NEWSLETTER

ISSUE 4
May 2019
Project Coordinator Dr Marcio H.O. Aquino

WELCOME TO THE 4th EDITION OF THE TREASURE PROJECT NEWSLETTER!

Marcio H.O. Aquino Coordinator of TREASURE

Having passed its mid-term review with flying colours, TREASURE is now full steam ahead on its second and final term. And it all started very well with a team including four TREASURE fellows winning the Galileo App Competition 2018/2019. Here is how the story goes.... In November 2018, TREASURE ESRs Jon Bruno (ESR2), Dimitrios Psychas (ESR9), Francesco Darugna (ESR10) and Lotfi Massarweh (ESR13) joined forces with Jin Zhao, a Human-Computer Interaction Master student of the University of Nottingham to form team O ThiSa-VRoS (Greek word for TREASURE) to enter the 2018/2019 ESA sponsored Galileo App Competition (https://www.gpsworld.com/esa-launches-new-galileo-app-competition/)... [read more]

SHORT ARTICLES

• GNSS Based Ionospheric Tomography and SSR High Accuracy Positioning

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Jon Bruno ESR2 and
Francesco Darugna ESR10

[read more]

EXPERTS VOICE

Realistic Simulation of Ionospheric Scintillation in GPS Signals for Robust PNT Testing

Ionospheric scintillation of radio signals is the rapid fluctuation of amplitude and phase of the signal caused by diffraction and refraction processes as the signal propagates electron density gradients in the ionosphere. The impact of scintillation in GNSS signals is generally observed at the tracking stage of a GNSS receiver, where the rapid amplitude/phase fluctuations of the signal disrupt the receiver's tracking capability...

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Marcio H.O. Aquino
University of Nottingham
Nottingham Geospatial Institute

FROM THE COORDINATOR

Toulouse, 2nd TREASURE workshop.

Having passed its mid-term review with flying colours, TREASURE is now full steam ahead on its second and final term. And it all started very well with a team including four TREASURE fellows winning the Galileo App Competition 2018/2019. Here is how the story goes.... In November 2018, TREASURE ESRs Jon Bruno (ESR2), Dimitrios Psychas (ESR9), Francesco Darugna (ESR10) and Lotfi Massarweh (ESR13) joined forces with Jin Zhao, a Human-Computer Interaction Master student of the University of Nottingham to form team O ThiSaVRoS (Greek word for TREASURE) to enter the 2018/2019 ESA sponsored Galileo App Competition (https://www.gpsworld.com/esa-launches-new-galileo-app-competition/). The task was to design, develop and test a real-time satellite-based positioning smartphone application able to provide a position and time fix exploiting GNSS raw measurements. To cut a long story short, team O ThiSaVRoS developed the GADIP3 (GNSS Android-based Dual-frequency Iono-estimated Precise Point Positioning) app, which went all the way through to the finals of the event that took place on 18 April 2019, and, amazingly, went to receive the winner's award in the whole competition! Well done to team O ThiSaVRoS!

Toulouse, 2nd TREASURE workshop.

Another milestone of the project was completed just recently with the second TREASURE workshop, "A response to user needs in PPP and RTK", which took place 21-22 May 2019 in Toulouse, France. The workshop was locally organised by TREASURE partners Noveltis SAS and aimed primarily to allow the TREASURE fellows to expose their latest research outcomes and gather feedback from within and outside the project's network. In addition to the presentations by all TREASURE fellows, a number of relevant invited speakers internal and external to the TREASURE consortium kindly provided insight on different aspects of the project, covering the technical and the business sides of real time high accuracy GNSS positioning and applications. In particular we had the pleasure to host talks by Joanna Rupiewicz (ESSP SAS) on the

"TechTIDE project: how technology can support space weather applications", Flavien Mercier (CNES) on "LEO satellite GPS-derived orbits with integer ambiguity fixing in zero difference mode", François Fund (GEOFLEX) on "Industrial perspective on PPP services", Paul Bhatia (UNOTT/GRACE) on "Business and IP issues in the context of the TREASURE project", Michal Babacek (GSA) on "Market and business aspects of precision agriculture" and Victor dos Santos (Toulouse Business School) on "Emergence of high technology markets: the case of space business ".

