Preliminary Report
of
The Hakuhō Maru Cruise KH-91-1

(OMLET and WENPEX Cruise)

January 11-February 5, 1991

The Western North Pacific
South of Japan

Ocean Research Institute
University of Tokyo
1992

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By
The Scientific Members of the Expedition

Edited by
Tomio Asai

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1. Introduction

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The observations of atmospheric and oceanic mixed layers and energy and material exchange at the sea surface were performed in the Western North Pacific south of Japan during the period of 26 days from the January 11 to February 5 in 1991. The research cruise is a part of observational studies of (1) the Ocean Mixed Layer Experiment (OMLET) and (2) the Western North-Pacific Cloud-Radiation Experiment (WENPEX), both of which are components of the WCRP in Japan. The previous cruise KH-88-2 in April and May 1988 was carried out in a decaying phase of the ocean mixed layer, while this second cruise was in the developing phase of the ocean mixed layer in the same sea area as in the first one.

Above all it should be spelled out that observations of ocean mixed layer have been successfully made by mooring the surface buoy newly developed by the ORI group in both the cruises of KH-88-2 and KH-91-1. They will provide valuable data to study seasonal variation of surface oceanic mixed layer.

As is shown in Fig.1.1, the KH-91-1 Cruise consists of two legs: Leg 1 from January 11 to January 24 arriving in Kagoshima via the OWS-T and Leg 2 from January 28 leaving Kagoshima to February 5 arriving in Tokyo via the OWS-T.

The forty two scientists from ten universities and one governmental organization participated in many different types of observation on board the research cruise.

On behalf of all scientists aboard I would like to express my gratitude to Captain Shimamune and all the crew of the R.V. Hakuho Maru for their cooperation.

Much of the editorial work was assisted by Dr. Nakamura and I thank especially for his contribution.

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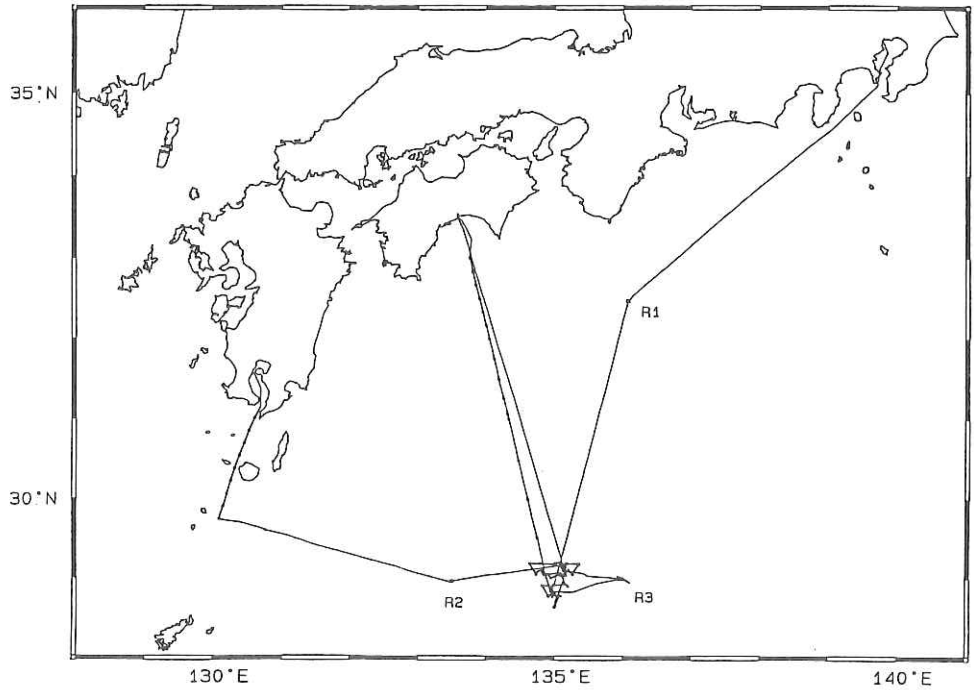
TRACK CHART (Leg.1)



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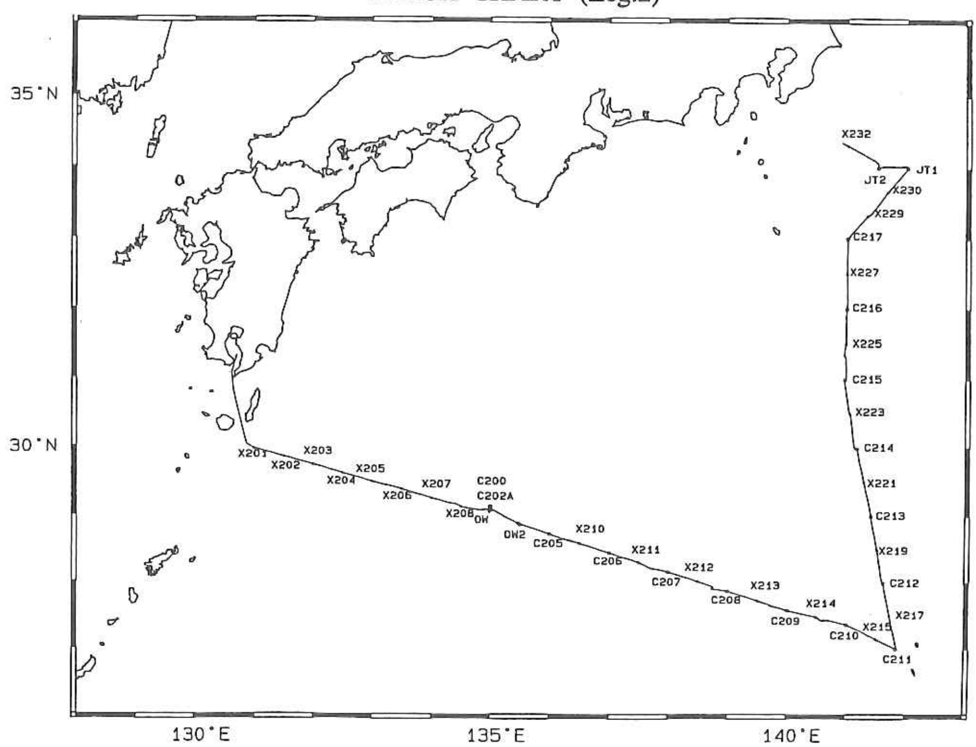

Fig. 1.1 Track chart of the KH-91-1 Cruise of the Hakuho Maru.

2. Aerological observations with Omega-sonde sounding system

T. Asai, K. Nakamura, K. Tsuboki, K. Ishikawa, N. Misawa and E. Tamura
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2.1 Introduction

Cloud topped boundary layers (CTBL) play an important role in the global radiation budget of the atmosphere and in the linkage between the troposphere and the earth's surface. The CTBL reduces the surface radiative heating due to the significant decrease in solar energy at the surface, while it reduces the surface radiative cooling due to the longwave radiation from the surface. For further progress in climate research, we must advance our knowledge of how clouds form and maintain in the boundary layer.

Although there is a large variety of CTBL regimes, they can be divided into two types. One is the CTBL which develops over cold ocean currents to the west of continents and is largely driven by cooling from above. The Californian coastal stratocumulus, which the First ISCCP Regional Experiment, FIRE, is studying, is one of the typical examples of this type of CTBL. The other is the CTBL which forms when cold air moves over relatively warmer water, especially to the east of continents over warm ocean currents, and it is largely driven by heating from below. This is the boundary layer to be investigated in the Western North-Pacific Cloud-Radiation Experiment. The structure of the CTBL depends strongly on the dominant processes responsible for generating turbulence. Therefore, it is important to investigate the structure and maintaining mechanism of this CTBL regime, in comparison with the results found in FIRE.

2.2 Temporal variation of the weather situation

The upper-air observations with Omega-sonde system were made every 6 hours from 21 JST 13 January to 21 JST 23 January during Leg. 1, except at at 09 JST and 15 JST on 16. They were also made every 6 hours from 09 JST 29 January to 09 JST 31 January and every 12 hours from 21 JST 31 January to 09 JST 4 February during Leg. 2. They were performed as a part of the four special sonde observation in the Western North-Pacific Cloud-Radiation Experiment. The four points of the sonde observation are Kagoshima, Naze, Chofu-maru, and Hakuho-maru. The data will be used to study the heat and momentum budget analyses surrounded by these observation points. All data at standard levels are tabulated in Appendix II.

Fig. 2.1 shows the vertical-time sections obtained by the upper air observation. Potential temperature and specific humidity are indicated by a solid line and a dashed line respectively. The cold outbreaks are indicated by the upward propagation of cooling in the lower atmosphere, and the mixed layer developed in the cold airmass are indicated by the constant potential temperature and specific humidity in the lowest part of the atmosphere. The inversion layer is indicated by the large vertical gradients in the potential temperature and specific humidity.

Fig. 2.2 shows typical examples of the vertical profiles of temperature and dew point temperature in the boundary layer. The profiles in (a) are the case of small cloud amount at 03 JST on 14 January, and the profiles in (b) are the case of large cloud amount at 21 JST on 31 January.

The boundary layer in (a) is composed of three layers: subcloud layer below 880 hPa with constant potential temperature and almost constant specific humidity, cloud layer between 880 hPa and 810 hPa with conditionally unstable stratification, and inversion layer between 810 hPa and 790 hPa with increasing

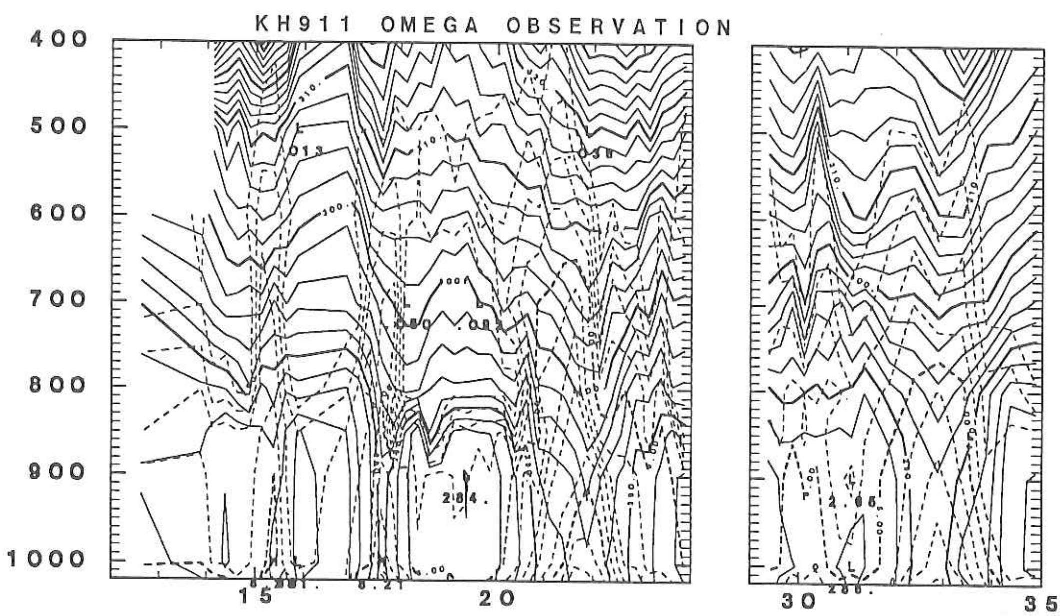

Fig. 2.1 Vertical time section of potential temperature (solid line) and specific humidity(dashed line).

temperature and large decreasing dew point temperature with respect to height. The air above the mixed layer is very dry, and the criterion for the break-up of a layered cloud is satisfied: equivalent potential temperature of the subsiding dry air at the top of the inversion is well to the left of the moist adiabat through cloud base.

There are also three layers in the boundary layer in the case of (b). The cloud layer, however, is very humid and with almost moist adiabatic stratification. The air above the mixed layer is not so dry, and the criterion for the break-up of a layered cloud is not satisfied.

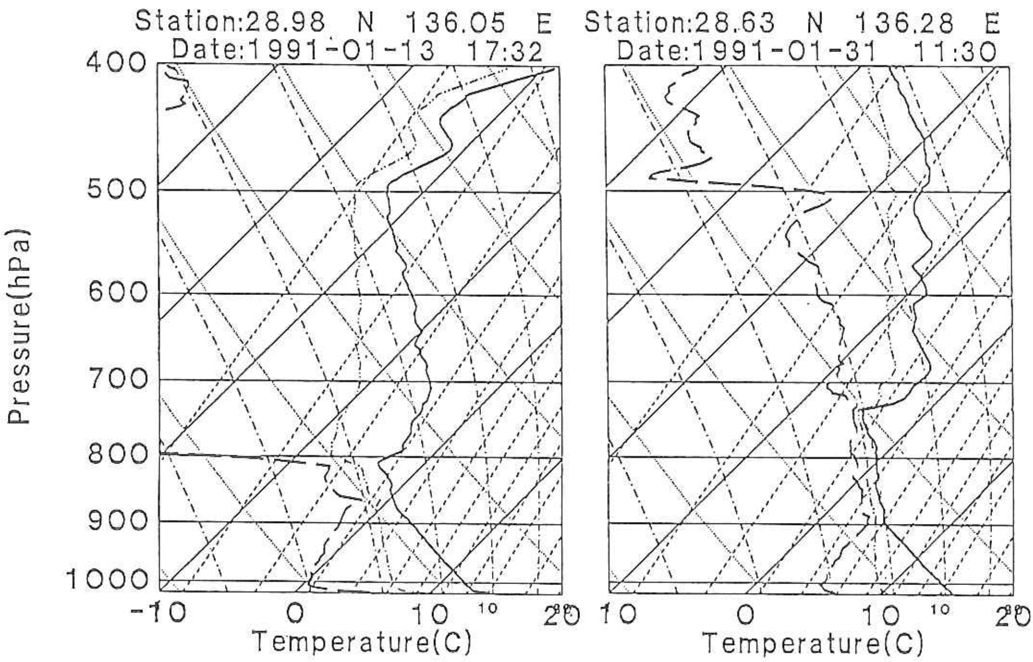

Fig. 2.2 Two examples of the soundings in skew-T diagram. The profiles in (a) are sounding at 03 JST on 14 January when small cloud amount is observed, and the profiles in (b) are sounding at 21 JST on 31 January when large cloud amount is observed. Solid lines, dotted lines, and dash-dotted lines are isopleths of temperature, potential temperature and saturation equivalent potential temperature at every 10 degrees. dashed lines are isopleths of saturation mixing ratio at every 1 gkg^{-1}. The thick solid line indicates the temperature sounding and the thick dashed line indicates the dew point temperature soundings. The thin dash-double-dot line between two sounding profiles indicates the observed equivalent potential temperature profile.

3. Polarimetric investigation of the maritime aerosols over the pacific ocean

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For a feasibility study setting up the maritime aerosol model, measurements of the radiance and degree of polarization of the skylight radiation were previously carried out over the Pacific ocean during the cruise of the Hakuho Maru KH-88-2. The wavelengths 0.4, 0.6 and 0.9 μm were considered using the portable spectroradiometer (resolution about 30nm). The derived visibility is in good agreement with that reported from ships (Takayama et al, 1991). Furthermore the optical thickness and the mixing ratio of aerosol constituents are shown to be derived from the measurements of maximum degree of polarization for moderate solar elevations, provided that the maritime aerosol is a mixture of oceanic and water-soluble aerosols.

This time (KH-91-1), to improve the previous method, the portable sunphotometer (Eko-MS-120) is simultaneously used for the measurement of the directly attenuated solar radiation at 0.368, 0.500, 0.675 and 0.778 μm. The data sets and results of the optical thickness are shown at Table 1.

Table 1a. The directly attenuated radiation measured by sunphotometer (Eko-MS-120)

day	time	tem	λ=368	500	675	778	cloud
1.18	13:11	21.0	42.8		1.043	0.656	8
	13:25	26.1		0.497			
	13:33	22.3	42.6	0.508	1.029	0.661	
	13:36	23.2					
1.19	7:59	26.5	5.4	0.221	0.698	0.508	6
		25.8					
	9:01	20.3	23.2	0.406	0.950	0.629	
	9:04	19.7					
1.22	8:53	28.2	12.0	0.224			8(hazy)

	11:10	25.8	32.8	0.412	0.896	0.567	8(hazy)
	11:15	25.0	32.7	0.410	0.924	0.598	8(hazy)
1.23	13:57	22.1	29.2	0.380	0.856	0.566	8(hazy)
	14:08	21.5	28.8	0.384	0.869	0.554	8(hazy)
1.28	14:53	25.2	29.0	0.326	0.668	0.419	cirrus
	14:56	22.4	22.5	0.315	0.670	0.422	cirrus
	15:04	18.3	29.8	0.426	0.966	0.614	cirrus
	15:12	18.0	29.2	0.428	0.952	0.616	cirrus
1.31	13:12	29.5	29.3	0.381	0.880	0.580	8(hazy)
	13:40	27.5	28.2	0.376	0.885	0.580	8(hazy)
2.02	14:57	29.5	15.6	0.298	0.767	0.506	4(hazy)
	15:31	23.0	7.8	0.219	0.616	0.429	6(hazy)
		21.2	7.3	0.194	0.597	0.418	
	16:24	22.1	1.1	0.095	0.408	0.314	2(hazy)
2.04	13:04	21.8	33.5	0.438	0.962	0.615	2(hazy)
		20.0	34.0	0.450	0.998	0.633	
	13.19	18.1	36.6	0.468	1.020	0.649	w=4.2m
		16.9	36.0	0.459	1.002	0.631	
	14:20	15.2	28.6	0.428	0.980	0.625	
		15.2	28.2	0.428	0.985	0.630	
	15:05	14.3	18.2	0.359	0.905	0.596	w=2.8m
		14.4	18.1	0.354	0.900	0.595	
	15:36	14.0	9.6	0.266	0.778	0.536	w=1.8m
		14.1	9.3	0.264	0.775	0.533	
	16:19	13.5	0.9	0.089	0.437	0.352	
		13.6	0.8	0.082	0.417	0.341	

Reference

Y. Takayama, K. Masuda and T. Takashima, 1991: Polarimetric investigation of the atmospheric aerosols over the Pacific ocean, Int. J. Remote Sensing, 12, 5, 969-983.

