The Abdus Salam International Centre for Theoretical Physics

# ICTP-COST-USNSWP-CAWSES-INAF-INFN International Advanced School on Space Weather

Cosponsor(s): Sponsored by ICTP, SCOSTEP/CAWSES, European COST actions 724 and 296, INAF, U.S. National Space Weather Program (NSWP) and INFN.
Organizer(s): Directors: J.M. Forbes, M. Messerotti; S. Radicella (ICTP Local Organizer)
Trieste - Italy, 02 - 19 May 2006

## Final programme

**Tuesday, 2 May 2006** (Room:Main Building Main Lecture Hall)

**08:30 - 12:00** **REGISTRATION and ADMINISTRATIVE FORMALITIES**
Registration: Main Building Lobby (main entrance); Administrative Formalities: upon registration Enrico Fermi Building

**12:00 - 14:00** --- Lunch Break ---

**14:00 - 14:15** **K.R. Sreeenivasan** / *Director, ICTP*
**Opening Remarks**

**14:15 - 14:30** **S.M. Radicella / J. Forbes, M. Messerotti** / *Local Organizer/School Co-Directors*
**School Overview**

**14:30 - 14:45** **J. Grassberger** / *ICTP Scientific Computer Section, Trieste*
**Introductory Talk on ICTP Network**

**14:45 - 15:45** **M. Messerotti** / *INAF-OATs, Trieste*
**Introduction to Space Meteorology**
Space Weather and Space Climate describe the short- to long-term time evolution of inner and outer perturbations originated by a variety of astrophysical processes occurring in the Solar System, where anthropogenic processes are relevant as well, and in exoplanetary systems. To define a suitable terminology, a foundation ontology for Space Meteorology will be introduced and the related observational framework will be outlined by means of Concept Maps to emphasize the interrelationships among the various phenomena and their effects on planetary environments.

**15:45 - 16:45** **V. Cadez** / *Astronomical Observatory, Belgrade*
**Basic Physics of Magnetoplasmas-I: Single Particle Drift Motions**

**16:45 - 17:00** --- Break ---

**17:00 - 18:00** **V. Cadez**
**Basic Physics of Magnetoplasmas-II: Fluid Description and MHD**

**18:00 - 19:00** **V. Cadez**
**Basic Physics of Magnetoplasmas-III: Statics and MHD Waves in Gravitational Field**

**19:00 - 19:30** **M. Messerotti**
**Introductory Lecture on RSI IDL Programming**

**THE SUN: THE PHYSICS BEHIND** (Room:Main Building Main Lecture Hall)

**3 May 2006**

**08:30 - 09:30** **N. Gopalswamy** / *NASA-GSFC, Greenbelt,MC*
**The Sun as a Star**
The first lecture will deal with generalities and address the following questions. What is our place in the universe? Where is the solar system located in the Milky Way? How does the Sun fit into the Hertzsprung-Russell diagram? What is the final state of the Sun? What is the structure of the Sun?

**09:30 - 10:30** **N. Gopalswamy**
**Physics of the Solar Interior**
The second lecture will deal with how energy is generated and transported in the solar interior. The following topics will be discussed: Thermonuclear fusion with proton-proton and Carbon-Nitrogen-Oxygen cycles; the solar neutrino problem and its final resolution; details of the internal structure of the Sun; Helioseismology/solar oscillations; the solar dynamo; solar cycle and polarity reversal

**10:30 - 11:00** --- Break ---

**11:00 - 12:00** **N. Gopalswamy**
**Physics of the Solar Atmosphere**
This lecture will deal with photosphere, Chromosphere and Corona. The following topics will be discussed: granulation, sunspots, faculae, physics of the chromosphere, chromospheric network and super granulation, chromospheric heating, flares, prominences, The solar corona and phenomenology.

**12:00 - 13:00** **N. Gopalswamy**
**Physics of the Extended Corona**
This lecture will deal with the solar corona, where most of the actions directly affecting space weather take place. In particular, the following topics will be discussed: Closed and open magnetic fields on the Sun; coronal heating and solar wind, slow and fast solar wind; coronal mass ejections, shocks, energetic particles, general comments on geoeffectiveness and SEP effectiveness.

