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BOOKLET OF INFORMATION

ABSTRACTS OF TALKS
PROGRAMME
LIST OF PARTICIPANTS

UNITED NATIONS
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United Nations/ICTP Workshop on the Use of Global Navigation Satellite Systems for Scientific Applications

ICTP, Trieste, Italy
1 - 5 December 2014

Abstracts

Content

Azerbaijan

1. AZERBAIJAN: AZERBAIJAN POSITIONING OBSERVATION SYSTEM FOR REAL ESTATE CADASTRE DATA BASE

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Azerbaijan Positioning Observation System (AZPOS) is 37 Continuously Operating Reference Stations (CORS) network in different regions of Azerbaijan. 37 Continuously Operating Reference Stations, enabling point positioning in real time with an accuracy of ±2 cm horizontally and ±4 cm vertically at the entire territory of the Republic (excluding Nakhchivan and Mountainous Autonomous Garabagh), continuously receive GPS/NAVSTAR and GLONASS satellite signals. The system maintains service flexibility based on both real time kinematics (RTC) and Differential Global Navigation Satellite System (DGNSS) operations. RTC operations have more distance availability rather than DGNSS operations. Both operations require reliable internet coverage. CORS operate continuously 7 days/24 hours.

The system is also capable to receive European Union Galileo satellite signals which are not in full functionality yet. This system has been created with the state-of-art Global Navigation Satellite System (GNSS) technological products Leica.

AZPOS will provide the following benefits: Access to comprehensive geospatial reference systems; high productivity and operation availability in common system; Real-time 3D positioning, RTC in cm level and DGNSS in meter level operations;

All surveying works in the Republic will be carried out in the same system and format. Map and cadastral works, engineer surveying, underground communication works, planning works etc. will be carried out rapidly and with reduced costs by means of the system.

AZPOS stations have been installed above the administrative buildings of government which are available for security and easier service in 30-40 km distance from each other. Base stations antennas have been fixed by means benchmark made of high quality material.

AZPOS provide different GNSS Surveying Methods: Post-Processing; RTK (Real Time Kinematics); DGNSS (Differential Global Navigation Satellite System).

The following aspects have been considered while construction of antenna ground points and installation of communication network for AZPOS development: providing the protection of antennas; providing the sustainability of selected locations and receipt of waves without obstacles with starting construction activities; no limitations in internet access of antenna; eliminating thunder risks; non-existence of underground communications in the location areas of antenna poles to be installed above the land; maintenance of construction works, installation of antenna cable roads and provision of electricity and communication mountings will be controlled by the assigned specialists of the responsible organizations; WGS-84 coordination system has been considered reasonable in UTM38,39 projection, main geodetic system of the country. Additionally, the system has capability for calculation of transformation parameters from WGS84 coordination system to SC42 coordination system.

The Management Centre has been provided with software which controls the activities of the stations, as well as able to maintain data management, data corrected in real time adjustments and calculations. The Control Centre is monitoring the data received from 50 reference stations in the Republic territory and provides 100 parallel users with RTK services, meantime 25 parallel users with Web services.

Azerbaijan

2. AZERBAIJAN: Navigation in Azerbaijan

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Global Navigation Satellite Systems or GNSS are among the fastest growing businesses in the World. GNSS technology is currently being used in a wide range of sectors like land, maritime, aviation transport, safety, land cadaster and urban mapping, engineering survey, construction and other.

The evolvement of ICT in Azerbaijan is not a long path, but is an exciting one, which has allowed the fast-growing South Caucasus republic to fill the ranks of the most developed ICT countries in the region and connects it with the rest of the world.

We couldn’t imagine ICT without navigation system. On April 1, 1996, by decision of the Board of Directors of the State Civil Aviation Company, under the auspices of ICAO and the European Bank for Reconstruction and Development, the air navigation service company Azeraeronavigatsiya (AZANS) was created, making it the first of the structural divisions of Azerbaijan Hava Yollari State Company to obtain a legally independent status. The main objectives of the company's operations were to guarantee high-quality air navigation services in accordance with international standards; and to provide reliable and high-quality air navigational and meteorological information. Over the past 16 years, air traffic has increased by more than 200%. Azeraeronavigatsiya Air Traffic Control Administration is working to integrate itself into the European Air Navigation System through the introduction of ICAO and EUROCONTROL standards and recommended practices.

"Caspian NavTel" Company is the largest company in Azerbaijan that deals with creation of the local electronic maps, appropriate softwares, providing, controlling and service of the appropriate equipment.

The Company was established in 2007. "Caspian NavTel" has made a detailed electronic map that covers the whole territory of the country and made satellite navigation achievable by every person.

Striving to be an active participant of international outer space cooperation, the Government of Azerbaijan hosted a regional workshop on the applications of GNSS which was held in Baku, Azerbaijan from 11 to 15 May 2009 in the framework of the UN Program on Space Applications, in partnership with the Office for Outer Space Affairs. The Conference addressed, inter alia, the space technology applications such as: remote sensing, aviation, transport and communications, e-learning, natural resources management and environmental monitoring by applying GNSS technologies.

Azerbaijan has joined the ranks of the space nations with the launch of its first ever satellite. The Azerspace/Africasat-1a blasted into orbit from the European Space Port in French Guiana on 7 February, 2013. Azerspace-1 has 36 active C- and Ku- band transponders, enabling it to provide top-class communications services to Azerbaijan, Central Asia, Europe, the Middle East and Africa.

Its launch was the first step in the implementation of prospective projects on turning Azerbaijan into a country with a space industry. The existence of a national satellite establishes qualitative and reliable communication, ensures the creation of VSAT multi-service networks, renders digital television services, Internet access, as well as ensuring information independence and forming a common information space.

In 2011 The Ministry of Culture and Tourism of Azerbaijan has held a presentation of the GoMap online tourism navigator. The electronic navigation system contains information about 70 cities, 4,530 settlements, 3,300 cultural and historical monuments, 43,000 kilometers of roads.

All these shows the Azerbaijan interests and efforts for developing navigation systems in the country, and makes 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 in Azerbaijan.

3. BANGLADESH: GNSS Technology Applications and related projects in Bangladesh Space and Remote Sensing Organization

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Abstract

Bangladesh is one of the disaster prone country in the world. Almost every year the country is affected by some of the natural disasters like; cyclone, flood, tornado, draught, landslide, dense fog, etc and damages lives and properties. Sometimes the fishermen are victimized mostly during cyclone when they enter into the deep Bay of Bengal for fishing. The fishermen use some large and small fishing vessels for this purpose. These vessels enter into the distant sea area even in inclement weather and loss their lives and vessels. So, Global Navigation Satellite System (GNSS) system is very much useful to track their locations and also to monitor during their voyages.

The coastline of the country is about 710 km long and about 35 million people live in this area. The normal tidal wave height of the Bay of Bengal around 3.65 meter in the eastern part and 4.10 meter in the western part could be measured in near real-time using GNSS Technology. Long continuous GNSS tide gauge records are invaluable for sea level change research because dynamic oceanographic and meteorological impacts can be increasingly averaged out over time to reveal the comparatively small underlying change in mean sea level.

During monsoon period (June to September) floods are common in Bangladesh and damages lives and crops. GNSS can help to identify and delineate flood-affected areas, which can help the Government considerably in taking appropriate timely measures action plan and policy.

About 75% rainfall occurs during monsoon period in Bangladesh. Humidity plays a key role in several atmospheric processes relevant for Numerical Weather Prediction (NWP). The ground-based GNSS meteorology serves primarily the atmospheric humidity monitoring could improve accuracy of weather prediction.

Dense fog occurs every year in winter season and makes an adverse impact, especially on the communications system. It causes noticeable road and river accidents. GNSS navigation system can track and monitor the vehicles & ferry services to minimize the incidents.

Bangladesh is an agricultural country. About 80% of the people depend on agriculture. So, precision agriculture using GNSS technology is very much useful for management of soil type, utility of fertilizer, pesticides etc over the entire field.

The tropospheric and ionospheric regions of the atmosphere affect the propagation of GPS signals. Researches on temporal and spatial distribution variation of total electron content (TEC), based on space-based navigation system is very much useful for capacity building of SPARRSO.

This paper will be presented in the United Nations/Abdus Salam International Centre for Theoretical Physics Workshop on the *"Use of Global Navigation Satellite Systems for Scientific Applications"* from 1-5 December, 2014, Trieste, ITALY

Bosnia and Herzegovina

4. BOSNIA and HERZEGOVINA: Could the multipath effect on GNSS positioning be used for benefit of mankind?

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Multipath effect is a major limiting factor in achieving high accuracy positions for most geodetic applications. Is it possible, in the reality, the main culprit for the limited accuracy of positioning turn to the benefit of mankind? Although at first glance this may sound funny and incredibly, the answer to the question is yes! Multipath separated from the phase measurements can be transformed into a new source of geospatial information useful for detecting changes in the environment!

So, multipath can be applied as a sensor in the early warning systems for prediction of natural hazard installed for the preventions of life's lost and destructions reduction as well as the management of the natural disasters: volcanoes eruption, flooding and landslide, earthquakes and tsunamis...However, GNSS signal multipath can also be used for the climatology, weather forecast and flooding prediction, sea level rise, snow and ice cover monitoring, vegetation cover monitoring...

This paper is focused to the soil moistures investigation based on signal/noise ratio - SNR of reflected GNSS signal on the reference station. Possibilities to apply results in the agriculture and precion farming are considered as well.

In this paper the methodology will discuss and preliminary results of the soil moistures investigation to be presented.

Brazil

5. BRAZIL: RBMC: The main geodetic infrastructure contributing for land reform and weather researches in Brazil

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INTRODUCTION

The Coordination of Geodesy of the Brazilian Institute of Geography and Statistics (IBGE) has the responsibility to provide and maintain the official geodetic reference frame in Brazil. Considering the advances in spatial geodesy in the last decades, Brazil officially adopted, in 2005, a geocentric reference system SIRGAS2000, epoch 2000.4, fully compatible with GNSS technology. Since then, government and private sector should start migrating into SIRGAS2000.

The Brazilian Network for Continuous Monitoring of GNSS (RBMC), has been playing an essential role for the maintenance and user access to the fundamental geodetic frame in the country. It provides to the users a direct conection to the Brazilian Geodetic System – SGB for post-processing and real-time applications.

More than 40 brazilian institutions collaborate with the RBMC operations. In this respect, it is important to mention that RBMC represents a substantial economical, technological and scientific effort of several Brazilian federal, state and academic institutions to build and maintain a modern geo-spatial infrastructure.
Through the partnership of two federal institutions, the National Institute of Colonization and Land Reform (INCRA) and National Institute for Spatial Researches (INPE), RBMC was recently densified with modern GNSS receivers, which allow remote control, real time operations and meteorological data collect.

OPERATIONS and SERVICES

The RBMC increased from 24 stations by the end of 2006 to 101 stations at the beginning of 2014.The modern GNSS receivers allow for remote control and real time transfer of observations over the Internet. GNSS and meteorological data are available in two websites; INCRA providing hourly and IBGE providing daily files with different sampling rates, 5 and 15 seconds respectively. This data is used for several post-processing applications.

The receiver in each station is configured to send data each hour to a server at the control center in Rio de Janeiro through the Internet connection (cable or satellite). At the end of each 24 hour observing session, the collected data is checked, organized and made freely available at the site ftp://geoftp.ibge.gov./RBMC/ in the morning of the next day.

