

**IDEAS AND RESEARCH PROGRAMMES -EARTH'S ENVIRONMENT
INTERNATIONAL COOPERATION**

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Abstract

In this paper we examine the possibilities of international cooperation for research programmes on the EARTH'S ENVIRONMENT including NORTH and SOUTH countries.

We propose as an example of methodology of scientific project developed in an International Geophysical Research Group EUROPE AFRICA during the last decade with the new organization and methods in the frame of "International Laboratory Without Frontiers".

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Introduction :

The planetary studies of Earth's environment are limited by the fact that observations at low latitudes and in the southern hemisphere are scarce. In 1981 Keith Cole in Edinburgh created the Inter Divisional Commission for developing Countries and proposed the project of the International Equatorial Year. In the frame of the International Equatorial Electrojet Year (1992-1994), a new approach for cooperation studies between north and south countries was build up. In this paper we present the results after ten years of work. The first section briefly recalls the research cooperation in aeronomy and geomagnetism between France and Africa before 1982. The second part highlights factors which prevent a good development of research in the North hemisphere as well as in the South, and the solution which consists to increase sharing practices. The third section describes the schedule and the methods developed during the IEEY project in the European African sector. In section four we propose ethic rules for the international cooperation and a proposal of research programmes for the next decades to develop geosciences in developing countries.

I. Ionospheric and Geomagnetic studies in Africa: French programmes before 1982

Before 1982, French researchers were involved in ionospheric and magnetic studies over Africa.

Before 1965

ORSTOM observers (Ponthier, Crenn...) Father P. N. Mayaud and Father Gouin studied the variations of the Earth's magnetic field at the equator, in Africa. They discovered the counter-electrojet (Gouin and Mayaud, 1967).

Figure 1 : Map of AFRICA



From 1965 to 1982 : Three French institutes developed research in Africa: ORSTOM, CNET and LSEET

Ionospheric surveys made by the CNET 1965-1971

Preliminary aeropoorted ionosonde over the central African network (1965-1966) described the plasma fluxes in the F layer (Vila, 71). Ionospheric studies of the electron densities over SARH (Chad) were made by Faynot and Vila at equatorial latitudes to characterize the morphological features of the equatorial fountain phenomena .(Faynot and Vila, 1979). There were also three permanent ionosondes at Dakar(Senegal), Ouagadougou (Burkina Faso) and Bangui (RCA). These ionosondes were run under military contracts of french Telecom CNET.

Magnetic survey made by ORSTOM (1968-1970)

Fambitakoye (Fambitakoye, 1976, Fambitakoye and Mayaud, 1976a, 1976b, 1976c) and Father Mayaud, ran a chain of 10 magnetic observatories (crossing the equator), during more than one year in order to characterize the morphology of the equatorial electrojet and modelize this ionospheric electric current (Fambitakoye et al., 1976). At this time, there were also two permanent observatories run by the French institute ORSTOM (presently IIR) at Bangui in the Republic of Central Africa and M'Bour in Senegal.

HF radar measurements made by LSEET (Hanuise and Crochet, 1977; Hanuise and Crochet, 1981).

In 1973 a light HF radar system (communicated by B. Basley to the french laboratory LSEET/CNRS) made series of crucial observations at ADDIS ABEBE (ETHIOPIA) on the ionospheric plasma instability modes and their dependance on the DP magnetic field.

Figure I shows the map of AFRICA to localize the various countries where data were recorded : Senegal, Chad, Ethiopia, Central African Republic.

During these periods, research in Africa depended on military facilities and there was no programme for teaching ionospheric or geomagnetic studies to African people. Some isolated African researchers were trained but there was no real investment of the French government in the teaching and training of African scientists.

In 1982, the French scientific community decided to stop ionospheric and geomagnetic studies in Africa and to confine all the ionospheric studies to Auroral zones with the advantage of the Incoherent scatter sounder EISCAT facilities.

The magnetic studies of the equatorial electrojet were also interrupted, but the data collection of magnetic parameters was maintained at M'Bour and Bangui, Ouagadougou.

In 1990 under the pressure of the International community, a group of researchers from various countries organized the International Equatorial Electrojet Year project in Africa (Amory-Mazaudier et al., 1994). Figure 2 presents the International Equatorial Electrojet Year experiment run from November 1992 to December 1994. During the IEEY campaign, the observatory of Korhogo was build up and this observatory is still operating.

