UNITED NATIONS
OFFICE FOR OUTER SPACE AFFAIRS

Seminars

of the United Nations Programme on Space Applications

Selected Papers from Activities Held in 2005

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OFFICE FOR OUTER SPACE AFFAIRS
UNITED NATIONS OFFICE AT VIENNA

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INTRODUCTION

This publication consists of nine selected papers from workshops organized by the United Nations Office for Outer Space Affairs, within the framework of the Programme on Space Applications in 2005.

The Programme on Space Applications was established in 1971, with one of its main objectives to further general knowledge and experiences in the field of space technology between developed and developing countries. The Programme organizes eight to ten workshops, seminars and training courses on an annual basis for students and professionals from developing countries with the aim of increasing local capabilities in space technologies, thus helping to promote the peaceful use of outer space, in accordance with United Nations goals and principles. These activities bring together professionals from developed and developing countries and allow for an exchange of information in several space-related fields, including telecommunications, remote sensing and satellite applications, global environment and land resources management and international space regulations.

This volume of "Seminars of the United Nations Programme on Space Applications" is the seventeenth and final publication in an annual series that began in 1989. The selected papers discuss a variety of science policy issues and are published in the language of submission.

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I. REGIONAL CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION AFFILIATED TO THE UNITED NATIONS

REGIONAL CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION AFFILIATED TO THE UNITED NATIONS

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Abstract

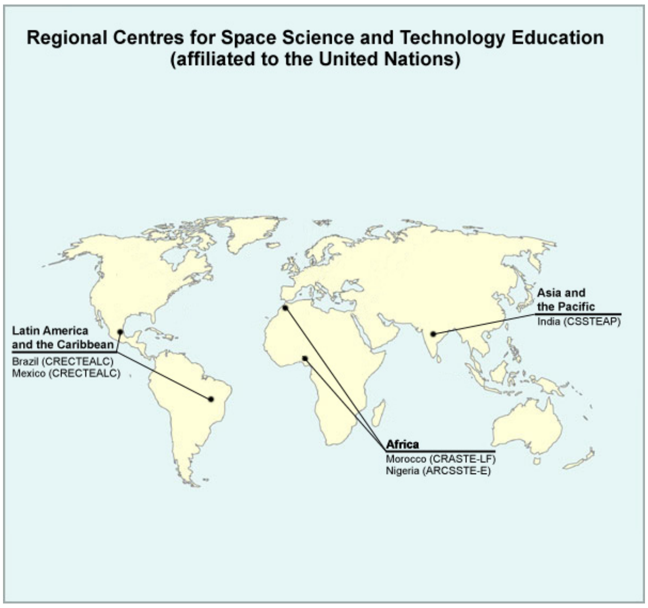
Based on resolutions of the United Nations General Assembly, regional centres for space science and technology education were established in India, Morocco, Nigeria, Brazil and Mexico. Simultaneously, education curricula were developed for the core disciplines of remote sensing, satellite communications, satellite meteorology and space and atmospheric science. This paper provides a brief report on the status of the operation of the regional centres and draws attention to their educational activities.

1. Background

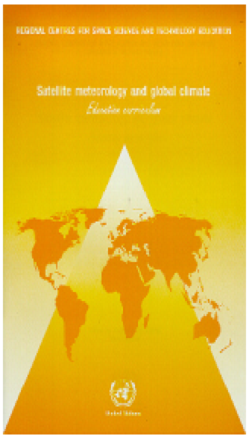
The United Nations General Assembly, in its resolutions 45/72 of 11 December 1990 and 50/27 of 6 December 1995, endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPOUS) that regional centres for space science and technology education should be established on the basis of affiliation to the United Nations, in developing countries.

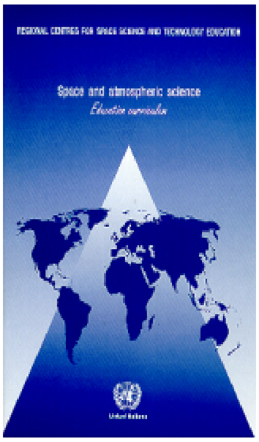
Under the auspices of the United Nations, through its Office for Outer Space Affairs (OOSA), four regional centres were established on the basis of regions that correspond to the United Nations Economic Commissions: Asia and Pacific (India), Latin America and the Caribbean (Brazil and Mexico) and Africa (Morocco, Nigeria). All of these Centres are affiliated to the United Nations through OOSA. A fifth Centre in Western Asia (Jordan) will be established in the future. These Centres use existing facilities and expertise already available in education and other research institutions in their respective regions.

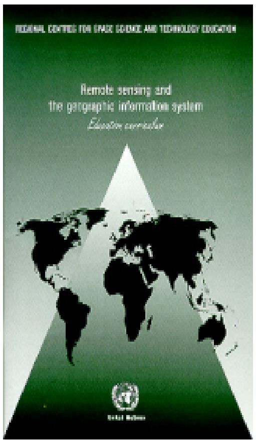
The overall policy-making body of each Centre is its Governing Board and consists of Member States (within the region where the Centre is located), that have agreed, through their endorsement of the Centre's agreement, to the goals and objectives of the Centre.



The United Nations Programme on Space Applications, with the support of prominent educators, has developed standard education curricula, which were adopted by the Centres for teaching each of the four core disciplines.







The overall goal of the Centres is to develop, through in-depth education, an indigenous capability for research and applications in the core disciplines of remote sensing and geographic information systems, satellite communications, satellite meteorology and global climate, and space and atmospheric sciences. Education curricula have been developed for the four core disciplines.

2. Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), which was established in India in 1995, pioneered the United Nations initiative to create space educational Centres in developing countries. The Centre is headquartered in Dehradun, India, and its programmes are implemented by staff of the Department of Space at campuses in Dehradun and Ahmedabad. The Centre has access to the facilities, infrastructure and expertise of the Indian Institute of Remote Sensing in Dehradun, the Space Applications Centre and the Physical Research Laboratory, both in Ahmedabad. Its Governing Board is comprised of 15 members from 15 countries in the Asia and Pacific region and two observers. To date, CSSTEAP has conducted 21 long-term postgraduate courses and 16 short-term programmes in the core disciplines. These programmes have benefited 46 countries and more than 600 scholars in the Asia and Pacific region and beyond. Since 1999, CSSTEAP has achieved the status of an institution of excellence and is celebrating the tenth anniversary of its establishment in 2005.

3. African Centre for Space Science and Technology – in French Language (CRASTE-LF)

The African Centre for Space Science and Technology – in French Language (CRASTE-LF) was established in Morocco in 1998. It is based at the Mohammadia School of Engineers at the University Mohammed V Agdal in Rabat. Important national institutions such as the Royal Centre of Space Remote Sensing, Scientific Institute, Agronomic Institute and Veterinary Hassan II, National Institute of Telecommunications and Directorate of National Meteorology, actively support the educational programmes offered by the Centre. The Governing Board of CRASTE-LF is composed of 13 members from 13 countries in the region and three observers. The Centre has already carried out six long-term postgraduate courses and 10 short-term programmes. The long-term programmes were attended by 80 scholars from 16 countries in the region. In 2005 the Regional Centre hosted two workshops sponsored by the USA, which donated Landsat images, and the European Space Agency. Both events focused on natural resources management and environmental monitoring.

4. African Regional Centre for Space Science and Technology Education – in English Language (ARCSSTE-E)

The African Regional Centre for Space Science and Technology Education – in English Language (ARCSSTE-E) was inaugurated in Nigeria in 1998. It operates under the auspices of the National Space Research and Development Agency and is located at Obafemi Awolowo University (OAU) campus, Ile-Ife. The Centre´s facilities are mainly provided by departments from OAU and the Regional Centre for Training in Aerospace Surveys, which is also located on the OAU campus. ARCSSTE-E has already offered six postgraduate courses and eight short-term programmes. About 30 scholars from nine countries in the region attended the long-term courses.

5. Regional Centre for Space Science and Technology Education for Latin America and the Caribbean - Brazil and Mexico campuses (CRECTEALC)

The Regional Centre for Space Science and Technology Education for Latin America and the Caribbean - Brazil and Mexico campuses (CRECTEALC) was established in 1997 after Brazil and Mexico signed an agreement recognizing the Centre with a campus located in each country. The campus in Brazil benefits from the facilities made available to it by the National Institute for Space Research, a renowned Brazilian research institution in space science and technology. Similar high quality facilities are found at the campus in Mexico, which is supported by the National Institute of Astronomy, Optics and Electronics. The Governing Board of CRECTEALC is chaired alternatively by Mexico and Brazil. The Brazil campus has already conducted two postgraduate courses and four short-term programmes. Those postgraduate courses have benefited 25 scholars from 10 countries in the region.

Acknowledgement

The United Nations Office for Outer Space Affairs is grateful that the Regional Centres have had the opportunity to be displayed on the recently released DVD titled “Hubble: 15 Years of Discovery”, produced by the European Space Agency (http://www.spacetelescope.org/projects/anniversary/index.html).

Detailed information on each Regional Centre and the education curricula can be accessed online at: http://www.oosa.unvienna.org/SAP/centres/centres.htm.

TECHNOLOGIES SPATIALES ET DEVELOPPEMENT DURABLE: LE ROLE DU CRASTE-LF

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1. Introduction

Dans sa définition communément admise, le Développement Durable consiste à se doter de moyens de gestion des ressources et de l'environnement, de moyens économiques et politiques pour garantir, à long terme, le développement actuel et futur des sociétés humaines dans le respect de leur environnement.

Dans ce contexte, les technologies spatiales, de par leurs caractères transdisciplinaire et multiforme, trouvent de nombreux domaines d'applications au service du développement durable. Elles présentent un potentiel considérable, en apportant une contribution décisive au processus de connaissance objective de l'état de l'environnement et de sa dégradation. Combinées à d'autres technologies, elles permettent de répondre aux questions qui se posent en matière d'aménagement du territoire; de gestion rationnelle des ressources naturelles; de lutte contre la désertification et pour la sécurité alimentaire; de lutte contre les maladies, en particulier celles liées à des paramètres environnementaux; de mise en œuvre de politiques de prévention contre les catastrophes naturelles ou technologiques. Les télécommunications, la localisation et l'observation de la Terre sont appelées également à intervenir de plus en plus souvent en appui des politiques de développement notamment par l'accès à l'information et à la formation, l'accès aux soins et à la santé pour tous, …

Le Sommet Mondial sur le Développement Durable (SMDD – Johannesburg 2002) a explicitement fait référence aux technologies spatiales dans ses résolutions, en affirmant que :

> "… Les applications spatiales contribuent au développement durable en mettant à notre disposition des informations et des mesures quantifiables sur des phénomènes tant naturels qu'artificiels. Elles facilitent d'observation de la Terre, la quantification des phénomènes, leur surveillance et la transmission des données."
> "… Les données spatiales sont à la base de tout système de renseignement sur l'environnement à l'échelle du globe pouvant permettre de modéliser, d'expliquer et de prévoir les phénomènes affectant la planète entière."

De son coté, le document de vision du Nouveau Partenariat pour le Développement de l'Afrique (NEPAD) reconnaît explicitement le rôle de la science et de la technologie comme moteurs de la croissance économique et du développement durable pour le continent africain. Il considère que le recours à ces technologies devient une condition *sine qua non* pour atteindre les objectifs du NEPAD. Son programme d'action envisage la création de l'Institut Africain des Sciences de l'Espace qui vise à regrouper les activités et installations dans le domaine de la spatiologie dans un réseau qui sera axé sur les sciences de pointe mises au service du développement de l'Afrique.

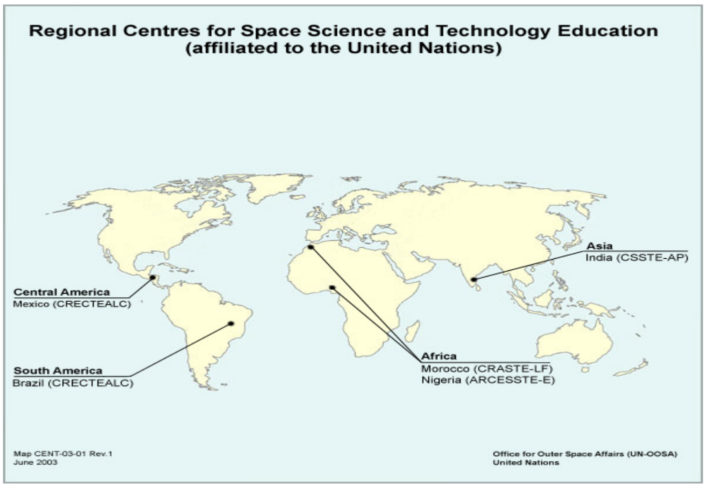
Mais plus que le coût de ces technologies, c'est leur usage opérationnel, efficace et coordonné qui constitue le défi majeur. Aussi, l'accent est-il mis sur l'information, la sensibilisation, la formation aux technologies spatiales et leur adaptation aux conditions spécifiques d'utilisation. Le partage des expériences à travers la mise en œuvre de projets coordonnés impliquant des partenaires internationaux, régionaux et nationaux constitue également un axe majeur de renforcement de capacités.

2. Le renforcement de capacités

S'appuyant sur ce constat, la communauté internationale a pris plusieurs initiatives menées principalement dans le cadre des Nations Unies pour promouvoir une utilisation efficace et coordonnée des technologies spatiales dans les pays en développement, s'appuyant particulièrement sur le développement des connaissances et des savoir-faire dans ces pays. Plus que dans tout autre domaine, l'accès à l'information et à la formation s'avère ici essentiel, car la connaissance est la condition de toute action de fond.

Les Centres Régionaux de Formation aux Sciences et Technologies de l'Espace constituent les solutions appropriées pour l'implémentation de programmes de formation (de courte ou moyenne durée), d'information, de valorisation des expériences et des compétences accompagnant la mise en œuvre de ces initiatives. Ils ont été mis en place en s'appuyant sur des résolutions 45/72 du 11 novembre 1990 et 50/27 du 6 décembre 1995 de l'Assemblée Générale des Nations Unies qui recommandaient l'animation d'un effort de création de centres régionaux de formation aux technologies spatiales, sur une base d'affiliation aux Nations Unies.

Cinq centres ont ainsi été progressivement mis en place pour les différentes régions du monde: en Inde pour l'Asie et le Pacifique, au Brésil et au Mexique pour l'Amérique Latine et les Caraïbes, au Nigeria et au Maroc pour l'Afrique.



Les Centres Régionaux de Formation aux Sciences et Technologies de l'Espace (affiliés aux Nations Unies)

Au niveau de ces institutions, des programmes de formation validés par des groupes d'experts et régulièrement actualisés sont mis en œuvre dans les spécialités suivantes identifiées comme essentielles pour atteindre les objectifs de développement: la Télédétection et les Systèmes d'Information Géographique (SIG), les Télécommunications Spatiales, la Météorologie par Satellites et le Climat Mondial, les Sciences de l'Espace et de l'Atmosphère.

3. Le CRASTE-LF

Le Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française (CRASTE-LF) a été mis en place le 23 octobre 1998 au Maroc. Ses missions, telles que fixées par son Conseil d'Administration, sont :

- d'accroître les connaissances dans le domaine des Sciences et Technologiques de l'Espace par l'organisation de cours de formation, séminaires, ateliers, conférences, … en vue d'améliorer les compétences techniques des spécialistes, enseignants, décideurs et de les tenir informés des progrès enregistrés dans les domaine ;
- d'assister les pays de la région au développement des capacités endogènes en matière de sciences et technologies de l'espace;
- de consolider les capacités nationales et régionales;
- de promouvoir la coopération entre les pays développés et les États membres ainsi qu'entre ces États;
- de développer l'expertise en Télédétection et SIG, en Télécommunications Spatiales, en Météorologie par Satellites et Climat Mondial, en Sciences de l'Espace et de l'Atmosphère;
- de fournir des services consultatifs aux États membres et aux institutions régionales qui ont font la demande; et
- de collecter et diffuser des informations ayant trait à l'espace et aux technologies spatiales.

3.1. La formation post-graduée et l'initiation à la recherche

Un des axes majeurs de l'action du Centre est la mise en œuvre de programmes de formations post-graduées et d'initiation à la recherche. Ces programmes qui s'adressent à des scientifiques ayant un niveau d'ingénieur conduisent à l'obtention d'un diplôme de **Master en Sciences et Technologies de l'Espace** dans la spécialité choisie. Ils comprennent deux phases:

- la phase I de 9 mois qui se déroule au siège du Centre et pendant laquelle les stagiaires reçoivent un enseignement théorique et pratique d'environ 1000 h; et
- la phase II de 12 à 15 mois, qui voit la réalisation d'un projet de recherche par le stagiaire, dans son pays d'origine et sur une thématique intéressant son institution. Au terme de cette phase, une soutenance de mémoire de recherche est organisée au Centre, devant un jury.

Les curricula de formation peuvent être consultés à: www.oosa.unvienna.org/SAP/centres/

Grâce au soutien d'institutions scientifiques marocaines, régionales et internationales, le CRASTE-LF a, depuis avril 2000 et jusqu'à ce jour, mis en œuvre six (06) formations post-graduées.

Ainsi, trois sessions de *formation en Télédétection et SIG (TSIG),* deux sessions de formation en *Télécommunications Spatiales (TS)* et deux de formation en *Météorologie par Satellite et Climat Mondial (MSCM)* ont concerné un total de plus de 80 stagiaires africains en provenance des Etats membres. En novembre 2005, une nouvelle session de formation post-graduée en Télédétection et SIG sera lancée.

Session	Période	Stagiaires	Pays
TSIG 2000	avr. 2000 – fév. 2001	12	*Algérie – Cameroun – Rep. Centrafricaine Maroc – Niger - Togo - Tunisie*
TS 2000	nov. 2000 – juil. 2001	10	*Algérie – Cameroun – Rep. Centrafricaine – Maroc Niger – Togo*
TSIG 2001	déc. 2001 – juil. 2002	15	*Algérie – Burkina Faso – Cameroun – Gabon – Maroc – Mauritanie – Niger - Togo - Tunisie*
MSCM 2002	fév. 2002 – oct. 2002	7	*Algérie - Maroc – Mauritanie Niger - Sénégal*
TS 2002	nov. 2002 – juil. 2003	13	*Algérie – Cap Vert – Maroc – Mauritanie Niger - Sénégal*
TSIG 2003	nov. 2003 – sept. 2004	14	*Algérie – Cameroun – Rep. Centrafricaine – Gabon – Madagascar – Maroc – R. D. Congo – Sénégal*
MSCM 2004	Nov. 2004 – juil. 2005	11	*Algérie - Cameroun – Maroc – Mauritanie – Niger - R. D. Congo - Sénégal – Togo*

- Bilan des formations post-graduées organisées au CRASTE-LF à ce jour -

Le Centre a par ailleurs commencé à enregistrer les soutenances de mémoires de Mastère résultant de l'achèvement de la phase II des cursus de formation. Les problématiques de recherches choisies s'inspiraient des préoccupations des institutions parrainant le candidat et ont produit, selon l'avis des jury universitaires chargés de les évaluer, des résultats de niveau scientifique appréciable.

A titre d'illustration sont présentés ci-après quelques uns des thèmes des mémoires de recherches soutenus au Centre. Le détail de ces mémoires est consultable à l'adresse http://www.oosa.unvienna.org/SAP/centres/morocco/index.html.

- Extraction et Analyse du tissu urbain par approche texturale et structurale à partir de l’imagerie satellitale à haute et très haute résolution.

- Application de la transformation en ondelettes à la classification texturale multi-résolution des images satellitales.

- Apport de la télédétection et des SIG au suivi de la dynamique de l’occupation du sol en milieu aride tunisien. Cas de l’observatoire Haddej Bou Hedma.

- Compression et transmission des images médicales par les terminaux à très petite ouverture d’antenne (VSAT).

- Contribution des images ETM+ de Landsat 7 à la mise à jour cartographique au 1/200.000. Cas de la feuille de Msila (High lands, Algérie).

- Évaluation de la contribution des images Ikonos à la cartographie topographique – Application à la cartographie à grande échelle.

- Étude de faisabilité d'un nano-satellite marocain dédié à la transmission du signal sismique.

- Contribution à l'étude de l'impact de la désertification sur la partie continentale du Parc National du Banc d'Arguin (Mauritanie).

- Proposition d'un modèle décisionnel intégrant l'approche systémique et l'analyse spatiale pour une gestion efficace des resources naturelles au Maroc.

- Bases de données multisources et gestion intégrée du littoral du Togo: procédures d'intégration des données multisources de l'occupation du sol.

- Validation du modèle global GOCART de l'Administration nationale pour l'aéronautique et de l'espace des Etats-Unis (NASA) et son apport à l'étude des variations mensuelles des phénomènes de sable sur la Sahara algérien.

- Technologie VSAT pour les communications aéronautiques au Cap Vert.

- Étude et conception d'une charge utile Telecom d'un picosatellite pour la mission A.P.R.S.

- Apport de la télédétection à la cartographie géologique dans la chaîne panafricaine des Dahomeyides, Région des Plateaux au Sud du Togo.

- Spatialisation du risque d'érosion à Torokoro (Burkina Faso): approche méthodologique d'intégration des indices de l'équation USLE par télédétection et SIG.

- Intégration des méthodes d'analyse multicritère dans un SIG – Application à la planification routière.

- Étude et réalisation du sous-système d'alimentation électrique d'un nanosatellite.

On notera cependant que de nombreux stagiaires éprouvent quelques difficultés dans la conduite de leur travail de recherche en raison d'un accès aux données problématique. Le renforcement de la coopération et l'établissement d'interfaces avec les centres producteurs de données spatiales utiles et avec les centres d'expertise permettra de contournement de ces difficultés. Ainsi, le prochain Atelier sur l'Utilisation des données Landsat pour la région nord de l'Afrique qu'envisage d'organiser le CRASTE-LF avec l'appui du Bureau des Affaires Spatiales des Nations Unies en juillet 2005 doit s'accompagner d'un transfert des archives et leur mise à la disposition des stagiaires et des Etats, ce qui constitue une mesure dont l'impact sera certainement appréciable.

Ce bilan traduit l'expérience acquise par le Centre depuis sa création, dans la mise en œuvre et le suivi des actions de formation diplômante pour lesquelles il s'est appuyé prioritairement sur les compétences et les expertises nationales et régionales. Il s'agit là d'une orientation fondamentale pour son action qui vise la constitution et la consolidation d'un espace régional de formation, de recherche, de coopération à même d'assurer la maîtrise et l'utilisation rationnelle des technologies spatiales et leurs applications au service du développement durable de la région.

3.2. L'animation scientifique

Dans le cadre de ses missions d'animation scientifique, le Centre a également mené de nombreuses activités. Ainsi, sur sollicitation de l'Union Internationale des Télécommunications, le Centre a organisé en juillet 2001 un atelier international sur la "*Réglementation et la Gestion du Spectre des Fréquences*".

Il a également pris l'initiative d'organiser en juin 2003, un Atelier International sur le thème "*Technologies Spatiales et Télémédecine*" avec l'appui du Bureau des Affaires Spatiales des Nations Unies (Vienne) et de l'Agence Spatiale Européenne (ESA), et le soutien de l'Agence Spatiale Canadienne, du Centre National d'Etudes Spatiales (France), de l'ISESCO, d'Eutelsat, de l'Organisation mondiale de la Santé (OMS), …

Le Centre a également organisé, en juillet 2004 et sur sollicitation de la National Oceanographic and Atmospheric Administration (NOAA – USA), un atelier de formation RIPI (*Ranet Internet Presence Initiative*) qui a concerné plus d'une trentaine de participants.

En novembre 2005 et à l'occasion du lancement de la 4ème session de formation post-graduée en Télédétection et SIG, le Centre envisage également, en partenariat avec l'Institut Scientifique de Rabat, l'Organisation Islamique pour l'Education, les Sciences et la Culture ISESCO, l'UNESCO et avec l'appui du Bureau des Affaires Spatiales des Nations Unies, de l'ESA et d'autres partenaires, la tenue d'un workshop intitulé : "*Information Spatiale et Développement Durable*".

L'action menée jusqu'ici par le CRASTE-LF le positionne désormais comme un partenaire crédible dans les initiatives à caractère régional et qui concernent l'utilisation de l'outil spatial. C'est à ce titre que l'initiative TIGER du Programme de Suivi du Sommet Mondial sur le Développement Durable du CEOS, visant à développer des services d'information durables en matière d'observation de la Terre à des fins de gestion des ressources hydrique en Afrique, a recommandé de s'appuyer en particulier sur les Centres tels que le CRASTE-LF pour le renforcement de capacités en Afrique.

De même, il a été demandé au Centre d'accompagner la mise en œuvre du Projet NAFREF de définition d'un Référentiel Géodésique Unifié pour l'Afrique du Nord, en particulier pour la réalisation de l'important volet formation qui y est prévu.

Par ailleurs, le Centre a été sollicité par le Secrétariat du SMOC (Système Mondial d'Observation du Climat – Organisation Météorologique Mondiale), pour participer à la *Définition d'un Plan d'Action pour l'Afrique Occidentale et Centrale*, à travers la formulation d'un projet relatif au renforcement de capacités en matière d'utilisation des données de l'observation spatiale.

C'est également à ce titre que des conventions de coopérations ont récemment été signées entre l'ISESCO ou avec le Centre Africain pour les Applications de la Météorologie au Développement (ACMAD), sans compter les conventions passées avec les organismes spécialisés des Etats membres.

(Voir adresse : http://www.oosa.unvienna.org/SAP/centres/morocco/index.html.)

4. Des actions multiformes pour promouvoir l'utilisation des technologies spatiales

S'appuyant sur ce bilan et au titre de sa mission et du mandat qui lui a été donné par ses Etats membre, le CRASTE-LF se considère pleinement engagé dans la définition et la concrétisation d'une **Stratégie Globale sur l'Utilisation des Technologies Spatiales pour le Développement Durable en Afrique**. A cela s'ajoute la spécificité du Centre d'utiliser le français comme véhicule de diffusion des connaissances et de communication, offrant de ce fait la possibilité d'éviter l'entrave que peut constituer la langue dans l'accès aux connaissances et au développement de contacts et d'échanges d'informations.

