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Updating a national scale LiDAR based height model

T. Knudsen and S. L. Kokkendorff
National Survey and Cadastre, Copenhagen, Denmark

Generating a new LiDAR based height model is a huge and complex task. Updating a model with new data is a smaller, but in some ways even more complex task. Even more complex because while a new model requires quite a bit of data management, preprocessing, adjustment, etc., at least it is based on a homogeneous and (ideally) consistent data set. When updating a model, we must handle a heterogeneous data set consisting of the existing height model and at least one other data set. But before even taking on the task to solve the technical and scientific intricacies of this, there is a range of practical complications that must be taken into account:

1. If we have new and "perfect" data for an area that reveals a bias in the heights of the old model, what should we do at the border between old and new data?
   - Introduce the new data directly in the model, and live with the step inevitably introduced on the border between the biased and the unbiased data?
   - Arbitrarily modify the old data near the border to get a smooth transition?
   - Gradually introduce the bias of the old data into the new data, as we get closer to the border?
2. The difference between updating and bringing up to date: what should be done in areas where we have new data, but also know that these data are already outdated by even newer developments?
3. New observations having error bars falling entirely within the error bars of the old model may actually not bring any new information to the table. Do we update the models anyway (e.g. to get a local reduction of the error bars)?
4. What should we do if we get new, but technically inferior data (e.g. more noisy and/or lower resolution than the existing model) for an area where we know that changes have happened

Assuming these complications have been solved, we turn to the actual updating. Here, we demonstrate how methods originating in the geodetic community, can be used for height model updates. The point of this is that geodetic gravity data sets typically consist of large numbers of individual surveys, comming with each their bias and noise characteristics. Hence, geodetic methods based on covariance modelling, optimum interpolation, and draping, are designed to handle large and heterogeneous data sets. They are, however, also designed to work on anomalies, rather than full range data. In geodesy this is not a problem, since for potential-field data there is always a suitable low order model to refer to. For height model data this is not the case. To work around this, we introduce the *bimorphologically constrained filter*, which generates a suitable reference surface from the existing height model. The actual update is then carried out working on the anomalies with respect to this surface.