Ministry of Higher Education and Scientific Research

REPORT on the 3rd EDITION OF THE SCHOOL OF SPACE WEATHER ISWI-MAGHREB-WEST AFRICA (IMAO 2017) Abidjan/Côte d'Ivoire [16 - 28 OCTOBER 2017]

VAFI DOUMBIA, OLIVIER OBROU, UFR SSMT

Organized by
Laboratory of Atmosphere Physics, UFR-SSMT,
University Félix Houphoüet Boigny
in collaboration with CRASTE-LF
With the support
International Space Weather Initiative (ISWI)

Under the patronage of the Minister of Higher Education and Scientific Research

Sponsors

- Ministry of Higher Education and Scientific Research
- Felix Houphouët Boigny University
- Virtual University of Côte d'Ivoire (UVCI)
- National Agency for Environment (ANDE)
- Scientific programs (SCOSTEP, ISWI, Esters)
- Laboratories: LPP, IMT Atlantique, site de Brest, CRAAG(Algeria), STO (Tunisia), University Cadi Ayyad (Morocco).
- International organizations: ICTP, CRASTE-LF, GIRGEA
- Participants of countries: Algeria, Burkina Faso, Cameroun, RDC

Welcome from the Minister of High Education and Research

CONTENT

1. Presentation of the project

The School on Space Weather IMAO 2017 aimed to build the capacity of young researchers, Master degree and PhD students from French speaking countries of Maghreb and West Africa in all scientific disciplines concerned with "**Space Weather** ".

The Space Weather is a new branch of astronomy that is concerned with the understanding and prediction of solar electromagnetic and particles impacts on the Earth's environment. It seeks to predict the arrival and amplitude of solar events, solar winds, disturbances of the magnetosphere and the ionosphere and geomagnetic disturbance associated ground currents and their impacts on technological infrastructures.

The courses are focused on the physics of the sun, of the magnetosphere and ionosphere, Atmosphere / Ionosphere / Magnetosphere couplings, Geomagnetism and Aeronomy, but also on climate modeling, the dynamics of the ocean and the GNSS (Global Navigation Satellite System).

1.1 Context

The great interest for the COPE21 summit in the international community showed the importance of environmental issues and climate change that have been discussed there. The summit especially attracted the attention of policy makers worldwide about the urgency of a collective awareness face of growing threats to our overall ecosystem. The fragility of our modern technological infrastructure to electromagnetic impacts of solar activity, necessitated the development of a new discipline known as the "**Space Weather**".

The Space Weather is a very new discipline, still in development, which studies the impact of solar activity on our terrestrial environment. The interaction of electromagnetic radiation and solar particles with the geomagnetic field and the Earth's atmosphere has important implications on our technological world and our space environment. Indeed, the sun continuously sends large masses of particles (electrons and protons) that carry high-energy part of the solar magnetic field. This mass called "solar wind" causes in the Earth's major environmental electromagnetic interference (magnetic storms) that can seriously affect the functioning of our economic infrastructure (satellites, telecommunications networks and energy transmission, pipelines, etc.) and the normal conduct of certain activities such as air and space navigation. Quebec events in January 1989 and Sweden in October 2003 are eloquent examples. To better understand and prevent such events, a consortium of the United Nations through its UNOOSA agency (United Nations Office for Outer Space Affairs, http://www.oosa.unvienna.org, the US space agency NASA, the European ESA and JAXA Japanese, initiated in 2007 the scientific program called "International Heliophysical Year" **IHY** (http://ihy2007). As part of this program, several instruments were deployed throughout the globe. Particularly in Africa, magnetometers, GPS receivers, particle detectors etc. were installed to collect data on ionospheric, magnetospheric and heliospheric phenomena from 2007 to 2009. To continue the 2007 IHY program, the international initiative ISWI (International Space Weather Initiative, www.iswi-secretariat.org) was established to promote the study and develop the Space Weather.

1.2 Justifications

Because of the fragility of our modern space and ground infrastructures facing the devastating effects of solar disturbances and obvious scientific interest of Space Weather, Côte d'Ivoire, through the Atmospheric Physics Laboratory (LAPA) University Félix Houphouët-Boigny takes part to these international scientific programs. Indeed, with the experience gained during the **I**nternational **Y**ear of **E**quatorial **E**lectrojet (**IEEY 1992-1994**), researchers from the geomagnetism and Aeronomy group developed competence in various disciplines related to Space Weather. They have also become key partners of **IHY** and **ISWI** programs in Africa. For this reason Côte d'Ivoire was considered as appropriate venue for organizing the third edition of the West-African Maghreb ISWI-school (IMAO) on Space Weather in 2017.

The school ISWI West-Africa-Maghreb (IMAO) on Space Weather is a high-level scientific meeting that takes place every two years. The first edition was held from 6 to 16 May 2013 at the University of Sciences and Technology Houari Boumediene (USTHB) Algiers (Algeria), the second in CRASTE-LF Rabat (Morocco) from 16 to 21 February 2015. At the end of the second edition, the Côte d'Ivoire has been strongly urged by all the organizers, because of its strong scientific potential in this theme, to host the third edition in 2017.