The attendance to the workshop was excellent, with a total of 45 enthusiastic participants, who made the discussions and networking all the more relevant with their diverse background, ranging from professional GNSS positioning to business, applications and marketing. We also for the first time offered a number of bursaries to students and researchers external to TREASURE, based on a selection made by a committee set up by the project, with the decision supported by the assessment of the applicants' one page CV and their one page personal letter explaining why they wanted to participate and what benefits they expected from the workshop. Through this process we were lucky to have the participation of three young scientists from Wuhan University (China), University of Burdwan (India) and University of Bath (UK). More importantly, from the coordinator's perspective, the workshop demonstrated clearly that all TREASURE fellows are at the top of their game on their research! Our next open event will be the third TREASURE school to be held in Torino, Italy, early in November 2019. Keep an eye on the project website for the latest information about this event, titled "State of the art EGNSS high accuracy positioning: what can Galileo bring to the table?", and which will focus on the forthcoming Galileo FOC and its potential impact on high accuracy GNSS positioning.

I hope you enjoy the articles of our May 2019 newsletter!

Toulouse, 2nd TREASURE workshop.

SHORT ARTICLES

GNSS Based Ionospheric Tomography and SSR High Accuracy Positioning

Jon Bruno and Francesco Darugna are Early Stage Researchers (ESRs) under the Horizon 2020 Marie Skłodowska-Curie TREASURE project. Jon is a PhD candidate at the University of Bath, UK. His research is mainly focused on ionospheric physics, with a special interest in its effect on Global Navigation Satellites System (GNSS) positioning. Within TREASURE, he is part of the Work Package 1, responsible for providing accurate and real-time ionospheric corrections for precise positioning. Francesco currently works at Geo++ GmbH and is a Ph.D. candidate at the Leibniz University of Hannover, Germany. His current research mainly focuses on state space modelling of atmospheric influences and the impact on high accuracy Global Navigation Satellites System (GNSS) positioning.

• Multi-constellation ionospheric tomography

With the recent addition of Galileo, four fully operational GNSS are now available, increasing the number of navigation satellites orbiting around the globe to more than 70 and providing a global network of multi-GNSS receivers available for the scientific community. This has shown great improvements for different solutions, such as Positioning, Navigation and Timing (PNT) applications and Earth monitoring techniques. Many GNSS precise positioning algorithms, such as Precise Point Positioning (PPP), rely on precise ionospheric corrections, the main error source in GNSS because it introduces a distortion when the signal travels through it. The ionosphere is mainly created by the interaction between the Sun's electromagnetic emissions and the Earth's atmosphere. It changes both spatially and temporally and is influenced by changes in solar emissions, atmospheric dynamics and the interplanetary and geomagnetic fields. Free electrons within the ionosphere affect electromagnetic waves by refraction, and the effect varies with the frequency of the wave. This property makes dual-frequency GNSS signals ideal for ionospheric sensing. Using a GNSS receiver network recording observations of phase and time delay of each signal, the Total Electron Content (TEC) along each satellite-receiver ray path can be derived and used to investigate ionospheric properties. The imaging technique called Computerised Ionospheric Tomography (CIT) uses these TEC measurements from satellite to receiver, obtained from GNSS dual frequency observations, to create three-dimensional electron density images. TEC measurements are susceptible to different error sources, such as satellite and receiver biases, so the use of them in tomographic imaging requires some process of calibration. One of the key issues of GPS ionospheric tomography is the lack of data due to poor satellite and receiver coverage over the area under study. With the addition of GLONASS and Galileo satellite constellations into the ionospheric imaging algorithm, this problem is reduced, as shown in Figure 1. The inversion algorithm known as the Multi-Instrument Data Analysis System (MIDAS), property of the University of Bath, is used within TREASURE to create ionospheric electron density maps to aid GNSS positioning. These 3-dimensional images represent the ionospheric electron density, which allows obtaining accurate satellite-to-receiver delays with the main goal of correcting the errors the ionosphere introduces in the GNSS observations.

The expertise gained during these years within TREASURE, combined with his previous software engineering experience, gave Jon the opportunity to participate in the ESA Galileo App competition 2018/2019.

