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Parameter Choices for Approximation by Harmonic Splines

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The approximation by harmonic trial functions allows the construction of the solution of boundary value problems in geoscience, e.g., in terms of harmonic splines. Due to their localizing properties regional modeling or the improvement of a global model in a part of the Earth's surface is possible with splines.
Fast multipole methods have been developed for some cases of the occurring kernels to obtain a fast matrix-vector multiplication. The main idea of the fast multipole algorithm consists of a hierarchical decomposition of the computational domain into cubes and a kernel approximation for the more distant points. This reduces the numerical effort of the matrix-vector multiplication from quadratic to linear in reference to the number of points for a prescribed accuracy of the kernel approximation.
The application of the fast multipole method to spline approximation which also allows the treatment of noisy data requires the choice of a smoothing parameter. We investigate different methods to (ideally automatically) choose this parameter with and without prior knowledge of the noise level. Thereby, the performance of these methods is considered for different types of noise in a large simulation study.
Applications to gravitational field modeling are presented as well as the extension to boundary value problems where the boundary is the known surface of the Earth itself.