CAWSES - INDIA

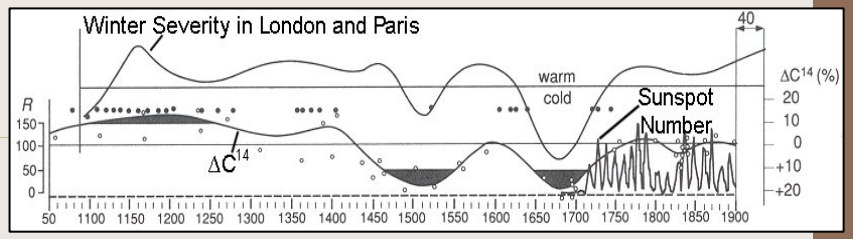
R.Sridharan

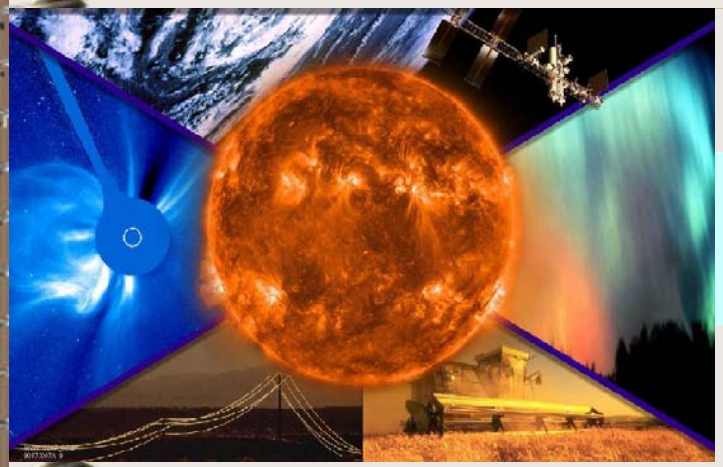
Space Physics Laboratory

V.S.S.C

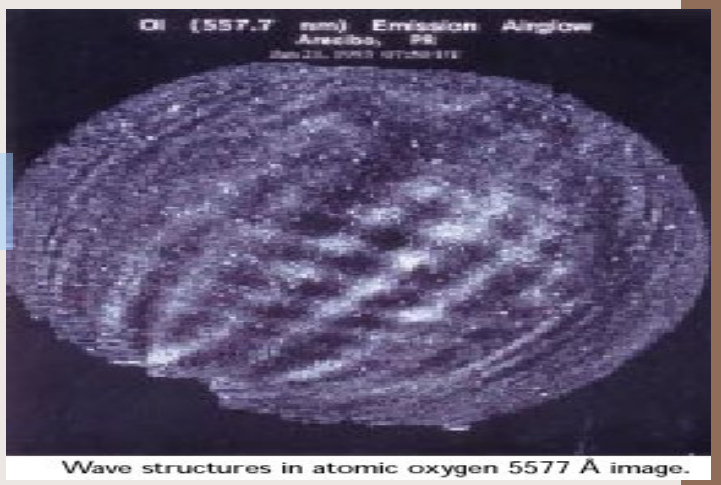
Four Themes under CAWSES

Solar Influence on Climate



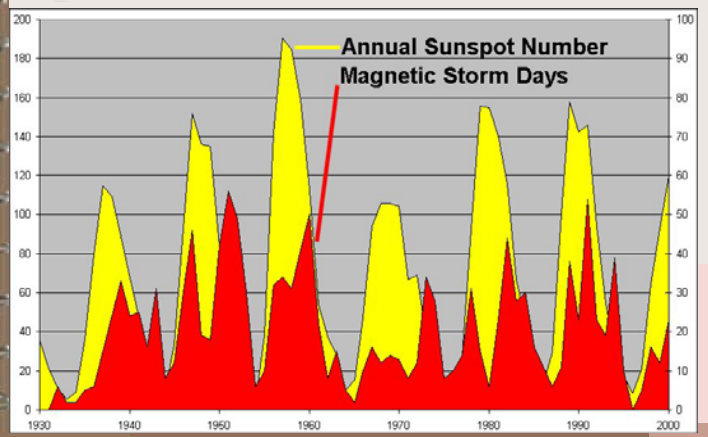


Space Weather: Science and Applications



Wave structures in atomic oxygen 5577 Å image.

