Previsibilidade de eventos extremos no Estado de São Paulo, Brasil: Verificação das previsões do modelo Meso-Eta (24 - 48 horas)

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III WORKETA
CPTEC, Cachoeira Paulista
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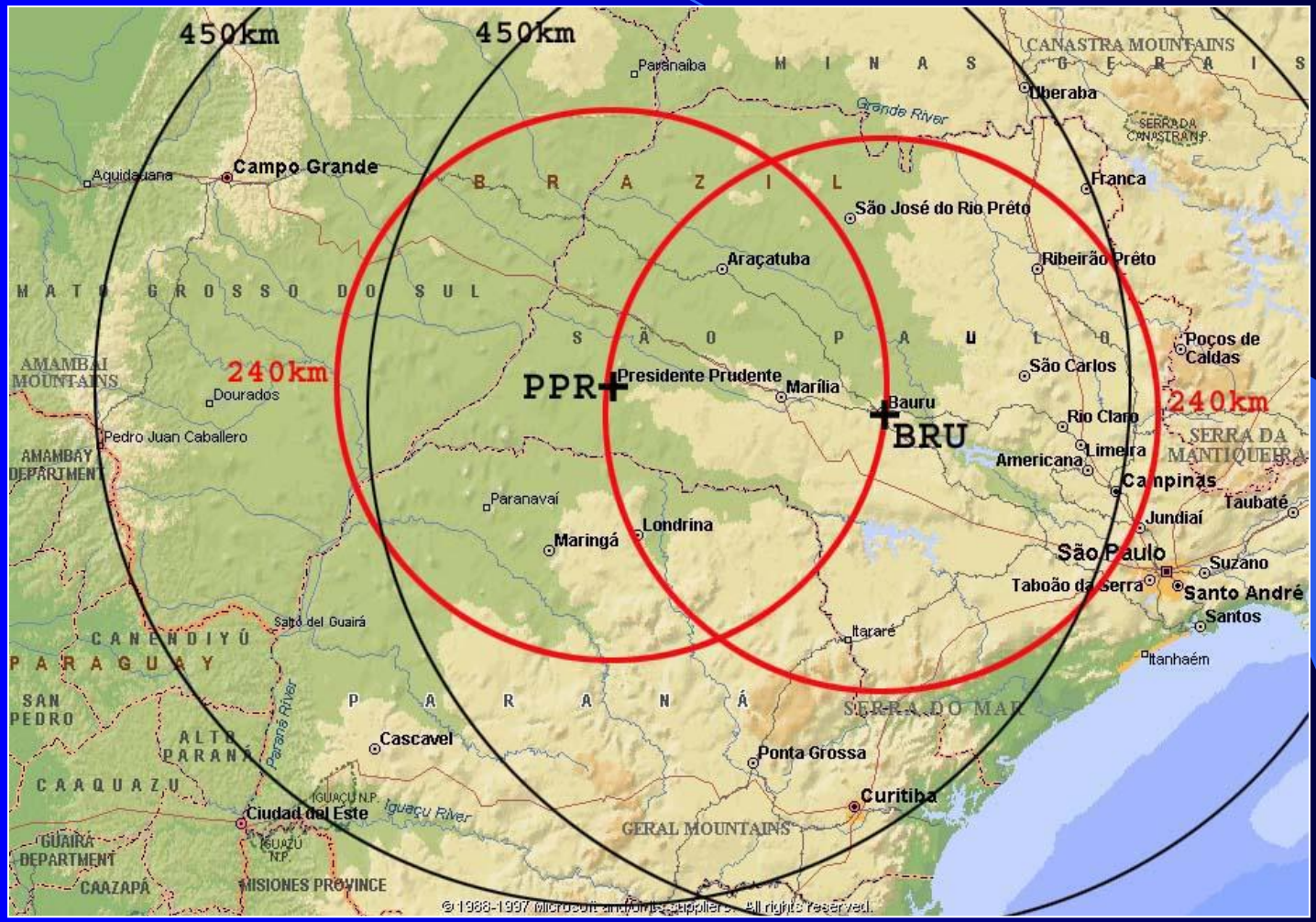
INTRODUCTION

- 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), hailstorms, intense lightning and flash floods, resulting in many millions of US Dollar damage annually;
- Until recently, 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).

OBJECTIVES

- **The objective of this study is firstly, to test the capabilities of the Meso-Eta model for an early alert system in Southeast Brazil;**
- **To compare Betts-Miller and Kain –Fritsch convection schemes;**
- **And ultimately, to provide a better Alerting System (up to 48 hours) for the State of São Paulo.**

DATA & METHODS - Radars



2x S-band DopplerRadars, PPR & BRU

volume scans 7.5 min, 11 (15) elevations, resolution: 1km (250 m) x 1°AZ

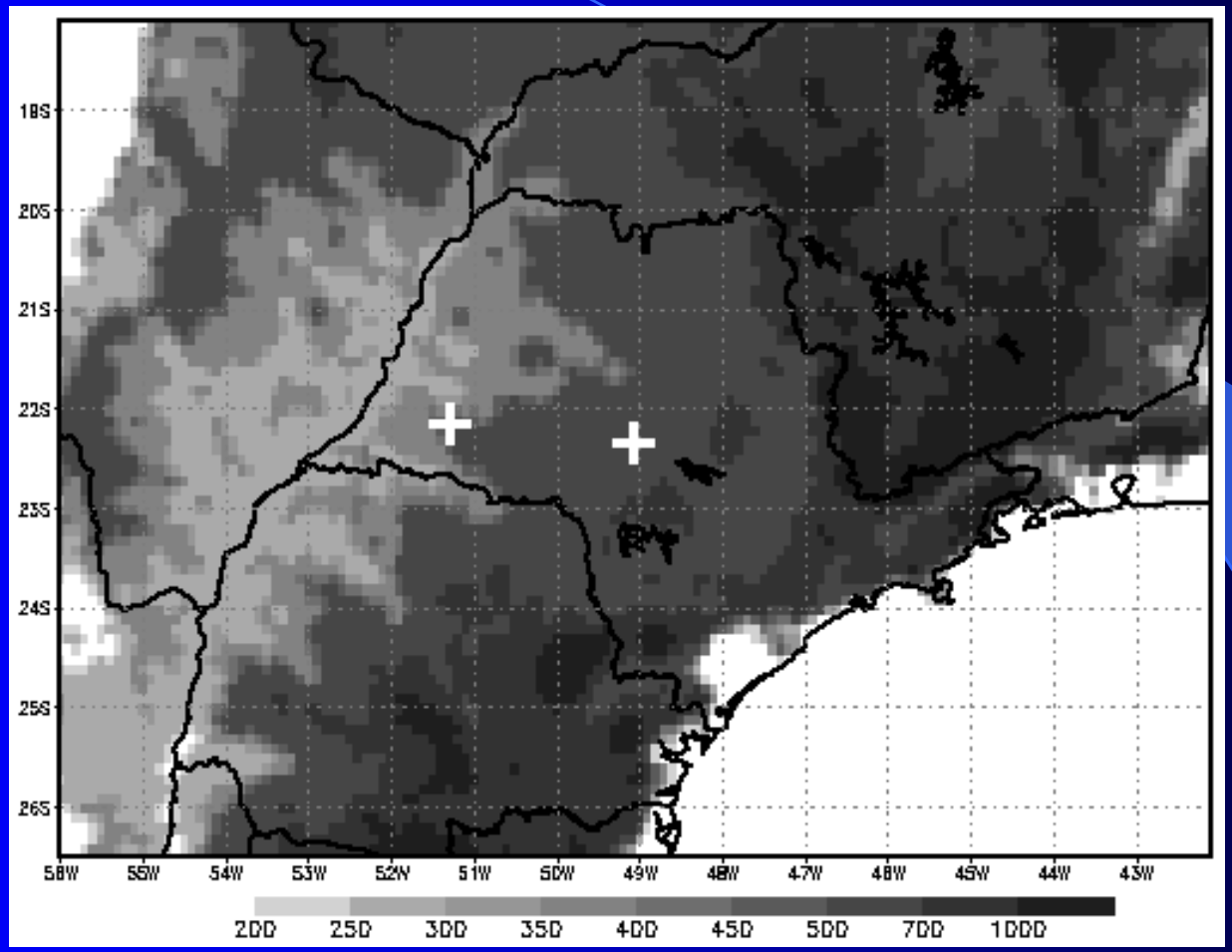
DATA & METHODS - Meso-Eta Model

- The Meso-Eta model is part of the Regional Eta model family, which runs operationally at CPTEC with a resolution of 40x40 km and 20x20 km, producing 6-hourly forecasts for up to 168 hours);
- IPMet's version of the Meso-Eta model is running twice daily in non-hydrostatic mode, initialized with NCEP analysis, but boundary conditions are updated with the CPTEC/Eta operational model (40x40 km);
- Its domain is about 1440x885 km, 30 levels, centered over Bauru;
- The output resolution is 10x10 km, for every hour, but operationally with forecasts every 3 hours up to 72 hours ahead;
- Recent improvements include a better topography (increased from 4 to 10 levels), computation of convective parameters (SR helicity, BRN Shear, supercell index, Helicity-Energy Index, etc) and generation of vertical profiles (Skew T – Log P) at any grid point;
- Each model run is performed twice, using the Betts-Miller and Kain-Fritsch convective parameterization schemes, respectively.

Modelo Meso-Eta: Versão e configaração no IPMet

- Versão Original Betts-Miller-Janic (ICPT 2005)
- Com Module Kain-Fritsch (original)
- Ponto Central: Bauru Radar
- Domain: approx. 1440 x 885 km
- Long = -49.00
- Lat = -22.35
- IM = 101
- JM = 141
- LM = 38
- LSM = 30
- Res = 10 km

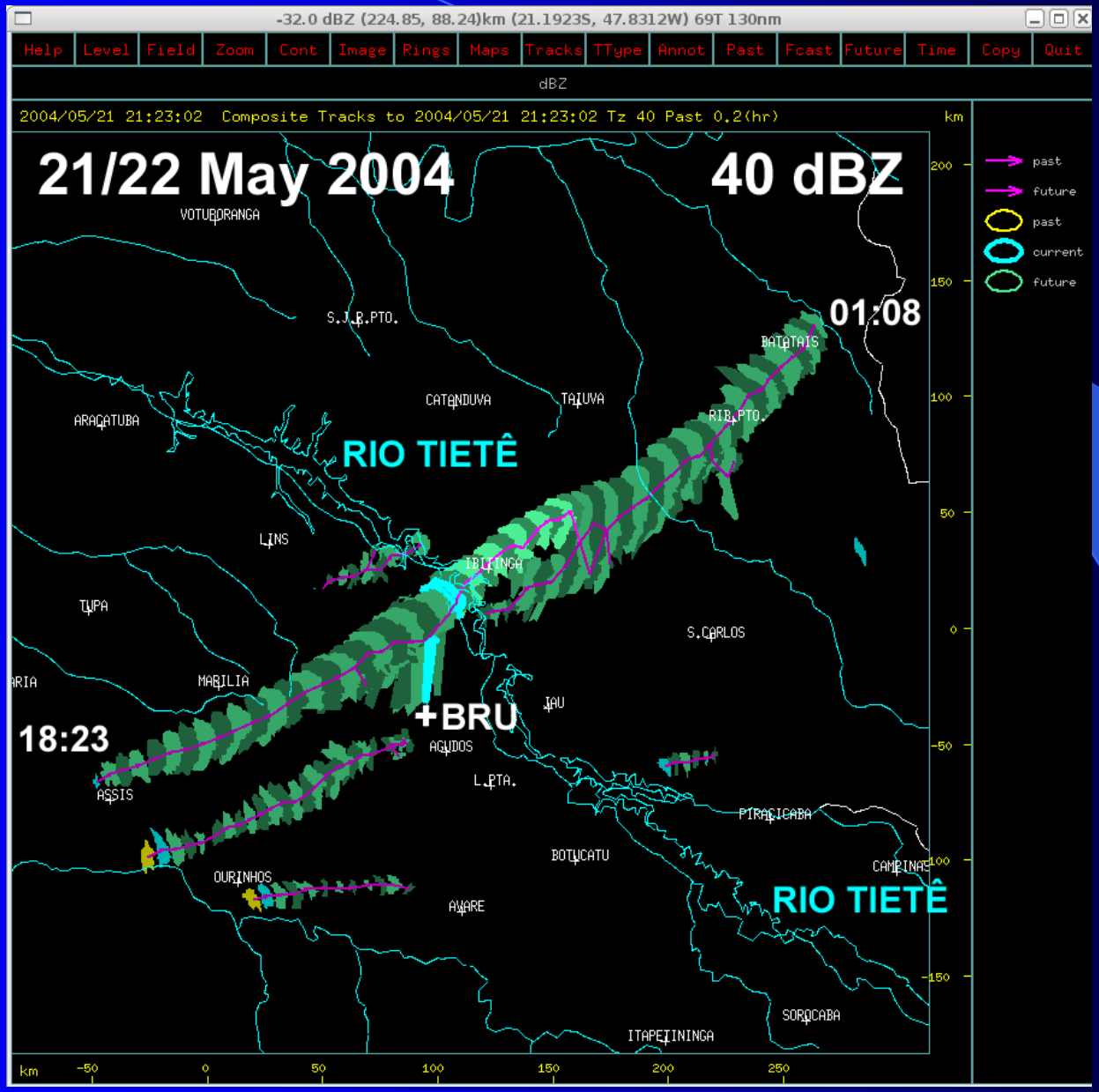
Meso-Eta Model: Domain & Topography



14 cases studied so far:

Supercells; Tornados (F0 – F3); Bow Echoes generating extreme Gust Fronts; Hail swaths

