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Comparison of substorm occurrence at Earth and Saturn

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Substorms are arguably the most important, but least predictable, mode of solar wind energy processing by Earth's magnetosphere, and are thought to have analogues in other planetary magnetospheres. Comparison of substorm occurrence in differing solar wind and planetary environments provides insight into the substorm process and specifically the necessary and sufficient conditions for substorm onset. Statistical analysis of a thousand or so terrestrial substorms has revealed them to preferentially recur every 2-3 hours, but with considerable variability that may be largely attributable to the variability of the solar wind power input. Exploration of Saturn's magnetosphere by the Cassini spacecraft has revealed evidence of correlated magnetic, plasma and radio signatures indicative of the kronian equivalent of terrestrial substorms, but so far only about ten such events have been observed in-situ, insufficient to characterise their occurrence frequency and influences on it. To overcome this, we use data from the Cassini Radio and Plasma Wave Science (RPWS) instrument to remotely sense many more substorm-like events (SLEs) and compare their occurrence at Saturn with that at Earth. The SLEs are identified by a transient radio emission that extends continuously in frequency from the main band of Saturn kilometric radio emission at 100-400 kHz down to about 10 kHz, similar to substorm-related dual-source auroral kilometric radio emissions observed at Earth. Their occurrence is analysed by both the probability distribution of waiting times between substorms and the power spectrum of the 1-bit time series of substorms. We attempt to interpret these results by relating substorm occurrence to solar wind variability using the common framework of a minimal substorm model, and by considering other possible influences such as solar wind compressions and Saturn's moons.