AIDA – From airborne data inversion to in-depth analysis

A-132: Application and validation of a parameter constrained irregular resampling framework for highly resolved data sets

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Introduction

Many data sets in geosciences contain a very large amount of data. The high point density of these data sets often causes problems for processing and visualisation. For efficient numeric handling, resampling techniques are used to ease the data for better computation performance. Most common resampling methods usually reduce either highly resolved gridded data regularly or interpolate dense scattered 3D point data on a coarse grid. Because of parameter independency and interpolation, these methods cause a high loss of information. To avoid this problem, the presented "CIDRe" algorithm was developed. CIDRe stands for: "**C**onstrained **I**ndicator **D**ata **Re**duction" and uses irregular and parameter-constrained resampling to improve handling, visualisation and exchangeability of data and results. The method causes much lower errors than regular or interpolating resampling methods with similar resampling rates, in particluar for data with strongly varying parameter distributions.

In the poster, we show examples which demonstrate the efficiency of the new algorithm by three different applications. The first is a synthetic example, a second stems from colaboration with partners of the AIDA project: (BGR´s subproject 2) and the third one from the South American continental margin. The new algorithm was developed in subproject 5 of the AIDA project.

Example 1: Synthetic RGB data set

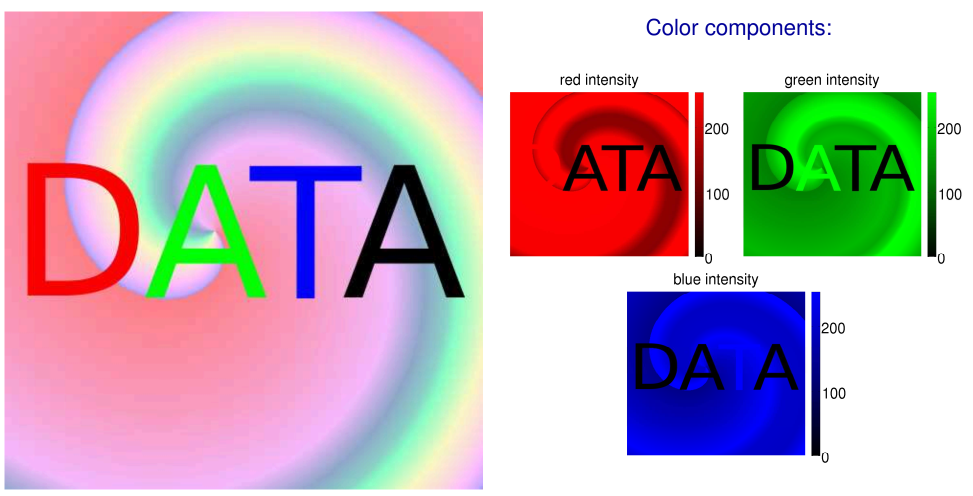


Fig. 1a: Syntetic RGB data set and its color channels. Each color component is treated as separate data parameter.

To demonstrate and test the irregular resampling method, a synthetic multiparameter data set was constructed. The data is represented in a raster image with three color channels (Fig. 1a). For each cell 3 color values are defined, treated as independent parameters for this application. The resampling algorithm uses all parameters to identify cells, which are essential for the given parameter distributions and need to be further used after resampling. The resampling result for the complete data set and reconstruction errors for each separate color component are shown in Fig. 1b. A mean reconstruction error of 0.15% is achieved for all parameters. For reconstruction, an interpolation method, presented in (Mundy, 1970), was implemented and adapted for this application. According to Fig. 1c, the presented resampling method provides a better result than a regular method for all applied resampling rates.

