The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

SMR 2333-33

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)

11 April - 1 May, 2012

AMISR Technology: Possibilities for Africa

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Radar Instrumentation in the African Sector: Why and How?

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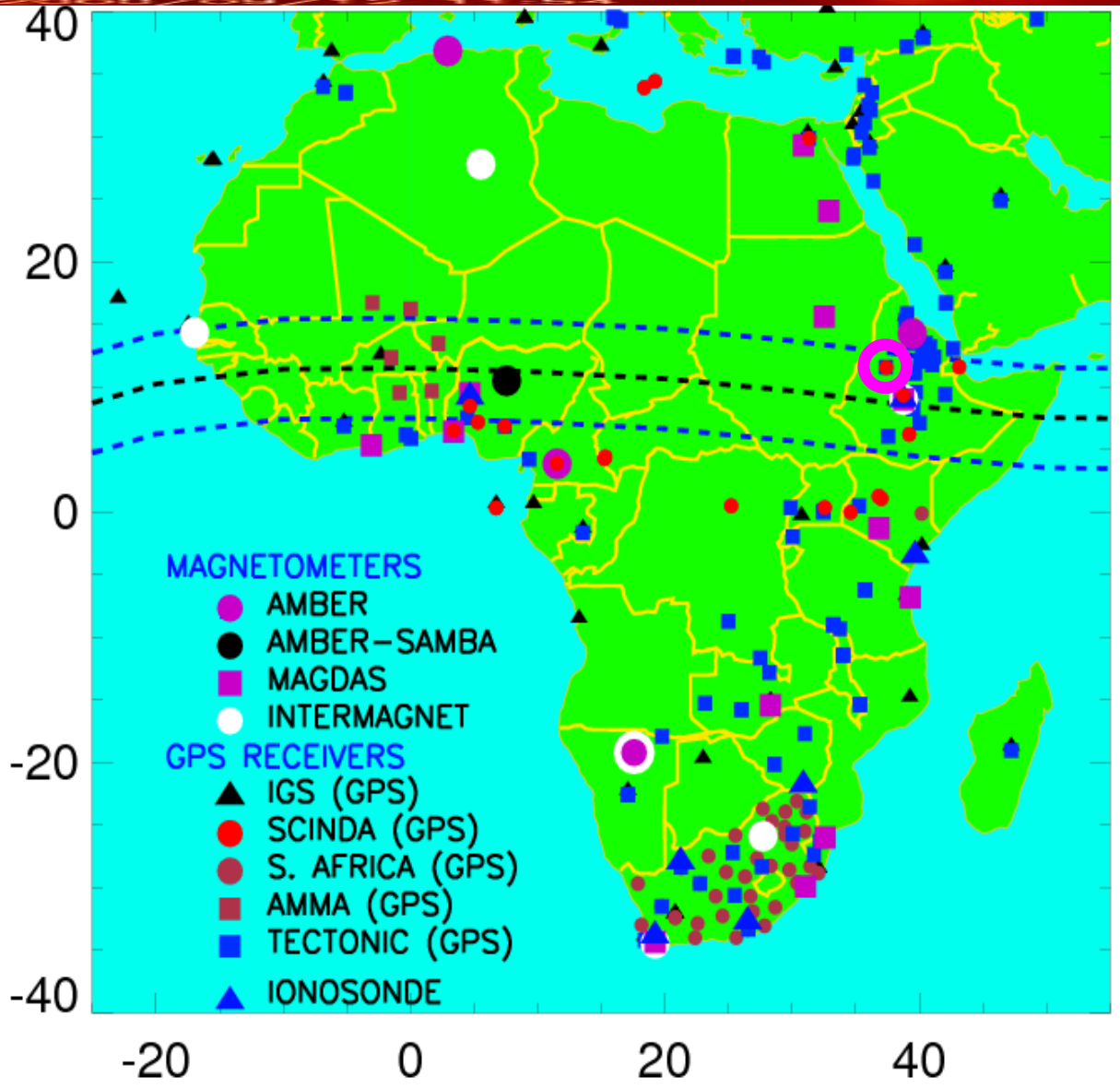
Instrumentation in Africa

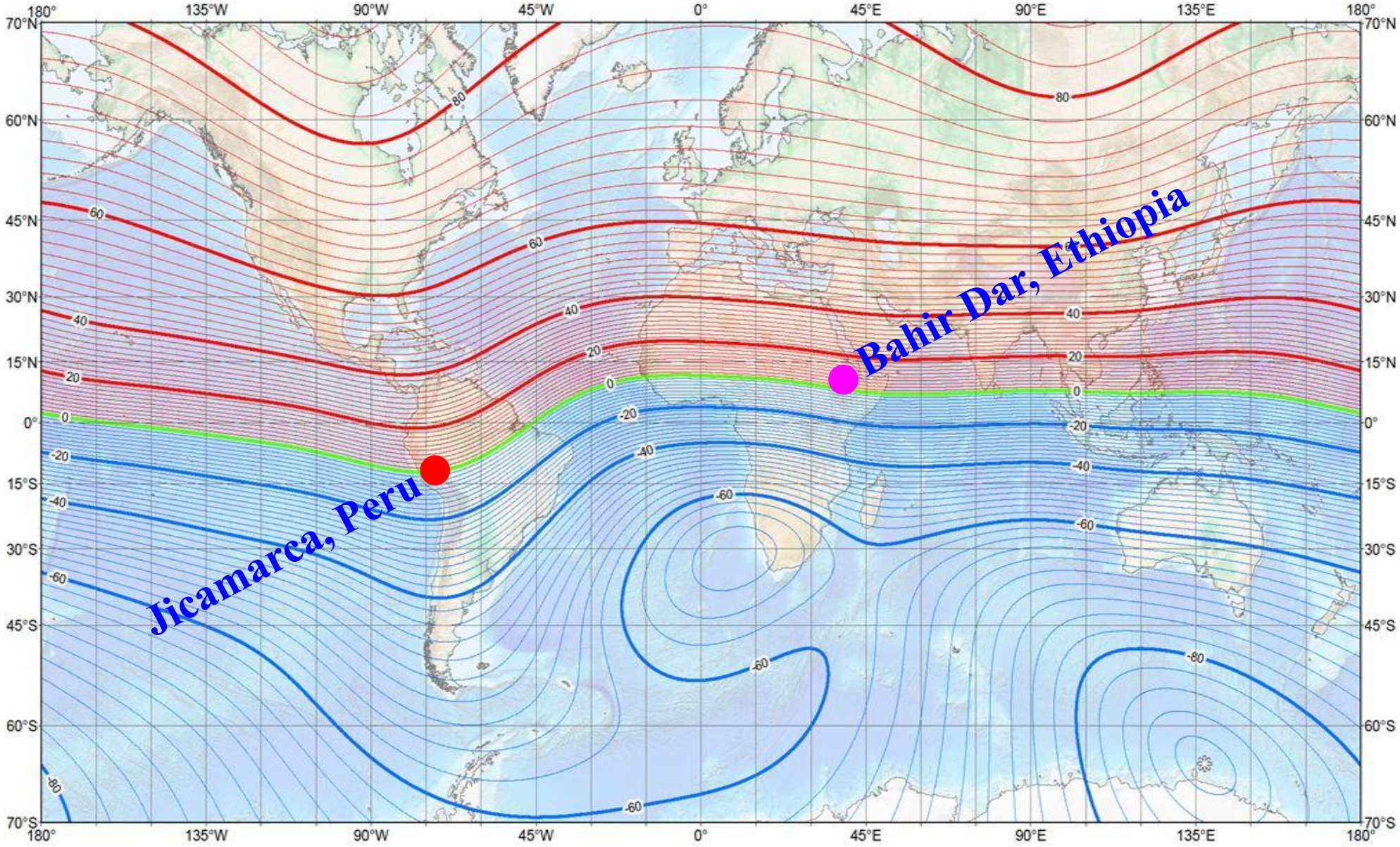


Instruments Network: Five years ago

Instruments Network: Present

Possible AMISR ???

