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Kairei Cruise Report

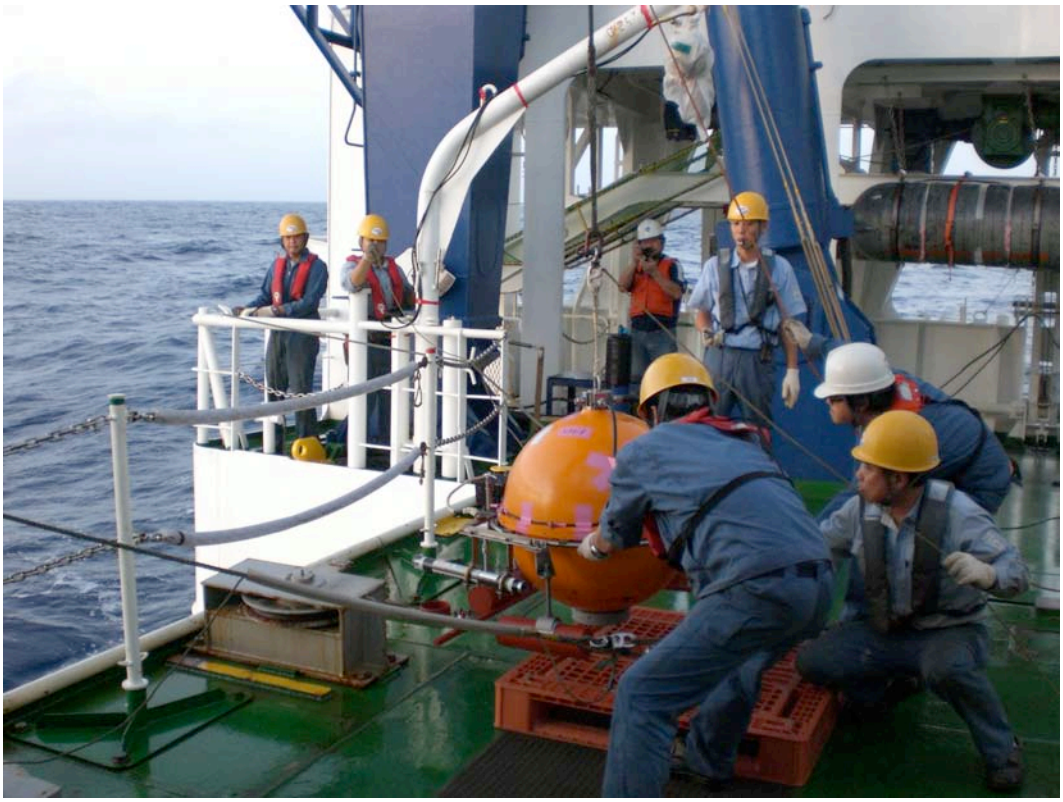
KR11-10

Deployment and recovery of BBOBS's and OBEM's in Northwest Pacific Ocean

Nov. 16 - 30, 2011

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)



Deployment of BBOBS (above) and OBEM (below).

Contents

1. Cruise Information

● Cruise ID KR11-10

● Name of vessel Kairei

● Title of the cruise Deployment and recovery of BBOBS's and OBEM's in Northwest Pacific Ocean

● Title of proposal New phase of Ocean Hemisphere Project: Imaging the normal oceanic mantle by advanced ocean bottom observations (The NOMan Project)

● Cruise period Nov.16 – 30, 2011

● Ports of call JAMSTEC Yokosuka - Sendai

● Research area Northwest Pacific Ocean

● Research Map

See Fig. 1 in Section 3.2.

2. Participants list (KR11-10)

2.1. Researchers

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Co-chief Scientist

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Noriko Tada [IFREE, JAMSTEC]
Satoru Tanaka [IFREE, JAMSTEC]
Luolei Zhang [ERI, Univ. Tokyo]
Toyonobu Ohta [Tierra Technica Corp.]
Hitoshi Kawakatsu [ERI, Univ. Tokyo, land support]
Daisuke Suetsugu [IFREE, JAMSTEC, land support]
Yozo Hamano [IFREE, JAMSTEC, land support]
Takafumi Kasaya [IFREE, JAMSTEC, land support]
Masanao Shinohara [ERI, Univ. Tokyo, land support]
Morifumi Takaesu [NME, scientific support staff]

2.2. R/V KAIREI Officers and Crew

Captain	MASAYOSHI ISHIWATA
Chief Officer	NAOTO KIMURA
2nd Officer	TAKESHI EGASHIRA
3rd Officer	YUMIHIKO KOBAYASHI
Jr.3rd Officer	HIROHARU OHMAE
Chief Engineer	KIYONORI KAJINISHI
1st Engineer	KOJI FUNAE
2nd Engineer	DAISUKE GIBU
3rd Engineer	YOSHIHIRO OTSUGA
Chief Electronics Operator	YOICHI INOUE
2nd Electronics Operator	YOSUKE KOMAKI
3rd Electronics Operator	MISATO HATA
Boat Swain	YOSHIAKI KAWAMURA
Able Seaman	YASUO KONNO
Able Seaman	YUKITO ISHII
Able Seaman	YOSHIAKI MATSUO
Able Seaman	DAISUKE YANAGITANI
Sailor	SHINSUKE UZUKI
Sailor	TORU NAKANISHI
No.1 Oiler	MASARU KITANO
Oiler	MORIYA ABE
Oiler	YOSHINORI KAWAI
Assistant Oiler	TAIJUN IWAO
Assistant Oiler	TORU HIDAKA
Chief Steward	YUKIO TACHIKI
Steward	SHINSUKE TANAKA
Steward	HIROYUKI OBA
Steward	AKIHIDE SAITO
Steward	YOSHIE HIDAKA

3. Observation

3.1 Purpose and background

We proposed and funded by Grant-in-aid for specially promoted research (JSPS) to conduct a research program in 5 years toward understanding of the mantle dynamics from an innovative observational approach by answering two fundamental questions in Earth science:

(a) ***What is the physical condition for the lithosphere-asthenosphere boundary (LAB)?***

(b) ***Is the mantle transition zone (MTZ) a major water reservoir of the Earth?***

The "normal" ocean floor is the best window to approach these questions as it allows us to see the inside of the Earth through it without the disturbance due to the thick and heterogeneous continental crust. However, any approach, if ever attempted, has not yet been successful because of technological difficulties in obtaining high-quality geophysical data in the ocean.

The present investigators had led the Ocean Hemisphere network Project (OHP) in 1996-2001, in which a network of geophysical observatories was built in the western Pacific region. Data from the OHP network, especially from broadband seismographs on land and under water, precise magnetometers, submarine cables to measure electric field, successfully provided improved global images of the Earth's interior in terms of seismic velocities and electrical conductivity (e.g., Utada et al., *GRL*, 2003). During the OHP project, we had also developed a set of new portable ocean bottom instruments, broadband ocean bottom seismometers (BBOBSs) and ocean bottom electro-magnetometers (OBEMs).

These new observation technologies have been fully utilized in the 5-year Stagnant Slab Project (SSP) that succeeded the OHP since 2004. In the SSP, we have carried out a long-term (3 years in total) joint observation of BBOBSs and OBEMs in the Philippine Sea (Shiobara et al., *EOS*, 2009) to study the upper mantle and the MTZ where the subducted Pacific slab appears to be stagnating. We have made significant contributions to the SSP by obtaining results such as the estimation of water content in the MTZ by joint interpretation of seismic and electromagnetic tomography (Koyama, Utada et al., *AGU Monograph*, 2006; Utada et al., EPSL, 2009) and the seismic evidence for water transportation deep into the mantle by subducting slab (Kawakatsu & Watada, *Science*, 2007). We also revealed the upper mantle structure in this region by analyzing BBOBS data (Isse et al. *PEPI*, 2010) and OBEM data (Baba et al., *PEPI*, 2010). From the northwest Pacific Ocean, Kawakatsu et al. (*Science*, 2009) presented seismic evidence that indicates the lithosphere-asthenosphere boundary to be a sharp seismic discontinuity. Integration of these pieces of evidence obtained by existing technology is undoubtedly useful to solve two questions, but it is not enough.

Recently, we developed (e.g. Shiobara et al. 2011) further innovative instruments (BBOBS-NX: broadband ocean bottom seismometer next generation; EFOS: Earth electric field observation system). By improving the mechanical coupling between the sensor housing and seafloor sediments, the BBOBS-NX enables us to record horizontal seismic motions, as well as vertical ones, with a typical noise level comparable to land observations. This gives us a strong advantage over other OBS's because it

allows us to apply station-based powerful seismic analysis methods commonly used on land, such as the receiver function and shear-wave splitting analyses, for ocean bottom data. The EFOS, on the other hand, measures the electric voltage difference at the seafloor by using a 10 km long cable. Compared to the OBEM measuring the electric field with a spacing of only 5 m, it successfully reduces the noise level to 1/10 or lower so as to provide reliable estimates of electromagnetic responses in a wide period range (1,000-500,000 s) that have high sensitivity to the electrical conductivity in the upper mantle and in the

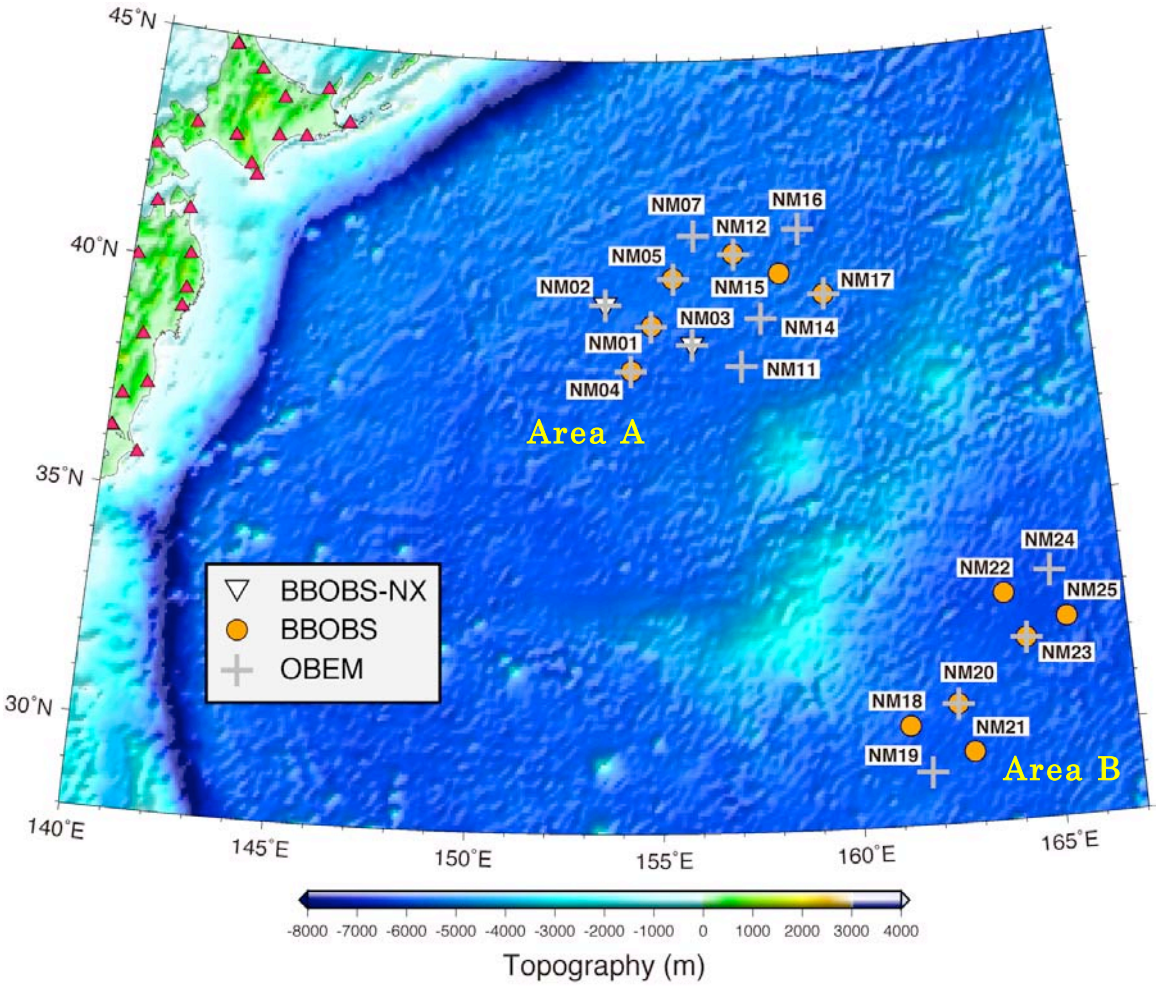


Fig. 1. Locations of two target areas of the present cruise and site distribution conducted and planned in the entire project.

MTZ. Therefore, we are now capable of providing strong constraints to answer the two questions (a) and (b) listed above by applying our advanced observational technologies to the "normal oceanic mantle" (as opposed to the mantle beneath subduction zones, hot spots or mid-oceanic ridges). Therefore we call the project as **the NOMan project**.

In KR10-08 conducted in last June, we started a pilot experiment of the NOMan project, in which two BBOBS-NX's and one EFOS are deployed together for the first time in our experience, as well as 3

BBOBS's and 5 OBEM's of conventional type. We expect it provides a good opportunity to train ourselves for instrumentations, observations, data processing and analyses. The present cruise, KR11-10 was planed as the first phase of the main observation of the project, recovering instruments deployed in the pilot experiment, and deploying more number of BBOBS-NX's and EFOS's as well as BBOBS's and OBEM's. However, we are obliged to change our cruise plan so that only conventional instruments (BBOBS's and OBEM's) which do not need 7000-II dive are going to be recovered and deployed. The recovery and deployment of advanced instruments (BBOBS-NX's and EFOS's) are postponed to be conducted in next summer. In summary, the present cruise aims to recover 3 BBOBS's and 5 OBEM's and to deploy 12 BBOBS's and 12 OBEM's, respectively.

3.2. Research Areas

The NOMan project has two target areas A and B in the northwest Pacific Ocean (Fig. 1). The area A (northwest of the Shatsky Rise) is the main target of the project where the sea floor is considered as 'normal'. The area B (southeast of the Shatsky Rise) is the second target, selected for testing generality of the result. In area A, recovery and deployment of BBOBS are planed at 3 sites (NM01, NM04 and NM05) and at 6 sites (NM01, NM04, NM05, NM12, NM15, and NM17), respectively. Recovery and deployment of OBEM are planned at 5 sites (NM01, NM02, NM03, NM04, and NM05) and at 8 sites (NM02, NM03, NM07, NM11, NM12, NM14, NM16, and NM17), respectively. In area B, deployment of BBOBS and OBEM is planned at 6 sites (NM18, NM20, NM21, NM22, NM23, and NM25) and at 4 sites (NM19, NM20, NM23, and NM24), respectively. In area A, we also visit the sites NM02 and NM03 to check the status of BBOBS-NX that was installed in last June. Locations of all these sites in plan are listed in Table 1.

Table 1. Locations of observation sites in plan. Sites from NM01 to NM17 belong to the area A and from NM18 to NM25 belong to the area B.

Site	Lat. (N)	Lon. (E)	Site	Lat. (N)	Lon. (E)	Site	Lat. (N)	Lon. (E)
NM01	39.200	154.783	NM14	39.300	157.867	NM22	32.940	163.920
NM02	39.650	153.467	NM15	40.283	158.450	NM23	31.937	164.397
NM03	38.763	155.912	NM16	41.233	159.050	NM24	33.348	165.157
NM04	38.208	154.208	NM17	39.783	159.683	NM25	32.317	165.485
NM05	40.233	155.400	NM18	30.182	161.295			
NM07	41.167	156.000	NM19	29.148	161.772			
NM11	38.267	157.283	NM20	30.603	162.530			
NM12	40.750	157.150	NM21	29.540	162.860			

3.3.a Change of the cruise plan

The present cruise was originally planned in June 2011, but postponed to the period from

November 16 to 30, 2011. The sea condition in this season is not as good as that in the last pilot experiment in June, especially in the area A. On the way to the area B of this cruise, we decided to change our installation plan. In the new plan, BBOBS and OBEM are deployed at each of 8 sites (NM 18, NM19, NM20, NM21, NM22, NM23, NM24 and NM25) in the area B. If the sea condition allows, we go to the area A and recover and deploy rest of BBOBS and OBEM at NM01, NM04 and NM05. At NM03, we deploy and recover OBEM, and check the operation status of BBOBS-NX at the seafloor.

