Optimal Terrain Correction Software for Window Remove-Restore Technique with a Case Study for Africa

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Abstract

The window remove-restore technique, suggested by Abd-Elmotaal and Kühtreiber (2003) to get rid of the double consideration of the topographic-isostatic masses within the data window, is implemented for the African gravity field recovery in the framework of the activities of the IAG Sub-Commission on the gravity and geoid in Africa. Within the course of the window technique, one needs to compute the effect of the topographic-isostatic masses (terrain correction) for the full data window. Since the African data window is fairly large (-42º [?] φ [?] 44º; -22º [?] λ [?] 62º), the computation of the effect of the topographic-isostatic masses of the full data window consumes very long CPU time using the common TC-program (Forsberg, 1984). This investigation proposes an optimal terrain correction software for the window remove-restore technique. It uses three radii around the computational point. The first radius is used for the innermost zone utilizing the finest DTM for a relatively short radius (around 2 km). The second radius is used for the inner zone up to a short radius (10-15 km). Here a reasonably fine DTM is sufficient. The third radius is used for the rest of the full data window utilizing a coarse DTM. A thorough comparison between the developed software and the TC-program is performed to assess the quality of the developed technique and to compare the needed CPU time to perform the terrain correction for Africa.

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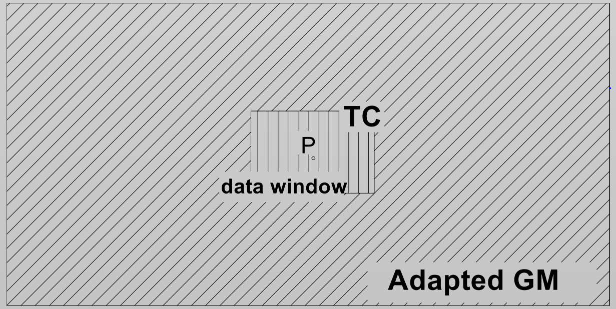
Introduction

The window remove-restore technique, suggested by Abd-Elmotaal and Kühtreiber (2003) to get rid of the double consideration of the topographic-isostatic masses within the data window, is implemented for the African gravity field recovery in the framework of the activities of the IAG Sub-Commission on the gravity and geoid in Africa. Within the course of the window technique, one needs to compute the effect of the topographic-isostatic masses (terrain correction) for the full data window. Since the African data window is fairly large ($-42° \leq \phi \leq 44°; -22° \leq \lambda \leq 62°$), the computation of the effect of the topographic-isostatic masses of the full data window consumes very long CPU time using the common TC-program (Forsberg, 1984). This investigation proposes an optimal terrain correction software for the window remove-restore technique. It uses three radii around the computational point. The first radius is used for the innermost zone utilizing the finest 3″ DTM for a very short radius (6 km). The second radius is used for the inner zone up to a relatively short radius. Here the 30″ DTM is sufficient and tested for different radii. The third radius is used for the rest of the full data window utilizing a coarse DTM.

Window Remove-Restore Technique

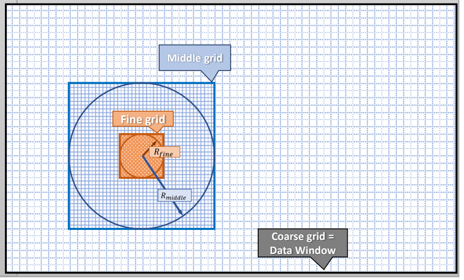


Remove step: $\Delta g_{red} = \Delta g_F - \Delta g_{TC\,win} - \Delta g_{GM} + \Delta g_{wincoff}$

$\Delta g_{wincoff}$ stands for the contribution of the harmonic coefficients of the topographic-isostatic masses for the data window.

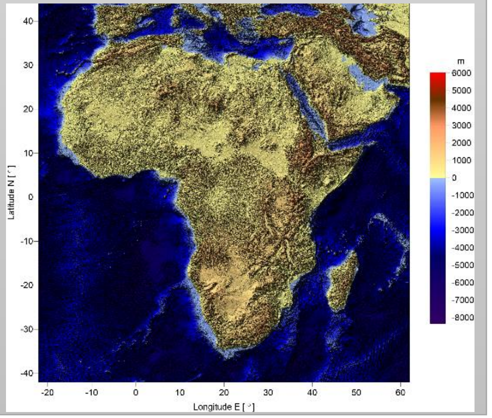
Basic Idea

Introducing a middle grid with a grid resolution between the fine and coarse grids aiming to reduce the CPU time keeping the results unchanged. The proper radius of the middle grid is empirically determined.



AFH16 DTM for Africa

Different resolutions are available from 3″ to 30′ (Abd-Elmotaal et al., 2017; https://doi.org/10.1007/1345_2017_19)



Assessment versus Original TC-program

1. Middle Radius = 30 km (105609 points)

Statistical parameter [mgal]	Coarse grid resolution			
	3′	5′	15′	30′
min	-0.127	-0.241	-0.492	-2.696
max	0.224	0.475	1.666	5.074
mean	-0.001	-0.012	0.017	0.101
std	0.059	0.121	0.254	0.481

2. Middle Radius = 120 km (105609 points)

Statistical parameter [mgal]	Coarse grid resolution			
	3′	5′	15′	30′
min	-0.013	-0.028	-0.072	-0.134
max	0.070	0.130	0.373	0.817
mean	0.004	0.007	0.028	0.064
std	0.010	0.021	0.059	0.108

3. Middle Radius = 240 km (105609 points)

Statistical parameter [mgal]	Coarse grid resolution			
	3′	5′	**15′**	30′
min	0.000	-0.001	**-0.012**	-0.027
max	0.022	0.039	**0.107**	0.244
mean	0.003	0.006	**0.021**	0.040
std	0.003	0.005	**0.017**	0.036

CPU Time Comparison (105609 points) [minute]

Middle radius [km]	Coarse grid resolution			
	3′	5′	15′	30′
30	414	155	43	37
120	420	161	52	48
240	442	187	**81**	83
Original TC	15040 (250.66 h)			

Conclusion

- The developed software saves up to 99.5% of the required CPU time for the terrain correction computations maintaining the results accuracy.