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RV *Investigator* ADCP Data Processing Report

Voyage ID	IN2023_V02
Voyage Title	Gigantic submarine landslide offshore western Tasmania: risk mitigation for shelf-derived tsunami in Australia
Depart	Hobart, 0800 Friday 24 th March 2023
Return	Hobart, 0800 Sunday 30 th April 2023
Chief Scientist	Dr. Martin Jutzeler (UTAS)
Data Processor	Vito Dirita (CSIRO – E&T Data Acquisition & Processing)

Document History

Date	Version	Author	Comments
27 September 2023	1.0	Vito Dirita	Initial version
6 March 2026	1.1	Vito Dirita	Revised version

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1 Summary

A recent, well-exposed gigantic submarine landslide with a volume equivalent of 740 times the size of Uluru occurred off the west coast of Tasmania in the past.

The IN2023_V02 aimed to survey and sample the surface and sub-surface area of the landslide and surrounding areas to understand how, when and why this event happened, and to establish hazard mitigation maps for the future.

An array of multi-disciplinary methods were utilised to achieve the aims of this voyage, utilising the following MNF equipment; Multi-beam bathymetry/backscatter, Sub-bottom profiling, Seismic reflections, Sediment coring, Dredging, Single-beam and Multi-beam Echo-sounding, Gravity measurements, Video footage and Underway sensors

This report describes the production of quality-controlled ADCP data from RV *Investigator* voyage IN2023_V02.

Overall Data Quality:

Investigations into the OS75 kHz ADCP fault were conducted at the start of the voyage in an attempt to operate the instrument at a reduced capacity and to assist with further diagnosis of the fault from works completed in the port period.

Data was collected from the OS75 and sent to UHDAS Hawaii for analysis. They recommended a software configuration change where the acquisition software would ignore data from beam 4, allowing the OS75 to operate at a reduced capacity, thereby displaying noisy current data to 600m, and this was implemented.

Additionally, all performance tests commands were run on the instrument and the results were sent to RDI for analysis, along with the dry end cable results that were completed during the recent port period. RDI re-confirmed that beams 1 & 2 had crosstalk interference and beam 4 was in a permanent state of error and recommended the return of the instrument to RDI for repairs. The OS75 kHz was shut-down and will be swapped over with a spare during the next port period.

ADCP data were collected using the University of Hawaii Data Acquisition System (UHDAS) and post-processed using the Common Ocean Data Access System (CODAS). Documentation for these systems can be found in (Hummon, 2009-2021).

Both the RDI Ocean Surveyor 150kHz ADCP and the RDI Ocean Surveyor 75kHz ADCP were run in narrowband mode.

Internal triggering was used.

The drop keel (port) is located approximately 6.0m below the water line, additionally the keel was extended by 2.0m for the entire duration of the voyage, subsequently the transducers were located approximately 8.0m below the water line.

To access the full voyage plan and other reports and data associated with this voyage, please see the contact information at the end of this report.

