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

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ISWI Workshop – ICTP, Trieste,
May 20-24, 2019

The Boston College/Abdus Salam International Centre for Theoretical Physics Collaboration and Outreach Workshops

The first joint activity

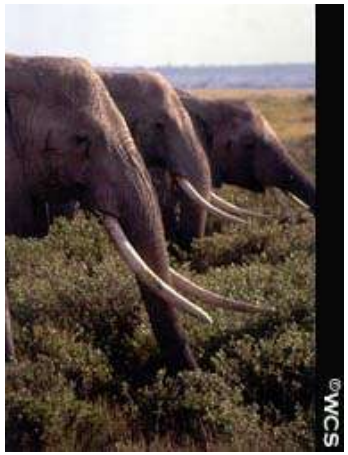
Africa's Science and Technology Plan of Action (1) clearly states Africa's commitment to develop and use science and technology for socio-economic transformation and full integration into the world economy.

Global Navigation Satellite Systems (GNSS) are a space technology that can help meet that goal.

1) Africa's Science and Technology: Consolidated Plan of Action (2006): www.nepadst.org

GNSS Applications

- Increase food security; manage natural resources; wildlife conservation
- Provide efficient emergency location services; disaster relief
- Improve mapping and surveying
- Provide greater precision and safety in land, sea and air navigation
- Scientific research and exploration – SPACE SCIENCE



Wildlife Conservation

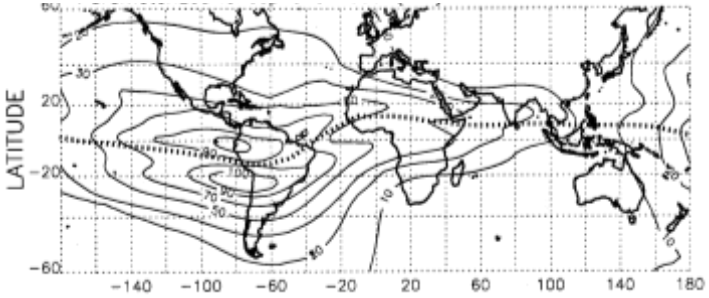
Land Navigation

Precision Farming

Air Navigation

Water Navigation

Disaster Relief



Scientific Exploration

Initial Project Goals

- To help build a knowledgeable GNSS African workforce
- To encourage the use of GNSS for societal and economic development and scientific exploration
  - Increase food security; manage natural resources; wildlife conservation
  - Provide efficient emergency location services; disaster relief
  - Improve mapping and surveying
  - Provide greater precision and safety in land, sea and air navigation
  - Scientific research and exploration

International Committee on Global Navigation Satellite Systems

10 Workshops held since 2006

- Most held at the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy
- 2014 held in Kigali, Rwanda

- Curriculum
  - Fundamentals of GNSS
  - State of the art GNSS Technologies
  - Scientific Exploration using GNSS
    - **Ionosphere, Space Weather**
  - Data acquisition, processing and analysis
  - Aviation Applications
  - Lego Robots Contest
  - Geocache Challenge
  - Android phones using GNSS

5th Workshop – 2014 Kigali, Rwanda
African School on Space Science

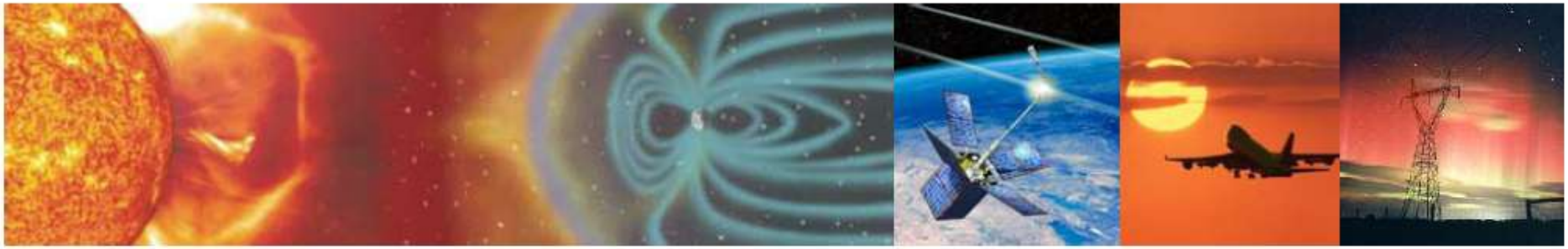
GNSS fundamentals and scientific exploration together with a greater focus on space and solar physics and how solar events can affect our technology on Earth – specifically GNSS.

