

For Using Data

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Quality DMO-Processed

Instrument

Shipboard acoustic doppler current profiler (ADCP)

**Overview**

Acoustic Doppler Current Profiler (ADCP) transmits acoustic pulses from a transducer assembly. The transducers receive backscattered sounds from small particles floating with water currents. Using the Doppler shift principle, the backscattered sound data can be converted into components of water current velocity at multiple depths. The shipboard ADCP mounted on R/V HAKUHO-MARU can measure the speed and direction of water currents for up to 128 layers. The dataset provided here is a 5-minute time average of absolute velocity data (i.e., water current velocity in geophysical coordinates) after various kinds of corrections. This data processing was carried out by DMO. See "Data correction method for the shipboard ADCP" for detailed correction methods.

Measurement System

Manufacturer :	Teledyne RD Instruments
Type :	OS-ADCP 38kHz
Frequency :	38.4 kHz
Configuration :	4-beam phased array
Beam angle :	30 degree
Transducer Depth :	6.5 m beneath calm water line
ADCP data logger :	Teledyne RD Instruments VmDas 1.46.5
Ship heading and attitude	
[instrument maker/model] :	iXBlue/Octans
Navigation	
[instrument maker/model] :	Trimble/SPS356

ADCP configuration

Bottom track mode	
2020/09/10 03:57 - 2020/10/04 03:35	
Depth range :	40 m - 1,304 m (bin centers)
Bin length :	16 m
Number of bins :	80
Blanking interval :	16 m
Sound speed calculation :	used transducer temperature during acquisition
Correction of the alignment error	
[corrected angle] :	0.281 degree

Note

If you would like the raw data set, please contact DMO at "dmo@jamstec.go.jp".

1. Introduction

Shipboard ADCP measures water and bottom velocities relative to the ship. Water velocity in earth coordinates, called "absolute velocity", is calculated by subtracting the ship's velocity (over the ground) from water velocity measured by ADCP which is called "relative velocity". Here, the ship's velocity is calculated from GPS positioning data.

Detailed correction method for the ship's velocity and ADCP relative velocity is as follows.

2. Correction of the GPS data (ship's velocity)

Errors in GPS data need to be removed in advance in order to calculate high quality ship's velocity. GPS data used here is 1-Hz GPS NMEA data recorded in the ADCP logger. Bad position data are detected by the following criteria, when:

- a) the estimated ship's velocity from the GPS data in every second exceeds 19 knots, and
- b) the estimated ship's acceleration by GPS data in every second exceeds 0.5 m/s^2 .

Bad data are removed and interpolated from nearby good data. Furthermore, high frequency fluctuations are removed by a 20-second running mean filter.

3. Correction of the ADCP data

Errors (alignment of hull-mount transducer and roll/pitch error) in relative velocity were rejected by the following method:

1) Calculation of miss alignment using bottom track data

The miss alignment value is estimated from the ADCP data measured in bottom track mode, as follows:

- * When bottom track data were not measured, preset alignment value which was obtained in the latest performance test cruise has been applied.

1-1) Ship's velocity correction and roll/pitch error correction

For the selected bottom track data, GPS data is replaced by the corrected data pre-processed in Section 2. Then, roll/pitch error is also corrected if ship's heading and roll/pitch data are measured by the inertial navigation system. These processing are performed by "VM-DAS" software (Teledyne R. D. Instruments).

1-2) Estimation of miss alignment

Miss alignment value was estimated from bottom track velocity and GPS velocity, using formula of Joyce (1989). Then, input data were selected as follows: a) ship velocity and ship heading were continuously, b) the "Ping Correlation" of ADCP is 200 counts and over (MAX: 255 counts), and c) the "Echo Intensity" is 60 counts and over (MAX: 255 counts).

2) Correction of miss alignment and roll/pitch error for all period of data

Using the estimated miss alignment value, the miss alignment is corrected for all period of the ADCP data by VMDAS software. Then, replacing of GPS data and roll/pitch error correction are performed by the same processing as 1-1) in this section.

4. Calculation of absolute velocity for each ping and making 5-minute time-average dataset

Dataset provided here is a 5-minute time average of absolute velocity, which is calculated from the screened pings of absolute velocity data. Screening of ping velocity data is executed in the following sequence:

1) Removal of the error velocity near the sea surface (so-called ringing velocity)

Velocity data near the sea surface, which measured immediately after sending pulse, is often recorded as much faster than actual velocity by the influence of transducer resonance. Such error velocity near the sea surface, called "ringing velocity", is often measured with similar direction to ship's course.

So, for each ping data,

- a) if the magnitude of calculated absolute velocity for a layer is faster than 1.0 m/s and more than twice compared with the value of one layer below, and -
 - b) if the direction of the velocity is within ± 45 degrees from the ship's heading,
- then, the velocity data between the surface and this layer are all removed as ringing velocity.

2) Removal of the "Bad Correlation" and "Bad Echo Intensity" data

Ping velocity data are used for the average calculation only when the "Ping Correlation" of ADCP is 120 counts and over (MAX: 255 counts) and the "Echo Intensity" is 25 counts and over (MAX: 255 counts).

3) Removal of data near the seafloor

The data measured near the seafloor is often recorded error velocity due to side rope. Thus, 85% or more water depth measurement data is removed. If the seafloor depth was not measured by ADCP, we apply the seafloor depth measured by MBES system concurrently. During the period that the seafloor depth was not measured by both ADCP and MBES, we use the extracted seafloor depth under the ship track from 500 m Mesh Depth-sounding data of Japan Oceanographic Data Center (JODC)*. If none of the seafloor depths exist, data quality flag (4 : Questionable) is added to all vertical layer of the data during the period that sound reflection from the seafloor was detected.

