REPORT - SUMMER SPACE WEATHER SCHOOL
Physics and use of tools 17-28 October 2022,
Houphouët Boigny University, Abidjan, Côte d'Ivoire
2022

- ✓ Centenary of the discovery of the Equatorial Electrojet
- ✓ Thirty years of the International Year of the Equatorial Electrojet hé

Group photo of school

Editorial committee of GIRGEA

Organized by

The Ivorian Society of Physics (SIPhys), the Laboratory of Matter and Solar Energy Sciences (LASMES), UFR-SSMT, Félix Houphouet Boigny University

With the support of

International Space Weather Initiative (ISWI)
ICG (International Commission of GNSS)

Under

the High Patronage of Mr. Minister of Higher Education and Scientific Research
Professor Adama DIAWARA

Summary

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PITOUT Frédéric (IRAP / France)

SOULA Serge (Paul Sabatier University / France)

ZERBO Jean Louis (University Nazi BONI / Burkina Faso)

II. INTRODUCTION

As part of the international ISWI (International Space Weather Initiative) project, in collaboration with GIRGEA, the 5th MAOI school (ISWI Maghreb Africa West) will be organized at Houphouët Boigny University in Abidjan, in October 2022.

The main objective of this school is to improve the level of expertise of students in the sub-region to enable them to participate and contribute to international projects. The two key points are:

1) competence to use already existing datasets and tools relating to studies of the terrestrial environment; there are a lot of environmental and geophysical data. The use of existing data is estimated to be less than 10%. These data, using new technologies, knowledge of physical phenomena, various models, are the source of original scientific work.

2) The development and use, by scientists from the Maghreb and West Africa, of the results of studies combining environmental sciences and sustainable development by combining ground data with satellite data - for example: geophysical studies, telecommunications, positioning etc ...

To achieve these objectives the courses will include:

1) A scientific part for understanding the measurements, information that can be extracted from the data and examples of applications in different fields.

2) A computer part on the algorithms used, their performance, and their installation.

3) Practical computer work for the use of algorithms and ground and satellite databases.

4) The use of models like TIEGCM, CTPIM, IRI, NeQuick, IGRF.

5) Information presentations on new technologies used in this field such as Grid, Web services, databases

To achieve these goals, we offer a school to discover and use:

1) All the possibilities of measurements of the ground network of GNSS stations, radar and other instruments located in Africa and in the world, as well as the measurements available via the internet:
    a. Studies of the ionosphere and the impact of the Sun on the earth's ionized environment (International Year of the Heliosphere and ISWI project);
    b. Exploit other instruments for development.
2) Geographic information systems that allow the management and visualization of spatial data in all areas.
3) 3) The development of local databases and the use of existing databases via the internet and an introduction to new technologies.

The purpose of this school is to develop data analysis in Africa and thus make many existing projects profitable (IHY: *International Heliophysical Year*, ISWI: *International Space Weather Initiative,* etc.).