Figure 2 : International Equatorial Electrojet Year Experiment

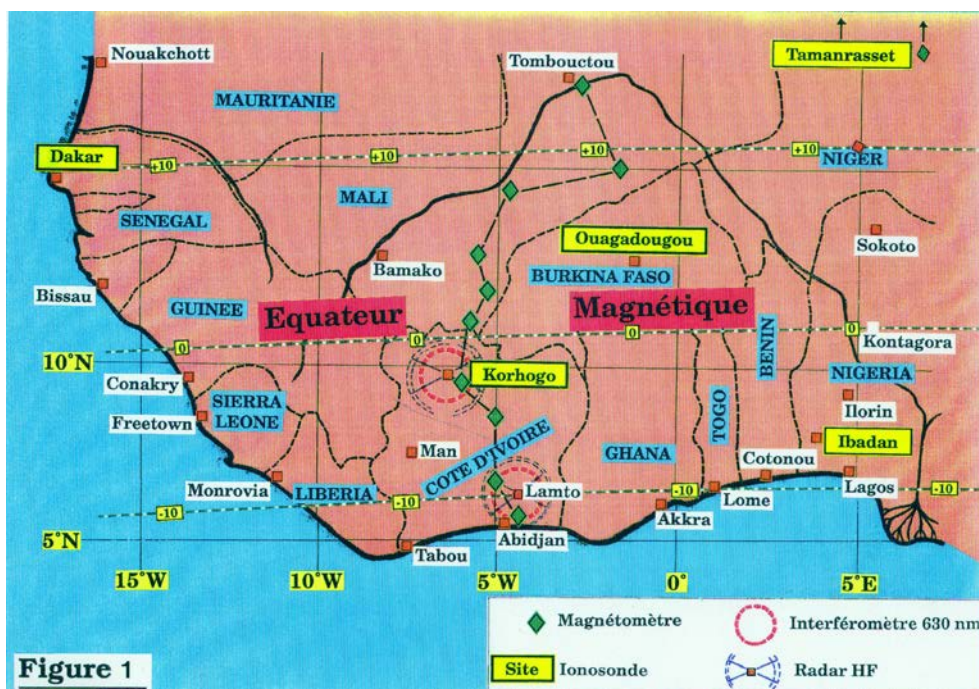







Table I summarizes the period before the International Equatorial Electrojet Year.

TABLE I : IONOSPHERIC AND MAGNETIC STUDIES IN AFRICA- FRENCH PROGRAMMES BEFORE 1982











IONOSPHERIC AND MAGNETIC STUDIES : <u>FRENCH PROGRAMMES</u>	
	Before 1965 P.N. Mayaud and P. Gouin Magnetometers at M'Bour Addis Ababa, Bangui -> ORSTOM network Ionosondes at Dakar, Tamanrasset, Bangui, Arta (Djibouti) -> CNET network
	1965-1977 P. Vila, J-M. Faynot -> IONOSPHERE STUDY OF IONOGRAMS - Central African network of 9 ground based and one air borne ionosondes -> Dakar (Senegal) and Ouagadougou (Burkina Faso) P.N. Mayaud, P. Gouin, O. Fambitakoye -> Sq and Equatorial Electrojet Studies ELECTROJET AND COUNTER-ELECTROJET -> Dakar (Senegal) , Bangui (RCA) -> Chad and RCA combined campaigns
	1973-1982 M. Crochet, C. Ogubasghi, C. Hanuise -> IONOSPHERE MEASUREMENTS OF HF RADAR PLASMA INSTABILITIES -> Addis Abbaba (Ethiopia) Research was interrupted INTERNATIONAL PROGRAMMES
	1981 : Keith Cole -> IAGA Edinburgh (England) creation of the ICDC : Inter divisionnal Commission for Developing Countries
	1990 : proposal of the IEEY International Equatorial Electrojet Year Project in Africa
NB : This table concerns the French past cooperation . The contribution of other countries in research over Africa before 1982 is out the scope of this paper.	

II. Analysis of the factors preventing a good research in the two hemispheres

One can be surprised by scientists who pretend to do planetary studies without any data in equatorial regions and very scarce data in the southern hemisphere. However, this situation is still going on and should be amended.

In table II we recall the factors which prevent the good development in the Earth's environment sciences in the both hemispheres. In Table II we have set up together several factors which prevent a good development of the Earth's environment in both hemispheres. It appears that many problems could be solved if researchers managed to develop exchanges between scientific communities of the North and the South.

