Time-variable magnetic field responses at Ceres with different conductance

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Introduction The dwarf planet Ceres has been visited by the Dawn spacecraft, which revealed its numerous geologic details [Russell et al, 2016; McCord and Castillo-Rogez, 2018]. The brine layer suggested to be about 40 km deep inside Ceres [Ermakov et al., 2017] should have electric conductivity supporting currents to the global Ceres size. Such conductivity should respond to incoming solar wind that carries magnetic field, and induce currents to expel the variations in the IMF. Such perturbations to the solar wind should be measurable close to the Ceres surface.

We estimate several possible scenarios of the subsurface salt content in a muddy layer, and neglect the conductivity of the rock under the briny layer and of the icy crust. We set up three cases with different thickness of such a briny layer, to deduce the conductivity distribution across Ceres.

We build a plasma model to simulate the interaction between the time-varying solar wind and Ceres, whose conductivity is set by these three cases. Our model solves two different sets of equations in the two regions [Jia et al., 2015] separated by the orange circle in Figure 1. The plasma equation is solved in the solar wind above the Ceres surface, while the Maxwell's equation is solved inside the body of Ceres.

The solar wind is introduced from the inflow boundary of our calculation domain. A steady-state is reached to set our initial condition for our time-variable simulations. Next, we use several typical time variations in the IMF to determine the time response of the induced field, so as to evaluate the difference between these three conductance cases. A chart of the comparison is then given to predict the time-variation signature of induced magnetic field close to Ceres surface by different thickness and salinity parameters of the brine layer in Ceres.

References:

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Figure 1. Grid and density contour of our simulation plotted in x-y and x-z slices of our 3-D simulation domain. The lines with arrows are projections of magnetic field lines. The orange circle is Ceres. The red circle is the location of the brine layer.