1.3 Objectives

The organization of the IMAO school in 2017 on Space Weather, in Côte d'Ivoire, had several objectives the main ones:

13.1 General objective

To reinforce the capacity of young researchers, Master and PhD students , from French speaking countries, from Maghreb and West Africa, in all scientific disciplines concerned with "Space Weather." The sustainability of these schools with a periodicity of two years offers the unique opportunity to bring together young researchers from different countries of the Maghreb and West Africa to forge lasting and fruitful relations within the GIRGEA.

1.3.2 Specific objectives

1- Develop skills in the use of existing data sets and tools to studies of Space Weather.
2- The assimilation of recent data and existing databases.
3- Use of the results of the Space Weather, combining satellite and ground data, for research and sustainable development.
4. Train researchers of international level in Space Weather in Maghreb and West Africa.
5. Promote scientific collaboration between researchers from Maghreb and West Africa.
6. Promote new vocations in Space Physics through general public lectures in secondary and primary schools.
7. Assist in the dissemination of research results in Space Weather.

1.4 Expected Results

At the end of the 3rd edition of IMAO school 2017:

1- Techniques to use available data from many data bases for environmental studies are acquired.
2- A local expertise of the tools necessary for data processing use is developed.
3- The training of scientists and researchers from West African and Maghreb, in order than they can use the results of studies combining environmental science, space Weather and sustainable development
4- Researchers from North and West Africa have acquired high-level scientific knowledge for prediction in Space Weather.

1.5 Methodology

1.5.1 Participants

The courses offered during the school are intended for Master2 students, PhD students and young researchers beginners in Space Physics. For this third edition, there were ~33 listeners (students) including 15 foreign and 18 national. The courses were taught in French by 15 top scientists, including 12 foreigners from Africa and Europe and 3 national.

1.5.2 Dates and location

The school took place from October 16 to 28, 2017 on the site of the University Félix Houphouët-Boigny (Ex-ESIE) at Bingerville.

1.5.3 Program

To achieve the objectives of IMAO 2017, the courses included:

1) A scientific part for understanding measurements and information that can be extracted from the data and sample applications in Space Weather.

2) Lab works through computer internet connections for the direct use of databases like OmniWeb, SPIDR, INTERMAGNET, World Data Center Kyoto, and existing models such as IRI, IGRF, TIE-GCM, etc ...

IMAO 2017 included solar physical processes and their actions on the near Earth environment: magnetosphere, ionosphere and atmosphere.

The following points were detailed:
- Recent discoveries about the sun,
- Impact of the Sun on the ionized Earth's environment,
- Influence of the sun on the earth's atmosphere,
- Use of tools and useful measurements such as GNSS data (GPS, GLONASS, Galileo, etc ...) for navigation, space weather, climate or magnetic field measurements for the study of GIC .

The subjects taught covered the media and physical phenomena involved in solar-terrestrial relations, namely:
1- The Sun;
2- The interplanetary space;
3- The Earth's magnetosphere;
4- The Earth's ionosphere;
5- The Geomagnetism.
6. Impact of solar disturbances on technological infrastructure;
7- Using GNSS data (Global Navigation Satellite System) for the study and forecasting Space Weather

During this school, participants were also encouraged to present their research in oral presentations. This approach allowed the trainers to better understand the scientific profiles of the participants.

1.6 Record of decisions

1) Next school is planned in 2019: Idrissa proposed to host the 4th edition of the school in Senegal. We will have to be fixed if it is possible in March 2018
2) Ahmed proposed to organize the 5th edition of the school in Tunisia in 2021. For information the professor of Ahmed, Hassen Ghalila, confirmed his agreement for the organization of the 5th edition of the school in 2021. He is the ISWI coordinator for Tunisia. (Http://www.iswi-secretariat.org)
3) It was decided to make 10-day schools
4) It was asked to introduce more physics of the atmosphere (Monique proposal)
5) It is desired to introduce an EGNOS-GPS session in relation with ESA (Rolland proposal)
6) The participants asked for the possibility of having new instruments (Christine will talk about it at the next meeting of the Steering Committee ISWI)
7) The name should be changed because now there is West Africa, the Maghreb, Central Africa and East Africa. The name MAOI corresponds to the Maghreb and West Africa.
8) It is emphasized that instruments should be put where there are researchers interested in the measures.
9) It was proposed to give the students a project that they would build during the whole duration of the school. It is necessary that students must be able to work outside of class time with a good internet speed (Jean proposal)

2. Committees

2.1 Honorary Committee

Professor BAKAYOKO Ly Ramata, Minister of Higher Education and Scientific Research, Côte d'Ivoire
Professor Abou Karamoko, President of the University Félix Houphouët Boigny, Côte d'Ivoire
Professor Assamoi Paul, Director of the laboratory of Physic of the Atmosphere , Côte d'Ivoire
Professor EMRAN Anas, Director of CRASTE-LF, Rabat, Morocco

2.2 **Scientific Committee**

President : Pr. Arsène Kobéa Toka
Vice-president : Pr. Christine Amory Mazaudier, Zaourar Naima
Members : Pr. Vafi Doumbia, Pr. Adohi Bibi Jean-Pierre, Pr. Obrou Olivier Kouadio, Dr. Boka, Dr ZAKA, Dr. Méné