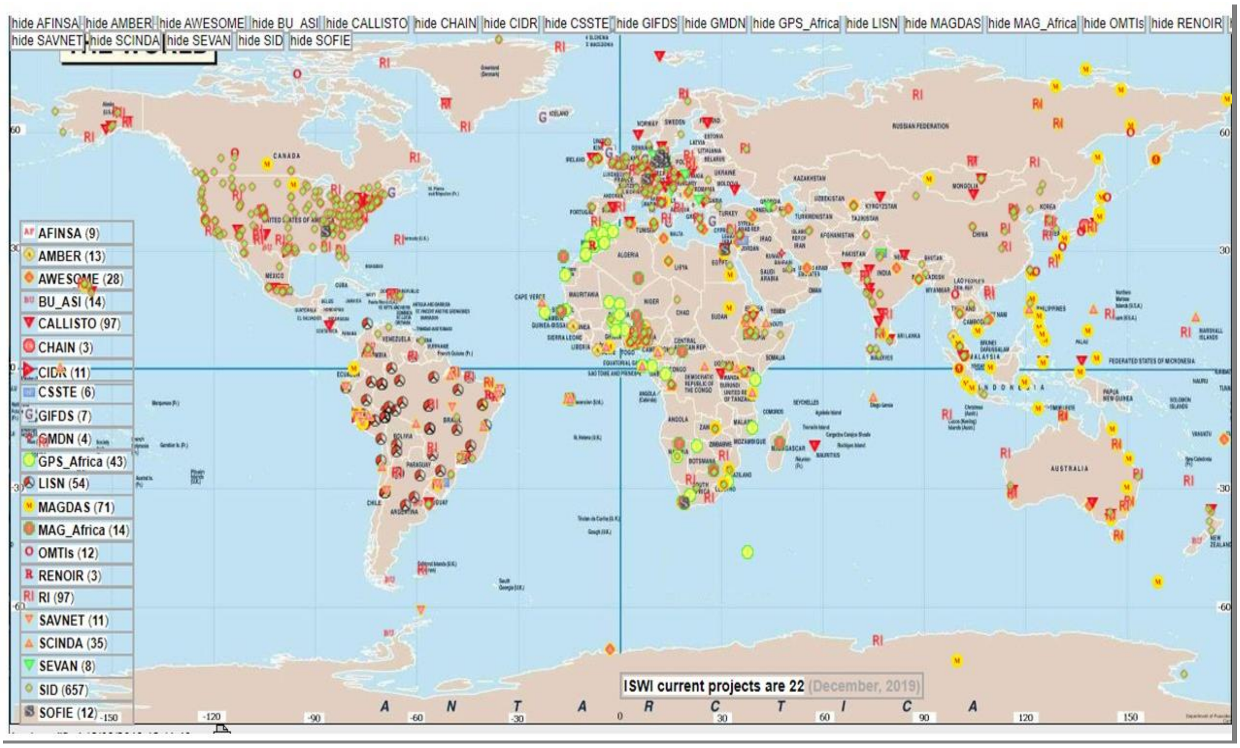
It will also offer an opportunity to researchers and scientists from the Maghreb and West Africa who wish to learn or acquire the skills to use the already existing datasets and the tools relating to Space Meteorology studies, to participate and contribute to international projects.

The IMAO schools also bring together young researchers from different countries to forge lasting and fruitful collaborative relationships.

III. MOTIVATIONS

1. Instrument networks in Africa and around the world

After the project "International Heliophysical Year 2007-2009, the International Space Weather Initiative ISWI program (2010-2012) continued the development of instrument networks on the African continent and in the world and in particular networks of GNSS stations, magnetometers, radars, etc…. (See figure below from the site http://www.iswi-secretariat.org.)



GIRGEA (International Group for Research in Geophysics Europe Africa www.girgea.org) present in Africa for more than 30 years has developed research teams in different countries in Africa (Côte d'Ivoire, Burkina Faso, Algeria, Egypt, Morocco, DRC…) and in Asia (Vietnam, Nepal, Pakistan).

In tropical and equatorial zones, it is necessary to know the contributions of the ionosphere (*ionized layer surrounding the earth and located between 90 and 1000 km*) and the atmosphere to the GNSS signal for many and various applications, because the crossing of these two media disturbs the received signals.
This school will focus on GPS applications to study the impact of the sun on the ionized layers of the atmosphere.

The adoption of information and communication technologies (ICTs) and access to the Internet are booming in Africa, but due to their rapid growth all over the world, the digital divide between Africa and the rest of the world persists. It is also important to inform and train scientists and students on databases (creation and use of existing ones), monitoring of the Internet network in order to verify its evolution, and access to computers and the grid calculation to enable them to exploit their data, run their simulations, and collaborate with teams from all over the world.

2. Training: SPACE WEATHER SCHOOL

GIRGEA has already organized schools in Côte d'Ivoire (1995, 2017), Republic of Congo (2009), Egypt (2010), DRC (2011), Algeria (2013), Morocco (2010, 2014, 2015), Senegal (2019). All the reports of the preceding schools are on the website www.girgea.org.

The schools aim to:
1) to introduce students to Sun-Earth relations and Space Meteorology with specialists from different disciplines (physics of the Sun, solar wind, magnetosphere, ionosphere, troposphere and internal and external magnetic field),
2) to analyze the existing data in these different disciplines using digital tools, computing grid, data server, internet, intensive computing resources,
3) to develop student scientific mini projects on a given event,
4) to learn the management of a project, the progress of theses and scientific publications, participate in national or international calls for tenders,
5) to promote exchange and cooperation between students of different nationalities,
6) to publish in refereed journals despite the cost which is sometimes difficult to find.

3. . The Project

The school caters to 40 participants from universities in West Africa and the Maghreb. Successful participants must already have basic computer skills and databases.
This school aims to allow participants to:
• Master the handling of GPS and the collection of information in the field,
• Master the use of GPS data according to their area of expertise and possible applications,
• Initiation to cartography and mastery of basic and advanced GIS functionalities with various standard software,
• Promote synergy between GIS and GPS.

