SOUTHERN REGIONAL SPACE RESEARCH CENTER - CRS/INPE - MCT
SPACE SCIENCE LABORATORY OF SANTA MARIA - LACESM/CT – UFSM

AERONOMY: AN INTERNATIONAL COOPERATION FOR SCIENCE DEVELOPMENT IN SOUTH AMERICA

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4. Centro de Rádio Astronomia e Astrofísica Mackenzie - CRAAM, São Paulo, Brazil.
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6. Universidad de Magallanes, Punta Arenas, Chile.
7. Universidad Nacional De La Plata, La Plata, Argentina.
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2010 The Meeting of the Americas
8–12 August – Foz do Iguaçu, PR, Brazil.

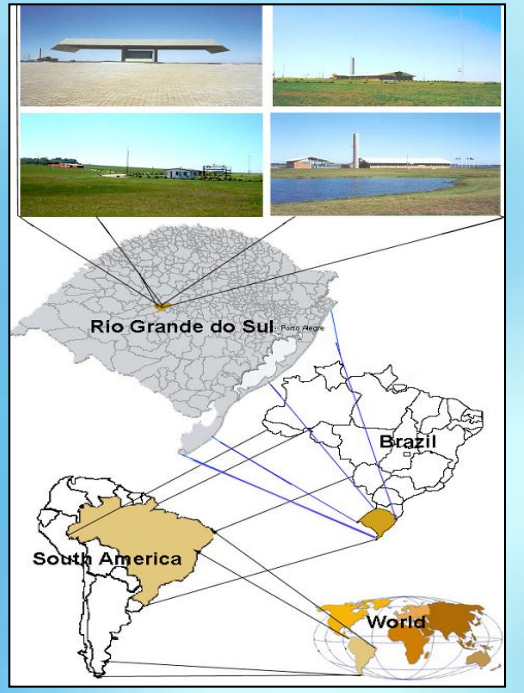
SA23A-04 SPA – Aeronomy
Room Iguassu III – Tuesday - 14:55h

SOUTHERN REGIONAL SPACE RESEARCH CENTER – CRS/INPE

Panoramic view of the main building at

Santa Maria, RS, Brazil

AN ACTIVE AND PASSIVE SITE FOR INSTRUMENTATION SYSTEMS



SOUTHERN SPACE OBSERVATORY SSO/CRS – INPE

Main gate and buildings 1, 2, 3, 5 and 6 at

São Martinho da Serra, RS, Brazil

Geographic Coordinates:
Latitude: 29º 26´ 24”,06 S
Longitude: 53º 48´ 38”,98 W
Ellipsoidal Altitude : 488 m

Geomagnetic Coordinates:
Latitude: 19º 13´ 48” S
Longitude: 16º 30´ E
Inclination or “dip”: 33º S
Total Geomagnetic Field: 22,800 nT.

A PASSIVE SITE FOR INSTRUMENTATION SYSTEMS

AERONOMY – AN OVERVIEW OF THE SUN – EARTH INTERACTIONS MONITORING PROJECTS AT THE SOUTH OF BRAZIL AND SOUTH AMERICA

I - PROJECTS AT THE SOUTHERN SPACE OBSERVATORY – SÃO MARTINHO DA SERRA, RS, BRAZIL:

- **GEOMAGNETISM – MAGNETOSPHERE**
  1 – **MAGDAS** – GEOMAGNETISM

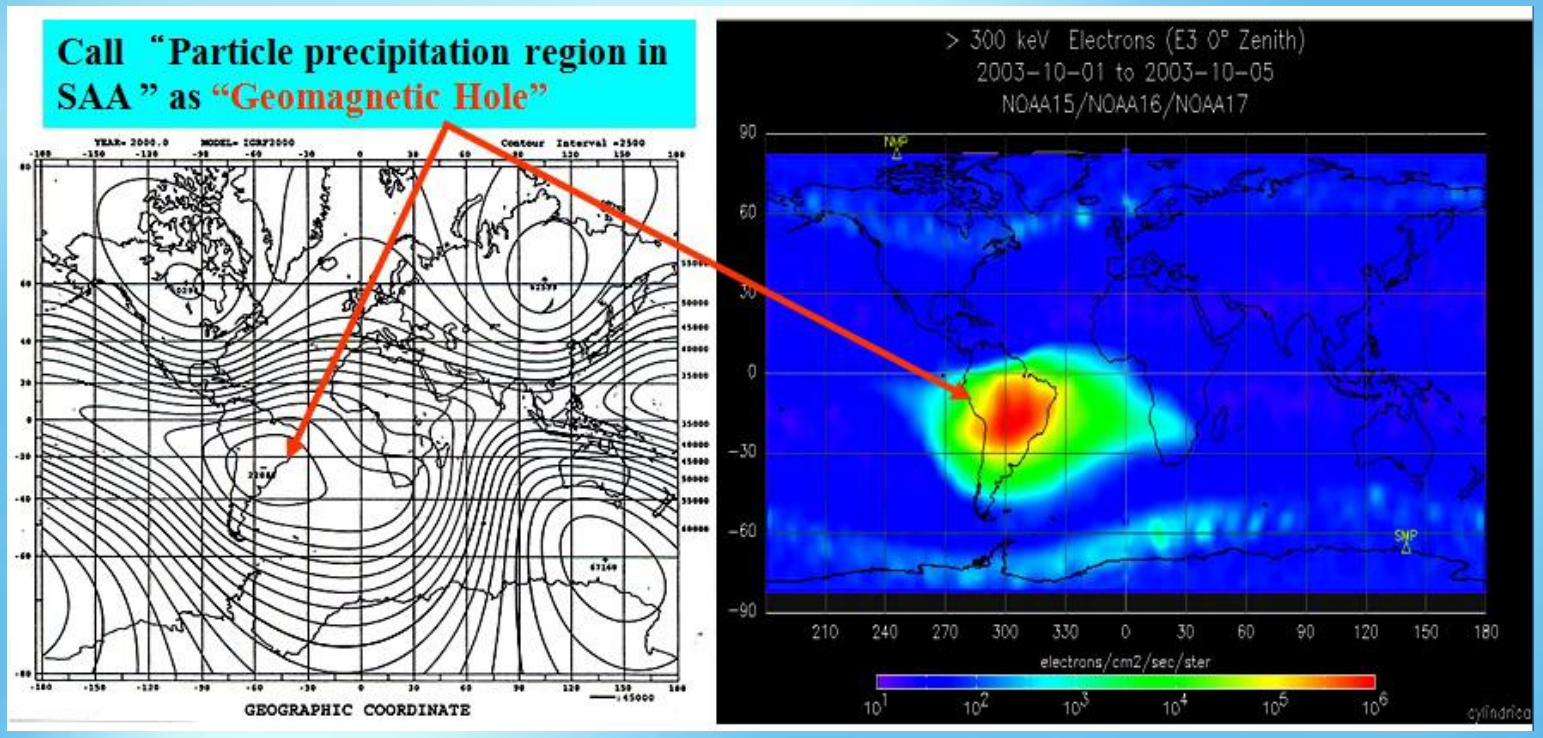
- **AERONOMY PASSIVE –THERMOSPHERE – IONOSPHERE**
  2 – **AIRGLOW** – ATMOSPHERIC NIGHT AIRGLOW
  3 – **SAVNET, SARINET** – IONOSPHERIC OPACITY MONITOR WITH AN IMAGING RIOMETER
  4 – **GNSS, GPS** – IONOSPHERIC SCINTILATION MONITOR WITH A GPS RECEIVER INTERFEROMETER
  5 – **STARNET** – SFERICS TIMING AND RANGING NETWORK - IAG/USP

