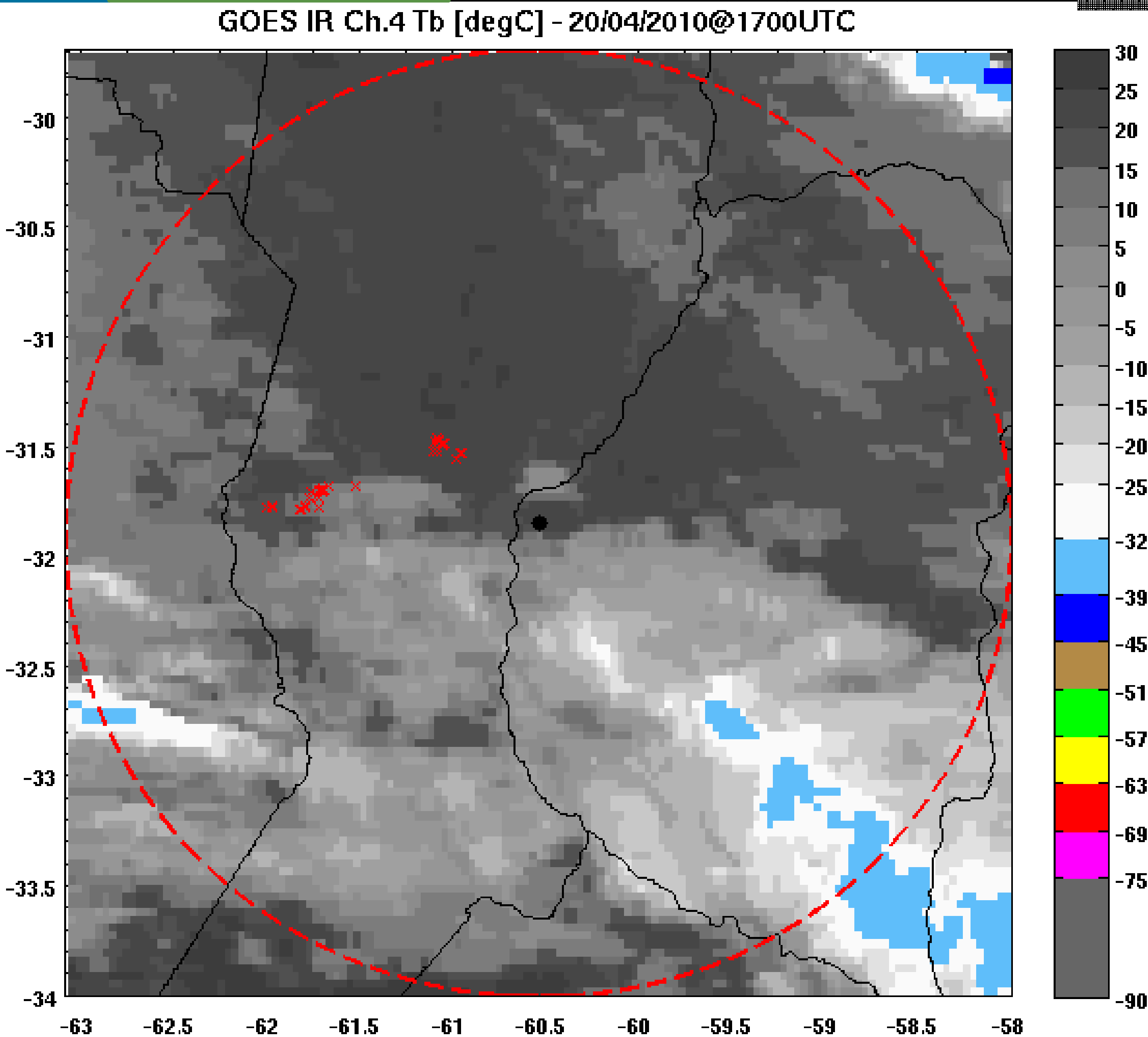
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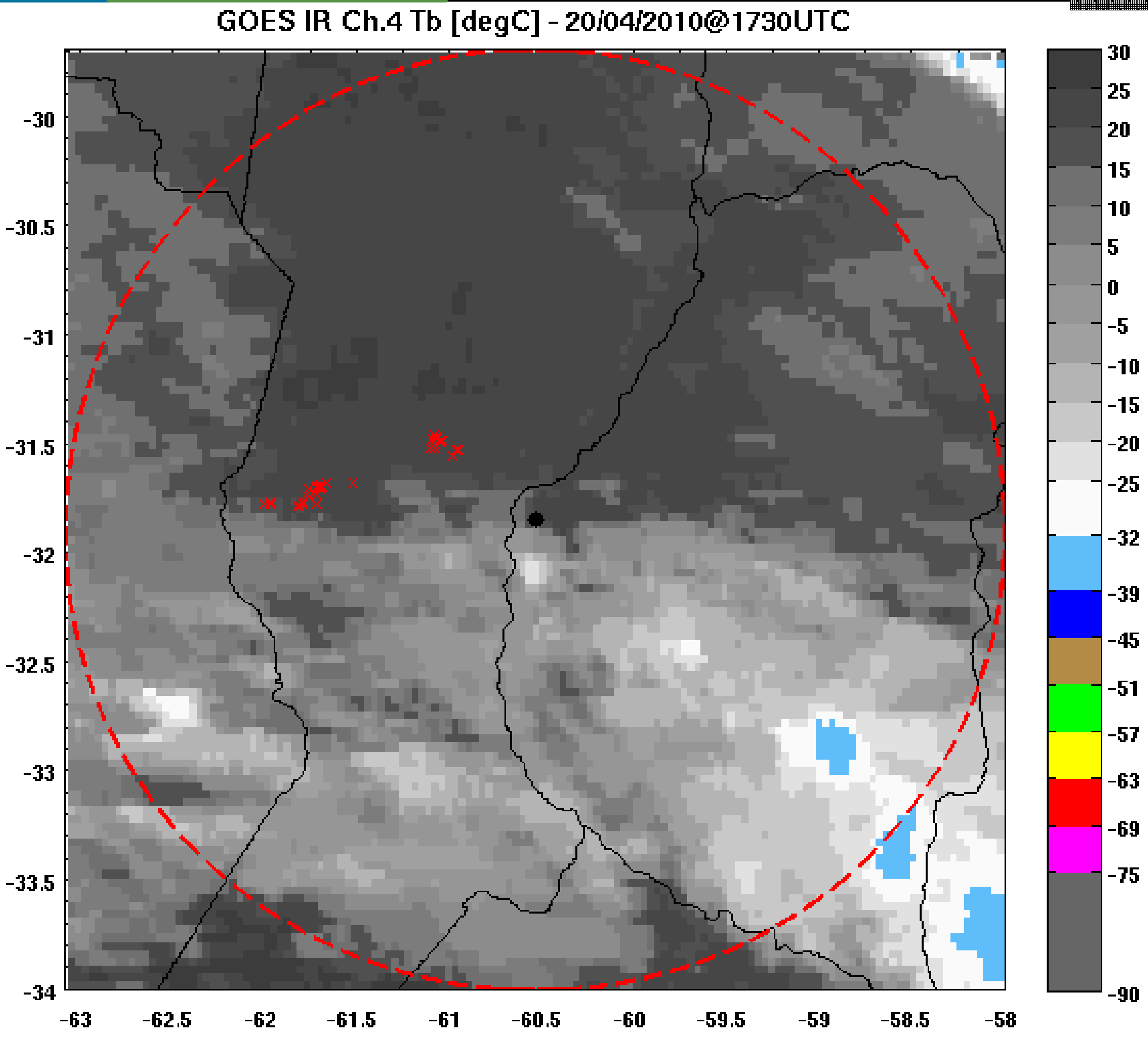
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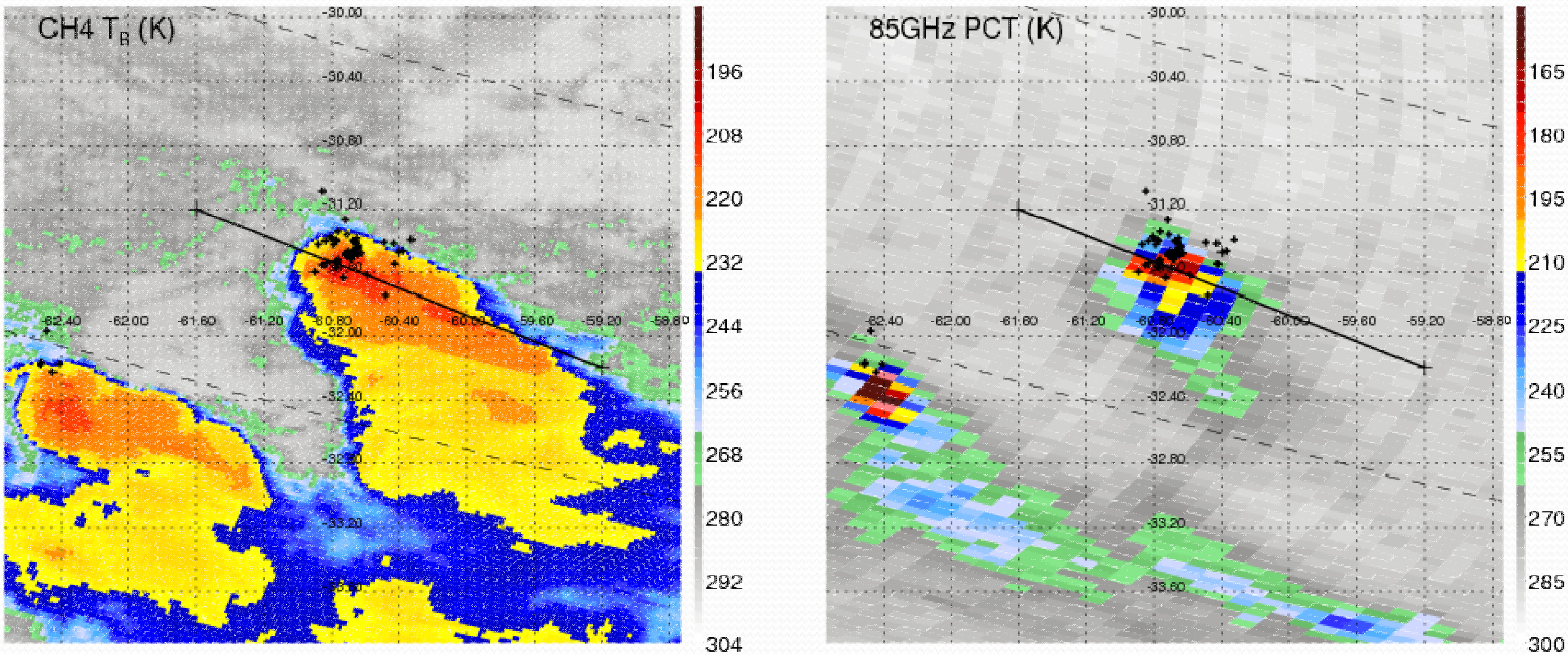
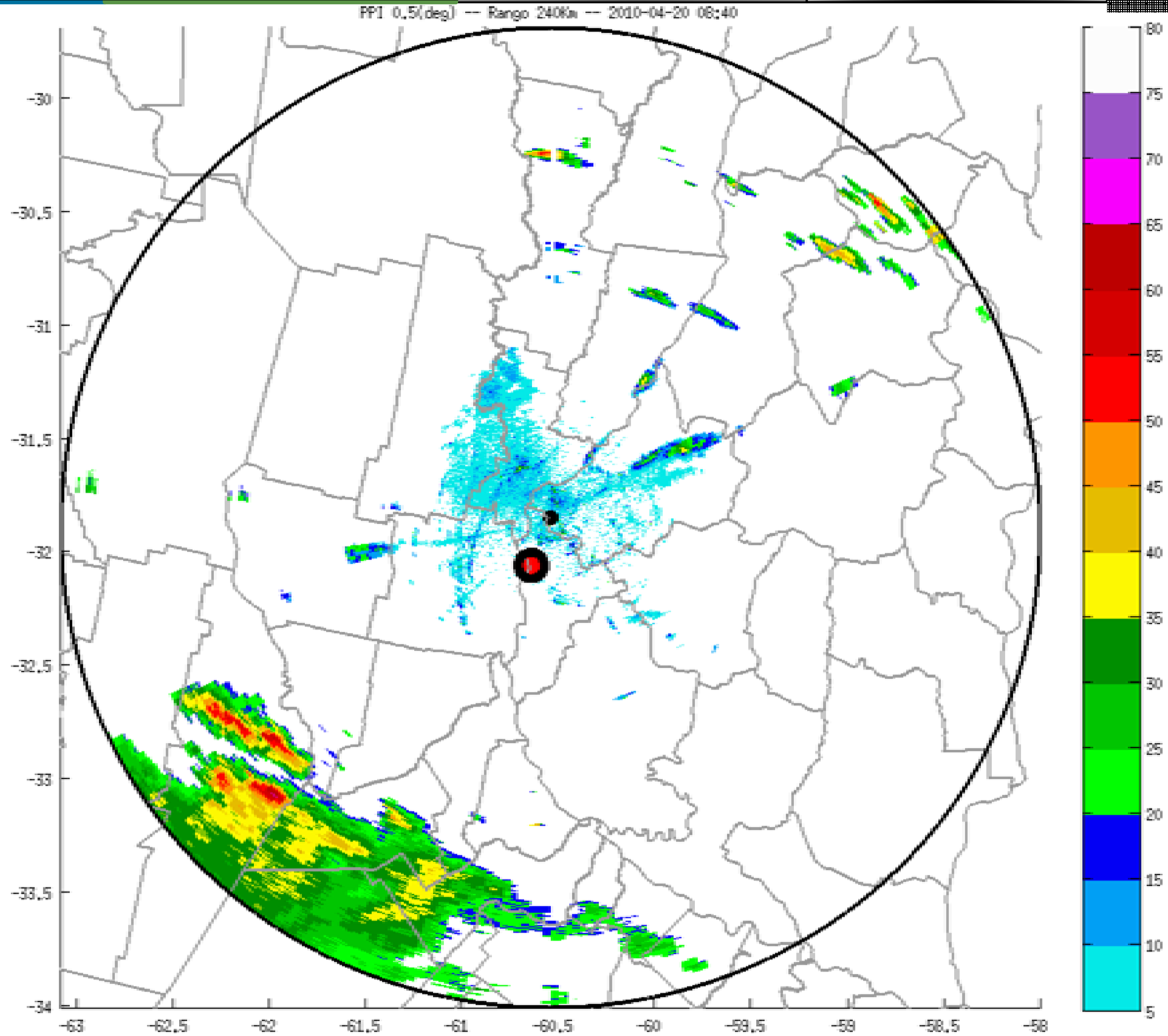
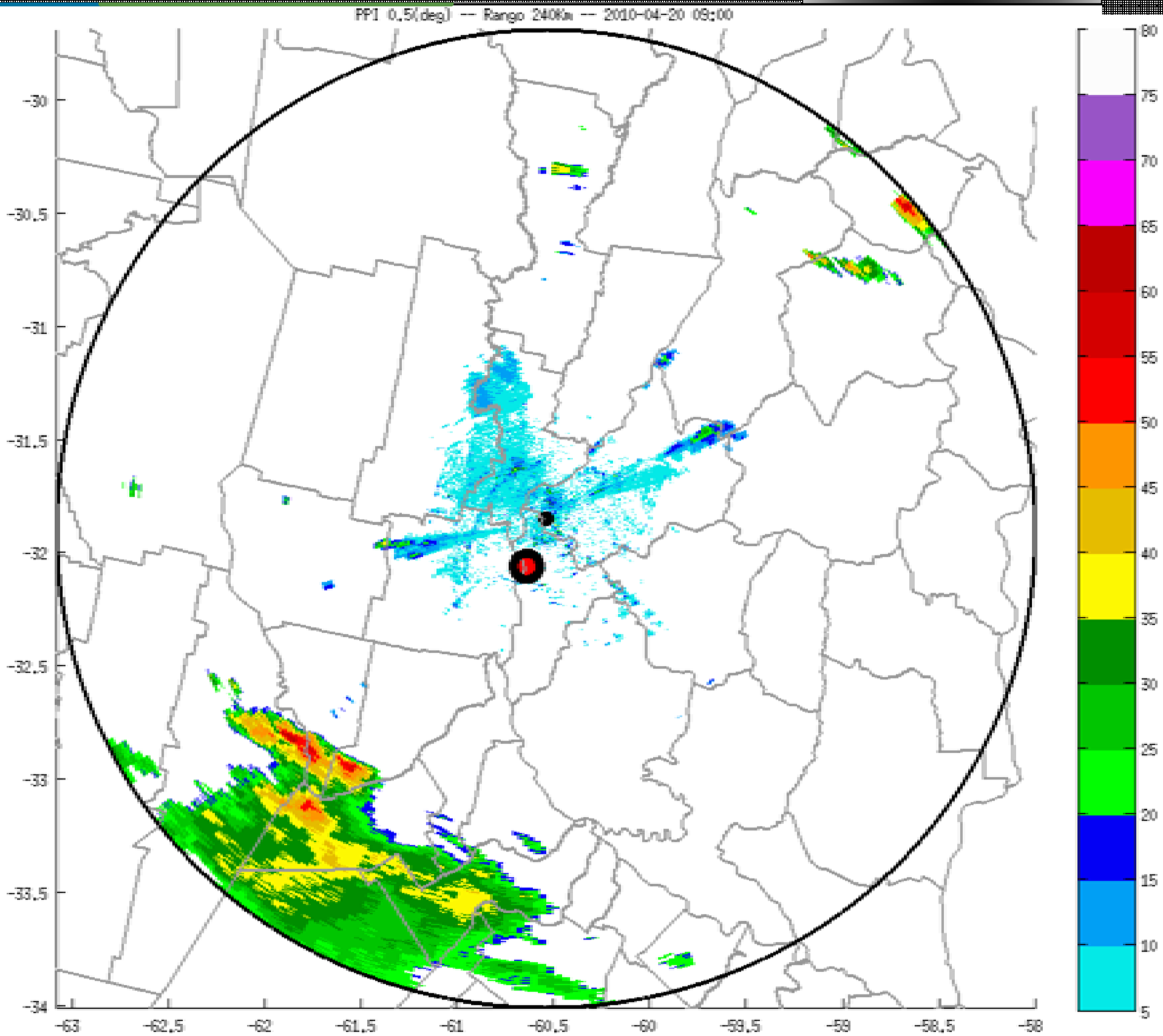


