Geophysical Research Abstracts
Vol. 20, EGU2018-10223, 2018
EGU General Assembly 2018

A Performance Analysis of Several Downward Continuation Methods for Airborne Gravimetry

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Scalar Airborne Gravimetry (Childers et al 1999, Forsberg and Olesen 2010) is routinely used in the National Geodetic Survey's Gravity for the Redefinition of the American Vertical Datum project (GRAV-D, Smith 2007). Vast amounts (about 40 blocks containing over several hundred flight lines) of high quality ($\sim$1-2mGal accurate, Youngman and Johnson 2017) airborne gravity data have been obtained, and have shown up to -20cm to +20cm improvements in terms of geoid undulation change (Li et al 2016). These huge amounts of data were collected at altitudes between 5,000m to 11,000m over quite different topographic features with nonhomogeneous surface gravity supporting the analysis. Thus, the strategies of downward continuation are directly affecting the precision and resolution of the resulting gravity field model. The range of this study is limited to the harmonic space (source-free regions). The main focus is on the numerical treatments (such as iterations, regularizations, and parameter optimizations) of several mathematically rigorous methods such as Spherical Harmonic Analysis (Smith et al 2013), Radial Basis Functions (Schmidt et al 2007, Klees and Wittwer 2007, Klees et al 2008, Li 2017), the Fredholm Equation of the first kind (Sebera et al 2015, Huang et al 2017), the 3D Fourier series (Wang, Roman, and Saleh 2008), and Least Squares Collocation. A full performance analysis and comparison will lead to some conclusions as to how best to use the GRAV-D airborne data for local gravity field enhancement.