At the end of this training, participants should be able to:

<u>For Space Weather</u>
• Thoroughly analyze solar activity and its consequences on the earth's environment and related systems.

<u>For GNSS</u>
• Know how to use a GPS (different functions of the instrument, installation);
• Quantify the various errors in positioning accuracy and analyze correction systems of the local differential GNSS type or by geostationary satellite,
• Know how to use measurements on the ground or on board satellites / probes for morphological studies of the atmosphere, ionosphere and geodesy,
• Analyze the various existing satellite navigation systems and their evolutions,
• Know the different fields of application.

<u>For GIS</u>
• Establish a geographic database (opening and creation of layers, scanning, digitization, structuring and organization of geographic data, modification or deletion of graphic objects, change of coordinates and manipulation of projection systems, geo-referencing, integration of points GPS in an existing base map),

• Carry out thematic and spatial analyzes (cartographic restitution),
• Know the equivalences between software (principles and terminology).

For GPS and GIS
• Know how to take charge of, recording, identification, storage, search for coordinates of points in the field, report of points, etc…;
• Know the interesting databases in the various fields covered,
• Know how to collect field data from a GPS and transfer them to a GIS,

For new technologies
• Know the calculation resources available and the underlying techniques,
• Know how to create databases and the portals to access them,
• Have technical support for network monitoring,
• Participate and collaborate in the global effort of new technologies.

Practical applications should be based on varied thematic data and relate to areas of national interest.
An analysis of the targeted needs of participants and their level will be made as soon as registration opens.
We recommend that registered students bring their laptop. The content of the various courses is generally provided at the end of each session. Participants will be master's students, theses and academic staff or other organizations requiring an upgrade in their training.

The next school will be organized in 2024, several host countries have been chosen: Algeria, Benin, DRC, Tunisia.

IV. CLASSES

IV.1 Course plan: the sun – Karl-Ludwig Klein
[Ludwig.klein@obspm.fr]
4 classes: 6h, 2 TP 3h

Lesson 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, corona
- Temperature profile
- Abundances and ionization states
- Hydrostatic models of the solar atmosphere

The solar wind

- Limits of the hydrostatic model of the crown
- Hydrodynamic description of the solar wind
- Comments

Lesson n°2: 1h30

The Sun: magnetic field

Observational manifestations and interaction with plasma

- Observations in the photosphere: sunspots and the Zeeman effect
- Structuring of the magnetic field by the movements of gas in and below the photosphere
- Structuring of the crown by the magnetic field
- The magnetic field of the solar wind: Parker's model
- Structuring of the interplanetary medium`

Photosphere-chromosphere-corona coupling, solar atmosphere heating process

Lesson n°3: 1h30

The Sun: eruptive activity and high energy particles

- Solar flares
- Overview of energy storage and dissipation processes
- Coronal Mass Ejections (“CMEs”)
- High energy particles

Lesson n°4: 1h30

The Sun: cycle(s) of activity

- Cycle of activity: sunspot index, F10.7, corona shape, heliospheric magnetic field
- Variation of long-term solar activity
- Active regions and global magnetic field of the Sun
- A qualitative overview of a dynamo mechanism (Babcock-Leighton)

Practical work n°1: 1h30

Corona and solar wind

The Sun: studying the origin of the fast solar wind by comparing in situ measurements with images of the solar corona

- Solar wind data sources (here in particular ACE) and solar corona images
- Plot (with website tools) the density and speed of the solar wind, 9-16/04/2016
- Identify a fast solar wind current
- Estimate the travel time of this current between the Sun and the satellite
- Examine the image of the solar corona in EUV around the moment of departure of the plasma from the Sun, identify the structure of origin of the fast solar wind
- Examine the evolution of proton density around the arrival of the fast solar wind at ACE
- Examine a broader time frame of ACE to identify the recurrence of fast solar wind
- Calculate the departure to the Sun for one of these dates
- Examine the image of the corona and confirm the identification of the structure emitting the fast solar wind.