Atmospheric Coupling Processes



Climatology of the Sun-Earth System

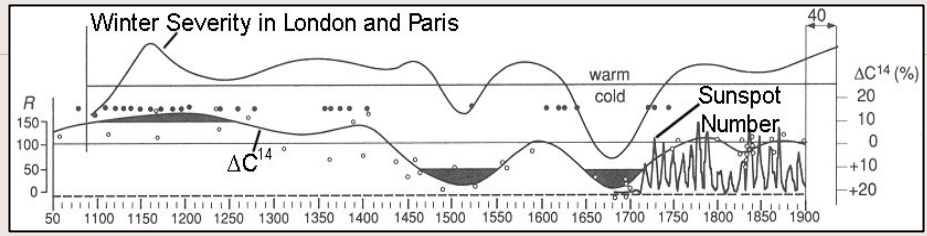
Formation of the National Steering Committee reporting to ADCOS

- **Prof.P.B.Rao Chairman**
- **Dr.S.C.Chakravarty co-chair**
- **Prof.R.Sridharan**
- **Prof.D.Narayana Rao**
- **P.Venkatakrishnan**
- **Prof.J.H.sastri**
- **Prof.G.S.Lakhina**
- **Prof.R.Ramesh**
- **Prof.S.Anantha Krishnan**
- **Prof.B.N.Goswami**
- **Dr.R.S.Dabbas**
- **Prof.P.K.Bhuyan**
- **Prof.Ashish Dasgupta**
- **Dr.Kusuma G.Rao (member Secretary)**
- **Programme co ordination by the Space Science Office ISRO HQ**

WG co- chairs

• **Theme I**	**Prof.B.N.Goswami**	**(IITM)**
	Prof.R.Ramesh	**(PRL)**
• **Theme II**	**Prof.J.H.Sastri**	**(IIA)**
	Prof.P.Venkatakrishnan	**(USO)**
Theme III	**Prof.D.Narayana Rao**	**(NARL)**
	Prof.S.Gurubaran	**(EGRL)**
Theme IV	**Dr.R.S.Dabbas**	**(NPL)**
	Prof.Harish Chandra	**(PRL)**

Theme I : Solar Influence on Climate



Proposals 1

- Variability of spectral irradiance, energetic particles & cosmic rays
- Effects of solar variability on middle and lower atmosphere
- Study of paleo-climate
- Study of extreme environments in the Sun-Earth system

- The solar irradiance is the primary source of energy
- Paleo-climate studies:

provide clues to direct forcing

Important :

Fast changes within 50yrs could lead to extreme conditions like ice age

Just 1 % change in the solar irradiance could lead to a catastrophe

Emphasis:

Use of existing long data base both for atmospheric and space climate

- Modeling :

one of the important aspects

RCM, Meso-Scale model, Global circulation model etc…. Nesting of the models…

parameterization of the atmospheric parameters through campaigns,

Role of green house gases, minor constituents and trace gases etc., to be taken into account

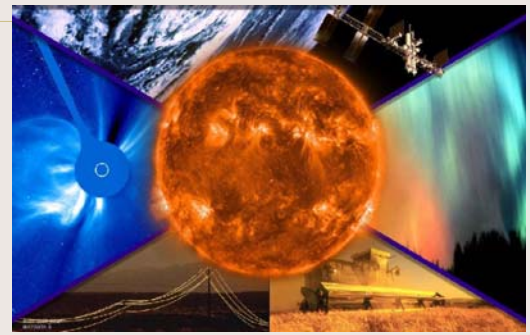
Land campaign I & II

ICARB Mar - Apr 2006

ISRO-GBP initiative

(CAWSES-INDIA Proposal –1)

