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Abstracts

Algeria

GNSS Earth Sciences Studies in Algeria

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The main tool to set earth sciences applications in a global geocentric reference frame is based on the dynamic of the GNSS (global navigation satellite systems) orbital motion around the earth. Practically, all the GNSS earth sciences applications are based on the establishment of the homogeneous and precise networks for the determination of the earth surface and monitoring its time variation caused by geophysical effects.

For the realisation, the GNSS, which have a spatio-temporal cover of the world, allows precise positioning, geodynamic deformations, ionospheric and tropospheric modelisation.

The main earth sciences activities developed in Algeria are about large scale applications as geodynamical studies done during the Tyrgeonet project, in collaboration with the INGV (Italy), and cover the West Mediterranean area, and Algeonet and REGAT project in the North of the country. Several GPS observing campaigns are done with bifrequency receivers and the data collected are processed using specific software (Bernese, Gamit/GlobK) and the periodic measurements are analysed with the Kalman Filter cinematic method.

For the realisation of a Total Electronic Contain (TEC) map, a network based on IGS stations and local data was used to evaluate the ionospheric errors on the area for precise positioning using a simple layer model which provide some results at several test altitudes as 350, 400 and 450 km.

The tropospheric modelisation using a GPS data collected at the same area permit the evaluation of the IVW (Integrated Vapour Water) on a test region in the West Mediterranean area.

In geodetic applications, a setting up of the national GPS network is started with the establishing of a network of 13 permanent GPS stations as reference points of all the national geodetic network and cartography and GIS applications.

Finally, for educational activities, a graduate (Master) and post-graduate curriculum on space applications, including space geodesy and GNSS positioning, are dispensed for hundreds students each year.

Brunei Darussalam

A Geocentric Datum of Brunei Darussalam 2009 (GDBD2009)

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At the 1996 International Earth Rotation Service (IERS) Workshop, the IERS recommendations encourage national agencies to establish a precise national datum based on International Terrestrial Reference Frame (ITRF) in order to be linked into regional or continental solutions and used for many applications (refer Reigber C. et al, 1997). Survey Department and KT Ryan and Communication & Services together with their technology and geodetic partner University Teknologi Malaysia (UTM) Consortium were given the task to establish a geocentric datum for Brunei Darussalam under the project known as Replacement of Brunei Datum to Geocentric Datum. The main objectives of the project are

- To investigate and analyze the existing BT48 reference system over the areas of Brunei, Sarawak, Labuan and Sabah
- To define and realize a new geocentric datum for Brunei Darussalam (ITRF at a particular epoch), and
- To determine the optimal transformation parameters between the new geocentric datum and the existing BT48 reference system

Based on the concepts for the establishment of a geocentric coordinate system using GNNS as adopted by many countries such as Australia and Malaysia, a complete procedure for implementation are described as follows:

- To set up a Zero Order Network and Primary GNSS Network
- To achieve a high accuracy three-dimensional coordinate data set for all the stations of the Zero Order Network by connecting with selected IGS sites whose coordinates are well-defined in the

ITRF.

- To achieve a high accuracy three-dimensional coordinate data set for all the stations of the Primary GNSS Network through a rigorous GNSS network adjustment, based on dual frequency carrier phase data observed by static GNSS of more than 24 hours
- To chose GRS80 as the reference ellipsoid for coordinate converting between rectangular coordinate of (X,Y,Z) and the curvilinear coordinate of (φ,λ,h)
- To determine the optimal transformation parameters between the new geocentric datum and the existing BT48 reference system
- To adopt the Rectified Skew Orthomorphic (RSO) projection for plane coordinate mapping

The Brunei's Zero Order Network consists of three (3) existing and five (5) new GNSS permanent stations of Brunei. Seven (7) Malaysia RTK Network (MyRTKnet) stations were chosen to be part of the network. The network was connected to more than 50 selected IGS sites whose coordinates are well-defined in the ITRF2005 in order to realize high accuracy three-dimensional coordinate data set for all the stations.

The observed GPS data from the network was processed using Bernese processing software version 5.0. The final combined solution consists of 17 daily solutions (DoY 136-154) with 64 stations (8 RTK stations, 49 IGS stations and 7 MyRTKnet stations). Minimal constraints adjustment using free network solution with 3-parameter helmert transformation was used to adjust the daily normal equation freely and transform them using forty one (41) selected IGS station. This process will allow for the internal reliability investigation and to detect outliers. With short data span, the introduction of reference velocity for the fixed stations is not possible; hence, the final coordinates for all stations were fixed at the middle of the observation epoch. The RMS of the residuals is between 2.78 - 3.73 mm, 3.50 - 6.27 mm and 4.89 - 10.15 mm for northing, easting and height components respectively. It can be concluded that the internal accuracy of the Brunei Darussalam RTK stations from the free network adjustment is 2 to 7 mm for the horizontal component and 4 to 10 mm in the height.

Comparison of IGS stations coordinates has been made in order to determine the accuracy of the network with respect to the ITRF2005 reference frame. The final combined coordinate from the network adjustment was fixed on 25 May 2009 ($\approx$ 1st June 2009) or 2009.45, the reference coordinates (ITRF2005 Epoch 2000.0) for the IGS stations were propagated on the same epoch as the adjusted coordinates. The RMS of fitting is 5.6 mm, 5.1 mm and 6.3 mm for the northing, easting and height components. It can be concluded that the accuracy of Brunei Darussalam Zero Order Network with respect to the ITRF2005 reference frame for the free network strategy is 7 to 12 mm in the horizontal component and 11 to 16 mm in height.

The Primary GNSS network consists of 13 existing Primary Triangulation stations and five (5) Secondary Triangulation Stations. The GNSS observation of the network has followed the guidelines and procedures as Zero Order Network. Observation on each triangulation station was carried out for 48 hours with calibrated GNSS equipment and accessories. GNSS observation was made from 13 February 2009 to 03 March 2009 for the 18 stations. In the network adjustment, a total of 15 Zero Order Network stations were held fixed and their coordinates were referred to 1st June 2009 epoch. Results were analyzed statistically for coordinate repeatability and RMS of residuals. The RMS of the campaign solution is less than 10 mm for both the horizontal and height components.

