Estrutura e comportamento de tempestades supercélulas no Estado de São Paulo, Brasil

Gerhard Held[1], Ana Maria Gomes[1] e Kleber Naccarato[2]

[1] Instituto de Pesquisas Meteorológicas (UNESP), Bauru, S.P.

[2] Grupo de Eletricidade Atmosférica (INPE), São José dos Campos S.P. Brazil

III WORKETA

Cachoeira Paulista, 28 de Out. de 2010

The Structure and Behaviour of Supercell Storm Events in the State of São Paulo, Brazil

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ERAD 2010

Sibiu, Romania, 06-10 September 2010

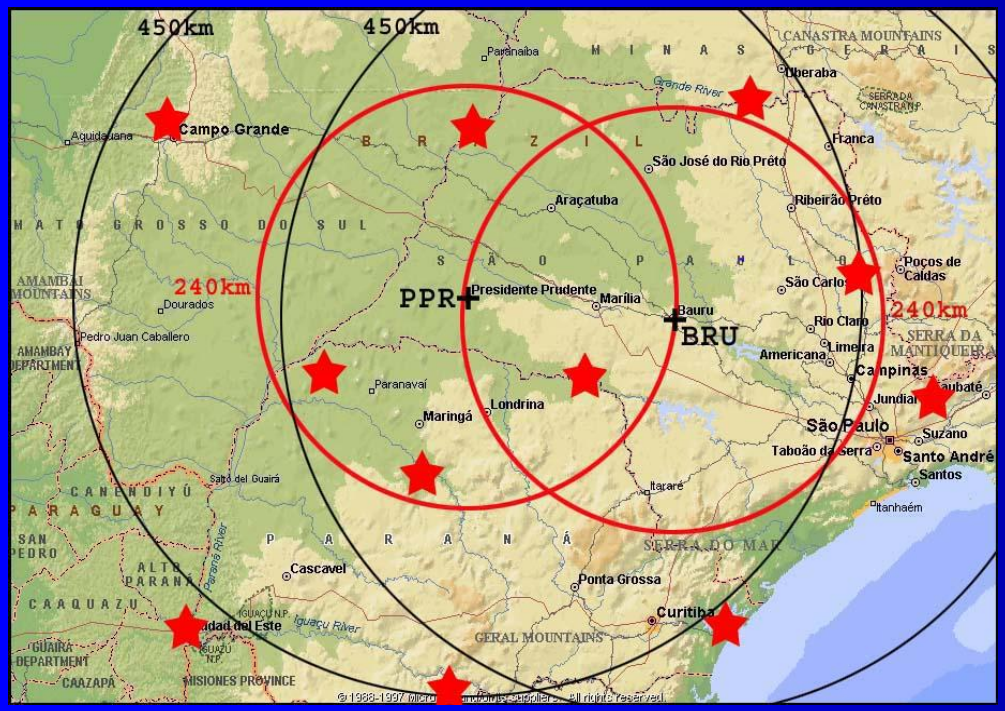
INTRODUCTION

- Severe storms in Southeast Brazil frequently cause enormous damage to agriculture, urban areas, industries, as well as loss of many lives, due to strong winds (relatively frequent microbursts and occasional tornadoes), hailstones, intense lightning and flash floods, resulting in many millions of US Dollar damage annually;
- IPMet's efforts had mostly been concentrated on identifying specific signatures during severe storm events from radar observations, which could be used as indicators of storm severity, as well as to develop algorithms for short-term predictions;
- However, it is of equal importance to develop an effective alert system for the occurrence of such severe events, ranging from a couple of days (based on model outputs) to 30 min to three hours ahead (nowcasting, using model outputs and radar information);
- The objective of this study is, to test the capabilities of the Meso-Eta model for an early alert system in Southeast Brazil;
- And ultimately, to provide a better Alerting System (up to 48 hours) for the State of São Paulo .

OBJECTIVES

This paper presents characteristics of supercell storms, using TITAN (Thunderstorm Identification, Tracking, Analysis and Nowcasting) to determine cell tracks and storm severity parameters, together with lightning data (CG strokes) from the Brazilian Lightning Detection Network BrasilDat (only available from 1999 onwards).

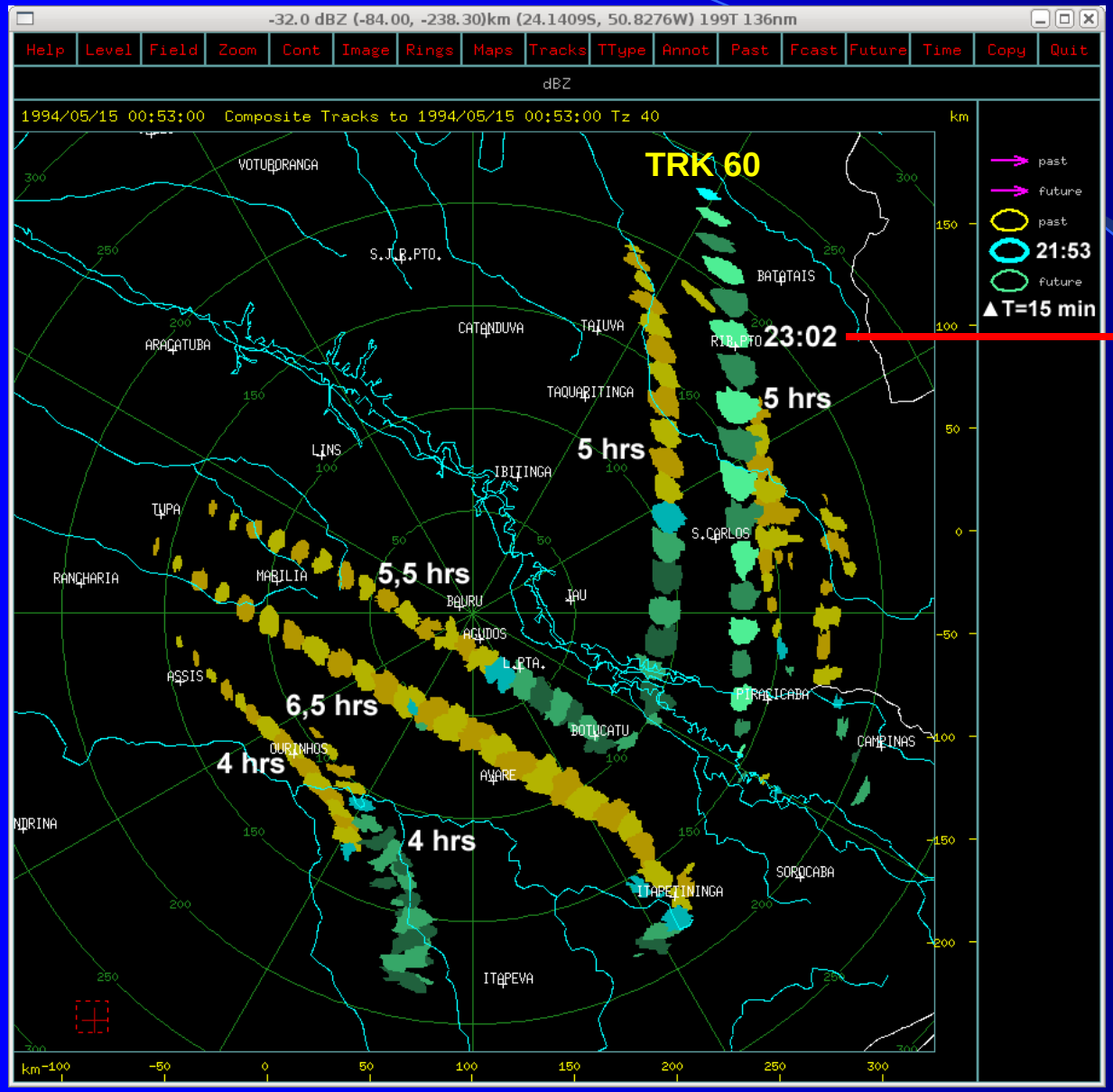
This study is still in progress.

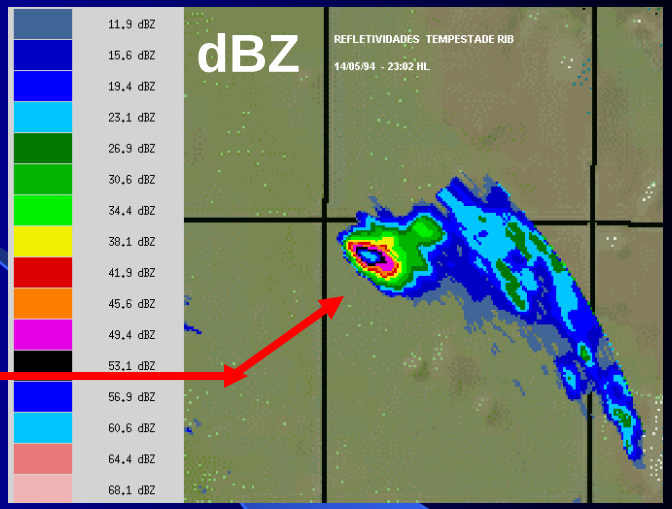


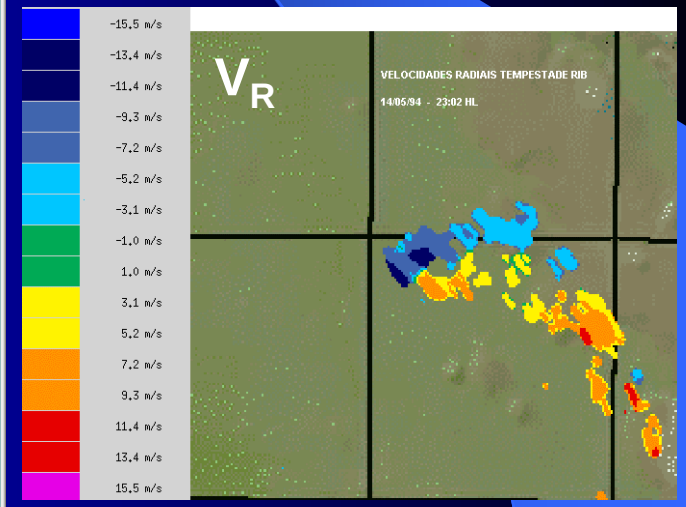
TITAN thresholds:
≥40 dBZ and volume ≥ 16 km^3

2x S-band Doppler Radars, PPR & BRU volume scans 7.5 min, 11 (15) elevations, resolution: 1km (250 m) x 1°AZ

CASE STUDY: 14/15 May 1994



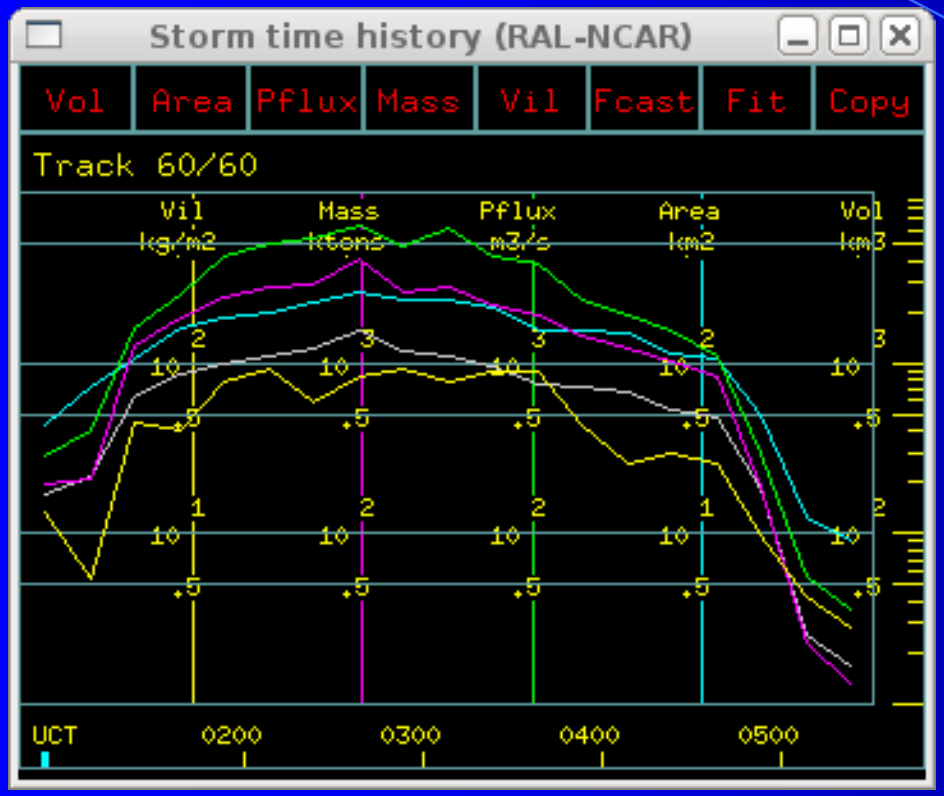




Shear: $-3{,}5 \times 10^{-3}\ s^{-1}$

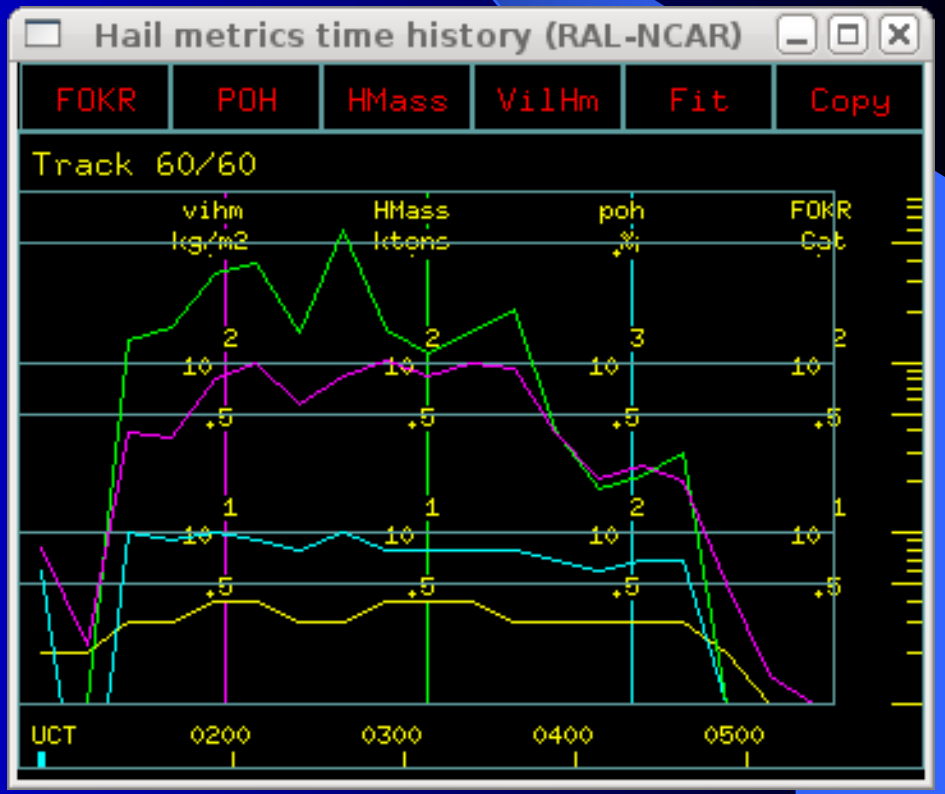
TITAN Tracks and duration of 40 dBZ cores (reference time 21:53 LT)

