

# CAWSES Activities in Brazil

# Institutions involved in CAWSES related Research Activities:

- **Instituto Nacional de Pesquisas Espaciais – INPE (National Institute for Space Research), São José dos Campos**
- **Universidade do Vale Paraíba –UNIVAP, São José dos Campos**
- **Centro de Radio Astronomia e Astrofísica da Universidade Mackenzie CRAAM, São Paulo**
- **Universidade Estadual de São Paulo –UNESP, Presidente Prudente**
- **Universidade Federal do Campina Grande, Paraíba**
- **Universidade Federal de Rio Grande de Norte - UFRN, Natal;**
- **Observatório Nacional and UFRJ, Rio de Janeiro.**

(Researchers: ~40; students:10; Post-Docs: 5)

## National CAWSES representatives and their contact information

- Hisao Takahashi (Instituto Nacional de Pesquisas Espaciais- INPE, [hisaotak@laser.inpe.br](mailto:hisaotak@laser.inpe.br))
- Walter Gonzalez (INPE, [gonzalez@dge.inpe.br](mailto:gonzalez@dge.inpe.br))
- Inez S. Batista (INPE, [inez@dae.inpe.br](mailto:inez@dae.inpe.br))
- Eurico R. de Paula (INPE, [eurico@dae.inpe.br](mailto:eurico@dae.inpe.br))
- M. A. Abdu (INPE, [abdu@dae.inpe.br](mailto:abdu@dae.inpe.br))

# Brazilian Funding Agencies for CAWSES related research

- Ministry of Science and Technology -MCT;
- Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP (Sao Paulo State Foundation for promotion of Research);
- Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq (National Council of Research and Development);
- Financiadora de Estudos e Projetos – FINEP (Financing agency for studies and projects);

# Science Agenda within the CAWSES themes

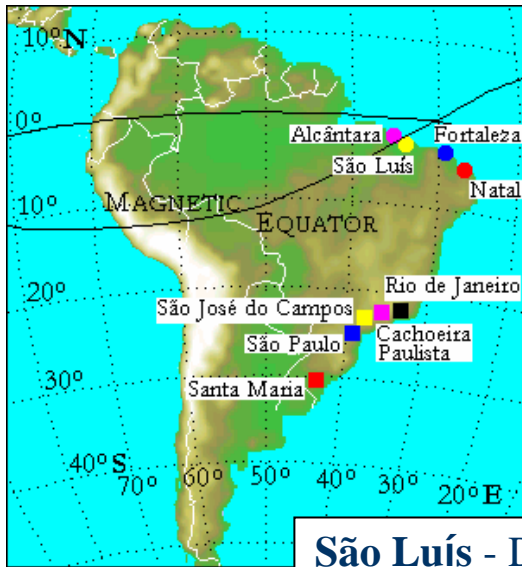
**The main focus of research concerning the themes 2, 3 and 4 are the following:**

- Solar – Interplanetary - Magnetospheric Processes and Magnetic Storms;
- Space weather of the Equatorial- and Low- latitude ionosphere –thermosphere system -High-low latitude Ionospheric Coupling:
  - Disturbance electric fields (prompt penetration and disturbance dynamo electric fields), plasma drifts and disturbance thermospheric winds, and their effects on the major phenomenology of the equatorial region:
    - Plasma bubble irregularities,
    - Equatorial plasma fountain and anomaly,
    - Electrojet current system and instabilities.
- Atmosphere-Ionosphere coupling processes (vertical coupling):
  - Sunset electrodynamics, F layer dynamo /prereversal electric field and Spread F/Plasma bubble irregularity generation mechanism.
    - COPEX Campaigns
    - Campaign on gravity waves seeding of ESF
- Planetary wave effects in the mesosphere and ionosphere:
  - PW effects Prereversal electric field and ESF
- Long term trends in the mesosphere

# CAWSES related meetings

- A CAWSES – Brazil meeting was held during the STP11 event in Rio de Janeiro in March 2006;
- A few meetings of informal nature have been held at INPE during 2005.