3.3. Type of instruments

3.3.1 BBOBS

BBOBS's have been used in many of our previous projects, and are to be used in the present project. It consists of a pressure housing, hydrophone for acoustic release system, and an anchor. A broadband sensor batteries and recording unit are contained in the pressure case (a 65 cm f sphere) made of titanium alloy (Fig. 2). It is deployed by free-fall and recovered by self pop-up system. The instruments deployed in this cruise are supposed to be recovered in one and a half years (in 2013).

3.3.2 OBEM

OBEM's have also been used in our previous projects together with BBOBS's. It consists of two grass spheres, frame made of titanium, an acoustic release system, and an anchor. A three-component fluxgate sensor and recording unit are installed in one sphere and batteries in the other (Fig. 3). It is deployed by free-fall and recovered by self pop-up system. The OBEM's deployed in this cruise are also planned to be recovered in one and a half years (in 2013).

3.3.3 BBOBS-NX

BBOBS-NX (Fig. 4) is an advanced ocean bottom seismometer newly developed by our group (Shiobara et al., 2011). It is deployed by free-falling with the recording unit tied above the sensor unit by a rope. After confirming that the sensor unit is penetrated into the sediment deeply enough, the recording unit is untied and replaced on the seafloor nearby the sensor unit by ROV Kaiko-7000II. This operation enables us to make seismic noise level as low as those at normal land observatories at the period band (1-1000 sec) important for the present purpose. During this cruise, we plan to visits two sites installed with this seismometer in last June to check their operation status by acoustic communication.

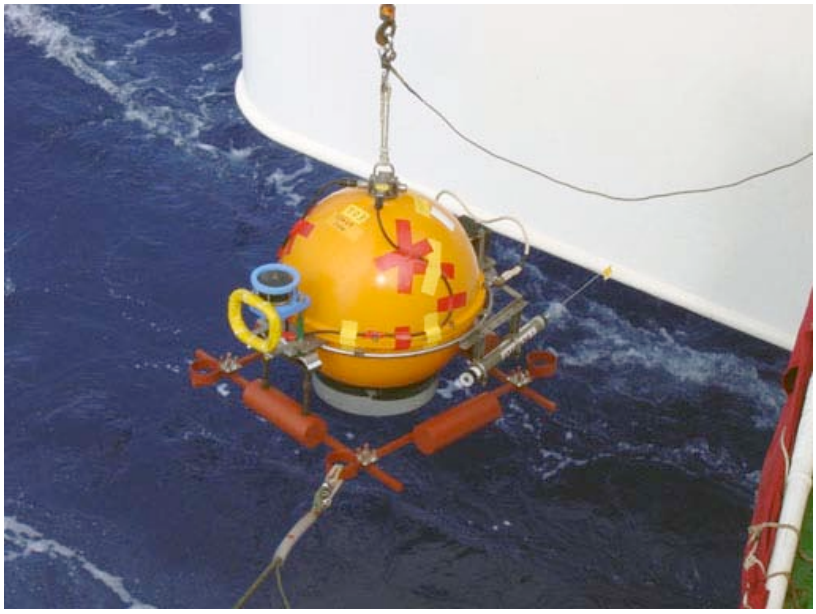


Fig. 2 BBOBS to be recovered and deployed in the present cruise. The photo was taken at the deployment from Kairei in KR10-08.

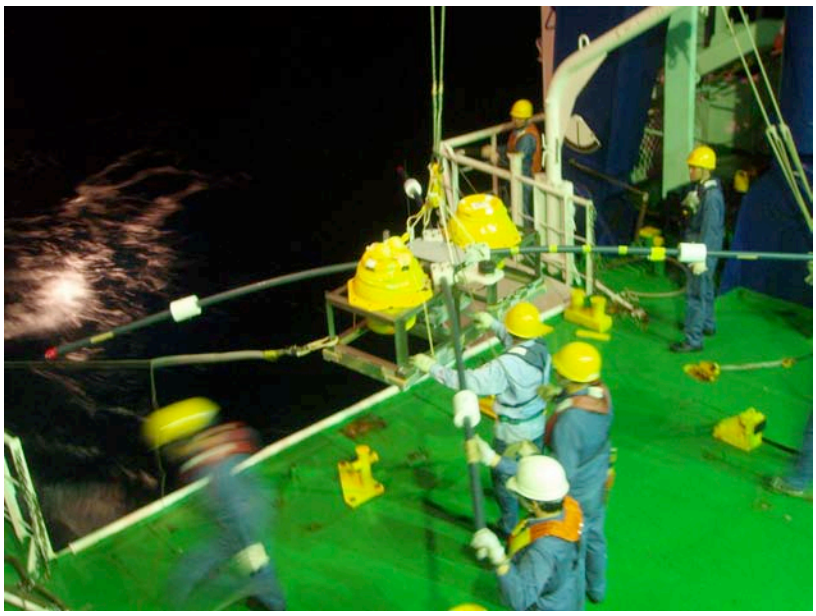


Fig. 3 OBEM to be recovered and deployed in the present cruise. The photo was taken at the deployment from Kairei in KR10-08.

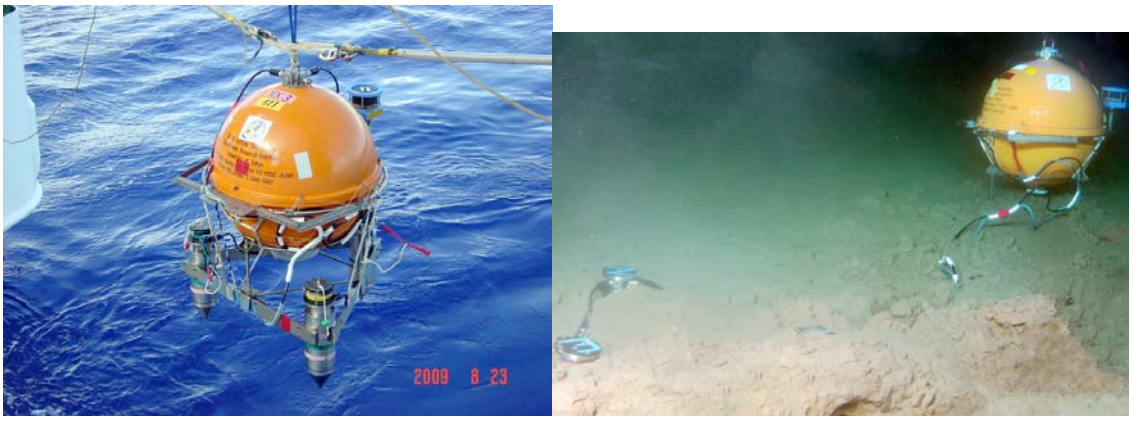


Fig. 4 BBOBS-NX at the deployment from Kairei (left) and after development on the seafloor (right). The photo was taken in Kairei cruise KR10-08.

3.4. Cruise Log

Date	Time	**Note**	Description	Position/Weather/Wind/ Sea condition
16-Nov		**Sail out, proceeding to research area**		11/16 12:00 (UTC+9h)
	08:00	boarded		34-48.2'N, 139-53.3'E
	09:00	let go all shore line, left Yokosuka		South off Nojima-saki
	10:00	education and training for safety		Fine but cloudy
	16:40	KONPIRASANPAI		NNE-6 (Strong breeze)
	18:00	Scientific meeting		4 (Sea moderate)
				2 (Low swell long)
				Visibly: 8'
17-Nov		Proceeding to research area		11/17 12:00 (UTC+9h)
	18:00	Scientific meeting		30-21.5'N, 144-38.2'E
				Northwest pacific
				Fine but cloudy
				WNW-5 (Fresh breeze)
				3 (Sea slight)
				2 (Low swell long)
				Visibly: 8'
18-Nov		Proceeding to research area		11/18 12:00 (UTC+9h)
	18:00	Scientific meeting		29-21.0'N, 149-46.5'E
				Northwest pacific
	M.N.	Time adjustment – 1hour ahead (JST +1 h)		Fine but cloudy
				NNE-5 (Fresh breeze)
				4 (Sea moderate)
				3 (Moderate short)

				Visibly: 7'
19-Nov		Proceeding to research area		11/19 12:00 (UTC+10h)
	00:00	Time adjustment – 1hour ahead (JST +1 h)		28-55.0'N, 155-54.5'E
	18:00	Scientific meeting		Northwest pacific
				Fine but cloudy
				ENE-6 (Strong breeze)
				4 (Sea moderate)
				4 (Moderate average)
				Visibly: 8'
20-Nov		Deploy OBEM / OBS at site NM19		11/20 12:00 (UTC+10h)
	12:00	arrived at research area B		29-09.0'N, 161-37.2'E
	12:49	deployed XBT @ 29-08.9256'N, 161-41.5850'E		Northwest pacific
	13:43	deployed OBEM @ site NM19 (29-09.0911'N, 161-46.5050'E)	depth: 5983m	Fine but cloudy
	13:51	deployed BBOBS @ site NM19 (29-09.0286'N, 161-46.4387'E)	depth: 5877m	East-6 (Strong breeze)
	18:00	Scientific meeting		5 (Sea rough)
		proceeding to site NM21		3 (Moderate short)
				Visibly: 8'
21-Nov		Deploy OBEM / OBS at site NM21 / NM18		11/21 12:00 (UTC+10h)
	05:11	deployed OBEM @ site NM21 (29-32.5079'N, 162-51.5495'E)	depth: 5934m	29-47.0'N, 162-14.5'E
	05:19	deployed BBOBS @ site NM21 (29-32.5152'N, 162-51.5076'E)	depth: 5936m	Northwest pacific
	08:09-0	commenced calibration for site NM21		Fine but cloudy

	9:38			
		proceeding to site NM18		ESE-5 (Fresh breeze)
	16:02	deployed OBEM @ site NM18 (30-10.9570'N, 161-17.4384'E)	depth: 5924m	3 (Sea slight)
	16:09	deployed BBOBS @ site NM18 (30-10.9093'N, 161-17.7190'E)	depth: 5978m	3 (Moderate short)
	18:00	Scientific meeting		Visibly: 8'
	18:56-19:51	commenced calibration for site NM18		
		proceeding to site NM20		
22-Nov		Deploy OBEM / OBS at site NM20 / NM23 / NM25		11/22 12:00 (UTC+10h)
	01:46	deployed OBEM @ site NM20 (30-38.5023'N, 162-32.7201'E)	depth: 5969m	31-47.2'N, 164-09.6'E
	01:52	deployed BBOBS @ site NM20 (30-38.4785'N, 162-32.9768'E)	depth: 5913m	Northwest pacific
	03:04 -03:50	commenced calibration for site NM20		Fine but cloudy
		proceeding to site NM23		SE-5 (Fresh breeze)
	13:34	deployed OBEM @ site NM23 (31-55.5169'N, 164-24.5673'E)	depth: 6013m	3 (Sea slight)
	13:39	deployed BBOBS @ site NM23 (31-55.4143'N, 164-24.4312'E)	depth: 6011m	3 (Moderate short)
	14:04 - 14:18	commenced eight circle figure		Visibly: 7'
	15:16 -15:40	commenced calibration for BBOBS site NM23		
	16:30 -17:10	commenced calibration for OBME site NM23		
		proceeding to site NM25		
	22:01	deployed OBEM @ site NM25 (32-19.4743'N, 165-26.3105'E)	depth: 6046m	
	22:06	deployed BBOBS @ site NM25	depth: 6057m	

		(32-18.9433'N, 165-26.6675'E)		
	18:00	Scientific meeting		
	23:41	commenced calibration for BBOBS site NM25		
23-Nov		Deploy OBEM / OBS at site NM24 / NM22		11/23 12:00 (UTC+10h)
	00:15	finished calibration for BBOBS site NM25		33-07.5'N, 164-52.8'E
	01:00 -01:54	commenced calibration for OBEM site NM25		Northwest pacific
		proceeding to site NM24		Overcast
	07:24	deployed OBEM @ site NM24 (33-13.2361'N, 165-15.6548'E)	depth: 6106m	North-6 (Strong breeze)
	07:30	deployed BBOBS @ site NM24 (33-12.9980'N, 165-15.6963'E)	depth: 6059m	4 (Sea moderate)
	07:45 -08:00	commenced eight circle figure		3 (Moderate short)
	09:04 -09:45	commenced calibration for BBOBS site NM24		Visibly: 5'
		proceeding to site NM22		
	16:31	deployed OBEM @ site NM22 (32-56.9443'N, 163-48.8481'E)	depth: 6192m	
	16:36	deployed BBOBS @ site NM22 (32-57.1379'N, 163-48.6724'E)	depth: 6118m	
	19:15	Scientific meeting		
	19:20	commenced heave to NM20		
24-Nov		Heave to and MBES mapping survey around NM20		11/24 12:00 (UTC+10h)
	17:05	commenced MBES mapping survey		32-03.4'N, 163-18.9'E
	18:00	Scientific meeting		Northwest pacific
				Fine but cloudy
				ENE- Strong breeze
				4 (Sea moderate)

				4 (Moderate average)
				Visibly: 7'
25-Nov		Proceeding to research area A		11/25 12:00 (UTC+10h)
	09:42	finished MBES mapping survey		30-40.0'N, 161-57.2'E
	10:00	Proceeding to research area A		Northwest pacific
	18:00	Scientific meeting		Fine but cloudy
				SE-5 (Fresh breeze)
				3 (Sea slight)
				3 (Moderate short)
				Visibly: 8'
26-Nov		Proceeding to research area A		11/26 12:00 (UTC+10h)
	09:00	commenced evacuation drill		33-31.2'N, 156-22.2'E
	18:00	Scientific meeting		Northwest pacific
				Fine but cloudy
		154_12.2059		SSW-3 (Gentle breeze)
				2 (Sea smooth)
				4 (Moderate average)
				Visibly: 8'
27-Nov		Deploy and recover OBEM / BBOBS at site NM04		11/27 12:00 (UTC+10h)
	17:00	arrived at area A		37-02.9'N, 154-09.8'E
	17:02	deployed XBT @ 38-12.4364'N, 154-12.9996'E		Northwest pacific
	17:13	deployed OBEM @ site NM04 (38-12.7791'N, 154-12.2059'E)	depth: 5959m	Fine but cloudy
	17:22	deployed BBOBS @ site NM04 (38-12.6152'N, 154-12.3497'E)	depth: 5917m	WNW-6 (Strong breeze)
	19:28	recovered BBOBS @ site NM04		4 (Sea moderate)

	20:47	recovered OBEM @ site NM04		4 (Moderate average)
				Visibly: 8'
28-Nov		Proceeding to SENDAI-ko		11/28 12:00 (UTC+10h)
	00:10	commenced proceeding to SENDAI-ko		37-00.0'N, 151-15.0'E
	08:30	Scientific meeting		Northwest pacific
				Cloudy
	M.N.	Time adjustment – 1hour back (JST + 0 h)		West-6 (Strong breeze)
				4 (Sea moderate)
				3 (Moderate short)
				Visibly: 8'
29-Nov		Proceeding to SENDAI-ko		11/29 12:00 (UTC+9h)
	00:00	Time adjustment – 1hour ahead (JST +1 h)		37-00.0'N, 151-15.0'E
				Northwest pacific
				Cloudy
				West-6 (Strong breeze)
				4 (Sea moderate)
				3 (Moderate short)
				Visibly: 8'
29-Nov		Proceeding to SENDAI-ko		11/29 12:00 (UTC+9h)
	00:00	Time adjustment – 1hour ahead (JST +1 h)		37-00.0'N, 151-15.0'E
				Northwest pacific
				Cloudy
				West-6 (Strong breeze)
				4 (Sea moderate)