Practical work n°2: 1h30

The Sun: coronal mass ejections

- How to measure their speed? The speed measured in the images is a projection on the plane of the sky
- Geometry of heliographic coordinates. Angle of inclination of the Sun's axis of rotation on the ecliptic.
- Presentation of a simple 3D geometric model ("cone model"), relation between the speed in the plane of the sky and the 3D speed.
- Application to a case: from velocity in the plane of the sky (catalogue) to 3D estimation

IV.2 Course plan: Terrestrial magnetosphere – Olivier Le Contel
[olivier.lecontel@lpp.polytechnique.fr]

3 lessons: 4h30, 2 practical works: 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 for understanding the description of the Earth's magnetosphere that will follow.
1. What is a plasma?
2. How to describe plasmas?
3. The dynamics of charged particles

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. Some notions on the solar wind
2. The upstream shock and the magnetosheath
3. The magnetopause
4. Magnetospheric convection
5. High latitude currents and regions
6. The internal magnetosphere

Part III: Magnetospheric dynamics
The objective of this course is to present the different dynamic modes of operation of the Earth's magnetosphere in order to know how to identify them in a data set.
1. Magnetospheric substorms
2. Magnetic storms

PW 1&2 – Installations (Linux and Windows) and use of the free access pyspedas (python) library (https://github.com/spedas/pyspedas) for the visualization and analysis of spatial and ground data relating to meteorology from space.

IV.3 Frédéric Pitout course plan
[frederic.pitout@irap.omp.eu]
2 lessons: 3h, 2 practical works: 3h

Some methodological elements
What does it mean to "do research"?
Good practices in research: ethics, integrity and deontology
Publications: why, how and where to publish
Data interpretation: trend and error bars, correlation and causation
Cognitive biases and critical thinking

Introduction to the ionosphere (auroral)
Atmospheric layers
Photoionization and the Chapman model
The ionospheric layers
Collisions and conductivities

High latitude ionosphere and VS-M-I couplings
energy balance
Particle precipitation
Light emissions
Magnetospheric convection
Couplings for Various MFI Orientations

Observation of the ionosphere
Ground instruments
Space instrumentation

PW 1: CDPP
Presentation of the tools of the Plasma Physics Data Center
Handling of AMDA

PW 2: Halloween Storm
Observation and effects of a flare on the terrestrial space environment
Mass coronal ejection and its effects
Doses received in commercial flights

IV.4 Plan of the Cours Rolland Fleury
[rolland.fleury@telecom-bretagne.eu]

3 lessons: 4h30, 3 practical works (PW): 4h30 (including 1 practical work on the use of GPS to study the atmosphere)

Lesson 1: GPS and ionosphere
1. The ionosphere
2. Trans-ionospheric propagation
3. The GPS system
4. The RINEX format

Lesson 2: Modeling VTEC
1. The Klobuchar model
2. The MADRIGAL website
3. GIM models
4. The IONEX format
5. The NeQuick model
6. The IRI model

Lesson 3: Ionospheric scintillation
1. Definitions
2. EPBs
3. Occurrence
4. S4, sigma-phi, ROTI indices
5. Examples
6. S4 and ROTI measured in Ivory Coast

PW1: Using my Matlab software (tec_not_igs.m) to calculate the single-station VTEC from pseudo-distance measurements,
PW2: PW1 suite + use of LEICA software to represent GIM cards

Lesson 4/PW: Troposphere and GPS
1. Morphology
2. Influence on GNSS propagation
3. IWD/PWD with ground measurements
4. ZTD with GNSS
5. IGS Results Internet Files

IV.5 Jean-Louis Zerbo course
[JeanLouis.zerbo@gmail.com]

1 lesson: 1h30
Classification of Legrand and Simon on Solar activity and geomagnetism

IV.6 Christine Amory-Mazaudier course
[christine.amory@lpp.polytchnique.fr]

3 lessons: 1h30: intro + 2 times 45 minutes
- The dynamo process in the Earth-sun system: Introduction to school
- The Equatorial Fountain
- The magnetic indices and the DDEF, high and low latitude coupling

IV.7 Zaka Komenan Course
[komzach@yahoo.fr]

1 lesson: 45 minutes

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

IV.8 Course plan of Franck Grodji
[franckgrodji@gmail.com]

1 lesson: 1h30

The conductivities of the ionosphere
1. densities of neutral and charged particles in the ionosphere
2. forces acting on electrons and ions
3. movements of electrons and ions in the presence of an electric field
4. Ohm's law: direct, Pedersen and Hall components 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 ionospheric dynamo mechanism
1. Maxwell's equations
2. electrostatic electric field assumption
3. DC current assumption
4. electric field in the frame of the moving gas
5. Generation of the Bias Field

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

Telluric currents/effect of a 'Solar Flare'

