

## For Using Data

Data Policy	JAMSTEC
Principal Investigator	Data Management Office
Use Constraints	See Terms and Conditions about constrain of use.
Data Citation	See Terms and Conditions about data citation.

## Quality

DMO-Processed

## Instrument

Doppler radar ( - MR14-02)



## Overview

The data that can be provided are "MIRAI Doppler radar data set (Processed data)" converted into an orthogonal coordinate system after the necessary filters for each about radar reflectivity and Doppler velocity are processed. There are following two kinds in data set.

(1) The volume scan data: we composite the Doppler mode PPI scan data of plural elevation, and then converted the coordinate system of the data into three-dimensional orthogonal coordinates (horizontal 201km square, an altitude of 0-20km).

(2) The surveillance scan data: we converted two-dimensional coordinates of the intensity mode PPI scan data of the lowest elevation into an orthogonal coordinate system (horizontal 601km square).

The correction and processing method was produced by Dr. M. Katsumata (Research Institute for Global Change/JAMSTEC) in cooperation with DMO (Data Management Office). This data processing was carried out by DMO. (See "Flow of doppler radar data processing" for detailed correction methods.)

## Measurement System

## 1) Doppler radar

Manufacturer :	Mitsubishi Electric Co. Ltd., Japan
Type :	RC-52B
Frequency :	5290MHz (C-band)
Peak power :	250kW
Antenna diameter :	3m
Beam angle :	< 1.5 degree
Location (from sea surface) :	21m (center position of antenna)
Processing system :	RVP-7 (Vaisala Inc. Sigmet Product Line, USA)
Data acquisition software :	IRIS ver. 8.5.10 (Vaisala Inc. Sigmet Product Line, USA)

## 2) Inertial navigation system

Manufacturer :	iXBlue SAS, France
Type :	PHINS
Location (from sea surface) :	21m

## Parameter

	Surveillance Scan	Volume Scan
Pulse width [ $\mu$ s] :	2.0	0.5
Scan speed [deg/sec] :	18	18
PRF*1 [Hz] :	260	900 / 720 *2
Sweep integration :	32 samples	40 samples
Ray spacing [deg] :	about 1.0	about 1.0
Bin spacing [m] :	250	250
Elevations [deg] :	0.5	0.5, 1.0, 1.5, 2.1, 2.8, 3.5, 4.3, 5.1, 5.9, 6.8, 7.6, 8.5, 9.4, 10.4, 11.5, 12.7, 14.0, 15.5, 16.8, 18.8, 21.3

Range [km] :	300	160
Scan interval [min] :	30 *3	10

\*1 Pulse Repetition Frequency

\*2 During this cruise, the data were measured with the dual-PRF mode. Therefore, unfolding of Doppler velocity was applied automatically.

\*3 Every an hour data is provided (Processed data).

#### Note

1) Processed and/or raw data can be provided off-line.

Please contact us from "dmo@jamstec.go.jp", if you wish to use them.

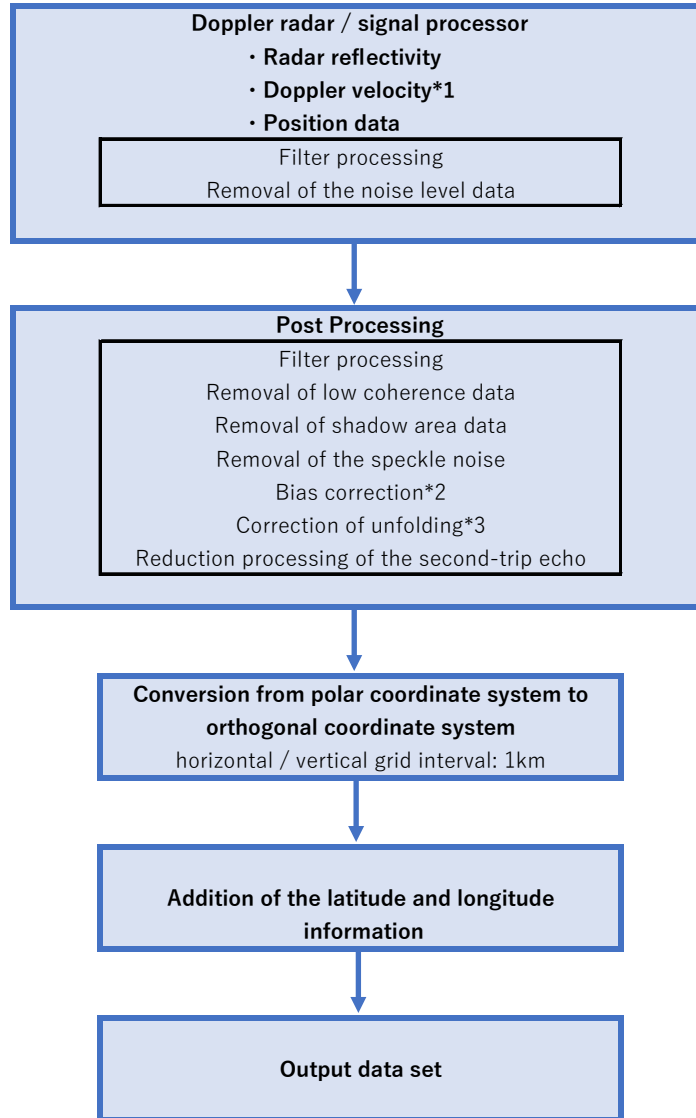
2) During this cruise, surveillance scan was operated at a peak power of 200kW due to the transmitter system trouble.