* <https://www.jodc.go.jp/jodcweb/JDOSS/infoJEGG.html>

4) Removal of the random noise

In order to remove random noise, 2-sigma filter is used for ping velocity data in every 5-minute average section.

In calculating 5-minute average, if more than 90% of ping velocity data in an average section are screened out by the above filters, "Percent Good" is not more than 10%, then the average data is assumed unreliable and replaced it to be invalid (NaN).

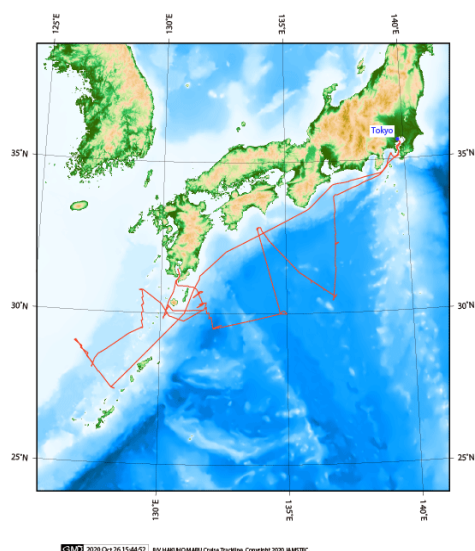
In addition, data quality flag (4 : Questionable) are added when:

- a) Absolute "Error Velocity" in 5 minutes is 12 cm/s and over, or
- b) "Percent Good" in 5 minutes is less than 50%.

The dataset is written in ODV (Ocean Data View) format. See Data Format for details.

Related Information

R/V HAKUHO MARU Cruise Trackline in KH-20-9



KH-20-9

Ship Name: HAKUHO MARU
Period: 2020/09/10 - 2020/10/05
Chief Scientist: Hiroaki Saito (AORI, The University of Tokyo)
Proposal: Study of the hotspots of nutrient supply in the Kuroshio region: For solving the Kuroshio Paradox

Format Description for ADCP Corrected

About data format

We provide the dataset as AWI Ocean Data View format (generic spreadsheet format).

Ocean Data View : <http://odv.awi.de/>

Format Description (tab space separated)

No.	Content	Format	Unit	Remarks
1	CruiseID	i6		Cruise name
2	Station	i4,i2,i2,i2,i2		Station name set to be measurement time [YYYYMMDDhhmm]
3	Type	a1		Always "B", due to the number of data acquisition layers lower than 250-layer
4	Day	i2,a1,i2,a1,i4		Measurement day(UTC) [MM/DD/YYYY]
5	Time	i2,a1,i2		Measurement time [Center of average time](UTC) [hh:mm]
6	Longitude	f8.4	degree	Position at the measurement time [0 - 360]
7	Latitude	f8.4	degree	Position at the measurement time [North: +, South: -]
8	Bottom depth	f6.1	m	Set to be "0" if there is no data
9	Measurement depth	f7.2	m	Depth of measurement layer
10	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
11	Current speed (zonal)	f8.4	m/sec	5-minute average of zonal component of absolute velocity [Eastward: +] [Only good data of more than 120 count of ping correlation and more than 25 count of echo intensity were used for the average]
12	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
13	Current speed (meridional)	f8.4	m/sec	5-minute average of meridional component of absolute velocity [Northward: +] [Only good data of more than 120 count of ping correlation and more than 25 count of echo intensity were used for the average]
14	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
15	Current speed (vertical)	f8.4	m/sec	5-minute average of vertical component of absolute velocity [Upward: +] [Only good data of more than 120 count of ping correlation and more than 25 count of echo intensity were used for the average]
16	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
17	Speed of absolute velocity	f7.4	m/sec	Magnitude of absolute velocity
18	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
19	Current direction	f5.1	degree	Current direction of absolute velocity [0 to 360]
20	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
21	Error velocity	f8.4	m/sec	5-minute average of error velocity
22	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
23	Correlation	f5.1	count	5-minute average by 4-beam average correlation(send beam - received beam) [max:250count] [The data used to calculate velocity were used to average]
24	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
25	Echo Intensity	f5.1	count	5-minute average by 4-beam average echo intensity [max:120count] [The data used to calculate velocity were used to average]

26	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
27	Percentgood	f5.1	%	Rate of the good data that is used velocity calculation to the all data [0 to 100]
28	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
29	Ship's speed	f7.4	m/sec	Ship's speed by GPS
30	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
31	Standard deviation of the Ship's Speed*	f5.2	m/sec	Standard deviation of the Ship's Speed in the 5-minute
32	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
33	Standard deviation of the Ship's Heading*	f6.2	degree	Standard deviation of the Ship's Heading in the 5-minute
34	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
35	Standard deviation of the Ship's Roll*	f5.2	degree	Standard deviation of the Ship's Roll in the 5-minute
36	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad
37	Standard deviation of the ship's pitch*	f5.2	degree	Standard deviation of the ship's pitch in the 5-minute
38	Quality flag	i1		"0"=good, "4"=questionable, "8"=bad

* Standard deviations of the ship's speed and the ship's heading, roll, and pitch in each 5-minute average section are also included in the dataset, since data quality of ADCP velocity might be dropped due to the high variabilities of each variables. However, DMO doesn't make any evaluation for the ADCP data by them.