Themes have matured

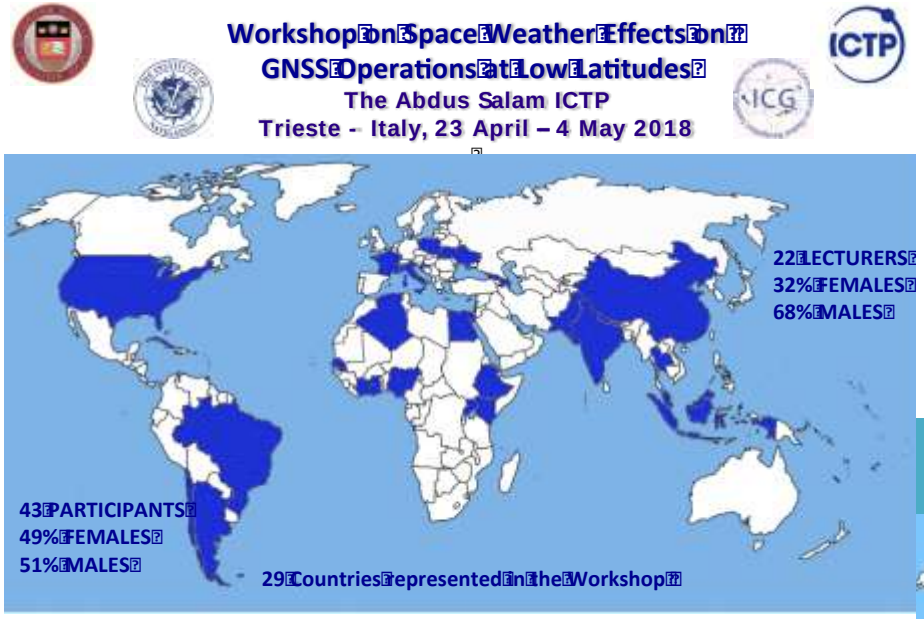
GNSS, Navigation, Ionosphere, Space Weather

2009: Workshop on Satellite Navigation Science and Technology for Africa
2010: Second Workshop on Satellite Navigation Science and Technology for Africa
2012: Workshop on Science Applications of GNSS in Developing Countries
2013: Workshop on GNSS Data Application to Low Latitude Ionospheric Research
2014: African School on Space Science, Rwanda
2015: Workshop on Ionospheric Effects on SBAS and GBAS Applications at Low Latitudes
2016: Workshop on the Use of Ionospheric GNSS Satellite Derived TEC for Navigation, Ionospheric and Space Weather Research
2017: Extended Workshop on Space Weather Effects on GNSS Operations
2018:Workshop on Space Weather Effects on GNSS Operations at Low Latitudes