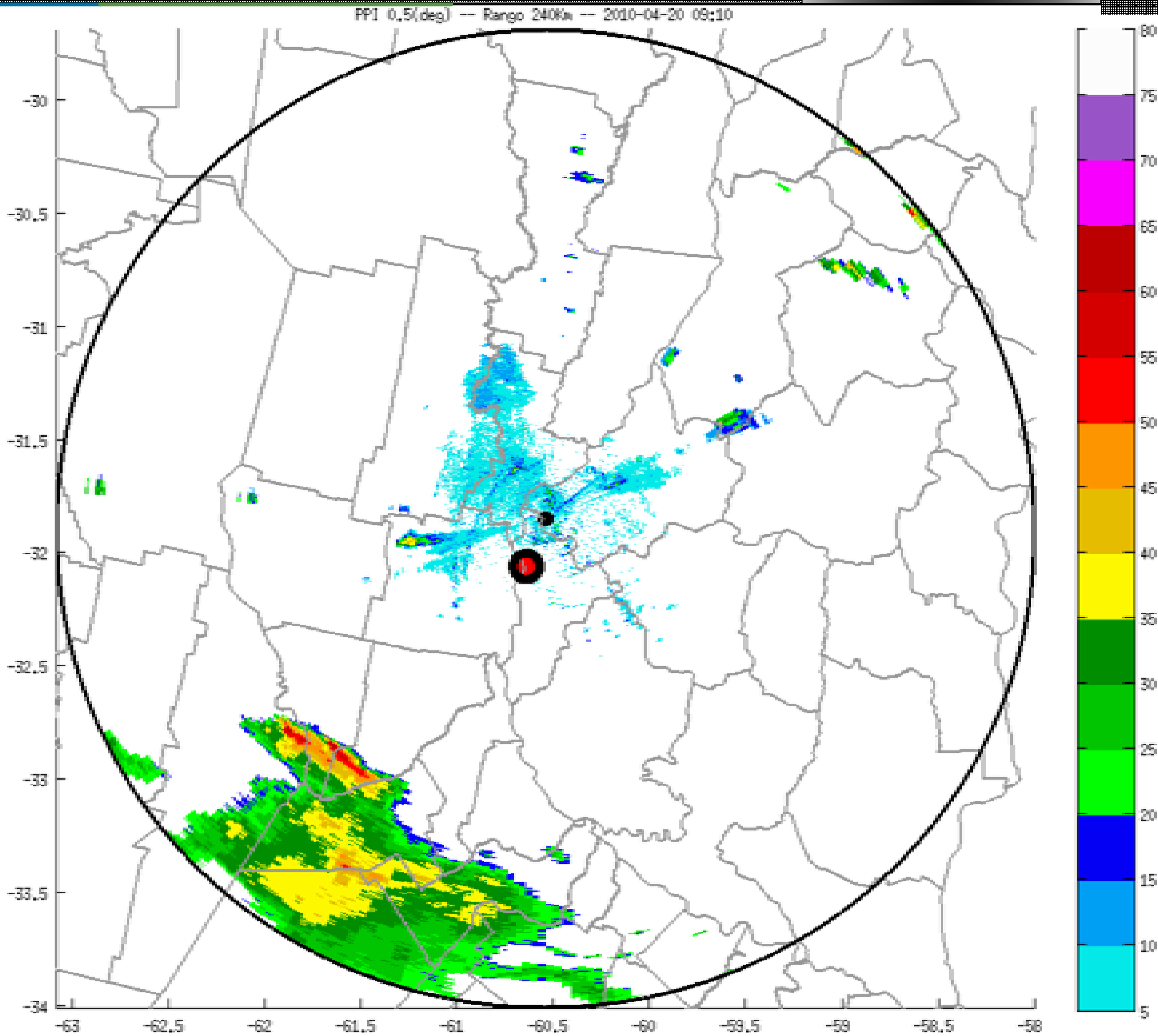
Case studies



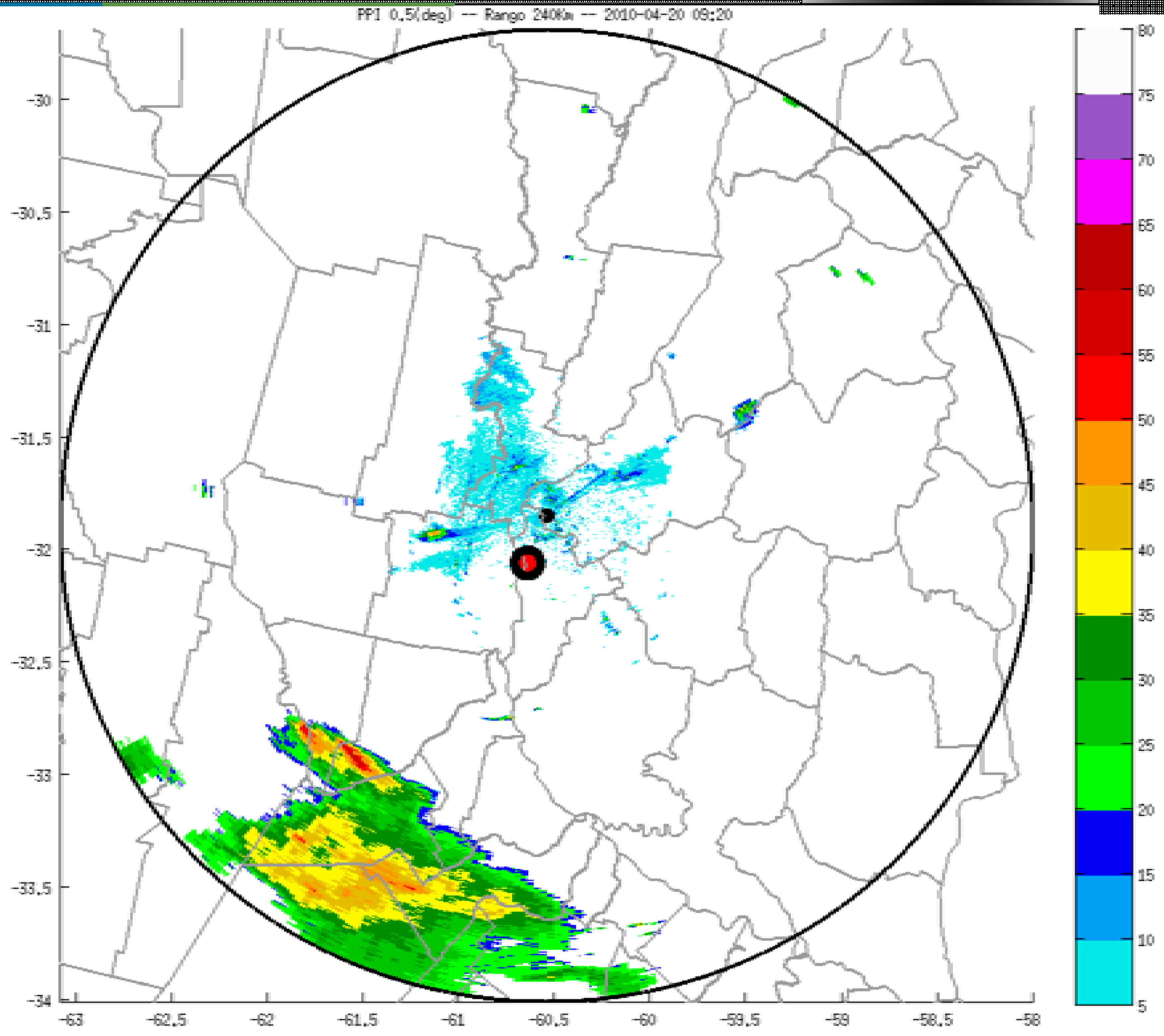
Case studies



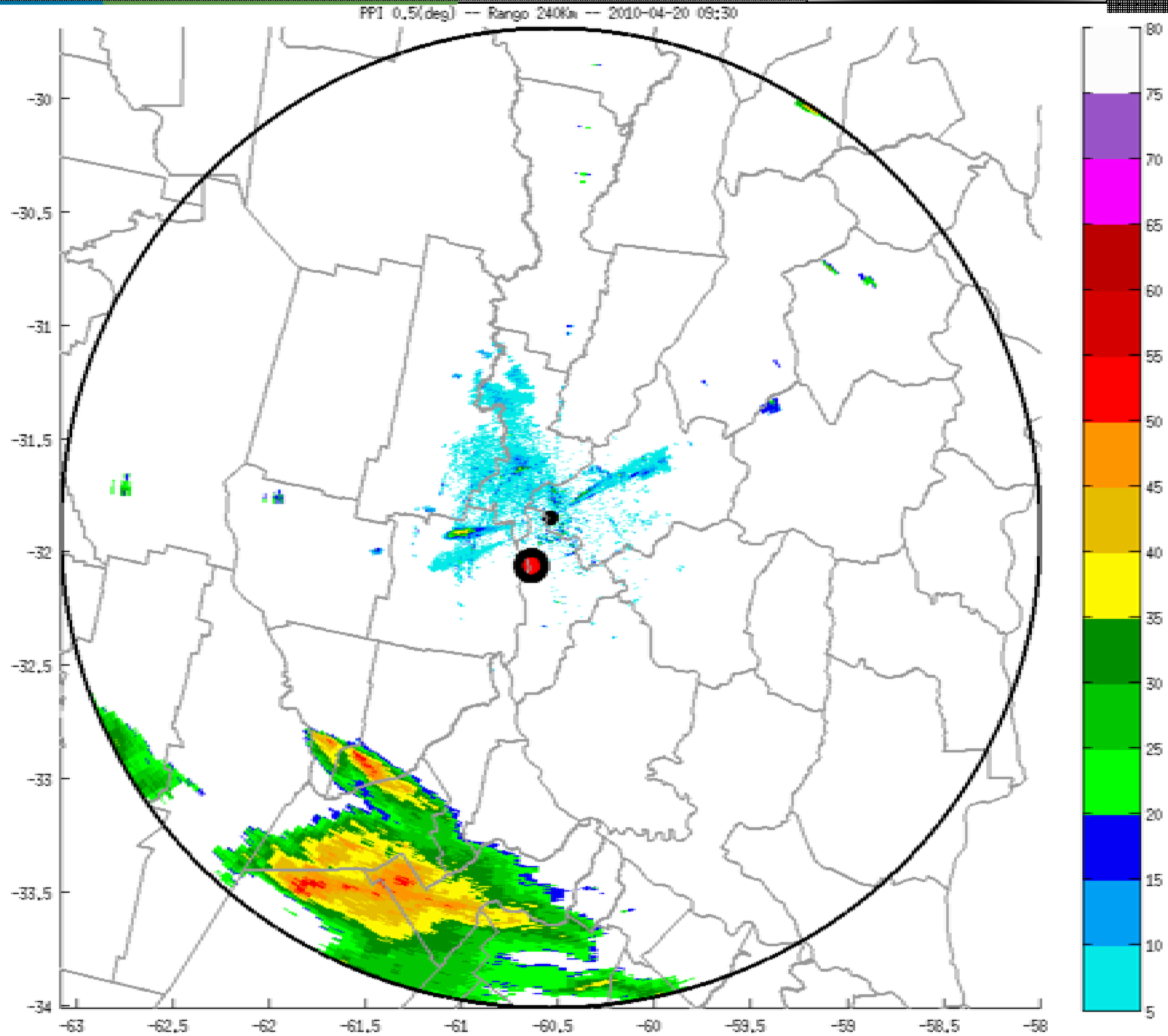
Case studies



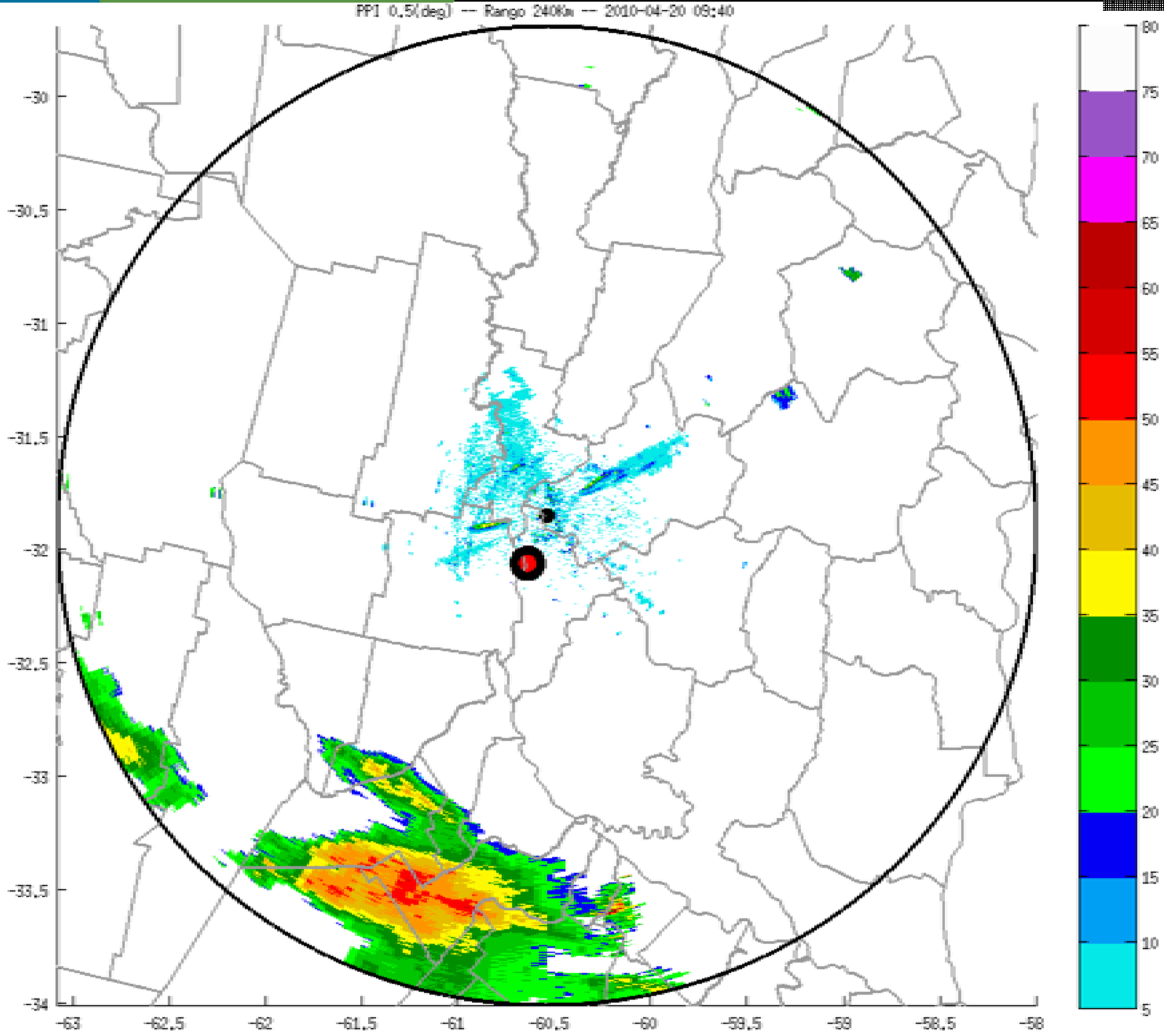
Case studies



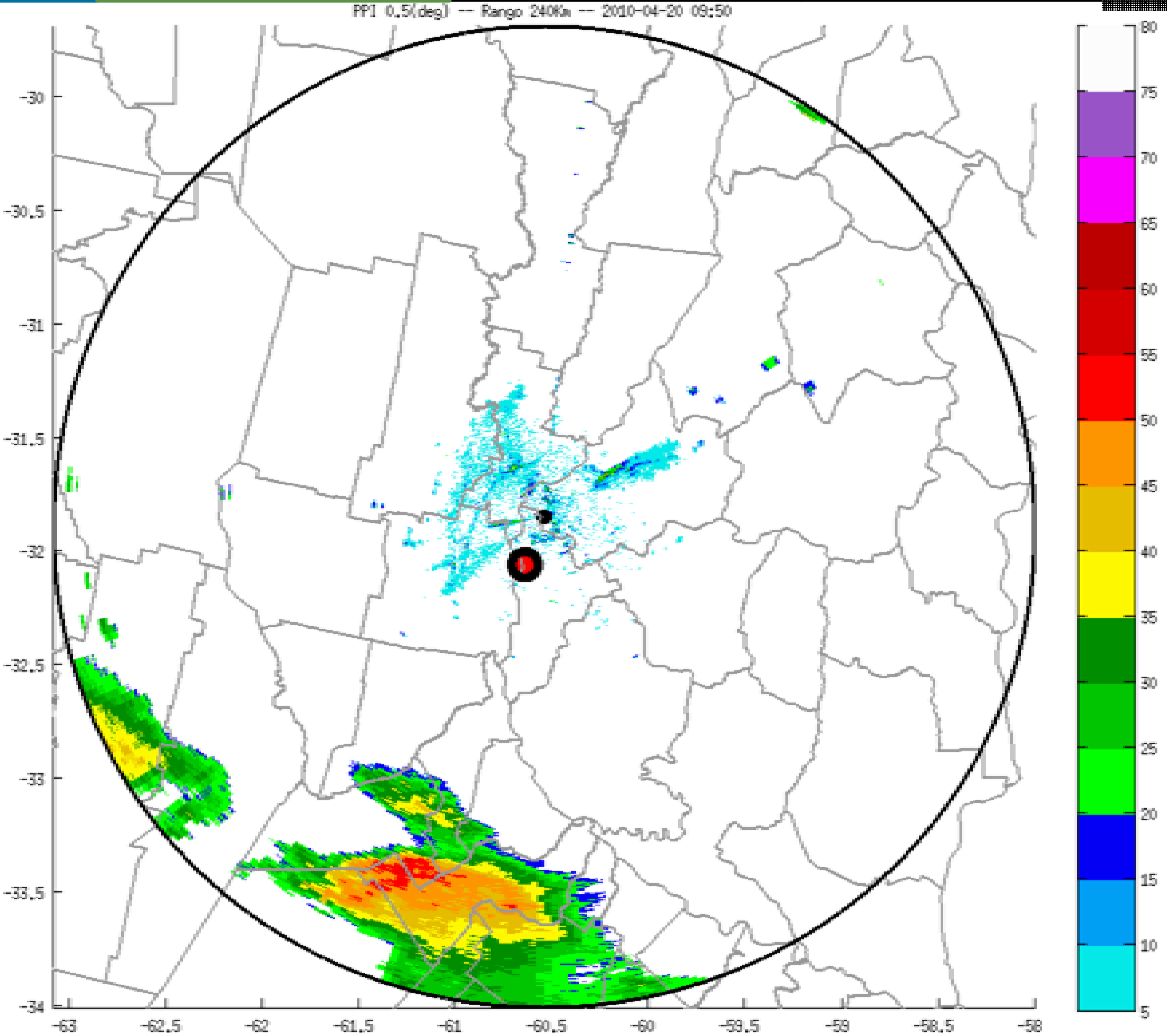
Case studies



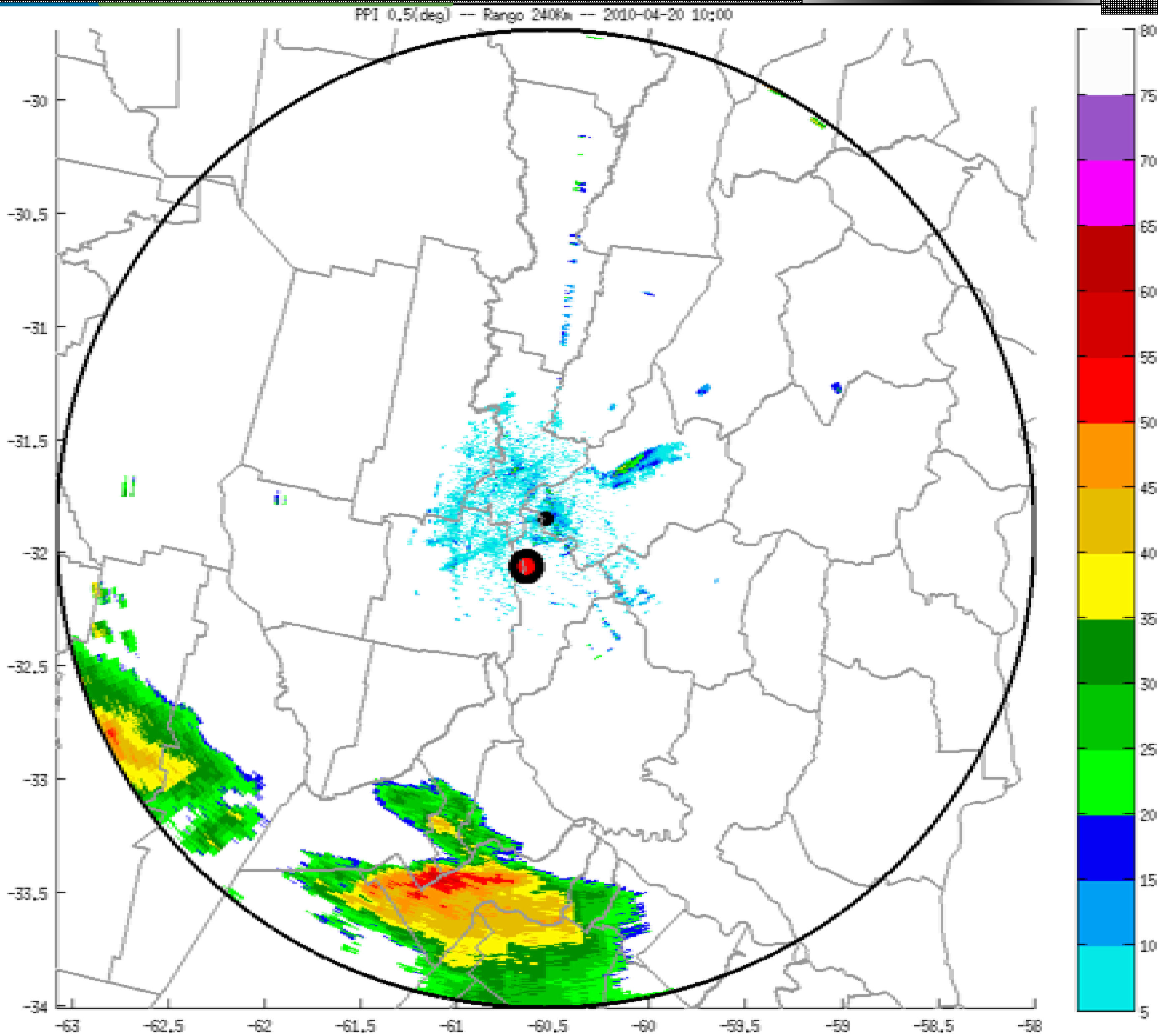