IV.9 Le Huy Minh course
[lhminhigp@gmail.com]

2 lessons: 1h30 + 45 minutes

Use of GNSS in Vietnam
- GPS network in Vietnam
- Studies of the ionosphere
- Studies of the movement of the earth's crust
- Studies of water vapor in the troposphere

Studies of magnetic and ionospheric data in Vietnam
- Magnetic and ionospheric observatories in Vietnam
- Some study results of the magnetic field at low latitudes
- Some results of ionospheric study in Vietnam

IV.10 Emran Anas Course on Geographical Information Systems
[craste@emi.ac.ma]

1 lesson: 1h30, + 1h

1. Theoretical aspects
- Introduction to GIS: definitions, methodological approaches, modeling and structuring of spatial data,
- Notion of Coordinate System in GIS and GPS
- Some examples of GIS assembly from GPS

2. Presentation of the CRASTE-LF

IV.11 Plan of the Hassen Ghalila course: Propagation of Very Low Frequency (VLF) waves in the Earth-Ionosphere waveguide,
[hassen.ghalila@gmail.com]

lesson: 1h30, 1 lab: 1h30

1. Courses
- Earth-Ionosphere waveguide
- Propagation of VLF and ELF waves in the waveguide
- Responses of the ionosphere to terrestrial and extra-terrestrial solicitations

2.Practical Works
- Installation of the LWPC code (Long Wavelength Propagation Capability) and the associated SuperLWPC interface
- Application: Sunset-Sunrise
- Application: Solar Flare

IV.12 Serge Soula course plan
[serge.soula@aero.obs-mip.fr]

2 lessons of 1h30 and 2 labs (Practical works-PW) of 1h30

Course: Development, organization, electrification and electrical activity of thunderstorms
* Development of the thundercloud
* Dynamics and organization of thunderstorms
* Thundercloud Electrification
* Lightning physics
* Lightning detection
* Lightning climatology
* Altitude electrical discharges - TLE (Sprites, Elves, Jets)

PW n°1
Use of a database of lightning detected by the LIS space optical sensor on the ISS
- Selection of a geographical area and an observation period
- Analysis of the displayed data and calculation of characteristic quantities of lightning activity
- Data recovery and representation of the spatio-temporal variation of lightning activity

PW n°2
Data processing for a TLE event and identification of this TLE with reference to the course
- Recovery of information files on the evolution of four parameters as a function of time
- Identification and understanding of the four parameters, three for the flash and one for the brightness of the TLE
- Trace evolutions on Excel, choice and optimization of the representation, on one or two graphs
- Analysis and identification of the type of TLE

IV.13 Pétronille Kafando : Thermodynamics of the atmosphere
[kafandopetronille@yahoo.fr]

1 lesson: 1h30 and 1 lab: 1h30

Lesson 1h30
I/ Thermodynamics of the atmosphere (1h)
1) Chemical composition of the Earth's atmosphere
2) State variables of the atmosphere
3) Energy exchanges within the atmosphere
4) The transformations of atmospheric air leading to the formation of clouds
5) Stability and instability in the atmosphere
6) Convective energy and inhibition energy
II/ Atmospheric gravity waves (30 minutes)
Presentation of some results of the study of gravity waves in the lower stratosphere of West Africa

Practical work: 1h30
1) Getting started with the emagram 761
2) Exercise 1: Analysis of the state of saturation of an air parcel; Graphical determination of dew point, condensation point and mass of condensed water.

3) Exercise 2: Plot of the state curve relative to a radiosonde; Graphical determination of mixing ratio and saturation mixing ratio; Analysis of cloud formation conditions; Determination of cloud base and top; Determination of the mass of condensed water in a cloud.