2.3 **International Committee**

Christine Amory-Mazaudier, Zaourar Naima, PITOUT Fréderic, Vafi Doumbia, Adohi Bibi Jean-Pierre, Obrou Olivier, Kobéa Arsène, ……

2.4 **Local organizing Committee**

President : Pr. Vafi Doumbia
Vice-president : Pr. Adohi Bibi Jean-Pierre

2.5 Commissions

2.5.1 Commission of finance, logistics, transportation, accommodation and sibsistance.

President : Pr. Obrou Olivier Kouadio
Vice-president : Dr. BOKA Kouadio
Member: Dr Tanoh Koua Serge

2.5.2 Commission of secretariat and communication

President : Dr. Zaka Kobenan
Vice-president : Dr. Méné Médard
Secretary : Coulibaly Soro Ibrahima
Members : Grodji Franck Oswald, Tuo Zié, Zillé, Nguessan Kouassi.

3. TEAM OF PROFESSORS

LOCAL PROFESSORS		
1	DOUMBIA Vafi doumbia.vafi@univ-fhb.edu.ci	Université Félix Houphouet Boigny, UFR-SSMT, Laboratoire de Physique de l'Atmosphère, 22 BP 582 Abidjan 22, Côte d'Ivoire
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3	KONE Tiémoman dg@uvci.edu.ci	Université Virtuelle de Côte d'Ivoire (UVCI).

FOREIGN PROFESSORS		
1	AMORY-MAZAUDIER Christine Christine.amory@lpp.polytechnique.fr	Laboratoire de Physique des Plasmas (LPP) Polytechnique UPMC, 4 place Jussieu 75005, Paris, France
2	ANAD Fatma f_anad@yahoo.fr	Centre de Recherche en Astronomie, Astrophysique et Géophysique. CRAAG. Route de l'Observatoire. BP 63, Bouzareah, Alger Algérie
3	BERTHOMMIER Matthieu Matthieu.berthomier@lpp.polytechnique.fr	Laboratoire de Physique des Plasmas (LPP) Polytechnique UPMC, 4 place Jussieu
4	EMRAN Anas + HAKDAOUI Sofia emran@israbat.ac.ma	Institut Scientifique, Université Mohammed V-Agdal Coordinateur CRASTE-LF affilié à l'ONU 1 Avenue Ibn Sina, Agdal, Rabat, Maroc
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9	YAHIAT Yasmina yasminayahiat@yahoo.fr	Laboratoire de Géophysique, FSTGAT /USTHB, BP 32 El Alia, Bab- Ezzouar 16111 Algérie
10	ZAOURAR Naima naimaboulasba@gmail.com	Laboratoire de Géophysique, FSTGAT /USTHB, BP 32 El Alia Bab- Ezzouar 16111 Algérie
PARTICIPANT /FOREIGN PROFESSORS		
11.	AMMAR Ahmed ahmed.ammar@fst.utm.tn	Faculté des Sciences de Tunis, Université de Tunis, El Manar, Tunisie
12.	ZERBO Jean-Louis jeanlouis.zerbo@gmail.com	Université NAZI BONI de Bobo-Dioulasso (UPB) Burkina Faso

4. SCHEDULE

Week 1

Hour	Monday 16	Tuesday 17	Wednesday 18	Thursday 19	Friday 20	Saturday 21
08h00-09h00			4 dynamos			
09h-10h00		Sun	Magnetosphere	Sun	External Earth's Magnetic field	Magnetosphere P W
10h-10h30	Opening Ceremony	Sun	Magnetosphere	Sun	External Earth's Magnetic field	Magnetosphere PW
10h30-11h	pause	pause	pause	pause	pause	pause
11h-11h45	Intro : 4 dynamos	network Wacren	S un	Magnetosphere	GPS ionosphere	Sun -PW
11h45-12h30	Intro : 4 dynamos	Network Wacren	Sun	Magnetosphere	GPS ionosphere	Sun -PW
12h30-14h	meal	meal	meal	meal Student presentation	meal Student presentation	meal
14h-14h45	Lecture Informatic		Python-PW	Sun	GPS ionosphere-PW	Sun-geomagnetism
14h45-15h30	idem	Sun -PW	Phyton-PW	Sun	GPS Ionosphere-PW	Sun-geomagnetism
15h30-16h	pause	pause	pause	pause	pause	pause
16h-16h45	PW administration	Sun -PW	Magnétosphère PW	Magnetosphere	student presentation	
16h45-17h30	PW administration	Soleil-PW	Magnétosphère PW	Magnetosphere	student presentation	student presentation
Poster				Session Poster	Session Poster	