Bursa-Wolf seven parameter transformation model has been used to transform from GDBD2009 coordinates to BT48 coordinates. The Earth Geopotential Model 2008 (EGM2008) has been used to derive the orthometric height of the BT48 stations using the final GDBD2009 coordinates of the respective stations. The orthometric heights obtained from this strategy are more homogeneous. One of the computation procedures for 3-dimensional datum transformation is to use ellipsoidal height instead of orthometric height. This procedure is important in order to obtain better relationship between the local and global sysrems. For the ellipsoidal solution, the orthometric heights (*H*) have to be converted into their corresponding ellipsoidal heights (*h*) on the Modified Everest Spheroid. The first iteration of computations results reveal that the scale factor between GDBD2009 and BT48 is at -7.297 ppm and the standard error of unit weight is 0.584. The residuals plot for common points has shown that station B039 (Ulu Tutong) has large residuals in all components. In the second iteration, this station was excluded and the results have improved drastically. The standard error of unit weigh is 0.240 and residuals for common point are less than 0.5 meter. Therefore, the results of the second iteration are adopted as the final transformation parameter between GDBD2009 and BT48. Through this project, it is revealed that the BT48 datum had an origin shift of about 690m, -624m and 66m in the X, Y, Z components and scale factor of 5.9 with respect

to ITRS. Thus, a new set of seven parameters transformation has been derived between GDBD2009 and BT48 datum. It is recommended that a series of approaches and strategies have to be developed in order to encourage the survey and other communities to use GDBD2009.

Parameter derivation between GDBD2009 and WGS84 is using a simple three (3) parameter transformation model. It involves only the translation in X, Y and Z axis. Three (3) World Geodetic System 1984 (WGS84) points was provided by Survey Department, Brunei Darussalam. A single iteration has been carried out to determine the transformation parameters. The results have shown a very good agreement between the two datum and the standard error of unit weight is 0.137. The residuals for the common point are less than 20 cm in all components.

The RSO provide an optimum solution for minimizing distortion whilst remaining conformal for Brunei/Borneo. The New Geocentric RSO Projection Parameters were computed using GRS80 ellipsoid instead of Modified Everest Ellipsoid. Conversion of Geographical to Rectangular coordinates and vice versa was also made by the consultant for the benefits of the users.

The Geocentric Datum of Brunei 2009 (GDBD2009) is based on International Terrestrial Reference Frame 2005 at epoch ITRF2000@2009.4 and is computed for 8 Brunei Darussalam RTK Stations. The Brunei Primary Geodetic Network (BPGN) which consists of 18 BT48 points is now connected to the International Terrestrial Reference Frame 2000 (ITRF2000) at centimeter level accuracy. It is undeniable that the GDBD2009 would provide an internationally compatible system for all spatial data. This in turn will generate greater benefit in the application of satellite positioning such as GNSS and particularly GPS in the country. The establishment of an accurate reference frame for Brunei guarantees consistency of information within the country and between neighbouring countries and the region.

The ITRF reference system is global and is not fixed to any specific tectonic plate. The coordinates defined in ITRF will change over time due to the displacement of the plates and possibly to some intra-plate motions. Therefore, the defined ITRF frame (both coordinates and velocities) is referenced to a specific epoch of time. For a national coordinate system which is based on ITRF, a procedure must be designed for regular maintenance. For maintenance of permanent stations such as network of RTK, the precise and accurate coordinates of the stations can be determined in a network adjustment integrating the selected IGS stations which are well-defined in the ITRF. If the stations are permanently operating and routinely computed, it is implied to have good maintenance. For long period of acquisition of GPS data, it can be used to investigate the time evaluation, station velocities and other scientific and geodynamic studies.

Burundi

Enhancing GNSS Accuracy and Availability in Inter-Tropical Zone

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Main transport applications using Global Navigation Satellite Systems are employed in dense urban area. One of the reasons involving bad position accuracy is the ionospheric and scintillation errors.

Many solutions are currently used to decrease the influence of the ionospheric error on the accuracy and the availability of GNSS systems. This study focuses on particle filtering methods (Sequential Monte Carlo Methods) and presents an algorithm for estimation error in order to improve the position accuracy.

In open area, Kalman filter is well appropriate to estimate the GNSS position. In case of positioning in equatorial zone, the noises observed have not a non-gaussian distribution. This is due to reflected signals that will induce a geometrical delay on the pseudorange measurement. A new solution has to be defined to provide better performance taking into account a more realistic error model in the equatorial areas.

The originality of the approach is to adapt the error model in the filtering process to the reception condition of each satellite signal. Particle filtering algorithms have shown their interest for such systems. For an alternate path reception, the probability distribution of the errors is unspecified because of multipath. This distribution is then modeled by a Gaussian mixture model. This modeling allows us to model the overall reception process which switches between the observation's models corresponding with the states of reception.

The particle filter algorithm performed takes into account the multi-sensor (multi-satellite)

characteristic of the observation model.

China

BeiDou System Update

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Since 1980's, Chinese government has been supporting satellite navigation technologies research and system development. From 2000 to 2004, the 3 GEO (Geostationary Earth Orbit) BeiDou satellites were launched and started to provide PNT services for Chinese users as the first phase. Now the BeiDou system has 9 satellites with 7 in operational and 2 in validation status, which could serve the Asia-Pacific regional users. From 2015, BeiDou system construction will enter into the third phase and will include 5 GEO, 30 non-GEO satellites for the full operation. And all the users in the whole world are encouraged to make full use of BeiDou signals for PNT and non-PNT applications like remote sensing.

The BeiDou time and coordinate system is also introduced in this presentation with the effort China made for the Asia-pacific region reference frame.

BeiDou system would like to cooperate with other GNSS providers, international organizations on compatibility and interoperability, interference detection and mitigation, GNSS applications, academic exchange and technological cooperation. Chinese government has many academic activities on satellite navigation such as annual conference and CAE-NAE GNSS workshop.

China

iGMAS and the BeiDou/GNSS Application Demonstration and Experience Campaign(BADEC)

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In September, a subgroup was formally proposed by China and approved by ICG-6 meeting, which is dedicated to deal with iGMAS (international GNSS Monitoring and Assessment Service) which draw much attention and support from GNSS providers, users and international organizations.

And BeiDou system will soon provide testing operation services for users of the Asia Oceania region, and then users will be benefited a lot with Multi-GNSS systems including GPS, GLONASS, BeiDou,QZSS and GALILLEO. With the new signals and services of BeiDou satellites,the Asia Oceania region can gain early experience regarding the multi-constellation GNSS. So at the 3rd Asia Oceania region GNSS workshop, China introduced plans for several long-term project activities under the banner of the "BeiDou/GNSS Application Demonstration & Experience Campaign(BADEC)". The goals of BADEC are seeking to make the Asia-Oceania region a "showcase of the new GNSS era", and include BeiDou-specific goals such as "welcome the introduction and utilization of BeiDou services", "let users experience the Multi-GNSS including BeiDou", and "encourage GNSS provider and users to carry out experiment and demonstration jointly".