V. CALENDRIER DES COURS

First week

Hours	Monday 17	Tuesday 18	Wednesday 19	Thursday 20	Friday 21	Saturday 22
09h-9h45		Sun L. K.	Magnetosphere O. L.	Sun L. K.	GPS ionosphere R. F.	Auroral Ionosphere F. P.
9h45-10h30	Opening Ceremony	Sun L. K.	Magnetosphere O. L.	Sun L. K.	GPS ionosphere R. F.	Ionosphere instrumentation F. P.
10h30-11h	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11h-11h45	Intro: 4 dynamos C A-M	Magnetosphere O. L.	Sun L.K.	Magnetosphere O. L.	Advises on Methodology F. P.	GPS ionosphere R. F.
11h45-12h30	Intro: 4 dynamos C A-M	Magnetosphere O. L.	Sun L. K.	Magnetosphere O. L.	Ionosphere introduction F. P.	GPS ionosphere R. F.
12h30-14h	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
14h-14h45	Geomagnetism J-L. Z.	Magnetosphere O. L.	Sun L. K.	Sun PW L. K.	GPS Ionosphere PW R. F.	CDPP PW F. P.
14h45-15h30	Geomagnetism J-L. Z.	Magnetosphere O. L.	Sun L. K.	Sun PW L. K.	GPS Ionosphere-PW R. F.	CDPP PW F. P.
15h30-16h	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
16h-16h45	Sun L. K.	Magnetosphere O. L.	Equatorial Fountain C. A-M	Sun PW L. K.	Communications of students	
16h45-17h30	Sun L. K.	Magnetosphere O. L.	Equatorial Fountain R. F.	Sun PW L. K.	Projects	
17h30-18h00			Session poster	Session Poster		

Second week

Hours	Monday 24	Tuesday 25	Wednesday 26	Thursday 27	Friday 28
9h-9h45	Magnetic Indices C. A-M	Study on magnetic Data in Vietnam M. L-H	Atmosphere P. K.	Atmosphere S. S.	What digital support for the hybridization of IMAO training in space weather Pr Kouame
9h45-10h30	Electrodynamics C. A-M	Electrodynamics PPEF Z. K.	Atmosphere P. K.	Atmosphere S. S.	
10h30-11h	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11h-11h45	GNSS Vietnam M. L-H	Atmosphere H. G.	Atmosphere S. S.	GPS PW atmosphere R. F.	Atmosphere PW P. K.
11h45-12h30	GNSS Vietnam M. L-H	Atmosphere H. G.	Atmosphere S. S.	GPS PW atmosphere R. F.	Atmosphere PW P. K.
12h30-14h	Lunch	Lunch	Lunch	Lunch	Lunch
14h-14h45	CDPP PW F. P.	SIG E. A.	Equatorial Electrodynamics EEJ - F. G.	Atmosphere PW H. G.	13h30-14h Closing of the school
14h45-15h30	CDPP PW F. P.	SIG E. A.	Informations ICTP, SCOSTEP, AGS O. O.	Atmosphere PW H. G.	Free afternoon
15h30-16h	Coffee break	Coffee break	Coffee break	Coffee break	
16h-16h45	GPS ionosphere R. F. PW	SIG PW E. A.	Atmosphere S. S.	Atmosphere PW S. S.	
16h45-17h30	GPS ionosphere R. F. PW	SIG PW E.A.	Atmosphere S. S.	Atmosphere PW S. S.	
17h30-18h00	Session poster	Session poster	Session poster	Session poster	

VI. The participants and their communications

VI. 1 Invited participants

N°	Names and Firstnames	Countries
1	ALI Mahamat Nour /n'est pas venu nouralimht@yahoo.fr	Tchad
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VI.2 Présentations des participants

Day	Speaker
Mercredi 19 octobre 17h30-18h	**Alain GNABAHOU** Burkinasat 1 : The first nano satellite of Burkina Faso **Edouard OUEDRAOGO** Extraction of TEC from the GNSS-CORS data of the station BF01 of Burkina Faso **Raphaël MUKANDILA** Analysis of the GNSS data of Africa from 1994 to 2017, characterization of the motion and active deformation
Jeudi 20 octobre 17h30-18h	**Mohammed BARAKA** Study of a dayside magnetopause reconnection event detected by MMS and related to a large-scale solar wind perturbation and cold ions **Jocelyn BOUNGOU POATY** Contribution of solar wind parameters to the variation to equatorial ionospheric activity in Africa
Vendredi 21 octobre 16h-18h	**Soboh ALQEEQ** Dipolarization fronts observed by MMS in the geomagnetic tail **Inza GNANOU** Energetic dynamic of the Earth's magnetosphere via high speed solar winds during solar cycles 20 to 23 **Raphaël MUKANDILA (Project)** GNSS network for the GIRGEA
Lundi 24 octobre 17h30-18h	**Christian ZOUNDI** Study of the geomagnetic storm of April 17, 2015 with the data of Koudougou **Harris Yao MARC** Galaxies forming active stars vs Galaxies controlled by the activity of the core
Mardi 25 octobre 17h00-18h	**Christian TCHANA** Estimation of induced geomagnetic currents with magnetometer data from Central Africa **Théogène NDACYAJIESNGA** An observational overview of Type II radio burst with the e-Callisto and analysis of their space weather effects during the ascending phase of cycle 25 **Tinlé PAHIMA** TEC variability during periods of fluctuating activity during solar cycle 24 at the station of Koudougou **Ange SEBEGO** Investigations on the aging of photovoltaic solar modules in a tropical Sahelian climate **Idrissa GAYE** Research works at the University of Thiès /Senegal
Mercredi 26 octobre 17h30-18h	**Prefina SAMBA** Interaction between surface water and groundwater in the karsh environment in the Republic of Congo and their relationship with the structural ones. **Koliè OUOOUO** Study of temperature and pluviometry,in the framework of the climatic change in the urbain town of N'Zerekore **Kassamba Abdel DIABY** Association of Astronomy of Côte d'Ivoire
Jeudi 27 octobre 17h30-18h	**Emmanuel SAWADOGO** Effects of the reccurrent activity on the diurnal variation f_0F_2 at the station dof Ouagadougou during solar cycles 20 and 22

