TRANSMIT NEWSLETTER
2014 MAY • **ISSUE 4**

TRANSMIT - Training Research and Applications Network to Support the Mitigation of Ionospheric Threats, an FP7 Marie Curie Initial Training Network. The project addresses in particular ionospheric threats to Global Navigation Satellite Systems (GNSS) and related applications, in areas such as civil aviation, marine navigation and land transportation.

INSIDE THIS ISSUE

'The in-orbit validation of the European Galileo system has been achieved and the full deployment of the system at all levels is progressing at a high pace. The final constellation will consist of 30 satellites, which transmit unique signals in three different frequency bands. This plethora of new satellites and signals will increase ionospheric observability and will be a welcome addition to GNSS-based ionospheric science'.

The worldwide capability to detect and model ionospheric perturbations will increase, as evidenced by **Tom Willems'** (Septentrio Satellite Navigation) article, benefiting, among the others, the TRANSMIT science-services-users community. The TRANSMIT's Early Stage Research (ESR) fellows **Federico Da Dalt** (ESR10), **Đorđe Stevanović** (ESR11) and **Oksana Grynyshyna-Poliuga** (ESR6) tell us about their ongoing studies on ionospheric monitoring and modelling.

NEWS

TRANSMIT is coming to a close in February 2015 and as part of its activities a **final open event** aiming to showcase the project's outcomes, with presentations by all the project fellows and a comprehensive discussion on the project results, is planned for 2014 **within the 11th European Space Weather Week (ESWW)**, whereby TRANSMIT will be inserted into the session entitled **'Modelling the Earth's ionosphere and solutions to counter ionospheric threats to GNSS applications'.**

This session is convened by Marcio Aquino (University of Nottingham), the TRANSMIT coordinator, Cathryn Mitchel (University of Bath, UK) and Giorgiana De Franceschi (Istituto Nazionale di Geofisica e Vulcanologia, Italy), members of the TRANSMIT Supervisory Board and will, within the spirit and objectives of the project and of the ESWW conference, be open to and very interested in contributions from the wider relevant community. It is also possible that a splinter session will be dedicated to a more focused discussion on the project outcomes. See more in the Update/Status section of the newsletter.

www.transmit-ionosphere.net

Update Status

Marcio **Aquino**
Alan **Dodson**

Welcome to the May 2014 issue of the TRANSMIT newsletter! As announced in our previous issue, February saw the organisation and successful running of the TRANSMIT 2014 Workshop: "Appraisal of Scientific and Technological Output" in Torino, where an update on the research work was given by the fellows, with a focus on current preparations for the launch of the TRANSMIT prototype demonstrator. The proceedings of the workshop will be soon made available through the open access publishers InTech (http://www.intechopen.com/), in the form of a book titled "Mitigation of Ionospheric Threats to GNSS: an Appraisal of the scientific and technological outputs of the TRANSMIT project", so please watch out for further news on our website. Equally relevant was the TRANSMIT session that was organised within the prestigious European Navigation Conference – ENC 2014, held in April in Rotterdam. The session also saw fellows' presentations on their research and was kindly chaired by two of our most active industrial partners' representatives, Dr Kees de Jong from Fugro Intersite and Dr Tom Willems from Septentrio Satellite Navigation. The TRANSMIT prototype demonstrator is a web based interface aiming to showcase the project research outcomes in a user friendly manner, through a series of model outputs and tools that could serve as the blueprint for a future service to assist users and industry to mitigate the effects of ionospheric threats to GNSS [Please refer to our website and our previous newsletter to learn more about the rationale behind the TRANSMIT prototype]. The prototype demonstrator will consist of 'processors' (referred to as 'TRANSMIT processors') addressing a selection of topics. In this issue we thought of giving you a hint of what this demonstrator could look like when activated for one of the TRANSMIT processor that is under development. The chosen processor is being provisionally referred to as Processor 2 and addresses the topic of 'improved tracking architecture and positioning error mitigation', whereby the demonstrator allows the user to compare the performance of different signal tracking schemes under different scintillation and interference conditions, from tracking robustness to positioning accuracy for instance in a PPP solution. This processor is currently divided into two complementary parts: Processor 2a, dealing with mitigation of effects at positioning level, and Processor 2b, dealing with signal tracking. Figure 1 illustrates a proposed candidate graphical interface for Processor 2b as it would be made available on the web. In the case of Processor 2b the research covers novel tracking algorithms that can bring an advantage for tracking under scintillation, such as a scintillation level based adaptive Kalman filter PLL (Phase Locked Loop), which uses live scintillation information to improve the tracking robustness on the fly, for GPS and Galileo signals. Also the effect of different types of interference and its mitigation can be assessed, so as to ensure for instance that scintillation information can be correctly retrieved.