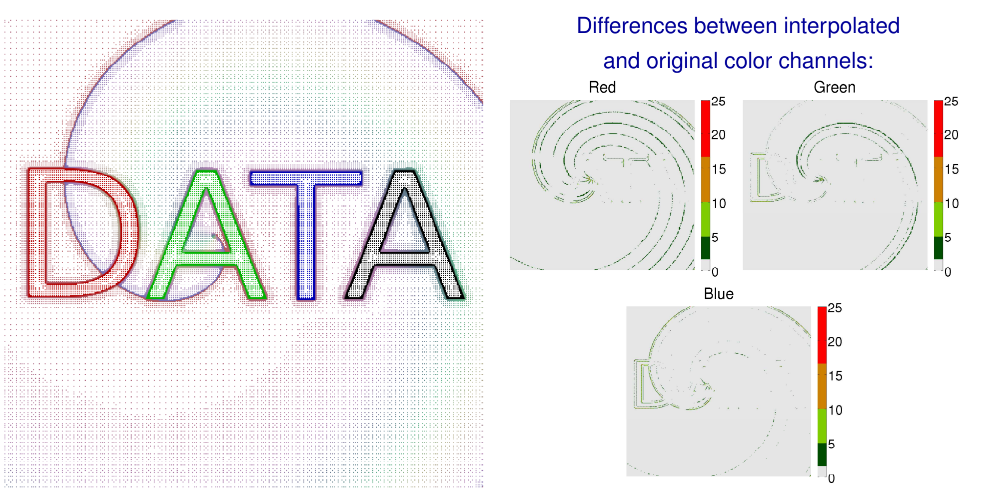


Fig. 1b: After resampling, 14.4% of original data, displayed as colored pixels, were used for further computations (left). The reconstruction errors come up to a maximum absolute value of $\pm$ 25 color values (right).

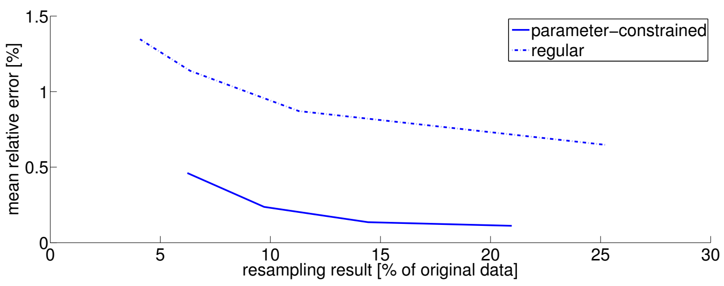


Fig. 1c: Correlation between resampling result and achieved reconstruction error for **parameter constrained** and **regular** resampling for shown synthetic RGB data set.

Example 2: AIDA application - apparent resistivities basing on measured HEM data

This data set based on real Helicopter-borne electromagnetics (HEM) data, which were collected during a HEM survey near Cuxhaven (Germany) in 2000 covering an area of 530 km^2 (Siemon et al, 2006) and were used in the AIDA project for inversion (subprojects 2, BGR Hannover, and 3, TU Bergakademie Freiberg) and geological modelling (subproject 5, LUH Hannover). The measured secondary field data are transformed to apparent resistivities (Siemon, 2001). The apparent resistivity ρ_A, inverted for the secondary field measured with a frequency of 384.6 Hz, is choosen as resampling constrain (Fig. 2). The resampling result achieves an average difference of 0.19% to original parameter distribution.

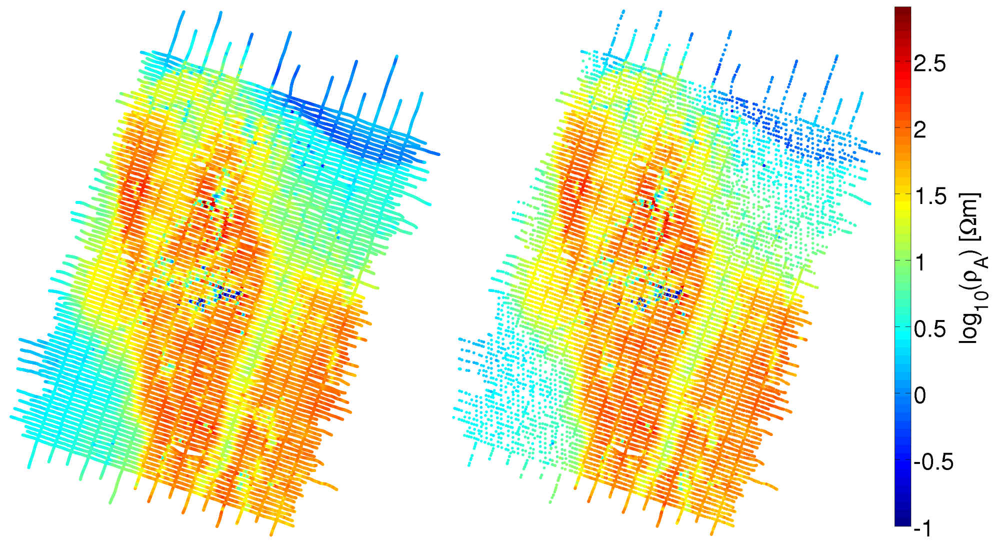


Fig. 2: Original (left) and resampled (right) ρ_A data. The resampled data set contains of 22.3% of original data.