CASE STUDY: 21/22 May 2004

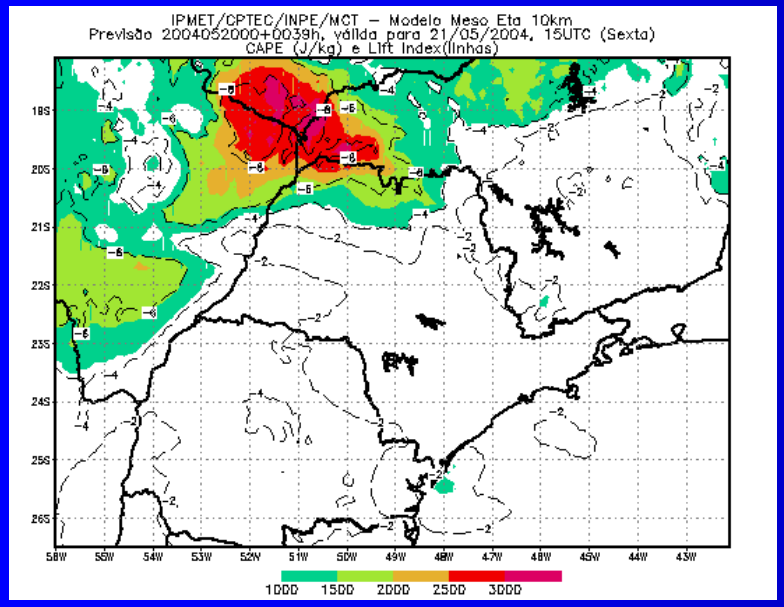


Supercell: 21/22 May 2004 / 20/05/2004-00UT

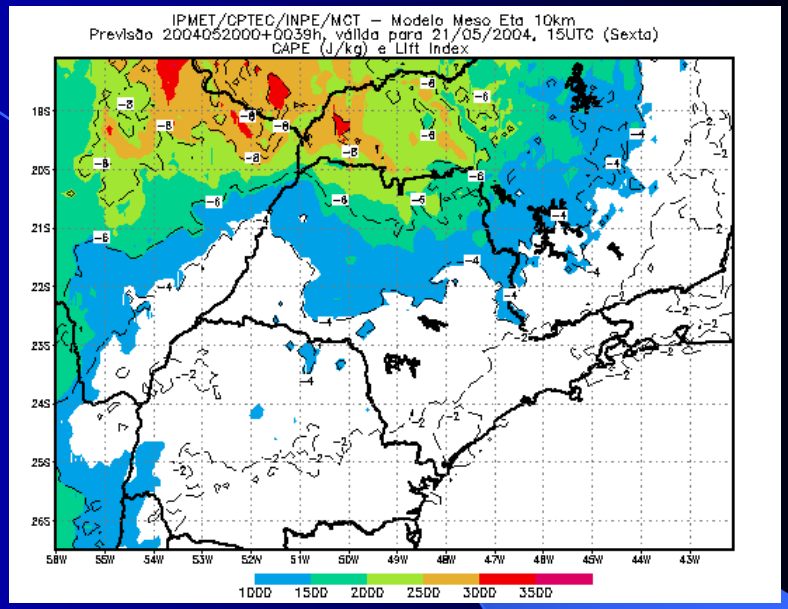
B-M

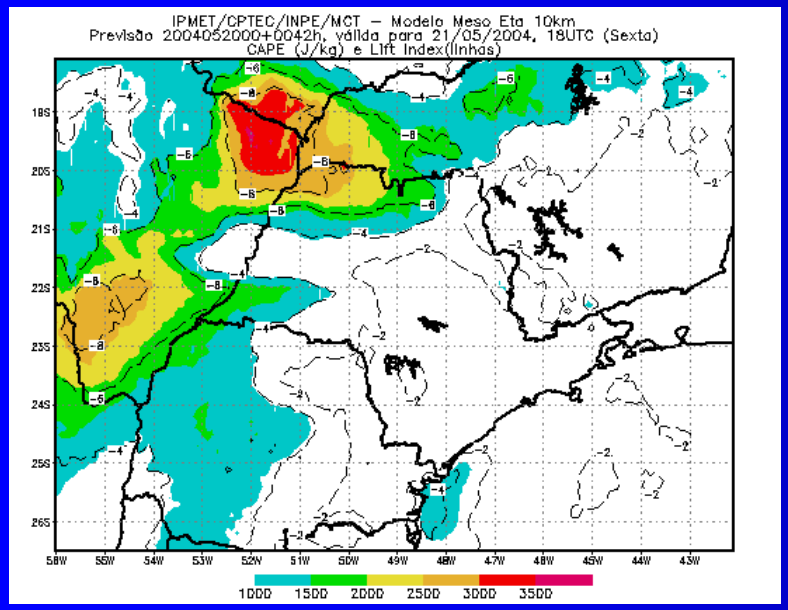
CAPE, LI

K-F



Fcst 39h
12:00 LT





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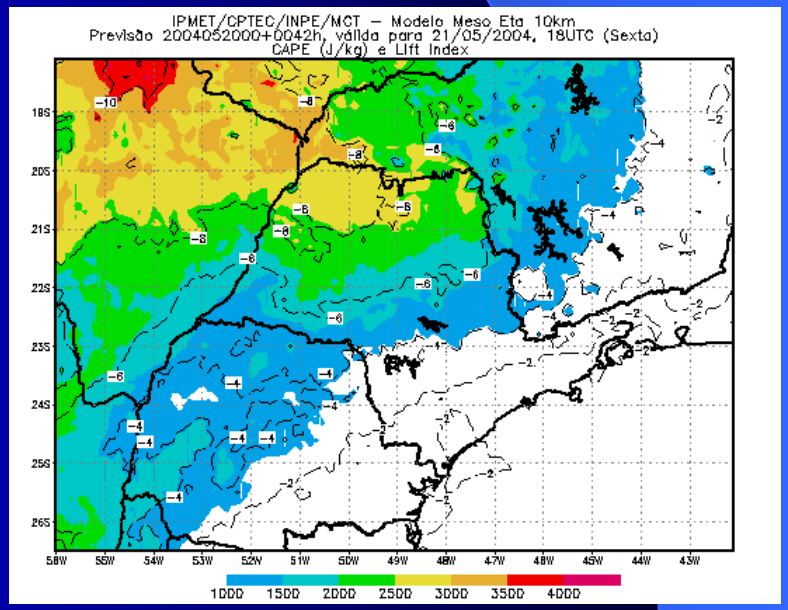
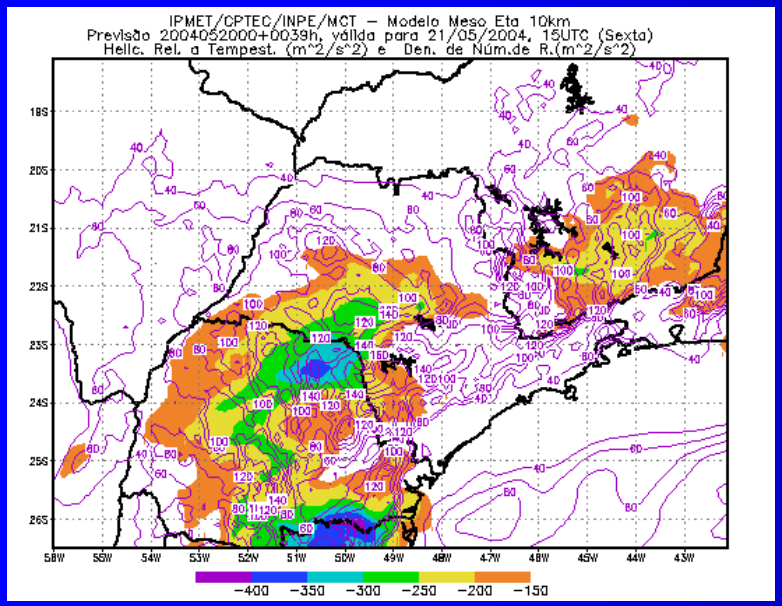
15:00 LT



Supercell: 21/22 May 2004 / 20/05/2004-00UT

B-M SRH, BRNS K-F



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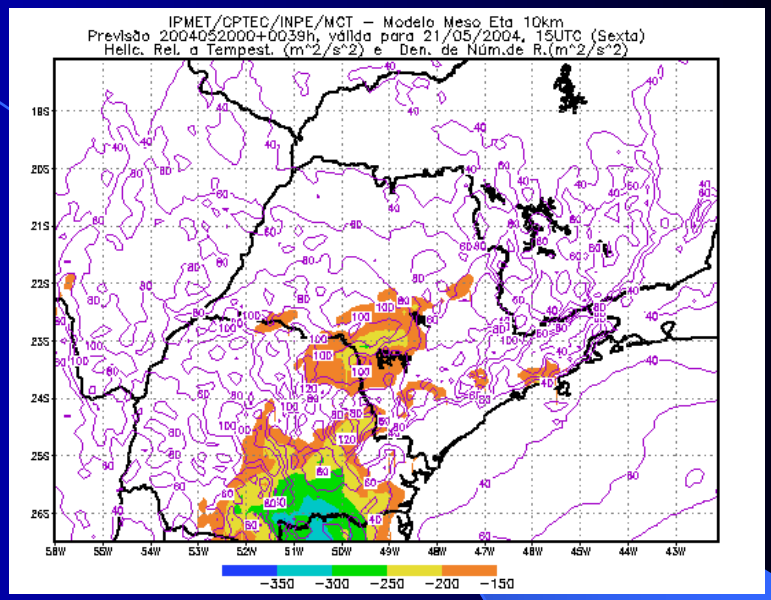

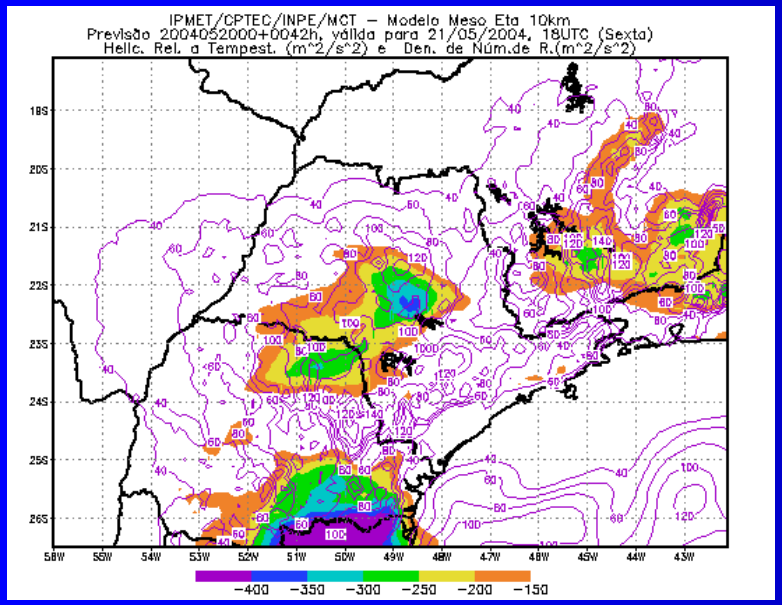

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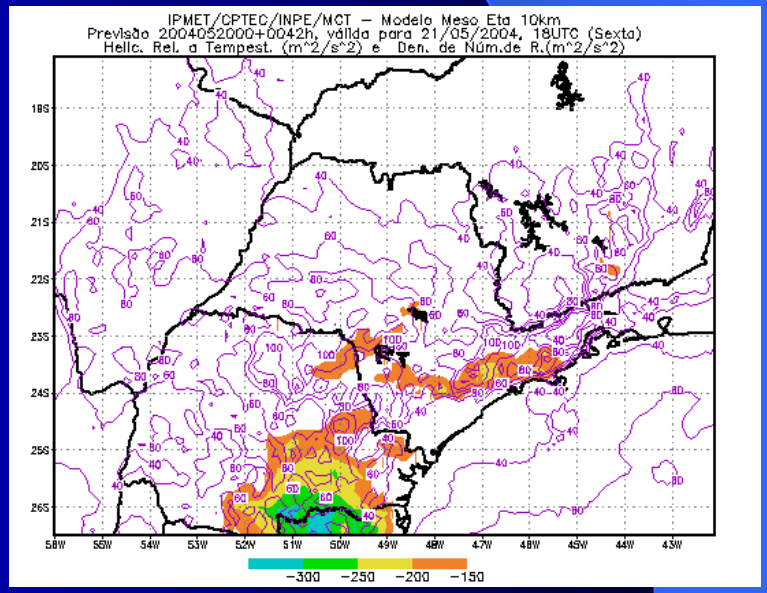
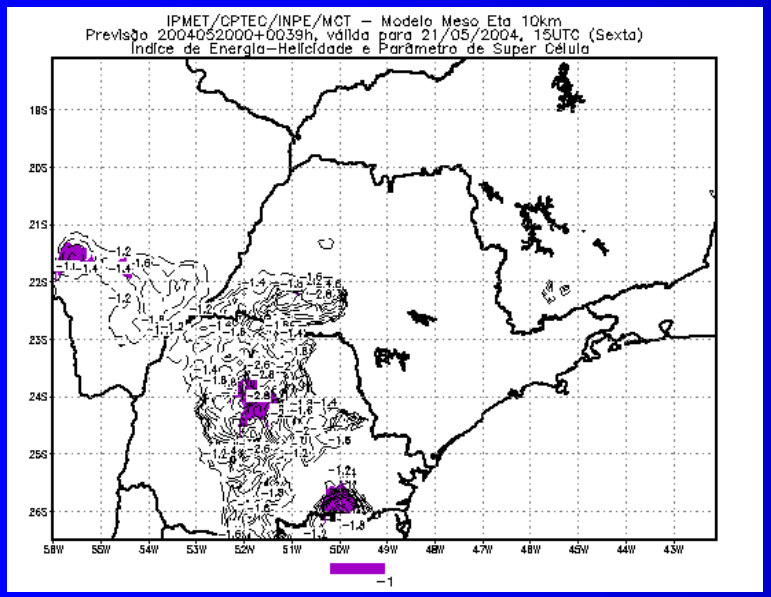