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Increased Ionospheric Observability with the Galileo System

Tom Willems
Septentrio Satellite Navigation

Figure 1 • Septentrio Test User Receiver (TUR-N) developed for the Galileo Test User Segment

Introduction

Ionospheric sounding techniques based on Global Navigation Satellite Systems (GNSS) greatly benefit from the constant evolution of existing GNSS systems and from the arrival of new GNSS constellations. New satellites allow additional trans-ionospheric propagation paths to be examined. And because dual-frequency GNSS measurements are the core observables which can be used to derive the electron content along the propagation path, new GNSS signals allow additional signal combinations to be formed. One of the upcoming GNSS systems is the European Galileo system. In contrast to the many uncertainties and delays which the project encountered in the past, the Galileo system is now evolving rapidly. Galileo recently concluded its validation phase and has entered the full deployment phase. The European Commission has signed all important contracts for the deployment of the system. Galileo could provide an important added value to the ionospheric science community. In the next paragraphs, we will explore the current status and the future evolution of Galileo.

Four-Satellite IOV Constellation

The Galileo constellation at the time of writing consists of four satellites. Two satellites (PFM and FM2) were launched in October 2011 and two more satellites (FM3 and FM4) were launched in October 2012. This mini-constellation of four satellites – the minimum required for computing a full PVT (position, velocity and time) solution – form part of the In-Orbit Validation Phase (IOV) of Galileo. The purpose of this phase is to demonstrate that Galileo, when fully deployed, will be able to reach its expected performance. The development and expansion of the Galileo ground infrastructure, essential for the derivation of navigation messages, is also part of the IOV phase. Note that the four IOV satellites will be part of the final Galileo system, while the experimental Galileo satellites GIOVE-A and GIOVE-B, launched in 2006 and 2008 respectively, have been retired.

In-Orbit Validation Successes

Galileo reached a significant milestone on 12 March 2013, when the four IOV satellites started transmitting valid navigation messages. For the first time ever, a Galileo-only PVT solution was computed from the IOV satellites' signals. This historic demonstration was performed by ESA using the 'Test User Receivers' developed by its industrial partners (see Figure 1). Since that date, the IOV satellites have continued transmitting valid navigation messages, and various groups around the world have since reported obtaining Galileo-only position fixes. This has been possible thanks to the public availability of the Galileo OS SIS ICD (Open Service Signal-In-Space Interface Control Document). The dual-frequency L1+E5a horizontal position accuracy is currently around 8 metres (95th percentile). This is an excellent result considering that only 4 satellites and limited ground infrastructure are available so far. During the IOV phase, ESA and its industrial partners have performed successful test campaigns in various environments, including test flights with a Fairchild Metro-II aircraft. Other milestones which have been achieved include the dissemination of the Galileo System Time (GST) vs. UTC time offset and the GST vs. GPS time offset (GGTO). The accuracy of these time offsets is currently around 5 nanoseconds. The GGTO is particularly useful for multi-constellation equipment, because it eliminates the need to estimate the GGTO in the receiver (thus making an additional satellite available for position estimation).

Full Deployment Started

In February 2014, following the successes described above, ESA announced that the in-orbit validation of Galileo has been achieved. The deployment of the Galileo system is now proceeding with the launch of 22 additional satellites, i.e. the so-called FOC (Full Operational Capability) satellites. The European Commission has signed all important contracts for the full deployment of the system, including satellite manufacturing, ground infrastructure, launch services etc. According to the current schedule, 6 FOC satellites will still be launched in 2014. With a total of 10 satellites in orbit, Galileo early services are scheduled to start by the end of 2014. Full Operational Capability is expected by 2019-2020. This pace of deployment will quickly place many additional satellites at the disposal of GNSS ionospheric research.