Table 1b. Optical thickness obtained by sunphotometer(Eko-MS-120) Lines correspond to optical thickness of total, molecule, ozone and aerosol, respectively.

day	time	Lλ	Lφ	θ。	λ=368	500	675	778	cloud
1.18	13:18	29.15	135.11	52.5	0.875	0.350	0.186	0.250	8
					0.500	0.141	0.041	0.023	
					0.0	0.009	0.012	0.0	
					0.375	0.200	0.133	0.266	
1.18	13:34	29.15	135.11	53.8	0.850	0.325	0.188	0.238	8
					0.500	0.141	0.041	0.023	
					0.0	0.009	0.012	0.0	
					0.350	0.176	0.135	0.214	
1.19	7:59	29.12	135.19	78.1	0.736	0.291	0.148	0.140	6
					0.501	0.141	0.042	0.023	
					0.0	0.009	0.012	0.0	
					0.235	0.141	0.095	0.116	
1.19	9:02	29.04	135.26	67.0	0.806	0.304	0.157	0.178	6
					0.501	0.141	0.042	0.023	
					0.0	0.009	0.012	0.0	
					0.305	0.154	0.104	0.155	
2.04	13:04	35.28	139.76	54.2	0.981	0.406	0.224	0.275	2(hazy)
					0.491	0.138	0.041	0.023	
					0.0	0.009	0.021	0.0	
					0.490	0.259	0.171	0.252	
2.04	13:19	35.28	139.76	55.4	0.903	0.355	0.184	0.237	w=4.2m
					0.491	0.138	0.041	0.023	
					0.0	0.009	0.012	0.0	
					0.412	0.208	0.132	0.214	
2.04	14:20	35.28	139.76	62.1	0.862	0.335	0.171	0.214	w=4.2m
					0.491	0.138	0.041	0.023	
					0.0	0.009	0.012	0.0	
					0.371	0.187	0.119	0.191	

4. Measurements of fluxes at the sea surface

4.1 Direct Measurements of Turbulent Fluxes at the Sea Surface

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4.1.1. Measurements

Turbulent fluxes of momentum, sensible heat and water vapor were measured with eddy correlation method during the cruise. A combination of three dimensional sonic anemometer(Kaijo Denki,DAT-300) and a fine wire thermocouple psychrometer(Kaijo Denki, PY-100) was used to measure turbulent fluctuations of wind velocity components, air temperature and wet- and dry-bulb temperatures. Specific humidity was evaluated from the data of wet- and dry-bulb temperatures(Tsukamoto,1986). These sensors were mounted at the top of the foremast(16m above the sea level). Usually the ship heading was against the wind direction during the turbulence observation in order to reduce the blockage effect of the ship body. These signals of turbulent fluctuations were sampled at 10Hz and recorded on floppy disk(TEAC, DR-F1).

The informations of ship motion is necessary to remove the false velocity components from observed velocity components. During the cruise of KH-88-2, ship motions were measured by ourselves. In the new R/V Hakuhomaru, ship motions are measured with high-precision gyro(Tokyo Aircraft Instruments Co., SGC-1) at No.9 Laboratory and the signals are put into optical-LAN system(Nakanishi et al.,(1990)) every 0.5sec. These ship motion signals were obtained through RS-232C interface into a personal computer(NEC, PC-9801n).

The original turbulence data(10Hz) were averaged to 0.5sec data and the correction of wind velocity and statistical processing were made with this averaged data. A block diagram of the observation system is shown in Fig.4.1.1.

At the OWS-T, measurements were carried out 4 times a day(3,9,15,21 JST) in principle, and 8 times a day during the intensive periods(18/19 & 29/30 Jan). Measurements were also continued across the "Kuroshio" on the way to Kochi.

4.1.2. Correction of ship motion

The wind sensor is fixed to the top of the foremast and sways with ship body. Therefore the observed wind velocity components relative to the frame fixed to the ship should be corrected for ship motion to obtain true velocity components. The correction equation is expressed in vector notations as follows.

$$V = T\,V_0 + \Omega \times T\,R + Vs \qquad (4.1.1)$$

$$Vs = Vs_0 - \Omega \times T\,L \qquad (4.1.2)$$

Here V is the true wind velocity, Vs is the velocity component of the ship body and Vs_0 is the observed velocity at the position of the motion sensor. The motion sensor is located at No.9 Laboratory and the position vector from the center of the gravity is L=(16.7m, 0m,1.1m). The position vector of the wind sensor is R=(35.8m, 0m, 16.5m).

In the present system, all components of ship motion are obtained from LAN system. Horizontal components of ship motion were not exactly corrected for the data of KH-88-2. It was improved in the present observation system.

Fig.4.1.2 shows an example of the time series.

VN : ship speed(northward component)

VE : ship speed(eastward component)

HV : displacement of heaving motion

AZ : direction of bow azimuth(clockwise from north)

RO : rolling angle(port down angle)

PI : pitching angle(bow down angle)

Fig.4.1.3 shows the comparison of wind velocity components before and after the correction. This correction is confirmed by cross spectral analysis shown in Fig.4.1.4. It is found that power spectra and cospectrum are improved around 0.1Hz. The details of the correction are given by Tsukamoto et al(1990), Fujitani(1985).

4.1.3. Preliminary scientific results

The preliminary results of turbulent statistics and fluxes are tabulated in Table 4.1.1. Turbulence observations were carried out through an hour and it is separated into two parts(every 30 minutes) in principle. Some of the data were withdrawn due to unfavorable wind direction(momentum flux), rain(heat fluxes) and insufficient water supply to the wet-bulb(latent heat flux).

Turbulent fluxes of latent heat and sensible heat are compared in Fig.4.1.5. The average Bowen's ratio is evaluated as 0.42, which is much larger than that (0.25) of KH-88-2(Tsukamoto et al(1990). And the magnitude of heat fluxes are much larger for the present data. The relative importance of sensible heat flux is also inferred from air-sea temperature difference. Sensible heat flux over Kuroshio is nearly 200W/m^2, which is about 3 times larger than KH-88-2. Latent heat flux over Kuroshio was not evaluated.

In order to evaluate average drag coefficient, covariance, $-\overline{u'w'}$ were plotted against U^2(Fig.4.1.6). It is found that average value of C_D=1.30X10^{-3}

, which is a little smaller than KH-88-2(C_D=1.42X10^{-3}). The drag coefficient are plotted as a function of wind speed in Fig.4.1.7.

Further analysis of bulk transfer coefficient including C_H and C_E are continued.

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Tsukamoto,O., Ohtaki, E.,Ishida H., Horiguchi M. and Mitsuta, Y. 1990: On-board direct measurements of turbulent fluxes over the open sea. Jour.Met.Soc. Japan, Vol.68, 203-211.

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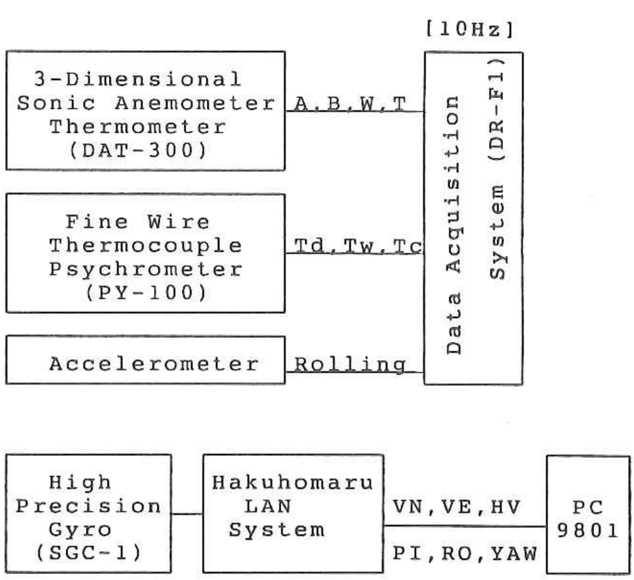

Fig.4.1.1 Blockdiagram of turbulence measurement

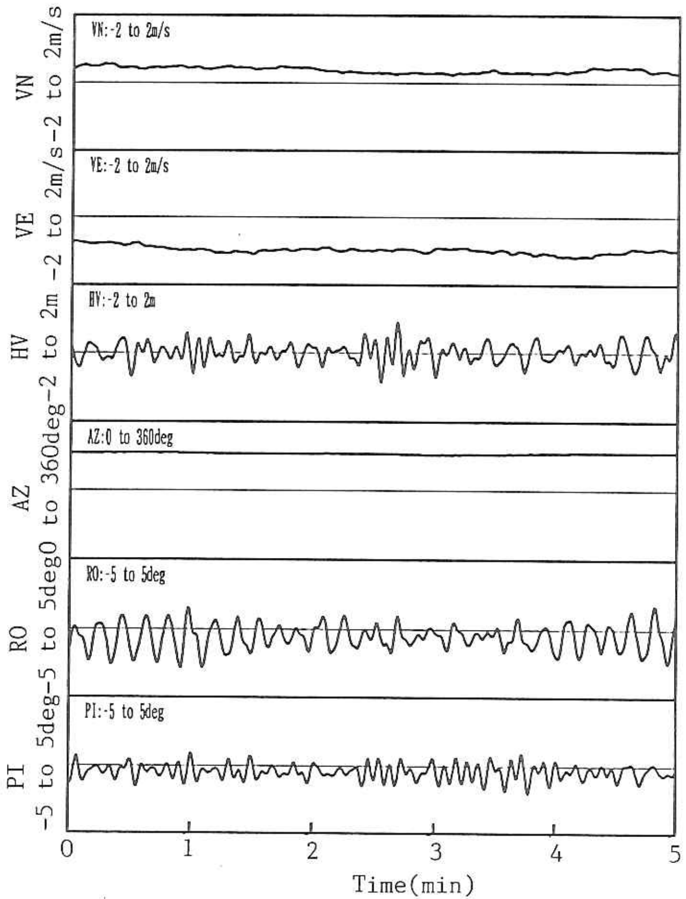

Fig.4.1.2 An example of time series of ship motion. Details are given in the text.

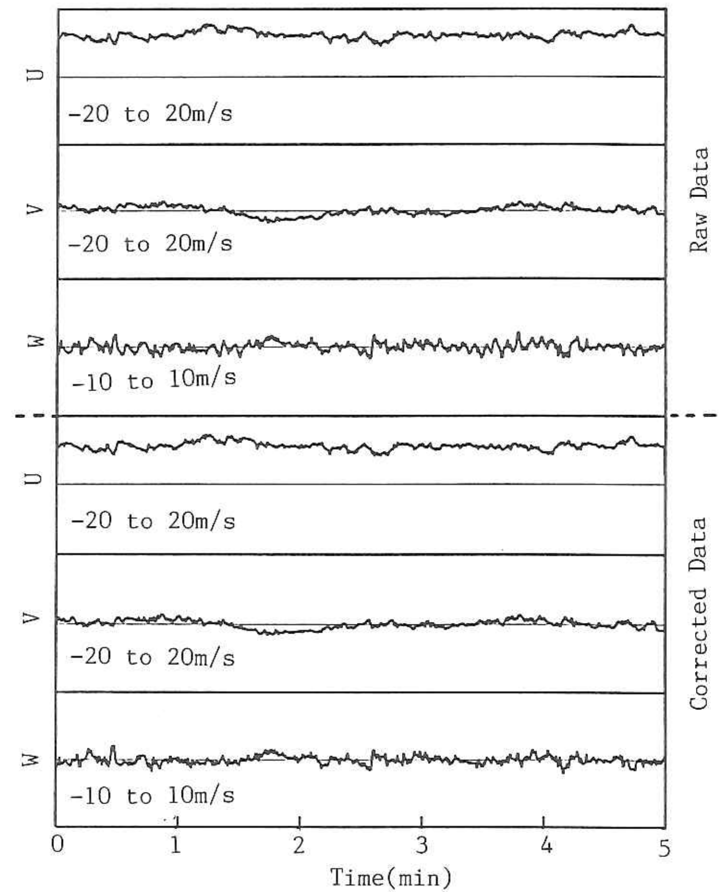

Fig.4.1.3 Comparison of 3 components of wind velocity before and after the correction of motion

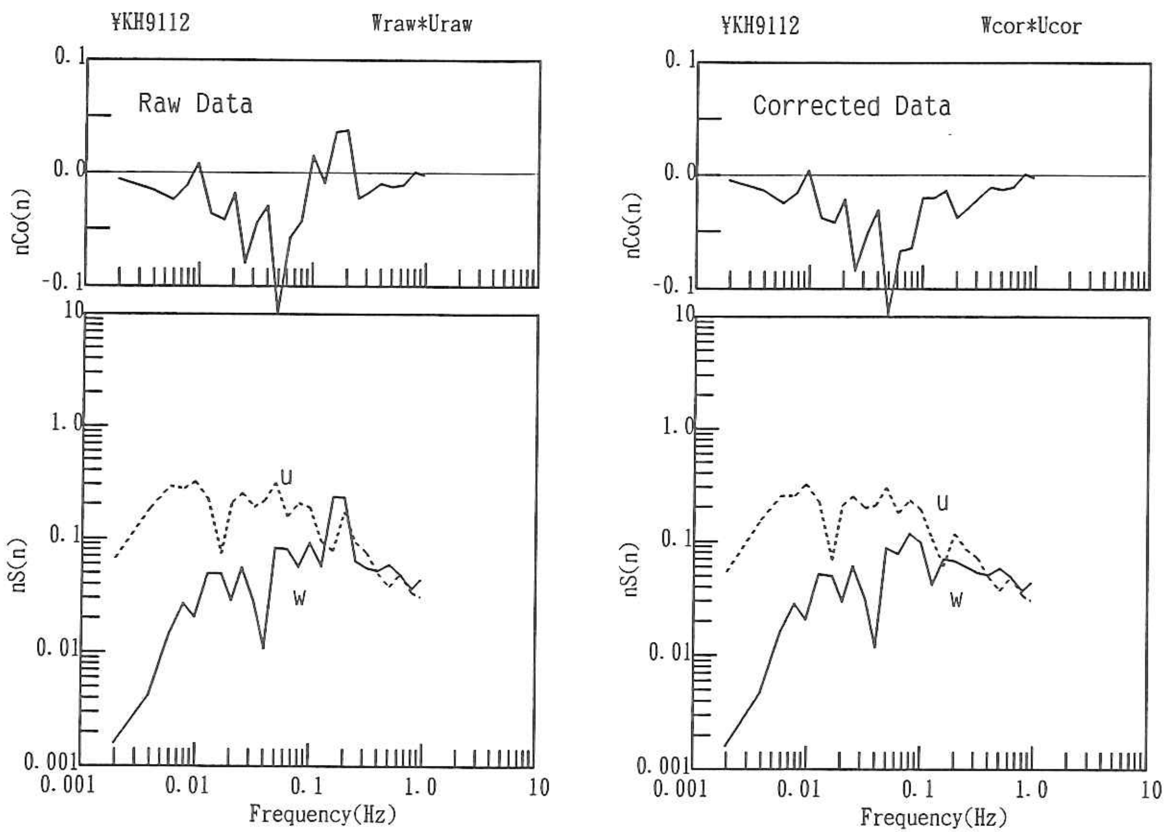

Fig.4.1.4 Comparison of power spectra of u- and w- conponents and cospectrum between them

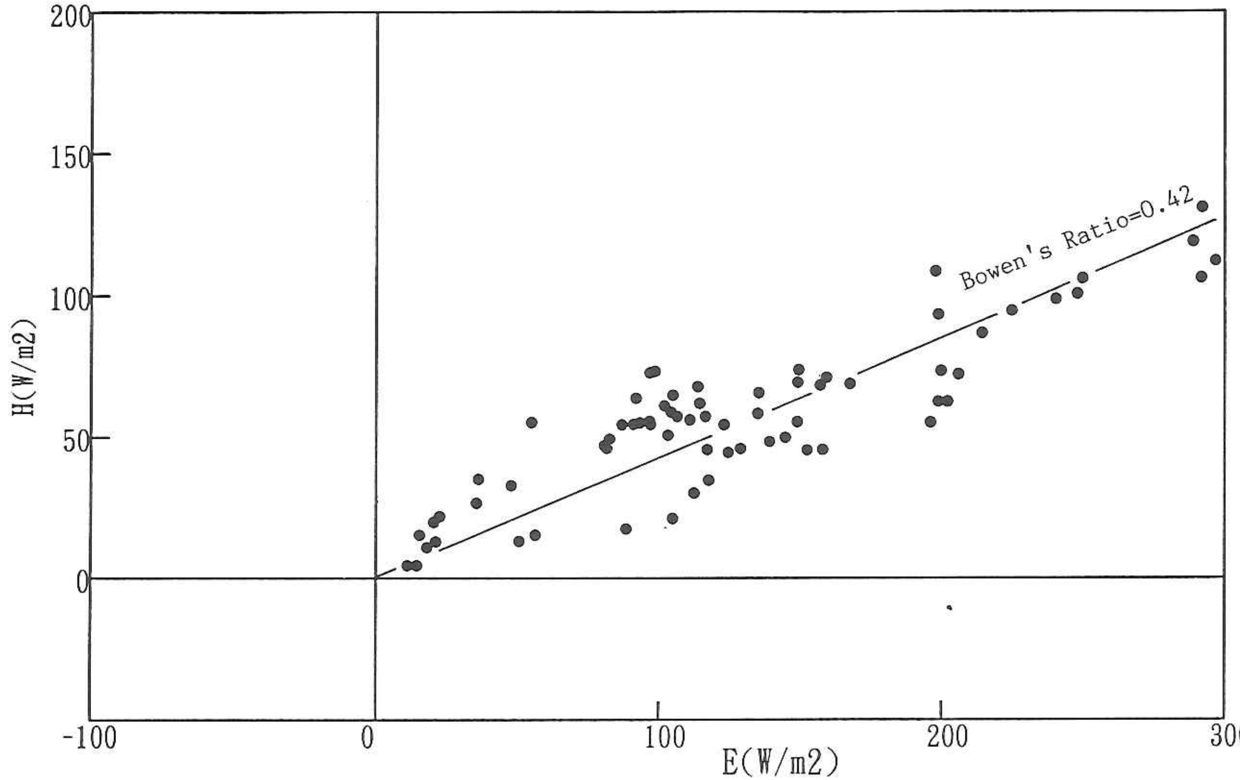

Fig.4.1.5 Sensible heat flux(H) vs. latent heat flux(E) at OWS-T.
Solid line gives the average Bowen's ratio of 0.42.

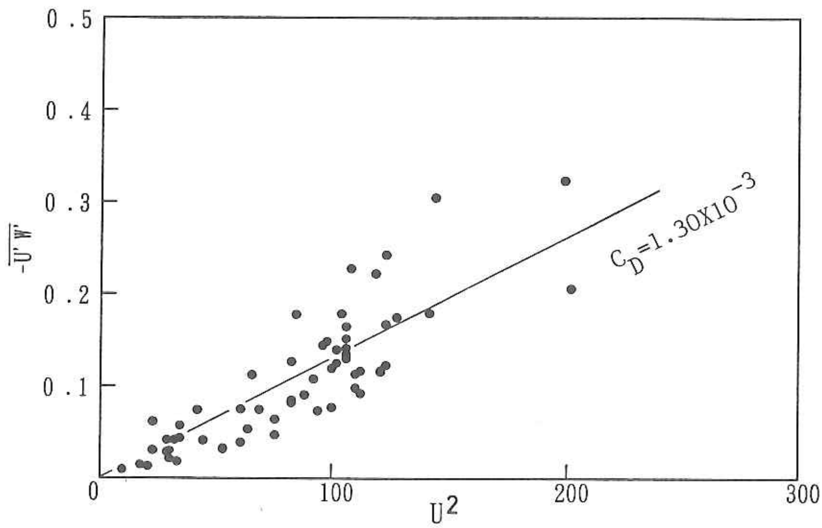

Fig.4.1.6 Covariance($-\overline{u'w'}$) vs. U(mean wind speed)^2
Solid line gives the average drag coefficient of 1.30X10^{-3}.