Both iGMAS and BADEC will contribute to promote the GNSS open service performance, compatibility and interoperability, and will be implemented through extensive international co-operations. This paper will provide backgrounds,goals,tasks and plans on both iGMAS and BADEC, describe the organization and outlines, give proposals.

China

GNSS Curriculum for Master's degree and Capacity Building at Beihang University

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Beihang University is one of 16 key universities in china and established 1952, which was the one of the earliest university having developed the education and training on space technology and application program. From 2006, master program for Asia-pacific region on remote sensing and GIS, Communication Satellite was held at Beihang University, which curriculum adopted the curriculum developed by

UNOOSA. More than 40 students from 8 countries have been graduated and 26 students are studying at Beihang University. Master degree program on GNSS which cooperated with APSCO (Asia- Pacific Space Cooperation Organization) will be held in the September, 2012. The outline, design idea and brief introduction of each course are discussed in this presentation. And the major achievements in international education in recent years at Beihang University will also be introduced. Now, Beihang University has become the international cooperation and training center of the China Satellite Navigation Office and Beihang University is exploring the way to apply ICG information center affiliated by United Nation in China.

Colombia

SIRGAS: The achievements 1993 – 2011, and beyond

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During the last eighteen years SIRGAS has consolidated as the reference frame for the Americas and one of the most successful geodetic initiatives of cooperation and scientific brotherhood in the world.

The original idea, seemed as an utopic enterprise, has evolved into a dynamic body based on the cooperation of more than fifty institutions that under the umbrella of the International Association of Geodesy (IAG) and the Pan American Institute of Geography and History (PAIGH), day after day, build and maintain the densification of the International Terrestrial Reference Frame (ITRF), as well as the national geodetic networks in the Americas region.

Today, SIRGAS means a continental geodetic infrastructure based on permanent GNSS stations network, the modernization and unification of the vertical reference systems and the national densifications of the geodetic infrastructure.

In this context, a review of achievements and challenges to be faced by SIRGAS is shown.

Croatia

Raising Public Awareness of Space Weather Induced Effects on GNSS Performance and Operation in Croatia

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Space weather and ionospheric effects are the major sources of the GNSS performance degradations and disruptions. The general public, comprising numerous individual GNSS users, has so far developed a very modest understanding of space weather-induced GNSS vulnerabilities. Here we present the recent developments in raising the public awareness of the space weather and ionospheric effects on GNSS performance and operation in Croatia. The actions taken include the introduction of multidisciplinary academic courses, orgainsation of the seminars for the general public, and the establishment of the national space weather and GNSS information web-site.

Croatia

GNSS Laboratory Research: Academic Education and Professional Advancement

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Studying GNSS requires both theoretical and practical work. A dedicated facility is to be provided to students as well as to researchers in order to allow for research, academic education and professional advancement. Here we present the recent developments in establishing the GNSS laboratory at Faculty of Maritime Studies, University of Rijeka, which is aimed to foster research activities, and at the same time provide a practical laboratory facility for both university students and professionals undergoing the professional advancement. Consisting of GNSS equipment and simulators, and the sensors of the space weather activity, the GNSS laboratory at Faculty of Maritime Studies in Rijeka provides a framework for a

hands-on experience, thus both enhancing the competence of professionals and allowing for scientific activities. The paper will conclude with the brief summary of improvements in education as the result from the GNSS laboratory utilisation, and the plans for laboratory extensions.

Egypt

Toward Enhancing the Capacities of the Middle-East Region in Space Weather Disciplines

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With a population of more than 250 million people and a notable strategic position between the North and South, the Middle-East constitutes a distinct region of the developing world. The region is cemented by a number of common characteristics related to its distinctive climate, ecology, history, language and culture. Egypt is located at the heart of the Middle East, which gives it a strategic position in that region of the world.

Egypt has taken the lead to establish the Space Weather Monitoring Centre (SWMC) at Helwan University. The center was founded in 2007 to support the Egyptian Space Programm through monitoring and forecasting space weather. SWMC includes twenty two researchers working in four groups in the fields of the ionosphere, geomagnetism, solar physics and cosmic rays. The research topics of each group are in harmony with the other groups and focusing on space weather related effects.

We discuss the need to establish the UN-affiliated centre for space science and technology education in Egypt to sustain space weather disciplines, not only in Egypt but in the Middle East. We present all the facilities and capacities that enable Egypt to host this centre.

France

G-TRAIN : Supporting education and training in the field of satellite navigation in Europe

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G-TRAIN is a project funded by the European Commission to contribute to the development of Europe's GNSS education offer through concrete actions. The partners of the project are highly recognized GNSS education centres that are located in European GNSS centres of excellence: Politecnico di Torino (Polito) and Istituto Superiore Mario Boella (ISMB) in Torino, Italy; Universitaet der Bundeswehr Muenchen (UniFAFM) in Germany; Ecole Nationale de l'Aviation Civile (ENAC) and Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) in Toulouse, France.

The concrete actions undertaken within G-TRAIN target the second and third cycles of education and are developed around 5 well defined objectives:

- The creation of a new Master of Science in GNSS (2-year program taught in English) developed and hosted by ENAC and ISAE with the collaboration (through teaching and internships) of Polito and UniFAFM. This new programme will start in Sept. 2012.
- The strengthening of the Specializing Master on Navigation and Related Applications already existing and hosted by ISMB and Polito with the development of new specializations
- The support of Doctoral candidates by creating an inter-linkage between education and research. This is done through two annual events:
    - GNSS PhD Training (3 days of training for PhD students on specific GNSS-related topics)
    - GNSS PhD Summit (event where PhD students can present and discuss their research with highly qualified professors/experts)
- The availability of funding for PhD students to attend the relevant GNSS-related conference and events.

- The creation of the Satellite navigation University Network (http://www.snun.eu) that aims at linking European GNSS education centers to support cooperation, interchange and creation of educational programme

This presentation aims at showing the status and achievements of these initiatives after 2 years within the G-TRAIN project and to discuss the remaining task and future developments of these initiatives.

France

Satellite Navigation Applications Realizing Global Challenges and Ambitions

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The public budget must be carefully invested in R&D areas which have both a strong growth potential, and secondly, satisfy the political, societal and economic interest. The domain of GNSS applications, becoming one of the pillars of 21-century society, offers a splendid opportunity among the most promising ones!