Case studies



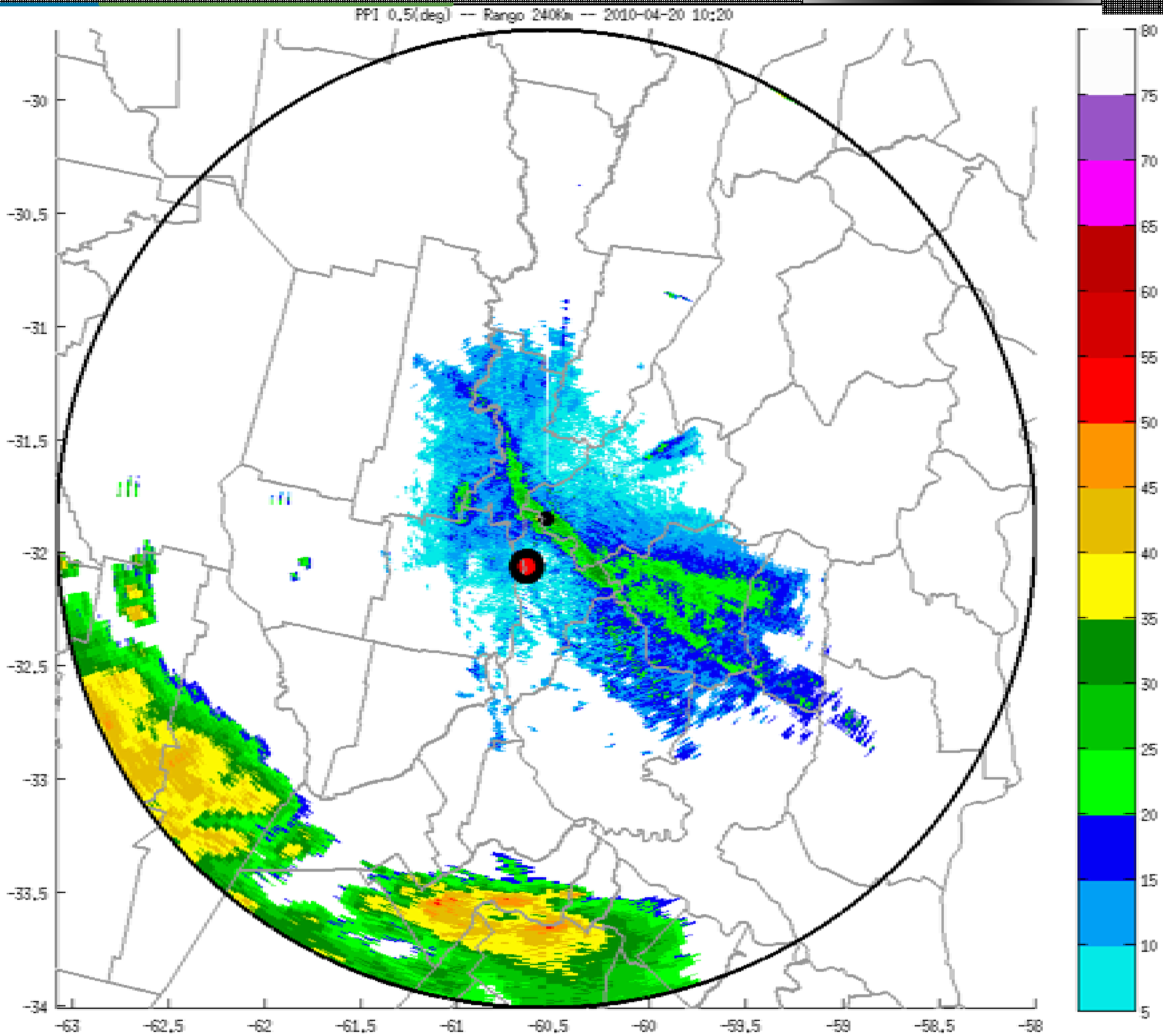
Case studies

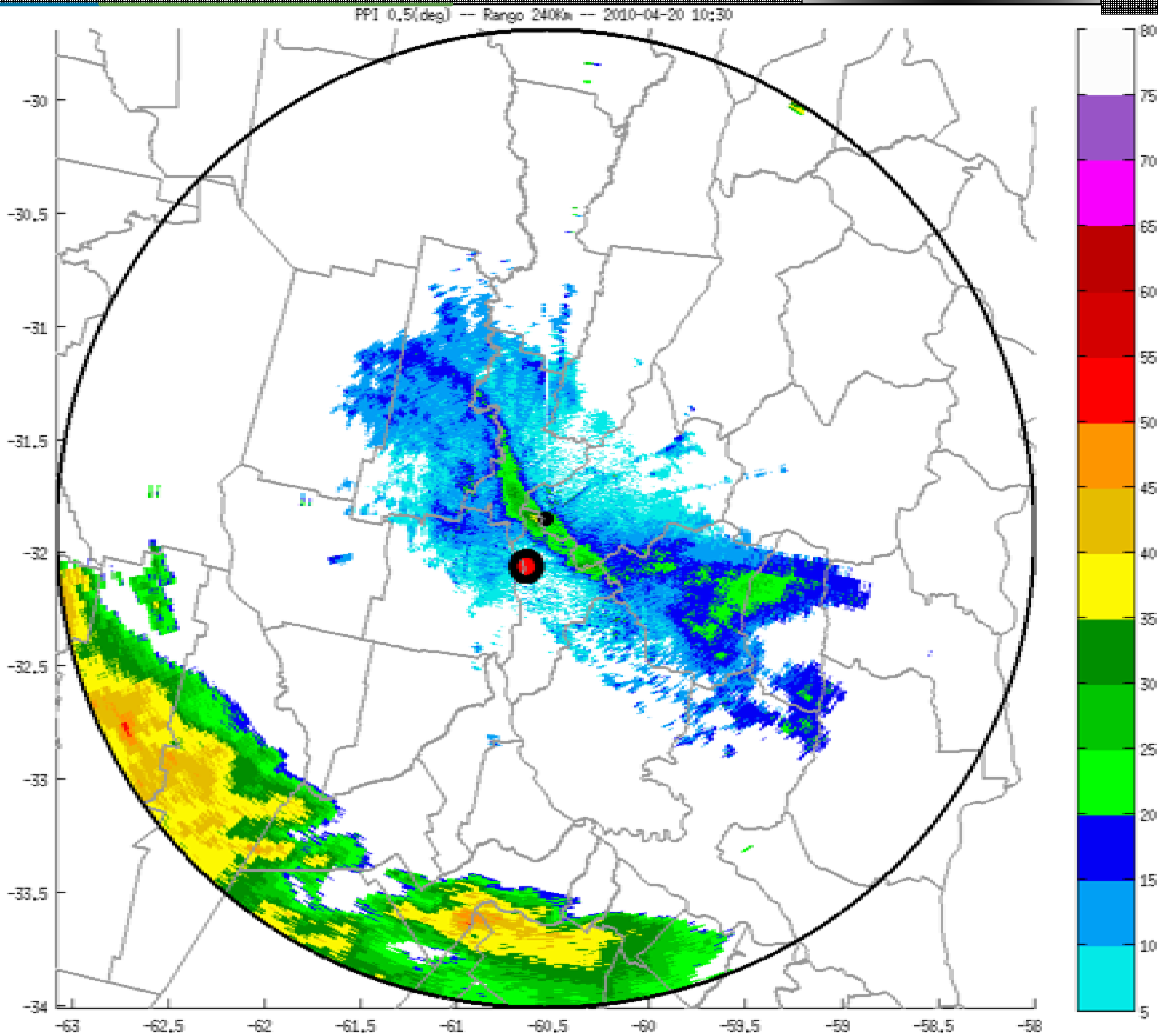


Case studies



Case studies

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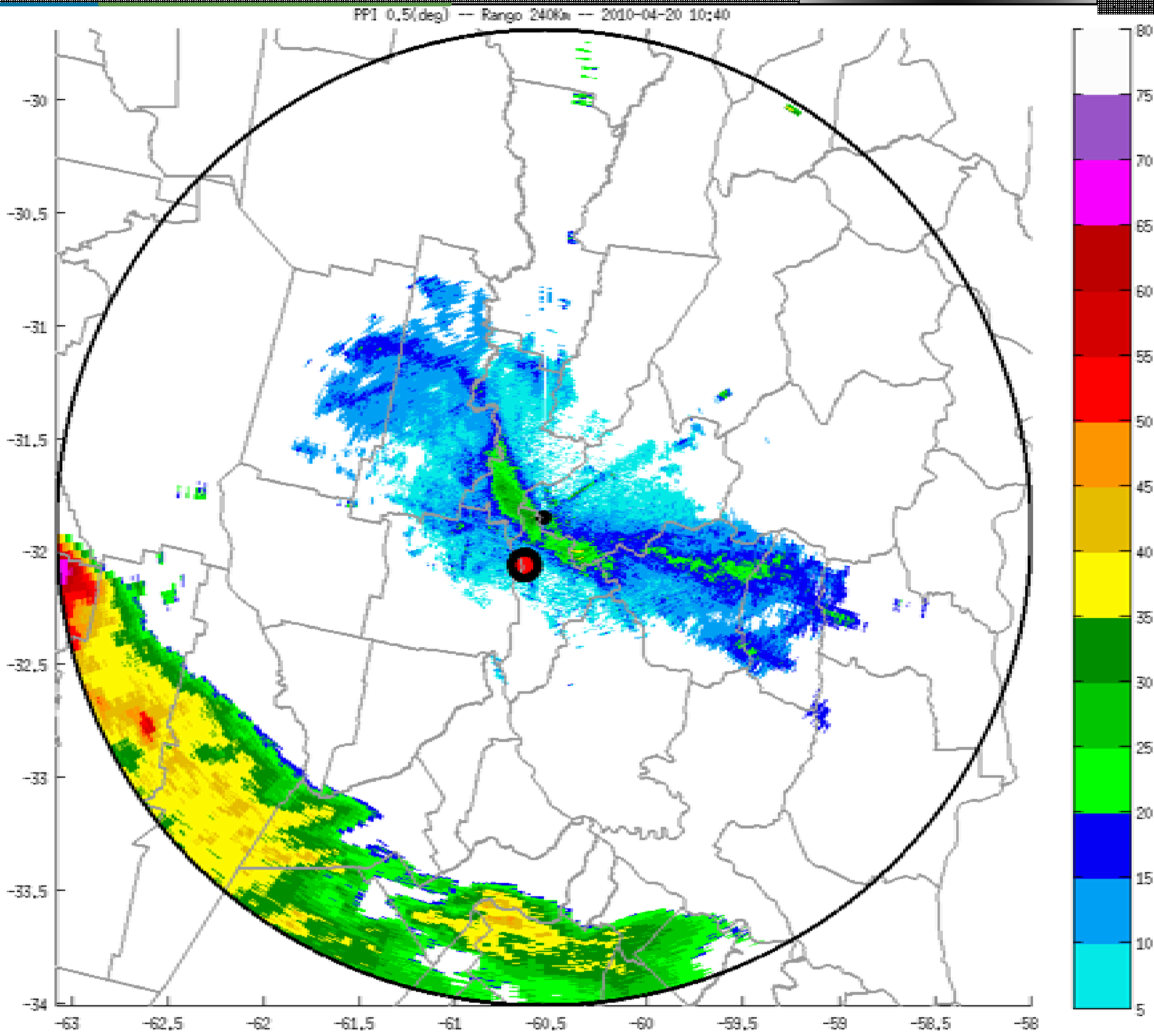
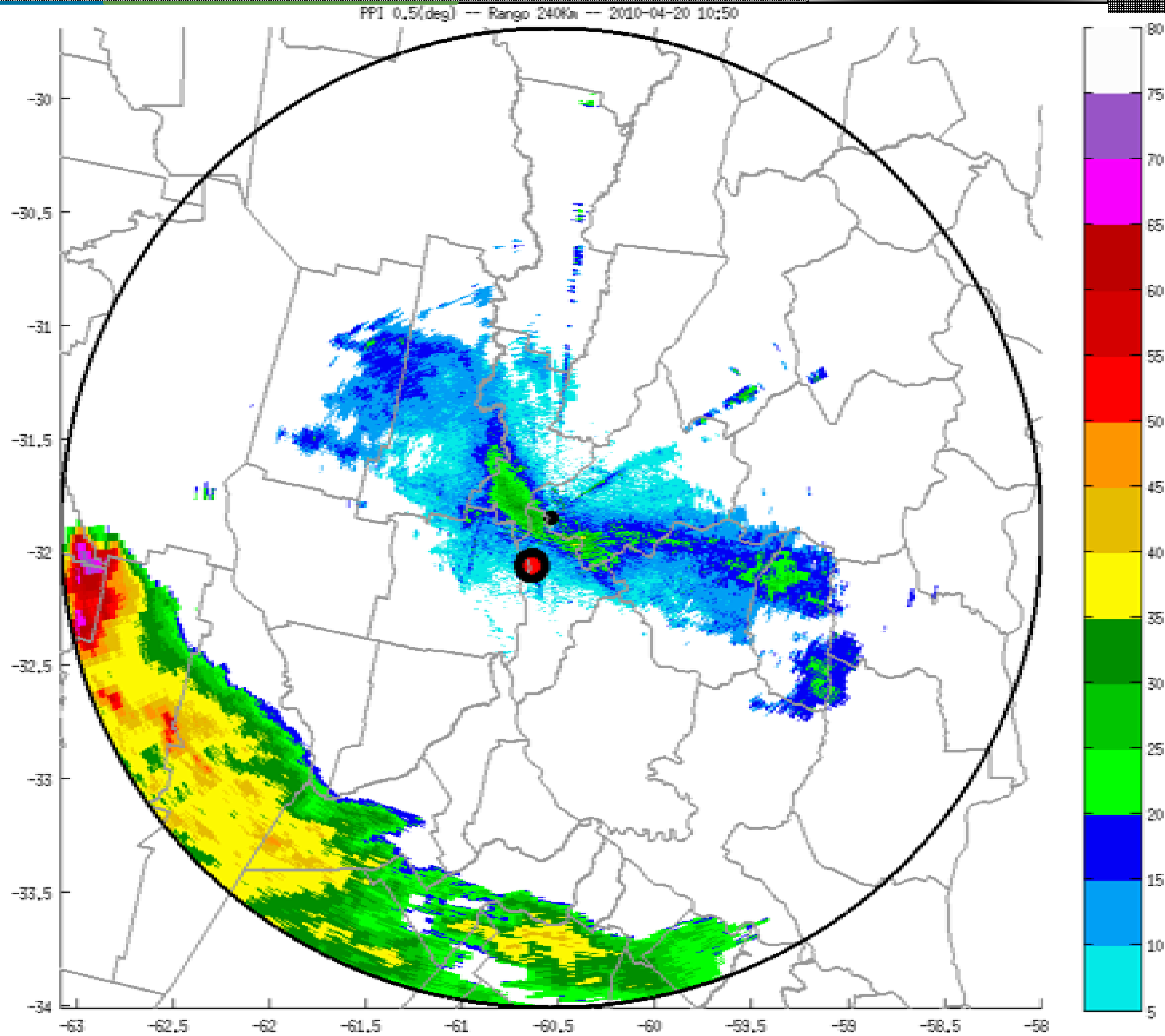
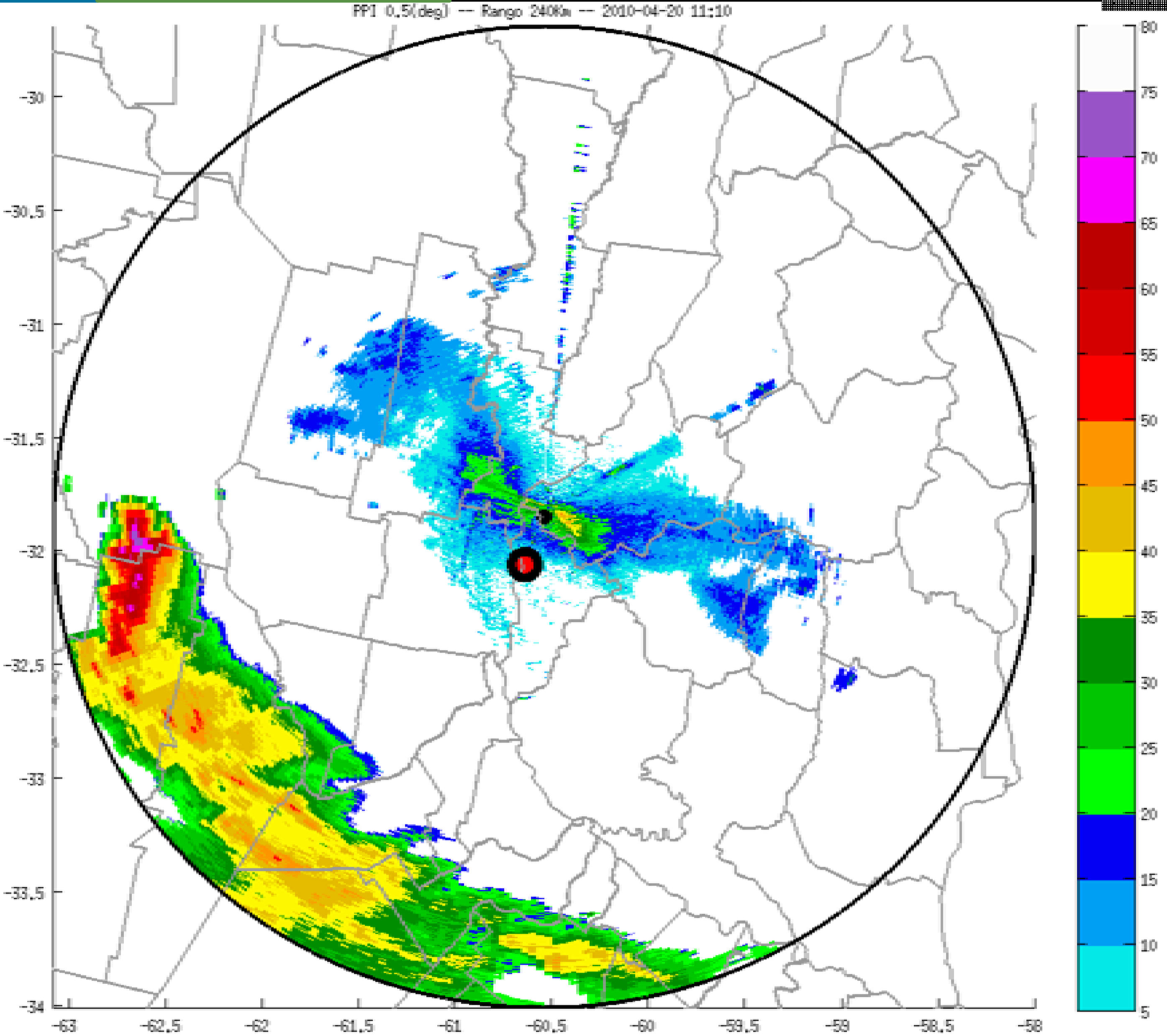
Case studies