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**R. Bentley** / *MSSL/UCL, Surrey*
**SOLAR DATA HANDLING**

Typologies of Solar Data and Solar Data Archives

Solar Data Archives

Solar Data Grids (SDG) and solar Virtual Observatories (SVO)

Solar Sotware Libraries: Typology, Availability and Use

**16:00 - 16:30** --- Break ---

**18:00 - 19:00** **W. H. Matthaeus** / *Bartol Research Institute, Department of Physics and Astronomy, University of Delaware, USA*
**Turbulence Throughout the Heliosphere**

## THE SUN: SPACE WEATHER APPLICATIONS (Room:Main Building Main Lecture Hall)

**4 May 2006**

**08:30 - 09:30** **H. Lundstedt** / *Swedish Institute of Space Physics, Lund*
**Solar Activity: Observations and Definition**
The first lecture will review observations of solar activity. Focus will be on magnetic field measurements and associated helioseismics observations. Observed phenomena will be classified according to a definition of solar activity.

**09:30 - 10:30** **H. Lundstedt**
**Solar Activity: Exploration with Wavelets**
Solar activity is often characterized by transient events, and by oscillations that arise and die away. Wavelet methods are therefore particularly suitable. Solar activity variations on all times scales will be described.

**10:30 - 11:00** --- Break ---

**11:00 - 12:00** **H. Lundstedt**
**Solar Drivers of Geoeffective Phenomena and their Precursors**
Solar drivers such as Coronal Mass Ejections (CMEs), solar proton events, solar flares, and fast solar wind from coronal holes will be discussed. Some of the precursors of these drivers have been know almost hundred years, others have recently been discovered. Examples of geoeffects of these drivers will also be given.

**12:00 - 13:00** **H. Lundstedt**
**Solar Activity: Predictions and Real-Time Forecasts**
Finally, I will illustrate how solar activity and solar drivers have been predicted with data-based and more physics-based neural networks including also results of MHD models. Today, real-time forecasts are available, based on space-based observations. Real-time forecast service is given by Regional Warning Centers of International Space Environment Service (ISES).

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**P. Vanlommel, A. Zhukov** / *Royal Observatory of Belgium, Brussels*
**SOLAR DRIVER MODELLING AND PREDICTING**

Solar Flare Prediction

CME Occurrence Predition

10.7 cm Radio Flux Prediction

Proton Event Prediction

Coronal Hole Prediction

Fast Solar Wind Propagation Prediction

CME Propagation Predictions

CME Magnetic Field Configuration Prediction

**16:00 - 16:30** --- Break ---

**18:00 - 19:30** (Room: Computer Lab. (M))
**FREE LABORATORY**

## **INTERPLANETARY MEDIUM** (Room:Main Building Main Lecture Hall)

**5 May 2006**

**08:30 - 09:30** **M. Storini** / *INAF-IFSI, Rome*
**Cosmic Ray (CR) Origin and Propagation**
What are CRs? - CRs Discovery CR Energy Spectrum CR Source/Acceleration A Picture of the Heliospheric Environment

**09:30 - 10:30** **M. Storini**
**Cosmic Rays in the Heliosphere**
CR Populations CR Propagation in the Heliosphere CR Modulation (long-, medium- and short-term) Solar Cosmic Ray Events

**10:30 - 11:00** --- Break ---

**11:00 - 12:00** **M. Storini**
**Effects in the Heliosphere**
CRs: Probe of the Heliospheric Environment CRs: Hazard for Space Vehicles and Life CRs and Planets

**12:00 - 13:00** **M. Storini**
**Effects in the Earth Environment**
Terrestrial Effects of CRs: An Overview CR data: Direct Use in Space Weather CR data: Indirect Use in Space Weather

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**R. Bentley**
**USE OF CR SIMULATION TOOLS**

