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Magnetic field perturbations in the magnetosphere caused by cusp currents

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Perturbations of the magnetospheric magnetic field due to the electric currents from the magnetopause to the Earth's ionosphere is analyzed. It is supposed that electric current is put through the magnetopause into the magnetosphere at one Earth's radius as a result of magnetic field reconnection. This current density is positive at the morning head part of the magnetopause and negative at its evening part. These currents go further to the ionosphere as field aligned cusp currents. A typical value of the total current in a cusp is taken equal to 250 kA. First the 3-D problem with the Earth's magnetic dipole inside a rather conventional domain with ideal conductor behind the boundary is solved to get shape of the field lines. Then the problem with added cusp currents is solved. The solution of the 3-D magnetostatic equations with currents distributed inside the magnetosphere is obtained in contrast with our previous model in that currents were collected to some surface for mathematical simplicity. Calculated magnetic field in the main part of the magnetosphere differs up to 30% from those in that model, but the difference is much less near the subsolar point. The resulting perturbation of z-component of magnetic field in the head part of the magnetosphere is of about -1.5 gamma. It means about 2.5% decrease of the magnetic field. To return to the pressure balance at the subsolar point the magnetosphere must become smaller. If we suppose geometric similarity of the new and old shapes of the magnetopause, the new size must be about 0.8% less, because magnetic field at the boundary is directly proportional to this parameter cubed. So the magnetopause must be shifted approximately 500 km closer to the Earth. This shift, that is referred as the erosion of the magnetopause, in our model is directly proportional to the cusp current and to

the square root of the distance of initial distance of penetration of the current into the magnetosphere.