TITAN Time History: Track 60

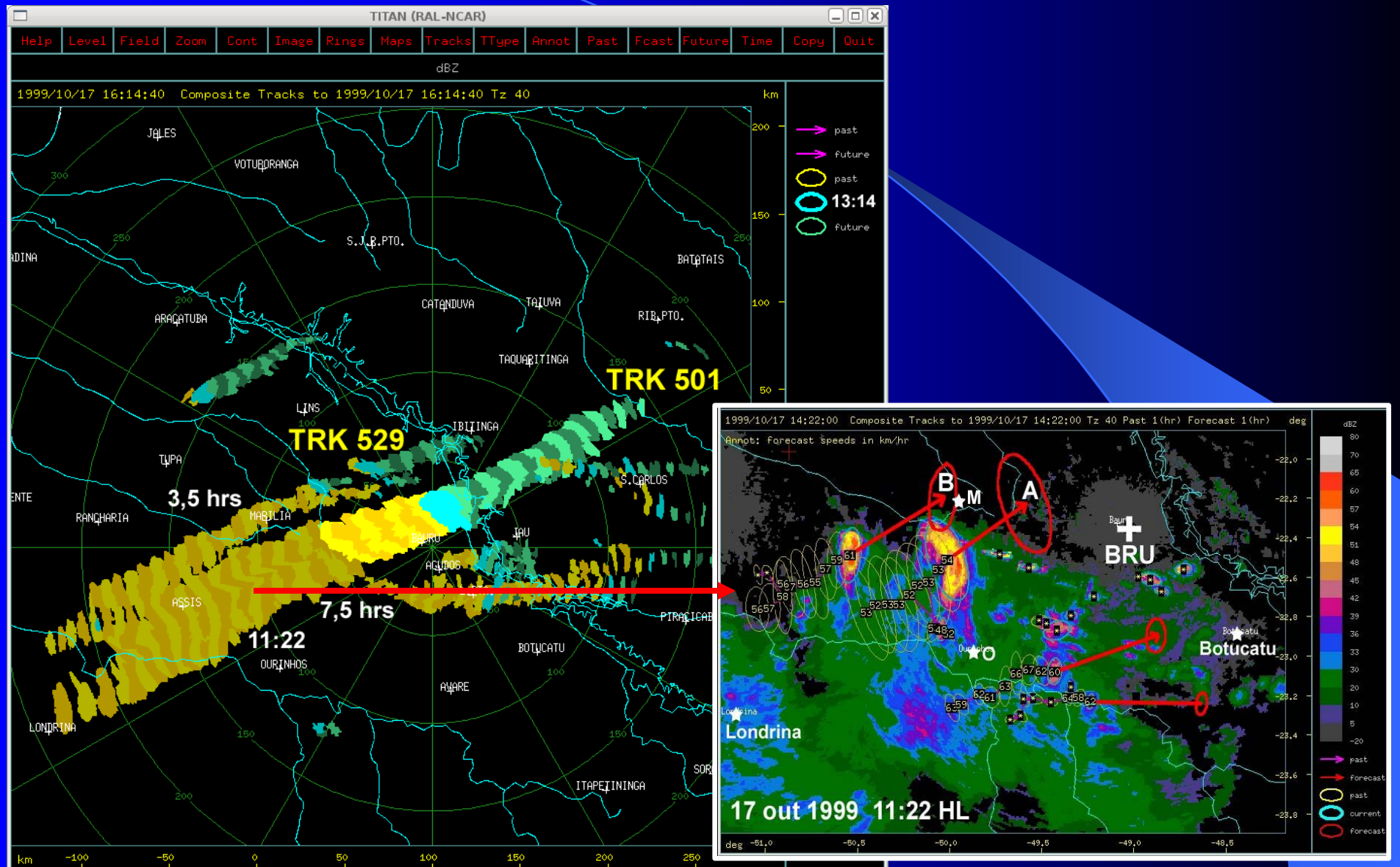


Max_dBZ: ≥60 → 68 dBZ
Tops (40 dBZ): 10-11 km
Speed: 70 km.h^{-1}
VIL: 77-92 kg.m^{-2}

POH: 0,8-1,0
FOKR: 3 & 4

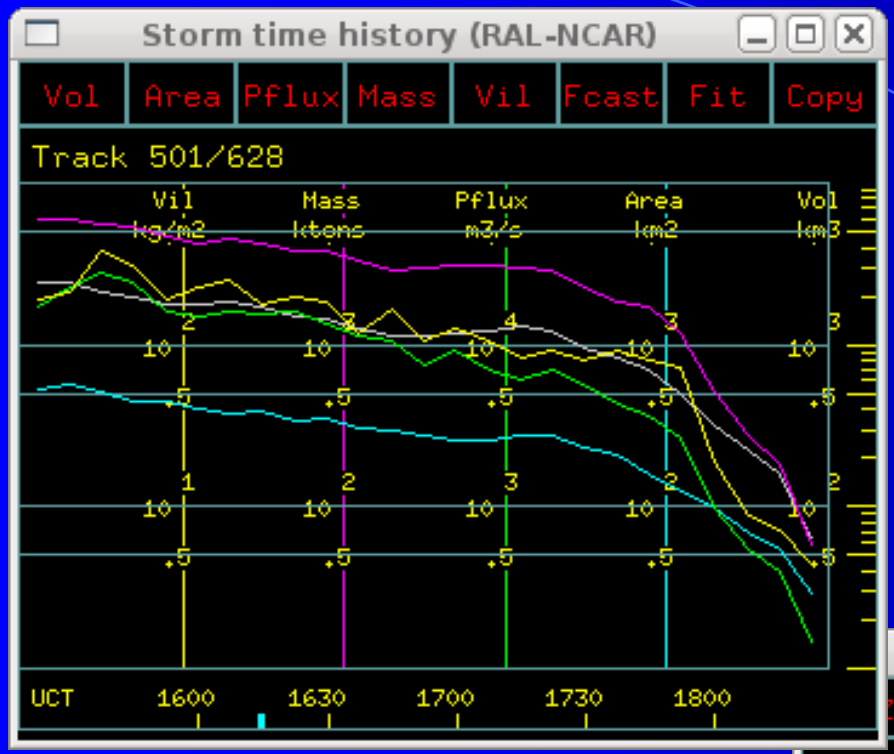


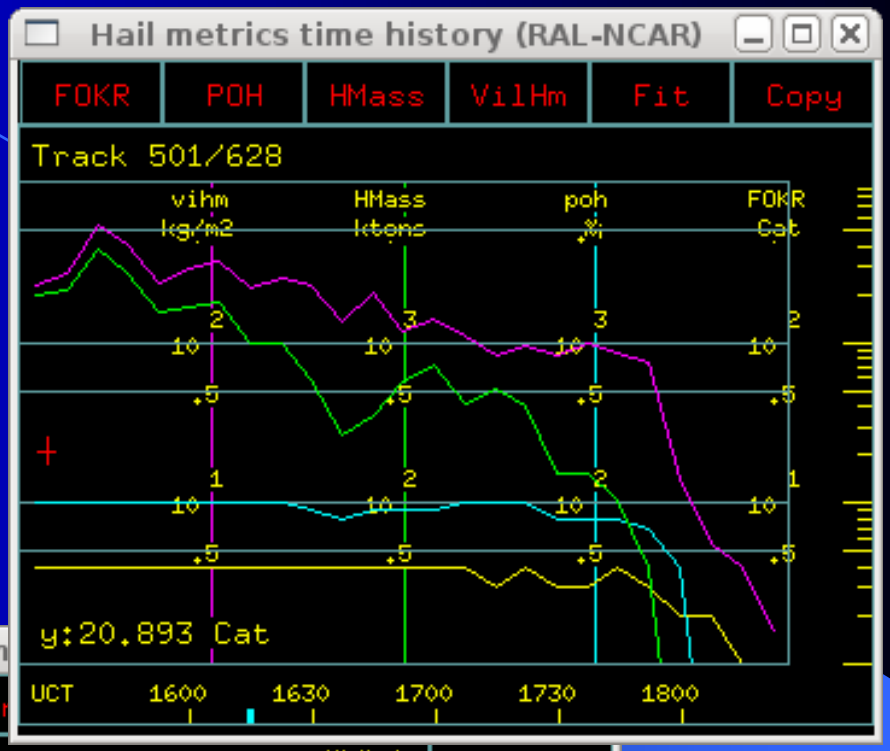
CASE STUDY: 17 October 1999

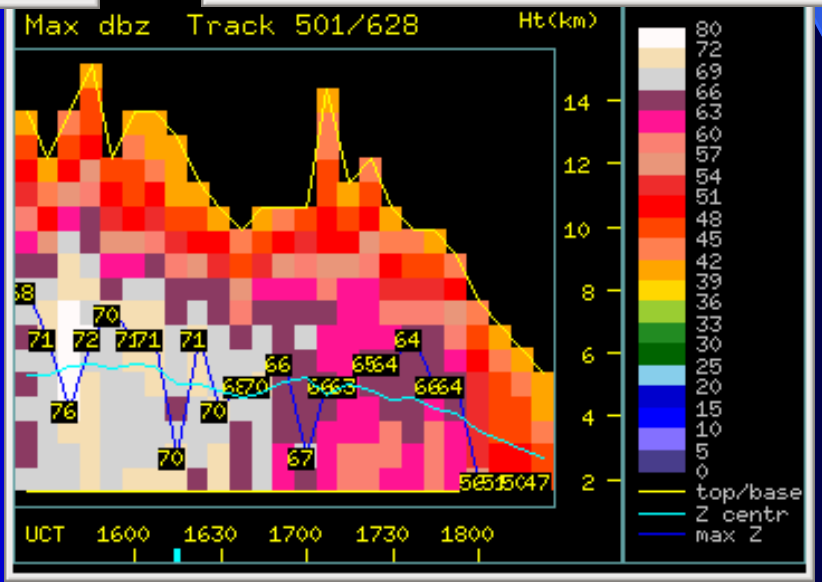


TITAN Tracks and duration of 40 dBZ cores (reference time 13:14 LT)

TITAN Time History: Track 501/628 (12:22 – 15:22 LT)



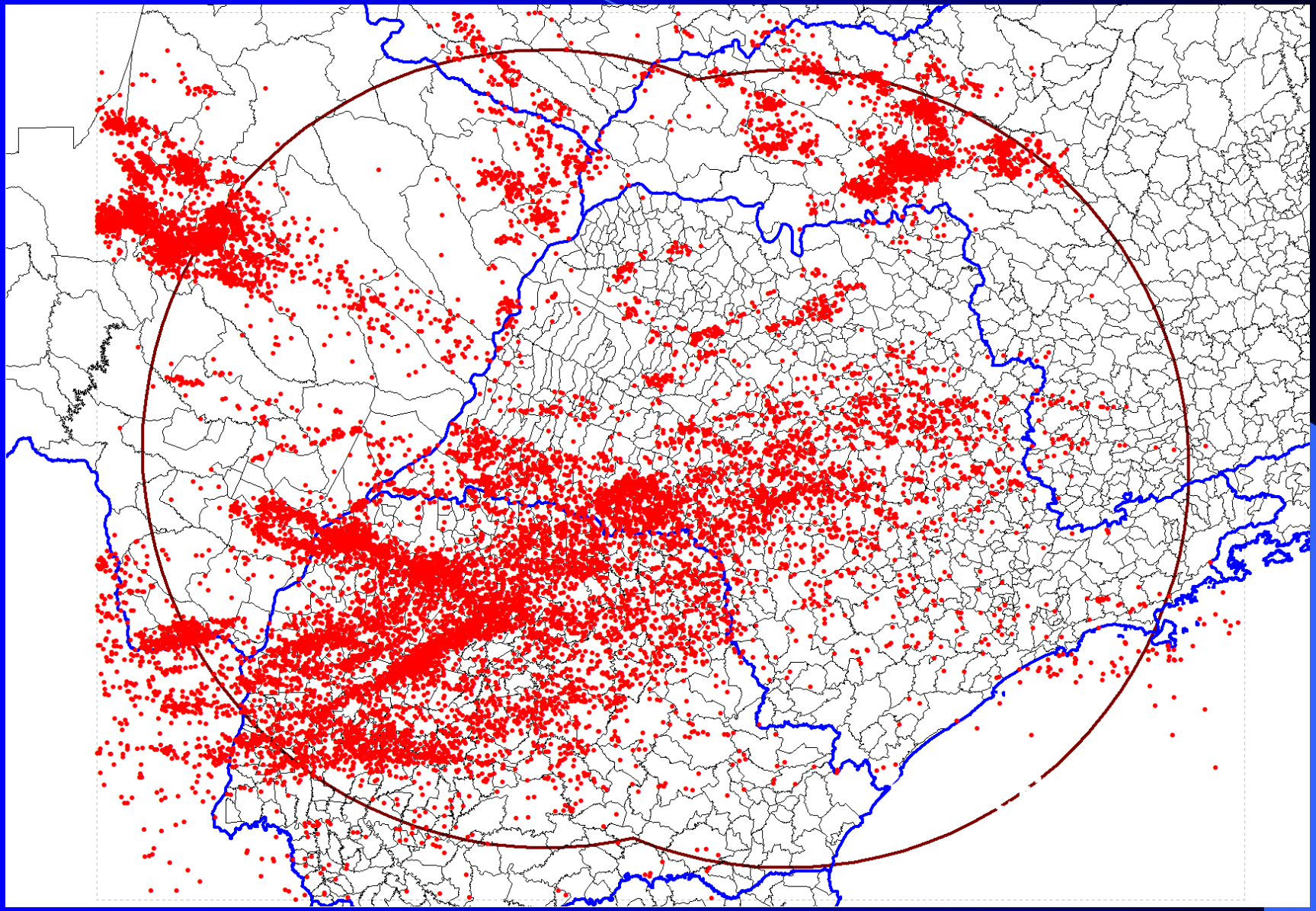




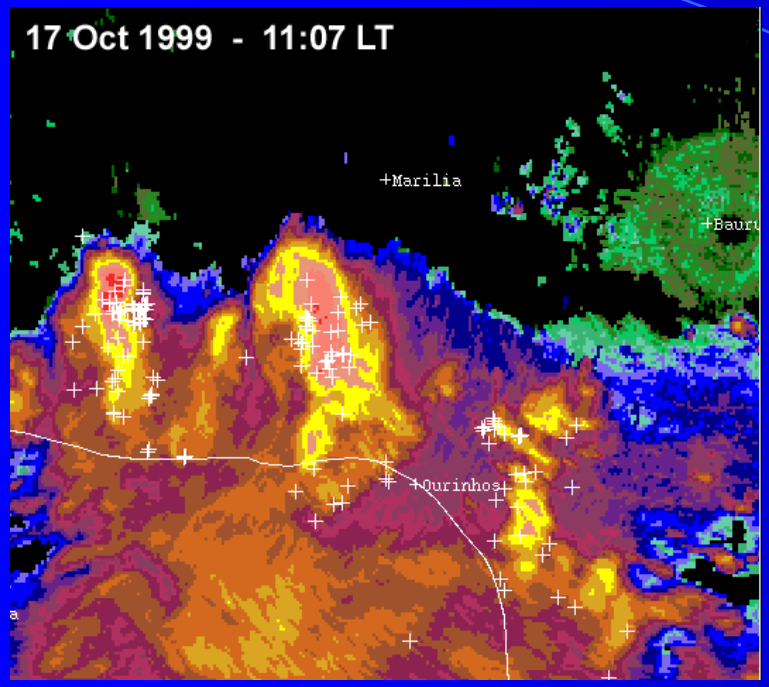
Max_dBZ: 60-72 → 76 dBZ
Tops (40): (9-10) 11-13 km
Speed: (50-55) 60-70 km.h^{-1}
VIL: (25-30) → 370 kg.m^{-2}

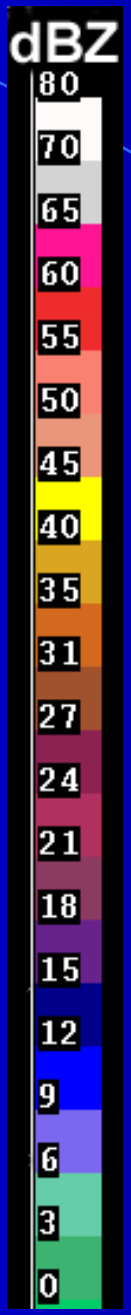
POH: (0,7-0,8) → 1,0
FOKR: 3 + 4

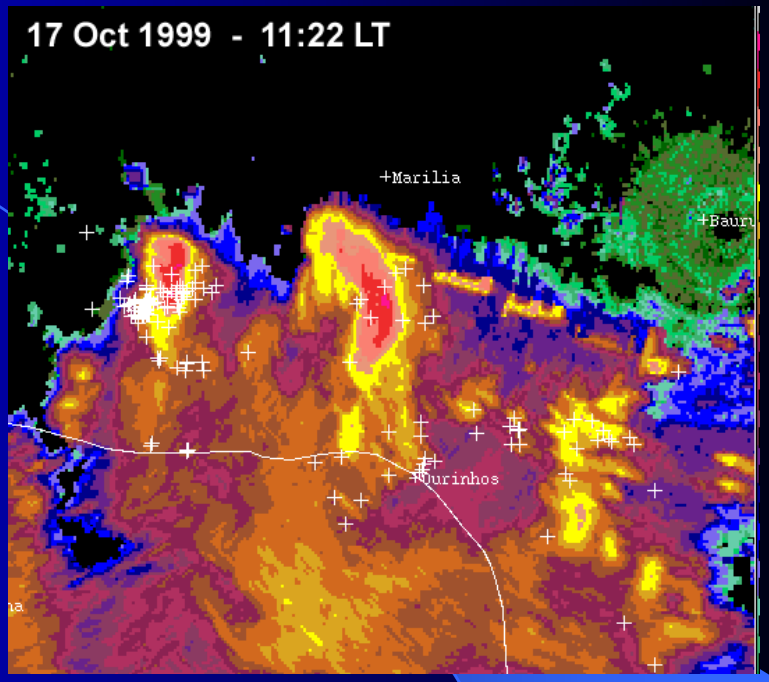
BrasilDat: Cloud-Ground (CG) strokes on 17/10/1999