Week 2

Hours	Monday 23	Tuesday 24	Wednesday 25	JThursday 26	Friday 27	Saturday 28
9h-9h45	GPS ionosphere	Auroral ionosphere	Electrodynamics equator	Auroral ionosphere	Coupling high and low latitudes	Internal Field PW
9h45-10h30	GPS ionosphere	Auroral ionosphere	Electrodynamics equator	Auroral ionosphere	Coupling high and low latitudes	Internal Fiels PW
10h30-11h	pause	pause	pause	pause	pause	pause
11h-11h45	Auroral ionosphere	Internal Fiels	External magnetic field Sr/Sq	GPS ionosphere	Atmospheric emissions	Results of the GIRGEA
11h45-12h30	Auroral ionosphere	Internal Field	External magnetic field Sr/Sq	GPS ionosphere	Atmospheric emissions	Closing Ceremony
12h30-14h	meal student presentation	meal student presentation	meal student presentation	meal student presentation	meal student presentation	meal
14h-14h45	GPS ionosphere PW	SIG	Sun to the Earth PW	GPS ionosphère PW	GPS ionosphere PW	
14h45-15h30	GPS ionosphere PW	SIG	Sun to the Earth PW	GPS ionosphere PW	GPS ionosphere PW	
15h30-16h	pause	pause	pause	pause	pause	
16h-16h45	Auroral ionosphere PW	SIG-TP	External magnetic field Sr/Sq PW	Auroral ionosphere PW	Philosophy of Science	
16h45-17h30	Auroral ionosphere PW	SIG-PW	External magnetic field Sr/Sq PW	Auroral ionosphere PW	Philosophy of Science	

[PW : Practical work]

5. TRAINING

Lesson Plan Le Soleil - Karl-Ludwig Klein
4 classes: 6h, 2 lessons 3h

Course n° 1: 1h30

The Sun: from the heart to the solar wind
Internal structure
• Generation and radiative transport of energy
• Convection
The solar atmosphere
• Some illustrative observations: photosphere, chromosphere, crown
• Temperature profile
• Abundances and ionization states
• Hydrostatic models of the solar atmosphere
The solar wind
• Limitations of the hydrostatic model of the crown
• Hydrodynamic description of the solar wind
• Observations

Course n ° 2: 1h30

The Sun: magnetic field
Observational Manifestations and Plasma Interaction
• Observations in the photosphere: sunspots and Zeeman effect
• Structuration of the magnetic field by the movements of the gas in and below the photosphere
• Structure of the crown by the magnetic field
• The solar wind magnetic field: Parker model
• Structuring of the interplanetary medium
Photosphere-chromosphere-crown coupling, solar atmosphere heating process

TP n ° 1: 1h30

Crown and solar wind

Course 3: 1h30

The Sun: eruptive activity and high energy particles
What is a solar flare?
• Observations: EUV, X, gamma, radio, visible
• GOES classification of the importance of eruptions: classes A, B, C, M, X
• Source of energy, energy storage in the crown
• Explosive conversion of energy in a scalable magnetic configuration - notion of magnetic reconnection
• Thermal radiation: X soft, EUV
• Acceleration of particles, hard X-emissions, gamma, radio
What is a coronal mass ejection (CME)?
• Coronographic observations
• Twisted flow tubes, their stability, their destabilization
• Propagation in the crown and interplanetary medium, kinematic
• MHD shock waves

Solar particles of high energy
• Observations in the interplanetary space
• Qualitative view of particle acceleration processes

TP n ° 2: 1h30

Eruptive activity of the Sun: X-radiation and associated observations, high-energy particles

Course n° 4: 1h30

The Sun: the activity and its cycles

Cycle (s) of solar activity
• Global measurements of solar activity: index of spots, radio flux 10.7 cm ...
• The cycle of the spots
• Cosmic radiation and the long-term evolution of solar activity

The global magnetic field of the Sun and its evolution
• The global magnetic field: morphology of the crown, magnetic structure of the active regions
• Evolution during the activity cycle
• Dynamo effect and magnetic flux transport

An overview of the statistics of eruptive events - space weather and extreme events

TP n ° 3: 1h30

Solar activity cycles and extreme events

Course Earth magnetosphere - Matthieu Berthommier
3 classes: 4h30, 2 lessons: 3h

The course is divided into 3 parts.

Part I: Introduction to plasma physics

The objective of this introductory course is to present notions of plasma physics necessary to understand the description of the terrestrial magnetosphere that will follow.
1. What is a plasma?
2. How to describe plasmas?
3. The dynamics of charged particles
4. The waves in the magnetosphere
5. The wave-particle interactions

Part II: The structure of the magnetosphere

The objective of this course is to present the global morphology of the terrestrial magnetosphere, the physical origin and the nature of the different regions that compose it.
1. Upstream shock and magnetomain
2. Magnetopause and the open magnetosphere model
3. Magnetospheric convection
4. The magnetic tail
5. The internal magnetosphere

Part III: Magnetospheric Dynamics

The objective of this course is to present the various dynamic modes of operation of the terrestrial magnetosphere in order to know how to identify them in a set of data.

1. Magnetospheric pulsations
2. Magnetospheric storms
3. Dynamics of radiation belts
4. Magnetospheric substorms

Course of Jean Lilensten
3 classes: 4h30, 2 lessons: 3h
Philosophy of Science: 1h30

• the atmosphere: a simple approach
– Description of the upper atmosphere.
– Presentation of the absorption cross sections
– Demo (on the blackboard) of the hydrostatic equilibrium and the scale height. Typical values
– Demo (same) of the absorption law (Beer Lambert approach)
– The Chapman layers
– Limitations of this approach

• Kinetic and fluid theory
– The kinetic theory (demo on the board too)
– Presentation of the impact cross sections
– Presentation of the collision frequency concept
– Presentation of the true upper atmosphere layers (production, heating rate)
– De-excitation processes and airglow, including auroras
– Fluid mechanics (blackboard)
– From Production / Heating to Densities / Temperatures
• the atmosphere : more
– Presentation of the true upper atmosphere layers (densities, temperature) and its variability
– Presentation of the TEC

• Space weather: from the theory to applications
- Effects on the spacecrafts
- Effects on the telecommunications
- GIC's
- Global positionning
- Space debris
- Space weather and Earth climate
- Other effects (rocket launches, pipelines, space object reentry, biological effects, tourism, insurance companies, militaries...)