Theme II : **Space Weather: Science and Applications**



- The changes in the near Earth environment in response to variations in the solar radiation, solar wind, electromagnetic status of the interplanetary medium.
- Geomagnetic Indices – proxy indicators of the conditions of GEOSPACE

- Areas of investigation:

- The sun including the Solar radiation,energetic particles and solar wind
- The magnetosphere including SW interaction, magnetospheric waves,particles and fields, ring current dynamics and geomagnetic storms and substorms
- The ionosphere-thermosphere system, EF, Current systems, irregularities,ionospheric disturbances and the neutral atmosphere

- Final objective: Forecasts !

ensure safety and reliability of the space based systems

Operational forecasting experiment

(initiated)

ESF campaign May-June, 2006

(proposals –12)

Working Group-2 of CAWSES-India:
Space Weather and Applications

Three main scientific problems identified…

P1: Investigation of the evolution of magnetic field structures on the sun and solar wind disturbances.

P2: 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)

P3: Investigation of Solar and interplanetary origin of geomagnetic activity and related magnetosphere-thermosphere-ionosphere (MTI) effects.

First multi-institutional multi-instrument campaign was conducted during March-April 2006 with special emphasis on P2.

Solar/Geomagnetic Conditions during WG-2 Campaign

- The weather of the sun-earth system during March-April 2006 was moderately disturbed, with no geo-effective solar flare occurrence
- Three moderate geo-magnetic storms with gradual commencement were observed.

Important Outcome

A. Evidence that even small amplitude solar events could lead to systematic changes in the interplanetary-scintillations, followed by changes in terrestrial atmosphere

B. Evidence for the E and F region coupling controlling the evolution of ESF structures, plumes in particular.

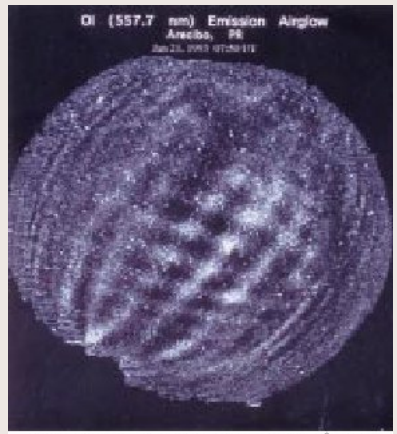
C. Evidence of significant longitudinal differences in the occurrence of the post-evening VHF scintillations.

D. Evidence for storm-induced lowering in the optically estimated daytime mesopause temperature over equatorial latitudes.

Theme III:

Atmospheric Coupling Processes

- Dynamical coupling
- Electrical coupling
- Chemical coupling of atmospheric regions



Wave structures in atomic oxygen 5577 Å image.

Dynamical …

- Spatial and temporal variations of atmospheric waves,source regions,dissipative mechanisms,wave-mean flow interaction,wave breaking,instabilities etc.,
- QBO, SAO – causative mechanisms, mid-low latitude coupling
- Generation of turbulence –consequences Middle atmospheric response to solar activity
- Troposphere-stratosphere coupling etc.,

MIDAS campaign - ongoing

Break Monsoon - campaign

Strat-warm - campaign

Tides – campaign

salient features…..