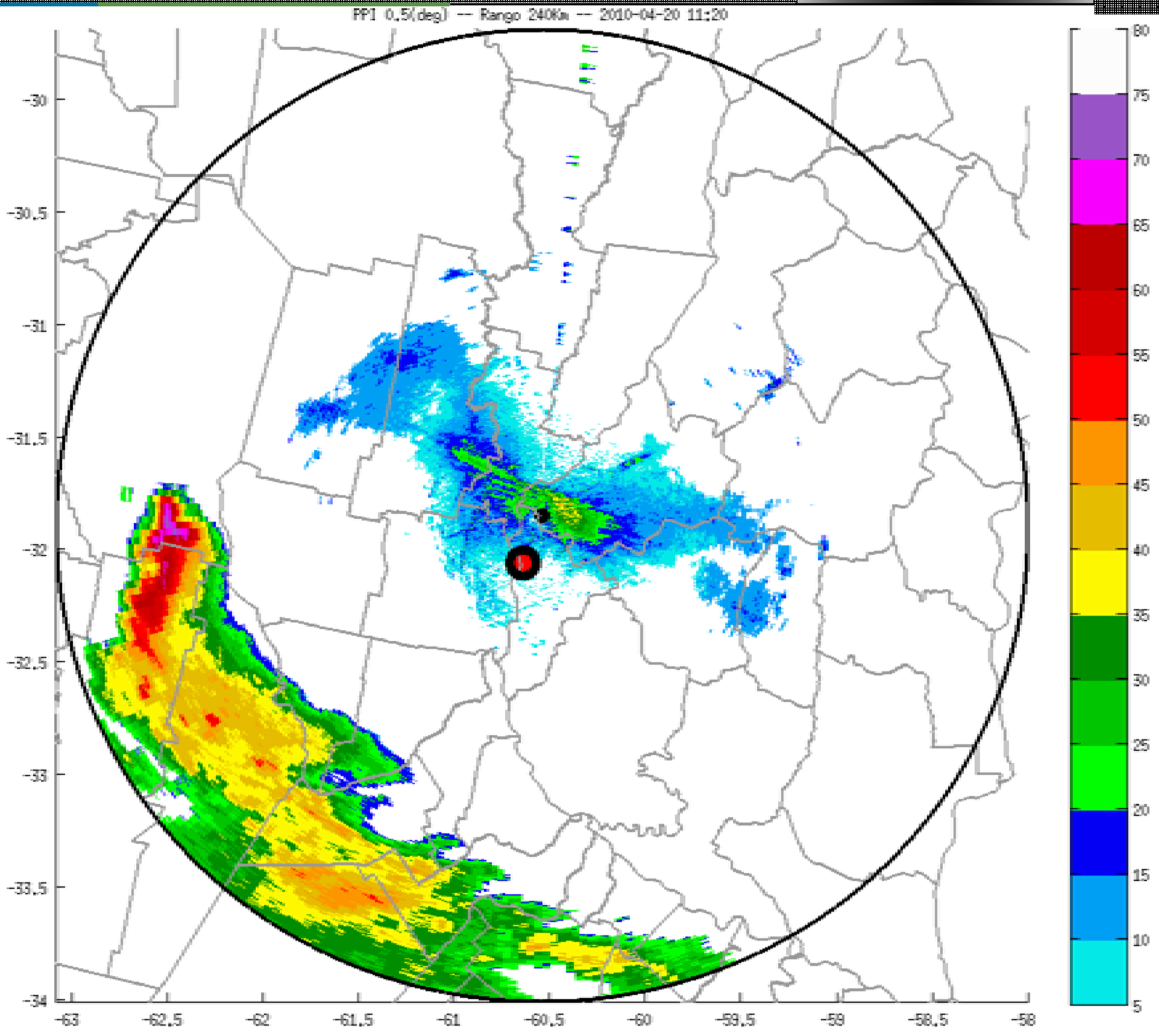
Case studies

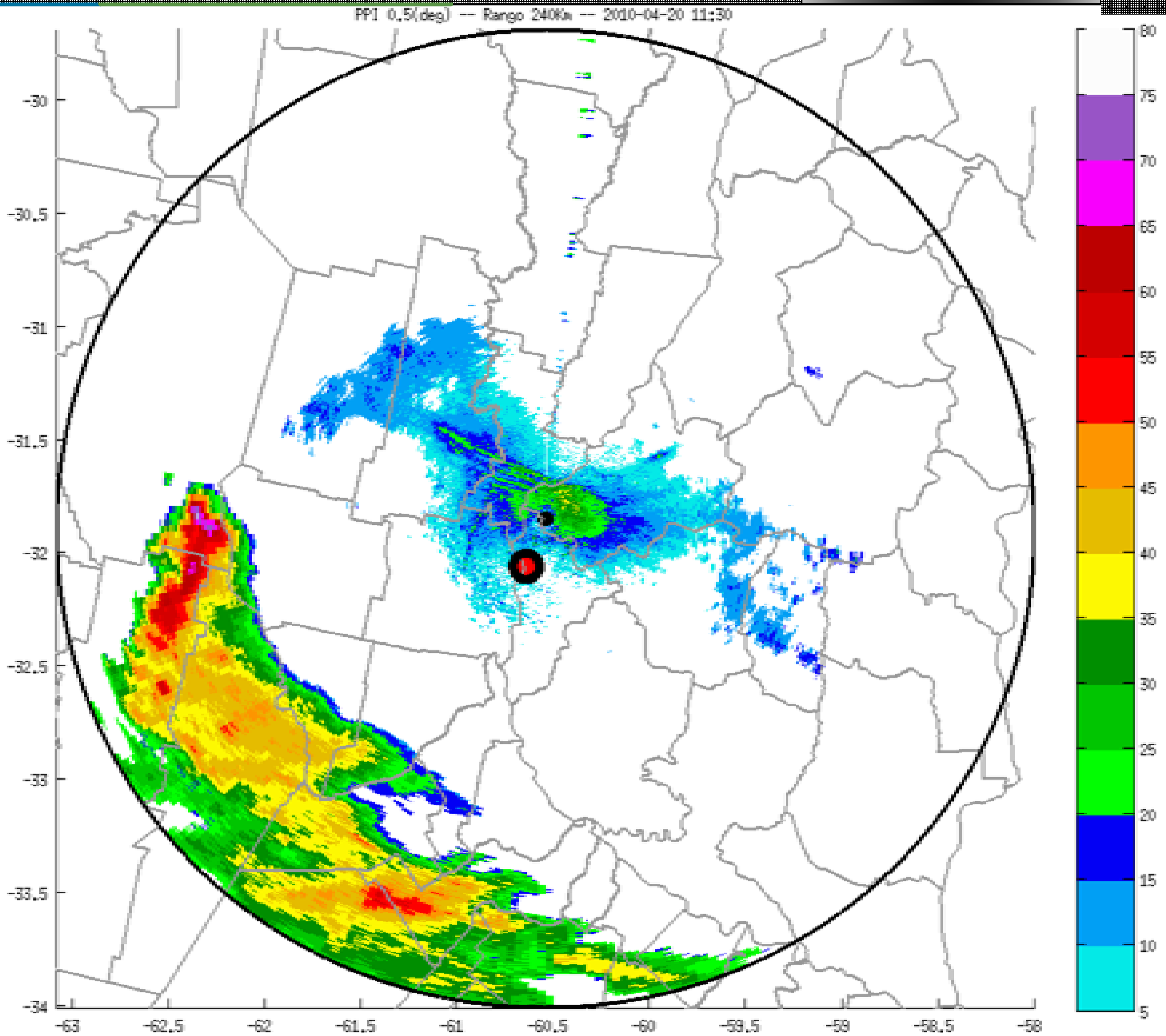


Case studies



Case studies

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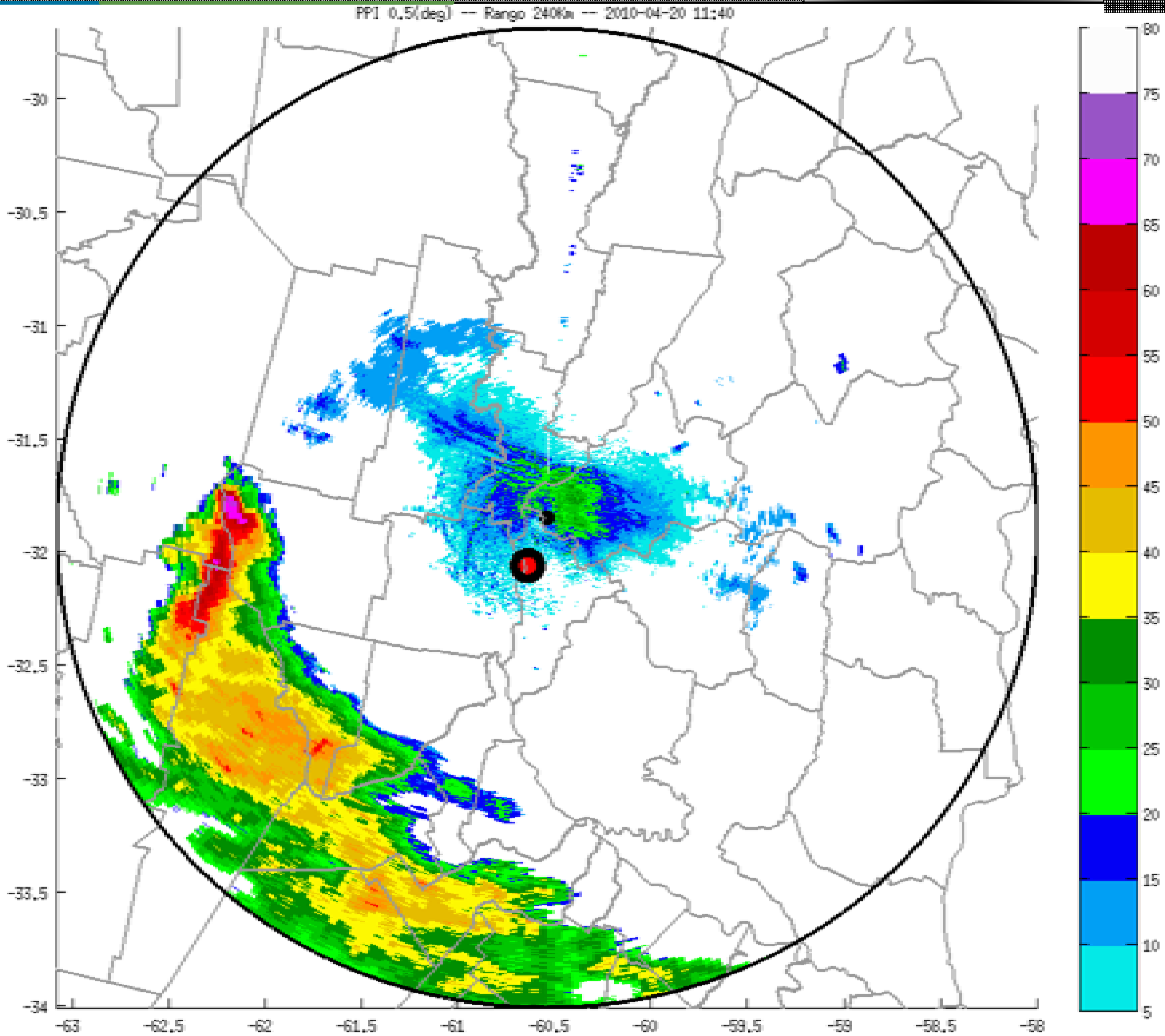
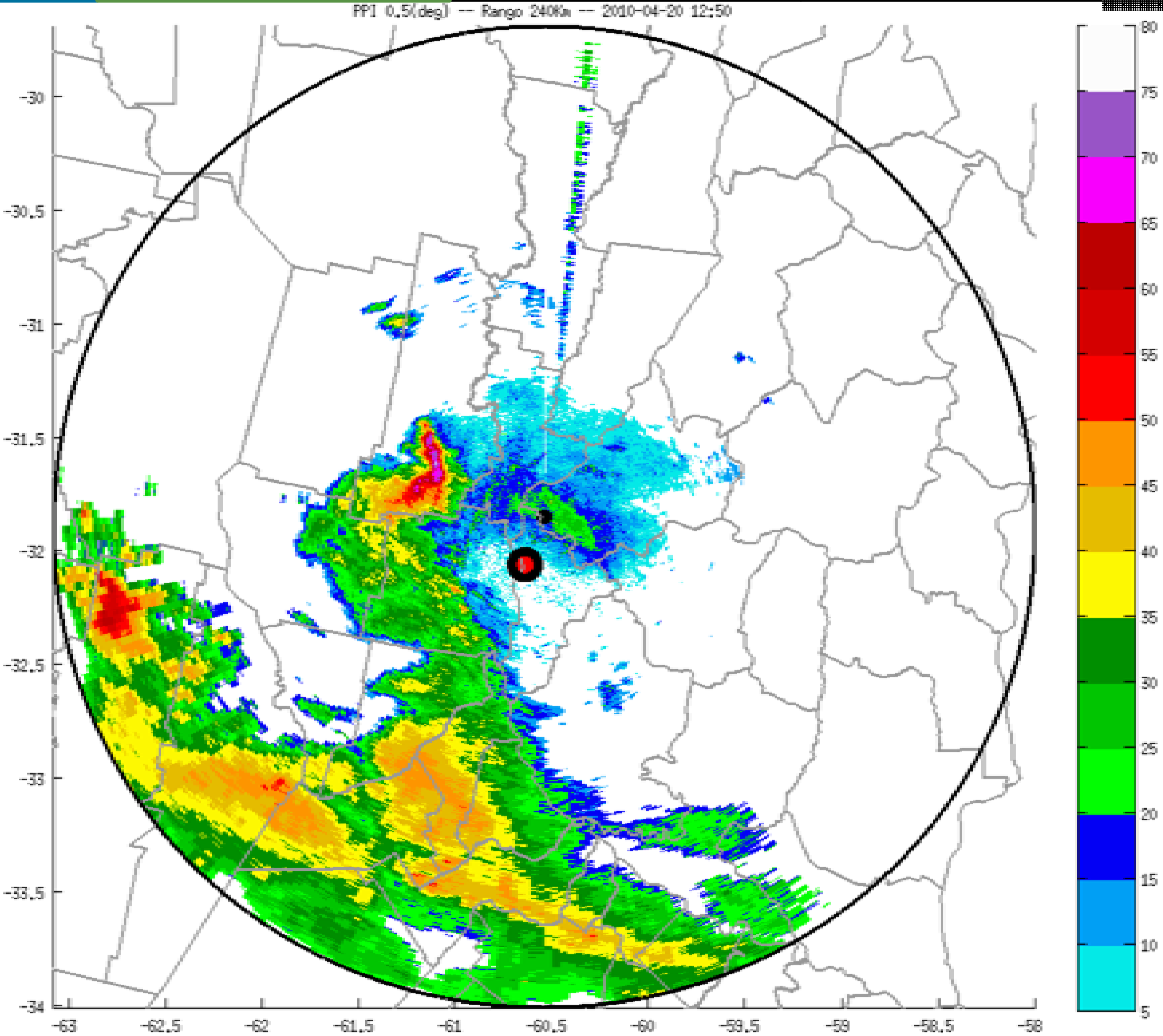
Case studies

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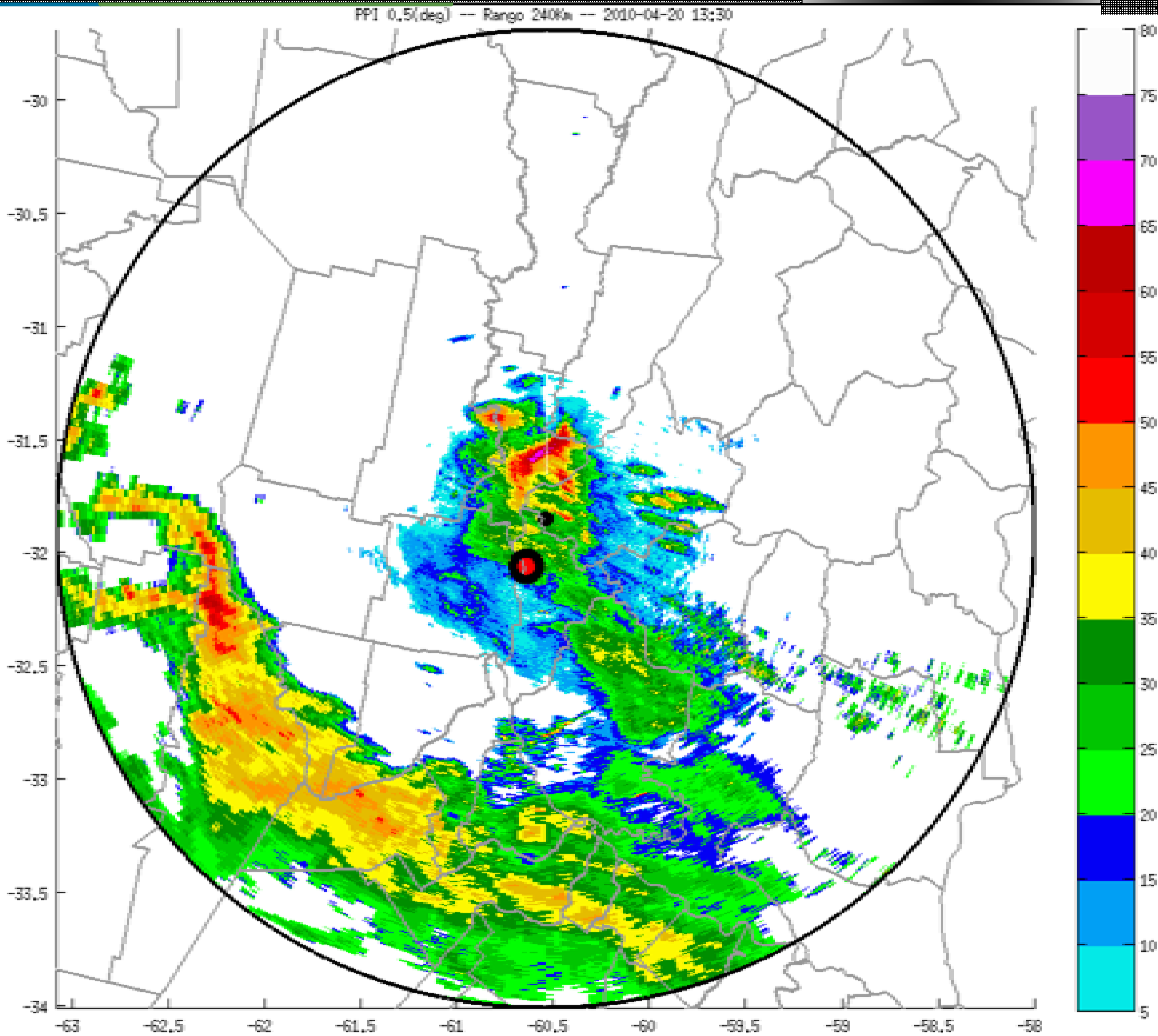
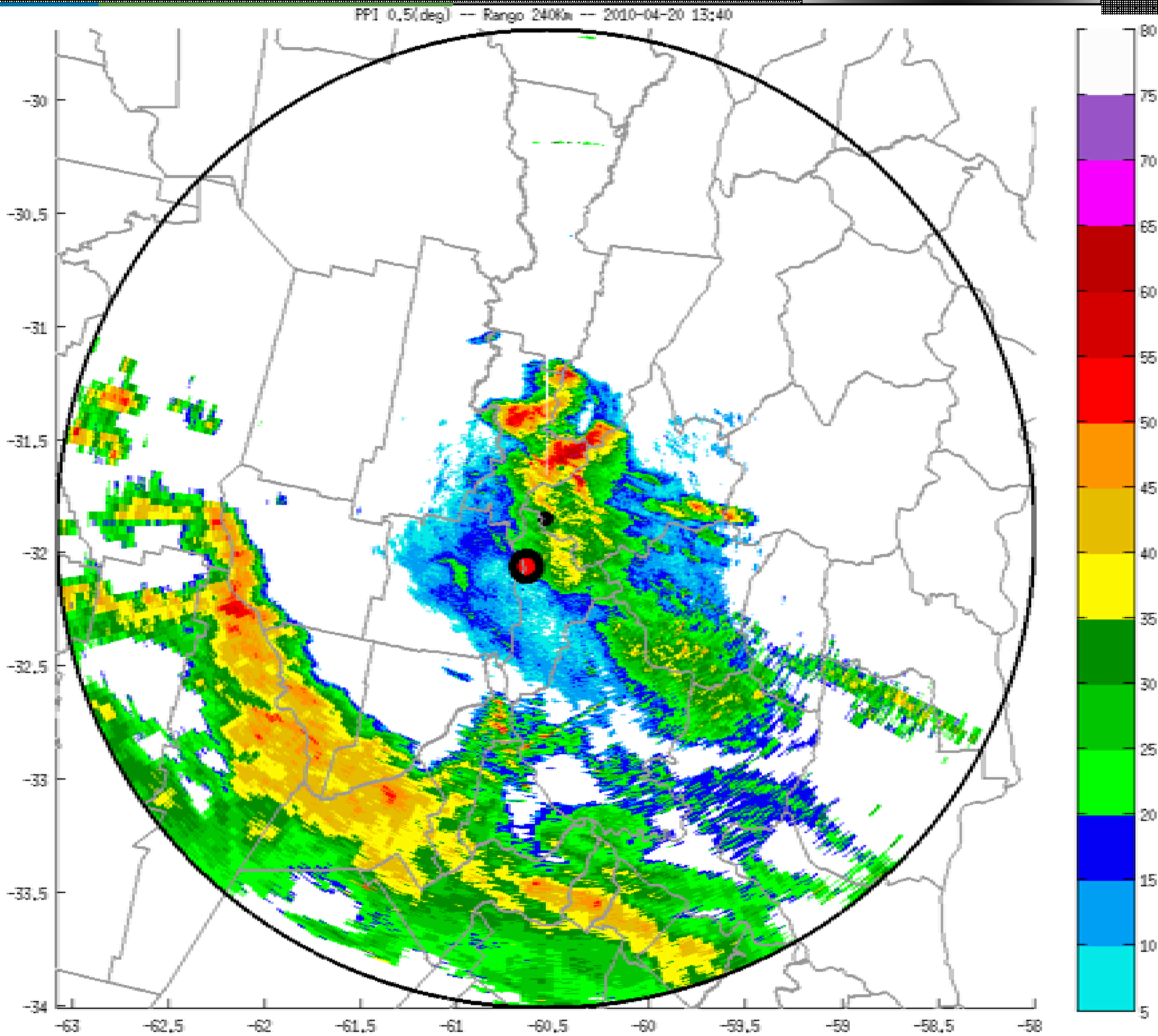
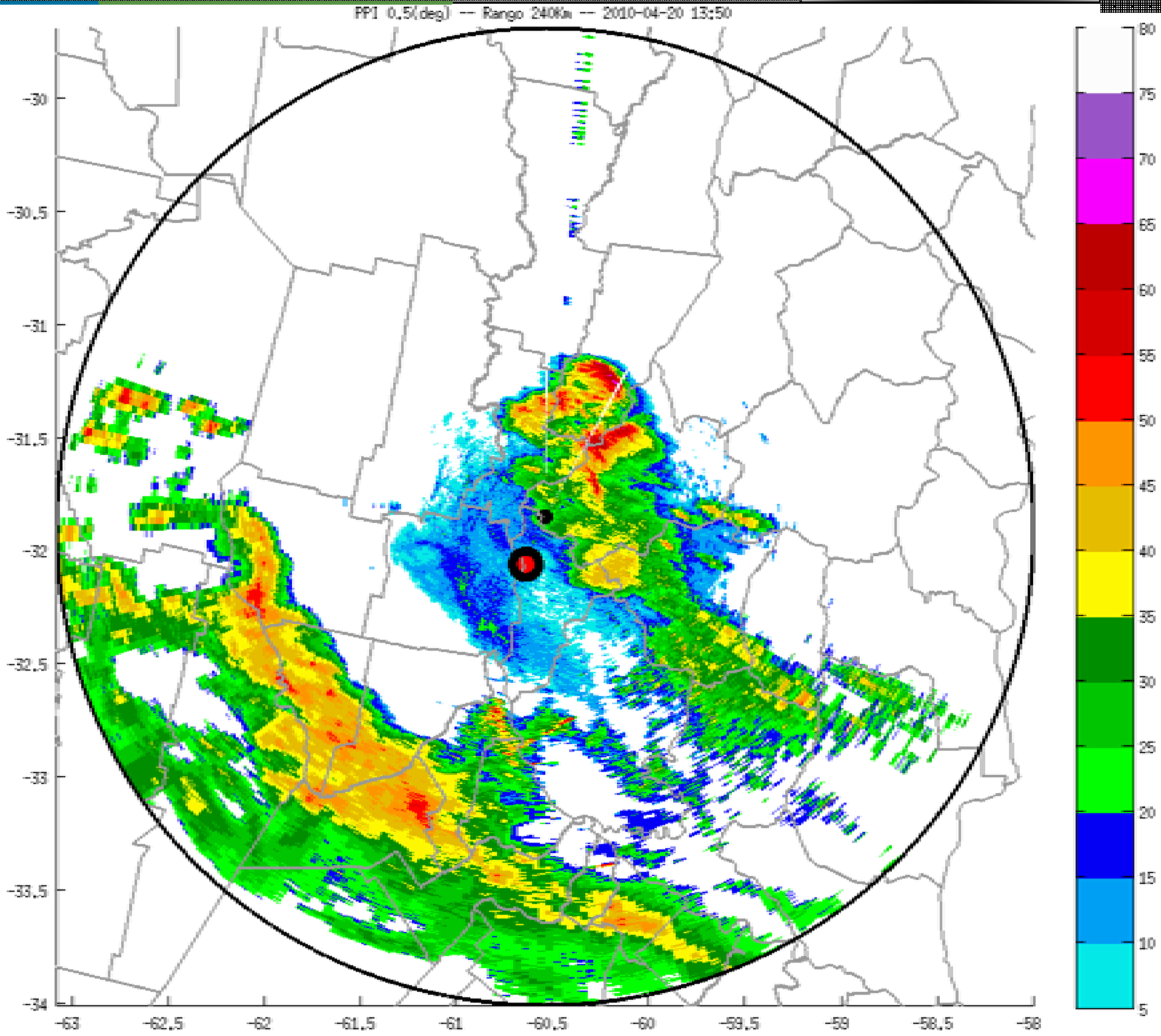
Case studies



Case studies

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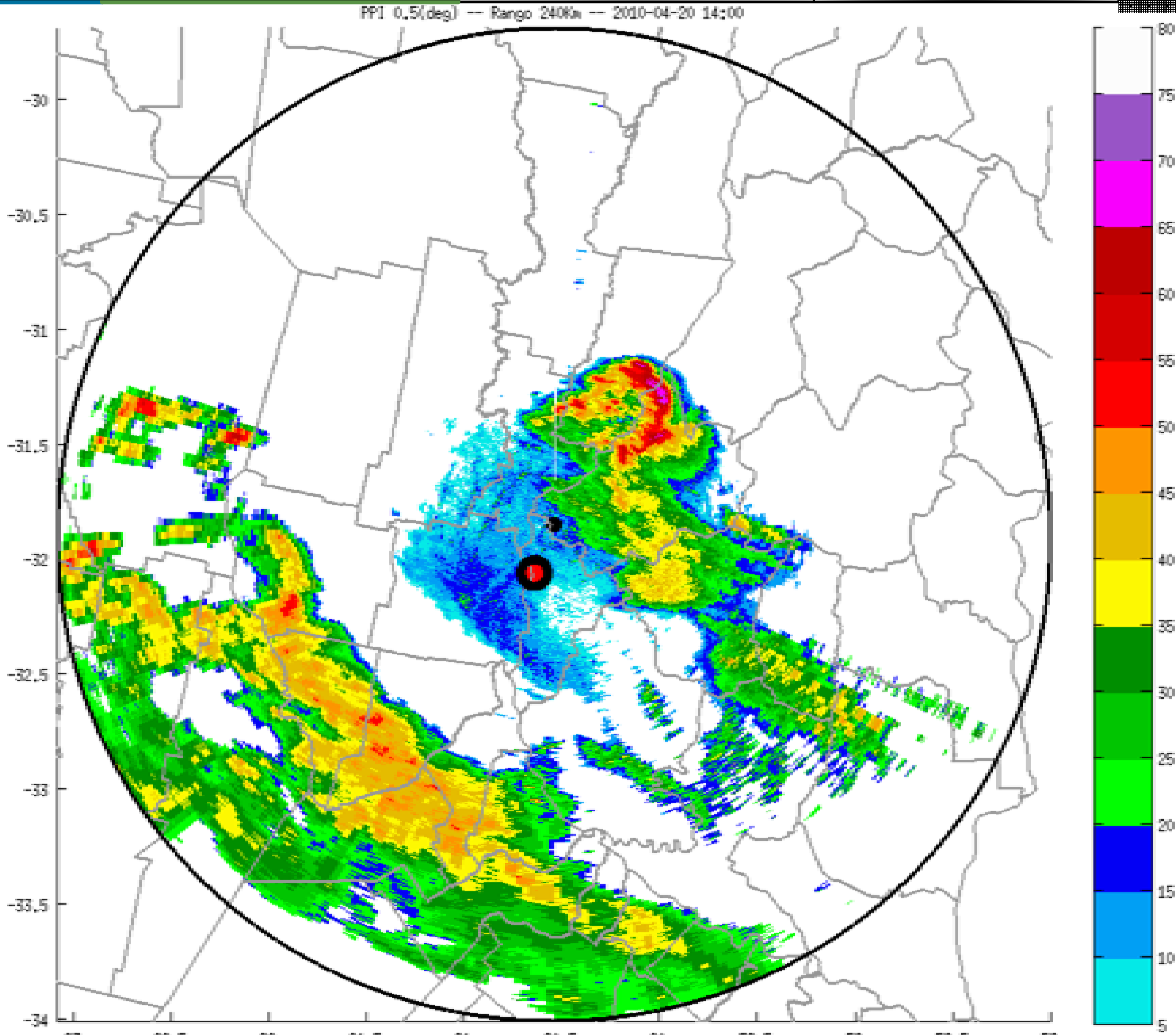
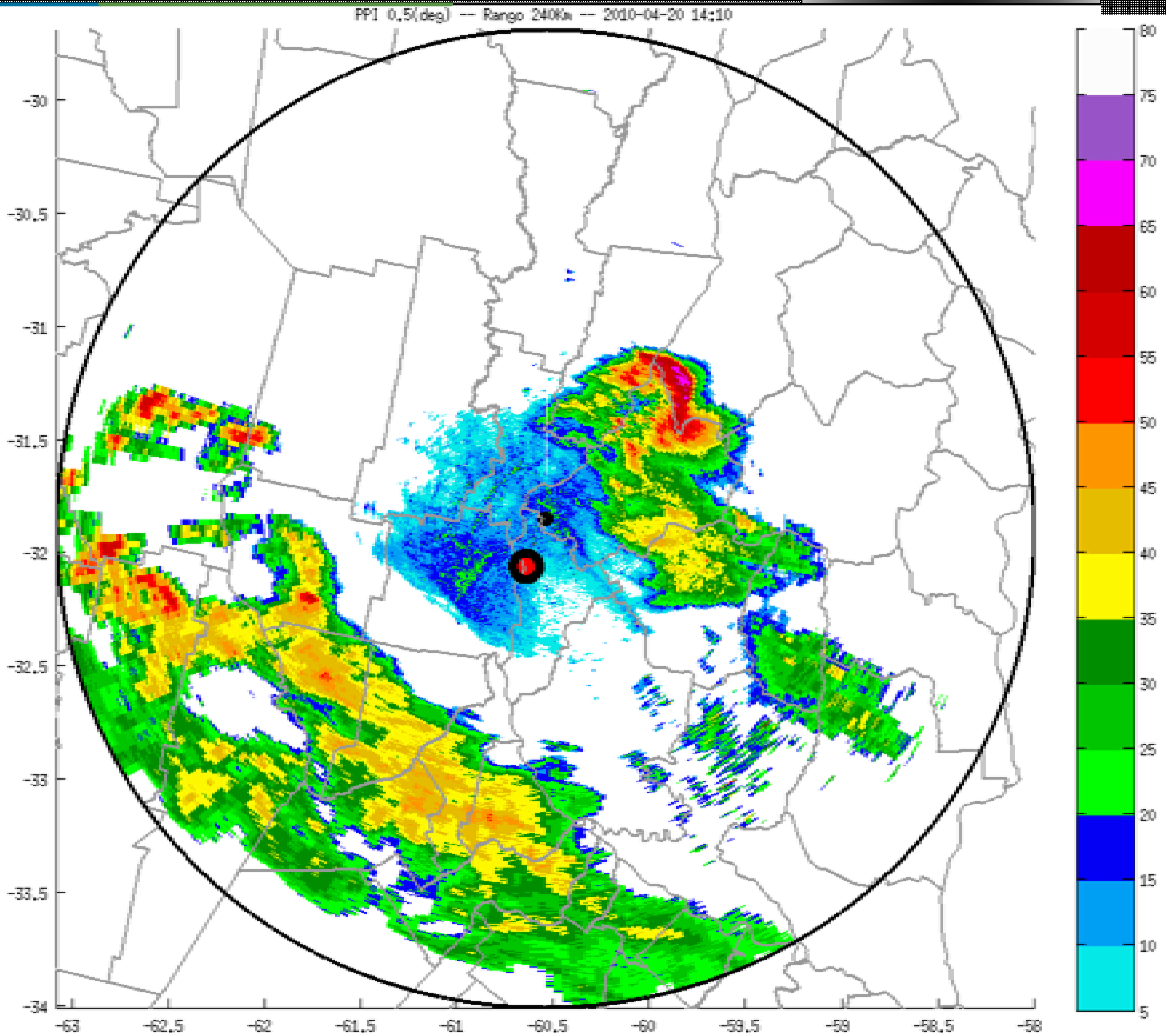
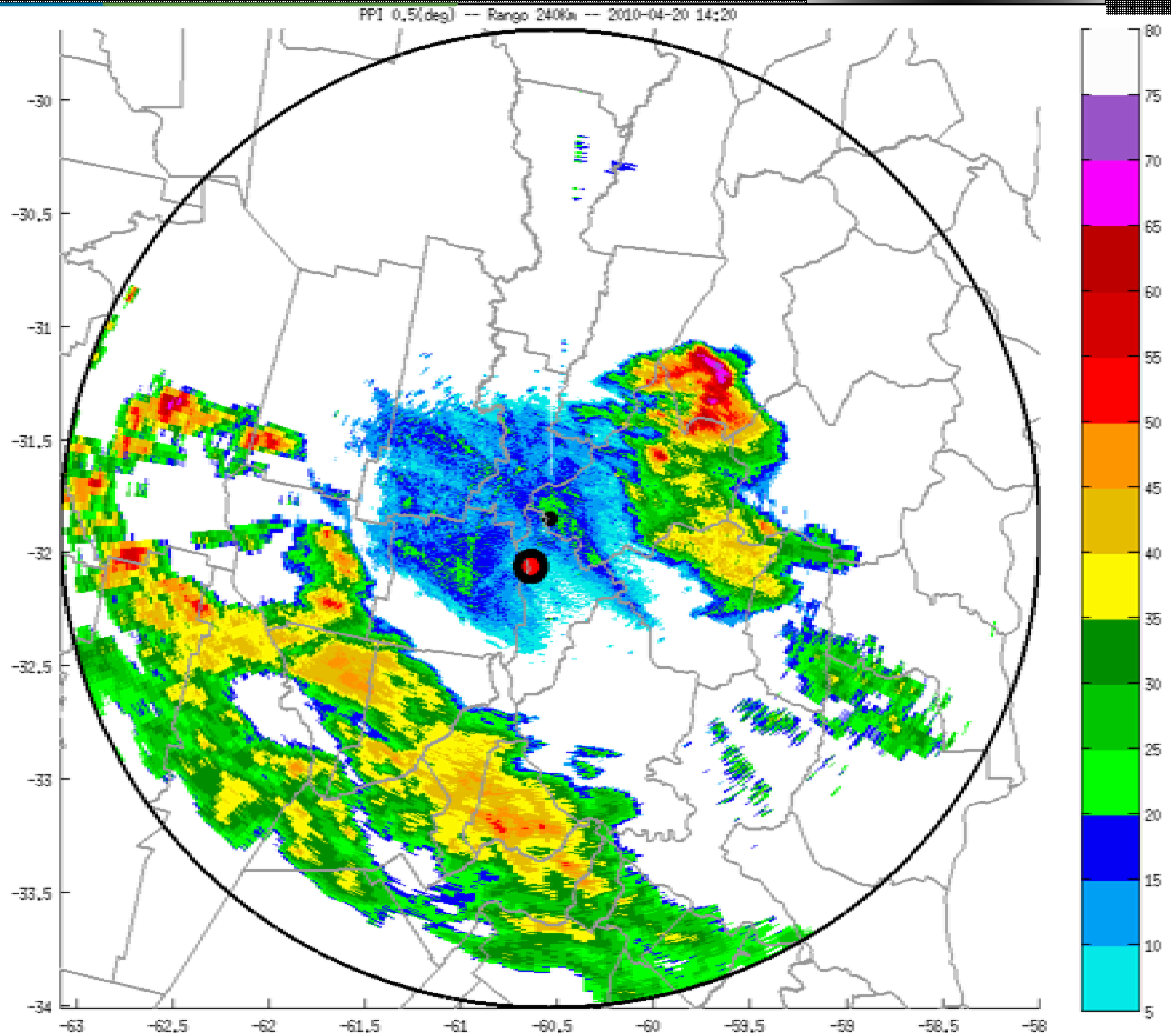
Case studies