Why the location is important??

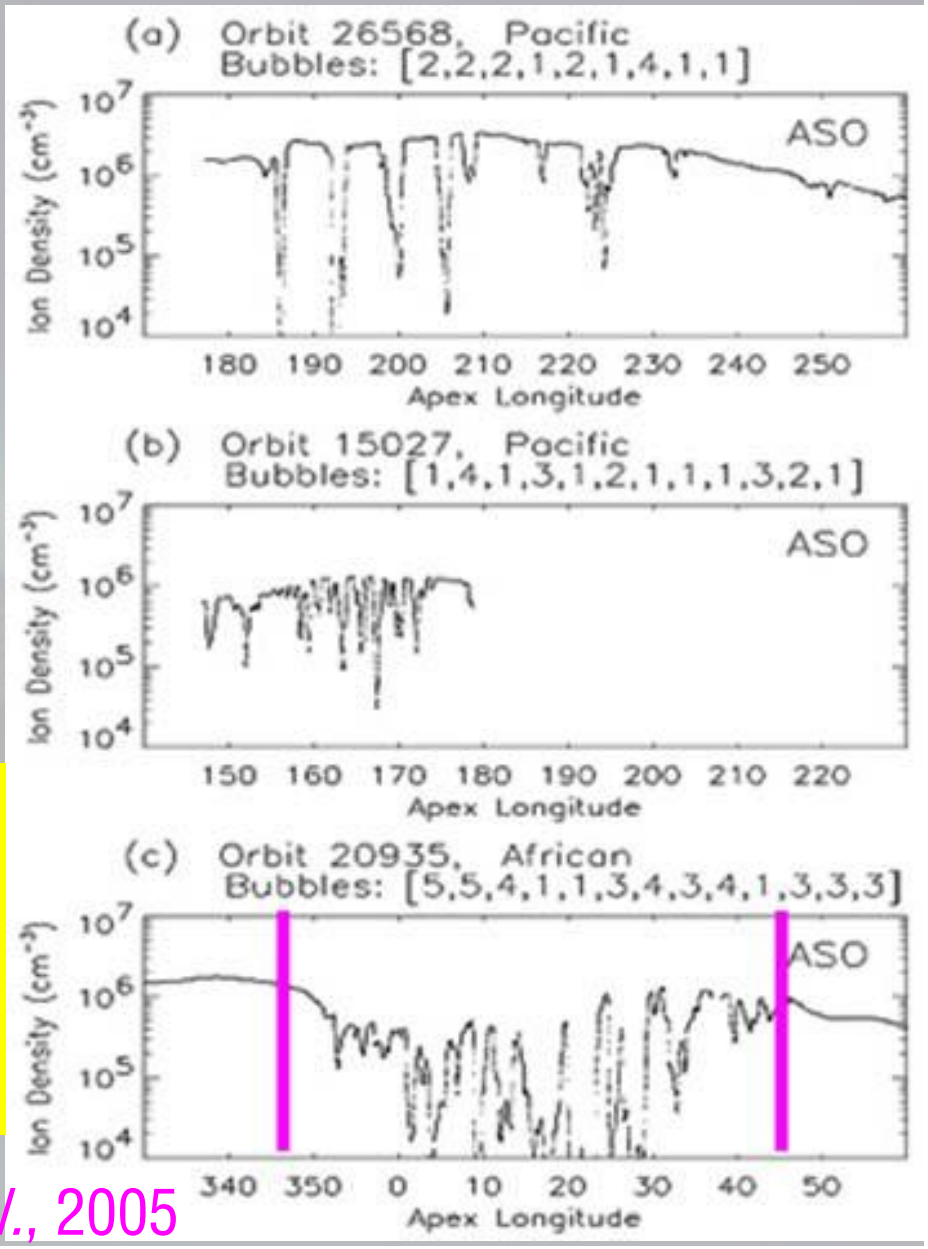


Why AMISR in Africa? (AEE Obsr.)

Satellite observations exhibit unique bubble characteristics

- Bubble envelope frequently shows very large deep and wider longitudinal extent in the African sector compared to other longitude sectors?

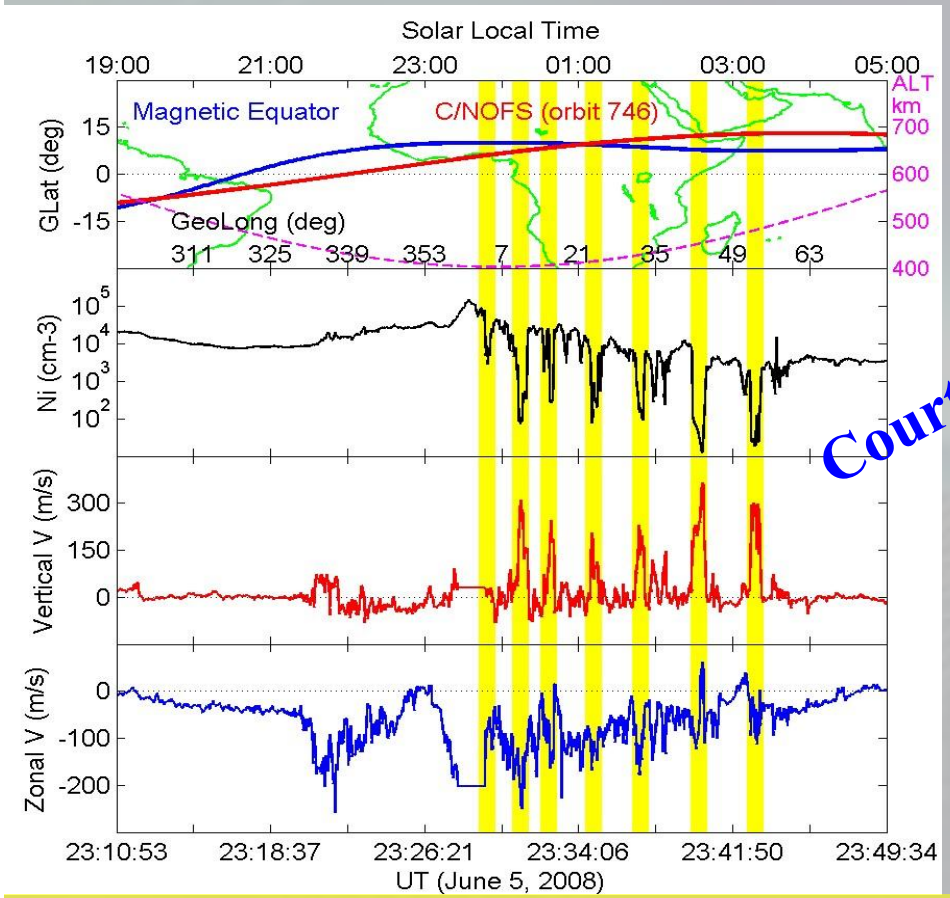
- That is why we need AMISR in Africa to understand the physics behind this unique structures

