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Solid Earth Discussions

# *Interactive comment on* "Regularization methods for the combination of heterogeneous observations using spherical radial basis functions" *by* Qing Liu et al.

**Anonymous Referee #1**

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The manuscript is a good scientific writing, with clearly defined question, i.e. how to choose the optimal Tikhonov regularization parameter in the combination of heterogeneous observation for regional gravity field modeling. Numerical experiments are properly designed to investigate this problem and the results are fully discussed to get a reasonable conclusion. However, I couldn't see much scientific significance from the manuscript.

Among the five candidate regularization parameter choice methods, the first two methods that based on CM 1, i.e. equal weighting between different observation types, are naturally anticipated to be worse than the other three methods that based on CM 2 even



without numerical experiments. The proposed two new approaches, VCE+L-curve and L-curve+VCE, differs in fixing which relative weighting first, between different observation types or between observation and a-prior information, and seems there is not much scientific rationale in these two approaches. Moreover, the differences in residual RMS of the two approaches are not significant, just around 1-2$\%$, the differences in correlations are even smaller.

Instead of the proposed two approaches, I prefer the third approach, i.e. VCE based on CM2, but with iteration. Since the relative weighting between different observations (weighting factors) and relative weighting between observations and a-prior information (regularization parameter) are adjusted simultaneously. Give the same initial variance components in the VCE+L-curve method, apply VCE based on CM2, then iterate this process with newly estimated variance components. I didn't find description on whether iteration is applied on the 'VCE based on CM2' approach in this manuscript, if not, I highly suggest the authors to test this iterated VCE method.

Also the 'regularization methods' in the title seems to be too 'big' for this manuscript, actually only one regularization method, Tikhonov regularization, is applied in this manuscript, something like 'regularization parameter choice methods' may be more appropriate.

Then there are some minor problems and typos:

Line 28, page 1, the fact that they are fulfilling the Laplacian ..., change to 'they fulfill...'.

Line 5, page 2, remove the acronym 'SRBF' since it's already defined in the abstract.

Line 6, page 3, ... the aforementioned two combination models, actually the CM1 and CM2 are not mentioned yet.

Line 3, page 5, ... the tensor $\Delta V$ of the gravity gradients $V_{ab}$, change to '... the tensor of the gravity potential ...'.

Equation 10, usually we use the symbol $\Delta$ to denote Laplacian operator in physical

geodesy, suggest to use $\nabla^2 V$ for tensor of gravity potential, and change $trace(\Delta V) = 0$ to $\Delta V = 0$.

Line 7 page 5, $V_{zz} \approx V_{rr}$, this doesn't stand universally, actually they are only approximately equal around the z-axis.

Typo in equation 25, the variances are all the same $\sigma_1^2 P_1^{-1}$, which should not.

Line 2, page 9, plotting the norm of ..., change to 'plotting the log of the norm of ...'.

Line 11, page 12, ... is chosen to 4 degree, change to '... is chosen to be 4 degree', same problem in line 1 page 13.

Figure 5, according to the legend, the blue dots represent terrestrial I data, but how can there be terrestrial data even over the Mediterranean sea? Moreover, I can't identify the validation area in the figure.

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