# Observational network in Brazil for CAWSES Research



**São Luís** - Digisonde, VHF Coherent Scatter Ionospheric Radars (30 MHz and 50 MHz), 3 Cornell GPS Scintillation Monitors, 2 GPS TECmeters, VHF Receiver and Magnetometer.

**Alcântara** – Rocket launching site,

**Fortaleza** - digisonde, magnetometer

**Natal** - Rocket launching site, CADI (UFRN)

**Cachimbo**: CADI (Canadian Digital Ionosonde)

**Cachoeira Paulista** – Digisonde, Meteoric Radar, 2 Cornell GPS Scintillation Monitors, GPS TEC meter, VHF Receiver, Fabri Perot Interferometer, Magnetometer

**Santa Maria** – Meteor radar, Photometers, imaging riometer, 2 GPS Scintillation Monitors, Digisonde (to be installed) and magnetometer.

**São João do Cariri (PB)** – Airglow photometers, all-sky imager, Meteor radar.

**Cuiabá** – 2 Cornell GPS Scintillation Monitors, GPS TECmeter (from AFRL), VHF Receiver (AFRL)

**São José dos Campos** – GPS TEC meter Cornell GPS Scintillation Monitor and, Laser Radar

# Brazilian CAWSES Campaign 2005:

Mesosphere-Ionosphere Coupling, Formation of Plasma Bubble

## **Campaigns Conducted in 2005:**

- (1) March 1 – 15 (OK, data in analysis)
- (2) April 1 – 13, (OK, data in analysis)
- (3) Sept. 22 – October 9 (OK, data analysis in preparation)
- (4) October 22 – November 7 (OK, data in preparation)

The Campaigns (3) and (4) are with cooperation of NASA (Dave Fritts) team



# Brazilian CAWSES Campaign 2005:

Mesosphere-Ionosphere Coupling and Formation of Plasma Bubbles

## Objectives:

1. **Troposphere to Ionosphere dynamical coupling**
2. **Planetary waves** in the equatorial mesosphere and Ionosphere
3. **Gravity waves** – Plasma Bubble seeding ?
4. Gravity wave - **Sprites**

