Report from 2024 COSPAR Capacity Building Workshop on the International Reference Ionosphere

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The 2024 COSPAR Capacity-Building Workshop (CCBW) on the International Reference Ionosphere (IRI) was held in Kilifi, Kenya during September 2 – 13, 2024, expertly organized locally by Dr. Joseph Olwendo and his team from Pwani University. The workshop was supported by COSPAR and by the Kenyan Space Agency. Additional funds were provided by URSI and SCOSTEP and Pwani University provided the administrative and secretarial support.

In response to the official announcement of the workshop in early 2024 we had received applications from 69 students, and young researchers, mostly from African countries, to participate in the workshop. Out of the 69, 35 were selected based on an evaluation of their submitted CVs, Letters of Recommendation and Research Plans. The final selection included attendees from eight African countries: Kenya, Egypt, Nigeria, Uganda, Tanzania, Ghana, South Africa, Ethiopia. One selected Kenyan student accepted the invitation but did not come to the meeting and no explanation was provided. The 34 attending students and young scientists were: Mostafa Hegy, Egypt; Nahum Maundu, Kenya; Davis Athwart, Kenya; Kisembo Francis, Uganda; Khanyile S. Lionel, South Africa; Mary Dusabe, Kenya; Athman Masoud, Kenya; Mefe Moses, Nigeria; Jonah Chepkurui, Uganda; Hellen Babirekere, Uganda; Ola Abu Elezz, Egypt; Awuor O. Adero, Kenya; Geovian Stower, Kenya; Robert Sylivanus Tanzania; S. Otoo Lomotey, Ghana; Zipporah Njeri, Kenya; Hezekiah Cherop, Kenya; Jie Wu, China; Ahmed Yassen, Egypt; Adam Fron, Poland; Wilberforce Muniafu, Kenya; Malkia Kelelue, Kenya; Ifeoluwa Adawa, Egypt; Shunzu Gao, China; Alicreance Hiyadutuje, South Africa; Solomon Degefa, Ethiopia; Temitope Ojebisi, Nigeria; Harold Safary, Kenya; Kibrop Webber, Kenya; Aghogho Ogwala, Nigeria; Joan Tanin, Kenya; Edwin Odhoch, Kenya; Bruno Kyamulesire, Uganda; Hagar Awad, Egypt. The student from Poland and the two Chinese students were self-payers. With only 10 female students, the gender distribution (29.4% female) was not as balanced as in earlier COSPAR-IRI Workshops. The percentage corresponds to similar numbers at African universities (Google AI Overview).

During the first week tutorials, lectures and hands-on demonstrations taught the students the basics and recent advances in observation techniques and modelling approaches for the Earth's ionosphere. An important goal of the workshop was to familiarize the students with the access to and usage of ionospheric data sets and models so they will be able to continue their research interests at their home institutions. The lectures, tutorials and hands-on demonstrations were given by 10 lecturers:

Shigeto Watanabe, *Hokkaido University, Sapporo, Japan*
Ionosphere – An Introduction.

Dieter Bilitza, *George Mason University, Fairfax, USA*
IRI-Introduction and latest developments

John Bosco Habarulema, *SANSA, Hermanus, South Africa*
Ionosondes and the measurements they take
GIRO and GAMBIT: access to ionosonde data.

Shunrong Zhang, *MIT, Boston, USA*
Incoherent scatter radar and ionospheric studies

Access to incoherent scatter data.

Andrzej Krankowski, *University of Warmia and Mazury, Olsztyn, Poland*

GNSS data and ionospheric studies

Access to GNSS data.

Vladimir Truhlik, *Institute for Atmospheric Physics, Prague, Czech Republic*

Representation of plasma temperatures in IRI

Representation of ion composition in IRI

Access to satellite data.

Haris Haralambous, *Frederick University, Nicosia, Cyprus*

Radio Occultation & access to COSMIC data.

Joseph Olwendo, *Pwani University, Kilifi, Kenya*

Low latitude electrodynamics, scintillation, Spread F.

Jia Yue, *Community Coordinated Modeling Center (CCMC), NASA/GSFC, Greenbelt, USA*

A general description and introduction to CCMC

Min-Yang Chou, *CCMC, NASA/GSFC, Greenbelt, USA*

IRI at CCMC

The two CCMC lecturers were self-payers. The airfare of one USA lecturer was funded by NASA.

Lectures in the morning and team work in the afternoon

The 34 selected students, were divided into 7 groups and each team received a specific research problem to be studied during the 2-week meeting. Each team had one of the lecturers as their main advisor, but was free to ask help from other lecturers as well. Each project was related to an ionospheric modelling problem that required the students to review the provided problem-related papers, to download data from some of the sites explained in the tutorials, and run some the online models shown during the hands-on demonstrations. The first week ended with a dry run where each team presented their results so far and got feedback from the lecturers.