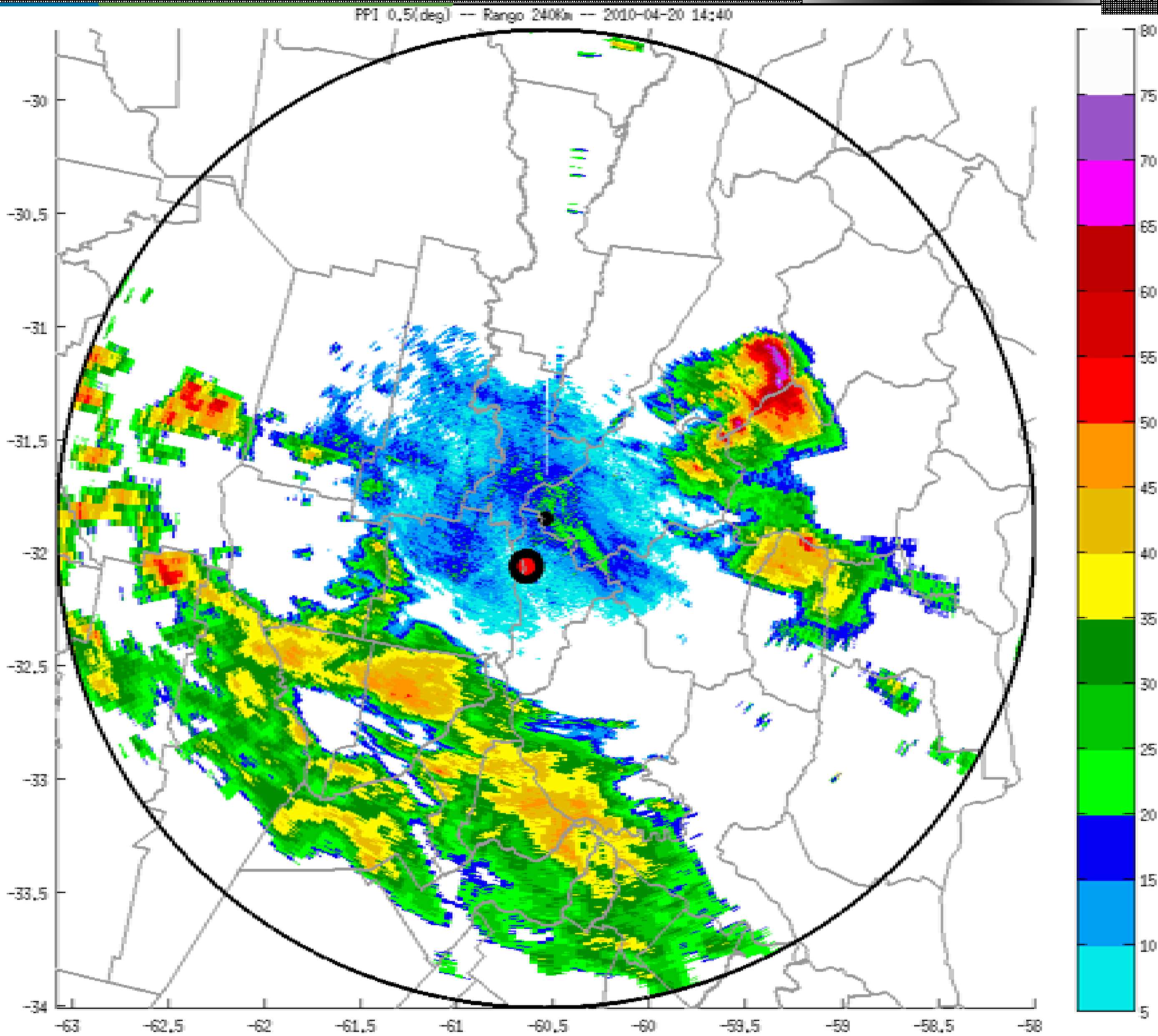


Case studies



Case studies

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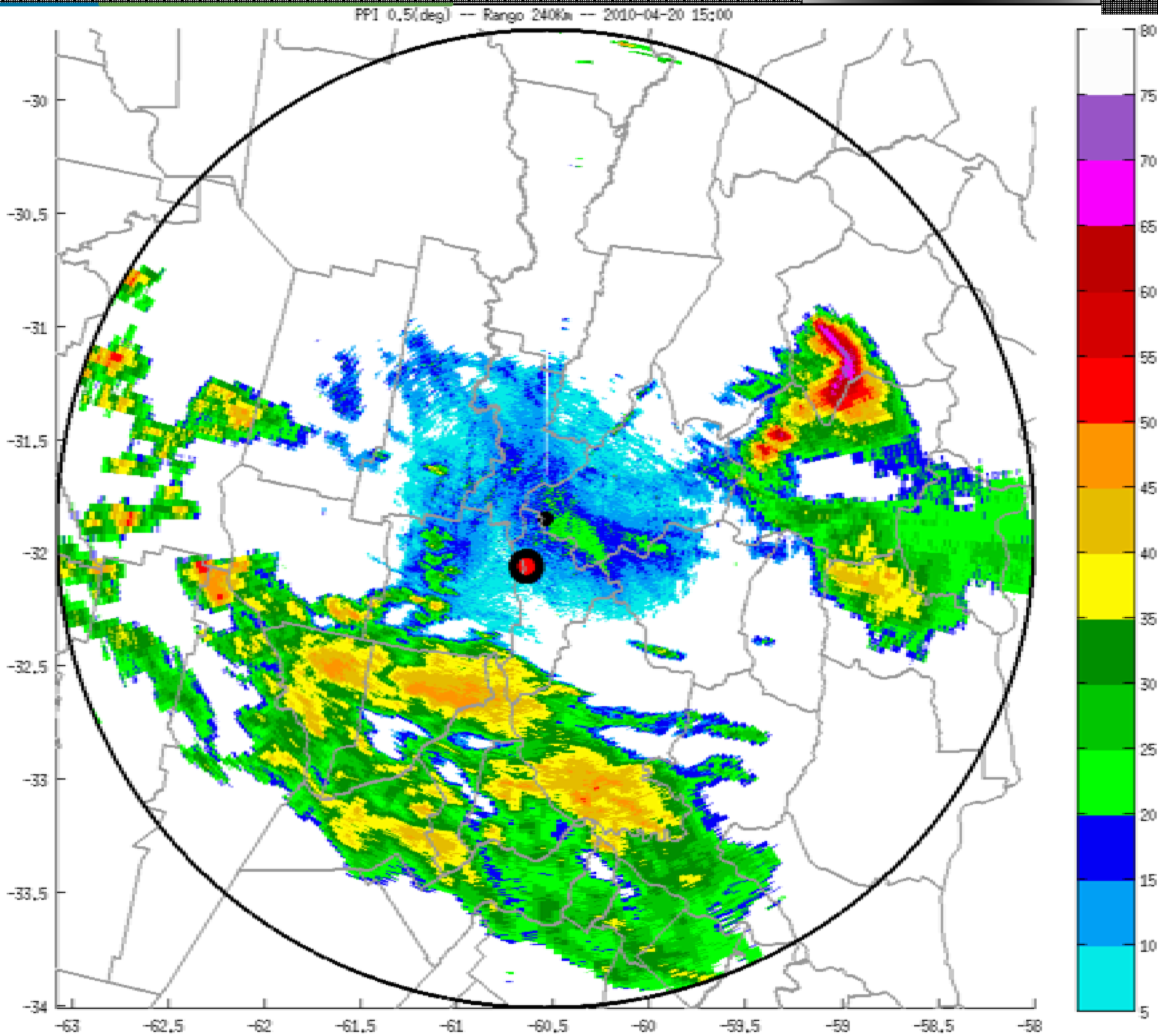
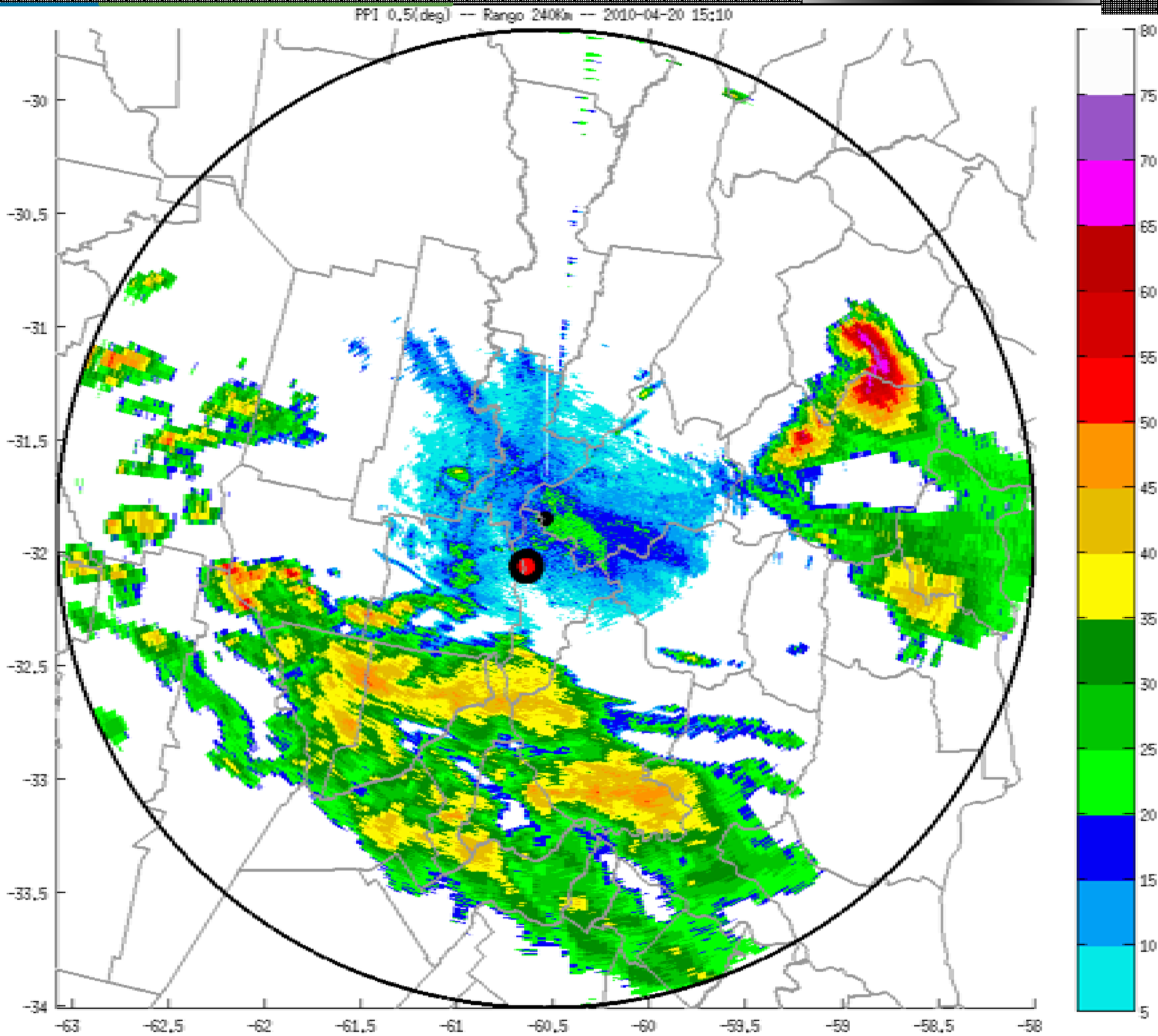
Case studies

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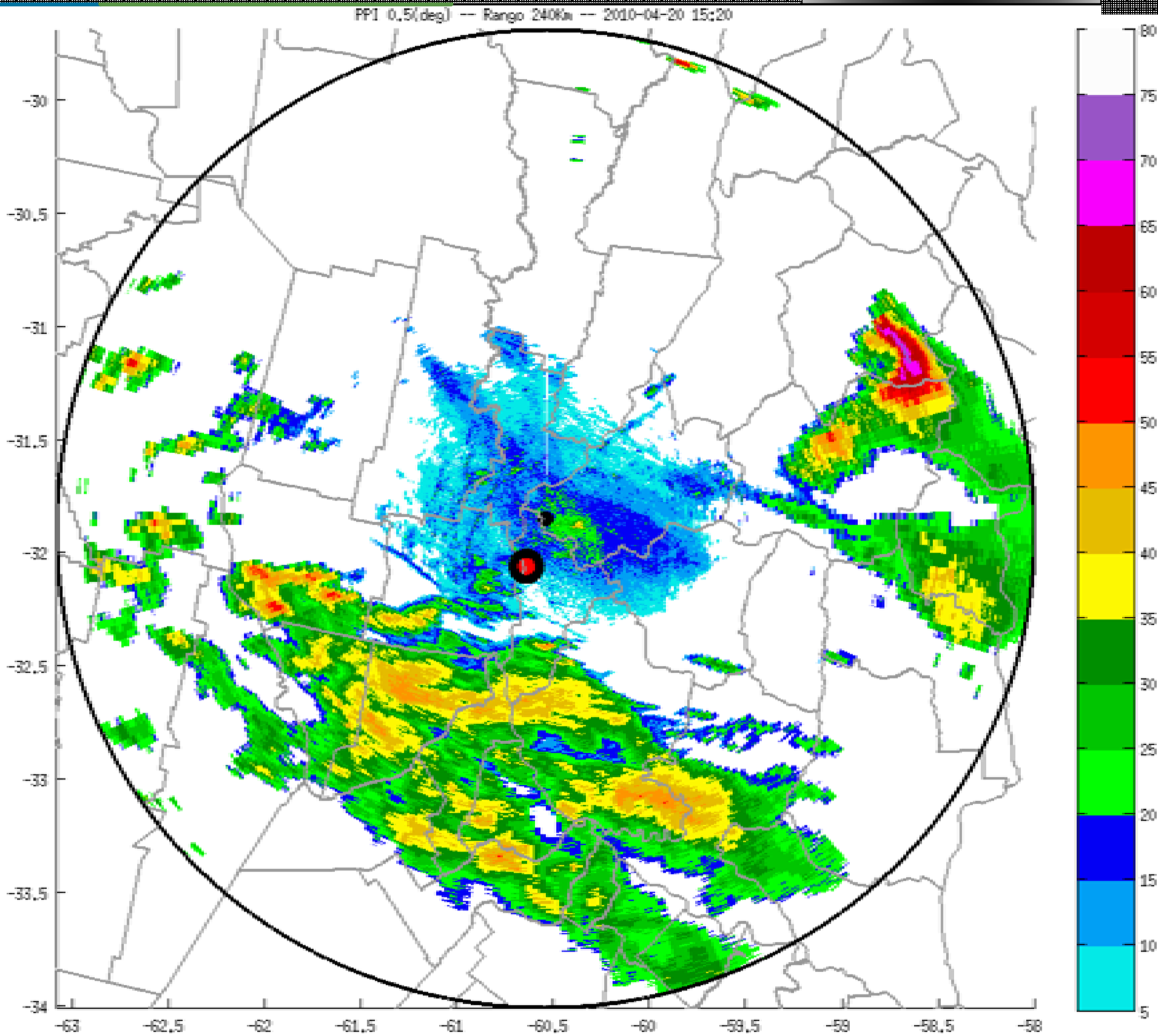
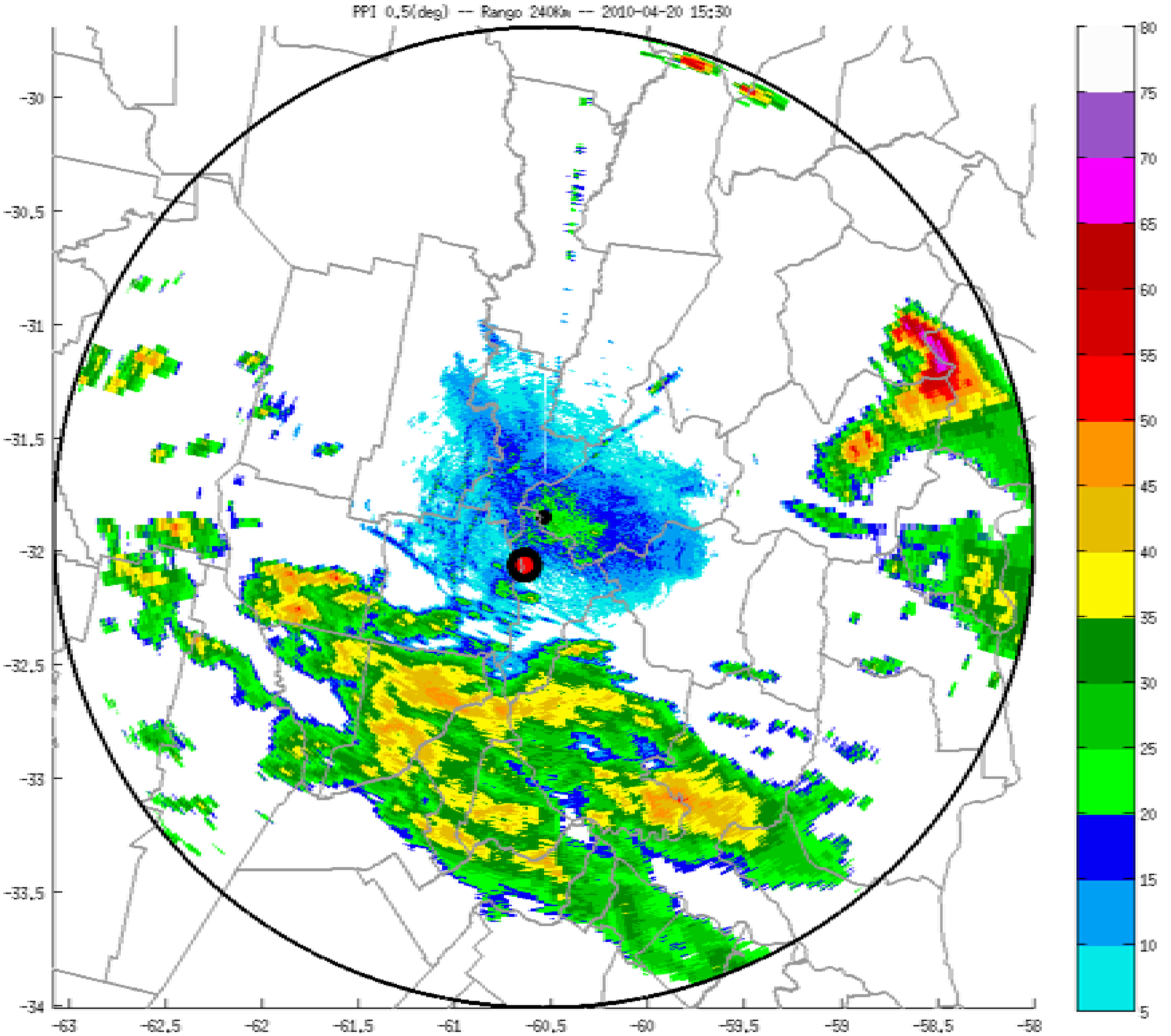
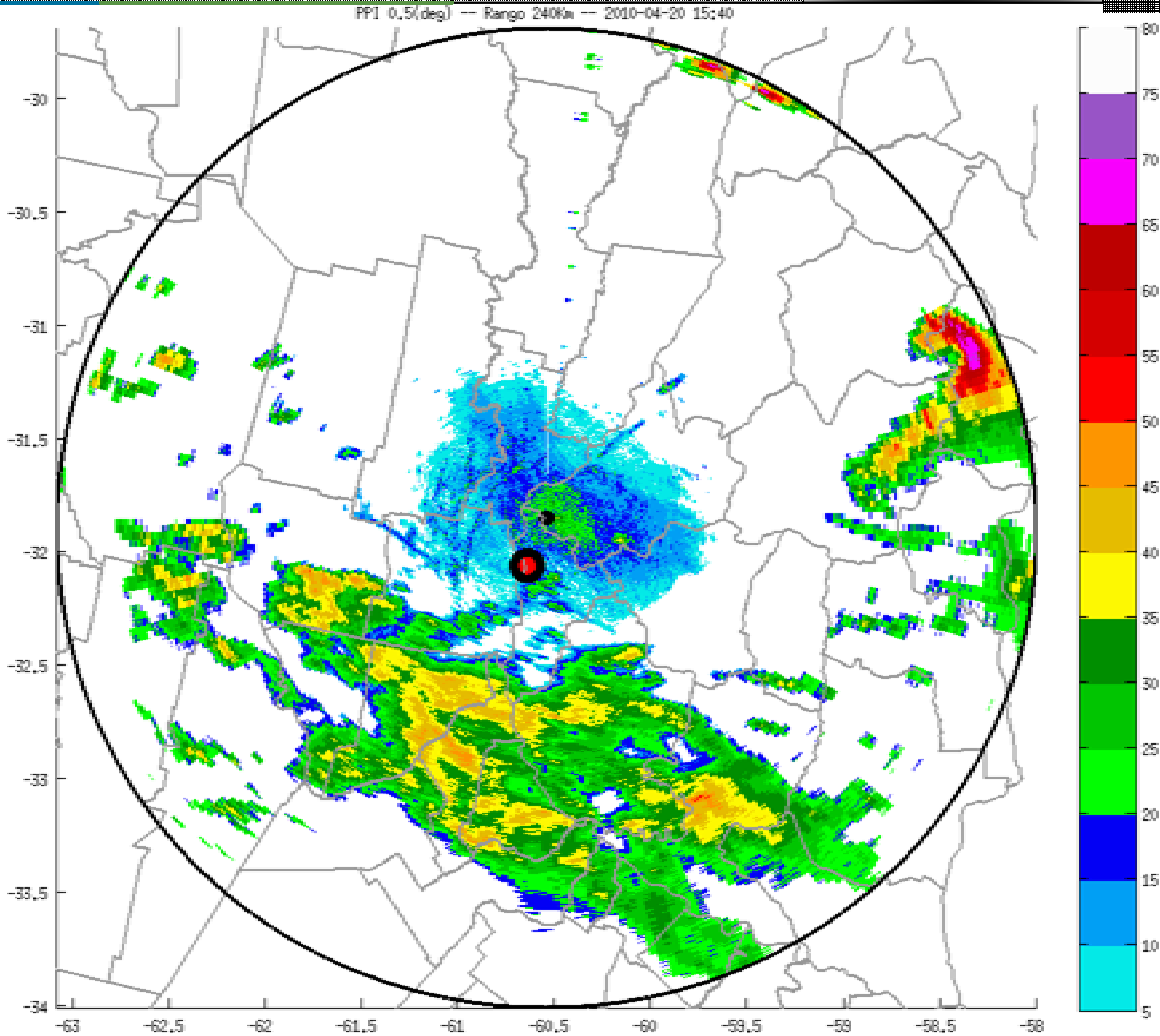
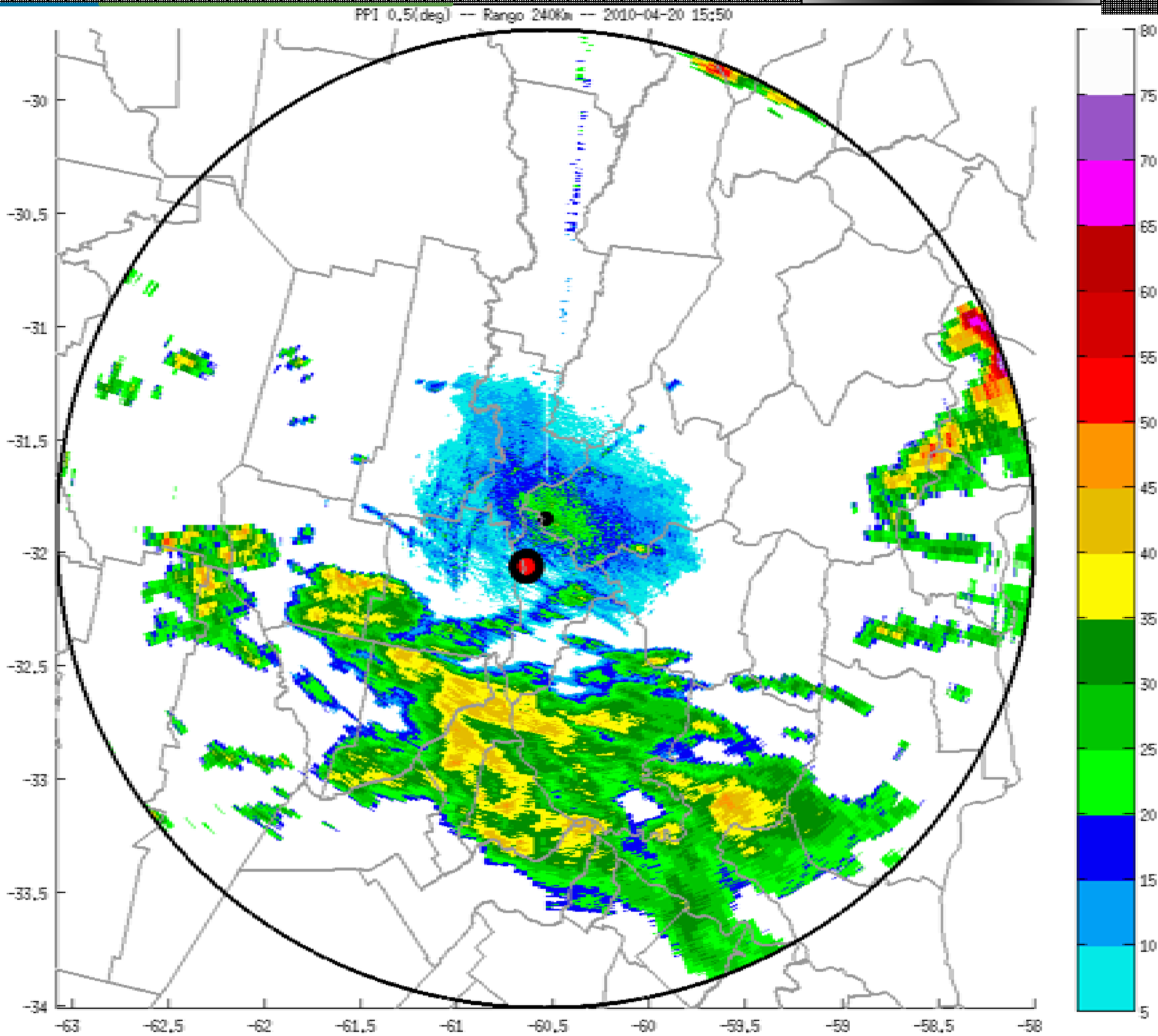
Case studies