Since may 2009, the Networked Transport of RTCM via Internet Protocol (NTRIP) and a caster was set up, providing real-time corrections and data of 26 stations installed at the main cities of country. The software ntripcaster was made available to IBGE by the German Federal Agency for Cartography and Geodesy (BKG) based on cooperation with the IGS Real Time working group (IGS-RT). According to this cooperation, real time data of nine RBMC stations are released to IGS to support computation of precise satellite orbits, among other IGS products.

The RBMC real-time service called “RBMC-IP” is open for all users through a login and password that need real-time corrections for their surveys. The national and international research institutions have real-time data access for all stations. At this moment, august 2014, RBMC-IP service has 76 stations providing real-time data for TEC maps estimated by INPE.

Under the same cooperation with IGS-RT there is another service for a experimental period called RT-PPP (Real-Time Precise Point Positioning), provide access to precise GNSS satellite orbits and clocks via NTRIP. For Brazil, there are two corrections streams disseminated for SIRGAS2000.

The network maintenance and operation improved in the last years with only 6 % of outages per month and consequently the number of users increased in the last years due to service credibility. More than 400,000 GNSS 24-hour observation files are downloaded per month. Regarding its real time component (RBMC-IP), more than 4,000 users are registered per year, in order to have access to the service.

NATIONAL AND INTERNATIONAL COOPERATION

As mentioned before RBMC contributes to many international initiatives, such as SIRGAS, IGS, Real-Time IGS, and others related to world climate monitoring. The recent collaborations with INCRA and INPE brought economic and research benefits to Brazil.

In 2001 INCRA published the Law 10,267 of 08/28/2001 known as the "Law of Georeferencing", requiring all rural properties to be referred to the Brazilian geodetic system intensified the use of RBMC reference data. Once the perimeter of property surveyed, the owner will have economic support when requested the Brazilian government.

The Space Weather Information and Prediction Center (EMBRACE) - INPE, has been producing daily and near real time maps of Total Electron Content(TEC) and GNSS scintillation maps(S2) over Brazil, using RBMC real-time and post-processing data. The TEC maps are designed to estimate the signal delay for single and dual frequency GNSS applications. The spatial resolution of the maps are, at this moment, with 200 to 1000 km distance, but must be improved with new RBMC stations.

Another research program under development in INPE is the Numerical Weather Prediction (NWP), carried out by Center for Weather Forecasting and Climate Researches (CPTEC). The integrated water vapor estimated from RBMC data is assimilated in NWP models as additional information of the atmospheric humidity. Another activity is the predictions of the components of the zenithal tropospheric delay - ZTD (wet and hydrostatic), which are estimated using the NWP products. The values of ZTD are obtained using regional model of NWP and are updated twice a day at INPE website, the first at 09:00 UTC (with reference at 00:00 UTC) and the seconds at 21:00 UTC (with reference at 12:00 UTC). The ZTD estimated from RBMC data has been used in the evaluation of these predictions in a quality control process.

All RBMC stations belong to the SIRGAS continental network, providing the necessary integration of the Brazilian geodetic frame into the continental frame. IBGE is one of the analysis (i.e., processing and combination) centers since 2008, being responsible for the weekly processing of GNSS data collected by 121 SIRGAS continental network (http://www.sirgas.org/index.php?id=61&L=2) stations and for the combination of weekly solutions of nine processing centers. The time series of the SIRGAS stations' coordinates feed the computation of station velocities, which are very important for the maintenance of the SIRGAS reference frame and for geodynamics studies of the South American plate.

Figure 1: Current status of RBMC for
post-processing and real-time services.

Bulgaria

6. BULGARIA: a) Crustal movements in Bulgaria from GPS solutions; and BULGARIA: b) Study of fog forecast impact for Sofia Airport from Numerical Weather Predictions simulation and use of GNSS tropospheric products

a) **“Crustal movements in Bulgaria from GPS solutions”,** Keranka Vassileva, National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev Street, Bl. 3, 1113 Sofia, Bulgaria, ker@bas.bg, Keranka.vassileva@gmail.com

Abstract: Crustal movements of the territory of Bulgaria are studied on the base of results from processing of GPS data of the reference GNSS BULiPOS network stations. The effect of datum definition changes on the estimated station horizontal velocity vectors have been first assessed due to the small magnitude of the movements on the whole territory of the country. Several slightly more or less different datums defined by different combinations of involved IGS reference stations have been applied in the combined solutions of GPS data processing. Analysis of the obtained results shows that the effect of datum definition is important and significant in combined use of velocities from different sources as input data in geotectonic and geophysical investigations and interpretations, especially in case of small movements. Different parameters of Euler pole have been estimated from the obtained coordinates and velocities for several sets of GNSS permanent stations. The results obtained from different sets have been analyzed and an attempt to determine transition microplate boundaries for the Bulgarian territory is made.

b) **“Study of fog forecast impact for Sofia Airport from Numerical Weather Prediction simulation and use of GNSS tropospheric products”,** Guergana Guerova, Faculty of Physics, Sofia University “St. Kliment Ohridski”, Bulgaria, Ilian Manafov, Bulatsa, Bulgaria, Keranka Vassileva, National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev Street, Bl. 3, 1113 Sofia, Bulgaria, ker@bas.bg, Keranka.vassileva@gmail.com

Abstract: The accurate fog forecast is of a critical importance for the operational aviation. At present, the operational fog forecast is based on assessment of the visibility and the low level cloud height. The current operational tools at the Sofia Airport are based on the synoptic analysis, and regression methods. In this study we use the Numerical Weather Prediction model Weather Research and Forecasting (WRF) in combination with GNSS tropospheric products to study 18 fog cases for the period 2010-2012. Compared is the water vapour field simulated with WRF model and derived from GNSS data at station Sredec of the BULiPOS GNSS network. Investigated is the potential to develop operational forecast tools based on the model and GNSS data.

Cameroon

7. CAMEROON: A METHODOLOGY TO MINIMIZE THE OPERATING COST OF A WATER SUPPLY NETWORK USING GNSS AND WEB MAPPING

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The management of the water supply network (WSN) of Cameroon is a very big challenge for this country, particularly in terms of maintenance and monitoring. This network has started being constructed between 1980 and 1990 years without a spatial reference, what is more, it has rarely been updated. Consequently, the knowledge of the position of its elements becomes weak over the years, making the interventions on the network very difficult. This situation increases the operating cost of the water networks which lose a huge amount of water due to leakages and also reduce the performance of the WSN.

In this paper, a methodology for fast localization of predicted failed elements of a water supply network was presented. It was demonstrated the great advantage offered by a combination of a GNSS receiver and a nomad GIS for localizing network elements and specially failed elements. This tool allows the technician in charge of the WSN maintenance, not only to fast find any of these elements, but even better, to visualize their relative position to other objects of environment such as roads, bridges and railways. GNSS/nomad GIS used in the management of WSN will also be useful for agents from public work who are called to develop projects near water networks. Therefore, the surveying accuracy of the network equipment position deserved a particular focus. This led to a development of different positioning methods that can be applied to this system.

The importance of databases as a starting point for predicting the defaults of network elements and its performance was underlined. The information about this equipment includes diameter, length, date of installation, material, roughness; and leakage and maintenance history etc. It was shown in this study that the combination of collected data through a query allows to determine the failure date of elements and thus anticipate their replacement.

Another tool that was essential in this document was Google's Fusion Tables which is a free data visualization web tool. Based on some sample data of pipes and valves, thematic web maps displaying data points and spatial information were developed in other to visualize when and what network elements to change. The possibility to update databases and then web maps was also highlighted.

The last part of the paper suggested a new procedure for maintenance and monitoring of Cameroon's WSN. From the manager of field works who is the administrator of the network web maps to the technician who receives the order to intervene on a specific area of the Water network whit his GNSS/nomad SIG receiver.

Colombia

8. COLOMBIA: THE GEORED PROJECT: GPS/GNSS GEODETIC INFRASTRUCTURE IN COLOMBIA, SOUTH AMERICA, FOR MULTIPURPOSE RESEARCH

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Colombian Geological Survey

Major advances in space geodetic techniques, as well as the rapid development of GNSS receivers and data transmission capabilities has launched a global revolution in geosciences. Under this perspective, in order to investigate the current kinematics of northwestern South America, the Colombian Geological Survey initiated in 2007 a research and development project based on space geodesy technology. GeoRED, the acronym for "Geodesia: Red de Estudios de Deformación" was adopted for the project "Implementation of the National GPS/GNSS Network for Geodynamics", which takes a multifaceted approach to cataloging and defining the geodynamics of northwestern South America in order to reduce the risk associated hazards within a wide plate margin deformation zone.

The GEORED Project is deploying a high-quality GNSS infrastructure that will be the fundamental geodetic framework for the study of crustal and atmospheric dynamics of the entire Colombian territory, and at the same time sharing data and research results with neighbouring countries. Data products will include raw GNSS observations that will permit the generation of time series of high precision daily geodetic positions, that in turn will help the compilation of surface velocity fields that register crustal dynamic behaviour that is of direct relevance to geohazards in earth and atmospheric sciences. It is intended to achieve a greater density of the National GNSS Network in an effort to address specific geoscience aspects such as tectonic plate motion, plate boundary interaction and deformation, including the understanding of earthquake cycle processes; the registration of active fault slip rates, surface subsidence, etc.

The space geodetic network has two main components: an active network, composed by continuously operating permanent stations; and the passive network, which corresponds to episodic occupation stations conducted in field campaigns. In order to establish the most appropriate locations for the installation of the stations, several discussions within the GeoRED group led to a master plan for the distribution of the permanent GNSS stations array and specific areas of interest for campaign site construction. The use of previously identified active faults as preferred structures along which stresses are transferred through the deformational area led to the idea of segmentation of the North Andes within Colombia into 20 tectonic sub-blocks. Each of the 20 sub-blocks is expected to have, at least, 4-5 permanent GNSS stations within the block along with construction of campaign sites along the boundaries.

Currently, the GeoRED Network is managing 60 continuously operating GPS stations, including: 52 GeoRED GPS/GNSS continuously operating stations; 4 GNSS continuously operating stations provided by the COCONet Project funded by NSF; the Bogotá IGS GPS station (BOGT), installed under the agreement between JPL-NASA and the SGC; the San Andres Island station, installed under the MOU between UCAR and the SGC; the Medellin UNME station provided by the National University, and the CCAN station provided by Cenicaña, a Colombian Sugarcane Research Institute. In addition to the permanent installations, more than 280 GPS campaign sites have been constructed and are being occupied one time per year. Full implementation of 100 permanent installations and 350 campaign sites should be completed by 2016. The Authority of the Panama Canal and the Escuela Politécnica de Quito, Ecuador have also provided data of 4 and 5 GPS/GNSS stations, respectively. The GNSS stations are located on the three major plates that interact within the Wide Plate Margin Deformation Zone including existing GNSS permanent stations at Galapagos and Malpelo Islands on the Nazca Plate, and San Andres Island on the Caribbean plate. The GNSS data are processed using the GIPSY-OASIS II software. The existing data were rerun in order to express the positions in ITRF-2008.

Ecuador

9. ECUADOR: Use and Application of GNSS in Air Navigation in Ecuador

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The Civil Aviation Administration of the Republic of Ecuador, based on the guidelines issued by ICAO from the Tenth Air Navigation Conference held in Montreal in 1991, which adopted the concept of the new Communications, Navigation and Surveillance (CNS) and air Traffic Management (ATM) systems using the Global Navigation Satellite System (GNSS) has been gradually promoting GNSS implementation for air navigation in Ecuadorian airspace and in some special airports in its territory.