	Estelle TAPSOBA TEC variability during magnetic quiet periods of solar cycle 24 **Abidima DIABATE** Variation of the foF2 critical frequency at Ouagadougou during magnetic period of CIR and magnetic clouds. **Nguessan KOUASSI** Electromagnetic Induction at low latitudes due to Solar Flare **Alfred DAMA** Variability of the magnetospheric electric field during periods of reccurent activity of solar cycle 24. **Zié TUO** EEJ longitudinal Variation from satellite CHAMP data

VII BUDGET and FUNDING

Regarding the funding of schools, GIRGEA is a network that has no permanent infrastructure and only manages training schools within the framework of large projects with the help of different laboratories and international structures.

Tickets for students and teachers are covered by different organizations (CNRS, SCOSTEP, ICTP, ICG, Teachers' Laboratories and Universities).

V.I. Local budget supported by Côte d'Ivoire

Chapter	Quantity	Description	P.U.	Montant
Prints	75	Ballpoint pen	fr. 200	fr. 15 000
	75	Shirt Flap	fr. 1 000	fr. 75 000
	10	Ream	fr. 5 000	fr. 50 000
Restoration	1200	Coffee break	fr. 1 500	fr. 1 260 000
	700	Lunch (Starter/resistance/mineral water/dessert/water in the dining room)	fr. 7 000	fr. 3 640 000
Transport and logistics	1	Mini Bus type vehicule	fr. 500 000	fr. 500 000
	10	Conference room	fr. 50 000	fr. 500 000
Accommodation	280	Accommodation (20 rooms with 2 beds for 14 nights)	fr. 30 000	fr. 8 400 000
	104	Accommodation (20 rooms with 2 beds for 14 nights)	fr. 50 000	fr. 5 200 000
Honorary	104	Teachers (Dinner)	fr. 140 000	fr. 1 040 000
	40	Auditors (Dinner)	fr. 98 000	fr. 3 920 000
				fr. 24 600 000
total				**~Eu. 37 850**

V.2 Flight tickets for the students and the teachers

Institutions	Tickets (AR)	Funding
UN- ICG International Commission of GNSS	6 tickets Tunis-Abidjan Hanoï-Abidjan Dakar-Abidjan Rabat-Abidjan Brazzaville-Abidjan Ouagadougou-Abidjan	~ 5450€
SCOSTEP Scientific Committee on Solar Terrestrial Physics	6 tickets Alger-Abidjan Kigali-Abidjan Ndjamena– Abidjan Strasbourg-Abidjan Ouagadougou-Abidjan Ouagadougou-Abidjan	5000€
ICTP International Centre for Theoretical Physics	3 tickets Yaoundé-Abidjan Brazzaville-Abidjan Conakry-Abidjan	2500€
INSU/France Institut National des Sciences de l'Univers	2 tickets Paris-Abidjan Toulouse Abidjan	2700€
CNFGG / CNES/France French National Committee of Geodesy and Geomagnetism	2 tickets Paris-Abidjan Brest-Abidjan	1500€
LPP/France Laboratory of plasma physics	3 tickets Paris-Abidjan	2265€
University Norbert Zongo Burkina Faso	2 tickets Ouagadougou-Abidjan	1038€
Members of GIRGEA - France	1 ticket Ouagadougou-Abidjan	535€
Laboratory of aerologie France	1 ticket Toulouse -Abidjan	1580€
MESRSI Ministry of Higher Education, Research and Innovation, Burkina Faso	2 tickets Ouagadougou-Abidjan	1038€
University Iba Der Thiam de Thiès - Senegal	1 ticket Dakar-Abidjan	450 €
Total		24 056 €

