Crustal Magnetization Equivalent Source Model of Mars Constructed from a Hierarchical Multiresolution Inversion of the MGS Data

Ling-Yun Chiao[*,1,2], Ja-Ren Lin[1] and Yuan-Cheng Gung[2]
[1] Institue of Oceanography, National Taiwan University
[2] Department of Geosciences, National Taiwan University

Abstract

Several magnetic field models of Mars have been constructed since the Mars Global Surveyor data became available. Three distinct schemes formulated through spherical harmonic functions, discrete equivalent dipoles and the continuous magnetic field kernels have yielded results that are grossly compatible but with very different details. Models of internal potential function in terms of spherical harmonics tend to yield divergent high degrees Mauersberger-Lowes spectra, whereas crustal magnetization models exhibit flat but still significant spectra up to high degrees. To have a better fitting to the observed data seems to have dominated previous efforts that have yielded fine details with wavelengths shorter than the lateral track spacing. The variance-reduction versus model-variance tradeoff analysis is invoked in this study for the determination of the appropriate regularization. Taking advantage of the recently developed multiscale inversion, we are able to conservatively retain only the model components that are robustly constrained by the data rather than unilaterally pushing for higher degree of fitting. With the variance-reduction around 82%, we find that to reach a reasonably fair data fitting without high model-variance, the high degrees power spectra of our preferred model exhibit an obvious decaying trend, implying that a lot of the short wavelengths energy embedded within established models are either not robustly resolvable or are of external origin or are simply reflecting the non-uniform distribution of sampling at short scales. The reason that models based on spherical harmonics have greater high degrees power is attributed to the spectral leakage due to the truncated representation.