Use of Simulatin Tools for CR Propagation

Spacecraft Effects

Aircrew Doses during Flights

**16:00 - 16:30** --- Break ---

**18:00 - 19:30** (Room: Computer Lab. (M))
**FREE LABORATORY**

## **EARTH MAGNETOSPHERE: THE PHYSICS BEHIND** (Room:Main Building Main Lecture Hall)

**8 May 2006**

**08:30 - 09:30** **J. Watermann** / *Danish Meteorological Institute,Copenhagen*
**The formation of the Earth's Magnetosphere: Basic Physical Principles and Steady-State Electrodynamics**
The lecture discusses the formation of the magnetosphere under steady-state solar wind conditions. We start with early yet still valid models of the formation of the magnetosphere developed half a century ago. The basic physical principles of the electrodynamic coupling between the supersonic solar wind plasma and embedded magnetic field on one hand and the geomagnetic field and thermospheric ion reservoir on the other hand are described. Characteristic properties of various magnetospheric plasma regimes prevailing under stable condition are oulined. The lecture leads eventually to a presentation of a basic model of the magnetosphere in the unperturbed state.

**09:30 - 10:30** **I. Daglis** / *Natonal Observatory of Athens, Athens*
**The Dynamic Magnetosphere: Reaction to and Consequences of Solar Wind Variations**
The lecture discusses the response of the magnetosphere to various types of solar wind variations, including the arrival of plasma clouds and shocks at the magnetosphere and the impact of the dynamic pressure changes and interplanetary magnetic field rotations on the state of the magnetosphere. Resulting phenomena such as geospace magnetic storms and magnetospheric substorms and their relation to the energetics and dynamics of the magnetosphere are discussed.

**10:30 - 11:00** --- Break ---

**11:00 - 12:00** **I. Daglis**
**The Particle Radiation Environment of the Near-Earth Space**
The lecture addresses the origin, formation and dynamics of two highly important magnetospheric particle populations: the radiation belts and the ring current. These populations constitute the particle radiation environment of the near-Earth space, and they are part of the chain that interconnects the Sun and interplanetary space with the terrestrial magnetosphere, ionosphere, and atmosphere ? and often even the surface of the Earth.

**12:00 - 13:00** **J. Watermann**
**Nowcasting and Forecasting Magnetospheric Electrodynamic Parameters**
Two fundamental objectives of magnetospheric physics include building realistic physical models of the state and behaviour of the magnetosphere and the design of schemes to nowcast the state and potentially forecast the evolution of the magnetosphere. Many years ago scientists started to devise parameters (proxies or indices) which aid in categorizing magnetospheric properties and deriving systematic aspects of its behaviour. It is now possible to nowcast the state of the magnetosphere (describing its actual state) using a comprehensive suite of near-real-time observations. In principle it is even possible to forecast the evolution of the magnetosphere (though with limited accuracy) using observations from solar and solar wind monitors such as the ACE and SOHO spacecraft. Recent attempts and developments of forecast schemes are outlined in order to prepare for the afternoon lab class.

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**E. Amata(INAF-IFSI, Rome), I. Daglis, J. Watermann**
**PRACTICUM ON MAGNETOSPHERIC DATA**

Magnetospheric Data: Plasma, Fileds, Archives and Data Retrieval

Magnetospheric Virtual Observatories

Magnetospheric Models

Magnetospheric-Ionospheric Plasma Parameter Forecasts - Descriptors and Proxies

**16:00 - 16:30** --- Break ---

**18:00 - 19:30** (Room: Computer Lab. (M))
**FREE LABORATORY**

## **EARTH MAGNETOSPHERE: SPW APPLICATIONS** (Room:Main Building Main Lecture Hall)

**9 May 2006**

**08:30 - 09:30** **K. Kudela** / *Institute of Experimental Physics, Kosice*
**Magnetospheric Optics for Cosmic Rays**
Low energy particles: guiding center approach. High energy particles: Stormer theory for dipolar field. Allowed and forbidden trajectories. Concept of cutoff rigidity and asymptotic directions.

**09:30 - 10:30** **K. Kudela**
**Transmissivity in the Disturbed Magnetosphere**
Numerical solution of equation of particle motion. Geomagnetic field models used for cosmic ray trajectory computations. Results for particular disturbed intervals

**10:30 - 11:00** --- Break ---

**11:00 - 12:00** **K. Kudela**
**Solar Particle Penetration into Magnetosphere**
Ground level events. Observations of solar energetic particles by satellites. Transmissivity computed for low earth orbits.

