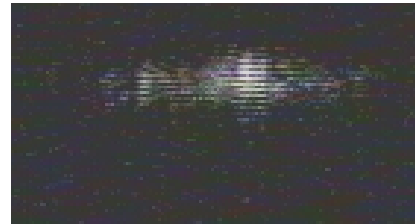
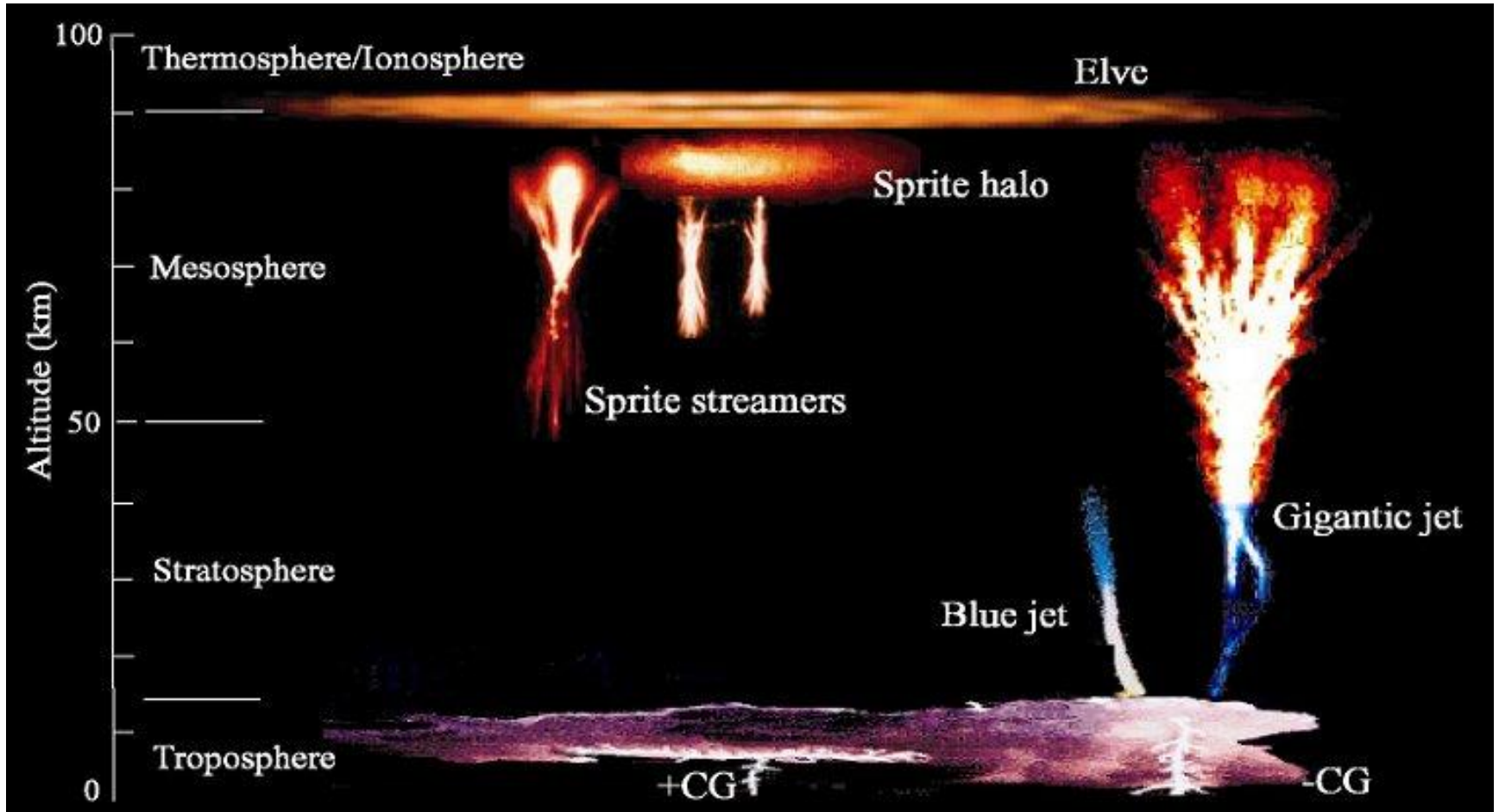