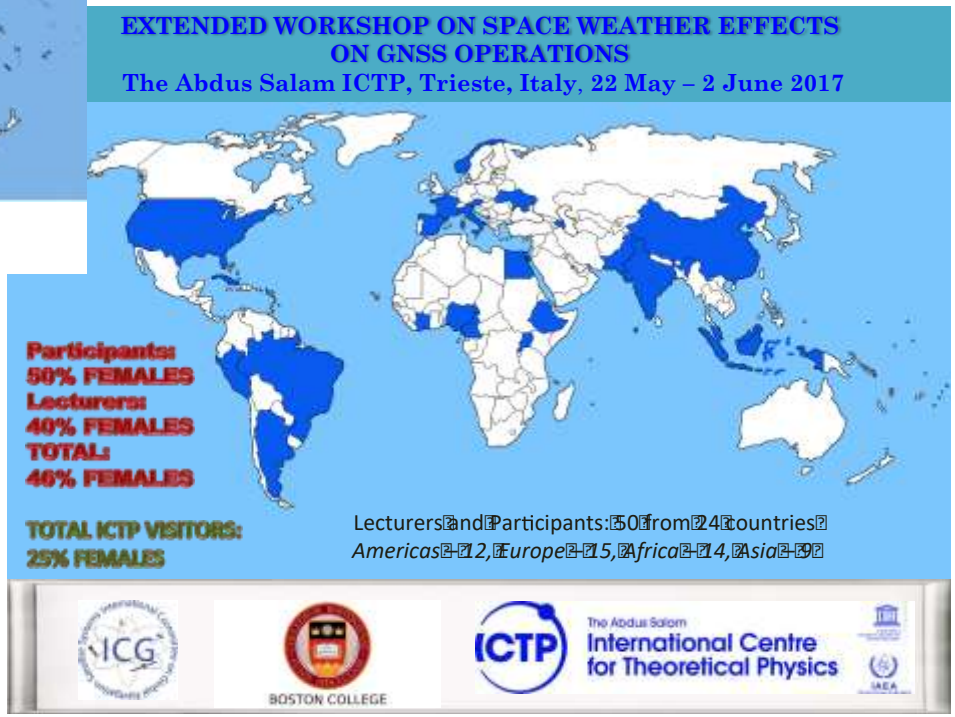
Significant ISWI Relevance



Geographic Area Extended

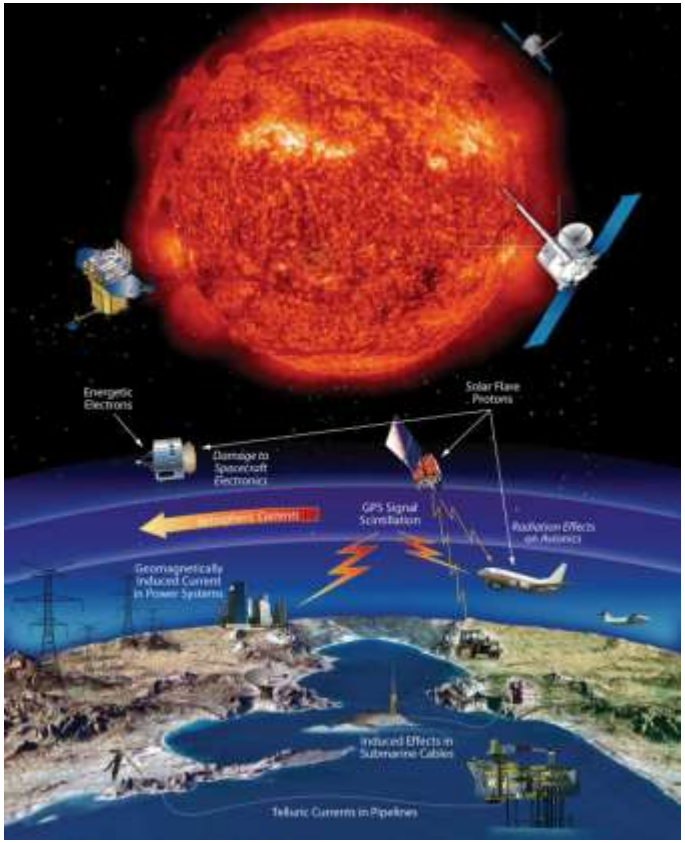


2018 - 29 countries



2017 – 24 countries

2018 Workshop
Extended Workshop on Space Weather Effects on GNSS Operations

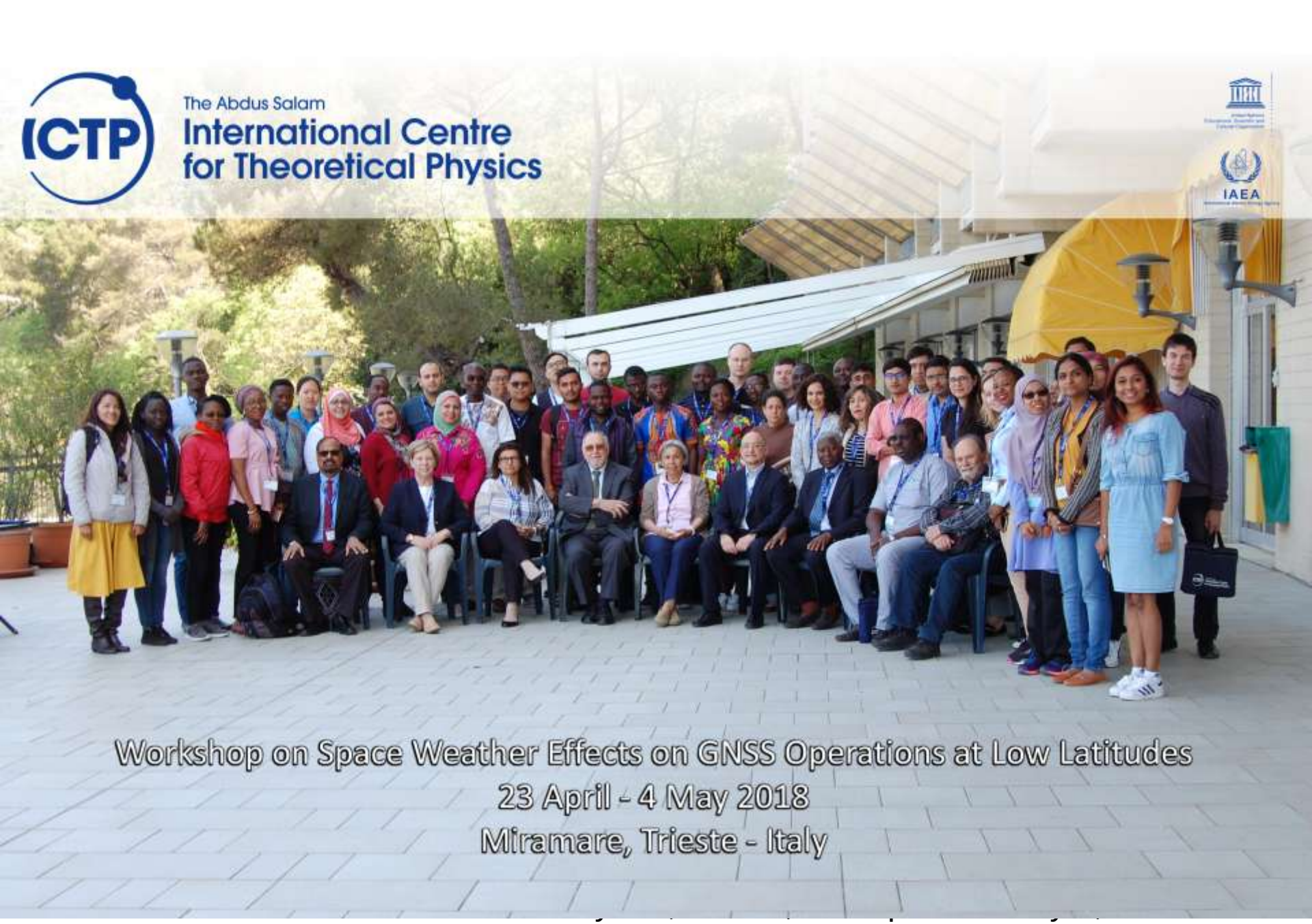


- > 45 participants
- 49% were women
- 29 countries
  - Argentina, Bosnia and Herzegovina, Brazil, Cote d'Ivoire, Egypt, Ethiopia, Indonesia, Malaysia, Nigeria, Peoples Republic of China, Peru, Republic of Cameroon, Rwanda, Uganda and Ukraine
- Prime focus on space weather effects

All topics relevant to ISWI interests.