•Organization of space weather
- The predictions and the predicting centers
- Where to find the informations?
- The different space weather networks
- The journals dealing with space weather
- The future of space weather
- How to be involved?

Course of Rolland Fleury
3 classes: 4h30, 4 lessons: 6h

GPS and ionosphere

Practical work, single-station VTEC calculation from pseudo-range measurements, Matlab software support 1 developed

Calculation of the regional CET based on phase measurements, 1 Matlab software developed + exploitation of GIM / CODG cards, support 1 Matlab software developed

calculation of the Roti index from a daily rinex file and relations with equatorial scintillation, support 1 Matlab software developed

Course of Naima Zaourar
2 classes: 1h30, 1 TP: 1h30

Course 1: External Earth Magnetic Field

1. Solar-magnetosphere-ionosphere interaction
   1.1 Dynamo solar wind-magnetosphere: magnetospheric field
      -Topology of magnetospheric currents
   1.2 The electric currents in the ionosphere: ionospheric field

2. Variations of the Earth's magnetic field (CMT)
   2.1 Diurnal and annual variations: ionospheric electric currents
      - Periodicity: day / night modulation and seasonal modulation
      -Mari Regular CMV Variations
   2.2 Irregular variations: Impact of solar events
      - solar flares,
      - coronal mass ejections,
      solar sunglasses from coronal holes
2.3 Impulsive phenomena
   - magnetic storms
   - magnetic storms

3. Magnetic indices

Course 2: Fractal Analysis of Geophysical Signals. Application to magnetospheric-ionospheric time series

1. Problematic
The fractal dynamics of geophysical signals
Solar Activity - Magnetosphere
Solar activity-ionosphere
Ionospheric telluric activities

2. Methodology: Invariance of scale process
Procedure for describing complex structure signals
Multi-scale analysis of geophysical signal fluctuations
Continuous Wavelet Transform (TOC) and Scaling Process

3.Objectifs
-Discover the complex dynamics of magnetospheric-ionospheric signatures
- Establishment of a prediction index in the approach of major events

Course of Yasmina Yahiat
1 class: 1h30, 1 TP: 1h30

Historicy
Geomagnetic field measurements
Presentation of the Earth's magnetic field
Internal field
- Core field
- lithospheric field

Spatio-temporal variations of the field:
- Analysis of the temporal evolution of the components of the field in different positions
- magnetic jitter detection

Mathematical representation of the Earth's magnetic field
- Decomposition of the potential in spherical harmonics
- Energy spectrum of the internal field
- Modeling in spherical harmonics

Global modeling of the geomagnetic field
- Presentation of different field models:
IGRF, GRIMM, CHAOS, CM4 and CM5.

Applications:
- Model GRIMM3: Calculation and analysis of geomagnetic field residues from CHAMP satellite data
-Model CM4: Modeling of the different sources of the geomagnetic field and study of the temporal evolution of the field of each source over a given period in different positions.

Course of Fatma Anad
1 class: 1h30, 1TP: 1h30

- The different magnetic measurements
- Determination of the zero level (baseline) from observatory data.
- The different methods of determination of Sq
- The methods of determining the focus of the Sq system,

the Practical work focus on the calculation of Sq: using the method of Price and the Hibberd1-Determination of the different components (internal and ionospheric) of the CMT from the CM4 model

Course of Vafi Doumbia
1 class: 1h30

The conductivities of the ionosphere
1. densities of neutral and charged particles in the ionosphere
2. the forces acting on the electrons and ions
3. movements of electrons and ions in the presence of an electric field
4. Ohm's Law: Direct Components, Pedersen and Hall of Conductivity
5. variation of conductivity components as a function of altitude
6. variation of conductivity according to local time, season and solar cycle

The dynamo ionospheric mechanism
1. Maxwell's equations
2. Electrostatic electric field assumption
3. DC assumption
4. electric field in the moving gas mark
5. generation of the polarization field

The equatorial electrojet
1. establishment of the vertical electric polarization field
2. electric current of the electrojet
3. magnetic disturbances associated with the electrojet
4. influence of plasma irregularities on the polarization field and on the current
5. two-dimensional model of electrojet
6. influence of a constant east-west wind on the electrojet
7. influence of an east-west wind, variable in altitude, on the electrojet

The telluric currents / effect of a 'Solar Flare'

Course of Jean-Louis Zerbo
1 class: 1h30

Legrand and Simon's classification on solar activity and geomagnetism

Course of Christine Amory-Mazaudier
2 classes: 3h
Administration workshop: 2h

The dynamo process in the Terre Soleil system
4 big dynamos: Introduction to the school

Course of Arsène Kobéa
1 class: 1h30

Magnetosphere-Ionosphere coupling: case of the direct penetration of the electric convection field .... ".