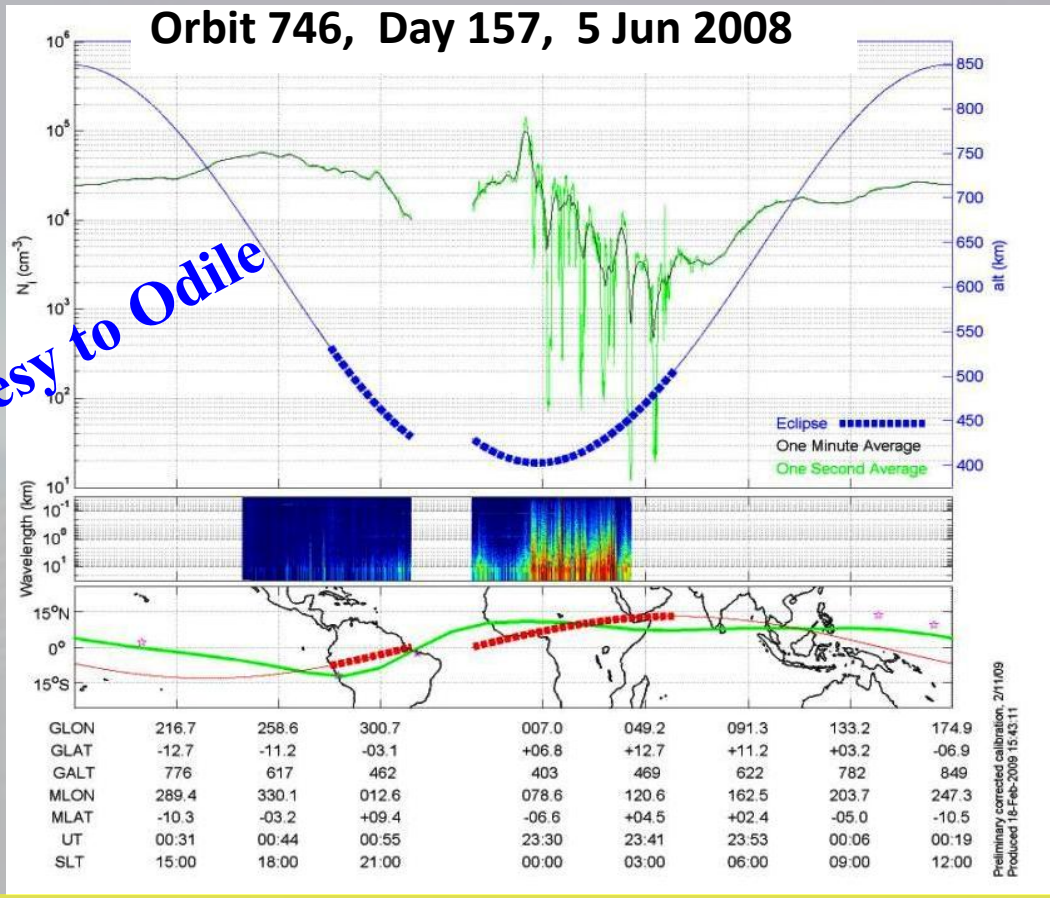


Hei et al., 2005

Why AMISR in Africa? (C/NOFS Obsr.)

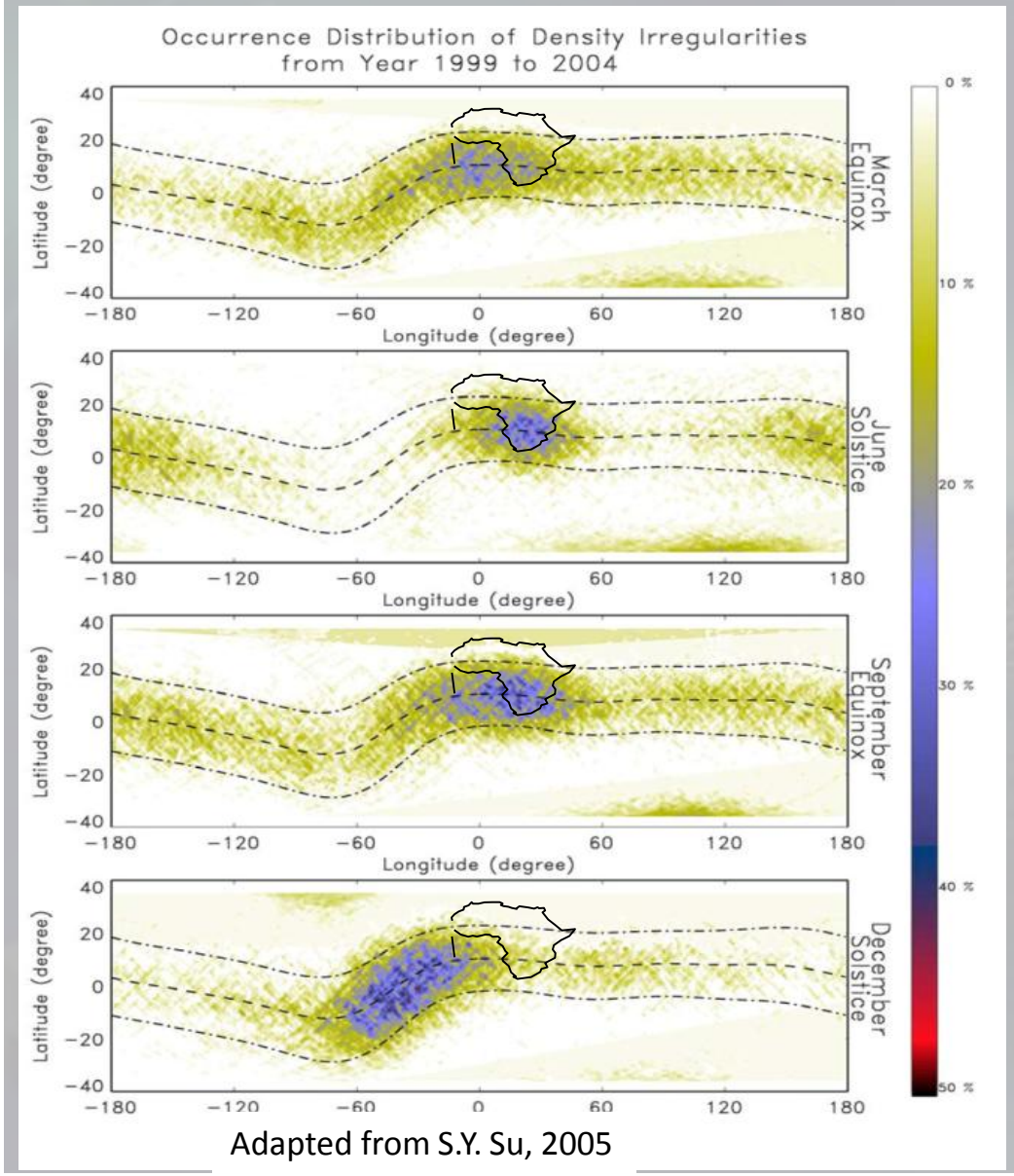
Equidistant Equatorial Plasma Bubbles (C/NOFS)