Based on the experience of other States in the use of GNSS that has demonstrated the required reliability, dependability and accuracy, Ecuador has decided to join this important stream of benefits and adopt this new navigation system, regulating the use of GPS for air navigation in the Ecuadorian airspace.

Therefore, the Ecuadorian Civil Aviation Administration, since 2000, in conjunction with the International Air Transport Association (IATA) and American Airlines, started working on RNAV / GNSS / RNP implementation at the former international airport in Quito, performing the first tests in 2005 and then coming into effect in 2006, accomplishing the following phases:

- Design
- GNSS / RNAV / RNP Seminars for Airworthiness Technical Pilots and Air Traffic Controllers (ATC).
- Obstacle analysis and evaluation
- Quality Control
- Flight simulator tests
- Test flight with B757 aircraft
- Flight test with laboratory aircraft
- Publication of approach and departure instrumental procedures letters.

To this end, the Ecuadorian Aviation Administration published an Aeronautical Information Circular (AIC) at the end of 2006, with the aim of establishing the Ecuadorian policy regarding the use of the Global Navigation Satellite System (GNSS), specifically the Global Positioning System (GPS), in the airspace of the Republic of Ecuador, as well as to clearly establish the requirements for installation and operation of equipment for use of the GPS system onboard as well as the ratings that the flight crews must met in order to operate in the different flight phases.

With the publication of these procedures using GNSS, we became the first South American country to use satellite technology for instrument approach and departure procedures. This was a determining factor for the fleet of aircraft in Ecuador to enter into a renewal process with aircraft having GNSS / RNAV / RNP capacity.

By 2006, a decision was made at the State level to initiate a process of planning and implementing the project of building the new Quito airport, because at the time the Quito airport was practically in the middle of the city. It became a much larger challenge than expected because the new site is surrounded by irregular topography. Therefore, we began our study for the location of radio and navigational aids and then the design of the conventional approach procedures and the study and design of GNSS / RNAV/RNP procedures, a process that was rather long. We followed a process similar to the old Quito airport, complying with the various stages until publication in the Publications Manual of Ecuador (AIP), having started operations successfully both of the new Quito airport as well as of the conventional instrument procedures and GNSS on February 20, 2013, which are in effect.

BENEFITS OBTAINED FROM THE USE OF GNSS

- Flexibility in the design of the ATS route structure.
- More direct routes
- More efficient use of available airspace, with more flexible routes and application of the FUA (Flexible Use of Airspace) concept.
- Reduction of distance and flight time, due to implementation of optimal flight paths.
- Fuel savings.
- Optimization of ground-based navigation infrastructure.
- Reduced aircraft gas emissions into the atmosphere
- Noise Reduction.

- Reduced workload of air traffic controllers and pilots

The Civil Aviation Administration of Ecuador, based on the commitments made by the State on Performance Based Navigation (PBN), with satellite use (GNSS), are also working on redesigning traffic flow of arrival and departure routes, and approach and departure procedures for the "José Joaquín de Olmedo" airport of Guayaquil, the second largest in Ecuador, in order to optimize air navigation and operations in Ecuador.

Egypt

10. EGYPT: Evaluation of the Deformation Parameters of the Northern part of Egypt using the Global Navigation Satellite System (GNSS)

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The northern part of Egypt is rapidly growing development is accompanied by increasing levels of standard living particular in its urban areas. However, there is a limited experience in quantifying the sources of risk management and in designing efficient strategies to keep away serious impacts of earthquakes. The northern part of Egypt is one of the interested regions from both tectonic and seismic point of views. It shows an active geologic structure attributed to the tectonic movements of the African and Eurasian plates from one side and the Arabian plate from other side. So, the northern part of Egypt has been selected for this study. From the historical point of view and recent instrumental records, the northern part of Egypt is one of the seismo-active regions in Egypt. The investigations of the seismic events and their interpretations had been led to evaluate the seismic hazard for disaster prevention and for the safety of the dense populated regions and the vital projects. In addition to the monitoring of the seismic events, the most powerful technique of Global Navigation Satellite System (GNSS) will be used where geodetic network is covering the northern part of Egypt. Joining the GPS Permanent stations which lies in the northern part of Egypt and Southern part of Europe will give a clear picture about the recent crustal deformations and the African plate velocity. The results from the data sets are compared and combined in order to determine the main characteristics of the deformations and hazard estimation for specified regions. The final compiled output from the seismological and geodetic analysis will threw lights upon the geodynamical regime of these seismo-active regions. This work will trying also to threw lights upon the geodynamical regime and to delineate the crustal stress and strain fields in the study regions, which has been done using the Egyptian and European GPS networks measurements. However, the main objective is to study neo-tectonic features by combining previous tectonic studies and crustal deformations. This also enables to determine the evaluation of the active tectonics and surface deformations and their directions from repeated accurate geodetic observations.

Estonia

11. ESTONIA: ESTPos - new Estonian GNSS-RTK network

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Currently now the renovation and densification of Estonian GNSS-RTK permanent station network – ESTPos – is ongoing. In the paper the overview of the establishment of ESTPos is given, starting from site selection phase up to final network establishment. The overview of the accompanied instruments – GNSS receivers and antennas, as well software possibilities are introduced. For reference frame establishment, all coordinates of permanent station network shall have ETRS89 coordinates, computed by Bernese 5.2 software. Last but not least, the future insights and cooperation ideas will be introduced.

India

12. INDIA: Characteristics of low latitude total electron content during solar cycle 23 and 24 over Indian longitude sector using 16 years of GIM VTEC

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Global ionosphere maps (GIM) are generated on a daily basis at CODE(Centre for Orbit Determination in Europe) using data from about 200 GPS/GLONASS sites of the IGS and other institutions. The vertical total electron content (VTEC) is modelled in a solar-geomagnetic reference frame using a spherical harmonics expansion up to degree and order 15. The time spacing of their vertices is 2 hours, conforming with the epochs of the VTEC maps. CODE GIMs are based on the so-called single-layer or thin-shell model.The GIM VTEC has been analysed to obtain long term characteristics of equatorial and low latitude ionosphere over Indian zone consisting 16 years of data (1998-2014) covering the recent deepest solar minima and the present subdued maxima besides the previous solar cycle. Three locations one each at northern low latitude, equatorial and southern low latitude has been chosen to quantify the forcing from the sun with regard to latitude. The main results of the study present the multi-scale latitudinal-temporal

variations with emphasis on the nature of the ionospheric anomalies and its deviation from previously reported features varying with solar activity and quantification of correlation using long term data. Results show that the northern low latitude exhibited persistent higher summer IEC (ionospheric electron content) from 2003 to 2013 for 10 years and the highest IEC in winter during 2000-2002. Interestingly, the winter anomaly appeared irrespective of latitude or hemisphere during high solar periods whereas the semi-annual anomaly and equinoctial asymmetry disappeared in high solar period of cycle 24. The equatorial location showed weakest amplitude of these anomalies during the deepest solar minima. RMS width of the curve of solar EUV proxy index (PI) performed reasonably well as a definition of high solar activity. The lowest mean daytime peak VTEC at about 15 TECU were noted during the deepest solar period and the highest at about 110 TECU in high solar of cycle 23 and at about 75 TECU in that of present cycle 24. Higher post-sunset winter VTEC than September equinox in southern low latitude is one of a few other inter-solar cycle deviations noted among VTECs of equinoxes and solstices that require further attention. It is found that the nature of correlation between the PI and IEC not only depends upon latitude and season but also on length of data and on the selected cut-off to define high and low solar activity. Minimum of 2 years of data is required to obtain positive correlation between them and for more than 8 years of data the correlation saturates at each latitude specific peak value. The proxy index (PI) value of ~120 sfu might serve as a robust cut-off for high solar activity and a cut-off of ~100 sfu would result into equal coefficient of determination between the two times series at any latitude. Strong signature of QBO (quasi biennial oscillation) has been observed in wavelet spectrum of solar index only during high solar activity of both the cycles 23 and 24. Intriguingly, strong QBO in IEC in both low hemispheres has been noted besides subdued QBO over geomagnetic equator at the same duration. Thus the ionospheric existence of QBO only during high solar periods and its latitudinal variation are still open question to resolve for its origin. Further the annual scales are noted to be very weak in southern hemisphere throughout the length of data in contrast to other two locations. The planetary wave signatures have been noted in IEC at all three locations with almost similar but varying strengths with regard to change in solar activity.

Italy

13. ITALY: GNSS Space weather monitoring and study at INGV – An overview

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The Istituto Nazionale di Geofisica e Vulcanologia (INGV) is managing a network of specially modified dual-frequency GPS receivers for Ionospheric Scintillation and Total Electron Content (TEC) monitoring since 2003. The first receiver was deployed in Ny Alesund (Svalbard Islands, Norway), hosted by the Italian station "Dirigibile Italia" managed by the Italian Council of Resaerch CNR. It is still in operation accounting for data covering an entire solar cycle. Other similar receivers were subsequently installed in Svalbard Islands, in Antarctica (at the Italian and Italian-French stations), in the Mediterranean area, in Argentina. Past and on-going international collaborations enabled the data sharing of additional GNSS networks in Brazil, UK, Antarctica, Norway, Belgium, South Africa, Canada, Vietnam, China. The high sampling (50 Hz) GNSS data acquired by these receivers allow to monitor the ionospheric weather in real-time and to study the temporal/spatial evolution of the "irregular" ionosphere by means of post-processing analysis. The huge data analysis and treatment produced over more than a decade made INGV a worldwide recognized expert in the field of ionospheric monitoring, investigation and modelling. Such expertise has contributed to development of a number of tools oriented to realization of several GNSS-based services. This paper would like to give a brief but significant overview of INGV activity in the field, highlighting the most important aspects related to the international cooperation, to the GNSS technological application and to the awareness of public and private stakeholders on the use of GNSS and its applications.

Italy

14. ITALY: Development and Application of an Experimental Data Server hosting EGNOS and RTCM/RTK Correction Data for terrestrial navigation

Mauro Calderan, Raffaela Cefalo

The implementation of the EGNOS Message Server (EMS) and the opportunities offered by the SISNeT (Signal-In-Space through the Internet) and EDAS technology have encouraged the development of a number of applications within the GNSS users community.

One possible application is to provide GNSS users with the best available correction data for their GPS measurements within the area of operations. Corrections can be based on: SBAS, RTCM and RTK data.

The research idea is then to make all correction data available on a data server, allowing GNSS users to access this server through a communication link and download the desired corrections. In this way GNSS users, depending on the application and on the operation area, can always benefit of the best available corrections.

An experimental Data Server making available at the same time EGNOS augmentation messages as well as RTCM and RTK differential corrections computed by dedicated receivers located at a known reference position, has been set up at GeoSNav Laboratory, Department of Engineering and Architecture, University of Trieste, ITALY.

All the corrections available on the Data Server are made accessible via VPN (Virtual Protected Network) through the Internet to authorised users equipped with an integrated GPS/GPRS terminal.

Depending on the operational conditions and on the operation area (distance from reference station/visibility of EGNOS satellites), the user can choose the augmentation to be included in the computation of position, velocity and time.

The research project has encompassed: the development of the data server, the development of the user terminal, tests on the availability/accessibility of augmentations on the data server, tests on the communication link between the server and the user terminal, static and dynamics tests to assess the navigation performance of the user terminal and the integration of the user terminal with other sensors.