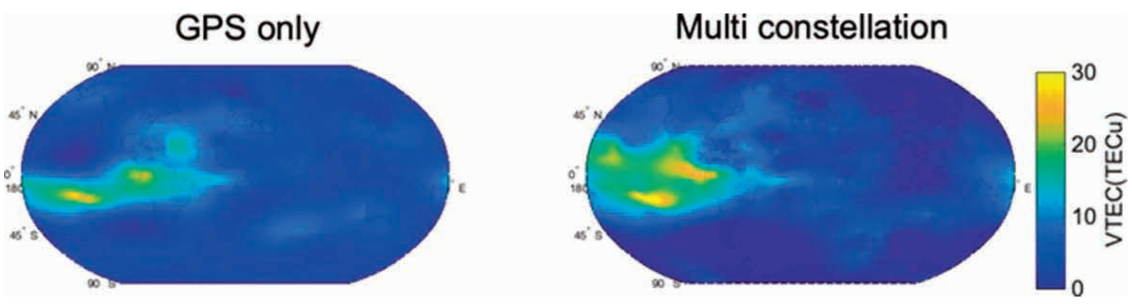


Figure 1. GPS-only vs GPS-GLONASS-Galileo ionospheric maps.

• State space modelling of atmospheric influences on GNSS measurements and the impact on high accuracy positioning

Recently, the demand for satellite-based positioning solutions has become increasingly significant for many applications: from agriculture to automotive industry. GNSS observations, e.g. pseudorange and carrier-phase, are used to compute user positions. Whilst both observations are affected by different error sources, e.g. the passage through the atmosphere, only the carrier-phase has an ambiguous nature. The resolution of this ambiguity is a key factor to reach fast and high precise GNSS-based positioning. Real-Time Kinematic (RTK) is a carrier-phase differential technique used to compute real-time cm-level user positions by considering a close reference station and reliably solving the phase ambiguities. However, this technique is strongly influenced by distance-dependent errors, like atmospheric effects. In recent years, many reference station networks have been set up, enabling GNSS services that can provide a state vector of corrections to the user to perform precise point positioning (PPP). The state of each error component can be estimated in real-time using GNSS observations from the network. Among others, distance-dependent GNSS effects are computed and the user, receiving the complete state information, is capable to do ambiguity resolution achieving RTK accuracy level and enabling so-called PPP-RTK. So far, the GNSS corrections are sent to the user as described by the worldwide accepted RTCM standards. In order to provide the corrections, the error states are represented in a mathematical and consistent way, i.e. the so-called State Space Representation (SSR). Atmospheric parameters computed by a reference network need to be interpolated for the user location. The quality of this interpolation is investigated along with the propagation of the errors from the state modelling at the network level to the user application in terms of ambiguity resolution and positioning performance.
The use of external information, e.g. numerical weather model (NWM), has been investigated to improve the interpolation, especially during severe weather events. Furthermore, the user needs to know how to apply the RTCM-SSR corrections. A demonstrator has been developed in the Python programming language, aiming to provide a useful tool for decoding RTCM-SSR messages and translating them into Observation Space Representation (OSR). The RTCM-SSR Python demonstrator provides a framework to elaborate messages for the use by other TREASURE modelling work packages, i.e. WP1, WP2 and WP3. Figure 2 describes the possible data flow of correction messages, which provide residual information used for an observation weighting scheme by the positioning algorithm.

