2023-2032 Planetary Science and Astrobiology Decadal Survey: A Smallsat Proposal for Ocean Worlds Program.

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Introduction: The overarching goal of an Ocean Worlds Program (OWP) is to identify/ characterize ocean worlds and evaluate their habitability. The confirmed ocean worlds Enceladus, Titan, and Europa have known subsurface oceans, as determined from geophysical measurements by Galileo and Cassini space missions. Lessons may be learned from near-term study missions to the Earth's moon and to Mars in locating water regions. The purpose of this poster is to provide notional smallsat architectures developed for the lunar and Martian missions that will address OPAG concerns about implementing technologies of communications, data rates, and power supply.

OWP mission classes include smallsats to address questions that focus on (1) understanding where/why oceans are present, which allows for (2) characterizing ocean environments in these known ocean worlds. With known ocean environments, it becomes important to (3) characterize their habitability and ultimately (4) search for extant life. Disruptive technologies for miniature systems – CubeSats and SmallSats – can potentially be useful for prospective OWP missions the poster aims to show [1].

Moreover, classical oceanography might not currently fit well within NASA's R&A portfolio. However, National Science Foundation (process studies), the National Oceanic and Atmospheric Administration (exploration), and the Office of Naval Research (technology, especially autonomy/robotics) all support different aspects of ocean research on the Earth under OWP-like conditions including pressure, temperature, ocean salinity, seafloor composition [2]. Lunar and Martian in-situ resource utilization planned for near-term operations may suffice for future missions including those of OWP.

One of the primary opportunities in the outer solar system is to explore subsurface oceans. Both radiogenic heating (for Europa, Ganymede, Callisto, and Titan) and tidal energy (for Europa and Enceladus) play a role in sustaining oceans [3]. Observations by the Cassini spacecraft have demonstrated that such heating does, in fact, occur [4]. Seismology is the best tool for remotely investigating possible "vital signs" in ocean worlds. Detecting 30 fluid-related seismic signatures similar to those on Earth would provide key information for constraining available redox fluxes and locating possible niches for life [5]. A Europa Clipper mission would include a radar sounding instrument and magnetometer to probe the subsurface structure of Europa. Broad applications of planetary seismology have been well explored at solid silicate bodies, such as the Moon and now Mars with the InSight mission [5]. Comparatively, the Lunar Geophysical Network mission involves the emplacement of four geophysical nodes at geographically diverse locations on the lunar surface, each with a suite of science instruments that probes the Moon's [6].

In-situ resource utilization equipment, extra-terrestrial landers as well as hardware utilized for communications, power supply, and transit constitute national in-orbit or extraterrestrial-based assets worthy of protection. In uncertain geopolitical times, the 2023-2032 Planetary Science and Astrobiology Decadal Survey requires provisions for safeguarding national in-space assets architecture as well. This poster further shows a recommended notional architecture comprised of smallsats dedicated to space situational awareness.

References:

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