Campaigns of WG-3 on Atmospheric Coupling Processes

First Campaign: Study of Tidal Effects

The Campaign was conducted by WG-3 members during March-April 2006 with the following objectives:

1. **To determine the characteristics of tides in the troposphere and lower stratosphere (0-20 km) and mesosphere and lower thermosphere (MLT) region (80-100 km)**
2. **To explore and identify what lower atmospheric processes drive middle atmospheric tides in the Indian continental region (*vertical coupling*)**
3. **Provide information on those short-term variations of MLT tides that are likely to have an impact on the ionospheric variations and contribute to the upper atmospheric weather**

Second Campaign (Planned): Gravity Wave Generation From Tropical Convective Systems (TCS) And Easterly Jet (TEJ)

Electrical …

- Electrical ---- Sprites,Blue jets, Elves, GEC in the whole domain starting with Solar wind,
- Air Earth currents,Schumann resonance etc..

Chemical …

- Temperature and dynamics control the chemical coupling between the different atmospheric regions – while the chemical reactions themselves might alter the thermal structure

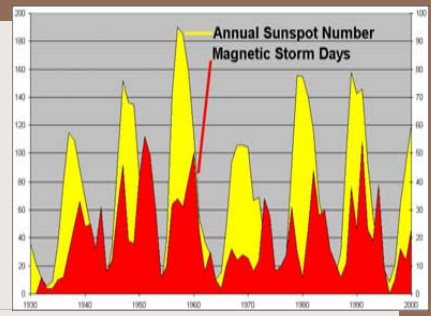
- Chemical---- O3, NO,OH ,
- **MLTI region – campaign outcome**

- **WG III**

- **All the vertical domain of the atmospheric regions covered.**

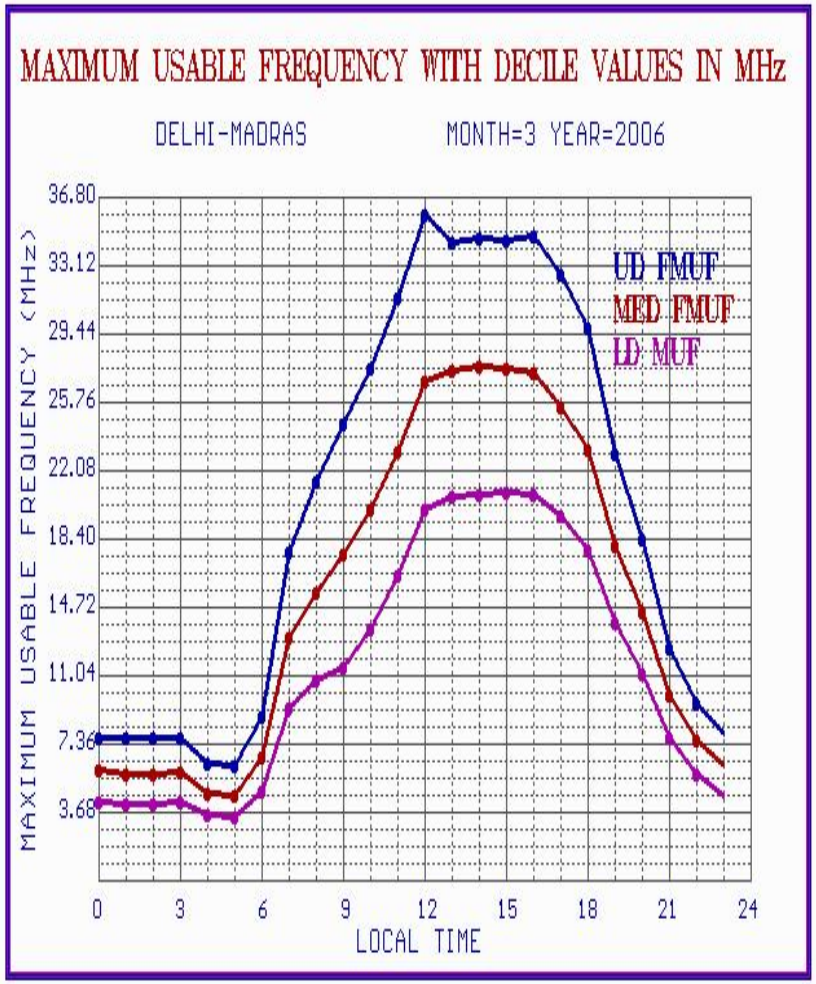
(proposals-6)