PPI 0.5(deg) -- Rango 240Km -- 2010-04-20 15:30
-30
-30.5
-31
-31.5
-32
-32.5
-33
-33.5
-34
-63
-62.5
-62
-61.5
-61
-60.5
-60
-59.5
-59
-58.5
-58
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5

Case studies

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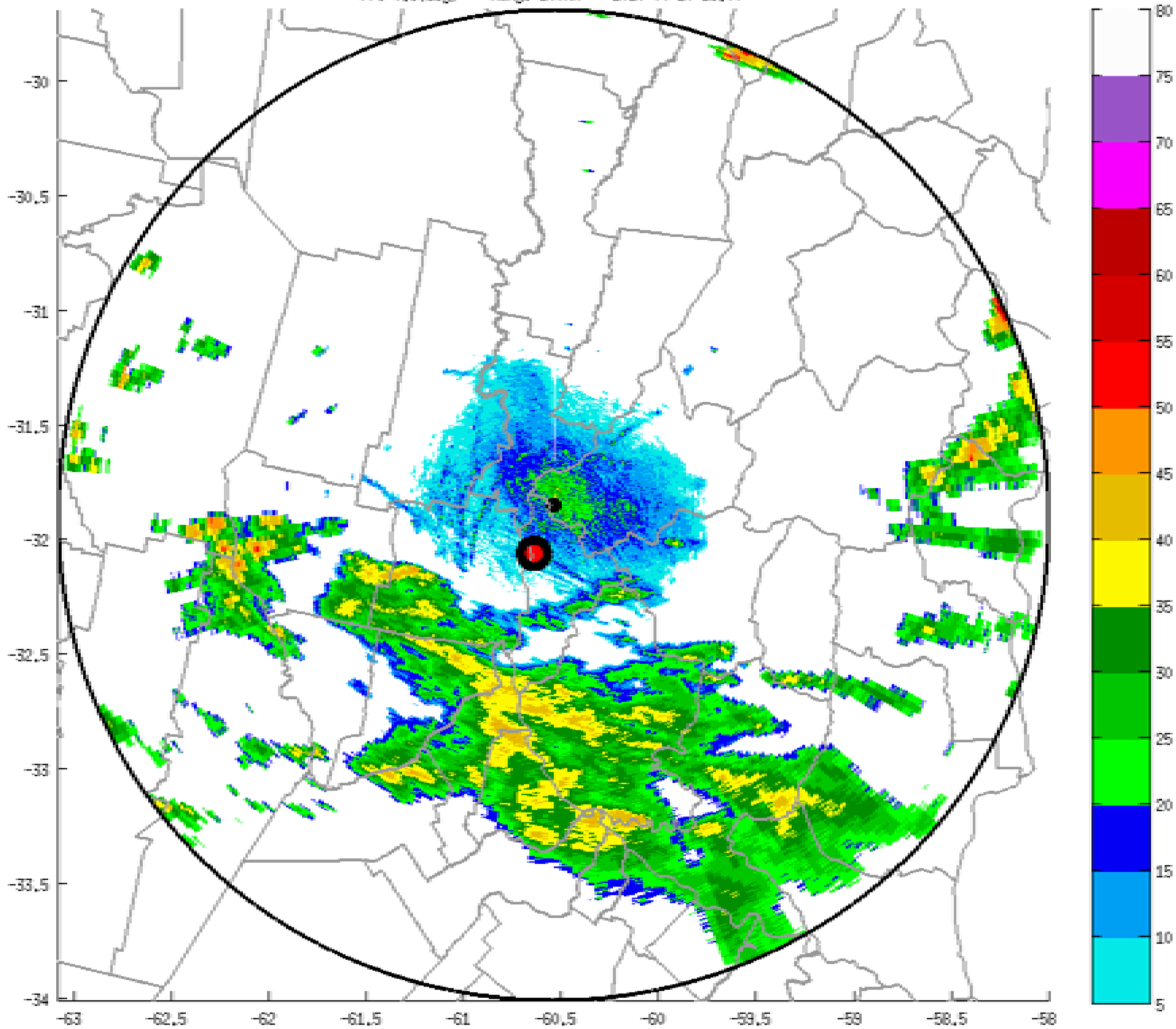
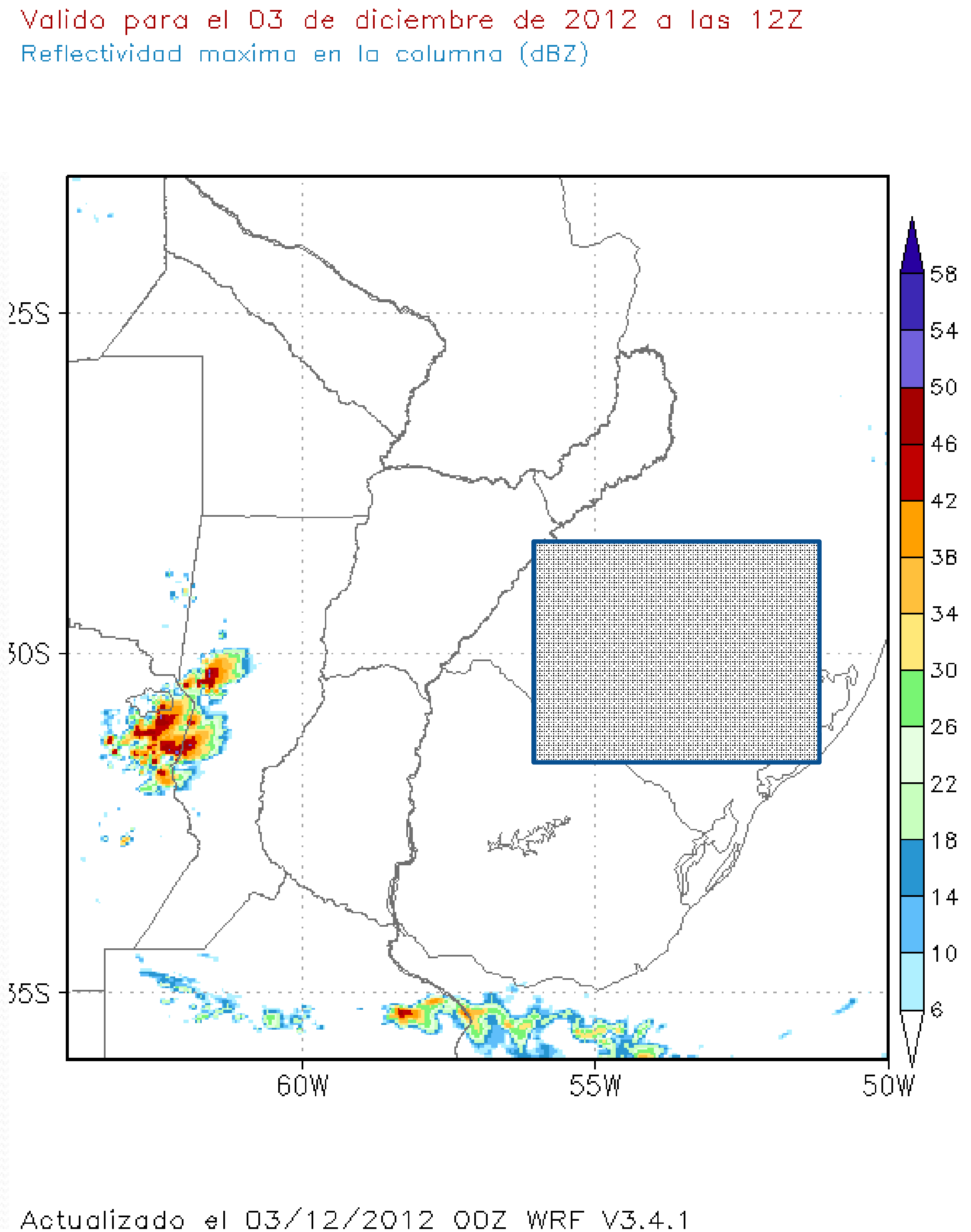
-30
-30.5
-31
-31.5
-32
-32.5
-33
-33.5
-34
-63
-62.5
-62
-61.5
-61
-60.5
-60
-59.5
-59
-58.5
-58
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5

Case studies

PPI 0.5(deg) -- Rango 240Km -- 2010-04-20 16:00

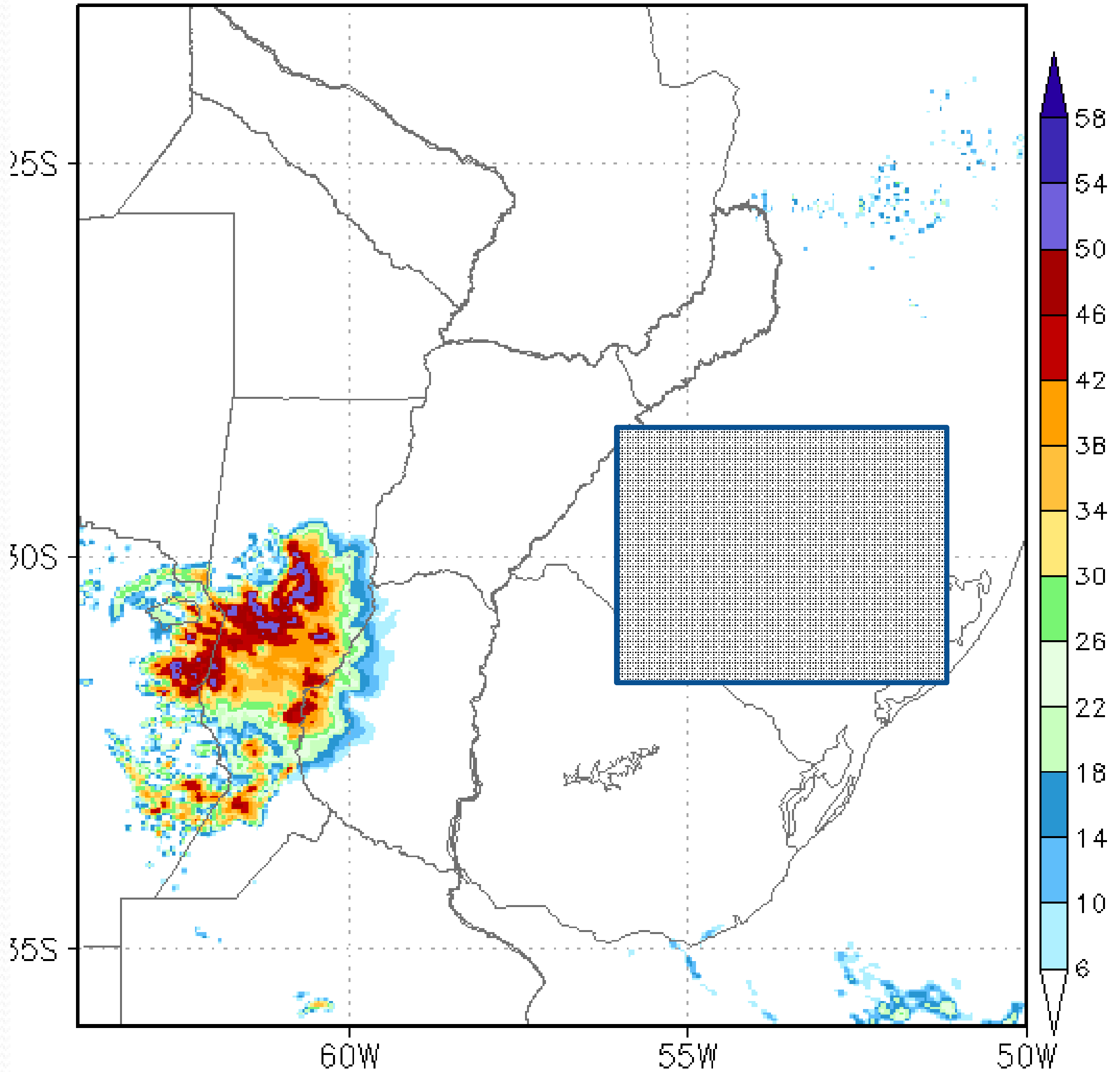


CHUVA – Santa Maria

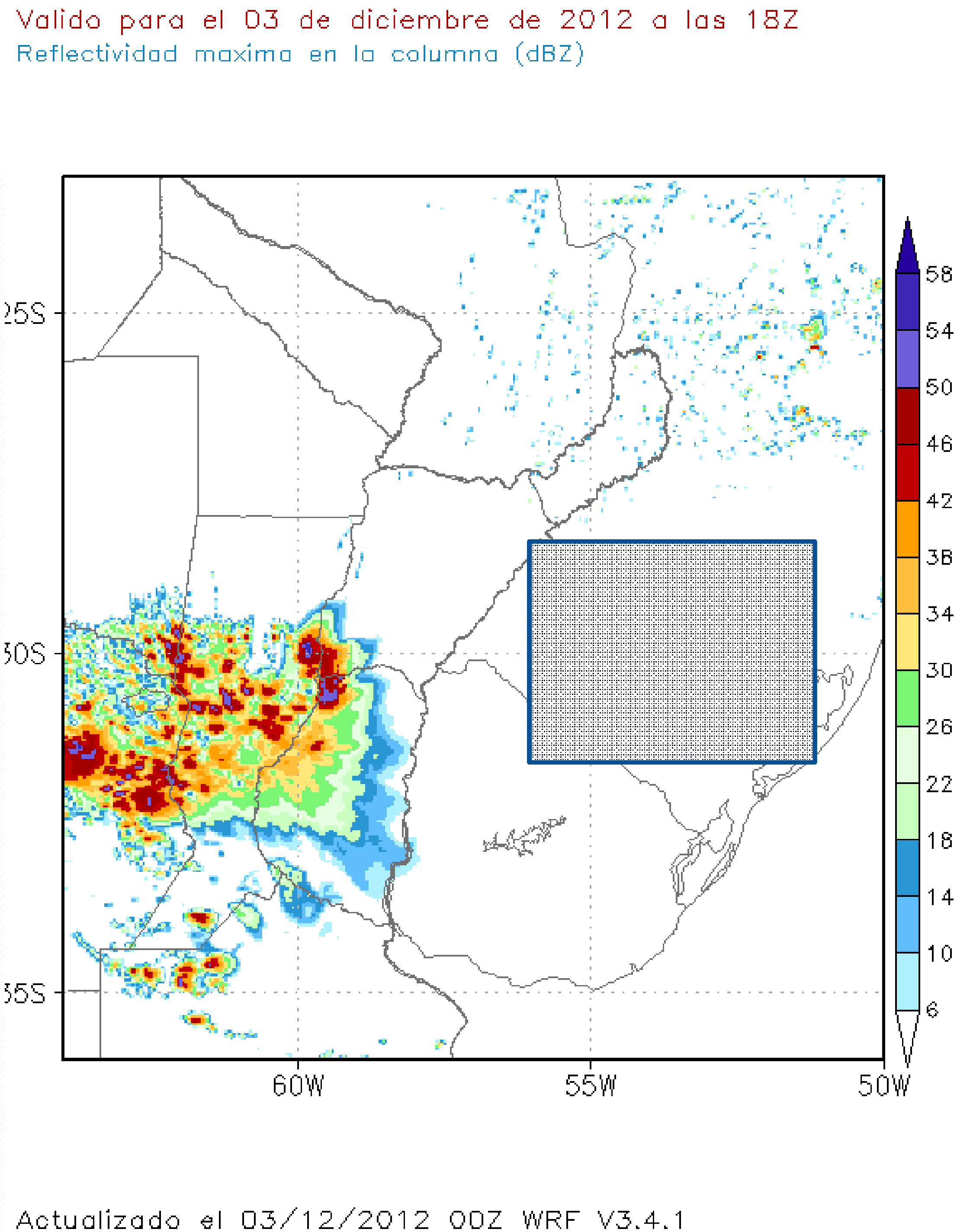

Valido para el 03 de diciembre de 2012 a las 12Z
Reflectividad maxima en la columna (dBZ)
25S
30S
35S
60W
55W
50W
58
54
50
46
42
38
34
30
26
22
18
14
10
6
Actualizado el 03/12/2012 00Z WRF V3.4.1

Valido para el 03 de diciembre de 2012 a las 15Z

Reflectividad maxima en la columna (dBZ)

