

Global Analysis of Jason-1 over Inland Water

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ABSTRACT

The Jason-1 mission is collecting a huge database of altimeter echoes over the earth's land surfaces. However, it is widely reported that the performance of this instrument over inland water is severely sub-optimal, with few targets successfully acquired, and poor derived heights.

This paper presents a global analysis of the performance of Jason-1 over inland water targets, and demonstrates that, although the performance of this instrument is significantly poorer than would be expected on the basis of analysis of TOPEX data, Jason-1 does successfully acquire data over a considerable number of inland water targets. Whilst endemic off-ranging compromises the utility of some of these data, resulting in gaps in the derived time series over inland water, a global analysis of 3 years of waveforms confirms that excellent time series of heights can be obtained if the waveforms are filtered to minimise off-ranging and are then retracked to obtain an accurate range to target. Jason-1 thus makes a valuable contribution to the global monitoring and measurement of inland water; additionally, the Near-Real-Time capability gives the possibility of deriving inland water heights within a few days of measurement.

INTRODUCTION

The Jason-1 mission has been successful at acquiring altimeter echoes over much of the earth's land surfaces [1]. However, it is widely reported that the capture of inland water targets is not well achieved by Jason-1, and only a few large targets have successfully produced measurements of inland water heights. Accordingly, it was decided to undertake a global analysis of Jason-1 waveforms over inland water, to determine what contribution could be made to measurement and monitoring of inland water heights by Jason-1.

ANALYSIS

To gain a general idea of the data available from Jason-1, an analysis was performed initially on the Rift Valley lakes, using the SGDR dataset [2]. This area was chosen to illustrate the performance of Jason-1 because it is in varying topography but also in general does not have large areas of surrounding wetland or overly wet soil likely to provide off-ranging targets. As a first step in the analysis, Jason-1 waveforms returned from the Rift Valley lakes were identified and analysed, and sequences examined over one year. The waveforms were checked for the presence of a viable leading edge and the presence of significant power. The locations where waveform sequences satisfying these constraints were successfully acquired are shown in Fig. 1.



Figure 1 Jason-1 possible targets (white circles) where valid waveform shapes are returned over Rift Valley lakes

In fact, these results were quite encouraging: many locations were found where these constraints were satisfied and apparently viable waveform sequences were returned. These waveforms were then retracked using an expert system approach [3] and time series of heights generated. These were converted to difference from mean height. Examples are shown in Fig. 2 over Lake Tanganyika. Here, we have deliberately not removed outliers, in order that the retrieved heights can be evaluated clearly. Whilst there is some data dropout, and one evident outlier in the second timeseries, these two time series agree well both with each other and with co-temporal EnviSat timeseries.

The same procedure was repeated over Lake Malawi (Fig. 3). Again, very good timeseries were obtained. To illustrate the agreement between Jason-1 and EnviSat timeseries, Fig. 4 shows timeseries over Lake Malawi with the Jason-1 timeseries from Fig. 3 plotted together with the corresponding EnviSat timeseries. Comparison of the timeseries shows the extremely good quality of the Jason-1 derived heights and the advantage of the 10 day repeat sampling compared with the EnviSat 35 day orbit repeat.

