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Using Radial Basis Functions in Airborne Gravimetry for Local Geoid Improvement

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Radial basis functions (RBF, Schmidt et al 2007, Klees and Wittwer 2007, Klees et al 2008) have been extensively used in satellite geodetic applications (Eicker 2008, Wittwer 2009, Naeimi 2013, among others). However, to date, to the author's knowledge, their roles in processing and modeling airborne gravity data have not been fully advocated or extensively investigated in detail, though compared with satellite missions, the airborne data is more suitable for this kind of localized basis functions especially considering the following facts:
(1) Unlike the satellite missions that can provide global or near global data coverage, airborne gravity data is usually geographically limited.
(2) It is also band limited in the frequency domain, considering that various filter banks and/or de-noising techniques (Li 2007) have to be applied to overcome the low signal-to-noise ratio problem that is present in airborne gravimetric systems. This is mainly due to the mechanical and mathematical limitations in computing the accelerations (both the kinematic and dynamic accelerations, Jekeli 2000).
(3) It is much easier to formulate the RBF observation equations from an airborne gravimetric system (either a scalar one (Forsberg and Olesen 2010) or a vector one (Kwon and Jekeli 2001)) than from any satellite mission, especially compared with Gravity Recovery and Climate Experiment satellites (GRACE, Tapley et al. 2004) where many accurate background environmental models have to be used in order to separate out the gravity related functionals.
As a result, in this study, a set of band-limited RBF is developed to model and downward continue the airborne gravity data for local geoid improvement. First, the algorithm is tested with synthesized data from global coefficient models such as EIGEN6c4 (Försteet al. 2014), during which the RBF not only successfully recovers a harmonic field but also presents filtering properties due to its particular design in the frequency domain. Then, the software is tested for the GSVS14 (Geoid Slope Validation Survey 2014) area as well as for the area around Puerto Rico and the U.S. Virgin Islands by using the real airborne gravity data from the Gravity for the Redefinition of the American Vertical Datum (GRAV-D, Smith 2007) project. The newly acquired cm-level accurate GPS/Leveling bench marks prove the RBF airborne enhanced geoid models are not inferior to other models computed by conventional approaches. By fully utilizing the three dimensional correlation information among the flight tracks, the RBF can also be used as a data editing tool for airborne data adjustment and cleaning.