				3 (Moderate short)
				Visibly: 8'
30-Nov	0800	Arrival in Sendai Port		

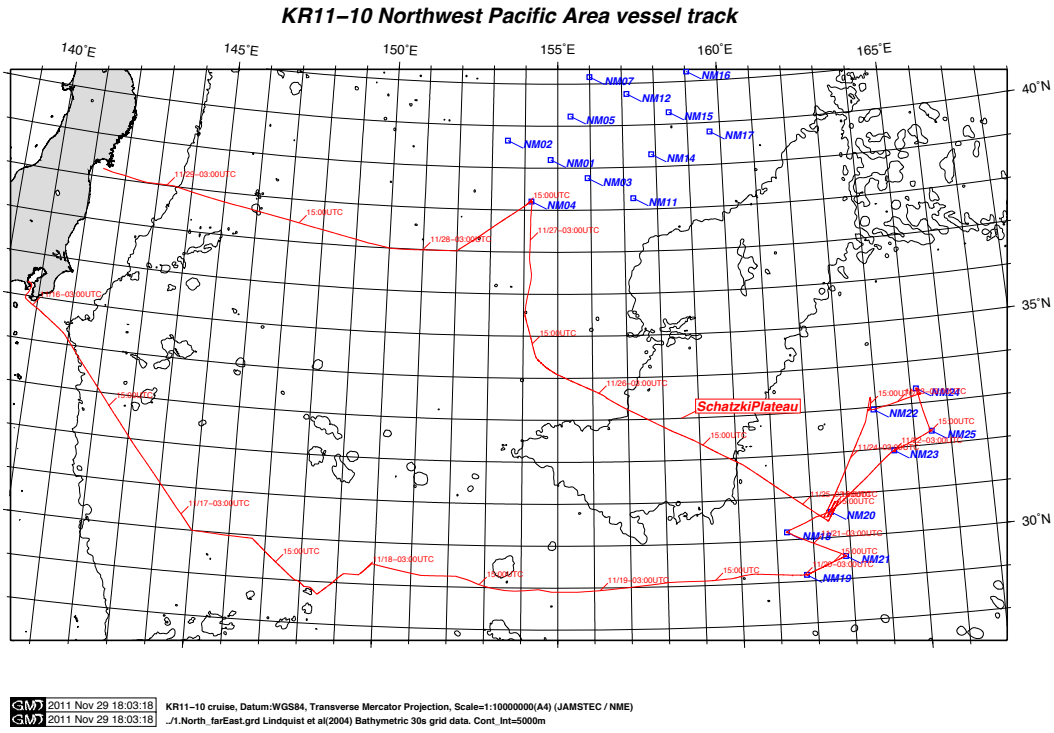
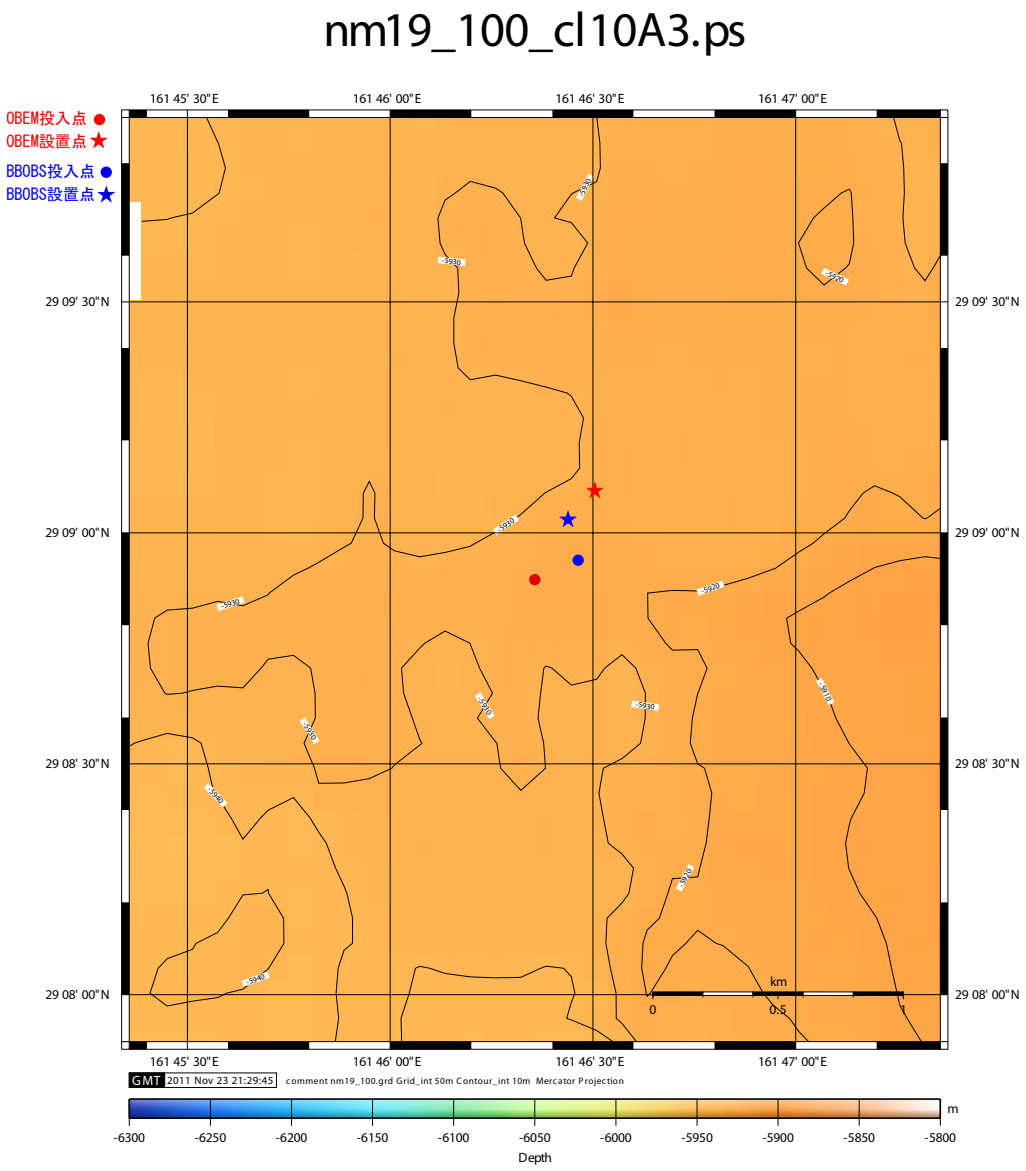


Fig. 5 Map of research area with vessel track of KR11-10.

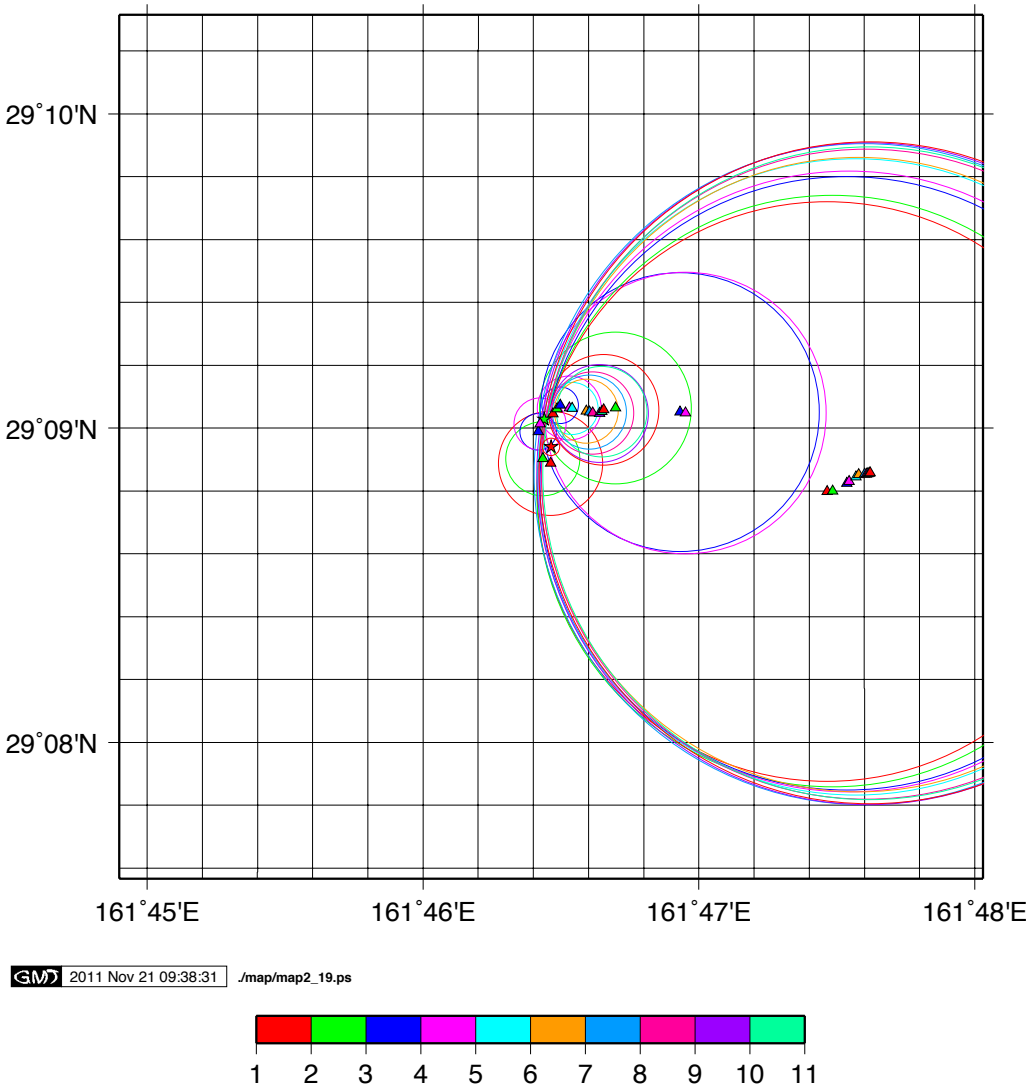
3.5. Installation point information

In spite of the rough weather, which is not surprising at all for the study area in this season, we have completed deployment of BBOBS and OBEM at 9 sites (8 in the area B and 1 in the area A). We are also successful in retrieving BBOBS and OBEM at NM04 that were deployed last summer in KR10-08. Overall, high value of the completion rate (number of sites done)/(number of sites planned) = 9/12 was obtained both for installation of BBOBS and OBEM. For recovery, the rate was 1/3 for BBOBS and 1/5 for OBE. Thus we conclude that the result of the present cruise was quite satisfactory. Given below is installation point information for each site in the order of deployment completion in KR11-01, including detailed bathymetric map, result of positioning of BBOBS, and result of positioning of OBEM (in case applicable).

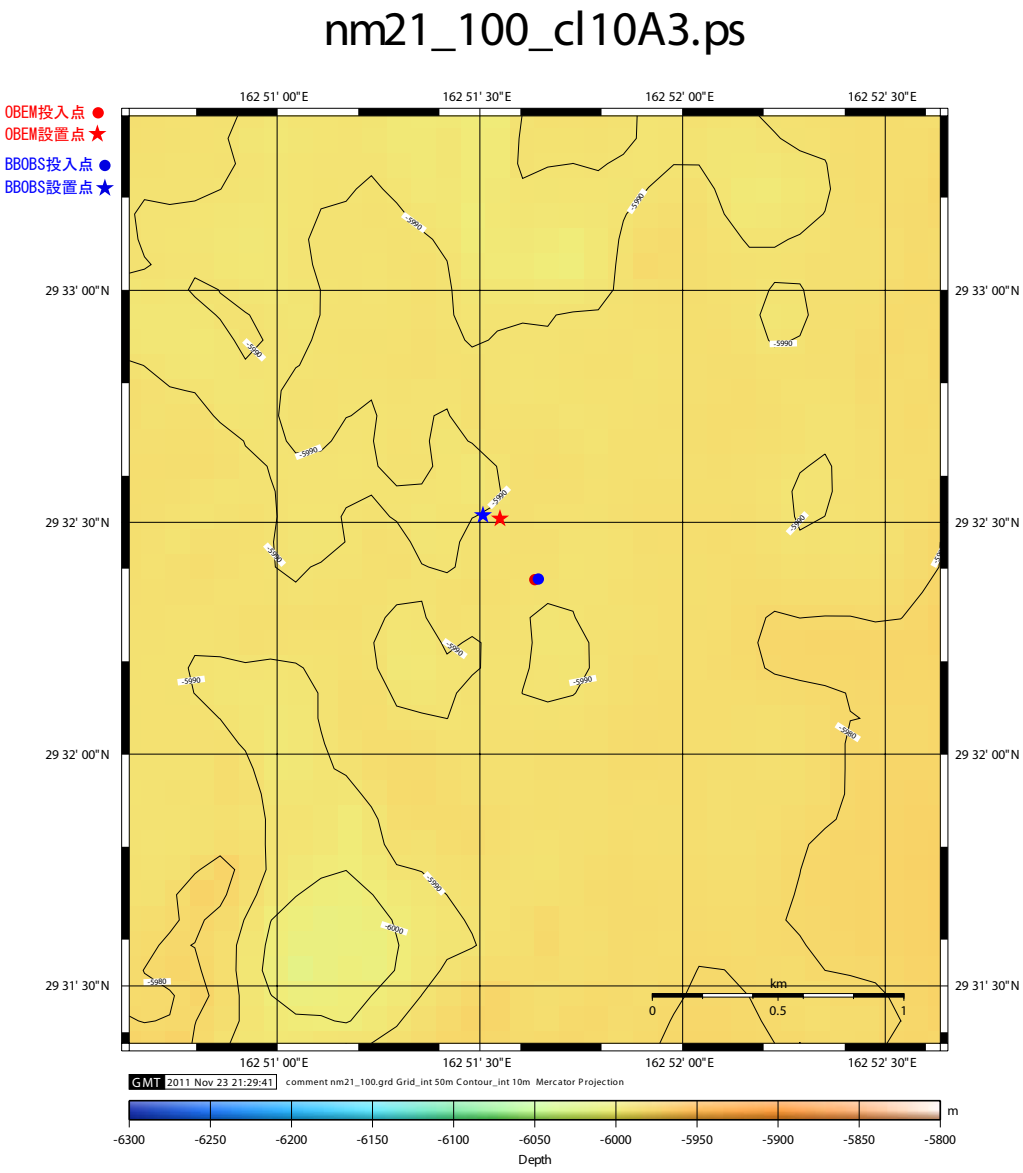
3.5.1. NM19


nm19_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
161 45' 30"E
161 46' 00"E
161 46' 30"E
161 47' 00"E
29 09' 30"N
29 09' 00"N
29 08' 30"N
29 08' 00"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:45
comment nm19_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