# TRANSIENT LUMINOUS EVENTS DURING CHUVA SUL CAMPAIGN IN 2012



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Instituto Nacional de Pesquisas Espaciais - INPE

# TRANSIENT LUMINOUS EVENTS: SUMMARY



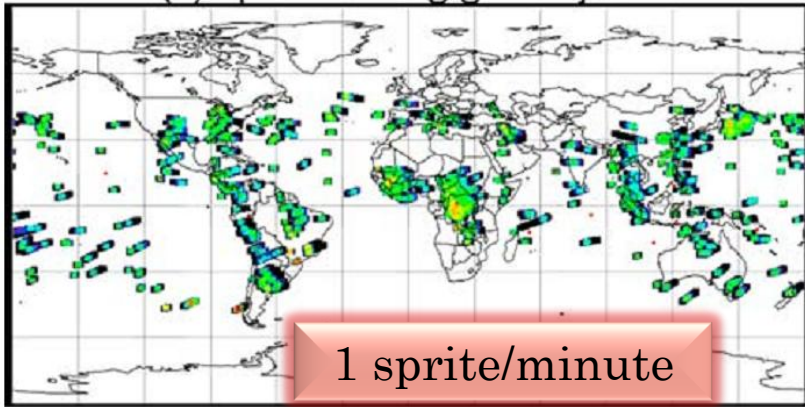
# HISTORICAL SUMMARY UP TO DATE

- 1991: First TLE observations over South America
  - Space Shuttle, Mesoscale Lightning Experiment – MLE, STS-43 mission
- 1995: First airplane observations of sprites over Peru
  - University of Alaska Peru95 Campaign
- **2002/2003: First sprite campaign in Brazil**
  - **Result from international effort: UW, INPE, UAF, USU**
- 2005: First observations of TLEs above Argentina
  - University of Alaska Chile2005 Campaign
- **2005-2008: DEELUMINOS Project / FAPESP grant**
  - DEELUMINOS: Electromagnetic Energy Deposition in the Upper Atmosphere Signaled by Sprites and Other Transient Luminous Events
  - **5 TLE campaigns in Brazil**
  - **International and national collaborations**
- **2012: Start of ACATMOS group and LEONA**
  - ACATMOS: Atmospheric Electrodynamical Coupling group at INPE
  - LEONA: TLE and Thunderstorm High Energy Emission Collaborative Network in Latin America

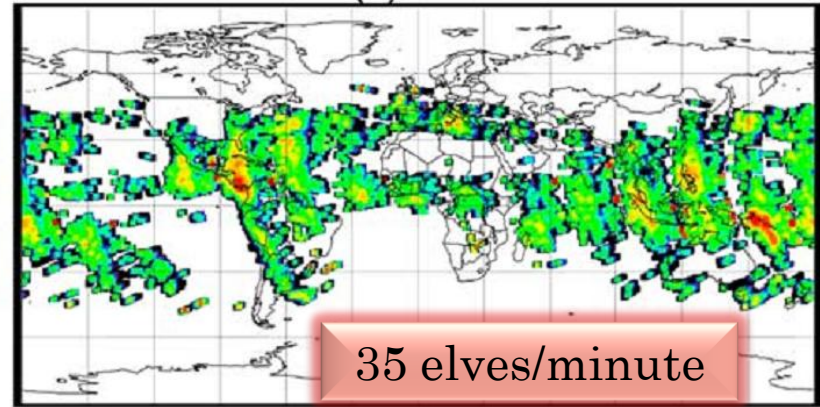
# TRANSIENT LUMINOUS EVENTS: GLOBAL RATES