Example 3: Station data for gravity forward modelling

To have a control on the "quality" of the resampling method, it was tested by an already existing 3D density modelling approach (Prezzi et al, 2009): (1) the original gravity data set (Fig. 3a, Schmidt & Götze, 2006) was used to fit modelled and measured gravity. (2) The data set was reduced by CIDRe and used to calculate a modeled gravity field again (results in Fig 3b). (3) the differences between the two modelled gravity fields are shown in Fig. 3c: differences are small and do not exceed the maximum error of 5×10^{-5} m/s^2 for the measured Bouguer gravity field.

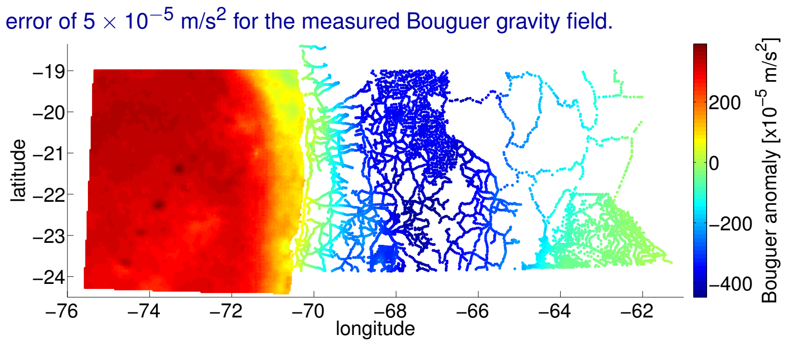
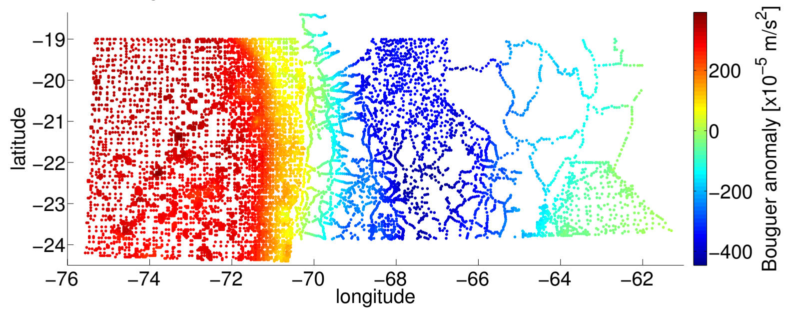


Fig. 3a: Measured Bouguer anomaly of South American continental margin. (Schmidt & Götze, 2006)

Fig. 3b: Resampled data set containing 30.3% of original data (Fig. 3a).



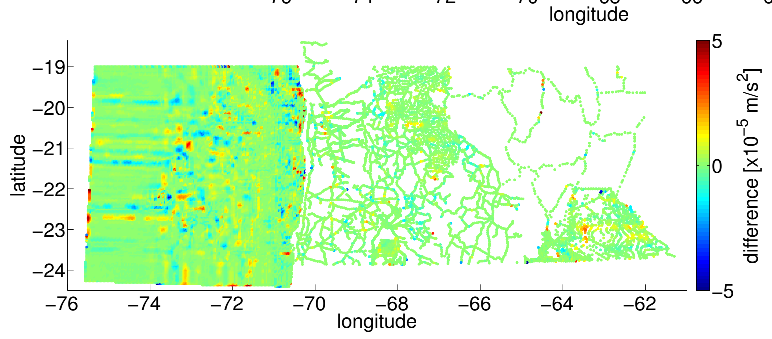


Fig. 3c: Differences in the calulated fields for original and resampled station locations do not exeed the given limit of $\pm 5 \times 10^{-5}$ m/s^2

Conclusions

The application of the new resampling method "CIDRe" to synthetic and "real world" examples demonstrate the increase of the processing performance and visualisation of large data sets with extreme small information loss. For data sets with locally high parameter variations "CIDRe" achieves a far better reproducibility than regular resampling methods. Additionally, we learned from the first example, that multiparameter data can be resampled in compliance with all given data parameters. Further information about "CIDRe" resampling is given in DGG session **MI, A131, We. 2013-3-6, 09:00am, HS7**.

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