Supercell: 21/22 May 2004 / 20/05/2004-00UT

B-M

HEI, SCI

K-F



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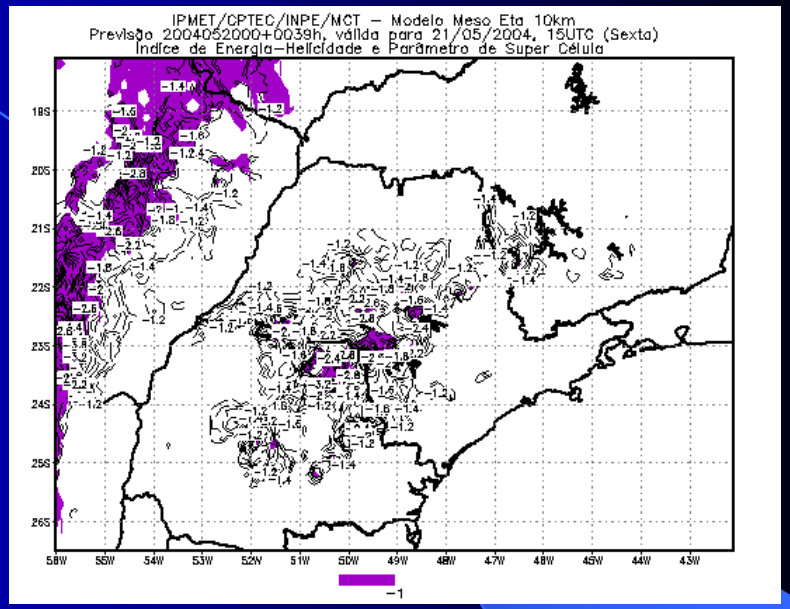

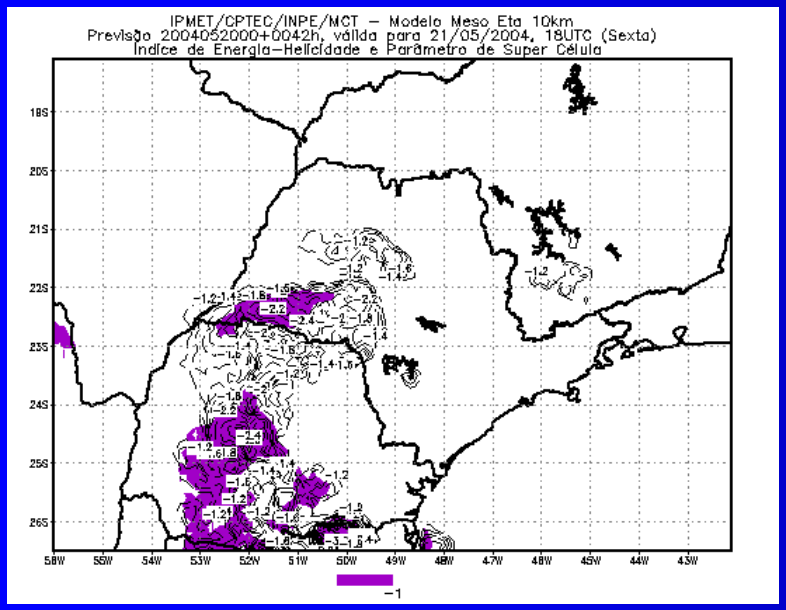

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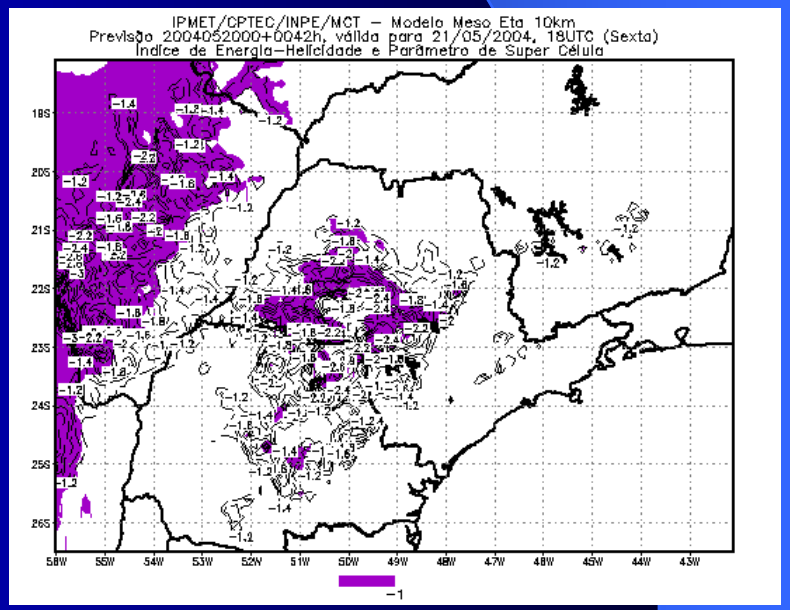
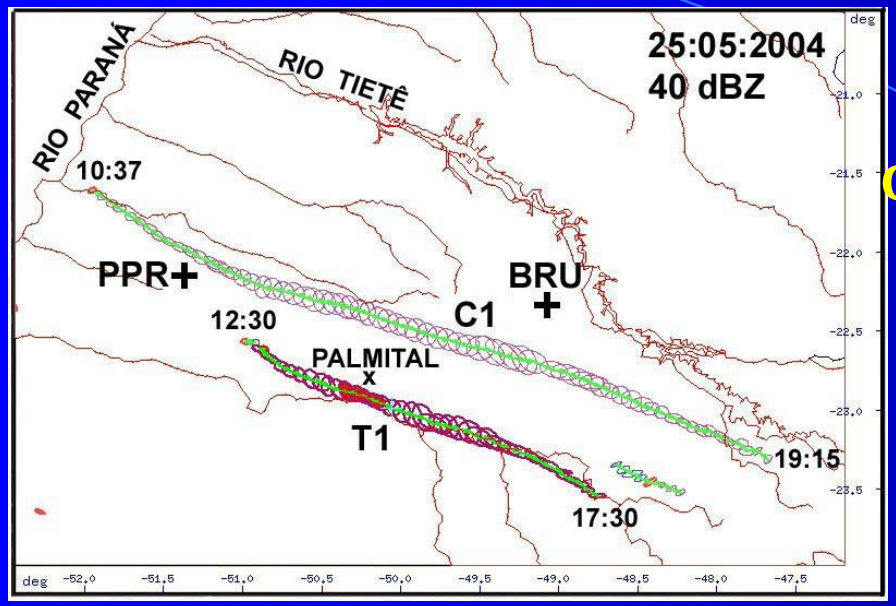


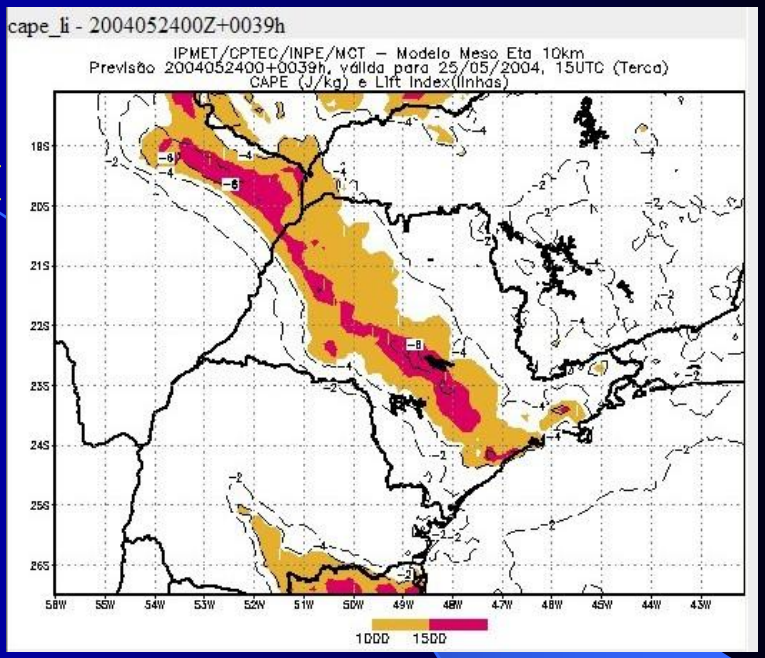
CASE STUDY: 25 May 2004

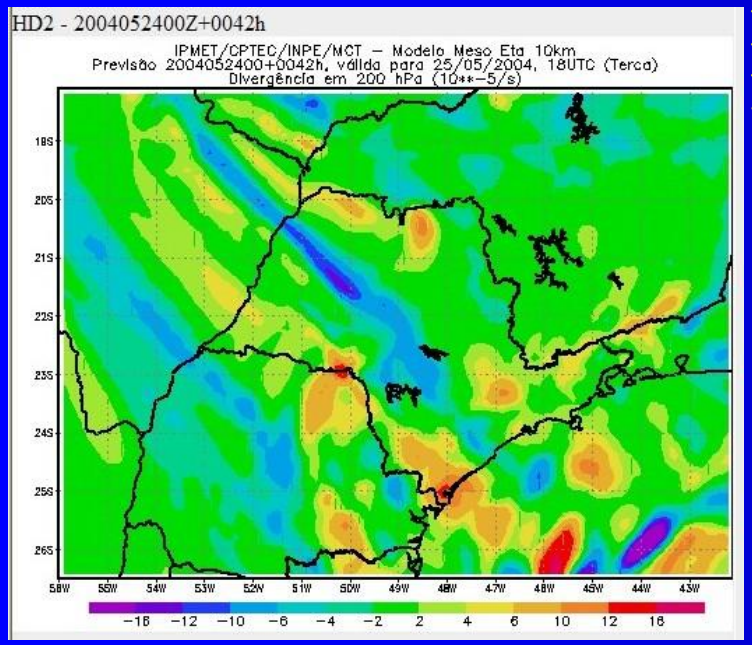
- **Several storms, associated with areas of strong convective activity created by the passage of a baroclinic system with strong convective instability and vertical wind shear;**
- **1 Supercell storm (40 dBZ track for 8.5 hours);**
- **2 Tornadoes (F2-F3; F2);**
- **The model was initiated on 23 May 2004, 12UT; 24 May 2004, 00UT & 12UT; 25 May 2005, 00UT;**
- **The best forecasts were delivered by the run of 24 May 2004, 12UT.**