- ISUAL: Imager of Sprites and Upper Atmospheric Lightning onboard FORMOSAT-2

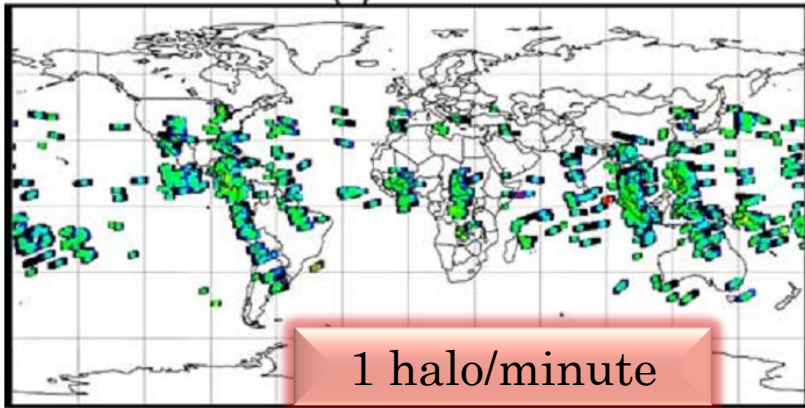
(a) sprites and gigantic jets



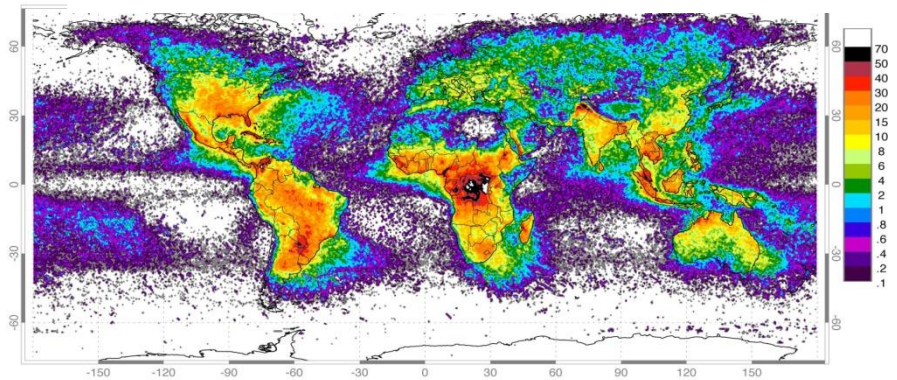
(b) elves



(c) halos



(d) Global lightning distribution

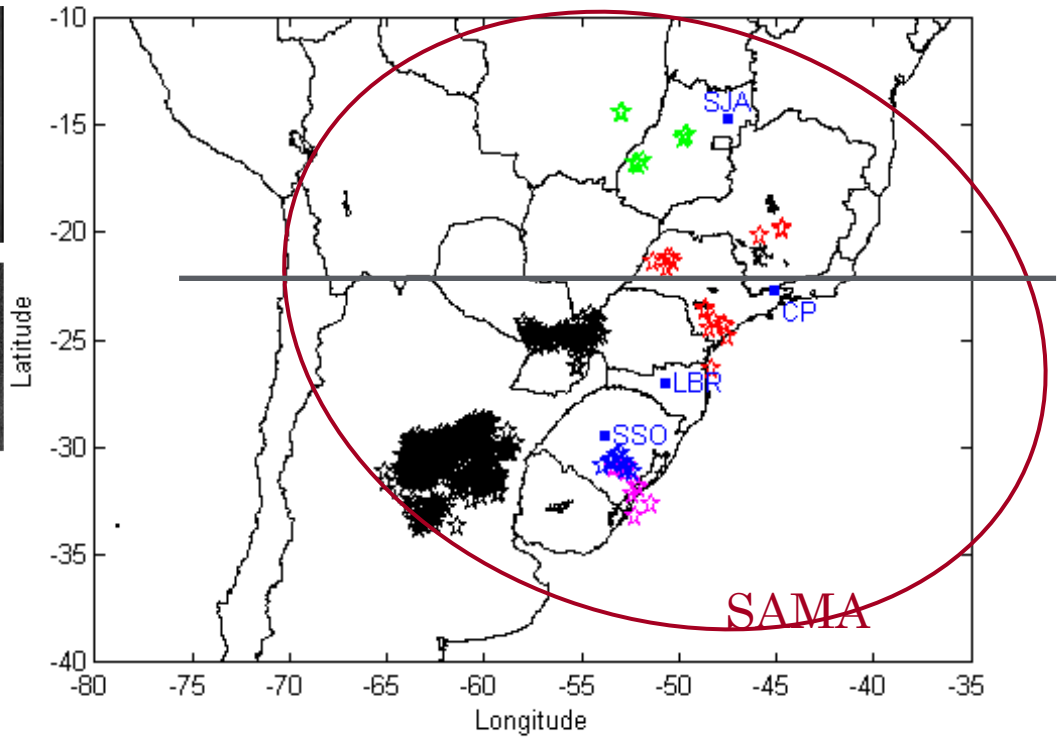


High Resolution Full Climatology Annual Flash Rate

Global distribution of lightning April 1995-February 2003 from the combined observations of the NASA OTD (4/95-3/00) and LIS (1/98-2/03) instruments



# SUMMARY OF TLE CAMPAIGNS



## Convective System

### Tropical Region

- Local Convection;
- 3 Convective systems;
- ~3,6 sprites/CS;
- Thermodynamic factors;
- Lifetime: ~14 hours;
- Max area: ~90.000 km<sup>2</sup>

### Subtropical Region

- Mesoscale Convective Systems;
- 3 MCSs;
- ~174 sprites/CS;
- Dynamic factors;
- Lifetime: ~25 hours;