II - PROJECTS AT THE SITE OF THE CRS/INPE – UFSM'S CAMPUS – SANTA MARIA, RS, BRAZIL:

- **AERONOMY ACTIVE – MIDDLE ATMOSPHERE & IONOSPHERE**
  6 – **SKIYMET** – MESOSPHERIC DYNAMICS – THE SKIYMET METEOR RADAR
  7 – **GNSS/GPS, DIGISOND** – IONOSPHERE SOUNDING – GPS, AND DIGISONDE (FUTURE)

THE SOUTH ATLANTIC ANOMALY (SAA)
THE SOUTH ATLANTIC MAGNETIC ANOMALY (SAMA)

The lowest value of the total magnetic field intensity defines the position of the SAA/SAMA center. Its present location is near the Southwest of Brazil and very close to the SSO Observatory, with Total Geomagnetic Field around 22,800 nT.



From : (UeNo et al., 2010) – CAWSES-II, Kyoto, Japan

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MAGNETOSPHERE MONITORING PROGRAMS AT THE SOUTHERN SPACE OBSERVATORY

The secular variation of the total geomagnetic field F and the westward drift of the South Atlantic Magnetic Anomaly - SAMA have been observed in the South of Brazil since 1985, in cooperation with the **Space Environment Research Center – Kyushu University, Japan,** (http://www.serc.kyushu-u.ac.jp). The main objective of the Magnetic Observatory at SSO is to monitor the SAMA westward drift and to provide valuable observations for Space Weather studies at CRS/INPE – MCT, in Santa Maria, RS, and at INPE/MCT headquarters in São José dos Campos, SP.

MAGDAS International Principal Investigator:
K. Yumoto - Space Environment Research Center – Kyushu University, Japan.

Brazilian Principal Investigators:
Nelson Jorge Schuch, Nalin Babulal Trivedi, Severino Luis Guimarães Dutra,
Sergio Luis Fontes, Ícaro Vitorello, Antônio Lopes Padilha.

Local Team CRS/INPE - MCT:
Nelson J. Schuch, Andirlei Claudir da Silva, Tardelli Ronan Coelho Stekel, José Paulo Maechezi,
Cristofer Rorian Claro Pedrozo, Cassio Espindula Antunes (INPE/SJC).

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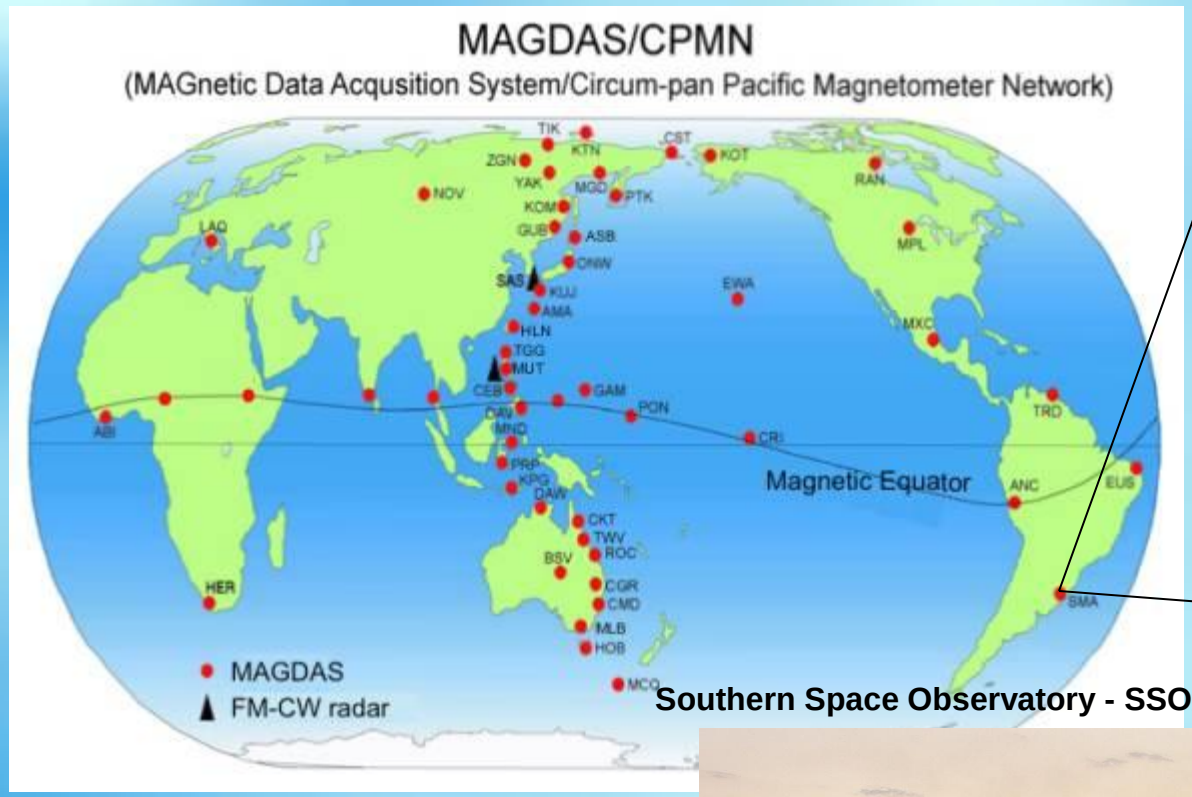
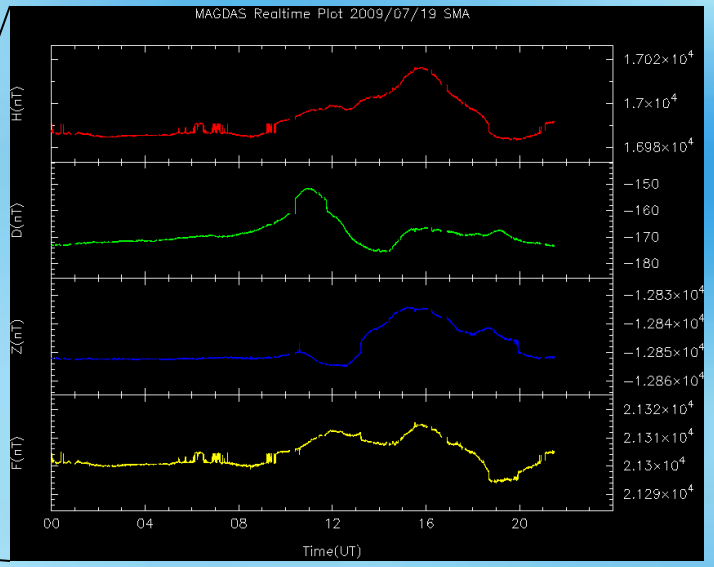
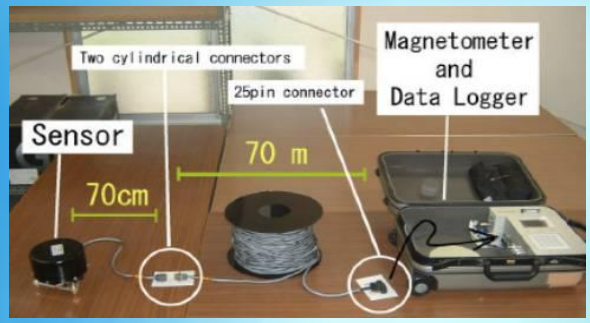