Afin d'apporter une contribution à sa réalisation, le CRASTE-LF se propose de déployer un dispositif de renforcement de capacités s'appuyant sur des actions multiformes, décrites ci-après et ciblant tous les acteurs du processus décisionnel pouvant impliquer le recours aux technologies spatiales.

Formations académiques et initiation à la recherche

Il est essentiel de pouvoir assurer la concrétisation du processus d'appropriation des connaissances et des savoirs et assurer sa **durabilité à long terme**, à travers l'émergence d'un véritable **réseau régional d'experts** dans le domaine des outils spatiaux et leur utilisation dans les problématiques liées au développement durable. Un des moyens d'y parvenir est la poursuite des formations diplômantes et d'initiation à la recherche dans le domaine des Sciences et Technologies de l'Espace telles qu'elles sont conduites dans les Centres affiliés aux Nations Unies. Ces actions permettront de disposer de personnels ayant les capacités de produire des résultats scientifiques originaux et de conduire des recherches appliquées.

Séminaires à l'intention des décideurs

Ces journées d'information seront destinées à présenter aux décideurs les avantages de l'observation spatiale par rapport aux enjeux actuels. Elles doivent constituer un effort permanent et viser à faire la démonstration du rapport coût-bénéfice lié à l'utilisation des données de télédétection et autres technologies spatiales. Les actions reposeront sur données très concrètes fondées sur les réalités de terrain, des études appropriées et des présentations attractives et auront un caractère démonstratif de l'apport des diverses technologies spatiales.

Stages de formation de courte durée pour les professionnels

Ces stages de formation viseront à donner aux techniciens les connaissances et outils nécessaires à l'exploitation opérationnelle des données issues l'observation spatiale. La programmation de formations de courte durée (3 à 4 semaines) abritées par le Centre, sur des thématiques ciblées démontrant l'usage des technologies spatiales à travers des exemples concrets, constitue un moyen efficace de familiarisation à ces technologies. Les Curricula de ces formations devront être déterminés avec soin, ainsi que les moyens pédagogiques nécessaires (données, logiciels, supports de cours, …), pour constituer un package pédagogique.

Conception et maintenance d'un site Web

Ce site permettra de tenir informé la communauté utilisatrice des techniques spatiales des développements technologiques les plus récents, des expérimentations et projets conduits, … Il mettra en contacts les experts impliqués dans l'exécution du projet ainsi qu'entre ces derniers et la communauté utilisatrice des données de l'observation spatiale qui y trouvera les conseils appropriés. Des cours en ligne pourront être proposés ainsi que toute information utile. Ce site permettra les échanges et la durabilité des contacts dont il est crucial d'assurer le développement et la continuité.

5. Conclusion

Il est aujourd'hui reconnu que les technologies spatiales ont un rôle important à jouer pour aider au développement durable dans ses composantes économiques, sociales et environnementales. En Afrique, le NEPAD, qui a pour ultime objectif de combler le retard qui sépare l'Afrique des pays développés, a tout à gagner en mettant à profit les technologies spatiales, notamment dans l'appréciation et l'exploitation des ressources naturelles.

Cependant, les technologies spatiales requièrent, pour leur mise en œuvre effective, un niveau d'information et d'expertise conséquent. Le renforcement des capacités en matière d'utilisation de ces technologies, en particulier à travers la formation, constitue une réponse à cette exigence mais c'est un processus de longue haleine qui doit être conduit dans une perspective à long terme. Ceci souligne l'urgence de la mise en œuvre d'une stratégie globale pour l'Afrique, dans ses différentes composantes.

La formation, l'éducation et l'information y apporteront la garantie de l'efficacité et de la durabilité. Il restera à réunir les conditions d'exécution de cette stratégie, à travers la consolidation des partenariats indispensables et la mobilisation des opportunités de financement. Le CRASTE-LF, au titre de sa mission, se considère pleinement engagé dans la concrétisation et la réussite des objectifs assignés par les Etats membres.

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DONNEES GLOBALES LANDSAT SUR L'AFRIQUE UN EXEMPLE: SUIVI DE L'EVOLUTION SPATIO - TEMPOREL DE LA VILLE DU RABAT AU MAROC

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Résumé

L'observation de la terre et de son environnement connaît actuellement un développement significatif justifié à la fois par sa contribution à une meilleure connaissance scientifique de notre planète Terre et par son apport à la solution des problèmes concrets tels que la surveillance de la pollution marine ou côtière, développement urbain, l'aménagement du territoire ou la gestion des ressources naturelles etc.

L'un des grands avantages de la télédétection spatiale est sa capacité à amasser périodiquement de l'information d'une même région de la Terre. Les caractéristiques spectrales et texturales de la région observée peuvent changer dans le temps. La comparaison d'images multitemporelles permet alors de détecter ces changements.

Dans ce contexte, le programme LANDSAT constitue le plus ancien système civil d'observation de la surface de la Terre. Il a démarré en 1972 et a produit la plus ancienne et la plus grande archive de données-image couvrant la surface de la Terre. L'initiative du gouvernement américain « Données Globales LANDSAT pour soutenir le développement Durable en Afrique » a permis de mettre à disposition de la communauté africaine les jeux de données relevant des années 1975, 1990 et 2000, actuellement disponibles au siège du Bureau des Affaires Spatiales de l'ONU à Vienne en Autriche et au CRASTE-LF (Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française) à Rabat au Maroc.

Dans ce cadre, le Bureau des Affaires Spatiales de l'ONU a organisé au siège du CRASTE-LF à Rabat, un atelier regroupant plus de dix représentants de pays africains ainsi que des stagiaires de la deuxième session de formation post-graduée en Météorologie Spatiale et Climat Global, et en présence des représentants du Bureau des Affaires Spatiales, du CRASTE-LF et de l'Organisation Islamique pour les Sciences, l'Education et la Culture (CRASTE-LF, 2005).

Au cours de cet atelier, nous avons sorti deux images de la base de données globale correspondant respectivement aux années 1987 et 2001 et sur lesquelles nous avons extrait les parties d'image qui couvrent la région sud de Rabat, zone ciblée par cette étude. La lecture de ces images qui s'est fait au laboratoire et sur le terrain, en présence de tous les stagiaires présents, a montré clairement l'apport des images Landsat dans l'identification des classes qui occupent la zone sud de Rabat et de suivre leur évolution entre 1987 et 2001.

Introduction

La ville de Rabat et son environnement ont subi depuis le début des années soixante dix, de profonds changements liés à une forte croissance socio-économique et un exode rural très accéléré, notamment pendant les grandes années de sécheresse qui ont affecté le Maroc (BZIOUI, 2004). Ainsi, depuis le début des années quatre-vingt de nouveaux espaces aménagés ont vu le jour: des zones résidentielles, des espaces verts, mais aussi des habitats insalubres. La partie sud de Rabat est parmi les secteurs les plus touchés par ce phénomène ce qui justifie son choix pour illustrer cette dynamique de changement spatio-temporel qui a affecté la ville.

L'objectif de ce travail d'identifier de façon simplifiée, à partir de l'imagerie Landsat, les différentes classes qui occupent le sol dans la région sud de Rabat, d'étudier leur évolution spatio-temporelle et d'examiner leurs affectations actuelles.

Il s'agit d'une application pratique présentée dans le cadre des cours et des travaux pratiques présentés à l'atelier « Données Globales LANDSAT pour soutenir le développement Durable en Afrique » organisée entre le 7 et le 9 Juillet 2005 par le Bureau des Affaires Spatiale de l'ONU et le CRASTE-LF en partenariat avec l'Organisation Islamique pour les Sciences, l'Education et la Culture (CRASTE-LF, 2005).

La démarche entreprise dans ce travail sera d'abord visuelle. Nous avons réalisé au début la photo-interprétation des extraits d'images Landsat en composition colorée couvrant la zone d'étude. Nous nous sommes rendu par la suite sur le terrain pour faire les opérations de contrôle et d'identification pour constater les différents changements et les nouvelles affectations de terrain.

P1 : ***Contrôle sur le terrain de la carte d'occupation du sol dressée par photo-interprétation de l'image Landsat en composition colorée***

Contexte géographique

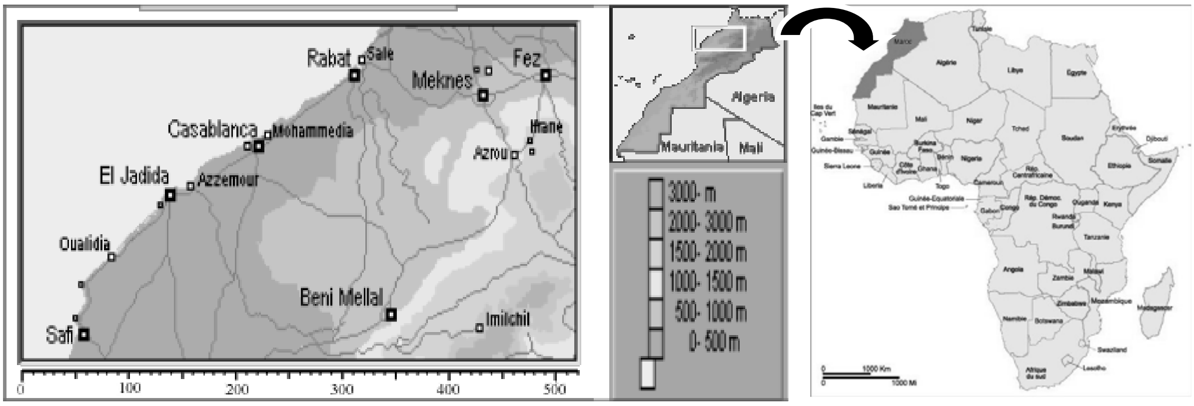


Fig. 1- Localisation de la ville de Rabat dans le littoral atlantique

La ville de Rabat, capitale administrative du Royaume de Maroc, se trouve sur la côte Atlantique à l'embouchure du Bou Regreg, compte environ 700.000 habitants (1,8 million si l'on compte l'ensemble des deux villes jumelles Rabat et Salé). Ville commerciale et industrielle (textiles, denrées alimentaires), c'est avant tout le centre politique et administratif du pays. A l'images des grandes villes marocaines, Rabat a connu ces trente dernières années, une développement urbain accéléré et une nouvelle redistribution des terres dans son périmètre urbain et extra-urbain.

Matériel et méthodes

1. Données

Les images utilisées ont été extraites de jeux de données Landsat mis à disposition par le gouvernement des Etats Unis d'Amérique et qui fournit une couverture entière en images de tout le continent africain sur trois périodes : 1975, 1990 et 2000.

Les images ont pour mission de servir et soutenir les activités nationales dans les secteurs de gestion de ressources naturelles, le contrôle environnemental, la sécurité environnementale, la gestion de désastre et le développement durable.

Elles sont fournies à un niveau de traitement élevé, géocodées et orthorectifiées dans le système de projection Universal Transverse Mercator (UTM). Elles se présentent sous forme de scènes cataloguées et hiérarchisées selon le path et le row (fig. 2). Chaque scène est constituée par des quick-look (images dégradées en format JPEG) et des canaux Landsat individuels et en format compressée. Les images originales sont en format Geotiff.

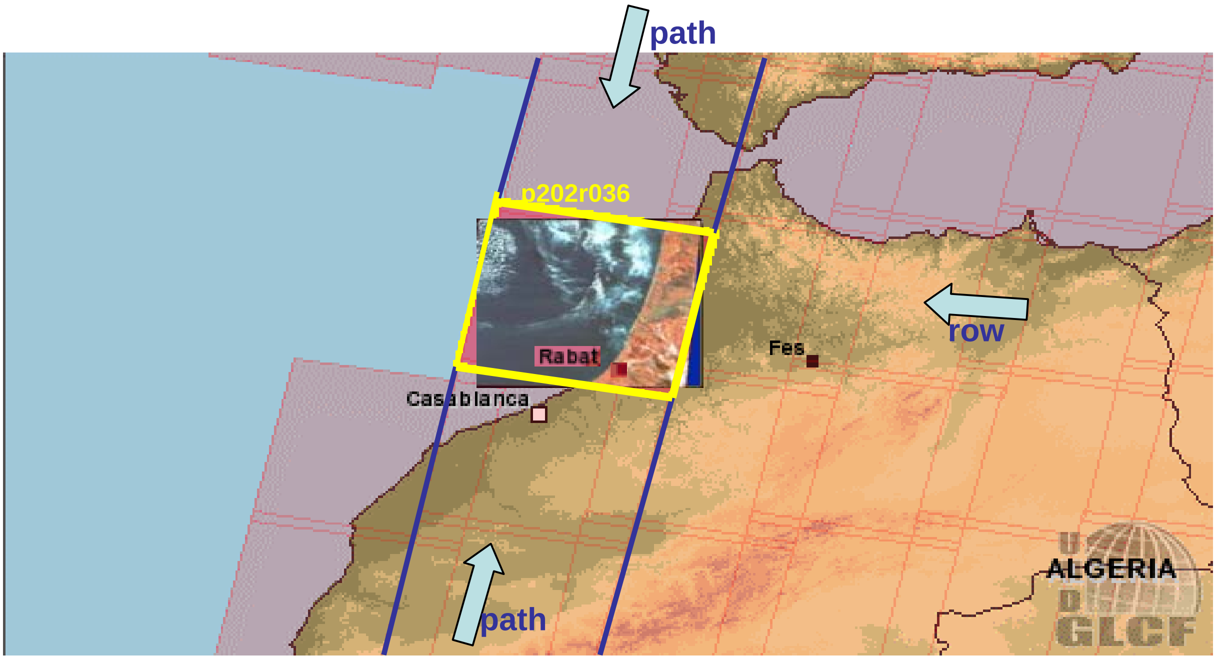


fig.2 : Image Landsat couvrant la ville de Rabat (Path 202, Row 036)

2. Extraction de l'information

Pour la réalisation de ce travail, nous avons extrait de la carte topographique au 1/50.000 et des images Landsat de path & Row 202/036, la zone qui couvre le secteur d'étude situé au sud de Rabat (fig. 3) :

- L'extrait de l'image **Landsat5-TM** acquise le 06.01.1987 qui représente la réalité de terrain en 1987, date antérieure aux grandes constructions urbaines; et
- L'extrait de l'image **Landsat7-ETM+** acquise le 10.04.2001 qui représente la réalité de terrain actuelle, postérieure aux grandes aménagements urbains.

Nous disposons donc pour ce travail d'une réalité de terrain très variable dans le temps (fig.3) ; la dernière acquisition date de presque quatre ans, il faudrait en tenir en compte lors de l'interprétation.

La comparaison des trois documents montre un grand développement urbain de la ville de Rabat. Nous sommes en effet passés, d'une situation initiale en 1970 avec un très petit noyau urbain et des habitations très dispersées au centre de la zone d'étude, à une situation en 2001 qui se caractérise par le développement de deux centres urbains bien distincts:

- le premier au Nord-Est constitue le quartier Hay Riad; et
- le deuxième au Sud-Ouest forme la cité de Témara.

Fig. 3a -Extrait de la carte topographique de Rabat au 1/50.000 (1970)

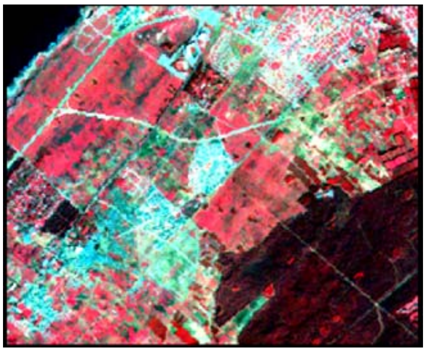


Fig. 3b -Extrait de l'Image Landsat5-TM de 1987 en composition colorée 4, 3,2

Fig. 3c -Extrait de l'Image Landsat7-ETM+ de 2001 en composition colorée 4, 3, 2

Fig. 3: Changement dans l'Occupation du sol entre 1970, 1987 et 2001

Pour ne pas trop compliquer la tache de photo-interprétation, nous avons choisi de discriminer quatre classes aisément identifiables sur les extraits d'images Landsat en composition colorée (4, 3, 2): les plans d'eau, les zones boisées, les zones urbanisées et les sols.

La démarche entreprise donc dans ce travail est visuelle et la réalisation de la carte d'occupation du sol s'est faite par le processus de photo-interprétation des extraits d'images Landsat qui couvrent la zone d'étude, soit en composition colorée (4, 3, 2), soit en canaux pris individuellement. Cette opération a été suivie par d'une campagne de terrain pour contrôler le travail d'identification et améliorer la qualité de la carte.

La photo-interprétation des images satellitales est dominée essentiellement par l'analyse des tonalités, des structures et des textures et la recherche des anomalies. On peut cependant schématiser ces processus d'analyse en mettant en évidence six niveaux de perception qui sont: la teinte, l'assimilation, la forme, la structure, la texture et les indices indirects (EMRAN et al., 1988)

Résultat

1. Les Plans d'eau

L'eau apparaît sur les images à l'ouest de la zone d'étude dans le littoral atlantique (fig.3). L'eau est facilement reconnaissable grâce a sa réflectance très faible et décroissante (fig.4-Profile 1), ce qui se traduit par une teinte noire sur les compositions colorées Landsat, avec parfois une tendance vers le bleu-vert surtout prêt de la côte.

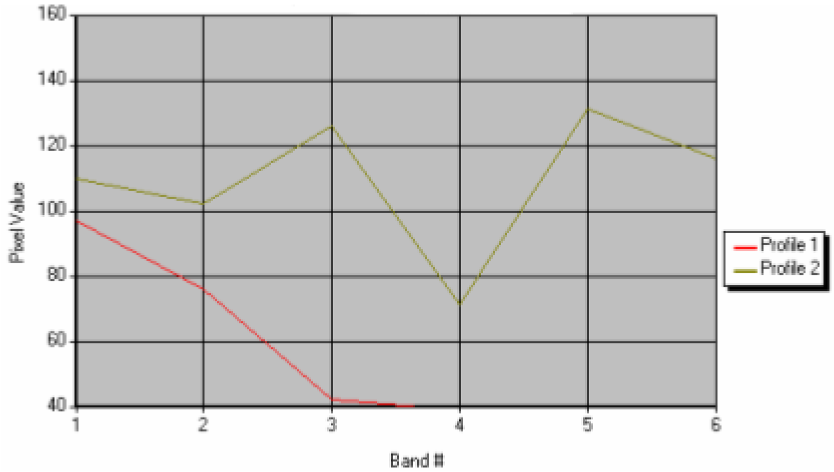


fig. 4 Signatures spectrales de l'eau (Profile 1) et de bâti (Profile 2)

2. Les zones urbanisées

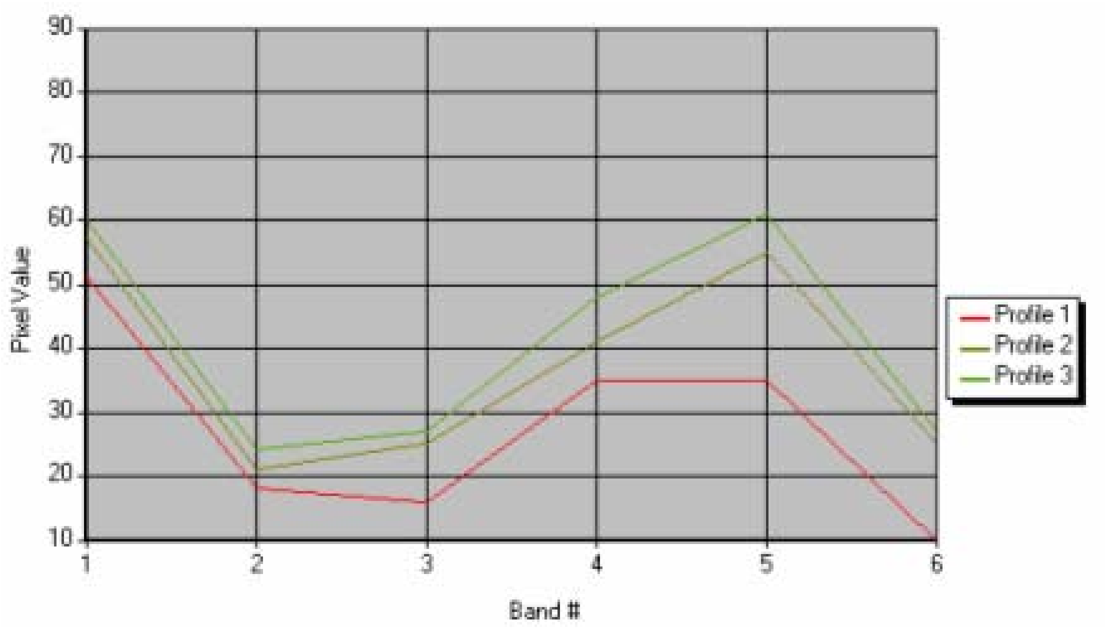
Les zones urbanisées se localisent au centre de l'image et sont orientées selon un axe Nord-Est – Sud-Ouest. Elles sont identifiables grâce à leur forte réflectance dans les petites longueurs d'ondes "Canal 2 et 3 de l'image Landsat" (fig. 4- Profile 2). Ceci se traduit par un ton bleuté sur la composition colorée (4, 3, 2).

Le bâti se caractérise aussi par une texture en quadrillage qui peut changer en fonction de la nature de l'habitat (densité, forme etc.). Nous remarquons à ce niveau un développement urbain très important entre 1987 (fig. 3b) et 2001 (fig. 3c).

Cependant, nous pouvons distinguer dans les zones urbanisées du Sud de Rabat, une meilleure organisation vers le Nord-Est (texture quadrillée) dans le quartier Hay Riad avec des parcellaires nettes et espacées. Vers le Sud-Ouest, dans la cité de Témara, la texture en quadrillage présente une maille très serrée avec une très forte réflectance dans le bleu, ce qui témoigne de la densité des habitations et une désorganisation du bâti.

3. Les zones boisées

Les zones boisées peuvent être discriminées grâce à leur texture rugueuse. Elles possèdent toutefois plusieurs tonalités dont nous avons pu séparer au moins trois (fig. 5 et 6) :



1. un ton rouge caractéristique d'une signature spectrale typique de la forêt de chêne liège (fig. 5- Profile 1) -- Subéraie (Ghabat de Témara) ;
2. un ton vert caractéristique de la forêt d'Eucalyptus de la ceinture verte de Rabat (fig. 5-Profile 2);
3. un ton sombre caractéristique de la forêt des conifères de la ceinture verte de Rabat avec des valeurs de réflectance très basses (fig. 5 – Profile 3).

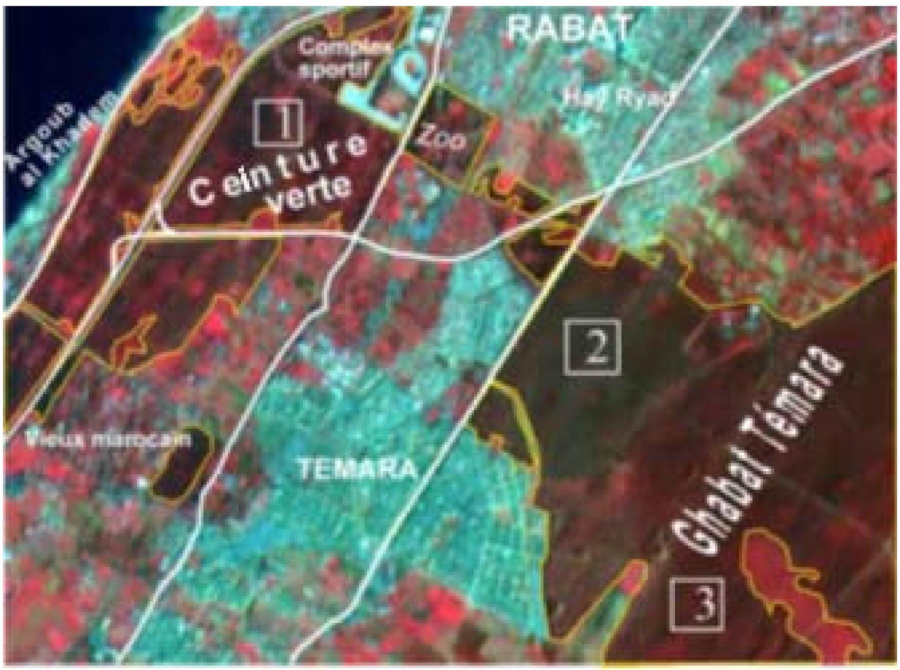


fig. 6 Extrait de Image Landsat-ETM+ en composition colorée (4, 3, 2) de Path 202 & Row 036, acquise le 10.04.2001

4. Les sols

Dans les classes des sols nous pouvons distinguer les sol nus et les sol couverts :

- les sols nus, démunis de couvert végétal, possèdent une signature spectrale très typique, caractérisée par une forte absorption depuis les petites longueurs d'onde du visible, qui caractérise les sols rouges de la région de Rabat (fig. 7- Profile 1);

- les sols couverts ont une signature typique de couvert végétal (fig. 7- Profile 2), faible réflectance dans le rouge (canal 3 de Landsat) et très forte réflectance dans le proche infrarouge (PIR) (canal 4 de Landsat) d'où son ton rouge vif sur la composition colorée (4, 3, 2).