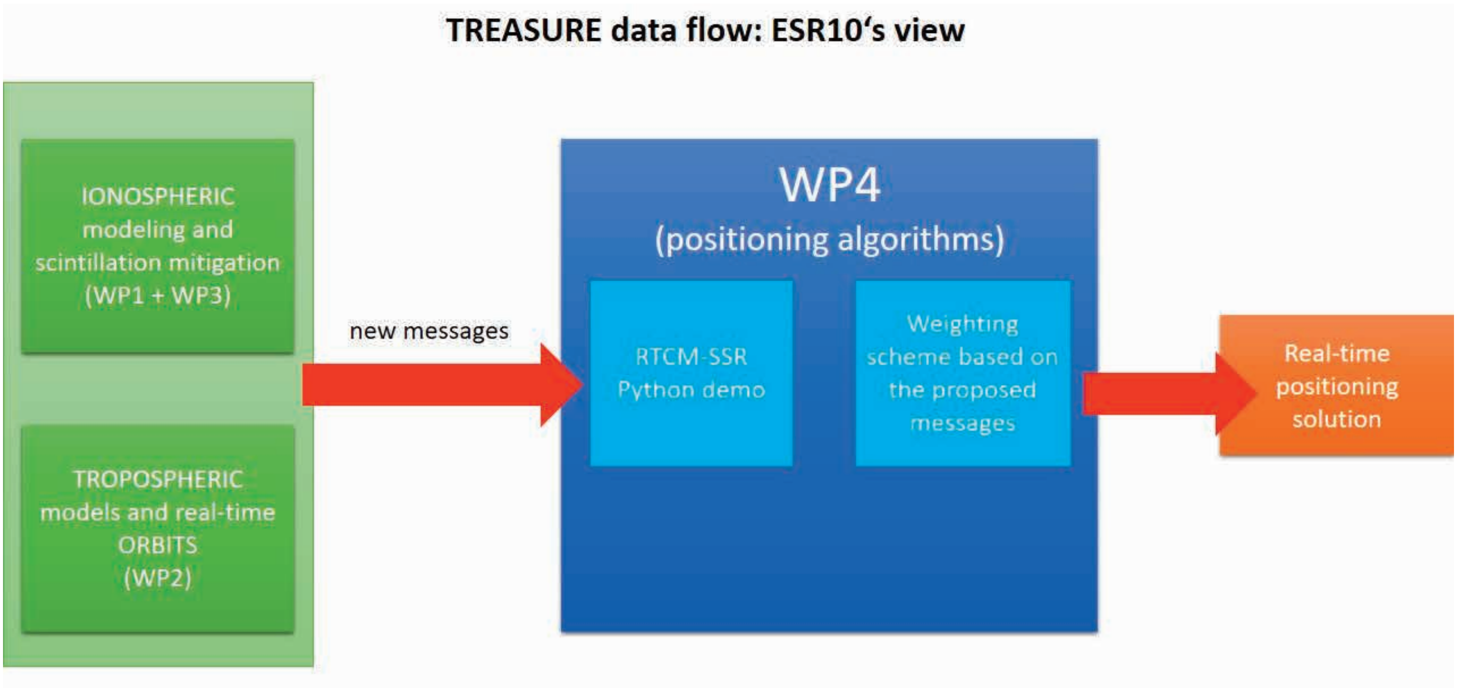


Figure 2. ESR10's view of the data flow of new messages fed into the positioning algorithm. A weighting scheme based on the WP1-3 information messages can be considered.

In the last two years, a new specific GNSS-user application came up: the use of GNSS raw data from Android devices for precise positioning. The access to smartphone raw data allows to investigate the performance of mass-market low-cost GNSS receivers, which, however, are continuously under development. The dynamic nature and the increasing number of potential applications led to start exploiting this technical innovation within the TREASURE project. The quality of smartphone GNSS measurements has been analysed for RTK and PPP-RTK applications. GNSS-based smartphone applications are a challenging framework where the atmospheric analysis and application of SSR corrections can be further evaluated. Moreover, the interest in this topic gave Francesco the opportunity to be part of a group of TREASURE ESRs that successfully participated in the ESA Galileo App competition 2018/2019.

• Galileo APP Competition 2018/2019

In September 2017 Broadcom released the first GNSS dual-frequency chipset BCM47755. One year later Xiaomi employed it, making the Xiaomi Mi8 the first

Figure 3. The O ThiSaVRoS team, winner of the Galileo App Competition 2018/2019 at ESA's ESTEC technical centre in Noordwijk, the Netherlands.

world's smartphone allowing the use of GNSS raw data from a mass market receiver. In November 2018 four TREASURE ESRs decided to build a team to participate in the Galileo App Competition 2018/2019. Together with Jin Zhao, a Human-Computer Interaction master student of the University of Nottingham, Jon Bruno (ESR2), Dimitrios Psychas (ESR9), Francesco Darugna (ESR10) and Lotfi Massarweh (ESR13) formed the O ThiSaVRoS (TREASURE in Greek) team and applied to the competition. The main objective of the competition was to design, develop and test a real-time satellite-based positioning smartphone application able to provide a position and time fix by using GNSS raw measurements. The dual-frequency data was directly extracted from a Galileo-enabled chipset (BCM47755) and used in a multi GNSS scenario. Through three milestones, where the progress in the app development has been checked by the ESA Technical Advisory Team, the top five apps have been selected to attend the final. The final took place on the 18th of April 2019 at ESA's ESTEC technical centre in Noordwijk, the Netherlands, where the proposals have been evaluated by a jury consisting of representatives from ESA, GSA, the EC and Google. The app developed by the O ThiSaVRoS team is GADIP3 (GNSS Android-based Dual-frequency Iono-estimated Precise Point Positioning), the user-driven app on the edge of GNSS technology. One of the main features of this app is to provide a GNSS positioning framework for everyone, from the common user who wants to check their position on the map to the researcher who wants to have a feeling of the estimated ionospheric delay. Furthermore, the modularity concept, which it is built on, allows user-friendly and easy selection of several options, e.g. choosing the constellation and/or the frequency to use. Thanks to its features and showing the best positioning performance carried out by ESA in the test, GADIP3 was selected as the winner app of the Galileo App Competition 2018/2019. The O ThiSaVRoS team won the first prize (see Fig.3) and will, therefore, attend the SA & EC International Summer School on Global Navigation Satellite Systems in Portugal.

