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Titan's highly dynamic magnetic environment: A systematic survey of Cassini MAG observations from flybys TA-T67

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We analyze the variability of the ambient magnetic field near Titan during Cassini encounters TA-T67 (October 2004-April 2010). Cassini MAG data show that the moon's magnetic environment is strongly affected by its proximity to Saturn's warped and highly dynamic magnetodisk. In the nightside sector of Saturn's magnetosphere, the magnetic field near Titan is controlled by intense vertical flapping motions of the magnetodisk current sheet, alternately exposing the moon to radially stretched lobe-type fields and to more dipolar, but highly distorted current sheet fields. In southern summer, when most of the Cassini encounters took place, the magnetodisk current sheet was on average located above Titan's orbital plane. However, around equinox in August 2009, the distortions of Titan's magnetic environment due to the rapidly moving current sheet reached a maximum, thus suggesting that the equilibrium position of the sheet at that time was significantly closer to the moon's orbital plane. In the dayside magnetosphere, the formation of the magnetodisk lobes is partially suppressed due to the proximity of the magnetopause. Therefore, during most encounters that took place near noon, Titan was embedded in highly distorted current sheet fields. Within the framework of this study, we not only provide a systematic classification of all existing Titan flybys as lobe-type or current sheet scenarios, but we also calculate the magnetospheric background field near Titan's orbit whenever possible. Our results show that so far, there is not a single Cassini flyby that matches the idealized picture of Titan's plasma interaction from the pre-Cassini era (background field homogeneous, stationary and perpendicular to the moon's orbital plane). Even on time scales of only a few hours, the assumption of a constant magnetic background field near Titan is not applicable. The implications for the development of numerical models for Titan's local plasma interaction are discussed as well.