**12:00 - 13:00** **K. Kudela**
**Direct Effects of Cosmic Ray on Materials(Satellites, Airplanes, Atmosphere)**
External exposure to natural radiation. Cosmic rays in the atmosphere. Dose at the airplane altitudes. High energy electrons and their effects. Spacecraft failures and high energy particles

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**I. Stanislawska, H. Rothkaehl** / *Space Research Centre,Warsaw*
**PRACTICUM ON SPW APPLICATIONS**

Survey of Space Weather Center's Web Pages

*Presentation has been prepared as a training kit for participants of the International Advanced School of Space Weather. It contains a navigator for space weather related home pages together with some examples of data, models and services. Space weather impact on everyday life is illustrated. Full version as pps file is available for request from organizers, as well as from the author (stanis@cbk.waw.pl)*

Satellite Experiments and Data

**16:00 - 16:30** --- Break ---

**19:00 - 21:00** (Room: Main Building Terrace)
--- RECEPTION ---

## **IONOSPHERE-THERMOSPHERE BASICS** (Room:Main Building Main Lecture Hall)

**10 May 2006**

**08:30 - 10:00** **J.M. Forbes** / *University of Colorado, Boulder*
**Ionosphere-Thermosphere Basics I: Neutral Atmosphere Vertical Structure**
Neutral temperature and composition vertical structures; hydrostatic law; energy sources and sinks; interaction between solar radiation and neutral atmosphere.

**10:10 - 10:30** **S.R. Dasso** / *IAFE, Buenos Aires*
**Magnetic Fluxes and Helicity in Magnetic Clouds**

**10:30 - 11:00** --- Break ---

**11:00 - 13:00** **M. Mendillo** / *Boston University, Boston*
**Ionosphere-Thermosphere Basics II: Ionosphere Vertical Structure**
Photoionization; ionospheric chemistry; ambipolar diffusion; ionosphere morphology; ionosphere measurements and models; plasma irregularities.

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** **J. Lilensten** / *Laboratory of Planetology, Grenoble*
**Introduction to Birkeland's Terrella Experiment**
The Birkeland's Terrella Experiment: The Underlying Physics and Plans for Reconstruction of a Terrella Experiment

**16:00 - 16:30** --- Break ---

## **IONOSPHERE-THERMOSPHERE BASICS** (Room:Main Building Main Lecture Hall)

**11 May 2006**

**08:30 - 10:15** **J.M. Forbes**
**Ionosphere-Thermosphere Basics III: Dynamics of the Thermosphere**
Momentum balance; dynamical effects on diurnal, seasonal and magnetic storm variations in composition; influences of waves propagating upward from the lower atmosphere.

**10:15 - 10:30** **A. Mahrous** / *Helwan University, Cairo*
**Signature of July 14, 2000 Magnetic Storm on Ground-Based and Satellite Detectors**

**10:30 - 11:00** --- Break ---

**11:00 - 12:30** **R. Heelis** / *University of Texas, Dallas*
**Ionosphere-Thermosphere Basics IV: Dynamics and Energetics**
Momentum balance of the ionospheric plasma; current continuity; electrical conductivity; ionospheric dynamo; electric field and wind effects on ionosphere plasma.

**12:45 - 13:00** **N. Parihar** / *Indian Institute of Geomagnetism, Mumbai*
**Mesopause Temperatures from the Observation of OH (6-2) Main Line Band Emission at Kolhapur, India**

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 16:00** (Room: Computer Lab. (M))
**M. Mendillo**
**PRACTICUM ON IONOSPHERE-THERMOSPHERE MODELS AND DATA: Exercises with Ionosphere Data and Models**

**16:00 - 16:30** --- Break ---

**16:30 - 18:00** (Room: ICTP-INFN Laboratory (Mlab))
**J. Lilensten, C. Simon**
**PRACTICUM ON THE TERRELLA EXPERIMENT: Construction of Terrella Experiment**

**18:00 - 18:15** **R. Bucik et al.** / *Institute of Experimental Physics, Kosice*
**Gamma Rays under Radiation Belts: Coronal-F Observations of Event on January 27, 2005**

**18:15 - 18:30** **E.Y. Kassie** / *IGPP/UCLA*
**Space Weather Effect on Communication and Navigation System**

## **THERMOSPHERE-IONOSPHERE COUPLING IN A TIEGCM** (Room:Main Building Main Lecture Hall)

**12 May 2006**

**08:30 - 10:00** **R. Heelis**
**Ionosphere-Thermosphere Basics V: Magnetosphere-Ionosphere Coupling**
Field-aligned currents; high-latitude electric fields and plasma transport; Joule heating; magnetic activity effects.