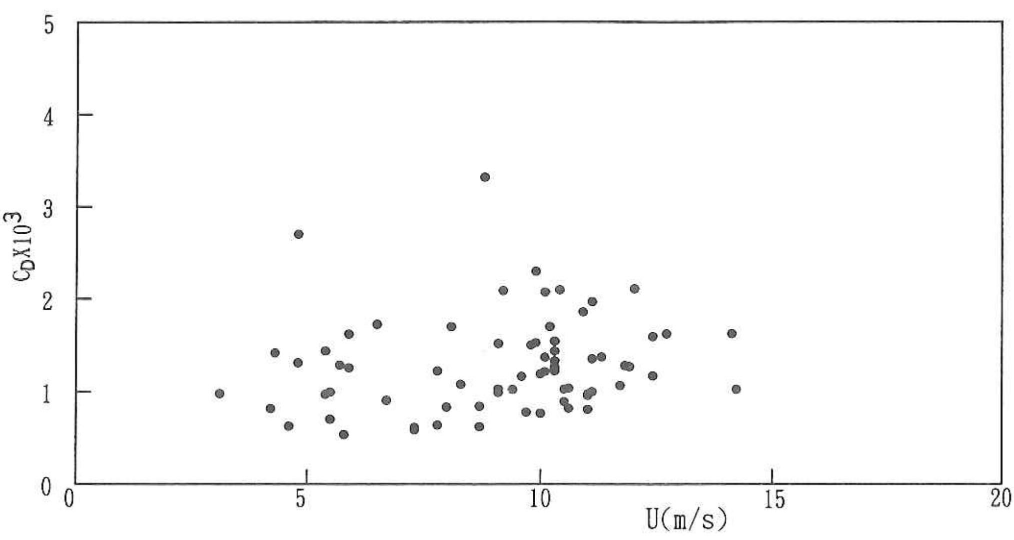

Fig.4.1.7 Drag coefficient as a function of mean wind speed.

Table 4.1.1 The preliminary results of turbulent statistics and fluxes (to be continued)

Run	DATE '91	Start Time	U m/s	WD deg	T °C	q g/kg	σu m/s	σw m/s	σ_T °C	σq g/kg	τ N/m2	H W/m2	E W/m2
1a	1/12	11:31	4.9	286	13.2	6.4	1.037	0.420	0.294	0.269	******	69.4	148.9
1b		12:01	4.3	287	13.6	6.7	1.371	0.422	0.312	0.262	0.032	57.4	116.1
2a	13	15:27	12.4	313	14.2	*7.0	1.340	0.723	0.424	*****	0.217	170.5	*****
2b		15:57	12.4	315	14.1	*6.3	1.548	0.745	0.469	*****	0.294	219.7	*****
3a	14	10:30	10.1	320	13.0	*5.4	1.301	0.573	0.461	*****	0.257	177.7	*****
3b		11:00	10.2	323	12.9	*4.9	1.253	0.539	0.355	*****	******	107.7	*****
4a	15	12:19	8.8	310	12.4	*7.1	1.358	0.524	0.441	*****	0.311	161.9	*****
4b		12:49	9.9	325	12.0	*7.1	1.617	0.526	0.670	*****	0.271	159.6	*****
5a		14:25	12.7	311	12.6	*5.3	1.330	0.589	0.498	*****	0.318	186.0	*****
5b		14:55	11.8	307	12.2	*6.9	1.612	0.591	0.478	*****	0.214	181.1	*****
6a		17:28	11.7	318	11.6	*4.8	1.357	0.597	0.536	*****	0.175	177.6	*****
6b		17:58	11.0	328	11.0	*4.8	1.506	0.594	0.498	*****	0.118	153.2	*****
7a		20:32	7.9	4	10.5	*4.0	1.450	0.543	0.416	*****	******	154.6	*****
7b		21:02	6.3	357	10.7	*4.4	1.029	0.514	0.388	*****	******	121.2	*****
8a		22:40	6.7	324	10.3	*3.8	1.268	0.513	0.399	*****	******	135.1	*****
8b		23:10	8.5	326	9.9	*4.3	1.484	0.506	0.426	*****	******	136.2	*****
8c		23:40	8.6	321	9.4	*3.8	1.387	0.568	0.517	*****	******	179.4	*****
9a	16	00:24	7.9	328	9.1	*4.3	1.350	0.544	0.463	*****	******	170.5	*****
9b		00:54	7.4	333	9.0	*3.8	1.392	0.582	0.497	*****	******	202.4	*****
9c		01:24	6.5	322	8.7	*3.4	1.338	0.545	0.430	*****	******	156.1	*****
10a		02:07	6.1	320	8.8	*3.2	1.203	0.483	0.382	*****	******	114.6	*****
10b		02:37	5.9	298	8.5	*3.7	1.734	0.513	0.365	*****	******	117.5	*****
10c		03:07	6.4	284	8.3	*3.5	1.832	0.548	0.338	*****	******	128.9	*****
10d		03:37	5.7	282	8.2	*3.5	1.456	0.517	0.313	*****	******	103.1	*****
11a		04:15	3.1	332	7.5	*3.5	0.972	0.490	0.337	*****	******	69.7	*****
11b		04:45	2.9	330	6.7	*3.5	0.634	0.400	0.357	*****	******	57.7	*****
11c		05:15	3.8	354	5.7	*3.5	0.575	0.390	0.413	*****	******	76.9	*****
(Start OWS-"T")													
12a	17	18:11	11.3	293	17.7	8.9	0.983	0.497	0.226	*****	0.211	65.1	*****
12b		18:41	12.0	302	17.2	8.9	1.105	0.574	0.306	*****	0.367	123.5	*****
13a		21:06	10.6	318	17.1	7.3	0.880	0.482	0.219	0.357	0.111	55.3	196.0
13b		21:36	10.6	316	17.0	6.6	1.055	0.461	0.238	0.374	0.140	62.6	198.7
14a	18	00:08	9.1	342	16.2	7.1	0.819	0.502	0.256	0.355	0.153	62.6	201.9
14b		00:38	9.2	344	15.9	6.7	0.988	0.484	0.240	0.305	0.214	72.2	205.7
15a		03:03	10.3	348	14.9	6.1	1.040	0.552	0.331	0.372	0.170	106.0	291.7
15b		03:33	10.3	349	14.7	6.0	0.979	0.514	0.342	0.389	0.163	98.7	240.5
16a		06:17	10.5	336	13.7	4.9	1.076	0.571	0.355	0.401	0.119	118.7	288.8
16b		06:47	9.1	338	13.5	4.7	1.280	0.525	0.339	0.429	0.099	111.8	296.8
17a		09:00	8.7	346	13.2	4.3	1.437	0.546	0.401	0.416	0.077	130.6	292.1
17b		09:30	8.5	324	13.2	4.3	1.207	0.476	0.336	0.385	******	100.5	248.0
18a		12:05	8.1	339	13.1	4.6	1.096	0.522	0.339	0.335	0.135	105.8	249.9
18b		12:35	8.1	335	13.2	4.6	1.116	0.484	0.319	0.327	******	94.6	224.7
19a		15:00	8.7	336	13.6	5.2	1.159	0.485	0.353	0.337	0.056	93.3	198.6
19b		15:30	9.1	339	13.6	5.3	1.122	0.557	0.361	0.388	0.102	108.3	197.6
20a		21:00	7.3	341	13.6	5.3	1.011	0.425	0.315	0.288	0.038	68.3	156.8
20b		21:30	7.8	350	13.8	5.4	1.022	0.444	0.300	0.375	0.047	86.6	214.1
21a	19	09:00	5.7	17	14.0	5.0	0.998	0.435	0.292	0.321	0.050	73.4	199.7
21b		09:30	5.3	20	14.2	5.1	0.981	0.439	0.280	0.286	******	68.8	167.3
22a		15:00	5.5	53	14.0	5.2	0.930	0.422	0.255	0.286	0.036	71.1	159.0
22b		15:30	4.8	55	14.0	4.9	0.905	0.355	0.237	0.231	0.037	45.4	116.9
23a		21:00	4.6	75	14.4	4.5	0.997	0.379	0.234	0.247	0.016	49.8	144.5
23b		21:30	4.8	71	14.6	4.7	0.897	0.386	0.189	0.247	0.074	44.5	124.3
24a	20	03:00	4.2	117	15.4	5.4	0.779	0.352	0.182	0.233	0.018	34.7	117.3
24b		03:30	5.5	112	15.5	5.2	0.730	0.379	0.207	0.283	******	45.3	152.3
25a		09:00	5.9	115	17.0	7.3	0.796	0.394	0.259	0.280	0.069	45.5	157.6
25b		09:30	5.9	112	17.2	7.3	0.782	0.332	0.188	0.246	0.052	30.1	112.2
26a		14:45	2.0	85	17.3	8.2	0.483	0.265	0.140	0.129	******	12.9	50.5
26b		15:15	3.1	114	17.7	8.2	0.542	0.290	0.124	0.156	0.011	15.2	56.3

Table 4.1.1 The preliminary results of turbulent statistics and fluxes (continued)

Run	DATE '91	Start Time	U m/s	WD deg	T °C	q g/kg	σ_u m/s	σ_w m/s	σ_T °C	σ_q g/kg	τ N/m2	H W/m2	E W/m2
27a		21:00	8.0	143	19.0	9.7	0.631	0.360	0.154	0.242	0.064	17.3	88.5
27b		21:30	8.3	149	19.1	9.8	0.616	0.386	0.147	0.249	0.090	21.1	104.8
28a	21	03:00	10.3	152	18.6	10.9	0.801	0.433	*****	*****	0.156	*****	*****
28b		03:30	10.1	154	19.1	10.9	0.854	0.456	*****	*****	0.168	*****	*****
29a		09:00	10.3	168	18.9	12.0	0.904	0.420	*****	*****	0.159	*****	*****
29b		09:30	9.4	158	18.6	12.7	1.050	0.390	*****	*****	0.109	*****	*****
30a		15:02	14.1	206	21.0	14.3	1.557	0.650	0.148	0.107	0.390	10.7	17.7
30b		15:32	14.2	212	21.0	14.2	1.321	0.647	0.165	0.123	0.248	15.2	15.2
31a		21:00	10.5	253	20.8	14.3	0.825	0.499	0.143	0.038	0.136	4.3	14.2
31b		21:30	10.1	252	20.8	14.4	0.789	0.454	0.078	0.034	0.150	4.4	11.0
32a	22	03:00	11.0	273	20.1	13.2	1.162	0.478	0.112	0.122	0.141	12.8	20.9
32b		03:30	11.9	275	20.0	13.1	1.033	0.520	0.174	0.088	0.216	21.7	22.2
33a		08:30	11.1	286	19.8	12.0	0.997	0.490	*****	*****	0.201	*****	*****
33b		09:00	11.1	295	19.6	12.3	0.912	0.478	*****	*****	0.148	*****	*****
34a		15:00	9.9	326	18.0	9.8	0.957	0.444	0.322	0.307	0.179	45.9	128.6
34b		15:30	9.4	333	17.9	9.6	0.914	0.461	*****	*****	******	*****	*****
35a		21:00	8.6	357	17.0	8.0	0.795	0.435	0.219	0.290	******	48.3	138.9
35b		21:30	8.5	2	17.0	8.0	0.798	0.487	0.222	0.278	******	55.4	148.7
							(End of LEG 1 / Start of LEG 2)						
36a	29	11:55	3.9	43	14.4	7.0	0.869	0.369	0.261	0.180	******	55.1	93.3
36b		12:25	2.9	49	14.5	7.2	0.929	0.363	0.188	0.176	******	32.8	47.5
37a		15:01	3.8	22	14.3	6.8	0.758	0.350	0.209	0.167	******	46.0	81.7
37b		15:31	3.9	26	14.4	6.7	0.902	0.399	0.201	0.162	******	49.4	82.7
38a		18:03	4.3	32	14.5	6.7	0.772	0.355	0.238	0.168	******	47.0	80.7
38b		18:33	5.2	36	14.5	6.9	0.822	0.389	0.262	0.181	******	54.5	87.1
39a		21:00	7.8	24	14.3	7.3	0.762	0.428	0.280	0.192	0.090	73.3	98.6
39b		21:30	7.3	23	14.4	7.2	0.818	0.403	0.274	0.176	0.039	63.7	92.0
40a	30	00:00	6.3	9	14.5	7.1	0.859	0.425	0.279	0.215	******	72.8	96.9
40b		00:30	6.2	357	14.4	7.0	0.771	0.394	0.266	0.208	******	64.8	104.9
41a		03:00	5.4	4	14.9	7.2	0.760	0.392	0.237	0.182	0.034	54.6	97.0
41b		03:30	5.8	14	14.8	6.9	0.861	0.399	0.232	0.200	0.022	58.9	104.1
42a		06:00	5.5	27	14.9	6.0	0.874	0.413	0.228	0.246	0.026	58.4	134.6
42b		06:30	5.5	40	14.8	6.2	0.906	0.408	0.225	0.221	******	56.2	110.7
43a		09:00	7.1	44	14.6	7.4	0.784	0.410	0.291	0.209	******	67.8	113.5
43b		09:30	6.0	37	14.7	7.4	0.843	0.389	0.304	0.229	******	65.7	134.9
44a		12:01	5.4	20	14.5	6.9	0.841	0.409	0.254	0.203	0.050	55.6	96.7
44b		12:31	5.0	357	14.6	6.6	0.873	0.378	0.217	0.216	******	54.4	122.7
45a		15:00	5.1	333	14.5	6.8	0.873	0.393	0.238	0.174	******	54.6	91.1
45b		15:30	4.8	334	14.7	6.8	0.776	0.395	0.244	0.206	******	57.3	106.4
46a		21:00	6.5	326	14.6	6.3	0.979	0.387	0.253	0.241	0.089	61.0	102.0
46b		21:30	6.7	339	14.7	6.5	0.827	0.439	0.263	0.275	0.049	73.7	149.2
47a	31	09:00	5.2	343	14.4	6.5	0.845	0.430	0.240	0.211	******	61.9	114.1
47b		09:30	4.9	334	14.4	6.5	1.120	0.409	0.248	0.203	******	50.7	103.2
48a		14:46	4.5	311	14.8	8.8	0.855	0.368	0.211	0.135	******	34.9	35.9
48b		15:16	6.4	339	14.4	8.3	0.752	0.424	0.261	0.133	******	55.3	54.9
49a		21:00	2.1	303	15.0	7.8	0.831	0.336	0.194	0.099	******	26.5	35.2
49b		21:30	1.8	283	15.0	7.8	0.615	0.313	0.123	0.077	******	19.8	20.1
							(END of OWS-"T")						
50a	2/ 1	09:00	10.9	242	17.7	10.7	1.199	0.596	*****	*****	0.268	*****	*****
50b		09:30	11.0	253	17.0	10.9	1.461	0.498	*****	*****	0.139	*****	*****
51a		15:00	10.0	262	18.7	11.7	1.007	0.461	*****	*****	0.093	*****	*****
51b		15:30	9.6	284	18.1	11.6	1.207	0.545	*****	*****	0.130	*****	*****
52a		21:00	10.2	300	18.6	*10.3	0.934	0.538	0.202	*****	0.215	42.0	*****
52b		21:30	9.7	294	18.3	*10.0	0.796	0.431	0.170	*****	0.088	28.0	*****
53a	2	10:30	10.3	311	17.1	*8.4	0.959	0.489	0.210	*****	0.198	49.9	*****
53b		11:00	9.8	308	16.8	*8.6	0.888	0.460	0.213	*****	0.174	59.9	*****
54a		23:10	11.1	309	12.7	*6.1	1.137	0.536	0.390	*****	0.292	128.5	*****
54b		23:40	10.4	319	12.6	*6.0	1.470	0.562	0.421	*****	0.275	91.3	*****
55a	3	08:30	10.3	309	11.3	*4.7	1.290	0.602	0.477	*****	0.183	161.6	*****
55b		09:00	10.0	304	11.4	*5.3	1.206	0.586	0.478	*****	0.144	183.5	*****

4.2 Partial Pressure of Carbon Dioxide in Sea Water

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4.2.1 Introduction

It is well known that the carbon dioxide content in the atmosphere is increasing (e.g., Ciattaglia et al., 1987; Tanaka et al., 1987). The atmospheric content of carbon dioxide is controlled by the balance of carbon dioxide exchanges amongst atmosphere, ocean and plant. Especially, the exchange between atmosphere and ocean plays an important role to determine the atmospheric carbon dioxide content, because the ocean covers a large part of the earth surface.

In a fair approximation, when the carbon dioxide from the atmosphere dissolves into sea water, it enters the following chain of reactions (e.g., Kanwisher, 1960).

atmosphere CO_2 (air)

$$\downarrow\uparrow$$

sea $$CO_2\,(\text{sea}) + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO^- \rightleftarrows 2H^+ + CO_3^{2-} \quad (1)$$

Here, CO_2(air) and CO_2 (sea) are respectively partial pressure of carbon dioxide in the atmosphere and sea water. It is noted that the carbon dioxide flux over the sea surface can be calculated from the partial pressure difference between CO_2 (air) and CO_2(sea). In this paper, the measuring technique of CO_2(sea) is briefly described, and then data for partial pressure of carbon dioxide in sea water obtained during cruise of KH-91-1 are presented.

4.2.2 Methods

Fig. 4.2.1 shows a measuring instrument of partial pressure of carbon dioxide in sea water. Details of the instrument will be shown elsewhere. Therefore, only a blief description is given here. The measuring instrument consists of a plastic chamber, a water bath, and a non-dispersive infrared gas analyzer (NDIR). The plastic chamber had a cross section of 3 cm^2 and 15 cm tall. A outlet pipe for carrier gas was fixed to the upper cap of the chamber. Three pipes were inserted through tight sealed holes from the bottom of the chamber. One was jointed to a capillary in the chamber, and others were for temperature measurement of sample water and exchanging the air over the water surface in the chamber. The plastic chamber with sample sea water (18 ml) was immersed in a constant temperature water bath. The temperature in the bath was controlled within an accuracy of 0.1°C.