Italy

15. ITALY: Expanding EGNOS horizons

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The EU project MEDUSA is helping countries in North Africa and in the Middle East utilise EGNOS services

EGNOS1 and Galileo, that constitute the European Global Navigation Satellite System (E-GNSS), can provide benefits not only to European countries, as also stated in the new EU2 GNSS Regulation 1285 approved at end of 2013.

EGNOS in particular which is already operational since 2009, has a European regional coverage that could be quite easily extended to areas adjacent to European Union through the deployment of limited additional ground infrastructure elements, but sharing the same existing space segment and leveraging the other core ground infrastructure.

The European Commission has put in place a series of actions since 2006 to support the EGNOS service extension in neighbouring areas. MEDUSA3 is one of the on-going European initiatives related to EGNOS extension in the so-called Euromed region, including the North Africa and Middle East countries around the Mediterranean basin (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, and Tunisia). MEDUSA runs a programme of technical assistance in these Euromed countries, in order to prepare them for an optimal adoption and exploitation of E-GNSS services in their priority market segments.

MEDUSA is the second stage of the Euromed GNSS programme (Euromed GNSS II), the first being the Euromed GNSS I/METIS project.

Besides, MEDUSA also sets up a long term cooperation and operation structure named GEMCO (Galileo EuroMed Cooperation Office), with an associated Work Plan ensuring the proper regional participation of the beneficiary countries. Located in Tunis (Tunisia) and operated by MEDUSA, GEMCO acts as a point of reference for all Euromed countries and towards Europe. Through GEMCO, MEDUSA catalyses and fosters initiatives related to E-GNSS in the Euromed region, and develops promotion and awareness activities for all markets/user domains.

For GEMCO, MEDUSA undertakes a capacity building package, combining shadow management and technological transfer activities to achieve the goal of an autonomous and running entity after the completion of MEDUSA. GEMCO also contributes to the implementation of the technical assistance put in place by MEDUSA, as a concrete way for the office staff training.

In the frame of such technical assistance programme, MEDUSA carries out two life demonstrations of EGNOS services in concrete applications and use cases: one in aviation for supporting landing operations, and one in freight transport for tracking and tracing the shipment of goods containers.

Through its achievements, MEDUSA is confirming the ability to foster cooperation and involvement in EGNOS programme of the great majority of the Euromed countries. Moreover, MEDUSA is clearly showing that Euromed region, presently lacking the full support of SBAS technologies, represents an opportunity for EGNOS service extension, with many benefits for the countries of the region and for Europe.

The presentation aims at informing about MEDUSA, its activities, results and next steps.

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1 European Geostationary Navigation Overlay Service
2 European Union
3 MEDiterranean follow-Up for EGNOS Adoption

16. ITALY: Benefits of GNSS software receivers for scientific applications

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Software Defined Radio (SDR) refers to an ensemble of hardware and software technologies enabling a reconfigurable communication architecture. The term SDR was coined in 1984 by a team at E-Systems Inc. to refer to a digital baseband receiver; then, in 1991, Joe Mitola independently reinvented the term [1]. Since that time, SDR has gained more and more attention and followers, thanks to the huge opportunities it opens to the prototyping of new architectures, which feature lower development costs, shorter development time and far easier maintainability and upgradability, when compared to the dedicated hardware approaches [2].

Despite the fact that software implementations are generally less efficient than hardware dedicated receivers, SDR has entered the field of the GNSS receivers as soon as satellite navigation enlarged its popularity. The availability of digital signals opened new opportunities and lead to the design, directly in the digital domain, of new algorithms, which were too complex to be implemented in an analog way. For example, the possibility to access intermediate processing stages and observables, which is not possible in commercial hardware receivers, paved the way towards innovative interference [3] or spoofing detection techniques [4]. SDR GNSS receivers are nowadays tools of paramount importance for R&D and still offer new interesting and un-explored perspectives, like the case of a Multi-GNSS scenario.

In particular, flexibility and re-configurability have been the key-drivers in the implementation of the N-Gene fully software receiver, developed by the NavSAS group. N-Gene [5] is a GPS/EGNOS/Galileo single frequency real-time fully-software receiver, running on a general purpose processor, developed to be a test-bed that allows to master the whole receiving chain and to test advanced algorithms in a complete receiving architecture. N-Gene processes the Intermediate Frequency (IF) digital output of a Radio Frequency (RF) front-end, such as the GN3S Sampler v2, and executes acquisition, tracking, decoding of the navigation message, pseudorange measurement and Position-Velocity-Time (PVT) calculation.

In the presentation we will provide a summary of the advantages and disadvantages of the design of software GNSS receivers, an analysis of the difference between SDR and fully software receivers, an overview on the issue of the real time processing, and a description of the N-GENE fully software receiver. Then we will give a few examples on the possibilities and advantages offered by the use of software receivers, with focus on real cases, characterized by a strong scientific background:

- GPS REMOTE SENSING AND REFLECTOMETRY: development of a system for territory monitoring, based on the installation of GNSS devices on unmanned aerial vehicles (UAVs), for preventing and controlling a wide range of events (floods, fires, landslides, traffic, urban situations, pollution and crops) [6].

• IONOSPHERE SCINITILLATION MONITORING IN VIETNAM: Installation of a GNSS antenna and front-end based on a general purpose Universal Software Radio Peripheral (USRP) at the NAVIS Centre, University of Science and Technology, Hanoi (Vietnam), in collaboration with the European Joint Research Centre, Italy; development of a fully software receiver, capable of processing scintillated GPS and Galileo signals; post-processing data coming from the USRP and calculation of the scintillation indices [7].

• IONOSPHERE SCINTILLATION MONITORING IN ANTARTICA REGION: development of a data grabber, to acquire GNSS raw data at very high latitudes; development of a fully software receiver for post-processing of the samples at the pre-correlation level and assessing the impact of ionospheric threats on GNSS signals for several different fields (positioning, space weather, study of the polar regions).

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[1] J. Mitola, "Software radios: Survey, critical evaluation and future directions," in IEEE Aerospace and Electronic Systems Mag., vol. 8, Apr. 1993, pp. 25–36.

[2] L. Lo Presti, et al., "Software Defined Radio technology for GNSS receivers," in Metrology for Aerospace (MetroAeroSpace), 2014 IEEE. p. 314-319.

[3] K. Ali, E. G. Manfredini, F. Dovis, "Vestigial signal defense through signal quality monitoring techniques based on joint use of two metrics," Position, Location and Navigation Symposium - 2014 IEEE/ION PLANS, 5-8 May 2014, pp.1240,1247

[4] L. Musumeci, F. Dovis, "Use of the Wavelet Transform for Interference Detection and Mitigation in Global Navigation Satellite Systems," International Journal of Navigation and Observation, vol. 2014

[5] M. Fantino, A. Molino, and M. Nicola, "N-Gene GNSS receiver: Benefits of software radio in navigation," in ENC GNSS 2009, Napoli, Italy, May 2009

[6] M. Troglia Gamba, S. Ugazio, Y. Pei, L. Lo Presti, R. Notarpietro, M. Pini, and P. Savi, "A new SDR GNSS Receiver Prototype for Reflectometry Applications: Ideas and Design," 4th International Colloquium Scientific and Fundamental Aspects of the Galileo Programme, Prague, Czech Republic December 2013

[7] R. Romero, F. Dovis, "Ionospheric Scintillation: A Comparison between GPS and Galileo," 4th International Colloquium Scientific and Fundamental Aspects of the Galileo Programme, Prague, Czech Republic December 2013.

Italy

17. ITALY: The Master in Navigation and Related Applications: a programme to prepare the future experts in the field of GNSS.

Gabriella Povero

Satellite navigation is becoming a more and more pervasive and enabling technology. In the last two decades, users have been able to fix their position on the basis of ranging signals broadcast by satellites of GPS, the Global Navigation Satellite System (GNSS) owned by the USA government. However, at international level new systems are currently under development: Europe and China are deploying their own system Galileo and BeiDou, Russia has brought its GLONASS to be again fully operative, Japan and India are deploying their regional systems. The expectation for the coming years is to have a Multi-GNSS environment at worldwide level where user equipment will be able to exploit the availability of many signals transmitted by different systems to achieve better performance. In this framework, GNSS providers are involved not only in the development of the systems but also in the promotion of all possible services enabled by the availability of new signals and systems. This represents a real boost for the introduction of applications and a substantial amount of skilled personnel is needed to be engaged in production and management of innovative navigation-oriented applications.

The II Level Specializing Master in Navigation and Related Applications (MNRA) is an effective answer to the work market demands in terms of high level technicians endowed with a broad vision of the navigation/localization world but also with specific skills on related technical topics. MNRA is supported by the United Nations Office for Outer Space Affairs (UN-OOSA), and offered by Politecnico di Torino and Istituto Superiore Mario Boella (ISMB), with the collaboration of Istituto Nazionale di Ricerca Metrologica (INRIM), in Turin, Italy.

The MNRA program is addressed to graduate students having completed a Master Degree or an equivalent title in Electrical Engineering, Aerospace Engineering, Environmental Engineering, Communication Engineering, Information Technology or related subjects. Written and spoken English is required (English is the official language of the MNRA), together with basic notions in communication theory and electronics. MNRA offers scholarships to talented students from within and outside the European Union.

The MNRA has been designed to meet new needs from students, from GNSS industries and providers. In 2014-2015 the MNRA is in its 11th edition. The successful stories of former students demonstrate that the Master on Navigation has been able to meet those needs. Along the years, one of the most important outcomes is the establishment of a growing MNRA student's community. Students from almost all over the world who studied at the MNRA are now part of the GNSS community and most of them are working in the field of GNSS not only in private companies but also in universities and governmental agencies.

Among the most relevant outcomes of the MNRA there is the set-up of the NAVIS Centre in Hanoi, Vietnam, aiming to act as linking entity between Europe and South East Asia in the field of GNSS. In fact, NAVIS director Dr. Ta Hai Tung and many other NAVIS researchers are MNRA alumni. Moreover, both Politecnico di Torino and Istituto Superiore Mario Boella are among the co-founders of the NAVIS and part of the scientific committee that supervises the scientific activity of the Centre.

The collaboration with UN-OOSA allowed the creation of a long-term fellowship programme for candidates from developing countries and countries with economy in transition interested in GNSS topics. This action from UN-OOSA is fundamental to continue fostering the exploitation of the peaceful use of GNSS technology, such as in land monitoring, rescue and emergency operations, etc., in those countries.

Israel

18. ISRAEL: Location Based Social applications and crowd sourced efforts future role in disaster management scenarios

(Theme: GNSS user Applications)

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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 enable generating and sharing of information and data in new and exciting forms, including crowd sourced location-based information. Location based social application leverage this trend. We witness the increasing traction of location based social media that is used or can optionally be used for disaster management. The use of Social applications and crowd sourced efforts for disaster management shows tremendous benefits. Recent disaster events that were accompanied by social media echo brought past vision into real life activities and showed the potential of those networks in disaster management.

As technology advances, people are increasingly more connected and connected communities have the opportunity to create a reliable real time and free to the public geographic databases. Using social networks, GNSS-based applications can support daily activities of users while in disaster same applications becomes lifesaving tools , providing a decision support tool to both users and decision makers.

