

2458-5

Workshop on GNSS Data Application to Low Latitude Ionospheric Research

6 - 17 May 2013

Ionospheric research and GNSS at ICTP

S.M. Radicella

ICTP

Trieste

Italy



Workshop on GNSS Data Application to Low Latitude Ionospheric Research

The Abdus Salam ICTP
Trieste - Italy, 06 - 17 May 2013



Directors: S.M. Radicella (ICTP), P. Doherty (Boston College), R. Prieto (European Space Agency)
Local Organizer: B. Nava (ICTP)



The Abdus Salam
**International Centre
for Theoretical Physics**



Ionospheric research and GNSS at ICTP

S. M. Radicella

Head, Telecommunications/ICT for Development

Laboratory (T/ICT4D)

the former ARPL

Workshop on GNSS Data Application to Low Latitude Ionospheric Research

The Abdus Salam ICTP

Trieste - Italy, 06 - 17 May 2013

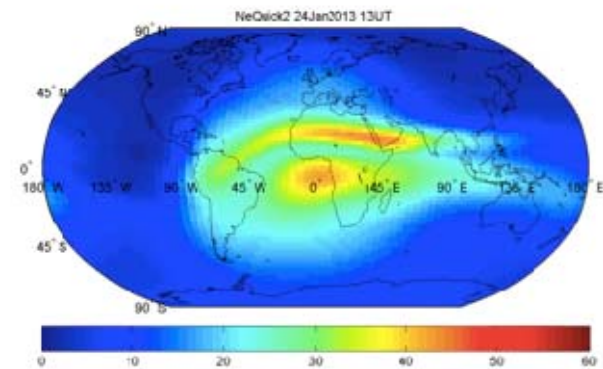
T/ICT4D (former ARPL): two sections



Ionospheric Radiopropagation

(since 1990):

*research and training in ionospheric physics
with application to GNSS science and technology*



Wireless communications

(since 1995):

*research and training in Wireless ICT
including Wireless Sensors Networks for
Development*



T/ICT4D: personnel



Head: Sandro M. Radicella
Ionospheric radiopropagation Section

Bruno Nava (coordinator)
Yenca Migoya
L. Ciruolo
C. Papparini



Wireless communications Section

Marco Zennaro (coordinator)
Carlo Fonda
Ermanno Pietrosevoli



administrative assistant
Stanka Tanaskovic



short and long-term visitors:
mostly from Africa and Latin
America

From 1990 to 1999



● Ionosphere modeling efforts in the framework of four European COST (Cooperation in Science and Technology) Actions.



● In the framework of the International Reference Ionosphere (IRI), a joint project of URSI and COSPAR, IRI Task Force Activities every year for 11 years since 1993.



- The scheme of the activities consisted in bringing together from 10 to 20 ionospheric data providers from developing and developed countries and modelers in front of computer terminals and carry out discussions and tests during informal round-table meetings and working sessions.



- The results of these activities have contributed substantially to the improvement of the IRI model.



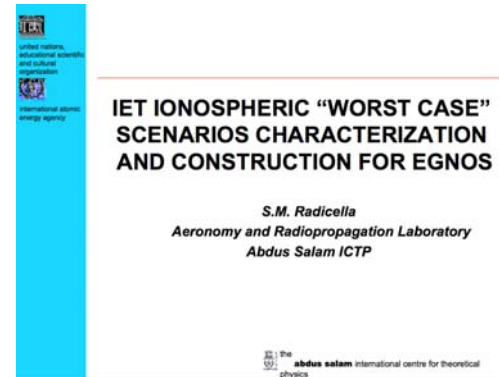
INTERNATIONAL
REFERENCE
IONOSPHERE



Orientation towards ionospheric effects on GNSS operation



From 1999 ionospheric modeling efforts of the Laboratory became strongly oriented towards trans-ionospheric propagation effects related to GNSS operation.



Since the same year until 2006, the ICTP laboratory coordinated the Ionospheric Expert Team (IET) of ESA supporting EGNOS project.



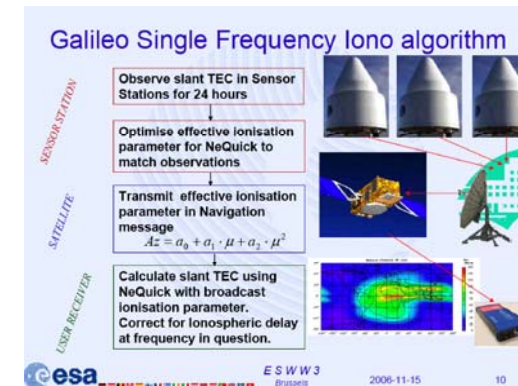
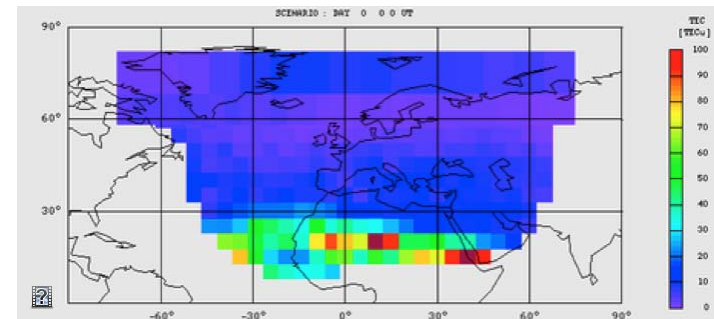
From 2000 to 2006 the work was closely related to the European GALILEO system ionospheric issues.