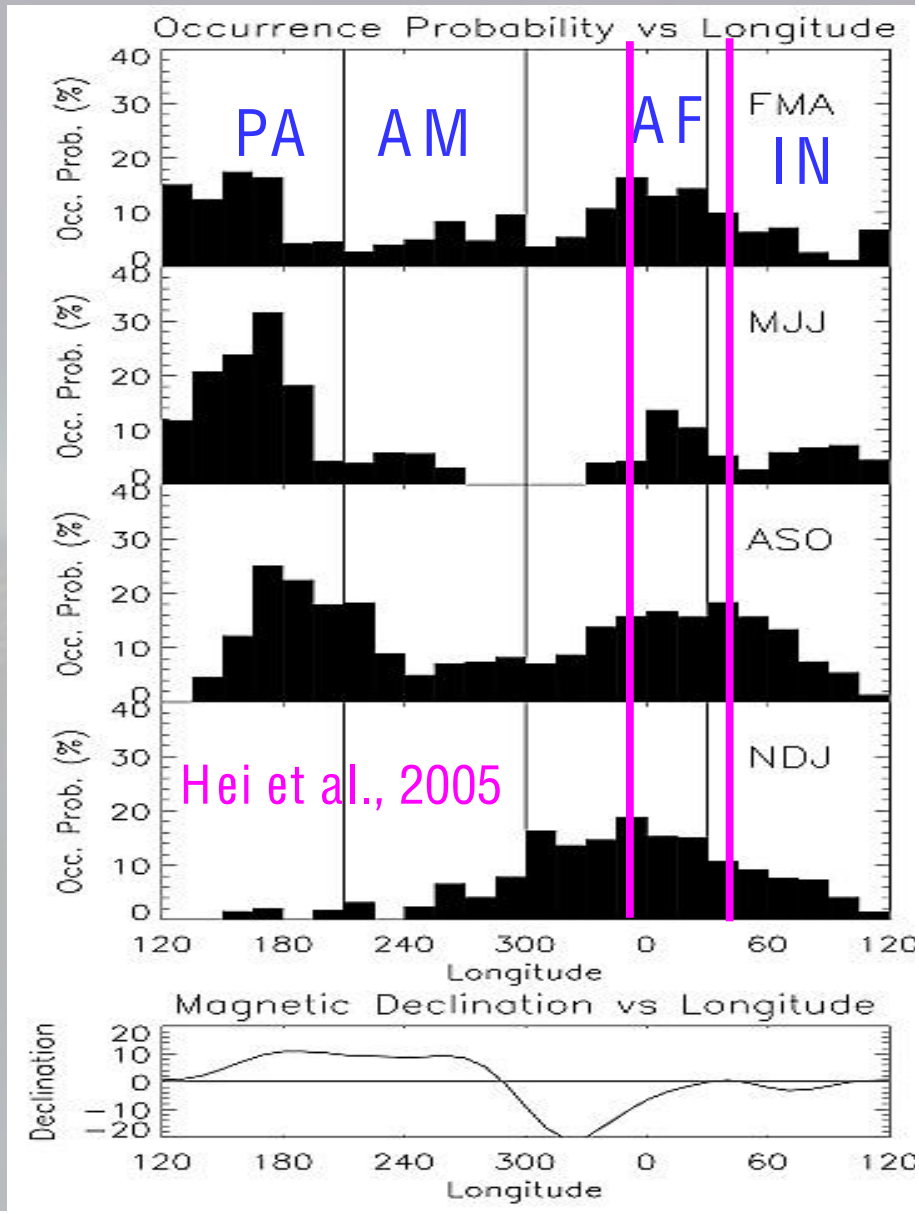


Upward ion velocity (measured from VEFI) reaches 300 m/s in the set of almost equidistant EPBs, separated by ~ 1000 km (8.1°) in longitude. During earlier orbit (Orbit 745), waves were present which could have triggered the EPBs, but they are longer (λ ~ 10.3°) and only 2 waves are apparent, thus the equidistant EPBs may not have been seeded by these waves.

Why AMISR in Africa? (ROCSAT & AEE Obsr.)

