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ABSTRACTS

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Argentina

Advances in the implementation of the UN Resolution on global geodetic reference frame in Argentina

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Earth observation from artificial satellites generates massive, global, timely, accurate, standardized and accessible information about the complex Earth system. The infrastructure that generates this information is not exhausted in the satellites that orbit in the space nor in the earth stations from where they are operated. It also includes a global network of fundamental observatories that realizes the core global geodetic reference frame (GGRF) essential for referencing satellite information worldwide and extracting maximum social benefit from it.

On 26 February 2015 the United Nations General Assembly adopted the Resolution “A global geodetic reference frame for sustainable development”, which identifies the GGRF as a key infrastructure for sustainable developments and encourage the Member States to commit to improving and maintaining appropriate national geodetic infrastructure as an essential means to enhance it.

The Argentinean - German Geodetic Observatory (AGGO), installed in 2013 near the La Plata city, in Argentina, is the joint response of Argentina and Germany to the UN call. The

Observatory brings together the most modern techniques of geodesy, including systems for time, VLBI, SLR, GNSS and gravimetry, what makes it the only observatory of its kind in Latin America and the third in the Southern Hemisphere.
This talk will summarize the process that led to the installation of AGGO in Argentina, describe its instruments and the data generated by them and present a vision for the future in the frame of the UN Resolution on GGRF.

Argentina

Hardware in the Loop Test Bed for Distributed Satellite Platform Orbit Control

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Accompanying CONAE's growing interest in segmented architecture space systems, we here describe current CONAE and INVAP joint program to build a modular, high-fidelity, hardware-in-the-loop test-bed for testing and validation of guidance, navigation and control (GNC) hardware and software components under realistic scenarios prior to integration on board future distributed platform space missions.
The test-bed shall enable real time validation of space-graded GNSS receivers as well as other subsystems relevant to precise autonomous orbit control (absolute and relative) system for LEO satellites. Besides actual HW receivers, it shall thus permit to test flight models of onboard computers (OBC) hosting the required GNC-SW for at least two LEO satellites in flight formation.
The test-bed architecture will consist of the next interconnected sub-systems: a) CONAE´s-SPIRENT GSS8000 simulator delivering simultaneous GPS, GLONASS & GALILEO RF signal in the space to the antennae of up to 4 independent space vehicles; b) A high fidelity real time multiple orbit propagator including a thrust control module; c) At least 2 multifrequency space enabled GNSS receivers; d) The OBC running the GNC algorithms under test; e) A simile of a Mission Control Center.

Brazil

Russian-Brazilian SLR and GNSS monitoring stations: operation and recent research activities

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This work presents some recent research results of the operation of the SLR and GNSS monitoring stations in the context of the Brazil and Russia space cooperation. The activities include the use of GNSS data in Artificial Neural Networks (ANNs) models in order to estimate the Vertical Total Electron Content (VTEC) in Brazil, and the operation of the GLONASS satellite laser ranging (SLR) system. The results obtained by using the ANNs models suggest that this is a promising tool for VTEC estimation and forecasting, being able to provide good VTEC estimates. In addition, this work presents a brief overview of the history of the Russian-Brazilian SLR station, its present status, and suggestions for future investigations.

Brazil

GNSS infrastructure and services for positionning in Brazil

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With the official adoption of SIRGAS2000, epoch 2000.4 in 2005, the Coordination of Geodesy of Brazilian Institute of Geography and Statistics (IBGE), as responsible for geodesy in the country, is working intensely in order to provide GNSS infrastructure and services to support users access to the new geocentric system, fully compatible with GNSS technology. This presentation provides an overview of RBMC as main GNSS network and GNSS web services for the Precise Point Positioning, IBGE-PPP and MAPGEO online, for the interpolation of geoid undulation.

RBMC : THE MAIN GNSS INFRASTRUCTURE

The Brazilian Network for Continuous Monitoring of GNSS (RBMC), since its establisment in 1996, has been playing an essential role for the maintenance and user access to the fundamental geodetic frame in the country. It provides to the brazilian users the direct link to the Brazilian Geodetic System – SGB, currently in SIRGAS2000. Considering the continental dimensions and adversities of country, the maintenance and network operations are tasks shared under the collaboration with more than 50 national institutions, mainly universities. Its role has become more relevant with the massive use of positioning techniques based on Global Navigation Satellite Systems (GNSS) under expansion, mainly for Beidou and Galileo systems. Considering this fact, IBGE recently acquired 20 new GNSS receivers with four constellations (GPS, GLONASS, Galileo and Beidou). The new equipments will be installed in the main stations of the network, for example, International GNSS Service (IGS) and IGS real-time and in stations with only GPS receivers.

At the moment RBMC has 138 stations in operation, 104 of them for post and real time missions. A network densification is planned for 2018, for the first semester it is planned the

operation of nine new stations and the installation of 4 new ones, reaching 151 stations in operation by the end of the year.

OPERATIONS and SERVICES

For post mission operation, 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 IBGE site in the morning of the next day.

For real-time operations, a NTRIPcaster was set up, providing real-time corrections and data. 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.

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 number of users increased in the last years due to service credibility. More than 300,000 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.

SERVICES FOR GNSS POSITIONING

With the adoption of the SIRGAS2000 reference in 2005, IBGE Geodesy, were beyond the establishment and expansion of GNSS networks (active and passive), beginning a new era, where access to the geodetic information is through web services, among other applications available on its portal:

(1) Coordinates of all stations belonging to the Brazilian Horizontal and GNSS passive Networks referred to SIRGAS2000 at the 2000.4 reference epoch. The access of these Geodetic Database is through a friendly interface available on Internet;

(2) Geoid Model referred to SIRGAS2000, which converts ellipsoidal heights determined by satellite positioning techniques to the mean sea level. This model is continuously improved by IBGE, in cooperation with the University of São Paulo. The current version is named MAPGEO2015;

(3) IBGE-PPP: IBGE's Precise Point Positioning Online Service, a free service which computes, in post-mission mode, precise coordinates referred to SIRGAS2000 and ITRF based on GNSS data collected by users in Brazil and surrounding regions.

