

Lightning activity on Saturn during Cassini's orbital tour and the Grand Finale

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Abstract

Since 2004 the Cassini spacecraft has observed Saturnian lightning storms with durations of a few days up to several months [1]. Saturnian thunderstorms raged at certain latitude bands, preferentially at the so-called storm alleys around 35° south and 35° north. The lightning discharges in these thunderstorms are thought to originate from areas of the atmosphere where there are water clouds at similar temperatures to terrestrial clouds, but at a higher pressure level of 8–10 bars. There are two different classes of Saturn lightning storms: The "smaller" storms have a horizontal extent around 2000 km and a flash rate of a few flashes per minute, and there are the rare and giant "Great White Spots" with latitudinal diameters of 10,000 km with a flash rate of a few flashes per second [2]. Cassini was lucky to observe such a Great White Spot in the years 2010 and 2011 [3]. After the Great White Spot the lightning activity on Saturn decreased considerably, and to date the last small thunderstorm was observed in October 2013.

The Cassini RPWS (Radio and Plasma Wave Science) instrument has monitored the flash rates by detecting the radio emissions from Saturn lightning discharges radiated at high frequencies (in the MHz range) above the ionospheric cutoff frequency. However, lightning is known to also emit whistler waves at low frequencies propagating along magnetic field lines from the source to the observer. In the case of Saturn the detection of only one lightning whistler has been reported in the literature [4], albeit there were no corresponding high-frequency radio emissions detected at the same time. The lack of whistler detection can be explained by Cassini's trajectory since the storm alleys at a planetocentric latitude of 35° connect to a magnetic L-shell of $L = 1.44$. With the exception of Saturn Orbit insertion, the Cassini spacecraft was never located at such low L-shells until the beginning of the

Grand Finale. The Grand Finale orbits, with Cassini traversing between the innermost ring and Saturn's upper atmosphere, should allow us to observe lightning whistlers and strong high-frequency radio emissions of lightning. We are hoping for more thunderstorm activity on Saturn, and we will report on possible new detections of Saturn lightning during the Grand Finale orbits in this presentation.

References

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