International Centre for Theoretical Physics, Trieste, IT – April 23– May 4, 2018

The Abdus Salam
International Centre
for Theoretical Physics



Workshop on Space Weather Effects on GNSS Operations at Low Latitudes

23 April - 4 May 2018

Miramare, Trieste - Italy

Increasing number of students and young scientists studying and using GNSS and their applications

(Many more applications than we can support)

Increasing participation by women

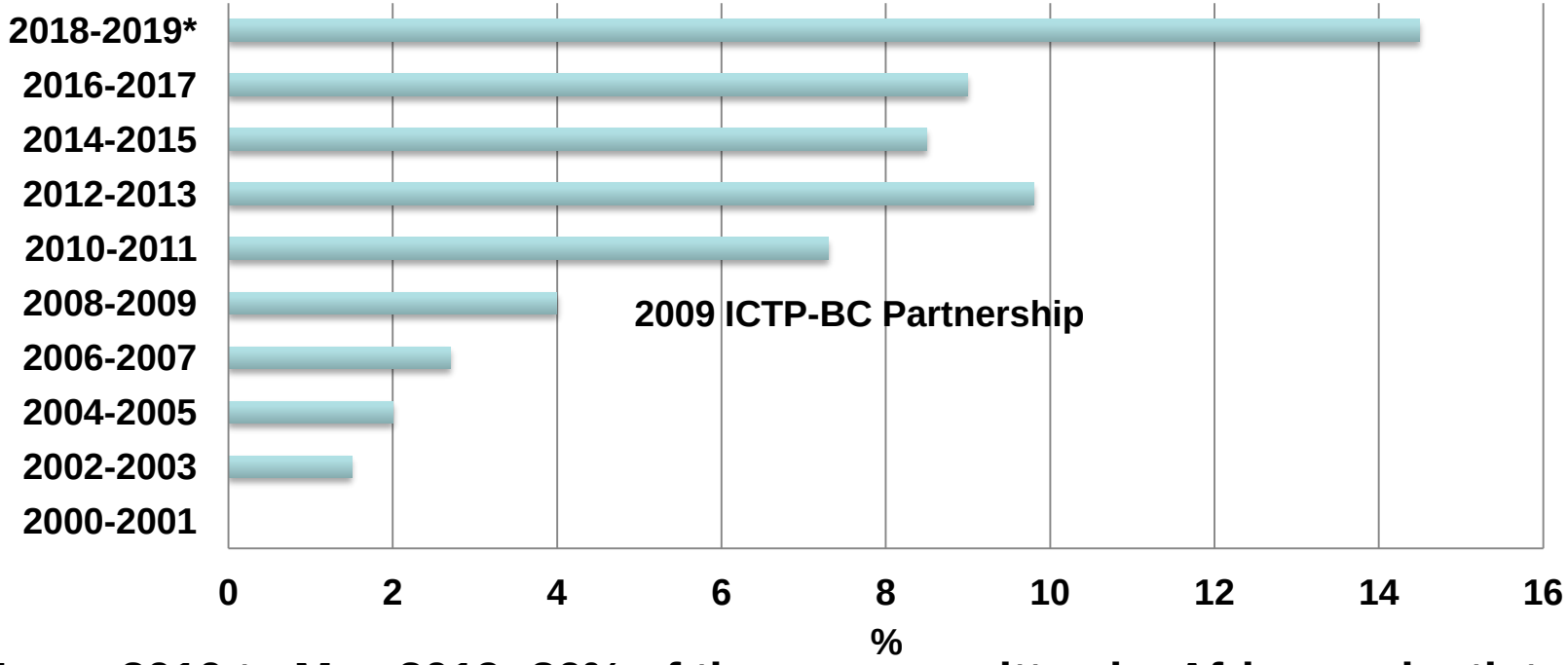
17 women from 14 countries – May 2017

Hands-On Laboratories

Small Group Projects
Typically on Space Weather Events

Measuring the Impact

% of the Total number of papers published on "equatorial ionosphere" by African scientists (first author African working in Africa) (*source Web of Science Core Collection*)



