How does the magnetosphere go to sleep?

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Energy and circulation in the Earth's magnetosphere and ionosphere are largely determined by conditions in the solar wind and interplanetary magnetic field. When the driving from the solar wind is turned off (to a minimum), we expect the activity to die down but exactly how this happens is not known. Utilizing global MHD modelling, we have addressed the questions of what constitutes the quietest state for the magnetosphere and how it is approached following a northward turning in the IMF that minimizes the driving. We observed an exponential decay with a decay time of about 1 hr in several integrated parameters related to different aspects of magnetospheric activity, including the total field-aligned current into and out of the ionosphere. The time rate of change for the cessation of activity was also measured in total field aligned current estimates from the AMPERE project, adding observational support to this finding. Events of distinct northward turnings of the interplanetary magnetic field were identified, with prolonged periods of stable southward driving conditions followed by northward interplanetary magnetic field conditions. A well-defined exponential decay could be identified in the total hemispheric field-aligned current following the northward turning with a generic decay constant of 0.9, corresponding to an e-folding time of 1.1 hr. A possible physical explanation for the exponential decay follows from considering what needs to happen for the convection in the magnetosphere to slow down, or stop, namely the unwinding of the field-aligned current carrying flux tubes in the coupled magnetosphere-ionosphere system. A statistical analysis of the ensemble of events also reveals both a seasonal and a day/night variation in the decay parameter, with faster decay observed in the winter than in the summer hemisphere and on the nightside than on the dayside. These results can be understood in terms of stronger/weaker line tying of the ionospheric foot points of magnetospheric field lines for higher/lower conductivity. Additional global modeling results with varying conductance scenarios for the ionosphere confirm this interpretation.