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Oblique derivative and its treatment in the direct BEM for the fixed gravimetric BVP

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A combination of gravimetry and precise 3D positioning by GNSS naturally leads to a solution of the fixed gravimetric boundary value problem (FGBVP) where surface gravity disturbances represent oblique derivative boundary conditions. In our numerical solution to FGBVP using the boundary element method (BEM) we treat the oblique derivative problem by a decomposition of gradients of the unknown disturbing potential into their normal and tangential components. We present two approaches. In the first iterative approach we solve the Neumann BVP where the normal derivatives are derived iteratively computing tangential components of gradients of the disturbing potential obtained from the previous iterative step. In the first iteration we neglect the oblique derivative, i.e. we consider zero tangential components. In the second direct approach we derive a boundary integral equation for FGBVP. Here the tangential components are directly considered in the system matrix of BEM. Both approaches are tested in three artificial experiments, namely (i) in case that the gravitational potential is generated by a sphere with a shifted center of mass, (ii) the oblique derivative is given by the real topography of the Earth, and (iii) similar as (i) but only projections of oblique derivatives into different and known directions are given. In all cases an experimental order of convergence is close to order two. Finally both approaches are applied to obtain numerical solution to FGBVP using real input gravity disturbances generated from DTU10_GRAV model. A contribution of the tangential components that is dominant in mountainous areas (mainly in Himalayas and Andes) is presented.