Ocean Worlds Seismology from a Rotorcraft : Dragonfly at Titan

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Dragonfly was selected in June 2019 as NASA’ s next New Frontiers mission. Planned for launch in 2026 with arrival in 2034, the lander will use a set of eight rotors to relocate itself at new sites, several kilometers apart. It will spend typically a month (two Titan days or Tsols) at each site, making chemical composition measurements as well as imaging and geophysics and meteorology observations.

A mobile vehicle, let alone one that flies, has some challenges as a seismology platform. In particular, it is not practical to deploy instrumentation far from the vehicle, so wind-induced loads on the lander are inevitably communicated by elastic deformation of the ground to the seismometer. Furthermore, the cold dense atmosphere and the limited power available mean the instrument must operate at 94K.

The present concept is to have a single-axis (vertical) moving-coil seismometer, based on the unit developed by JAXA/ISAS for the LUNAR-A penetrator mission. This instrument would be lowered to the ground beneath the lander by a winch in the lander belly, and has been demonstrated to operate at cryogenic temperatures. Prior to a relocation flight, the seismometer is retracted by its winch.

Studies are underway to evaluate different noise contributions to the seismometer : a possible tradeoff exists between a monolithic streamlined seismometer housing, and a separate windshield. Preliminary analysis suggests that deployed horizontal axis measurements would be limited by tilt noise due to lander wind loads. The lander skids would be equipped with geophones. In addition to providing horizontal sensing capability, these can measure the skid displacements directly and it may be possible thereby to decorrelate some of the lander noise from the main seismometer.

The skids also support rotary-percussive drills for chemical sample acquisition. These drills can be used as an active seismic source, with differences between the geophones and/or seismometer response permitting the determination of the seismic properties of the near-subsurface.

Keywords: Titan, Seismology