Since the adoption of SIRGAS2000, IBGE has been providing users a desktop application for the Windows environment, called MAPGEO, for the interpolation of geoidal undulations from the regular grid that represents the model, MAPGEO2015 being the latest version published by the Institute. Since June 2017, the geoidal undulations of the MAPGEO2015 model can also be obtained through the MAPGEO online service (https://ww2.ibge.gov.br/mapgeo/mapgeo.htm).

A post-mission Precise Point Positioning (PPP) service has been established based on the current Geodetic Survey Division of NRCan (CSRS-PPP) service. IBGE has been challenged to adapt this service to the needs of brazilian users, providing official results in SIRGAS2000, less than 24 hours after survey, allowing surveyor check GNSS results before leaving the survey area, optimizing resources and time.

This service is freely available on the IBGE portal since April 2009 and it is the most popular coordinate services in Brazil.

IBGE-PPP has registered an annual growth of approximately 30% in the number of processing, reaching since its launch a total of more than 950,000 results submitted by more than 32 thousand different users!

Brazil

Response of total electron content (TEC) at Brazilian low latitude to the occurrence of corotating interaction region and high speed streams during low solar activity

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In this work we investigate the Brazilian low latitude ionospheric response to two High Speed Streams (HSSs) events during the solar minimum of solar cycle 23, in 2008. For this purpose we used the Total Electron Content (TEC), one of most important parameters to diagnosis of the ionosphere. HSSs are commonly observed during descending phase and low solar activity. Prompt penetration of electric field, auroral activity caused by particles precipitation or Joule heating may trigger distinct local and global ionospheric responses, which englobes changes and variations in the ionospheric density and heights. One of most affected parameter is the TEC, which is intensified or depressed during the distinct phases of the disturbances, especially on the crests of Equatorial Ionization Anomaly (EIA). The important aspect of this work is to investigate the response of EIA over the Brazilian sector to two geomagnetic storms caused by HSSs in 2008 and contribute to a better understanding of the ionospheric response over this region. This subject is of the great interest for studies associated to Space Weather monitoring, modeling and forecasting. We analyzed the Vertical Total Electron Content (VTEC) calculated over the latitudinal range from equatorial region to the region around the South crest of EIA. It was observed that during weak or moderate geomagnetic disturbances related to HSSs intervals VTEC may be intensified more than 100% over the quiet times averaged values, which is comparable to strong geomagnetic storms. On the other hand, it is observed decreasing of VTEC during the recovering phase of the storm which is lower than the average of the 5 quietest days (5QD). Spectral analysis using gapped wavelet revealed periodicities of

7, 9, 13.5, and 27 days in VTEC and hmF2, which are similar to periods observed in solar and geomagnetic indexes such as Vsw, IMF_Bz and AE during HSSs intervals.

Brazil

Open-source hardware for GNSS education and research: The case of GNSS reflectometry applied to sea level monitoring

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Sea level monitoring is paramount given ensuing climate change. The challenge is especially difficult along the coastline, because of vertical land motion (subsidence or uplift) and because of limitations of spaceborne altimeters. Ground-based altimetry is possible via Global Navigation Satellite System Reflectometry (GNSS-R). Coastal GNSS-R thus exploits sea-surface reflections of radio waves broadcast by GNSS satellites. Yet its initial demonstrations relied on expensive high-end GNSS receivers and antennas. More recently, we have succeeded in employing mass-market consumer electronics to offer a lower-cost open-hardware device. Such alternative instrumentation has supported education and research in geodesy at both undergraduate and postgraduate levels. We will demonstrate some of the prototypes developed and present preliminary results of a comparison and validation to conventional tide gauges.

Brazil

Assessment of real time relative GNSS positioning based on the Brazilian CORS Network

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This paper presents an assessment of real time relative GNSS positioning from RBMC-IP, the real time Brazilian CORS Network. For this, RTKLIB free software was used with an unconventional technique to obtain the observations. In this sense, two RBMC-IP stations were considered, one as a remote station and the other as a base station, both transmitting over the Internet data streams that were received and processed by RTKLIB in kinematic mode. By this way it was possible to compare the coordinates obtained for the station considered remote with those of reference, subsidizing the determination of the positioning accuracy. In the tests performed, the SAVO and SSA1 stations were used in Bahia, comprising a 10 km baseline, and the SJSP and UBA1 stations, in São Paulo, corresponding to a baseline of 82 km. RTK and real time DGNSS techniques were used to process GPS L1, GPS+GLONASS L1, GPS L1+L2 and GPS+GLONASS L1+L2 observations, generating a total of 16 RTK solutions and 8 DGNSS solutions for the two baselines. RTK results achieved Root Mean Square errors (RMS) of coordinates varying from centimeter to decimeter level, depending on the baseline length, whereas DGNSS results achieved meter quality. In both cases, using GPS+GLONASS data combined improved coordinates RMS when comparing with those using GPS-only data.

China

Beidou high-precision positioning applications in the High Speed Rail industry

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This report focus on the high- precision measurement and monitoring needs of the High Speed Rail（HSR） industry. The construction of the National BeiDou Ground-Based Augementation System （BDGBAS）has been preliminarily completed. Based on the nation-wide reference station network and the centimeter/millimeter level services，many high-precision positioning applications of Beidou navigation and positioning system have been conducted. This report introduce the applications and achievements of BDS in the high-precision deformation- and track regularity- measurement and monitoring， especially in major infrastructure of Chinese HSR industry，including side slope，subgrade，large bridge ，etc. The recent situation of basic measurement and coordinate reference system of control network in HSR industry will also been briefed.