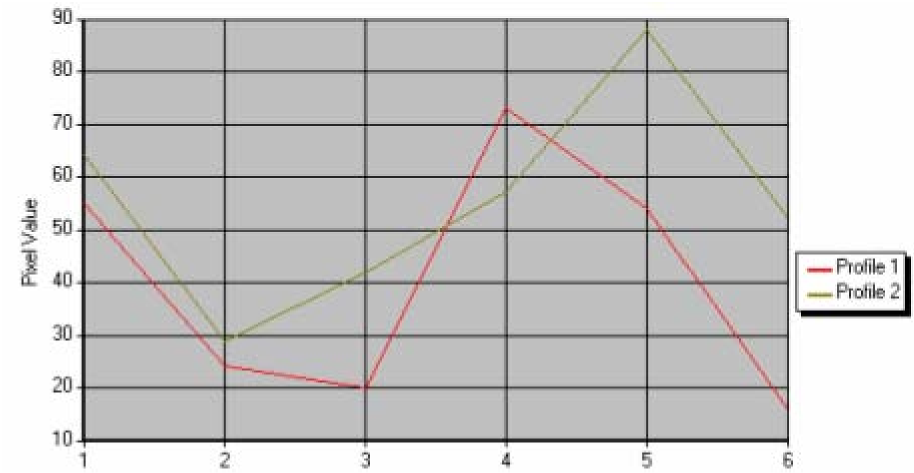


fig. 7 Signatures spectrales des sols nus (profile 1) et des sols couverts (Profile 2)

Sur la composition colorée (fig. 6), les sols sont discriminés soit par un ton rouge vif, lorsqu'ils disposent d'un couvert végétal, soit par un ton vert-bleuté lorsqu'ils sont nus, ce qui traduit la signature du minéral.

Lors de la réalisation de la carte d'occupation du sol nous nous sommes contentés d'une seule classe pour les deux classes des sols, vu leur caractère très changeant et fluctuant.

Carte d'Occupation du sol de la partie sud de Rabat

Sur la carte d'occupation du sol réalisée au laboratoire et contrôlée sur le terrain, nous avons pu discriminer les principales classes qui occupent la zone d'étude: les plans d'eau, les zones urbaines, les zones boisées et les sols (fig. 8).

La comparaison entre la carte topographique de 1970 et les images Landsat acquises en 1987 et 2001 a permis de suivre l'évolution spatio-temporelle de l'occupation du sol dans la région sud de Rabat. Nous constatons à partir de ce document (fig.3 et 8):

- Une avancée considérable du bâti selon un axe orienté Nord-Est – Sud-Ouest avec deux centres urbains: le quartier Hay Riad au Nord-Est et la cité de Témara Sud-Ouest;

- Une avancée très importante des zones boisées qui marquent la ceinture verte autour de Rabat;

- Un recul spectaculaire des sols couverts et non couverts sur toute l'étendue de la zone d'étude.

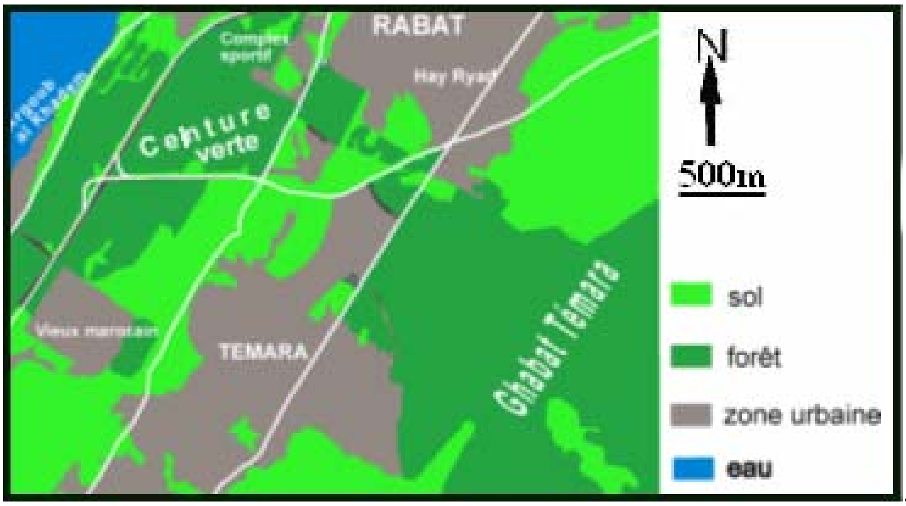


fig. 8 Carte d'occupation du sol de la partie sud de Rabat réalisée à partir de l'image Landsat7-ETM+ (10.04.2001)

Conclusion

A partir de l'analyse diachronique de deux images Landsat acquises entre 1987 et 2001 et de la carte topographique présentant l'occupation du sol an 1971, nous montrons l'intérêt et les possibilités qu'offrent les images Landsat pour analyser des changements spatio-temporels aussi importants que l'occupation du sol dans une région très dynamique comme la ville de Rabat, qui se caractérise par une pression anthropique intense générant une extension considérable et rapide.

Dans ce contexte, la base de données globales LANDSAT devient donc très importante, car elle offre gracieusement des images de grande qualité, acquises à trois dates différentes et repartis sur les trente dernières années.

Nous pouvons considérer qu'aujourd'hui les chercheurs africains disposent enfin d'une base globale qui faisait défaut pour l'étude des ressources naturelles, la gestion des catastrophes et le développement durable.

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AFRICAN REGIONAL CENTRE FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION – IN ENGLISH LANGUAGE (ARCSSTE-E)

(AFFILIATED TO THE UNITED NATIONS)

Mission Statement

The African Regional Centre for Space Science and Technology Education – in English Language (ARCSSTE-E) aims to build high quality capacity and a critical mass of indigenous educators in English-speaking African countries in the application of space science and technology for sustainable national, regional and continent-wide development.

Background

The second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), held in Vienna, Austria in 1982, recommended that the United Nations Programme on Space Application should focus its attention, inter alia, on the development of indigenous capabilities in space science and technology at the local level. That recommendation was endorsed by the United Nations General Assembly in its resolution 37/90 of 10 December 1982.

In its resolution 45/72 of 11 December 1990, the Assembly further endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPOUS) that the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries (A/AC. 105/456, annex II, paragraph 4[n]). In various United Nations documents such as the progress report on the regional centres (document A/AC.105/498 of 1992) and the updated project document on the centres (document A/AC.105/534 of 1993), the United Nations Office for Outer Space Affairs outlined a number of steps to translate the above-mentioned General Assembly resolutions into operational programmes. One of those steps was the organization of an evaluation mission to each of the countries that offered to host a regional centre. In Africa, the following countries were visited: Ghana, Kenya, Morocco, Nigeria, Senegal and Zimbabwe. Nigeria won the offer due to its numerous existing facilities in the field of space science and technology and its well-trained human resources in different aspects of space education and activities. A similar Centre was established in Morocco for the benefit of francophone countries in Africa.

Inauguration

The African Regional Centre for Space Science and Technology Education – in English Language (ARCSSTE-E), as it came to be known, was inaugurated on 24 November 1998. The previous day had witnessed the official meeting of government representatives from many English-speaking African countries, as well as the preparation of the Draft Agreement that established the Centre, under the chairmanship of Adigun Ade Abiodun of the Office for Outer Space Affairs. The inauguration ceremony was chaired by the former Nigerian Minister for Science and Technology, Major-General Sam Momah, at an event attended by some representatives of English-speaking African countries. Notable among those were Egypt, Ghana, Liberia, Namibia, Sierra-Leone, The Gambia and host Nigeria.

Mandates of the Centre

The Centre has a four-point mandate-- to train at the postgraduate level, in the following areas:

- Remote sensing and geographic information systems (GIS)
- Satellite meteorology and global climate
- Satellite communications
- Space and atmospheric science

In carrying out this task, ARCSSTE-E draws a lot of institutional support from many top-grade institutions in the country. These are affiliates of the Centre in terms of manpower exchange and research collaboration.

Some institutions in Nigeria that are affiliated with the Centre include:

- The Regional Centre for Training in Aerospace Surveys (RECTAS), Obafemi Awolowu University (OAU), Ile-Ife.
- University of Nigeria, Nsukka.
- University of Lagos, Lagos
- Bayero University, Kano
- Federal University of Technology, Minna.
- University of Ilorin, Ilorin.
- Federal University of Technology, Akure.
- National Centre for Remote Sensing, Jos.
- Rivers State University of Science and Technology, Port Harcourt.
- Centre for Information and Communication Technology Development, OAU, Ile-Ife.

Goals of the Centre

- **Short-term**

In addition to the primary goal of the Centre, the immediate objectives of the Centre according to Article II of its objectives are to:

(a) Develop the skills and knowledge of university educators, environmental research scientists, communication engineers and others in the four principal areas of remote sensing/GIS, space and atmospheric science, satellite meteorology and global climate and satellite communications;

(b) Assist educators to develop environmental and atmospheric sciences curricula that can be used to inculcate and advance the knowledge of the students in space science and technology;

(c) Assist research scientists and project personnel in preparing space-derived information for presentation to the policy and decision makers in charge of national and regional development programmes;

(d) Enhance regional and international cooperation in space science and technology programmes;

(e) Assist in disseminating to the general public, the value of space science and technology in improving the everyday quality of life;

(f) Stimulate the use of satellite communication in the improvement of telecommunications and information networks; and

(g) Ensure that African countries are part of the global information society, using leapfrog technologies provided by satellite communication.

- **Medium-term**

In the medium-term, the Centre will work at achieving the following goals:

(a) Developing environmental and atmospheric sciences curricula that can easily be taught and demonstrated at high schools and universities in each country;

(b) Effectively preparing educators to teach classes in these disciplines upon their return to their institutions;

(c) Actively participating in regional and international environmental programmes such as the International Geosphere-Biosphere Programme (IGBP) and the United Nations Environment Programme (UNEP); and

(d) Contributing to the understanding and support of international actions on such issues as global warming and climate change, ozone layer depletion, global deforestation, land degradation and management of coastal marine environment, among others.

- **Long-term**

In the long-term, the Centre will achieve the following objectives:

(a) Contribute to sustainable management of natural resources (air/water/land);

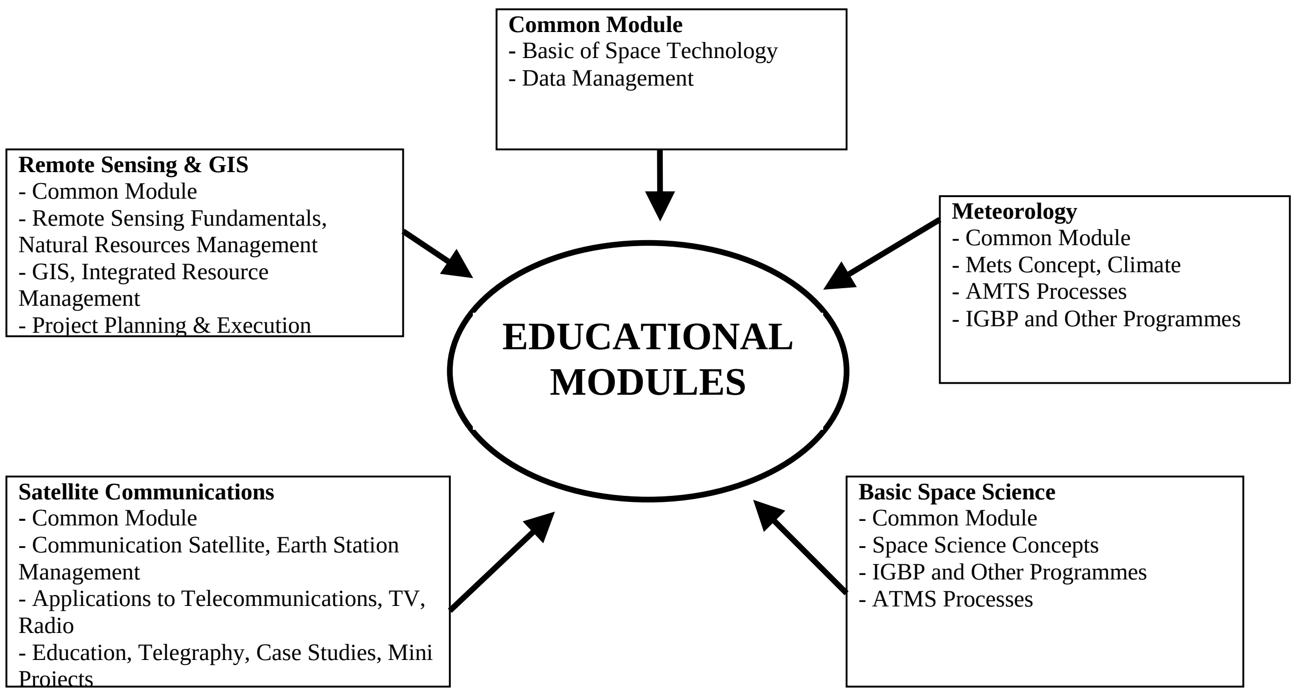
(b) Provide an input for biodiversity conservation and other related environmental programmes through the development of in-depth knowledge and skills of educators, research and application scientists, engineers and other professionals in environmental information systems, with an emphasis on remote sensing, satellite meteorology and relevant technologies at the local level;

(c) Activities at ARCSSTE-E will lead to the development of an indigenous capacity and capability in the region so as to enable local resource design and the implementation of education, research and application programmes, with environmental and natural information systems being the initial area of interest. This process should equip participating Member States in the region to afford the requisite skills and knowledge in space-based Earth Observing Systems (EOS) and GIS. Such competencies will enable the implementation of national development programmes, particularly those contained in Agenda 21;

(d) The successful establishment of the programmes in education, research and applications will create multiplier effects that will be sustained by national motivation and commitments; and

(e) The Centre will also enter into partnerships with international organizations in the space industry. International cooperation will enable students and citizens of Member States to take advantage of modern and advanced facilities.

Educational programmes at the Centre



The Centre executes a well developed and interlinked modular format covering its four-point mandate. There is a module common to all the programmes, which deals with the basic concepts in space science and technology, as well as data management related to space technology applications.

The Common Module is designed to provide a uniform idea of basic understanding in space technology to all the participants in the other education modules. The Common Module lasts for three months. The different education modules planned by the Centre are described below.

Remote sensing and GIS

The Remote Sensing and GIS module places an emphasis on the utilization of remote sensing for efficient resources utilization and management, hence generating sustainable plans for development, with an emphasis on Natural Resources and Environmental Management (NREM). This module would cover: Fundamentals of Remote Sensing; Concepts of Resource Management and Science of Sustainable Development; GIS and Global Positioning System (GPS) technology concepts; Integrated Resources Development; Carrying Capacity Assessment; and Environmental Management based on Global Issues and Project Planning for NREM. The Module is designed as a nine-month programme.

Satellite communications

The Satellite Communications module is taught with an emphasis on the understanding of communications technology and its applications for providing services for education, health care, rural communications, etc. Satellite-based communications are the only means for reaching out to the world and it is towards this that the module will be focused. The module will cover systems design and system engineering in satellite communications areas, including undertaking major projects for demonstration and validation of system concept and their applications and design, fabrication and the testing of specialized ground and space hardware. This programme is envisaged to last for nine months, including the three-month Common Module.

Satellite meteorology

The Satellite Meteorology and Global Climate module is directed towards research and study of climate and weather modelling, with a view to understanding and managing such phenomena as cyclones, rain-storms, cloud dynamics, etc. The programme will include, but will not be limited to, aspects of satellite meteorology, El Niño and Southern Oscillations Index in the region. The impact of the sub-tropical high pressure systems, Monsoon systems, the subtropical jets, the African Easterly jets, oceans processes, the Earth’s boundary layer processes, etc., on the weather and climate regimes of the continent as revealed by meteorological satellites, will form an important part of the programme. The programme will last for six to nine months, including the three-month Common Module.

Space and atmospheric science

The Space and Atmospheric Science module places an emphasis on the understanding of the basic aspects of space and atmospheric sciences (and technology). The programme is research-oriented, and will include research programmes in the Earth's atmosphere and its change over the region/globe; ionosphere and solar terrestrial interaction; space science; and data acquisition and modelling. The module will cover system design and system engineering desired space technology systems; undertaking projects for demonstration and validation of systems concepts and their applications and design; and fabrication and testing of simple and specialized space technology hardware. The programme will have a duration of six months, including the three-month Common Module.

The post-graduate diploma programme

ARCSSTE-E has offered a post-graduate programme since 2000. The first batch of graduates included three Nigerians and two Liberians. They received their diplomas in the Remote Sensing and GIS module of the mandate. The post-graduate diploma usually runs for nine months of rigorous coursework followed by a 12-month practical on relevant areas of national need in the student's home country. The diploma is awarded after the completion of the practical work and submission of thesis to the Centre.

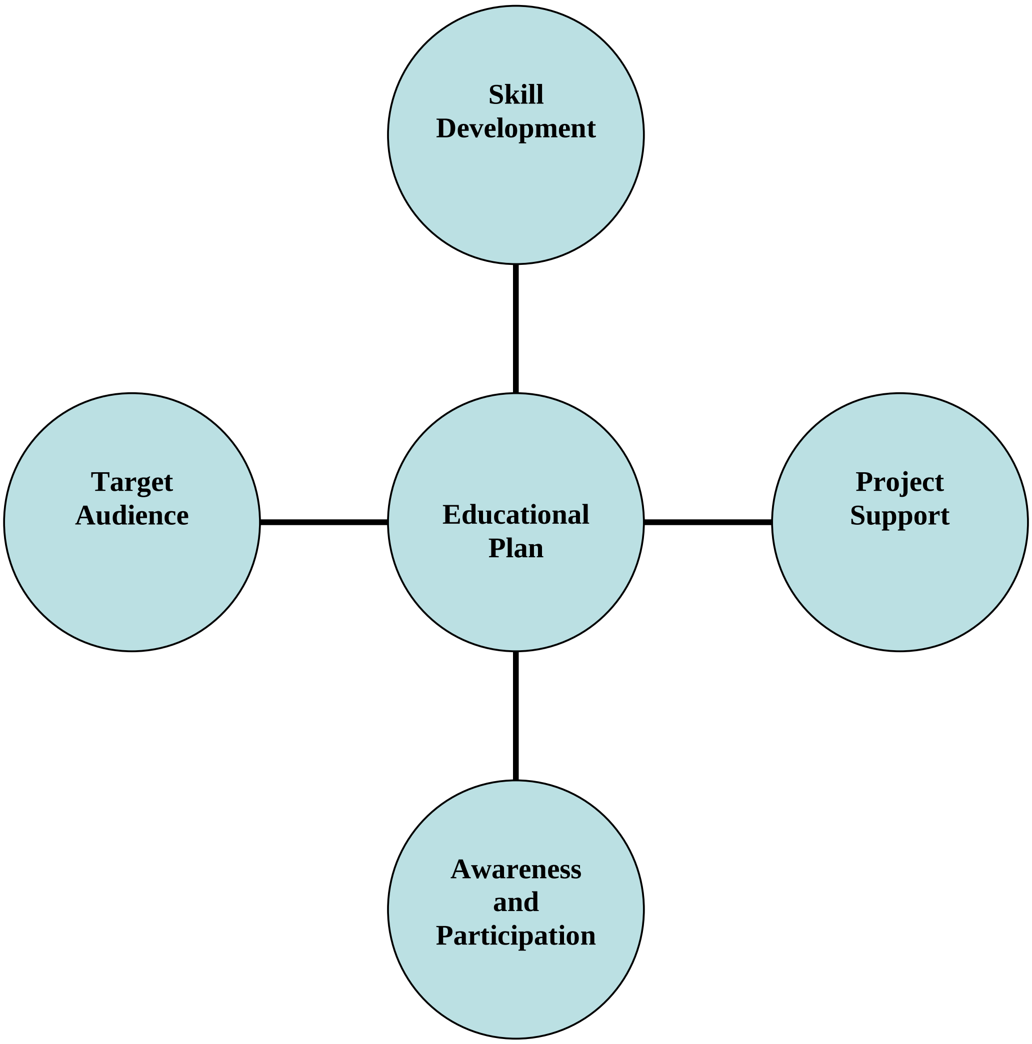
The programmes are advertised both internally (within Nigeria) and externally within the participating African countries i.e. Angola, Botswana, Cameroon, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mozambique, Namibia, Nigeria, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, The Gambia, Uganda and Zimbabwe.

Eligibility

Applicants are expected to have a Bachelor's degree from an internationally recognized university/institution. A minimum of five years of postgraduate experience in teaching, research or practical work-experience in any field of natural sciences, telecommunications, broadcasting, healthcare, disaster monitoring, etc. is desirable. In cases of applicants with higher qualifications, this requirement could be waived. Policy and decision makers from ministries, government agencies, or parastatal organizations are particularly encouraged to apply.

Educational plan

The overall educational plan is centred on achieving some basic results. The schematic below shows the manifestation of the Centre's educational plan in four cardinal domains.



These domains consist of:

Target audience

- University professors
- Researchers
- Scientists
- Non-governmental organizations
- Government agencies and institutions
- Science teachers in elementary and secondary schools
- Project personnel

Skill development

- Earth observation system
- Satellite communications

- Space and atmospheric sciences
- Satellite meteorology

Project support

- Project planning
- Project execution
- Policy development

Awareness and participation

- Scientific/research information
- Public awareness programmes
- Outreach programmes for elementary and secondary schools

Management of the Centre

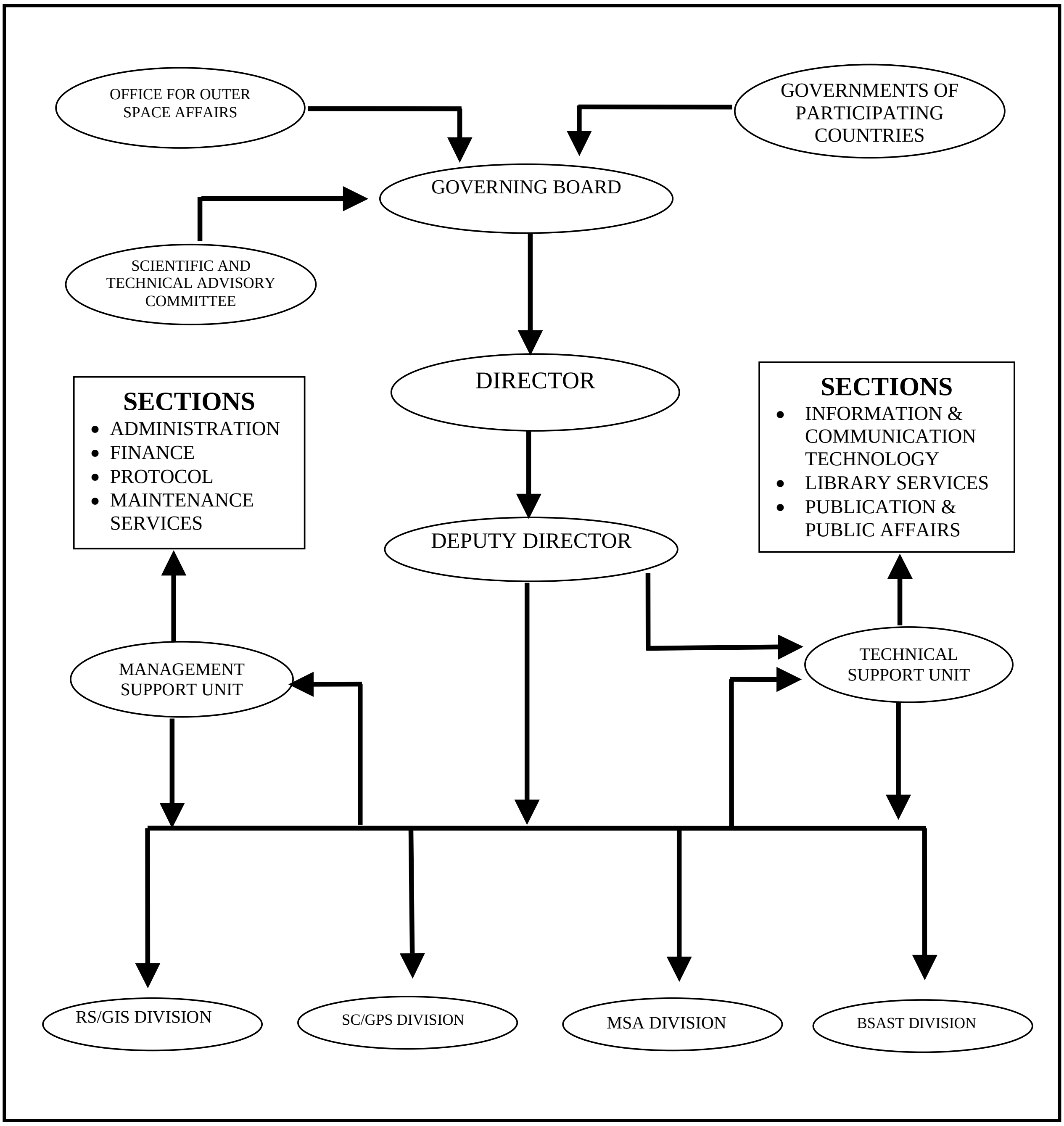
ARCSSTE-E, like the other regional centres affiliated to the United Nations, is administered by a Governing Board, which is the principal policy-making organ of the Centre. The Governing Board oversees every aspect of the Centre and is comprised of the Ministers of Science and Technology of the participating English-speaking African countries (or their representatives) who have agreed, through their signing of the Centre's agreement, to the goals of the Centre. They are fully committed to working in cooperation with other Member States of the region for the Centre's well being.

The Governing Board as described above is necessary for the Centre because the citizens of Member States are more familiar with their own peculiar needs and aspirations, capabilities and resources, and are better equipped to find solutions to local problems.

The day to day implementation of the Centre's mandate was originally meant to be handled by a team comprising the Director, Deputy Director and a team of top level personnel who are elected based on the contribution of their sponsoring governments. The Director of the Centre is automatically the Secretary of the Governing Board; however, since the Centre's Governing Board is yet to be constituted (since 1998), Nigeria the host country gets to fill the top level management with its nationals.

