

Space Weather studies in India

Solar Influence on Climate

Space Climate

24 projects
15 institutions

Space Weather – Science and Applications

Atmospheric Coupling Processes

**Presentation by Indian Delegation
to 48th STSC-UNCOPUOS
February 17, 2011 - Vienna**

The theme of Space Weather Research in India

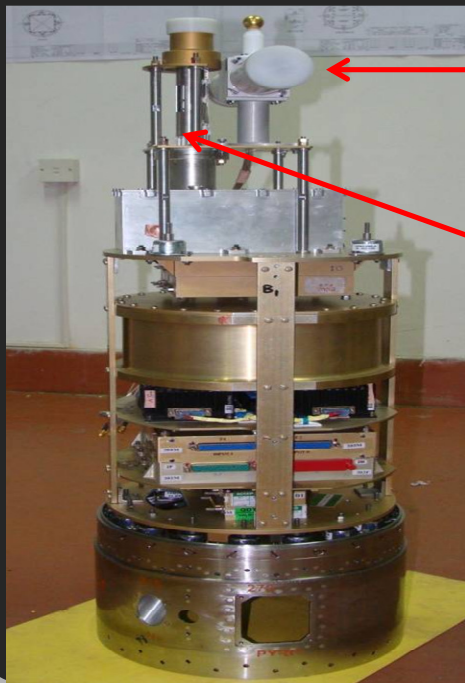
- Investigation of the evolution of magnetic field structures on the sun and solar wind disturbances.
- Investigation of the Day-to-day variability of equatorial and low latitude thermosphere-ionosphere system with an emphasis on the generation and development of Equatorial Spread F (ESF)
- Investigation of Solar and interplanetary origin of geomagnetic activity and related magnetospheric-thermospheric-ionospheric (MTI) effects.

In order to address these problems, it was decided that every year one / two campaigns, {one during equinox and the other during winter/summer } would be required.

- For Y2006, the campaign windows were identified as **March-April 2006**. Campaign March 15 – April 31, 2006 : a unique multi-institutional multi-instrumented campaign .
- A follow up campaign was done in Feb – April 2008.
- The first one was **SOORYAGRAHAN 2010** - to address the annular solar eclipse of Jan 15, 2010

SOORYAGRAHAN-2010

- ❖ Annular Solar Eclipse of January 15, 2010 - Path of annularity passes over southern India during noontime, a rare occurrence and an ideal opportunity for investigating the impact of changes in the solar forcing in the terrestrial atmosphere
- ❖ ISRO conducted a multi-platform (ground, balloon and rocket), multi-instrument, multi-institutional national campaign under the aegis of CAWSES India.
- ❖ This led to 'one of it's kind' in-house development of scientific experiments and some new and significant results



ENWi
(Electron Density and Neutral Wind Probe)

EACE
(Earth's Atmospheric Composition Explorer)