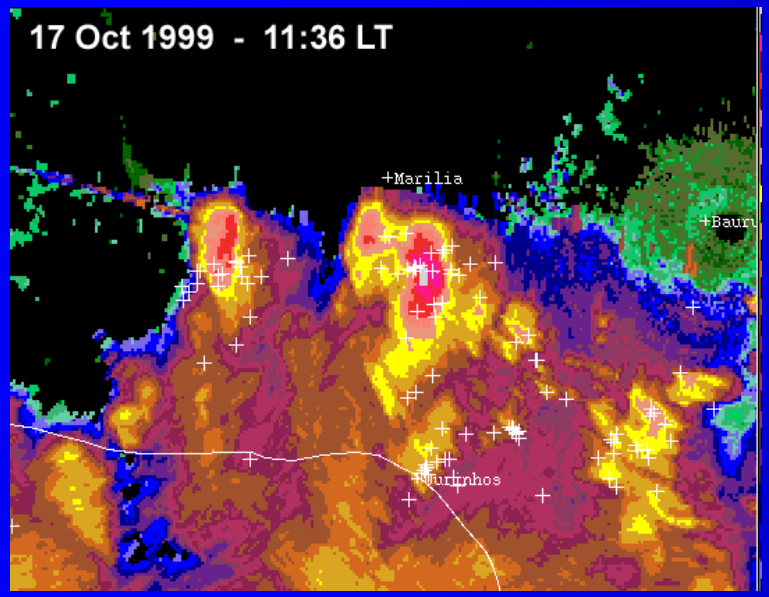


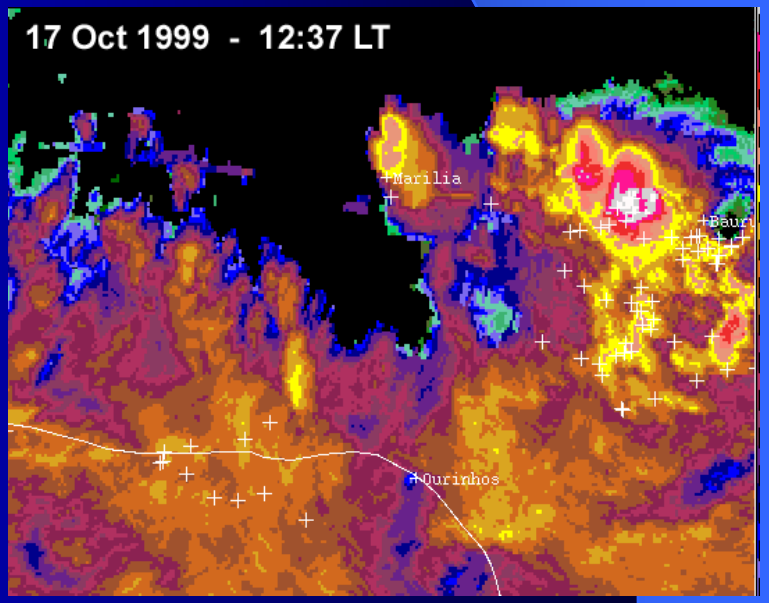
TITAN/CIDD Cloud-Ground (CG) strokes



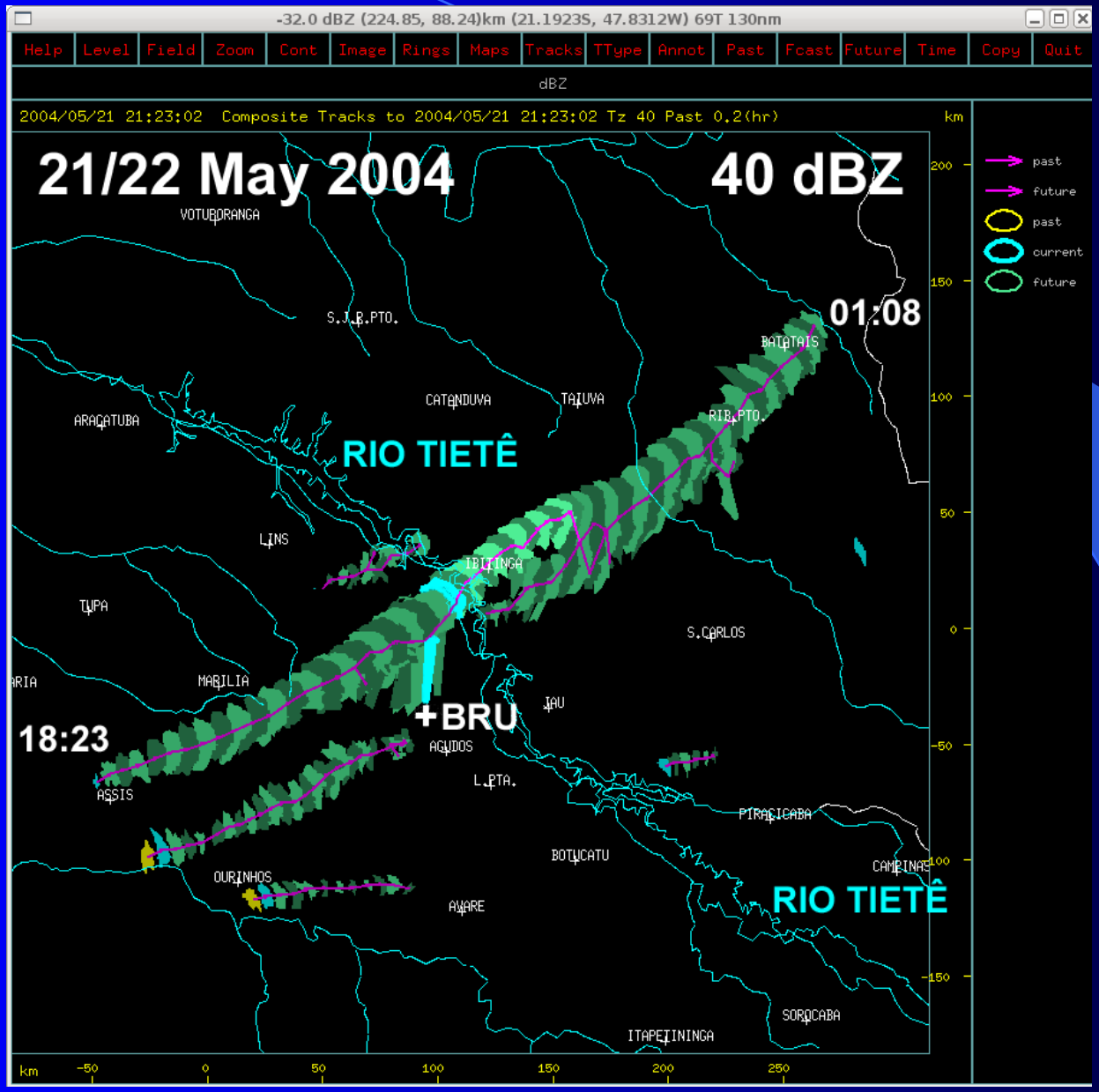




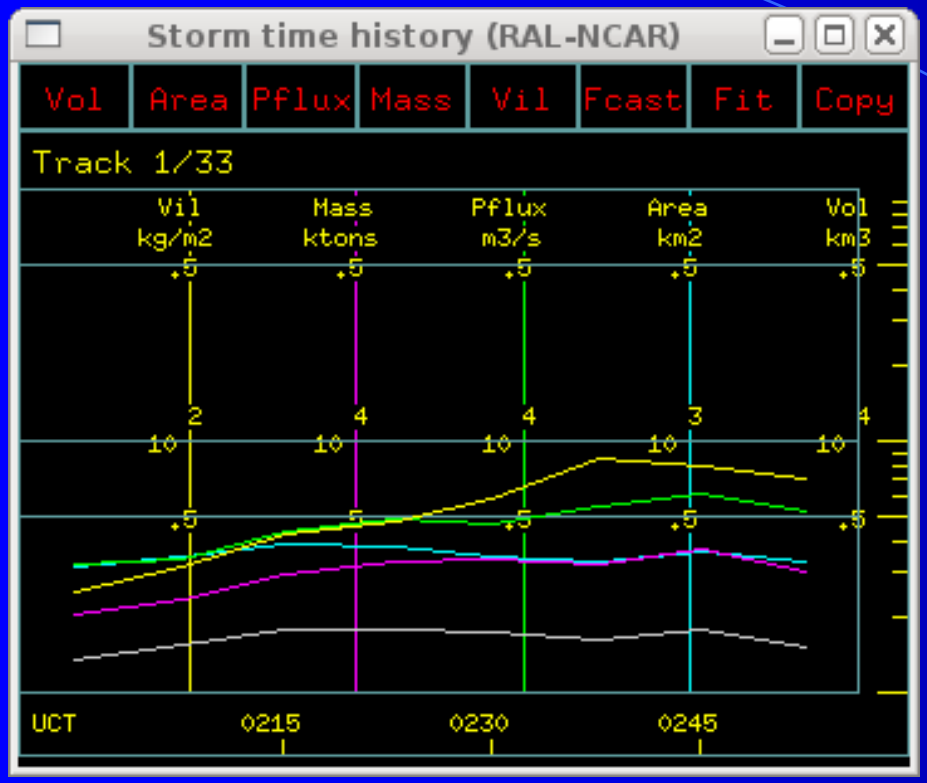




CASE STUDY: 21/22 May 2004

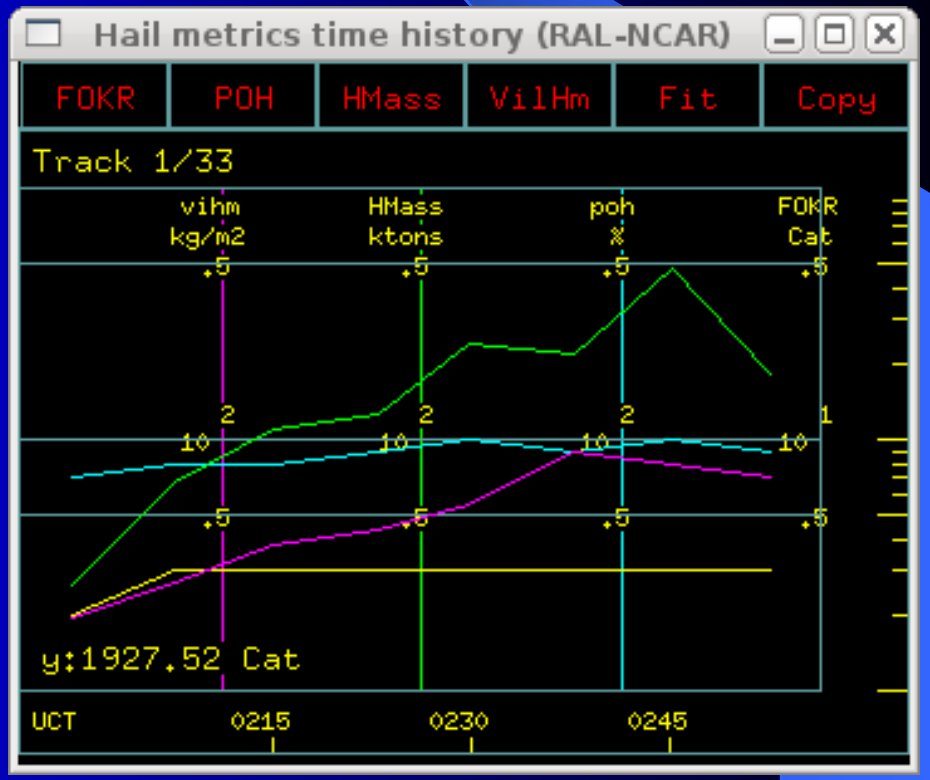


TITAN Time History: Track 01/33 (22:30 – 00:08 LT)

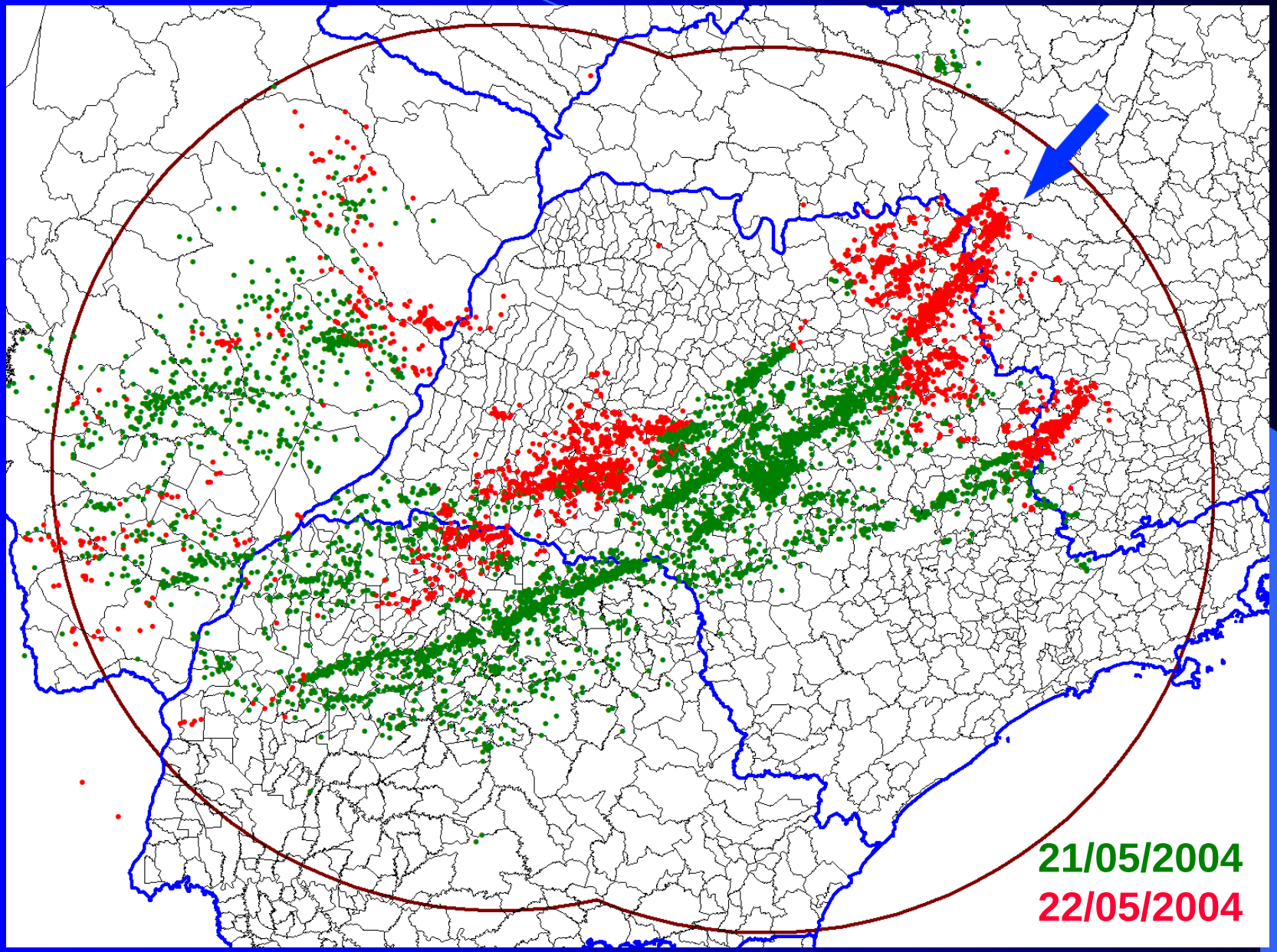


Max_dBZ: ≤65 dBZ
Tops (40 dBZ): 11-12 km
Speed: 55-60 km.h^{-1}
VIL: 55-70 kg.m^{-2}