From 2010 to May 2019: 86% of the papers written by African scientists trained trough ICTP-BC partnership activities

2018-2019* means from January 2018 to May 2019

African Success Stories – just a few of many

Dr. Babatunde Rabiu
Director NASDRA
1st President, **African Geophysical Society**
Delivered the 70th inaugural lecture
at Federal University of Technology, Akure

Dr. Baylie Damtie
Former President Bahir Dar University
President Kepler University, Rwanda

Dr. Melesseuw Nigussie
Bahir Dar University – first PhD recipient
ICTP STEP Program // AGU Award Winner

PhDs Awarded to former participants
Dr. Joseph Olwendo, Kenya
Dr. Amira Shimeis, Egypt
Dr. Ibrahim Salem, Egypt
Dr. John Bosco Habarulema, Uganda
Dr. Daniel Okoh, Nigeria
Dr. Patrick Sibanda, Zambia
And others…





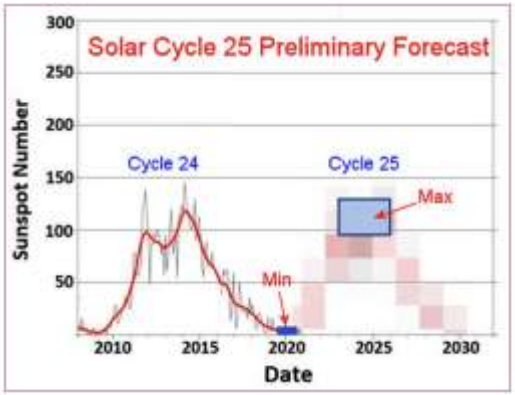


What's next?

Workshop on Ionospheric Forecasting for GNSS Operations in Developing Countries: Findings and Challenges

May 27 – May 31, 2018
The Abdus Salam International Centre for Theoretical Physics

The 11th Workshop – A larger program open to all countries. Featuring many Presentations from former participants.



2020 - West African Workshop on GNSS and Space Weather

October 2020
UN Affiliated Regional Centre for Space Science and Technology Education, Rabat, Morocco

ICG International Committee on Global Navigation Satellite Systems

Thank you and we hope to see you at a future workshop!