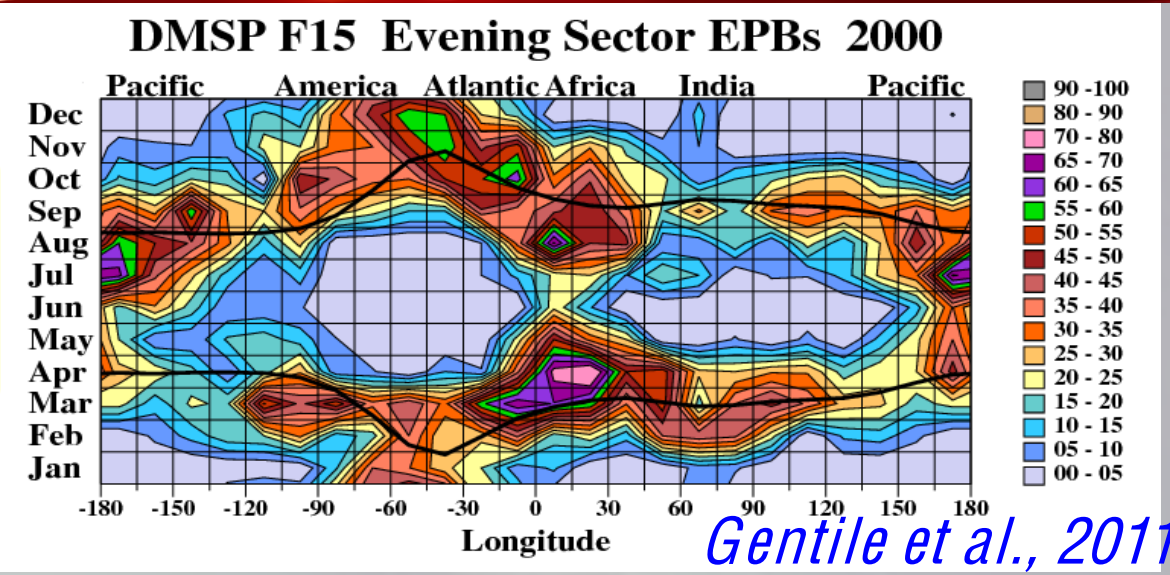


Adapted from S.Y. Su, 2005



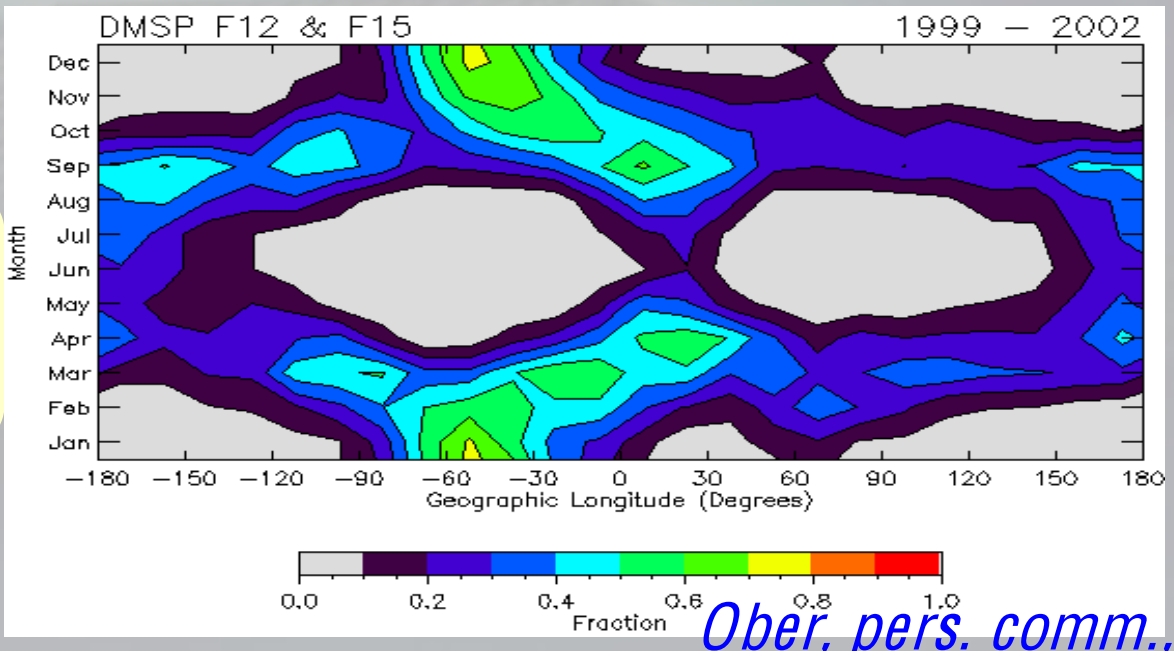
Why AMISR in Africa? (DMSP Obsr.)

In Africa (Long ~ -20° to 52°) dusk irregularities seen almost all year at solar max.



Gentile et al., 2011

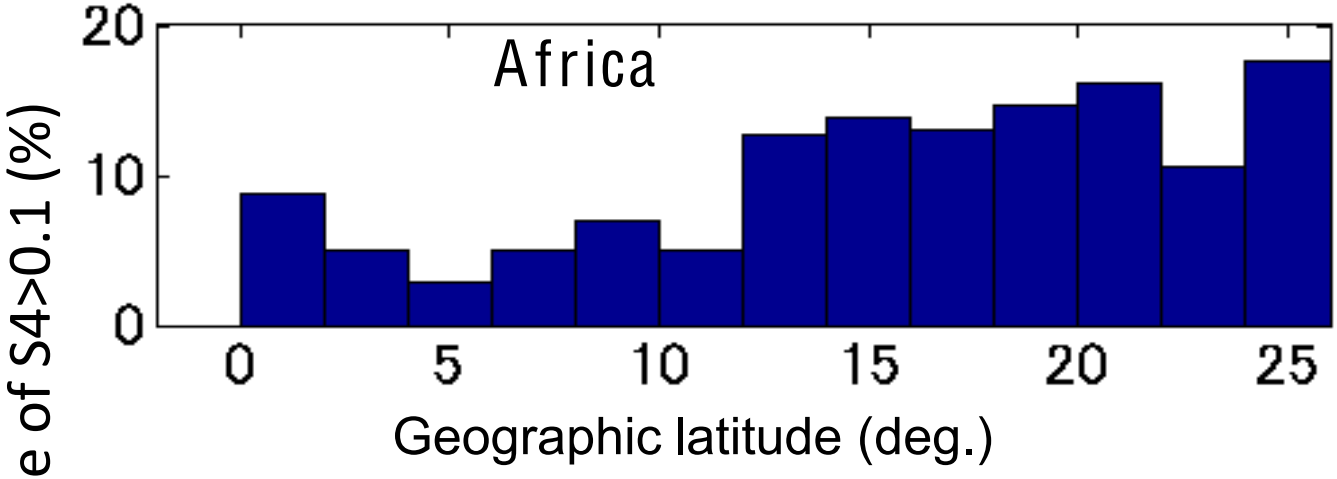
Plot of dn/n from DMSP similar to the plot above.

