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Prediction of ocean-induced magnetic signals in the satellite observations due to tidal forcing

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An increase in accuracy of the Earth's magnetic field observations by the future SWARM satellite mission strengths the interest of dealing with magnetic signals of small amplitudes but a global support. An example of such a signal is the magnetic field variation induced by global ocean dynamics. Since sea-water is a good electrical conductor, the ocean currents represent electrical currents moving in the main magnetic field. According to the Faraday's law, they induce a secondary magnetic field that is, in principle, observable by ground and satellite observations. Although they are of small amplitudes, they have recently been identified for ocean currents forced by the tidal wave M2.

The identification of small magnetic components in the total magnetic signal can be helpt by their numerical prediction. The 2-D theory for computing the magnetic field generated by ocean currents that has been proposed by Tyler et al. (1997) is combined with the ocean tidal flows simulated by the numerical ocean model for circulation and tides (OMCT; Thomas 2002) and used to calculate secondary magnetic field generated by lunar-solar tidal potential for individual tidal waves. Unlike to some recent studies where the ocean currents have been deduced from altimetry data by applying the geostrophic method, the ocean flows calculated by the OMCT approach are forced directly by the lunisolar tidal potential that is deduced from analytical ephemerides. As a result, the method provides the radial component of the ocean-induced magnetic signal at the sea surface and satellite altitude. A comparison with published results by Tyler et al. (2003) and Maus et al. (2004) shows a good agreement in terms of global spatial pattern and magnitude, though some minor differences occur. This new method simplifies the calculation of ocean-induced magnetic fields and allows the prediction of the secondary magnetic fields induced by the complete lunisolar tidal forcing. This numerical approach can be used to estimate the opportunities in detecting ocean-induced magnetic signals in satellite observations.