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On ground-based instrumentation for ionospheric research: challenges and opportunities

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Advances in our understanding of physical processes controlling the variability of the Earth's ionosphere and in our ability to better specify these variabilities would benefit from efforts towards new observational capabilities. There are, for instance, outstanding science questions requiring observations with better temporal and/or spatial resolution than currently available. In this talk I would like to argue that engaging in observational efforts has various challenges but also many unique opportunities. I will briefly describe my career path and share some information about a couple of ongoing research efforts that illustrate opportunities and challenges associated with ground-based instrumentation.

My experience with ionospheric physics and instrumentation started during my undergraduate years when I was tasked with deploying ground-based optical (e.g., photometers, airglow imagers) and radio (e.g., riometers, VLF receivers) instruments and analyzing the observations made by them at a branch of the National Institute for Space Research (INPE) in Southern Brazil. This experience led me to the challenge of creating an alternative ionospheric monitoring system that could produce observations less susceptible to weather conditions and to RFI. This challenge was followed by three opportunities: First, preliminary results allowed me to develop a HF system as part of my undergraduate senior design project [1]. Second, it allowed me to realize the type of work that brings me satisfaction and that I would like to contribute with. Third, it gave me the experience and some of the credentials needed to pursue further education related to ionospheric studies using ground-based measurements. For my Masters in INPE, I was tasked with the deployment of specialized GPS receivers and analyses of ionospheric measurements using GPS signals. For my PhD at Cornell University (USA), I had the experience of running experiments and working with analyses of ionospheric measurements using coherent and incoherent backscatter radar systems. Since 2012 I have been a faculty member of the University of Texas at Dallas (UTD).

With respect to ongoing efforts related to ground-based instrumentation for ionospheric research, I will mention that reductions in the cost and increases in the availability of electronics can provide an opportunity for the development of more accessible ionospheric instruments. Engagement in this type of effort can be motivated by the results obtained with commercial off-the-shelf (COTS) GNSS receivers [2]. The increase in availability and reduction in cost of these receivers has allowed the creation of low-cost, easy to install and easy to maintain ionospheric total electron content and scintillation sensors. For junior faculty members, this also provides an opportunity for engagement of students and educational initiatives. The development in observational capabilities made in adjacent research areas can also provide an opportunity for more advanced ionospheric observations. This can be exemplified by the application of new radio-array developments in radio astronomy to expand ionospheric radar observations [3]. In that front, I will present an ongoing effort to augment the radar observations at the Jicamarca Radio Observatory using receiving stations that are based on the design of the radio-array stations of the Long Wavelength Array (LWA) project [4]. While such an effort is certainly a challenge, it will create much needed new observational capabilities for the scientific community and will benefit early career scientists.

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