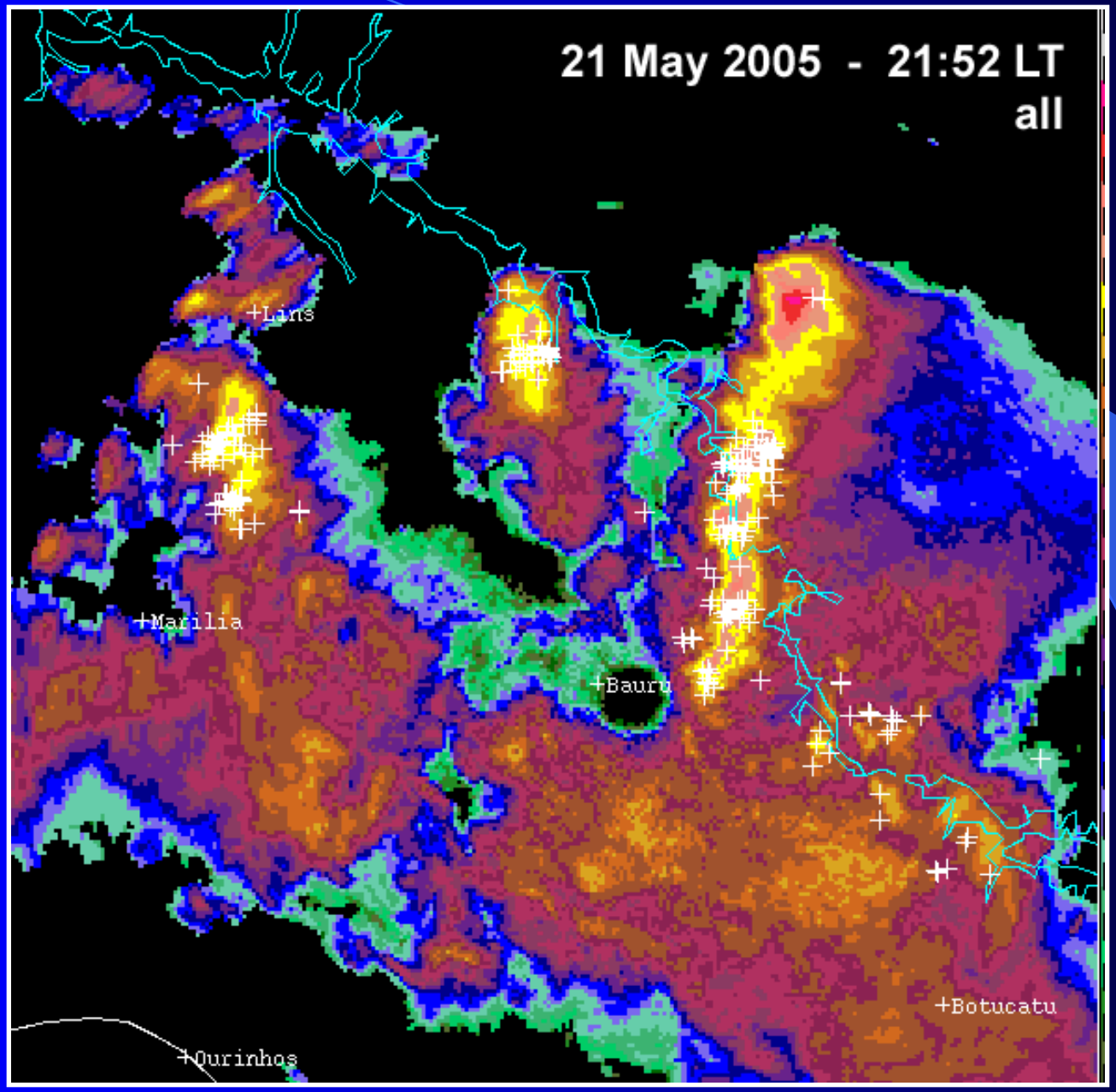
POH: 0,8-1,0
FOKR: 3



BrasilDat: Cloud-Ground (CG) strokes on 21-22/5/05/2004



TITAN/CIDD Cloud-Ground (CG) strokes

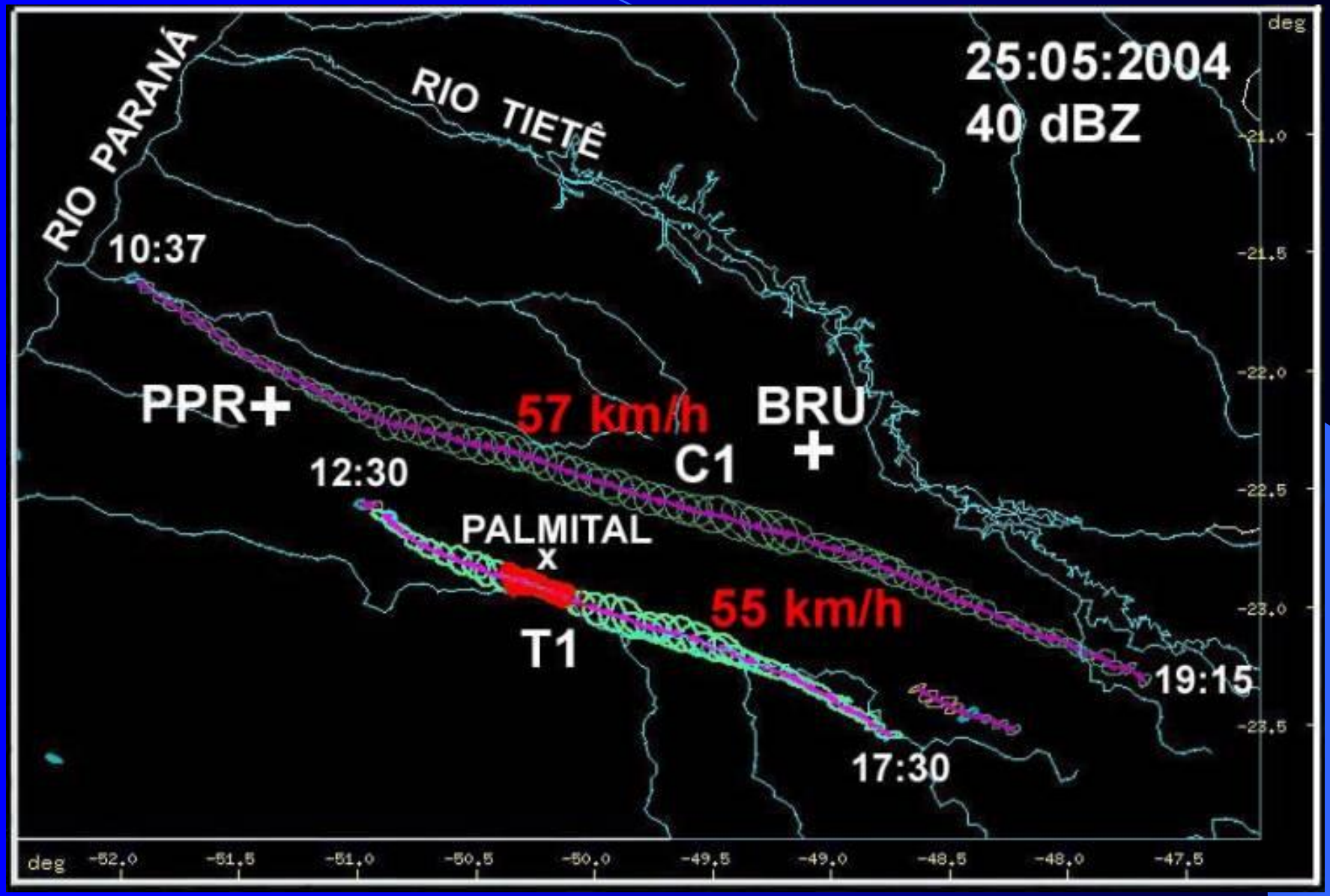


CASE STUDY: 25 May 2004

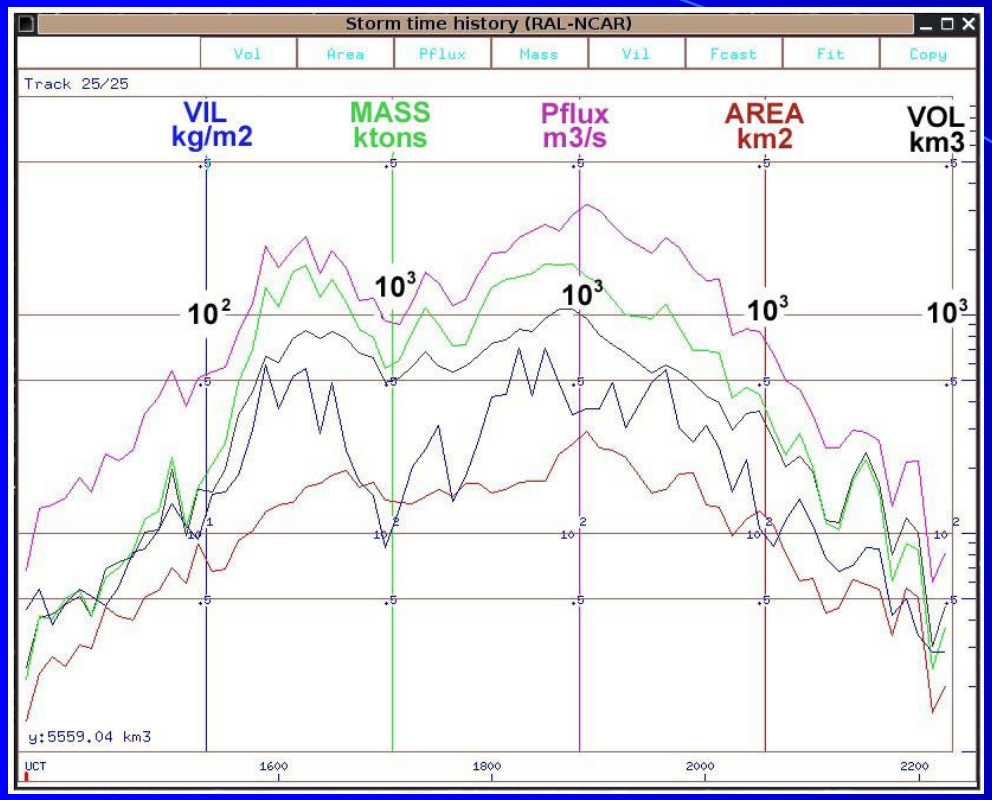
- **Several storms, associated with areas of strong convective activity created by the passage of a baroclinic system with strong convective instability and vertical wind shear;**
- **1 Supercell storm (40 dBZ track for 8,5 hours);**
- **2 Tornadoes (F2-F3; F2);**
- **Damage to sugar plantations, but 2 persons killed and >50 severely injured.**

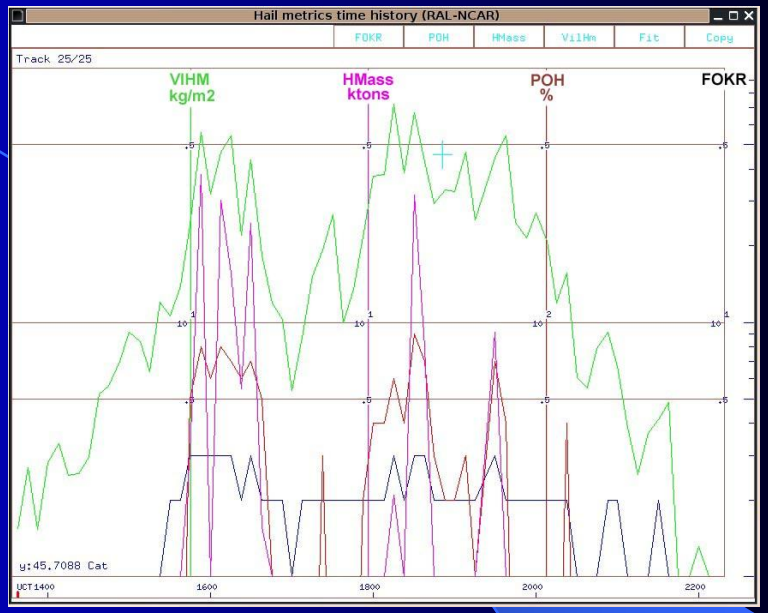
Palmital 25/05/2004 ~ 14:00h

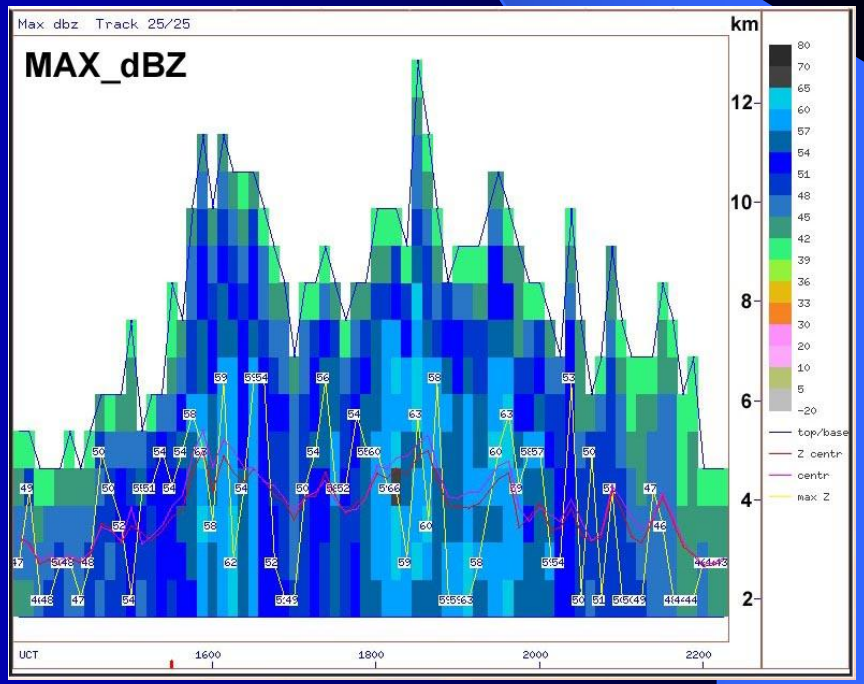
Palmital Tornado (T1) & Supercell (C1)