1.1 Voyage Track

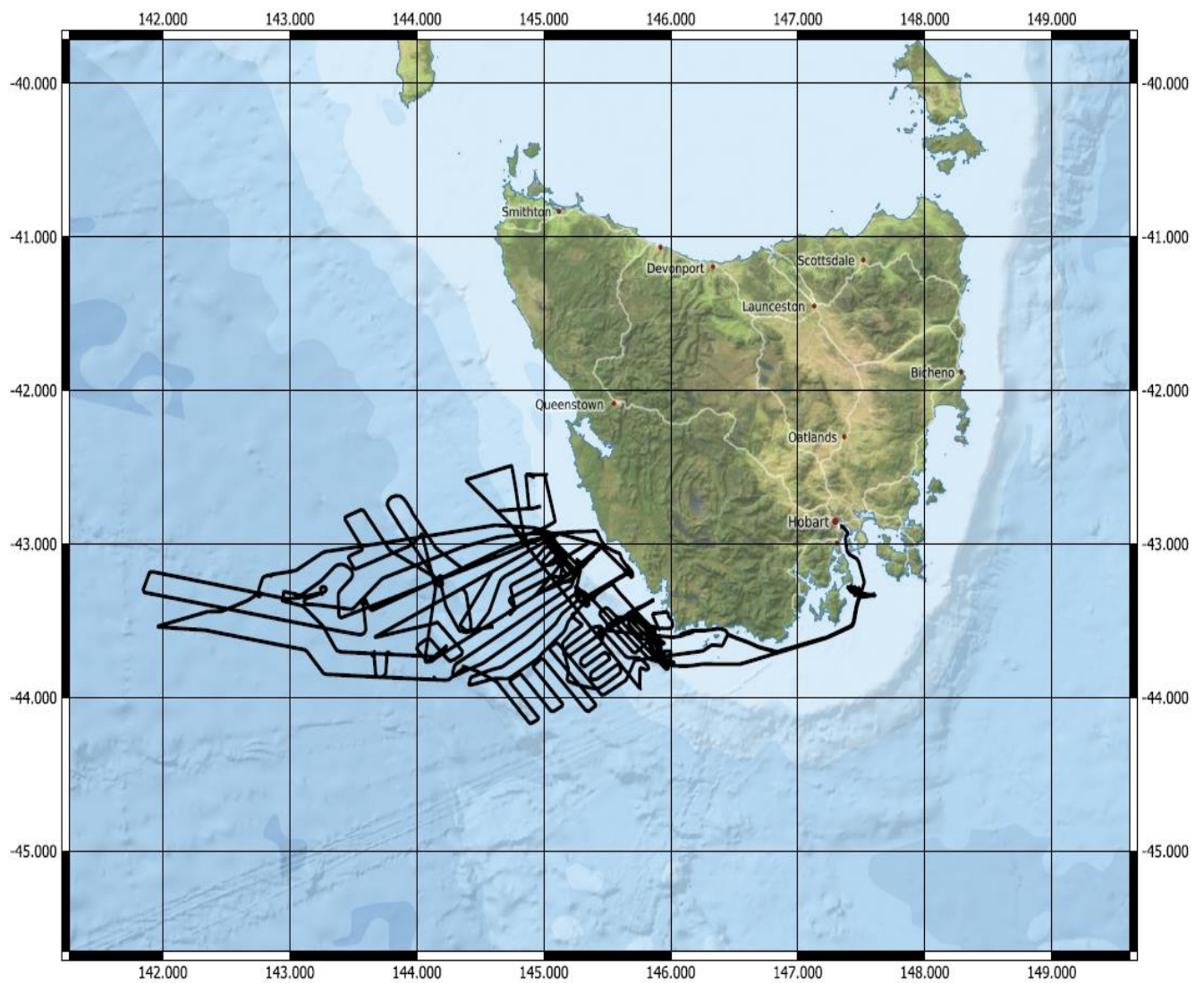


Figure 1: Voyage track

Please see the webpy folders for plots of collected data.

2 Data Processing

2.1 Background Information

The University of Hawaii's CODAS software (Built 2021-10-20) contained in their "focal_20.04" Oracle VM Virtual Machine (VirtualBox) image was used for data post-processing.

2.2 Processing Notes

The datasets have been segmented into two parts, with dates as follows:

Part	ADCP	Data Dates	Comments
1	OS75	24/03/2023 to 24/03/2023	No Data, refer to page 3.
	OS150	24/03/2023 to 27/03/2023	No Heading correction required
2	OS75	27/03/2023 to 14/04/2023	Heading correction applied, Tables 2,3
	OS150	27/03/2023 to 20/04/2023	Heading correction applied, Tables 2,3

Table 1: Data Dates

For the first part of the voyage, no OS75 data was available, for the OS150, only minor editing was required, no heading correction was applied to the OS150.

For the second part, both OS75 and OS150 data was available. Some editing was required, data were masked where instrument anomalies were suspected and where the OS75 and OS150 data differed significantly. A heading correction was applied to both ADCPs using `patch_hcorr.py` using bottom track calibration:

OS75		OS150	
Amplitude	Phase	Amplitude	Phase
1.0040	0.2255	1.0110	-0.0950

Table 2: Amplitude and phase rotation heading corrections applied (part-2 only)

OS75		OS150	
Amplitude	Phase	Amplitude	Phase
1.0000	-0.0005	1.0000	0.0025

Table 3: Final OS75 and OS150 amplitude and phase (part-2 only)

Water-track Amplitude and Phase rotation calibration were applied to the data. When processing the data, the true transducer offsets from the GPS position of the ship were as follows:

OS75		OS150	
dx (m)	dy (m)	dx (m)	dy (m)
-1.0	4.0	-1.0	1.0

Table 4: True ADCP transducer offsets from GPS position

Instrument Serial Numbers

Manufacturer	Instrument	Serial Number
TRDI	ADCP 75 kHz	65008
TRDI	ADCP 150 kHz	61315

Table 5: ADCP serial numbers

3 NetCDF Data Headers

```
IN2023_V02_ADCP_os150nb_pt1.nc      os150nb  24/03/2023 02:53:34 to 27/03/2023 08:50:17
IN2023_V02_ADCP_os150nb_pt2.nc      os150nb  27/03/2023 09:02:08 to 20/04/2023 19:37:07
IN2023_V02_ADCP_os75nb_pt1_nodata.nc os75nb   24/03/2023 08:55:25 to 24/03/2023 23:28:54
IN2023_V02_ADCP_os75nb_pt2.nc      os75nb   27/03/2023 09:02:08 to 14/04/2023 08:35:12
```

CODAS_variables:

Variables in this CODAS short-form Netcdf file are intended for most end-user scientific analysis and display purposes. For additional information see the CODAS_processing_note global attribute and the attributes of each of the variables.

```
=====
time          Time at the end of the ensemble, days from start of year.
lon, lat      Longitude, Latitude from GPS at the end of the ensemble.
u,v           Ocean zonal and meridional velocity component profiles.
uship, vship  Zonal and meridional velocity components of the ship.
heading       Mean ship heading during the ensemble.
depth         Bin centers in nominal meters (no sound speed profile correction).
tr_temp      ADCP transducer temperature.
pg            Percent Good pings for u, v averaging after editing.
pflag        Profile Flags based on editing, used to mask u, v.
amp          Received signal strength in ADCP-specific units; no correction
              for spreading or attenuation.
=====
```

CODAS processing note:

```
=====
```

Overview

```
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```

The CODAS database is a specialized storage format designed for shipboard ADCP data. "CODAS processing" uses this format to hold averaged shipboard ADCP velocities and other variables, during the stages of data processing. The CODAS database stores velocity profiles relative to the ship as east and north components along with position, ship speed, heading, and other variables. The netCDF **short** form contains ocean velocities relative to earth, time, position, transducer temperature, and ship heading; these are designed to be "ready for immediate use". The netCDF **long** form is just a dump of the entire CODAS database. Some variables are no longer used, and all

have names derived from their original CODAS names, dating back to the late 1980's.

Post-processing

CODAS post-processing, i.e. that which occurs after the single-ping profiles have been vector-averaged and loaded into the CODAS database, includes editing (using automated algorithms and manual tools), rotation and scaling of the measured velocities, and application of a time-varying heading correction. Additional algorithms developed more recently include translation of the GPS positions to the transducer location, and averaging of ship's speed over the times of valid pings when Percent Good is reduced. Such post-processing is needed prior to submission of "processed ADCP data" to JASADCP or other archives.

Full CODAS processing

Whenever single-ping data have been recorded, full CODAS processing provides the best end product.

Full CODAS processing starts with the single-ping velocities in beam coordinates. Based on the transducer orientation relative to the hull, the beam velocities are transformed to horizontal, vertical, and "error velocity" components. Using a reliable heading (typically from the ship's gyro compass), the velocities in ship coordinates are rotated into earth coordinates.

Pings are grouped into an "ensemble" (usually 2-5 minutes duration) and undergo a suite of automated editing algorithms (removal of acoustic interference; identification of the bottom; editing based on thresholds; and specialized editing that targets CTD wire interference and "weak, biased profiles". The ensemble of single-ping velocities is then averaged using an iterative reference layer averaging scheme. Each ensemble is approximated as a single function of depth, with a zero-average over a reference layer plus a reference layer velocity for each ping. Adding the average of the single-ping reference layer velocities to the function of depth yields the ensemble-average velocity profile. These averaged profiles, along with ancillary measurements, are written to disk, and subsequently loaded into the CODAS database. Everything after this stage is "post-processing".

note (time):

Time is stored in the database using UTC Year, Month, Day, Hour, Minute, Seconds. Floating point time "Decimal Day" is the floating point interval in days since the start of the year, usually the year of the first day of the cruise.

note (heading):

CODAS processing uses heading from a reliable device, and (if available) uses a time-dependent correction by an accurate heading device. The reliable heading device is typically a gyro compass (for example, the Bridge gyro). Accurate heading devices can be POSMV, Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this varies with the technology of the time. It is always confusing to keep track of the sign of the heading correction. Headings are written degrees, positive clockwise. setting up some variables:

X = transducer angle (CONFIG1_heading_bias)
 positive clockwise (beam 3 angle relative to ship)
 G = Reliable heading (gyrocompass)
 A = Accurate heading
 dh = G - A = time-dependent heading correction (ANCIL2_watrk_hd_misalign)

Rotation of the measured velocities into the correct coordinate system amounts to $(u+iv) \cdot (\exp(i \cdot \theta))$ where theta is the sum of the corrected heading and the transducer angle.

$$\text{theta} = X + (G - dh) = X + G - dh$$

Watertrack and Bottomtrack calibrations give an indication of the residual angle offset to apply, for example if mean and median of the phase are all 0.5 (then R=0.5). Using the "rotate" command, the value of R is added to "ANCIL2_watrk_hd_misalign".

$$\text{new_dh} = dh + R$$

Therefore the total angle used in rotation is

$$\begin{aligned} \text{new_theta} &= X + G - \text{dh_new} \\ &= X + G - (dh + R) \\ &= (X - R) + (G - dh) \end{aligned}$$

The new estimate of the transducer angle is: X - R
ANCIL2_watrk_hd_misalign contains: dh + R

=====

Profile flags

Profile editing flags are provided for each depth cell:

binary value	decimal value	below bottom	Percent Good	bin
000	0			
001	1			bad
010	2		bad	
011	3		bad	bad
100	4	bad		
101	5	bad		bad
110	6	bad	bad	
111	7	bad	bad	bad

IN2023_V02_ADCP_os150nb_pt1.nc (24/03/2023 02:53:34 to 27/03/2023 08:50:17)