NeQuick model



- The NeQuick, one of a family of models developed in collaboration with the University of Graz, Austria, was used to generate “worst case” ionospheric scenarios for generation and tuning of the operational algorithms of EGNOS.
- The same model has been adopted for ionospheric corrections of GALILEO system.
- The model has been adopted by Recommendation ITU-R P. 531 of the International Telecommunication Union as an improved procedure for calculating TEC.
- The topside section of the model has been adopted as a default option of the IRI model.



The most recent version of the model (NeQuick 2) is now available for on-line calculations at:

<http://t-ict4d.ictp.it/nequick2/nequick-2-web-model>

Online facilities



A new web-based platform that aims to automate and simplify the use of the NeQuick model and the way to obtain TEC calibrated from GNSS.

This screenshot shows the 'NeQuick 2 Web Model' interface. It includes a navigation menu at the top with links for Home, About T/ICT4D, NeQuick 2, People, News, Projects, and Bibliography Search. The main content area is titled 'NeQuick 2 Web Model' and describes the computation and plotting of slant electron density profile and total electron content. It features input fields for 'Endpoints Coordinates' (Lower and Higher endpoints) with fields for Latitude, Longitude, and Height in km. There are also fields for 'Date and Time' (Year, Month, Day, Time) and 'Solar Activity' (R12, Daily Solar Radio Flux, or User Input). A 'Run NeQuick' button is located at the bottom of the form.

NeQuick 2 web model

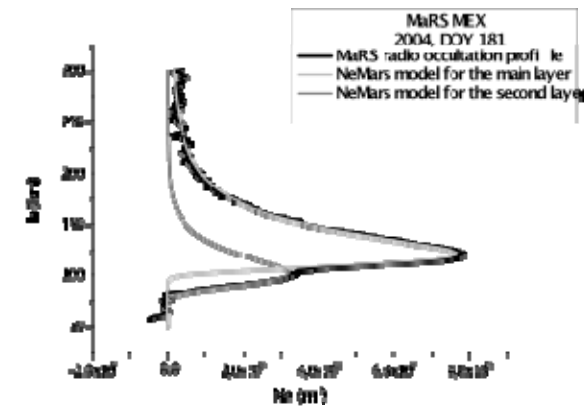
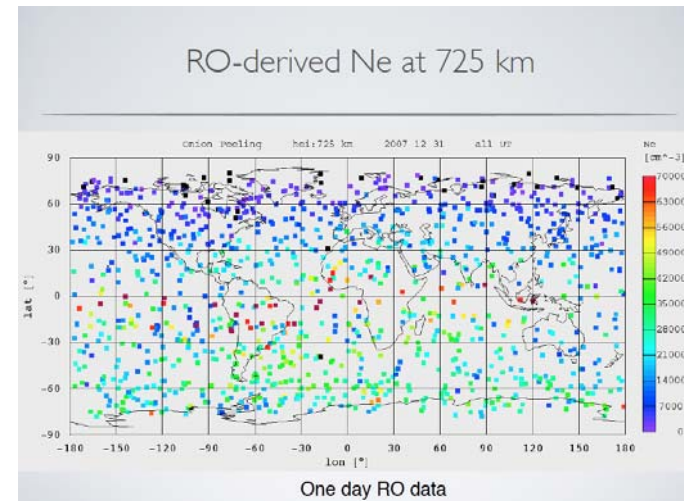
This screenshot shows the 'Experimental GNSS TEC Calibration online' interface. It features a navigation menu and a sidebar with links for 'NeQuick 2 Web Model', 'Terms of Use', 'References', 'Source Code', and 'GNSS TEC Calibration online'. The main content area is titled 'GNSS TEC Calibration online' and includes a description: 'Calibration of Total Electron Content from GPS phase observable. --- Single-station estimation of arc offsets ---'. It has an 'Input' section with a 'Station Marker Name (ex. mata)' field and a 'GNSS' dropdown menu set to 'GPS'. There is also a 'Date' section with 'Year(YYYY)' and 'Day of Year (day)' fields. An 'Output Setting' section includes an 'Interval' dropdown set to '5min'. An 'Obtain TEC' button is located at the bottom of the form.

Experimental GNSS TEC Calibration online

Examples of other related activities



- GNSS and other ionospheric data assimilation in models, particularly in the NeQuick 2 model. Work on this field is done in the Laboratory and also in collaboration with colleagues from African universities.
- The Laboratory has developed a software to extract ionospheric electron density profiles from satellite radio-occultation data in the framework of an Italian Space Agency project.
- Studies are being carried out on the performance of EGNOS under different conditions.
- The Laboratory has developed a model of the daytime ionosphere of Mars in collaboration with the Universidad Complutense of Madrid and ESA.