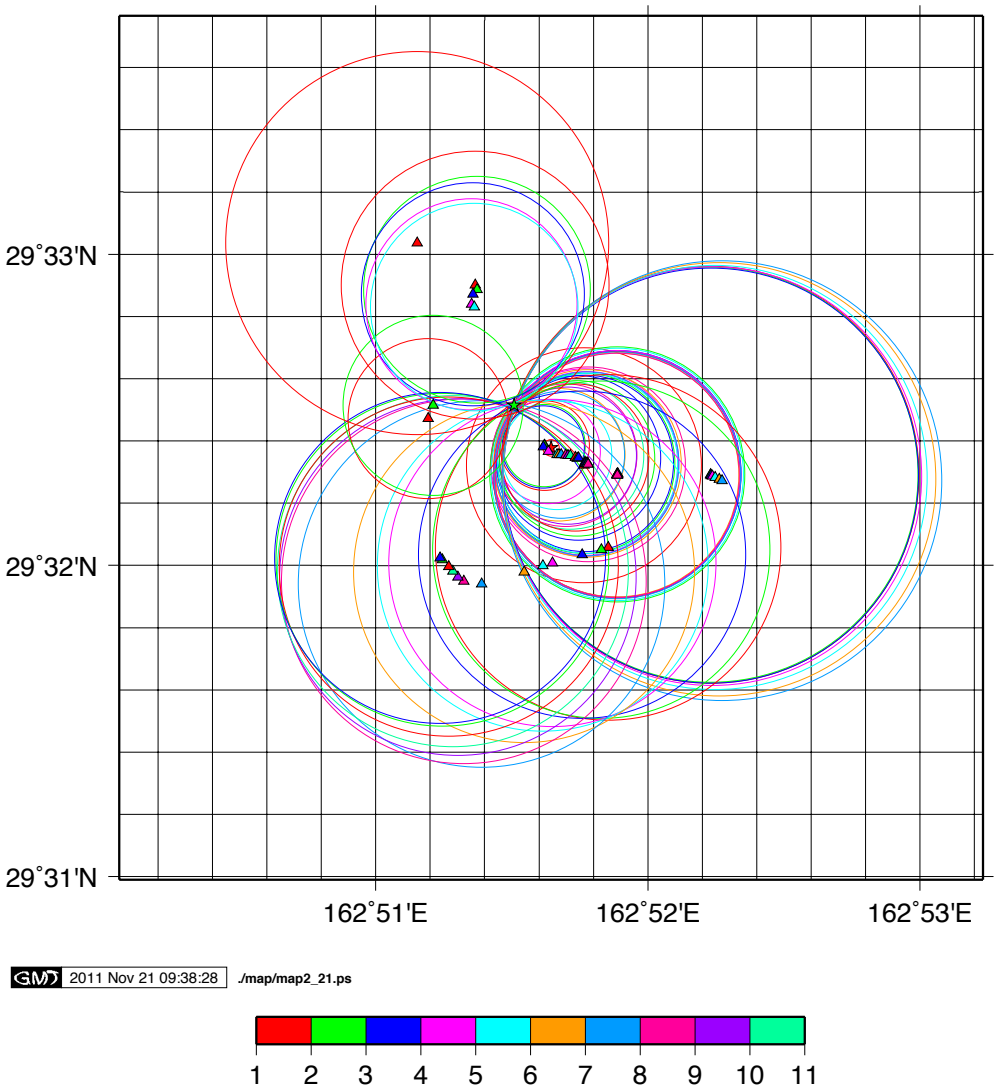
29° 09.0286' N 161° 46.4387' E 5877m



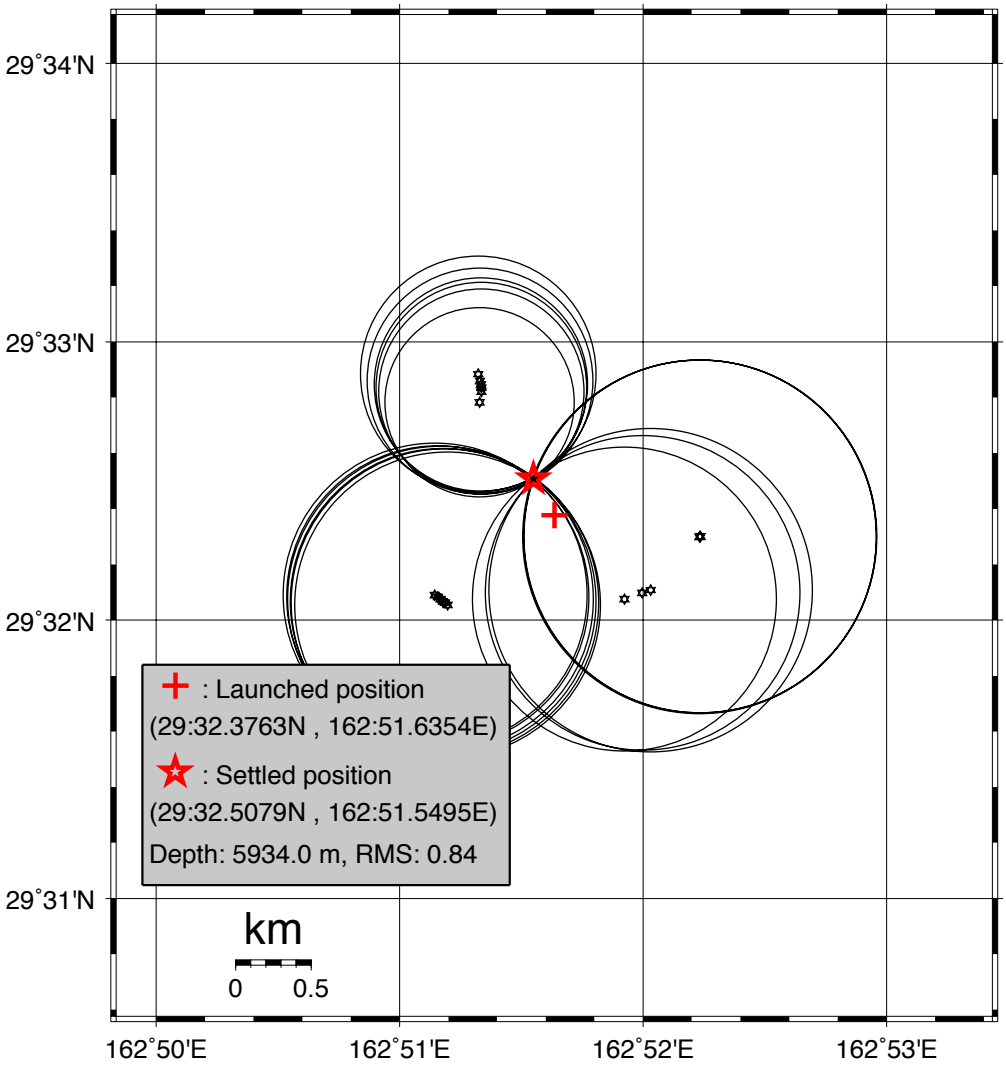
3.5.2. NM21


nm21_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
162 51' 00"E
162 51' 30"E
162 52' 00"E
162 52' 30"E
29 33' 00"N
29 32' 30"N
29 32' 00"N
29 31' 30"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:41
comment nm21_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

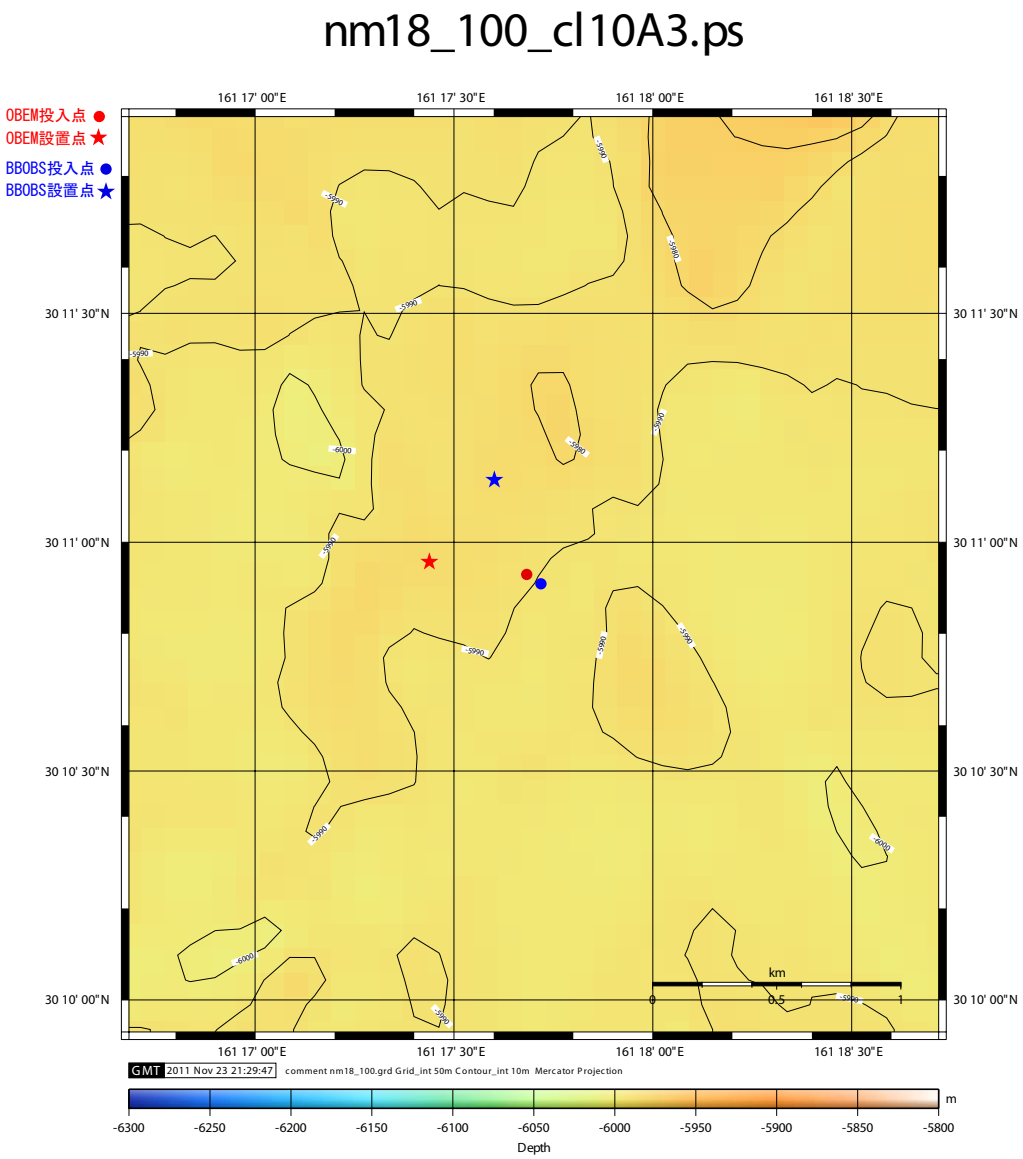
29° 32.5152' N 162° 51.5076' E 5936m

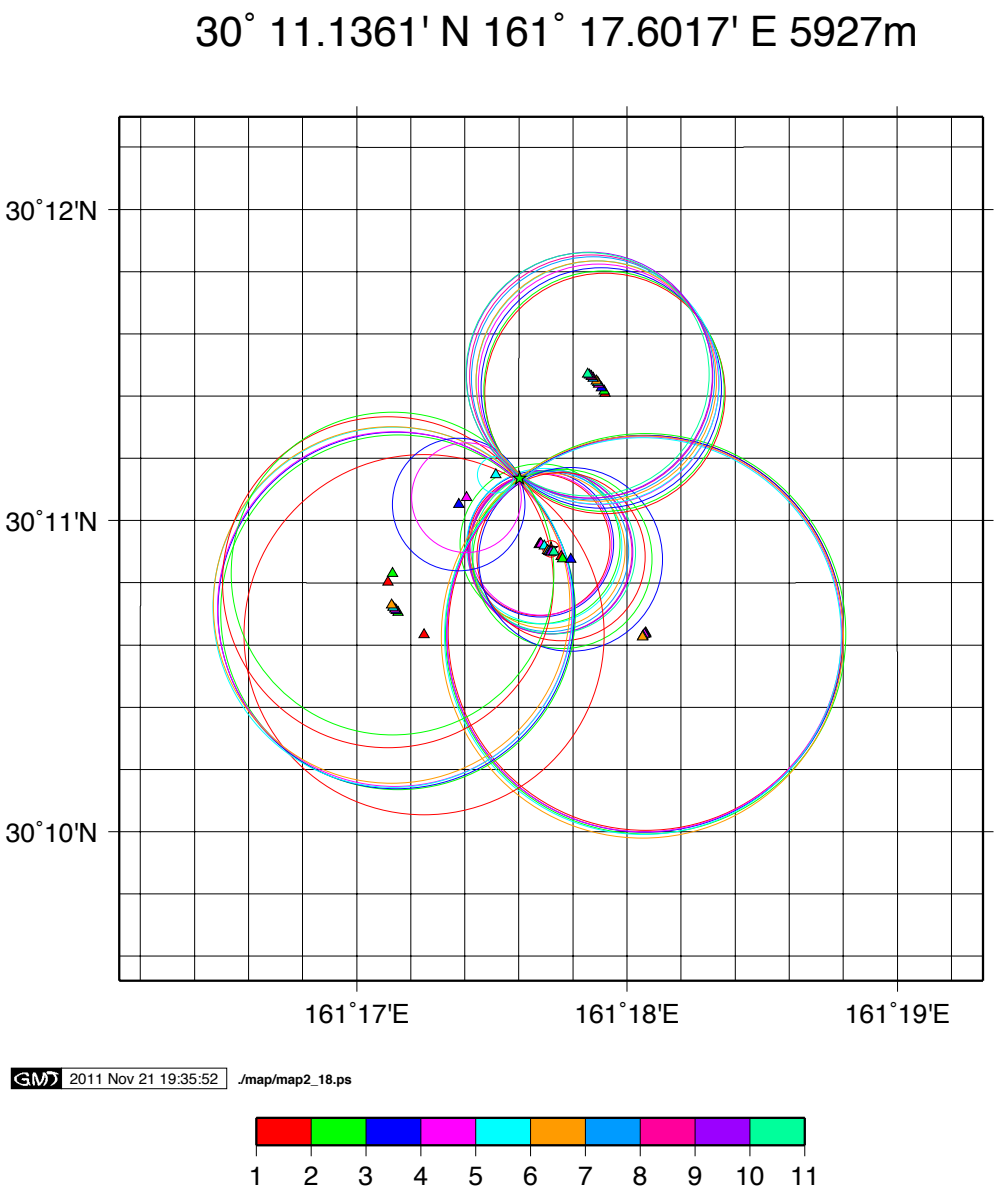


NM21 (TT7)

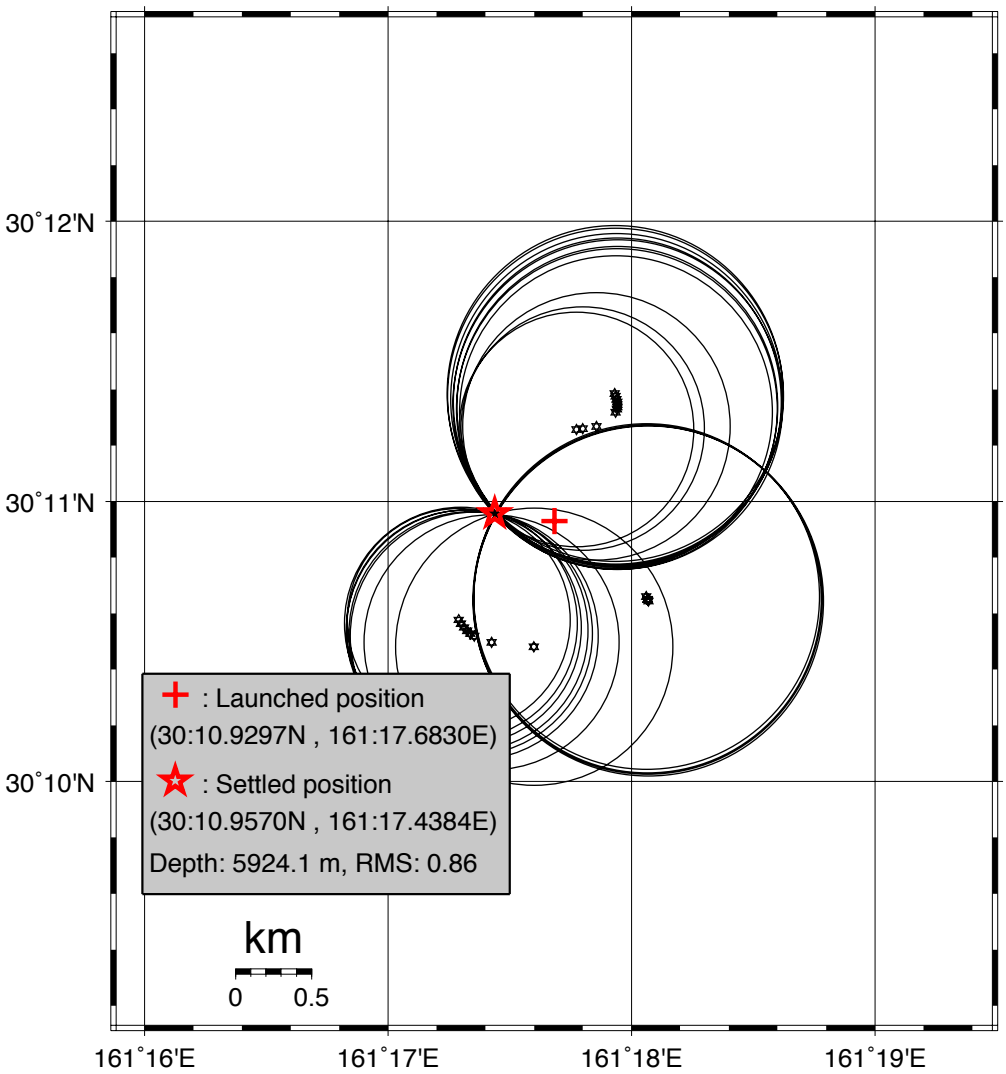

29˚34'N
29˚33'N
29˚32'N
29˚31'N
162˚50'E
162˚51'E
162˚52'E
162˚53'E
: Launched position
(29:32.3763N , 162:51.6354E)
: Settled position
(29:32.5079N , 162:51.5495E)
Depth: 5934.0 m, RMS: 0.84
km
0
0.5

