

# Space-Borne Radio-Sounding Investigations Facilitated by the Virtual Wave Observatory (VWO)

Robert F. Benson<sup>1</sup>, Shing F. Fung<sup>1</sup>, Dieter Bilitza<sup>2</sup>, Leonard N. Garcia<sup>3</sup>, Xi Shao<sup>4</sup>, and Ivan A. Galkin<sup>5</sup>

<sup>1</sup>NASA/Goddard Space Flight Center, Geospace Physics Laboratory (Code 673), Greenbelt, MD 20771 USA  
[robert.f.benson@nasa.gov](mailto:robert.f.benson@nasa.gov) [shing.f.fung@nasa.gov](mailto:shing.f.fung@nasa.gov)

<sup>2</sup>George Mason University/Goddard Space Flight Center, Heliospheric Physics Laboratory, Code 672, Greenbelt, MD 20771, USA [dbilitza@gmu.edu](mailto:dbilitza@gmu.edu)

<sup>3</sup>Wyle Information Systems, LLC/Goddard Space Flight Center, Greenbelt, MD 20771 USA  
[leonard.n.garcia@nasa.gov](mailto:leonard.n.garcia@nasa.gov)

<sup>4</sup>University of Maryland, College Park, MD 20742, USA [xshcn@astro.umd.edu](mailto:xshcn@astro.umd.edu)

<sup>5</sup>University of Massachusetts, Lowell, MA 01854 USA [ivan\\_galkin@uml.edu](mailto:ivan_galkin@uml.edu)

The goal of the Virtual Wave Observatory (VWO) is to provide user-friendly access to heliophysics wave data [1]. While the VWO initially emphasized the vast quantity of wave data obtained from passive receivers, the VWO infrastructure can also be used to access active sounder data sets. Here we demonstrate the application of the VWO capabilities to data from the Alouette/ISIS topside sounders. The sounders were designed to produce analog data records that were displayed in the ionogram format on 35 mm film [2]. This format required manual inspection to convert the ionospheric-reflection traces to topside electron-density profiles Ne(h). Due to cost considerations, not all of the topside-sounder data from this highly successful program, which spanned nearly three decades, were used to produce 35-mm film ionograms. In addition, not all of the 35-mm film ionograms were manually scaled to produce Ne(h) profiles. A data preservation effort, including analog-to-digital conversion of the topside-sounder data, was performed on a subset of the original telemetry tapes to produce a half-million Alouette-2, ISIS-1, and ISIS-2 digital topside-sounder ionograms [3]. The digital format allowed (1) an automatic scaling technique to be developed in order to more efficiently produce topside Ne(h) profiles [4] and (2) efficient data search capabilities (see <http://nssdc.gsfc.nasa.gov/space/isis/isis-status.html>). Here we emphasize the latter capability to demonstrate the desirability of gaining access to the actual ionograms for investigations of both natural and sounder-stimulated plasma-wave phenomena. By this demonstration, we wish to encourage investigators to make other valuable space-borne sounder data sets accessible via the VWO.

1. S. F. Fung, "The Virtual Wave Observatory (VWO): A Portal to Heliophysics Wave Data," *Radio Science Bulletin*, No. 332, March 2010, pp. 89-102.
2. C. A. Franklin, C. A. and M. A. Maclean, "The design of swept-frequency topside sounders," *Proc. IEEE*, 57, 1969, pp. 897-929.
3. R. F. Benson and D. Bilitza, "New satellite mission with old data: Rescuing a unique data set," *Radio Sci.*, 44, 2009, RS0A04, doi:10.1029/2008RS004036.
4. X. Huang, B. W. Reinisch, D. Bilitza, and R. F. Benson, "Electron density profiles of the topside ionosphere," *Ann. Geophys.* 45, 2002, pp. 125-130.