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Sensitivity of different orbital geometries of an altimetic orbiter for the detection of a subsurface ocean on Europa.

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Abstract

The unambiguous detection of the putative subsurface oceans of Ganymede and Europa is one of the main objectives of the Europa Jupiter System Mission, which has been recently selected by ESA and NASA for further study and implementation. The baseline of EJSM consists in placing two orbiters around Ganymede and Europa. In the absence of landing elements, one of the most promising ways to obtain strong, although indirect, indications on the presence of an undercrust, global ocean and possibly to reliably estimate its crucial parameters—namely depth and distance from the frozen surface—is the analysis of the effects of the tidal and librational mass deformations on the measurements carried out on or by the spacecraft. This analysis can be performed through the combined use of ground-based radio tracking to the spacecraft and the measurements performed by an onboard altimeter to the surface of the satellite.

The study of the tidal deformations of the surface and the tidal variations of the gravitational field can be used to infer the presence of a global water layer, but this approach is not effective in determining the distance from the surface and the depth of the ocean. This information can be obtained through the accurate measurement of the libration parameters of the outer shell. It has been shown for Europa that theoretical models exhibit a linear relationship between the ice shell libration amplitude and the ice shell thickness.

Through the inversion of synthetic altimeter and Earth-based range measurements, this study simulates the detection of the Love numbers h_2 and k_2, along with the libration parameters of the icy shell and of the solid interiors, in the case of a Europa orbiter. Reference orbital geometries are obtained from families of repeat ground-track orbits. This analysis provides insight into the sensitivity of the solve-for model parameters to the orbital geometry. In addition, results will show how the precision and time-rate of the simulated measurements relates to the errors associated with the estimated parameters. This information can be of value for the preliminary planning phases of EJSM.

References

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