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Introducing the local time ring current indices SMR: Validation and Insight

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Using the extensive set of stations in the SuperMAG collaboration, we introduce partial ring current indices, which provides unprecedented clarity in partial ring current development. The indices are labeled SMR-00, SMR-06, SMR-12 and SMR-18 for their center local time range. An investigation of the varying local time effects during storms and substorms, on both an individual and superposed epoch basis, produces consistent patterns. The initial positive spike before a storm, which results from solar wind pressure enhancements, is seen simultaneously at all local times. Once the main phase of the storm begins, however, SMR-18 nearly always drops fastest and furthest in magnitude, while SMR-06 drops more slowly (i.e. has weaker ring current signatures), and never as far. Symmetry in the "symmetric-H" component is, in fact, not reached until storm recovery is underway, which averages about 20 hr after onset. If the main phase continues to new depths (larger magnitude negative SMR) over a longer time period, the SMR-18 sector will continue to lead, and SMR-06 to lag. There has been controversy over the extent to which substorm auroral and cross-tail currents perturb Dst and SYM-H signatures. The signature of substorms can be seen very clearly as a spike of about 8 nT magnitude in SMR-00, and only to a much lesser extent elsewhere. Since the net result of a substorm is only a few nT drop in SMR, and since there are only typically 1-2 substorms in a main phase, substorms are clearly only a minor factor in the development of the ring current. Indeed, because even the peak perturbation of substorms currents in the most affected sector is an order of magnitude smaller than the storm perturbation (about 8 nT versus 80 nT), field-aligned currents in general are not a major influence over Dst or SYM-H as observed in the ionosphere.