China

Status and Development Plan of Beidou System and Applications in Transportation

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I will introduce status, development plan and applications of Beidou satellite navigation system in all walks of life, especially in field of transport. This presentation is mainly divided into three parts.

The first part is the overall introduction of Beidou satellite navigation system, which includes time and area development, and current service capacity. Beidou follow the 3-step strategy in order to provide the global service in 2020. It is worth noting that transportation is the most important users in each step. China started the experiment and validation procedure for Beidou during the Step I, moreover, our country has finished some demonstration projects during the Step II. At the moment we also participate in the step III to build a better Beidou.

Next is development of BDS in transportation, such as Beidou applications, demonstration on road transportation, maritime search and rescue, and high-precision services, etc. We continue to cooperate with different organizations and committees to promote the globalization of Beidou. For COSPAS-SARSAT, IMO, ICAO we have started the application procedure and we also have made some progress in the last several years.

The third part is future plan of BDS. The transportation industry will extend applications of Beidou system, carry out forefront research, and gradually serve the world by promoting this Beidou system. Focus on people's daily lives, safety critical issues and the mobility of transportation.

Croatia

Initiative for concerted international co-operation on collection of GNSS Positioning Environment Data using Low-cost Sensors Networks

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Satellite navigation is a component of the national and international infrastructure, and has become a public good, in appreciation to the efforts and accomplishments of GNSS operators. Numerous technology and socio-economic applications and services are in operation and under development, all of them relying to sustained and resilient GNSS positioning, navigation and timing (PNT) service quality.

The recognition of potential risks due to temporal deterioration of GNSS PNT service quality has become an essential scientific and engineering task. Reliance against natural (space weather, ionospheric, tropospheric, multipath) and artificial (jamming, spoofing, meaconing, systemic failures) sources of vulnerability is today a hot scientific and engineering subject under concern of electrical engineers, mathematicians, statisticians, computer scientists, geodesists, transport and traffic engineers, but also the growing number of the GNSS application operators and users.

Space weather, geomagnetic and ionospheric effects are the prime natural sources of GNSS positioning performance degradation. Understanding of the natural processes that generates GNSS signal delays and waveform alterations, the sources of GNSS positioning errors, requires real-time data sets that describe numerous scenarios of GNSS utilisation. What is even more important, such observations of GNSS positioning environment (space weather, geomagnetic and ionospheric conditions) should be taken everywhere in to allow for GNSS positioning environment description on different scales, and for development of accurate and reliable forecasts of GNSS positioning performance deterioration that can be used for mitigation of its sources and for issuing the appropriate alerts to GNSS-based applications and operators.

Here the initiative for concerted international co-operation on collection of GNSS positioning environment dana using the networks of low-cost ionospheric space weather activity is introduced. A structural view (ontology) of relevant space weather, geomagnetic and ionospheric activity will be given, based on scientific results related to the subject achieved by GNSS specialists in Croatia and elsewhere. Experience with low-cost sensors of ionospheric activity will be presented. The methodology for utilisation of the in collection of ionospheric activity data through processing raw GNSS measurements obtained from the Google Location Application Programming Interface will be introduced. Finally, a common practice in the international co-operation on the GNSS positioning environment dana collection will be presented in facilitation of the proposed initiative and for recommendation for international collaboration on successful understanding, modelling and forecasting of space weather-caused GNSS positioning performance degradation.

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Ecuador

Use and application of GNSS in the implementation of Navigation Based on Performance (PBN) in Ecuador

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The first steps taken by Ecuador in the use and application of GNSS date from 2006, once the International Aviation Organization of ICAO, in 2003, at the eleventh world conference on air navigation (ANCONF/11), gave the guidelines for the transition to the satellite navigation system in the Caribbean and South America Regions (CAR / SAM), and adopted at the twelfth meeting of the planning and implementation group (GREPECAS), to use the evolutionary capacity of GNSS in all phases of flight, publishing the first approach and takeoff procedures RNAV/GNSS/RNP in the old international airport of Quito in coordination with International Association of Air Crew (IATA).

The Ecuadorian State, in accordance with the commitments assumed with ICAO, has continued to work on the application and use of GNSS through the design of RNAV Instrument Procedures for the new Quito airport that began its air operations since 2013; Since then, Ecuador has been developing RNAV/GNSS/RNP procedures not only for the Quito airport but also in airports such as Guayaquil, Cuenca and Galapagos.

If we want to optimize air navigation and raise the levels of operational safety, we must not only work on the design of instrumental procedures, but also on the restructuring of the airspace, designing routes and approach and exit procedures with criteria established in the manual operations of continuous descent (CDO) and continuous ascent (CCO), which constitute the current challenge of the State and in which we are working and we have managed to publish the first restructuring of the airspace in the Terminal Control Area of Guayaquil, which has allowed us to obtain operational advantages such as, more direct routes between the cities of Quito and Guayaquil, decreased flight time between city pairs, provide

air operators optimal flight profiles, fuel savings, reduction of carbon dioxide emissions to the atmosphere and avoid destabilized approaches.

In order to achieve this work of restructuring of the Ecuadorian airspace and in particular of the Terminal Control Area (TMA) of the Guayaquil airport, the Aeronautical Administration of Ecuador has followed the guidelines of the following documents published by the International Civil Aviation Organization (ICAO),:

Doc. 8168 / OPS / 611, Procedures for air traffic services, Operation of aircraft, vol. II
Doc. 9613 AN / 937, performance-based navigation manual (PBN)
Doc. 9931 AN / 476, continuous descent operations manual (CDO)
Doc. 9993 AN / 495, Continuous Ascent Operations Manual (CCO)
Doc. 9992 AN / 494 Handbook on the use of performance-based navigation (PBN) in airspace design.

The DGAC of Ecuador initiated this project with the Guayaquil airport and then we will continue working on the restructuring of the terminal control areas of the international airports of Manta and Latacunga and, in the medium term, in some of the country's domestic airports.