Additional Signals for Ionospheric Monitoring

Galileo satellites transmit navigation signals in the following frequency bands: L1 (centred at 1575.42 MHz, like GPS L1), E5 (at 1191.795 MHz) and E6 (at 1278.75 MHz). Of these signals, the open (freely accessible) signals are: L1BC and E5-AltBOC. The non-open signals, not discussed here, are: L1A, E6A and E6BC. The L1BC signal's modulation, CBOC, is a further evolution of the BOC (Binary Offset Carrier) modulation scheme offering additional multipath resistance. The CBOC modulation is interoperable with the L1C TMBOC signal which will be transmitted by future GPS-III satellites.

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Update Status

[continues from page 1]

As seen in Figure 1, on the graphical interface of TRANSMIT Processor 2b, the user can select specific scenarios to work with.

Once the scenario is defined and the processor run, outputs will be provided whereby the tracking performance can be assessed for the chosen tracking scheme. Additionally a number of related outputs can be retrieved and displayed or archived. For instance, Processor 2b is designed to provide scintillation indices as well as pseudo-range and phase measurements that can be used in Processor 2a to assess positioning performance under the defined scenario. There is still a lot to be done to get our prototype up and running but the team is working hard and we are on schedule. TRANSMIT is coming to a close in Feb 2015 and a final showcase, with presentations by all the project fellows and a comprehensive discussion on the project results, is planned for 2014. We are glad to announce that an agreement was reached with the organizing committee of the 11th European Space Weather Week (ESWW), so that TRANSMIT will be inserted into the session entitled "Modelling the Earth's ionosphere and solutions to counter ionospheric threats to GNSS applications". This session will be open to and very interested in contributions from the wider relevant community, and it is also possible that a splinter session be dedicated to a more focused discussion on the project outcomes. The 11th ESWW conference will take place in Liege, Belgium, 17-21 November 2014 (http://www.stce.be/esww11/abstract.php). Do have a look at the conference sessions, and then click on the abstract submission link to submit your contribution.

We hope to see you there!

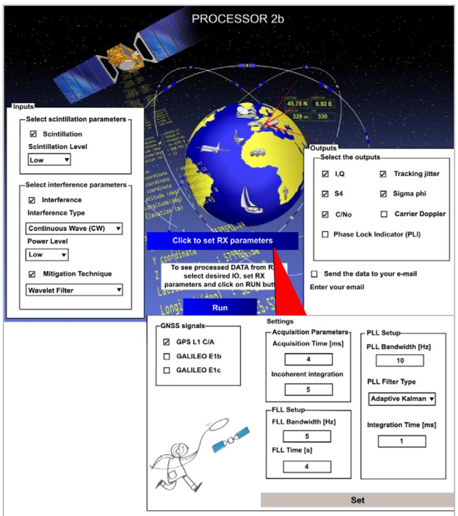

Figure 1 • Proposed graphical interface for the TRANSMIT Processor 2b

THE EXPERT'S VOICE

[continues from page 2]

The E5-AltBOC signal is the best-performing signal of all current and planned GNSS signals in the sky. It is a high-bandwidth signal (ca. 92 MHz transmitted bandwidth) with an innovative modulation scheme that results in high multipath resistance and low tracking noise. The E5-AltBOC signal consist of two coherent components, E5a (at 1176.45 MHz, like GPS L5) and E5b (at 1207.14 MHz), which can also be processed as individual signals.

The L1BC, E5a and E5b signals consist of a 'data' and 'pilot' component. The data component provides the means to disseminate navigation messages. Pilot components are easier to acquire and track, e.g. indoor, because receiver processing does not need to take the presence of (generally unknown) data into account. This increased robustness leads to increased measurement availability (e.g. in case of severe ionospheric events) which in turn can benefit research.

Conclusion

The in-orbit validation of the European Galileo system has been achieved and the full deployment of the system at all levels is progressing at a high pace. The final constellation will consist of 30 satellites which transmit unique signals in three different frequency bands. This plethora of new satellites and signals will increase ionospheric observability and will be a welcome addition to GNSS-based ionospheric science.

