A high-resolution model of the Martian magnetic field using MGS and MAVEN orbital measurements

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Prior to the Mars Global Surveyor (MGS) mission (1996-2006) it was thought that Mars had no or very little magnetic field of internal origin. The first magnetic field measurements thus revealed an enigmatic signature. During its lifetime, MGS led to the discovery of surprisingly intense and localized magnetic field anomalies of crustal origin, with fields exceeding 1500 nT measured at 90 km altitude. MGS had an 8-year sun-synchronous and circular orbit, on a 2:00 am / 2:00 pm plane at 400-km altitude. This orbit was especially well-suited to provide complete and repeated coverage of the Martian magnetic field. Repeated night time measurements over the same locations allowed the identification of time-varying external fields, aiding characterization of the magnetic field of internal origin. These measurements were also complemented by indirect estimates of the magnetic field intensity at 185-km altitude, using the Electron Reflectometry method. However very few direct measurements were performed at low altitudes. Because the field intensity is multiplied by ~6 from 400 to 150 km, such measurements are very valuable, and they are one of the reasons which motivated the mission Mars Atmosphere and Volatile EvolutioN –MAVEN, in orbit around Mars since 2014. The main objectives of MAVEN are to characterize the current atmospheric escape processes around Mars; some of these are directly related to the morphology of the magnetic field. In order to fulfill these objectives, MAVEN is in an eccentric orbit, with a periapsis close to 150 km, and occasionally less than this. On the contrary to MGS, local time varies along the orbit. As a consequence MAVEN returns more low-altitude night-side measurements than MGS. Here we report on a new model of the martian magnetic field, in which we combined the vector magnetic field measurements of these two missions and the ER data from MGS. The modeling is based on two step approach. First a discrete Equivalent Source Dipoles scheme is used, where the magnetization of 14386 dipoles is inverted to match the available measurements. This method is less sensitive to heterogeneous data distributions, and each dipole represents a surface area of 10,000 km^2. The misfit is as low as 4 nT rms at 400-km altitude. It increases to 10 nT for MAVEN measurements between 125 and 600 km. Second, this ESD model is used to predict the magnetic field at a constant altitude of 150 km, which is then converted into a spherical harmonic model with maximum degree of 134. This allows prediction of the Martian magnetic field at the Martian surface, with an unprecedented spatial resolution. The magnetic field is in general globally weak, but is mean value is about 450 nT. A substantial portion of the planet shows surface magnetic field strengths that exceed 1200 nT, with a predicted maximum of 11280 nT above Terra Cimmeria and Terra Sirenum, the oldest geological units on Mars. In this poster we will report on this new model and show the field morphology over some regions.