Spatio-temporal characteristics of ocean-induced magnetic field variations

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SUMMARY

Satellite magnetic field observations have the potential to provide valuable information on dynamics, heat content and salinity throughout the ocean. Here we present the expected spatio-temporal characteristics of the ocean-induced magnetic field at satellite altitude on periods of months to decades. We compare these to the characteristics of other sources of Earth's magnetic field, and discuss whether it is feasible for the ocean-induced magnetic field to be retrieved and routinely monitored from space. We focus on large length scales (spherical harmonic degrees up to 30) and periods from one month up to five years. To characterize the expected ocean signal we make use of advanced numerical simulations taking high resolution oceanographic inputs and solve the magnetic induction equation in 3D including galvanic coupling and self induction effects. We compare the magnetic field calculated for several different ocean models, and isolate spatio-temporal features which are consistent across the inputs. We find the time-varying ocean-induced signal dominates over the primary source of the internal field, the core dynamo, at high spherical harmonic degree with the cross-over taking place at degree 15 to 20 depending on the considered period. The ionospheric and magnetospheric fields (including their Earth induced counterparts) have most power on periods shorter than one month and are expected to be mostly zonal in magnetic coordinates at satellite altitude. Based on these findings we discuss future prospects for isolating and monitoring long period ocean induced magnetic field variations using data collected by present and upcoming magnetic survey satellites.

Keywords: ocean-induced magnetic field, electrical conductivity of oceans