Post-Cruise QC of DIMES UK4 (JR281) LADCP Data

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1 Introduction

During the DIMES UK4 cruise, 110 CTD/LADCP profiles were collected. On the ship, the data were processed with Version IX_9 of the LDEO implementation of the velocity inversion method and a preliminary quality control was carried out, primarily by inspecting diagnostic plots produced during processing. The following material expands on some of the topics in the main LADCP cruise report, drawing primarily on post-cruise analysis and additional QC.

2 Instrument Range

LADCP data quality depends on instrument range. Below a limiting range, some sort of interpolation is used by all processing methods to bridge gaps in LADCP profiles. While the instrument range depends on the acoustic scattering environment and varies with depth, here a single value is estimated for each profile as the distance from the transducer of the farthest bin with less than 20% missing velocities. During previous cruises I found that ≈60–70 m of single-instrument WH300 range is required for valid LADCP profiles. Consistent with this expectation, the UK4 single-head shear-method processed profiles have gaps on stations 67–71, where the instrument range drops below 70 m (Figure 1). The velocity inversion method, on the other hand, produces warnings about large "shear-inverse differences" for a larger range of stations (61–71). The affected profiles were all taken in a region of comparatively weak flows and the LDEO-processed final profiles look plausible. The top-to-bottom shear and the vertically averaged flow are constrained strongly by the GPS, SADCP and bottom-tracking data and are, therefore trustworthy.

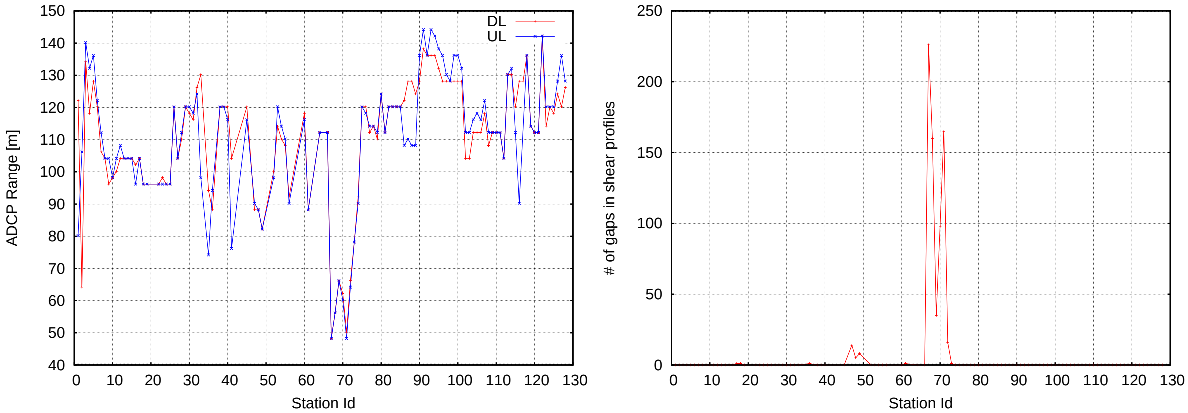

Figure 1: Left panel: Instrument range in meters. Right panel: Gaps in shear-method output.

How faithfully the sparse data constrain the velocity field on shorter vertical wavelengths is not clear to me, however. Caution is advised when interpreting shear spectra from profiles 67–71.

3 Package Wake Issues

Soon after the beginning of sampling, it was discovered that some of the uplooker data were affected by package wake effects. This is illustrated in the left panel of Figure 2, which shows the down-/up-casts of the downward-/upward-looking instruments from an example cast processed separately with an implementation of the shear method. Note, in particular that there is decent agreement between the downlooker downcast and the uplooker upcast, whereas the shear in the remaining two profiles is associated with considerable bias.

The CTD rosette used on the cruise was attached to the wire with a slip-ring, allowing it to swivel freely. Additionally, a vane kept the package in an approximately constant orientation with respect to the incident flow. Therefore, and in contrast to LADCP profiles collected with most other rosettes, we expect wake effects to affect always the same beams. Experimentally, it was soon found that the main two beams affected were beam 4 of the downlooker and, in particular, beam 2 of the uplooker. When data from those beams are ignored, the 4 individual velocity profiles from wake-affected casts tend to agree much better (right panel in the figure).