Course of Monique Petitdidier
1 class: 1h30
1 lecture on the evolution of computer science: 1h

Course: Atmospheric emissions at night

At night, except during the solar minimum of Maunder, 1645-1715, in the northern countries people used to see scroll in the sky green and red structures, called Aurora. It was only at the beginning of the 20th century during astronomers' project on the counting of stars that atomic and molecular emissions in the mid-latitude sky were detected. There followed studies according to the latitude, longitude and the solar cycle ...
The first presentation starts with a short historical presentation of this discovery, it is an example of how from a discovery the research was conducted. In order to interpret the observations, a base of spectroscopy and chemistry which concern these emissions is introduced. At night it is through chemical reactions that the atoms and molecules are brought to an energy level above the base level, after which they are de-excited by collision and emission of a line or of a "band" of lines - cases of molecules. To finish this part a list of the principal atmospheric emissions (green and red line of the atomic oxygen, the doublet of the Sodium, the spectrum of OH and O2 ...) is given with their characteristics.
The second presentation deals with atmospheric emissions, tracers of the state of the atmosphere, dynamics, temperature ... How to interpret their variations in time, latitude, longitude? Depending on its emission altitude and latitude each emission will be examined to determine which parameters can be deduced from its observation and interpretation limitations. More particularly, the oxygen O (green and red stripe), and OH emissions will be examined. The spectrum and structure of the aurora will also be discussed.

Course of Tiémoman Koné
1 class: 1h30

Connectivity & WACREN initiative

Course of Emran Anas and Sofia on Geographic Information Systems
1 class: 1h30, 1 TP: 1h30

1. Theoretical aspects

• Introduction to GIS: definitions, methodological approaches, modeling and structuring of spatial data;
• Concept of coordinate system in GIS and GPS
• Some examples of GIS editing from GPS

2. Tutorials

• Getting started with QGIS software / Getting Started with GPS
• Data imports into the database manager of a GIS
• Generate maps from GPS data and overlay or join with already existing layers
• Using a Raster image in a GIS (Geo referencing, photo interpretation)
• Spatial query, Geostatic analysis
• GIS and internet

Ahmed Ammar
TP: 1h30

Using Python

6. PARTICIPANTS

6.1 List of the participants

School on Space Weather - Abidjan[16-28 October 2017] list of non-Ivorian participants	
Algeria (4)	MAZARI Anis anissmazari@gmail.com HAMMOU Omar hammou201147@gmail.com BELKHEIR Ali " belkheirali19@gmail.com BOUDRA Abderrahim " boudraabderrahim624@gmail.com
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Senegal (1)	Idrissa GAYE idrissagaye3@hotmail.com
Guinea Conakry (1)	René Tato LOUA lrenetatometeo@gmail.com
RDC (2)	KAHINDO MURUMBA Bruno bkahindo@gmail.com YOMBO PHAKA Rodriguez rodriguez2yombo@gmail.com
RC(1)	NSONGA Julor Roselin njulorroselin@yahoo.fr
Rwanda (1)	BOB Lionel boblionel1@gmail.com
Tunisia (1)	AMMAR Ahmed ahmed.ammar@fst.utm.tn

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6.2 Participant presentations

	Time	Name	Titles of the presentations
1	19 October 17 13h40	COULIBALY SORO Ibrahim	Ionosphere response to the storm of September 1999 From 22 to 26
2	20 October 13h40	AMMAR Ahmed	Studies of ionospheric disturbances through VLF waves
3	20 October 13h50	GRODJI Franck	Study of the equatorial electrojet from the electrodynamic parameters of the equatorial ionosphere
4	20 October 16h40	LOUFTI Amal	The impact of extreme solar events on the Earth's upper atmosphere
5	20 October 16h50	ELBOUYAHYAOUI Khaoula	Impact of solar events on the ionosphere between 2014-2016
6	20 October 17h00	DIABY Kassamba Abdel Aziz	Comparative studies of vertical drift from ionospheric and magnetic data
7	20 October 17h10	HAMMOU Ali	Study of variations of the ionosphere from GPS data
8	20 October 17h20	YOMBO Rodriguez	Implementation and installation of a computer-assisted air pollution measurement system
9	23 October 13h40	BOUDRA Abderrahim	Impact of kinetic transport on diurnal variations at high and medium latitudes
10	23 October 13h50	BELKHEIR Ali	Study of the ionic and electronic productions at medium and high altitude according to the solar activity
11	24 October 13h40	AHOUA MALAN Sylvain	Evaluation of the NeQUICK model by the data ingestion method
12	24 October 13h50	NSONGA Roselin	Study of the variability of the TEC in the intertropical zone
13	25 October 13h40	ACKAH Jean-Baptiste	Study of the variations of the ionospheric scintillation and the TEC during eruptive solar phenomena, in equatorial zone
14	25 October 13h50	MESSANGA ETOUNDI Honoré	Measurement and interpretation of the regular variation of the horizontal component of the magnetic field in Yaounde
15	26 October 13h40	MAZARI Aniss	Estimation of the drift of the equatorial ionosphere from the variation of the Earth's magnetic field
16	26 October 13h50	LOUA René Tato	Variability and change of thermal and dynamic structures by observations (satellite soil) and numerical modeling Troposphere-Atmosphere Interaction
17	26 October 14h00	TUO Zié	Spatio-temporal variability of the equatorial electrojet from the magnetic data of the CHAMP satellite
18	26 October 17 14h10	KOUASSI N'Guessan	Electromagnetic induction associated with eruptive solar events at low latitudes
19	27 October 13h40	GAYE Idrissa	Study of the influence of irradiation on semiconductor materials: case of silicon
20	27 October 13h50	KAHINDO MURUMBA Bruno	Contribution to the study of the ionosphere at the southern crest of the equatorial anomaly