The presentation will detail how GNSS applications can act to take up global challenges and to reach global ambitions. It will reiterate the necessity to make public funding accessible to GNSS applications R&D. It will identify the critical GNSS technologies, applications and services that will be boosted by public funding and will provide a set of recommendations to maximizing the potential of the GNSS applications' market so as to generate sustainable economic growth and new jobs and to enhance citizens' wellbeing.

Some key GNSS Applications

- Transport: safety and efficiency increase for aviation, maritime and inland waterways, rail, road transport…
- Environment protection: support to ecologic driving, waste control, Land monitoring and Land Administration…
- Health: Tracking and Tracing of medical goods, assistance to elderly/disabled people…
- Agriculture: Precision Agriculture, Livestock management…
- Mobility: Navigation, Road tolling, LBS, multi-modal transport services…
- Security and Safety: PAYD insurance, law enforcement, protection of IPRs, Customs and Freight monitoring…

Germany

Challenges of Regional Reference Frame Implementation

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Where geodetic reference frames has been renewed in periods of decades during the last century, this situation has changed since the establishment of permanent operating GPS receivers at the reference sites. Since the years around 1990 a new infrastructure consisting of permanent GPS tracking sites, data centres and analysis centres provide relevant geodetic parameters, e.g., station coordinates, satellite orbits or earth rotation parameters, on daily basis. After a few years of operation linear trends were obtained and applied for, e.g., tectonic movement interpretation. During the past years various innovations opened the horizon for manifold challenges to implement regional reference frames. To mention a few of them there started so-called "re-processing initiatives" meaning that archived GPS data are analysed once again, but now using improved and consistent modeling. Results of the EUREF "re-processing 1" initiative demonstrate that this effort is worthwhile to achieve time series of station coordinates with highest precision. Other actions aim to supplement GPS observations with further Global Navigation Satellite Systems (GNSSs), where today GLONASS is already in use for tasks considered here and more GNSSs are planned. It is required to handle the systematic differences existing between the various GNSSs to achieve compatibility and interoperability. Also format issues need to be addressed to archive and stream GNSS observations. The EUREF data centre already provides so-called RINEX version 3 files, to support multi-constellation developments, even if the discussion on the best suitable format for future GNSS observations is going on. The orientation of the reference frame implementation approaches towards real-time enables

today new applications for monitoring the earth and precise "in-the-field" positioning. EUREF is actively involved in the definition of RTCM standards for multi-system messages and state space representation messages, both urgently needed for multi-system real-time applications. All mentioned recent developments focus not only on geodetic aspects of reference frames, but also on the monitoring of global changes of the earth that is deemed to be a seamless scientific task. Thus, EUREF established partnerships to EuroGeographics and EUMETNET to increase synergies and collaborations between European organisations.

India

Indian Regional Navigation Satellite System (IRNSS) an overview

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ISRO Satellite Centre IRNSS Project

Indian Space Research Organisation (ISRO) is implementing Indian Regional Navigation Satellite System (IRNSS) to provide navigation services to the various users. IRNSS is an independent regional navigation satellite system of India.

Indian Regional Navigation Satellite System (IRNSS) envisages establishment of Regional Navigation Satellite System using a combination of GEO and GSO Spacecrafts over Indian region. The IRNSS constellation will consist of seven satellites - three Satellites in GEO orbit (at 32.5º E, 83º E and 131.5º E) and four Satellites in GSO orbit inclined at 29º to the equatorial plane with their longitude crossings as 55º E and 111.5º E(two in each plane). All the satellites are visible in the Indian region for 24hours.

The IRNSS System is expected to provide two sigma position accuracy better that 20 meters over India and a region extending to the about 1500 kms around India. IRNSS system consists of Space Segment, Ground Segment and User Segment. IRNSS will provide two type of services viz. Standard Positioning Service (SPS) and Restricted Service (RS) with encryption. The payload will transmit the signals at L-band (1176.45 MHz) and S-band (2492.028 MHz).

The paper covers an overview of Indian Regional Navigation Satellite System; its configuration and implementation strategy.

Indonesia

GNSS applications for space weather monitoring in Indonesia

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Space weather is the conditions on the sun and in the solar wind, magnetosphere, thermosphere, and ionosphere that can influence the performance and reliability of space-borne and ground-based technological systems and endanger human life or health. The technological systems that are affected by space weather are Global Navigation Satellite System (GNSS), satellite telecommunication systems, ionospheric radio propagation, geomagnetic surveys for geological interpretation, directional drilling surveying, high voltage power transmission grids, active chatodic protection against corrosion of pipelines, long distance telecommunication cables and possibly railway signalling. The performance and reliability of GNSS are significantly affected by space weather particularly the conditions of ionosphere that can affect propagation of GNSS signals. In GNSS navigation and positioning the ionosphere-induced range errors, ambiguities in phase due to phase fluctuations and loss of lock due to ionospheric scintillation can not be ignored. Fortunately GNSS technique itself provides a unique opportunity to be used for monitoring of ionospheric activity continuously on regional in real time to provide corrections and early warning of ionospheric disturbances. Indonesian Permanent of GNSS Stations Network (IPGSN) established by National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) can be used for near real time space weather monitoring. This paper describes the status and plans of GNSS applications for space

weather monitoring in Indonesia.

Israel

Active radar observations of meteors and passive detection possibility using GNSS

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Meteors have traditionally been observed visually or by photographic means. Modern observations are done with intensified video cameras and reach typically meteors brighter than 6 mag. These produce light by ablation and ionization of the ablated material and the surrounding atmosphere at altitudes of 80 to 120-km. The meteoric plasma can also be detected by reflection and scattering of radio waves. Radars have been used to detect meteors via plasma scattering, mostly at tens of MHz. High-Power Large Aperture (HPLA) radars that can be used for meteor research are few but provide unique results. I shall describe results used during a number of observing campaigns with the EISCAT radar in Norway that show the existence of meteoric plasma at much higher altitudes than the typical optical meteors, as high as 300-km. The plasma there is probably produced by sputtering of meteoric material.

The meteoric plasma can also be detected passively by scattering of radio waves; this has long been known by radio amateurs that use this method for long-distance contacts. With the existence of many GNSS systems, this passive detection method can now be attempted to provide panoramic information about meteors using tomographic techniques.

