32nd URSI GASS, Montreal, 19–26 August 2017

The ICEBEAR Radar: A New Fully Digital 50-MHz VHF Bistatic Radar for E-region Radar Observations and Research

Glenn C. Hussey*(1), Devin R. Huyghebaert(1), Kathryn A. McWilliams(1) and J-P. St.-Maurice(1)
(1) Institute of Space and Atmospheric Studies (ISAS), Department of Physics and Engineering Physics, University of Saskatchewan, Saskatoon, SK, Canada

Extended Abstract

The *Ionospheric Continuous wave E-region Bistatic Experimental Auroral Radar* or ICEBEAR radar is a new fully digital bistatic 50-MHz VHF radar for E-region observations and research. The radar group in the Institute of Space and Atmospheric Studies (ISAS) at the University of Saskatchewan has been developing the ICEBEAR radar and it will be deployed into the field for observations in the summer of 2017. This paper will present the scientific motivation for the new radar, the radar design and technical details, and first results if available.

The motivation for the ICEBEAR radar was to produce very high resolution spatial and temporal radar observations of the auroral E-region. The E-region is a very dynamic plasma medium with the two-steam and gradient drift instabilities operative. The improved measurement abilities of the new ICEBEAR radar will provide new detailed physical insight which will help to better understand E-region irregularity physics, for example as recently presented in [1]. The E-region portion of the ionosphere, being the base of the magnetosphere, has both global (ionosphere-magnetosphere system) as well as local phenomena of interest. The currents in the magnetosphere close in the E-region. Field-aligned currents (FACs) and Alfvén waves are phenomena with origins in the magnetosphere which present their *signatures* in the E-region. For example, Alfvén waves (produced by the Alfvén wave resonator) have different time scales from less than a Hertz to periods of tens of minutes — and the high temporal and spatial resolution of the ICEBEAR radar will be able to observe this entire range.

The field of view of the ICEBEAR radar will be situated in the auroral zone at $\sim 58°$N geographic latitude, roughly over Wollaston Lake in northern Saskatchewan, Canada. The bistatic radar configuration was selected to obtain high temporal resolution to meet the scientific objectives. Traditionally bistatic radars had excellent time resolution, but were significantly lacking in range resolution. Now, with easily available accurate timing and advanced signal modulation techniques, bistatic radar configurations are able to obtain simultaneously both excellent temporal and spatial resolution. The bistatic setup allows the radar to transmit and receive continuously for excellent temporal resolution, while advanced signal modulation techniques allow for enhanced spatial resolution. This has been implemented on the ICEBEAR radar, allowing for high resolution maps or *images* of the E-region.

The ICEBEAR radar is a fully digital system. The transmitter portion of the radar system consists of an array of 10 antennas. Each antenna is individually fed with a digitally generated pseudo-random modulation scheme allowing for beam steering of the array and/or multi-mode broadcasting. And each antenna transmitting path is amplified by a 1 kW high power amplifier. The receiver portion of the radar system also consists of an array of 10 antennas. On the receiver side each antenna will be directly digitally sampled and stored, allowing for complete digital post-processing, and therefore flexibility with data analysis, of the received E-region backscatter. First results from the ICEBEAR radar will be presented if available.

References

[1] St.-Maurice, J.-P. and J. L. Chau (2016), "A theoretical framework for the changing spectral properties of meter-scale Farley-Buneman waves between 90 and 125 km altitudes", *J. Geophys. Res. Space Physics*, **121**, 10,341–10,366, doi:10.1002/2016JA023105.