3.5.3. NM18

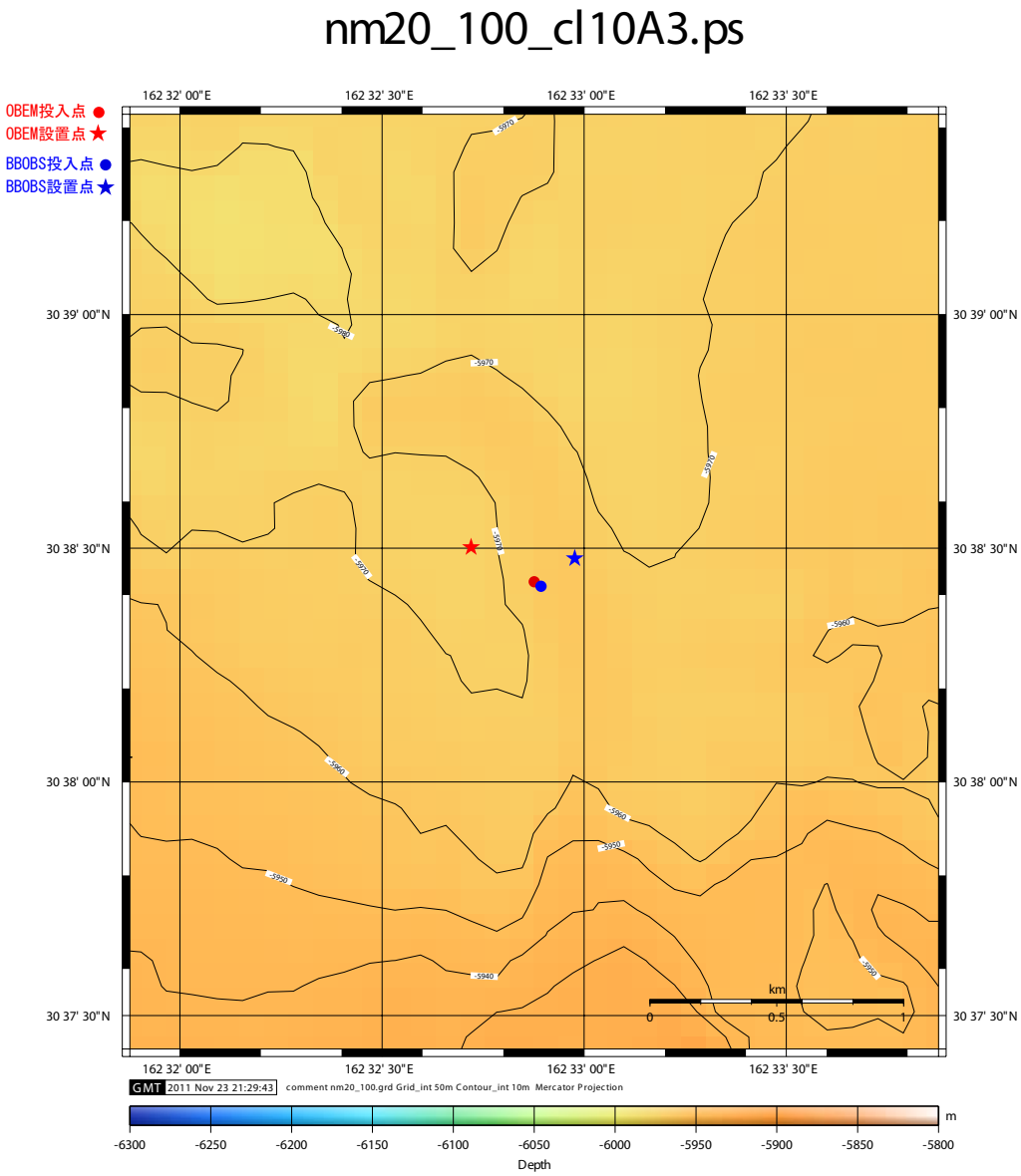

nm18_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
161 17' 00"E
161 17' 30"E
161 18' 00"E
161 18' 30"E
30 11' 30"N
30 11' 00"N
30 10' 30"N
30 10' 00"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:47
comment nm18_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

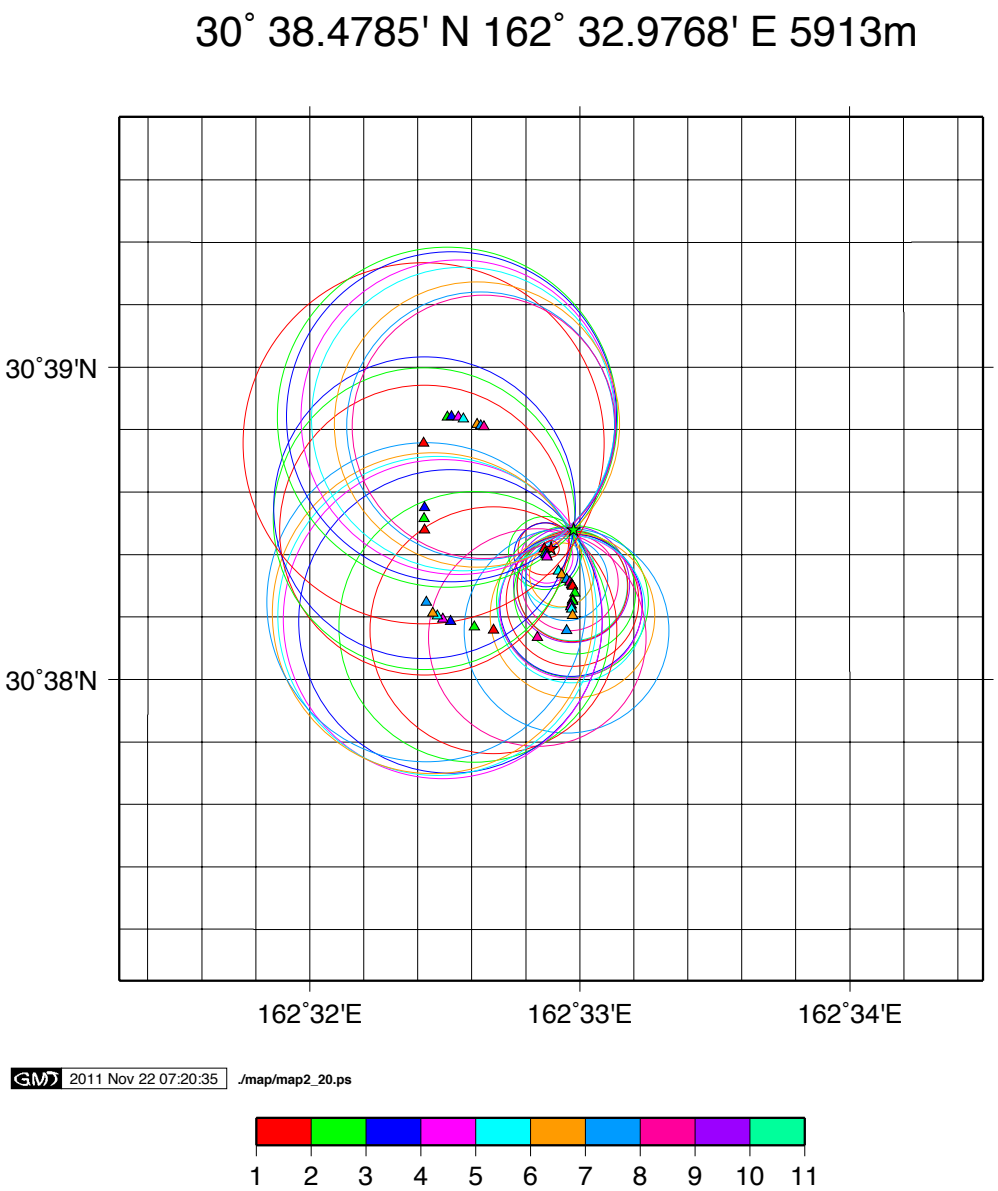

30° 11.1361' N 161° 17.6017' E 5927m
30°12'N
30°11'N
30°10'N
161°17'E
161°18'E
161°19'E
GMT 2011 Nov 21 19:35:52
./map/map2_18.ps
1 2 3 4 5 6 7 8 9 10 11

NM18 (TT8)

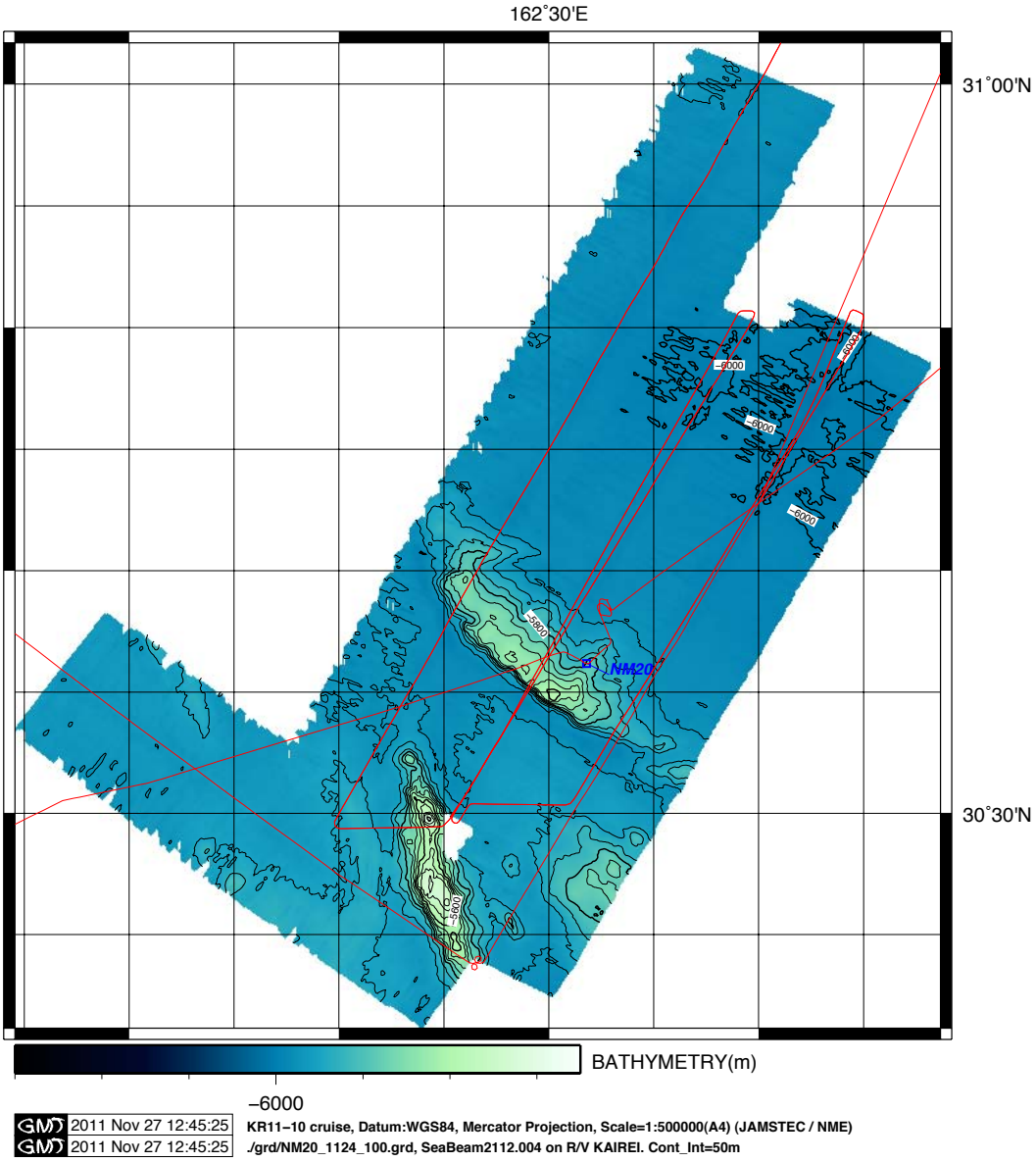

30˚12'N
30˚11'N
30˚10'N
161˚16'E
161˚17'E
161˚18'E
161˚19'E
: Launched position
(30:10.9297N , 161:17.6830E)
: Settled position
(30:10.9570N , 161:17.4384E)
Depth: 5924.1 m, RMS: 0.86
km
0
0.5

3.5.4. NM20

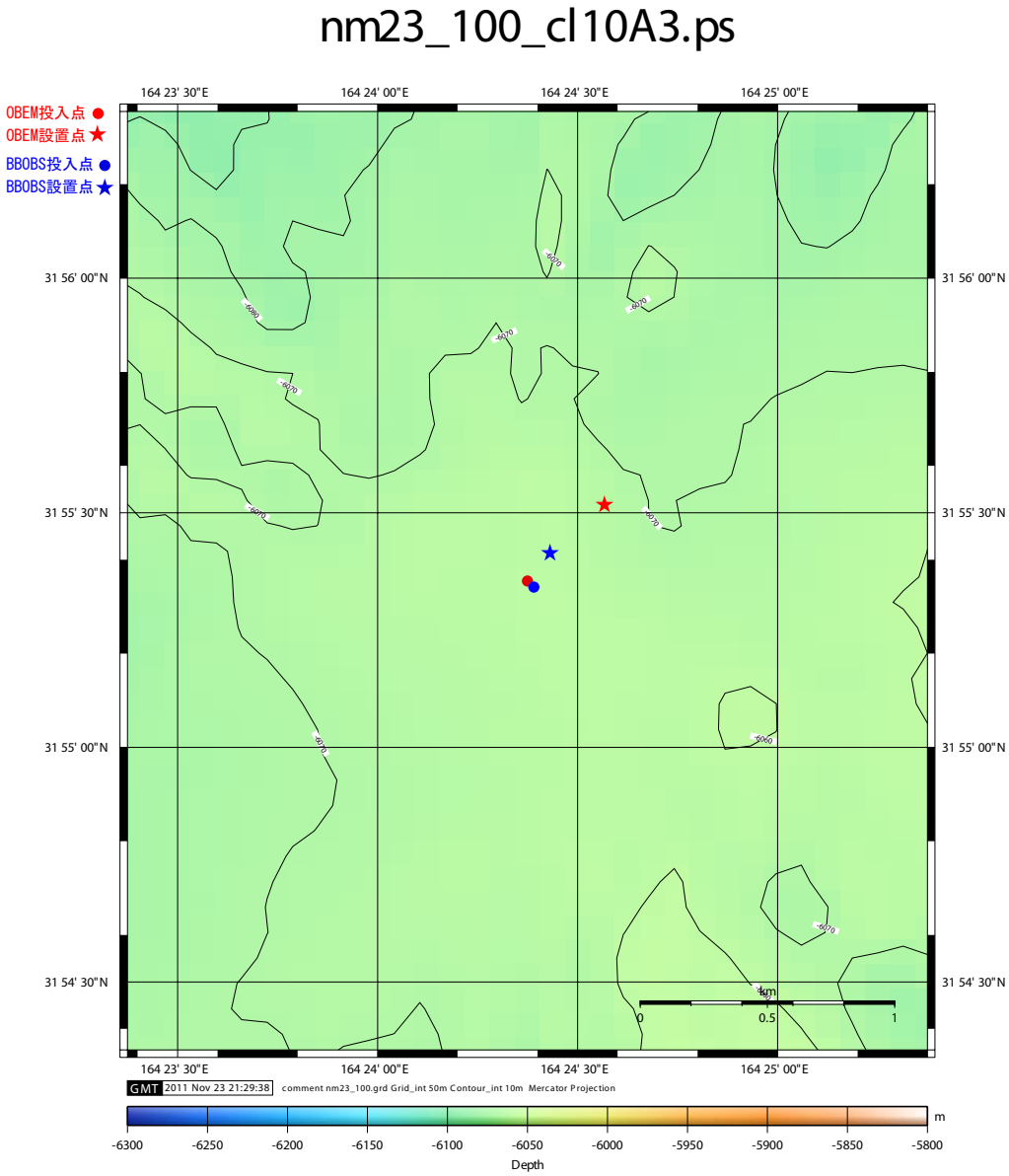

nm20_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
162 32' 00"E
162 32' 30"E
162 33' 00"E
162 33' 30"E
30 39' 00"N
30 38' 30"N
30 38' 00"N
30 37' 30"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:43
comment nm20_100.grd Grid_int 50m Contour_int 10m Mercator Projection
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
m
Depth

