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Saturn's Auroral Field-Aligned Currents: Observations from the Northern Hemisphere Dawn Sector During Cassini's Proximal Orbits

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We examine the azimuthal magnetic field signatures associated with Saturn's northern hemisphere auroral field-aligned currents observed in the dawn sector during Cassini's Proximal orbits (April 2017 and September 2017). We compare these currents with observations of the auroral currents from near noon taken during the F-ring orbits prior to the Proximal orbits. First, we show that the position of the main auroral upward current is displaced poleward between the two local times (LT). This is consistent with the statistical position of the ultraviolet auroral oval for the same time interval. Second, we show the overall average ionospheric meridional current profile differs significantly on the equatorward boundary of the upward current with a swept-forward configuration with respect to planetary rotation present at dawn. We separate the planetary period oscillation (PPO) currents from the PPO-independent currents and show their positional relationship is maintained as the latitude of the current shifts in LT implying an intrinsic link between the two systems. Focusing on the individual upward current sheets pass-by-pass we find that the main upward current at dawn is stronger compared to near-noon. This results in the current density been ~ 1.4 times higher in the dawn sector. We determine a proxy for the precipitating electron power and show that the dawn PPO-independent upward current electron power is ~ 1.9 times higher than at noon. These new observations of the dawn auroral region from the Proximal suggest the possibility of an additional upward current at dawn likely associated with strong flows in the outer magnetosphere. These findings provide new insights into the dawn sector of giant planet magnetospheres.