Because of these wake issues, the instrument orientation on the rosette was changed several times during the cruise in order to try to minimize wake effects. Three different configurations were used:

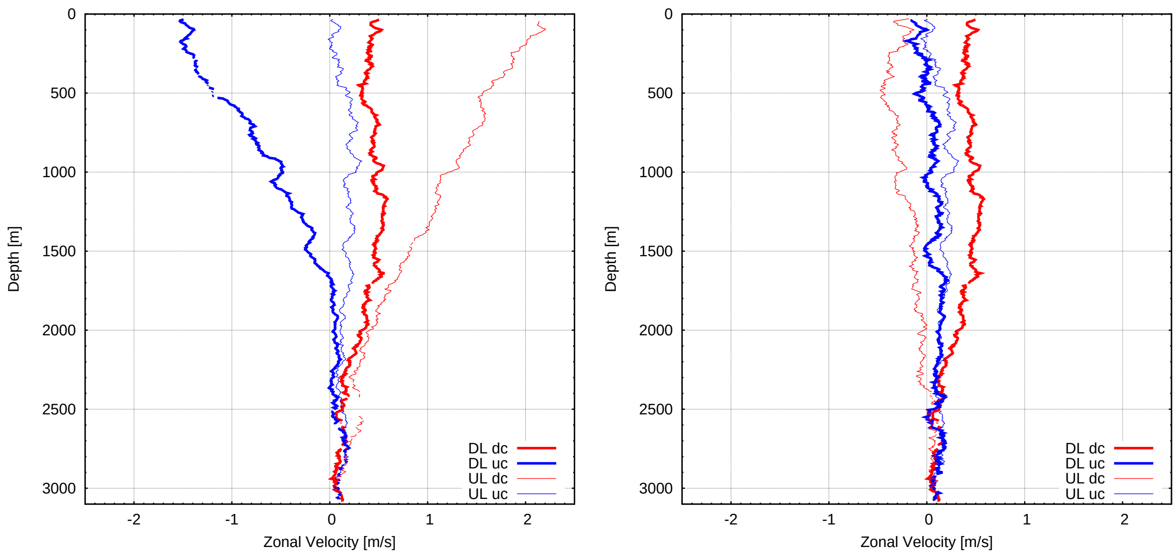

Figure 2: Example LADCP profile of zonal velocity, with down-/up-casts of the downward-/upward-looking instruments processed separately. Left panel: Using all beams. Right panel: Without data from down-/up-looking beams 4 & 2, respectively.

Original orientation. Stations 1–18, 26–34.

Uplooker rotated. Stations 19–25.

Up- & Downlooker rotated. Stations 36–end.

Inspecting the diagnostic figures from station #064 processed with data from all beams reveals anomalous coherent structure in the uplooker residuals (Figure 3). As the anomalous residuals are restricted to the downcast, a wake effect was suspected and the data were re-processed with the data from the affected beam (#4) removed. The results from the two processing runs are largely identical with the difference that the residuals in the run without beam 4 do not show any anomalous structure (not shown). No other casts were found with such strong anomalous residual structure necessitating additional wake editing.

After the cruise all profiles were re-processed with the LDEO software both with and without the data from the wake-affected beams. SADCP data were not used to constrain the velocities but, rather, to obtain a relative measure of profile quality (Figure 4). Interestingly, the LDEO-processed velocity profiles derived from all data (i.e. without wake editing) are associated with consistently smaller differences with the SADCP velocities than the profiles derived from the wake-edited data. Therefore, no wake editing was done for the final LDEO processing of the UK4 data.