**Collaboration with NASA/USA Project team (Dave Fritts), starting on September 2005**

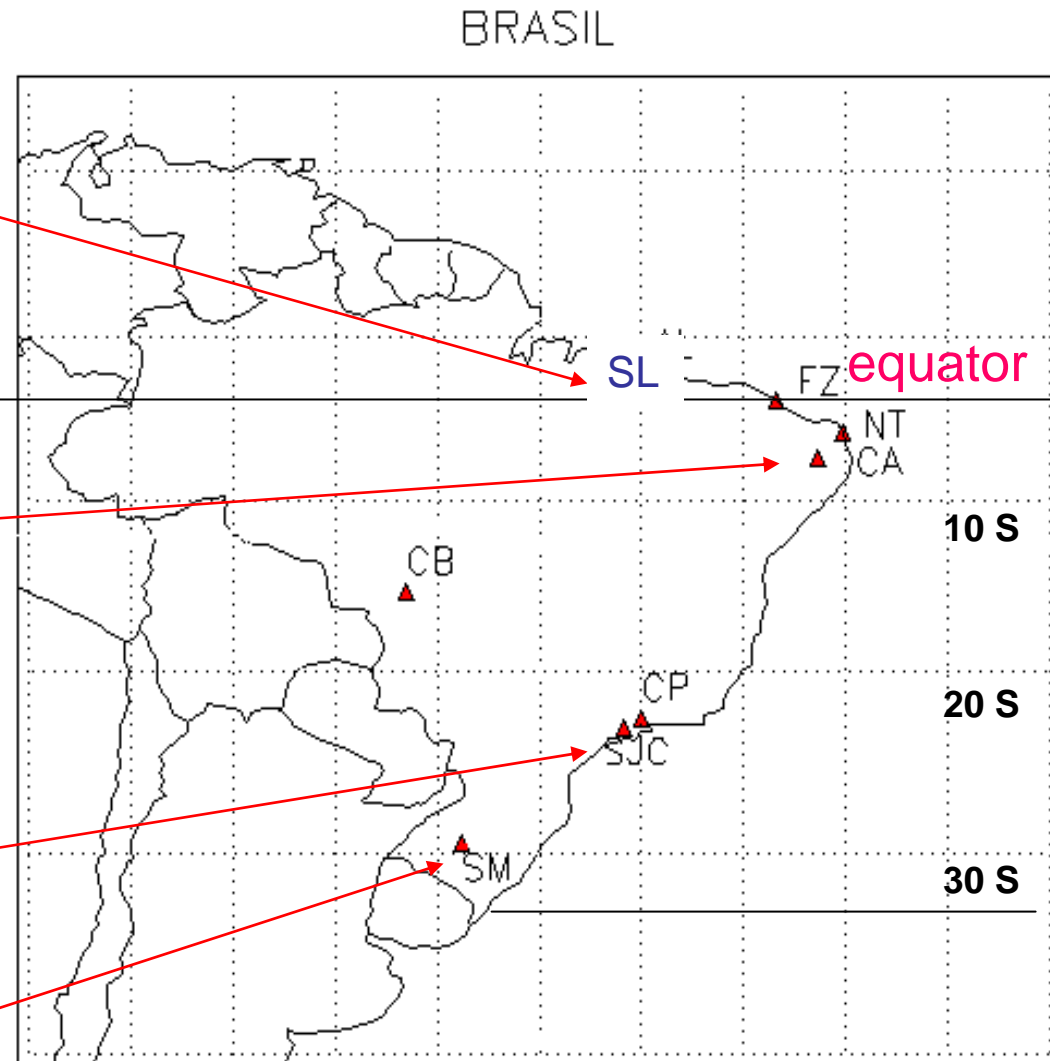
# Brazilian CAWSES Campaign 2005:

## Mesosphere-Ionosphere Coupling, Formation of Plasma Bubble

	(Lat. Long.)	Ionosonde	Imager	Photometer	Meteor radar	Coherent Radar	Laser Radar
São Luís	(2.6S, 44.2W)	OK (DIGI)				OK	
Manaus	(3.1 S, 60.0 W)	OK (CADI)					
Natal	(5.8 S, 35.2 W)	OK?(CADI)					
Fortaleza	(3.9S, 38.4W)	OK (DIGI)					
Cariri	(7.4S, 36.5W)		OK*	Start on 30/09	OK		
Palmas	(10.3S, 48.3W)	OK (CADI)	Start on 22/10				
LNA(Brasopolis)	22.5S, 45.6W)		OK				
S. J. Campos	(22.7 S, 45.2W)						OK (?)
C. Paulista	(22.7S, 45.0W)	OK (DIGI)	OK*	OK	OK		

# Geophysical Observatories used in the Campaigns

- Sao Luis: Digisonde, Coh. Radar
- Manaus: CADI
- Fortaleza: Digisonde
- Natal: CADI
- Cariri: Imager, Photometer  
Meteor radar
- Palmas: CADI, Imager, GPS
- LNA (Brazópolis), Imager
- C. Paulista: Digisonde,  
Photometer, Imager, Meteor  
Radar
- S. J. Campos: Lidar, CADI
- Santa Maria: Meteor radar,  
(DIGI)