Some indigenously developed experiments flown onboard rockets

Experiments for Space Weather Studies



Rockets



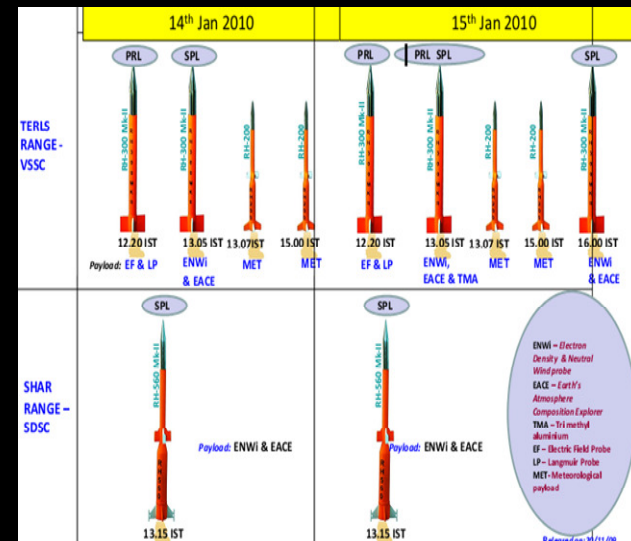
Multiwavelength dayglow photometer



SKiYMET Radar



Digisonde



Fleet of rockets during SOORYAGRAHAN

The network of RaBIT (Radio Beacon for Ionospheric Tomography) stations

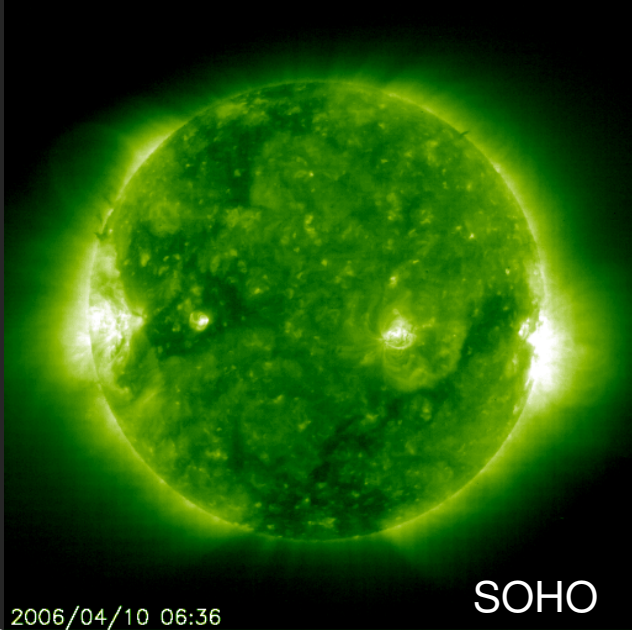
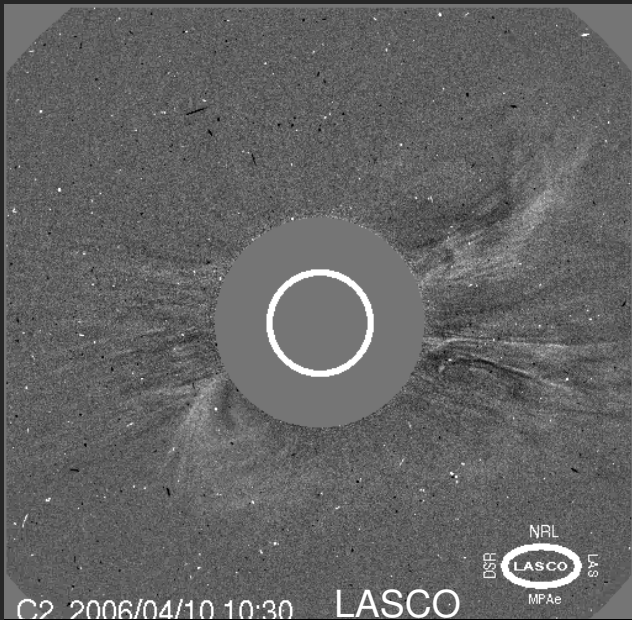


Station	Lat. (°N)	Long. (°E)
Trivandrum	08.50	77.0
Bangalore	12.98	77.6
Hyderabad	17.80	78.0
Bhopal	23.20	77.2
Delhi	28.67	77.2

