Downward continuation of gravity anomalies to the geoid is required for the use of Stokes’s integration in geoid determination. The downward continuation problem can be exactly formulated as an inversion of the Poisson integral, a Fredholm integral of the first kind. However, numerical evaluation of the inversion requires a solution of a system of equations that—while well-posed in the Hadamard sense—is also ill-conditioned in regions of large heights, especially when data are given at a fine resolution. In such cases, even an exact solution to the system will provide a noisy result, and some regularization method must be applied.

Considering the usual solution to the problem by the Jacobi iterative method, we show how the problem can be regularized simply by choosing an appropriate tolerance for the convergence of the Jacobi solution that reflects the conditioning of the downward continuation problem for any particular area. By relaxing the tolerance, we do not require more accuracy from the procedure than it can provide, effectively regularizing the solution. We demonstrate our solution for data spaced at 1 arc-minute, in a region of high elevations, where the condition number of the problem is especially large. We also suggest a method for choosing a suitable Jacobi tolerance a-priori for any computation, based on the estimated condition number of the problem.

While in our context this method is applied to the Poisson downward continuation, it could be applied to the inversion of other Fredholm integrals describing a well-posed but ill-conditioned problem. The approach represents a spatial counterpart of Piccard’s spectral approach.