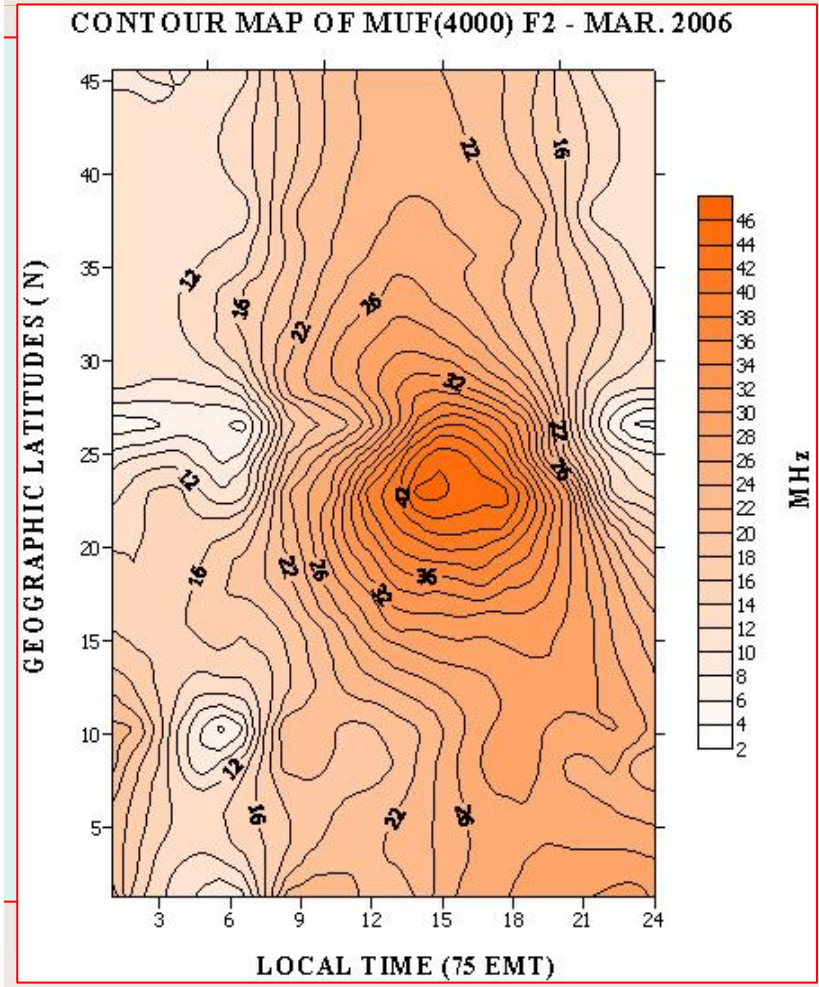
Theme IV: Space Climatology (proposals – 4)



- Time scales minutes to millenia
- Variability caused by direct and indirect forcings------global warming a case in point
- In addition, sporadic, irregular and localized variabilites exist
- Approach on statistical basis
- Existing long data base both meteorological and ionospheric data

