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Thermal-Orbital History of Titan

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Titan is the only satellite in the Solar System surrounded by a dense atmosphere, its surface shows features of intense geologic activity (as revealed by the *Cassini/Huygens* mission), it may contain a subsurface ocean of substantial thickness similar to the ones proposed for the icy satellites of Jupiter, its orbital eccentricity is remarkably high, and it is locked in a 4:3 mean motion resonance with its outer neighbor Hyperion. These properties show that Titan must have had a remarkable history. However, the interaction of the individual aspects listed above is not well understood. Here we investigate the impact of tidal forces on the thermal-orbital history of Titan. Tidal forces are acting on the satellite because of its non-zero orbital eccentricity. This has two major consequences: 1. the orbit evolves with time due to tidal torques exerted by Saturn, 2. orbital energy is dissipated in Titan's interior due to periodic tidal deformation. The latter connects the orbital history with the thermal evolution of the satellite. As a consequence of tidal dissipation in Titan, the orbital eccentricity is damped. The rate of change of Titan's orbit depends on the internal structure and dissipation mechanisms of both, Titan and its primary Saturn. We use various dissipation models of Titan to calculate thermal-orbital histories, e.g. models including a sub-surface ocean and those without an ocean. Since the tidal dissipation rate is expected to be smaller in the latter case, Titan may evolve faster. Furthermore, we investigate whether the obtained solutions are consistent with the present orbital state of the 4:3-resonance with Hyperion. Possible scenarios are discussed in the context of results from the *Cassini/Huygens* mission.