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Librations of Titan with atmospheric and orbital couplings

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The knowledge of the rotational motion is an important piece of information about the interior processes of bodies and to understand the tidal response. Recently, the observations obtained by the gravity experiment on the space mission Cassini have revealed the presence of an internal ocean on Titan. The obliquity of Titan brings argument in favor of the internal ocean. Here we focus on the complementary information that we can extract from the libration in longitude. The librational motion in longitude, which is variations around the uniform rotational motion, will present a wide spectrum of frequencies due to the orbital variations of the satellite. Two different timescales dominate the spectrum, long periods on seasonal timescales coming from the orbital motion of Saturn around the Sun and short periods related to the orbital period of the satellite. We determine the amplitude of librations for a three-layer model of Titan evolving on a non-keplerian orbit and disturbed by atmospheric torque. The long period librations have amplitudes almost independent of the distribution of mass with a small signature of the atmosphere and bring no information on the geophysical interior. On contrary, the short period librations are sensitive to the interior model where the presence of the putative ocean increases strongly their amplitudes. Here, we built the transfer function of the librational response in order to study the impact of geophysical parameters, such as the ocean density, on the amplitude of the librational motion. We will discuss the observational consequences.