Israel

Using Location-Based Social Media for Emergency Response

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Cyberspace and Social Media have become an integral part of life in developed countries. Nations use cyberspace to communicate with the public, disseminate information, collect government payments, and even referendum voting. Smartphones and computers enable nearly anyone to communicate from almost everywhere, and enable creating, generating and sharing of information and data, including location-based information. Recent events have shown that in an emergency, access to cyberspace has a critical role in the crisis management efforts. In some major disasters in the last decade cyberspace played a major role in search, rescue and recovery efforts. Such examples could be found in the Japan earthquake-tsunami 2011 and Haiti earthquake 2010, and in the 2011 Irene hurricane. In Japan, for example, although telephone networks were disrupted, internet access remained reliable and cyberspace was a firm base for applications and services.

As technology advances, people are increasingly more connected and connected communities have the opportunity to be more resilient in a crisis situation. This understanding could be further utilized in future disasters to efforts. Using social networks, GNSS-based applications can support search-and-rescue teams and help them arrive faster to survivors, provide a decision support tool on prioritizing scarce rescue resources, and give online psychological support to survivors to increase overall community resilience.

The presentation will (1) present case studies of the use of cyberspace and social networks in disaster situations (2) discuss current applications pros and cons (2) provide possible GNSS based social media approach for disaster recovery efforts (3) offer possible international cooperation to increase efficient use of those applications (4) present an Israeli test case.

Latvia

GNSS education and development at the RTU

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Riga Technical University (RTU)

At the Riga Technical University in the field of geodetic observations, navigation, different educational and research projects, GNSS plays main role. It is important for students to understand

principles of GNSS and obtain experience with practical examples. We go up to studies of Kepler's orbit elements and laws.

The main experts on GNSS at the RTU within faculty of Civil Engineering are located in the Geomatics department. Every year at the RTU more than 100 students have classes on GNSS theory and practice at least for one semester. This branch develops very rapidly and any new information or practical examples give benefit to study process and involvement of more students. Without research and start of new technologies we could not plan our development and future.

As one of important part for use of GNSS must be connection with other space based techniques, like what we have in Latvia, too. Such option could be Satellite Laser Ranging (SLR) observations of satellites jointly with GNSS. There is place for research and studies, it is attractive for students and young scientists, especially if we add sea level observations with satellite radar altimeters. In Latvia we have our Baltic Sea coastline of more than 600 km lengthwise. And from point of view from environmental part – it is important to connect all different technologies in one creative tool for complex monitoring and analysis of Earth geosystems with the benefit for humanity.

Latvia

Spatial data quality improvement with GNSS base station System LatPos

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Classic Geodetic Network system was taken over from Soviet Union. New Geodetic benchmarks have been established to achieve homogenous dispersion on all country. Latvia Coordinate System was founded in 1992. New coordinate set was determined in August 29, 1992, totally with 20 GPS receivers. Each Year geodetic network was improved. In Year 2004 decision about establishing Next generation geodetic network – RTK GPS base station Network was agreed. Base station established at the end of Year 2005. System consists of 19 base stations and one data center. System uses Leica Spider software. In Year 2010 additional 3 reference stations was installed. To improve reference station system 2 stations was moved to new locations and in 2011 one station was moved. In LatPos system all receivers upgraded to receive GLONASS satellite systems. There are 119 real-time users and about 450 post processing data users. Real-time users use wireless (GPRS) connection to cell phone providers to connect to internet and to system. System is working 24 hours a day and 365 days in Year. In three Years only 0,5% of time system was offline. Main problem why system goes down is data lines from base stations to server and main power failure, where processing center is located. System preciseness is controlled with measurements on control points – on ground based geodetic network benchmarks. Control measurements were done in all country. Coordinate compatibility with old fashion geodetic network, inside of LatPos system network provides two centimeters. Measurements with this preciseness mark out all irregularity in classic benchmark networks. This is one aspect, which is improved by using GNSS base station network. As base stations are not placed near country border, measurements outside network are possible. Maximum error reached is four centimeters. Coordinate compatibility with old pre-historic geodetic network – triangulation network can reach level of twenty centimeters because of coordinate determination with transformation from old coordinate systems. Another problem shows up is local network fragmentation as LatPos is homogenous network in all country. Each local network raises problems to be kept up and running because of many constructions going on. Height measurements with RTK are possible with Latvia geoid model. Geoid model preciseness is seven centimeters. New Geoid model is in progress. Combined Geodetic Network will be created. Second GPS RTK network – Riga has five stations. System compatibility test on ten control points in Riga territory was carried out. There was compatibility within five millimeters between system's measurements.

Madagascar

GNSS Aviation Application and Programmes

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Madagascar is in an economical transition period. Located in Indian Ocean region with its 587000

square kilometres of area, Madagascar has not utilised GNSS technologies in most vital sectors for social and economic growth. GNSS was a valuable tool which should be taken advantage of as it could contribute to improvements in the quality of life. Now GNSS is mainly used in civil aviation, maritime, telecommunication, Data acquisition for Geographic Information Systems (GIS) and Mining, mapping and surveying sectors, it was not applied in other sectors, so GNSS technologies were vital to support Government priorities for sustainable development of the Millennium Development Goals (MDGs).

Moldova

Development of Geodetic Databases for MOLDPOS Services

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Starting from 1999 a new reference system MOLDREF99 based on the ITRF97 and ETRS89 was established in Moldova. The realization of MOLDREF99 is the national GPS Network with density about 1 point per 15 sq. km. However, this density is insufficient for many geodetic applications. In order to provide real time positioning services the decision to pass from GPS "passive" Network to GNSS "active" Network in the period 2009-2011 was adopted by Land Relation and Cadastre Agency. To provide real time position and navigation service the GNSS-reference stations network and Moldavian Positioning Service (MOLDPOS) were developed.

The process of the establishment of MOLDPOS services and respective GNSS-reference stations network implies the replacement of the georeferencing in the old classical reference frame SC-42 by the ITRF-related horizontal geoferencing provided by the MOLDPOS service. The transformation parameters database was created using COPAG software based on the finite element modelling (FEM). To generate and distribute height anomalies for real time normal height determination from GNSS measurements a 3-4 cm accuracy Height Reference Surface based on precise GNSS/levelling was calculated using DFHBF software. The CoPaG and DFHBF databases will be implemented in the control centre for setting up the recent world-standard of RTCM 3.1 transformation messages for the GNSS rover-clients using a RTCM transformation messages server.

The capacity of an absolute positioning by GNSS-positioning services requires that possible changes of the coordinates of the GNSS reference stations in the amount of few millimetres are detected immediately. To solve that task, the GNSS-reference-station MONitoring by the KArlsruhe approach and software (MONIKA) has been developed.

