FUNCTION OF INJECTION TO MAGNETOSPHERIC STORM-TIME CURRENTS

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Equation for temporal behaviour of the *Dst*-variation is commonly written as follows

$$dH / dt = Q - (H - H_0) / \tau \qquad (1)$$

where Q is the function of injection to magnetospheric currents responsible for the storm-time depression H, H_0 is the effect of the undisturbed currents, τ is the relaxation time. *Burton et al.* [JGR, 1975,**80**, 4201] obtained experimentally $Q = 1.5 \cdot 10^{-9}\ VB_Z$, where V and B_Z are the solar wind velocity and the IMF southward component, but physics of such a relationship was not understood. For calculating Q we have used the following equation for the *Dst*-variation derived in our previous papers

$$H = \sqrt{2\mu_0 p} + DR - F/2S \qquad (2)$$

where p is the solar wind pressure in the stagnation point, DR is the ring current effect, S is the equatorial cross-section of the stable trapping region where the ring current flows, F is the magnetic flux beyond the stable trapping region. Equation relating S to the other parameters has the form

$$\sqrt{S}\left(S\sqrt{2\mu_0 p} + F\right) = 3\pi^{3/2}(M_E + M_{RC}) \qquad (3)$$

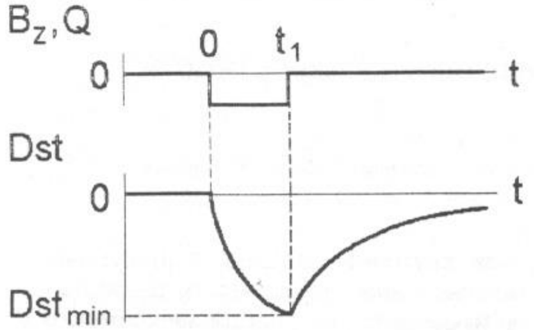
where M_E and M_{RC} are the magnetic moments of the earth dipole and the ring current. The flux F goes mainly to the night side of the magnetosphere and grows after southward turning of the IMF due to transport from the day side to the tail in the following manner

$$dF / dt = U - (F - F_0) / \tau \qquad (4)$$

where U is the electric potential difference between the dawn and dusk sides of the magnetosphere, F_0 is the undisturbed magnetotail flux. Differentiating (2) and (3) over time, assuming p, DR, and M_{RC} to be constant, and substituting (4), we get equation (1) with

$$Q = -\ k\, U / S \qquad (5)$$

where k is a coefficient varying from 0.5 to 1.5 depending on S, F, and p. Assuming $U = -1.4 \cdot 10^7\ VB_Z + 55.3 \cdot 10^3$ [*Doyle and Burke*, JGR, 1983, **88**, 91251, $k = 1$, $S = 9 \cdot 10^{15}$ m^2 , we obtain $Q = 1.5 \cdot 10^{-9}\ VB_Z$ which is in agreement with the observations.



If the behaviour of Q in time has a square-like form as shown on the top side of the figure: $Q = 0$ for $t < 0$ and $t > t_1$, $Q = Q_0 \sim V B_{Z0}$ = const for $0 < t < t_1$, equation (1) has the following solution

$H - H_0 = 0, \quad t < 0$

$H - H_0 = Q_0\tau\left(1 - e^{-t/\tau}\right), \quad 0 < t < t_1$

$H - H_0 = Q_0\tau\left(1 - e^{-t_1/\tau}\right)e^{-(t-t_1)/\tau}, \ t > t_1$

This solution is shown on the bottom side of the figure. Note that $Dst = H - H_0$. The storm-time depression is maximum at the end of the period of the southward IMF. Assuming B_{Z0} = -10 nT, V = 500 km/s, we get Q_0 = -27 nT/h. For τ = 7.7 h [*Burton et al.*, 1975], t_1 = 10 h, one can obtain $Dst_{\min} \approx -151$ nT.

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