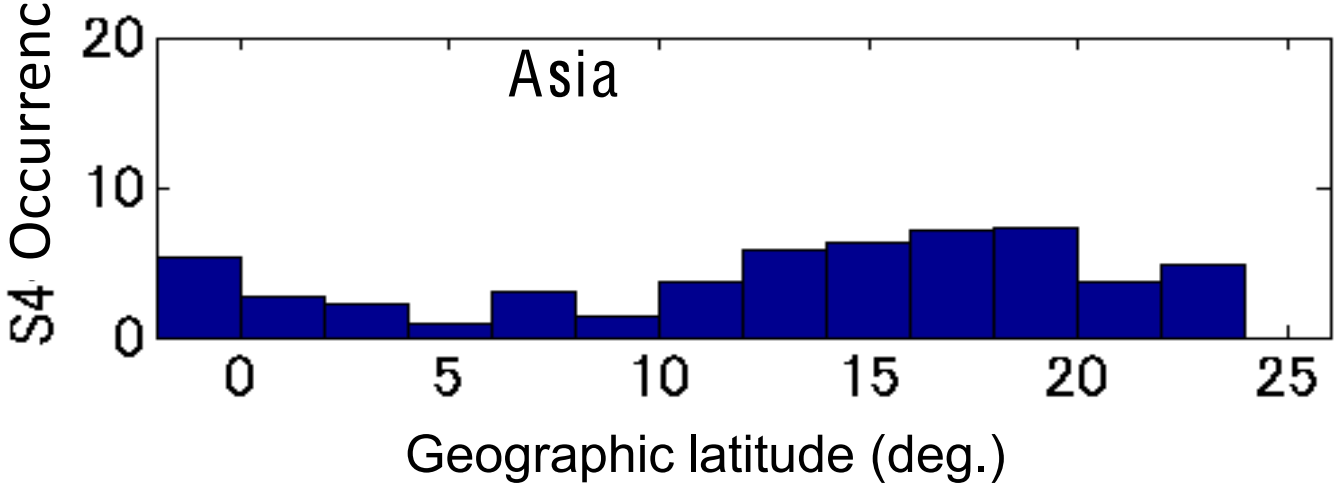


Ober, pers. comm., 2012

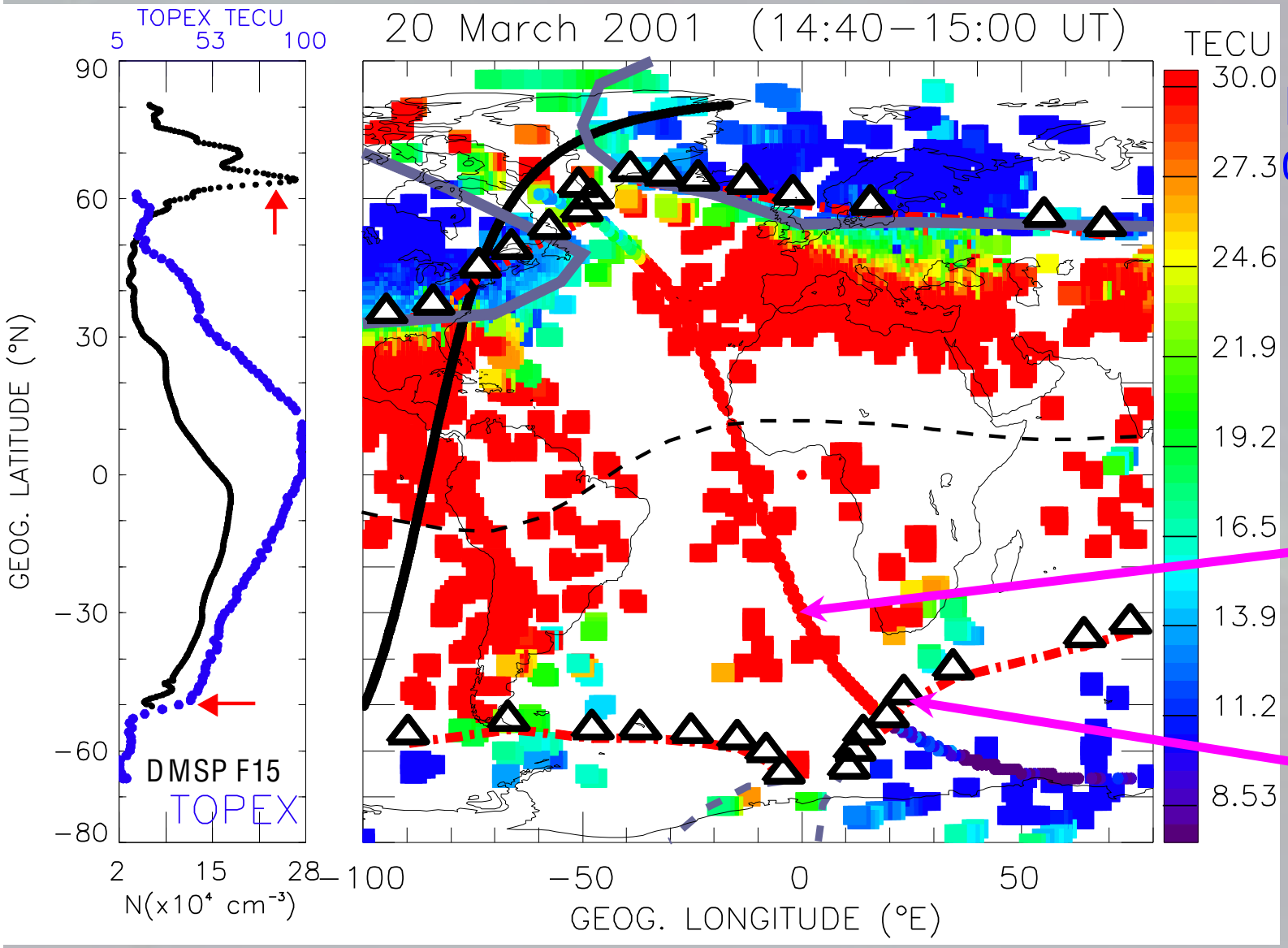
Why AMISR in Africa? (COSMOS Obsr.)

Latitudinal variation of S_4>0.1 occurrence (from paths of COSMOS satellites) courtesy of M. Yamamoto





SED/Plume base over Africa



Madrigal TEC database

TOPEX pass

Plasmapause position from IMAGE EUV

Yizengaw et al., 2008

Why Ethiopia??

- Topside, heat transport, photoelectrons, and the anomalies, ESF, dynamo efficiency, and thermospheric winds, equatorial electrojet, the E region, MLT winds .... other mysterious and puzzling phenomena .....
- *To one degree or another, all of these phenomena are influenced by the regional geomagnetic field, its declination, and the proximity of the magnetic to the geographic equator.*

D. Hysell

Questions that need to be answered by AMISR

- Why are ionospheric irregularities in Africa unique? More frequent, large scale bubble properties (zonal width, depletion level, and spacing)?
- Why do depleted plasma regions (or bubbles) penetrate to higher altitudes in the African sector? .
- Why is the ESF phenomenon much deeper and more active throughout the year in the African region as compared to other longitude sectors?
- Why is a very intense and widely separated equatorial ionospheric anomaly (EIA) often observed in the African sector?
- What is the role of the neutral atmosphere, including winds, tides and waves, in creating the unique equatorial electrodynamics of the African ionosphere?

Steps to Proposing New AMISR deployment locations

- Identify a scientifically compelling location.
- Convene a workshop or other venue for soliciting broad community input.
- Prepare a document describing the scientific rationale for the location
- Conduct a site survey to investigate logistical aspects, partnering opportunities, student participation, etc.
- Work with NSF throughout, particularly with regard to funding strategies

AMISR in Africa Societal Benefits

- Placing the AMISR in Africa will attract scientists worldwide and rapidly position Africa at the top of global ionospheric research, creating strong international collaborations, recognition and opportunities for the African Space Science Community
- AMISR in Africa has also direct impact in advancing space science research into Africa by establishing and furthering sustainable research/training infrastructure within Africa so that more young scientists will be educated in their own country.
- It will also play a vital role in the future socioeconomic development of Africa.
- It will spark interest into the young African generation and encourage them to do science and technology, which is the back bone for the economic development of any country.

Why Ethiopia is chosen as home for AMISR in Africa

- **Its geographic location:** Bahir Dar is located approximately the same geomagnetic latitude as Jicamarca but the two locations has different excursions between the geomagnetic and geographic equator. Thus, placing AMISR in Bahir Dar will provide great opportunities to the scientific community for new science investigations.
- **Operational sustainability:** Operating AMISR sustainably requires well trained local personnel, and Bahir Dar University has already ISR specialized scientist (Dr Baylie Damtie).
- **Space Science research activity:** Bahir Dar University is also one the two universities, next to Addis Ababa University, in the country that has space science research and education activities.
- More importantly AMISR in African is not only Ethiopian but it is for the entire African nations and are welcome to take part.

Funding Opportunities for AMISR in Africa development and deployment

- MRI (Major Research Instrumentation).
- DURIP (Defense University Research Instrumentation Program)
- Mid-size Infrastructure funding opportunities (GEO, AGS, OPP)
- MREFC (Major Research Equipment and Facility Construction)
- International Partnering (Canada Foundation for Innovation, SuperDARN)
- Ethiopian government (there is some green light)

Other additional Funding Opportunities for AMISR in Africa development and deployment

Partnerships for Enhanced Engagement in Research (PEER):

In collaboration with NSF-funded scientists at U. S institutions

- U. S. Agency for International Development (USAID) will provide support for scientists in developing countries for:
  - ✓ Laboratory improvement
  - ✓ Equipment
  - ✓ Education
  - ✓ Research

- AMISR project may qualify the requirements of PEER funding.