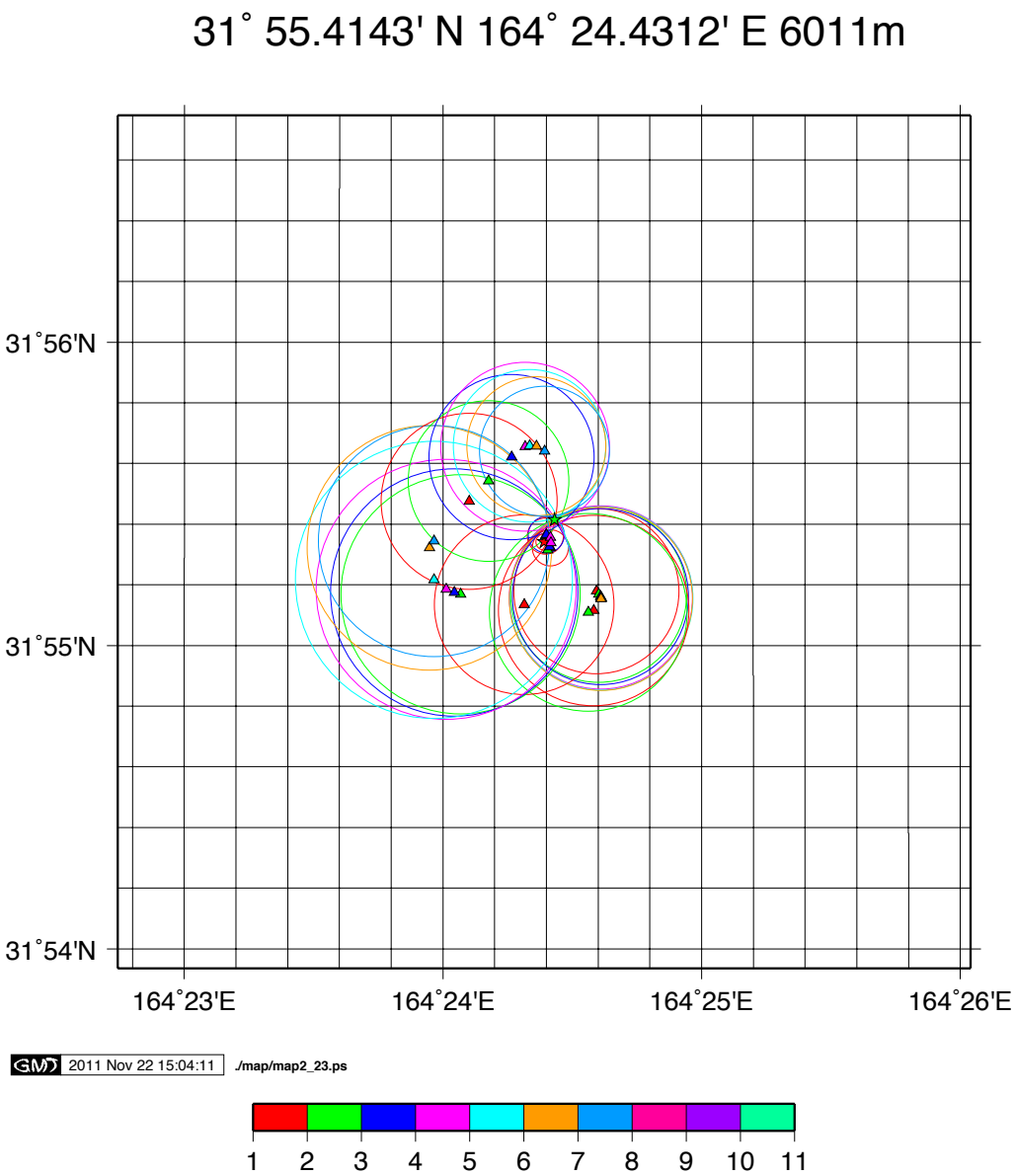

30° 38.4785' N 162° 32.9768' E 5913m
30°39'N
30°38'N
162°32'E
162°33'E
162°34'E
GMT 2011 Nov 22 07:20:35
./map/map2_20.ps
1
2
3
4
5
6
7
8
9
10
11

KR11−10 Northwest Pacific Area , SE off Schatzki Plateau, NM20

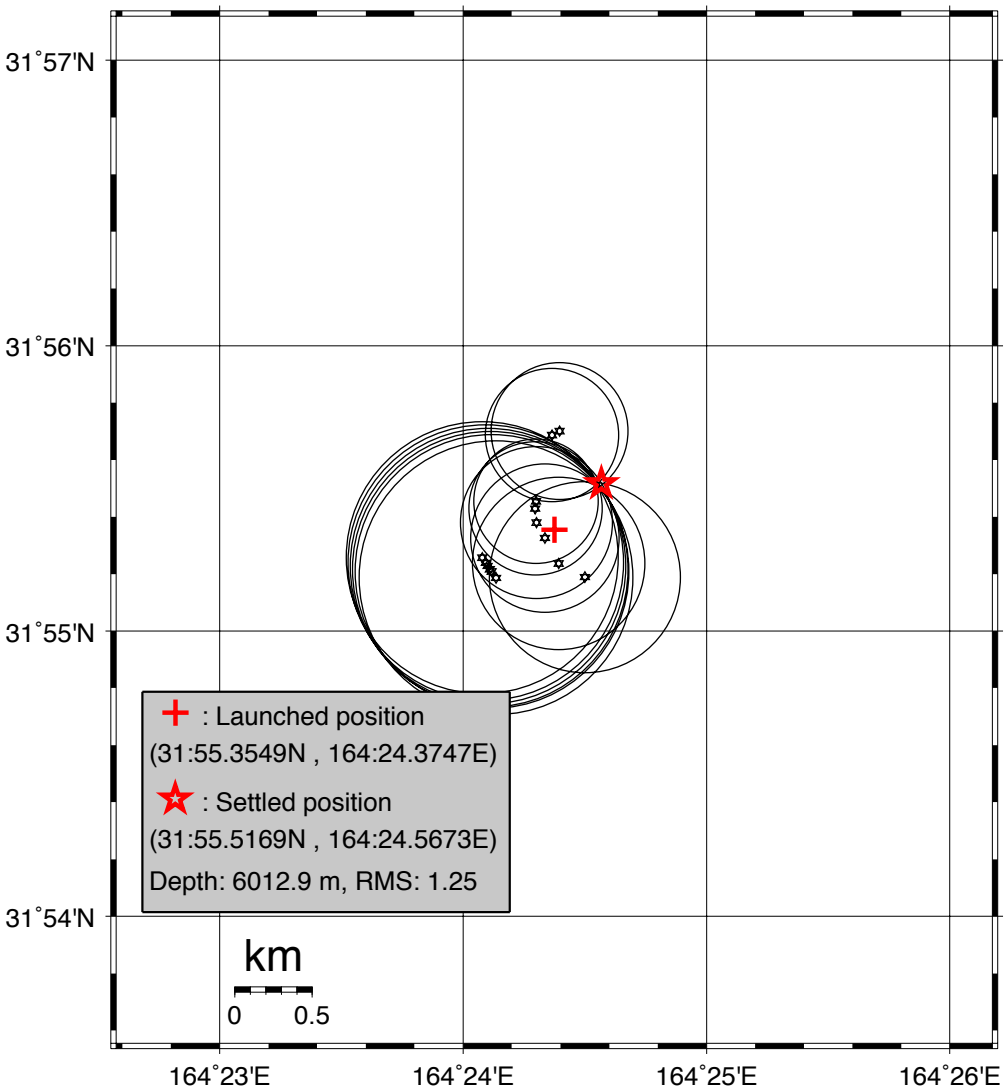


3.5.5. NM23

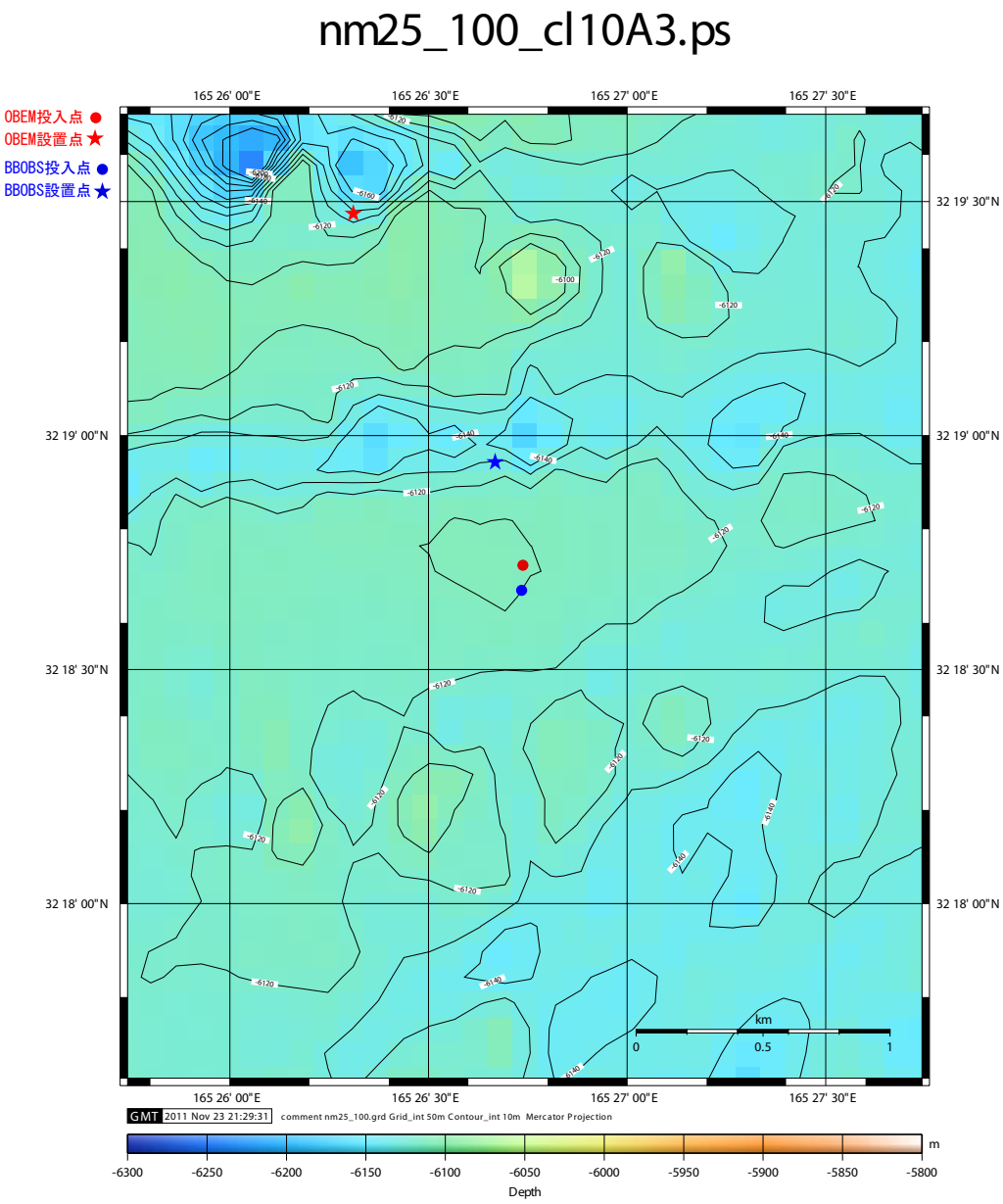

nm23_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
164 23' 30"E
164 24' 00"E
164 24' 30"E
164 25' 00"E
31 56' 00"N
31 55' 30"N
31 55' 00"N
31 54' 30"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:38
comment nm23_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

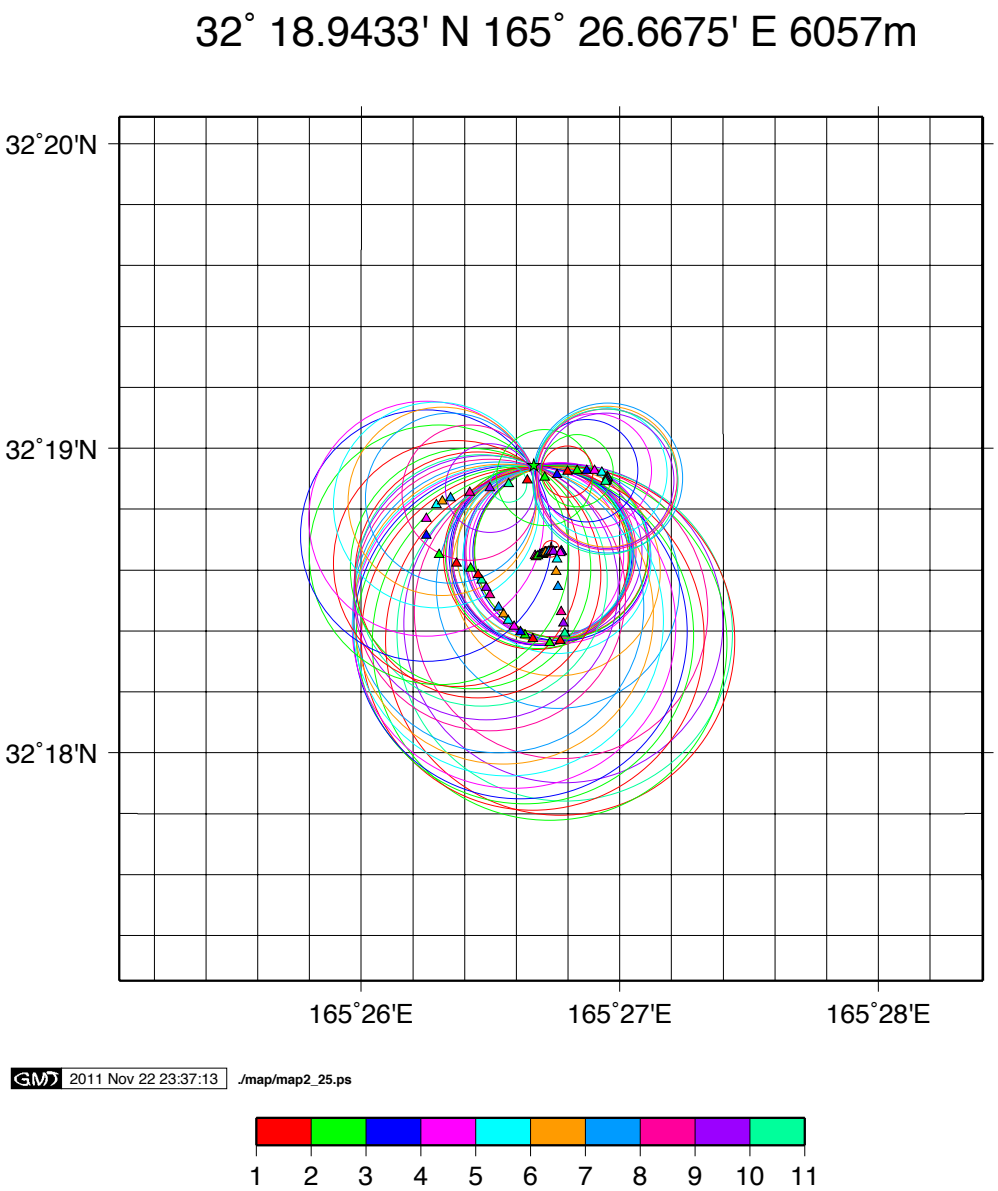

31° 55.4143' N 164° 24.4312' E 6011m
31°56'N
31°55'N
31°54'N
164°23'E
164°24'E
164°25'E
164°26'E
GMT 2011 Nov 22 15:04:11
./map/map2_23.ps
1 2 3 4 5 6 7 8 9 10 11

NM23 (JM8)