```
featureType      : trajectoryProfile
history          : Created: 2023-09-26 04:30:35 UTC
Conventions      : COARDS
software         : pycurrents
hg_changeset     : 3211:63370479787a
title            : Shipboard ADCP velocity profiles
description      : Shipboard ADCP velocity profiles from in2023_v02 using instrument
os150nb - Short Version.
cruise_id       : in2023_v02
sonar            : os150nb
yearbase        : 2023
ship_name       : RV_Investigator
```

Longitude (degrees_east)	lon	143.6698	147.2517
Latitude (degrees_north)	lat	-43.7961	-42.9364
Depth (meter)	depth	17.97	493.96
Zonal velocity component (meter second-1)	u	-0.44	0.40
Meridional velocity component (meter second-1)	v	-0.55	0.43
Received signal strength	amp	23	214
Percent good pings	pg	0	100
Editing flags	pflag	0	6
Ship heading (degrees)	heading	-180.0	179.8
ADCP transducer temperature (Celsius)	tr_temp	14.5	16.8
Number of pings averaged per ensemble (None)	num_pings	218	251
Ship zonal velocity component (meter second-1)	uship	-5.8932	5.8332
Ship meridional velocity component (meter second-1)	vship	-5.2225	6.0705

ship_name : RV_Investigator

Longitude (degrees_east)	lon	141.8418	145.7014
Latitude (degrees_north)	lat	-43.9197	-42.6865
Depth (meter)	depth	29.99	973.99
Zonal velocity component (meter second-1)	u	-0.82	1.13
Meridional velocity component (meter second-1)	v	-0.55	0.86
Received signal strength	amp	30	147
Percent good pings	pg	0	100
Editing flags	pflag	0	6
Ship heading (degrees)	heading	-179.9	179.5
ADCP transducer temperature (Celsius)	tr_temp	14.1	16.6
Number of pings averaged per ensemble (None)	num_pings	28	133
Ship zonal velocity component (meter second-1)	uship	-7.8246	36.7829
Ship meridional velocity component (meter second-1)	vship	-5.6652	5.8685
Decimal day	time	85.37648	103.35778

4 References

Alix Post (2023). The RV Investigator. *Voyage Plan IN2023_V02*. Retrieved from Marine National Facility: Voyage Plans and summaries:

https://www.marine.csiro.au/data/reporting/get_file.cfm?eov_pub_id=2697

Hummon, J. (2009-2021). *CODAS+UHDAS Documentation*. Retrieved February 1, 2023, from https://currents.soest.hawaii.edu/docs/adcp_doc

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