3)The following period, volume scan data were invalid due to the transmitter system trouble.  
2013/10/13 20:50 - 2013/10/13 20:59

### 1. Summary of the processing

"The MIRAI Doppler radar data set (Processed data)" is processed with the following methods for the raw data acquired using IRIS (Vaisala Inc. Sigmet Product Line, USA).

- Filter processings
- Conversion from polar coordinate system into orthogonal coordinate system
- Addition of the latitude and longitude information



\*1 : Surveillance scan mode does not contain the Doppler velocity data. In dual-PRF observation, correction of unfolding is carried out in signal processor automatically.

\*2 : Bias correction is applied only to the MR04-01 cruise during which the receiver trouble occurred.

\*3 : Correction of unfolding is not applied to single-PRF observation.

### 2. Details of filter processing

#### 2.1 Removal of the noise level data (IRIS Programmer's Manual, 2010; Katsumata et al., 2008)

The following equation is used to define the threshold between the valid signal and the noise of the raw data:

$$Z_{min}(r) = Z_{min}(1km) + 2[10 \log_{10}(r - 1) + C_{gas} \cdot (r - 1)]$$

$Z_{min}$  is the threshold reflectivity to be obtained (in dB);

$r$  is the range distance in km;

$Z_{min}(1km)$  is the threshold reflectivity at the range distance of 1km (in dB);

$C_{gas}$  is the gaseous attenuation coefficient (dB/km).

The  $Z_{min}(1km)$  and  $C_{gas}$  are taken from the dataset in IRIS/Open RAW format.

## 2.2 Removal of low coherence data

SQL(Signal Quality Index) is the value calculated in the signal processor system RVP7 and is used as a threshold for determining whether the Doppler velocity is valid or not. The SQL varies between 0 for an uncorrelated signal (white noise) to 1 for a noise-free zero-width signal (pure-tone). The larger SQL as threshold is, the harder the noisy bin are adopted.

The SQL with value of 0.3 are adopted as threshold.

Before the MR01-K05 cruise, RVP7 was not installed. Therefore, the correction using SQL is not carried out.

See "Sgment RVP7 User's Manual, 2003 for detailed correction method.

## 2.3 Removal of shadow area data (Katsumata et al., 2008)

"MIRAI" has some structures that become the obstacles for the radar observations.

The data in these shadows are removed by referring to look-up tables. The look-up tables are constructed statistically from the observational data. To simplify, we assume the shadow depends only on the azimuth and elevation, not on range distance, because all obstacles existed only in the vicinity of the radars.

In case of the R/V MIRAI, the data in the azimuths with an anomaly of the averaged reflectivity of less than -3 dB (i.e., half power) are removed as the shadow direction.

## 2.4 Removal of the speckle noise data

In case the data do not exist in 2 consecutive bins of the beam direction, it is determined to be a speckle noise.

## 2.5 Correction of unfolding (Katsumata et al., 2005)

The automatic Doppler velocity unfolding with the signal processor may mistake processing in a domain with a few data. Therefore, we judge the need of the correction of the Doppler velocity data from the following conditions:

- The discontinuity of the Doppler velocity in the range of +/-2 degree in the azimuth direction from bin of the aim.
- The discontinuity of the Doppler velocity in the range of +/-3km in the beam direction from bin of the aim.

The unfolding is conducted up to five times at the maximum.

## 2.6 Reduction processing of the second-trip echo (Katsumata et al., 2005)

In case that the second-trip echo exists, the large discontinuity of the reflectivity occurs between a beam next to each other. Using this characteristic, the second-trip echo removes by the following processing.

- For bin where horizontally changes more than 2dB/km are seen, it is flagged as the "invalid data".

If this "invalid" data flag exists more than 70% in a range of 5km of the beam direction, the bin is removed as the second-trip echo.

\* Reduction processing of the second-trip echo is effective for the dual-PRF observation.

## 2.7 Conversion from polar coordinate system to orthogonal coordinate system

On the virtual globe centered the interpolated grid, the weighted interpolation method with a Gaussian distribution is used to convert from polar coordinate system to orthogonal coordinate system.

The weighted value is expressed in the following expressions.

$$W(d) = e^{-d^2 \cdot wcoef}$$
$$wcoef = \ln(1/2)/H^2$$

d : Distance from the interpolation point

W(d) : Weighted coefficient of the data which separated only distance (d) from the interpolation point

H : Half bandwidth

The half bandwidth is set to horizontally direction in 500m and vertically direction in 250m.

## 2.8 Addition of the latitude and longitude information

The central location of volume scan is set up from a position of "MIRAI" at the start time of each volume scan observation.