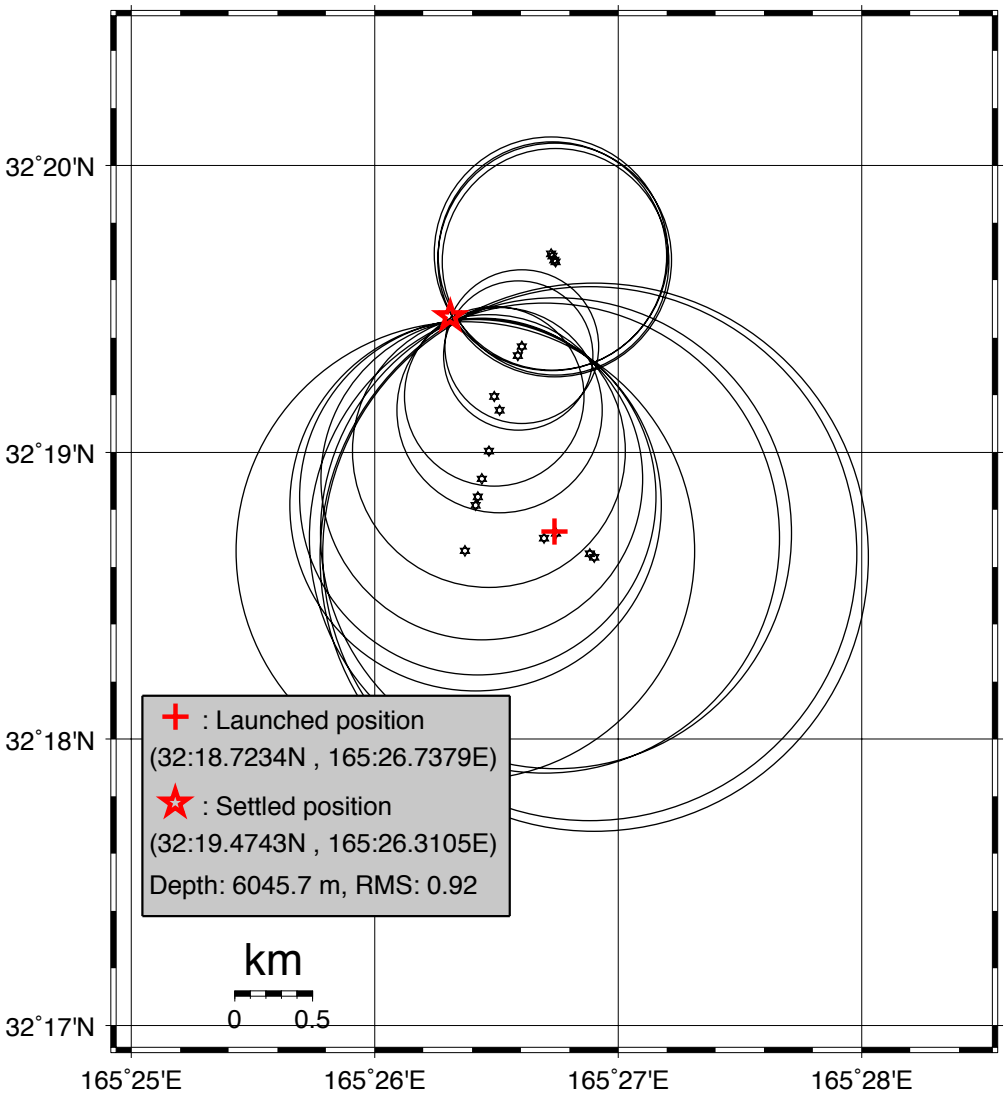

31˚57'N
31˚56'N
31˚55'N
31˚54'N
164˚23'E
164˚24'E
164˚25'E
164˚26'E
: Launched position
(31:55.3549N , 164:24.3747E)
: Settled position
(31:55.5169N , 164:24.5673E)
Depth: 6012.9 m, RMS: 1.25
km
0
0.5

3.5.6. NM25

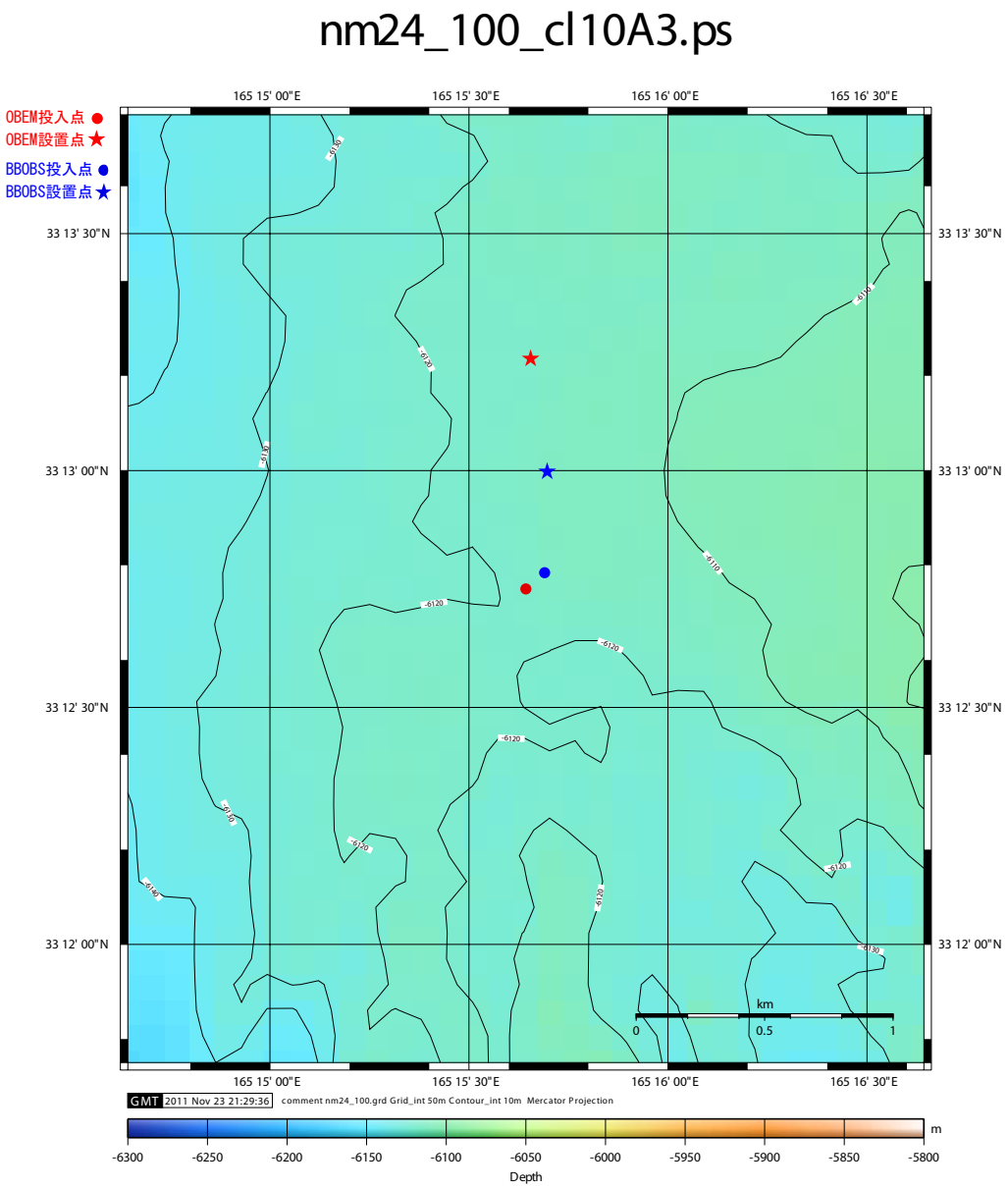

nm25_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
165 26' 00"E
165 26' 30"E
165 27' 00"E
165 27' 30"E
32 19' 30"N
32 19' 00"N
32 18' 30"N
32 18' 00"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:31
comment nm25_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth


32° 18.9433' N 165° 26.6675' E 6057m
32°20'N
32°19'N
32°18'N
165°26'E
165°27'E
165°28'E
GMT 2011 Nov 22 23:37:13
./map/map2_25.ps
1
2
3
4
5
6
7
8
9
10
11

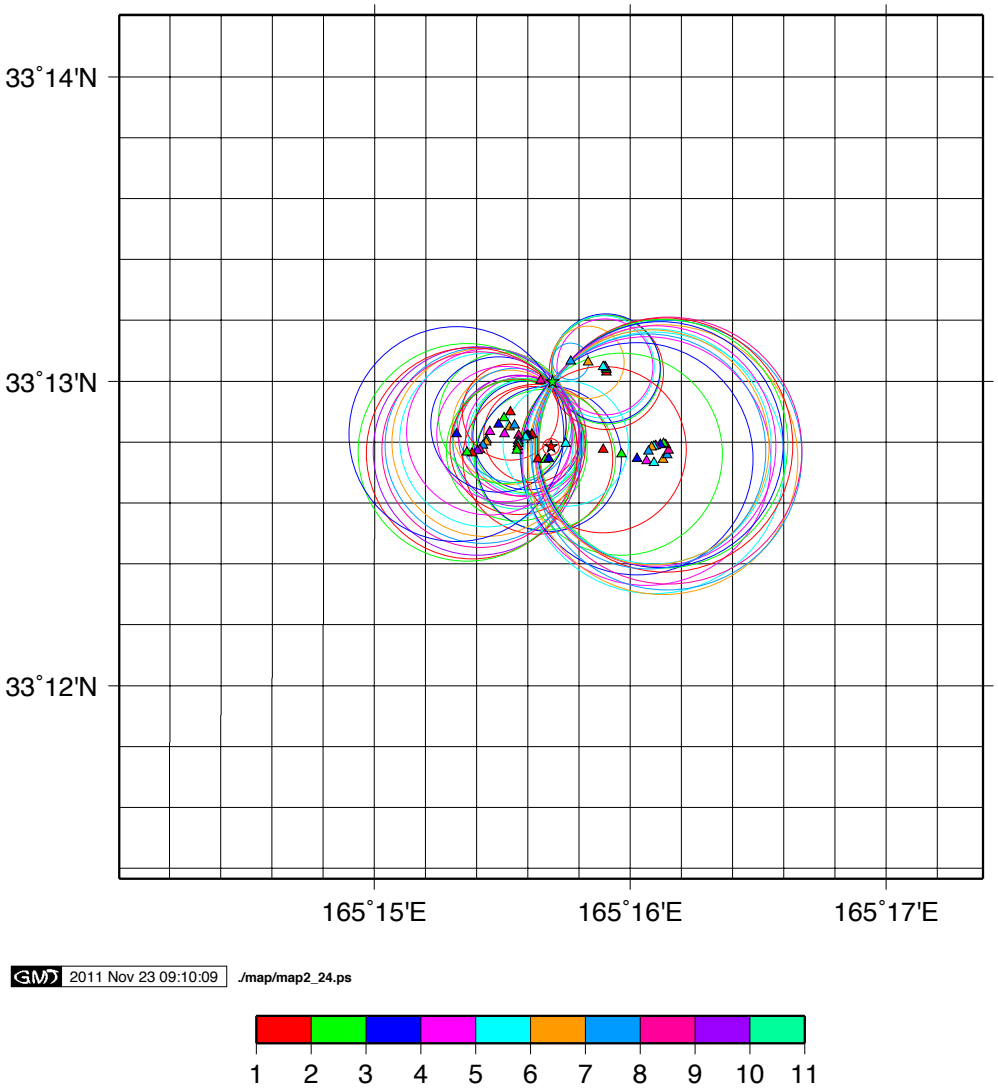
NM25 (TT5)


32˚20'N
32˚19'N
32˚18'N
32˚17'N
165˚25'E
165˚26'E
165˚27'E
165˚28'E
: Launched position
(32:18.7234N , 165:26.7379E)
: Settled position
(32:19.4743N , 165:26.3105E)
Depth: 6045.7 m, RMS: 0.92
km
0
0.5

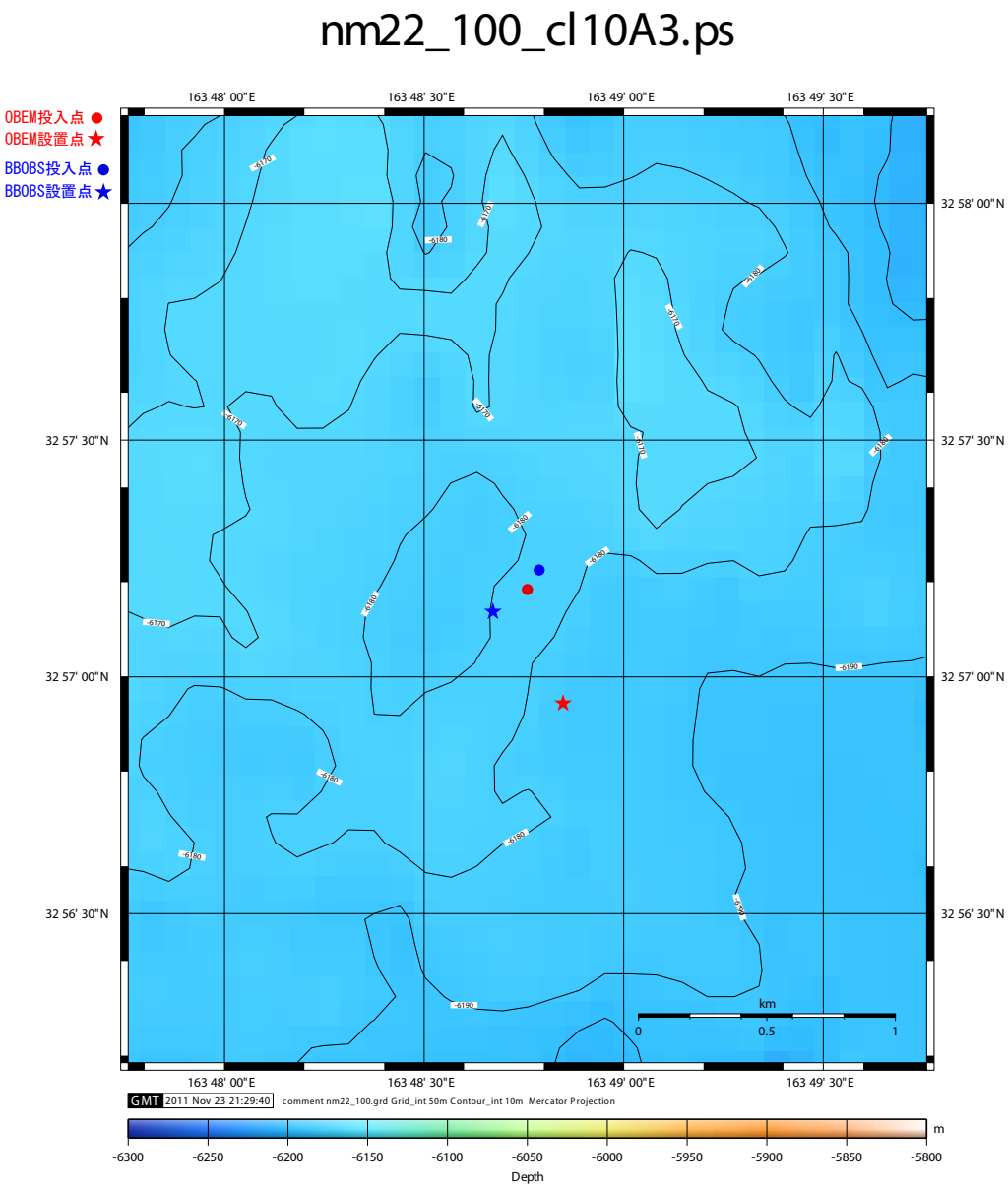
3.5.7. NM24


nm24_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
165 15' 00"E
165 15' 30"E
165 16' 00"E
165 16' 30"E
33 13' 30"N
33 13' 00"N
33 12' 30"N
33 12' 00"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:36
comment nm24_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