As can be seen from the figure, the NDIR was operated by a differential mode. The carbon dioxide standard gas of known concentration was passed through a reference cell of the NDIR. Other standard gases of carbon dioxide were used as the carrier gas. The flow rate of the carrier gas was regulated by a mass flowmeter and passed through a capillary which made small bubbles in the chamber. They travelled up about 6 cm through sample sea water. The carrier gas was then dried by a column of $Mg(ClO_4)_2$ and led to a measuring cell of the NDIR. The outlet of the NDIR was opened to the atmosphere to maintain the carrier gas line as barometric pressure. The output signal of the NDIR was recorded on a potentiometric pen recorder.

In general, when the carrier gas is flushed through sample sea water, the output signal of the NDIR shows a positive (or negative) peak (Fig. 4.2.2). This implies that CO_2 (sea) in sample sea water is removed (or dissolved) by the carbon dioxide in carrier gas, and the removed (or dissolved) carbon dioxide is responsible for the peak of the NDIR. The peak height (CPH) of the output signal from the NDIR is used to deduce the partial pressure of carbon dioxide equilibrated in sea water. In practice, several kinds of carrier gases of known concentration are flushed through sample sea waters, and the CPH values are measured from the chart records. The values of the CPH are plotted in Fig. 4.2.3 for partial pressure of carrier gases. It is noted that the CPH shows a linear relationship to the partial pressure of carrier gases. The partial pressure of carbon dioxide in sea water is assumed to be that of carrier gas where the CPH is zero. In the present study, the partial pressure of

CO_2(air) and CO_2(sea) is used in ppm unit. For the case of Fig. 4.2.3, the partial pressure of the sea water is determined to be 333 ppm.

4.2.3 Preliminary results

16 data of partial pressure of carbon dioxide in sea water were obtained during cruise of KH-91-1. They are summarized in Table 1. The partial pressure for sea water shows values ranging from 315 to 335 ppm. It is noted that these values of partial pressure are about 30 ppm smaller than those in the atmosphere. This means that the carbon dioxide may be transported from the atmosphere to the sea water during cruse of KH-91-1.

Further efforts have to be focused on the determination of transfer coefficient of carbon dioxide in order to estimate the exchange rate of carbon dioxide between atmosphere and ocean.

References

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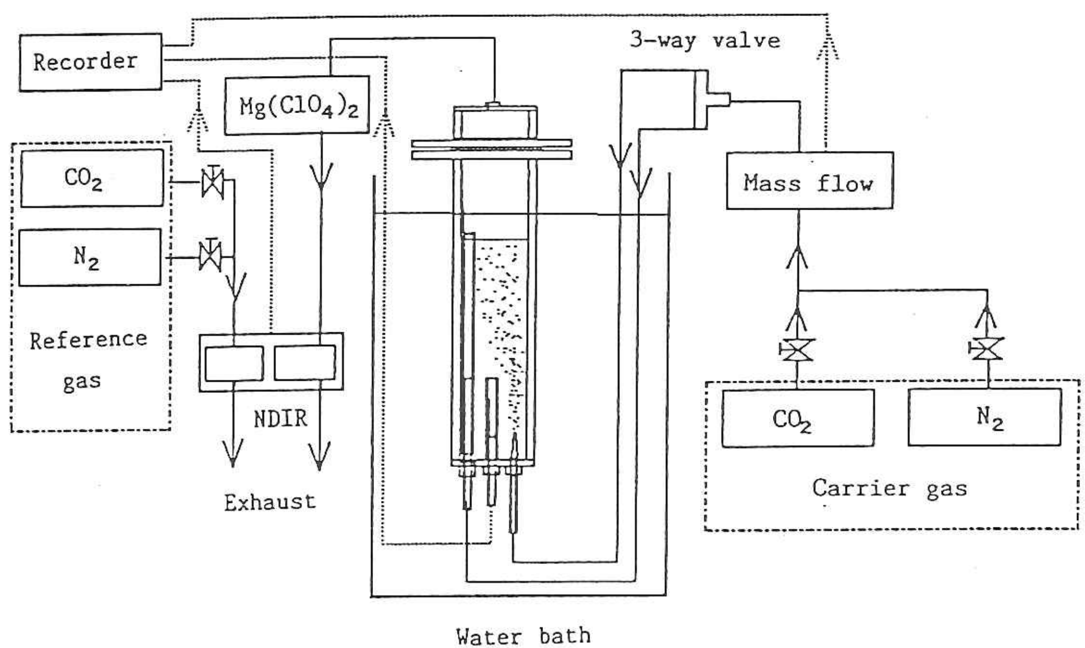

Fig. 4.2.1 The detail of measuring instruments of partial pressure of carbon dioxide in sea water.

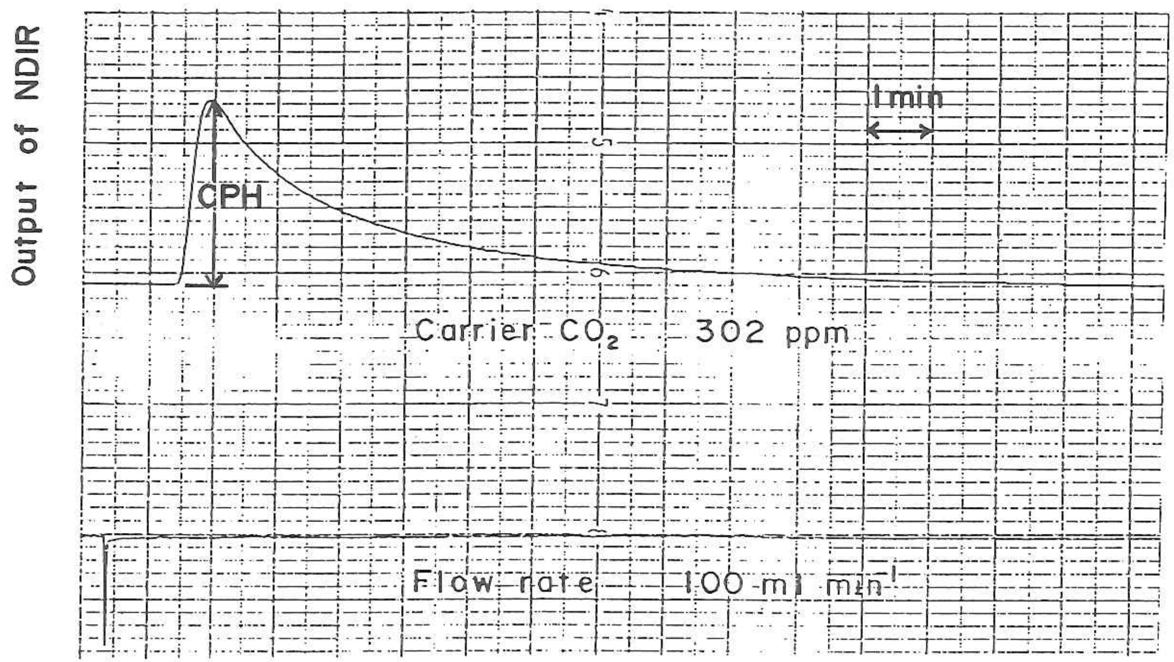

Fig. 4.2.2 The output signal of NDIR. The positive peak means removal process of carbon dioxide from sea water sample. Concentration of carrier gas is 302 ppm, and flow rate is 100 ml min^{-1}.

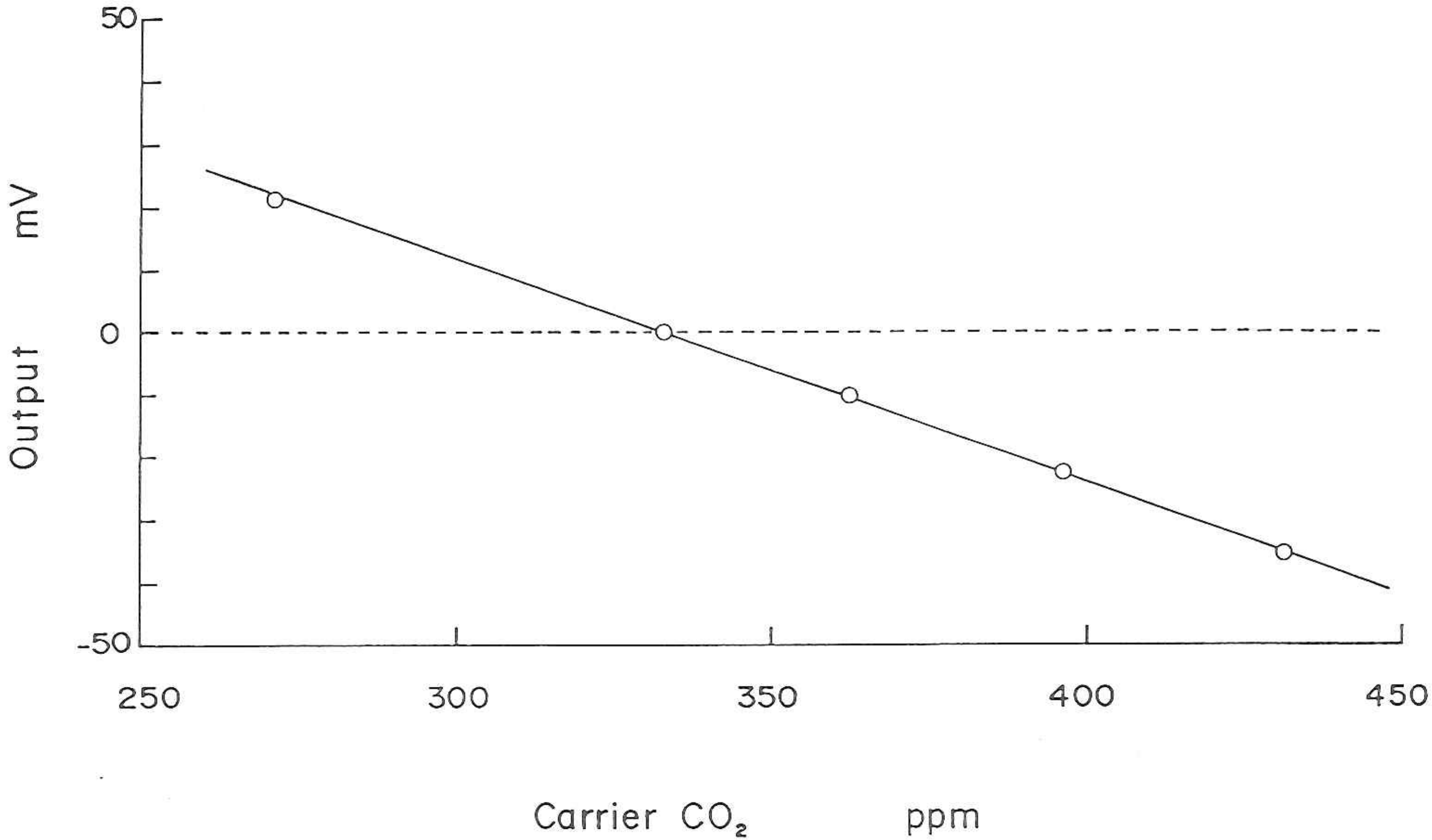

Fig. 4.2.3 Determination of partial pressure of carbon dioxide in sea water from the peak height (CPH). The partial pressure of carbon dioxide is considered to be that of carrier gas where CPH is zero.

Table 4.2.1 Preliminary results of partial pressure of carbon dioxide in sea water

Date	Lat. (deg)	Long. (deg)	CO_2(sea) (ppm)	CO_2(air) (ppm)	Tsea (°C)	U (m/s)
Jan 12	32:27	136:04	343	356	21.8	11.2
14	28:59	135:59	337	357	21.3	9.3
17	29:07	135:08	315	359	21.3	6.2
18	29:09	135:08	345	359	20.6	8.0
20	29.03	134:44	333	358	21.5	5.0
22	29:09	135:07	337	358	21.1	8.8
29	29:04	134:58	333	360	21.3	4.1
30	29:04	135:01	330	358	21.3	5.1
31	29:51	135:30	337	359	20.8	4.9
31	28:43	136:00	332	359	20.8	4.0
Feb 01	27:52	139:00	327	360	21.4	9.6
01	27:35	140:01	327	360	21.2	9.7
02	28:00	141:37	335	361	20.2	8.9
02	29:00	141:24	334	359	20.4	11.9
03	32:00	140:59	326	364	21.0	10.8
03	33:01	141:00	330	364	19.9	10.4

5. Observation of significant wind-wave period by using a stop watch

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1. Introduction

In case when we have no sophisticated equipment for the wave measurement on board a vessel, observations of significant wind-wave period and swell period by using a stop watch are rather easy and can give useful data. Toba and Chaen (1973) used this method for observations of wave breaking, whitecapping, number concentration and distribution of sea-salt particles on the sea surface, in relation to the wind speed, wind waves and air and water temperatures.

During the OMLET Cruise in 1988 (KH-88-2), we examined this method critically, compared the observed data with data by the Ocean Data Buoy (ODB) off Shikoku of the Japan Meteorological Agency (JMA), and showed that this method of observation of wind waves gave reasonable values (Toba et al., 1988). The present observation is a continuation of this series of examination.

Another objective of the present observation is a cooperation with the turbulence group. We already reported that the drag coefficient C_D, or the aerodynamic roughness length of the sea surface z_0, was affected largely by the existence of wind waves (Toba et al., 1990; Ebuchi et al., 1990; Toba and Ebuchi, 1991). We have estimated the values of drag coefficient from the data of wind and our wind-wave observation together with our C_D formulas (Toba et al.,1990), and have compared these with the data by the turbulence group reported by Tsukamoto et al. (1992).

2. Measurement procedure

The method of measurement of wind-wave period by using a stop watch was described in Toba et al. (1988). We have used the same procedure of measurement. Interested readers can refer to their description.

The principle of the procedure is to watch some floating substance such as a foam patch, and to measure by a stop watch the period of two waves, that is, to measure a time interval from the moment when a foam patch come to the top of an individual crest of wind waves, to the moment when it comes to the top of the crest following the next crest, i.e., the time for two waves to pass. After repeating this procedure ten or more times, an average wave period T_0 is obtained. We estimate the significant wind-wave period T_S by $T_S = 1.1\ T_0$.

Table 1 shows the date and time, wind direction and wind speed, the value of T_0 and its standard deviation, together with the initial of the observers. For some cases, swell periods are also shown.

The standard deviation is generally small for the cases of pure wind waves free of significant swell. However, when the wind direction chages and swells from various directions are included, it becomes large. The magnitude of the percentage standard deviation may be thus considered as a measure of the purity of wind waves.

3. Estimation of significant wind-wave height and other air-sea boundary parameters

For pure wind waves which are in local equilibrium with the wind, the following 3/2-power law holds (Toba, 1972; Toba, 1988; Ebuchi et al., 1992):

$$gH_s/u_*^2 = B\ (gT_s/u_*)^{3/2},\ B = 0.062, \qquad (1)$$

where g is the acceleration of gravity, H_s the significant wave height, and $u_* = [(C_D)^{1/2}\ U_{10}]$ is the friction velocity of air. The logarithmic wind profile is applicable to the atmospheric boundary layer over the sea when the sea-air temperature difference is not large, especially under strong wind conditions:

$$U_z/u_* = (1/k)\ \ln\ (z/z_0), \qquad (2)$$

where U_z is the wind speed at a height z, k (= 0.4) is the von Karman constant and z_0 is the roughness length. As for z_0, we have two formulas to examine by using the present observation data. One is Toba-Koga formula:

$$z_0\sigma_p/u_* = \gamma,\ \gamma = 0.025, \qquad (3)$$

which, we consider, gives an upper limit values of z_0 for pure wind waves growing under a steady wind, and the other is the TIKEJ formula:

$$gz_0/u_*^2 = 0.020\ (\sigma_p u_*/g)^{-0.5}, \qquad (4)$$

which was proposed as a conservative practical formula (Toba et al., 1990), where σ_p is the spectral peak frequency of wind wave part of the wave spectra, and can be related to T_s by

$$\sigma_p = 2\pi/1.05\ T_s. \qquad (5)$$

Since the system of Eqs. (1), (2), (3) and (5) or (1), (2), (4) and (5) is closed, we can estimate H_s, u_* and z_0 from the observed T_s and U_z, and then also U_{10} by using Eq.(2).

4. Results

Figure 1 shows the values of the wind direction W, U_{10}, T_s, air temperature T_a, water temperature T_w and the bulk Richardson number Ri, thus obtained on board Hakuho Maru, together with the wind direction, U_{10} and the significant wave period, which were observed at the ODB off Shikoku, as shown by continuous lines through the whole period.

The two series of data of W and U_{10} are in good agreement, considering the distance of the ship's position from the site of the ODB. The significant wave periods at the ODB were mostly over 8s, and much larger than our T_s values observed for wind waves on board. This is an indication of the existence of swells during this period (cf. Ebuchi et al., 1992). Nevertheless there are some occasions when these values coincide with each other, e.g., on 13, 14, 15, 18 and 21 January, when the wind speed was higher than about 10 ms^{-1}, in support of results by Ebuchi et al. (1992). We may consider that on these occasions wind waves had grown to an extent comparable to the existed swells.

The bulk Richardson number was in the range of near neutral in most part of the period.

Figures 2 and 3 show u_*, H_S and C_D obtained by the procedure described in the previous section. Figure 2 shows the case using Eq.(3), and Fig. 3 the case of Eq.(4).

As for H_S, the continuous lines show ODB values of the significant wave height, and the triangles show values read from JMA's Wave Chart. There is a considerable tendency that the three kinds of wave values coincide with one another on the above listed dates when the stop watch T_S data coincide with the ODB data. It is considered that this point indicates that the system of equations described in the previous section, including the 3/2-power law (1), worked well.

As for C_D, values obtained from the direct measurement of momentum flux by using sonic anemometers by the turbulence group (Tsukamoto et al., 1992) are entered by crosses connected by thin line. In general, better correspondence is given in case of Fig. 3 than the case of Fig. 2. This seems to indicate that the z_0 formula (4) is better applicable than (5) for the present situations.

As mentioned before, considerable amount of swells prevailed during the observation period. However, there were some occasions in strong winds when wind waves developed to an extent comparable to the swells, and in this situation the H_S obtained by using stop watch gave data which were consistent with data from other sources. Thus we may conclude that the stop watch measurement of the significant period of wind wave components can give reasonable values.

The only thing to notice is the personal difference of the observed values of H_s. Looking at some cases where two observers made measurement almost at the same time, one had a tendency to give a larger values of H_s with a small value of standard deviation than the other, though there was an opposite case. It is considered that the former observer tends to observe more significant waves than the latter. However, the difference in H_s values were 7% in the average of four cases where the time difference of observation was smaller than six minutes. Consequently, the personal difference does not seem significant.

