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High current density observations in the near-Earth plasma sheet and substorm dynamics

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The statistical properties of the near-Earth current sheet from 8 Re to 12 Re were recently revealed by the THEMIS multi-spacecraft measurements. A typical cross-tail current density was found to be ~2 nA/m^2, while in some cases, the current density increased above 4 nA/m^2. In contrast to the commonly accepted picture, these high current densities appeared in two magnetic configurations: tail-like and dipolar structure. The former configuration is a typical feature during the substorm growth phase and quiet times. Although the high current density was associated with the tail-like structure, we ruled out the notion that the high current density is caused by plasma sheet compression. Instead, we discuss that an alternative process of plasma sheet thinning proposed by *Hsieh and Otto* [2014], which is caused by an erosion of the magnetic flux in the dayside rather than the loaded magnetic flux in the tail, is relevant. The latter configuration of dipolar structure is a typical feature during the substorm expansion phase. A strong field aligned current was also associated with the high cross-tail current density observations. These high current densities lasted several to a few tens of minutes after the local dipolarization onsets. While the dipolarization is a fast process with a time scale of $<$1 min, diminishing the growth phase current sheet, which is a measure of the magnetic energy, is found to be a slower process.

Keywords: substorm, THEMIS, magnetotail, current sheet