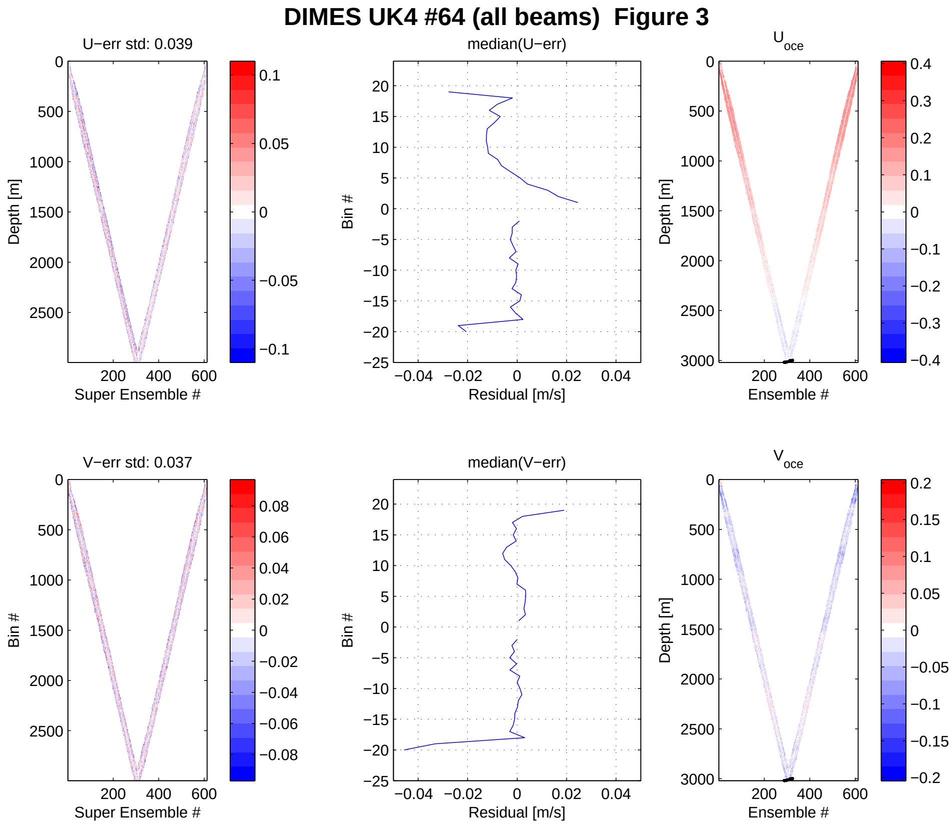

Figure 3: Diagnostic figure 3 from LDEO processing of station 64. The upper middle panel shows large vertical structure in the residuals. .

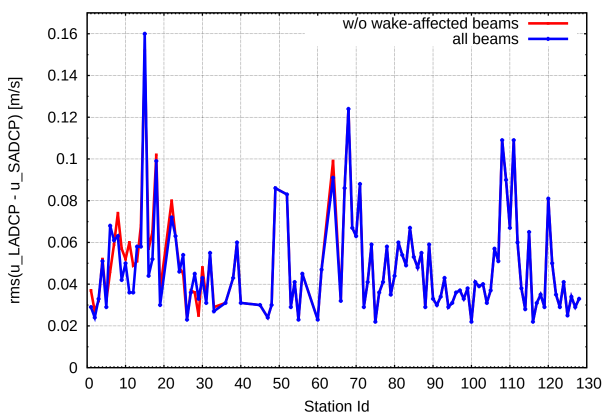

Figure 4: *rms* velocity differences between LADCP and SADCP velocities in the upper ocean. See text for details on wake editing.

4 Final Post-Cruise Processing and QC

For final processing with the LDEO method, no wake editing was done and the SADCP data were used to constrain the velocities. On the resulting profiles, another QC was carried out, again primarily based on diagnostic figures. Particular attention was paid to the profiles that produced warnings during processing. The following list includes notes from both the on-cruise and the post-cruise QC; profiles that produced warnings but no apparent anomalies are not listed:

001 Broken UL beam 3. Since there are no significant differences between the shear-method processed DL and combo solutions the UL data were kept for processing.

035 This cast was aborted due to mooring work. In spite of the fact that the CTD file is incomplete, missing the top 200 m of the upcast, the profile can be processed without problems.

060 Shortly after the beginning of the upcast, both instruments stopped pinging for nearly 11 minutes. As far as I can tell, this data gap does not affect LDEO processing in any significant way.

067-071 Profiles potentially affected by poor instrument range. See notes on range above.

086–089 UL beam 2 is gradually getting weaker, apparently without significantly affecting the profiles.

115–116 UL beam 3 quickly deteriorates, apparently without significantly affecting the profiles.

117 The UL instrument has two bad beams (#2 & 3). There are no apparent problems with the profile constructed from DL data alone.

The profiles from final processing are nearly identical to the profiles processed by X. Liang during the cruise. The main difference is that for final processing, RDI bottom-track data was used, whereas the on-ship processing used post-processed bottom track data. While it is unclear in general which bottom-track data stream is better, using RDI bottom track in this data set results in one fewer processing warnings than using the post-processed bottom track. The only other difference is that the UL data were removed from profile #117 for final processing.