5. Conclusions

The result of analyses can be summarized as follows.

(1) The values of the significant period of wind waves T_s obtained by stop watch observations are well correlated to significant wave periods observed at an ODB at occasions when 10-m wind speed exceeds $10ms^{-1}$ and wind wave energy becomes comparable to existed swells, or of 2m in significant wave height.

(2) For these occasions the significant wind-wave heights H_s, estimated from T_s together with U_{10} and TIKEJ z_0 formula (4), agree well with significant wave heights obtained at an ODB as well with those of JMA's Wave Charts. From the above items (1) and (2), we may conclude as follows.

(a) The stop watch observation can give reasonable values of significant wave period of wind waves.

(b) The system of equations (1), (2), (4) and (5) works well for occasions where local equilibrium between wind and wind waves holds. During the present observation period, these occasions were realized when U_{10} exceeded $10ms^{-1}$ and wind waves reached 2m in H_s (8s in T_s). Consequently in this situation we can estimate H_s from the stop watch observation of T_s combined with ship's wind data.

Acknowledgements

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Table 5.1 Data set of observation of wind wave period T_0.

Day	Time	Wind at 22m		Observed wave period			Observer and Remarks	
		Dir. (deg)	Speed (m/s)	Mean (s)	S.D. (s)	S.D. (%)		
1/12	7:19	324	9.2	3.6	0.2	5.6	T	
12	8:10	235	10.0	4.3	0.4	9.3	T	
12	9:00	220	5.9	3.7	0.5	13.5	T	
12	11:00	300	11.0	3.4	0.6	17.6	T	
12	13:00	284	10.4	4.3	1.1	25.6	T	
12	15:00	293	11.0	5.6	0.6	10.7	T	
12	17:00	289	16.0	6.1	0.7	11.5	T	
13	7:59	314	14.4	7.7	1.0	13.0	T	
13	9:01	322	11.6	7.5	1.3	17.3	T	
13	11:06	314	12.0	6.4	1.2	18.7	T	
13	13:15	314	12.4	7.4	1.1	14.9	T	Swell
13	13:29	314	12.4	4.0	0.7	17.5	T	Wind wave
13	15:13	319	12.0	6.3	1.7	27.0	T	
13	15:36	313	13.4	6.7	1.2	17.9	T	
13	16:15	315	13.7	6.6	1.4	21.2	T	
13	17:11	321	11.0	6.0	1.2	20.0	T	
14	9:48	336	7.6	6.9	1.2	17.4	T	
14	10:42	325	10.9	6.8	1.5	22.1	T	
14	11:03	330	10.8	7.4	1.1	14.9	T	
14	13:17	329	7.8	6.3	1.3	20.6	T	
14	15:50	312	8.2	3.0	0.5	16.7	T	Wind wave
14	15:50	312	8.2	6.4	1.0	15.6	T	Swell
15	8:00	342	11.7	4.2	0.5	11.9	T	
15	9:30	339	11.3	5.4	0.5	9.3	T	
15	11:21	344	12.2	6.3	0.6	9.5	T	
15	12:31	324	8.5	5.7	0.7	12.3	T	
15	12:53	335	10.8	5.6	0.6	10.7	T	
15	15:18	322	11.6	5.3	0.8	15.1	T	
17	7:57	199	6.8	2.2	0.2	9.1	T	
17	9:43	178	9.3	3.2	0.4	12.5	T	
17	9:45	178	9.0	3.5	0.2	5.7	K	
17	10:15	176	9.8	3.7	0.1	2.7	K	
17	11:10	188	9.7	3.7	0.4	10.8	T	
17	11:15	176	9.5	4.1	0.1	2.4	K	
17	12:12	199	10.4	4.4	0.3	6.8	K	
17	13:30	215	7.0	4.0	0.5	12.5	T	
17	16:23	256	11.6	4.2	0.5	11.9	T	
17	16:35	247	11.0	5.1	0.2	3.9	K	
17	17:15	277	10.2	4.6	0.8	17.4	T	

Table 5.1 continued (1)

Day	Time	Wind at 22m Dir. (deg)	Wind at 22m Speed (m/s)	Observed wave period Mean (s)	Observed wave period S.D. (s)	Observed wave period S.D. (%)	Observer and Remarks
1/18	8:00	359	9.7	6.0	1.2	20.0	T
18	9:13	355	9.0	5.9	1.1	18.6	T
18	10:03	335	8.2	6.1	1.3	21.3	T
18	10:20	338	6.8	8.2	0.8	9.8	K
18	12:26	344	8.5	4.4	0.7	15.9	T
18	15:16	342	9.1	3.1	0.5	16.1	T
18	17:17	3	8.8	3.6	0.6	16.7	T
19	8:25	49	5.6	2.3	0.2	8.7	T
19	9:34	23	6.2	2.6	0.4	15.4	T
19	15:45	58	5.0	2.0	0.4	20.0	T
20	7:00	126	4.4	2.7	0.2	7.4	K
20	8:10	114	5.1	2.3	0.1	4.3	K
20	8:21	126	5.0	1.3	0.1	7.7	T
20	9:42	113	6.5	1.9	0.4	21.1	T
20	11:03	118	7.6	2.4	0.5	20.8	T
20	13:11	123	5.2	1.7	0.2	11.8	T
20	16:34	131	6.0	1.4	0.3	21.4	T
21	7:27	165	13.2	4.4	0.8	18.2	T
21	8:20	167	12.3	4.9	0.5	10.2	K
21	8:26	167	12.4	5.2	0.5	9.6	T
21	9:13	179	10.4	5.1	0.9	17.6	T
21	9:54	165	11.8	4.9	0.7	14.3	T
21	12:07	189	14.5	5.7	0.4	7.0	K
21	12:13	194	14.7	5.0	0.9	18.0	T
21	13:38	204	13.5	5.4	0.7	13.0	T
21	15:14	208	13.8	6.0	0.8	13.3	T
21	15:45	215	15.4	5.9	1.0	16.9	T
21	17:19	225	15.8	6.2	0.9	14.5	T
22	7:14	288	11.6	5.0	0.8	16.0	T
22	9:23	297	12.2	4.8	1.0	20.8	T
22	10:51	299	10.8	6.3	0.5	7.9	K
22	12:10	328	10.1	4.5	1.0	22.2	T
22	15:16	330	10.1	5.2	0.9	17.3	T
22	15:28	325	11.0	4.1	1.0	24.4	T
22	15:48	333	9.3	5.0	1.5	30.0	T
23	7:16	3	9.8	3.8	1.0	26.3	T
23	10:13	13	10.4	4.0	0.8	20.0	T
23	12:29	20	11.3	4.3	0.8	18.6	T

Table 5.1 continued (2)

Day	Time	Wind at 22m		Observed wave period			Observer and Remarks	
		Dir. (deg)	Speed (m/s)	Mean (s)	S.D. (s)	S.D. (%)		
1/30	9:25	47	7.4	3.8	0.6	14.6	I	Swell
30	12:25	24	5.4	3.3	0.4	12.7	I	Swell
30	15:20	336	5.4	2.7	0.4	15.3	I	
31	8:10	352	4.8	2.9	0.5	15.5	I	
31	9:20	348	5.7	2.5	0.3	10.2	I	
31	14:20	306	5.0	2.7	0.3	12.0	I	
31	16:25	351	4.2	2.6	0.3	12.5	I	Swell
2/ 1	8:00	246	12.4	3.8	0.3	9.6	I	
1	9:45	254	11.2	4.1	0.4	8.7	I	
2	8:15	306	8.3	3.9	0.5	13.9	I	Swell
2	11:10	316	10.3	4.1	0.4	9.9	I	
2	14:05	299	14.1	4.7	0.6	13.2	I	
2	16:05	310	13.9	5.4	0.6	10.3	I	
3	9:45	313	11.0	4.4	0.6	13.0	I	

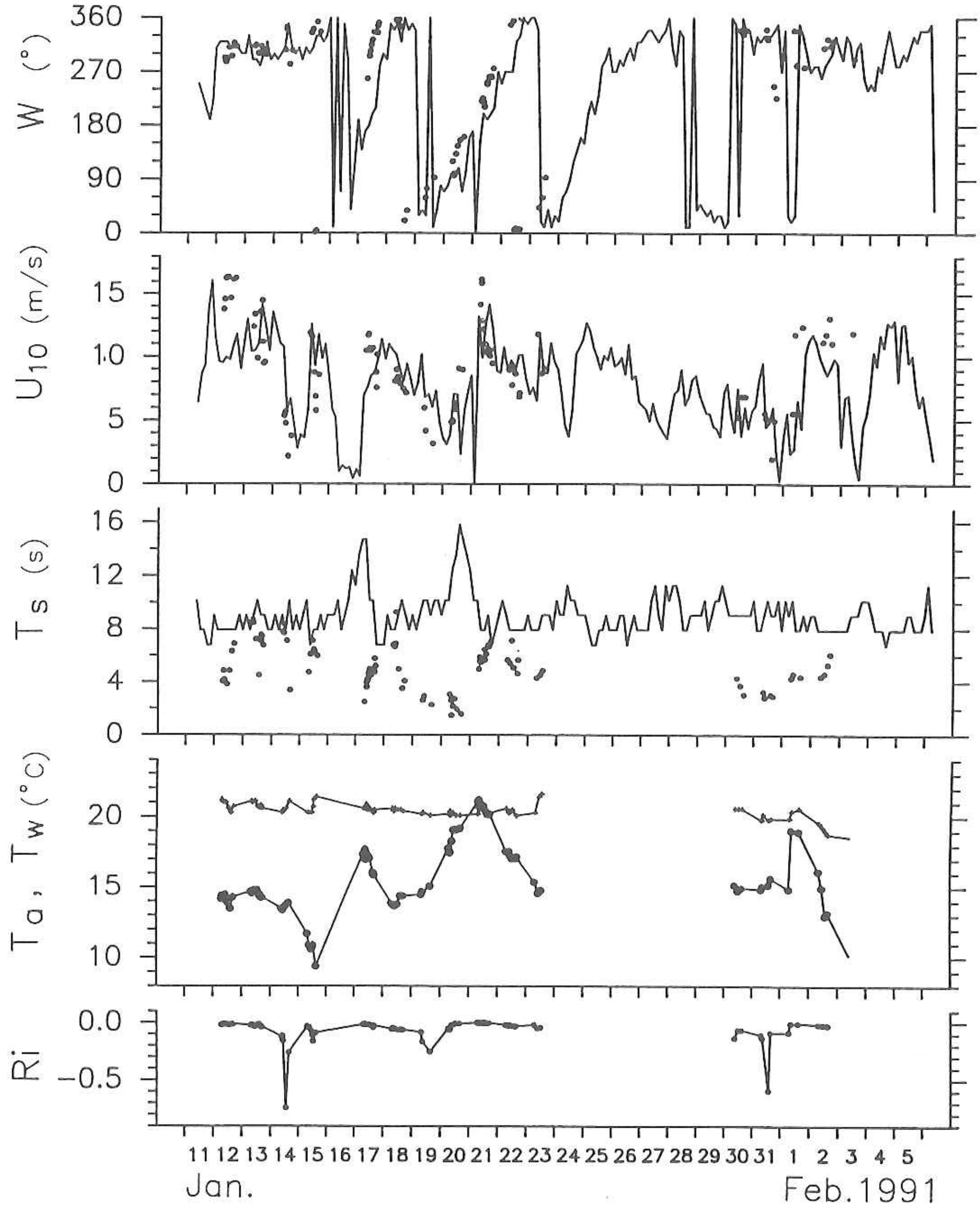

Figure 5.1 Comparison of on board measurements (closed circles) with data from JMA's Ocean Data Buoy off Shikoku (continuous lines) of wind direction (W), 10-m wind speed (U_{10}) and significant wave period (T_s). Note that on board T_s is for wind-wave component whereas ODB's T_s includes swells. The lower panels are air temperature (T_a, closed circles), water temperature (T_w, triangles) and bulk Richardson number (Ri).

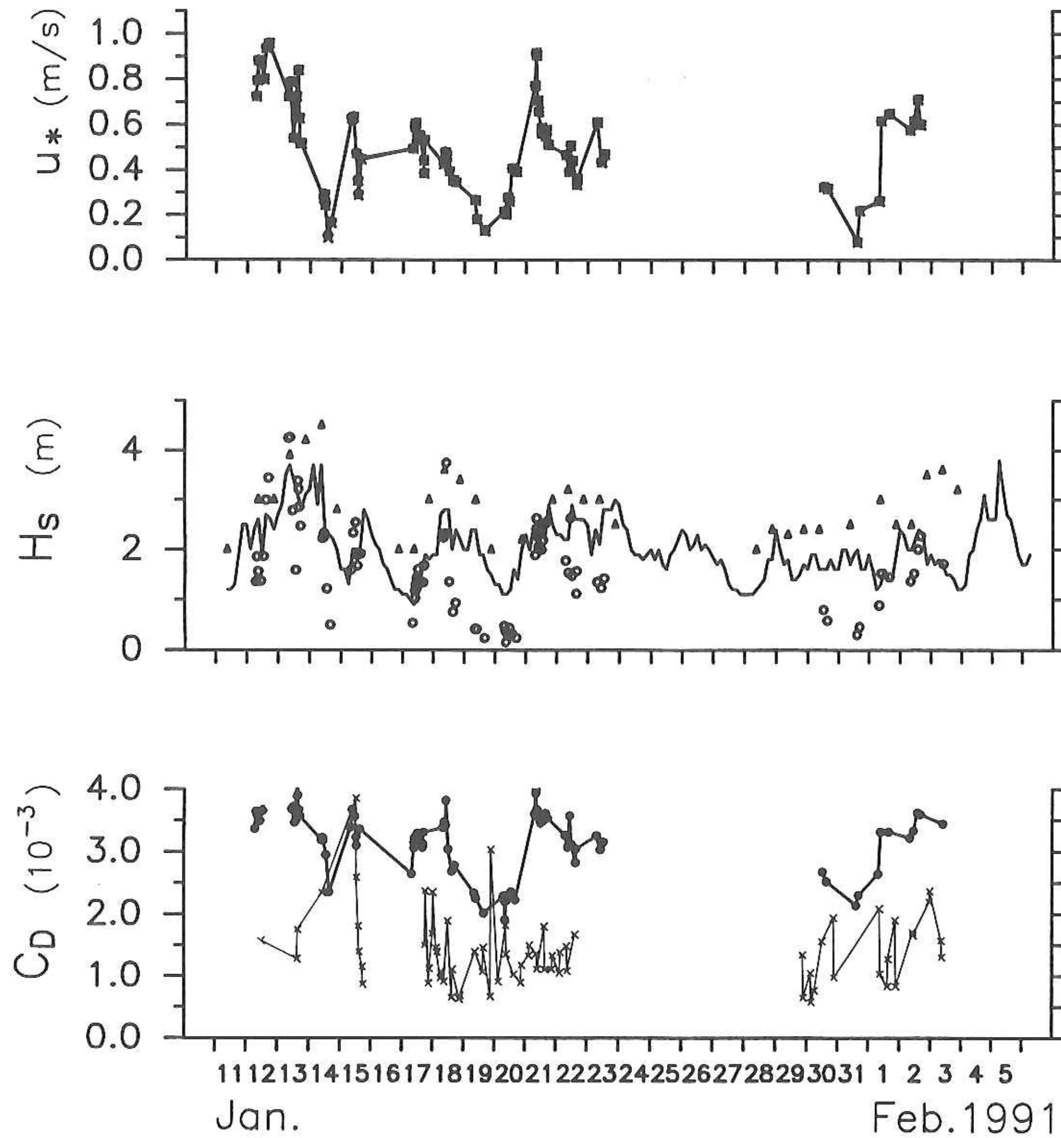

Figure 5.2 Air friction velocity (u_*, closed squares), significant wind-wave height (H_s, open circles) and drag coefficient (C_D, closed circles) estimated from on board T_s and U_{10} by using Eqs. (1),(2),(3), and (5), compared with H_s from JMA's ODB (continuous line), H_s read from JMA's Wave Chart (closed triangles) and C_D by the turbulence group (crosses, cited from Tsukamoto et al., 1992).

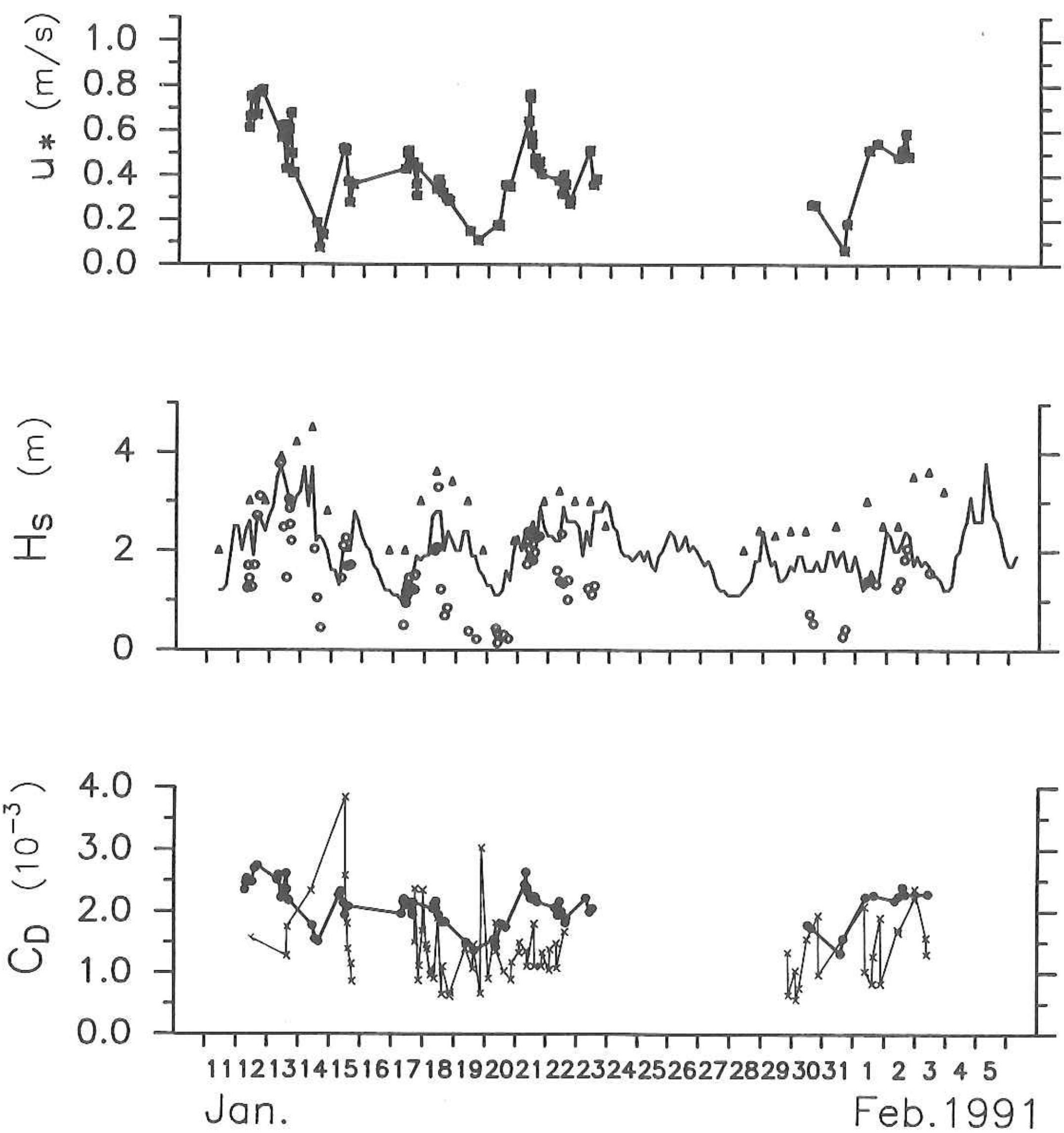

Figure 5.3 Same as Fig. 5.2 except for using Eqs. (1), (2), (4) and (5).