In streamlining the operations and management of the Centre, there exists an instrument which allots the general and specific responsibilities of the entities comprising the Centre. These are broken into unit, section and division. This instrument also spells out the roles and responsibilities of each participating country, the United Nations, the Host University and other supporting institutions and agencies. Under this guiding document, the institutional framework that defines and supports the structure, activities and operations of ARCSSTE-E are represented in the organigram below.

ARCSSTE-E ORGANIGRAM



II. INTERNATIONAL HELIOPHYSICAL YEAR 2007

PLANNING THE INTERNATIONAL HELIOPHYSICAL YEAR (IHY)

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Abstract

The International Geophysical Year (IGY) of 1957, a broad-based and all-encompassing effort to push the frontiers of geophysics, resulted in a tremendous increase of knowledge in space physics, Sun-Earth Connection, planetary science and the heliosphere in general. Now, 50 years later, there is a unique opportunity to further advance knowledge about the global heliosphere and its interaction with the interstellar medium through the International Heliophysical Year (IHY) in 2007. This will be an international effort that will raise public awareness of space physics.

IHY 2007 will coincide with the fiftieth anniversary of IGY, the most successful international science programme of all time. However, the tradition of international science years began almost 125 years ago with the first international scientific studies of global and polar processes in 1882-3 (Figure 1). A second International Polar Year (IPY) was organized in 1932, but a worldwide economic depression curtailed many of the planned activities. IHY will continue the legacy of these previous events, extending global synoptic study to the heliosphere.

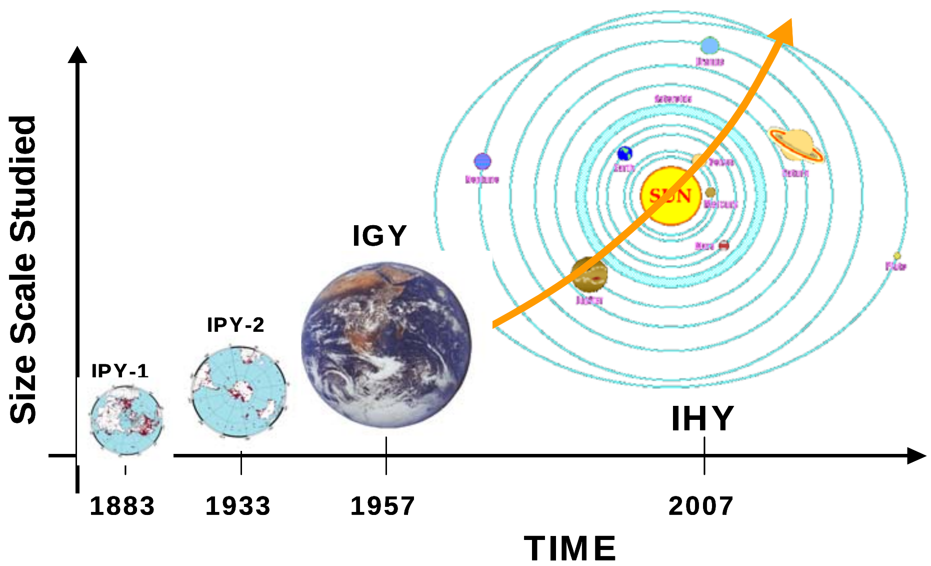

Figure 1. IHY is the natural extension of IGY to the larger heliospherical system

Introduction

On 4 October 1957, only 53 years after the beginning of flight in Kitty Hawk, the launch of Sputnik 1 marked the beginning of the space age; as mankind took the first steps to leaving the protected environment of Earth's atmosphere. Discovery of the radiation belts, the solar wind and the structure of Earth's magnetosphere prepared the way for the inevitable human exploration to follow. Soon, Cosmonauts and Astronauts orbited Earth, and then in 1969, Astronauts landed on the Moon. Today, a similar story is unfolding: the spacecraft Voyager has crossed the termination shock and will soon leave the heliosphere. For the first time, humans will begin to explore the local interstellar medium. It is inevitable that, during the next 50 years, exploration of the solar system including the Moon, Mars and the outer planets will be the focus of the space programme, and like 50 years ago, unmanned probes will lead the way, followed by human exploration.

The National Aeronautics and Space Administration (NASA) of the United States of America now operates nearly 30 missions, at strategic positions throughout the heliosphere, observing the plasma processes on the Sun, interplanetary space plasmas and various physical processes in Earth's atmosphere. Missions such as the Solar and Heliospheric Laboratory (SOHO), the Solar-B solar physics satellite (2006) and the Solar Terrestrial Relations Observatory (STEREO) (2006) provide unprecedented observations of solar processes. The Advanced Composition Explorer (ACE) provides solar wind monitoring upstream of Earth, while missions such as Cluster and the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) observe the response of the magnetosphere at the largest and smallest scales. Ulysses provides unique measurements of the solar wind far out of the ecliptic, and Voyager is set to leave the heliosphere entirely, providing the first in situ observation of the local interstellar medium.

Furthermore, with the phenomenal improvement of ground-based and space-based observations, the opportunity to observe these processes has never been better. Today, ground observatories routinely observe the ionosphere with ground radars, energetic particles with chains of neutron monitors and arrays of magnetometers monitor changes in Earth's magnetic field. Solar observatories provide images at resolutions that were only possible from space 10 years ago.

Large scale computer modelling has made it possible to assimilate and couple these diverse observational inputs, driving the need for cross-disciplinary studies that transcend traditional boundaries in space physics. It is now widely recognized that evolution in the magnetized plasma portion of the solar system proceeds through a set of universal physical processes, i.e. reconnection, particle acceleration, plasma wave generation and propagation, etc. These processes occur in the atmosphere of the Sun, the Earth and other planets; in the interplanetary medium; and in the outer reaches of the heliosphere where the solar wind meets the interstellar medium. During IHY, by studying universal processes in diverse environments, and in a comparative way, new scientific insights will be gained.

The cross disciplinary focus on universal processes assures a physics-based approach to the interpretation of observed phenomena, heliophysics, and allows the development of a comprehensive view of heliophysical systems. IHY will further the exploration out to interstellar space by encouraging modelling and observation of the outer heliosphere and the region near the termination shock. IHY will expand the legacy of synoptic observation, begun over 100 years ago with the first IPY in 1882-3, and provide a unique opportunity to foster international science.

History of international science years

The IHY proposal follows a tradition of international cooperation in scientific research begun in the 19th century, which consisted of the First and Second International Polar Years, followed by IGY in 1957.

The First IPY was the idea of an Austro-Hungarian Naval lieutenant, Karl Weyprecht (de V. Heathcote, Neils H., Annals of the International Geophysical Year, 1, 1959). Weyprecht (Figure 2) had just returned from a polar expedition, where he commanded one of the research vessels. In January 1875 at the Academy of Sciences in Vienna, Weyprecht expressed his ideas to establish an international collaboration to obtain a set of simultaneous observations, extending over a considerable time period, at various locations around the Arctic. The concept was presented again in September 1875 at the 4th Meeting of the Association of German Naturalists and Physicists in Graz. In 1877 a detailed programme was prepared and submitted to the International Meteorological Congress.

Figure 2. Lieutenant Karl Weyprecht first proposed IPY in 1875 after returning from an Arctic expedition. (From Chapman, 1959)

In 1879 the International Meteorological Congress met in Rome and recognized the importance of the proposal. From 1 to 5 October 1879 the 1st International Polar Conference (IPC) met in Hamburg, Germany. It was determined that a minimum of eight Arctic stations were needed to obtain observations of at least one-year duration. The Conference also established the IPC with representatives from Austria, Denmark, France, Germany, Hungary, the Netherlands, Norway, Russian Federation and Sweden. Dr. G Neumayer of Hamburg was the first Commission president. In July 1880 the 2nd IPC met in Berne, Switzerland. There, an Italian representative joined the existing representatives, and Prof. H. Wild became the second president. On 1 August 1881 the 3rd IPC met in St Petersburg, Russian Federation. The United States joined the group, and a programme of observations was adopted. The First IPY began on 1 August 1882 and continued for 13 months to 1 September 1883. Scientific results and observational data were published in the Bulletin of the International Polar Commission. In 1884 and 1891 the 4th and 5th Polar Conferences were convened. Weyprecht did not live to see the culmination of his grand concept; he died on 29 March 1881.

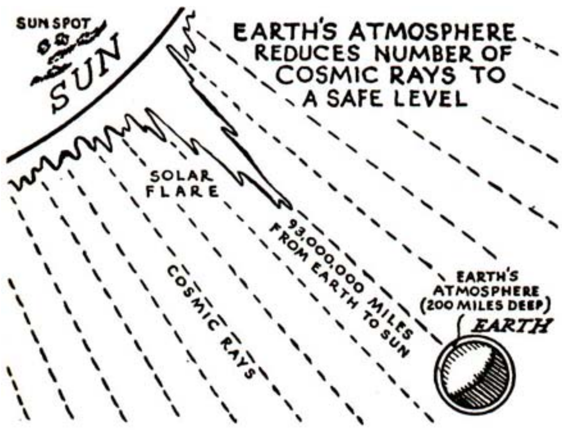

Figure 3. During IGY, it was known that events on the Sun influenced the Earth, but the exact mechanism was unknown. The discovery of the solar wind was a big step. (From Hyde, 1957)

In 1927 Dr. J. Georgi at Deutsche Seewarte in Hamburg suggested that a Second IPY be conducted on the fiftieth anniversary of the first (Laursen, V., Annals of the International Geophysical Year, 1, 1959, 211). A proposal was submitted to the International Meteorological Committee, and then forwarded to Reseau Mondial and Polar Meteorology. In June 1928 an informal organizational meeting was held in London to discuss plans for the event. Finally, in 1929 the Meteorological Conference of Directors in Copenhagen endorsed the plan for the cooperative study of magnetic, auroral and meteorological phenomena. Also in 1929 the International Cloud Commission passed a resolution for an international year for clouds coinciding with IPY. The Commission for IPY 1932-1933 was appointed to prepare detailed plans for the observations to be made and the methods for making them. A collaboration was established between the Commission for IPY and the International Union of Geodesy and Geophysics. In August 1930 the first meeting of the Commission for IPY took place in Leningrad to further refine proposals for IPY. In December 1930, at a meeting in London, the Commission prepared a detailed report containing proposals for research programmes in meteorology, terrestrial magnetism, atmospheric electricity, aurora and aerology. At a subsequent meeting in September 1931, the Commission for IPY, despite being urged to delay due to poor economic conditions worldwide, decided to go ahead with the IPY programme. On 1 August 1932 the second IPY began. It continued until 1 September 1933.

The Commission introduced the concept of “International Days”. The scientific objective was to study phenomena on the largest possible scale with simultaneous observations, the same as the previous IPY. The most significant new development that affected how the programme was conducted was the advent of radio communication.

In 1950, a proposal for IGY, 25 years after the second IPY, was brought before the Mixed Commission on the Ionosphere, which endorsed it. The Mixed Commission on the Ionosphere was formed by the International Council of Scientific Unions (ICSU), under the sponsorship of the International Union for Scientific Radio (URSI), with the cooperation of the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (IUGG). IUGG drew up a tentative programme and adopted a resolution to transmit it to ICSU, which sponsored the event. All bodies endorsed the proposal by 1951.

During the times when the Sun was especially active (Figure 3), on a day not designated as a World Day (Figure 4), alerts were issued. These could be followed by the declaration of Special World Intervals that followed alerts. These could be called with an 8-hour notice. Rocket and balloon launches might take place, and other programmes of study might be intensified. World Meteorological Intervals consisted of 10 consecutive days, four times a year, usually near the beginning of seasons, for intensive study, rocket campaigns, etc. Data were collected at three centres (the United States, Europe and the former Soviet Union) and made available to all countries.

IGY was a tremendous success. The newly developed space-flight capability was used to discover and explore Earth’s radiation belts, study the magnetosphere and provide the first observations of the emission from the Sun’s corona. Public interest in the scientific results of IGY was high. IGY provided a forum and a backdrop for discussing the importance of geospace influences on Earth. Space physics and many of its current institutions were born during IGY.

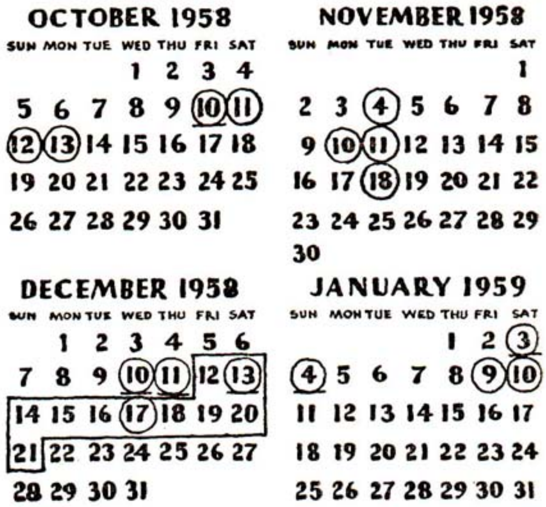

Figure 4. During IGY, calendars were marked to indicate World Days (circles) and World Meteorological Intervals (box) where more intensive observational campaigns were carried out. (From Hyde, 1957)

The International Heliophysical Year

Heliophysical: A broadening of the concept "geophysical," extending the connections from the Earth to the Sun and interplanetary space. On the 50th anniversary of IGY, the 2007 IHY activities will build on the success of IGY 1957 by continuing its legacy of system-wide studies of the extended heliophysical domain.

IHY will focus on the cross-disciplinary study of universal processes in the solar system, observed in a variety of settings. It is now widely recognized that evolution in the solar system proceeds through a set of universal physical processes, i.e. reconnection, particle acceleration, plasma wave generation and propagation, etc. By studying these universal processes together, in diverse environments, and in a comparative way, new scientific insights will be gained. This is perhaps best understood by citing a few examples: (1) Shocks are observed in situ in the interplanetary medium, shocks are believed to play a role in the acceleration of particles in the solar corona, and standing bow shocks and termination shocks separate the major regions in the heliosphere. Shock formation and particle acceleration are universal processes. (2) Auroras (Figure 5) are observed on Earth, Saturn and Jupiter, and Jovian auroral “footprints” have been observed on Io, Ganymede and Europa. The formation of auroras is observed to be the universal response of a magnetized body in the solar wind. The cross-disciplinary study of these processes will provide new insights that will lead to a better understanding of the universal processes in the solar system that affect the interplanetary and planetary environments, and pave the way for safe human space travel to the Moon and planets in the future, and it will serve to inspire the next generation of space physicists.

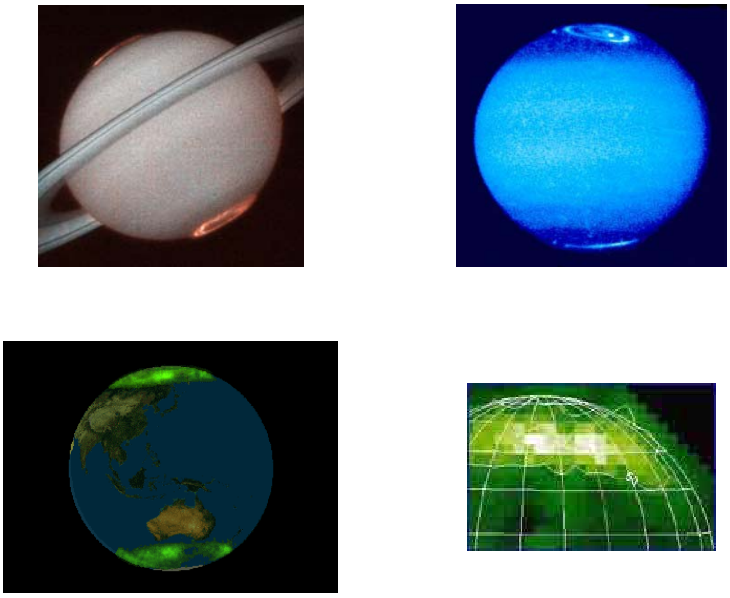

Figure 5. Auroras on Saturn (upper left), Jupiter (upper right), Earth (lower left) and Ganymede (lower right) are one example of universal physical processes at work in the solar system

The objectives of the IHY are to:

1. Develop the basic science of heliophysics through cross-disciplinary studies of universal processes;
2. Determine the response of terrestrial and planetary magnetospheres and atmospheres to external drivers;
3. Promote research on the Sun-heliosphere system outward to the local interstellar medium—the new frontier;
4. Foster international scientific cooperation in the study of heliophysical phenomena now and in the future; and
5. Communicate unique IHY results to the scientific community and the general public.

The IHY plan consists of four elements:

(1) Research Campaigns: During IHY, Coordinated Investigation Programs (CIPs), utilizing space and ground-based observatories will be organized to study universal processes at work throughout the solar system. Maximum use of the Internet and World Wide Web infrastructure will be used to facilitate communication and organization. These research campaigns will operate similar to the SOHO Joint Observing Projects (JOPs). The resulting data sets will be processed and assembled for easy access to the global science community. Coordinated data analysis will be performed during a series of workshops and the results will be published and made available to the science community.

CIPs will be entered by individuals within the research community (Figure 6). Discipline coordinators will review all suggestions and organize similar CIPs into observing programmes that can actually be implemented. Observatory coordinators, representing each of the instruments participating in IHY will assist in this process. Later, the observing programmes will be organized into cross-disciplinary topical Universal Process Workshops to discuss and communicate the scientific results of the IHY campaigns.

Joint campaigns with organizations having overlapping goals minimize the resources required for IHY. IHY will seek to identify areas where it can support programmes such as Climate and Weather of the Sun-Earth System (CAWSES), IPY, the Electronic Geophysical Year (eGY) and The International Year of Planet Earth, perhaps, for example, by providing the web-based campaign planning database software developed to support IHY to these groups. Detailed discussions on areas of support will be carried out during 2005, leading to detailed cooperation and coordination in 2006. IHY workshops and coordination meetings will be held in conjunction with Solar, Heliospheric and Interplanetary Environment (SHINE), Geospace Environment Modeling (GEM) and Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR), and in conjunction with major society meetings such as the American Geophysical Union (AGU) and the European Geosciences Union (EGU), whenever possible, to minimize travel time and expenses.

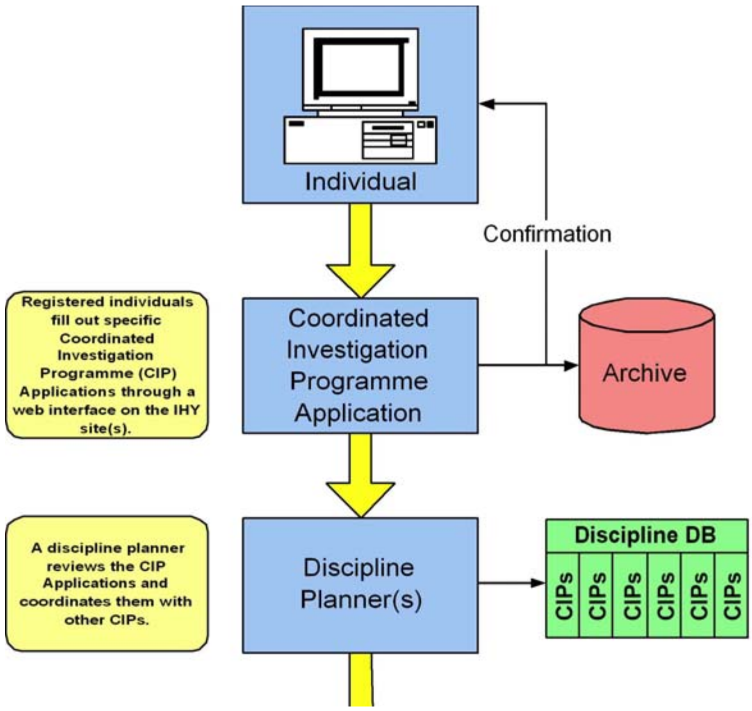

Figure 6. CIPs lead to observational plans organized by Discipline Coordinators. Scientific results are communicated through a series of topical Universal Process Workshops.

(2) Instrument Array Deployment: Through a cooperative programme with the United Nations Basic Space Science Initiative (UNBSSI) programme for 2005-2009, IHY will facilitate the deployment of a number of arrays of small instruments to make global measurements of space physics related phenomena. These may range from a new network of radio dishes to observe interplanetary coronal mass ejections, to extending existing arrays of Global Positioning System (GPS) receivers to observe the ionosphere. These instrument concepts are mature, and are developed and ready to be deployed. A coordination meeting was held between IHY and UNBSSI representatives in October 2004 at the NASA Goddard Space Flight Center (GSFC). As a result of that meeting, UNBSSI has dedicated its resources and activities through 2009 to providing the IHY with a link into developing countries. UNBSSI has provided more than 2000 scientist contacts in almost 200 countries, many of whom are eager to participate in international space science activities. A workshop led by the United Nations Office for Outer Space Affairs in November 2005 brought together instrument providers and interested instrument hosts for the first time to discuss facilities and requirements for each of the planned arrays. The Workshop was attended by approximately 150 participants, including instrument providers and potential instrument hosts. The first element of a new North African Atmospheric Weather Educational System for Observation and Modeling of Effects (AWESOME) very low frequency (VLF) array has already been delivered to the University of Tunis, Tunisia. Efforts are underway between the University of Tunis and Stanford University to bring this element into full operation.

(3) Education and Public Outreach is one of the main objectives of the IHY. For the most part, this effort is just starting to be defined. One of the primary objectives of the IHY/UNBSSI programme (discussed above) is to encourage the study of space science in developing countries, providing scientists from those countries with the opportunity to participate in space science research, while at the same time developing the curriculum and facilities to demonstrate and teach space science in the university environment. IHY fully supports these objectives and will be preparing booklets describing a space science curriculum for each of the deployed instrument arrays. Scientists at participating institutions will use these for a guide in teaching and fully participate in the analysis of the data from the array and in the resulting scientific discoveries.

(4) The History Initiative is a cooperative effort between IHY, the History Committee of AGU, and historian Ron Doel (Associate Professor, 20th Century Earth & Environmental International Science, Oregon State University, USA). In 2004 the IGY Gold Club was established to commemorate the achievements of the IGY participants. The first recipient, Dr. Alan Shapley, was presented with the award at the IHY Workshop in Boulder, Colorado, United States, in February 2005. The Gold Club award consists of a certificate and a pin with the IGY logo embossed on it. To be eligible for membership, one must (1) have participated in IGY in some way, and (2) provided some historical material (copies of letters, books, etc.) to the IHY history committee. That material will provide a lasting legacy of IGY for generations to come.

Planning for IHY is organized into seven regions: North America, South America, Africa, Europe, Western Asia, Eastern Europe/Western Asia and Asia-Pacific. Each of these regions has formed a regional planning committee to coordinate regional IHY participation. Representatives from each of these regions met in Toulouse, France, in July 2005 to begin the joint international planning process. Regional organizing meetings to continue international planning, additional information on meeting plans and regional organizations is available on the IHY website (http://ihy2007.org).

Summary

The 50th anniversary of the International Geophysical Year is a tremendous opportunity to advance our understanding of the Sun-Earth system, and to demonstrate the beauty, relevance and significance of Earth science to the people of the World.

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UNITED NATIONS BASIC SPACE SCIENCE INITIATIVE PROGRAMME FOR THE INTERNATIONAL HELIOPHYSICAL YEAR 2007

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1. Introduction

The International Heliophysical Year (IHY), a programme of international scientific collaboration to understand the external drivers of planetary environments, will be conducted in 2007. This will be a major international event of great interest to all the countries in the world. IHY 2007 will coincide with the fiftieth anniversary of the International Geophysical Year (IGY), held in 1957. IGY produced an unprecedented level of understanding of the Earth's space environment, and saw the start of the Space Age with the birth of the National Aeronautics and Space Administration (NASA) of the United States of America and the discipline of space science. IHY is the logical step to expand our focus to include the heliosphere in which the Earth and the Sun have a central place. During IGY 1957, humans were sticking their heads above Earth's atmosphere; during IHY 2007 they will stick their thumb into the local interstellar medium. The ultimate objective of IHY is to set up distributed collaborations that utilize ground and space based assets to further the science achievements in all sub disciplines: solar physics, polar physics, geophysics, space physics and heliospheric physics, with a strong emphasis on cross-disciplinary science.

IGY was organized to study global phenomena of the Earth and the geospace, involving about 60,000 scientists from 67 countries, who worked at thousands of stations around the world to obtain simultaneous, global observations from the ground and space. Building on results obtained during and after IGY 1957, IHY will expand to the study of universal processes in the solar system that affect the interplanetary and terrestrial environments (see Fig. 1 for an example). The study of energetic events in the solar system will pave the way for safe human space travel to the Moon and planets in the future, and it will serve to inspire the next generation of space physicists. The goals of IHY can be summarized as follows:

(a) Advancing our understanding of the heliophysical processes that govern the Sun, Earth and Heliosphere;

(b) Continuing the tradition of international scientific collaboration on the 50th anniversary of IGY;

(c) Demonstrating the beauty, relevance and significance of space and Earth science to the world; and

(d) Inspiring the next generation of space explorers and scientists.