Real time Status and Quick Look at 2009/07/19



Southern Space Observatory - SSO/CRS/CCR/INPE – MCT

MAGDAS Magnetometer



SAVNET – SOUTH AMERICA VLF NETWORK OVER THE SAMA REGION AT THE SOUTHERN SPACE OBSERVATORY

International Cooperation: Brazil, Argentina, Peru and Chile

The influence of the Solar variability on Aeronomic phenomena over the South Atlantic Magnetic Anomaly – (SAMA), in southern of Brazil and South America is being monitored with the **South America VLF NETwork – SAVNET**.

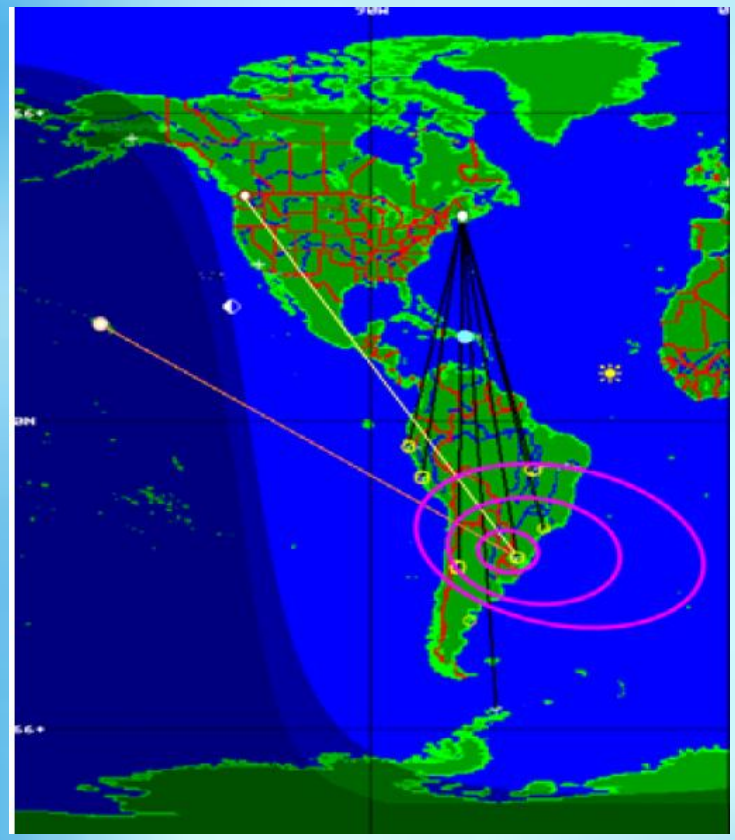
The investigation of the behavior of the low terrestrial Ionosphere is being achieved through the **South America VLF NETwork – SAVNET**, by analyzing the **VLF (Very Low Frequency: 3 - 30 kHz)** wave propagation over long distances within the Earth-Ionosphere waveguide, since these characteristics transmit information about the electrical properties of the waveguide's boundaries.

SAVNET International & Brazilian Principal Investigator:
Jean-Pierre Raulin – Centro de Rádio Astronomia e Astrofísica Mackenzie – CRAAM – São Paulo, Brazil.

The Brazilian Team:
Jean-Pierre Raulin (CRAAM), Nelson Jorge Schuch (CRS), Paulo Fagundes (UNIVAP), Emilia Correia (CRAAM), Fernando Bertoni (UNIVAP), Lilian Moor (UNIVAP), Juliano Moro (INPE/SJC), Tardelli Ronan Coelho Stekel (CRS), Claudio Machado Paulo (CRS), Dimas Irion Alves (CRS), Guilherme Simon da Rosa (CRS), Rozangela Eloi da Silva (CRS).