6.1 Observation of temperature and salinity fields around Sta.T(29°N,135°E)

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To study effects of mean horizontal velocity and upwelling on heat content of the surface mixed layer, CTD casts were made at 19 stations around the Ocean Weather Station T(29°N,135°E)(Fig.6.1.1). The 19 stations are Sta.C1 through Sta.C15, Sta.CB1 through Sta.CB3 and CBX. Sta.CB1 through Sta.CB3 are the surface buoy stations where temperature and velocity in the upper layer are recorded. Sta.CBX is the weather observation station occupied by the Japan Metheorological Agency. Stas.OC1, OC2, OC4 and OC5 are also CTD stations, but the results of the CTD casts at those stations and Sta.CB3 will be used to study the air-sea exchange of substances. The results of those CTD casts are in Table6.1.1.

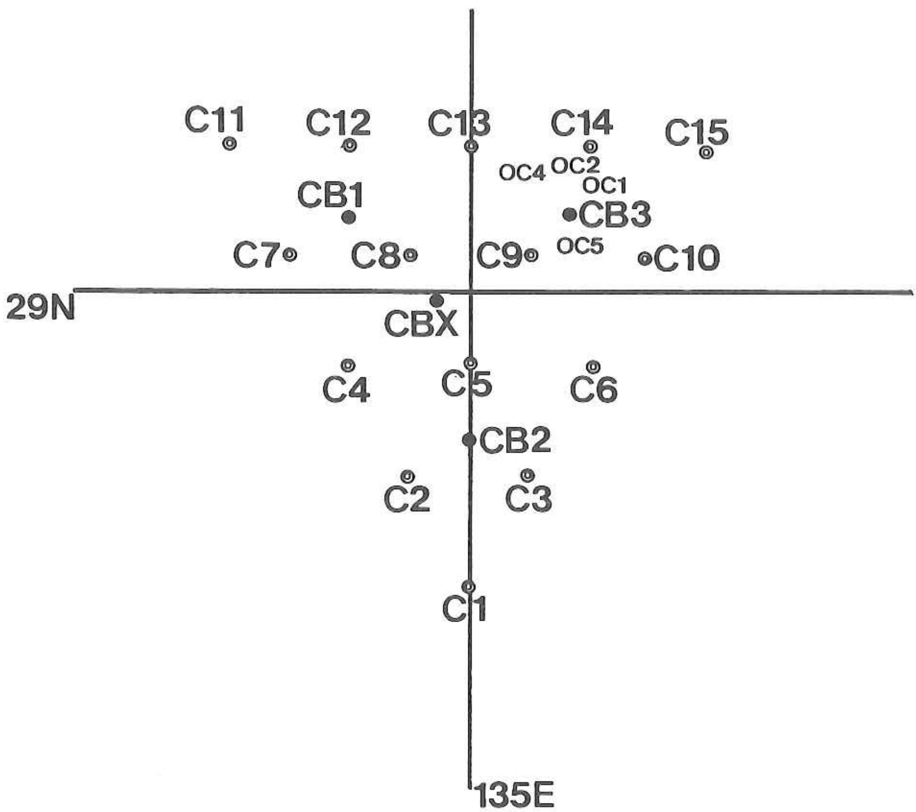

Fig.6.1.1 CTD observation stations around Sta.T(29°N,135°E)

Table. 6. 1. 1 CTD DATA KH−91−1 Leg. 1

Stn.OC1
Lat. 29°09.11N
Long.135°08.13E
DATE 1991.01.17
TIME 08:05
SST 20.6℃
Bucket Temp. 20.0℃

P	T	S
0.0	20.101	34.835
10.1	20.101	34.832
20.1	20.101	34.828
30.2	20.101	34.825
50.2	20.103	31.821
75.3	20.101	34.825
100.4	20.095	34.826
125.5	20.097	34.826
150.6	20.096	34.826
200.8	19.050	34.825
251.1	18.209	34.814
301.3	17.474	34.795
401.9	16.107	34.703
502.5	13.844	34.535
603.2	11.222	34.354
704.1	8.686	34.237
805.0	6.526	34.238
905.9	5.305	34.279
1001.8	4.492	34.344

Stn.OC2
Lat. 29°09.51N
Long.135°07.36E
DATE 1991.01.17
TIME 14:03
SST 20.2℃
Bucket Temp. 19.0℃

P	T	S
0.0	20.067	34.827
10.0	20.080	34.827
20.0	20.087	34.826
30.0	20.092	34.826
50.0	20.099	34.826
75.0	20.098	34.826
100.0	20.097	34.826
125.0	20.097	34.827
150.0	20.101	34.826
200.0	19.172	34.826
250.0	18.283	34.820
300.0	17.581	34.796
400.0	15.875	34.677
500.0	13.808	34.538
600.0	10.890	34.335
700.0	7.962	34.235
800.0	6.531	34.246
900.0	5.297	34.284
1000.0	4.540	34.335
1036.9	4.241	34.361

Stn.OC4
Lat. 29°09.33N
Long.135°06.60E
DATE 1991.01.18
TIME 11:00
SST
Bucket Temp. 19.5℃

P	T	S
0.0	19.718	34.047
10.1	20.039	34.826
20.1	20.047	34.826
30.2	20.049	34.825
50.2	20.052	34.824
75.3	20.057	34.824
100.4	20.060	34.825
125.5	20.066	34.824
150.6	20.071	34.824
200.8	18.989	34.822
251.1	18.242	34.818
301.3	17.676	34.802
401.9	16.043	34.694
502.5	13.479	34.469
603.3	10.733	34.315
704.1	8.119	34.237
805.0	6.425	34.248
906.0	5.154	34.296
1001.5	4.462	34.349

Stn.C01
Lat. 28°37.98N
Long.135°00.02E
DATE 1991.01.21
TIME 10:25
SST 21.1℃
Bucket Temp. 20.5℃

P	T	S
0.0	20.493	34.837
10.0	20.497	34.842
20.0	20.498	34.842
30.0	20.499	34.841
50.0	20.505	34.842
75.0	20.497	34.840
100.0	20.257	34.805
125.0	20.069	34.822
150.0	20.034	34.821
200.0	18.801	34.820
250.0	18.067	34.808
300.0	17.145	34.764
400.0	15.295	34.652
500.0	12.295	34.479
600.0	10.369	34.321
700.0	8.296	34.231
800.0	6.324	34.225
900.0	5.709	34.279
1000.0	4.273	34.333
1009.8	4.214	34.344

Stn.C02
Lat. 28°37.98N
Long.134°54.70E
DATE 1991.01.21
TIME 04:01
SST 21.0℃
Bucket Temp. 20.9℃

P	T	S
0.0	20.330	34.832
10.0	20.342	34.833
20.0	20.333	34.831
30.0	20.327	34.832
50.0	20.031	34.821
75.0	20.019	34.822
100.0	20.024	34.821
125.0	20.028	34.822
150.0	20.033	34.821
200.0	19.252	34.789
250.0	18.212	34.820
300.0	17.382	34.786
400.0	15.142	34.642
500.0	12.513	34.445
600.0	9.955	34.276
700.0	7.802	34.226
800.0	6.208	34.213
900.0	5.136	34.273
1000.0	4.378	34.331
1010.9	4.291	34.343

Stn.C03
Lat. 28°46.51N
Long.135°05.26E
DATE 1991.01.21
TIME 07:51
SST 20.4℃
Bucket Temp. 20.2℃

P	T	S
0.0	20.037	34.320
10.0	20.042	34.824
20.0	20.041	34.824
30.0	20.042	34.824
50.0	20.046	34.826
75.0	20.051	34.825
100.0	20.050	34.826
125.0	20.052	34.826
150.0	20.035	34.829
200.0	19.142	34.814
250.0	17.993	34.789
300.0	17.454	34.785
400.0	15.664	34.681
500.0	13.169	34.491
600.0	10.700	34.336
700.0	7.907	34.149
800.0	6.268	34.190
900.0	5.424	34.257
1000.0	4.424	34.326
1001.8	4.420	34.328

Stn.C04
Lat. 28°54.58N
Long.134°49.14E
DATE 1991.01.21
TIME 02:09
SST 21.0℃
Bucket Temp. 20.6℃

P	T	S
0.0	20.391	34.844
10.0	20.424	34.820
20.0	20.411	34.821
30.0	20.333	34.816
50.0	20.207	34.820
75.0	20.148	34.818
100.0	20.105	34.822
125.0	20.067	34.824
150.0	20.002	34.834
200.0	19.891	34.802
250.0	18.162	34.818
300.0	17.415	34.779
400.0	15.660	34.669
500.0	12.898	34.477
600.0	9.955	34.247
700.0	7.466	34.187
800.0	6.286	34.232
900.0	4.979	34.271
1000.0	4.365	34.349
1005.6	4.334	34.354

Stn.C05
Lat. 28°54.72N
Long.135°00.19E
DATE 1991.01.20
TIME 23:01
SST 20.4℃
Bucket Temp. 20.2℃

P	T	S
0.0	20.018	34.903
10.0	20.135	34.830
20.0	20.137	34.830
30.0	20.134	34.829
50.0	20.126	34.828
75.0	20.069	34.824
100.0	20.066	34.825
125.0	20.062	34.826
150.0	19.983	34.836
200.0	19.296	34.835
250.0	18.421	34.829
300.0	17.452	34.784
400.0	15.924	34.695
500.0	13.395	34.497
600.0	10.458	34.291
700.0	8.077	34.239
800.0	6.161	34.237
900.0	4.938	34.263
1000.0	4.366	34.328
1014.8	4.228	34.339

Stn.C06
Lat. 28°54.60N
Long.135°11.00E
DATE 1991.01.20
TIME 20:56
SST 20.5℃
Bucket Temp. 20.0℃

P	T	S
0.0	19.909	34.888
10.0	19.984	34.830
20.0	19.984	34.829
30.0	19.989	34.830
50.0	19.993	34.830
75.0	19.997	34.829
100.0	20.001	34.830
125.0	20.006	34.829
150.0	20.010	34.828
200.0	19.327	34.781
250.0	18.099	34.813
300.0	17.311	34.777
400.0	15.920	34.691
500.0	13.282	34.498
600.0	10.716	34.324
700.0	8.403	34.246
800.0	6.263	34.218
900.0	5.224	34.296
1000.0	4.388	34.346
1012.8	4.286	34.356

Stn.C07
Lat. 29°02.81N
Long.134°43.71E
DATE 1991.01.20
TIME 03:55
SST 20.6℃
Bucket Temp. 20.3℃

P	T	S
0.0	20.432	34.848
10.0	20.463	34.830
20.0	20.459	34.829
30.0	20.452	34.829
50.0	20.450	34.828
75.0	20.443	34.827
100.0	20.397	34.823
125.0	20.255	34.828
150.0	20.113	34.814
200.0	19.025	34.836
250.0	18.086	34.817
300.0	17.380	34.778
400.0	15.607	34.663
500.0	13.296	34.500
600.0	10.479	34.329
700.0	8.059	34.239
800.0	6.390	34.255
900.0	5.168	34.297
1000.0	4.375	34.346
1011.5	4.302	34.353

Stn.C08
Lat. 29°02.90N
Long.134°54.61E
DATE 1991.01.20
TIME 08:53
SST 20.3℃
Bucket Temp. 20.3℃

P	T	S
0.0	19.980	34.840
10.0	19.995	34.837
20.0	19.999	34.836
30.0	19.988	34.835
50.0	19.985	34.836
75.0	19.983	34.836
100.0	19.985	34.835
125.0	19.987	34.836
150.0	19.988	34.836
200.0	19.979	34.836
250.0	18.839	34.834
300.0	17.901	34.794
400.0	16.174	34.714
500.0	13.622	34.517
600.0	11.253	34.374
700.0	8.740	34.263
800.0	6.651	34.242
900.0	5.320	34.281
1000.0	4.463	34.344
1004.6	4.430	34.348

Stn.C09
Lat. 29°02.85N
Long.135°05.43E
DATE 1991.01.20
TIME 13:22
SST 20.4℃
Bucket Temp. 19.2℃

P	T	S
0.0	19.948	34.846
10.0	19.959	34.839
20.0	19.961	34.839
30.0	19.961	34.838
50.0	19.963	34.839
75.0	19.959	34.838
100.0	19.960	34.837
125.0	19.954	34.837
150.0	19.931	34.837
200.0	19.144	34.833
250.0	18.337	34.819
300.0	17.409	34.784
400.0	15.698	34.661
500.0	13.619	34.529
600.0	10.696	34.322
700.0	8.094	34.217
800.0	6.579	34.241
900.0	5.238	34.273
1000.0	4.518	34.340
1003.5	4.487	34.344

Stn.C10

Lat. 29°02.62N

Long. 135°15.54E

DATE 1991.01.19

TIME 08:41

SST 20.2℃

Bucket Temp. 19.8℃

P	T	S
0.0	19.929	34.895
10.0	20.023	34.835
20.0	20.029	34.837
30.0	20.033	34.835
50.0	23.029	34.835
75.0	20.031	34.834
100.0	20.011	34.833
125.0	19.983	34.836
150.0	19.983	34.837
200.0	19.745	34.805
250.0	18.451	34.815
300.0	17.434	34.768
400.0	15.906	34.690
500.0	13.601	34.520
600.0	10.751	34.334
700.0	8.320	34.243
800.0	6.522	34.238
900.0	5.076	34.298
1000.0	4.359	34.353
1012.4	4.300	34.359

Stn.C11

Lat. 29°11.04N

Long.134°38.20E

DATE 1991.01.20

TIME 01:54

SST 20.5℃

Bucket Temp. 20.1℃

P	T	S
0.0	19.985	34.864
10.0	20.058	34.824
20.0	20.058	34.826
30.0	20.059	34.826
50.0	20.062	34.826
75.0	20.061	34.826
100.0	20.064	34.825
125.0	20.062	34.825
150.0	20.058	34.828
200.0	18.989	34.831
250.0	18.055	34.797
300.0	17.166	34.774
400.0	15.646	34.665
500.0	13.438	34.514
600.0	10.850	34.347
700.0	8.489	34.225
800.0	6.383	34.209
900.0	5.160	34.290
1000.0	4.339	34.359
1008.8	4.294	34.363

Stn.C12

Lat. 29°11.02N

Long.134°49.27E

DATE 1991.01.19

TIME 23:01

SST 20.3℃

Bucket Temp. 19.8℃

P	T	S
0.0	20.045	34.836
10.0	20.055	34.836
20.0	20.057	34.836
30.0	20.061	34.835
50.0	20.062	34.836
75.0	20.066	34.835
100.0	20.069	34.835
125.0	20.074	34.834
150.0	20.075	34.834
200.0	20.073	34.832
250.0	18.583	34.826
300.0	17.560	34.796
400.0	16.164	34.711
500.0	13.936	34.542
600.0	11.128	34.370
700.0	8.650	34.245
800.0	6.879	34.240
900.0	5.334	34.279
1000.0	4.421	34.351
1007.9	4.351	34.359

Stn.C13

Lat. 29°02.62N

Long.135°15.54E

DATE 1991.01.19

TIME 08:47

SST 20.2℃

Bucket Temp. 19.8℃

P	T	S
0.0	20.62	34.835
10.0	20.068	34.834
20.0	20.077	34.830
30.0	21.080	34.829
50.0	20.082	34.829
75.0	20.085	34.829
100.0	20.091	34.829
125.0	20.095	34.829
150.0	20.099	34.829
200.0	20.075	34.822
250.0	18.508	34.809
300.0	17.683	34.973
400.0	16.218	34.714
500.0	13.901	34.546
600.0	11.063	34.356
700.0	8.434	34.247
800.0	6.748	34.243
900.0	5.436	34.283
1000.0	4.620	34.335
1003.0	4.617	34.335

Stn.C14
Lat. 29°02.62N
Long.135°15.54E
DATE 1991.01.19
TIME 08:47
SST 20.2℃
Bucket Temp. 19.8℃

P	T	S
0.0	19.966	34.916
10.0	20.075	34.831
20.0	20.082	34.830
30.0	20.086	34.830
50.0	20.084	34.830
75.0	20.095	34.829
100.0	20.101	34.829
125.0	20.103	34.827
150.0	20.107	34.827
200.0	19.931	34.830
250.0	18.403	34.827
300.0	17.584	34.786
400.0	15.992	34.692
500.0	13.702	34.480
600.0	10.213	34.318
700.0	8.550	34.247
800.0	6.644	34.236
900.0	5.440	34.279
1000.0	4.608	34.331
1010.5	4.546	34.338

Stn.C15
Lat. 29°10.67N
Long.135°21.21E
DATE 1991.01.19
TIME 11:00
SST 20.5℃
Bucket Temp. 19.9℃

P	T	S
0.0	20.041	34.843
10.0	20.062	34.836
20.0	20.074	34.836
30.0	20.072	34.835
50.0	20.078	34.835
75.0	20.081	34.835
100.0	20.083	34.834
125.0	20.067	34.833
150.0	20.052	34.833
200.0	19.245	34.826
250.0	18.171	34.807
300.0	17.431	34.786
400.0	15.979	34.702
500.0	13.891	34.544
600.0	11.107	34.376
700.0	8.614	34.223
800.0	6.843	34.221
900.0	5.461	34.285
1000.0	4.536	34.342
1010.7	4.472	34.350

Stn.CB1
Lat. 29°05.66N
Long.134°49.16E
DATE 1991.01.20
TIME 07:15
SST 20.6℃
Bucket Temp. 20.3℃