Supercell: 25 May 2004 / B-M, 24/05/2004-00UT



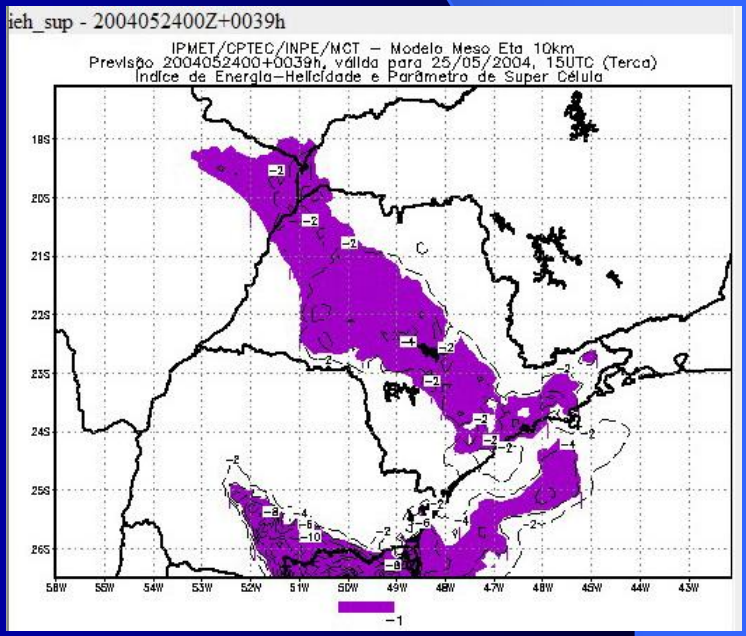
CAPE, LI
Fcst 39h
12:00 LT



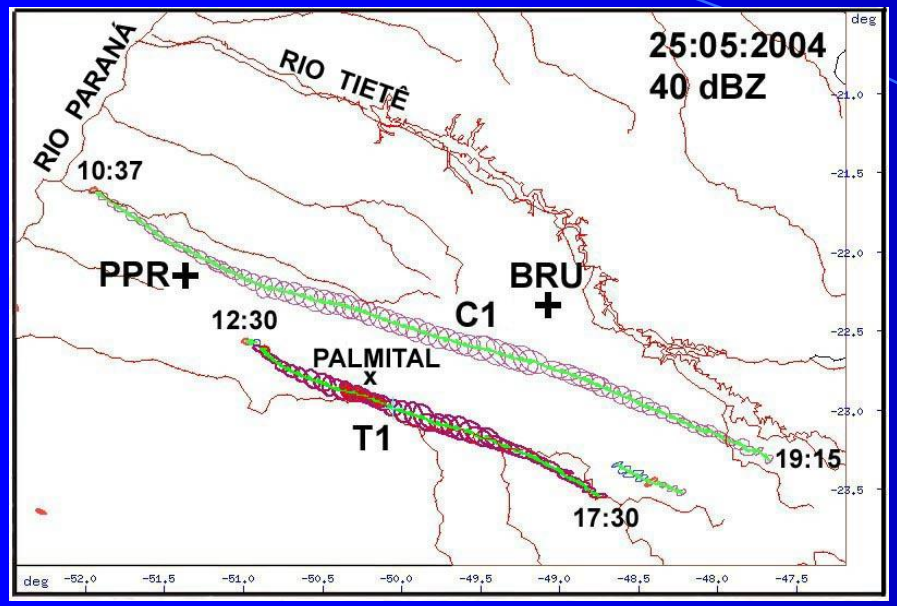


Div200hPa,
Fcst 42h
15:00 LT

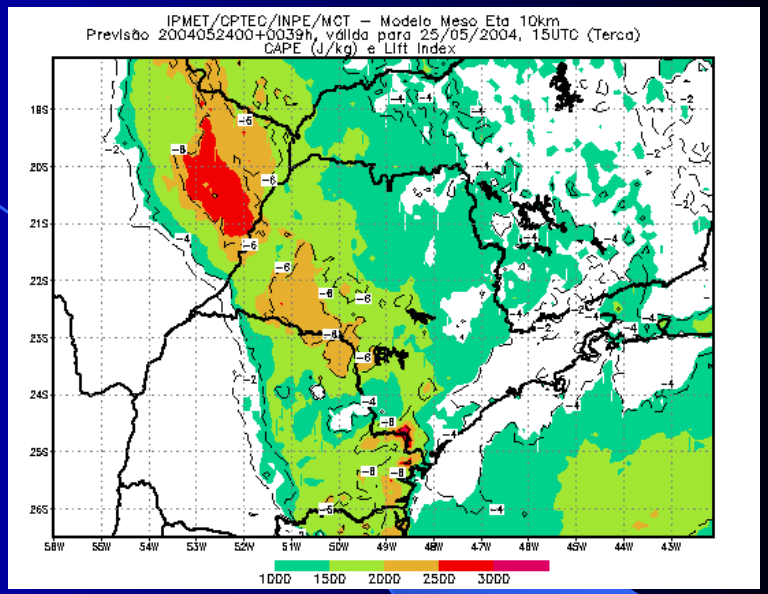
HEI-SCI
Fcst 39h
12:00 LT

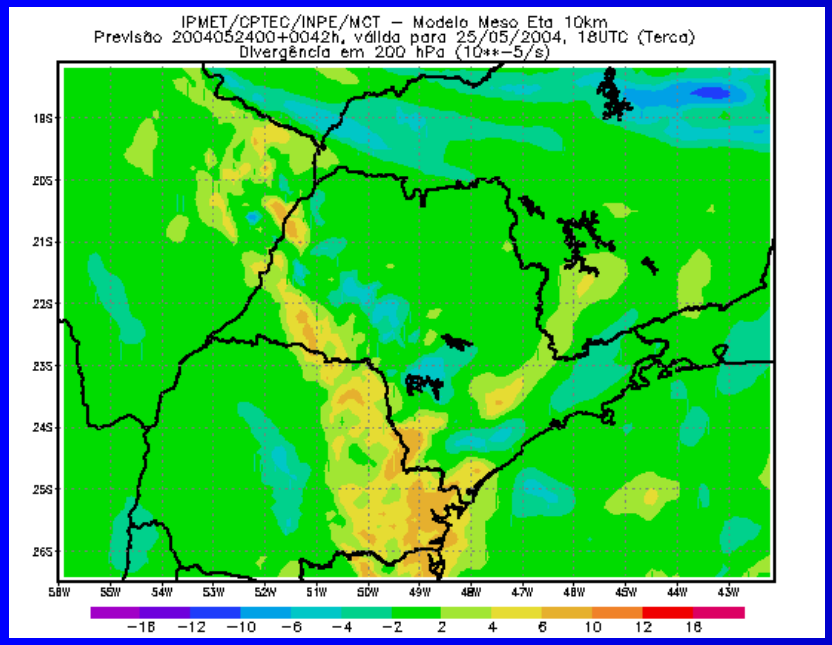


Supercell: 25 May 2004 / K-F, 24/05/2004-00UT

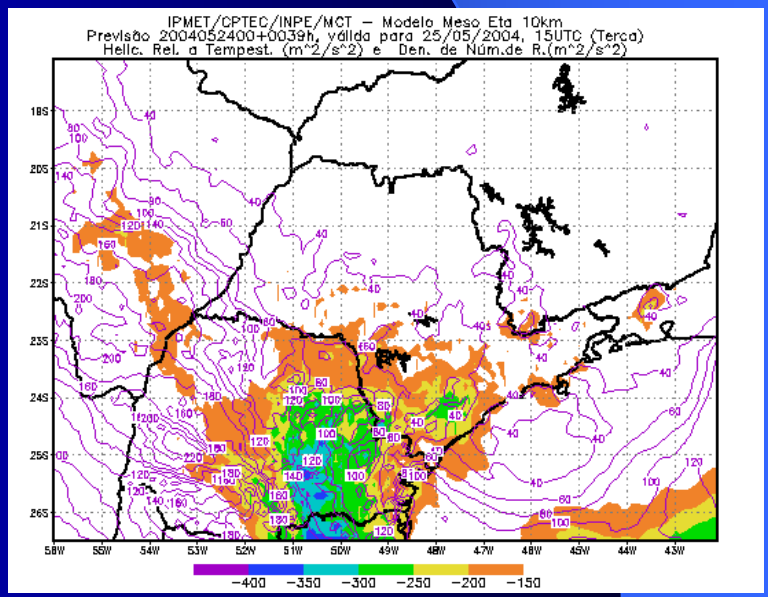


CAPE, LI
Fcst 39h
12:00 LT





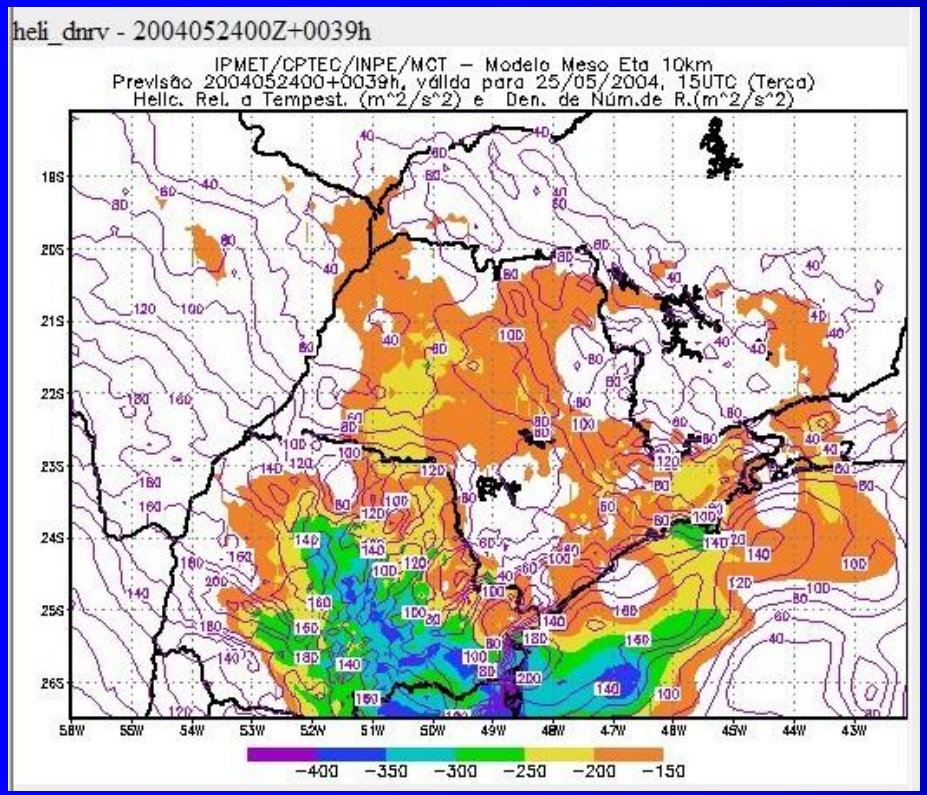
Div200hPa,
Fcst 42h
15:00 LT



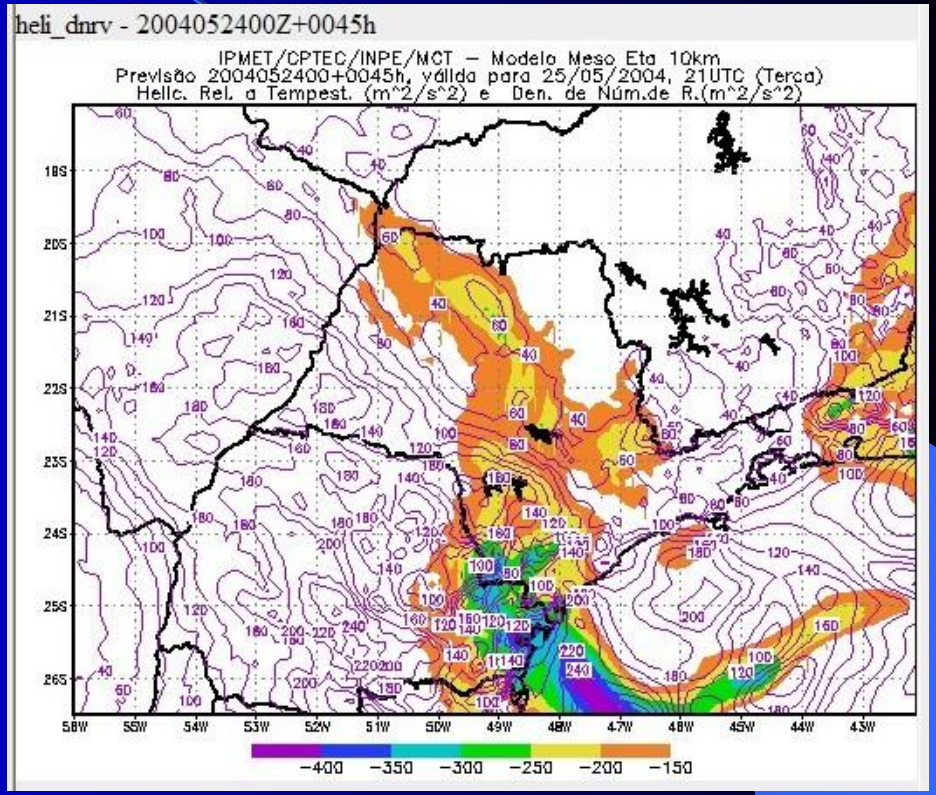
HEI-SCI
Fcst 39h
12:00 LT

Storm-Relative Helicity & Bulk Richardson Number Shear ($m^2.s^{-2}$) Betts-Miller

(SRH + BRNS)

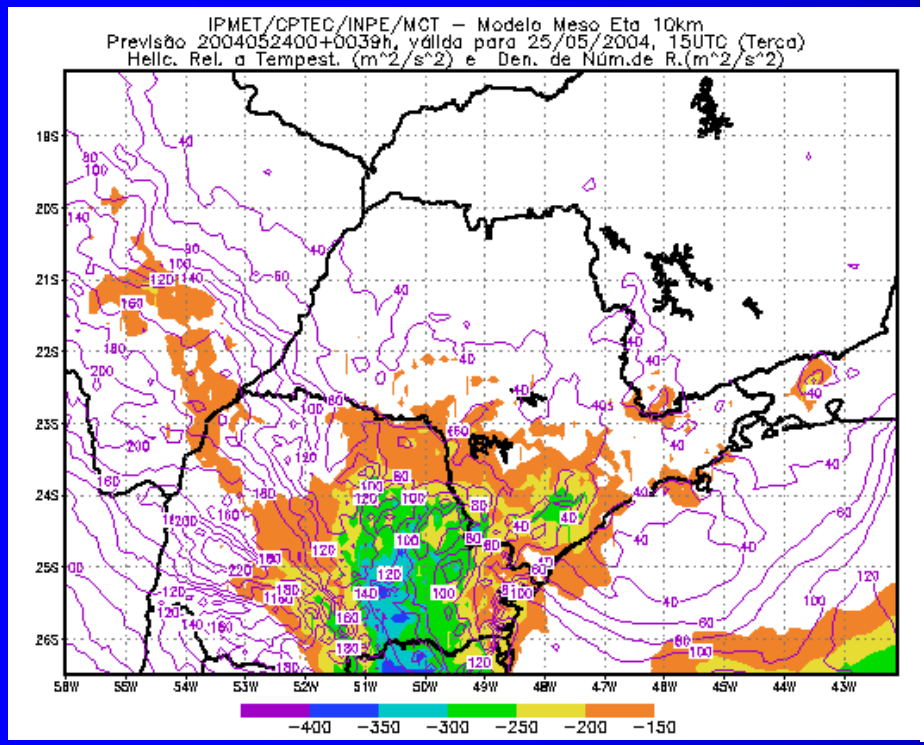


39-hour forecast (12:00 LT)

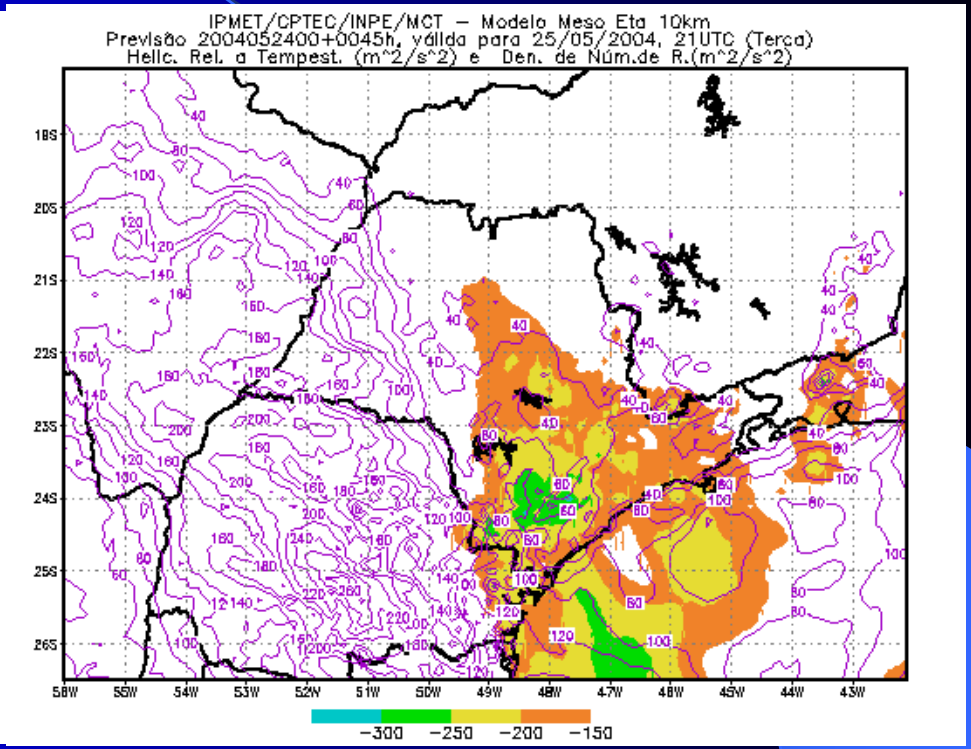


45-hour forecast (18:00 LT)

Storm-Relative Helicity & Bulk Richardson Number Shear ($m^2.s^{-2}$)
Kain-Fritsch
(SRH + BRNS)



39-hour forecast (12:00 LT)

