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

Sounders for Ionospheric Science

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Extended Abstract

It is recognised that measuring, monitoring and characterising the ionosphere is important for many applications. There are two main user bases: the first is those interested in trans-ionospheric propagation effects such as scintillation, relevant for GPS locking and accuracy and other space-based applications including radio astronomy. For these users, measurements of the ionospheric (and plasmaspheric) total-electron-content (TEC) and its variations provide most of information needed to correct or adjust for relevant ionospheric effects. The other user base is those interested in the bottomside of the ionosphere, relevant for radio communications in the high-frequency (HF) band, over-the-horizon (OTHR) and HF surface-wave radar, and the people who want to find these HF users. For these users understanding the shape and structure of the iso-ionic contours below the peak ionospheric electron density is of prime importance. For both sets of users, the temporal and spatial variability of the ionosphere is desired.

Although TEC is an important measure of the ionosphere, it is a height-integrated quantity, so does not adequately reflect the state and shape of the bottomside ionosphere. This paper won't deal with trans-ionospheric measures beyond comparisons of disturbance observations.

To measure and characterise the bottomside ionosphere the instrument of choice is the ionospheric sounder, or ionosonde. High-Frequency Radar Branch (HFRB) within the Defence Science and Technology (DST) Group, Australian Department of Defence, has been using ionospheric sounders to study bottomside features for many years. A sounder designed to probe the ionosphere vertically above, termed a vertical incident sounder (VIS), is generally thought of as an ionosonde. Soundings do not need to be vertically directed though. Much use has been made in the past and has seen a recent resurgence of the use of oblique incidence sounders (OIS) where the transmit and receive components are separated by 100s to 1000s of km. HFRB has also made extensive use of backscatter sounders (BSS), also known as a wide-sweep backscatter ionograms (WSBI) in the US community, where the transmit and receive components are nearly co-located but the transmission is designed to propagate obliquely and backscatter from the Earth at distant ranges and be captured by the receiver – analogous to an OTHR without Doppler information and swept in frequency like a sounder. Other sensors, such as channel-probes and the OTHR itself, have also been used by HFRB to study the ionosphere. Recently HFRB has been investigating the use of OIS with angle-of-arrival ability to study disturbance and gradients in the ionosphere and relating these new measurements to the more prolific OIS and VIS observations.

This paper will present some of the recent and some of the historic effort by HFRB to study the bottomside ionosphere using various sounding technologies, including validation of climatological models, ionospheric characterisation for HF communication and real-time ionospheric modeling, and ionospheric disturbance studies.

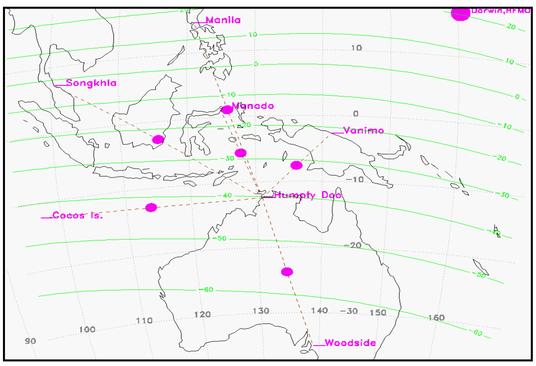

Figure 1 Paths for one of the four receivers used in the HF Channel Characterisation Trial, 2006. Magnetic dip latitudes are shown in green. Filled magenta circles indicate one-hop ionospheric "reflection" points.

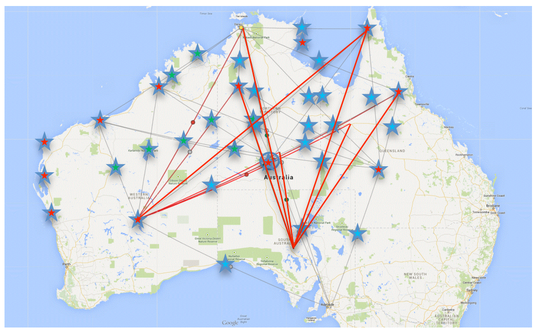

Figure 2 Paths and ionospheric sensor points for the ELOISE study. Stars indicate one-hop or overhead ionospheric "reflection" points.