The presentation will (1) provide a wide view on technology enablers (2) present case studies of natural and manmade disasters managed or viewed by location
based/social applications (3) present the challenges ahead and recommendation on the national/International level

Kazakhstan

19. KAZAKHASTAN: GNSS applications in monitoring the movements of the Earth's crust to assess the seismicity of south-eastern Kazakhstan

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The main objective of the work was to assess the possibilities of using the GPS observations from the standpoint of informativeness for solving geodynamic problems. It is assumed that the rate of displacement of GPS points should show the characteristics of modern deformation processes that are manifested in the increased seismic activity in the region.

The initial data were the results of the monitoring of modern crustal movements in the period 2009-2013 by 10 long-term GNSS stations, receivers equipped with Leica GRX1200GGPRO. Stations located within the ridge Ile Alatau, in the vicinity of Almaty city in the seismic zone with the possible 9 points shaking. By a single method of processing of GPS-measurements, a set of programs GAMIT/GLOBK calculated absolute values of the displacements in orthogonal components at each point of observation: the components of east-west, north-south and vertical.

For geodynamic analysis examined rates of recent movements (mm/year), defined as the linear trends increments of the corresponding coordinates of points per the normalized time. The maps of the absolute velocity of the component in the geocentric coordinate system (the center of the Earth) and the relative velocity in the reference frame of the Eurasian continent were created by interpolation of the measured values to the nodes of a rectangular mesh.

Relative to the center of the Earth predominant horizontal motion of the region is movement towards the east-northeast with the speed 1-6 mm/year for the northern component and 21-28 mm/year for the eastern component. Field of relative horizontal velocity vectors calculated in the reference system of the Eurasian continent, allows to allocate heterogeneity of movements that may be associated with features of the geodynamic regime. Dominated submeridional movement of individual crustal blocks to the north at speeds of 1-6 mm/year and at variable sign speeds of 1.5-2.5 mm/year in modulus for east-west components. In the vertical movement in both reference systems established stable lifting of the western part of the territory with velocities 1.5-3.0 mm/year and lowering the eastern part with velocities of 1.5-2.0 mm/year. Speed of vertical displacements of the Earth surface in the Northern Tien Shan by GPS data do not contradict modern ideas of seismic zoning and confirmed by the latest indicators of zoning of epi-platformal orogens by movement regime. The alternating sections of vertical velocities coincide with areas of uplift and subsidence (foothill and intermountain valleys) of different time duration and show the current active geodynamic movement of area.

The velocity field of modern movements can be represented as the absolute values of strain per unit time. Divergence of the field of horizontal velocity of GPS points relative to the Eurasian continent formally interpreted as a possible area of uniform compression-tension. Structure of the field of divergence qualitatively indicate the formation of the main strains in sub-latitudinal direction, ie parallel to the main ridge of the Northern Tien Shan. There is a coincidence of earthquakes in this region of the Northern Tien Shan with the boundary area compression-tension, the intensity of which is localized on the northern slopes of the ridge Ile Alatau and confinement of the manifestations of increased seismic activity in the region of maximum velocity of movement in the direction of south-north.

To identify vortex horizontal movements of the individual crustal blocks defined as rotational, anti-parallel shear deformation applied procedure of differentiation of the original field of horizontal velocity with the calculation of the normalized rotor. Reduced field of circulation indicates the possible presence of blocks opposite horizontal rotations. There is spatial coincidence of areas of seismic activity with areas in rotary motion.
It can assume that the use of GNSS in monitoring of movements the earth's crust is an informative method of assessing the stress-strain state of the area and can be used for the purpose of seismic zoning and seismic risk assessment.

Kazakhstan

20. KAZAKHASTAN: Radio occultation experiment on-board Kazakhstan's first nanosatellite

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At present, the usage of the signals of the global navigation satellite systems allows scientists to explore the structure and the dynamics of the processes in the ionosphere. The total electron content measurement is a reliable indicator of the present state of the ionosphere. It can also be used to improve the radio-technical systems taking into consideration the impact of the ionosphere on the radiofrequency signals. As part of the project on the space scientific system development in the Republic of Kazakhstan, the Institute of Space Technique and Technology started a new project on the first homegrown scientific nanosatellite mission for interplanetary environment exploration. There are several scientific instruments to install – a fluxgate magnetometer, a search-coil magnetometer and instruments for radio occultation (RO) measurement of the state of the ionosphere. It is planned to use a low cost COTS GPS/GLONASS receiver and an antenna for RO measurements in order to develop and implement a new method for the development of similar missions in as shortest time as possible, with minimum expenses. Taking into consideration some limits for a scientific mission using nanosatellite, particularly link and power budget constraints, it was decided to carry out selective radio occultation measurements and to schedule them in an experimental design ground center. This approach was successfully performed by one of the nanosatellite's missions [1] and can help develop our own method. The philosophy of the experiment, software and hardware for the selective radio occultation measurements as well as data processing software were developed. At present a technological unit of radio occultation experiment instruments is tested.

Latvia

21. LATVIA: Capacity building in the field of GNSS at Riga Technical University

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Riga Technical University has surveyors department since 1862. Since 2003 Geomatics department has been created. Programs have two types: professional bachelor's and master's professional studies. Professional bachelor studies include academic subjects - mathematics, physics, computer science, foreign language, and professional subjects, as well as practice.

Geomatics priorities can be learned: geodesy, surveying, mapping, photogrammetry, real estate management. After a professional bachelor's degree in Geomatics with an engineering degree in geodesy and cartography, studios can continue the professional master's degree. Master studies consist primarily of professional items, as well as field practice. After a professional master's degree in Geomatics, studies can be continued at doctoral level at Riga Technical University. Professional undergraduate and professional master's degree programs can acquire a full-time (days) and part time (part-time) form.

Riga Technical University, Department of Geomatics, the only one in Latvian universities with profile like this, where working professional geodesists, cartographers and photogrammetric specialists; Department of Geomatics is with a specialized surveying the audience, a computer room with the latest specialized software, advanced optical and electronic geodetic instrument collection. It is used not only in the learning process Geomatics programs, but also all the other Engineering Faculty, as well as the Faculty of Architecture and Urban Studies programs.

Our students participate each year in the reports RTU scientific and technical conference. There are active participation in international Socrates Erasmus exchange programs, studies in Germany, Greece, Belgium and Cyprus. Department of Geomatics with their knowledge and skills are complement to the students from the Technical University of Valencia Topography programs. They study process is organized in English.

At the Riga Technical University degree RTU Department of Geomatics graduates work in the Latvian Geospatial Information Agency, the company "Latvian State surveyor", State Land Service, private companies engaged in surveying, geodesy, photogrammetric, cartographic, real estate division.

GNSS course will introduce students with a global positioning system applications in various areas of the economy. To gain knowledge about the different types of construction and receivers, measuring techniques and skills to apply them in their work. After the acquisition of the subject students will be able to perform the measurement session planning activities, decide on the methods in the outcome and independently perform the state space (positioning) calculations.

One of the three-dimensional environment is the height. Global positioning technology allows for the measurement ellipsoidal (geodetic) heights and calculate heights to orthometric or normal height system. To the global positioning system (GPS) assistance to a certain height equivalent to the height of traditional detection methods require global and regional geoid or quasigeoid models. Height determination with GPS is used in geodesy, altimetry, cartography, etc. science. Subject practical party includes the use of GPS height determination and long-range distances.

Mexico

22. MEXICO: Feasibility study on the implementation of satellite based technologies in precision agriculture for Mexico

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In recent years, precision agriculture has been carried out by different countries to manage agriculture resources in an optimal manner. It provides information to farmers about specific locations along their property. There are several benefits of implementing such technologies in a region as Mexico. Some of them are: better estimation of the real needs of the crop (e.g. irrigation, nutrients, etc.), prediction of crop yields, an increase of the output, better planning and time management of agricultural activities, thoughtful distribution of pesticides, fertilizers and other chemicals only where is needed, among others. The applications of GNSS in this field are point guidance, parcel area measurement, topographic mapping, yield mapping, to name a few.

In this work, the Mexican Space Agency (AEM) presents a study of capabilities and better options to implement the precision agriculture in Mexico. In a first stage, we will compare different sets of crops to determine which has the most impact in food security, in the use of irrigation resources and which type of crop would be the most benefited. On a second stage, we will establish which set of space based technologies suits best for the needs of the country in matter of cost and performance. In addition, we analyze the feasibility of the integration of GNSS measurements along with open remote sensing data into a Geographic Information System (GIS) to optimize the monitoring of crops. The project will be developed by the AEM in collaboration with the Ministry of Agriculture of Mexico.

Moldova

23. MOLDOVA: Stage of GNSS Reference Stations Network development of in Moldova: Regional cooperation with Romania

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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 2011 was adopted by Government of Republic of Moldova.

To provide real time position and navigation service on the territory of Moldova 10 GNSS continuously operating stations with GPS/NAVSTAR, GLONASS and Galileo capacity receivers, were installed in the frame GNSS Permanent Network and MOLDPOS service project supported by Norwegian Government. Additional data streams added from Romanian Positioning Service ROMPOS – improving positioning accuracy nearby state border with Romania.

MOLDPOS are providing two methods for positioning with GNSS: post processing with high accuracy to millimeters and Real Time Positioning: Differential GNSS (DGNSS) for sub-meter accuracy and Real-Time Kinematic (RTK) for centimeter accuracy. RTK users are using wireless GPRS connection to cell phone providers. Main problems are related to mobile phone coverage of territory of Moldova and ionospheric errors. To increase area of cell phone coverage users are using GPRS service of all three Moldavian cell phone providers. In order to reduce ionospheric errors MOLDPOS service provides Network Online Visualisation of Accuracy (NOVA) Maps with estimated residual ionospheric errors for a single base RTK users using data from the nearest GNSS reference station and virtual reference station (VRS) RTK users using data from the GNSS network.

MOLDPOS accuracy is controlled with measurements on national geodetic network control points. The maximum horizontal errors are about 2-3 cm on the border with Romania and 3-4 cm on the border with Ukraine. Normal height determination with accuracy 5-7 cm is possible using GNSS/levelling geoids model. To increase accuracy up to 2 cm gravimetric geoid model development is necessary.

Moldova

24. MOLDOVA: Modernization and development new Curricula on GNSS-related Geodetic Infrastructures, Mobile IT and Precise Navigation Technologies from Technical University of Moldova according to European Countries. Present and Future

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In 1995 at the Technical University of Moldova was open new specialty: Geodesy, topography and cartography in the Department of Geodesy, Cadastre and Geotechnics.

Over the course of 19 years, the department has actively participated in many important international projects.

Examples:

1. **2001-2003** the Project "Modernization of educational System in Cadastre" Sweden International Development Assistance (SIDA)
2. **2004 – 2006** the Project "Education in Geographical Information Technology" supported by EU, TEMPUS
3. **2010** TUM in cooperation with Land Relations and Cadastre Agency finalized project focused on development of a High Capacity Real-Time GNSS Positioning Service for Moldova (MOLDPOS) in the frame of the International German-Moldavian scientific cooperation project "MDA 09/025" (http://www.moldpos.eu). In the frame of this project a High Capacity Real-Time GNSS Positioning Service for Moldova MOLDPOS was designed and 3D-datum transformation problems for territory of Republic of Moldova were solved using COPAG software based on finite element related mathematical modelling (FEM). The height transformation problem was solved using DFHBF software in a Finite Element (FEM) concept. In order to monitor GNSS stations in the amount of few millimetres GNSS-reference-station MONitoring by the KArlsruhe approach and software (MONIKA) has been implemented. The results of the project are implemented in educational process in order to modified curriculum of Master Program and PhD Program.
4. **2010-2013** the TEMPUS Project GIDEC "Geographic information technology for sustainable development in Eastern neighbouring countries" (http://gidec.abe.kth.se). In the frame of this project a new GNSS and reference systems curricula will be developed.
5. **2012-2013** the Technical University of Moldova is involved, as a partner, in a collaborative FP7 Project **EEGS2 «EGNOS Extension to Eastern Europe: Applications»** (http://www.eegs2-project.eu/).

