

1 Mapping ice-water on Europa by measuring tides through dynamic orbit tracking

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A main scientific objective of a future Europa orbiter mission is to detect and characterize the ocean through measurements of the strong tidal gravity, displacement and libration. The amplitudes and spatial patterns of tidal deformation depend strongly on the existence and dimensions of a possible internal ocean and other interior parameters. Dynamic tracking of the spacecraft orbit from Earth using radio Doppler and ranging data plays a central role in determining static and tidal gravity, spacecraft orbit positions for tidal displacement and libration measurements using other instruments, and Europa ephemeris. We quantitatively assess performances of comprehensive tidal measurement systems under various configurations and constraints through simulated orbit determinations and covariance analyses. With a high inclination, Love number k_2 can be determined extremely well with less than a month of X-band Doppler tracking. Radial orbit errors not correlated to that of GM are at the level of a few cm, while sub-meter precisions are achievable for along-track and normal components. Higher accuracy Ka-band Doppler data can improve gravity, tides and orbits by up to a factor of 4, while addition of sub-meter ranging data can significantly contribute to dynamic orbit and libration determination and to Europa ephemeris.