REVEALING SECRETS OF EUROPA'S ICE SHELL, HIDDEN WATER AND PLUME ACTIVITY THROUGH FLYBY RADAR SOUNDING. D.D. Blankenship[1], A. Moussessian[2], K.M. Soderlund[1], C. Grima[1], D.A. Young[1], D.M. Schroeder[2], Y. Gim[2], J.J. Plaut[2], G.W. Patterson[3],[1]Institute for Geophysics, University of Texas at Austin, TX, [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [3]Applied Physics Laboratory, John Hopkins University, Laurel, MD

The Europa Clipper is a NASA mission concept to study Europa, the ice-covered moon of Jupiter, though a series of fly-by observations of the Europan surface and subsurface from a spacecraft in Jovian orbit. The science goal of the Clipper Mission is to "explore Europa to investigate its habitability". One of the primary instruments in the strawman scientific payload is a multi-frequency, multi-channel ice penetrating radar (IPR) system. The IPR will play a critical role in achieving the mission's habitability driven science objectives, which include characterizing the distribution of any shallow subsurface water, searching for an ice-ocean interface and evaluating a spectrum of ice-ocean-atmosphere exchange hypotheses.

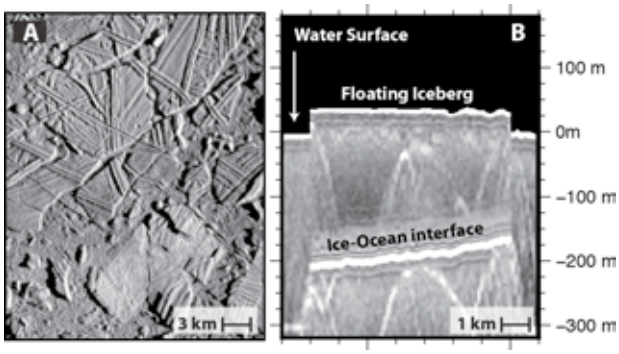

Figure 1. *Flotation of blocks within chaos terrains and their terrestrial analog.* ***(A)*** *Conamara Chaos (Galileo image, NASA/JPL).* ***(B)*** *Radar sounding of Iceberg B15 over the Ross Ice Shelf, Antarctica.*

The Europa Clipper mission concept presents a range of technical challenges and opportunities for ice penetrating radar science and engineering. The flyby-centric mission configuration is an opportunity to collect and transmit minimally processed data back to Earth and exploit advanced processing approaches developed for terrestrial airborne data sets. The observation and characterization of subsurface features beneath Europa's chaotic surface (Figure 1) requires discriminating abundant surface clutter from a relatively weak subsurface signal. Finally, the mission concept also includes using the IPR as a nadir altimeter capable of measuring tides to test ice shell and ocean hypotheses as well as characterizing roughness across the surface statistically to identify potential follow-on landing sites [1,2; Figure 2]. We will present measurement concepts for addressing these challenges.

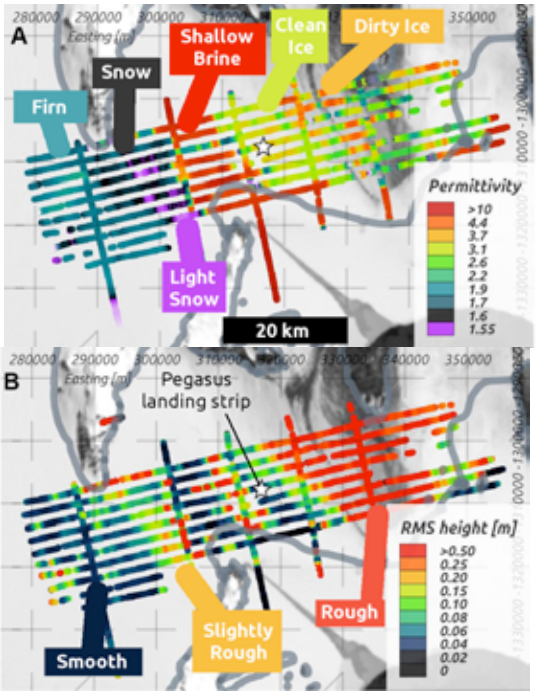

Figure 2. *A radar reflectometry technique (Grima et al., 2014) is applied to 60 MHz radar sounding data over McMurdo Ice Shelf, Antarctica. The* ***(A)*** *permittivity and* ***(B)*** *root mean squared (RMS) height maps with interpretations.*

The development of successful measurement and data interpretation techniques for exploring Europa should also leverage analogous terrestrial environments and processes. Towards this end, we will discuss a range of terrestrial radio glaciological analogs for hypothesized physical, chemical, and biological processes on Europa and present airborne data collected with the University of Texas dual-frequency radar system over a variety of terrestrial targets. These targets include water filled fractures, brine rich ice, water lenses, accreted marine ice, and ice surfaces with roughness ranging from firn to crevasse fields and will provide context for understanding and optimizing the observable signature of these processes in future radar data collected at Europa [3,4,5].

References:

[1] Pappalardo, R. T., et al. *Astrobio.* 13.8 (2013): 740-773. [2] Grima, C., et al., 2014, *Planet. Space Sci.*, 103, 191-204, [3] Blankenship, D. D., et al. in *Europa*, (2009): 631-654., [4] Schmidt, B. E. et al., 2011, *Nature*, 479, 7374, 502-5, [5] Peters, M. E. et al., 2007**,** *Geos. Remote Sens. Lett., IEEE,* 4, 1, 142—147