A new geodetic infrastructure will be used for large spectrum of applications (geodetic works, cadastral surveying, GIS, mapping, navigation, etc.) and will be the basis for support of scientific applications (landslide monitoring, environmental research, geohazard prediction, meteorology, etc.).

Morocco

The Role of Capacity Building and Training on GNSS in the Developing Countries

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GIE Galileo Morocco

During these last years, the technology and the applications of GNSS knew a spectacular evolution. GNSS is currently being used in a wide range of sectors: transport, climate change, search and rescue, etc. A number of studies and demonstrations have shown that all of these sectors will significantly benefit from the use of GNSS. These benefits include improved navigation coverage, accurate and also reliable information. Therefore it proves to be important to maximize the benefits of the use of GNSS applications and the mastery of this technology by training and capacity building to support sustainable development particularly in developing countries.

However, this situation meets the problem of the rarity of expertise and resources particularly in developing countries. Therefore, some efforts must be deployed to allow these countries to have their local qualified expertise in the GNSS field and to exploit fully the benefit brought by this technology. This approach must be adapted to the specificities of each country and take into account its objectives and

constraints.

Indeed, we can note that in several developing countries, the use of the GNSS is limited to very simple and isolated cases (topography, personal navigation, etc.) and that syllabus especially dedicated to GNSS does not exist indeed. So, it's important to conjugate the efforts of the local actors and the regional and international organisms (CRASTE-LF, …) in order to make actions permitting the development of local expertise in the GNSS field. The actions must cover the formation of both users and trainers and also the sensitization of decision-makers on the role of the GNSS applications.

In this presentation we will discuss about Moroccan experience in this field. We will present activities realized by the GIE Galileo Morocco, which is an Economic Interest Group created by the government in order to initiate and to encourage training, research and development in the GNSS field. The activities presented concern notably training, capacity building, initiating research projects in academic institutes, co-organizing workshops, developing GNSS applications, and collaboration with regional and international institution.

Nigeria

TEC Derived from some GPS Stations in Nigeria and Comparison with the IRI

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Total electron content (TEC) measured simultaneously using Global Positioning System (GPS) satellites at some locations in Nigeria during 2008-2010 was used to study the diurnal, seasonal, and annual TEC variations. The TEC exhibits features like the equatorial noon time bite-out, annual and semiannual variations, the equatorial ionization anomaly, and day-to-day variability. Daytime variability is compared with nighttime variability at all stations. The time of occurrence of the diurnal maximum in TEC also varies with season. Measured TEC were compared with those predicted by the International Reference Ionosphere (IRI). It was observed that IRI TEC is not in accord with those measured at about all local times.

Pakistan

Conceptual Framework of CORS Network for Precise Point Positioning Applications in Pakistan

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Global Navigation Satellite Systems (GNSS) is strengthening and escalating position and navigation arenas by providing uninterrupted and sustainable services worldwide. This service has made profound implications in Pakistan as of the other countries around the globe. Studies have been conducted for meeting the demands of current challenges and sustainable development of Pakistan utilizing the CORS Network. In continuation of this scenario and meeting the current demands; nationwide CORS network is sought to serve as a national infrastructure providing fast, correct, and reliable collection of all kinds of geographic data. Thus, resulting in laying down the foundation for standardized national positioning service, speeding up the activities of cadastre, assuring organized urbanization, constituting the spatial infrastructure for relevant works of e-government and other related projects, precise point positioning capacity for Civil Aviation Authority (CAA) and conducting scientific studies related to atmosphere and plate tectonics with high-tech's convenience and products. This presentation will encompass the conceptualization of CORS network as a whole for Pakistan stating its scope, deliverables and services along with SWOT matrix analysis.

Serbia

GNSS Technology in Thematic Maps Development

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This paper describes the usage of GNSS technology in the process of making thematic maps, on the example of hiking track maps on mountain Fruška Gora. This mountain is also a region (70x30km) of great importance in the Republic of Serbia with National park and developing touristic activities. Maps for this purpose are made in scale of 1:50000 and 1:60000, so it was not necessary to achieve high accuracy of the survey, but approximately 140km of tracks had to be mapped in unfavorable terrain configuration and in rather short time period. This made the process of data acquisition crucial so adequate method had to be chosen. Having in mind all the circumstances, GNSS technology was our choice. Survey was performed in 7 days but some methods of data processing had to be applied afterwards. GNSS data were processed in three steps. After each step the data accuracy was higher and in the end we achieved the results that could be used in thematic maps development.

Thematic maps were created combining the resulting GNSS data with various raster data: topographic maps, digital elevation model, satellite imagery etc. Overall 18 maps were created in electronic and hardcopy forms. Some maps were made in isometric 3D view. GNSS data were used to generate other numeric data such as slopes, lengths, height differences etc. This data were also put on the maps along with other data that are on maps for this purpose (peak and checkpoint names and heights, track marks etc).

Efficient procedure was established which involves field survey, data processing and representation. Not only it enables production of more accurate maps but it makes updating of these maps easier, and, therefore, increases overall quality of the maps.

Spain

GNSS-EGNOS approaches to European airports

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The most important objective for the utilization of the EGNOS system in aviation is to achieve the complete operational implementation in daily revenue operations, specially the LPV approach operations with integrated avionics. The effort has to focus on supporting the EGNOS adoption by interested end users of identified niche markets. Therefore, the main activities in Europe have focused on regional airlines, business and general aviation, as well as helicopters operator.

The first GIANT project for the "GNSS Introduction in the Aviation Sector" (www.gnss-giant.com) paid special attention to how GNSS systems particularly meet the needs of Regional Aviation, helicopter HEMS (Medical) operations and North Sea Oil Rigs operations. As a follow-up, the GIANT-2 Project (http://giant2.ineco.es/) continued these activities in other three key identified niche markets for the EGNOS-based LPV approaches, namely: Corporate & Business Aviation, General Aviation and SAR Helicopters,

Therefore, EGNOS-based LPV approach demonstrations and related technical support studies and analyses are being performed in different projects and benefits have been demonstrated for the key interested markets in Europe.

The coming steps and projects supported by the European Commission and Eurocontrol are aiming at starting a European wide-scale real-life adoption of EGNOS and GNSS in aviation, facilitating, fostering and providing support to airlines, end users for aircraft equipage, as well as ANSPs and airports for the publication of LPV procedures.

These activities are included in the ACCEPTA project (http://accepta.ineco.es/), which opened a Competitive Call in July 2011 in order to incorporate new partners and provide them with EC funding available in the project to equip their aircraft or to publish LPV procedures.