Further Reading

[1] Galileo works, and works well • http://www.esa.int/Our_Activities/Navigation/Galileo_works_and_works_well

[2] Galileo achieves its first airborne tracking • http://www.esa.int/Our_Activities/Navigation/Galileo_achieves_its_first_airborne_tracking

[3] Galileo starts to tell UTC, the world's time • http://www.esa.int/Our_Activities/Navigation/Galileo_starts_to_tell_UTC_the_world_s_time

[4] Galileo and GPS 'synchronise watches': new time offset helps working together • http://www.esa.int/Our_Activities/Navigation/Galileo_and_GPS_synchronise_watches_new_time_offset_helps_working_together

[5] Galileo fixes Europe's position in history • http://www.esa.int/Our_Activities/Navigation/Galileo_fixes_Europe_s_position_in_history

[6] Mission accomplished, GIOVE-B heads into deserved retirement • http://www.esa.int/Our_Activities/Navigation/Mission_accomplished_GIOVE-B_heads_into_deserved_retirement

[7] Space signal demonstrates Galileo interoperability with GPS • http://www.esa.int/Our_Activities/Navigation/Space_signal_demonstrates_Galileo_interoperability_with_GPS

ANIMo: A New Ionospheric Model

Federico **Da Dalt** | ESR10

Ionospheric tomography is an accredited approach to monitor and study the upper atmosphere and its dynamics. It is based on Computerized Tomography (CT) techniques and uses an inverse operator in order to generate three-dimensional reconstructions of electron density starting from Global Navigation Satellite System (GNSS) measurements. In contrast with other tomography applications (e.g. medical), ionospheric tomography cannot rely on a complete scan geometry because of the arrangement between the transmitting satellites and receivers. Furthermore, ground-based GNSS receivers, responsible for gathering the necessary data, are not evenly distributed on the Earth's surface (e.g. ocean surfaces are not covered). This lack of data makes the reconstruction extremely difficult, therefore the inverse operation needs to be regularized and supported by external information, which can be provided by ionospheric models in different ways. A New Ionospheric Model (ANIMo), developed in the context of TRANSMIT and within the INVERT group at the University of Bath, is a Physics-based ionospheric model specifically developed for supporting tomography imaging of the upper atmosphere. It is a global model used mostly for middle latitude regions of the ionosphere. Its inputs parameters are the indices of solar activity (F10.7) and geomagnetic perturbation (Ap index). It is based on the continuity equation of the monoatomic oxygen ion. Its outcomes are the major ions (O^+, O_2^+ and NO^+) and electron density profiles, from an altitude of 80 to 600 km (Figure 1). The most relevant application of ANIMo is expected to be within a Data Assimilation (DA) scheme. Largely used in weather forecasting, DA approaches combine observations and model outcomes (background) in order to have the most accurate awareness of the current state and perform improved forecasting. The objectives of this work are, therefore, to use ANIMo not only to improve the ionospheric imaging but also to perform short term ionospheric forecasting. ANIMo has been validated and its implementation in an ionospheric DA scheme is in progress.ionospheric DA scheme is in progress.

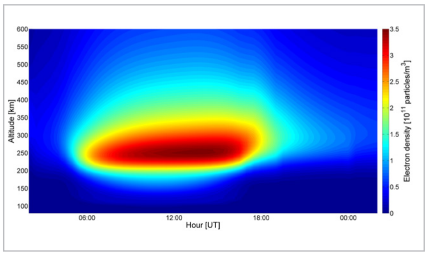

Figure 1: The plot shows the evolution of the electron density profile produced by ANIMo above Tromsø (Norway; Lat. 69.7°, Lon. 18.9°) on the 14th of March 2006 in calm solar and geomagnetic conditions (F10.7: 72.8, Ap: 2).

On modeling of ionospheric scintillation and statistical data analysis of GNSS signals

Đorđe **Stevanović** | ESR11

The number of new discoveries in the field of Global Navigation Satellite Systems (GNSS) technology grows from day to day, but a remaining problem that still impairs growth in the service providers and users sectors is ionospheric scintillation. As a possible solution to this problem, researchers are developing a whole arsenal of models and simulations of ionospheric plasma dynamics and on the scintillation influence on propagating radio wave signals. A model in science could be defined as a systematic construction of an idea, object, phenomenon, process and/or a system by setting hypothesis and theory and proving them through a set of statistical, mathematical and/or physical experiments [1]. Various types of model representations can be found, but in the field of ionospheric Physics and GNSS technology most common are models built on computer codes, based on a system of postulates made on the ionospheric phenomena with interference of various data analysis techniques. The Earth's ionosphere is a very complex system of physical and chemical processes; therefore, numerous models are focused on different simplified real case events or phenomena.