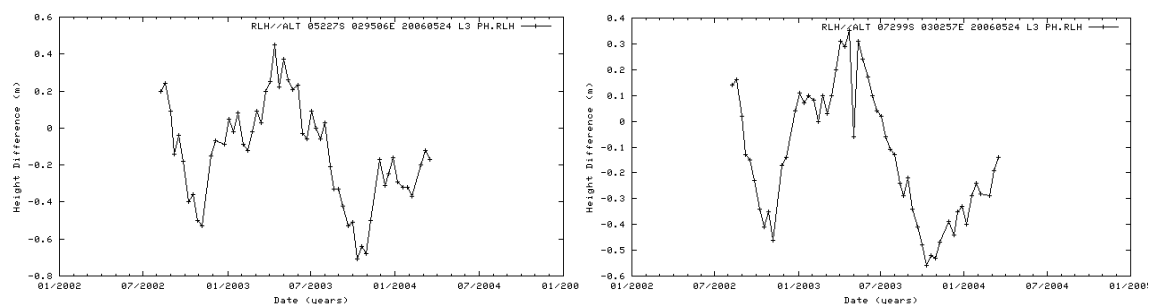


Figure 2 Good timeseries derived over Lake Tanganyika

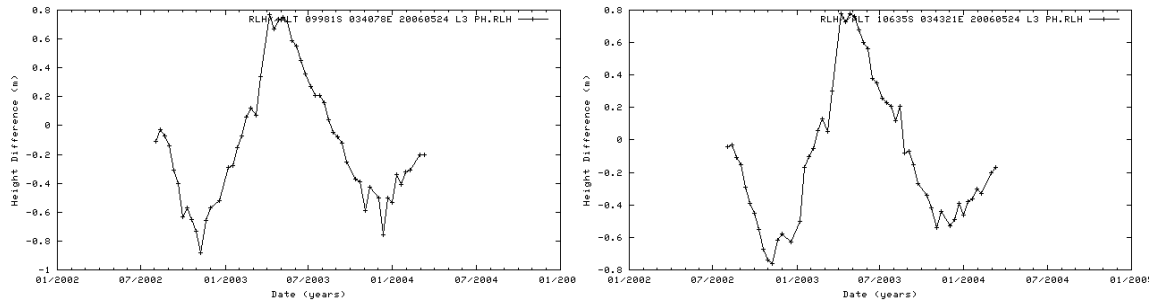


Figure 3 Good timeseries derived over Lake Malawi

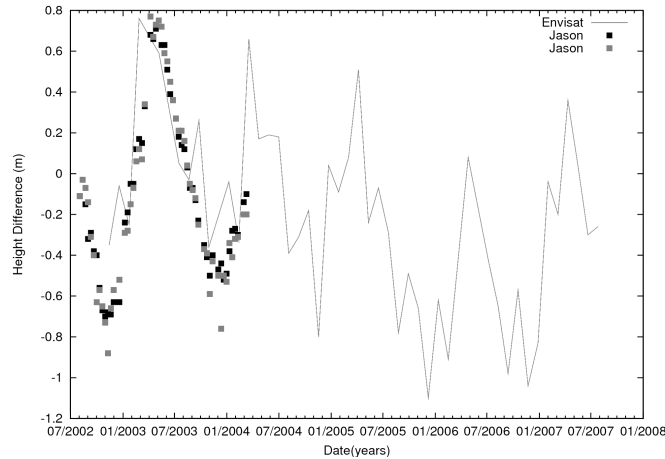


Figure 4 Combined Jason-1 and EnviSat timeseries over Lake Malawi

However, many timeseries were also generated which are clearly affected by errors. To illustrate typical results obtained from Jason-1, Fig. 5 was generated from measurements made over the Mtera Reservoir. Here, large off-ranging errors are very clearly evident; however, the upper part of the plot does appear to contain a signal, showing a decreasing trend in the heights, a finding in agreement with other observations. As a further example with more minor anomalies, Fig. 6 shows the results for Lake Rukwa. Here, the time series has a few significant outliers and some data dropout: however, there is consistency in the derived heights from many of the passes.

Widening the scope of the analysis, a detailed investigation was performed over the Amazon River network, to investigate the extent to which Jason-1 waveforms can be used to recover river heights. Fig. 7 shows the location of all viable waveform series derived from Jason-1 over the Amazon basin. Comparison was made with derived TOPEX timeseries, again produced by retracking the individual waveforms using an expert system approach [3]. Examples of the results for locations labelled A and B on Fig. 7 are shown in Fig. 8 and 9. In Fig. 8, a time series successfully acquired by TOPEX is not well continued by Jason-1. As the vertical scale shows, Jason-1 is off-ranging to another target and does not return viable heights from a crossing where TOPEX retrieves an extremely consistent time series. However, whilst there are many targets for which this pattern is seen, it is not always the case. Fig. 9 shows data from crossing B, where the TOPEX derived time series is only partially acquired; huge data gaps and inconsistent height values are seen. In striking contrast to this, the Jason-1 time series clearly contains a signal; outliers are present, but it is clear that these data are better than those derived from TOPEX.