It is important to mention that we are developing this work hand in hand with the ICAO Regional Office of Lima, Perú in accordance with the strategic goals contained in the regional and global air navigation plan.

Egypt

Monitoring of Space Weather using the Global Navigation Satellite Systems (GNSS) at the Space Weather Monitoring Center (SWMC), Egypt

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Here we will introduce the Space Weather Monitoring Center research work on GNSS in the ionosphere group, activities related to GNSS applications, what are the instrumentations and tools we use to monitor the space Weather effect on ionosphere using GNSS, what is the past, current and future research work in our group related to the GNSS, what is the challenges, ideas and initiations in our Center towards Space Weather Awareness and capacity building.

France

Training on GNSS and Space Weather in Africa in the framework of a North-South scientific network GIRGEA

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In this article we present the work undertaken to teach and develop the use of GNSS for research. To achieve our goals, two ways are used:

- the technical way with the installation of instruments followed by the recording and the treatment of the observations, and the analysis of the positioning parameters which can be modified by the movement of the tectonic plates.
- the path of physics, which consists in understanding the physical processes acting in the Earth-Sun system at the origin of the disturbances of the GNSS signal such as scintillations.

We organize schools to train students to analyze the GNSS data of their country, we provide them software and then we supervise them in the framework of PhD so that they take a position in their country.

Germany

GNSS Technology and ICAO's "No Country Left Behind" Initiative Strategy for Nepal

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The No Country Left Behind (NCLB) initiative is the ICAO's efforts to assist states in implementing Standards and Recommended Practices (SARPs). The initiative helps states to maximize the socio-economic benefits of safe and reliable aviation. Besides, the initiative can also be linked to 15 of the 17 United Nations Sustainable Development Goals (SDGs). For example, it can improve accessibility to remote areas and therefore facilitating urgent access to sufficient food to all people all year around. Similarly, it facilitates the development of resilient infrastructure, promoting innovation and sustainable industrialization, by encouraging scientific research, and by upgrading the technological capabilities of the technology sectors. In this overall framework, GNSS has a big potential to support the NCLB initiative and linked SDGs.

Nepal Astronomical Organization (NASO) has led an initiative to bring together the related stakeholders to maximize the benefits of GNSS for Nepalese airspace in safe, affordable, accessible, efficient and resilient manner. The country has a very diverse geographical features ranging from flat plain area to the high Himalayan mountain range. The construction of roadways is still very difficult, costly and time taking. Air transportation is the essential and only means to reach far flung remote areas and its modernization has the potential to contribute to all four areas of development- human, economic, technological and sustainability. Unfortunately, civil aviation in developing countries like Nepal suffers from safety issues. The infrastructure required to maintain standard airspace management can be very expensive. The government and regulatory body operations required to provide adequate safety oversight are expensive as well. Civil aviation safety has not always been a high priority in the country with massive debt burden, basic health, poverty, and education

concerns to address. As a result, Nepal has failed to efficiently implement the applicable ICAO standards and is often under the air safety list issued by ICAO and European Commission. Despite facing several constraints, Nepal's aviation sector has been growing at a healthy rate. There is a huge task for the integrated, seamless and harmonized airspace/air route and Air navigation systems in place in light of the present and future requirement. The satellite based technology like GNSS has given an opportunity to improve the capacity, capability and safety and thereby maximizing the use of airspace to greater flexibility to aircraft operation.

As a platform to build capacity for national airspace modernization in support of NCLB, NASO is forming a working group dedicated to the aforementioned topic. Civil Aviation Authority of Nepal (CAAN) formulated a Performance Based Navigation (PBN) roadmap centered at the use of GNSS for a short term (2010-2012), medium term (2013-2016) and long term (2017-2025) plan. The progress has been slow, and as of now, Nepal has used GNSS only for one operation- RNP AR APCH at the Tribhuvan International Airport. One of the reasons for the slow progress is the lack of technology capability in satellite technology including GNSS. There is a need to develop a GNSS plan to identify capabilities that should be in place in order to meet the various requirements at each approval stage and perform the steps needed for implementation. The transition to GNSS represents a significant change for aviation, so it requires new approaches to regulation, provision of services and operation of aircraft. A successful transition to GNSS requires a comprehensive orientation and training program aimed at all involved parties. This programme should keep pace with the evolution of GNSS.

Therefore, a good competence in the field of GNSS to create a technical and operation team necessary to support future satellite based air navigation services should be developed. Table 1 indicates a five years planning proposed for the working group at NASO.

Table 1: Five years planning

Goals	**Short-term (1 year)**	**Medium-term (3 years)**	**Long-term (5 years)**
What opportunities will we offer?	Working group formation	GNSS recording and monitoring (in compliance with ICAO) demonstration	Evolve research group to provide air navigation services (CNS)
Who are the potential partners?	Training for Civil Aviation Academy of Nepal	Universities; research institutes; student involvement and research	Technology transfer to tech companies

Italy

Training Activities on GNSS Science and Applications: The ICTP - Boston College Partnership

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The paper describes the program of training activities carried out since 2006 under a partnership between the Telecommunications/ICT for Development Laboratory of the International Centre for Theoretical Physics of Trieste, Italy, (ICTP) and the Institute of Scientific Research (ISR) of Boston College, USA. This program had from the beginning the support of the International Committee of GNSS (ICG). In December 2006 a Workshop was held at the ICTP on "The future of Ionospheric Research for Satellite Navigation and Positioning: its Relevance for Developing Countries" being directors of this activity P. Doherty (ISR) and S. M. Radicella (ICTP). Forty-six scientists from sixteen countries from Africa, the Americas, Asia and Europe participated in the workshop. The main conclusion of the meeting was the importance of providing a series of workshop on different aspects of GNSS science and applications for the benefit of developing countries with particular emphasis on the effects of the ionosphere on GNSS operations. To respond to this requirement a partnership between Boston College and ICTP was established in 2009 and since then nine workshops have been carried out including the one of 2006. From 2009 these activities had the support of the ICG. This year the tenth Workshop will be held in Trieste from April 23 to May 4. The structure of the workshops will be described and the impact of these activities in the developing countries research and development in the field will be analyzed with particular emphasis on Africa.