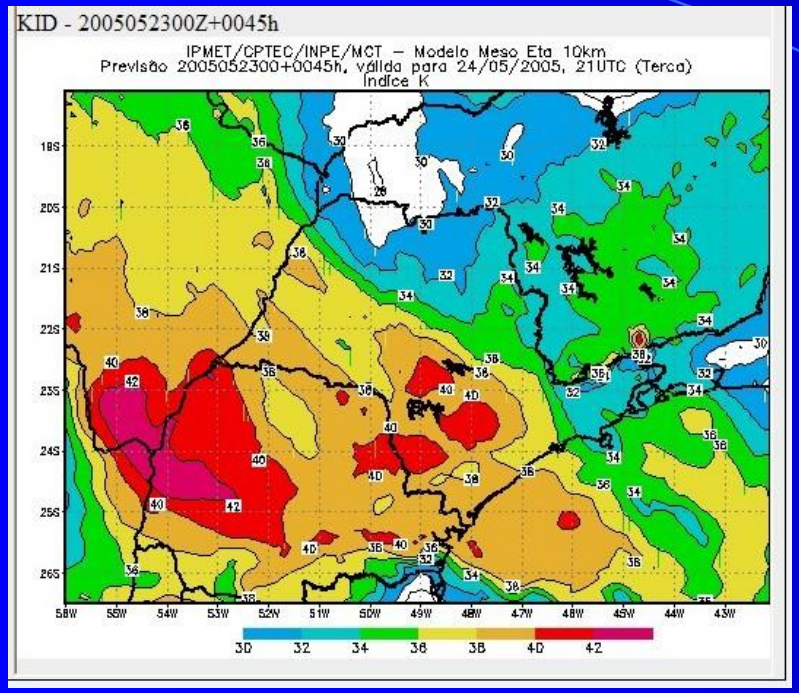


45-hour forecast (18:00 LT)

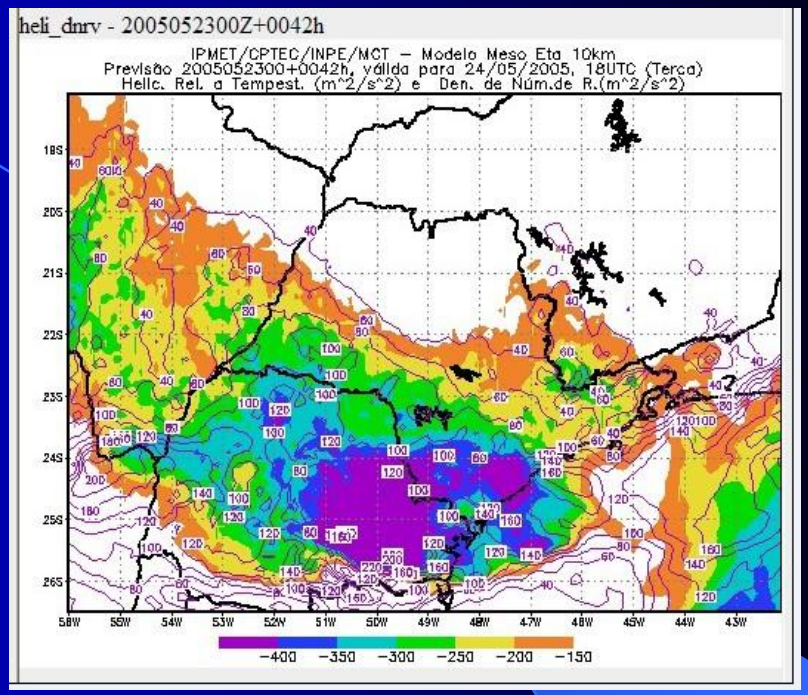
CASE STUDY: 24 May 2005

- **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 Severe wind storm (F2 like; 40 dBZ track for 3.5 h);**
- **1 Tornado (F3; 40 dBZ track for 3.2 hours);**
- **The model was initiated on 22 May 2005, 12UT; 23 May 2005, 00UT & 12UT; 24 May 2005, 00UT;**
- **The best forecasts were delivered by the run of 23 May 2004, 00UT.**

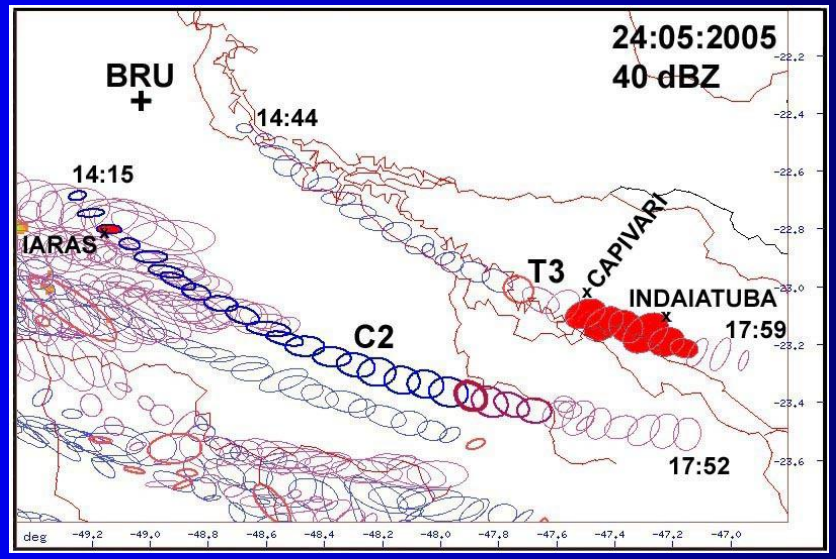
Tornado cell: 24 May 2005 / Kain-Fritsch, 23/05/2005-00UT



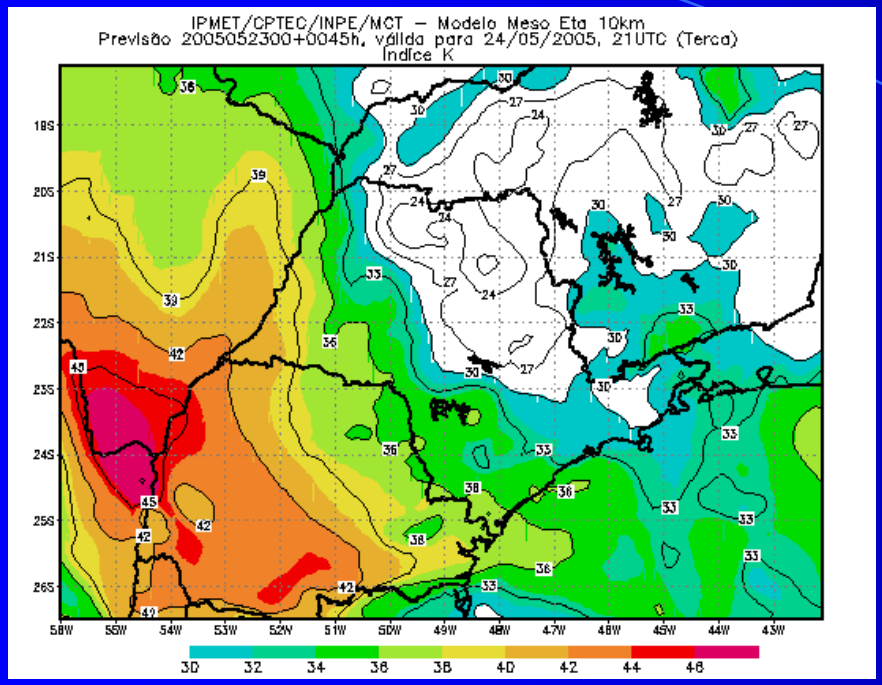
45-hour forecast (18:00 LT): K Index



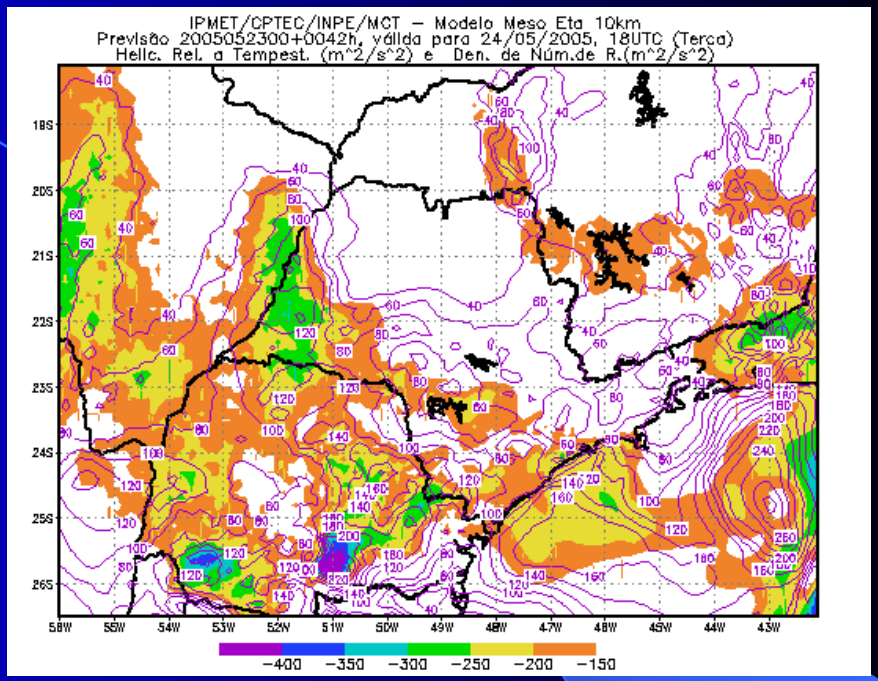
42-hour forecast (15:00 LT): SRH & BRNS ($m^2.s^{-2}$)



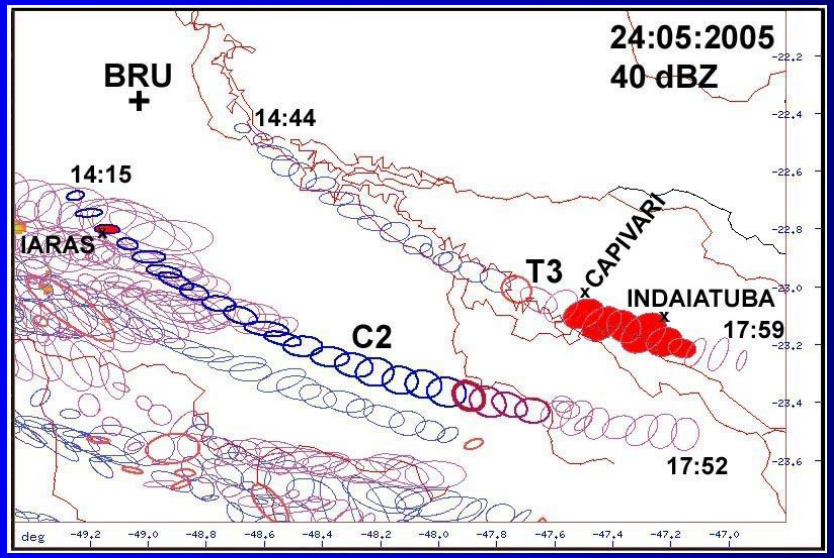
Tornado cell: 24 May 2005 / Betts-Miller, 23/05/2005-00UT



