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Using the Green's function method for solution domains with a complicated boundary in Earth's gravity field studies

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Green's function is an integral kernel, which, convolved with the boundary values, gives the solution of the particular problem considered. Regarding its construction, there exist elegant and powerful methods for one or two dimensional problems. However, only very few of these methods carried over to higher dimensions. In order to preserve the benefit of the Green's function method an approximation procedure is discussed. The aim of the paper is to implement the procedure with the particular focus on the solution of the linear gravimetric boundary value problem. A transformation of spatial coordinates is used that offers a possibility for an alternative between the boundary complexity and the complexity of the coefficients of Laplace's partial differential equation governing the solution. A system of general curvilinear coordinates, such that the surface of the Earth is imbedded in the family of coordinate surfaces is applied. Clearly, the structure of Laplace's operator is more complex after the transformation. It was deduced by means of tensor calculus and in a sense it reflects the geometrical nature of the Earth's surface. Nevertheless, the construction of the respective Green's function is simpler for the solution domain transformed. It gives Neumann's function (Green's function of the 2nd kind). In combination with successive approximations it enables to approach the solution of Laplace's partial differential equation expressed in the system of new coordinates. The iteration steps are analyzed and where suitable modified by means of Green's identities or the integration by parts. They are experimentally tested by means of a closed loop simulation. Stability and performance of the method are discussed.