In the context of TRANSMIT, my task is the development of an adequate statistical model of the ionospheric scintillation. The work is based on analyzing ionospheric scintillations and their influence on the GNSS signals amplitude and phase, with the purpose to develop improved algorithms for simple and realistic statistical modeling of scintillating GNSS signals. Previous research in this field gave various solutions for appropriate probability distribution of the scintillating signal phase and amplitude, but no work found in the literature represents an easy solution. While a Gaussian distribution could acceptably describe the Probability Density Function (PDF) of the signal phase, in the case of amplitude there is still no clear solution - in the literature several PDFs are proposed, such as the Rice or Nakagami-m distributions [2-3]. In order to test previous research results and conclusions, statistical analysis has been done by using higher order moments (skewness and kurtosis) of phase and amplitude of the signal. In our experiment emphasis is given to measurements from high and low magnetic latitudes (GNSS monitors, ionosondes, Incoherent and Coherent Scatter Radars and low orbit satellites data), because these are the most affected regions by ionospheric scintillations. At the high latitudes and Polar Regions phase scintillations are more pronounced, while amplitude scintillations are significantly stronger and more pronounced in near equatorial latitude regions. Analyses were made for periods of strong and moderate geomagnetic storms. Data from a GNSS receiver at Svalbard in 2010 and from a GNSS receiver in Brazil along 2011 were used. Comparisons were performed between phase and amplitude PDFs obtained from measured data and theory. A PDF test on higher order moments shows that strong amplitude scintillations of the GPS signal do not follow a Gaussian

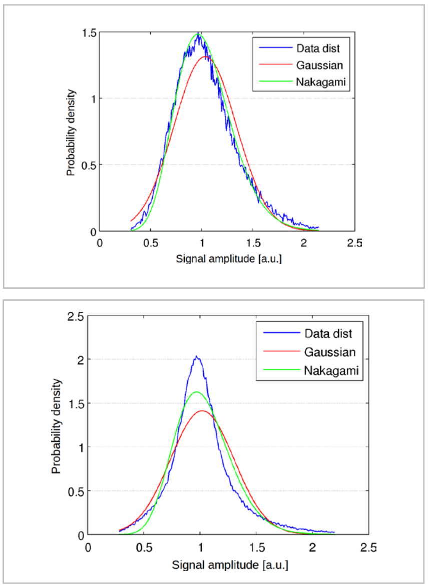

Figure 1 • An example of good agreement (top) and deviation (down) from the Nakagami PDF in case of scintillating signal amplitude distribution for PRN24 (top) and PRN31 (down). Experimental measurements come from the GNSS receiver at the Polish Polar Station, Svalbard, on 5th April 2010.

distribution, and partly follow Nakagami distribution (Figure 1). These results lead to the necessity for improvements in the accuracy of the ionospheric scintillation modeling, and possible advancements in scintillation forecasting and prediction. In the next steps of the research, we will carry out tests on more PDFs, including experimental ones, as well as comparative analysis between remote and in-situ measurement data.

• [1] A. Scharnhorst, K. Börner, and P. v. d. Besselaar, "Models of Science Dynamics: Encounters Between Complexity Theory and Information Sciences", Springer, Berlin 2012.

• [2] E. J. Fremouw, R. C. Livingston, and D. A. Miller, "On the statistics of scintillating signals", Journal of Atmospheric and Terrestrial Physics, Vol. 42, Issue 8, pp. 717-731, 1980.

• [3] T. E. Humphreys, M. L. Psiaki, J. C. Hinks, and P. M. Kintner Jr., "Simulating ionosphere-induced scintillation for testing GPS receiver phase tracking loops", IEEE Journal of Selected Topics in Signal Processing, Vol. 3, Issue 4, pp. 707-715, 2009.

