Improving the assessment of non-ideal GPS time series in Antarctica

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Method 1: Effects of 'campaign shape' on rate

Subsample continuous time series:

- **both real site campaign shapes and synthetic campaign shapes**
- **characterise shapes by:**
  - **periodicity (see Fig. 2b)**
  - **clustering (longest gap in time series / length of time series)**
  - **number of points in series**
  - **time spanned by series**

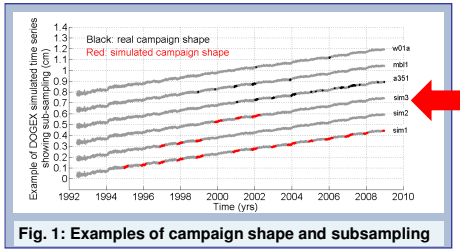


Fig. 1: Examples of campaign shape and subsampling

Background: Antarctic campaign data

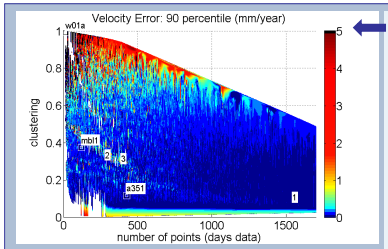
Antarctica: no sunlight in winter, very high winds, low temperatures, very large distances and sparse human activity all mean campaign data is common, especially in earlier years, and may have been collected by people who are not especially familiar with GPS equipment, which can lead to metadata errors. Continuous GPS time series are analysed to estimate annual and semi-annual effects and assess noise properties – this is not possible for campaign data. Glacial isostatic adjustment models use vertical GPS rates for comparison and sometimes assimilation in to the model. We need a better understanding of the error of individual rates to assign appropriate weights to them.

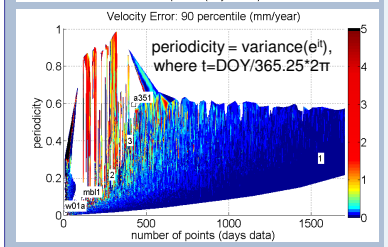
Method 2. Assessing metadata

The metadata for some GPS time series may be incorrect – for example the antenna used may be incorrectly recorded or an antenna replacement may not make it into the log.

It would be useful to be able to test if the antenna in the metadata is correct. Here we investigate if phase residuals can be used in this way, by processing one month of data for the site BOR1 repeatedly with different antenna models and investigating the difference in the residuals.

Results 1: effects of 'campaign shape' on rate





periodicity = 0 if measurements always taken at exactly the same time of the year

Fig. 2a,2b: 90th percentile of the velocity error seen for campaign shapes subsampling 50 DOGEx time series (Gazeaux et al 2013). Number of points in the campaigns plotted against (2a, top) how clustered the data are and (2b, below) how periodic (occurring at the same time of year) the data are.

Fig. 3: Range of velocity estimates for the three simulated campaign shapes.

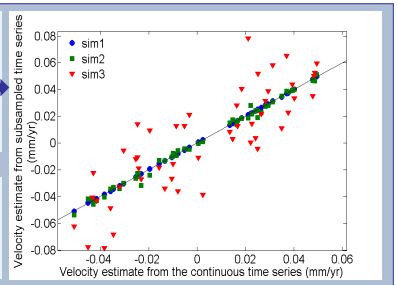
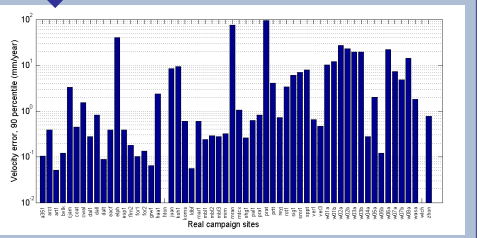


Fig. 4: Effects for Antarctic site campaign shapes



The DOGEx time series used include coloured noise, annual and semi-annual signals and noise improvement with time, but the offsets were removed.

Results 2: Comparing phase residuals

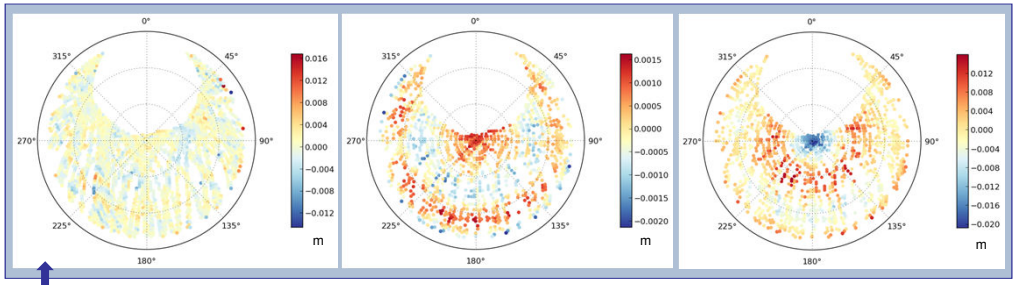


Figure 5a (left): Phase residuals (mean of 30 days data binned by azimuth and elevation) in metres for BOR1 using correct AOAD/MT antenna

Figure 5b (centre): Difference in mean phase residuals (m) between correct AOAD/MT antenna and ASH700936A_M SNOW

Figure 5c (right): Difference in mean phase residuals (m) between correct AOAD/MT antenna and TRM14532.00 NONE

The size of the residual differences depends on the similarity of the antennas. Ideally we would test successfully without knowing which is correct. This initial data suggests that it may become possible to exclude some antenna types.

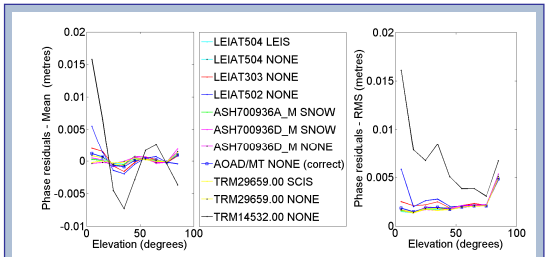


Figure 6: Mean and RMS of the aggregated 30 days data plotted against elevation using 10 degree bins.

Conclusions

- **Velocity errors due to campaign shape alone can be large**
- **Antenna assessment using phase residuals may have potential but need to develop a much larger set of correct and incorrect statistics**

Further Work

- **Investigate effects of adding offsets between campaigns & using IGS series**
- **Develop a set of customised velocity error estimates for individual sites**
- **Investigate a more extensive data set of phase residuals**

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References

Gazeaux, et al. (2013). "Detecting offsets in GPS time series: First results from the detection of offsets in GPS experiment." Journal of Geophysical Research: Solid Earth 118(5): 2397-2407.

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