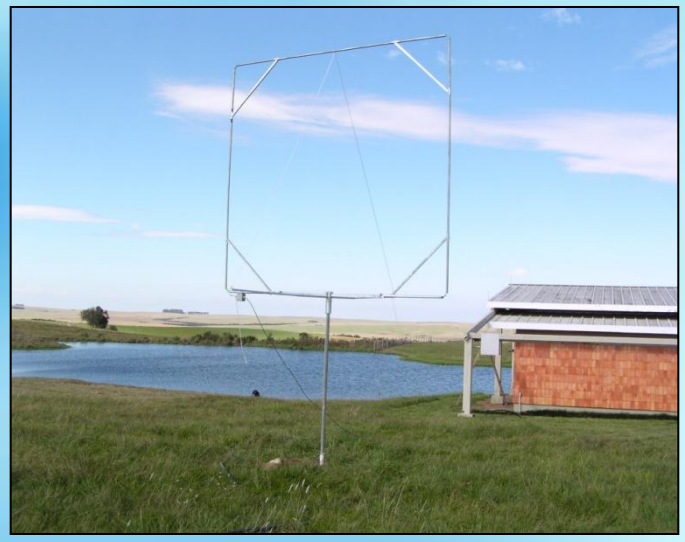
SAVNET
SOUTH AMERICA VLF NETWORK

Dr. Jean-Pierre Raulin
Principal Investigator
CRAAM/EE/Mackenzie



- Precipitation of particles in the SAMA region as a function of geomagnetic activity
- SAMA spatial structure

SAVNET Network stations distribution over the SAMA region



SAVNET STATION AT THE SOUTHERN SPACE OBSERVATORY

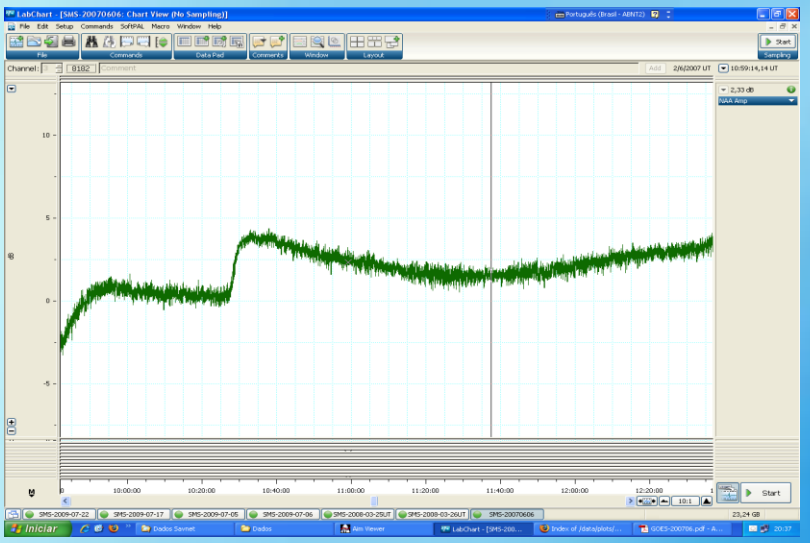
Solar flare observed at SSO with the VLF SAVNET Station on June 01, 2007.

SAVNET

Network stations distribution over the SAMA region

SSO's SAVNET is strategically located near the SAMA center, around 23000 nT. The VLF (Very Low Frequency: 3 - 30 kHz) waves propagate over long distances within the Earth-ionosphere waveguide. The waveguide transmits RF information related to the electrical properties of the lower ionosphere boundary.

M2.8-Class Solar flare observed at SSO with the VLF SAVNET Station on June 01, 2007.



M1-Class Solar flare observed at SSO with the VLF SAVNET Station on June 02, 2007.

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SARINET – SOUTH AMERICA RIOMETER NETWORK OVER THE SAMA REGION AT THE SOUTHERN SPACE OBSERVATORY – SSO

International Cooperation: Japan, Brazil, Argentina and Chile

The influence of the Solar variability on Aeronomic phenomena over the South Atlantic Magnetic Anomaly – (SAMA), in southern of Brazil, South America and Antarctica is being monitored with the **South America Riometer Network – SARINET (38.2 MHz)**. The SARINET Riometers operating at 38.2 MHz were installed in Brazil, Chile and Argentina.

The SARINET International Principal Investigator:
Kazuo Makita – University of Takushoku – Tokyo, Japan.

The Brazilian Team: Nelson Jorge Schuch, Mangalathayil Ali Abdu, José Humberto Andrade Sobral, Emília Correia, Clezio Marcos Denardin, Polinaya Muralikrishna, Paulo Fagundes, Fernando Bertoni, Lilian Moor, Juliano Moro, Tardelli Ronan Coelho Stekel, Claudio Machado Paulo, Dimas Irion Alves, Guilherme Simon da Rosa, Rozangela Eloi da Silva.

The South American Team:

Chile: Alberto J. Foppiano, Elias M. Ovalle, Ricardo M. MacMahon,
Argentina: Julio César Gianibelli.

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SARINET – SOUTH AMERICA RIOMETER NETWORK

Imaging Riometer:

- ✓São Martinho da Serra – Brazil
- ✓Concepcion – Chile
- ✓Punta Arenas – Chile
- ✓Trelew – Argentina
- ✓São José dos Campos – Brazil

Single channel Riometer:

- ✓ São Martinho da Serra – Brazil
- ✓ Concepcion – Chile
- ✓ Punta Arenas – Chile
- ✓ Trelew – Argentina
- ✓ São José dos Campos – Brazil
- ✓ Atibaia – Brazil
- ✓ San Juan – Argentina
- ✓ Manaus – Brazil
- ✓ Palmas – Brazil
- ✓ Antartica – Brazil
- ✓ Natal – Brazil
- ✓ Goiania – Brazil
- ✓ Pilar – Argentina
- ✓ La Plata - Argentina
- ✓ La Quiaca - Argentina

SARINET – Position of Riometer Stations

Japan
Kakioka,
Lat.:36°14´N, Long. 140°11´E, Altitude, 46.4 m

Trnidad & Tobago:
Port of Spain,
Lat.:10°38´N, Long. 61° 26´E, Altitude, 46.4 m

Brazil:
Manaus, Brazil
Lat.:3°06´30S, Long.:59° 58´ 29 W, Altitude, 46.4 m

Palmas, Brazil
Lat.:10°17´08 S, Long. :48°20´07W, Altitude, 254.1 m

Natal, INPE, Brazil (2012 planning)
Lat.:5°50´29 S, Long. :35°12´08W, Altitude, 69 m

