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On finite element and finite volume methods for solving geodetic boundary value problem

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The presentation is devoted to the finite element (FEM) and finite volume (FVM) methods and their application to the geodetic boundary value problem (BVP). The FEM assumes the discretization of the domain by a set of subdomains - the finite elements. In order to derive the FEM model, the weak formulation of the differential equation on every element is constructed. Since any continuous function can be represented by a linear combination of algebraic polynomials, numerical solution is sought as a linear combination of nodal values and approximation functions. The balance of the interelement fluxes and continuity of numerical solution on interlement boundaries are used to assemble the whole solution. Taking into account the boundary condition (BC) the global linear system of equation can be solved. For FEM analysis we use the FEM software ANSYS with its 3D 8-nodes linear elements.

The main feature of FVM is that numerical flux is conserved from one discretization volume to its neighbor. In order to get the local mass balance, the Green theorem is applied. Then the structure of discrete points is embedded into the finite volume mesh where centre of each volume is one of these discrete points. The finite volume numerical scheme is derived through an approximation of the normal derivative along boundaries by a difference between central values divided by their mutual distance.

In our numerical experiments we deal with the regional gravity field modeling. We have created 3D computational domain above the Earth bounded by the chosen part of the Earth's surface, corresponding upper spherical artificial boundary and four other planar boundaries. On the Earth's surface we use surface gravity disturbances as the

oblique derivative BC and on other boundaries the Dirichlet BC. They are simulated from EGM96 geopotential model. The numerical results represent the disturbing potential in the whole computational domain. Finally the solution on the Earth's surface is compared with the disturbing potential evaluated from EGM96.