EC Contribution Agreement with ICTP



The European Commission has approved a Contribution Agreement with ICTP to carry out the project *Training on EGNOS-GNSS in Africa (TREGA)* aimed to provide technical assistance, capacity building and provision and use of a test/simulation platform for the implementation of GNSS/EGNOS in Sub-Saharan Africa.



In the *Appropriateness of ICTP* note that justified the EC assignment to ICTP it is written:

“The specific knowledge of the institute, and its experience in training people from developing countries, put this organization in a unique position for the participation in the project.”

Participation in ESA ALCANTARA Initiative

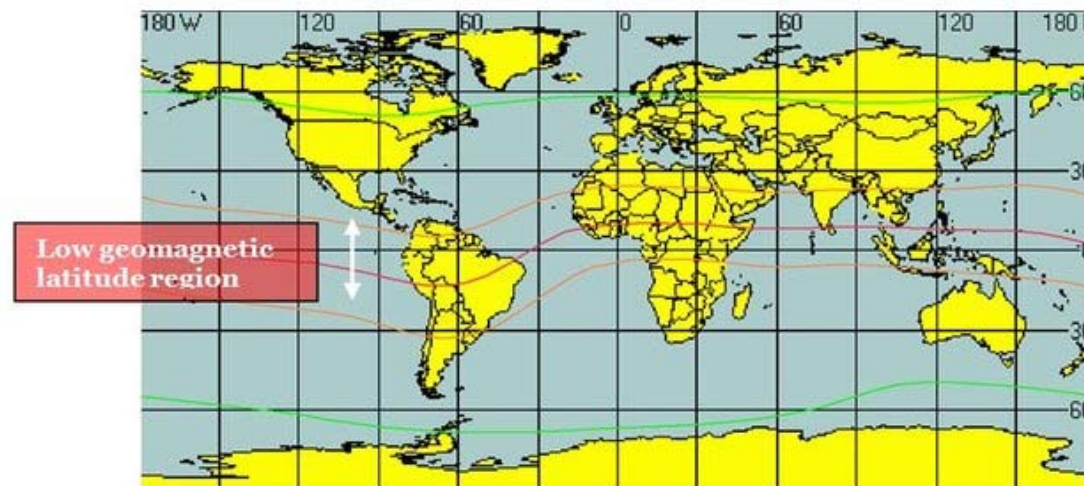


An Initiative implemented within the ESA's General Studies Programme (GSP)

COMPETENCE SURVEY: Ionospheric ground based monitoring network in low-latitude regions

Alcantara Competence Surveys are proposed in the context of Global Navigation Satellite Services (GNSS) programmes in order to better understand the research capabilities, facilities, activities and plans relevant to the monitoring of ionosphere perturbations in low-latitude regions and local and regional level. The three regions addressed by the Competence Surveys are Africa, South-America and Southeast Asia & Pacific.

ICTP through the Laboratory is responsible of the Survey on Africa



GNSS related training activities



4 December - 15 December , 2006
Workshop on the Future of Ionospheric
Research for Satellite Navigation and
Positioning: its Relevance for Developing
Countries.
Directors: P. Doherty and S. Radicella



ICTP and **Boston College** established in 2009 a partnership for the development of GNSS science and applications in Africa that gave rise to a series of training activities in Trieste and in Africa.

International Partnership for Education in Satellite Navigation Science and Technology for Africa

Patricia H. Doherty
Boston College
and
Sandro M. Radicella
Abdus Salam International Centre for Theoretical Physics



NASA International Space
Weather Initiative
Morocco - November 2009



The result of the ICTP-BC partnership



23 March - 9 April, 2009; Satellite Navigation Science and Technology for Africa, **Trieste**,
Directors: S.M. Radicella and P. Doherty

16-19 November, 2009, Nigerian National Meeting on GNSS Science and Applications, **Abuja, Nigeria**,

10-13 January, 2010; Workshop on the Ionosphere and its Effects on GNSS Systems, **Cairo/Alexandria, Egypt**

19-23 July, 2010; East, Central and Southern African GNSS and Space Weather Workshop, **Nairobi, Kenya**.

6 April - 23 April, 2010; Second Workshop on Satellite Navigation Science and Technology for Africa, **Trieste**, Directors: Patricia H. Doherty, Sandro M. Radicella



The result of the ICTP-BC partnership (cont.)



11 April - 1 May, 2012; Workshop on Science Applications of GNSS in Developing Countries (11-27 April), followed by the: Seminar on Development and Use of the Ionospheric NeQuick Model (30 April-1 May), **Trieste**, Directors: S.M. Radicella, Patricia H. Doherty



Workshop on GNSS Data Application to Low Latitude Ionospheric Research 6-17 May 2013



Applicants: 198

Accepted for participation: 66 (61 from 26 countries)

Cancelled participation: 5