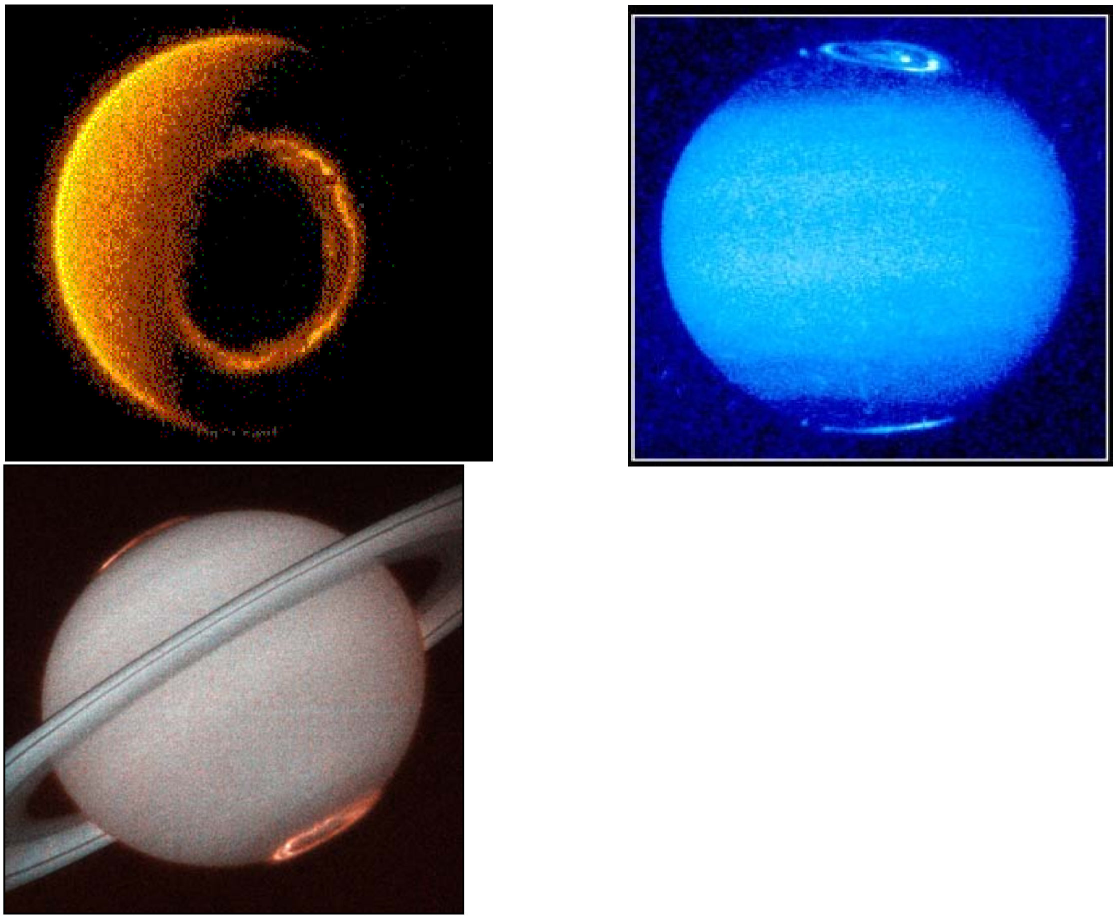

Figure 1. Similar physical processes are evident in vastly different environments: Aurora from Earth (top left), Jupiter (top right) and Saturn (bottom left). IHY will study universal processes in the solar system such as these auroras (pictures: courtesy NASA).

IGY 1957 was one of the driving events to establish the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) as well as many other scientific institutions that survive to this day. IHY will provide an opportunity for COPUOS and other relevant organizations to review their achievements over the last 50 years. IHY also strongly complements the International Living With a Star (ILWS) programme, providing more attention nationally, regionally and internationally for the ILWS programme. The IHY programme is directly relevant to the goals of the United Nations Office for Outer Space Affairs (OOSA): “to promote international cooperation in the use of space technology for sustainable economic and social development and for the protection and management of the Earth’s environment” and “to strengthen the capacity of developing countries to use space technology”.

The United Nations Basic Space Science Initiative (UNBSSI) will dedicate its workshops and activities through 2009 to the IHY developing nations programme. Drawing on nearly 15 years of workshops on basic space science for the benefit of scientists and engineers from developing countries, OOSA will assist scientists and engineers from all over the world in participating in the preparations for IHY 2007. The workshops to be held to achieve this will be referred to as the IHY/UNBSSI workshops. This joint programme will target activities that stimulate space and Earth science activities in developing countries, such as the establishment of ground-based instrument arrays and research programmes. The first of a series of annual IHY/UNBSSI workshops was held in Abu Dhabi and Al-Ain, United Arab Emirates, from 20 to 23 November 2005. Additional information on the workshop is available at www.ihy.uaeu.ac.ae.

A major thrust of the IHY/UNBSSI programme is to deploy arrays of small, inexpensive instruments such as magnetometers, radio antennas, Global Positioning System (GPS) receivers, all-sky cameras, etc. around the world to provide global measurements of ionospheric and heliospheric phenomena. The small instrument programme is envisioned as a partnership between instrument providers and instrument hosts in developing countries. The lead scientist will provide the instruments (or fabrication plans for instruments) in the array; the host country will provide manpower, facilities and operational support to obtain data with the instrument typically at a local university. Funds are not available through the IHY to build the instruments; these must be obtained through the normal proposal channels. However, all instrument operational support for local scientists, facilities, data acquisition, etc. will be provided by the host nation. The IHY/UNBSSI programme will hopefully be able to facilitate the deployment of several of these networks worldwide.

Following are simple guidelines for initiating projects related to the IHY/UNBSSI instrument programme:

(a) The projects must produce scientifically significant and publishable data pertaining to the objectives of the IHY activities;

(b) The projects must involve deployments in developing countries (many of which are near the equator);

(c) The costs and technical requirements must be compatible with the resources available in the participating countries;

(d) The projects are expected to lead to a beneficial relationship for the participants in developing countries;

(e) Instruments with several designs corresponding to increasing design complexity are preferred; and

(f) The projects are expected to involve university level students in the developing countries.

2. IHY/UNBSSI projects under consideration

In October 2004, UNBSSI and IHY scientists got together to discuss the potential instrument deployment opportunities. It was decided that the instrument deployment programme should match the UN Tripod concept, namely, instrument, observation and education in the developing countries. When the input from the global scientific community was solicited on the IHY/UNBSSI instrument programme, there was excellent response. Selected projects that are compatible with the objectives of the IHY/UNBSSI programme are summarized in this report. These projects formed the core of the UAE workshop deliberations for consolidation and eventual implementation.

2.1. Atmospheric Weather Educational System for Observation and Modeling of Effects (AWESOME)
Principal Investigator: Umran Inan, Stanford University

AWESOME is an ionospheric monitor that can be operated by students around the world. The monitors detect solar flares and other ionospheric disturbances.

About 60 km above the ground lies the Earth's ionosphere, where continual blasts of particles and energy from the Sun hit the Earth's atmosphere so strongly that electrons are stripped away from their nuclei. The free electrons in the ionosphere have a strong influence on the propagation of radio signals. Radio frequencies of very long wavelength (very low frequency or VLF) bounce back off the ionosphere allowing radio communication over the horizon and around the curved Earth. The ionosphere reacts strongly to the intense x-ray and ultraviolet radiation released by the Sun during a solar flare, solar storm or coronal mass ejection. By monitoring the signal strength from distant VLF transmitters and noting unusual changes as the waves bounce off the ionosphere, these disturbances can be monitored and tracked. To monitor a VLF signal, a radio receiver is needed that can tune to very low frequency stations, an antenna to pick up those VLF signals and a computer to keep track of the data. Since most consumer radios cannot pick up the VLF signals, a radio receiver and an antenna need to be built. This combination of receiver and antenna is called a VLF receiver.

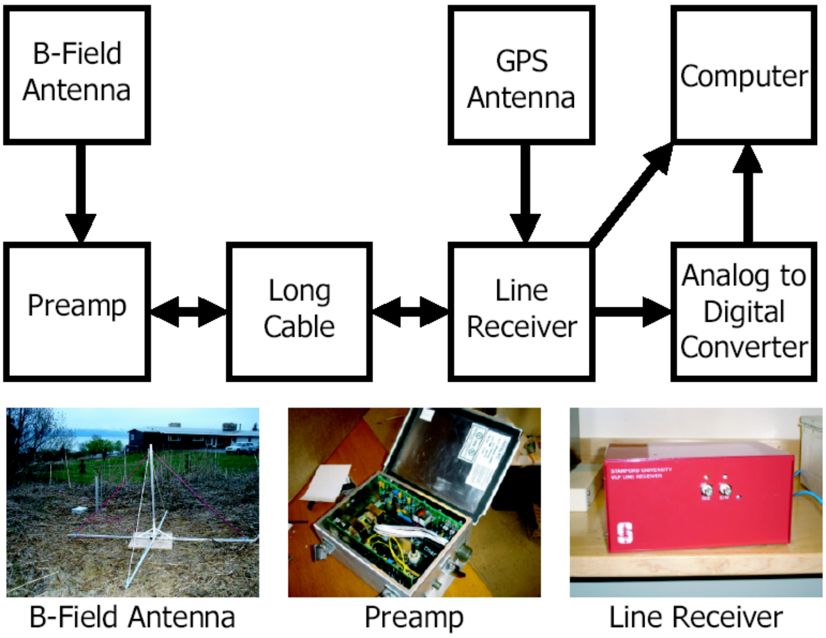

Figure 2. Very Low Frequency Data Acquisition (DAQ) system, which works in conjunction with a TrueTime GPS receiver, the line receiver and the North/South and East/West receivers (from R. Moore and E. Kim, Very Low Frequency Data Acquisition Software User Manual).

The key elements of AWESOME are the computer, the Stanford Monitor and the antenna. Internet link is important; otherwise a good quality DVD burner could be used. The setup is illustrated in Figure I. The line receiver gets VLF signals from two antennas. There is usually one antenna in the North/South orientation and another in the East/West orientation. These signals are sent to a 200kHz analogue-to-digital converter (ADC) card attached to the Peripheral Component Interconnect (PCI) slot of the computer. The ADC will capture data from the two antennae at 100kHz each. The timing signal from the GPS is also fed into the ADC card, allowing for very precise acquisition of data. Now in development is a Universal Serial Bus (USB) interface to replace the ADC card, which will enhance the ease of use and substantially reduce the cost.

There are two types of data saved by the receiver. Narrowband data involves monitoring the amplitude and phase of a single frequency, corresponding to a VLF transmitter. Broadband data involves saving the entire waveform from the antenna, thus enabling studies of many more ionospheric phenomena. The VLF Data Acquisition software controls precisely when the system should acquire broadband and narrowband data. Upon data acquisition, various user-specified signal processing can be performed on the data. The data may be sent to another computer at Stanford University, via the internet, where it will be made available to anyone through a web interface, so that interested parties at different sites can share their data and collaborate. The data produced by AWESOME is the same quality being used by researchers at Stanford University; the receiver sensitivity has exceeded the point where any detectable signal above the ambient noise floor will be recorded.

In addition to the AWESOME monitor, there is an inexpensive version known as the Sudden Ionospheric Disturbance (SID) monitor. The Stanford Solar Center, in conjunction with the Electrical Engineering Department's VLF group and local educators, have developed inexpensive SID monitors that students can install and use at their local high schools. Students can join the project by building their own antenna, a simple structure costing less than $10 and taking a couple hours to assemble. Data collection and analysis is handled by a local PC, which need not be fast or elaborate. Stanford University will be providing a centralized data repository and blog site where students can exchange and discuss data.

Deployment of one of the AWESOME monitors has recently been completed in Tunisia. Prof. Umran Inan (Stanford University) and Prof. Zohra Ben Lakhdar (University of Tunis) have started this collaboration under the IHY/UNBSSI programme. This project will provide a basis for quantitative comparison of lightning-induced disturbances of the ionosphere and the radiation belts in the American and European sectors. Most of the current data on such phenomena has so far been obtained in the western hemisphere, and the weight of scientific information indicates that lightning-induced effects at high altitudes and in the radiation belts may dominate other processes on a global scale. The proposed programme will facilitate the establishment and conduct of VLF observations in the European sector, thus providing a basis for comparison to facilitate global extrapolations and conclusions. As part of this collaboration, Professor Hassen Ghalila visited Stanford University to learn about how to operate the VLF receiver, and about all its scientific applications.

2.2. Magnetometer Networks

2.2.1 IHY Magnetometer Observatories

Principal Investigator: Dr Ian Mann, **Canadian Array for Realtime Investigations of Magnetic Activity (CARISMA)**
(Space Physics Group, Department of Physics, University of Alberta, Edmonton, Alberta T6G 2J1,Canada)

Magnetometer arrays provide a relatively low-cost method for monitoring solar-terrestrial interaction. Magnetometer stations provide monitoring of current systems local to monitoring stations, as well as local wave populations. Multi-continental IHY arrays would provide an excellent basis for meso- and global-scale monitoring of magnetospheric-ionospheric disturbances and provide scientific targets for mid- and low-latitudes and opportunities for developing countries to host instruments and participate in the science investigations.

Magnetometer observatories can be developed under the IHY/UNBSSI programme based on the achievements of the Canadian Array for Realtime Investigations of Magnetic Activity (CARISMA), which is the Magnetometer element of the Canadian Geospace Monitoring (CGSM) project. It is the continuation of the Canadian Auroral Network for the OPEN Program Unified Study (CANOPUS) magnetometer array, which ran from 1986 to 2005, upgrading to include higher time resolution and more complete time coverage. It utilizes the same 13 fluxgate magnetometers but with an upgraded site infrastructure and data transmission system.

Each proposed IHY magnetometer observatory shall consist of magnetometer station pairs separated meridionally by approximately 200 km. Other requirements are: a 2x3-component fluxgate magnetometer, data logger, GPS timing and power source. For remote locations, solar panels or wind turbines could possibly be used. The data retrieval method depends on available infrastructure: Phone-line modem or local internet where available.

The approximate cost of each observatory is $22,000 (three component fluxgates with RS232 output: approximately $6,000 each; Industrial grade data logger/PC with GPS: approximately $2,000; Solar panel power system: approximately $2,000). Commercial fluxgates are available from industrialized countries; however, an excellent low-noise supplier also exists at the Lviv Institute in Ukraine. Ukraine benefits from export trade/tax agreements with some industrialized countries (including Canada). The IHY magnetometer array could aid the development in countries such as the Ukraine where suitable expertise exists.

For the CANOPUS array, the University of Alberta is developing a solar cell/wind generator stand-alone power source that could be modified for IHY use in developing countries with little infrastructure (also allows site deployment in environmentally magnetically quiet locations; avoids problems with local power grid stability). Under the IHY/UNBSSI programme, the University of Alberta, together with other partner institutes, could develop GPS timed PC data logger interface for the magnetometer, develop solar-cell/turbine power source for the IHY Magnetometer observatories, integrate systems prior to delivery to scientists from participating countries and organize and run a number of regional/continent specific “deployment schools", whereby scientists from developing countries attend a single deployment, which will help them independently deploy their own observatories in their respective countries.

The IHY array data are more powerful than data from any single observatory, although data from a single observatory may be used, especially in combination with partner IHY data sets. Project involvement should require data delivery to IHY (perhaps in partnership with the electronic Geophysical Year (eGY)). It is valuable to have a central IHY magnetometer array data centre for collection, storage and archival of the data. The scientific value of the collective IHY array data set encourages collaboration between IHY magnetometer array scientists from participating countries. This dataset could also provide the basis for IHY science workshops/conferences with active involvement from the participating scientists.

2.2.2 Magnetic Data Acquisition System (MAGDAS) project

Principal Investigator: Kiyohumi Yumoto (Space Environment Research Center, Kyushu University, Japan)

The Magnetic Data Acquisition System (MAGDAS) is being deployed for space weather studies during 2005 to 2008, overlapping heavily with the IHY/UNBSSI programme. The project will aid the study of dynamics of geospace plasma changes during magnetic storms and auroral substorms, the electro-magnetic response of the iono-magnetosphere to various solar wind changes and the penetration and propagation mechanisms of DP2 channel-ultra low frequency (ULF) range disturbances from the solar wind region into the equatorial ionosphere. With the help of MAGDAS data, one can conduct real-time monitoring and modelling of: (1) the global three-dimensional current system; and (2) the ambient plasma density for understanding the electromagnetic and plasma environment changes in the geospace.

Global 3-D current system: The MAGDAS data will be used to map the ionospheric equivalent current pattern every day. The current and electric fields at all latitudes are coupled, although those at high, and middle and low latitudes are often considered separately. By using the MAGDAS ionospheric current pattern, the global electromagnetic coupling processes at all latitudes will be clarified.

Ambient plasma density: New MAGDAS magnetometers will be deployed at several pairs of stations along the 210° magnetic meridian to observe the magnetic field line resonance (FLR) pulsations. Each pair will be separated in latitude by approximately 100 km. The FLR oscillations are useful for monitoring temporal and spatial variations in the magnetospheric plasma density. The MAGDAS data will be analyzed by the amplitude-ratio and cross-phase methods to identify the FLR events and measure their eigen-frequencies, providing the plasma density varying with time. Those measurements will be highly valuable in understanding the variations of the ambient plasma density and the location of the plasmapause during magnetic storms and auroral substorms.

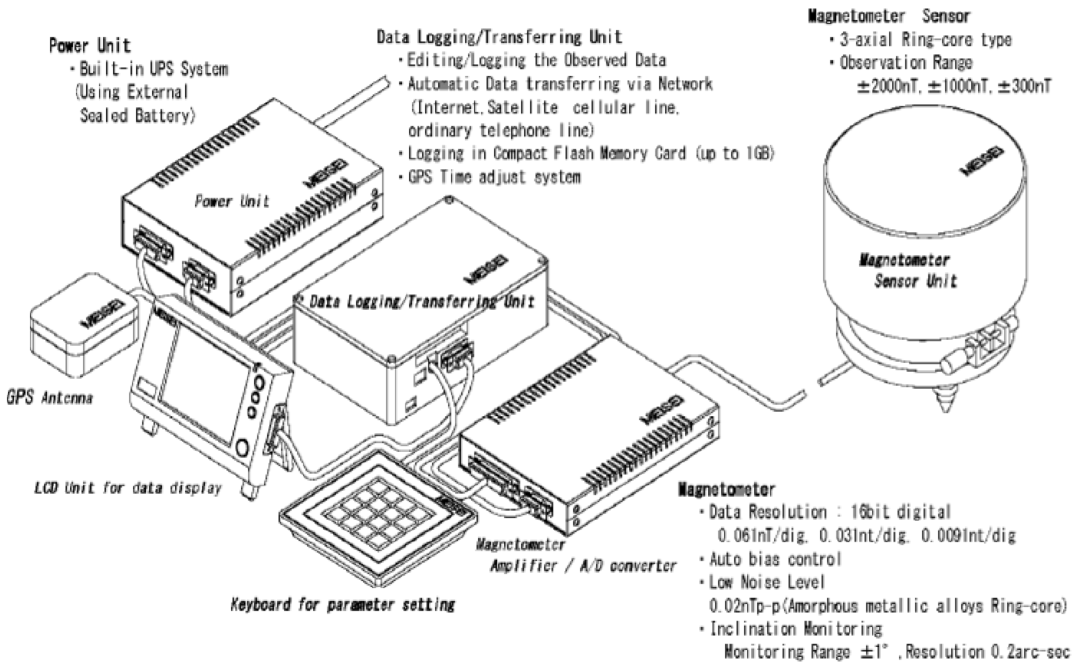

Figure 3. Details of the MAGDAS/CPMN magnetometer system for real-time data acquisition (courtesy: K. Yumoto).

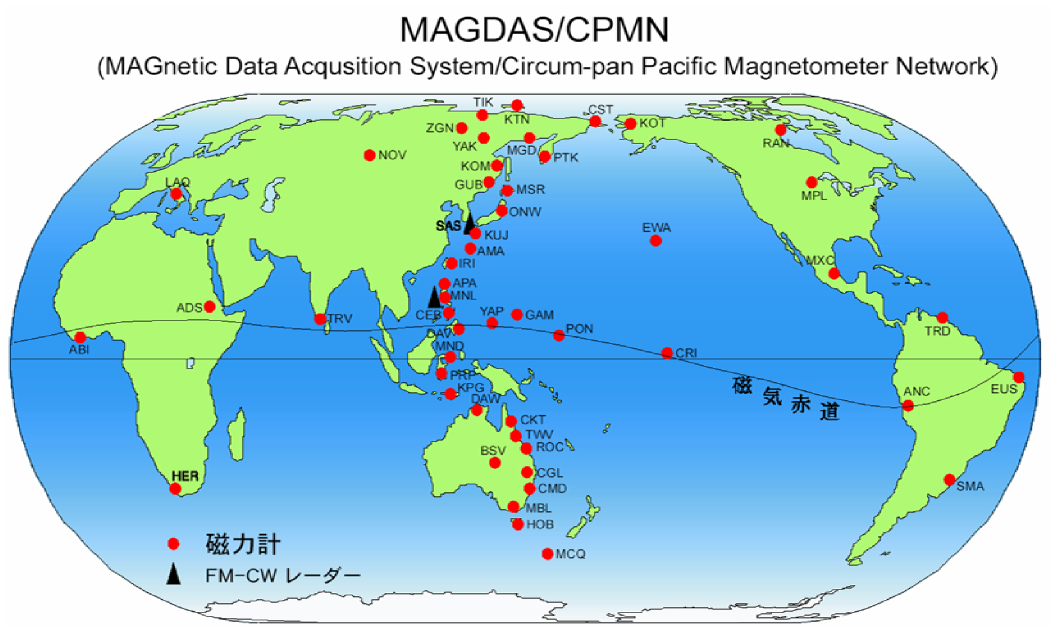

Figure 4. Stations of CPMN (courtesy: K. Yumoto).

MAGDAS will utilize the Circum-Pan Pacific Magnetometer Network (CPMN) involving several countries around the globe (Australia, Indonesia, Japan, Philippines, Russian Federation, United States and Taiwan Province of China). Additional locations where the magnetometers can be deployed are: Brazil, Canada, Côte d'Ivoire, Ethiopia, Federated States of Micronesia, India, Mexico, Peru, South Africa and Trinidad and Tobago.

2.3. IHY Radio Telescope Networks

2.3.1 CALLISTO Frequency Agile Solar Spectrometers

Principal Investigator: Arnold Benz, Institute of Astronomy, ETH-Zentrum in Zurich, Switzerland

The Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) is a dual-channel frequency-agile receiver based on commercially available consumer electronics. The low cost for hardware and software, and the short assembly time make this an ideal instrument for the IHY/UNBSSI programme. The total bandwidth of CALLISTO is 825 MHz, and the width of individual channels is 300 kHz. A total of 1,000 measurements can be made per second. The spectrometer is well suited for solar low-frequency radio observations pertinent for space weather research and applications. Space weather has become a topic of interest to the society that increasingly depends on satellites for day-to-day activities. One prime example is cell phones, which can be seriously affected by space weather. Space weather refers to the variable conditions in Earth's space environment primarily caused by changing conditions on the Sun. Radio observations are simple means of detecting the solar disturbances when they are still near the Sun. The early detection of solar disturbances such as shock waves is possible from the ground using radio spectrometers such as CALLISTO. The Sun produces various types of radio emissions, so spectrometers such as CALLISTO are necessary to identify the nature of coherent solar radio emissions from solar eruptions, relevant to space weather. One of the important types of radio emissions occurring in the CALLISTO spectral range are the shock related radio bursts known as type II radio bursts. These bursts are caused by shocks driven by coronal mass ejections. Occurrence of these bursts marks the formation of shocks near the Sun, which might arrive at Earth after a few days and mark the start of geomagnetic storms.

It is important to have continuous monitoring of the Sun, which requires a network of spectrometers at several locations in the world. Five CALLISTO instruments have been constructed until now and put into operation at several sites, including Bleien in Zurich, Switzerland and the National Radio Astronomy Observatory (NRAO) in the United States. Arrangements are being made to deploy one in India at the Radio Astronomy Center in Ooty. This network, in addition to the existing spectrometers at Hiraiso in Japan, ARTEMIS in Greece and Culgoora in Australia will form an excellent radio network for IHY science and for achieving the goals of the IHY/UNBSSI programme.

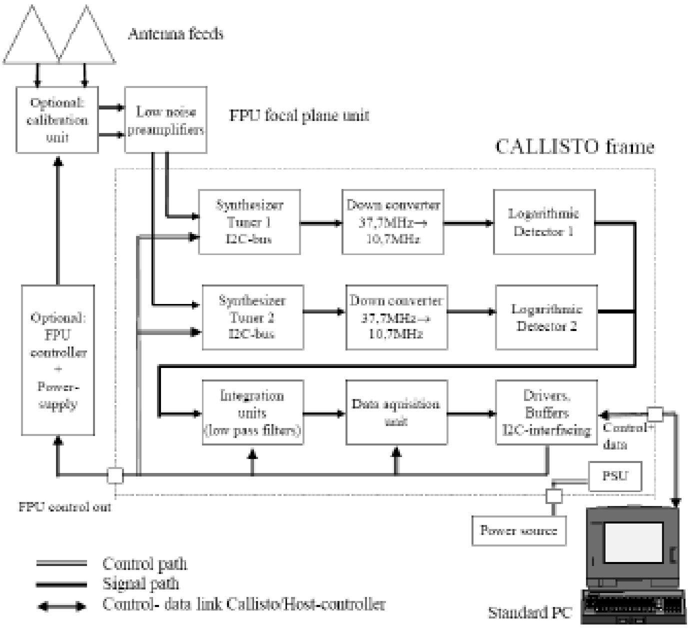

Figure 5 Basic design of CALLISTO (top) and the hardware (bottom). The main board for data acquisition and interface with a RISC processor ATmega16 and of two synchronous receivers are shown in the foreground of the right panel. The complete spectrometer is shown in the background. Its physical size (width) is 24 cm. It is a very cheap instrument suitable for copying easily and deploying in many locations.

The software is distributed on a Reduced Instruction Set Computer (RISC) processor ATmega16 and a standard PC or laptop. On the RISC, the driver, buffer and interfacing software is programmed in C++, using an interrupt-driven state machine concept. The host software on the PC is also in C++ and operates under Windows 2000 and XP. The relevant parameters are locally stored in a text file, which can be easily adapted to other observing configurations. Additional RS232 ports are pre-configured to communicate with an extended GPS system and external temperature and humidity sensors. It is also possible to control CALLISTO via the Internet, using an RS232 network adapter. A file-controlled scheduler starts and stops measurements in relation to local PC time (UT). The scheduler is repeated every day automatically and can be changed online and remotely.