IONOSPHERIC MODELLING USING GPS DATA

Oksana **Grynyshyna-Poliuga** | ESR6

The ionosphere plays an important role in high-technological systems for navigation, telecommunication and space missions because the microwave signals travelling through it experience a delay that depends on the number of free electrons along the ray path. Space geodetic techniques observing at two frequencies, such as the Global Positioning System (GPS), allow the observation and modelling of the ionosphere, which is a key point in correcting electromagnetic measurements for ionospheric disturbances. Information on the electron content of the ionosphere can be collected using GPS and by examining the phase and amplitude changes which occur in paths between transmitting satellites and ground-based receivers. These data can then be processed in order to create maps of the ionospheric TEC. The estimation of TEC values on a dense grid using the limited set of computed TEC is called TEC mapping [1, 2]. In the literature, there are various interpolation methods applied to ionospheric TEC mapping. The most commonly used interpolation technique for TEC-mapping studies is Kriging. Prior to use the Kriging technique it is necessary to determine an experimental semi-variogram, in order to adjust a theoretical one. In [3], semi-variances have been plotted against the lag distance as a scatter diagram, called the "semi-variogram cloud". Figure 1 contains all of the information on the spatial relations in the data to lag. In principle, I could fit a model to it to represent the regional semi-variogram, but in practice it is almost impossible to judge from it if there is any spatial correlation present, what form it might have. A more sensible approach is to average the semi-variances for each of a few lags and examine the results [4]. Nevertheless, the semi-variogram cloud shows the spread of values at the different lags, and it might enable us to detect outliers or anomalies. The tighter this distribution is, the stronger is the spatial continuity in the data. Plots in Figure 1 belong to the three days of the year (doy) 273 - 275 of year 2012 during geomagnetic storm and only 1 h intervals are depicted, from 12 to 13 UT for Warsaw station. Each pair of observations is separated by a potentially unique lag in both distance and direction. To obtain averages containing directional information the separations should be grouped by direction as well as by distance. When all comparisons have been made the experimental semi-variogram will consist of the set of averages for the nominal lags in both distance and direction. The semi-variogram is sensitive to outliers and to extreme values in general. If the extreme value is near the margin of the region then it will contribute to fewer comparisons than if it is near the centre. The end point on a regular transect, for example, contributes to the average just once for each lag, whereas points near the middle contribute many times. If data are unevenly scattered then the relative contributions of extreme values are even less predictable. The result is that the experimental semi-variogram is not inflated equally over its range, and this can add to its erratic appearance. My project within TRANSMIT aims to analyze the information about the ionosphere during different magnetic/ionospheric conditions. This work demonstrates the concept and practical example where Kriging algorithm is applied to generate TEC maps using the GPS data at mid-latitude. A region located between 30° and 60° latitude and -40° and +45° longitude was selected to produce the local ionosphere maps each 15 minutes on a 2.5° x 2.5° grid. This approach provides detailed analysis of the ionospheric response to the storm. The ionosphere was modeled for the period of 18 hours (5:00 to 23:00 UT) during three days (Figure 2). The maximum TEC was observed around 12:00 LT during the first disturbed day (30 September 2012). This might be explained by the active geomagnetic conditions (Kp=7).

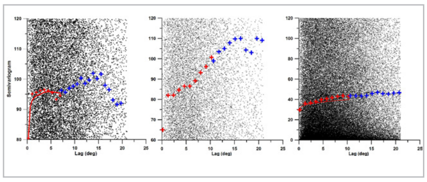

Figure 1 • An example of semi-variograms for disturbed conditions with logarithmic representation. Crosses are averaged data, lines – fitted data, red - full data set, and blue crosses – data created artificially.

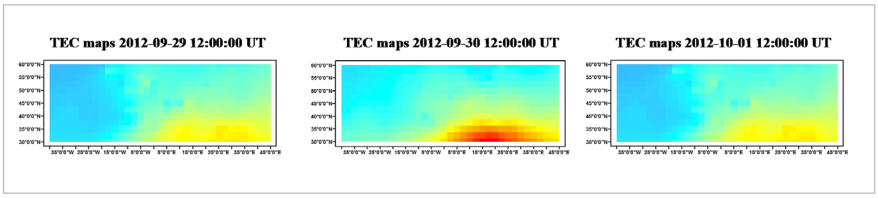

Figure 2 • Ionospheric TEC maps created with Kriging interpolations method

• [1] R. Hanbaba (Ed.) The final report of COST 251, Space Res. Cent., Warsaw, Poland, 1999.