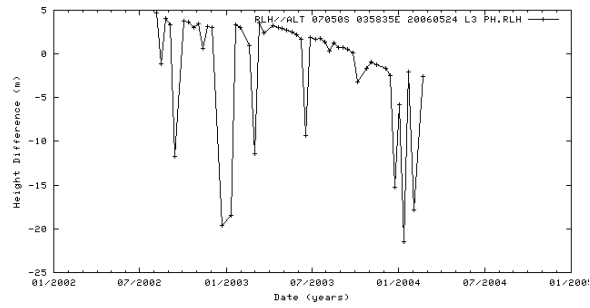


Figure 5 Downward trend over Mtera Reservoir

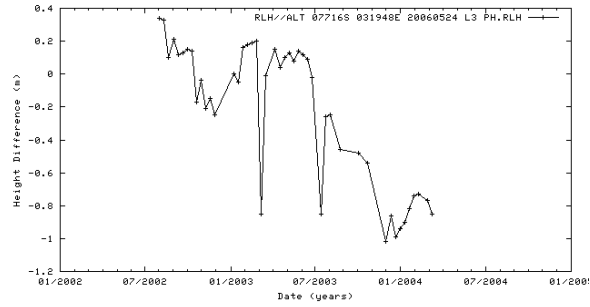


Figure 6 Downward trend over Lake Rukwa

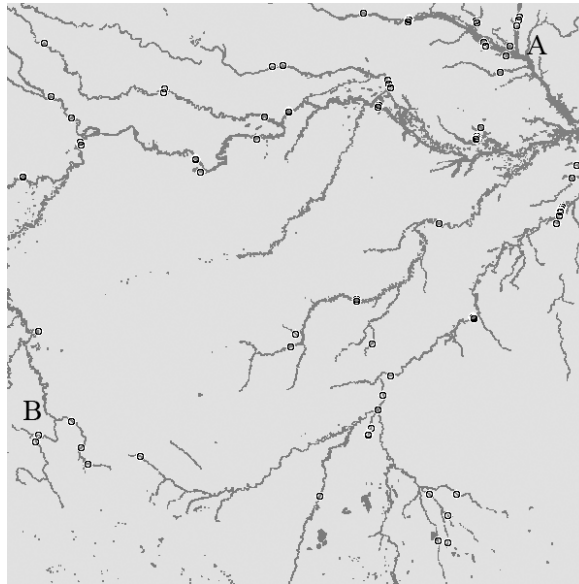


Figure 7 Location of Timeseries over Amazon

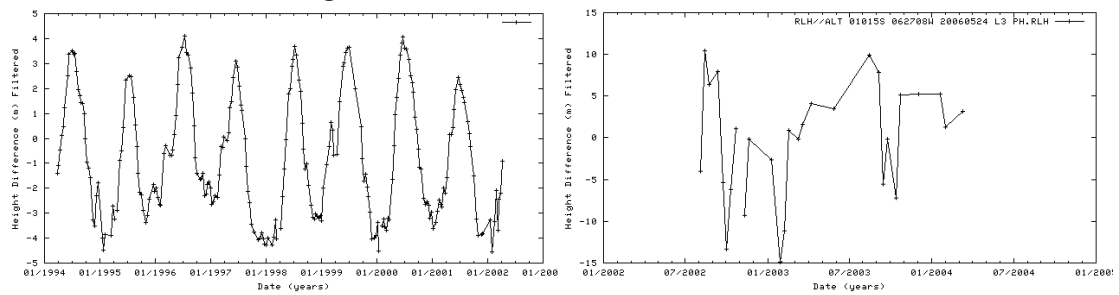


Figure 8 Example of TOPEX acquiring target when Jason misses at Point A

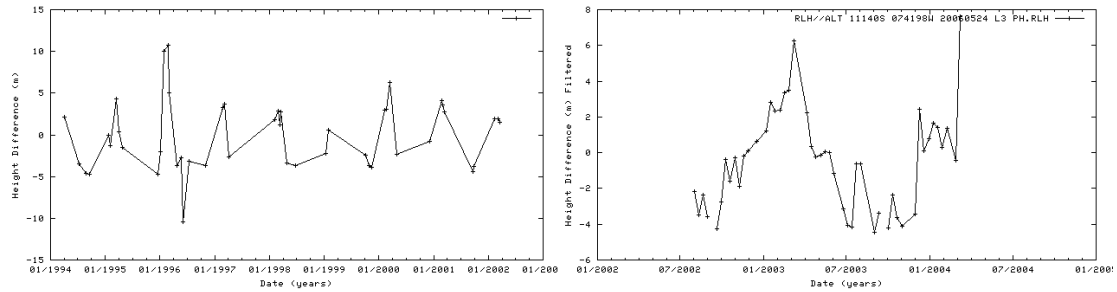


Figure 9 Example of TOPEX missing target that Jason acquires at Point B

DISCUSSION

A global analysis of three years of Jason-1 waveforms has shown that viable waveform series exist over many targets. However, recovery of viable heights from the Jason-1 waveforms is problematic. In many instances off-ranging to neighbouring targets precludes the recovery of the nadir target. Of particular note, the positioning of the waveforms within the range window is highly variable, resulting in very significant errors over most targets if these data are not retracked. However, the performance of Jason-1 is significantly better than that generally reported, with viable height series generated by proper retracking of the individual waveforms over a wide variety of targets. It is noted that there are instances, particularly associated with more severe terrain, where Jason-1 successfully retrieves data whilst TOPEX does not. In addition, the Near-Real-Time capability of Jason-1 means that, over these identified targets where Jason-1 consistently retrieves valid waveforms from which good height measurements can be derived, it will be possible to extend the Near-Real-Time capability for river and lake height retrieval from EnviSat RA-2 to Jason-1, increasing the temporal resolution of the data series over these targets.

REFERENCES

- [1] Berry, P.A.M; Smith, R.G.; Freeman, J.A., 2007; A Global Assessment of the RA-2 Performance over All Surfaces. "Envisat Symposium 2007", ESA Pub. SP-636 2007.
- [2] Zanife, O.Z. J.P. Dumont, J. Stum, T. Guinle (2004), SSALTO Products Specifications - Volume 1: Jason-1 User Products, *Issue 3.1, SMM-ST-M-EA-10879-CN, CLS/CNES, Toulouse, France.*
- [3] P. A. M. Berry, A. Jasper, and H. Bracke, "Retracking ERS-1 altimeter waveforms over land for topographic height determination: An expert system approach," *ESA Pub, vol. SP-414, no. 1, pp. 403–408, 1997.*