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Experimental studies on multi-scale representation of the gravitational potential of the Earth

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The gravitational potential of the Earth is usually represented by means of spherical harmonics. However, spherical harmonics are globally defined (have no compact support or at least a strong decay to zero), which for many purposes is rather inconvenient. In contrast a multi-scale representation allows decomposition of the gravitational potential function into frequency dependent signals, similarly as spherical harmonics do, but with an advantage of spatial localization. In this paper the use of radial basis functions, such as the reproducing or Poisson's kernel, for a multi-scale representation of the Earth's gravitational potential will be discussed. The kernels are harmonic and fulfill criteria for spatial representation. The multi-scale bases proposed are tested numerically on data derived from the spherical harmonic representations of the Earth's gravitational potential, such as EGM96 or GPM98. The experiments rest on a simple least square method applied on the Earth's surface. It shows very transparently the performance of the bases considered in representing the gravitational potential of the Earth. The results prove that in terms of quality and global definition the multi-scale representation is comparable to the representation based on spherical harmonics. They give evidence that already now, even with a better compression ratio of information (coefficients needed), it is possible to construct global gravitational potential models of the same accuracy as one can achieve with spherical harmonics.