• [2] I. Sayin, Total Electron Content mapping using Kriging and Random Field Priors, M.Sc. thesis, Hacettepe Univ., Ankara, Turkey, 2008.

• [3] P. Chauvet. The Variogram Cloud. In Proceedings of the 17th APCOM Symposium. Colorado School of Mines, Golden, CO, pages 757-764, 1982.

• [4] R. Webster, M.A. Oliver: Geostatistics for Environmental Scientists. Wiley, Chichester, 2001. Hardbound, 271 pp., ISBN 0471965537.

FORTHCOMING EVENTS

2014 MAY • ISSUE 4

EVENT	WEB SITE	DATE	LOCATION	DEADLINE/TYPE
2014				
2014 Joint Navigation Conference (JNC 2014)	http://www.ion.org/jnc/index.cfm	June 16-19, 2014	Orlando FLORIDA - USA	March 4, 2014 Conference
GEM Geospace Environment Modeling	http://aten.igpp.ucla.edu/gemwiki	June 15-20, 2014	Portsmouth VIRGINIA - USA	June 4, 2014 Workshop
ICL – GNSS 2014	www.icl-gnss.org	June 26-27, 2014	Helsinki FINLAND	April 10, 2014 Conference
COSMOS – COSPAR MOSKOW 2014	https://www.cospar-assembly.org/	August 2-10, 2014	Moskow RUSSIA	February 14, 2014 Conference
XXXI URSI GASS	http://www.chinaursigass.com/	August 16-23, 2014	Bejing CHINA	February 15, 2014 Conference
XXXIII SCAR Open Science Conference	http://www.scar2014.com/	August 25-28, 2014	Auckland NEW ZEALAND	February 28, 2014 Conference
ION GNSS+	http://www.ion.org/gnss/index.cfm	September, 8-9, 2014	Tampa FLORIDA - USA	March 7, 2014 Conference
Geospace revisited: a Cluster/MAARBLE/Van Allen Probes	http://geospacerev.space.noa.gr/index.php	September 15-20, 2014	Rhodes GREECE	June 15, 2014 Conference
Eighth FORMOSAT-3/COSMIC Data Users' Workshop	http://www.cosmic.ucar.edu/worshop_2014/index.html	30 September 2 October, 2014	Boulder COLORADO - USA	July 7, 2014 Workshop
Evolving Solar Activity and Its Influence on Space and Earth	http://lws-sdo-workshops.org/	November 2-6, 2014	Portland OREGON - USA	August 1, 2014 Meeting
XII International Conference on Substorms (ICS-12)	http://www.stelab.nagoya-u.ac.jp/ICS-12/	November 10-14, 2014	Shima JAPAN	June 30, 2014 Conference
11th European Space Weather Week	http://stce.be/esww11/index.php	November 17-21, 2014	Liege BELGIUM	June 1, 2014 TRANSMIT Final Event
47th AGU Fall Meeting	http://fallmeeting.agu.org/2014/	December 15-19, 2014	San Francisco CALIFORNIA - USA	August, 2014 Conference

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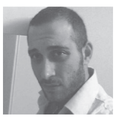
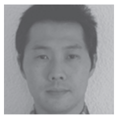

ELEFTHERIOS PLAKIDIS


JOE KINRADE


HIROATSU SATO

TRANSMIT Project PARTNERS

TRANSMIT counts on an exceptional set of partners, encompassing both academic excellence and top end users, including the aerospace and satellite communications sectors, as well as GNSS system designers and service providers, major user operators and receiver manufacturers. There is currently no assistance against ionospheric threats in Europe and TRANSMIT will promote step-change research that will enable Europe to minimise disruption and consequential societal costs associated with them. It will promote European competitiveness by ensuring the contribution of top centres of excellence in the field and by adopting a global approach to the problem. There are two types of partners in TRANSMIT, namely level 1 and level 2 partners.

TRANSMIT Coordinator