Goiania University of Goiania (2012 planning)
La.:17°52´S, Long.:51°43´W

Atibaia, Brazil
Lat.:23°11´05 S, Long.:46°33´28 W, Altitude, 208 m

San Jose dos Campos, Brazil
Lat.:23°02 ´ S, Long.:45°15´W, Altitude, ? m

Santa Maria(SSO), Brazil
Lat.:29°42 S, Long.:53°11´W, Altitude, 500 m

Comandante Ferraz, Antarctica
Lat.:62°04´S, Long. :58°23´W, Altitude, 30 m

Chile:
Concepcion, Chile
Lat.:36°50´S, Long.:73° 01´W, Altitude, 46.4 m

Punta Arenas, Chile
Lat.:53°07´S, Long.:70° 53´W, Altitude, 46.4 m

Argentina:
Trelew,Argentina
Lat.:43°15´45 S, Long. :65°22´37W, Altitude, 33 m

CASLEO,,Argentina
Lat.:31°48´01 S, Long. :69°17´34W, Altitude, 2487.9 m

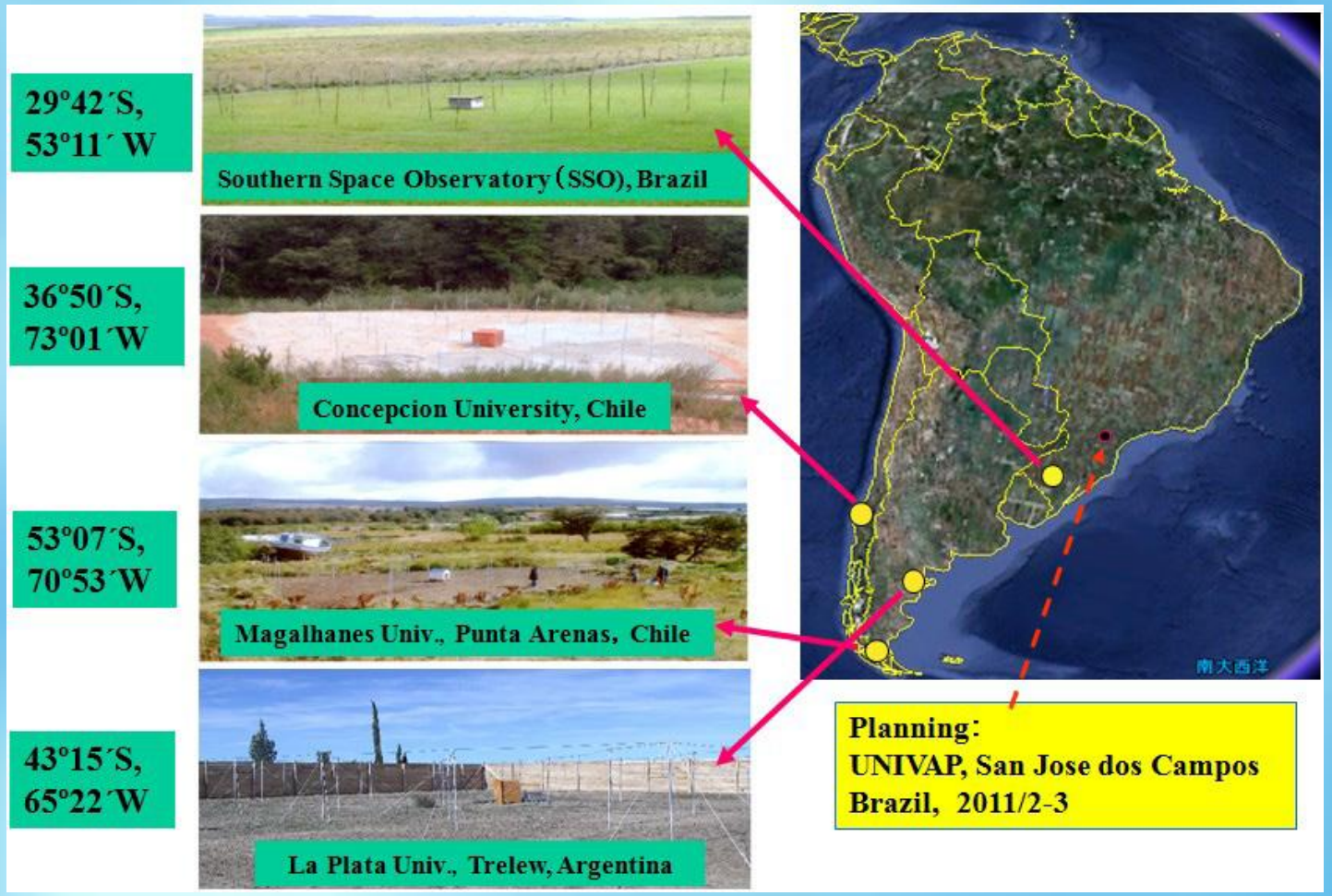
Pilar, Argentina (2010 planning)
Lat.:31°40´S, Long.: 63°53´W, Altitude 338 m

La Plata, Argentina (2011 planning)
Lat.:34°54´S, Long.: 57°56´W, Altitude ? m

La Quiaca, Argentina (2011 planning)
Lat.:22°06´02 S, Long.: 65°36´03W, Altitude, 3462 m

(Red character is planning stations)

SARINET – SOUTH AMERICA RIOMETER NETWORK



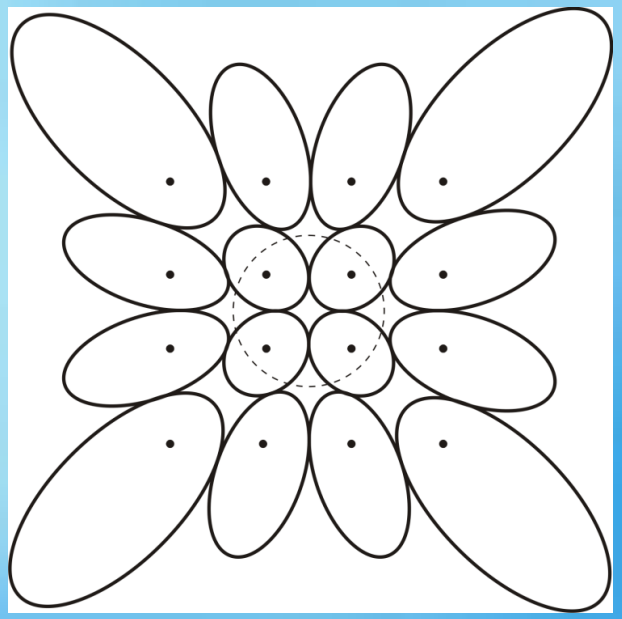
Four observation sites where the SARINET has already been installed.

From : (UeNo et al., 2010) – CAWSES-II, Kyoto, Japan.