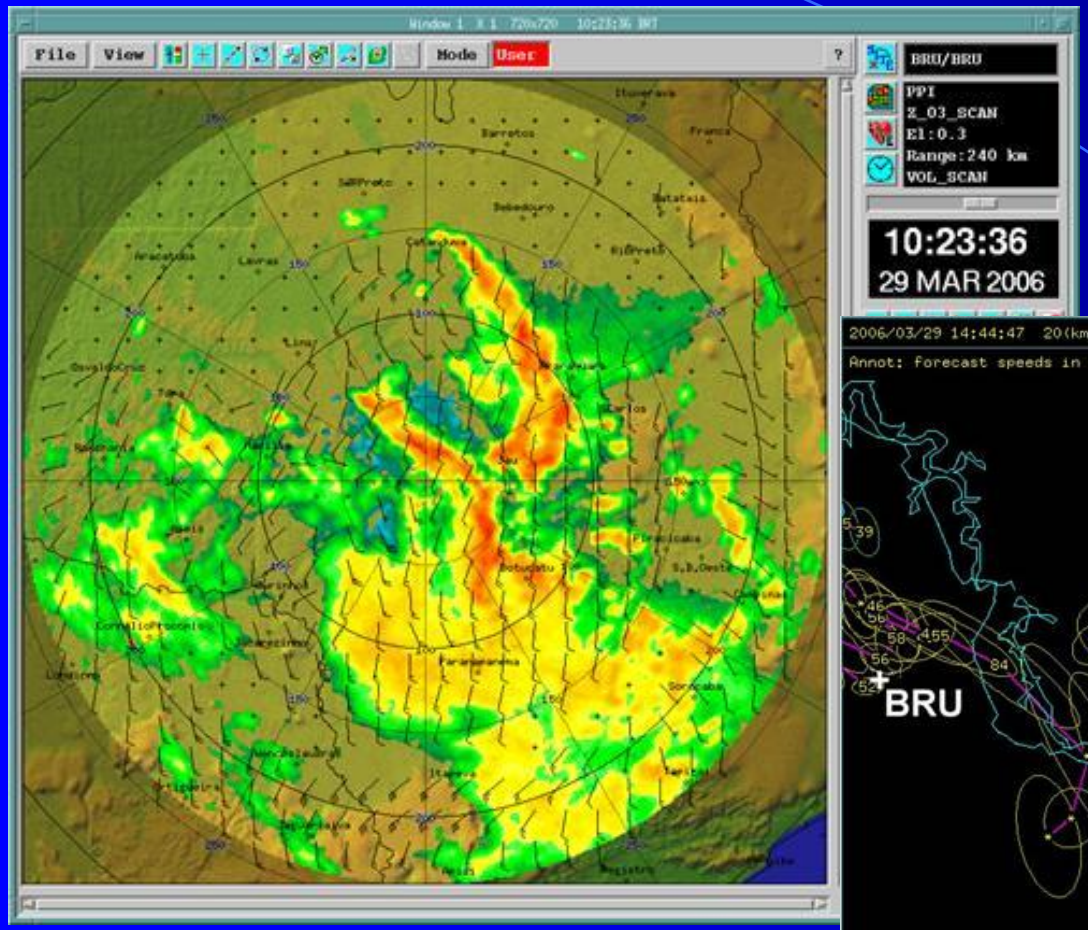
45-hour forecast (18:00 LT): K Index

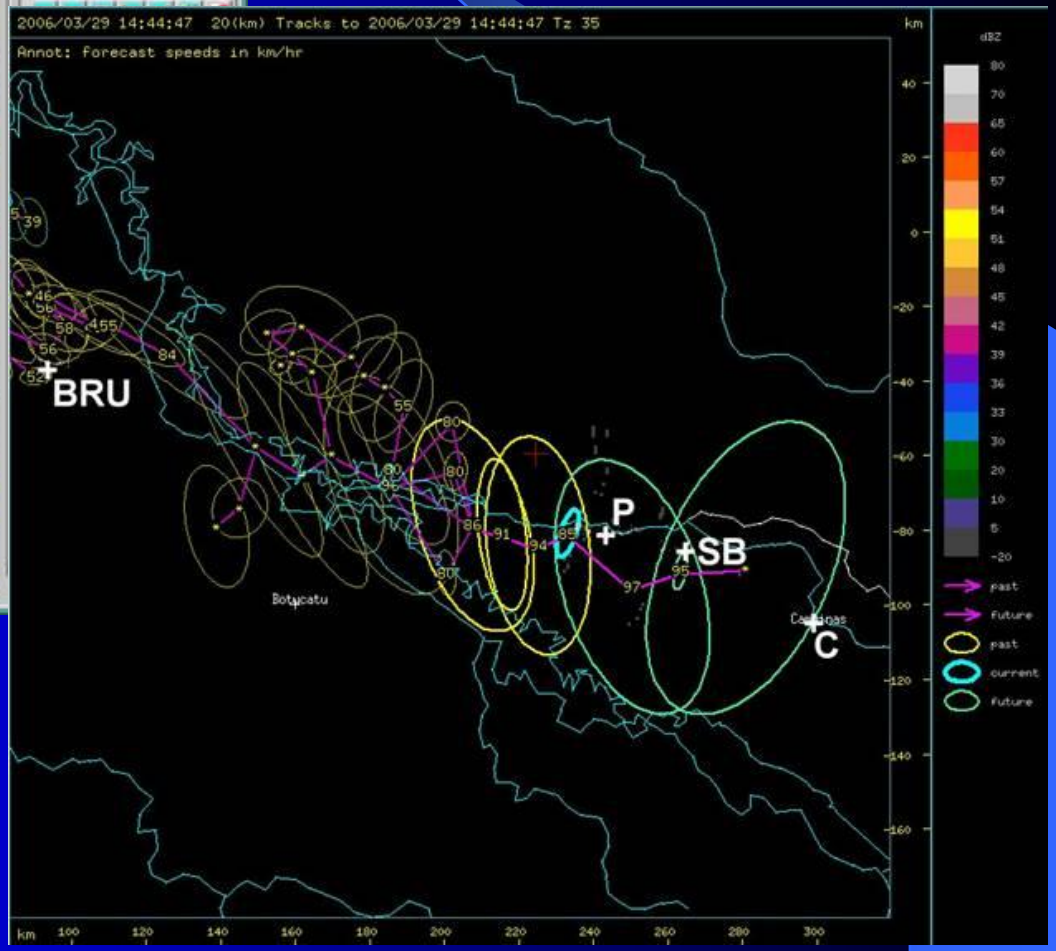


42-hour forecast (15:00 LT): SRH & BRNS ($m^2.s^{-2}$)



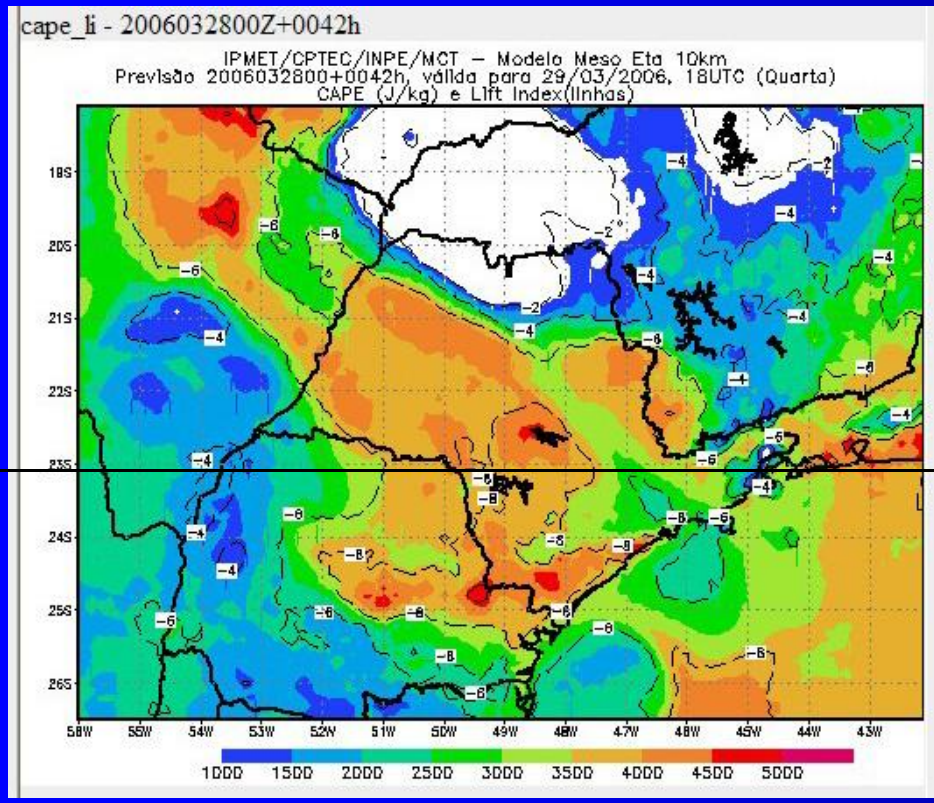
CASE STUDY: 29 March 2006 (Bow-Echo)



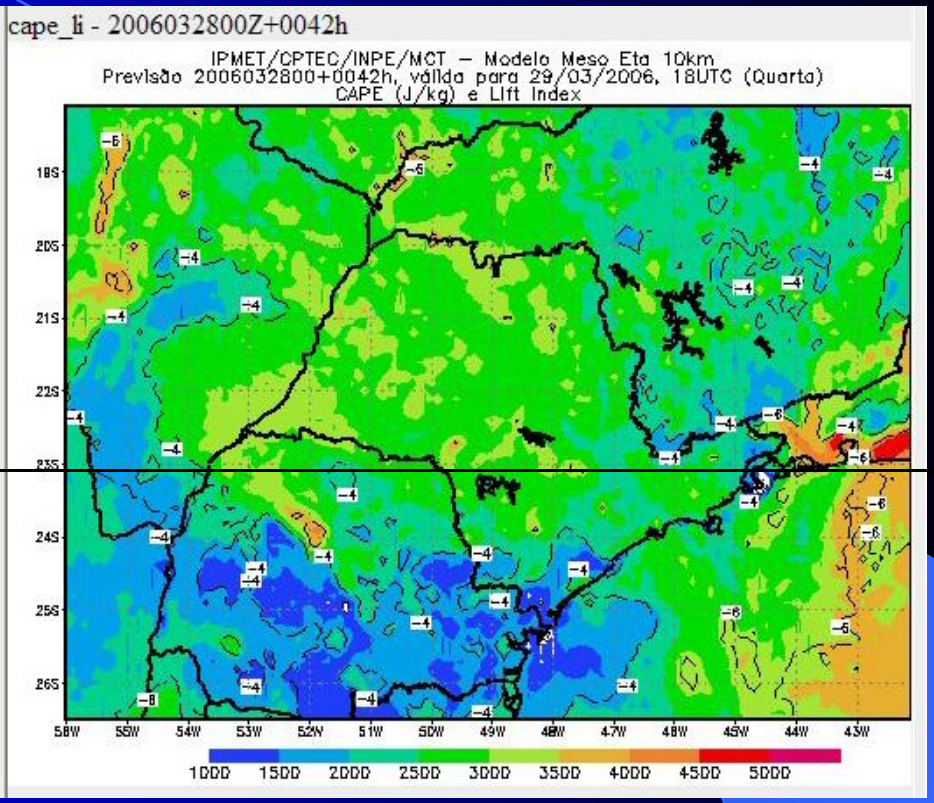


29 March 2006 / 28/03/2006-00UT

B-M



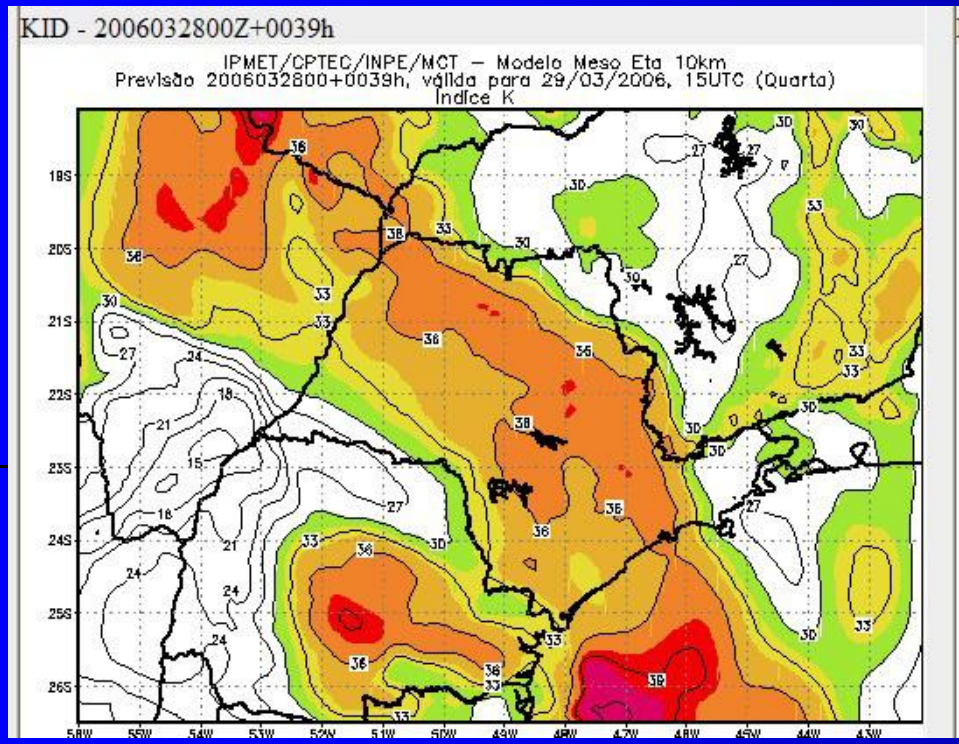
K-F



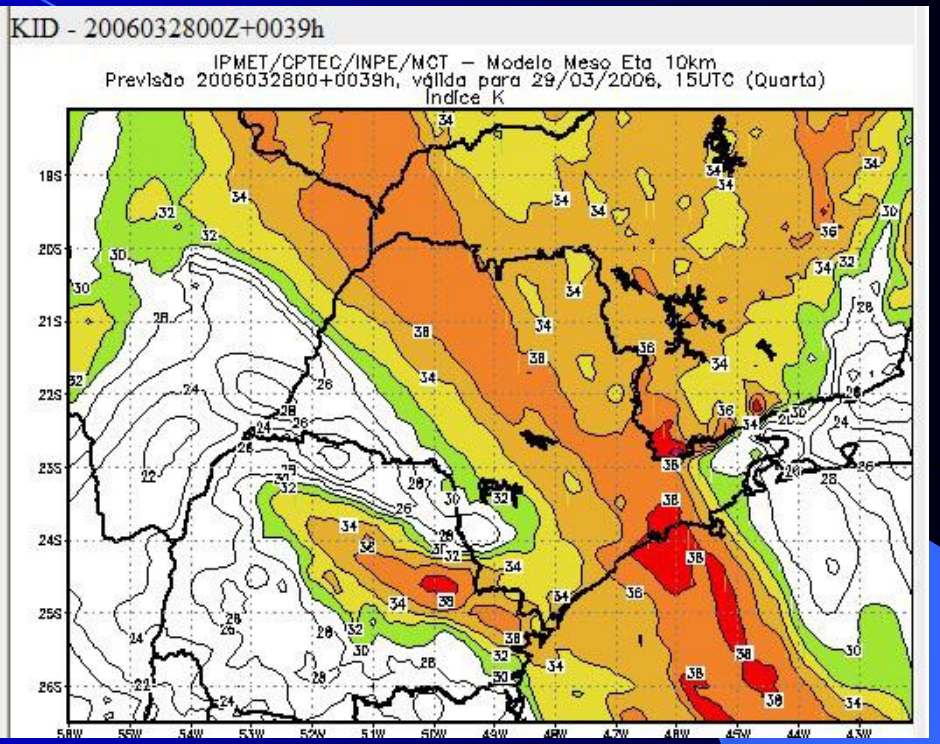
42-hour forecast (15:00 LT): CAPE ($J.kg^{-1}$) & Lifted Index (°C)