ICTP CALIBRATED TEC service

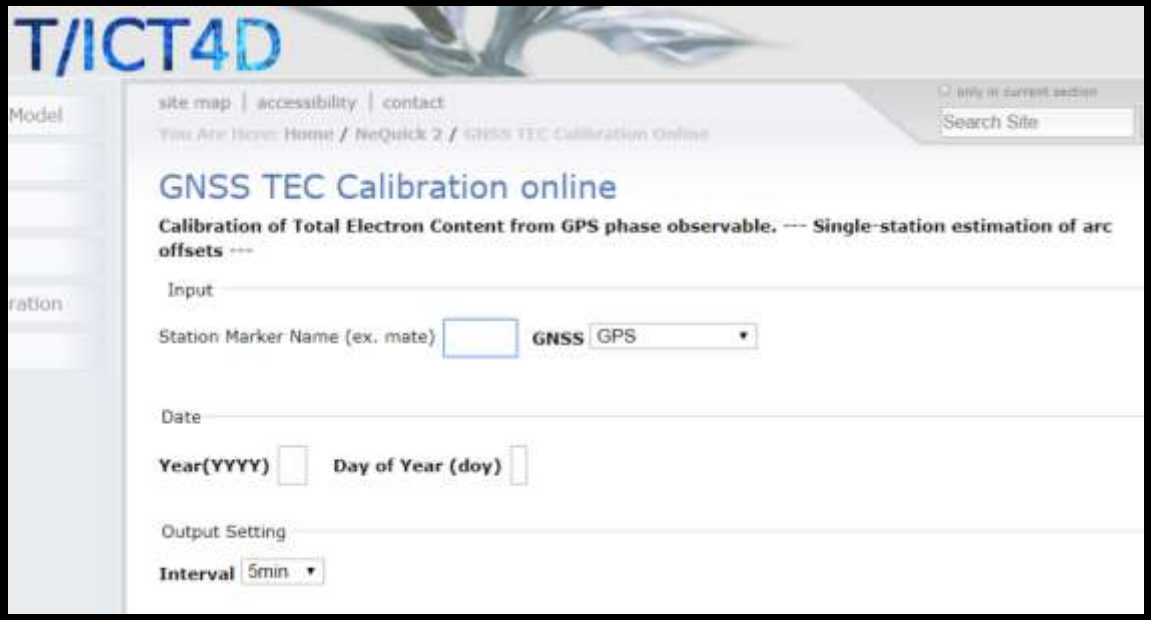
Sharing Data To Facilitate Research

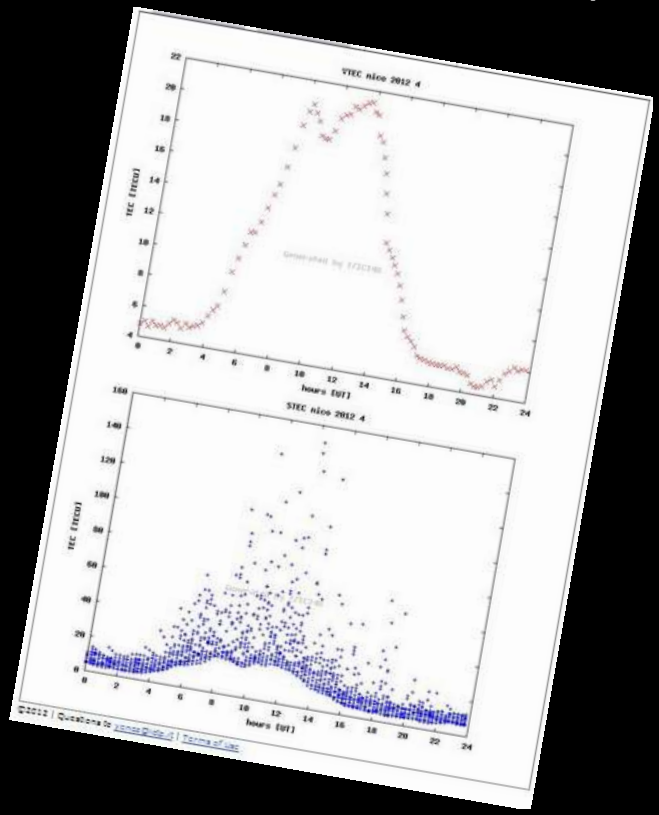
GNSS TEC CALIBRATION online - ICTP T/ICT4D

CALIBRATION of TEC from GPS/GLONASS technique
(single station estimation of arc offsets) developed by L. Ciraolo (ICTP T/ICT4D)

- Executable program distributed on demand and during ICTP activities.
- A web front-end that allows the automated processing and calibration of a single day of any station of the main GNSS networks (IGS, CORS, GARNER, UNAVCO).

http://t-ict4d.ictp.it





NEW Single Station TEC CALIBRATED SERVICE

(A joint effort of the ICTP T/ICT4D Laboratory and the ICT Section)

- Open data sets using FAIR standards (Findable, Accessible, Interoperable and Reusable).
- Coverage: initially all available IGS stations.
- Calibrated TEC data availability: best effort for all stations up to 5 days before present epoch.
- ICTP repository and possible mirrors (Africa, Asia, US).
- News and Updates: tec-updates@lists.ictp.it

TEAM: S. Radicella – C. Onime – L. Sitz
L. Ciraolo – K. Alazo-Cuartas – Y. Migoya-Orué