SARINET
SOUTH AMERICA RIOMETER NETWORK

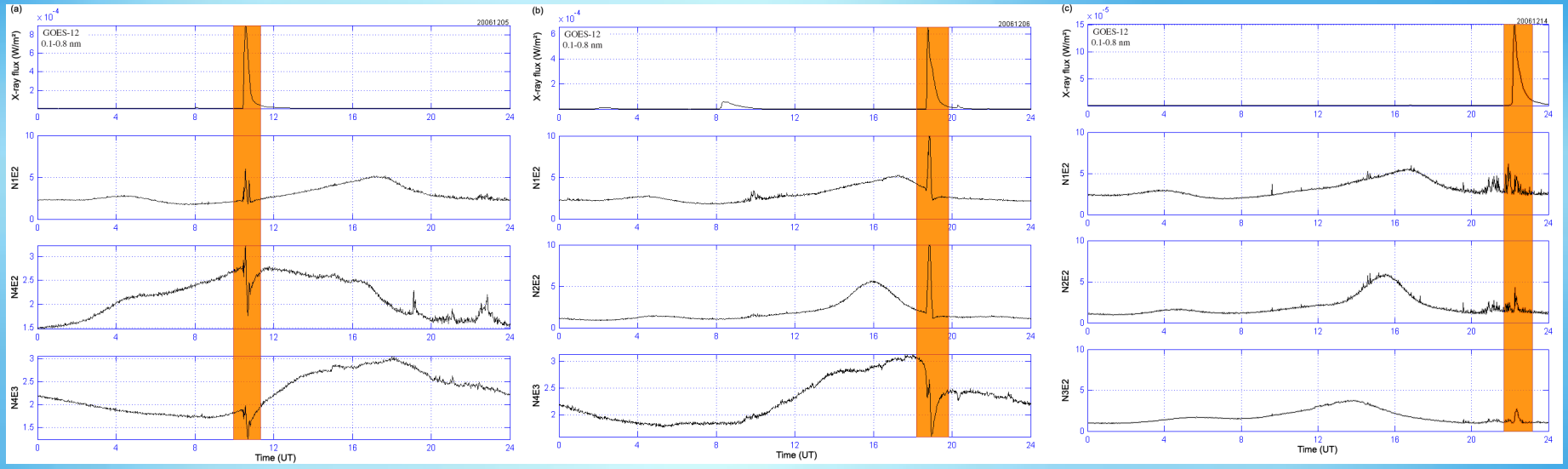
Observations with the SSO's Imaging Riometer

The SSO's imaging riometer consists of a 4x4 antenna array operating at 38.2 MHz developed to monitor the cosmic noise incident on the ground, thus determining the electronic density of the lower ionosphere.



SOLAR FLARE x SARINET at the SSO

Solar Flare – Sudden Ionospheric Disturbance (SID) observed at SSO with SARINET's Riometer data (38.2 MHz) for 2006, December 05, 06 and 14.



X-ray flux and three of the sixteen SSO Riometer's antennas for (a) 2006/12/05, (b) 2006/12/06 and (c) 2006/12/14. One can identify the solar flare effects on the SSO Riometer data. The Sudden Ionospheric Disturbance (SID) phenomenon was detected by the antennas of the SSO Riometer: figure (a) N4E2 and N4E3 and in figure (b) N4E3. The solar radio bursts can clearly be identified on the antenna graphs: (a) N1E2; (b) N1E2, N2E2; (c) N1E2, N2E2 and N3E2.

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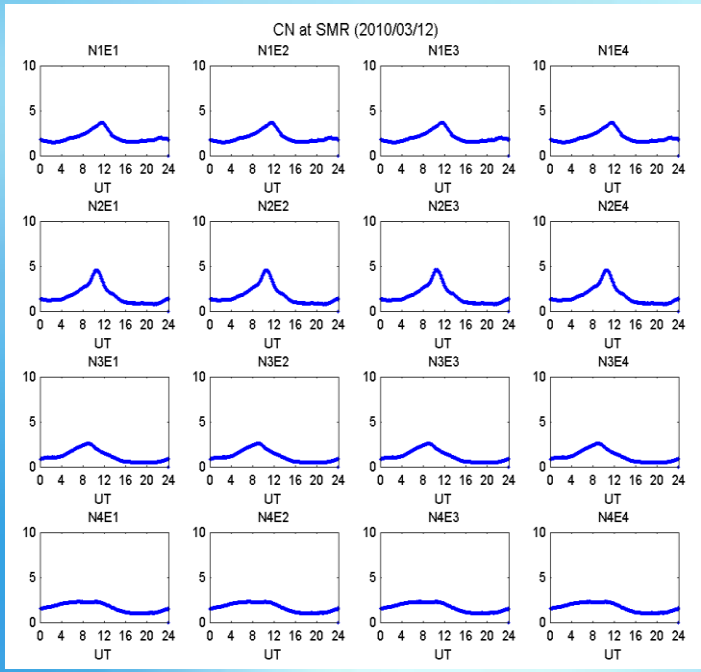
SARINET