29 March 2006 / 28/03/2006-00UT

B-M



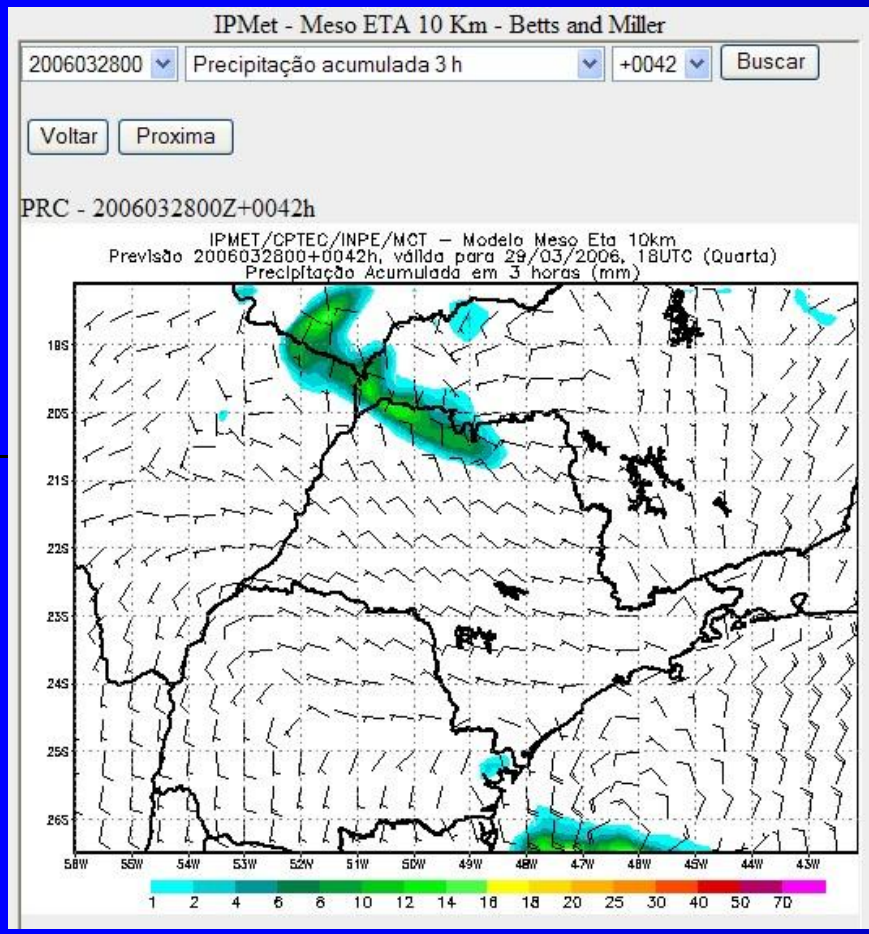
K-F



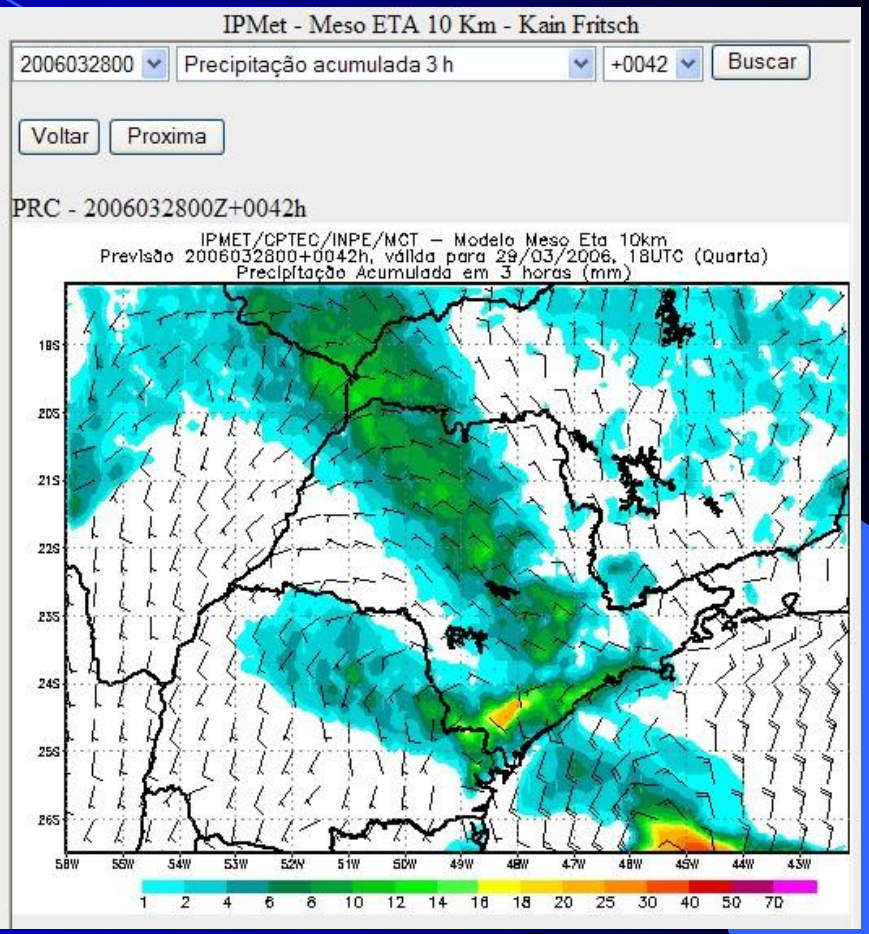
39-hour forecast (12:00 LT): K Index

29 March 2006 / 28/03/2006-00UT

B-M



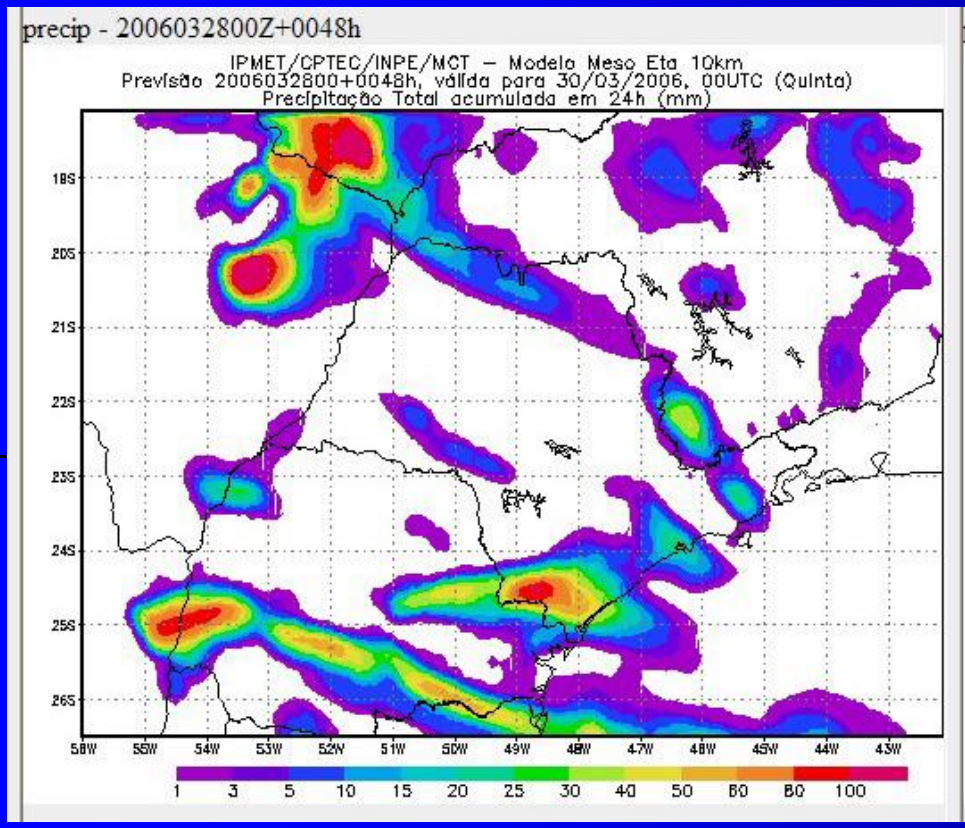
K-F



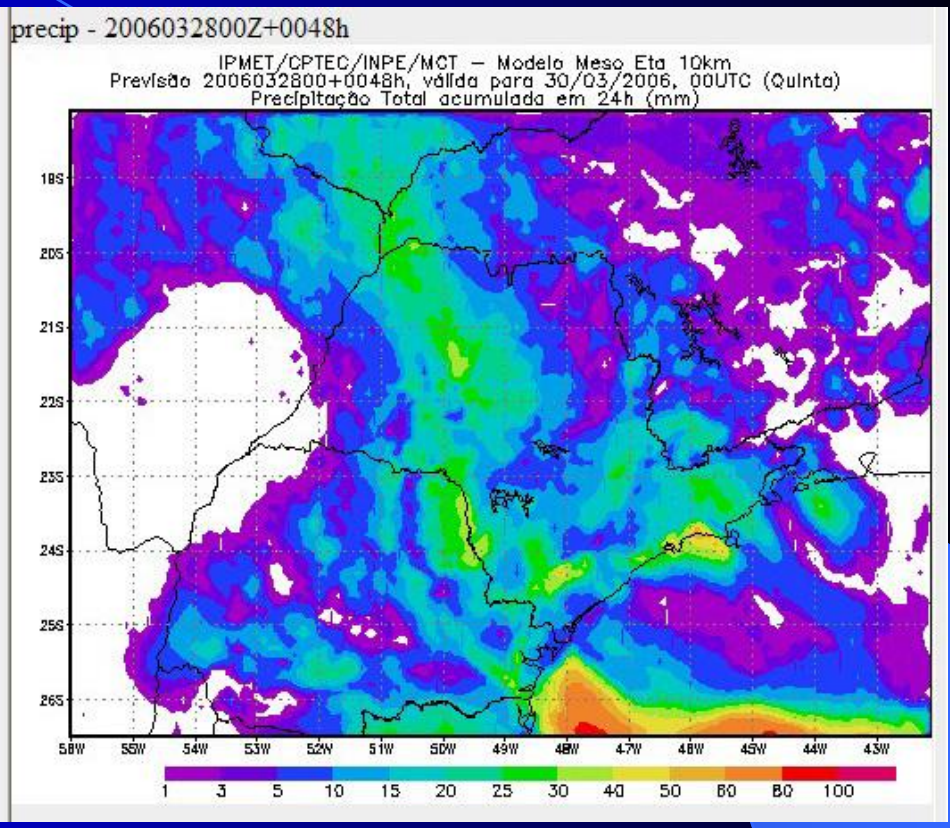
39-hour forecast: Chuva acumulada 09:00-12:00 LT

29 March 2006 / 28/03/2006-00UT

B-M

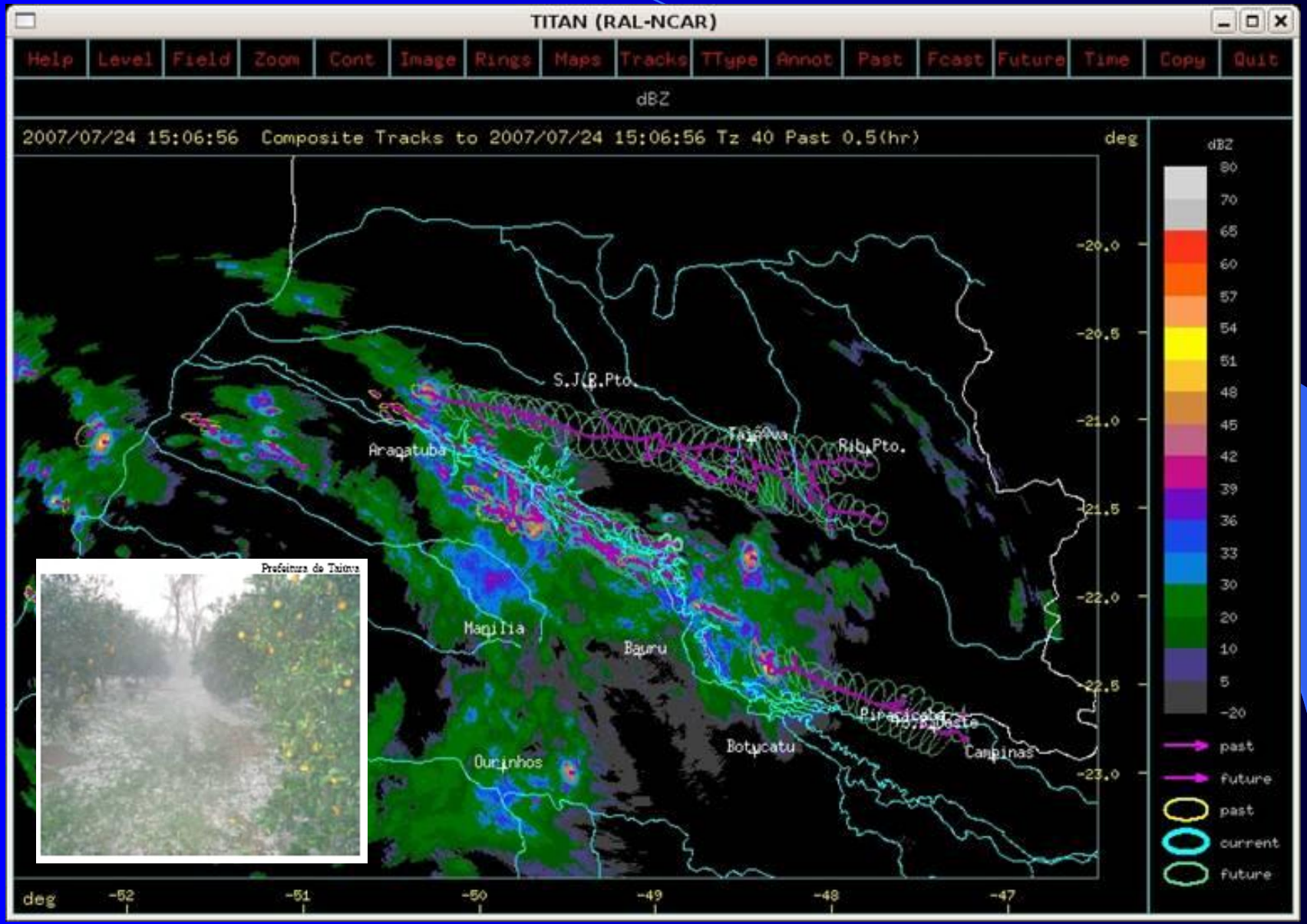


K-F



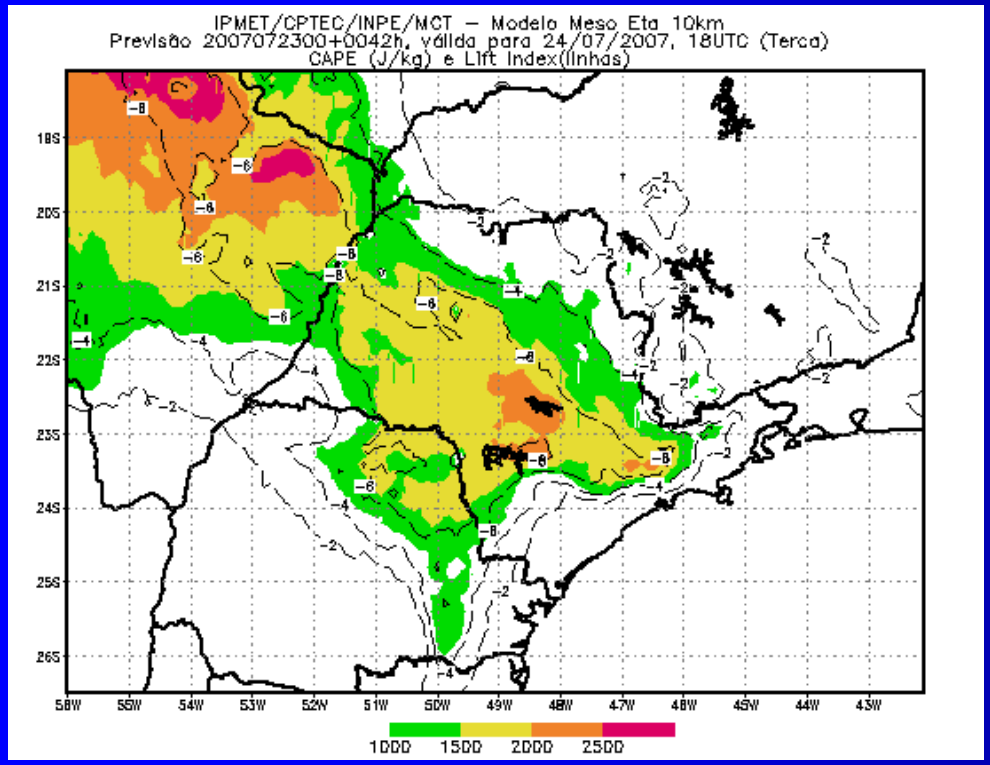
48-hour forecast: Chuva acumulada 24 horas até 29/03/2006 21:00 LT