TABLE II: FACTORS PREVENTING A GOOD DEVELOPMENT OF RESEACH IN THE EARTH'S ENVIRONMENT

Taking into account several facts concerning research in developed countries	Taking into account several facts concerning research in developing countries
<p>1° the need of observations over the whole world to do global studies  creation of observatories in the Southern Hemisphere</p> <p>2° the fact that satellites and ground observatories are complementary  creation of observatories in the Southern Hemisphere</p> <p>3° the constant increase of research fields  more researchers in the Southern Hemisphere</p> <p>4° for all disciplines, the multitude of tools and techniques  sharing between developed and developing countries</p> <p>5° the constant increase of data base, and our impossibility to analyse all the data  sharing between developed and developing countries etc...</p>	<p>1° the impossibility to stay in their country to do research in particular fields  to develop research in developing countries</p> <p>2° the lack of data to do research in their country  creation of observatories in the Southern Hemisphere  sharing between developed and developing countries</p> <p>3° the need of books, reviews, computers etc....  sharing between developed and developing countries</p> <p>4° the difficulty to publish in international scientific journals  sharing between developed and developing countries etc....</p> <p align="center">A change is needed</p>

Since 1990 the IEEY team, and later The IRGGEA group organized an international north-south community based on ethic values. The object was to change methods and organization of international projects in order to equilibrate the chance for all the researchers from the two hemispheres. In the next sections we briefly present this project and its main achievements.

III. The International laboratory without frontiers: the IGRGEA

To build the International Laboratory without frontiers we enter in the dynamics of an international scientific project : the IEEY. In the frame of this project we defined research subjects for many students. We have to take into account that there was no african research team in geomagnetism and aeronomy in the country first concerned by this project: the Ivory Coast.

Many things had to be done: - to teach geophysics
 - to install experiments - to run experiment
 - to collect data
 - to process data and build data bases - to analyse data
 - to publish results

All this jobs were performed in the frame of the project cooperatively with african people and all our knowledge was transferred to our African students who became our colleagues. Now the African team can teach geophysics in African universities, run experiment and continue the research.

In Table III we recapitulate the main steps of the project.

TABLE III: WORK OF THE IEEY TEAM AND IGRGEA DURING THE LAST DECADE

IRGGEA International Geophysical Research Group in Europe Africa	
1991 :	first meeting in Ivory Coast there is no study of geomagnetism and aeronomy
1992 :	creation of Korhogo observatory School in Paris
1993-1994 :	campaigns of measurements in Africa ionosonde HF radar magnetometers interferometer
1995-1996	data analysis data base connection with existing data bases
1995-2001	School in Abidjan 7 PHD and 1 Doctorat d'Etat (from 1993 to 2001) 1-> Senegal 3 -> Ivory Coast 2 -> France 1-> Nigeria 1 Doctorat d'Etat -> Ivory Coast special issue of Annales Geophysicae in June 1998 30 publications, research contracts
2001 -	extension over the West Africa workshop and school in Abidjan connection with other disciplines new campaigns of measurements

Table IV, from Amory-Mazaudier et al (1993) recalls the laboratories involved in this project, at the beginning, in 1991.

TABLE IV : LABORATORIES INVOLVED IN THE PROJECT
(from C. Amory-Mazaudier, 1993)

Haut Commissariat à la Recherche, CRAAG (Centre de Recherches en Astronomie Astrophysique et Géophysique) département de physique, Senegal .
ORSTOM (Inst.français de Rech. Sci.pour le développement en Coopération), Centre de Dakar, Senegal .
Station CNET, Dakar-Cambérène, Senegal géophysique.), Algeria .
Université Cheikh Anta Diop, ITNA (Inst.de Tech. Nucléaire Avanc.)
Faculté des Sciences d'Abidjan, Département de Physique., Ivory Coast .
Station géophysique de Lamto (A.D.E.GE.C.I.), Ivory Coast .
University of Ilorin, Faculty of Science, Department of physics, Nigeria .
University of Obafemi, Awolowo, Nigeria .
University of Calabar Nigeria
Anambra State University of Technology, Nigeria
Station CNET, Ouagadougou, Burkina Faso
ORSTOM, Centre de Bamako, Mali
IPGP, Institut de Physique du Globe, France
ORSTOM (Institut Français de Recherche Scientifique pour le Développement et la Coopération Scientifique) Centre de Bondy, France .
CEA (Commissariat à l'Energie atomique) Centre de Bruyères le Chatel, France .
CNET (Centre National d'Etude de Télécommunications) LAB/MER/PTI, Lannion France .
CNET (Centre National d'Etude de Télécommunications)/ CRPE, Saint-Maur-des Fossés, France .
LETTI (Laboratoire d'Etude des Transmissions Ionosphériques), Université Paris Sud, France .
Laboratoire de Physique de la Terre et des Planètes, Université Paris Sud, France .
Ebre Observatory, Roquetes, Tarragona, Spain .
Institut für Geophysik der Universität Göttingen, Germany .
UCL (University College of London), England .
NCAR (National Center for Atmospheric Research), HAO (High Latitude Observatory), USA .
Beijing University, China .