This paper will present the on-going activities in Europe for the implementation of aircraft and rotorcraft approaches based on EGNOS, as well as, the current uptake of this key GNSS application by the different stakeholders.

Swaziland

GNSS applications for Managing Informal Settlements in Swaziland

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The pattern of migration of people in developed countries is different from that of developing countries. In developed countries, the need for space and natural vegetation is a luxury that can only be afforded by the rich. In developing countries, it is the opposite. People living in urban areas have more land and a more natural atmosphere. They unfortunately, believe that life is better in urban areas and as a result they move to the cities. When they get there, to their surprise, they find that life is more difficult because they have to pay for everything they do, and as a result they struggle to survive. This situation slowly pushes them out of town such that they seek cheaper lifestyles in the peri-urban areas. This then becomes the main cause of informal settlements.

In Swaziland, the idea of informal settlements was unheard of about ten to fifteen years ago. The socio-economic status of the country is slowly bringing in the influx of people to the urban areas. The proactive attitude of the international community is responsible for the intervention that the Swazi government is implementing. The development of informal settlements is quite fast and if not monitored and controlled, it can easily escalate out of control. It is a great honour to developing countries for the developed countries and the international organisations and there agencies that they are involved in research and other activities that can be easily converted to civilian use to facilitate the growing needs of developing issues which are still so much related to the basic survival needs.

The process of monitoring and controlling informal settlements requires extensive use of Global Navigational Satellite Systems (GNSS). It is from this angle that this paper has been written to emphasize the importance of GNSS in this expensive and difficult task. Clearly developing countries are not in a position to invest in space activities for instance, but they need the technology that comes as a result of this research. The infrastructure that has been setup in space for GNSS purposes is now benefiting the developing countries.

Switzerland

Radionavigation Satellite Service (RNSS) and the ITU radio regulations

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The Radionavigation satellite service (RNSS) is probably today the most dynamic satellite service, creating a big professional as well as public interest.

1. RNSS definition from the ITU Radio Regulations: No. 1.43 radionavigation-satellite service (RNSS): A radiodetermination-satellite service used for the purpose of radionavigation

2. RES 609 Consultation Meeting - The new band 1164-1215 MHz is managed in application of RES-609. This presentation will explain in details the RES-609 process in this band.

3. RNSS related studies in the ITU-R This paper will address also a summary of the key findings of the studies listed below. ITU-R Working Party (WP) 4C is responsible for studies related to all mobile-satellite services including RNSS. These studies are very active:

a) Sharing and protection criteria have been intensively investigated for existing spectrum allocation for RNSS

b) Studies are also on-going for newly allocated bands for future enhancements and newly planned RNSS systems, addressing frequency sharing with other services

3.1 List of most important ITU-R Recommendations related to RNSS:

- ITU-R M.1088 - Considerations for sharing with systems of other services operating in the bands allocated to the radionavigation-satellite service
- ITU-R M.1787 - Description of systems and networks in the radionavigation-satellite service and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz

Thailand

Vertical Motions in Greater Bangkok Area after the 2004 Sumatra-Andaman Earthquake from GPS Observations and Its Prediction based on the Geophysical Modelling

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Following previous findings from the Thailand-EU joint research project carried out during 2009-2010, a new research project funded by the Thailand Research Fund has continued to exploit the GPS technique to monitor and model vertical land motions induced by the Sumatra-Andaman earthquake. It has been shown that up to the end of 2010 Thailand has been co-seismically displaced and subsequently undergoing a post-seismic horizontal deformation ranging from 10.5cm to 74.7cm. Largest horizontal displacements were observed in the southern part, while moderate and small displacements were seen in the central and northern parts of Thailand. Apart from horizontal displacements throughout Thailand, it became evident that after a couple years of Continuous GPS measurements large part of Thailand appears to start subsiding at rate approximately 1 cm/yr. Although this post-seismic vertical motion is not expected to continue significantly for the coming decades, it is the first time that such vertical deformations at large distances (650-1500 km away from the earthquake's epicentre) have been recorded. In addition, latest results from the project have confirmed that the greater Bangkok area is now facing a land subsidence problem at rates up to a couple of cm/yr. while the absolute sea-level rise value in the Gulf of Thailand is up to 4 mm/yr. These 3 phenomena may have a considerable impact on the socio-economic development of coastal and low-lying areas especially in the greater Bangkok area. In this study, a geophysical model based on a combination of slip on the fault plane and relaxation in the asthenosphere is used to explain and predict vertical motions in Thai region. Such a subsidence is well predicted by models with post-seismic relaxation in the asthenosphere. Its modelled final magnitude depends strongly upon rheological details of the subduction zone area but does not exceed 30cm.

The Philippines

Philippine active geodetic network: its application to surveying and mapping

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The Philippines thru NAMRIA has been a participant to the regional workshop on the applications of GNSS sponsored by UNOOSA in Beijing, China last 4-8 December, 2006. The agency's awareness of the benefits of satellite navigation technology has increased after participating in the workshop. With the coming of the Philippine Reference System of 1992 Project (PRS92), NAMRIA has invested on the establishment of permanent stations in the country starting 2007 as part of the Geodetic Network Development, which is a major component of the project. The permanent stations, called Philippine Active Geodetic Network (PageNET) will support the densification of geodetic control points and all types of survey in the country; improve the linkages among and between surveying and mapping communities both local and abroad; and it will link the national geodetic network into the International Terrestrial Reference Frame (ITRF). With our minimal capability and technical know - how, only thirteen (13) stations have been established since 2007. Upon its establishment, it has been used in various surveying and mapping projects in the country. It has been used as reference to the Zero Order Network observation and the Inter Island Benchmark connections. Used as reference to the Ground subsidence study in Metro Manila and it was used as reference in GIS mapping. Also, the volcanology Institute has been using our PageNet stations in monitoring active crustal structures in the Philippines.

In terms of international cooperation, we have always participated in the APRGP campaigns and lately the APREF. The station PTAG has been inducted to the IGS network on April 2010. It will also be collocated with the proposed location of monitoring station of QZSS of the Japanese Aerospace Exploration Agency (JAXA).

For our next steps, we plan to densify the stations for a complete Network – RTK coverage in

urban areas; Capability building for NAMRIA personnel; Promote the use of the PageNet in the country; and Continued cooperation with international and regional campaigns.