# Campaign Summary of 09 -10/2005

Day	Observation Period	Sky	Waves	Bubbles	Remarks
<b>9/22/2005</b>	18:11 to 22:11	clean	yes	yes	Bands for northeast and one bore
<b>9/23/2005</b>	18:11 to 22:40	clean	yes	yes	Bands for northeast, ripples and one bore
<b>9/24/2005</b>	18:11 to 23:35	clean	yes	yes	Bands for northeast
<b>9/25/2005</b>	18:11 to 00:27	clean	yes	yes	Bands for northeast
<b>9/26/2005</b>	18:11 to 01:16	clean with some moments cloudiness	yes	yes	Bands for southeast
<b>9/27/2005</b>	18:10 to 02:03	clean with some moments cloudiness	yes	yes	Bands for southeast
<b>9/28/2005</b>	18:10 to 02:46	clean with clouds in final of the period	yes	yes	Bands for east and northeast, ripples and one bore
<b>9/29/2005</b>	18:10 to 03:25	clean with some moments cloudiness	yes	yes	Bands for southeast and ripples
<b>9/30/2005</b>	18:10 to 04:05	clean eith clouds in final of the period	yes	yes	Bands for southeast and bubble for west
<b>10/1/2005</b>	18:10 to 04:26	clean	yes	yes	Bands for notheast, ripples and one bore
<b>10/2/2005</b>	18:10 to 04:23	Cloudiness during almost all period	yes	yes	Bands for northeast and one bore
<b>10/3/2005</b>	18:10 to 04:23	Cloudness after 23:50	yes	yes	Bands for southeast and one bore
<b>10/4/2005</b>	18:59 to 04:23	Cloudiness during almost all period	yes	yes	Bands for northeast and southaest
<b>10/5/2005</b>	19:52 to 04:23	clean	yes	yes	Bands for southeast and northeast and one bore
<b>10/6/2005</b>	20:49 to 04:21	Cloudness after 22:50	yes	yes	Bands for southeast
<b>10/7/2005</b>					Data not seen yet
<b>10/8/2005</b>					Data not seen yet
<b>10/9/2005</b>					Data not seen yet
<b>10/10/2005</b>					Data not seen yet