**10:15 - 10:30** **R. Kombiyil** / *Tohoku University, Sendai*
**Ionospheric Equivalent Currents Calculation for a Disturbed Day using the 210-deg Magnetic Meridian Chain**

**10:30 - 11:00** --- Break ---

**11:00 - 12:30** **M. Hagan** / *National Center for Atmospheric Research, Boulder*
**Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM) - I**
Description of thermosphere-ionosphere general circulation models and how they are used to gain insight into the physics of the system and the interpretation of observational data.

**12:45 - 13:00** **Qinghe Zhang** / *Polar Research Institute of China, Shanghai*
**Simultaneous in-situ Observations of the Feature of a Typical FTES by Cluser and TCI**

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 16:00** (Room: Computer Lab. (M))
**M. Hagan**
**PRACTICUM ON IONOSPHERE-THERMOSPHERE MODELS AND DATA: Exercises with TIEGCM Outputs**

**16:00 - 16:30** --- Break ---

**16:30 - 18:00** (Room: ICTP-INFN Laboratory (Mlab))
**J. Lilensten, C. Simon**
**PRACTICUM ON THE TERRELLA EXPERIMENT: Experimenting with Terrella**

**Saturday, 13 May:**
**GUIDED TOUR TO BASOVIZZA OBSERVING STATION OF TRIESTE OBSERVATORY** (**Saturday**)

**13 May 2006**

**10:00 - 11:00** **M. Messerotti**
**Solar Radiophysics and Space Weather**

**SPACE WEATHER AND RADIOCOMMUNICATIONS** (Room:Main Building Main Lecture Hall)

**15 May 2006**

**08:30 - 09:30** **C. Bianchi** / *INGV, Rome*
**Electromagnetic Waves, Radio and the Ionosphere**

**09:30 - 11:00** **C. Bianchi**
**Ionospheric Measurements Techniques (Receiver, Radar, Advanced Ionospheric Sounder and Related Techniques)**

**11:00 - 11:30** --- Break ---

**11:30 - 11:45** **E.T. Senalp** / *METU, Ankara*
**Frocasting Total Electron Content (TEC) for Constructing Maps Especially During High Solar Activity Periods**

**11:45 - 12:05** **G.K. Seemala** / *Andhra University, Visakhapatnam*
**L-Band Sintillations Study in the Indian Sector using GPS Network**

**12:05 - 12:25** **D. Hui** / *S.K. Mita Center for Research in Space Environment, Kolkata*
**An Investigation into the L-Band Ionospheric Scintillations Near the Crest of the Equatorial Anomaly and Towards Developing a Scintillation Model for Indian Longitudinal Sector**

**12:25 - 12:40** **Yanhong Chen** / *Centre for Space Science & Applied Research, Beijing*
**The Observations of TEC Nighttime Enhancement in Equatorial Anomaly Region**

**12:40 - 12:55** **E.I. Astafieva** / *Institute of Solar-Terrestrial Physics, Irkutsk*
**Global Electron Content as a New Ionospheric Index: Comparison with IRI Modelling Results**

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 15:00** **S.M. Radicella** / *ICTP, Trieste*
**Propagation Effects of the Ionosphere**

**15:00 - 16:00** **B. Zolesi** / *INGV, Rome*
**Ionospheric Prediction and Forecasting: Two New Services over the European Region for Space Weather and Radio Propagation Application**

**16:00 - 16:30** --- Break ---

**16:30 - 18:00** **PRACTICUM**

Experimenting with Terrella (J. Lilensten, C. Simon)

*Room: ICTP-INFN Laboratory (Mlab)*

Ionospheric prediction and forecasting: two new services over the European region for Space Weather and radio propagation application (B. Zolesi)