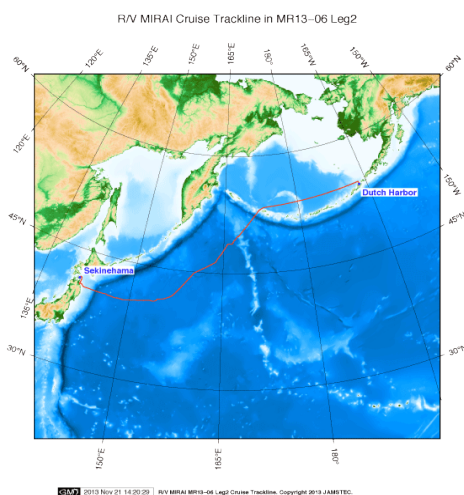
The conversion from the grid position (X, Y) in the orthogonal coordinate system to the latitude and longitude is made with the Lambert azimuthal equal-area projection method (Nakatsuka, 2006). In this case, the earth is supposed to be GRS80 ellipse.

## 3. References

- Katsumata, M., K. Yoneyama, Y. Yuuki, S. Sueyoshi, N. Nagahama, and K. Yoshida, 2005 : Noise filtering for dual-PRF observed data from R/V Mirai shipborne Doppler radar. JAMSTEC Rep. Res. Dev., 2, 29-34
- Katsumata, M., T. Ushiyama, K. Yoneyama, and Y. Fujiyoshi 2008 : Correction of Radar Reflectivity Using TRMM and Distrometer, SOLA, 4, 101-104
- Nakatsuka, T., 2006 : Library Software for Geophysical Data Processing and Representation (2), GSJ Open-File Report, no.442
- IRIS Programmer's Manual, 2010 : <ftp://ftp.sigmet.com/outgoing/manuals/program/3data.pdf>
- RVP7 User's Manual, 2003 : <ftp://ftp.sigmet.com/outgoing/manuals/rvp7user/5algor.pdf>

## Related Information

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### MR13-06 Leg2

Ship Name:	MIRAI
Period:	2013/10/09 - 2013/10/20
Chief Scientist:	Shigeto Nishino (JAMSTEC)
Project Name:	[Arctic Ocean Climate System Research]
Proposal:	Study on environmental changes in the sea-ice reduction regions of the Arctic Ocean

## Format Description for Doppler DMO

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The dataset is opened in the binary form of GrADS (Grid Analysis and Display System) format written in by little-endian and 4 bytes floating point.

Grid distance is 1km with horizontal and vertical directions. Owing to the factors such as beam width and beam interval, the precision of data deteriorates accompanied with the distance and altitude from the Doppler radar.

The number of the grids is as follows:

- Volume scan : to the east and west to 201 grids, north and south to 201 grids, vertical 21 layers (0-20km)
- Surveillance scan (range 300km) : to the east and west to 601 grids, north and south to 601 grids, vertical 1 layer
- Surveillance scan (range 200km) : to the east and west to 401 grids, north and south to 401 grids, vertical 1 layer

Grid of the domain center corresponds to the position of R/V "MIRAI".

-999.0 is a missing value.

The control files corresponding to each data are as follows.

### •Volume scan

```
DSET      ^Mirai_VS_%y4%m2%d2-%h2%n2.dat
OPTIONS   TEMPLATE
UNDEF     -999.0
XDEF      201 LINEAR -100.0 1.0
YDEF      201 LINEAR -100.0 1.0
ZDEF      21 LINEAR 0.0 1.0
TDEF      X LINEAR HH:MMZDDMMMYYYY XXmn
VARS      4
z          21 99 reflectivity
v          21 99 doppler velocity
dlat       1 99 latitude
dlon       1 99 longitude
ENDVARS
```

### •Surveillance scan (range 300km)

```
DSET      ^Mirai_Z_%y4%m2%d2-%h2%n2.dat
OPTIONS   TEMPLATE
UNDEF     -999.0
XDEF      601 LINEAR -300.0 1.0
YDEF      601 LINEAR -300.0 1.0
ZDEF      1 LINEAR 0.0 1.0
TDEF      X LINEAR HH:MMZDDMMMYYYY 1hr
VARS      3
z          1 99 reflectivity
dlat       1 99 latitude
dlon       1 99 longitude
ENDVARS
```

### •Surveillance scan (range 200km)

```
DSET      ^Mirai_Z_%y4%m2%d2-%h2%n2.dat
OPTIONS   TEMPLATE
UNDEF     -999.0
XDEF      401 LINEAR -200.0 1.0
YDEF      401 LINEAR -200.0 1.0
ZDEF      1 LINEAR 0.0 1.0
TDEF      X LINEAR HH:MMZDDMMMYYYY 1hr
VARS      3
z          1 99 reflectivity
dlat       1 99 latitude
dlon       1 99 longitude
ENDVARS
```

The elements, the contents and the units are as follows:

No.	Elements	Content	Unit	Remarks
1	z	Radar reflectivity	dBZ	
2	v	Doppler velocity	m/s	+ : away from the radar - : toward from the radar
3	dlat	Latitude	degree	+ : North latitude - : South latitude
4	dlon	Longitude	degree	E, 0-360

Refer to <http://www.iges.org/grads/> for the details about GrADS.