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Tracking of a lander on Ganymede surface for obtaining information on the interior

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1. Summary

The Russian Space Research Institute (IKI) is studying the possibility of a future mission including a lander on Ganymede. Assuming the presence of a lander on Ganymede's surface and an orbiter at the same time, we perform simulations in order to see how we can get information on the rotational variations (librations) and on the tidal vertical displacements of Ganymede from tracking this lander. Different links are used: we study a Lander-Earth Doppler, a Lander-Orbiter Doppler, a Lander-Earth Range and a Same Beam Interferometry observables. We particularly investigate the expected uncertainty on the diurnal libration amplitude and on the Love number as a function of the mission duration and for different configurations.

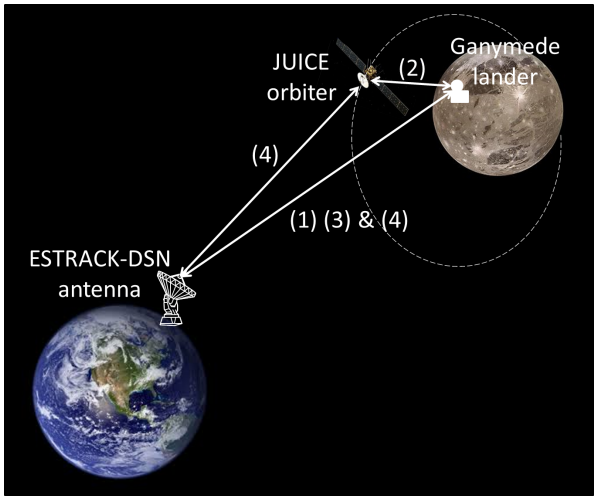
2. Objectives

The objective of these geodesy simulations is to estimate the expected precision on the amplitudes and phases of the main librations of Ganymede (Baland and Van Hoolst, 2010) by monitoring the lander position. The tidal vertical Love number h_2 is also determined. The surface displacement is expected to be between a few centimeters and a few meters (More and Schubert, 2003). Therefore these effects should be visible in the radioscience observations Since these parameters depend on the interior properties of Ganymede, like the depth of the liquid water ocean, the thickness, the rigidity and the viscosity of the ice shell, we will be able to constrain some of these interior properties.

These determinations of the Love number and libration amplitude will be complementary to the JUICE observations with the geophysical experiments.

3. The observables

A mission involving a lander will certainly envisage a radio system for tracking telemetry and send telecommands. This will provide different observables:
(1) Doppler data between the lander and the Earth
(2) Doppler data between the lander and the orbiter
(3) Range data between the lander and the Earth
(4) Same Beam Interferometry (SBI) data, combining the signals from the orbiter and the lander at the same time (see for example Gregnanin et al. 2012).



4. The method and the results

The lander is in the equatorial area in order to maximize the tidal surface displacements.

We use a simplified formulation for the observables and for the orbital motion of the orbiter, the planets and Ganymede. We take into account the visibility conditions between the Earth and the lander. A sensitivity analysis to the parameters is done. We also perform a least-squares fit on the simulated observations, as performed on Mars by Yseboodt et al. (2003).

The uncertainty on the main libration amplitude and on the h_2 Love number and the correlations between the parameters are shown as a function of the mission duration, for different configurations and tracking strategies.

Additionally, the fit of some additional parameters like Ganymede's obliquity will be investigated. We will also discuss how the addition of range data improves the determination of Ganymede ephemerides.

References

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