

Europa Clipper: A Multiple Flyby Mission Concept to Explore Europa's Habitability

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Abstract

Europa is a potentially habitable world that is likely to be geologically and chemically active today. Many well-defined and focused science questions regarding past and present habitability may be addressed by exploring Europa. The National Research Council's 2011 Planetary Decadal Survey placed Europa science among its highest priorities, but noted that the budget profile for the Jupiter Europa Orbiter (JEO) mission concept, which was prioritized in the Survey, was incompatible with NASA's projected planetary science budget. Thus, NASA initiated a study to consider more fiscally viable Europa mission scenarios. Among the options considered, a multiple-flyby mission concept (now named the "Europa Clipper") was found to have exceptional science merit while also meeting the challenge from NASA and the Decadal Survey for a reduced-scope Europa mission relative to JEO.

Why Europa?

Europa is believed to have a saltwater ocean beneath a relatively thin and geodynamically active icy shell. This planet-sized moon is unique among the large icy satellites because its ocean is believed to be in direct contact with its rocky mantle, where conditions could be similar to those on Earth's biologically rich sea floor. The discovery of regions of vigorous hydrothermal activity on Earth's sea floor suggests that such areas are excellent habitats, powered and fed by physical and chemical energy that results from reactions between the seawater and silicates. Consequently, Europa is a prime candidate in the search for present-day habitability and life in the solar system. Assessing Europa's habitability requires understanding whether it possesses the three "ingredients" for life: water, chemistry, and energy.

The Europa Clipper

In April 2011, NASA enlisted a small Europa Science Definition Team (ESDT) to consider Europa mission options feasible over the next decade, compatible with NASA's projected planetary science budget and addressing the high science priority set by the Planetary Decadal Survey. One of the options under study, and the subject of this paper, is the Europa Clipper, a multiple-flyby concept. The Clipper mission is a Jupiter-orbiting spacecraft that would make >30 close flybys of Europa. The flybys would be distributed in location such that near global surface coverage could be achieved. This concept would address three key science objectives for Europa:

- **Ice Shell:** Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange
- **Composition:** Understand the habitability of Europa's ocean through composition and chemistry
- **Geology:** Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.

These objectives trace to investigations that could be addressed without being in orbit around Europa. Example measurements suggest a model payload which includes: radar sounder, stereo imager, infrared spectrometer, and ion and neutral mass spectrometer. This architecture would provide for radiation-shielded instruments with high mass, power, and data rate. The architecture of a multiple flyby mission with a modest spacecraft is well-suited to the requirements of such relatively resource-intensive instruments.