In Table V we recapitulate our main success and our difficulties and in Table VI the method to guide the project.

TABLE V : SUCCESS AND DIFFICULTIES






<u>Our main success</u>
1- creation of an enthusiast research team in geomagnetism and aeronomy in Ivory Coast
2- many new scientific results from regular observations
3- maintenance of the Korhogo observatory, during ten years and more, by an Ivoirian technician
4- attraction of young scientists from Ivory Coast, Congo, Benin, Central African Republic etc ...
5- training and teaching in geomagnetism and aeronomy at the University of Abidjan by Ivoirians,
6- positions for all the students in their country
<u>Our difficulties</u>
1- to find Engineers and technicians in the country
 to develop more technical teachings inside University of Abidjan
2- the impossibility to have of good financial support from Ivoirian authorities (financial poverty of the country)
 to find financial support (outside Ivory Coast) to maintain Korhogo
3- there is still the lack of financial support for researcher work and travels (to reach meeting)
 help of other developed countries (Burkina, Mali, Mauritania, Cameroon ..)
etc...

TABLE VI : METHOD







The method to maintain the project is developed day after day in accordance with the situation	
	We organize
<ul style="list-style-type: none">- training in several disciplines in the project- teaching in management and data base organization- teaching in history of geomagnetism and aeronomy- we follow the students and help them to enter the international community- the students are involved in the project and can propose new developments- we maintain communication with a newsletter and keep contact with all participants.	
	We consider that we are in the same laboratory : "An International Laboratory, without frontiers"
<ul style="list-style-type: none">- we share knowledge, books, financial support, etc...	
The IGRGEA has no direct financial support. The IGRGEA establishes and maintains connections between research teams in different laboratories in Europe and Africa. The IGRGEA organize scientific projects, data base, research, training and teaching, communication between the research teams.	

IV. Ethical rules and proposal for the next decades

After ten years, all the problems are not yet solved, indeed, small African countries can not have their own research programme in Geophysics, they are strongly dependent as all the other scientific community on the international community. This is why it is necessary to define new rules for the international cooperation taking into account the whole world and ethical rules. We need each other, and we have to organize the scientific world in order to help all scientists to participate in advances of knowledge.





In Table VII, we propose some ethical rules to develop in international scientific projects in order to balance the North and the South scientific contribution to the world evolution.

TABLE VII : ETHICAL RULES

This kind of human experience can be reproduced by many researchers in various countries, various disciplines by following the following proposals :	
	to develop scientific projects with developing countries, by campaigns of measurements in developing countries
	to create observatories in developing countries supported financially by an "international laboratory without frontiers"
	to introduce ethical rules and sharing practices in scientific projects as : 20% of the financial support of the project for training and teaching in developing countries
	to organize research at a planetary scale by researchers including the participation of researchers from developing countries in all steps of organization
	to develop access to data base for researchers in developing countries (computer, internet..)
	twining of Universities to share knowledge and projects
	international scientific journals free for Universities in developing countries
etc...	
It is not necessary to change everything, just to introduce new practices.	

To continue and develop its own experience the IGRGEA propose to develop integrated studies in the Earth's environment. Table VIII gives the proposal.

TABLE VIII : PROPOSAL FOR THE NEXT DECADES

	Programmes of integrated studies in the frame of the Sun Earth relations
	- climate and solar activity
	- lower atmosphere motions and Earth's magnetic field
	- Earth's magnetic disturbances and external sources (integration of the physical processes from Sun to Earth)
	studies on existing data bases
	connections to do between the existing data bases
	campaigns in developing countries
	geomagnetism
	aeronomy
	atmospheric sciences
	development of historical studies

V. Conclusion

With the development of communication and internet network it is therefore possible to work easily in a laboratory without frontiers.

Data in equatorial and southern hemisphere regions are needed for the progress of planetary models in all fields. The satellite data need reference points in the various sectors of latitudes and longitudes. Around an observatory it is easy to organize research in developing countries.

The role of developing countries Universities will be to support their observatories and to inform their countries opinion and authorities. International scientific solidarity is highly necessary to back up this quest for scientific discovery and to promote eventual progress in technology.

Height PHD and Doctorat d'Etat were yet done : E. Sarnbou (1993), V. Doumouya (1995), J-F. Cecile (1997), O. Obrou (1997), M. Sow (1999), T. Farges (2000), A.B. Rabiou (2000), A.T. Koba (2001).

There is no unemployed worker in our students :

- two of them were employed before they begin the PhD
- four of the young scientists obtained a position in research in their country
 - o two in Ivory Coast, one in Nigeria, one in France
- two preferred to do computer sciences and obtained position on other countries
 - o one French student is now working in Canada and one Ivoirian student is now working in France

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