The Galileo App Competition has been an amazing experience, giving the opportunity to the ESRs to challenge themselves and improved their skills in GNSS raw data measurements and in working together as a team. Furthermore, it was a great opportunity to get in touch with experts in the positioning and navigation world, from both, a scientific and commercial point of view. GADIP3 will be soon available on the Google Play Store and it is continuously under testing and development.

The next release of the GADIP3 app will provide a PPP solution with the application of RTCM-SSR corrections retrieved via NTRIP, being one of the most innovative smartphone-based positioning apps.

Jon Bruno ESR2
Francesco Darugna ESR10

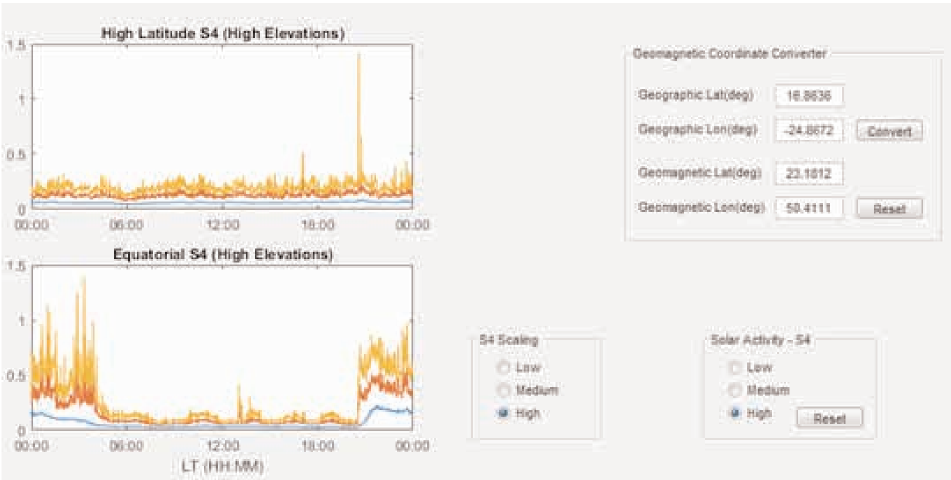
EXPERTS VOICE

Realistic Simulation of Ionospheric Scintillation in GPS Signals for Robust PNT Testing

Ionospheric scintillation of radio signals is the rapid fluctuation of amplitude and phase of the signal caused by diffraction and refraction processes as the signal propagates electron density gradients in the ionosphere. The impact of scintillation in GNSS signals is generally observed at the tracking stage of a GNSS receiver, where the rapid amplitude/phase fluctuations of the signal disrupt the receiver's tracking capability. This leads to a loss of signal lock, causing degraded reliability (accuracy, availability and integrity) of the position, navigation and timing (PNT) solution of the GNSS receiver. Scintillating GNSS signals are a major concern for safety critical applications such as aviation, and precise point positioning (PPP) applications, both of which require high availability, integrity and accuracy of the PNT solution. A well-known method of measuring the strength of amplitude scintillation is by using the S4 index, which is the normalised standard deviation of the received power over a specified duration of time (usually 60 seconds). Phase scintillation is measured using σ_φ, the standard deviation of the signal's carrier phase, φ, which is also performed over a specified time period, usually over 60 seconds. The highly dynamic nature of ionospheric scintillation, and its dependency on the satellite geometry, receiver location and time of day/year, result in a given receiver experiencing scintillation effects unique to its time and location. These properties of ionospheric scintillation mean that the combination of real scintillation signatures and empirical data are more likely to represent realistic conditions than the traditional empirical approach on its own. The Scintillation Strength Indicator (SSI) software discussed here simulates ionospheric scintillation scenarios by combining