- Max area: ~350.000 km<sup>2</sup>

2002/ 2003: 18 sprites

2006 A: >400 TLEs  
TLEs

2007: 46 sprites

2005: 11 TLEs

2006 P: ~100

2008: ~20 TLEs

Figures courtesy: Rodrigo Azambuja

# SUMMARY OF TLE CAMPAIGNS

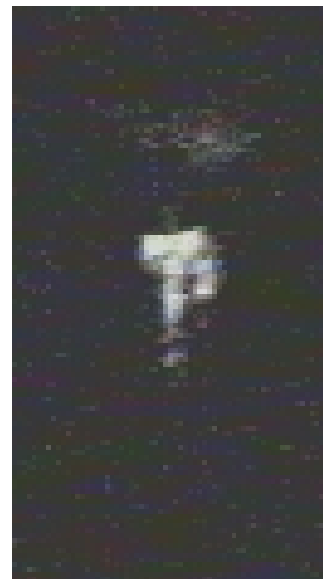
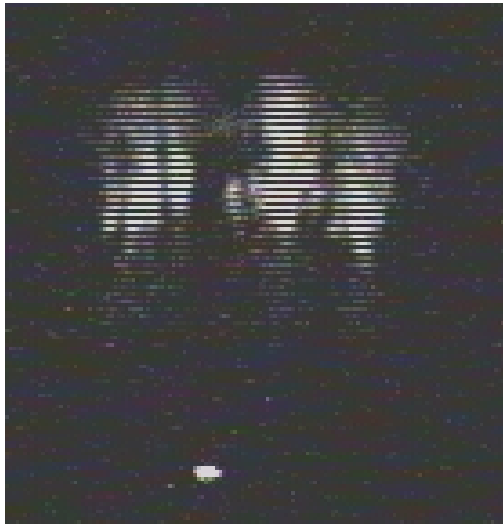
<b>Parameters/SCs</b>	<b>2005SC1</b>	<b>2005SC2</b>	<b>2006Fev</b>	<b>2006Mar</b>	<b>2007</b>
<b>Total of sprites</b>	6	5	380	94	20
<b>Start (UTC)</b>	15:30 h	17:00 h	17:30 h	07:00 h	04:45 h
<b>End (UTC)</b>	12:30 h	09:30 h	23:30 h	13:00 h	11:00 h
<b>Lifetime</b>	21 h	16,5 h	30 h	30 h	30,25 h
<b>Max area (km<sup>2</sup>)</b>	214.850	65.150	221.360	427.520	485.340
<b>Time of Max extent (UTC)</b>	21:00 h	23:30 h	04:30 h	20:00 h	02:00 h
<b>Total CG</b>	567	376	822	23.685	21.933
<b>-CG %</b>	68 ± 4	89 ± 5	-	76 ± 1	64 ± 1
<b>+CG ro) (%)</b>	32 ± 3	11 ± 2	-	24 ± 0	36 ± 0