What Bahir Dar University already offered for the success of AMISR project

- Tax to import AMISR systems shall be covered by BDU.
- Land shall be provided for free
- Focorflat construction
- Utilities (water, power, internet) shall be provided (depending on the location)
- Security.
- All necessary logistical support
- Technical maintenance (after building capacity)

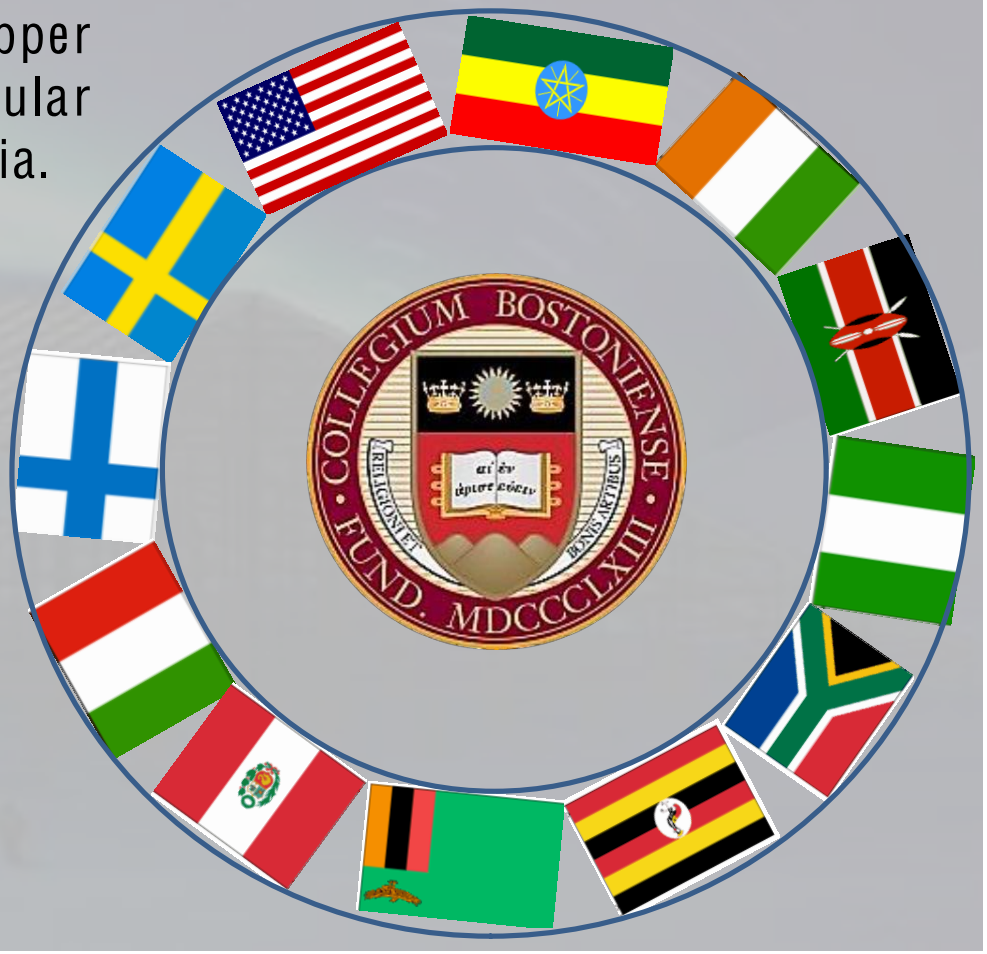
Where are we right now?

- Identify a scientifically compelling location. (Done)
- Convene a workshop or other venue for soliciting broad community input. (Done)
- Prepare a document describing the scientific rationale for the location. (we are in the middle)
- Prepare proposals for different funding agencies. (will be started soon)
- Conduct a site survey to investigate logistical aspects. (Schedule for November 2012)
- Work with NSF throughout, particularly with regard to funding strategies and partnering opportunities. (on going task)

AMISR in Africa Workshop

Boston College, 1-3 March 2012

Objective: The prime objective of the workshop is to discuss and identify the scientific and societal benefits of developing a new international upper atmospheric facility, Advanced Modular Incoherent Scatter Radar (AMISR), in Ethiopia.



ORGANIZERS

Endawoke Yizengaw, Boston College
Anthea Coster, Massachusetts Inst. of Technology
Mark Moldwin, University of Michigan