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
90	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
80	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
70	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
60	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
20	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
10	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-10	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
-20	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
-30	0.71	1.14	0.40	0.65	0.32	0.12	0.11	0.13	0.07	0.11	0.15	0.12	0.07	0.10	0.16	0.09	0.13	0.12	0.09	0.11	0.10	0.61	0.49	0.44
-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-60	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
-70	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
-80	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17
-90	0.22	0.25	0.33	0.17	0.19	0.19	0.11	0.28	0.19	0.22	0.19	0.17	0.17	0.22	0.17	0.22	0.19	0.17	0.25	0.17	0.25	0.28	0.22	0.17

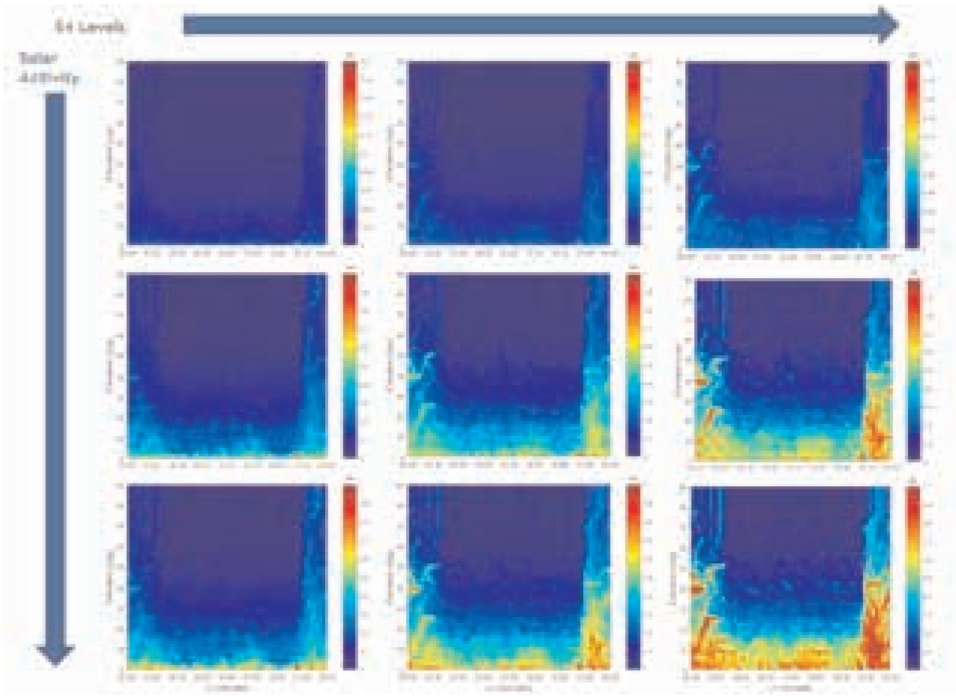
(a)



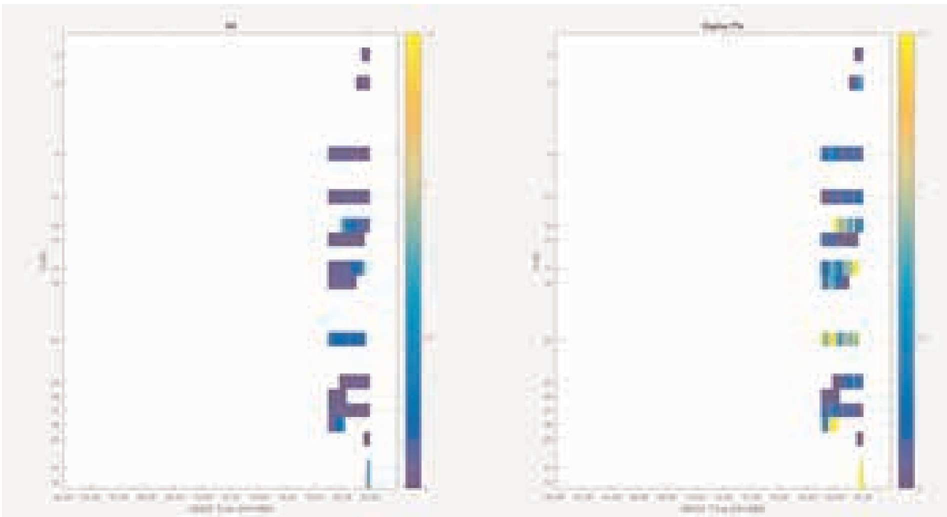
(b)

