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Global Evolution of the Earth's Magnetosphere in Response to a Sudden Ring Current Injection

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The dynamical evolution of the Earth's magnetosphere loaded with a transiently enhanced ring current is investigated by global magnetohydrodynamic simulations. Two cases with different values of the primitive ring current are considered. In one case, the initial ring current is strong enough to create a magnetic island in the magnetosphere. The magnetic island readily reconnects with the earth-connected ambient field and is destroyed as the system approaches a steady equilibrium. In the other case, the initial ring current is not so strong, and the initial magnetic field configuration bears no magnetic island, but features a wake of bent field lines, which is smoothed out through the relaxing evolution of the magnetosphere. The relaxation time of the magnetosphere is found to be about five to six minutes, over which the ring current is reduced to about a quarter of its initial value. Before reaching a steady state, the magnetosphere is found to undergo an overshooting expansion and a subsequent contraction. Fast and slow magnetosonic waves are identified to play an important role in the relaxation toward equilibrium. Our study suggests that a sudden injection of the ring current can generate an appreciable global pulsation of the magnetosphere.