**Sept. 22 – Nov. 21: a total of 36 days of observation.**

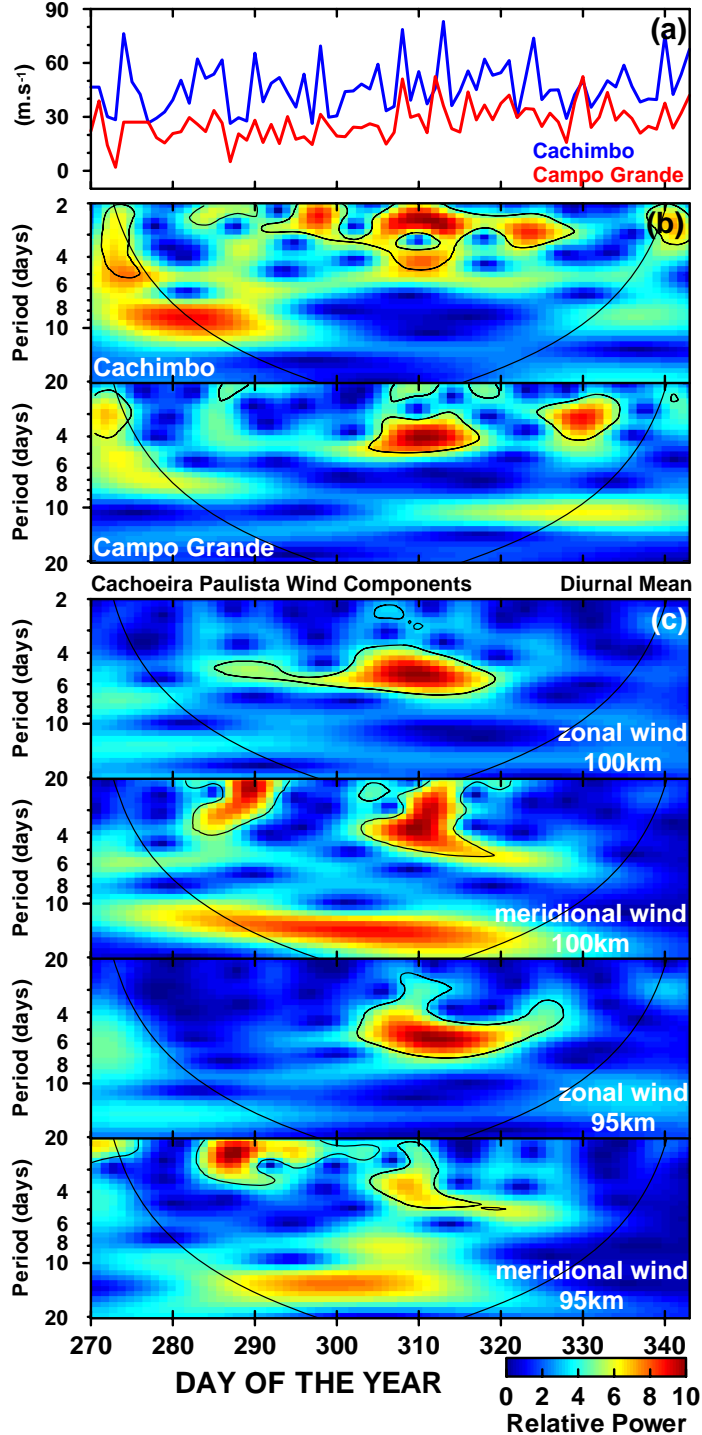
# Planetary scale waves

- Meteor wind and Ionospheric parameter  
Day to day variability  
Planetary scale oscillation

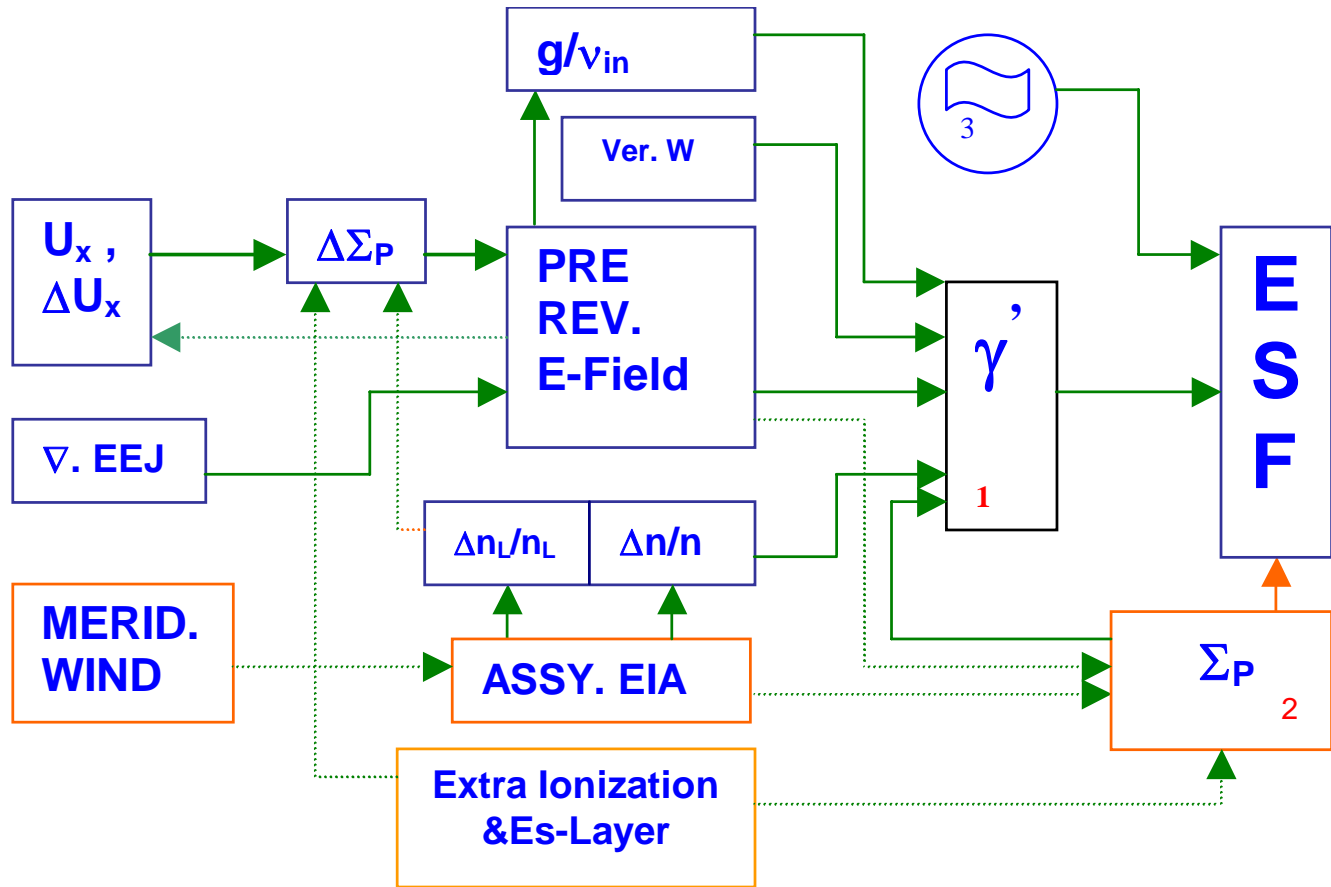
(a)- Evening Prereversal vertical drifts over Cachimbo and Campo Grande;