*Room: Computer Lab. (M)*

Vertical ionospheric sounding: a technique to measure the electronic density in the ionosphere (C. Bianchi)

*Room: Computer Lab. (M)*

## **SPACE WEATHER AND RADIOCOMMUNICATONS** (Room:Main Building Lecture Room C)

**16 May 2006**

**08:30 - 10:30** **L. Kersley** / *Professor Emeritus, University of Wales, Aberystwyth, UK*
**Trans-Ionospheric Propagation: Principles and Space Weather,Effects on Navigation and Positioning systems**

**10:30 - 11:00** --- Break ---

**11:00 - 13:00** (Room: Main Building Main Lecture Hall)
**ICTP PRIZE CEREMONY**
The 2005 ICTP Prize in honour of Armand Borel will be awarded to Xiaohua Zhu, School of Mathematical Sciences, Peking University ====== The presentation of the Prize by Professor K.R. Sreenivasan, Director of the Abdus Salam ICTP, will be followed by the 2005 ICTP Prize Lecture by Xiaohua Zhu on "Canonical metrics in Kähler geometry" Abstract: This will be a review of "canonical metrics" in Kähler geometry; examples are Kähler-Einstein metrics, Kähler-Ricci solitons, and extremal metrics. I will touch upon the following topics: 1) Calabi's conjecture. 2) Existence results for Kähler-Einstein metrics with c_1>0. 3) Geometric Invariant Theory related to the existence problem. 4) K-energy and K-stability on toric manifolds. 5) Kähler-Ricci flow and Kähler-Ricci solitons ===== XIAOHUA ZHU Citation for the award of the 2005 ICTP Prize The 2005 ICTP Prize in honour of Armand Borel is awarded to Xiaohua Zhu, Professor at the School of Mathematical Sciences, Peking University. Xiaohua Zhu has made fundamental contributions to complex differential geometry. He is best known for his work (jointly with G. Tian) on the uniqueness of ?Kähler-Ricci solitons?. This work introduced a new holomorphic invariant, and also a deep a priori estimate for solutions of certain complex Monge-Ampere equations. This was a major breakthrough in Kahler geometry. Zhu has also to his credit (jointly with X. Wang) an important existence theorem for Kahler-Ricci solitons, as well as impressive results on minimal submanifolds. More recently he has proved an important convergence theorem for the Kähler-Ricci flow, using the spectacular results of Perelman. At 37, he is one of the foremost young Chinese geometers, a mathematician who attacks and solves tough problems in geometric analysis. His excellent papers are published in front-line journals. The 2005 ICTP Prize is named after Armand Borel, who was a professor at the School of Mathematics at the Institute for Advanced Study at Princeton and lectured at ICTP.

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 15:00** **L. Kersley**
**Trans-Ionospheric Propagation: Principles and Space Weather,Effects on Navigation and Positioning Systems**

**15:00 - 18:00** **PRACTICUM**

GPS Data Analysis for Ionospheric Corrections in Navigation and Positioning (L. Ciraolo - IFAC-CNR, Florence)

*Room: Computer Lab. (M)*

Experimenting with Terrella (J. Lilensten, C. Simon)

*Room: ICTP-INFN Laboratory (Mlab)*

**16:00 - 16:30** --- ---

## PHOTOCHEMISTRY OF EARTH'S ATMOSPHERE (Room:Main Building Main Lecture Hall)

**17 May 2006**

**08:30 - 10:00** **D. Marsh** / *National Center for Atmospheric Research, Boulder*
**Basic Photochemistry of the Middle Atmosphere**
Introduction to minor constituent chemistry and pathways for solar energy transformation within the middle atmosphere.

**10:15 - 10:30** **A. Kilcik** / *Akdeniz University, Antalya*
**Regional Sun-climate Interaction**

**10:30 - 11:00** --- Break ---

**11:00 - 12:45** **K. Hamilton** / *University of Hawaii, Honolulu*
**Basic Dynamics of the Middle Atmosphere I**
An introduction to extra-tropical middle atmosphere circulation, including the mean circulation, gravity waves, radiative equilibrium and quasi-stationary planetary waves.