TITAN Time History: Supercell C1

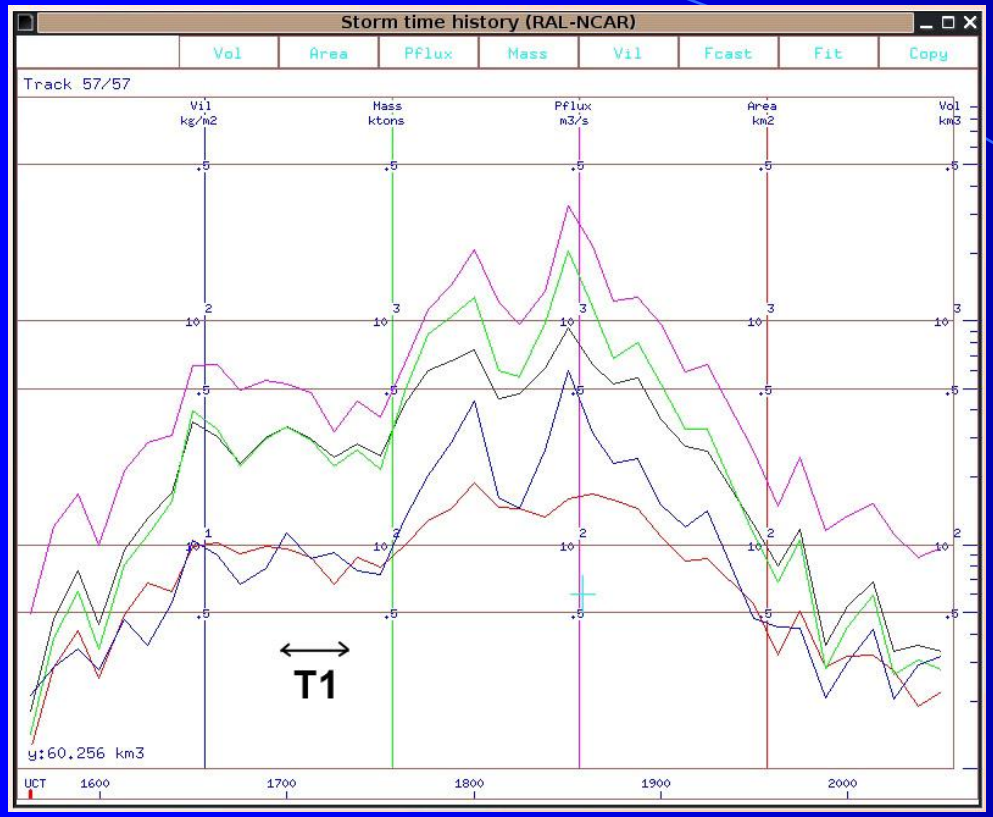


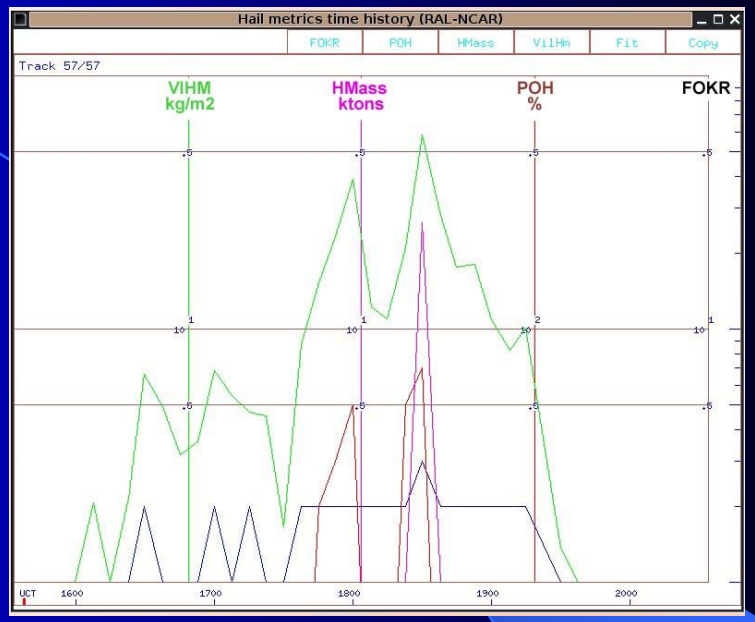


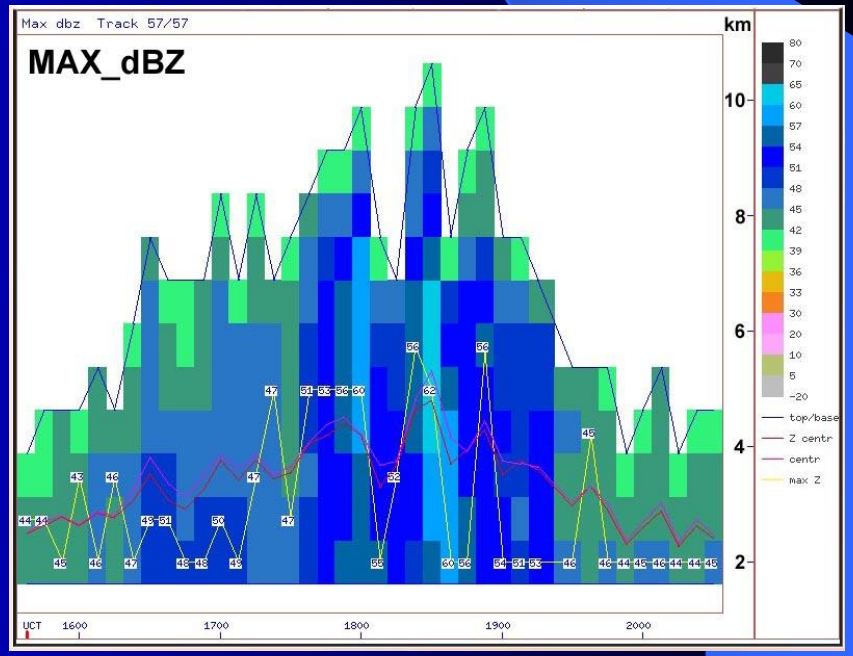


Max_dBZ: 50-60 → 66 dBZ
Tops (40): (9-11) → 13 km
Speed: 57 km.h^{-1}
VIL: 60 → 70,6 kg.m^{-2}
Rot.Shear: -5,0x10^{-2} s^{-1}
POH: 0,8-0,9
FOKR: 2 - 3

TITAN Time History: Tornadic Cell T1



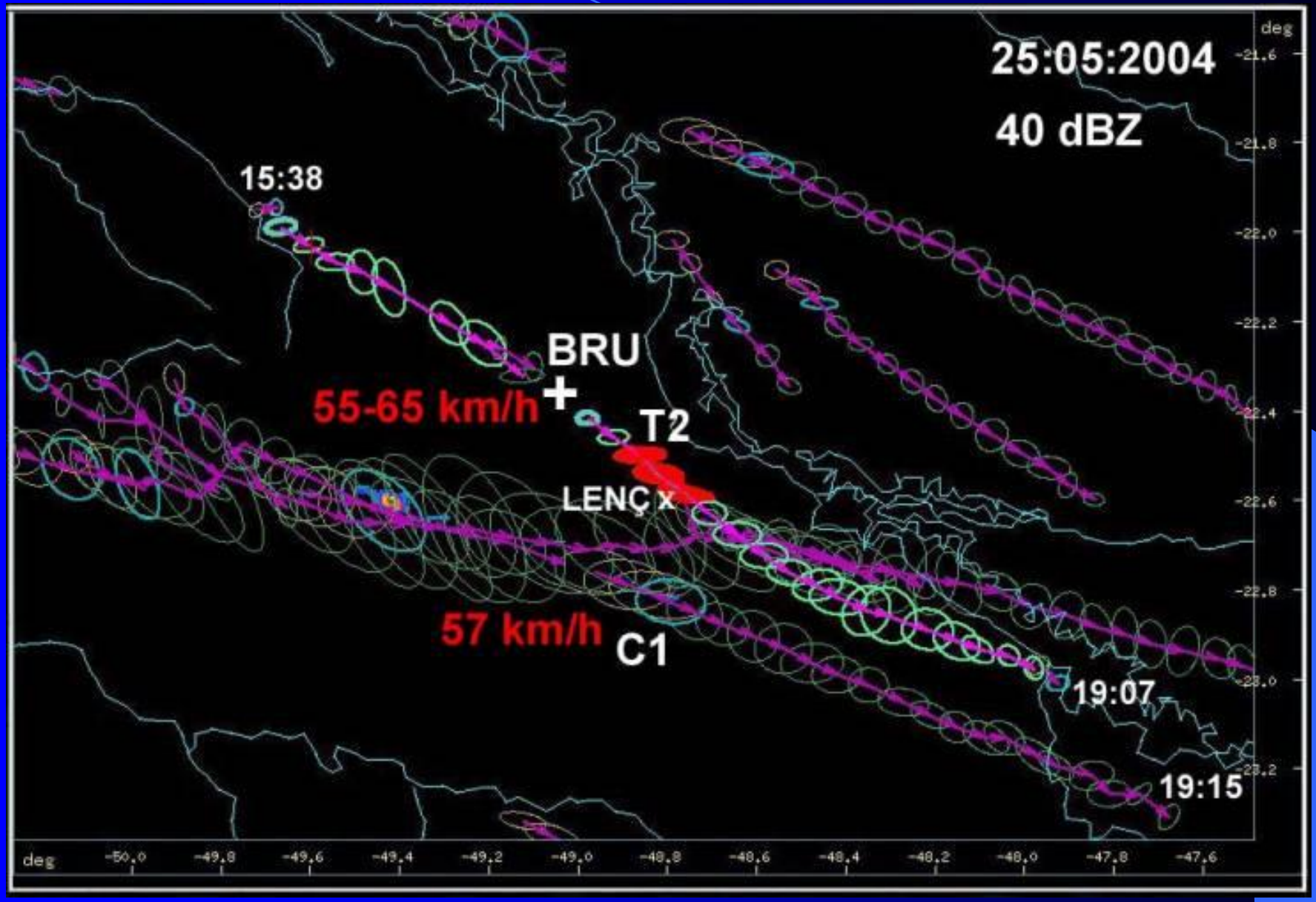




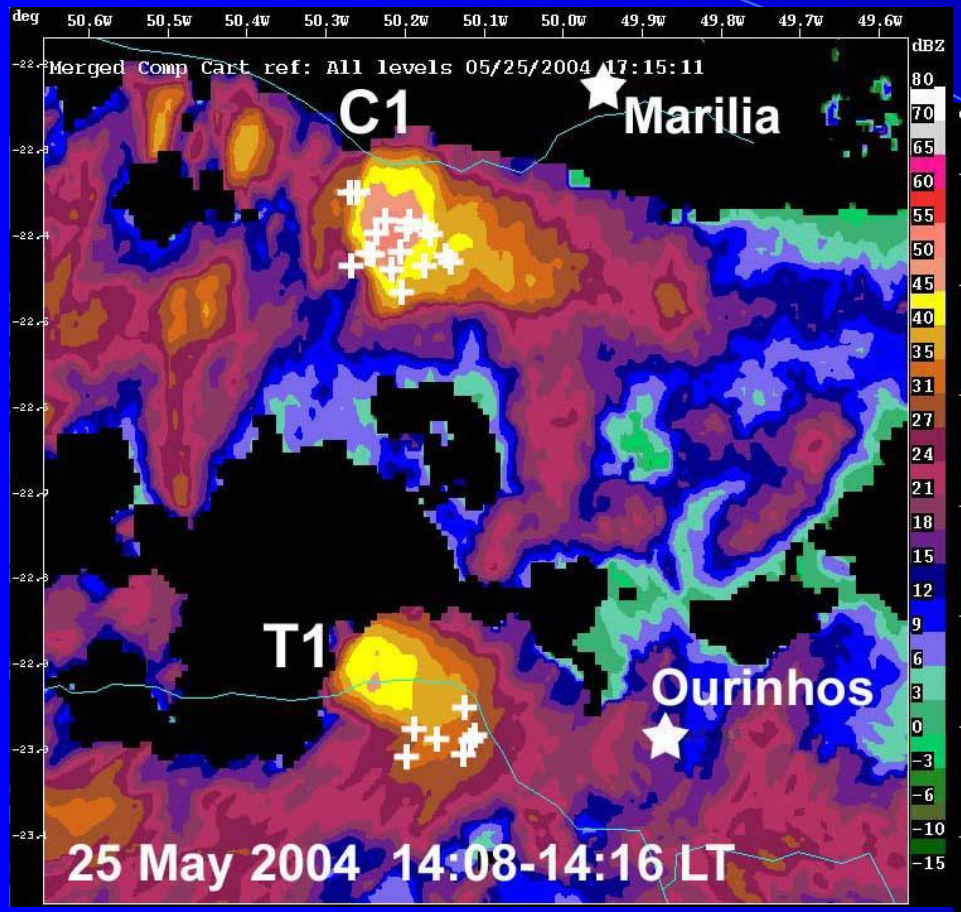
Max_dBZ: 50-60 → 62 dBZ
Tops (40): 8,5-10 → 11 km
Speed: 55 km.h^{-1}
VIL: 11,3 → 50-60,2 kg.m^{-2}

POH: 0,5-0,7
FOKR: 2 → 3

Lençois Paulista Tornado (T2) & Supercell (C1)