Japan

Dangers of Spoofing and Anati-SPOOFING SOLUTIONS

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GNSS signals are vulnerable to spoofing due to its very low power and openly available technical information required to generate a signal. Today, low-cost software defined radios (SDR) are available that can be used to broadcast any GNSS signal for position and time spoofing. This is extremely dangerous and poses a big threat to numerous applications that use GNSS for position and time data.

Recently, we have already witnessed few cases of GPS spoofing in Black Sea. The danger of spoofing is that it is very hard to detect. There might have been many cases of intentional spoofing which we are not aware at all. Newly designed civilian GPS, Galileo, QZSS and Beidou signals do not have any protections against spoofing. However, many new applications like auto-driving, assisted driving and ITS infrastructures are all based on civilian GNSS signals only. Thus, without anti-spoofing mechanisms being installed such new applications will neither be secured nor safe.

In order to solve this problem of spoofing, we have developed anti-spoofing solutions based on QZSS satellites. This solution broadcasts a digital signature data generated from other GNSS signals using QZSS L1S, L5S or L6E signals in real-time closed loop. This methodology helps to provide anti-spoofing capability to already existing signals like GPS, Galileo or Beidou.

Latvia

CORS "LatPos" multipurpose State geodetic network

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The continuous operation of the base station system LatPos was established and installed in 2005 in Latvia. It served in majority the surveyors, using the RTK method to determine the coordinates of objects, with two centimeters accuracy. LatPos acts as a state geodetic network system, providing coordinates for the entire territory of the country. The Latvian Geospatial Information Agency maintains and develops the LatPos base station system and mainly uses it for preparation of cartographic materials for the needs of the State and local governments. Over time, the LatPos system has expanded up to 25 stations and it is used in all sectors of the economy: surveying, construction, agriculture, forestry and science. The LatPos system works continuously and accumulates measurement data that scientists can use to study continental drifts, solar activity and weather conditions. Real-time data is used for surveying and precision agriculture. In following time period, applications for precise control of unmanned aerial vehicles are planned. In order to improve the accuracy of geospatial data, future alignment of base stations with horizontal surfaces with geodetic marks is planned in order to allow aerial photography and laser scanning to be geodetically coupled directly with state geodetic network, without additional coordinate measurements. To improve real-time measurement techniques and measurements in difficult conditions, in built-up areas, the LatPos system will be improved to receive all Global Navigation Satellite Systems. The annual measurement of the LatPos system is a proof that system correction data is stable over a longer period of time. Test measurements have been performed for four consecutive years on the National Geodetic Points. These tests shows the stability of the LatPos system and the coincidence of coordinates with the classical geodetic network.

The use of GNSS technologies for the acquisition of geospatial data requires educated people. Riga Technical University in cooperation with the Vilnius Technical University (Lithuania) has launched a new training program on the acquisition and processing of high-precision

geospatial data - ”Innovative solutions in Geomatics’, to expand GNSS application use in Geographic Information Systems. Information is the basis for coordinating the position of objects and planning for technical objects, so the course provides basic knowledge on geodesy and coordinate systems. Modern data acquisition technologies have diversified - topographical surveying and laser scanning. The course includes the knowledge about computer technology of GIS systems. GNSS data acquisition and post-production in real-time RTK. Data processing software and getting results with the accuracy required. In order to ensure the geodesic knowledge, course includes the teaching of geodetic networks and characteristics. Classical data acquisition - measurement with total station and levelers. Accelerated data acquisition method - laser scanning. Remote data acquisition techniques from different methods. Satellite images and satellite data processing - the result of preparation systems. For GIS designing needs, map preparation, theoretical cartography and digital cartography. A separate section devoted to thematical cartography, the tourism industry. The widespread use of information is provided on the use of data architecture photogrammetry and 3D models in preparation. Master's thesis is an independent study on the student's current innovative geomatics topics may include innovative technologies and development of applications, the introduction of the possibility of approbation, methodology of analysis, research and development of regional as well as international level. Consistency with the European Higher Education Area Development Strategy and the European economic growth strategic framework allows both academic staff and students to be mobile and to increase knowledge and gain experience in one of the foreign universities, as well as providing full employment opportunities in a rapidly changing international work environment.

Mexico

Instrumentation and Capacity Building for Space Weather Activities: The Mexican Experience

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Efforts have been made in the last decade, throughout the world, to incorporate space weather into the agendas of developing nations. In Mexico's case, this process began with the modifications made to the Mexican General Law of Civil Protection in 2014, which includes space meteorological phenomena as a possible threat for the country. Based on this regulation, the Mexican National Centre for Disaster Prevention and the Mexican Space Agency have jointly worked on the creation of public policies on prevention, mitigation and restitution related to space weather events. On this date, the first Space Weather Working Group in Mexico was established.

It will be discussed how the working group seeks to create a network with the available infrastructure encompassing solar energy, interplanetary, geomagnetic and ionospheric observations, and how the Mexican Space Weather Service (SCiESMEX) collect and disseminate space-based meteorological data, products and services, respectively, for which the necessary tools for monitoring have been acquired; thus, it is able to issue warnings to different sectors related to radio communications that could be affected by the effects of Space Weather.

I will also show the national efforts made to encourage students to pursue a degree in space physics through their participation in educational activities organized by institutions and government agencies. Mexican expertise can contribute with valuable lessons for other developing nations planning to participate in activities related to space weather; and offer space meteorological data, products and services. Mexican expertise can contribute with valuable lessons for other developing nations that plan to participate in activities related to space weather.