7- BUDGET

7.1 Accommodation, catering and transport

Designation	Amount (CFA)	Amount (Euro)
Restoration	1 760 000 F	2683,97 €
Meal at the hotel	213 750 F	325.83€
Transportation (Fuel + per diem driver)	410 000 F	625,04 €
Accommodation Students	394 000 F	600,65 €
Accessory Accommodation Students	116 000 F	176,84 €
Accommodation Professors	2 060 000 F	3140,45 €
Logistics (Signs, badges, paper)	45 000 F	68,60 €
Management costs of ICTP funds	163 989 F	250,00 €
Logistics (Batteries, honorary boy, room cleaning)	34 000 F	51,83 €
Total	**5 033 320 F**	**7677,82 €**

Contributions	Amount F	affectation
UVCI/ General Manager	380 000 F	Transport
ANDE/ General Manager	500 000 F	Restoration
UFHB/Rooms ex-ESIE	394 000 F	Student hosting ex-ESIE
GIRGEA local	116 000 F	Student accommodation accessories
CRASTE-LF	80 000 F	Accommodation of Moroccan teachers
GIRGEA local	1 260 570 F	Restoration
GIRGEA local	1 980 000 F	Accommodation of teachers
GIRGEA Local	30 000 F	Transport
GIRGEA Local	79 000 F	Logistics
Teachers of the school	213 750 F	Meal at the hotel
total	**5 033 320**	

7.2 Cost of airline tickets

	Name	Country	Cost of Ticket Currency of the Purchase	EUROS + Sponsors
1	ZERBO	Burkina Faso	331 000 Fr CFA	504,57 -ICTP
2	NSONGA	RC	481000 Fr CFA	733,23-ICTP
3	AMMAR	Tunisia	1150 Dinar Tu	264,5-STO-Tunisia
4	HAMMOU	Algeria	58160 Dinar Alg	432,35- Hammou
5	BOUDRA	Algeria	45000 Dinar ALg	334,52- Boudra
6	MAZARI Anis	Algeria	45156 Dinar Alg	335,68- CRAAG-Algeria
7	KAHINDO	RDC		687 -SCOSTEP
8	LOUFTI	Maroc	11940 Dirham	1074,6- Uni. Marrakech
9	ETOUNDI	Cameroon		494.63- SCOSTEP
10	YOMBO	RDC		724- ICTP
11	TATO LOUA	Guinea Conakry	530 dollars	449,15- SCOSTEP
12	GAYE	Senegal	276 400 Fr CFA	421,34 - ICTP
13	ELBOUYAHYAOUI	Morocco		499 -SCOSTEP
14	BELKEIR	Algeria	45000 Dinar Alg	334,52 - Belkeir
15	KABORE	Burkina Faso	284 200 Fr CFA	433,23 - Kabore
total				**7722,32 €**

	Name	country	Cost of Ticket Currency of the Purchase	EUROS + Sponsors
1	ZAOURAR	Algeria	45000 Dinars	334,52 - CRASTE-LF
2	ANAD	Algeria	45 000 Dinars	334,52 - CRAAG-Algeria
3	YAHIAT	Algeria	45000 Dinars	334,52 - GIRGEA
4	AMORY	France		518.64 - GIRGEA
5	PETITDIDIER	France		518.64 -GIRGEA
6	KLEIN	France		720 - ESTER
7	BERTHOMMIER	France		722 - LPP
8	LILENSTEN	France	460 000 Fr CFA	701,21 - UVCI
9	EMRAN	Morocco		0 other school
10	FLEURY	Morocco		641,93 – ENST Bretagne
11	HAKDAOUI	Morocco		0 other school
total				**4825,98 €**

Total ticket : 12548,3€ / Cost of visas ((58€ x3) + (73€ x3) + 127€ +120€ + (26€ x7) =822€
Total ticket + visa =13370,3€
Contributions: pink : ICTP/international , blue: SCOSTEP/international, orange : CRASTE-LF/international
yellow : participant/country, green : Côte d'Ivoire

ICTP: 2500 € including 250 € used for management fees by Houphouët Boigny University
SCOSTEP: 1800 €
These sums brought 8 non-Ivorian students

Total amount : 21 048,12€, is 13 806 660 FCFA (XOF).

