Geophysical Research Abstracts
Vol. 15, EGU2013-1478, 2013
EGU General Assembly 2013

Sparse Approximation of the Gravitational Potential from Extremely Scattered Data Sets

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Recent applications often produce highly non-equidistributed data on the sphere. The distribution of such scattered data sets causes several problems which are hardly solvable with the established approximation methods.
Our novel method, which is based on an orthogonal matching pursuit, however, iteratively chooses spherical trial functions out of a large redundant family of functions (dictionary) to best match the signal. The outcome is a smooth and sparse approximation of the unknown gravitational field with a comparatively low number of trial functions which is locally adapted to the detail structure of the signal as well as to the data density. The method is capable of combining arbitrary spherical basis functions which is a great advantage to former approximation algorithms. We use spherical harmonics to reconstruct global trends as well as localized trial functions, such as the Abel-Poisson kernel, with different localization properties to represent more detailed structures of the gravitationial field. Meanwhile, the smoothness of the solution is controlled with a particularly chosen norm. Numerical experiments are presented.