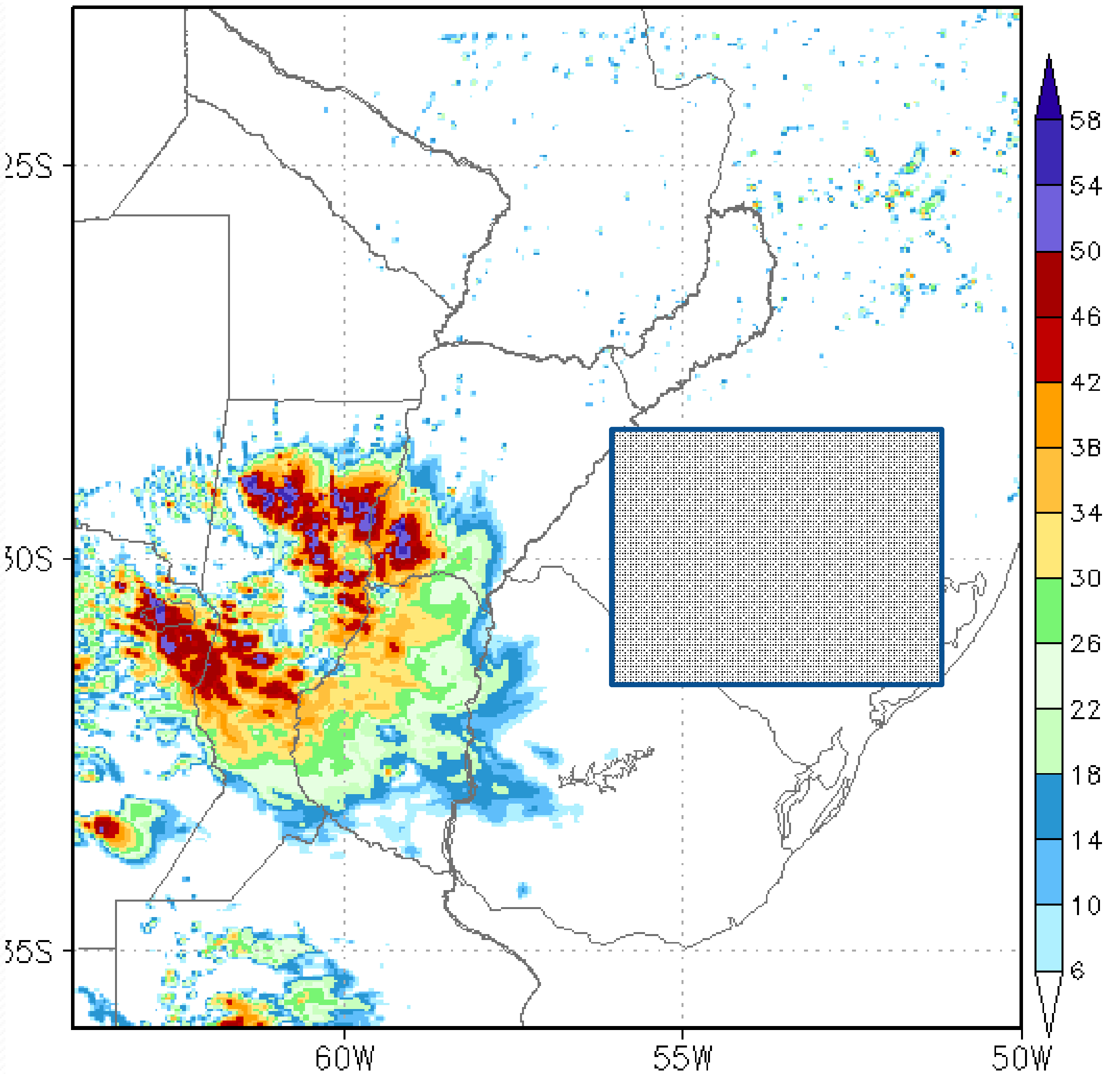


Actualizado el 03/12/2012 00Z WRF V3.4.1

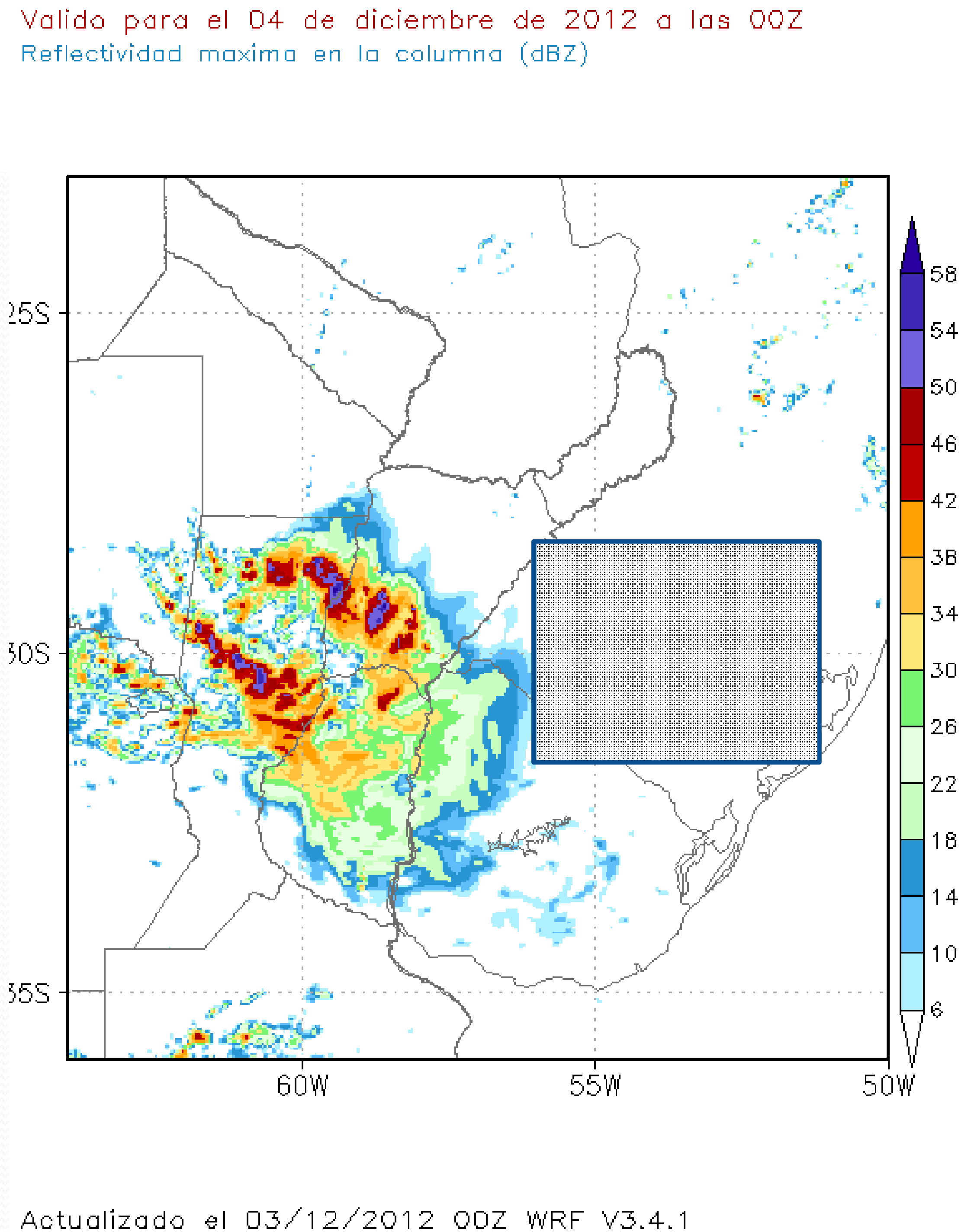

Valido para el 03 de diciembre de 2012 a las 18Z
Reflectividad maxima en la columna (dBZ)
25S
30S
35S
60W
55W
50W
58
54
50
46
42
38
34
30
26
22
18
14
10
6
Actualizado el 03/12/2012 00Z WRF V3.4.1

Valido para el 03 de diciembre de 2012 a las 21Z

Reflectividad maxima en la columna (dBZ)



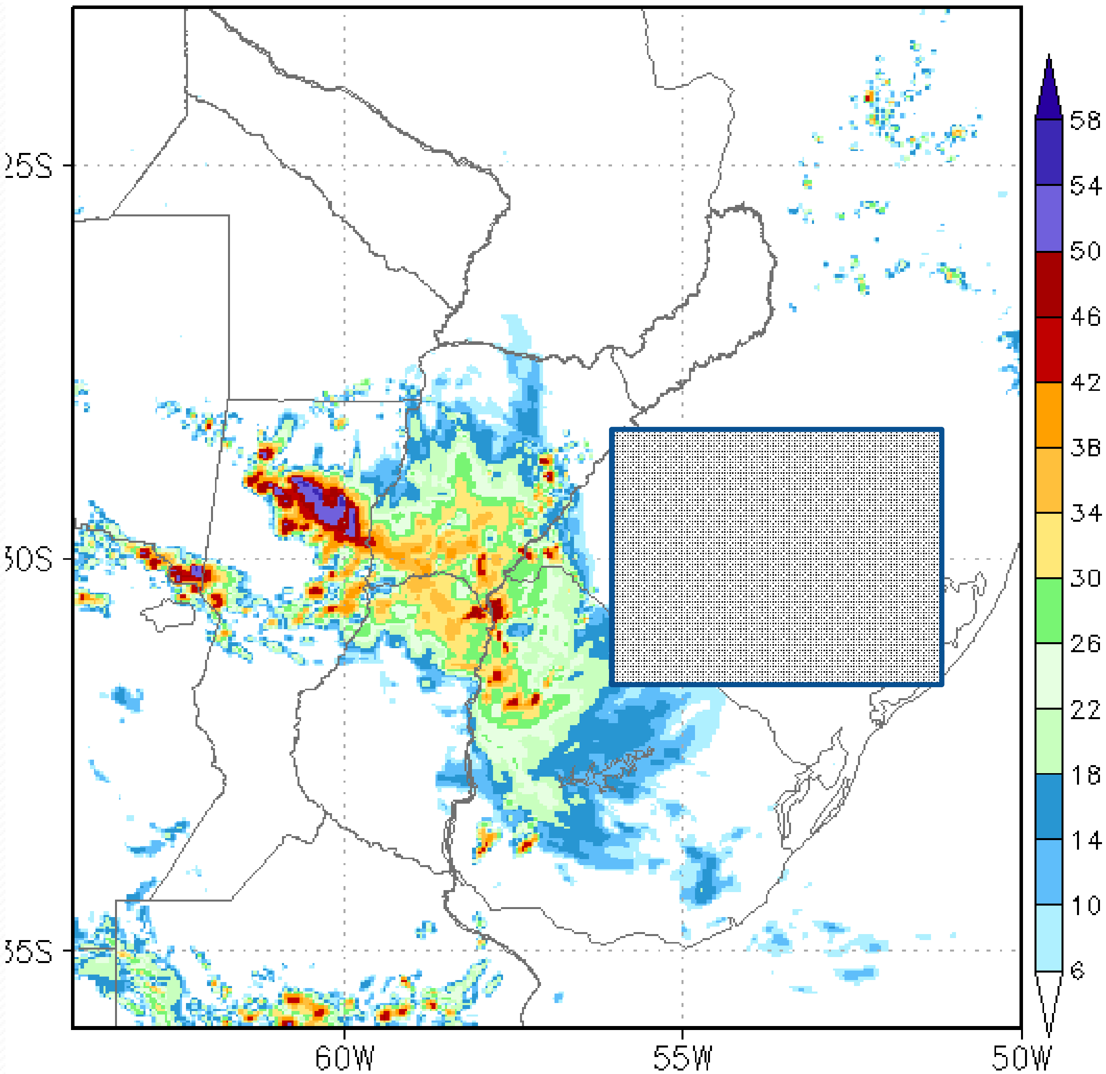
Actualizado el 03/12/2012 00Z WRF V3.4.1



Valido para el 04 de diciembre de 2012 a las 00Z
Reflectividad maxima en la columna (dBZ)
25S
30S
35S
60W
55W
50W
58
54
50
46
42
38
34
30
26
22
18
14
10
6
Actualizado el 03/12/2012 00Z WRF V3.4.1

Valido para el 04 de diciembre de 2012 a las 03Z

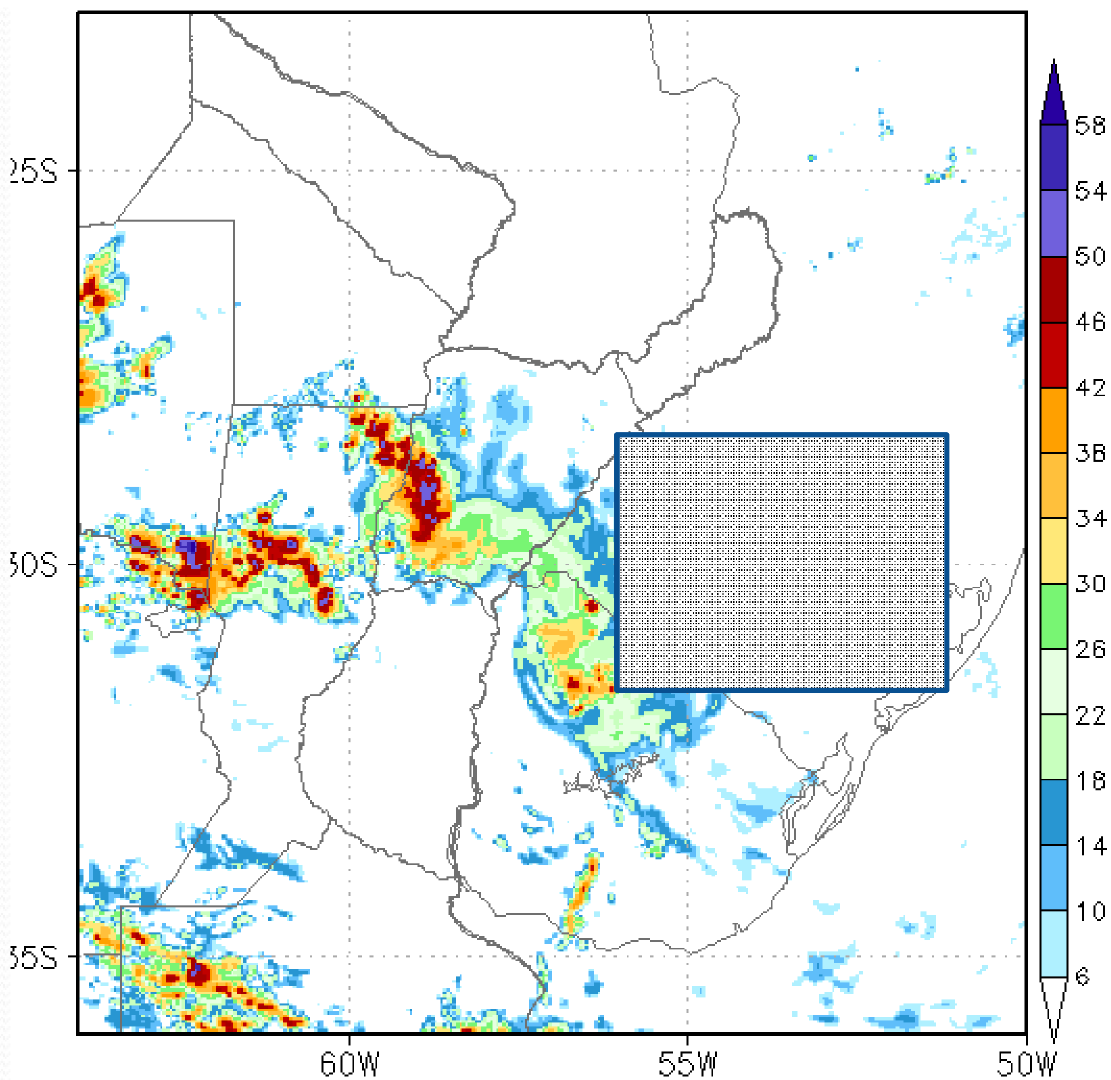
Reflectividad maxima en la columna (dBZ)



Actualizado el 03/12/2012 00Z WRF V3.4.1

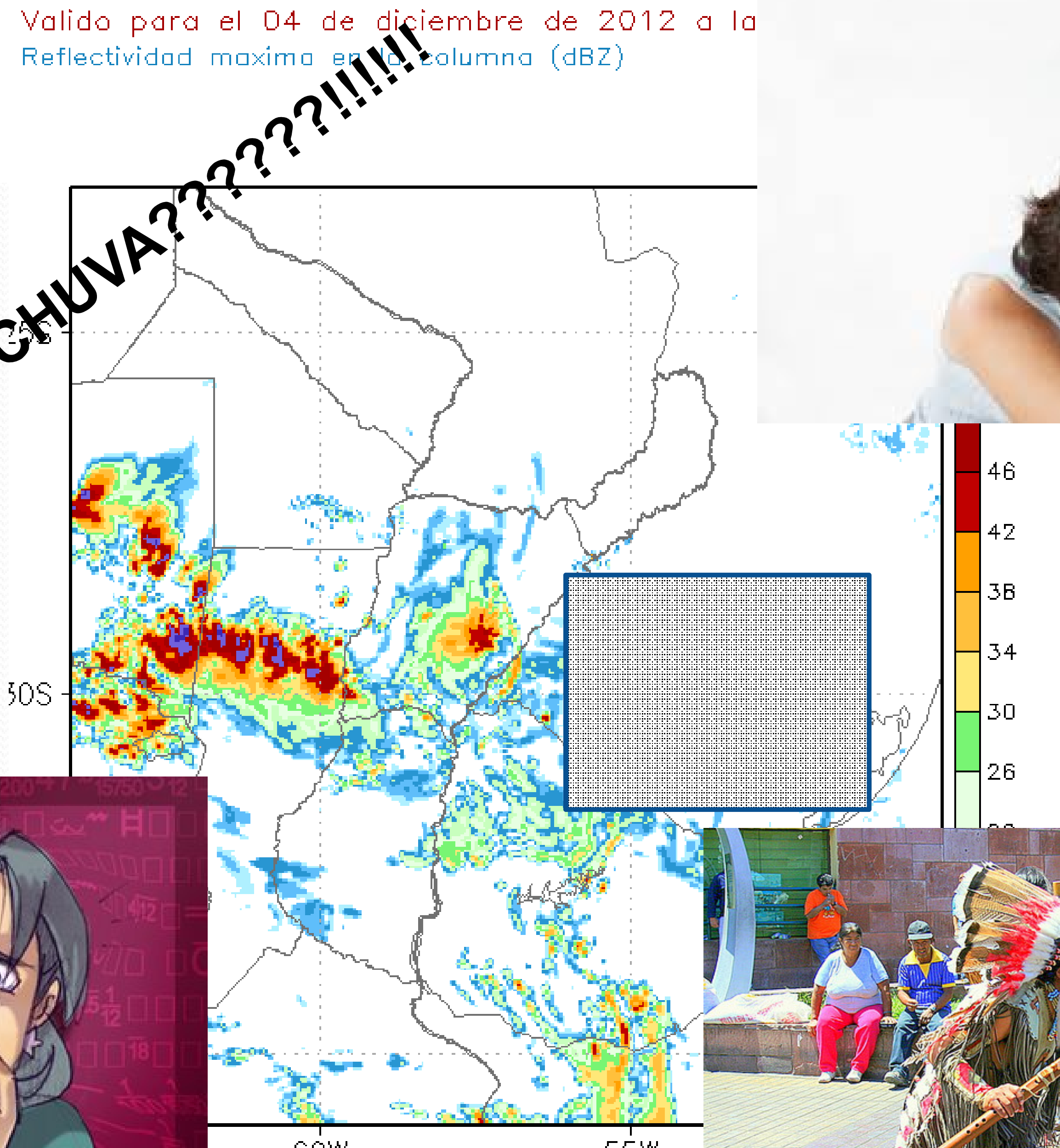
Valido para el 04 de diciembre de 2012 a las 06Z

Reflectividad maxima en la columna (dBZ)

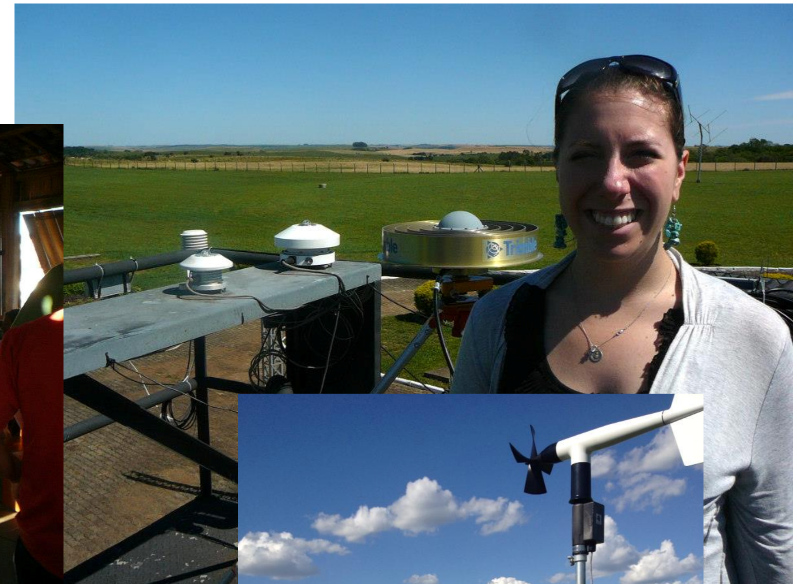


Actualizado el 03/12/2012 00Z WRF V3.4.1

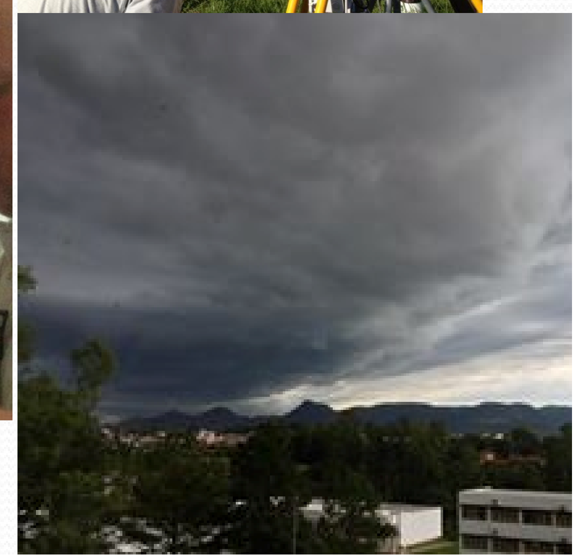
Where is the CHUVA??????!!!!!!