Educational programs and curricula were amended and approved every five years.

With the signing of the association agreement between Moldova and the European Union it necessary to create attractive education in special in higher education and in the field of geodesy and GNSS.

In this context it will achieve the modernization and development new Curricula on GNSS-related Geodetic Infrastructures, Mobile IT and Precise Navigation Technologies according to European countries.

Nepal

25. NEPAL: Potential Use of GNSS in Mountainous Country, Nepal

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Nepal is as disaster prone country. Floods, landslides, epidemics and fires cause considerable loss of life and property in Nepal every year. Earthquakes, on the other hand are not so frequent, but have the potential for causing the greatest damage. Nepal is a seismic prone country and the risk it faces from earthquakes is very high. Global Positional Systems (GPS) now is competing with traditional surveying techniques in almost all fields of geodesy and cadastral surveying after the availability of highly productive new systems such as Real Time Kinematic (RTK) systems along with the use of Global Navigation Satellite Systems (GNSS). This technology, however, will not replace the existing survey techniques but it will provide another means in carrying out cadastral surveys especially in the area where the conventional technique is not economically and temporally viable. Paschimanchal campus, Institute of Engineering, Tribhuvan University has started the geomatics engineering in Bachelor level has to support and adopt an appropriate innovative approach for cadastral mapping in the country in order to meet the growing public demands on reliable land information system, to provide speedy land administrative services as well as for the disaster mitigation and management for overall development of the country. Nepal is in the initial stage in space technology. Capacity building is essential part for this era including the support for developmental issues in space science.

Nigeria

26. NIGERIA: - Modelling of atmospheric parameters over Nigeria based on GNSS data

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Globally Continuously Operating GNSS Networks are being used for meteorological and climate research through a concept referred to as GNSS meteorology. One of the applications of GNSS meteorology is the estimation of the Zenith Tropospheric Delay (ZTD) from ground-based GNSS data. The estimated ZTD is then applied for the determination of the atmospheric water vapour. Atmospheric water vapor is a main greenhouse gas and plays an important role in weather prediction and climate monitoring. The ZTD is comprised of the Zenith Hydrostatic Delay (ZHD) and Zenith Wet Delay (ZWD) components. Water vapour is estimated from the wet part of the ZTD. The ZWD is thus an important data for the development of mathematical models of the troposphere and the Precipitable Water Vapour (PWV) for local, regional and global areas and for the meteorology and climate research. There are two models to map the wet ZTD onto the precipitable water vapour: (1) Weighted Mean Temperature Tm model, and (2) conversion factor Q. Firstly, in this presentation, we discuss the weighted mean temperature model for Nigeria, which was actualise by using 3years (2010- 2012) data from the Global Reanalyses model (NCEP/NCAR Reanalyses 1) and Radiosonde data from 24 radiosonde stations in the west African region, a total of 35,040 radiosonde soundings was utilised over the period of 5yrs (2009-2013). It is anticipated that the model will be applied in later GNSS meteorological studies in Nigeria. Secondly, we discuss the processing of GNSS data from the Nigerian Permanent GNSS Network (NIGNET) using GAMIT/GLOBK software to obtain ZTD estimates which are needed in modelling the conversion factor (Q). Furthermore, GNSS ZTD estimates were validated with estimates from refractivity and empirical models. Finally, we characterize the temporal and spatial variation of the ZWD and the ZTD, estimated using the NIGNET over the Nigerian territory for a period of 4.5years (2010-2014). This characterization is important for the improvement and validation of atmospheric water vapor models, applicable in GNSS meteorology, as well as in the navigation. The results presented herein are the preliminary results of the research in developing a near real time water vapour system for Nigeria. Future results and discussions are to focus on the accuracy of GNSS PWV estimates based the derived weighted mean temperature equation for Nigeria, surface meteorological parameter modelling, satellite orbit monitoring and precise ZTD estimation.

Keywords: Global Navigation Satellite System (GNSS), Zenith Tropospheric Delay (ZTD), Zenith Hydrostatic Delay (ZHD) and Zenith Wet Delay (ZWD)Precipitable Water Vapour (PWV), Times series

Pakistan

27. PAKISTAN: Enabling Precise Geo-Spatial Applications by Development of Multi-GNSS Continuously Operating Reference Station (CORS) Network for Pakistan

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Pakistan

Continuously Operating Reference Station (CORS) Network is established for enabling precise positioning applications, utilizing the GNSS technology and meeting the long term industry demand and support the sustainable development of country. Pakistan Space & Upper Atmosphere Research Commission (SUPARCO) has established multi-GNSS CORS Network initially in and around the Karachi City. This CORS Network provides correction parameters to GPS, GLONASS and BEIDOU signals through a Master Control Center (MCC) to all authorized users using NTRIP protocol. Initially five (05x) CORS have been established at the outskirt of the Karachi to cover the maximum area of Karachi. Subsequently these CORS will be established to other cities of Pakistan to cover the major economic zones of Pakistan. This CORS Network will enable the current GNSS users involved in geo-spatial applications to utilize the Robust, Accurate, Reliable and Economical (RARE) positioning services to improve the efficiency of the work. This presentation will cover the current development and status of CORS Network for Pakistan and services being offered to all authorized users.

Peru

28. PERU: Applications of the Theory of General Relativity TGR to the Global Navigation Satellite System, GNSS

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NOWADAYS, IS WELL KNOWN THAT GNSS IS A SUCCESSFUL SYSTEM FOR POSITIONING, NAVIGATION AND TIMING AT THE ACCURACY LEVEL OF NANOSECONDS. NEW APPLICCATIONS AS PRECISE APPROACH IN AIR NAVIGATION, AGRICULTURE, DETERMINATION OF OIL AND MINNING DEPOSIT, AS WELL AS SPACE EXPLORATION REQUIRES HIGHER ACCURACY LEVEL AT PICOSECONDS AND FEMTOSECONDS, BY MEANS OF MODERN HIDROGEN ATOMIC MASER CLOCKS. AT THIS LEVEL, RELATIVISTIC EFFECTS ARE EVIDENT AND IMPORTANT, SO A NEW CONCEPT IN POSITIONING, NAVIGATION AND TIMING IS REQUIRED. A FULLY RELATIVISTIC PARADIGM WAS FIRST PROPOSED BY BAHDER (2001), COLL (2001) AND ROVELLI (2001). FOR INSTANCE, TARANTOLA AND OTHERS (2009) PROPOSED A FULLY RELATIVISTIC MODEL APPLYING OPTMIZATION AND KALMAN FILTER ROUTINES TO SOLVE FOR GEODETIC EQUATIONS. THEY PROPOSED FOUR TIME COORDINATES INSTEAD OF THE CLASSICAL THREE SPACE COORDINATES PLUS ONE TEMPORAL. IT ALSO REQUIRES CROSSLINK RANGES BETWEEN SATELLITES CAPABILITIES. GRAVITATION MUST BE ADDED BUT IN SENSE OF SPACE METRIC RATHER THAN AS AN ATTRACTIVE FORCE. GRAVITY AND POSITIONING MUST BE TAKEN IT TOGETHER. THE MAIN

ADVANTAGES OF DOING SO IS THAT THEY DO NOT NEED "RELATIVISTIC CORRECTIONS", THEY ARE MORE ACCURATE AND DO NOT NEED CHANGE IN ALGORITHMS IF FURTHER KNOWLEDGE OF GRAVITATIONAL FIELD IS IMPROVED. THE AIM OF A RELATIVISTIC POSITIONING SYSTEM IS TO ALLOW ANY USER TO KNOW ITS LOCATION IN A WELL DEFINED FOUR-DIMENSIONAL PHYSICAL COORDINATE SYSTEM. THEN, PROVIDE THE USER WITH ITS PROPER TIME AND PROPER DISTANCE (SPACE-TIME METRIC). FINALLY, CHARACTERIZE ITS SPACE-TIME TRAJECTORY DYNAMICALLY (PROPER ACCELERATION) AND/OR GRAVITATIONALLY (GRAVIMETRY). IN THIS WORK WE PRESENT A VERY SPECIFIC APPLICATION OF THE THEORY OF GENERAL RELATIVITY TRG INTO DE THE MODERN GNSS. WE FIRST SHOW A NUMERICAL SCHEME TO ACCOUNT FOR RELATIVISTIC EFFECTS, PARTICULARLY IN THE WELL KNOWN GLOBAL POSITIONING SYSTEM GPS. ERRORS COME FROM DIFFERENT SOURCES, MAINLY IN THE TIME OF PROPGATION OF THE ELECTROMAGNETIC EM SIGNALS AND THE CLOCKS RATES, DEPENDING ON THE RELATIVE SPEED FROM ONE BODY TO RESPECT OF ANOTHER, AND BECAUSE OF THE DIFFERENCES IN THE GRAVITATIONAL POTENTIAL. ATMOSPHERE IS A VERY IMPORTANT SOURCE OF ERRORS BY REFRACTION OF EM SIGNALS, BUT WE ARE NOT GOING INTO THIS. HERE WE ARE PROPOSING A VERY FULLY RELATIVISTIC POSITIONING SYSTEMM BUT IN A VERY SIMPLIFIED WAY. THIS WORK IS MOSTLY THEORETICAL AND WE ARE GOING TO SHOW SOME NUMERICAL AND GRAPHICAL SIMULATIONS TO HAVE AN IDEA OF HOW THE MODEL IS. THE CURRENT SYSTEM IN GPS AND MOST THE OF THE UPCOMING GNSS IS THE NEWTONIAN MECHANICS FRAMEWORK. THEY INTRODUCE ERRORS OF ABOUT 45700 NS PER DAY. IT MEANS THAT THE CLOCK ONBOARD THE SATELLITE FORWARDS WITH RESPECT THERECEIVER ON GROUND FOR THAT AMOUNT OF TIME. SO REGARDING THAT 1 NS OF ERROR REPRESENTS 30 CM OF ERROR IN POSITION, SO, THE AMOUNT OF TIME, MENTIONED FOR TRG WILL YIELD AN ERROR OF ABOUT 13.8 KM IN POSITION. FURTHERMORE, IF WE THINK IN MODERN PRECISION AS HIGH ATOMIC CLOCKS STANDARDS EXPECTED FOR GALILEO, ERRORS OF HIGH ORDERS WILL BECOME APPARENT AS LENSE-THIRRING EFFECT OF ABOUT 10^{-11} m/s^{-2} AND DESITTER-GEODESIC EFFECT OF ABOUT 10^{-12} m/s^{-2}. FINALLY, WE EXPECT TO ELIMINATE THOSE EFFECTS AND OTHER THAT COULD BE ARISE IN THE FUTURE, SO WE ARE GOING TO USE AN EXTENDED KALMAN FILTER MODEL TO PERFORM A SIMPLIFIED VERSION OF THE KERR METRIC FOR SLOW ROTATING SPHERICAL MASS.