2.3.2 Low-Frequency Radio Antenna Arrays

Principal Investigators: Justin Kasper (Massachusetts Institute of Technology), Robert MacDowall (NASA Goddard Space Flight Center)

Low frequency radio arrays can be deployed at two levels: Option (1) low-frequency monitoring of solar radio bursts with single dipoles; and Option (2) 8-16 element arrays for all sky monitoring.

Opportunities are being explored to install a low frequency radio telescope at the Gauribidanur radio telescope site in India to work in conjunction with CALLISTO in Ooty.

2.4. GPS in Africa

Principal Investigator: Christine Mazaudier and Monique Petitdidier

The overarching plan is to increase the number of real-time dual-frequency GPS stations worldwide for the study of ionospheric variability. Of particular interest is the response of the ionospheric total electron content (TEC) during geomagnetic storms over the African sector. This programme is particularly compatible with magnetometry.

2.5. Remote Equatorial Nighttime Observatory for Ionospheric Regions (RENOIR)

Principal Investigator: Jonathan Makela (University of Illinois)

The Remote Equatorial Nighttime Observatory for Ionospheric Regions (RENOIR) is a suite of instruments dedicated to studying the equatorial/low-latitude ionosphere/thermosphere system, its response to storms and the irregularities that can be present on a daily basis. The occurrence of equatorial plasma instabilities, commonly referred to as equatorial spread-F, equatorial plasma bubbles or depletions, can cause radio signals propagating through the disturbed region to scintillate. This results in a fade in received signal power translating to a loss of the signal. Scintillations on frequencies from several GHz and below are known to occur and are a concern to many sectors. Through the construction and deployment of a RENOIR station, it is possible to achieve a better understanding of the variability in the nighttime ionosphere and the effects this variability has on critical satellite navigation and communication systems.

A typical RENOIR station involves the following: (1) an array of single frequency GPS scintillation monitors. These provide measurements of the irregularities present, their size, orientation and speed; (2) a dual-frequency GPS receiver. This provides measurements of ionosphere TEC. If a site that already fields a dual-frequency GPS receiver could be located, this would not be needed; (3) an all-sky imaging system. This measures two different thermosphere/ionosphere emissions from which the two-dimensional structure/motion of irregularities can be observed. The data can also be used to calculate the density and height of the ionosphere; and

(4) two miniaturized Fabry-Perot interferometers (MiniME). These provide measurements of the thermospheric neutral winds and temperatures. The two interferometers are separated by approximately 300km or so, allowing bistatic, common-volume measurements.

Deployment of RENOIR stations is being planned in collaboration with the IHY/UNBSSI programme. Ideally, the RENOIR stations would be fielded in Africa at a longitude of approximately 7 degrees from the magnetic equator. The instrumentation that make up a RENOIR station have all been used in the field in previous experiments and are at a moderately mature level of development. The optical systems can be housed in individual, self-contained housing units, requiring very little infrastructure. If an optical facility is available at a host institution, the optical equipment could easily be modified to interface with available optical domes. The facility should be located in a region with relatively dark skies (away from any major cities) and away from any tall structures (buildings and trees). If two Fabry-Perot interferometers are to be fielded, the second system should be located approximately 300 km away from the main site.

The dual-frequency GPS receiver is quite rugged and simply requires a location to mount the antenna and minimal space to locate the control computer. The array of single-frequency GPS scintillation monitors requires a space of approximately 100m x 100m over which to space the five antennae in a cross formation. Again, minimal space is needed to locate the control computers for each receiver. The facility should be located away from any tall structures (buildings and trees).

2.6. South Atlantic Magnetic Anomaly (SAMA) VLF Array

Principal Investigator: Jean-Pierre Raulin (Universidade Presbiteriana Mackenzie, Brazil)

This programme has three main goals: monitoring the solar activity on long and short time scales; monitoring ionospheric perturbations over the South Atlantic Magnetic Anomaly (SAMA); and atmospheric studies.

The VLF network will be deployed in a region where the coverage at similar frequencies is currently very poor. This will allow the study of the SAMA region at low ionospheric altitudes and its structure and dynamics during geomagnetic perturbations. The monitoring of transient solar phenomena will improve scientific knowledge of the low ionosphere and of the chemical processes occurring there. On longer time scales we will be able to define an ionospheric index of the solar activity characteristic of the ionizing agent of the low ionosphere (extreme ultraviolet and Ly-alpha). Currently these are poorly monitored and only accessible through models. The proposed instrument will also permit the study of the VLF counterpart of newly discovered atmospheric phenomena related to lightning and thunderclouds. The proposed science is relevant to the following IHY themes: impact of space weather phenomena on the Earth's climate; and the ionosphere/magnetosphere.

Ideally, the VLF receivers should be able to measure amplitude perturbations of 1 dB (relative to the unperturbed level) and phase changes as low as 0.5 μs, corresponding to changes observed for example during very small solar flares. The basic data output is composed of these phase and amplitude measurements. There are no strong requirements on the location of the receivers, except for minimal man-made interferences. Some potential sites with existing infrastructure are: Piura in the north of Peru (05°12’ S; 80°38´ W); Punta Lobos near Lima, Peru (12°30’ S; 76°48´ W); Palmas, Tocantins, Brazil (10°10’ S; 49°20´ W); Santa Maria, Rio Grande do Sul, Brazil (29°43´ S; 53°43´ W); and Complejo Astronómico El Leoncito (CASLEO), San Juan, Argentina (31°32´ S; 68°31´ W).

These new sites will complement the existing VLF sites at Atibaia, São Paolo, Brazil (23°11´ S; 46°36´ W), and the Brazilian Antarctic Comandante Ferraz research station (62°05´ S; 58°24´ W). It will be possible to compare the VLF propagation characteristics from paths that completely cross SAMA, paths for which the receivers are located at the border or outside the SAMA and paths that end at the SAMA centre location (see Figure 6). The estimated cost of the instrumentation is $5,000 per unit (there are five units) and an additional cost of $10,000 for travel between stations for installation, testing and maintenance.

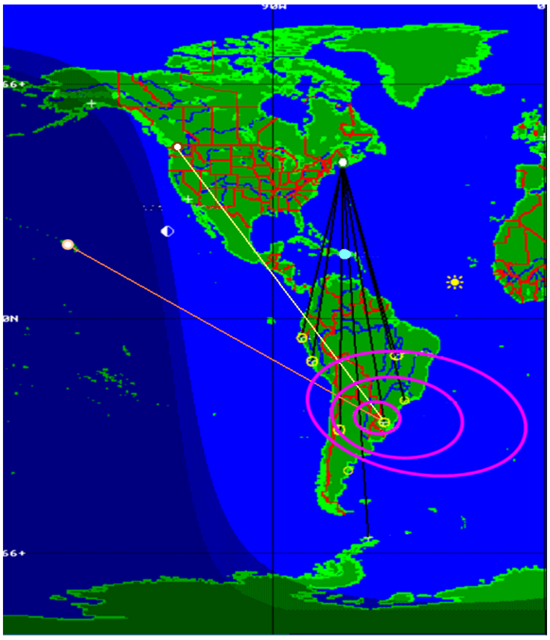

Figure 6. SAMA locations and the nearly north-south oriented paths from the NAA transmitter in the US (44°39´ N; 67°17´ W) will enable a comparison of examples of simultaneous measurements from totally sunlit path NLK (48°12´ N; 121°55´ W) and partially sunlit path NPM (38°59´ N; 76°27´ W), which are also shown. They will allow scientists to obtain a two-dimensional view of the SAMA region. In the case of NAA transmission, note also the path over Puerto Rico where ionospheric radio measurements are made at the Arecibo (18°30´ N; 68°31´ W) radio facilities in association with the sprites phenomena. (courtesy: J.-P. Raulin).

2.7. Scintillation Network Decision Aid (SCINDA)

Principal Investigator: Keith Groves of Hanscom Air Force Research Lab, United States

Scintillation Network Decision Aid (SCINDA) is a real-time, data driven, communication outage forecast and alert system. Its purpose is to aid in the specification and prediction of communications degradation due to ionospheric scintillation in the equatorial region of Earth. Ultra high frequency (UHF) and L-band scintillation parameters are measured, modelled and propagated in time to provide a regional specification of the scintillation environment in an effort to mitigate the impacts on the satellite communications community.

Equipment at the remote sites record scintillation parameters from available UHF Fleet Satellite Communication System and L-band (Geostationary Operational Environmental Satellite (GOES), GPS) satellite links and measure ionospheric drift velocities. The data drives a semi-empirical model that produces simple three-colour graphical representations of large-scale equatorial scintillation structures and associated communication impact regions.

Ionospheric disturbances can cause rapid phase and amplitude fluctuations of satellite signals observed at or near the Earth's surface; these fluctuations are known as scintillation. Scintillation affects radio signals up to a few GHz frequency and seriously degrades and disrupts satellite-based navigation and communication systems. SCINDA consists of a set of ground-based sensors and quasi-empirical models, developed to provide real-time alerts and short-term (< 1 hour) forecasts of scintillation impacts on UHF satellite communication and L-Band GPS signals in the Earth's equatorial regions.

The SCINDA system (see Figure 7) concept is presently being demonstrated using eight equatorial stations in South America, Southwest Asia and Southeast Asia (Figure 8). Scintillation parameters from available UHF (FLTSAT) and L-band (GOES, GPS) satellite links and ionospheric drift velocities are measured and recorded at the remote sites. The scintillation maps are available to users for proto-type operational support via a secure network. Analysis of data collected during the recent solar maximum period (2000-2002) indicates that both single and dual-frequency GPS receivers are subject to significant errors during severe scintillation events. All SCINDA sites are now equipped with GPS scintillation monitors and model development is in progress. Following the solar cycle, L-band scintillation activity will decline over the next few years and should remain relatively benign until around 2008. The goal is to have accurate GPS navigation error products available to support the operations before the next solar maximum.

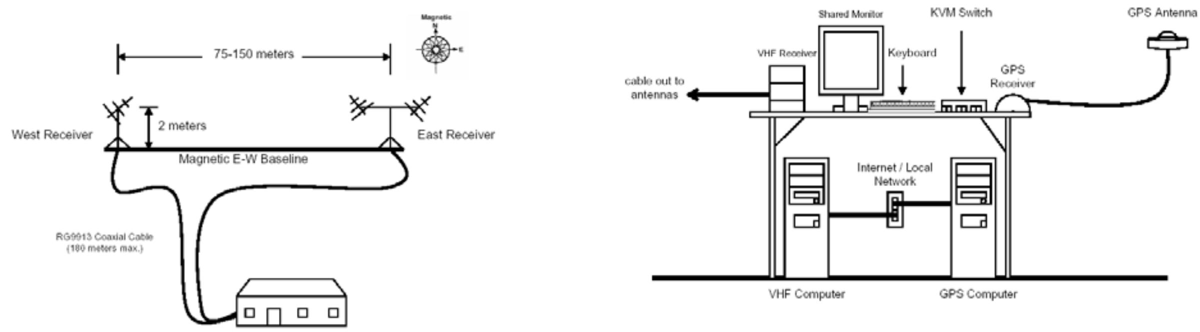

Figure 7 VHF Antenna Set-Up (left) and VHF Receiver Chain and Data Acquisition System (right) (courtesy: K. Groves).

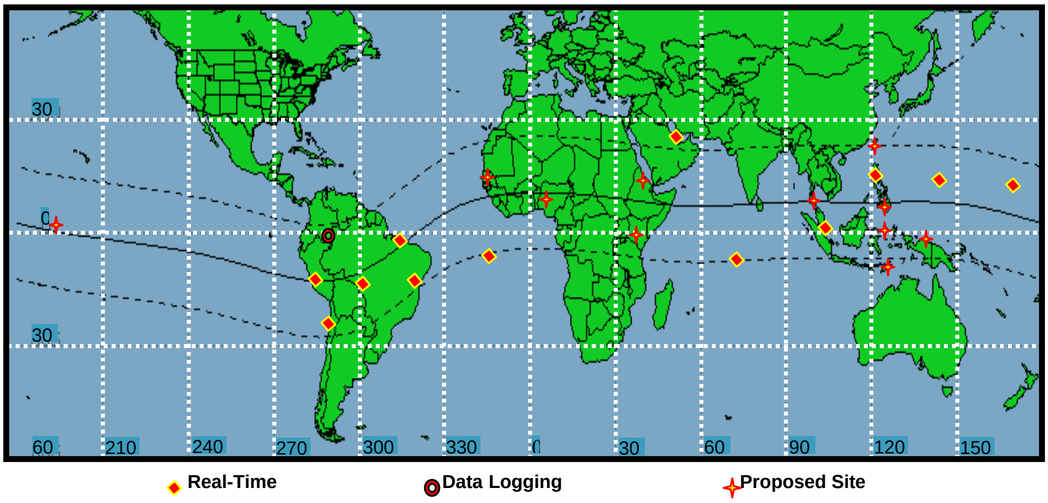

Figure 8 Existing and proposed SCINDA stations. The magnetic equator and northern and southern magnetic latitudes at 20 ° are shown by dashed lines. The most intense natural scintillation events occur during nighttime hours within 20 ° of the Earth's magnetic equator. SCINDA observations in this 20 ° belt on either side of the magnetic equator are sought. Current plans include expansion of the network to new geographic regions (courtesy: K. Groves).

2.8. New type of Particle Detectors for Space Weather Forecasting Network

Principal Investigator: Ashot Chilingarian (Aragats Space Environmental Center (ASEC) of the Cosmic Ray Division (CRD) of Alikhanian Physics Institute, Armenia)

Particle beams accelerated at the Sun are superimposed on the uniform and isotropic cosmic ray background from galactic and extragalactic sources. Space-borne spectrometers measure the time series of the changing fluxes with excellent energy and charge resolution. Surface detectors measure the time series of secondary particles, born in cascades originated in the atmosphere by primary ions. Studies of these particles shed light on the high-energy particle acceleration by flares and shocks driven by coronal mass ejections.

Time series of intensities of high-energy particles can provide highly cost-effective information on the key characteristics of the interplanetary disturbances. Because cosmic rays are fast and have large scattering mean free paths in the solar wind, this information travels rapidly and may prove useful for space weather forecasting. Size and occurrence of southward magnetic field component in interplanetary coronal mass ejections (ICMEs) is correlated with modulation effects the ICME poses on the ambient population of the galactic cosmic rays (GCRs) during its propagation up to 1 astronomical unit (AU). On the way to Earth (15 – 50 hours), the magnetic cloud and shock modulate the GCR flux, making it anisotropic. Surface monitors located at Aragats Space Environmental Center (ASEC) on Mt. Aragats, Armenia, at 2,000 and 3,200 m altitude (40˚30′N, 44˚10′E. Cutoff rigidity: 7.6 GV) detect charged and neutral components of the secondary cosmic rays with different energy thresholds and various angles of incidence (see Figure 9 for a schematic view of the new detector at ASEC). This richness of information (see Table 1) coupled with the simulation of the physical phenomena, can be used to estimate the shock size and the magnetic field “frozen” in the ICME. Consequently, one can predict the upcoming geomagnetic storms hours before the ICME arrival at the magnetometers on the Advanced Composition Explorer (ACE) and the Solar and Heliospheric Observatory (SOHO). The half-hour lead time provided by the L1 monitors is a bit short to take effective mitigation actions and protect surface industries from harm of major geomagnetic storms. To identify the major sources of error in the predictions, we need to measure, simulate and compare: (1) time series of neutrons, low energy charged component (mostly electrons and muons) and high-energy muons; (2) the correlation between changing fluxes of various secondary particles; and (3) directional information.

Detector	Altitude m	Surface m^2	Threshold(s) MeV	Operation	Count rate (min^{-1})
NANM (18NM64)	2000	18		1996	2 x 10^4
ANM (18NM64)	3200	18		2000	4.5 x 10^4
SNT-4 thresholds +	3200	4 (60 cm thick)	120, 200, 300, 500	1998	5.2 x 10^4 [a]
veto		4 (5cm thick)	10		1.3 x 10^5
NAMMM	2000	5 + 5	10 + 350 [c]	2002	2.5 x 10^4
AMMM	3200	45	5000	2002	1.2 x 10^5 [b]
MAKET-ANI	3200	6 x 16 groups	10	1996	1.5 x 10^5

[a] Count rate for the first threshold; near vertical charged particles are excluded
[b] Total count rate for 45 muon detectors from 100
[c] First number – energy threshold for the upper detector, second number – bottom detector

Table 1: Characteristics of ASEC Monitors (see also Fig. 9)

Based on experience with correlation analysis of multivariate time-series from ASEC monitors, several new types of particle detectors were designed and fabricated to meet the above goals. In order to keep the instrument inexpensive, the options are kept flexible by using modular designs. The price of a fully autonomous single unit, with facility to send data to the Internet, will not exceed $20,000, so that the network of countries involved in space research can be significantly expanded to enable them to participate in IHY. At any time, one can cascade units to achieve additional functionality, for example, by adding several new observational directions. The advantage to be gained by the world-network of neutron monitors will be the investigation of the additional populations of primary ions.

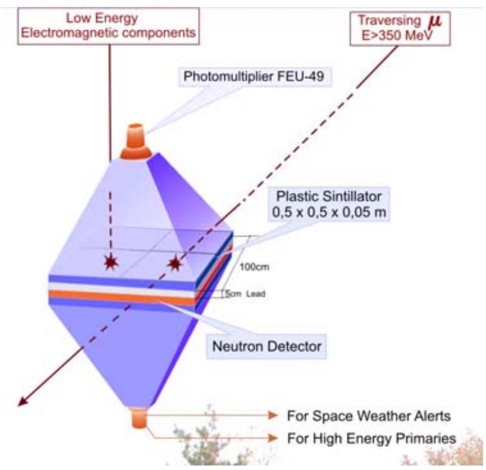

Figure 9. Schematic diagram of the new detector for muons and neutrons installed at the Aragats Space Environmental Center, Armenia (courtesy: A. Chilingarian).

The network is planned to be installed at middle and low latitudes and will be compatible with the currently operating high latitude particle detector network *Spaceship Earth*, coordinated by the group from Bartol Research Institute of University of Delaware in the USA and with the Muon network coordinated by the group from Shinshu University in Japan.

The potential recipients of particle detectors in this new initiative are Bulgaria, Croatia, Costa Rica, Egypt, Georgia, Indonesia and Kazakhstan. It is expected that particle fluxes measured at the medium to low latitudes with the new network, combined with information from satellites and detector networks at high latitudes, will reduce the number of "false alarms" in alerting on severe radiation and geomagnetic storms.

2.9. Muon Network

Principal Investigator: Kazuoki Munakata (Shinshu University, Japan)

Muon detector network collaboration consists of nine institutes from seven countries (Armenia, Australia, Brazil, Germany, Japan, Kuwait and the United States). Many of the countries are already operating muon detectors and some have recently installed them.

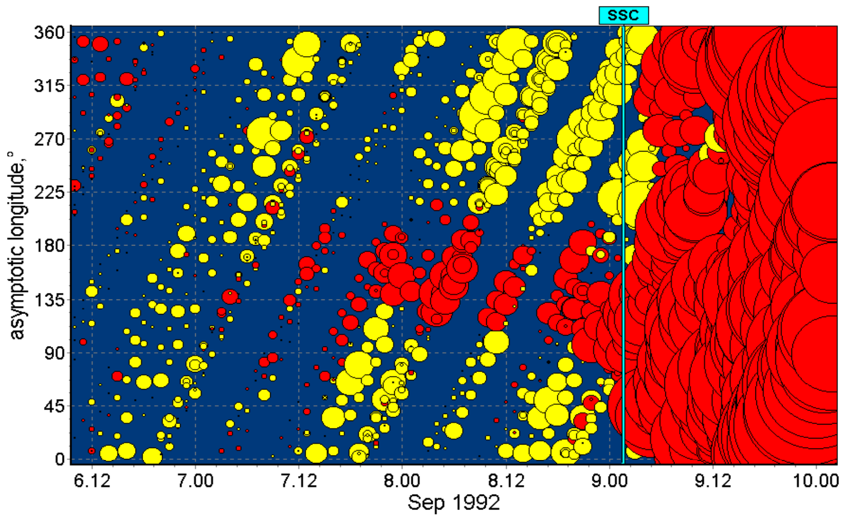

Figure 10a The "loss-cone" precursor observed prior to the arrival of a coronal mass ejection at Earth on 9 September 1992.

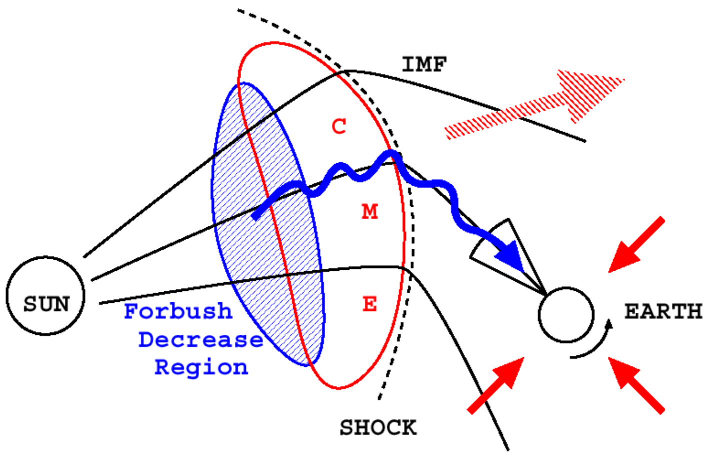

Figure 10b The physical mechanism causing the loss-cone precursor. The coronal mass ejection from the Sun (region marked CME), and the depletion region (Forbush decrease region) are also shown. The coronal mass ejection drives a shock shown by a curved dashed line. Particles entering the detector are denoted by the helical arrow. Three interplanetary field lines are also shown. (courtesy: K. Munakata).

The utility of the muon detector for detecting ICMEs is shown in Figure 10a. Each circle represents an hourly measurement by a single telescope as a function of time (day of year on the abscissa) and the asymptotic longitude of the viewing direction (in degree on the ordinate). The light and dark circles represent, respectively, an excess and deficit of cosmic ray intensity relative to the average, and the size of each circle is proportional to the magnitude of excess or deficit. The precursory decrease (dark circles) of cosmic ray intensity from ~135 deg longitude (sunward direction along the nominal interplanetary magnetic field (IMF)) is clearly seen more than one day prior to the sudden commencement of the storm (arrival of shock driven by coronal mass ejection at Earth). The physical mechanism for the precursory decrease is illustrated in Figure 10b. A coronal mass ejection propagating away from the Sun with a shock ahead of it, affects the pre-existing population of GCR in a number of ways. Most well-known is the Forbush decrease, a region of suppressed cosmic ray density located downstream of a coronal mass ejection shock. Some particles from this region of suppressed density leak into the upstream region and, travelling nearly at the speed of light, they race ahead of the approaching shock and are observed as precursory loss-cone anisotropy far into the upstream region. Loss-cones are typically observed four to eight hours ahead of shock arrival for shocks associated with major geomagnetic storms.

The current network (see Fig. 11) is almost complete except for a desired one in the United States (Hawaii or the West Coast) and the other in South Africa.

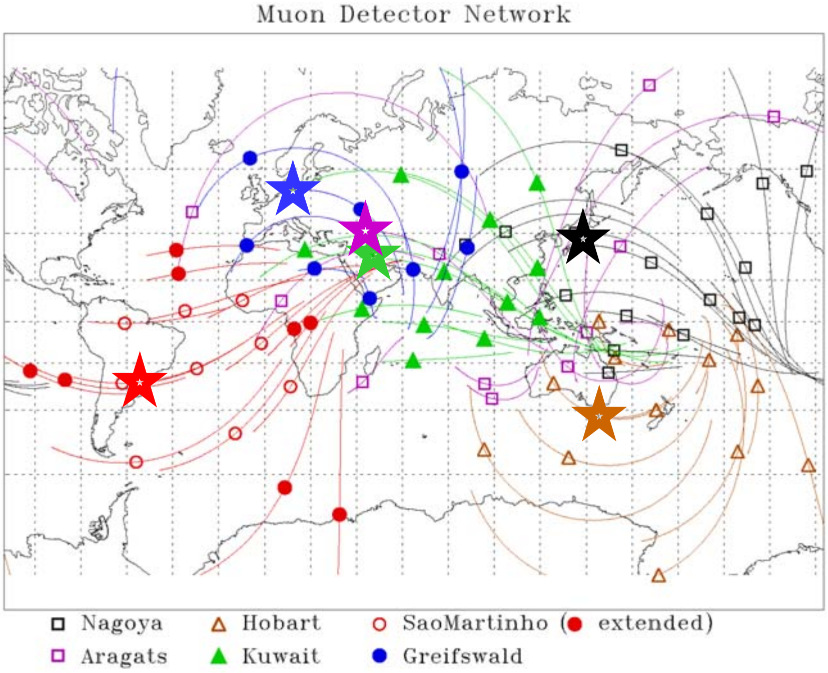

Figure 11 The geographic location of each detector is indicated by a big star and distinguished by number. Each of the symbols (squares, triangles and circles) shows the asymptotic viewing of a particle incident on each telescope with the median primary rigidity. Open symbols display the existing viewing directions, while full symbols represent the directions to be added by the planned installation and extension of detectors. The track through each symbol represents the spread of viewing directions corresponding to the central 80% of each telescope's energy response (courtesy: K. Munakata).

3. Conclusion

The summary presented above outlines most of the existing opportunities for the IHY/UNBSSI programme, which formally started with the workshop in Al-Ain, United Arab Emirates. It must be remembered that these are just the initial set of instrument deployment opportunities. The programme will continue beyond the nominal IHY interval (2007-2008), and the instruments deployed will be UNBSSI legacy instruments. New opportunities will be discussed in future workshops in 2006, 2007 and 2008. It must be remembered that this is not a simple donor-host programme, but an aspect for the promotion of IHY science. There may also be hosts from developed countries if the science demands additional deployment.