Mexico

Challenges of GNSS in Mexico

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The presentation intends to provide a vision of the situation of GNSS in Mexico, current developments and Apps, as well as uncertainties and opportunities for its use, Currently GNSS is present everywhere in Mexico from smart phones to high accurate devises as differential GNSS stations for surveying and define the Geode model, or coupled with atomic clocks, provide timing and synchronization services required by several important activities, we do not forget to aviation that depends on WAAS to apply its optimal procedures in route and under approach. The territory is covered by the American augmentation satellite system, WAAS, five reference stations are installed across Mexico, giving in that way the opportunity to use the advantages offered through the equipment's that are enabled for this condition. The challenge is to enlarge the society use of applications available and develop the ones specific for their needs, in that sense there are still a list of task to be performed like stablish an official monitoring and a dissemination of information within Mexico of the conditions under the WAAS and GNSS service is provided in order to give certainty, and make available the information needed by developers of application, there are still a huge number of opportunities, and we have to analyze also how other GNSS system and a different SBAS or GBAS could enhance the utilization of all applications like autonomous navigation in land, earth and sea, in an early warning system or a synchronization network, it is also an opportunity to take part of the technology development in global basis.

Mexico

Capacity-building activities at CRECTEALC

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CRECTEALC is devoted to give courses, workshops and activities focused on building capacities on geographic information systems and remote sensing for processing, gathering and spreading geographic information useful to support and leverage activities and decision making related to conservation, sustainability, prevention and response to disasters, development and planning of human activities. Our activities include teaching, developing, participating in different congresses, conferences, meetings and projects focused on capacity building related to these topics. Most of our students come from a wide range of countries at Latin America. They are professionals who devote their work to any of these activities and they are here to enlarge their skills and knowledge in order to use them to leverage their work when they are back to their country. Our other activities include enhancing our relationships to diverse institutions and projects in order to cooperate and to strengthen our activities and spread out our work.

Mexico

Areas of opportunity for GNSS applications in large-scale projects in Mexico

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Mexico has a strong legal system and research network for the monitoring of its natural resources, water being the most prominent of all. But a good portion of its forest and fauna and flora species monitoring is still dependent on analog maps and limited surveys of small areas. Furthermore, the collection of data for many research purposes in forestry and preservation of the environment is limited by Mexico's extension (2 million square kilometers), multiple mountain ranges and systemic underfunding for extended surveys. This presentation aims to show potential areas of opportunity for GNSS applications to support sustainable economic and social development so as to encourage conversation and interest of peers and experts participating in the UN/Argentina on Workshop on GNSS Applications with the common aim of developing joint solutions for similar problems.

Mexico

Monitoring ionospheric perturbations during solar energetic events using GNSS data

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The ionosphere is a plasma region affected by different internal and external ways. The Sun activity over the Earth-ionosphere can be studied using GNSS data. This method uses a dual frequency signal between a ground base receiver and a satellite. When this signal penetrates the Earth´s atmosphere it has a delay which is proportional to the Total Electron Content (TEC) along the line of sight between a receptor and a satellite. Nowadays Mexico is working on different products like real-time TEC maps which will provide public information about the ionosphere conditions over all mexican territory using several ground-base stations with real-time data. In this presentation, I will talk about how the geophysics institute is working on the development of this products and its problems working with real-time data. In addition, I will present part of my analysis on ionospheric disturbances over mexican territory during 23 and 24 solar cycles using the USTEC code.

Morocco

CRASTE-LF's contribution in GNSS Capacity Building in African French-Speaking Countries

Anas EMRAN

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The African Regional Centre for Space Science and Technology Education-in French Language (CRASTE-LF) was established in Morocco on 23 October 1998 under the initiative of the UN Office for Outer Space Affairs (UNOOSA) programme in fulfillment of the UN General Assembly Resolution 45/72 of 11 November 1990 and 50/27 of 6 December 1995. The CRASTE-LF is based at the Mohammadia School of Engineers of the Mohammed V University of Rabat in Morocco. It was initially founded by 11 Member States, and subsequently joined by 2 others African countries in 2002 and 2004.

The CRASTE-LF is mandated to build capacities in space technology in the francophone African region. Its objectives are to increase knowledge in space sciences and technologies by organizing postgraduate and/or activities: short courses, seminars, workshops and conferences at regional level; improve the technical competence of experts, teachers and decision-makers and to keep them informed about technical progress; assist the countries of the region in the development of endogen capacities in space tools; strengthen local and regional capacities; promote cooperation between the developed countries and member states as well as among these states; and develop expertise in space sciences and technology. Since 2000, the CRASTE-LF has regularly organized post-graduate training in space science and technology over a period of two years, based on a study programme drawn up on specifications prepared by UNOOSA experts, with six options for the candidates, namely Remote Sensing and Geographic Information Systems, Meteorology by Satellite and Global

Climate, Satellite Telecommunications, Space and Atmospheric Science, Space Law and Satellite Navigation Systems (GNSS).

To date, the CRASTE-LF has organized 24 post-graduate training sessions for 368 trainees from 22 countries, and 56 international and regional activities, including post-graduate training workshops in 11 French-speaking African countries in collaboration with partners such as UNOOSA, ISESCO, CNES, NASA, ESA, and so on. These activities covered a wide range of topics related to Earth Observation and Space Technology, such as spatial information and sustainable development, climate change, disaster management and emergency management in Africa, etc...

Regarding GNSS, the CRASTE organized so far three post-graduate training sessions for 41 trainees from 8 African countries, and 6 activities on GNSS applications for 247 trainees from 19 African countries. More scientific events are scheduled for 2018, including two regional short-courses in GNSS applications. The first activity is supported by the Regional Centre for Space Science and Technology Education in Asia and the Pacific (RCSSTEAP - China), is planned in Rabat in April 2018. The second is organized in collaboration with ISESCO and the Joint Program Office (JPO- Egnos Africa), is scheduled to Ouagadougou (Burkina Faso) in July 2018.