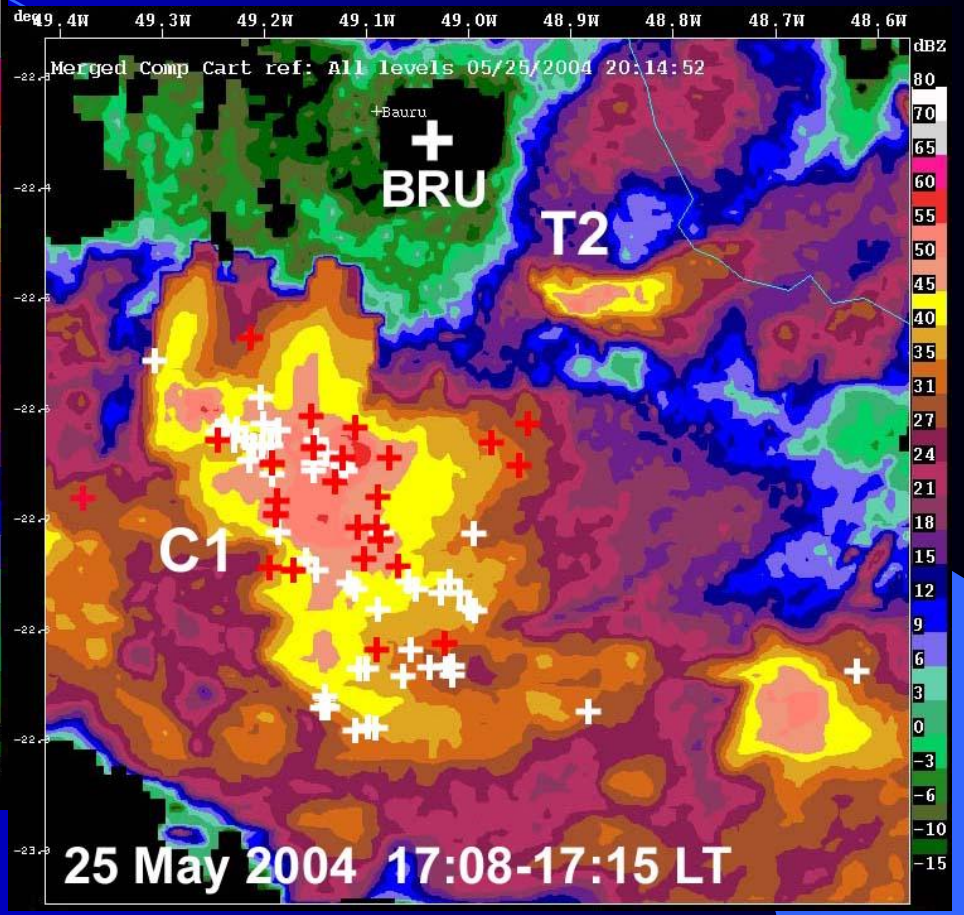


TITAN/CIDD:Total Ground Flashes (CG) per Volume Scan



T1 during tornado touch-down

C1 supercell



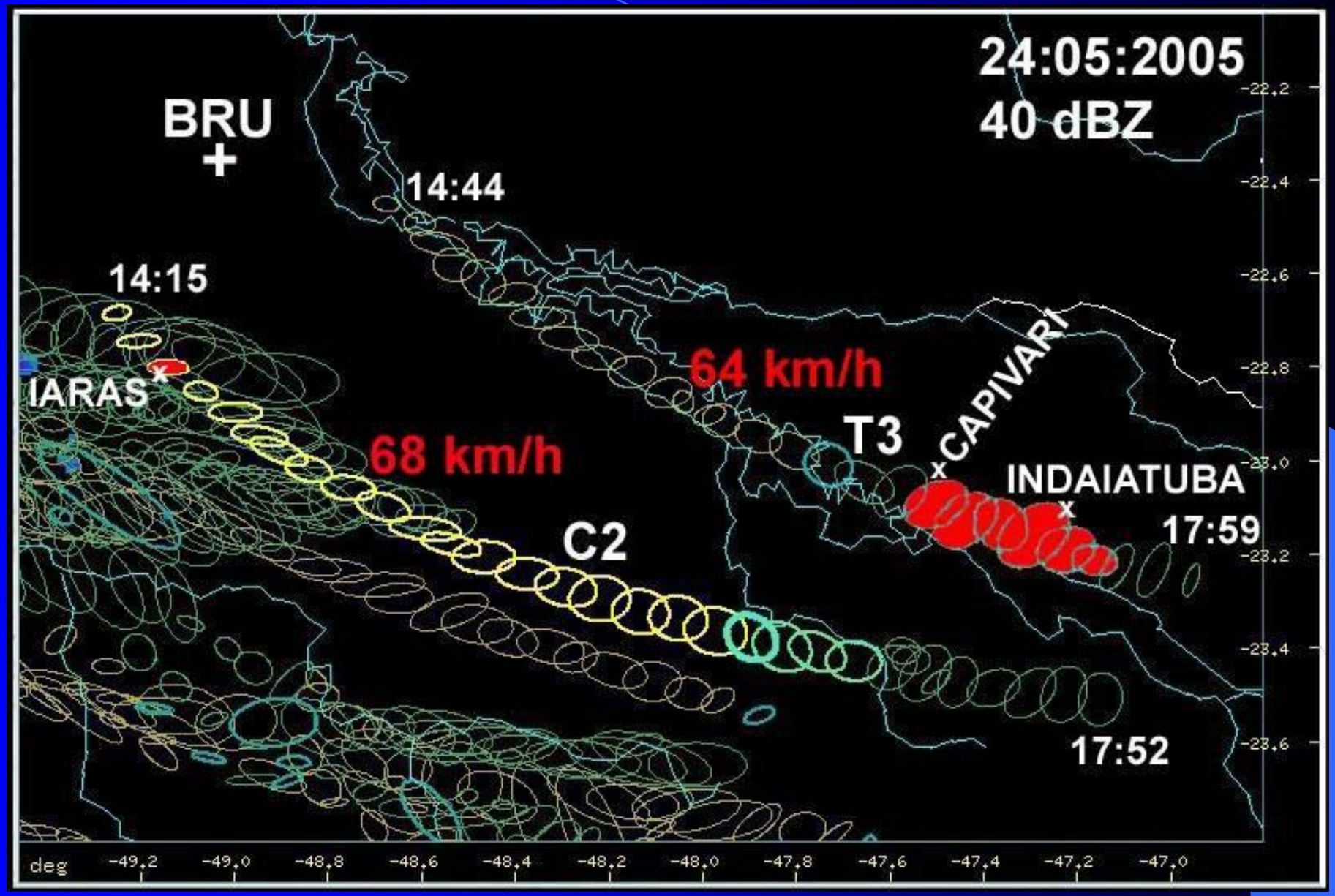
T2 during tornado touch-down

Key: + negative / + positive CG

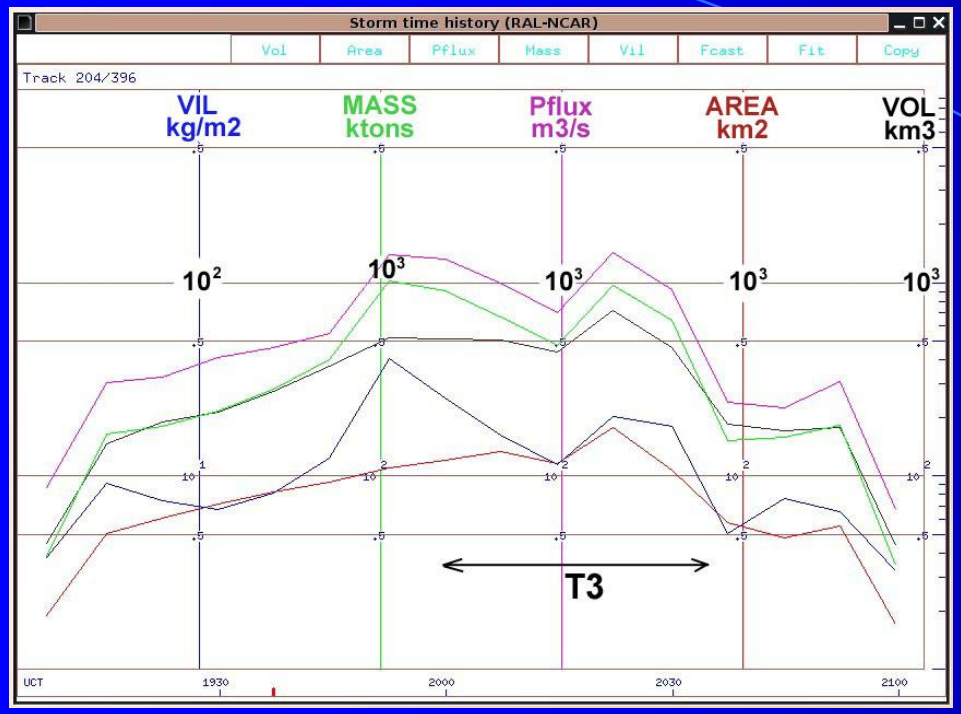
CASE STUDY: 24 May 2005

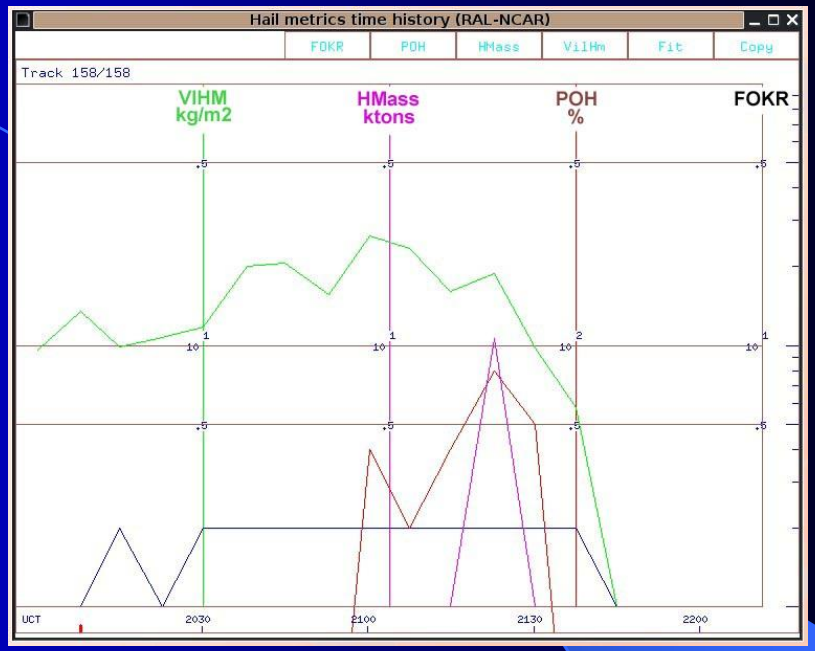
- **Synoptic situation similar to 25 May 2004;**
- **Severe wind storm (F2 like; 40 dBZ track for 3,5 h);**
- **Tornado (F3; 40 dBZ track for 3,2 hours);**
- **Damage ca USD 42 million; one person killed.**

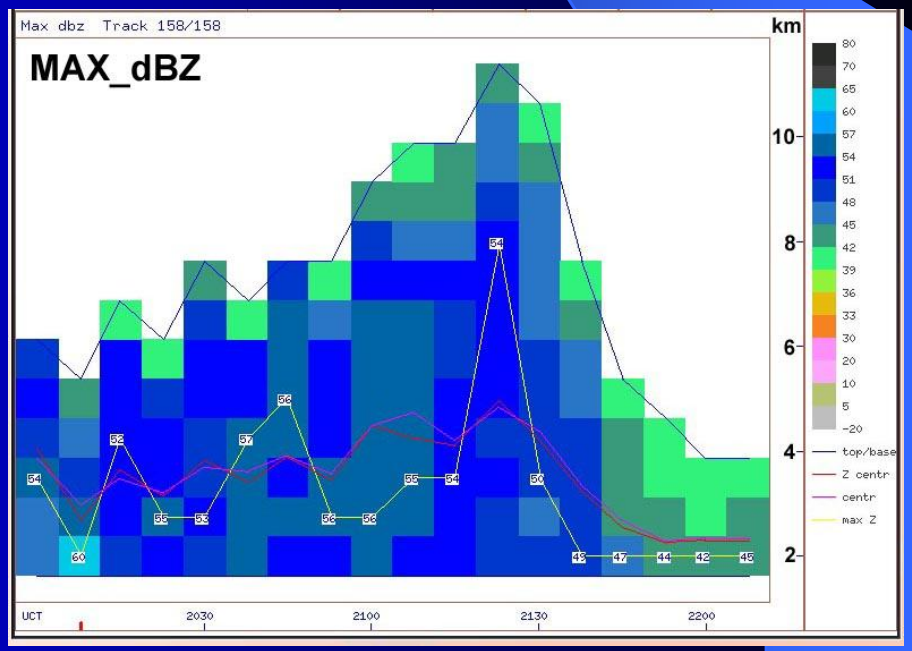
24 May 2005: TORNADIC STORMS



TITAN Time History: Tornadic Cell T3



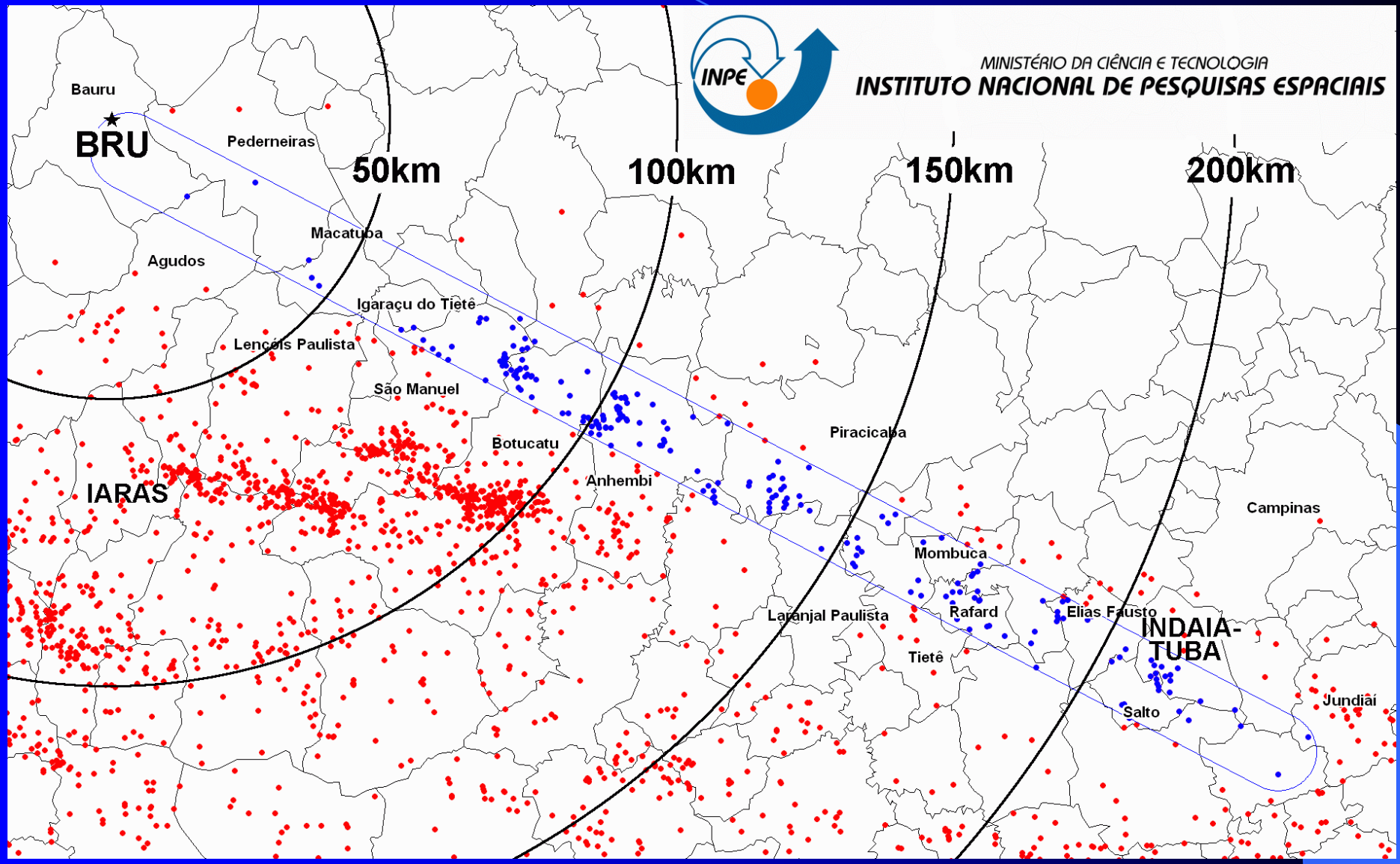




Max_dBZ: 55 → 57,5 dBZ
Tops (40): 8,5-10 → 11 km
Speed: 64 km.h^{-1}
VIL: (5-12) → 40,5 kg.m^{-2}

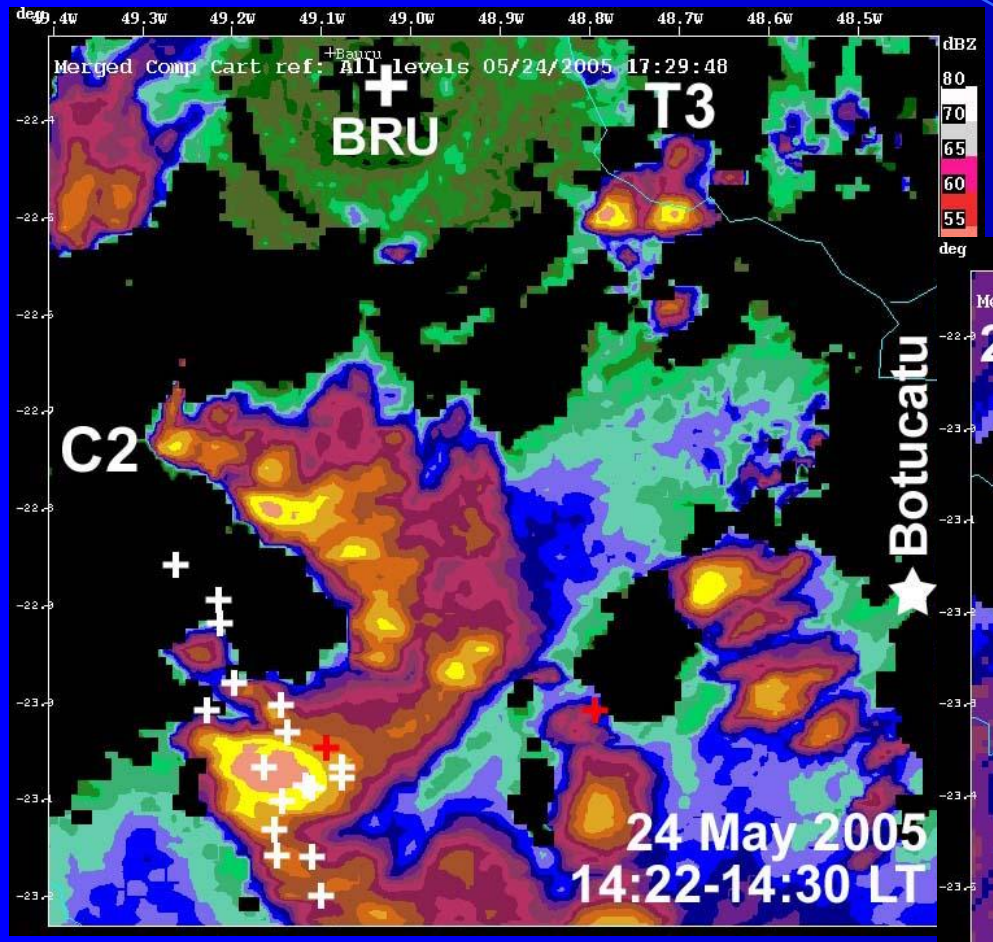
POH: 0,5-0,7
FOKR: 2

BrasilDat: Cloud-Ground (CG) strokes (14:00 – 19:00 LT)