The IHY/UNBSSI programme will provide a unique opportunity for enhanced international collaborations in understanding the external processes that affect the Earth's environment and human society. With the availability of electronic communication and data transfer, it is a lot simpler to coordinate observations from space and ground than was possible in 1957. The IHY/UNBSSI programme can enhance the investigations of instrument providers by providing additional data from remote locations. Observations from these instruments will be used not only by the instrument provider but also by the host, thus enhancing the science return. Involvement of students will build the next generation scientists and explorers and draw them from the extended global pool.

Acknowledgments: Most of the material presented above came from the Principal Investigators in the form of presentations, reports, e-mails or the web sites of their groups. Their help is gratefully acknowledged. Part of the support to the preparation of this report was provided by the NASA Solar and Heliospheric Supporting Research and Technology (SR&T) and Living with a Star (LWS) programmes.

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THE EFFECTS OF EARTH'S ATMOSPHERE ON RADIO-ASTRONOMICAL OBSERVATIONS

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Abstract

Radio-astronomical observations are made, of necessity, through the Earth's atmospheres. At low frequencies (longer centimetre wavelengths), the attenuation of the atmosphere is almost negligible; at higher frequencies (short centimetre and millimetre wavelengths), it can be devastating. The aim of this research is to model the effects of atmospheric gases and hydrometeors on radio waves.

The model is based on the assumption that the Earth's atmosphere consists of simple, flat, horizontal stratified levels, with a thickness of 1 km each. The slant path, or range, passing through the atmosphere is divided into equally spaced segments, 1 km apart, starting from the antenna. Calculations are based on highly accurate formulations describing the interactions of the electromagnetic waves with atmospheric constituents. The model provides a useful mean for predicting the atmospheric attenuation under various weather conditions and hence correcting the astronomical observations made under those conditions.

Several runs were conducted to investigate the importance of various atmospheric constituents in attenuating the radio waves. The results indicated that rain and snow can cause a serious degradation at short centimetre and millimetre wavelengths. In addition, other impairments, such as gaseous absorption and cloud attenuation become increasingly important with decreasing wavelengths.

Introduction

A lot of experimental and theoretical research has been conducted on the problem of radio waves attenuation by the constituents of the Earth's atmosphere. Oguchi [1] gives an excellent review of the subject. The increasing use of radio waves in observing technologies requires better modelling and accurate calculations of the attenuation by the Earth's atmosphere. The aim of this research is to develop a model for predicting the radio wave attenuation in the spectral range of 1 to 100 GHz for clear and hydrometeor atmospheres.

In the frequency range of interest, the clear atmosphere attenuation is due primarily to rotational absorption lines of water vapour and oxygen molecules. In addition to the clear atmosphere, hydrometeors such as fog, cloud, rain and snow attenuate radio waves by both scattering and absorption processes. In this work, hydrometeors are assumed to be homogenous spherical masses of pure water.

Theoretical aspects

In general, the power arriving at an antenna, at an elevation angle per unit solid angle, in the frequency interval f and f+df, is given by [2]

$$I_f = \int_0^\infty B_f(T)\exp\left[-\int_0^r \gamma_f(r')dr'\right]dr \qquad (1)$$

where $B_f(T)$ is the specific intensity of blackbody emission (Planck function), γ_f is the attenuation coefficient per unit length of ray path r, and T is the absolute temperature. In the frequency interval of interest, γ_s is the sum of the attenuation coefficients of the important atmospheric constituents. The following sections describe the theoretical bases used to compute these coefficients

a. Clear Air Atmosphere

In general, gases act as absorbers; however, the only gases that need to be considered as absorbers of the radio waves in this case are oxygen and water vapour (actual and dimer molecules $(H_2O)_2$). The theory of electromagnetic waves attenuation by these gases was given by Van Vleck and Weisskopf (1947), and Van Vleck (1947) [2,3] and has been discussed by many researchers, notably, Gunn and East (1954) [4], Falcone (1966) [5], Bean and Dutton (1968) [6] and Warner et al. (1985) [7].

Oxygen

Absorption by the oxygen molecules results from a large number of different spectral lines closely spaced in the frequency region of 50 to 60 GHz. The specific absorption coefficient for the oxygen (dB/km) is given by [7]:

$$\gamma_{o2} = 0.34D\left(\frac{1}{(2-\frac{1}{\lambda})^2 + D^2} + \frac{1}{(2+\frac{1}{\lambda})^2 + D^2} + \frac{1}{(\frac{1}{\lambda})^2 + D^2}\right) + \left(\frac{1}{\lambda}\right)^2 P_d\left(\frac{300}{T}\right)^2 \qquad (2)$$

with

$$D = 0.025P\left(\frac{300}{T}\right)^{0.85} \qquad (3)$$

where P is the total atmospheric pressure (atm), Pd is the dry air pressure (atm), λ is the electromagnetic wavelength (cm) and T is the atmospheric temperature (K).

Water Vapour

The absorption coefficient of water vapour consists of the contribution from a resonant line at 1.35 cm (22 GHz), the edges effects of several lines located in the submillimeter wavelengths region and from the effect of the dimer water vapour molecules. The specific absorption coefficient is given by [7, 8]:

$$\gamma_{wv} = \left[C_1 \left(\frac{318}{T} \right)^{-5/2} \exp\left\{ -644 \left(\frac{1}{T} - \frac{1}{318} \right) \right\} \left(\psi + C_2 D \left(\frac{318}{T} \right) \right) D \left(\frac{1}{\lambda} \right)^2 \right] \rho_v + \gamma_{Dimer} \tag{4}$$

with

$$\psi = \frac{1}{\left(\frac{1}{\lambda} - \frac{1}{1.35} \right) + D^2} + \frac{1}{\left(\frac{1}{\lambda} + \frac{1}{1.35} \right) + D^2} \tag{5}$$

$$D = 0.08478 P (1 + \beta \rho_v) + \left(\frac{318}{T} \right)^{0.625} \tag{6}$$

$$\gamma_{Dimer} = 3.365 \times 10^3 \left[\left(\frac{1}{\lambda} \right)^2 \left(\frac{\rho_v}{7.5} \right)^2 \left(\frac{318}{T} \right)^{11.7} \right] \tag{7}$$

where C_1 =0.00361, C_z = 0.06089 and β = 0.00708. P is the total atmospheric pressure (atm), T is the atmospheric temperature (K), λ is the electromagnetic wavelength (cm) and ρ_v is water vapour density (g/m^3).

b. Hydrometeors

The attenuation of radio waves by fog, clouds, rain and snow results from both absorption and scattering. To obtain the attenuation coefficients of these hydrometeors, the Mie theory shall be used. Mie's derivation is formulated in terms of

$$\alpha = k_o r = \frac{2\pi}{\lambda} r \tag{8}$$

and

$$m = n - ik \tag{9}$$

where α is the dimensionless size, k_o is the free space propagation constant, λ is the electromagnetic wavelength, r is the radius of the spherical particle, m is the complex refractive index, n is the refractive index, k is the absorption coefficient and i is the square root of -1. The resulting solution of Mie's theory leads to expressions for the absorption and extinction efficiency factors of the spherical particles. These expressions are given by [9]:

$$\zeta_s = \frac{2}{\alpha^2} \sum_{j=1}^{\infty} (2j+1) \left(|a_j|^2 + |b_j|^2 \right) \tag{10}$$

$$\zeta_e = \frac{2}{\alpha^2} \sum_{j=1}^{\infty} (2j+1) \mathrm{Re}\{a_j + b_j\} \tag{11}$$

where Re signifies the real part of Mie's coefficients a_j and b_j. These coefficients are functions of both m and α. A method developed by Deirmendijan [10] was used to calculate Mie's coefficients.

The scattering and extinction cross sections are related to the efficiency factors ζ_s and ζ_e by

$$Q_s = \pi r^2 \zeta_s \tag{12}$$

$$Q_e = \pi r^2 \zeta_e \tag{13}$$

The dielectric behaviour of water and ice at radio frequencies has been reported in the literature in tabulated form. In order to quantify the real and imaginary parts of the complex refractive parameter, the Ray model [11] has been used. This model covers the frequency and temperature range of interest and most importantly it is an empirical model.

Cloud and Fog

The only distinction between cloud and fog is their distance from Earth's surface. As cloud and fog droplets are 100 μm or smaller in size, the Rayleigh approximation to Mie theory was used to drive the specific attenuation coefficient for cloud (dB/km). The resulting formula is given by [12]:

$$\gamma_c = 8.1863 \frac{M}{\lambda} \mathrm{Im}(-K) \tag{14}$$

where λ is the electromagnetic wavelength (cm), M is the cloud liquid water content (g/m^3) and K is defined by:

$$K = \frac{m^2 - 1}{m^2 + 2} \tag{15}$$

where m is defined by equation (9). Table (1) shows the properties of standard cloud models [13].

Rain

The rain specific attenuation coefficient (dB/km) is defined by [14]:

$$\gamma_R = 0.4343 \times 10^6 \int_{r_{\min}}^{r_{\max}} Q_e(r) n(r) dr \tag{16}$$

where Q_e is the extinction cross section (cm^2), n(r)dr is the number of rain drops per unit volume of space with radii in the interval between r and r+dr (cm3) and r_{min} and r_{max} are the minimum and maximum radii of rain drops.

Rain refers to a collection of water drops with diameter up to 6.5 mm. In this case the Rayleigh approximation can only be applied for frequencies below 3 GHz [5]. Therefore, the full Mie theory should be used for calculating γ_R. The widely used Marshall-Palmer drop size distribution [15] was used. This distribution relates the meteorological parameter R (rainfall rate in mm/r) to the drop size distribution. It is given by:

$$n(r) = 0.16\exp(-82R^{0.21r}) \tag{17}$$

where r is the drop radius (cm).

Snow

The specific attenuation coefficient of snow (dB/km) is defined by [12]:

$$\gamma_s = 2.27\frac{R_s}{\lambda}\text{Im}(-K) + 0.178\frac{R_s}{\lambda^4}\left|K^2\right| \tag{18}$$

where R_s is the precipitation rate of melted snow (mm/hr), λ is the electromagnetic wavelength (cm) and K is defined by equation (15).

The Model

To numerically solve equation (1), a simple, flat, horizontal stratified atmosphere is assumed. In this atmosphere, the troposphere is divided into 16 horizontal stratified levels with a thickness of 1 km each. The slant path, or range, passing through the troposphere is divided into equally spaced segments, 1 km apart, starting from the antenna and passing through the entire troposphere. The maximum range is assumed to be 200 km. On the basis of these assumptions, a model was developed to compute the specific attenuation coefficients of various atmospheric constituents for each range bin and the integrated (total) attenuation along the path for a given frequency, antenna elevation angle and meteorological condition (radiosonde data). The relationship between the beam height and the range used in the interpolation process of the input data, is given by [6]:

$$H = -R_e + (R_e^2 + r^2 + 2R_e r\sin\theta)^{1/2} \tag{19}$$

where H is the height above the ground (km), R_e is the effective radius of the earth (km), r is the range (km) and θ is the elevation angle (deg).

Results and discussion

Several tests for the attenuation calculations were carried out. Comparisons with published calculations of Gunn and East [4] Battan [12], Staelin [16] and Hodge [17] suggest that the results of the models are acceptable and give a good indication of the amount of degradation of the radio signal.

To reflect the usefulness of the model in predicting the attenuation of the radio waves, several experiments were performed. Fig (1) shows the specific attenuation of clear air as a function of the radio frequency for the US standard atmosphere [6]. The effect of the 22 GHz water vapour and the 60 GHz oxygen absorption lines are very clear. The results also suggest that the attenuation increases with increasing frequency, and the effect of the oxygen is slightly larger than that of the water vapour. Figures (2) , (3) and (4) demonstrate the effects for the variations of temperature, water vapour density and pressure on the attenuation. It is clear that the most effective meteorological parameter is the water vapour density. Figure (5) illustrates the relative importance of the atmospheric constituents. It is seen that ice cloud has almost a negligible effect on radio waves. For the other constituents, the effects are also negligible at very low frequencies (below 10 GHz) and start to increase gradually as the frequency increases. The snow attenuation becomes prominent. Figure (6) shows the clear air integrated attenuation for an antenna elevation angle of 2^o for US standard, Mid-Latitude summer and Mid-Latitude winter soundings [6]. It is evident that a signal received by low elevation antennas can be seriously affected even by clear air. The results also show summer soundings cause slightly higher attenuation than those caused by colder soundings. This is due to higher water vapour density during summer. Figure (7) shows clear air attenuation for different elevation angles for the US standard atmosphere. As expected, the attenuation decreases with increasing the elevation angle, but this decrease is sharp at low elevations, below 30^o, and becomes gradual above this value. Figure (8) demonstrates the results of the atmospheric attenuation for clear air, cloudy, rainy and snowy atmospheres. It is seen that rain is the dominant factor in attenuating the radio waves for frequencies lower than 50 GHz, and at higher frequencies snow becomes the important factor.

Conclusions

Assuming a simple, flat, horizontal stratified atmosphere, a model was developed to predict the attenuation of radio waves passing through clear and hydrometeor atmospheres for a frequency range of 1 to 100 GHz. The model was based on the numerical solution of the radiative transfer equation. Several tests were carried out for the calculation procedures of the attenuation coefficients of various atmospheric constituents and the results were compared with other works. This suggests that the model gives acceptable outputs. The model permits calculations of a worldwide atmospheric attenuation for any arbitrary input atmospheres and geometry (slant range). It can be a very useful tool for correcting radio-astronomical observations.

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Table (1): The properties of standard cloud models [12].

Descriptive Cloud Type	Cloud Base (m)	Cloud Top (m)	M (g/m^3)	Principal Composition
Cirrostratus	5000	7000	0.10	Ice
Low-Laying Stratus	500	1000	0.25	Water
Fog Layer	0	50	0.15	Water
Haze Layer	0	1500	10^{-3}	Water
Fair Weather Cumulus	500	2000	0.50	Water
Cumulus Congests	1000	2000	0.80	Water

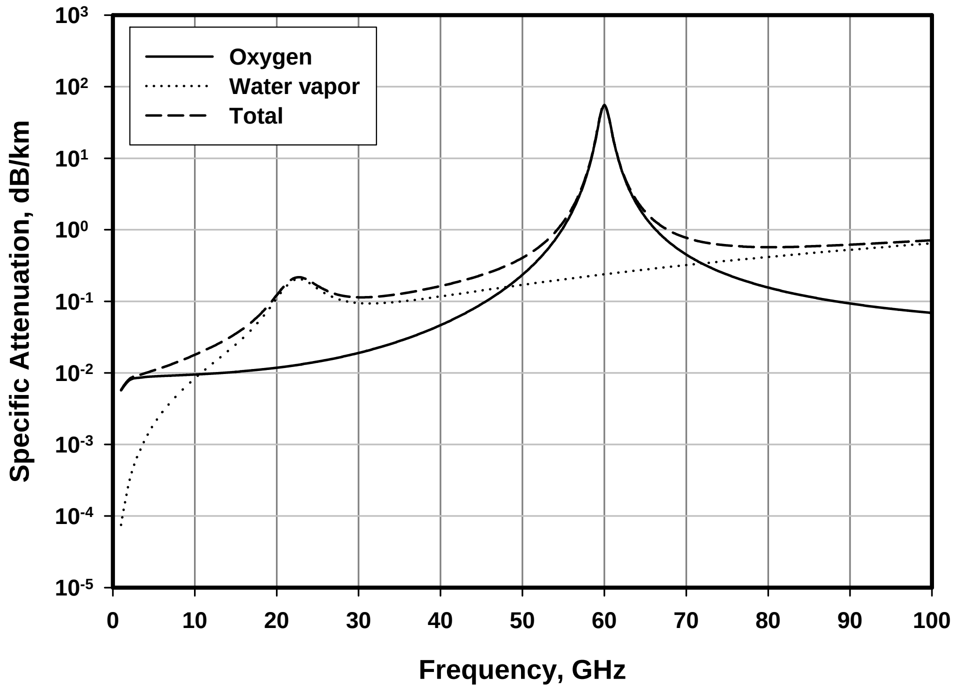

Figure (1): Specific attenuation due to atmospheric gases as a function of radio frequency for P=1013.25 hPa, T=293^o K and ρ_v=7.75 g/m^3.

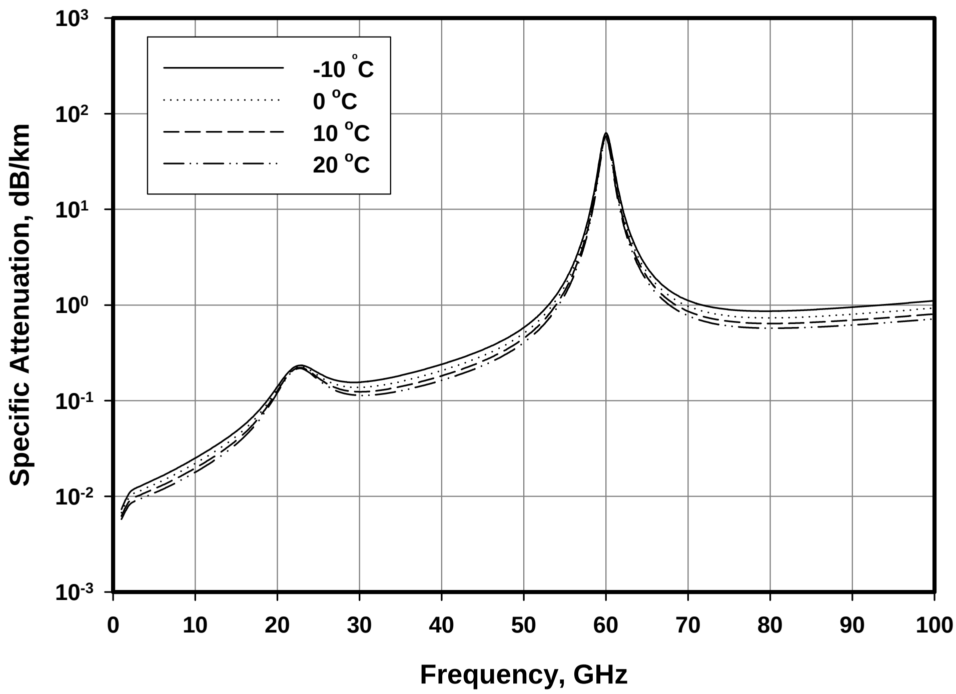

Figure (2): Specific attenuation due to atmospheric gases as a function of radio frequency and atmospheric temperature for P=1013.25 hPa and ρ_v=7.75 g/m^3.

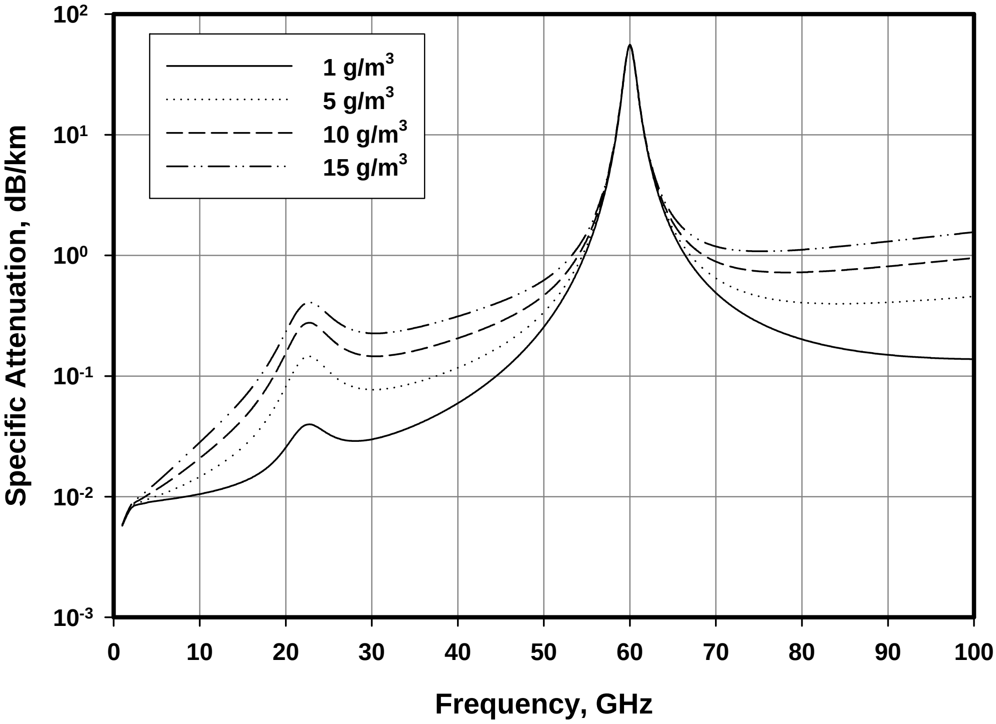

Figure (3): Specific attenuation due to atmospheric gases as a function of radio frequency and water vapour density for P=1013.25 hPa and T=293^{o} K.

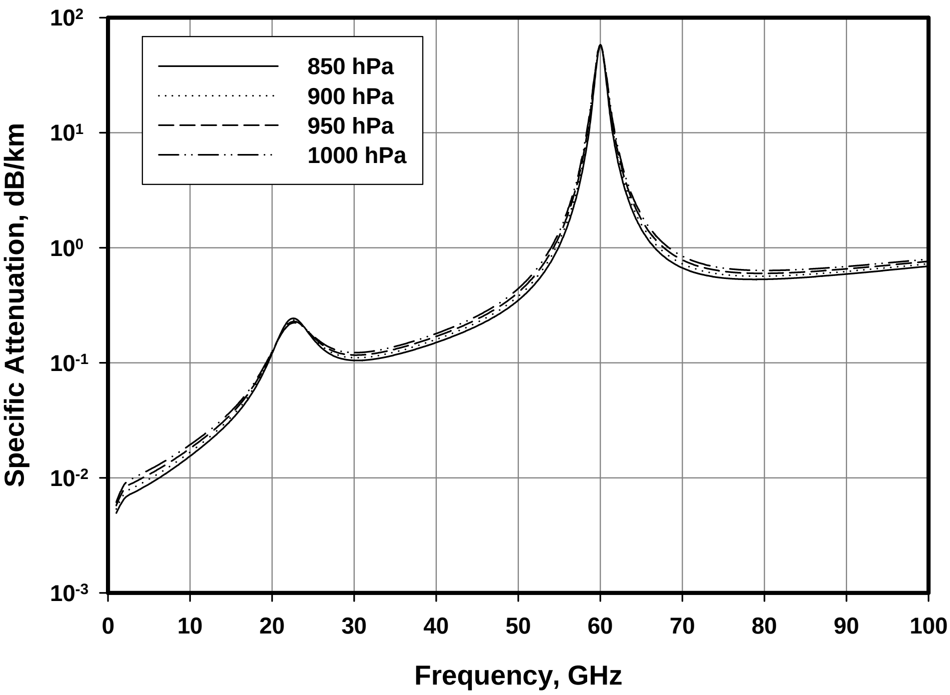

Figure (4): Specific attenuation due to atmospheric gases as a function of radio frequency and atmospheric pressure for T=293^{o} K and

ρ_v =7.75 g/m^3.

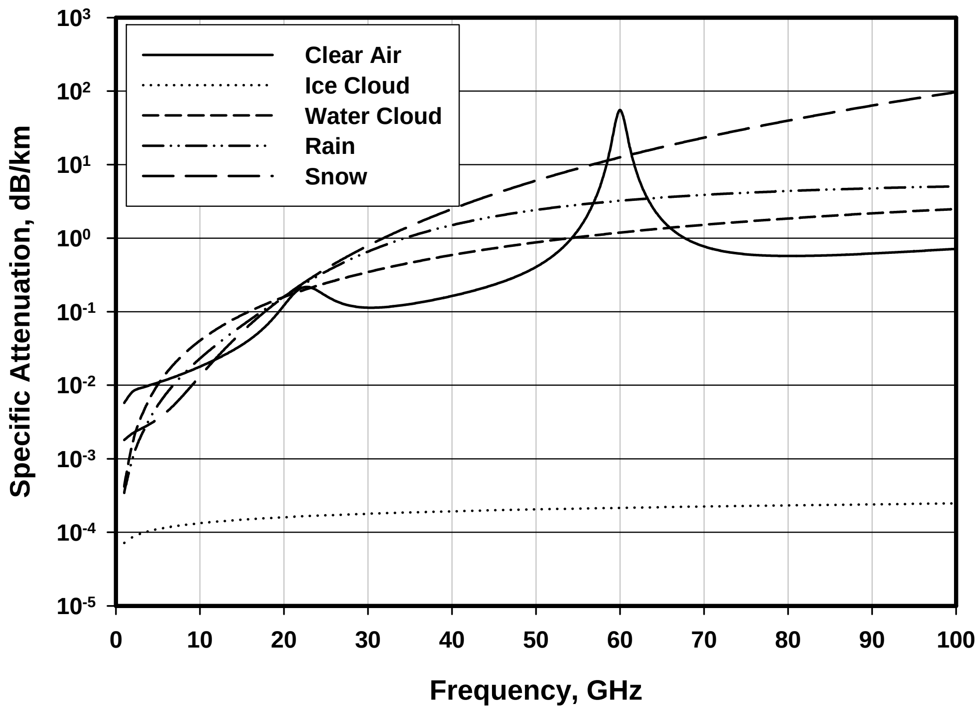

Figure (5): Specific attenuation due to different atmospheric constituents as a function of radio frequency and atmospheric pressure for P= 1013.25 hPa, T=293^o K and ρ_v =7.75 g/m^3.