8- LOGISTIC :

The Bingerville site where the school was held

The class room

Practical work

Coffee break

Transportation: a bus with a driver available throughout the school

Meals were taken at the Bingerville site

the delivered certificates

CERTIFICAT DE Formateur

Décerné à

ZAOURAR NAÏMA

Pour avoir participé à la

3ème édition

ECOLE DE METEOROLOGIE DE L'ESPACE

ISWI-MAGHREB-AFRIQUE DE L'OUEST (IMAO 2017)

UFHB, Campus de Bingerville, Abidjan, Côte d'Ivoire

Pr. KOBEA T. ARSENE
Président du Comité Scientifique

Pr. VAFI DOUMBIA
Président du Comité d'organisation

CERTIFICAT DE FORMATION

Décerné à

AHOUA MALAN SYLVAIN

Pour avoir participé à la

3ème édition

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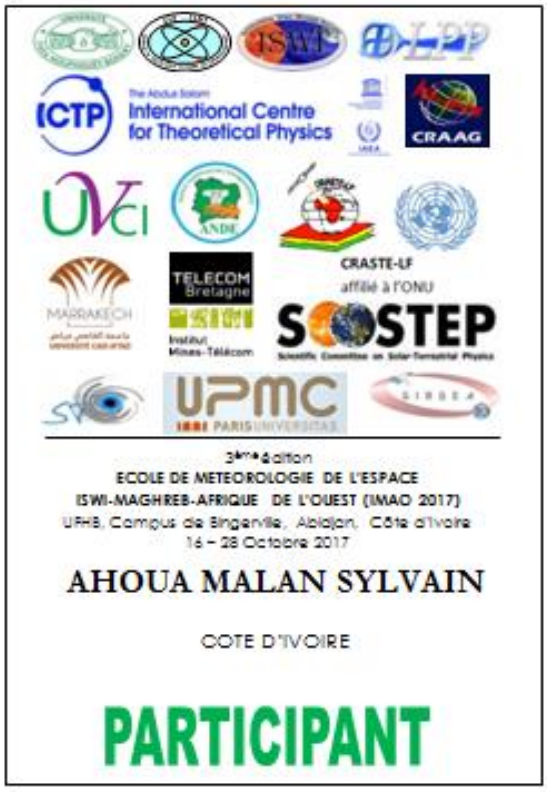
Président du Comité d'organisation

The badges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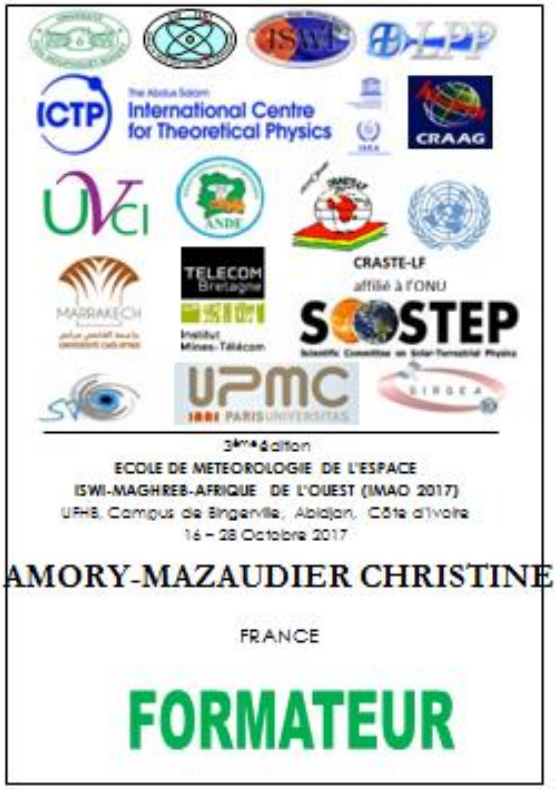
16 – 28 Octobre 2017
AHOUA MALAN SYLVAIN
COTE D'IVOIRE
PARTICIPANT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AMORY-MAZAUDIER CHRISTINE
FRANCE
FORMATEUR


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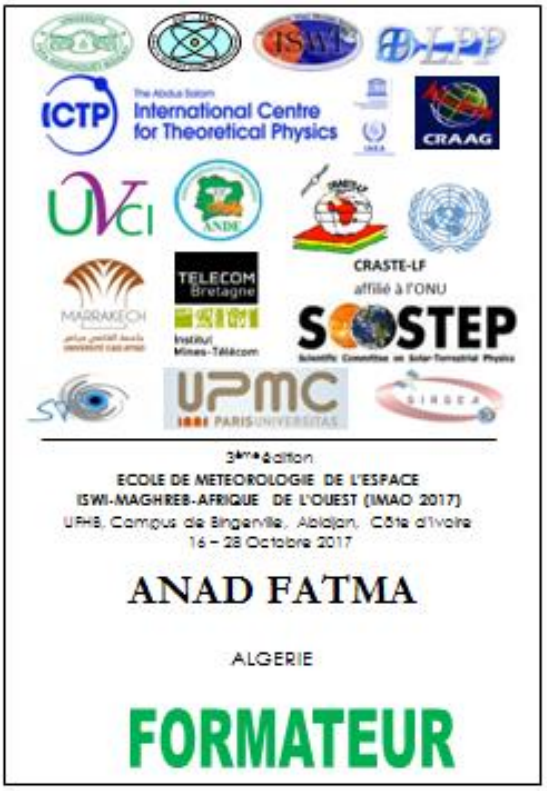
ZAKA KOBENAN ZACHARIE
COTE D'IVOIRE
PARTICIPANT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ANAD FATMA
ALGERIE
FORMATEUR