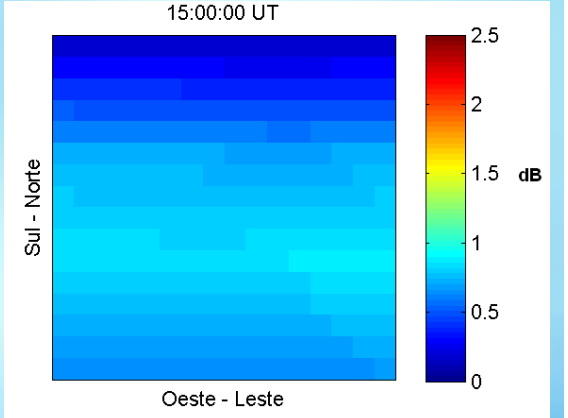
SOUTH AMERICA RIOMETER NETWORK

Observations with the SSO's Imaging Riometer

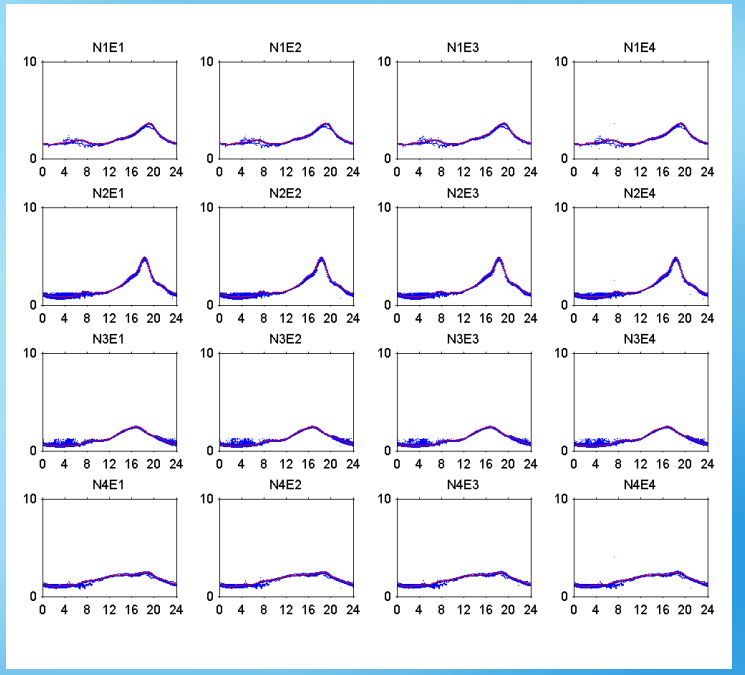
One day (2010/03/09)



Absorption (2010/03/12)



One month and QDC (March, 2010)



THE INPE SKiYMET METEOR RADARS IN THE SAMA REGION

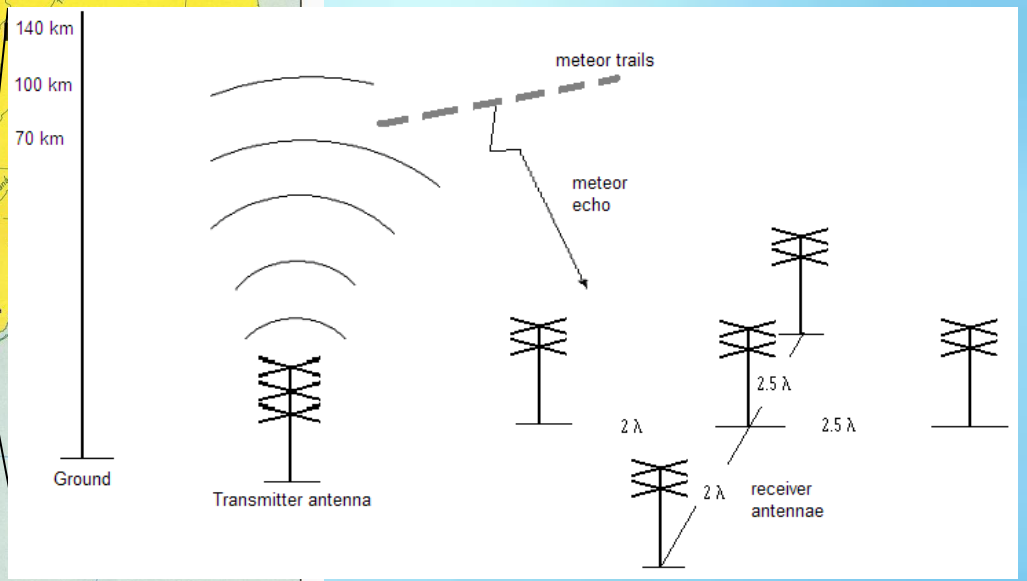
The INPE SKiYMET METEOR RADARS are distributed at three locations in Brazil: **São João do Cariri (37 W, 7 S), Cachoeira Paulista (45 W, 23 S) and Santa Maria (54 W, 30 S).** These radars provide 24-hour data on upper atmosphere winds between 80 and 100 km, with a time resolution of about 1 hour. Although this radar can be used for meteor studies, INPE's main research interest is the study of atmospheric dynamics.

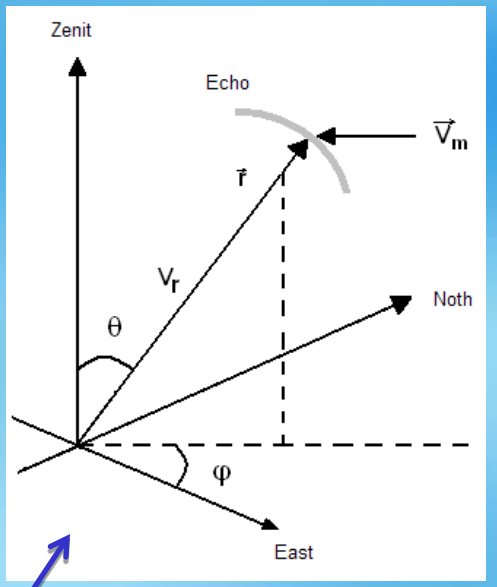
The SKiYMET meteor radar makes use of the ionized trails left by meteors when entering the terrestrial atmosphere. This ionization is the result of the friction between the surface of the meteor and atmospheric molecules. Measurements of echo delay, Doppler shift and angle of arrival are used to determine the location and radial velocity of the meteor trails.

The Brazilian SKiYMET Principal Investigators:
Barclay Robert Clemesha and Paulo Prado Batista – National Institute for Space Research – INPE/MCT, São José dos Campos, SP, Brazil.

Local Team at CRS/CCR/INPE – MCT:
Nelson J. Schuch, Barclay Robert Clemesha (SJC), Paulo Prado Batista (SJC), Vânia Fátima Andrioli (SJC), Guilherme Simon da Rosa, Rozangela Eloi da Silva, Carlos Pinto Da Silva Neto, Fernando Morais (SJC), Cassio Espindola Antunes(SJC).