Figure 1. User interface of the first stage of SSI showing the S4 and σ_φ grids, scaling factors for scintillation intensity and solar activity, and graphics to represent the scintillation strength with LT. (a) Magnified S4 grid for clarity. Rows represent geomagnetic latitude and columns represent local time. (b) Magnified image of the models implemented in the three S4 scaling levels for high solar activity. Similar features are available for σ_φ as shown in the full user interface in (a).

empirical modelling of scintillation strengths for varying elevations with real scintillation signatures extracted from measured GPS signals. The technique can be considered in three stages. The first is the modelling of amplitude and phase scintillation strengths – S4 and σ_φ – for a given location. The models are developed empirically using historical GPS L1 data for high elevation satellites, collected at Cape Verde and Tromsø, Norway for the period 2004-2012. Nine models are developed for amplitude and phase scintillation separately to allow the simulation of a combination of three scintillation intensity levels (low, medium and high) at three solar activity levels (low, medium and high). The empirical models are implemented within a grid of geomagnetic latitude (vertical axis) and local time (horizontal axis) [Figure 1]. The grid has a resolution of 1° x 1 minute (geomagnetic latitude x LT) and is editable to enable the default models to be modified or to enable the upload of user-defined scintillation models.The second stage of the process is to map the latitude-LT scintillation grids to each satellite in-view of the location. The instantaneous position of a given satellite is used to identify it's Ionospheric Pierce Point (IPP) on the grid to obtain the respective scintillation strengths for each satellite. The scintillation values obtained for each signal are then scaled according to the elevation. The scaling factors are derived empirically from the distribution of scintillation strengths with elevation observed in the dataset [Figure 2a]. The variation in the scintillation strengths as the satellite moves in its orbit throughout the scenario is considered in the software by processing the satellite and receiver position at each timestep of the simulation. The scintillation strengths experienced by each satellite throughout the scenario are then displayed graphically as guidance for the user [Figure 2b]. The final stage of synthesizing realistic scintillation events is the application of real, pre-recorded raw amplitude and phase scintillation profiles to the satellites-in-view during the event scenario.
The profiles are extracted from the same 50 Hz raw datasets of Cape Verde and Tromsø using established methods described in past literature: Amplitude perturbations are derived by normali-



(a)



(b)

Figure 2. Modelling of satellite-specific scintillation strengths. (a) The nine empirical models developed for S4 based on Cape Verde and Tromso data. The vertical axis of each model is the elevation, and horizontal axis represents LT. (b) Satellite-specific scintillation for a specific scenario, based on the elevation, time of day, scintillation intensity level and solar scaling. The latter two values are from stage 1 of SSI.

zing the scintillating signal intensity to the mean received intensity; phase scintillation is extracted from the received carrier phase by de-trending the signal using a 6th order high-pass Butterworth filter. Scintillation profiles for GPS L2 and L5 signals are derived from L1 data through mathematical relationships established in literature. A range of profiles are made available to the user, which can be applied to amplitude and/or phase independently. The user is also able to select which satellites experience scintillation in the scenario that provides maximum flexibility in simulation settings. The software was validated by comparing select events from captured live-sky data with simulations of scintillation conditions that would be most representative of those events. Results show that the scintillation strength profiles of true events are well represented by the simulations, particularly in equatorial regions. Overall performance statistics show a ±0.2-unit accuracy for S4 and σ_φ model for >90% data, where satellite elevations are above 20 degrees; below which signals generally experience a multipath rich environment. The SSI approach to simulating ionospheric scintillation addresses many of the limitations associated with the development of a standardised test framework capable of simulating scintillation threats applicable to GPS-based systems. This technique allows the generation of realistic scintillation scenarios for any given time and location, which can then be translated into GPS RF signals through a Spirent simulator – thus enabling a flexible test framework for ionospheric threats in GPS-based systems. Extension of this simulation capability to other Global Navigation Satellite System (GNSS) signals is planned as a future activity.