CASE STUDY: 24 July 2007 (Hail Swath)

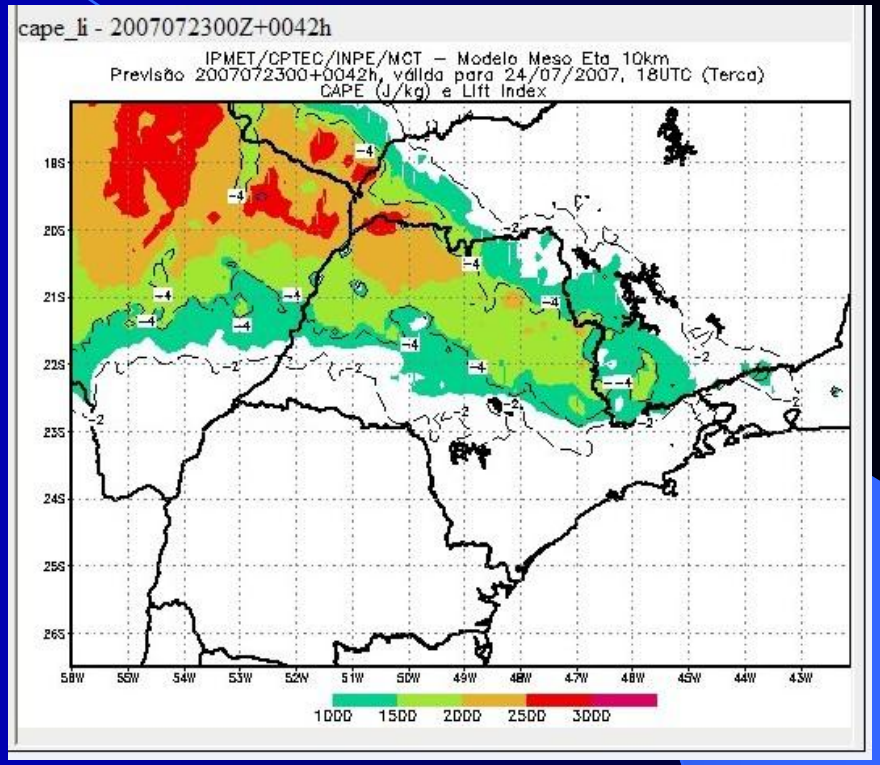


Hail Swath: 24 July 2007 / Model Run 23/07/2007-00UT

B-M



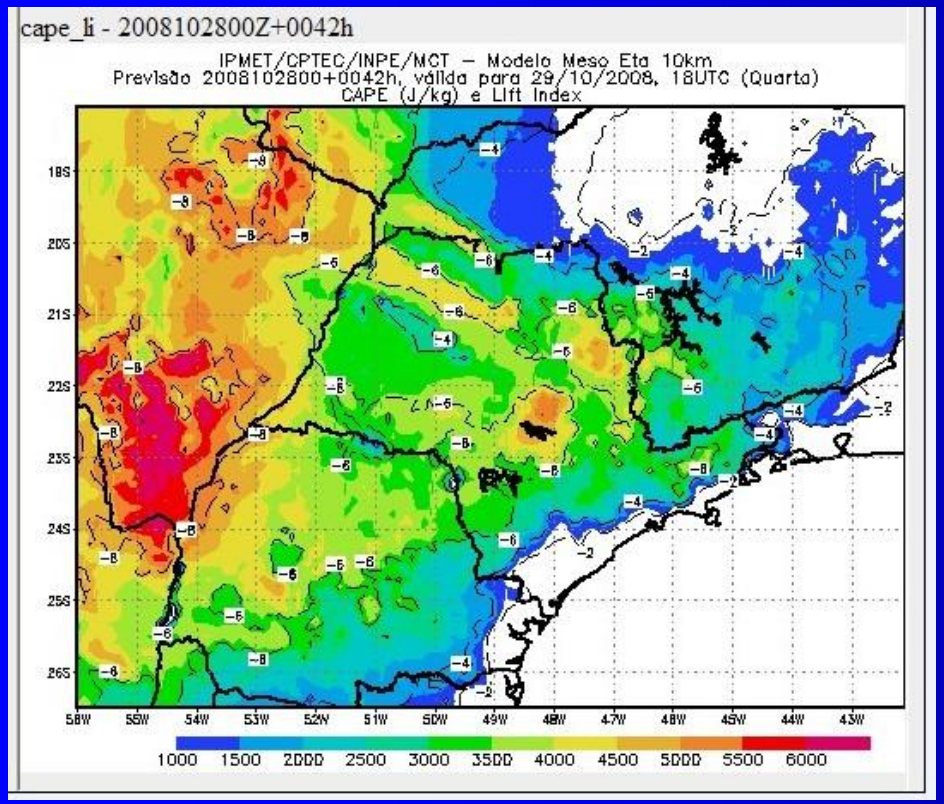
K-F



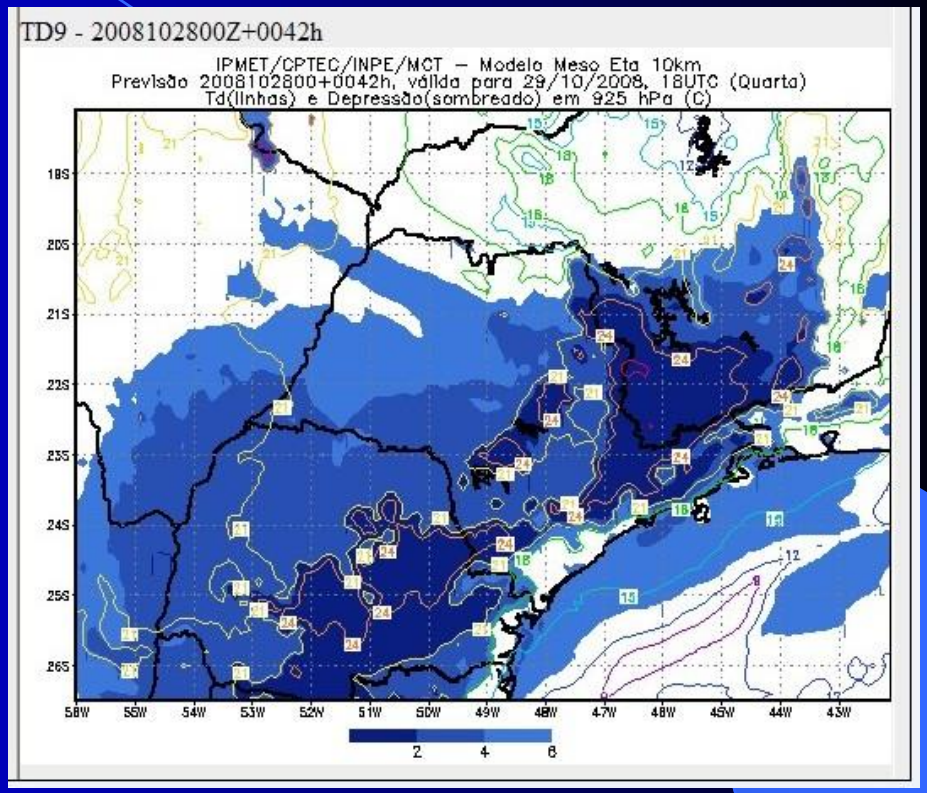
42-hour forecast (15:00 LT) of CAPE (colour bar $J.kg^{-1}$) and Lifted Index (°C)

CASE STUDY: 29 October 2008 (Bow Echo)

Bow-Echo: 29 October 2008 / Kain-Fritsch, 28/10/2008-00UT
42-hour forecast (15:00 LT)

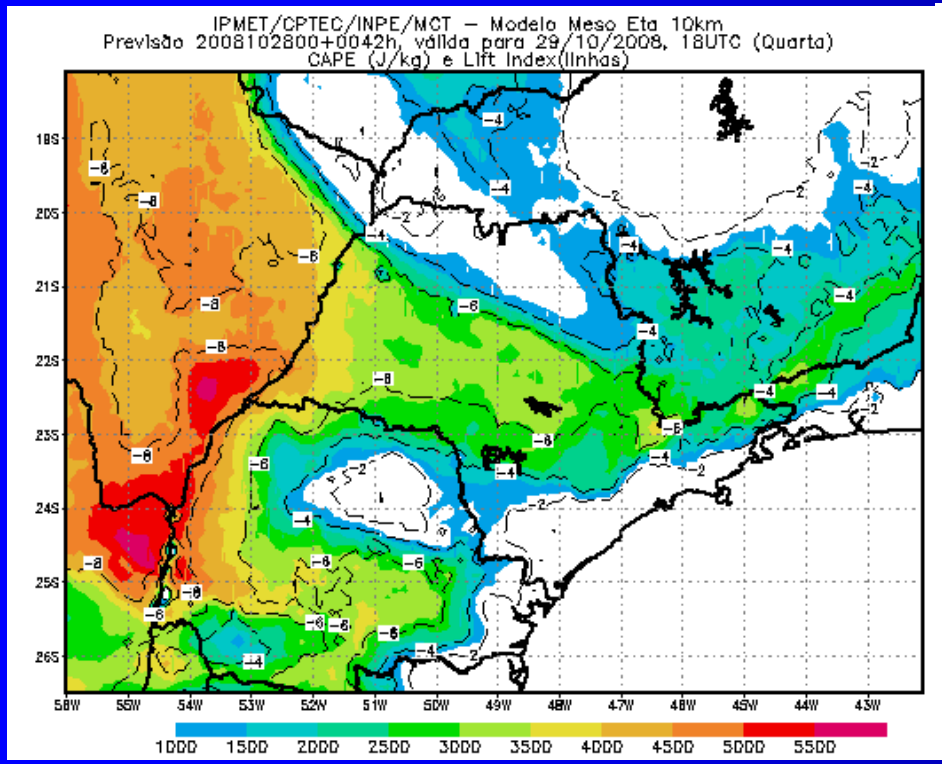


CAPE (J.kg^{-1}) and
Lifted Index (°C)

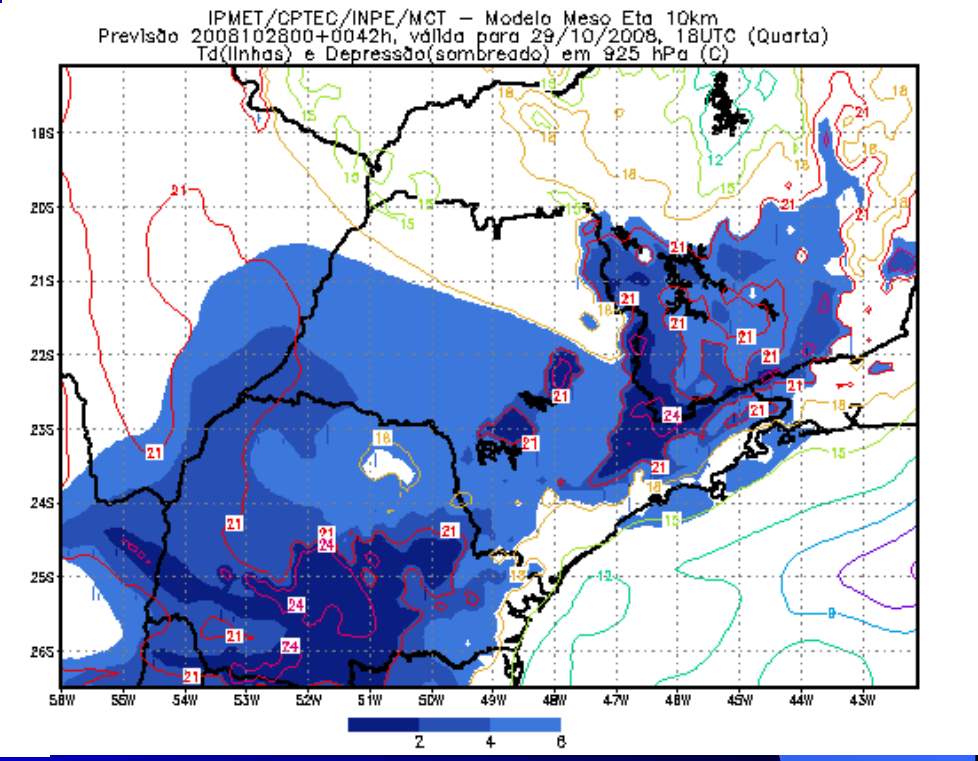


Dew Point (TD, lines) and Dew Point
Depression (shaded) at 925 hPa

Bow-Echo: 29 October 2008 / Betts-Miller, 28/10/2008-00UT
42-hour forecast (15:00 LT)



CAPE (J.kg^{-1}) and
Lifted Index (°C)



Dew Point (TD, lines) and Dew Point
Depression (shaded) at 925 hPa

CONCLUSION

- The onset time and the region of a severe rain event is generally well predicted by the Meso-Eta model (3-hour accumulation, Kain-Fritsch algorithm), using the 00UT run on the previous day (operationally available ca 06:30LT);
- Except for CAPE, Kain-Fritsch predicts the various instability indices well 24-60 hours ahead, depeding of the time of storms;
- Betts & Miller appear to be better for predicting CAPE, about 2x higher than Kain-Fritsch, providing a more pronounced alert - however, the predictions need to be verified against radiosondes;
- It is important, that more cases be studied before one can reach final conclusions.


Obrigado!
ipmet