VIII. OUTLOOKS

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Development of the GNSS network
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DAMA Alfred Jean Stéphan, Burkina Faso
KOUASSI Nguessan, Côte d'Ivoire
TCHANA Christian Brice, Cameroon
Rolland Fleury (IMT) and Christine Amory-Mazaudier (LPP)
SAWADOGO Wambi Emmanuel
Rolland Fleury (IMT-Atlantique)
TAPSOBA Estelle, Burkina Faso
OUEDRAOGO Pouraogo Edouard, Burkina Faso
Frédéric Pitout (IRAP) and Christian ZOUNDI (Université Norbert Zongo)
TRAORA Ibrahim, Burkina Faso

IX. Logistic : Photos

VIII.1 Class room and photos of some teachers

Idrissa Gaye et Rolland Fleury

Minh Le Huy

Serge Soula et Frédéric Pitout

Olivier Lecontel et Hassan Ghalila

A droite

Pétronille Kafando, Idrissa Gaye

et Ludwig Klein

VIII.2 coffee-break


VIII.3 Lunch


VIII.4 Bus


VIII.5 Rest day, on Sunday at grand Bassam

X. Press

All the articles are available on the link below

https://drive.google.com/drive/folders/10eFLcP4uvGAz3W2vTp38Gw64CGOUMWQ0?usp=sharing

https://www.gouv.ci/_actualite-article.php?recordID=14143&d=6

RECHERCHE SCIENTIFIQUE : LA 5EME EDITION DE L'ECOLE DE METEOROLOGIE DE L'ESPACE ISWI MAGHREB, AFRIQUE DE L'OUEST ET CENTRALE (IMAO) LANCEE

Abidjan, le 17 octobre 2022- Le ministre de l'Enseignement supérieur et de la Recherche scientifique, Adama Diawara, a lancé, le lundi 17 octobre 2022 à l'université Félix Houphouët-Boigny à Abidjan-Cocody, la 5ème édition de l'Ecole de Météorologie de l'Espace ISWI Maghreb, Afrique de l'Ouest et centrale (IMAO), prévue du 17 au 28 octobre 2022 sous le thème "Physique et utilisation des outils".

Durant une dizaine de jours, l'Ecole IMAO renforcera les capacités d'une quarantaine d'étudiants de niveaux Master 2 et doctorat, de jeunes chercheurs et enseignants-chercheurs des pays francophones d'Afrique du Nord, d'Afrique centrale et d'Afrique de l'Ouest dans les disciplines scientifiques qui se rapportent à la météorologie de l'espace, notamment à la physique du globe et de l'espace.

Les cours qui comportent une partie scientifique et des travaux pratiques, vont se dérouler sur le site de l'ex-ESIE à Bingerville.

« Pour un pays comme la Côte d'Ivoire, ce renforcement de capacités est très important, car il contribue à la formation de qualité des étudiants et chercheurs. Il est également nécessaire pour notre pays qui a besoin de ressources humaines de qualité pour contribuer efficacement à son développement. Également, la Côte d'Ivoire en tant que pays à vocation agricole, est très sensible à tout ce qui a trait aux études sur le changement climatique et à ses impacts sur les infrastructures, l'agriculture et la santé », a expliqué Adama Diawara.

A cette occasion, le ministre a annoncé pour bientôt, la mise en place de l'Agence spatiale ivoirienne, qui aura besoin des compétences de ces physiciens pour mettre en œuvre les missions qui lui seront assignées.

Selon le président du Comité d'organisation, par ailleurs directeur général de l'Enseignement supérieur et président de la Société ivoirienne de physique, Pr Vafi Doumbia, 20 auditeurs sont originaires d'Afrique du Nord, d'Afrique centrale et d'Afrique de l'Ouest, et une vingtaine d'auditeurs sont ivoiriens.

« Les auditeurs bénéficieront de l'encadrement de 12 experts venus de la France, du Maroc, de la Tunisie, du Vietnam, du Burkina Faso et de la Côte d'Ivoire », a-t-il relevé.

Cette 5ème édition de IMAO coïncide avec la commémoration du 100ème anniversaire de la découverte de l'électrojet équatorial (1922-2022) et du 30ème anniversaire de l'année internationale de l'électrojet équatorial (AIEE).