AN EVALUATION OF THE EARTH GEOPOTENTIAL MODEL 2008 (EGM2008) IN SOUTHERN AFRICA

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1. INTRODUCTION

The EGM2008 is the latest in a series of global geopotential models developed under the leadership of the National Geospatial-Intelligence Agency [1]. The model can be used to derive free-air gravity anomalies and height anomalies over the surface of the Earth. Combined with a digital elevation model (DEM), the height anomalies can be converted to geoidal heights. The major practical benefit of this latter quantity is to enable geodesists and surveyors to convert satellite-derived heights to heights above the geoid. In Africa, where the infrastructure for conventional surveying is sparse or non-existent, satellite positioning technology such as the Global Positioning System (GPS) is in many cases the only viable tool for surveying. In applications where heights are needed, a model such as EGM2008 is critical for the conversion of satellite-derived heights. Consequently it is important to be able to assess the quality and reliability of this model. Again, due to lack of infrastructure, external data sets are few and far between in Africa. However, such a data set exists for South Africa. In this study, the EGM2008 model is tested against an independently-created geoid model for Southern Africa and against a combination of GPS and levelled heights in South Africa.

2. METHODOLOGY

The African Geoid Project produced a geoid model for Africa – AGP2007, based upon a combination of gravity anomalies, DEM and low-order harmonic coefficients [2]. Although much of these data are common with those used in EGM2008, the combination method used was completely different to that used for EGM2008, and this model can act as a semi-independent source of comparison. Two comparisons were made:

- AGP2007 geoidal heights were compared with EGM2008 geoidal heights on a 5' grid for Southern Africa
- Observed free-air gravity anomalies for Southern Africa were compared with those deduced from the EGM2008

The Chief Directorate: Surveys & Mapping (CDSM) of South Africa has taken precise GPS measurements at 79 precise levelling benchmarks in South Africa. The differences in the two sets of heights provide a precise measure of the geoidal heights at these points. This provides a completely independent external data set to evaluate the quality of the EGM2008 geoidal height model.

3. PRELIMINARY RESULTS

The comparison of the two sets of geoidal heights for Southern Africa show some striking differences, of up to 4m. The large differences almost invariably occur in regions where no terrestrial gravity data exist, and the differences appear to be a result of the different approaches used to fill these gaps. In the case of AGP2007, the gaps were filled using a low-order spherical harmonic expansion deduced from satellite data; in the case of EGM2008, the satellite data were augmented with gravity anomalies deduced from a DEM. There is no independent data set available to test which of these approaches is the most reliable.

The comparison of gravity anomalies generally shows good agreement, although it appears (as expected) that EGM2008 is incapable of modelling short-wavelength features. There are still some puzzling discrepancies – in one case it appears that a datum bias has affected a large gravity survey in Southern Angola.

The GPS/levelling comparison in South Africa confirms that EGM2008 is a substantial improvement over its predecessor – EGM96. The RMS discrepancy for EGM2008 is 17cm, while that for EGM96 is 35cm. This conclusion is valid only for South Africa. The almost complete lack of reliable GPS/levelling data elsewhere in Africa means that this result cannot be assumed to apply in the rest of the continent.

4. REFERENCES

[1] N.K. Pavlis, S.A. Holmes, S.C. Kenyon and J.K. Factor, "An Earth Gravitational Model to degree 2160: EGM2008", presented, EGU General Assembly 2008, Vienna, Austria, April 2008.

[2] C.L. Merry, "An updated geoid model for Africa", presented, Symposium G2, XXIV General Assembly of the IUGG, Perugia, Italy, July 2007.