**12:45 - 13:00** **A.B. Rabiu** / *Federal University of Technology, Akure*
**On the Morphology of Equatorial Electrojet over India Sector**

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 15:00** **D. Marsh**
**Middle Atmosphere Response to Variations in Solar Output**
Observed and modeled atmospheric response to changes in solar radiation and particle fluxes.

**15:00 - 17:00** (Room: Computer Lab. (M))
**D. Marsh**
**PRACTICUM: Exercises with Solar and Ozone Data**
Calculation of the Solar Energy Reposition Rates within the Middle Atmosphere.

**16:00 - 16:30** --- Break ---

**18:00 - 19:30** (Room: Computer Lab. (M))
**FREE LABORATORY**

## SOLAR INFLUENCES ON OZONE AND CLIMATE (Room:Main Building Main Lecture Hall)

**18 May 2006**

**08:30 - 09:30** **K. Hamilton**
**Basic Dynamics of the Middle Atmosphere II**
Tropical dynamics: the quasi-biennial oscillation, semiannual oscillation, wave-mean flow interaction near the equator, and QBO effects on the extratropical circulation.

**09:30 - 10:30** **J. Haigh** / *Imperial College, London*
**Solar Influences on Climate - I**
Overview of the climate system; radiative processes and dynamics of the lower atmosphere; the ?greenhouse effect?; clouds.

**10:30 - 11:00** --- Break ---

**11:00 - 12:45** **J. Haigh**
**Solar Influences on Climate - II**
Evidence of solar variability effects within the climate record over a range of timescales.

**12:45 - 13:00** **A.M. Da Costa** / *INPE, Sao Jose dos Campos*
**Magnetogram Analysis Based on Wavelet Singularities**

**13:00 - 14:00** --- Lunch Break ---

**14:00 - 18:00** (Room: Computer Lab. (M))
**K. Hamilton**
**SOCIETAL IMPACT OF SPW AND GLOBAL CHANGE: Exercises with Climatological and Solar Data**
Exercises with Global Circulation Model Output

**16:00 - 16:30** --- Break ---

**18:00 - 19:30** (Room: Computer Lab. (M))
**FREE LABORATORY**

## **SPW AT OTHER PLANETS** (Room:Main Building Main Lecture Hall)

**19 May 2006**

**08:30 - 09:30** **M. Messerotti**
**Space Meteorology and Life on Earth**
The role of Space Weather and Space Climate on life emergence and evolution on Earth is considered with special emphasis on the effects of inner and outer energy sources.

**09:30 - 10:30** **C. Tuniz** / *ICTP, Trieste*
**The Fossil Record of the Ancient Sun**
Long-lived cosmogenic isotopes such as Beryllium-10 and Carbon-14 can be analysed in geological archives such as tree rings, ice cores, sea sediments and meteorites. Changes in their production rate in the past can give information on solar variability. This area of research will be reviewed and recent results presented.

**10:30 - 11:00** --- Break ---

**11:00 - 11:45** **J. Chela Flores** / *ICTP, Trieste / IDEA,Caracas*
**Origin, Evolution and Distribution of Life in the Solar System: Constraints from Space Weather. Part I Introduction to Astrobiology.**
In the first lecture we will discuss the new science of astrobiology that is concerned with the study of the origin, evolution, distribution and destiny of life in the universe.

| | |
|---|---|
| **11:45 - 12:30** | **J. Chela Flores**<br>**Origin, Evolution and Distribution of Life in the Solar System: Constraints from Space Weather. Part II Implications of Space Weather for the Search of Life.**<br>In the second lecture we will restrict the discussion to the origin, evolution and distribution of life in our Solar System. Special emphasis will be given to the problem of the search for a second emergence of life beyond the Earth, as well as the implications that space weather has on this problem. |
| **12:30 - 13:30** | --- Lunch Break --- |
| **13:30 - 14:30** | **END-OF-STAY CLEARANCE FROM HOUSING OFFICE, ETC (Enrico Fermi Building)** |
| **14:30 - 15:30** | **Final Discussion and Review** |
| **15:30 - 16:30** | **CLOSING CEREMONY AND DISTRIBUTION OF DIPLOMAS OF ATTENDANCE** |