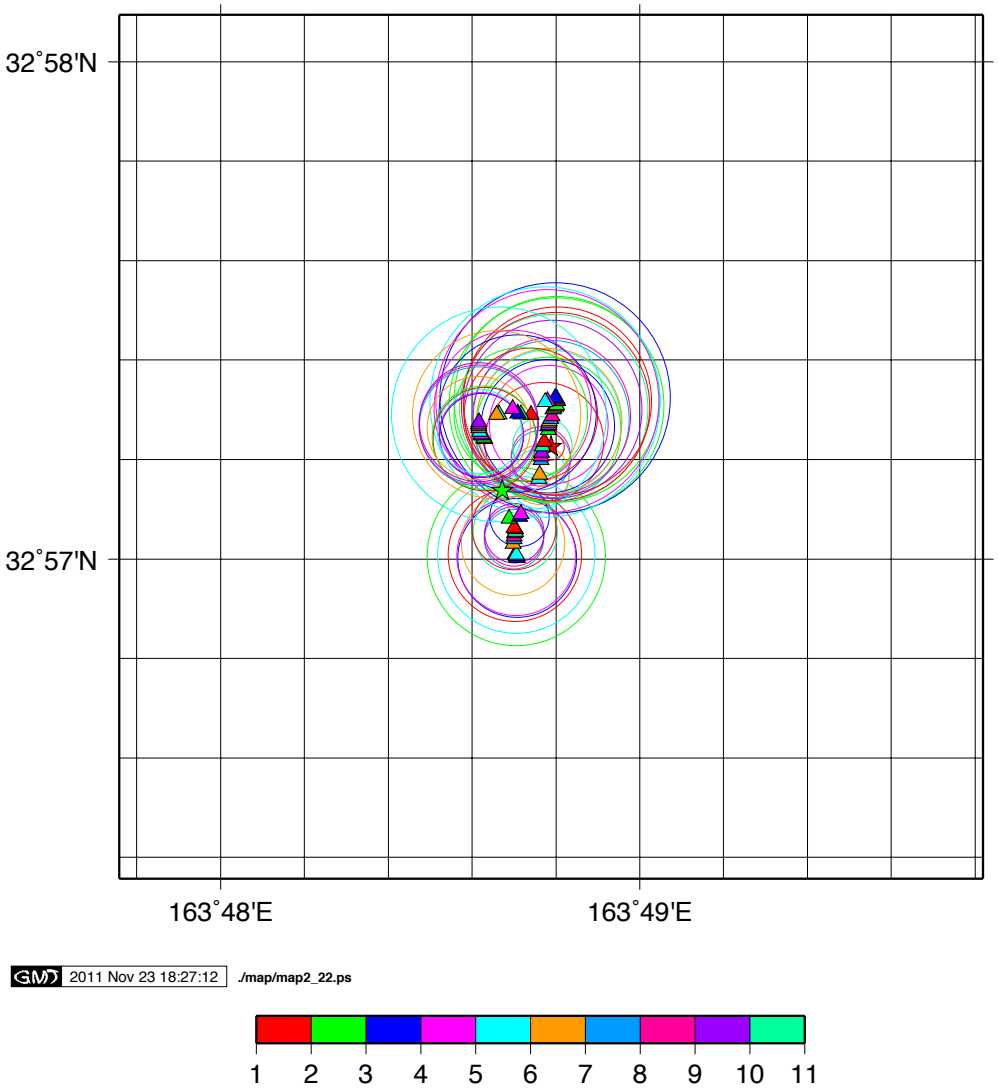
33° 12.9980' N 165° 15.6963' E 6059m



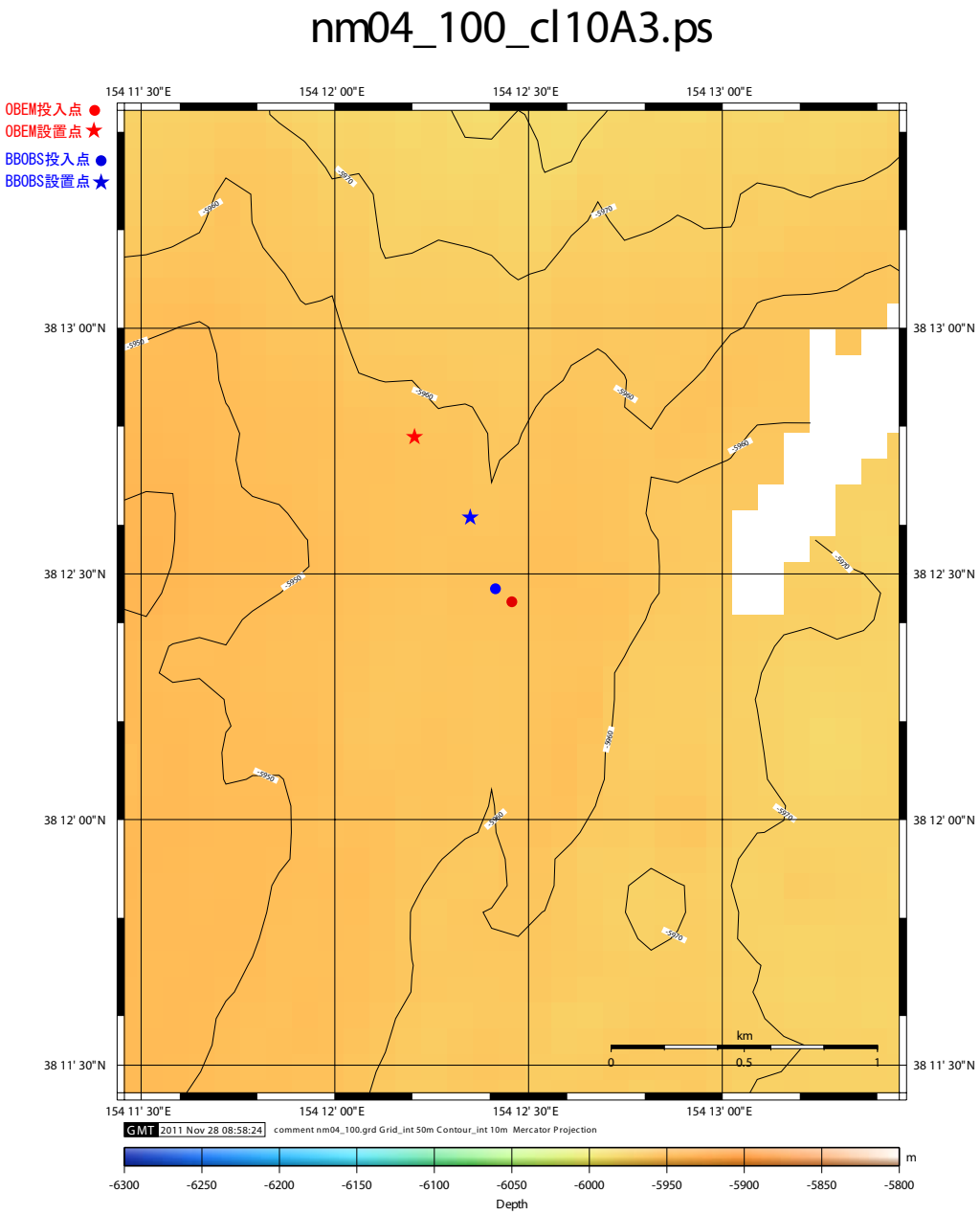
3.5.8. NM22

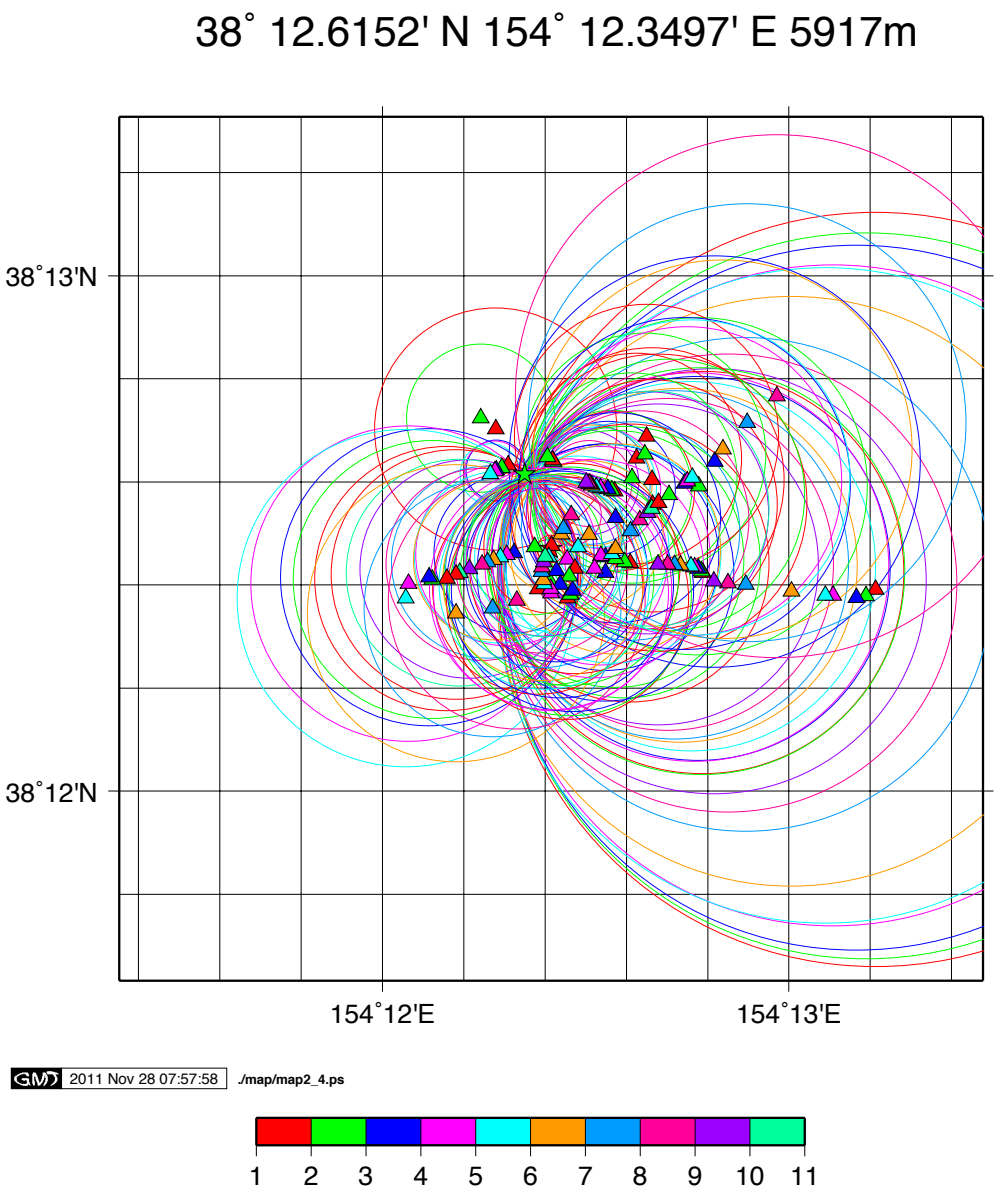

nm22_100_cl10A3.ps
OBEM投入点 ●
OBEM設置点 ★
BBOBS投入点 ●
BBOBS設置点 ★
163 48' 00"E
163 48' 30"E
163 49' 00"E
163 49' 30"E
32 58' 00"N
32 57' 30"N
32 57' 00"N
32 56' 30"N
km
0
0.5
1
GMT 2011 Nov 23 21:29:40
comment nm22_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth

32° 57.1379' N 163° 48.6724' E 6118m



NM04


nm04_100_cl10A3.ps
OBEM投入点
OBEM設置点
BBOBS投入点
BBOBS設置点
154 11' 30"E
154 12' 00"E
154 12' 30"E
154 13' 00"E
38 13' 00"N
38 12' 30"N
38 12' 00"N
38 11' 30"N
km
0
0.5
1
GMT 2011 Nov 28 08:58:24
comment nm04_100.grd Grid_int 50m Contour_int 10m Mercator Projection
m
-6300
-6250
-6200
-6150
-6100
-6050
-6000
-5950
-5900
-5850
-5800
Depth


38° 12.6152' N 154° 12.3497' E 5917m
38°13'N
38°12'N
154°12'E
154°13'E
GMT 2011 Nov 28 07:57:58
./map/map2_4.ps
1
2
3
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5
6
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9
10
11

3.6. Summary of Results

In the following, result of observation will be summarized in the order of completion.

November 20 (Area B, NM19): Deployment of BBOBS and OBEM. Positioning of installation point.

November 21 (Area B, NM21, NM18): The same as above.

November 22 (Area B, NM20, NM23, NM25): The same as above.

November 23 (Area B, NM24, NM22): The same as above.

November 24 (Area B, NM20): Detailed bathymetric survey.

November 27 (Area A, NM04): Recovery and deployment of BBOBS and OBEM*. Positioning of installation point.

* The OBEM recovered from NM04 was in normal operation after recovery. We have retrieved data from this instrument and found that continuous geomagnetic and electric field data were recorded since June 15, 2010.

Table 2. Installation Locations of KR11-10

Site	Date of deploy	BBOBS			OBEM		
		Lat.	Lon.	Depth	Lat. (N)	Lon. (E)	Depth
NM04	2011/11/27	38.210253	154.205828	5917	38_12.7791	154_12.2059	5959
NM18	2011/11/21	29.150477	161.773978	5927	30_10.9570	161_17.4384	5924
NM19	2011/11/20	30.641308	162.549613	5877	29_09.0911	161_46.5050	5983
NM20	2011/11/22	29.54192	162.85846	5913	30_38.5023	162_32.7201	5969
NM21	2011/11/21	32.951896	163.811207	5936	29_32.5079	162_51.5495	5934
NM22	2011/11/23	31.923572	164.407187	6118	32_56.9443	163_48.8481	6192
NM23	2011/11/22	33.216633	165.261605	6011	31_55.5169	164_24.5673	6012
NM24	2011/11/23	32.315722	165.444458	6059	33_13.2361	165_15.6548	6106
NM25	011/11/22			6057	32_19.4743	165_26.3105	6046

Table 3. NOMan Project BBOBS information

Site	Type, specification	Tx code	Radio freq. (MHz)	Date of deploy	Date of recover	Latitude (deg)	Longitude (deg)	Depth
NM01	BBOBS 400 days	505	159.200	2010/6/15		39.2006	154.7836	5725
NM02	BBOBS-NX 400 days	515	----------	2010/6/19		39.701	153.3547	5704
NM03	BBOBS-NX 400 days	522	----------	2010/6/13		38.7618	155.9102	5737
NM04	BBOBS 400 days	500	159.150	2010/6/15	2011/11/27	38.2101	154.2027	5923
	BBOBS 600 days	503	159.200	2011/11/27		38.210253	154.205828	5917
NM05	BBOBS 400 days	523	159.300	2010/6/20		40.2508	155.4086	5598
NM06								
NM07								
NM08								
NM09								
NM10								
NM11								
NM12								
NM13								
NM14								
NM15								
NM16								
NM17								
NM18	BBOBS 600 days	501	159.250	2011/11/21		30.185602	161.293362	5927
NM19	BBOBS 600 days LS9K	521	159.200	2011/11/20		29.150477	161.773978	5877
NM20	BBOBS 600 days	536	159.250	2011/11/22		30.641308	162.549613	5913
NM21	BBOBS 600 days	524	159.300	2011/11/21		29.54192	162.85846	5936
NM22	BBOBS 600 days	513	159.300	2011/11/23		32.951896	163.811207	6118
NM23	BBOBS 600 days	538	159.250	2011/11/22		31.923572	164.407187	6011
NM24	BBOBS 600 days	533	159.250	2011/11/23		33.216633	165.261605	6059
NM25	BBOBS 600 days	539	159.150	2011/11/22		32.315722	165.444458	6057

Table 4. NOMan project OBEM information

Site	OBEM ID	Sensor type	Tx type*	Tx (Ship) kHz	Rx (Ship) kHz	Release Code	Radio Freq. MHz	Date of deploy	Speed (down) m/min	Date of recover	Speed (up) m/min
NM01	ERI5	OBEM2005	K	10.563	14.000	2B-2	159.150	2010/6/15	34.2		
NM02	ERI4	OBEM2005	K	10.563	13.500	2A-1	159.200	2010/6/19	34.5		
NM03	ERI1	OBEM2005	K	11.029	13.500	1D-1	159.200	2010/6/13	35.2		
NM04	ERI3	OBEM2005	K	11.029	14.000	1F-2	159.150	2010/6/15	35.6	2011/11/27	29.8
	ERI16	OBEM2005	K	9.494	13.5	4F-1	159.25,	2011/11/27	34.2		
NM05	ERI2	OBEM2005	K	11.029	13.500	1E-1	159.150	2010/6/20	35.1		
NM06											
NM07											
NM08											
NM09											
NM10											
NM11											
NM12											
NM13											
NM14											
NM15											
NM16											
NM17											
NM18	TT8	OBEM2001	N	-	-	3F	159.300	2011/11/21	35.2		
NM19	TT4	OBEM2005	K	9.494	13.500	4C-1	159.250	2011/11/20	35.2		
NM20	JM7	OBEM2005	K	10.000	13.500	3C-1	159.150	2011/11/22	39.8		
NM21	TT7	OBEM2001	N	-	-	3E	159.250	2011/11/21	35.3		
NM22	JM6	OBEM2005	K	10.563	13.500	2C-1	159.200	2011/11/23	39.4		
NM23	JM8	OBEM2005	N	-	-	3B	159.150	2011/11/22	35.3-39.8		
NM24	TT1	OBEM2005	K	9.494	13.499	4A-1	159.200	2011/11/23	33.6		
NM25	TT5	OBEM99	N	-	-	3C	159.300	2011/11/22	N/A		

* K: Kaiyo-Denshi Corp., N: Nichiyu-Giken Corp.

4. Acknowledgment

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6. Notice for data users

This cruise report is a preliminary documentation as of the end of the cruise.
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