Tunisia

GEOMED project: objectives, impacts and accomplishments

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Cité Technologique des Communications

The presentation will concern the GEOMED (Géodésie à l'Ouest de la Méditerranée) project objectives and accomplishments. This project relates to the comprehension of geodynamics of the active border between north Africa and south Europe. This border relates to several coastal countries which are the seat of devastator's seismic events whose danger is increased by the capacity to generate tsunamis either by the seism as if it is at sea, or by causing underwater landslides near the coasts. This project aims to better apprehend and to better quantify the ground surface deformation and the seismic risk associated to the west Mediterranean region.

For that purpose, the concerned countries are gathered in a joint effort to study the surface deformation using space geodesy in bond with the seismic activity. It is also question of making possible all the partners to have access to the treatments and the analysis of the space techniques (GPS, satellite images, etc.) and share seismological competences.

The methodology used for the ground surface observation is based mainly on space geodesy, i.e. the GPS, SAR interferometry and satellite images correlation.

GPS Networks exist in each country partner of this project. There are 2 types of networks: permanent GPS networks and measurements networks. The permanent observations are regularly followed and treated and will make possible to have a deformation framework on a regional scale and for the whole studied area. The measurements networks are smaller networks with tight mesh in order to detect deformation related to particular tectonic structures.

The developed techniques for the treatment and the analysis of space imagery (SAR interferometry and correlation) will be shared by all the partners. They are applied to targets chosen for their tectonic, seismic interest or risk, in particular the urban environments. The seismological data will be also shared between the partners and will be analyzed in order to improve the precise localizations details, the model speeds, etc.

Preliminary results of ground surface deformation models will be presented and discussed according to GPS, satellite images and seismic data contributions.

United Nations

United Nations Programme on Global Navigation Satellite Systems Applications and International Space Weather Initiative

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Earth's ionosphere reacts strongly to the intense X-ray and ultraviolet radiation released by the Sun during solar events. Stanford's Solar Center, Electrical Engineering Department developed inexpensive space weather monitors that scholars around the world can use to track changes to the Earth's ionosphere. Two versions of the monitors exist – a low-cost version named SID (Sudden Ionospheric Disturbances) designed to detect solar flares; and a more sensitive version named AWESOME (Atmospheric Weather Electromagnetic System of Observation, Modeling, and Education) that provides both solar and nighttime research-quality data. Through the United Nations Basic Space Science Initiative (UNBSSI), such monitors have been deployed to high schools and universities in developing nations of the world for the International Space Weather Initiative (ISWI). The monitors come preassembled, the hosts build their own antenna, and provide a computer to record the data and an internet connection to share their data with worldwide network of SIDs and AWESOMEs. These networks are advancing the understanding of the fundamental heliophysical processes that govern the Sun, Earth and heliosphere, particularly phenomena of space weather. Monitoring the fundamental processes responsible for solar-terrestrial coupling are vital to being

able to understand the influence of the Sun on the near-Earth environment. A SID monitor is successfully operating at the United Nations Office at Vienna (UNOV) and will be extended to an AWESOME shortly. This project will also be supported by the programme on global navigation satellite systems (GNSS) applications, implemented through the International Committee on GNSS (ICG). ICG's establishment recognizes that GNSS has become a truly international resource and demonstrates the willingness by providers and users to ensure that GNSS services continue in the future for the benefit of all.

United States of America

The International GNSS Service – A Component of the Global Geodetic Observing System

R. Neilan, IGS Central Bureau, JPL/Caltech
U. Hugentobler, Technische Universität München, Germany

This presentation will outline recent developments of the International GNSS Service (IGS) and contributions to the realization of the Global Geodetic Observing System (GGOS). GGOS is a key program of the International Association of Geodesy (IAG) and is comprised of all geodetic services and techniques essential for understanding how the Earth is changing – with GNSS being a fundamental element.

IAG and IGS representatives contributed to the GNSS Action Team that led to the establishment of the International Committee on GNSS (ICG), and have participated in the previous regional workshops on GNSS since 2001. IAG and IGS continue to support this important activity organized through the efforts of the UN Office of Outer Space Affairs.

United States of America

Global Positioning System: Policy, Constellation, and Applications

Hank Skalski
U.S. Department of Transportation

This paper provides the latest status of the Global Positioning System (GPS) from the aspects of the National Space-based Position, Navigation and Timing Policy; GPS Constellation Status; and GPS Applications.

The first segment of this paper describes the United States policy governing the operation, availability and sustainment of the Global Positioning System. A brief description of the history leading to today's stable National Space-based Position, Navigation and Timing (PNT) policy will be presented; the key principles of this policy will be explained; and the organizational structure responsible for overseeing the execution of this policy will be described.

The second segment informs the audience of the current status of the Global Positioning System and the plans for future enhancements. To begin, a description of the current operational system will be provided, along with the signal-in-space performance that the Global Positioning System delivers today. This section will conclude with a description of the planned Global Positioning System modernization program.

The final segment provides an overview of the applications and benefits enabled by the availability and use of the Global Positioning System. Examples of these applications will demonstrate how the use of this Global Navigation Satellite System has benefitted users across the globe and continues to stimulate innovation in the development of new capabilities and applications.

Uzbekistan

Study of Ionospheric Perturbations Using GNSS Ground Station and AWESOME VLF Data

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Ulugh Beg Astronomical Institute

Space weather effects in the ionosphere are monitored using Uzbekistan GNSS ground stations' data and Tashkent AWESOME VLF receiver data.

There are two GNSS ground stations in Uzbekistan which are installed by GeoForschungsZentrum Potsdam (GFZ) and operated by Ulugh Beg Astronomical Institute (UBAI). The station KIT3 which is

located in Kitab was installed mid-90ths. The station TASH which is located in Tashkent is operational since 2001. The data from these and other regional stations are used for ionospheric total electron content (TEC) measurements. We analyze GPS derived TEC disturbances during solar activity events such as solar flares. We compare the amplitude of TEC with the nondisturbed initial monthly mean background value after the flare.

Tashkent VLF station is part of Atmospheric Weather Electromagnetic System for Observation, Modelling and Education (AWESOME) network being operated globally to study the ionosphere and the magnetosphere with the help of electromagnetic waves in ELF and VLF bands. Regular monitoring of the D- and F-layer of ionosphere over Central Asia territory has been performed on the permanent basis. Few Solar flare events are observed during February in 2010-2011 years and the analysis showed that there is simultaneous correlation between the times of change of amplitude of the waves and the Solar flares. Features of the lightning discharge generated by radio atmospherics are studied and its effectiveness in D-region ionosphere diagnostics is explained. Some of the initial results obtained from the preliminary analysis are presented to show the probing potentiality of VLF waves in ionosphere studies.