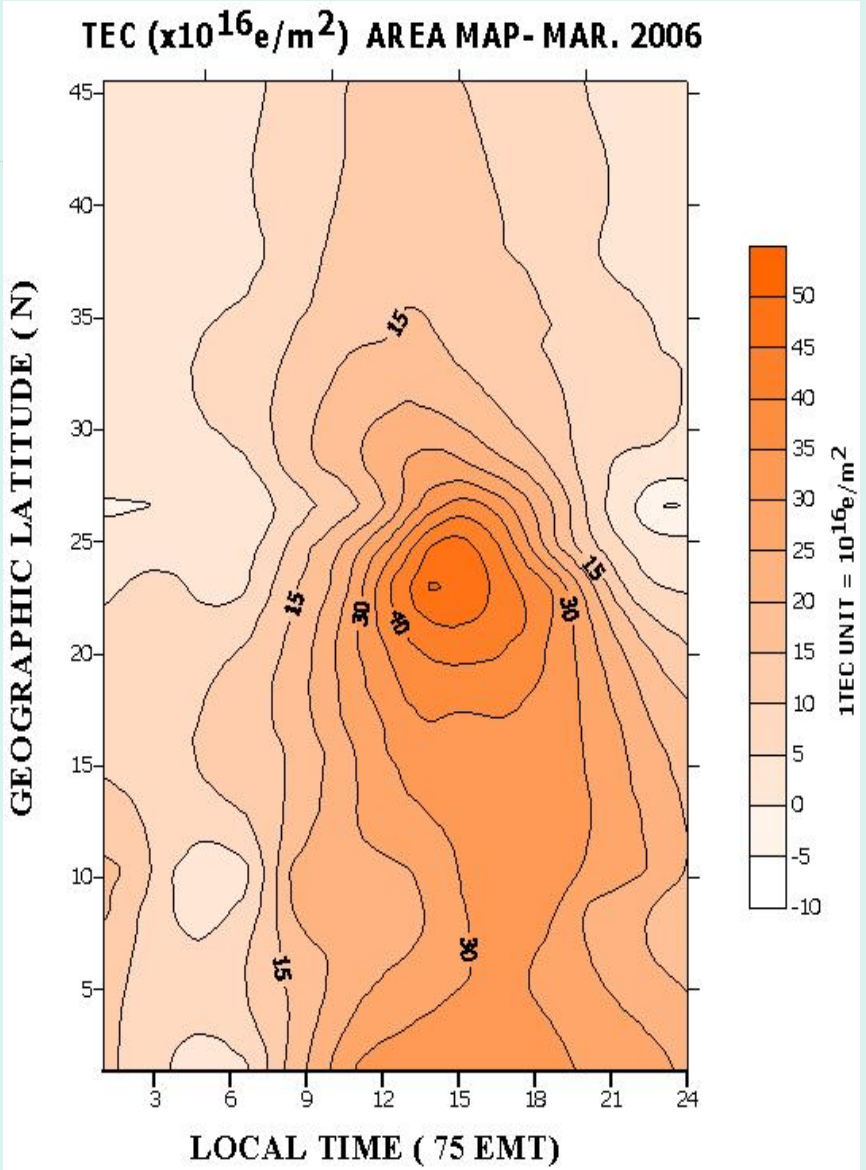
IONOSPHERIC POINT-TO-POINT LINK AND AREA PREDICTIONS FOR HF COMMUNICATIONS





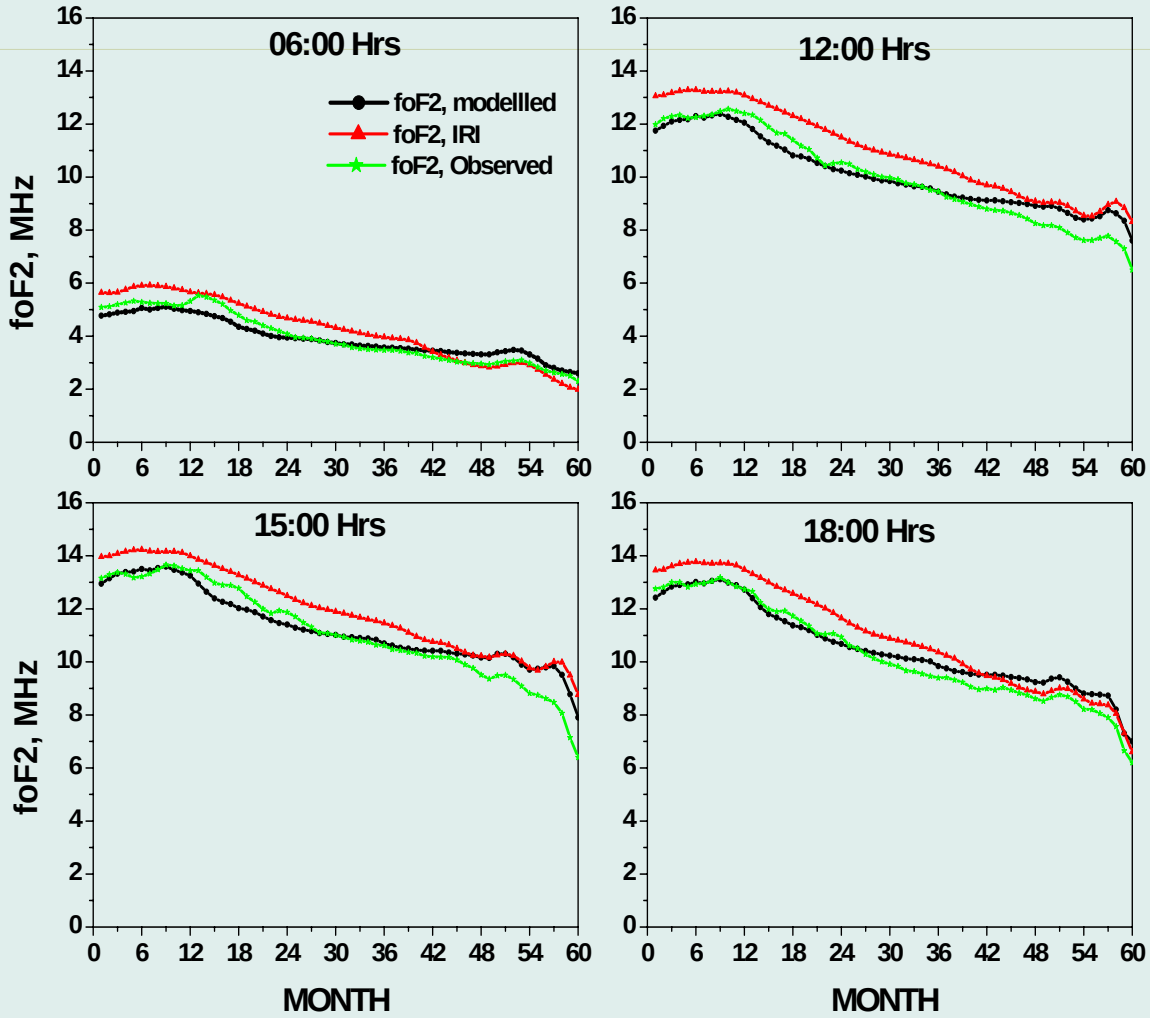
TEC PREDICTION MODEL FOR INDIAN ZONE

- A TEC model for Indian zone using fof2 and hmf2 values as input to IRI 2000 for different R12 values developed by NPL
- The model uses R12 predictions and the users have to give only station lat., month and year for which TEC is desired.
- Tec-integral of Ne along ray path (e/m^2) is significant in determining phase path, group delay, dispersion, refraction and faraday polarization rotation of trans-ionospheric signals
- The amount of time delay is
  $tg = 1.34 \times 10^{6} \times TEC/f^2$ (nanosec)
  where TEC is in unit of 10^{16} e/m^2



RESULTS

The foF2 values calculated from the present Model and compared with the observed foF2 values at Delhi and with the IRI model foF2 values at different local times for the strictly fall period of solar cycle 23 (2001-2005).



The equatorial / low latitude phenomena are given emphasis in

CAWSES – INDIA .

Outstanding problems of EITS like,

Day-day variability of ESF, Role of tidal, planetary and gravity waves in EIA,ESF,MTM,EEJ, and CEJ and the coupling effects of these phenomena in the neutral atmosphere, e.g.,ETWA will be attempted

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- Observations, theory and modeling to be utilized for understanding coupling processes
- Coupling processes important for understanding of Space Weather, Space Climatology and Solar Influence on Climate

Facilities ..