Russian Federation

29. RUSSIAN FEDERATION: GLONASS current status and plans

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The presentation will focus on programmatic issues, current status, performance and plans of GLONASS system. It will cover the background principles of the government policy based on GLONASS State Program.

The report will also include a brief summary of the System of Differential Corrections and Monitoring (SDCM) which is considered as a constituent part of GLONASS.

Russian Federation

30. RUSSIAN FEDERATION: Topside Ionospheric Density Response to Geomagnetic Disturbances

Irina Zakharenkova (1), Elvira Astafyeva (1), Iurii Cherniak (2)
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(2) West Department of IZMRAN, Russia

Measurements provided by Low Earth Orbit (LEO) satellite missions have already proved to be very efficient in investigations of global redistribution of ionospheric plasma and thermosphere mass density during such phenomena as geomagnetic storms. Undoubted advantage of LEO satellites with polar orbit is the principal possibility to get continuous data over all latitudes, as well as over regions with total lack of ground-based measuring facilities like oceans, deserts etc. The majority of the modern LEO satellites is equipped with the dual frequency GPS receivers and zenith looking antenna can be used not only for precise orbit determination (POD), but can also provide valuable information on the ionisation state of the topside ionosphere and plasmasphere above the satellite orbit. We discuss results, provided by LEO GPS technique at several LEO missions like CHAMP, GRACE, TerraSAR-X, SWARM, on research of the topside ionosphere response to the space weather events.

Tanzania

31. TANZANIA: The status of GNSS Technology in Tanzania

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Space Science is important today due to the fact that, space weather impacts have the ability to damage modern space-age technology (communication, navigation, power distribution, Oil pipelines, money transaction etc). Tanzania being one of the developing countries needs the GNSS technology for space weather monitoring. Few years ago there was no any instrument for monitoring space weather. This contributed to lack of people who were ready to study Space Science, and today we have no any expert with a PhD in this area. In 2008, one MAGDAS station was installed by the Space Environment Research Center (SERC), today known as International Center for Space weather Science and Education (ICSWSE) of the Kyushu University, Japan. This was the beginning of students in master's level (M.Sc.) to do research in Space Weather, and I was the first, although under minimum supervision because of lack of Experts. Other two students followed after me. Today we have also GPS receivers which can be used for different studies. First GPS receiver in Tanzania was installed in 2006 in Dar es Salaam. Currently there are eight (8) stations with GPS receivers, although most of these receivers were for tectonic monitoring. Following increasing number of GPS receivers in my country, I am now planning to start my PhD soon, so as to make use of the available data, and also to encourage more students to do research using these data. The plan is to include space science programs in master's curriculum. More instruments for monitoring Space weather are needed today in Tanzania to develop interest among students in this important area of study. I request organizations which involve in space weather monitoring and education to support Tanzania in this field of study.

32. UKRAINE: MONITORING AND MODELING OF IONOSPHERE IRREGULARITIES CAUSED BY SPACE WEATHER ACTIVITY ON THE BASE OF GNSS MEASUREMENTS

Iurii Cherniak, Irina Zakharenkova

The ionosphere plays an important role in GNSS applications because it influences on the radio wave propagation throughout. The ionosphere delay is the biggest error source for satellite navigation systems, but it can be directly measured and mitigated with using dual frequency GNSS receivers. However GNSS signal fading due to electron density gradients and irregularities in the ionosphere can decrease the operational availability of navigation system. The intensity of such irregularities on high and mid latitudes essentially rises during space weather events. For monitoring of the ionospheric irregularities data collected from all available permanent GNSS stations in the Northern Hemisphere are processed and analyzed. Here we used parameters ROT (rate of GPS TEC change) and ROTI (index of ROT) to study the occurrence of TEC fluctuations. ROTI maps are constructed with the grid of 2 deg x 2 deg resolution as a function of the magnetic local time and corrected magnetic latitude. The ROTI maps allow to estimate the overall fluctuation activity and auroral oval evolutions, in general the ROTI values are corresponded to the probability of GPS signals phase fluctuations.

There were developed several models in order to represent ionospheric fluctuations and scintillation activity under different geophysical conditions, but they were calibrated with data sets, that did not include GNSS derived data. It is very actual to develop empirical model based on GNSS derived measurements which can represent strong fluctuations of the ionosphere plasma density at high latitudes. The measurements provided by the existing permanent GNSS networks accumulated in order to develop the empirical model of ionospheric irregularities over the Northern hemisphere. As initial data the daily dependences of the ROTI index are used as a function of geomagnetic Local Time on the specific grid. With ROTI index maps it was determined the irregularities oval border and averaging parameter – semi-hemisphere fluctuation index. It was investigated the statistical and correlation dependences between Kp geomagnetic index and parameters that characterized the ionosphere irregularities activity for period of 2010 – 2014 years.

The results of observations for specific events, modeling and its validation will be presented.

Uzbekistan

33. UZBEKISTAN: Ionospheric Anomalies of Local Earthquakes Detected by Tec Measurements at Tashkent and Kitab GPS Stations

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We report the ionospheric anomalies observed during strong local earthquakes (M > 5.0) which occurred mostly in and around Uzbekistan in seismically active zones, during years 2006 to 2013 within approximately 1000 km distance from the observing GPS stations located in Tashkent and Kitab, Uzbekistan. The solar and geomagnetic conditions were quiet during occurrence of the selected strong earthquakes. We produce Total Electron Content (TEC) time series over both sites and apply them to detect anomalous TEC signals preceding or accompanying the local earthquakes. The results show anomalous increase or decrease of TEC before or during the earthquakes. In general the anomalies occurred 1–7 days before the earthquakes as ionospheric electromagnetic precursors. To identify the anomalous values of TEC we calculated differential TEC (dTEC). dTEC is obtained by subtracting monthly averaged diurnal vertical TEC (vTEC) from the values of observed vTEC at each epoch. This procedure removes normal diurnal variations of vTEC. The present results are in good agreement with the previous observations on ionospheric earthquake precursors reported by various researchers. TEC decrease during the solar eclipse on August 1, 2008 is also obtained from data at GPS station in Tashkent and Kitab. During the Solar flares occurrence the amplitude is icreased with compare to the nondisturbed initial monthly mean background value after the flare.

Viet Nam

34. VIET NAM: How Multi-GNSS Brings Benefits to SEA

La The Vinh
NAVIS Centre, Hanoi University of Science and Technology

South East Asia (SEA) region is covered by multi positioning satellite systems such as: GPS, GALILEO, GLONASS, BEIDOU and QZSSS. Currently GPS still dominates the other, however it is foreseen that multi-gnss approach is getting more and more popular. Although multi-gnss approach has its own challenges such as the inter-system interference due to the overlap of the frequency bands, the difference of the coordinate reference; it still has a clear advantage thanks to the high availability of the satellites. Therefore, we conducted some experiments to perform multi-gnss positioning and analazyed the result to see if multi-gnss really bring better performance in our region, which is also well-known as the region of complicated ionospheric conditions due to the low latitude.

Augmentation of a global navigation satellite system (GNSS) is a method of improving the navigation system's attributes, such as accuracy, reliability, and availability, for aircraft navigation and landing applications. through the integration of external information into the

calculation process. There are many such systems in place and they are generally named or described based on how the GNSS sensor receives the external information. Some systems transmit additional information about sources of error (such as clock drift, ephemeris, or ionospheric delay). The existing core satellite constellations alone however do not meet strict aviation requirements.

To meet the operational requirements for various phases of flight, the core satellite constellations require augmentation in the form of aircraft-based augmentation system (ABAS), satellite-based augmentation system (SBAS) and/or ground-based augmentation system (GBAS). ABAS relies on avionics processing techniques or avionics integration to meet aviation requirements. The other two augmentations use ground monitoring stations to verify the validity of satellite signals and calculate corrections to enhance accuracy. SBAS delivers this information via a geostationary earth orbit (GEO) satellite, while GBAS uses a VHF data broadcast (VDB) from a ground station. GNSS can improve airport usability, through lower minima, without the need to install a NAVAID at the airport. GNSS may support approach procedure with vertical guidance (APV) on all runways, with proper consideration of aerodrome standards for physical characteristics, marking and lighting.

When a landing threshold is displaced, the flexibility inherent in GNSS can allow continued operations with vertical guidance to the new threshold. GNSS may also be used to support surface operations.

United Nations/ICTP Workshop on Global Navigation Satellite Systems (GNSS) | (smr 2617)

Monday, 1 December 2014

09:00 - 12:00 Registration of Attendance and Administrative Formalities

at registration desk, outside Budinich Lecture Hall, Leonardo building from 9:00 to 10:30. Subsequently with the Event secretary in room 136, first floor near the Library.

09:30 **Coffee break** *1h0'*

12:00 - 13:30 Lunch Break

13:30 - 14:00 Registration of Attendance and Administrative Formalities

at registration desk, outside Budinich Lecture Hall.
Subsequently with the Event's Secretary in room 136,
first floor, near the Library, Leonardo building.

14:00 - 14:30 Welcome and Opening Ceremony

Prof. Sandro RADICELLA, Head, Telecommunications,
ICT for Development Laboratory
the Abdus Salam International Centre for Theoretical Physics
(ICTP) Trieste, Italy

Ms. Sharafat GADIMOVA, Office for Outer Space Affairs,
United Nations Office at Vienna, Austria

Material: **Introduction Note by S.M. Radicella**

14:30 - 16:00 Session 1: Update on Satellite-based Naviagtion Systems

Conveners: Babomurot AHMEDOV (Tashkent, Uzbekistan), Esraa Emam HASSAN (Cairo, Egypt)

14:30 **Global Positioning System (GPS)** *20'*
Speaker: Patricia DOHERTY (Boston College, U.S.A.)
Material: **notes**

14:50 **GLONASS: Current status and plans** *20'*
Speaker: Anna DOROFEEVA (Central Research Institute of Machine Building, Russian Federation)
Material: **notes**

15:10 **GALILEO program updates** *20'*
Speaker: Pieter DE SMET (European Commission, Brussels, Belgium)
Material: **notes**

15:30 **Coffee break** *30'* (LB (outside Budinich Lecture Hall))

16:00 - 17:00 Session 2: Update on Satellite-based Augmentation Systems

Conveners: Sonia Maria ALVES COSTA (Rio de Janeiro, Brazil), M. Haque SARKER (Dhaka, Bangladesh)

16:00 **WAAS development** *20'*
Speaker: Patricia DOHERTY (Boston University, U.S.A.)
Material: **notes**

16:20 **EGNOS update** *20'*
Speaker: Pieter DE SMET (European Commission, Brussels, Belgium)

Material: notes

16:40 **International Committee on GNSS** *20'*
Speaker: Sharafat GADIMOVA (Office for Outer Space Affairs, UN Vienna, Austria)
Material: notes

19:30 - 21:00 Welcome Dinner at Adriatico Guest House Cafeteria

Tuesday, 2 December 2014

09:00 - 10:00 Session 3: International Initiatives on GNSS Implementation and Uses
Conveners: Janis ZVIRGZDS (Riga, Latvia), Livia NISTOR LOPATENCO (Chisinau, Rep. of Moldova)

09:00 **How multi-GNSS brings benefits to the South-East Asia** *20'*
Speaker: Vinh The LA (NAVIS Research Centre, Vietnam)
Material: notes

09:20 **Expanding EGNOS horizons** *20'*
Speaker: Antonella DI FAZIO (Telespazio, Italy)
Material: notes