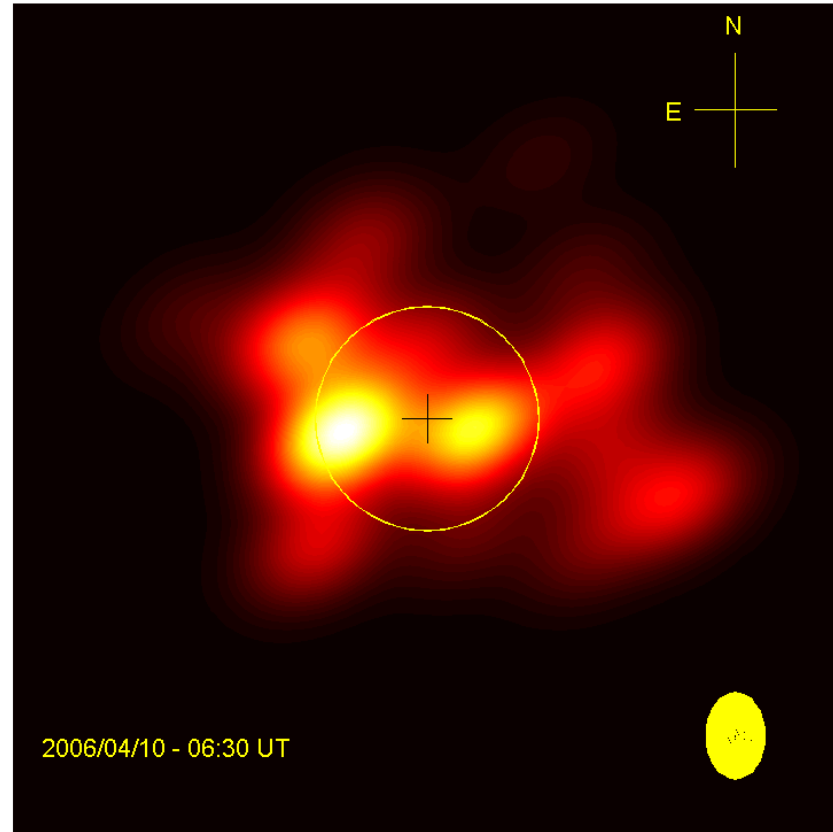
❖ This network is unique as it covers both the northern crest and the trough of the EIA, by far making it the *longest tomography chain of the world.*