(b)- Wavelet spectra showing PW scale oscillations around the days 305 – 320;

(c) Wavelet spectra of mesospheric winds at 95 and 100 km over Cachoeira Paulista showing similar oscillations as that of the evening F region vertical drift



# Gravity waves and Ionospheric Bubbles



$$\gamma'_L = \frac{\Delta n}{n} \left( \frac{E}{B} - \frac{g}{v_{in}} \right) - \beta_L \quad 1a$$

$$\gamma'_{FT} = \frac{\Sigma_P^F}{\Sigma_P^E + \Sigma_P^F} \left( \frac{E}{B} - U_L^P - \frac{g_e}{v_{eff}} \right) \frac{1}{R_E L^3 N_0^F} \frac{\partial}{\partial L} (L^3 N_0^F) - \beta_{FT} \quad 1b$$



# Brazilian CAWSES Campaign 2005:

## Mesosphere-Ionosphere Coupling, Formation of Plasma Bubble

### Cariri Airglow image data Archive (Amauri)

	2			4/3/2005	
	Bolha (OI 630,0nm)			Onda (OH)	
	Início (imagem)	1		Início (imagem)	1
	Término (imagem)	8		Término (imagem)	17
	Duração (imagem))	7		Duração (imagem))	16
	Início (hora)	22:32:28		Início (hora)	18:35:52
	Término (hora)	23:18:30		Término (hora)	19:11:19
Duração (hora)	0:46:02	Duração (hora)	0:35:27		
	3			6/3/2005	
	Bolha (OI 630,0nm)			Onda (OH)	
	Início (imagem)	5		Início (imagem)	1
	Término (imagem)	46		Término (imagem)	154
	Duração (imagem))	41		Duração (imagem))	153
	Início (hora)	19:01:51		Início (hora)	18:34:52
	Término (hora)	23:36:56		Término (hora)	0:14:54
Duração (hora)	4:35:05	Duração (hora)	5:40:02		
Observa-se claramente as bolhas se formando				Observa-se e ondas de vários tipos e em muitas direções	