Figures courtesy: Rodrigo Azambuja

# TLES DURING CHUVA SUL

- Observations during 2 nights: November and December
- Total of 17 events at ~450-600 km range



# TLEs ON 18-19 NOVEMBER 2012

- Observations started at 02 UT of 10 December
- Camera positioned at 220-240° az. and 10-2° el. → ~450-600 km range
- First sprite at 03:56 LT
- Elevation corrected → storm was tracked
- 16 TLE events detected, mostly sprites, 1 event with halo, a few dancing sprites
- Camera off at 07:43 LT





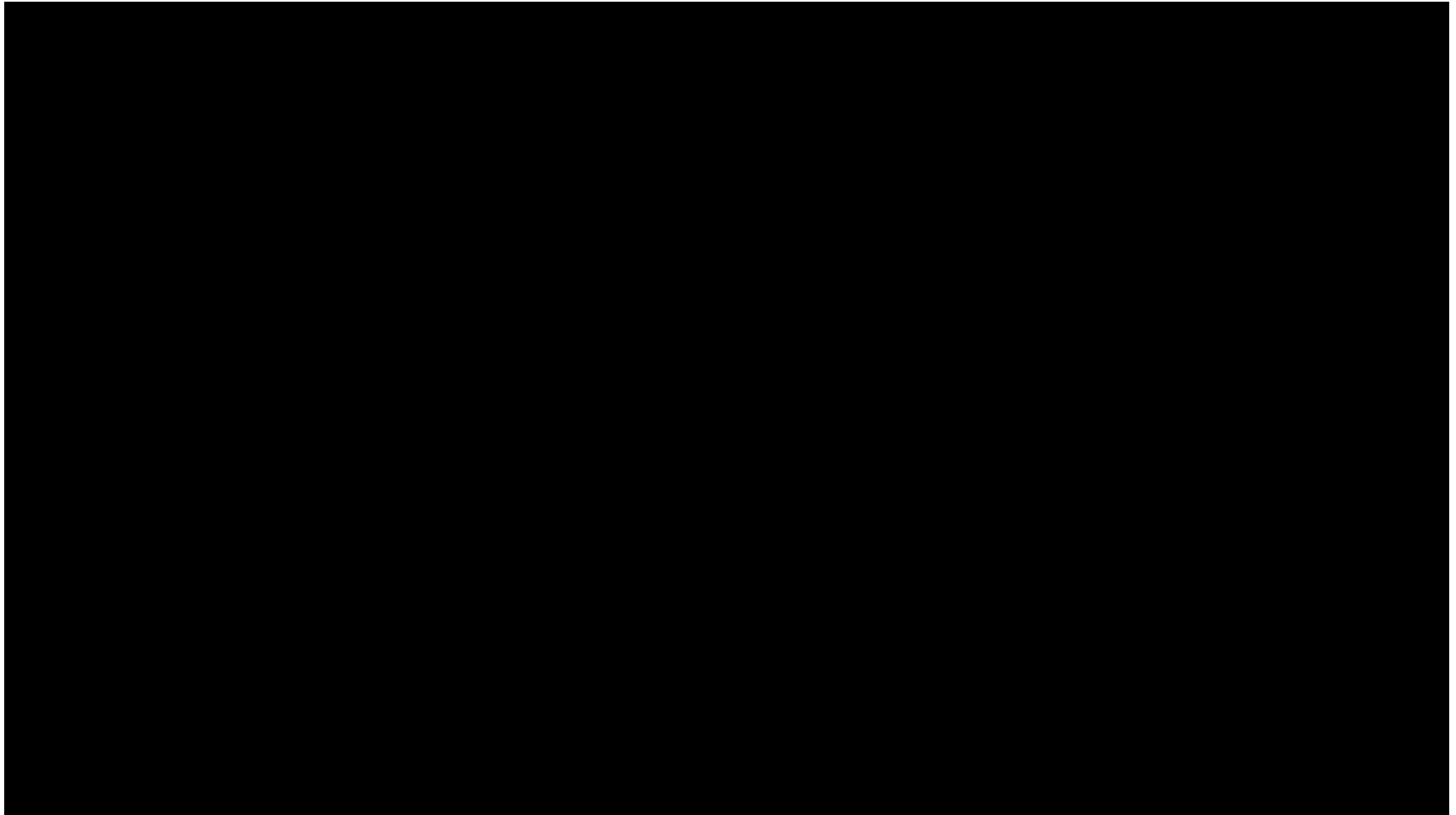
# TLEs ON 18-19 NOVEMBER 2012

**19/11/2012**

**Evento 1: 03:10:41 UT**



# TLES ON 18-19 NOVEMBER 2012



# TLEs ON 18-19 NOVEMBER 2012

**19/11/2012**

**Evento 3: 03:28:22 UT**



# TLEs ON 18-19 NOVEMBER 2012

**19/11/2012**

**Evento 4: 03:51:37 UT**



# MCS ON 18-19 NOVEMBER 2012

- TLEs were generated by a Mesoscale Convective System –MCS
- MCS started at 18:00 UT (Nov. 18<sup>th</sup>) and ended at 14:30 h UT (Nov. 19<sup>th</sup>)
- 20 h duration
- Maximum extent estimate  $\sim 100.000 \text{ km}^2$  at  $\sim 07:00 \text{ UT}$

**Sistema convectivo**

**18-19 de novembro de 2012**



# SPRITE ON 10-11 DECEMBER 2012

- Observations started at 23:36 UT of 10 December
- Camera positioned at 210-240° az. and 0° el. → ~450-600 km range
- Single sprite at 01:24 UT
- Site got overcast quickly