P	T	S
0.0	20.254	34.848
10.0	20.280	34.839
20.0	20.291	34.839
30.0	20.267	34.835
50.0	20.066	34.826
75.0	20.052	34.825
100.0	20.053	34.828
125.0	20.055	34.828
150.0	20.051	34.827
200.0	19.873	34.827
250.0	18.407	34.824
300.0	17.574	34.776
400.0	15.966	34.695
500.0	13.870	34.539
600.0	11.255	34.383
700.0	8.591	34.248
800.0	6.594	34.246
900.0	5.168	34.297
1000.0	4.499	34.343
1005.7	4.486	34.345

Stn.CB2
Lat. 28°48.96N
Long.134°59.99E
DATE 1991.01.21
TIME 05:09
SST 20.4℃
Bucket Temp. 20.1℃

P	T	S
0.0	20.002	34.782
10.0	20.012	34.825
20.0	20.012	34.825
30.0	20.015	34.826
50.0	20.015	34.825
75.0	20.018	34.825
100.0	20.021	34.824
125.0	20.025	34.824
150.0	20.029	34.824
200.0	18.926	34.805
250.0	17.913	34.810
300.0	17.185	34.775
400.0	15.271	34.642
500.0	13.057	34.479
600.0	10.264	34.312
700.0	7.840	34.198
800.0	6.237	34.175
900.0	5.081	34.257
1000.0	4.339	34.328
1008.8	4.203	34.345

Stn.CBX			Stn.OC5		
Lat. 29°02.19N			Lat. 29°05.98N		
Long.134°54.61E			Long.135°09.01E		
DATE 1991.01.20			DATE 1991.01.22		
TIME 08:53			TIME 00:33		
SST 20.3℃			SST 20.6℃		
Bucket Temp. 20.3℃			Bucket Temp. 20.0℃		
P	T	S	P	T	S
0.0	20.021	34.816	0.0	19.998	34.738
10.0	20.043	34.833	10.0	20.006	34.783
20.0	20.042	34.829	20.0	20.005	34.821
30.0	20.041	34.829	30.0	19.993	34.826
50.0	20.012	34.827	50.0	19.995	34.827
75.0	19.997	34.828	75.0	19.995	34.827
100.0	19.999	34.832	100.0	19.996	34.827
125.0	20.000	34.832	125.0	19.999	34.828
150.0	20.000	34.832	150.0	20.000	34.829
200.0	19.970	34.835	200.0	19.702	34.703
250.0	18.551	34.799	250.0	18.201	34.816
300.0	17.593	34.785	300.0	17.413	34.874
400.0	15.871	34.685	400.0	16.015	34.694
500.0	13.489	34.490	500.0	13.703	34.530
600.0	10.995	34.355	600.0	10.986	34.347
700.0	8.324	34.241	700.0	8.481	34.223
800.0	6.549	34.246	800.0	6.818	34.228
900.0	5.292	34.282	900.0	5.533	34.269
1000.0	4.441	34.342	1000.0	4.638	34.329
1002.8	4.419	34.343	1007.0	4.579	34.339

6.2 Observation of temperature section on a line from the Nakanoshima to the mouth of the Kagoshima Bay

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(Kagoshima University)

By analysing the sea surface temperature obcerved on the boad of the ferryboat regularly crossimg the Tokara Strait, Nagata and Takeshita (1985) found that a temperature front of the Kuroshio in the strait migrated from the Nakanoshima to the Satamisaki for several ten days. Coupling of the noethward migration with the topography around the south of the Kyusyu is possible to generate inflow of offshore water into the Kagoshima Bay and to strengthen the Osumi Branch Current of the Kuroshio. For the studies of the water exchange of the Kagoshima Bay and of the changes of the Osumi Branch Current, it is necessary to research subsurface structre of the front which is observed in such a short time as the ferryboat crossing the Tokara Strait.

The temperature fromt usually exists between the Nakanoshima and the Satamisaki. The XBT casts were made at 9.6-mile intervals on the line from east of the Nakanoshima(29°48.39'N,130°06.31'E) to the mouth of the Nakanoshima Bay(31 00.61 N,130 06.31 E) during 5 hours and 10 minutes from 00:18 to 05:28 on 24 January 1991 in the Cruise of KH91-1 (Fig.6.2.1). The temperature front exists north of Sta.T05 east of the Yakushima(Fig.6.2.2). The front extends to about 130m from the sea surface. The front may reaches the Satamisaki after ten and several days.

Through the depth of central area of the Kagoshima Bay is over 200m, the depth of the area near the mouth of the bay is only 80m. The inflow water to the bay produced by the shift of the front in Winter may be vertically homogeneous. Becouse the depth of the Osumi Strait is only 100m, the increase of the volume transport of the Osumi Branch Current produced may be due to the homogeneous water.

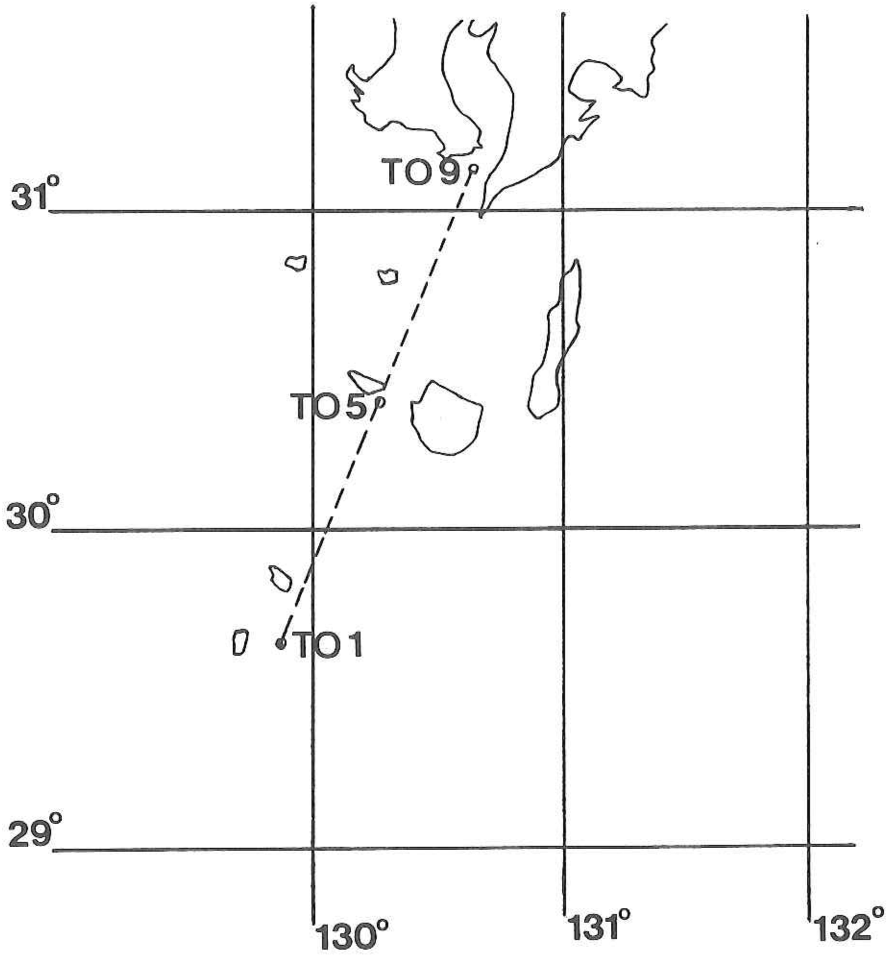

Fig. 6.2.1 Observation line of XBT in the Tokara Strait

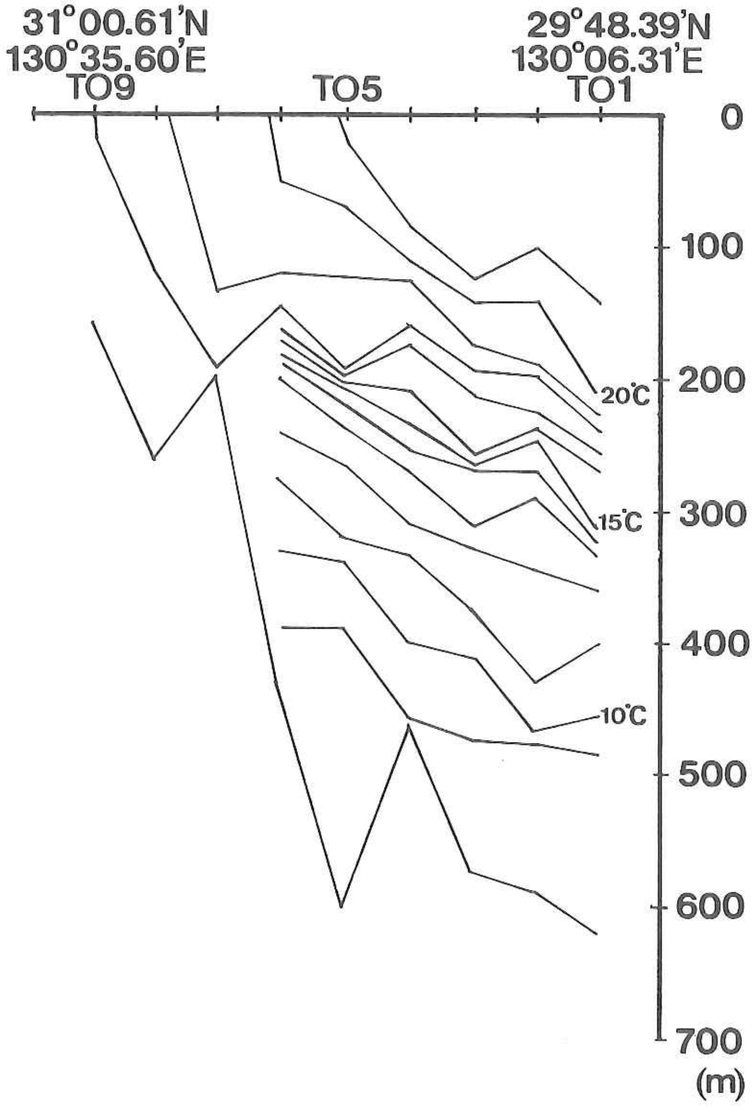

Fig.6.2.2 Temperature section in the Tokara Strait

6.3 XBT observation from the OMLET station to Kochi

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S.Kizu
(Department of Geohphysics, Tohoku University)

Temperature structure of upper 700m was measured with XBT along the section from the OMLET station (28°51'N, 134°59'E) to the mouth of the Kochi Bay (33°00'N, 133°45'E), which transverses the Kuroshio Current flowing south of Shikoku. The observaton line was consisted with 16 XBT stations (Table 6.3.1, Figure 6.3.1). In order to resolve the temperature structure around the Kuroshio current, the stations were placed with the separation differing with latitude–40 miles in latitude for stations south of 29°30'N, 30 miles for the stations between 29°30'N and 31°N, 15 miles for the stations between 31°N and 32°N, 10 miles for the stations between 32°N and 33°N.

The result is shown in Fig.6.3.2. The profile of the Kuroshio current is clearly depicted as steep inclination of isotherms around 32°N in Fig.6.3.2(f). The position of the 15°C isotherm at 200m, which is commonly used as an index of the position of the Kuroshio axis, is located at around 32°34'N.

Figures 6.3.2(b)-(d) show the distribution of the surface current normal to the ship heading (346 degrees) which was obtained by shipboard ADCP (Refer to section 6.4 for the distribution of surface velocity vector during KH-91-1 cruise). The strong westward flow greater than 2 knots (note that actual flow speed is more greater faster) is observed around 32°N, which is in accordance with the temperature distribution. Relatively weak eastward countercurrent less than 1 knot is observed in the region south of 31°N. There is also a weak eastward flow north of 32°45'N. The SST data obtained from the routine observation of the Hakuho Maru indicates the existence of a cold water mass around 32°40'N (Figure 6.3.2(a)), which also can be seen in XBT data.

The vertical distribution of water temperature very uniform for those in the upper 200m except for the Kuroshio region north of 32°. This results in little difference of the strength of the current at 20m and 120m depth (Figure 6.3.2(e)). Although there are some difference at 32.5N and 31.5N, which are the northern and the southern edge of the strong westward current. This may indicate that the strong westward current shifts southward with depth.

Station	X01	X02	X03	X04	X05	X06	X07	X08	X09
Date	01/15	01/15	01/15	01/15	01/15	01/15	01/15	01/15	01/16
Time (JST)	11:11	13:50	16:03	18:10	20:16	21:11	22:13	23:12	00:10
Lat (N)	28°51'	29°30'	30°01'	30°30'	31°01'	31°15'	31°30'	31°45'	32°00
Long (E)	134°59'	134°44'	134°36'	134°28'	134°19'	134°15'	134°11'	134°07'	134°03
0 m	20.51	19.02	18.95	18.87	18.93	18.46	19.89	20.06	19.70
10 m	20.66	20.28	19.94	19.95	20.14	19.75	21.01	21.31	21.32
20 m	20.67	20.33	19.98	19.96	20.16	19.81	21.03	21.31	21.41
30 m	20.69	20.34	19.99	19.94	20.19	19.81	21.05	21.37	21.59
50 m	20.66	20.33	19.98	19.88	20.20	19.77	21.05	21.36	21.40
75 m	20.65	20.36	20.02	19.87	20.20	19.75	21.01	21.35	21.43
100 m	20.61	20.36	20.02	19.84	20.21	19.73	21.01	21.03	21.56
150 m	20.35	20.38	19.55	19.74	19.91	19.54	20.96	20.94	21.41
200 m	18.96	20.08	19.00	19.58	19.17	19.26	19.67	20.69	20.43
300 m	17.21	17.89	17.81	18.65	19.01	18.92	18.40	17.55	16.66
400 m	15.48	16.16	16.25	16.98	17.51	17.43	16.78	16.30	13.70
500 m	12.71	14.04	14.10	15.11	15.62	15.54	14.70	14.76	10.22
600 m	9.68	11.35	11.65	12.60	13.42	13.34	12.30	11.31	7.92
700 m	7.37	8.35	9.21	10.05	10.67	10.38	9.88	8.60	6.20

Station	X10	X11	X12	X13	X14	X15
Date	01/16	01/16	01/16	01/16	01/16	01/16
Time (JST)	00:48	01:24	02:00	02:38	03:16	03:54
Lat (N)	32°10'	32°20'	32°30'	32°40'	32°50'	33°00'
Long (E)	134°00'	133°57'	133°54'	133°51'	133°48'	133°45'
0 m	19.77	19.75	19.57	17.35	17.05	17.89
10 m	21.26	20.91	20.74	18.27	18.37	18.80
20 m	21.26	20.94	20.78	18.32	18.24	18.77
30 m	21.28	20.97	20.78	18.34	18.18	18.59
50 m	21.30	20.91	20.62	18.21	18.01	18.13
75 m	21.31	20.86	19.33	17.40	17.93	18.06
100 m	21.20	20.36	18.83	17.07	17.25	18.03
150 m	20.73	19.44	17.73	15.26	15.92	15.96
200 m	19.42	17.14	15.62	13.71	13.66	13.90
300 m	15.54	13.30	12.32	10.63	10.80	10.56
400 m	11.38	10.40	8.98	7.97	7.13	7.48
500 m	9.00	7.40	6.15	6.34	6.13	6.24
600 m	6.38	5.47	5.21	4.70	4.77	4.86
700 m	5.00	4.47	4.29	3.97	4.11	4.28

Table 6.3.1 Summary of XBT observations from the OMLET station to Kochi.

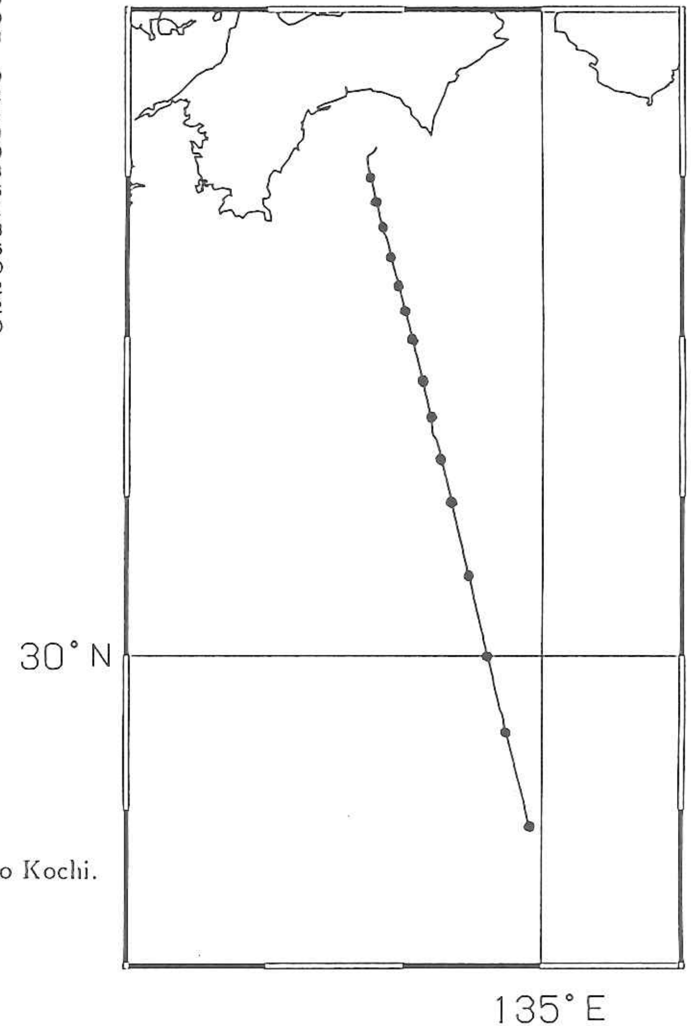

Figure 6.3.1 Ship track and the location of the XBT stations.