PERIGO
ALTA TENSÃO





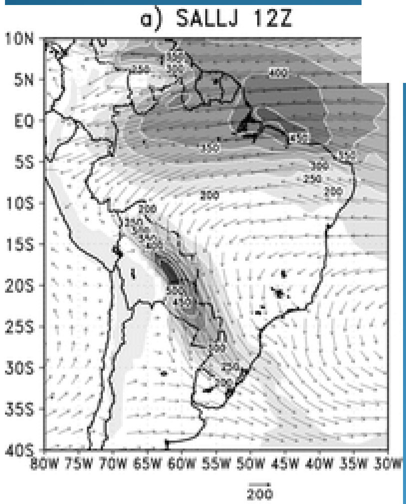



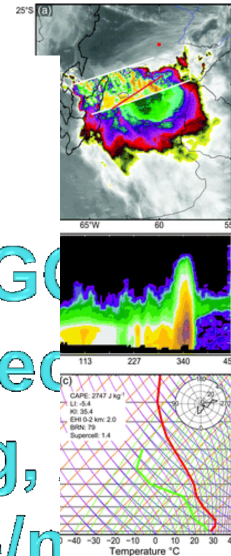
RELAMPAG

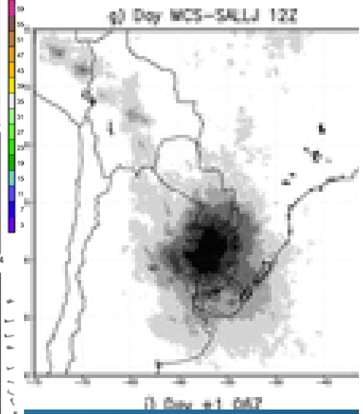
sensing of Elec

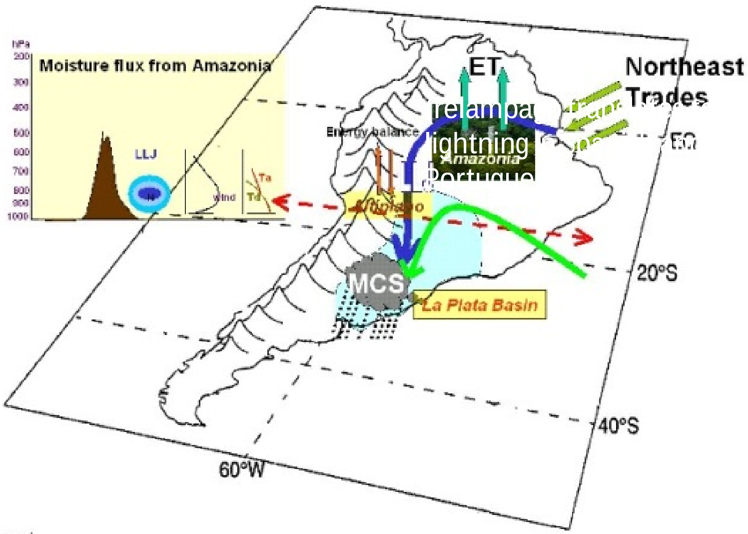
Lightning,

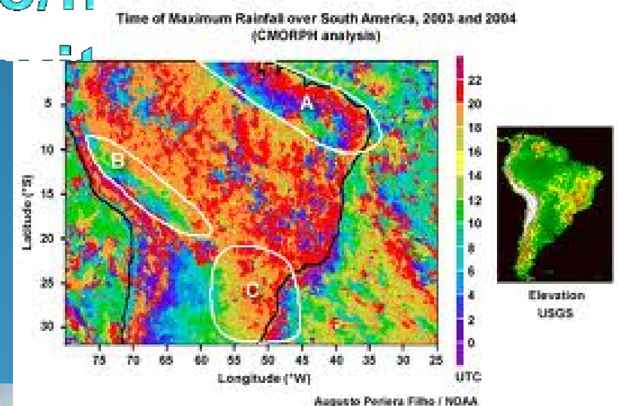
scale/m

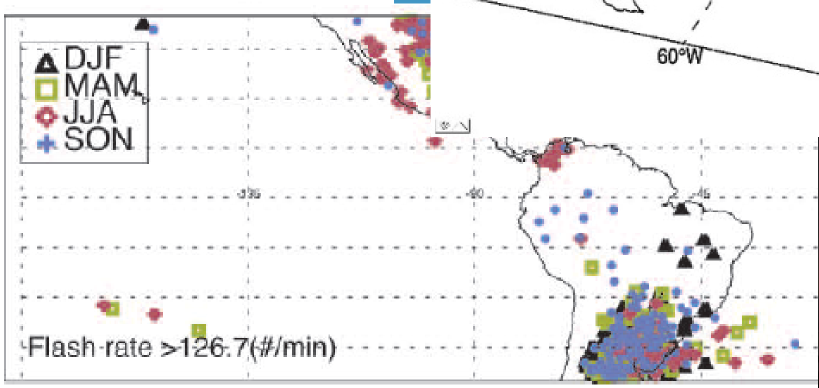


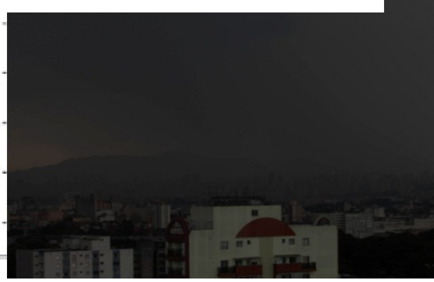








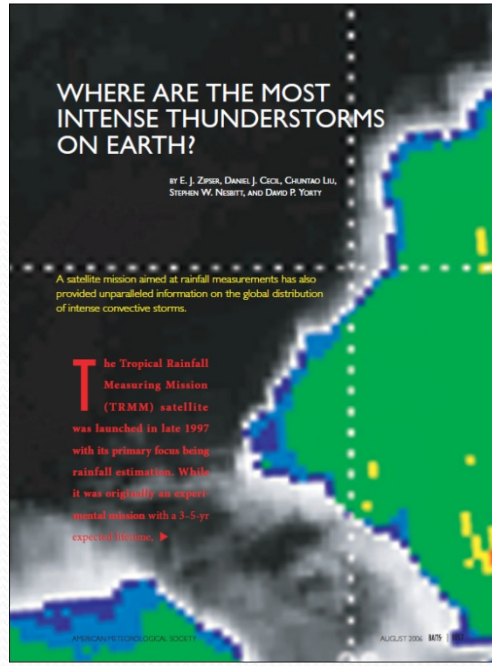




RELAMPAGO (a working acronym) is envisioned to be an international multi-agency field program to ***study multi-scale aspects of intense, organized convective systems that produce severe weathe***r in subtropical south America

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.



WHERE ARE THE MOST INTENSE THUNDERSTORMS ON EARTH?

BY E. J. ZIPSER, DANIEL J. CECIL, CHUNTAO LIU, STEPHEN W. NESBITT, AND DAVID P. YORTY

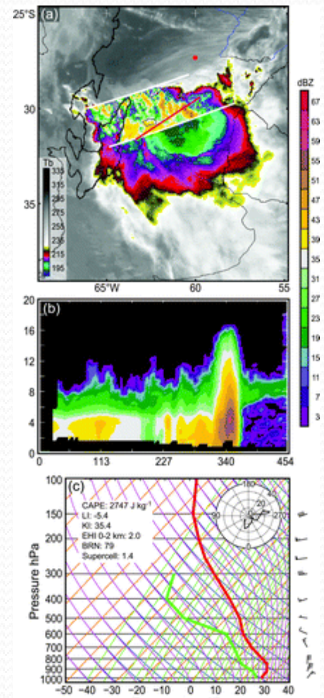
A satellite mission aimed at rainfall measurements has also provided unparalleled information on the global distribution of intense convective storms.

The Tropical Rainfall Measuring Mission (TRMM) satellite was launched in late 1997 with its primary focus being rainfall estimation. While it was originally an experimental mission with a 3–5-yr expected lifetime, ▶

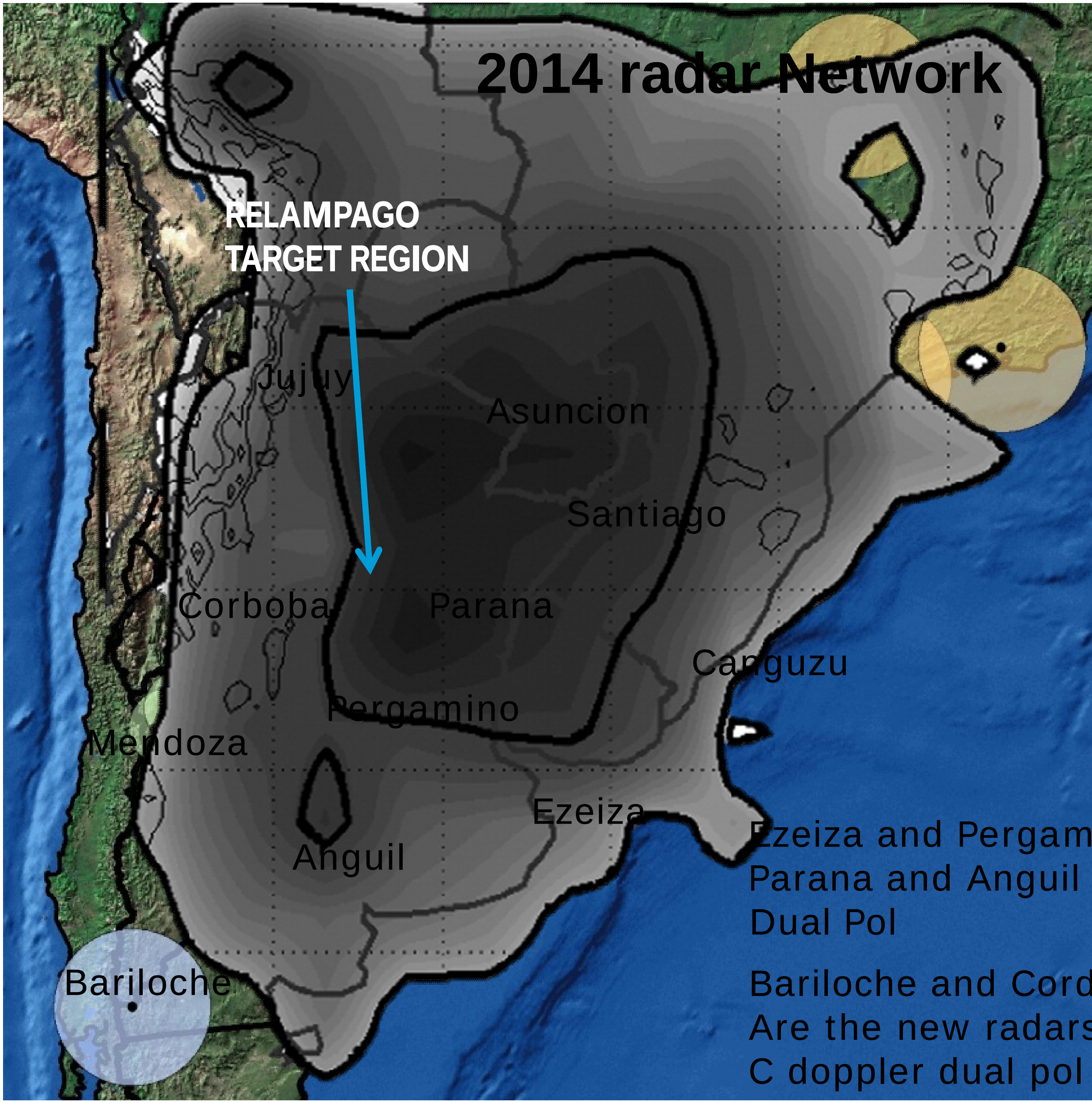
AMERICAN METEOROLOGICAL SOCIETY

AUGUST 2006 BAMS

Zipser et al. 2006



Rasmussen and Houze 2011



Each circle has
480km diameter

Target region has:

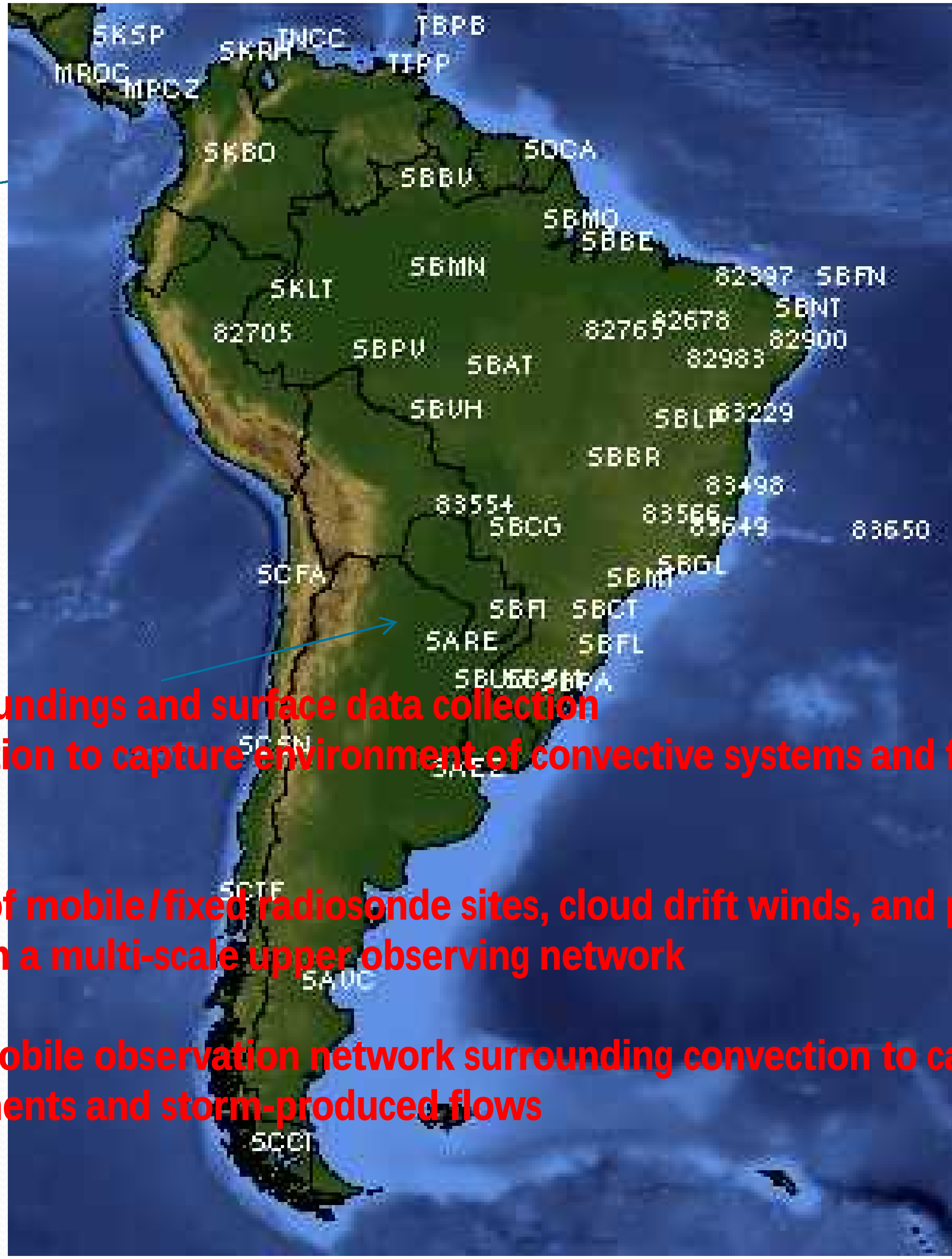
Satellite and ground based indications of severe weather

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



MAJOR CONCERN

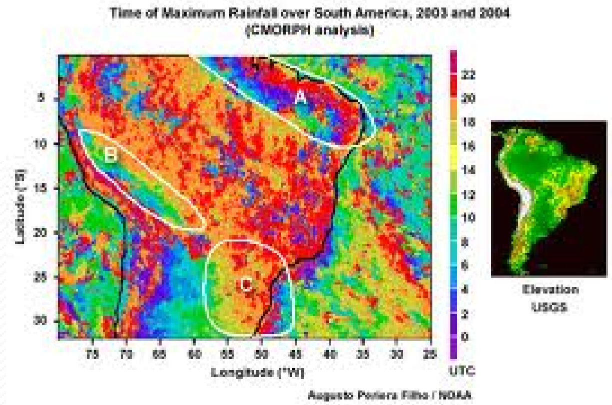
Need to enhance soundings and surface data collection surrounding convection to capture environment of convective systems and flows they generate

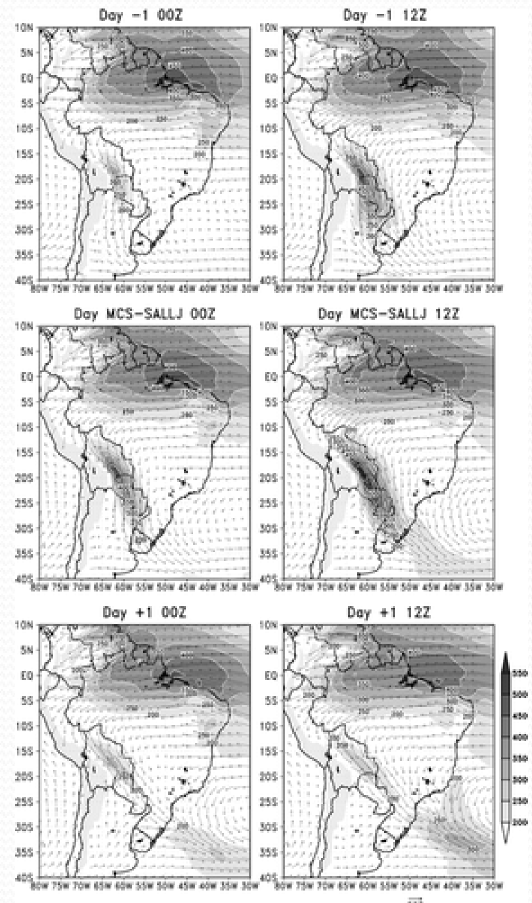
Use a combination of mobile/fixed radiosonde sites, cloud drift winds, and pilot balloon observations to form a multi-scale upper observing network

Deploy a stick net mobile observation network surrounding convection to capture mesoscale environments and storm-produced flows

MCS life cycle

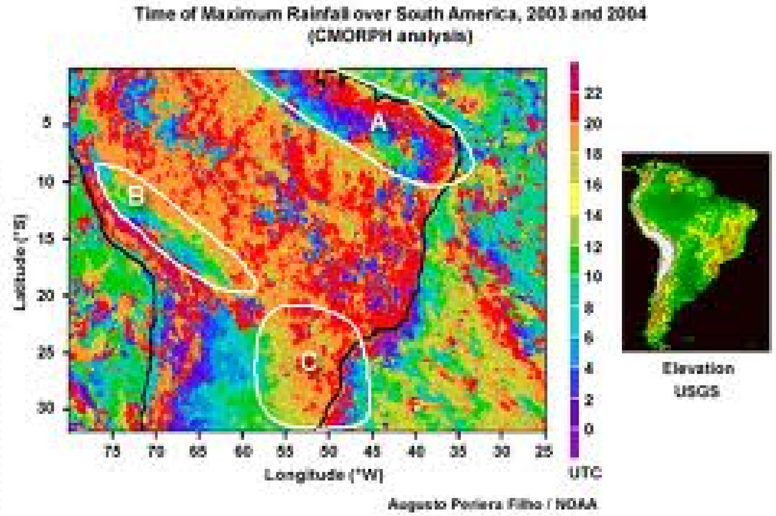
- What controls the diurnal cycle of convective system intensity (vertical structure) and mesoscale organization in the lee of the Andes?
- What is the role of microphysical and kinematic processes in leading to the upscale growth of convective clouds into MCSs and ultimately MCCs?
- Does the extreme 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?

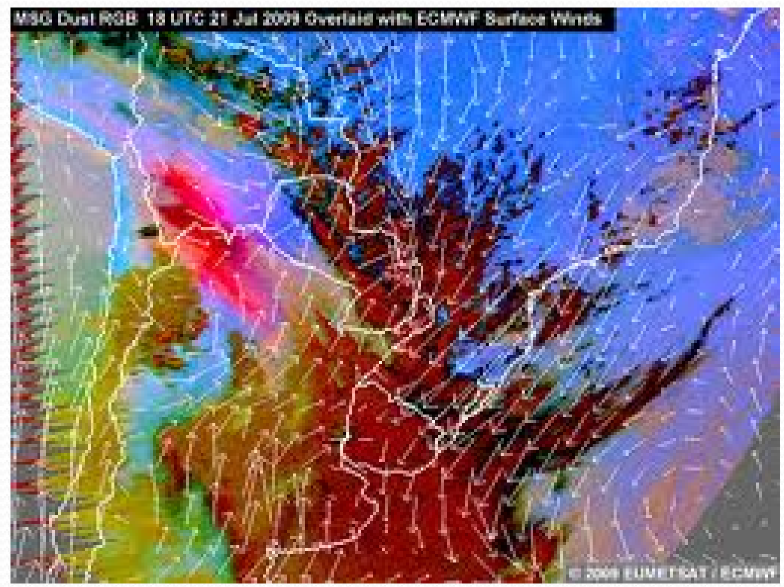




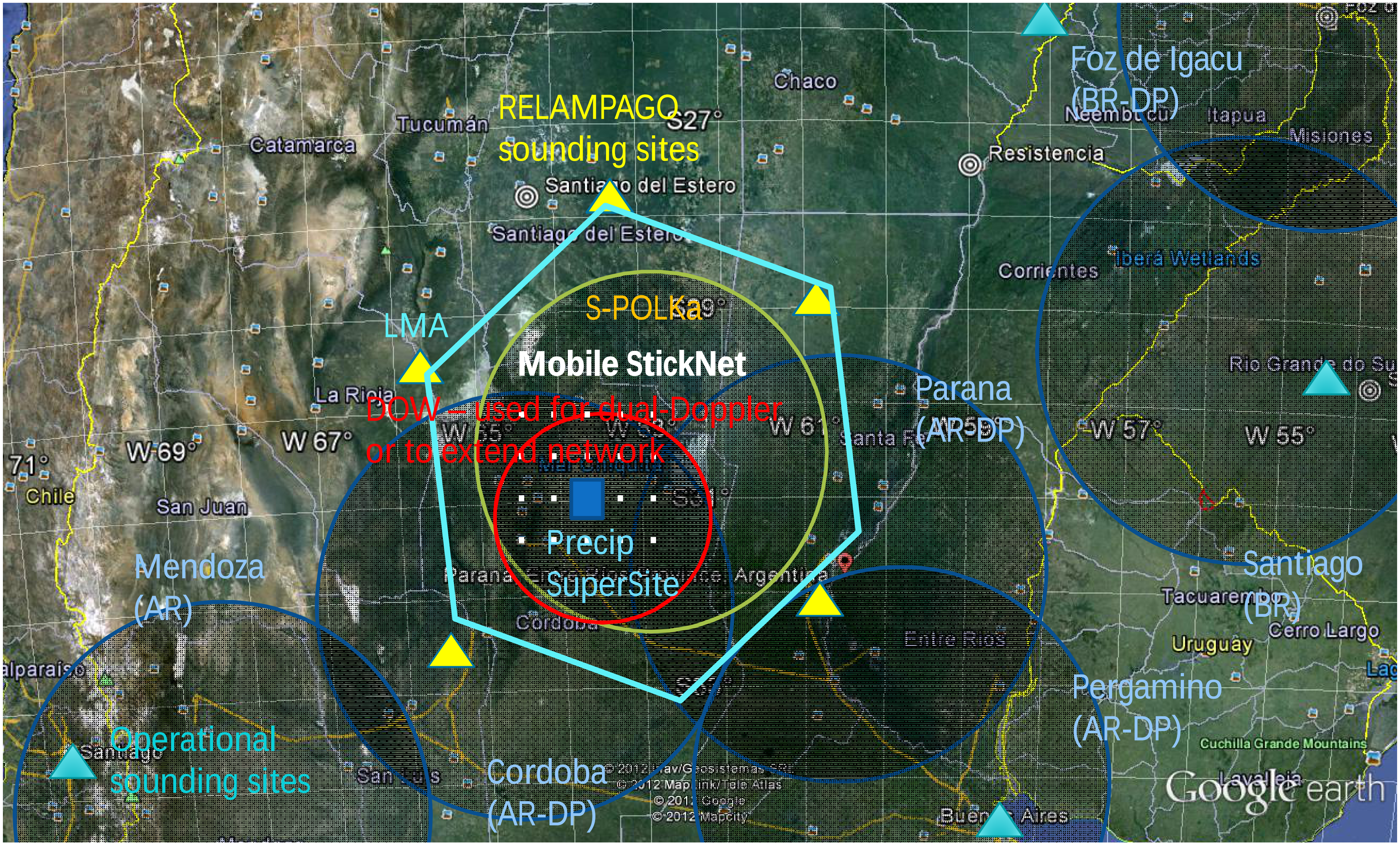
MCS environments

- 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?





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 (UFSM)
  - 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 Winter 2013.

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

Would you like to participate?

Everybody is welcome

Thank you!