Coronary Mass Ejection (CME) from various sources

CME on April 10, 2006

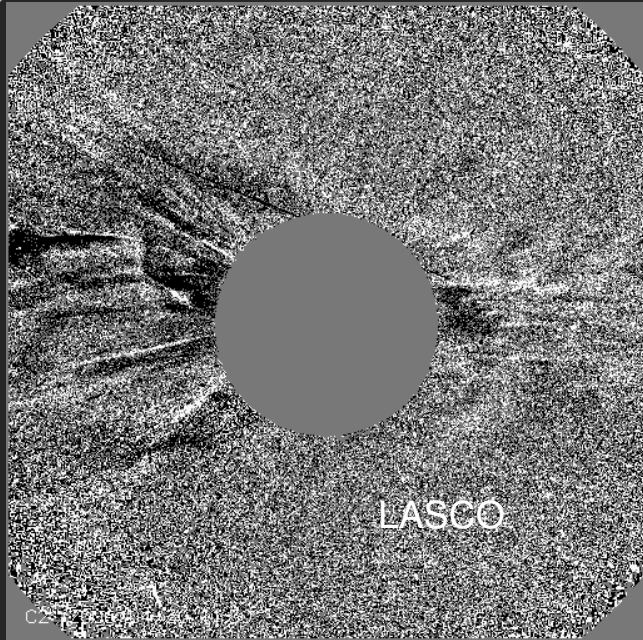


GAURIBIDANUR RADIOHELIOGRAM - 115 MHz



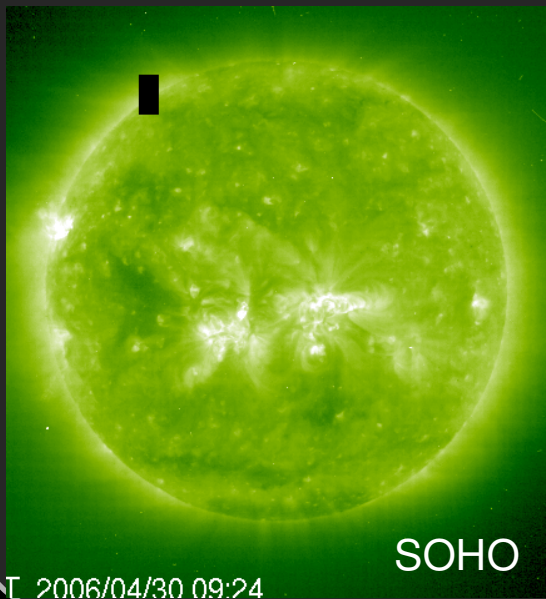
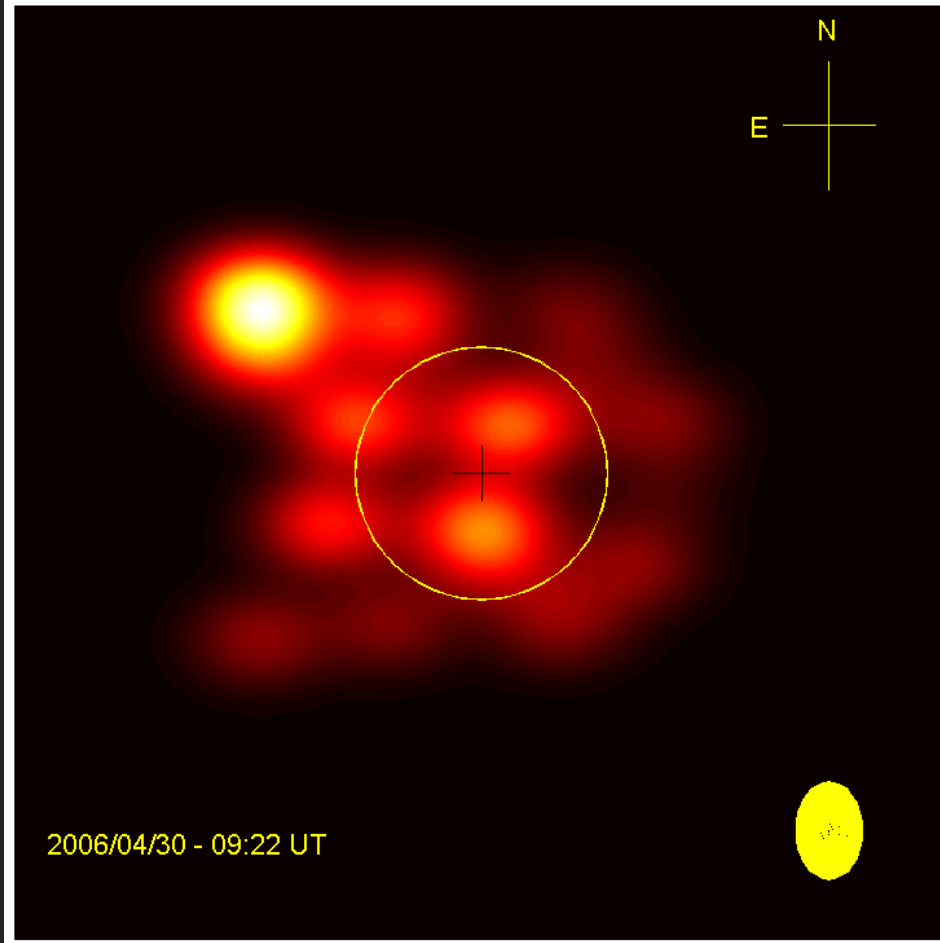
Gauribidanur , India

Evolution of Coronal Mass Ejection (CME)