# OH all sky image Observation

Sept. 24, 2005

18:15 - 19:35 hs

Mesosphere Gravity waves,  
band structure propagating to  
NE direction

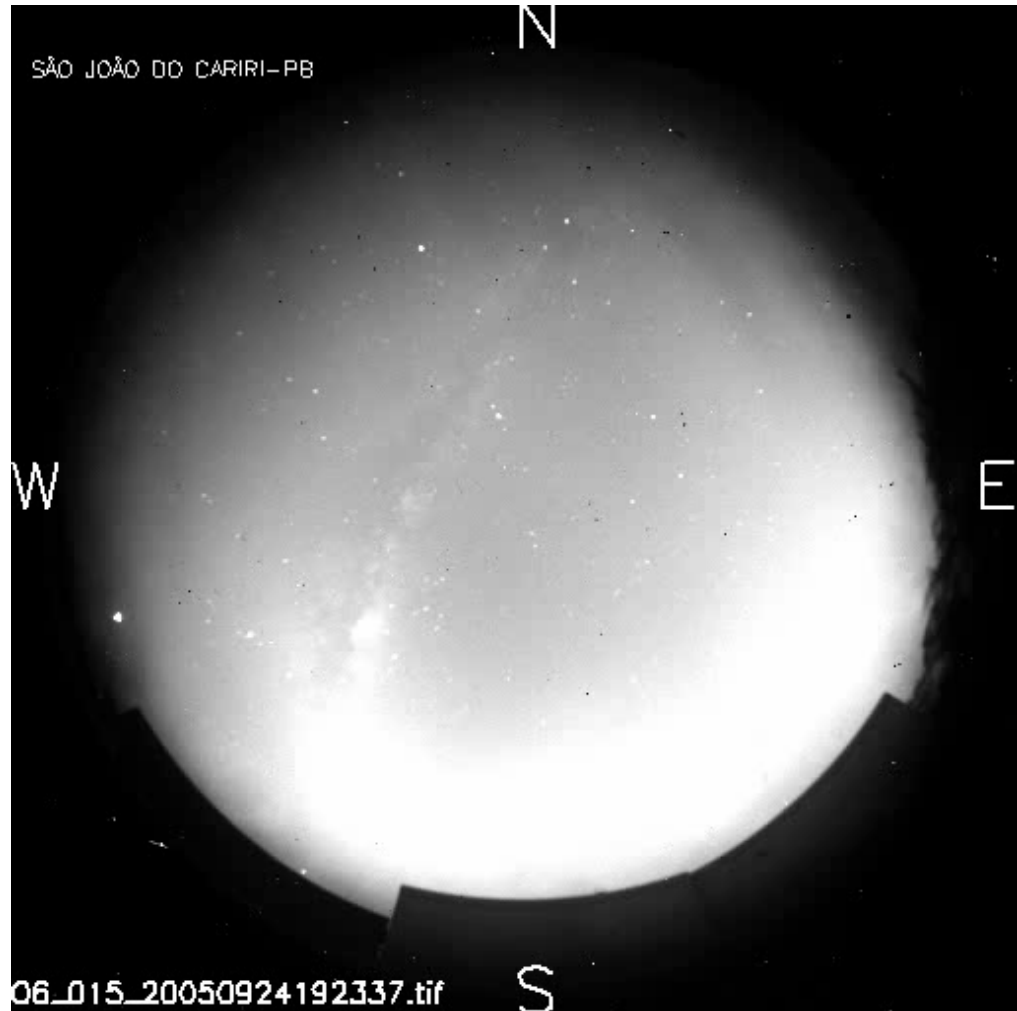


# OI 6300 all sky images

Sept. 24, 2005

18:30 – 19:23  
hs

Ionospheric  
Anomaly and  
Bubble  
Formation  
Phase



## Collaborations in CAWSES related research

- RISH, Kyoto University, Japan; (S. Fukao, M. Yamamoto);
- STELAB, Nagoya University; Japan; (T. Ogawa, K. Shiokawa);
- NICT, National Institute of Information and Communication Technology, Japan (T. Maruyama);
- CORA, Colorado Research Associates, (David Fritts);
- UWO, University of Western Ontario, Canada (J. MacDougall);
- Utah State University, USA (B. G. Fejer, M. Taylor);
- AFRL, Air Force Research Laboratory, USA (Chin Lin, Keith Grooves);
- ISRO, Indian Space Research Organization, (R. Sridharan).