09:40 **GNSS reference stations network development in Moldova: Regional cooperation with Romania** *20'*
Speaker: Vasile CHIRIAC (Moldova Union of Surveyors, Rep. Moldova)
Material: notes

10:00 - 11:00 Session 4: GNSS Capacity Building
Conveners: Vinh The LA (Hanoi, Vietnam), Keranka Slavova VASSILEVA (Sofia, Bulgaria)

10:00 **The Master in Navigation and related applications: A programme to prepare the future experts in the field of GNSS** *20'*
Speaker: Gabriella POVERO (ISMB, Italy)
Material: notes

10:20 **TREGA: A joint EC-ICTP project** *20'*
Speaker: Sandro RADICELLA (ICTP, Trieste, Italy)
Material: notes

10:40 **Coffee break** *20'* (LB (outside Budinich Lecture Hall))

11:00 - 12:00 Session 4: GNSS Capacity Building (continues)
Conveners: Vinh The LA (Hanoi, Vietnam), Keranka Slavova VASSILEVA (Sofia, Bulgaria)

11:00 **Modernization and development of new curricula on GNSS-related geodetic infrastructure, mobile IT and precise navigation technologies at the Technical University of Moldova** *20'*
Speaker: Livia NISTOR LOPATENCO (Technical University of Moldova, Rep. of Moldova)
Material: notes

11:20 **Capacity building in the field of GNSS at the Riga Technical University** *20'*
Speaker: Janis ZVIRGZDS (Riga Technical University, Latvia)
Material: notes

11:40 **The status of GNSS technology in Tanzania** *20'*
Speaker: Emmanuel Daudi SULUNGU (University of Doduma, Tanzania)
Material: notes

12:00 - 14:00 Lunch break

14:00 - 16:30 Session 5: GNSS Observation Data for Atmospheric Studies
Conveners: Medzida MULIC (Sarajevo, Bosnia and Herzegovina), Shamil GASIMZADE (Baku, Azerbaijan)

14:00 **GNSS space weather monitoring and study at INGV: An Overview** *20'*
Speaker: Lucilla ALFONSI (National Institute of Geophysics and Volcanology, Italy)
Material: notes

14:20 **Monitoring and modelling of ionosphere irregularities caused by space weather activity on the based of GNSS measurements** *20'*
Speaker: Iurii CHERNIAK (WD IZMIRAN, Russian Federation)
Material: notes

14:40 **NeQuick model: Features and applications** *20'*
Speaker: Bruno NAVA (ICTP, Italy)
Material: notes

15:00 **The NeQuickG model** *20'*
Speaker: Raul ORUS (European Space Agency, ESA-ESTEC, The Netherlands)
Material: notes

15:20 **NeQuick model performance analysis for GNSS mass market receivers positioning** *20'*
Speaker: Salvatore GAGLIONE (Univ. Napoli Parthenope, Napoli, Italy)
Material: notes

15:40 **Characteristics of low latitude total electron content during solar cycle 23 and 24 over Indian longitude sector using 16 years of GIM VTEC** *20'*
Speaker: Sunanda SURESH (National Atmospheric Research Laboratory, India)

16:00 **Coffee break** *30'* (LB (outside Budinich Lecture Hall))

16:30 - 17:30 Session 5: GNSS Observation Data for Atomospheric Studies (continues)
Conveners: Sunanda SURESH (Chittoor, India), Rafael ORTIZ AGUILERA (Mexico D.F.)

16:30 **Study of fog forecast for Sofia Airport based on numerical weather prediction simulation and use of GNSS tropospheric products** *20'*
Speaker: Keranka S. VASSILEVA (Bulgarian Academy of Sciences, Bulgaria)
Material: notes

16:50 **TREGA project results on ionospheric impact on SBAS in Africa** *20'*
Speaker: Xurxo OTERO VILLAMIDE (ICTP, Italy)
Material: notes

17:10 **Modelling of atmospheric parameters over Nigeria based on GNSS data** *20'*
Speaker: Olelakan Adekunle ISIOYE (Ahmadu Bello University, Nigeria and University of Pretoria, South Africa)
Material: notes

Wednesday, 3 December 2014

09:00 - 11:00 Session 6: General GNSS Applications
Conveners: Emmanuel Daudi SULUNGU (Dodoma, Tanzania), Karin KOLLO (Tallinn, Estonia)

09:00 **Use and application of GNSS in air navigation in Ecuador** *20'*
Speaker: Bolivar Enrique DAVALOS CARDENAS (General Civil Aviation, Ecuador)
Material: notes

09:20 **Radio occultation experiment on-board Kazakhstan's first nano-satellite** *20'*
Speaker: Pavel INCHIN (Institute of Space Technique and Technology, Kazakhstan)
Material: notes

09:40 **Benefits of GNSS software receivers for scientific applications** *20'*
Speaker: Nicola Umberto LINTY (Politecnico di Torino, Italy)
Material: notes

10:00 **Applications of the theory of general relativity to GNSS** *20'*
Speaker: Jorge David TARAMONA PEREA (Ministry of Transport and Communications, Peru)
Material: notes

10:20 **Coffee break** *20'* (LB (outside Budinich Lecture Hall))

11:00 - 12:00 Session 7: GNSS Positioning
Conveners: Jorge David TARAMONA PEREA (Lima, Peru), Iurii CHERNIAK (Kaliningrad, Russian Federation)

11:00 **A methodology to minimize the operating cost of a water supply network using GNSS and web mapping** *20'*
Speaker: Thibaut Aloys EKANI MEBENGA (National Institute of Cartography, Cameroon)
Material: notes

11:20 **Location-based social applications and crowd sourced efforts future role in disaster management scenarios** *20'*
Speaker: Tal DEKEL (Tel Aviv University, Israel)
Material: notes

11:40 **GNSS Scientific applications and related projects in Bangladesh** *20'*
Speaker: Mozammel Haque SARKER (Space Research and Remote Sensing Organization, Bangladesh)
Material: notes

12:00 - 14:00 Lunch Break

14:00 - 16:00 Session 7 - GNSS Positioning (continues)
Conveners: Vasile CHIRIAC (Chisinau, Rep. Moldova), Paul INCHIN (Almaty, Kazakhstan)

14:00 **Navigation in Azerbaijan** *20'*
Speaker: Shamil GASIMZADE (Ministry of Communications and High Technologies, Azerbaijan)
Material: notes

14:20 **Multipath effect on GNSS positioning** *20'*
Speaker: Medzida MULIC (University of Sarajevo, Bosnia and Herzegovina)
Material: notes

14:40 **Azerbaijan positioning observations system for real estate cadastre database** *20'*
Speaker: Chingiz TANIRVERDIYEV (State Committee on Property Issues, Azerbaijan)
Material: notes

15:00 **The main geodetic infrastructure contributing to land reform and weather researches in Brazil** *20'*
Speaker: Sonia Maria ALVES COSTA (Brazilian Institute of Geography and Statistics, Brazil)
Material: notes

15:20 **The GEORED project: GPS/GNSS geodetic infrastructure in Colombia for multi-purpose research** *20'*
Speaker: Hector MORA PAEZ (Colombian Geological Survery, Colombia)
Material: notes

15:40 **Coffee break** *20'*

16:00 - 17:00 Session 7: GNSS Positioning (continues)
Conveners: Thibaut Aloys EKANI MEBENGA (Yaounde, Republic of Cameroon), Enrique Bolivar DAVALOS CARDENAS (Quito, Ecuador)

16:00 **ESTPos- new Estonian GNSS/RTK network** *20'*
Speaker: Karin KOLLO (Estonian Land Board, Estonia)
Material: notes

16:20 **Enabling precise geo-spatial applications by development of multi-GNSS continuously operating reference station (CORS) network in Pakistan** *20'*
Speaker: Syed Zahid JAMAL (SUPARCO, Pakistan)
Material: notes

16:40 **Feasibility study on the implementation of satellite based technologies in precision agriculture for Mexico** *20'*
Speaker: Rafael ORTIZ AGUILERA (Mexican Space Agency, Mexico)
Material: notes

Thursday, 4 December 2014

09:00 - 12:00 Session 8: GNSS for Monitoring Applications

Conveners: Tal DEKEL (Tel Aviv, Israel), Syed Zahid JAMAL (Karachi, Pakistan)

09:00 **Ionospheric anomalies of local earthquakes detected by TEC measurements at Tashkent and Kitab GPS stations** *20'*

Speaker: Babomurot AHMEDOV (Ulugh Beg Astronomical Institute, Uzbekistan)

Material: **notes**

09:20 **GNSS applications in monitoring the movements of the Earth's crust to assess the seismicity of south-eastern Kazakhstan** *20'*

Speaker: Assylkhan BIBOSSINOV (JSC National Centre of Space and Technologies, Kazakhstan)

Material: **notes**

09:40 **Evaluation of the deformation parameter of the northern part of Egypt using GNSS** *20'*

Speaker: Esraa Emam HASSAN (National Research Institute of Astronomy and Physics NRIAG, Egypt)

Material: **notes**

10:00 **Crustal movements in Bulgaria using GPS** *20'*

Speaker: Keranka Slavova VASSILEVA (Bulgarian Academy of Sciences, Bulgaria)

Material: **notes**

10:20 **Potential use of GNSS in mountain areas** *20'*

Speaker: Krishna Prasad BHANDARI (Institute of Engineering, Nepal)

Material: **notes**

10:40 **Coffee break** *20'*

11:00 **Effect of the ionospheric irregularities occurring before earthquakes on the signal parameters of GNSS** *20'*

Speaker: Sergey PULINETS (Space Research Institute, Moscow, Russian Federation)

Material: **notes**

11:20 **Development and application of an experimental data server hosting EGNOS and RTCM/RTK correction data for terrestrial navigation** *20'*

Speaker: Raffaela CEFALO (GeoSNav Laboratory, University of Trieste)

Material: **notes**

11:40 **Effect of the April 5, 2010 storm on GPS positioning errors at Yamoussoukro** *20'*

Speaker: Olivier Kouadio OBROU (University of Cocody, UFR SSMT, Cote d'Ivoire)

Material: **notes**

12:00 - 14:00 Lunch Break

14:00 - 16:00 Panel Discussion on International and Regional Cooperation: Developing Partnerships and Networks for the Use of GNSS Science and Applications. PART I: GNSS Scientific Applications

Coordinators: Sandro Radicella, Sharafat Gadimova and Bruno Nava

15:30 **Coffee break** *30'*

16:00 - 17:00 Panel Discussion on International and Regional Cooperation: Developing Partnerships and Networks for the Use of GNSS. PART II: GNSS Applications

Coordinators: Sandro Radicella, Sharafat Gadimova and Bruno Nava

Friday, 5 December 2014

09:00 - 10:00 Final Open Discussion

Coordinators: Sandro Radicella, Sharafat Gadimova and Bruno Nava.

10:00 - 10:30 Summary Reports of Panel Discussions and Closing Remarks

Ms. Sharafat GADIMOVA, Office for Outer Space Affairs,
United Nations Office at Vienna, Austria
and
Prof. Sandro RADICELLA, Head, Telecommunications,
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10:30 - 11:00 Coffee Break

The Abdus Salam
International Centre
for Theoretical Physics
50th Anniversary 1964–2014

Activity SMR: **2617**

United Nations/ICTP Workshop on Global Navigation Satellite Systems (GNSS)

1 December 2014 - 5 December 2014
Trieste - ITALY

Co-organized and co-sponsored by:
United Nations, International Committee on Global Navigation Satellite Systems (ICG)

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