CME on April 30, 2006

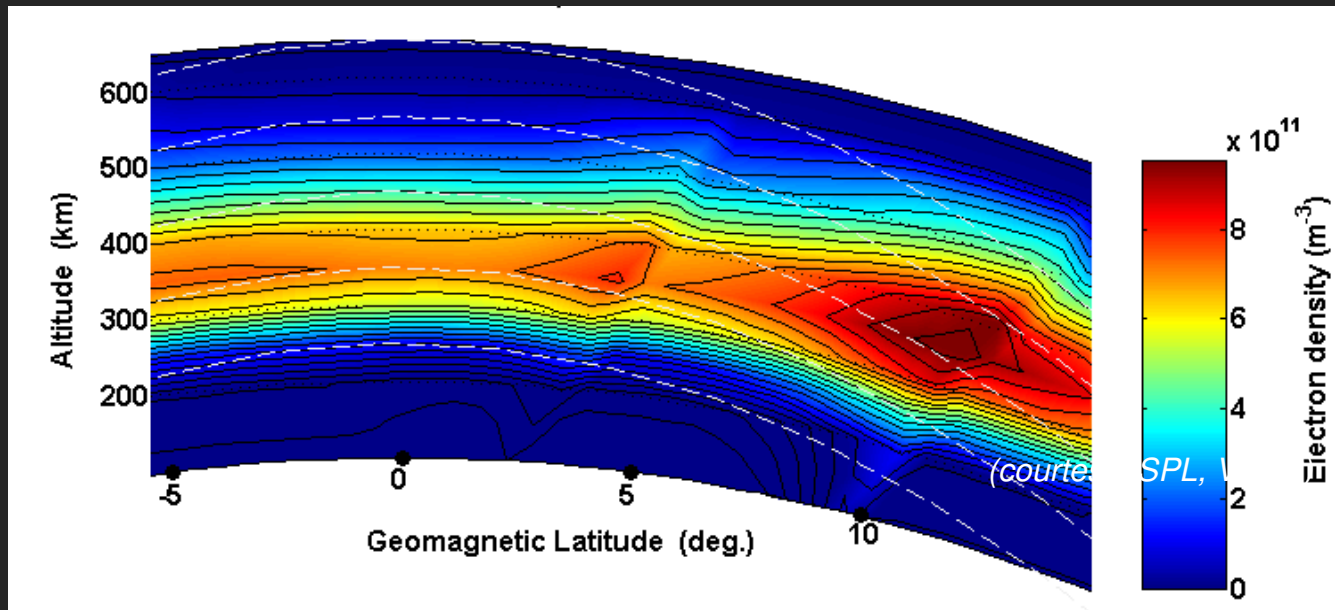
GAURIBIDANUR RADIOHELIOGRAM - 115 MHz



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Gauribidanur , India

Ionospheric Tomogram



A **three** station (Bangalore, Hyderabad and Trivandrum) Tomogram exhibiting the presence of a Travelling Atmospheric Disturbance on March 31, 2006 over the Indian longitude (77°E) during moderately disturbed ionospheric conditions.

Some important results on Space Weather issues achieved by Indian Scientists:

- a. Evidence of convective activity in lower atmosphere influencing tidal variability in the Mesosphere Lower Thermosphere (MLT) region.*
- b. Improved prediction of Equatorial Spread – F*
- c. Evidence of alteration in mesopause energetics as a consequence of active space weather events*
- d. Evidence of sun induced planetary wave oscillations in middle and upper atmosphere*
- e. Significant advances in the direction of modeling the ionosphere over the Indian longitudes region.*
- f. A quantitative understanding of the response of the terrestrial atmosphere as a whole to the changes in the direct solar forcing during eclipse*

Important Published papers on space weather research by Indian Researchers in peer-reviewed international journals

- ✓ Signature of additional stratification in the equatorial ionosphere during active space weather events.

(JGR 114, A08309, doi 10.1029/2009JA014491, 2009)

- ✓ Seasonal and solar cycle variations of electron density gradient scale length, Vertical drift and layer height – Implications over Spread – F

(Earth Planets and Space, 61, 1339-1343, 2009)

- ✓ Possible coupling between the MLTI over the polar latitudes and that over the equatorial Latitudes in context of the Polar Sudden Stratosphere Warming.

(GRL 36, L20104, doi 10.1029/2009GL040375, 2009)

- ✓ Large Solar flare of October 28, 2003 and its instantaneous manifestations in the equatorial Ionosphere

(Ann. Geophys. 27, 3853-3860, 2009)

Future Satellite Missions for Space Weather studies

Small satellite mission '**YOUTHSAT**' - ready to be launched in March 2011 , an Indo-Russian venture with three experiments onboard to investigate the Sun-Earth connection

The experiments are :

- ❖ **SOLRAD** – Russian experiment for monitoring solar energetics
- ❖ **RaBIT** (Radio Beacon for Ionospheric Tomography) – Indian beacon onboard YOUTHSAT for tomographic reconstruction of ionosphere over the Indian Longitudes
- ❖ **LiVHySI** (Limb Viewing Hyper Spectral Imager) – Indian experiment onboard to image terrestrial nightglow over limb.

A comprehensive mission addressing the **CAUSE** (i.e. solar energy) and **EFFECT** (terrestrial neutral and ionised atmosphere)

ADITYA-1

First Indian Space based Solar Coronagraph to study solar corona in visible and IR Bands. Launch planned during next high solar activity period by 2012.

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