The workshop was held at the Mnarani Hotel not far from Pwani University. The hotel offered a special full-board rate for Pwani university events and had excellent conference facilities and management support. The full-board included breakfast, lunch, dinner, tea/coffee/snacks for the session breaks and use of the conference facilities. It was especially

important that the hotel had promptly responding generators because there were quite a number of black-outs during talks.

Group picture of students and lecturers

On Wednesday afternoon an excursion was organized for the students and lecturers to the Gede Ruins about 35 km in the North of Kilifi. Gede is a UNESCO World Heritage site. It is an Arab-Swahili Islamic settlement from the eleventh century that has been intensely excavated and studied.


Excursion to the Gede ruins

The CCBW meeting was combined with an IRI expert meeting during the second week giving the students an opportunity to attend an international science meeting, for some the first time, and an opportunity to present a talk or poster at the meeting about their own research. Eleven of our students gave talks and one presented a poster. It was also a great opportunity to talk about potential post-doc positions. The IRI meeting was attended by 76 participants and included 46 talks and 10 Posters in sessions on ‘IRI and Data Assimilation, ‘Storm Effects’, ‘Irregularities’, ‘New Inputs for IRI’, TEC and Topside’, ‘Plasma Bubbles and Scintillations’, ‘F-peak’, ‘Plasmasphere’, ‘Plasma Temperatures and Ion Drift’, ‘Posters’, ‘Final Discussions’. During

Group picture of the IRI workshop participants.

the Final Discussions session several improvements for the next version of the model were discussed and it was decided to include the new models for the occurrence probability of sporadic-E, for electron temperature, and for the plasmaspheric extension of the electron density profile, that were all presented during the meeting. Two new members were invited and accepted to become members of the IRI Working Group: Dr. Joseph Olwendo (Pwani University, Kenya) without whose untiring effort and dedication before, during and after the meeting this workshop would not have been possible; Dr. Alessio Pignalberi (INGV, Rome, Italy) has made important contributions to the modelling of the IRI electron density in the topside and bottomside. There were also two short presentations about the COSPAR-IRI 2025 Workshop that is planned for October 2025 at ICTP, Trieste, Italy and about a proposal to hold the 2027 COSPAR-IRI Capacity Building Workshop at Wuhan University in Wuhan, China. A very moving memorial for Dr. Lee-Anne McKinnell was presented by John Bosco Habarulema with remembrances from the audience. Lee-Anne, who passed away on 19 August 2023, was the SANSA Space Science Managing Director. She was a very active member of the IRI Working Group and its Chair from 2010 to 2014. She had organized IRI Workshops in Grahamstown in 2003 and Hermanus in 2011.

First Place Team (from left to right): Haris Haralambous (Advisor), Kisembo Francis (Uganda), Mefe Moses (Nigeria), Nahum Maundu (Kenya), Mostafa Hegy (Egypt), Wilberforce Muniafu (Kenya), Joseph Olwendo (LOC). **PROBLEM:** Study the occurrence probability of sporadic-E for future inclusion in IRI.

The students continued their work during the second week and presented their project results at the end of the second week to the full IRI Workshop audience. Three senior scientists served as judges evaluating the project work, results, and presentation of the seven groups. The first to fifth placed teams received the Mandana Sigaroudi Young Scientist Awards which, thanks to the generous contribution by the award sponsor, include a monetary award.

Left picture: **2nd Place Team** (from left to right): D. Bilitza (Advisor), S. Degefa (Ethiopia), M. Kololuo (Kenya), T. Ojebisi (Nigeria), A. Hiyadutu (South Africa), K. Webber (Kenya). **PROBLEM:** Compare the IRI auroral boundary model with Ovation and other models.
Right picture: **3rd Place Team** (from left to right): E. Odhoch (Kenya), J. Tanin (Kenya), J.B. Habarulema (Advisor), H. Awad (Egypt), B. Kyamules (Uganda), A. Ogwala (Nigeria). **PROBLEM:** Spread-F climatology in IRI is limited to the American sector. Study other longitude sectors.

Left picture: **4th Place Team** (from left to right): D. Bilitza (MO) I. Adawa (Egypt), H. Safary (Kenya), D. Athward (Kenya), J. Olwendo (LOC), not shown: S. Gao (China), S.-R. Zhang (Advisor). **PROBLEM**: Compare the bubble model of Stolle et al. (2024) with satellite data and evaluate the model for future use in IRI.
Right picture: 5**th Place Team** (from left to right): D. Bilitza (MO), H. Cherop (Kenya), Z. Njeri (Kenya), S.O. Lomotey (Ghana), A. Yassen (Egypt), J. Olwendo (LOC), not shown: J. Wu (China), J. Yue & M.-Y. Chou (Advisors). **PROBLEM:** Use CCMC systems to study the relationship between IRI and NRLMSIS parameters and discuss how well this agrees with experimental data.