Paraguay

Very Small Aperture Terminal Sub-System

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The purpose of the VSAT Subsystem (SSVSAT) is to establish a Digital Network with interconnection between nodes for voice and data, based on the use of one of the available geostationary orbit communications satellites.

It is a flexible network, mesh type, that uses an MF-TDMA (Multi-Frequency - Time Division Multiple Access) technology, capable of increasing the Subsystem bandwidth in wide margins, without the need to increase hardware.

The System is based on the implementation of a mesh network without HUB, in order to interconnect all the stations that are part of the program SDMT (System of Transmission Media) of the DINAC, composed of 6 stations, located in the following sites; Silvio Pettirossi International Airport (AISP), Guaraní International Airport(AIG), Mariscal Estigarribia Airport, Concepción Airport, Bahía Negra Airport, The Node of San Juan Bautista de Misiones

Paraguay

GNSS technologies integrated to high altitude ballon payloads and other research applications as a tool for STEAM education in Paraguay

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The aim of this presentation is to give a description of one of the current GNSS technology application activities in Paraguay. In this particular case, GNSS was integrated to a High Altitude Balloon (HAB) Payload. Main purpose of these activities is to support STEAM education in rural communities by encouraging students to design, build, test, operate and data process HAB Payloads. This was effectively achieved through GNSS technology since the recovery of this type of stratospheric Payloads were critical. Open source hardware were utilized to obtain data from GPS module. The learning of fundamentals of this type of technology as well as, the study of the state of the art, the wiring of this module to a microcontroller board, the decoding programming to interpret positioning data were all valuable learning experience to students. As a result of the success of this program, in supporting STEAM education, made the local government initiate the process to include Space Education as part of the curriculum initiatives. In addition, other research projects lead by researchers in the higher education in Paraguay are actively utilizing GNSS technologies as part of their research tools. One of the most relevant case is the research on "Using infrared

photoelectric sensors for automatic detection of reinfestation by Triatoma infestans." This work consisted of a monitoring system based on a wireless sensor network to achieve remote detection and real-time localization of the presence of Triatoma infestans and other triatomines in domestic and peridomestic areas.

Paraguay

Genesis of the Paraguayan Space Agency: a historical review

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It is presented here the origins of the Paraguayan Space Agency (AEP). This is the first step towards the establishment of a government agency to promote space related activities in Paraguay. The historical review starts in 2014 from the official creation by the Paraguayan congress and later, in 2017 by the executive order to define the organizational structure of AEP.

Currently, the AEP is involved in more than 20 projects, relating but not limited to, space education, nano satellite developments, industry participation, entrepreneurship, space applications, international cooperation, research with academia and community outreach.
In addition, results of all space programs aimed to support space education is presented.

Peru

Space Weather and Conventional Weather for Civil Aviation in Low Latitude

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This article tries to discuss a technical point of view of the effects and/or forecast of the space weather and conventional weather (climate) for civil aviation in Low Latitude or Equatorial Region like Peru where the Geomagnetic Equator is, and by extension to the region of South America (SAM), taking into account the following [1], [2], [3], [4], [5], [6], [7]:

-Peru (Lima) is the center of Equatorial Region (Low Latitude - Southamerica), which is hostile for the GNSS signals.
-There is a continuos study of the scintillation and TEC effects.
-The scintillation can seriously affect the continuity and availability of GNSS.
-The effects of conventional weather/climate happen in the Troposphere up to 12 km approximately.
Taking into account phenomenon like electrical storms, turbulent, fog/blizzards, wind-shear
-The effects of space weather happen in the Ionosphere from 60 to 600 km approx. Taking into account phenomenon like solar cycle, solar storms and equatorial anomalies.
-Cost - benefit analysis

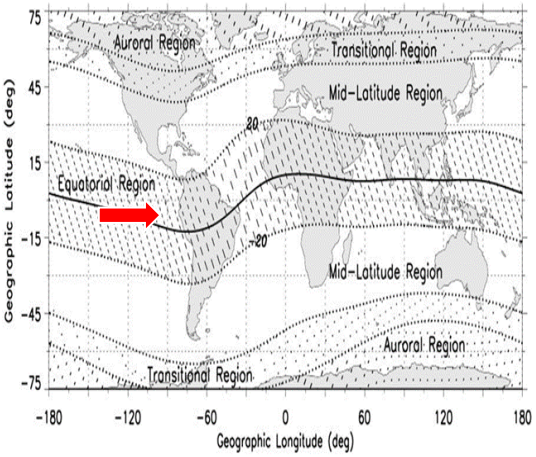

Figure 1. Geomagnétic Equator (+/- 20 grades), courtesy of NOAA

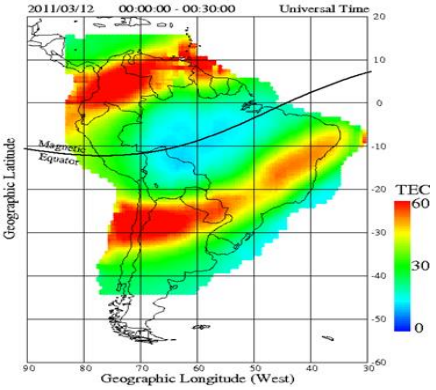

Figure 2. TEC generates delays, measurements made by LISN (Low-latitude Ionosphere Sensor Network) – Courtesy of Boston College

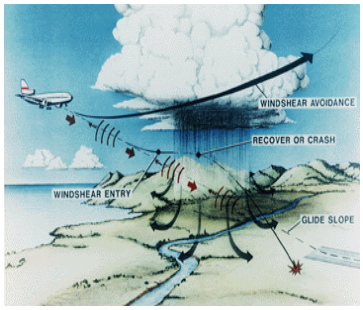

Figure 3. Windshear

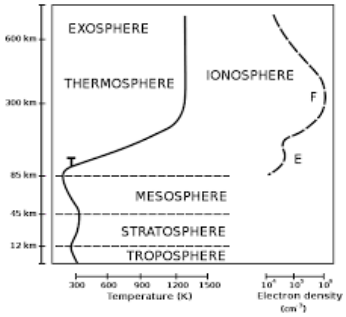

Figure 4. Atmospheric structure, courtesy of Wikipedia

Acknowledgements:

Sources courtesy of: CORPAC/ICAO/BOSTON COLLEGE/FAA/DECEA/NOOA

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Spain

GNSS education and promotional opportunities A vision from Spain

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An outlook about the emerging different opportunities already available to students, entrepreneurs, and to the general public, with the vision from this target public and in particular from the point of view of Spanish and Latin-American stakeholders.