- Camera off at 05:23 UT



# SPRITE ON 10-11 DECEMBER 2012

**11/12/2012**

**Evento 5: 01:24:17 UT**



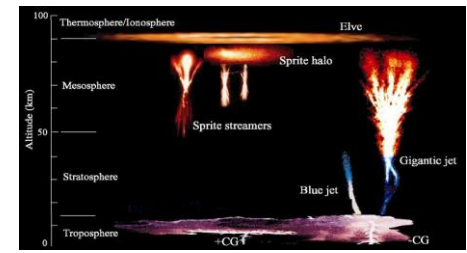
# MCS ON 10-11 DECEMBER 2012

- Single sprite was observed above a MCS
- MCS started at 11:00 UT (Dec 10<sup>th</sup>) and ends at 17:00 h UT (Dec 11<sup>th</sup>)
- 30 h duration, propagation speed > 80 km/h
- Maximum extent estimate > 800.000 km<sup>2</sup> at ~05:00 UT

**Sistema convectivo**

**10-11 de dezembro de 2012**

# LEONA Initial Team



## LEONA Team

*Transient Luminous Event and Thunderstorm High Energy Emission Collaborative Network in Latin America*

### - Brazil:

- National Institute for Space Research – INPE
- Instituto Tecnológico SIMEPAR
- Center for Radioastronomy and Astrophysics Mackenzie – CRAAM
- Lebedev Physical Institute – LPI/Russia via CRAAM collaboration
- Federal University of Mato Grosso do Sul – UFMS
- University of São Paulo – USP

### -Argentina:

- Observatorio Astronómico, Universidad Nacional de Córdoba – UNC
- Consejo de Investigaciones Científicas y Técnicas – CONICET

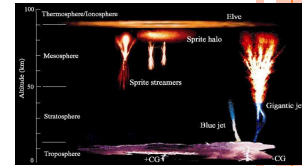
### -Peru:

- Jicamarca Radio Observatory – JRO



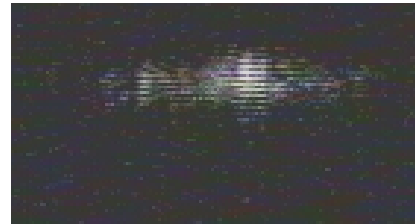


# LEONA INITIAL COVERAGE





# TRANSIENT LUMINOUS EVENTS DURING CHUVA SUL CAMPAIGN IN 2012



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