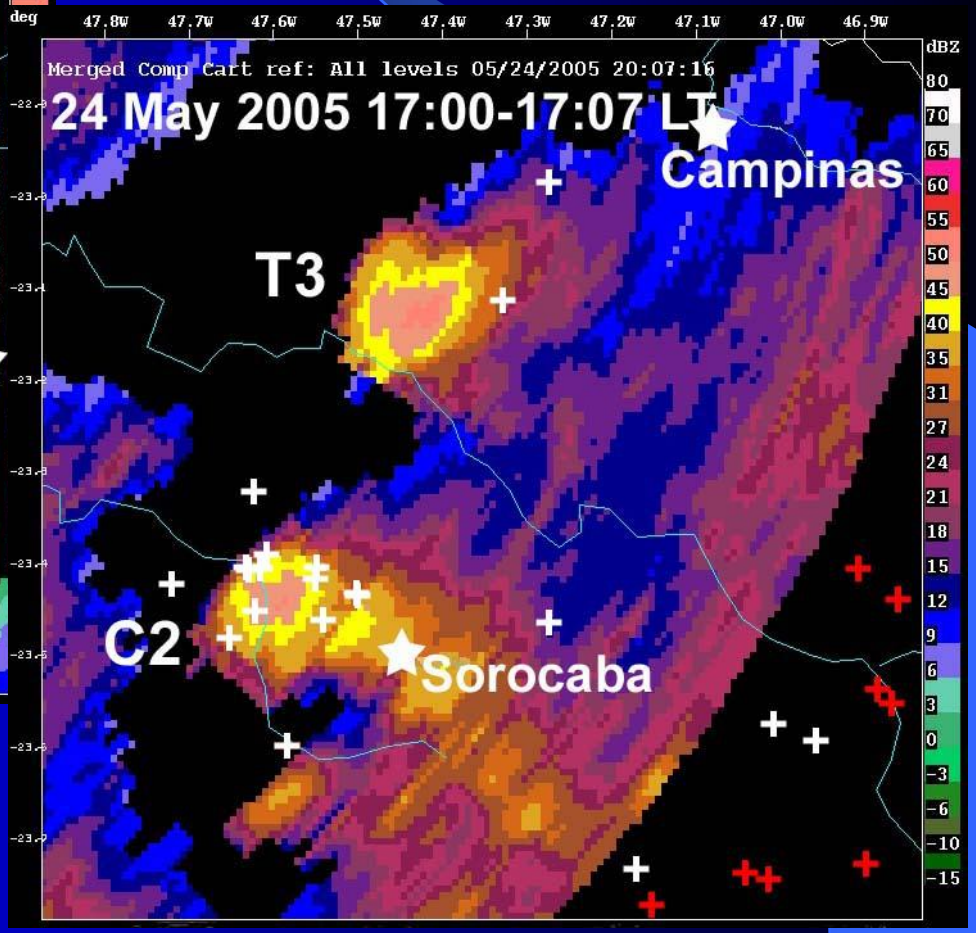
TITAN/CIDD: Total Ground Strokes per Volume Scan

Key: + negative / + positive CG

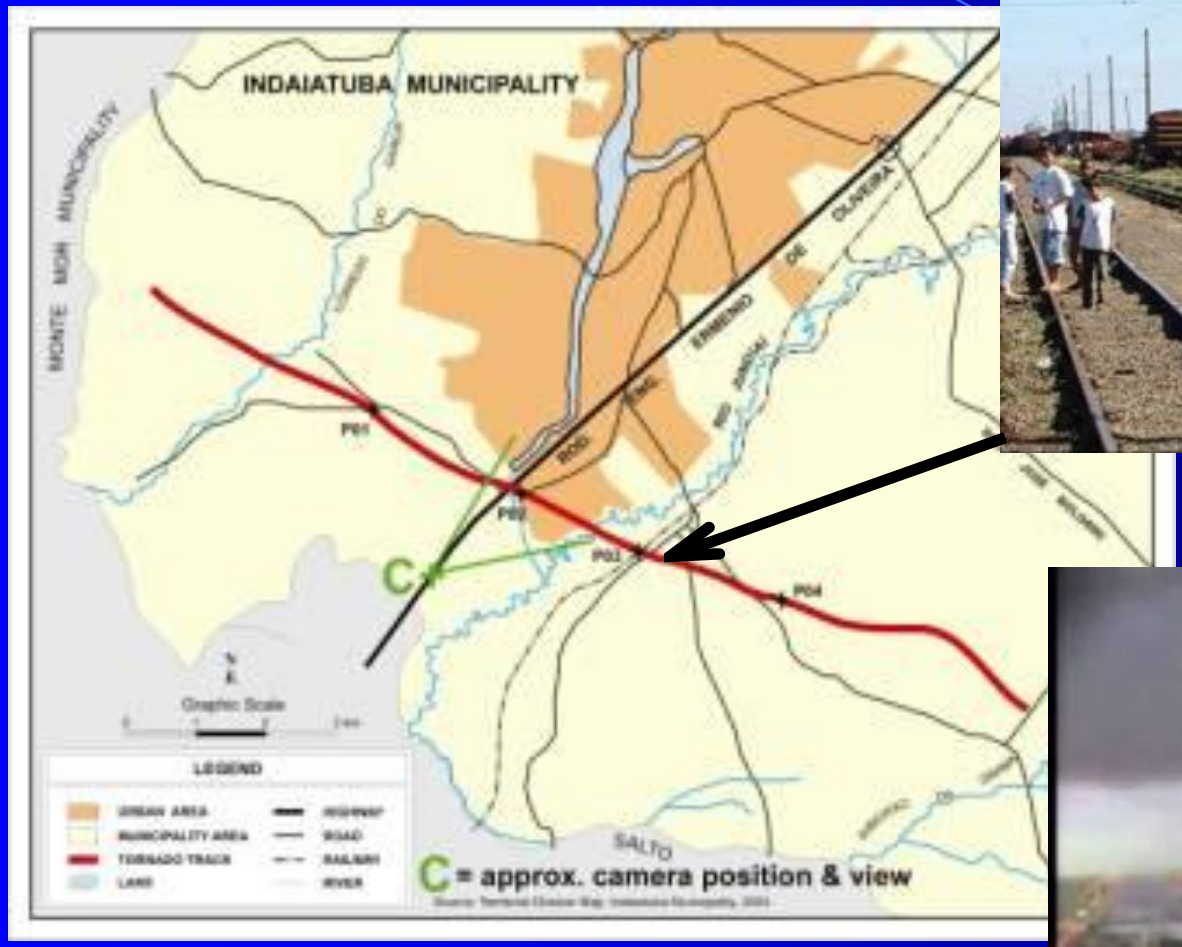


C2 during Iaras Wind storm

T3 during tornado touch-down

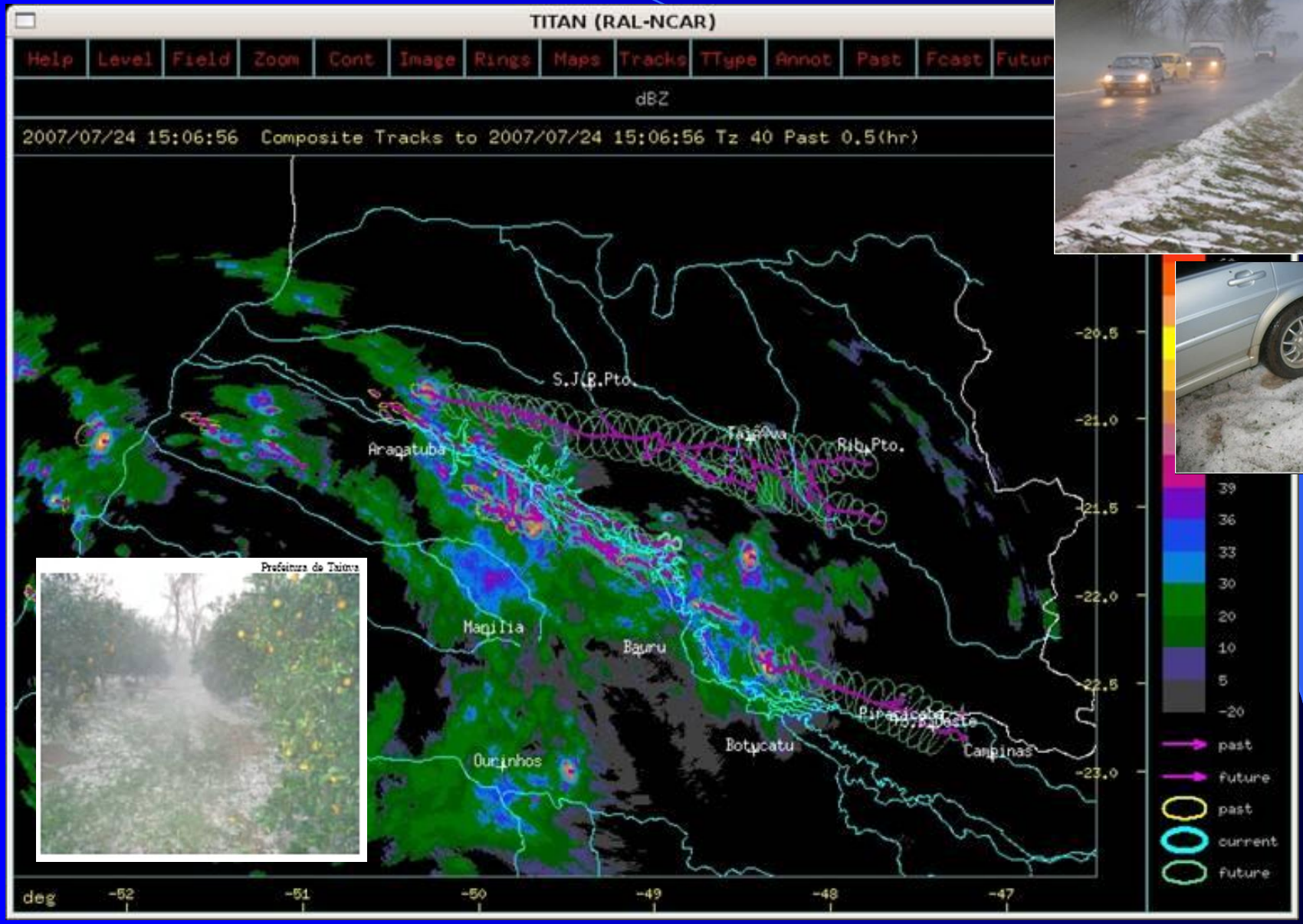


Indaiatuba tornado track



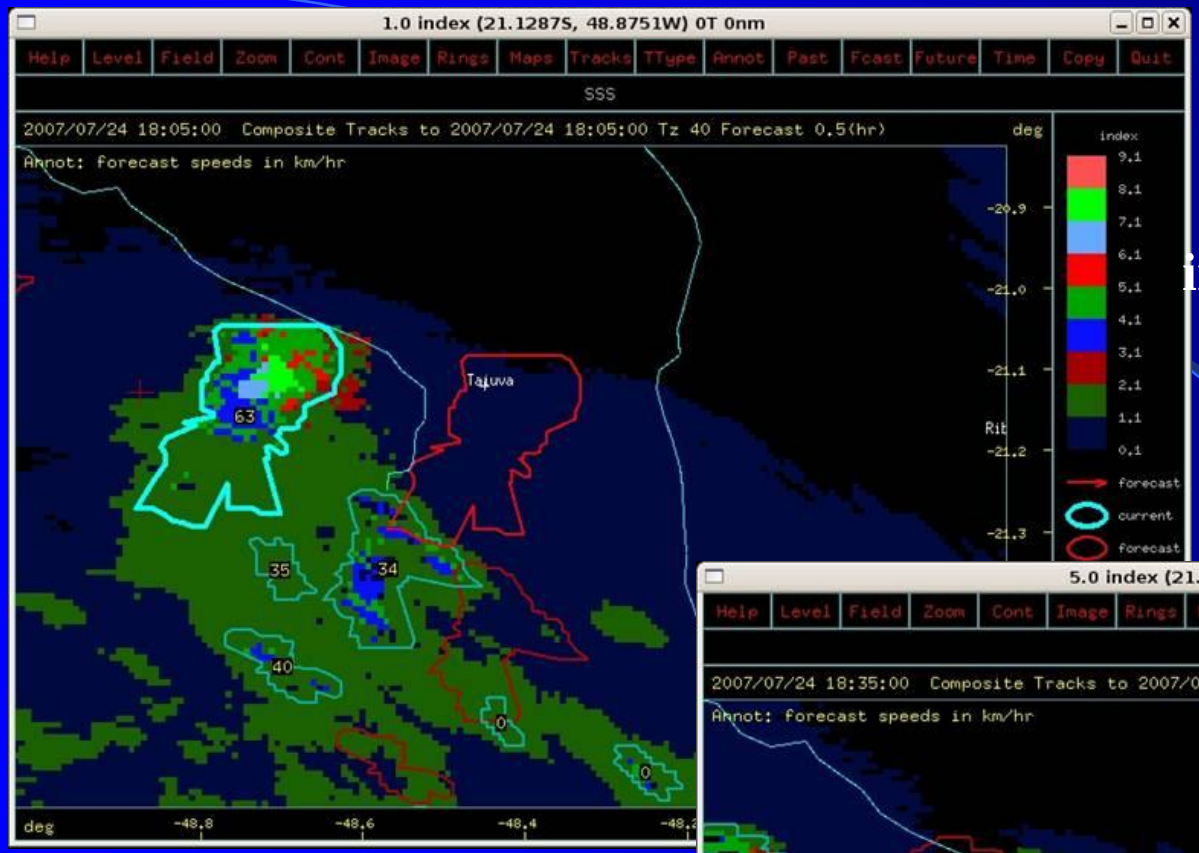
Length 15 km, with a width of up to 200 m (F3 intensity, US $ 42 million damage)

CASE STUDY: 24 July 2007 (Hail Swath)

