Study of Field-Aligned Currents and Aurora with the Magnetohydrodynamic Simulation of Kronian Magnetosphere

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Magnetohydrodynamic simulations of the interaction of Saturn's magnetosphere with the solar wind indicate that Kelvin-Helmholtz (K-H) waves can form on the dayside magnetopause when the interplanetary magnetic field (IMF) is northward. Dayside magnetic reconnection occurs at Saturn for northward IMF. The combination of K-H waves and reconnection caused enhanced vorticity in Saturn's magnetosphere. We have used a very high resolution version of our simulation code to study the consequences of the vortices and reconnection for the generation of field aligned currents (FAC) and aurorae in Saturn's ionosphere. We found three bands of alternating FAC toward and away from the dawn side of the ionosphere and two sets on the dusk side. The K-H waves generated a series of toward and away currents along the dayside side magnetopause. In the ionosphere they appear as a series of spots of up and down current. The K-H field aligned currents are adjacent to nearly continuous currents located from 1600 LT around past midnight to about 0700 LT The largest currents (j_{para}>5x10^{-8} A m^{-2}) are found at the highest latitudes. They map to the magnetopause and to the near-Earth tail region. We used the away current density and the Knight relationship to estimate the energy flux from discrete aurorae and obtained ˜1 mW m^{-2} in the region with the strongest currents. This gave approximately 70 GW for the auroral power. We found a region of enhanced thermal energy flux in the region where cusp aurorae are observed.