Local, regional, national, and European initiatives promoting the use of GNSS applications in different manners like courses, workshops, competitions, startups' incubation, and mentoring services are being deployed each year and are reaching a more general public with fewer resources but with great ideas. Cases are explained.

Thailand

GICGNSS: A university data and post-processing hub for GNSS

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Due to lack of easy post- processing services for GNSS data most of the researchers and user are having trouble to use precise positioning services. Users have to spend lot of time to search for the base data and use very sophisticated software for processing as well. Most of the users/researchers are not handy with scripting and automation, which make post-processing technique more complicated. To overcome this problems of GNSS post-processing we have developed the system that can automatically find the suitable base station (CORS station) and process the data based on user requirement then give complete positioning solution. User can download RINEX data of GIC CORS station at Geoinformatics Center, Asian Institute of Technology (we are communicating for more universities to provide their data as well) from our web interface. Users will also be able apply for NTRIP services using same web application.

When system get the Rover RINEX observation data (from user) then based on the tentative location of observation station an automated system search for nearest CORS station on FTP and download the base observation and navigation data on Apache server. Modern web server are capable to run the python script using CGI. We are using AJAX call from the web interface to the python script and script in the backend will run RTKLIB software using command line to generate the position solution for static, Kinematic and single point positioning. For PPP solution, system will search for the published Orbit and Clock products and based on those data RTKLIB will produce the position solution. There is a separate algorithm written in Python for Co-ordinate transformation using 7-parameter and Molodensky method, which will run as per user requirement. User will get the final report of

position solution in both ITRF and their selected local coordinate reference frame. From the positioning solution provided by RTKLIB system will prepare a report in both coordinate format (ITRF and Local) and send to user via email. In different Tab, users can apply for the real time positioning using NTRIP Access.

Turkey

GNSS Applications in Turkey

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In today's world, global navigation satellite systems has become essential for economy, security, technology and scientific applications. Based on the requirements of specific applications, regional systems are also introduced to increase the performance, availability and stability of these systems. The increasing need for and utilization of position, velocity and time (PVT) information for various applications increases the dependency to these systems. In addition, integration of PVT solutions on hardware has also become more practical through advanced integrated circuit technologies. We, the Space Technologies Research Institute (TUBITAK UZAY), are leading the development, integration, tests and operations of national space systems in Turkish Republic. In addition, our institute also specializes on data processing for remote sensing applications which completes our experience in life-cycle of a space system. In our development case, we have been developing multi frequency multi constellation GNSS receiver for our IMECE satellite for 2 years. In this receiver, we have solid requirements based on accuracy of position, velocity and time. As being user of GNSS, we have real-time applications like raw measurement generation, PVT generation and post-processing applications like orbit determination, mission planning. Real time applications basically require the PVT information and high accuracy onboard time synchronization. On the other hand, ground applications require high accuracy orbit information for payload data processing, orbital analysis, satellite tracking as well as mission and operations planning. While most of the applications require PVT information with moderate accuracy, high accuracy orbit information requires the generation and collection of raw measurements for orbit information through the processing of GNSS signals. These measurements include the code phase, carrier phase, integrated doppler or doppler as well as the information, such as ephemeris, encoded on the GNSS signals. Therefore, quality, content and availability of these

signals are driving factors for the accuracy and performance of real time and ground applications. In this manner, we have developed the use cases and specific requirements for both real time and ground applications related to space systems operations. In addition, we have transformed our role from being a GNSS receiver user only to a developer also by initiating the development of a spaceborne multi-constellation multi-frequency GNSS receiver. Through these studies, we identified the functional, design and performance requirements for both utilization and development of GNSS receivers. In this workshop, we will present these use cases which include the PVT and orbit information generation methods and evaluate the specific requirements on the utilization of GNSS signals.

Venezuela

Supporting GNSS Applications in Latin America through SIRGAS reference frame

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SIRGAS (Geocentric Reference System for the Americas) is the regional densification of ITRF (International Terrestrial Reference Frame) for Latin America. Since 1995 it provides to user community the possibility to satisfy requirements of stable and consistent reference frame for precise positioning based on GNSS (Global Navigation Satellite Systems) supporting wide number of technical and scientific applications inside geosciences branch. This is possible due to highly accurate geodetic network establishment, formerly passive and nowadays well defined and consolidated as continuously operating network called SIRGAS-CON (SIRGAS Continuously Operating Network), it is integrated by 400 GPS (Global Positioning System) and GLONASS (Global'naya Navigatsionnaya Sputnikovaya Sistema) tracking stations. In this sense, remarks must be done about participation level of Latin America countries which gradually have been modernizing their geodetic infrastructures, and so, densificating the continental reference frame to make it more accessible in practice. Besides, it is evident product coming from international cooperation demonstrated by SIRGAS and its Analysis Centres, to present under an organized work and a constant temporal basis, those results in terms of coordinates and velocities for every station belonging to the network. Inside this context, this contribution shows a landscape of SIRGAS-CON evolution, current status and advantages for GNSS implementation in the region.