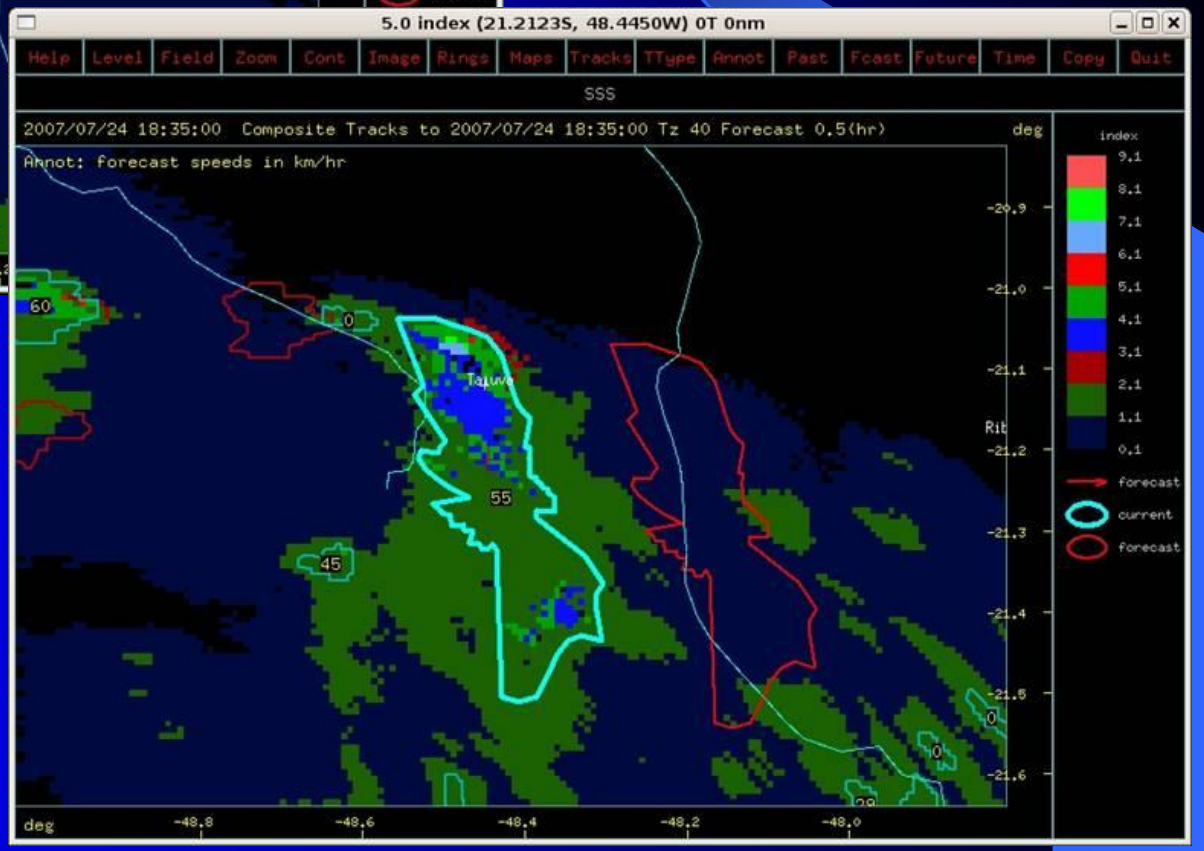


SSS index

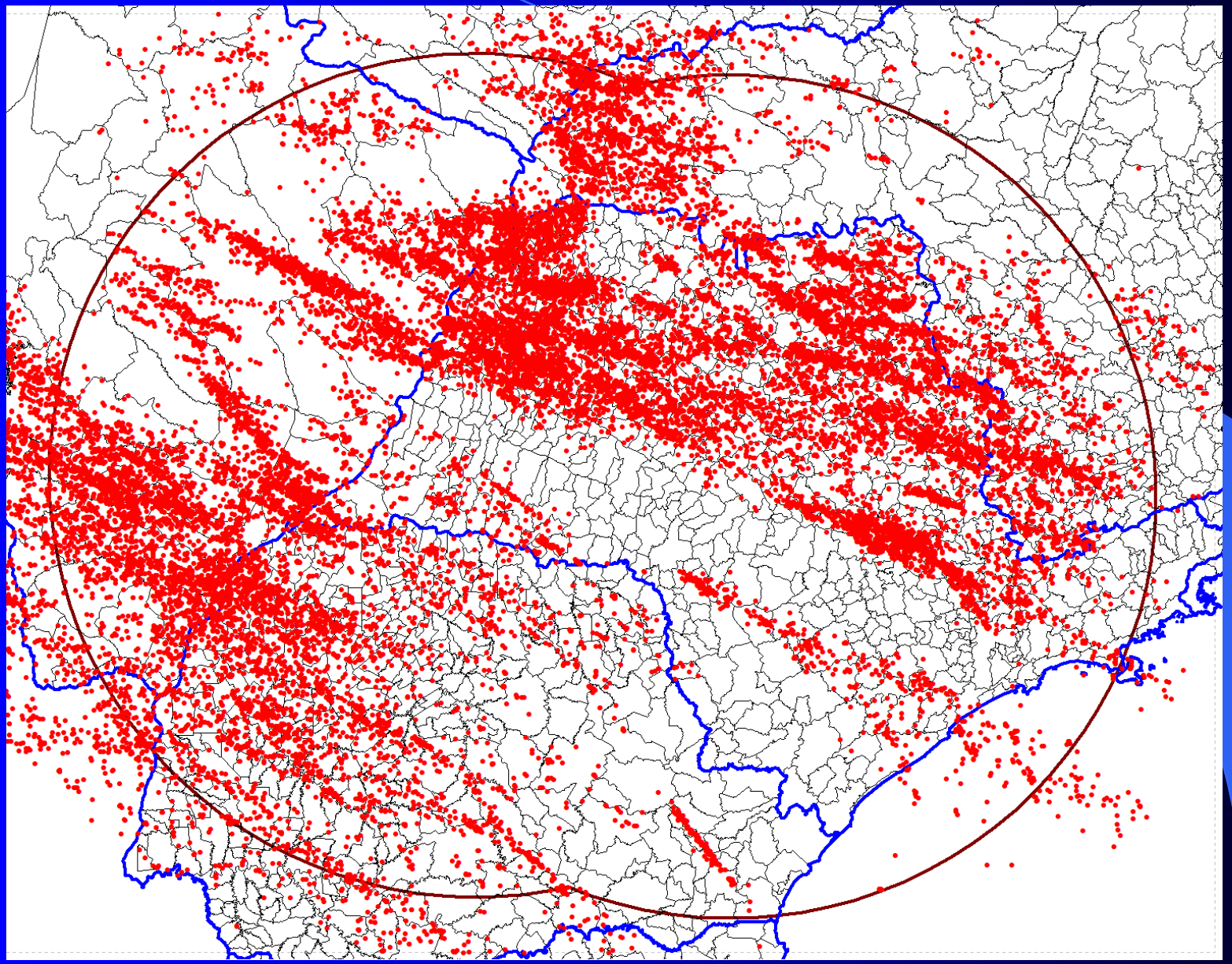
(Storm Structure Severety, Visser, 2001), at 15:05 LT, indicates a speed of 60 km.hr-1, and should reach areas of Taiuva town within the next 30 minutes



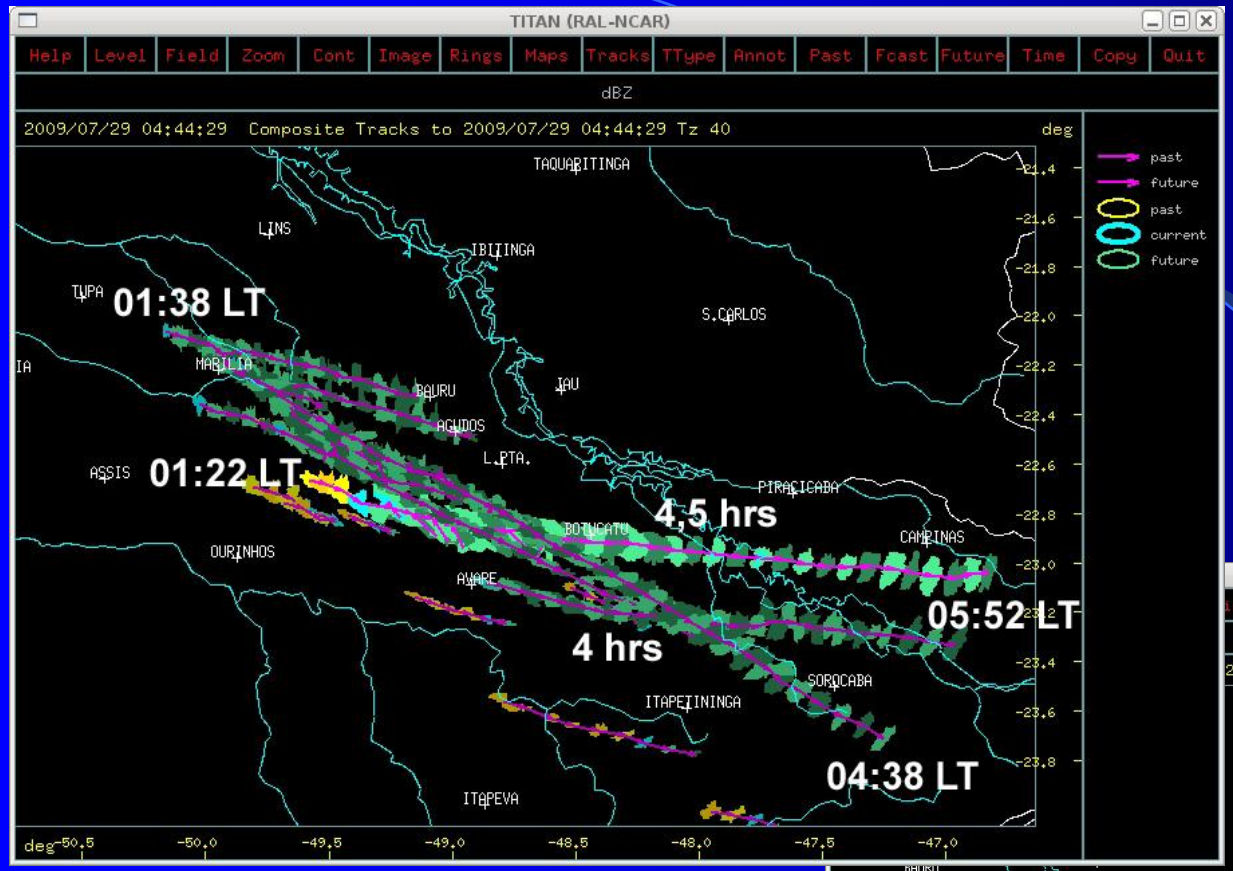
The hailstorm has reached Taiuva town 30 minutes later, at 15:35 LT, as was predicted by the TITAN system



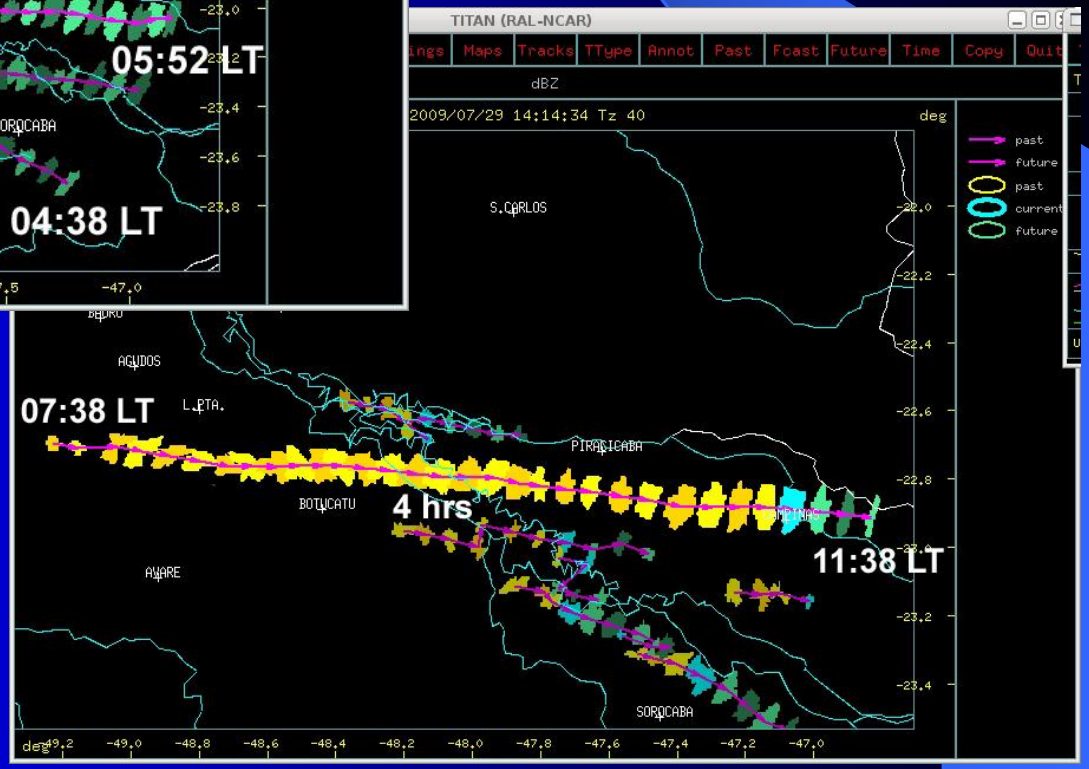
BrasilDat: Cloud-Ground (CG) strokes on 24/07/2007



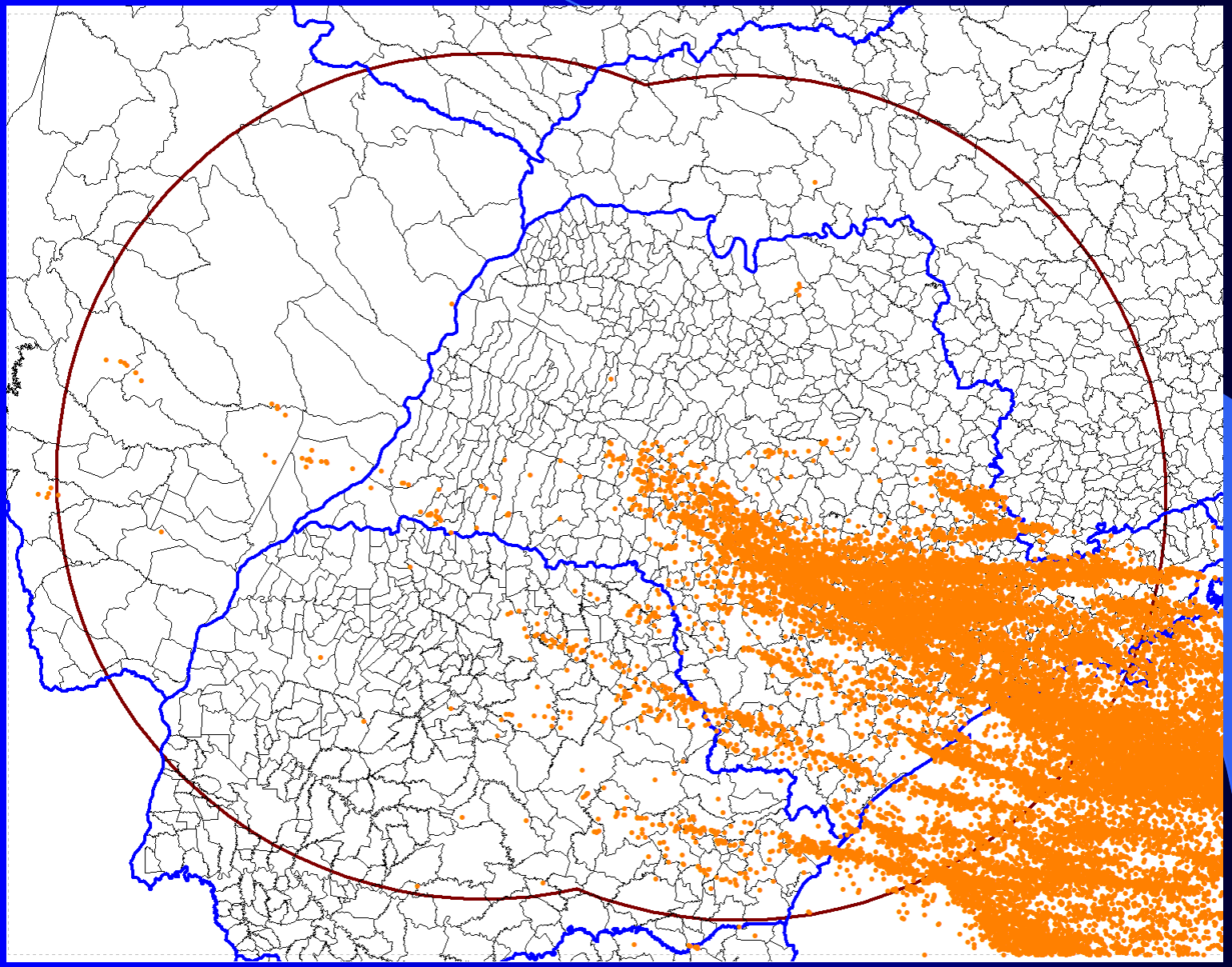
CASE STUDY: 29 July 2009



16:01



BrasilDat: Cloud-Ground (CG) strokes on 29/07/2009



CONCLUSION

- From 18 years of radar observations, seven cases have so far been analyzed when one or more supercells occurred;
- All cases occurred during the transitional seasons or in winter and were provoked by strong baroclinic synoptic situations (cold fronts approaching from south-west), creating extremely strong convective instability and vertical wind shear ;
- At least four of these supercells spawned a tornado, while another two produced an extensive hail swath;
- Their duration ranged from 3,5 to 8,5 hours and they occurred any time of the day;
- Using TITAN, the following typical Storm Severity signatures were noted: cell displacement >50 $km.h^{-1}$ with the most common direction from WNW to ESE, but other directions had also been observed; Max_dBZ >60 dBZ, VIL >70 $kg.m^{-2}$, as well as rotational shear of up to $–5,0x10^{-2}s^{-1}$ in the cases of the tornadoes;

CONCLUSION (continued)

- Intensive lightning activity (CG strokes) of the cells prior to the tornado touch-down, dropped to very low stroke frequencies during the mature tornado stage, after which it increased again. In contrast, the supercell storms, which did not spawn a tornado, had relatively constant flash rates;
- Although many more case studies will be needed, these severe storm signatures are being gradually implemented operationally for Nowcasting and severe weather alerts in the State of São Paulo.

Thank You !

OBRIGADO !

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