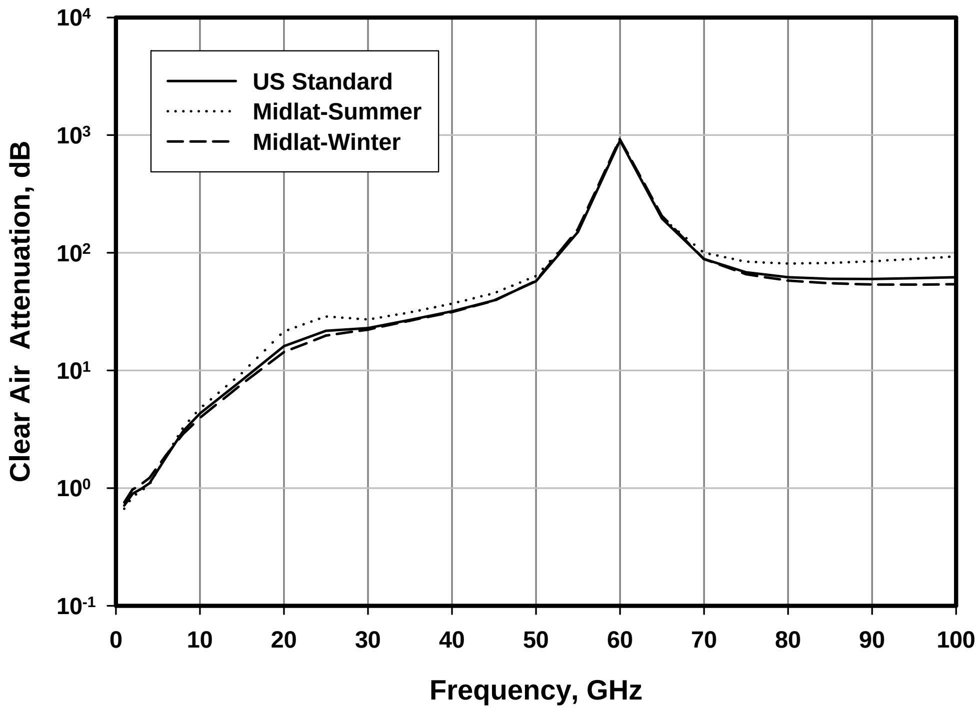

Figure (6): Clear air attenuation as a function of radio frequency for different standard atmospheres at an elevation angle of 2^o.

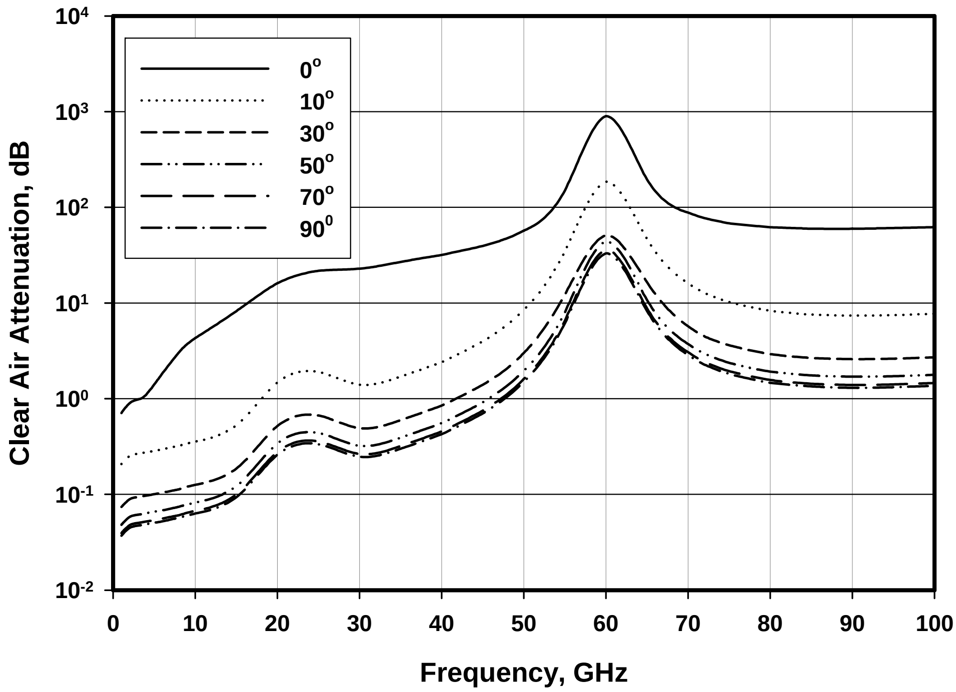

Figure (7): Clear air attenuation as a function of radio frequency for different elevation angles for US standard atmosphere.

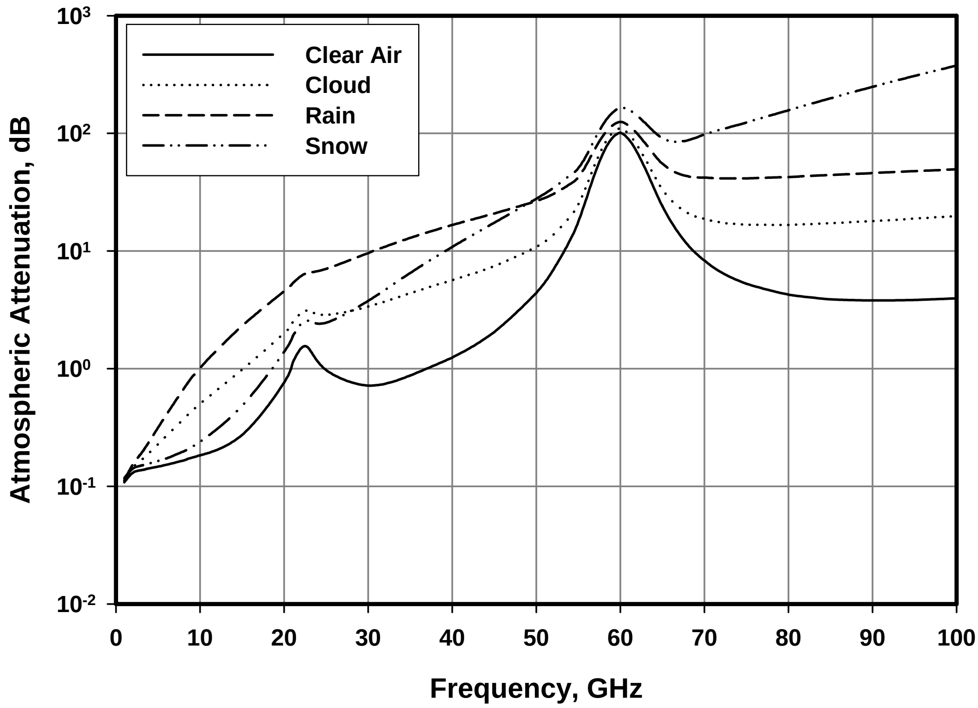

Figure (8): Integrated atmospheric attenuation as a function of radio frequency for clear air and hydrometeors atmospheres.

A PROPOSAL TO PARTICIPATE AT THE LIBYAN SOLAR PHYSICS AND SOLAR ECLIPSE SYMPOSIUM (SPSES2006)

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North Carolina Agricultural and Technical State University
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Possible funding sources: National Aeronautics and Space Administration (NASA) of the United States, European Space Agency (ESA), United Nations Educational, Scientific and Cultural Organization (UNESCO), U.S. Department of State, Government of the Libyan Arab Jamahiriya

Project summary

Sebha University of the Libyan Arab Jamahiriya, in collaboration with the Libyan Center for Remote Sensing and Space Science, is conducting an international Symposium on Solar Physics and Solar Eclipse (SPSES2006) in conjunction with the total solar eclipse that will occur on 29 March 2006. The location of the symposium lies along the path of totality, which will enable participants to view the eclipse and to set up their own experiments directly at the site of the symposium, Waw-an-Namus. The main objective of the symposium is to offer a perfect site to observe the solar eclipse, while providing a unique opportunity to establish and develop contacts between scientists all over the world. The event will present an inspiring occasion to discuss recent advances in solar astrophysics. A wide variety of topics will be discussed, particularly: history and contemporary science of solar eclipses; recent results of solar magnetic fields; polarimetric observations of the solar spectrum; effects of solar variability on Earth's climate and space weather; and recent developments in and current challenges to the utilization of solar energy.

At the United Nations/ESA/NASA Workshop on the International Heliophysical Year 2007, which was hosted by the United Arab Emirates University on behalf of the Government of the United Arab Emirates and held in Abu Dhabi and Al-Ain, from 20 to 23 November 2005, scientists from Cameroon **(Mr. Guemene Emmanuel Dountio)**, Côte d'Ivoire **(Dr. Olivier Obrou),** Egypt **(Dr. Maha S. Quassim)**, India **(Dr Arvind Paranjpye)**, Iraq **(Dr. Najat Al-Ubaidi)**, Libyan Arab Jamahiriya **(Dr. Abogader Abseim)**, Nigeria **(Dr. A. Babatunde Rabiu and Mr. Enoch Elemo)** and USA **(Dr. Abebe Kebede)**, proposed a unique international outreach programme around the March 2006 solar eclipse. While the main event is centered in Waw-an-Namus, Libyan Arab Jamahiriya, this group of collaborators will exchange content and experimental activities to be performed in their own countries as well as in countries lying along the path of totality. Of particular emphasis is that an international team of undergraduate and graduate students and faculty members will travel to the Libyan Arab Jamahiriya to participate in the SPSES2006, and conduct a two day SPSES2006 "COSMOS in the Classroom" workshop for Kindergarten to 12th Grade science, technology, engineering and mathematics (STEM) teachers, and "Physics on the Road" outreach activities for Kindergarten to 12th Grade students and the public.

Project description

The COSMOS in the Classroom Workshop for STEM Teachers

Kindergarten to 12th Grade outreach programmes and activities are the cornerstone for improving the quality of education, to enhance the breadth and depth of knowledge, functional literacy, as well as improve the science and mathematical skills of incoming first-year students across the USA. Programme developers for Kindergarten to 12th Grade activities have collaborated to develop effective outreach activities that initiate change of general behaviour towards specific fields. Particularly, such collaboration and exchange of ideas are vital in order to increase the number of university students in STEM. *"The COSMOS in the Classroom"* targets STEM teachers of grades 9-12. There are three important points to this workshop:

- It will address several specific competencies and skills reflective of national standards;

- It will address the "No Child Left Behind" Act of the United States; and

- It will add new teaching and learning technologies for STEM classroom instruction. Particularly, it will introduce the application of Logger Pro and other current educational products and learning tools. The Logger Pro software is an experimental and data analysis platform that is used to measure physical quantities in statics, dynamics, thermodynamics and electromagnetism.

SUMMARY OF SKILLS AND GENERAL TOPICS

SKILLS	GENERAL TOPICS
(1) Teachers will identify and learn to use NASA educational resources. (2) Teachers will learn how to use the web. (3) Teachers will launch email lists, make websites with links to simulation and virtual laboratories. (4) Teachers will have hands-on experience in undergraduate science laboratories. (5) Teachers will integrate NASA Kindergarten to 12th Grade learning/teaching materials and technology tools into their science syllabi. (7) Teachers will place their science syllabus online. (8) Teachers will develop learning communities.	- Scales - The sun and the solar system - Stars and evolution of stars - The death of stars -Space science missions - Light and matter superconductivity - Atomic and plasma physics - Solar physics - High energy physics - Nanotechnology - Biotechnology - General physics - Kinematics and dynamics

Comparative competencies and objectives using North Carolina Standards

The Workshop will follow North Carolina and US standards (shown in Tables I and II) as a bench mark to build the skill of participating teachers in the Libyan Arab Jamahiriya and any other participating country.

Table I: North Carolina competency requirement and the associated objectives

Competency	**Objectives**
The learner will acquire an understanding of the Earth in the solar system and its position in the universe.	(1) Analyze the theories of the formation of the universe and solar system. (2) Analyze planetary motion and the physical laws that explain that motion. This includes: • Rotation; revolution: apparent diurnal motions of the stars; Sun and moon: effects of the tilt of the Earth's axis. (3) Examine the sources of stellar energies: • Life cycle of stars, Hertzsprung - Russell Diagram. (4) Assess the spectra generated by stars and our Sun as indicators of motion and the composition of the Sun and stars (The Doppler Effect) (5) Evaluate astronomers' use of various technologies to extend their senses: optical telescopes, cameras, radio telescopes, spectroscope.

Table II: US Grades 9-12 Science Content Standard

Physical science ▪ Structure of atoms ▪ Structure and properties of matter ▪ Chemical reactions ▪ Motions and forces ▪ Conservation of energy and increase in disorder ▪ Interactions of energy and matter	Science as inquiry ▪ Abilities necessary to do scientific inquiry ▪ Understandings about scientific inquiry Earth and Space Science ▪ Energy in the Earth system ▪ Geochemical cycles ▪ Origin and evolution of the Earth system ▪ Origin and evolution of the universe

Tentative programme schedule

Day 1	Day 2
8:30-9:30AM: Technology Tools for Science and Mathematics Learning: Overview of technology for hands-on activities (Logger Pro, academic software, information technology) 9:35-10:35: Overview of astronomy • Observations and identification of prominent stars constellations and planets • Overall size, structure and age of the universe • Evolution of stars 10:45-11:55 Sun-Earth Connection I • Structure of the Sun-interior • Solar surface features • Motions of the Sun • Gravity • Tides • Tidal forces • Eclipses 12:00: Lunch 13:30-14:30: Orbital mechanics: The mathematics of space flight: Understanding gravity, Keppler's laws, Newton's laws of motion 14:35-15:30 Overview of Earth and space science education resources 15:40-16:30: Feedback, Q&A, ADJOURN	8:30-9:30AM: Technology Tools for Science and Mathematics Learning: Overview of technology for hands-on activities (Logger Pro, academic software, information technology) 9:35-10:35: Overview of astronomy • Solar systems: comparing the Sun to other stars • Formation of planetary systems • Comparative planetology; Early Earth; planetary exploration 10:45-11:55 Overview of astronomy • Position and motion of objects in our solar system and galaxy • Big Bang: synthesis of the elements • Technology of exploring space- human and non-human 12:00: Lunch 13:00-16:00: Operation of portable solar telescope; getting ready for the 29 March 2006 solar eclipse

Physics on the Road Project (PoRP): A project to enhance public visibility of Physics, to support Kindergarten to 12th Grade STEM Education in Guilford County schools and beyond

Scale of project

The project organizers plan to conduct the "Physics on the Road" Project (PoRP), which will be an international model for recruitment and retention of students in STEM. This programme begins with a meeting of participants on 20 March in Tripoli to work out the details of the activities. The international outreach group meet their counterparts and the meeting introduces the representatives of the schools to be visited and the vehicles to be fitted with the science experiments. The visit begins on 22 March. At least two hours will be spent at a given school. Pending the availability and commitment of contacts, the activity will be spread well beyond the city into the countryside.

Physics on the Road Program

This programme is an outgrowth of the recent science on wheels activities in several schools and after-school programmes in North Carolina. The programme began with an activity called "Colors are everywhere". This activity is tailored to the level of the

student. Several topics were introduced including identification of colours of the rainbow fractions, electromagnetic spectrum and the energy from the Sun. The activities were expanded to include demonstrations on mechanics, electromagnetism, change of phase, magnetic levitation, superconductivity and many others. A total of 500 students and their teachers have

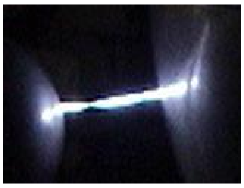
been served so far. Dr. Abebe Kebede and one undergraduate student currently lead this outreach. These activities will be replicated in Libyan schools. As much as possible, the workshop organizers will attempt to make the demonstrations reflect aspects of everyday life such as sports, toys and entertainment, climate and weather, safety, light and acoustics, famous people and the like. Each demonstration will attempt to build an every day experience of the observer and the experimenter.

List of possible activities

In order to develop a diverse set of activities, workshop organizers plan to collaborate

with similar activities in the United States and around the world. For example, activities from the following programmes will be adapted or directly used: Physics in a Van programme (University of Illinois at Urbana-Champaign), the Pacific Science Center, Little Shop of Physics (Colorado State University), Kids-Physics (Syracuse University), Science on Wheels (Marshall University) and the Science Houses (North Carolina State). Specific activities include the following:

(1) Colors are Everywhere: This module is about the origin of colour, and how colour forms as light passes through a devise such as a prism. The programme is designed to fit all classes, including high schools. The topics include identifying colours in the rainbow, manipulation of shapes, fraction, optical devises, energy and the Sun.



(2) Electrostatics: This module contains documentation and activities that will be used at any grade level. It will be accompanied with demonstrations and hands-on activities that will involve generation and transport of charge. The Van De Graff Generator will be used as the centrepiece equipment.

(4) Electromagnetism: This module contains documents about electricity and magnetism and the relationship between the two. It will be tailored to fit the Kindergarten to 12th Grade course of study. Students will design their own circuits and electromagnets. A variety of electromagnetic devices will be used to measure electrical quantities such as current and voltage power. While students learn the principles of electromagnetism, the magnetic field of the Earth will be introduced by using the function of a compass. The concepts of solar activity, magnetosphere and space weather will also be introduced.

(5) Mechanics: This module contains documents and activities about kinematics, dynamics, energy and momentum transfer. The demonstrations include rotational motion, bouncing balls, motion and motion detectors etc. Projectile motion, rocket design and space flight in a public setting will be added.

(6) State of Matter: This module contains documents and activities on state of matter. Liquid nitrogen will be used to demonstrate change of phase and the effect temperature has on the size of objects. Superconductivity and its interaction with the magnetic field will be further demonstrated.

(7) Hands-on solar eclipse models and the operation of a portable solar telescope.

Composition of the team

The composition of the international team of students, faculty and space science professionals will be as follows:

- Five lecturers from Sebha University;
- 100 undergraduate and graduate students from Sebha University;
- Two members of the NASA Sun-Earth Connection community;
- 25 graduates, undergraduate students and faculty from the United States;
- Five space science experts and educators from the United States; and
- Ten international students and educators from developing countries.

Fundraising activities

Local business will be solicited for sponsorship and for the sale of T-shirts. This proposal will also be submitted to funding agencies such as the US Agency for International Development (USAID), NASA, ESA, the American Geophysical Union, the American Astronomical Union, the International Union of Physics and Applied Physics and UNESCO.

Budget

The budget for the entire project is presented in the table below.

Line Items	**Explanation**	**Cost (U.S. $)**	**Number**	**TOTAL COST (U.S. $)**
15 US students and their mentors	Air travel	2,000	15	30,000
	Accommodation (10 days)	500	15	7,500
International participants	Partial travel support	1,000	15	15,000
Air cargo	Shipment of educational supplies			2,000
Rental bus (Physics on the Road)	=$300/week for 1 week	300	2	600
Printing, binding and award certificates, workshop ads, web support, T-shirt	Preparation of awards			7,000
Media coverage (CNN airtime)	The eclipse will be broadcast to the Greensboro, North Carolina, USA community			8,000
Educational supplies				4,000
TOTAL estimated budget				**74,100**

III. APPLICATION-BASED THEMES

Telemedicine: Future Medical Care Possibilities On Board

Uwe Stüben[1], Peter Hufnagl[2], Klaus Tille[1]

History

For the treatment of acute cases of illness on board, in addition to a medicine chest, a first aid kit and a well-equipped doctor's kit, Lufthansa also carries defibrillators on all its flights. With this equipment, the crew can assist resuscitation measures, which may possibly become necessary during the flight.

In addition, the airline cooperates with International SOS, a specialized service provider, which guarantees medical support around-the-clock. Since 1996, with its Patient Transportation Compartment (PTC), Lufthansa has been the only airline to make it possible to transport intensive-care patients on board scheduled flights. These examples indicate that Lufthansa sets standards with respect to the medical care of its passengers on board and thus clearly distinguishes itself from its competitors.

Lufthansa is well aware of the confidence invested in it and its responsibility towards its passengers and would like to further improve this medical service which today is already unique.

Innovation

When the decision was taken to become the first airline worldwide to implement high-speed Internet access on board, the airline already recognized opportunities for this innovation that go far beyond that of a mere "communication feature". Consequently, telemedicine applications using Internet on board were already simultaneously tested during the first test flights. Thus, a patient's most important vital parameters such as the oxygen saturation of the blood, heart frequency, body temperature or an electrocardiogram can be measured on board and transmitted directly to a ground station. The doctors there can then make a precise diagnosis and give the aircrew or specialist travelling personnel specific information about a therapy. In critical cases the contact to the ground station makes it easier to decide on an unscheduled stopover.

Test results

Several pieces of equipment commercially available were successfully tested, which, however, did not satisfy the high standards of the airline since they were far from making full use of the possibilities on board Lufthansa aircraft. Although the evaluation of the test runs revealed that the equipment already available on the market equipment was operable, none of the existing equipment made full use of the data capacity provided

[1] Deutsche Lufthansa AG, Frankfurt, Germany
[2] Charité – Universitätsmedizin Berlin, Germany

by FlyNet for the communication of vital parameters, images and sound. The current equipment only used a narrow band connection with strictly limited performance options. As the first airline worldwide with this powerful broadband Internet connection, Lufthansa has the corresponding transmission capacity for sending data. Therefore the time had come to acquire manufacturers for the development of new telemedical equipment with even greater customer benefits.

Resonance

The test flights already met with great media interest and thus Lufthansa has been able, among other things, to present its involvement at several specialist United Nations gatherings, where recognition was given to the airline’s “ethical and humanitarian" commitment.

Partner search

Also in the area of telemedicine, Lufthansa relies on excellent partners and. together with a consortium that includes, among others, the Charité Universitätsmedizin and GHC of Global Health Care GmbH in Berlin, is working on the development of a telemedicine emergency system, “TCS”, which satisfies the requirements and challenges. Due to the technically innovative and sophisticated development, co-financing was obtained from the Berliner Zukunftsfond (Berlin Future Fund).

Telemedical system TCS

TCS is intended to make the telemedical handling of emergencies possible from an emergency centre. The entire sequence of operations involved in emergency management, consisting of diagnostics, therapy, monitoring and finally transfer of the passenger on the ground, must be supported by TCS. Although TCS itself is a very complex technical system (medical technology, communication technology, video technology, remote control), it must be simple to operate for the personnel on board. Especially in critical emergency situations, this technology should not create additional problems but must optimally support the personnel on board. That objective can only be achieved through extensive practical tests during development.

Tests of the latest generation of equipment

Following the completion of a feasibility study, a totally new function demonstrator with revolutionary possibilities for data transmission was successfully tested on several FlyNet flights. For example, when flying over the Southern tip of Greenland on board an Airbus A340, the electrocardiograms of scientists who were on board at the time were directly transmitted to the Charité, and via video conference there was real-time communication with doctors on the ground. This is a promising approach that will now be consistently further developed. To this end, further test flights and workshops are being regularly conducted.

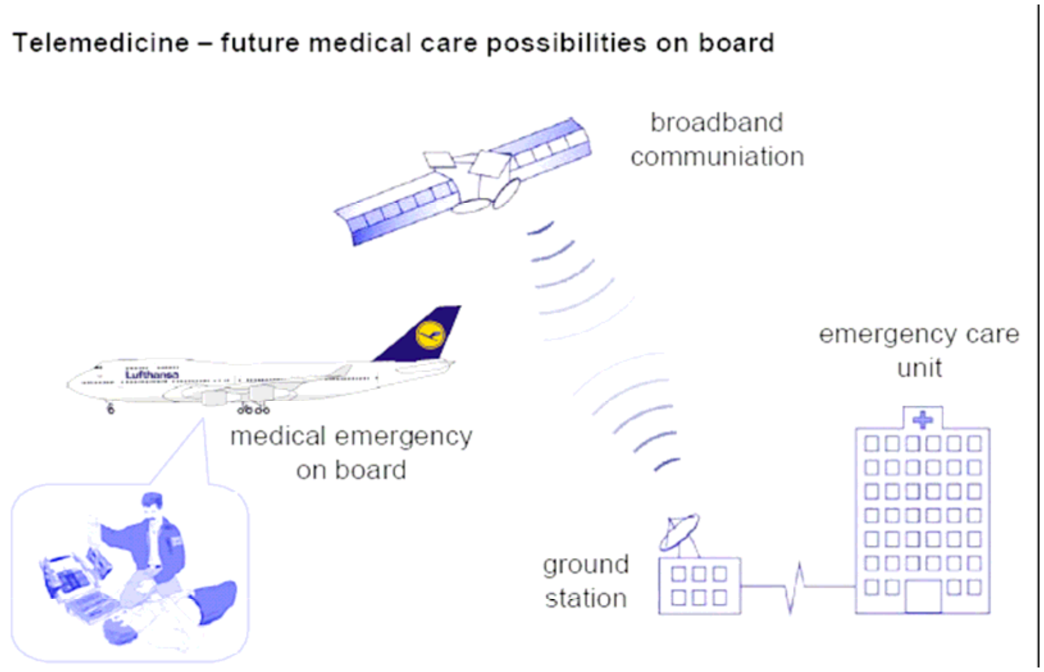
Charité Telemedicine Centre

At the Charité, a telemedicine centre was founded at the end of 2004, with which the Charité wishes to offer medical services around-the-clock worldwide. The medical tests on board are already operating via this telemedicine centre. Typical emergency situations are simulated under onboard conditions. Those tests, which also involve the cabin personnel, ensure that TCS satisfies all the requirements under normal flight conditions.

The necessary reception and control software for the telemedicine centre is being developed parallel to the development of TCS itself. The doctor on the ground must be able to quickly get an impression of the situation on board in order to provide effective help.

Vision

At the end of this process, a piece of telemedical equipment will be made available, the use of which will be self-explanatory for the crews and any medical practitioners who happen to be on board, making travel with Lufthansa even safer and more comfortable in a medical emergency or even as a service that can be booked in advance. Together with its partners in the consortium, Lufthansa is playing the pioneering role not only in use of the system, but also in the development of trend-setting telemedical applications on board passenger aircraft and will become the first airline to offer a broadband telemedical care service.



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