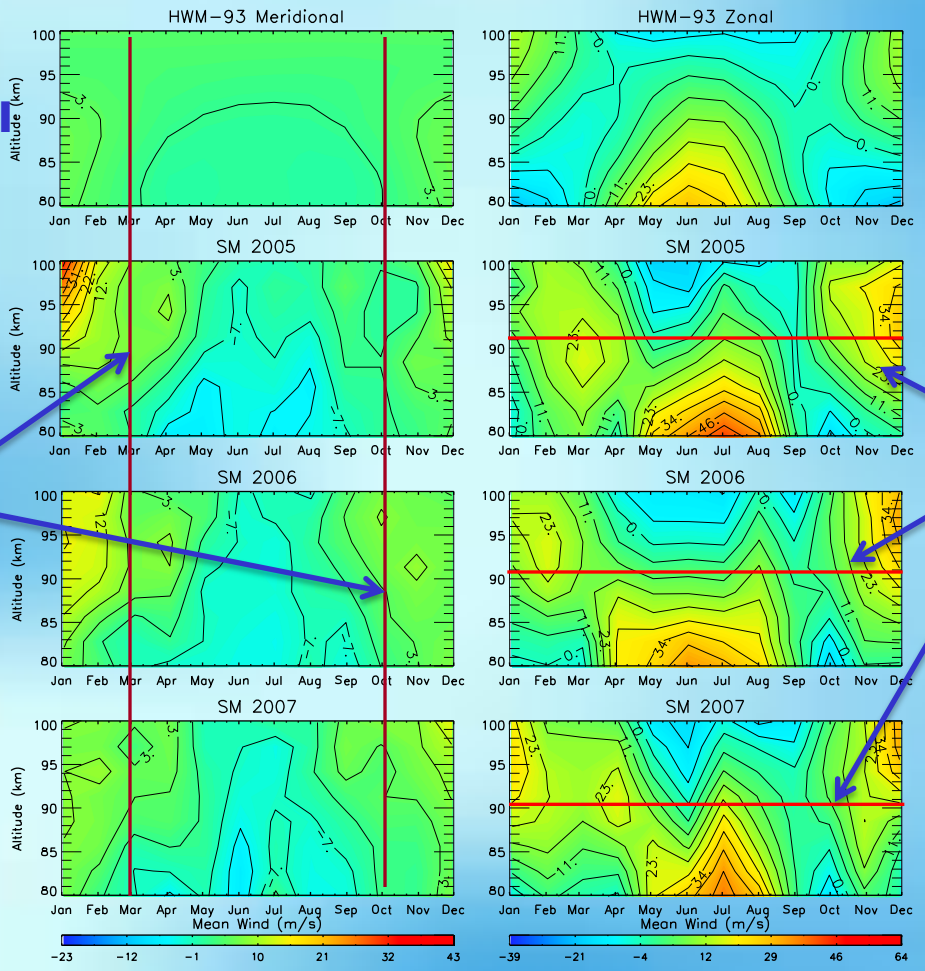
THE SKiYMET METEOR RADAR GEOMETRY





MONTHLY MEAN WINDS OBSERVED WITH THE SKiYMET METEOR RADAR AT SANTA MARIA FROM 2005 – 2007

HWM-93 Model



Annual variation with dependence on altitude.

Semi-annual variation around 90 km.

Annual above and below

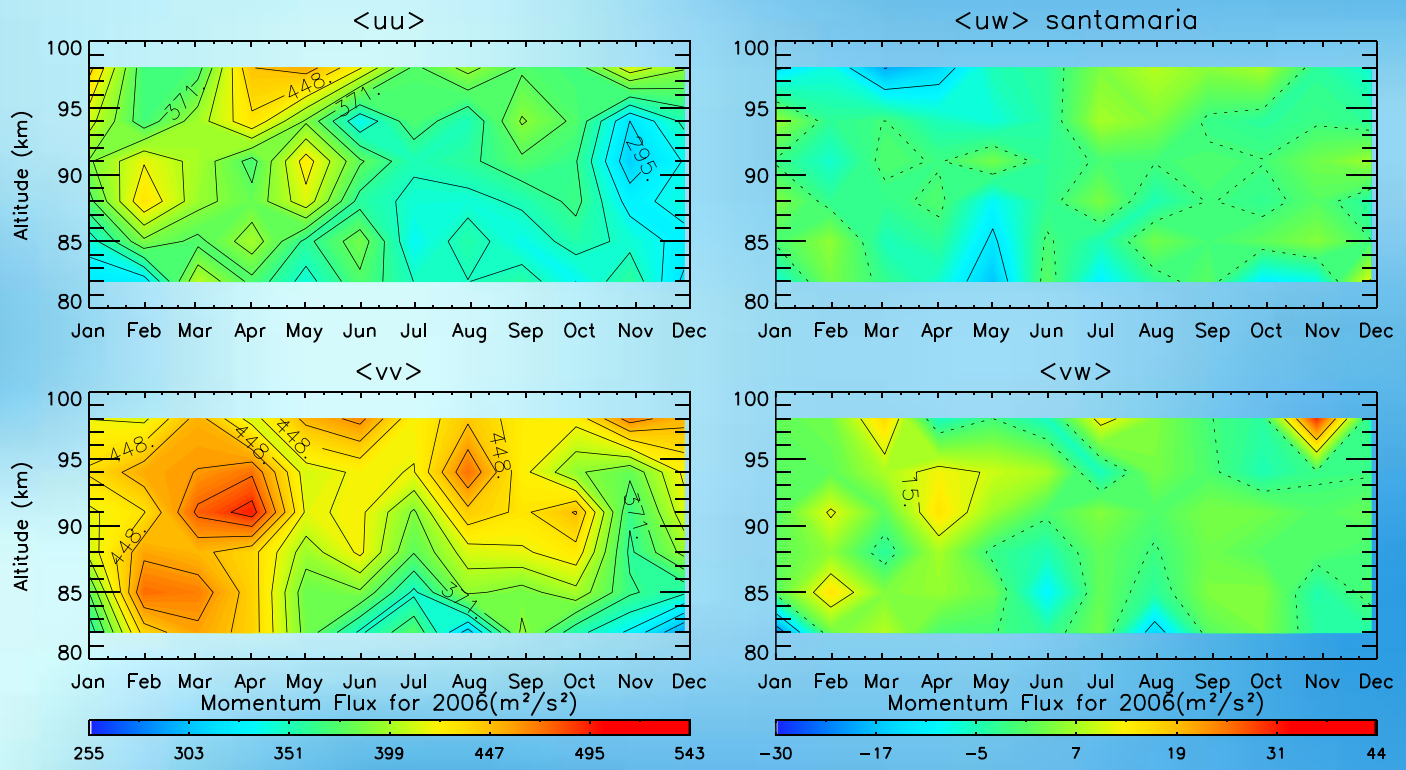
MOMENTUM FLUX OF GRAVITY WAVES

Also, we have been studying gravity wave activity by Hocking's technique that provides the momentum flux and the variance components from the SKiYMET data.

Example of a seasonal study for 2006 at Santa Maria

<uu>, <vv> zonal and meridional variances, respectively

<uw>, <vw> zonal and meridional vertical momentum flux, respectively



Obrigado

Thanks

Nelson Jorge Schuch

njschuch@lacesm.ufsm.br