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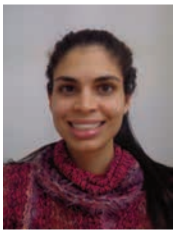
news

The 3rd TREASURE school will be held in Torino, Italy, 4 - 8 November 2019, with focus on the topic: "State of the art EGNSS high accuracy positioning: what can Galileo bring to the table?"
We all know for some time now that Galileo will challenge the existing satellite navigation systems, especially regarding the expectation of higher performance standards. But which features can be actually exploited in real life applications that demand real time high accuracy positioning, such as in the field of precision farming for example?
With that in mind, the program of the school will start from an extensive overview of the new features of Galileo that represent the real differentiators with respect to the other systems: the new High Accuracy Service (HAS) and the authenticated signals. But that is not all, the school will also offer an opportunity to students to get familiarized with modern implementation of user receivers, as well as with the booming field of integrated receivers, exploiting technologies such as INS, Vision, COM signals, in addition to GNSS.
The school will be delivered through lessons taught by top researchers on the different topics, and will also include hands-on and teamwork activities. In the framework of the TREASURE project, the school is locally organized by the Navigation, Signal Analysis and Simulation of Politecnico di Torino, with the support from the Politecnico Interdepartmental Center for Service Robotics – PIC4SeR, which is working on the application of automated drones for precision farming. Further information on registration will be on the website soon, so stay tuned to learn how to join us at this open to all event!

UPCOMING EVENTS

EVENT	WEBSITE	DATE	LOCATION
9th ICL-GNSS, INTERNATIONAL CONFERENCE ON LOCALIZATION AND GNSS 2018	http://www.icl-gnss.org/2019/	04-06 June 2019	Nuremberg, Germany
HORIZON EUROPE WORKSHOP	https://www.gsa.europa.eu/newsroom/news/have-your-say-horizon-europe	04 June 2019	Prague, Czech Republic
INTERNATIONAL PARIS AIR SHOW	https://www.siae.fr/en/	17-23 June 2019	Paris, France
3RD SPACE, NAVIGATION AND ROBUSTNESS WORKSHOP	http://www.navspace.org/	18 - 19 June 2019	Venice, Italy
GNSS RAW MEASUREMENTS TASKFORCE WORKSHOP	https://www.gsa.europa.eu/gnss-raw-measurements-taskforce-workshop	26 June 2019	Prague, Czech Republic
27TH IUGG GENERAL ASSEMBLY	http://www.iugg.org/assemblies/	08-17 July 2019	Montreal, Canada
FESTIVAL DELLO SPAZIO	http://www.navspace.org/	26–28 July 2019	Busalla, Italy
2019 INTERNATIONAL CONFERENCE ON NUMERICAL SIMULATION OF PLASMAS	https://www.lanl.gov/calendar/2019/September/0903-cnls-conference.php	03-05 September 2019	Santa Fe, New Mexico
SCIENTIFIC AND FUNDAMENTAL ASPECTS OF GNSS/ GALILEO	https://atpi.eventsair.com/QuickEventWebsitePortal/19a07---7th-gnss-colloquium/7th-international-colloquium	04-06 September, 2019	Zurich, Switzerland
ION GNSS+ 2019	https://www.ion.org/gnss/	16-20 September 2019	Miami, Florida USA
7TH ANNUAL IEEE INTERNATIONAL CONFERENCE ON WIRELESS FOR SPACE AND EXTREME ENVIRONMENTS (WISEE 2019)	https://attend.ieee.org/wisee-2019/	16-18 October 2019	Ottawa, ON, Canada
26TH ITS WORLD CONGRESS	https://itsworldcongress2019.com/	21-25 October 2019	Singapore
THIRD TREASURE SCHOOL	http://www.treasure-gnss.eu/events-2/	04-08 November 2019	Turin, Italy
16TH EUROPEAN SPACE WEATHER WEEK	http://www.stce.be/esww16/	18-22 November 2019	Liège, Belgium
SPACE TECH EXPO EUROPE	http://www.spacetechexpo.eu/	19-21 November, 2019	Bremen, Germany

TREASURE PROJECT FELLOWS


Juliana Damaceno ESR1


Jon Bruno ESR2


Karl Bolgrem ESR3

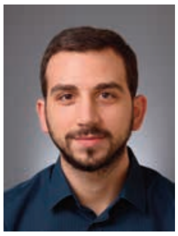

Hongyang Ma ESR4


Caner Savas ESR5


Wenjian Qin ESR6


Kai Guo ESR7


Brian Weaver ESR8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OSU Oregon State University
LGLN Landesamt für Geoinformation und Landesvermessung Niedersachsen
ISMB Istituto Superiore Mario Boella
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