SPONSORS

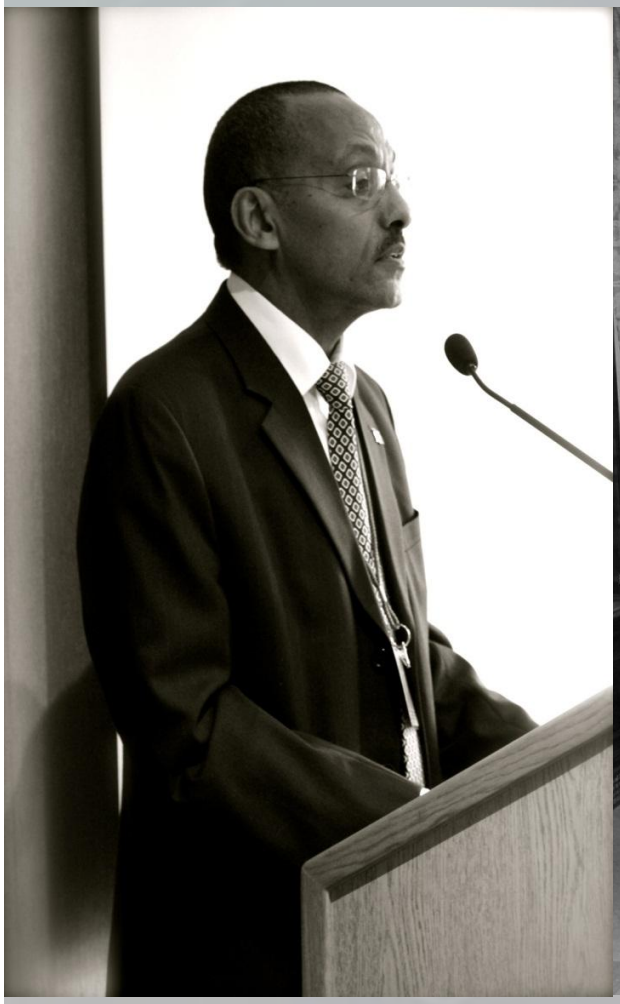
National Science Foundation

Boston College

Goals of AMISR in Africa workshop

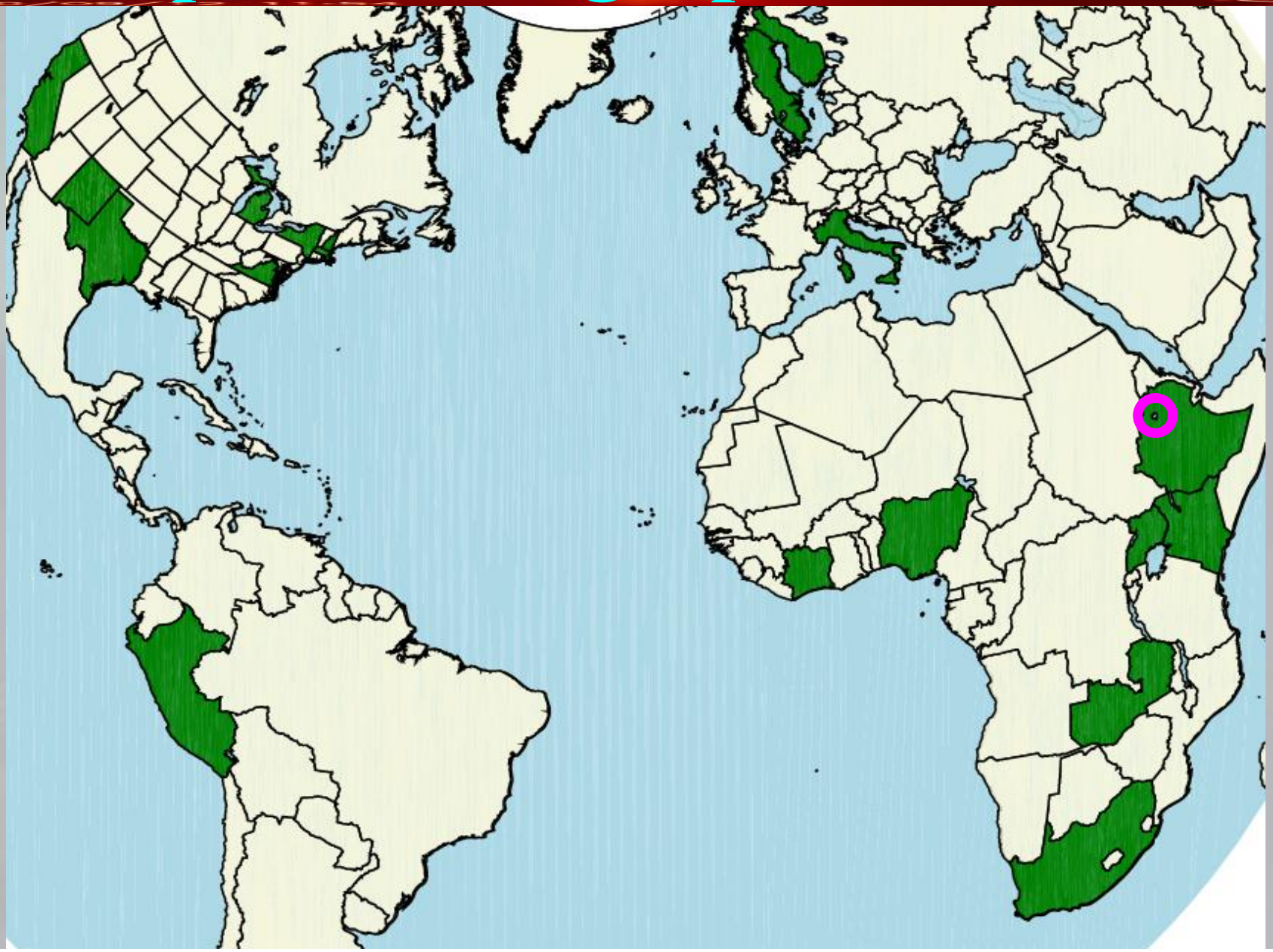
- What scientific questions need an ISR in Africa to be answered?
- To identify the scientific and societal benefits of developing a new AMISR in Ethiopia
- Are there any feasible technical and logistical issues that need to be addressed to satisfy the scientific need and successful deployment of AMISR?
- Are there any feasible international collaborations that could lead to a project to develop the facility

Workshop Participants



More information, including all slides presented at the workshop can be found http://www.bc.edu/sites/amisr

Participants' Geographic Distribution



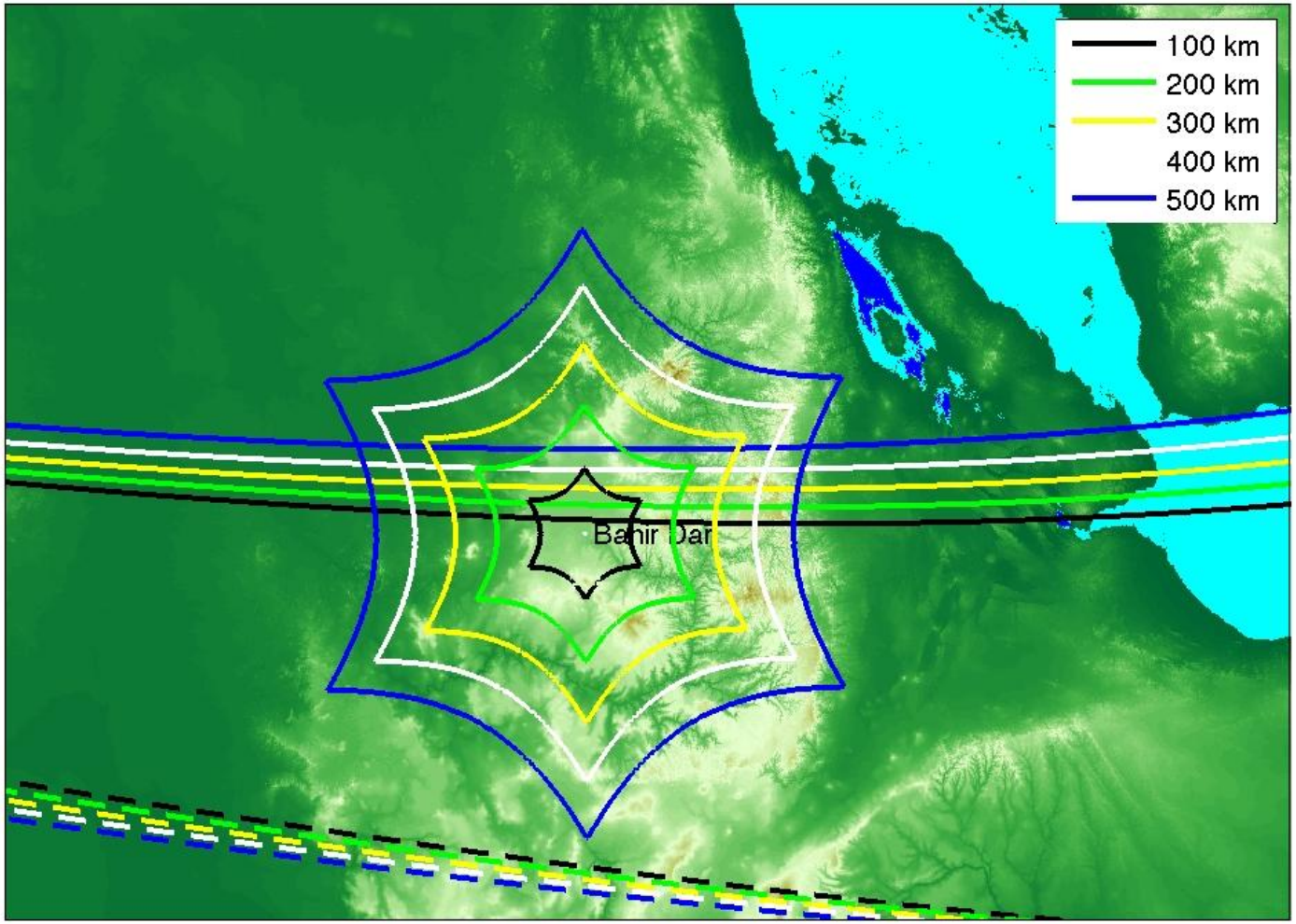
Unexpected results from Norwegian government scholarship program

- **~10 PhD's** (of these 3 PhD in Space Science)
- 30 MSc or more
- Brings Space science culture to Ethiopia
- Instrumentation
- Space Science program (now ~6 PhD and ~15 MSc or more graduate students at BDU and AAU)
- Global citizenship

- The question is, if few scholarships by the Norwegian tax payers can bring such results, what will an AMISR at Bahir Dar does for Ethiopia, Africa, and the world?


Thank you!
2000/09/12 11:54

2015 B-perpendicular Loci



Washera Geospace and Radar Science Laboratory at Bahir Dar University

Washera Geospace and Radar Science Laboratory

- Radar waveform design
- Inverse problems (tomography, decoding)
- East African region ionosphere specification

Oulu University
Boston College
AFRL
ICTP
World Bank