- Ionosondes,magnetometer,HF, VHF radars,MST radar,HFD radar,Meteor wind radar,VHF, UHF scintillation Rx,CRABEX network for Tomography,

PR radars,LIDARS,sounding Rockets,High altitude balloons,Cryo Sampler,Rocket payloads, small satellites for Atmospheric and near Earth space studies and Space borne LIDAR

Major Mile stone programs from INDIA during CAWSES time frame..

- **MIDAS** (ISRO's program for middle atmospheric sciences)
- **CRABEX** (Coherennt Radio Beacon Experiment)
- **SOXS** (Solar X ray Spectrometer)
- **GAGAN** (INDIAN WAAS- SAT NAV)

CHANDRAYAAN-1

- **DIGITAL IONOSONDES** at NEW DELHI & BHOPAL
- complementary expts. with C/NOFS ?!

- **co ordination between different groups and institutions, Capacity building, public outreach of the relevance of the STP activities are inherent features of the CAWSES –INDIA program**

Approved Scientific Projects

WG- I: Solar Influence on Climate	
1.	**Impact of Long-term Solar Variability on the Middle Atmosphere Chemical Climate using Satellite Data and Model Simulation.** **G. Beig, IITM, Pune**

WG/ II: Space Weather: Science and Applications

1.	Space weather aspects of active region vector magnetic fields, P. Venkatakrishnan, USO, Udaipur
2.	Pre-Eruptive phase of Solar Filaments, N. Srivastava, USO
3.	Low latitude geomagnetic and ionospheric response to space weather phenomena, S. Alex, IIG, Mumbai
4.	Boundary layer waves and ring current dynamics, S. Singh, IIG
5.	A study of the Interrelationship of Equatorial Scintillations, ambient Ionization and Electrojet, A. Dasgupta, Univ. Calcutta
6.	Space weather studies of ionosphere and its effects on ground and space based systems, A. K. Gwal, Barkatullah Univ., Bhopal
7.	Simultaneous space domain and frequency domain interferometers augmentation to Andhra University HF Doppler Radar, K. Niranjan, Andhra Univ., Waltair
8.	Operational Space weather forecasts, P. K. Manoharan, TIFR, Ooty

WG - III

1.	Longitudinal Variability of tides in the equatorial Mesopause region, S. Gurubaran, EGRL, Tirunelveli
2.	Stratwarm effects on the low latitude mesopause region, S. Gurubaran, EGRL, Tirunelveli
3.	Dynamics of the tropical tropopause, D. N. Rao et al, NARL, Gadanki
4.	Study of the solar wind-magnetosphere-Ionosphere coupling: Effects observed in low latitude ionosphere, A. Bhattacharya, IIG
5.	Development of Electro-Dynamic Coupling Model using Schumann Resonance and Global Electric Current, S. Choudhuri, Calcutta Univ.

WG - IV

WG/Theme 4: Space Climatology	
1.	Climatology and modelling of the F region over Indian equatorial and Low latitudes based on data from ionosonde network, P. K. Bhuyan, Dibrugarh Univ.
2.	Studies on low latitude space climatology with ground based Ionosphere–Thermosphere measurements, K. Niranjan, Andhra Univ., Waltair
3.	Study of Sun-Earth interactions using VHF scintillation, H. P. Joshi, Saurashtra Univ., Rajkot
4.	An Integrated approach for the investigation of the Equatorial Ionosphere thermosphere system using different ground based experimental techniques at the magnetic equatorial location of Trivandrum, C. V. Devasia, SPL, VSSC, Thiruvananthapuram
5.	Analysis and modelling of Indian Ionospheric Content, A. D. Sharma, Osmania Univ., Hyderabad


Thank you