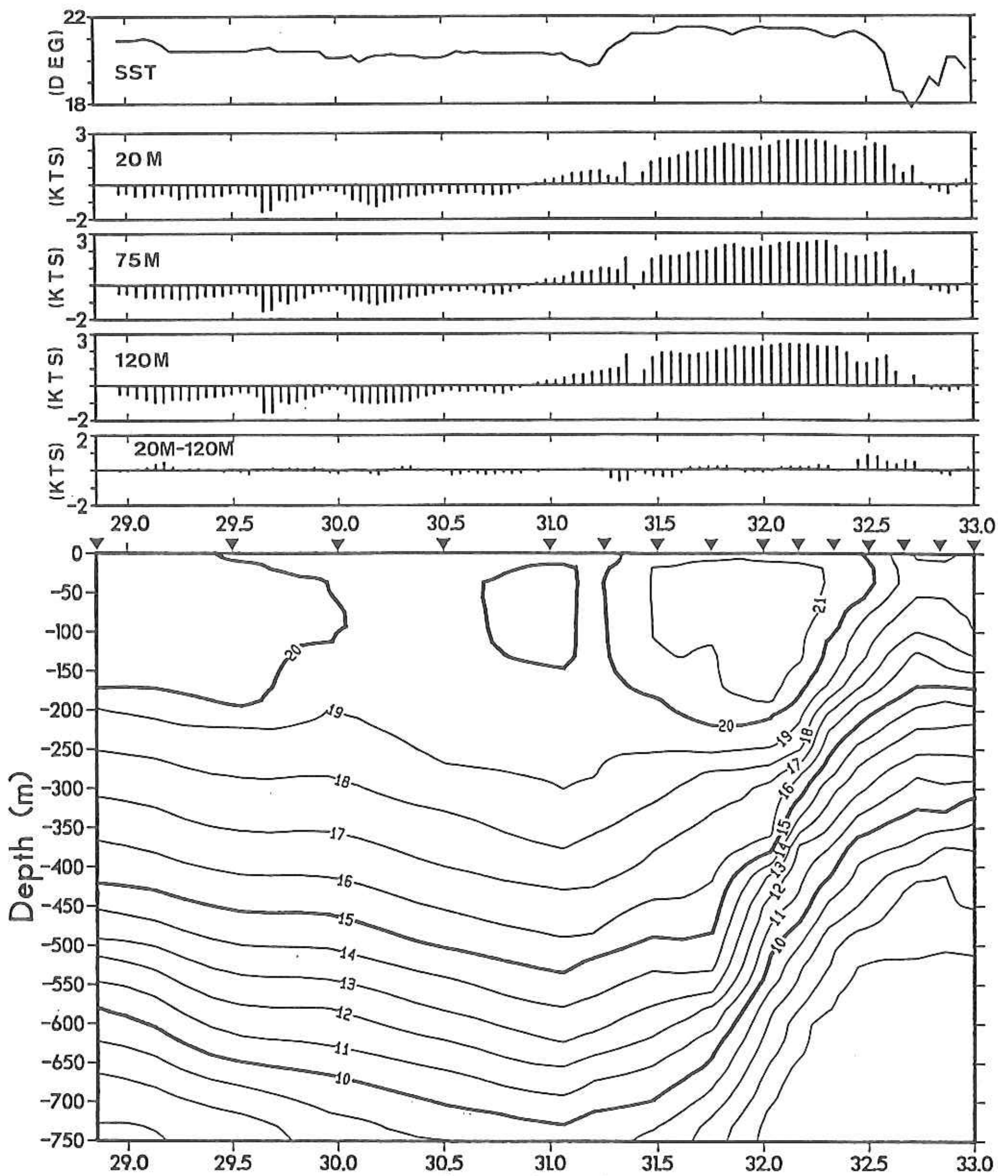

Figure 6.3.2 (a) SST measured by Hakuho Maru routine observations. The data used is the series of data with 10 minutes interval in time. (b) Distribution of the strength of the surface current (20m depth) normal to the ship heading (346 degrees) obtained by shipboard ADCP. Positive value denotes the west-north-west velocity in knots. ADCP data are taken the running mean of 21 minutes (21 data) and resampled with 10 min interval. (c) Same as (b) except the depth is 75 m. (d) Same as (b) except the depth is 120 m. (e) The vertical shear of the current calculated by subracting (b) by (d).

6.4 Surface current measurement with a shipboard ADCP

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In KH-91-1 cruise the shipboard ADCP was operated from the day 5 (15 January) till the end of the cruise to measure the surface current vector of three layers–20 m, 75 m, 120 m. The current vector is calculated internally by the ADCP system (Furuno CI-7000) from the 1 min average data of doppler log (Furuno CI-20H) and the 5 min averaged position data supplied by the ship navigation system (Magnavox S-5000). To estimate the errors due to the discrepancy between the gyro reference coordinate and the actual ADCP coordinate, a short test run was made on 18 January. From the test run data, no significant discrepancy was to be found. The configulation regarding the test run is described in 6.4.1, and the general description of the ADCP data is shown in 6.4.2.

6.4.1 Test run to estimate the systematic error of the reference frame.

One of the main factors for the systematic error of current data collected with a shipboard ADCP is the discrepancy between the reference frame used in the calculation of current vector relative to ship and the actual ship's head. This discrepancy is estimated for the shipboard ADCP of the Hakuho Maru by using the equation introduced by Joyce (1988) and Pollard and Read (1989).

Let φ the misalignment angle counterclockwise from the ship's head and A the scaling factor, then the absolute current velocity relative to the ground (u_w, v_w) should be

$$u_w = u_s + A(\ u'_d cos\varphi + v'_d sin\varphi) \quad (1)$$

$$v_w = v_s + A(-u'_d sin\varphi + v'_d cos\varphi) \quad (2)$$

where (u_s, v_s) and (u'_d, v'_d) denote the velocity of the ship relative to the earth and the apparent current speed relative to the ship, respectively. The ship velocity is calculated from the position of the ship of a certain time interval, the current speed relative to the ship is measured from the doppler log. To derive the absolute current velocity vector (u_w, v_w) correctly, we must know the angle φ. If we apply equations (1) and (2) to the velocities before and after the turn and use the assumption that the absolute current velocity does not change, eliminating (u_w, v_w) yield

$$0 = du_s + A(\ du_d cos\varphi + dv_d sin\varphi) \quad (3)$$

$$0 = dv_s + A(-du_d sin\varphi + dv_d cos\varphi) \quad (4)$$

where

$$(du_s, dv_s) = (u_s^2, v_s^2) - (u_s^1, v_s^1) \quad (5)$$

$$(du_d, dv_d) = (u_d'^2, v_d'^2) - (u_d'^1, v_d'^1) \quad (6)$$

The suffix 1 and 2 correspond to the velocity before and the after the turn. From (3) and (4),

$$tan\varphi = \frac{dv_d \times du_s - du_d \times dv_s}{dv_d \times dv_s + du_d \times du_s} \quad (7)$$

As (du_s, dv_s) and (du_d, dv_d) are known parameters, we can estimate the angle φ from equation (7).

To estimate this misalignment angle, a short test run was made during the leg 1 of KH-91-1 cruise. The ship course is shown in Fig.6.4.1. Ship went back and force between two stations, A and B, with the speed and course fixed. The distance between the stations was 2 miles and the ship speed and direction was fixed to 10 knots and 0 degree (or 180 degree). Before reaching the station, the ship took a straight prepartory course for 5 minutes to stabilize the speed and the direction. The ship went two times northward and southward. The estimated φ is 0.4 degree (reffer to Fig.6.4.2) and it may be negligible because of the effect of other errors (e.g. positioning error, error of doppler log, etc.).

6.4.2 The surface current measurement during the cruise

Figure 6.4.3 shows the stick diagram of the surface current measured by ADCP during KH-91-1 cruise. ADCP was in operation throughout the day since 15 January till 5 February except when the ship was in port. Inside the ADCP system, absolute current data was calculated by adding the dopper log current data (current speed relative to the ship) the ship speed obtained from the ship position data from the navigation system. As we have seen in 6.4.1, the discrepancy between the reference frame of the doppler log and the actual ship's head was negligibly small. Hence no correction was made for calculating the absolute velocity. The dopper log data used in calculation was 1 minutes average and the position data was 5 minutes average. The absolute velocity was sampled for every 1 minutes.

Small vertical shear of the current reflects the thickness of the uniform layer which is prominent in this season (about 200 m according to the CTD data). Near the coast of Japan, strong northeastward flow which stands for the Kuroshio Current is to be found. From the data west of Izu Islands, it is to be found that the Kuroshio was taking a course south of Hachijo Island at the period of the observation. At sections from the Omlet station to Kochi or the Omlet station to Kagoshima, the direction of the Kuroshio is slightly changed when going back to the Omlet station. This may be indicating the temporal change of the Kuroshio path in time scale of few days.

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Pollard, R.P. and J. Read, 1989: A Method for Calibrating Shipmounted Acoustic Doppler Profilers and the limitations of Gyro Compasses. J. Atmos. Oceanic Technol. **6**, 859 - 865.

run	bound	time started (GMT)	uw (kts)	vw (kts)	us (kts)	vs (kts)
1	South	09:03	.795±.113	-10.39±.181	.023±.080	-10.22±.176
2	North	09:33	.734±.197	9.94±.335	.134±.042	10.39±.096
3	South	10:06	.664±.121	-9.98±.258	-.197±.108	-9.95±.310
4	North	10:36	.721±.284	9.62±.408	-.005±.214	10.06±.252

run	dud (kts)	dvd (kts)	dus (kts)	dvs (kts)	phi (degree)
2-1	-.061	20.33	.112	20.61	.484
3-2	-.070	-19.92	-.332	-20.35	.731
4-3	.058	19.60	.192	20.02	.379

Table 6.4.1 Result of the test run. The current data shown are the average of each run. This average data is used to calculate the misalignment angle.

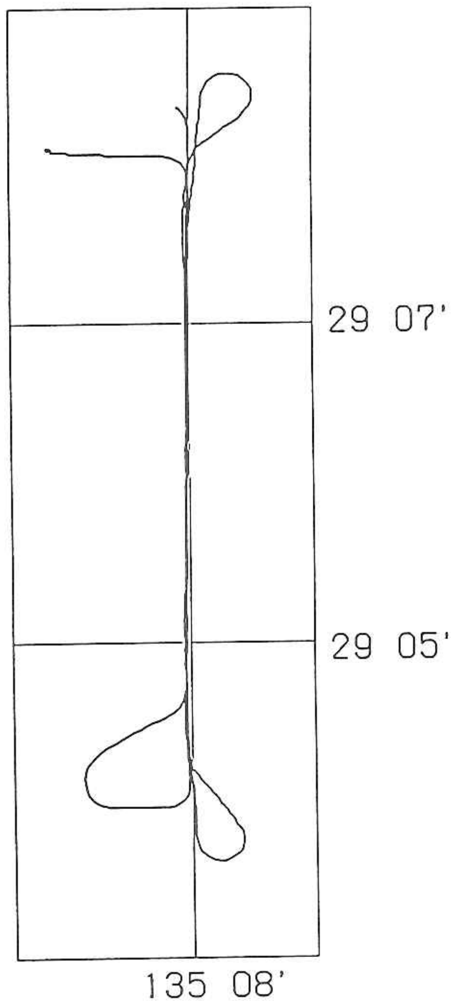

Figure 6.4.1 Ship track for the test course in order to estimate the systematic error of the reference frame of the doppler log and the actual ship's head.

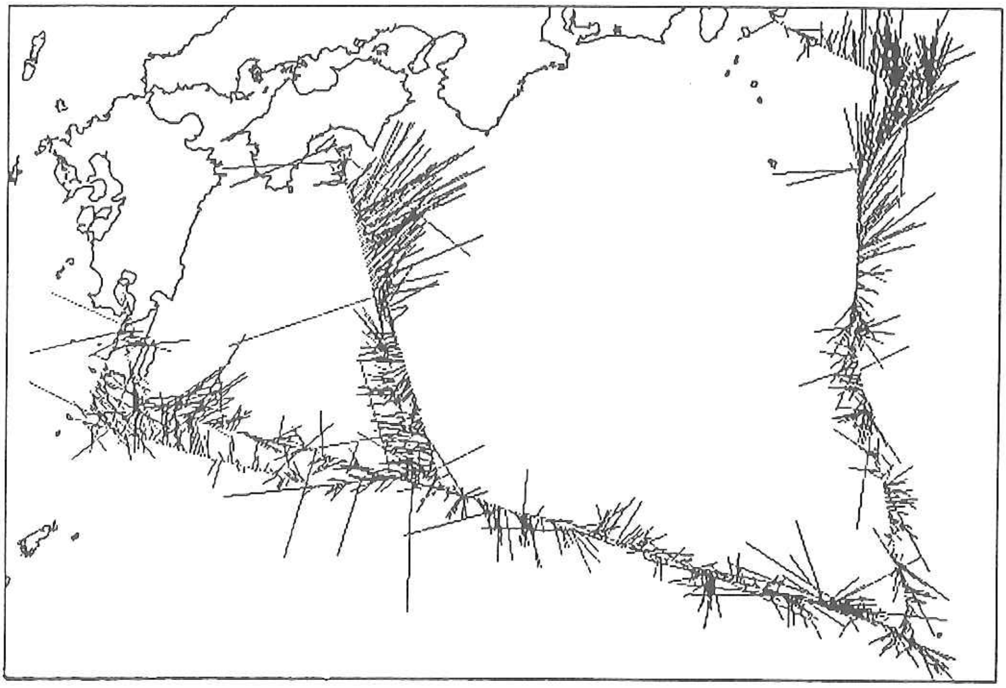

Figure 6.4.2(a) Current distribution of 20m depth obtained throughout the cruise from the raw ADCP data.

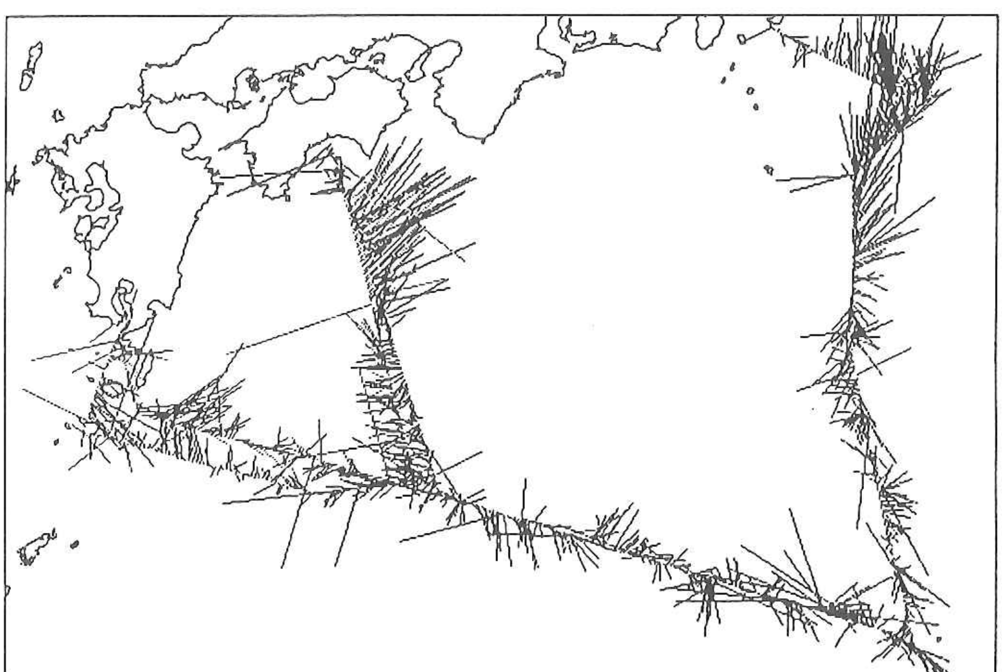

Figure 6.4.2(b) Same as Fig.6.4.2(a) except that the depth is 75m.

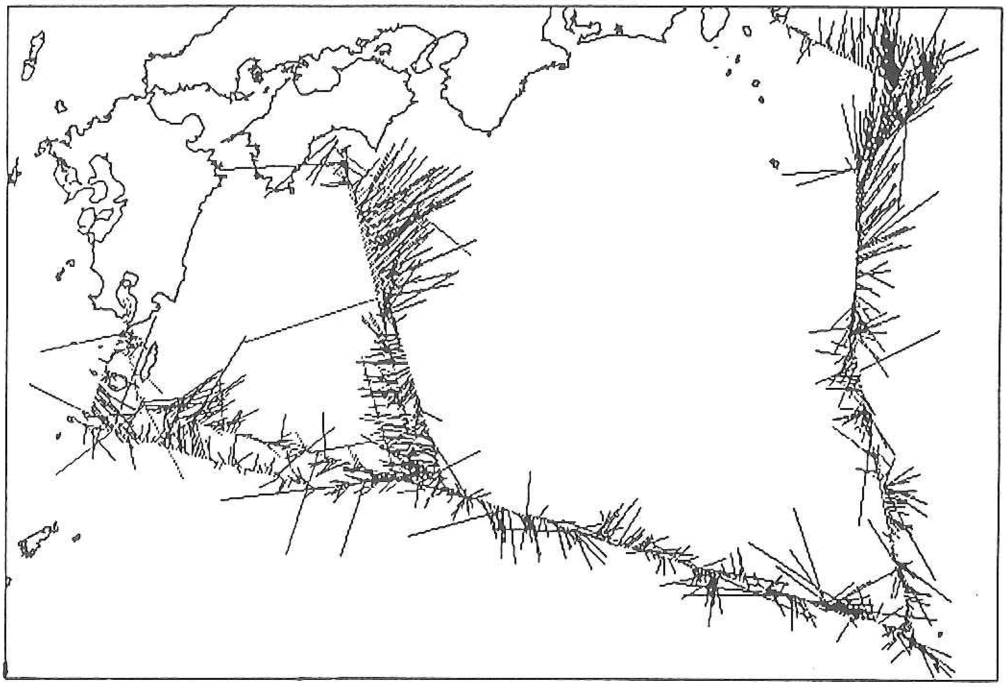

Figure 6.4.3(c) Same as Fig.6.4.2(a) except that the depth is 120m.

6.5 Hydrographic observation of ocean mixed layer and Subtropical Mode Water south of Honshu in winter 1991

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6.5.1 Introduction

Subtropical Mode Water plays an important role in the coupled atmosphere-ocean system on the time scale of years. Climatological features of its formation, circulation and dissipation have been revealed mainly using historical data. For further understanding of its role in climatic change mechanisms, it is required to clarify its formation area, circulation pattern and dissipation by accumulation of appropriate synoptic observations. Vertical profiles of temperature and salinity taken by CTD and chemical tracers like dissolved oxygen seem especially useful. In the cruise of the R/V Hakuho Maru KH-91-1, we made hydrographic observations focusing on the characteristics of the wintertime ocean mixed layer as the STMW formation area and subsurface STMW south of Honshu, Japan. Climatological features of STMW formation obtained so far have been confirmed and/or refined by the present observation.

6.5.2 Observation

Along the ship course of Leg 2, we performed three kinds of hydrographic observations: XBT's (T-7 probes), CTD casts down to 1000m and CTD casts with the Rossete Multi Sampler (RMS) as shown in Figure 6.5.1. Some XBT and CTD observations were made simultaneously to obtain a depth correction for XBT data (Hanawa and Yasuda, 1991). For convenience, call the line from X201 to C211 the A line and the line from C211 to X235 the B line.

6.5.3 Ocean mixed layer and STMW

Figures 6.5.2a and 6.5.3a show temperature sections and the layer with temperature gradient lower than $2x10^{-2o}Cm^{-1}$ along the A line and the B line,

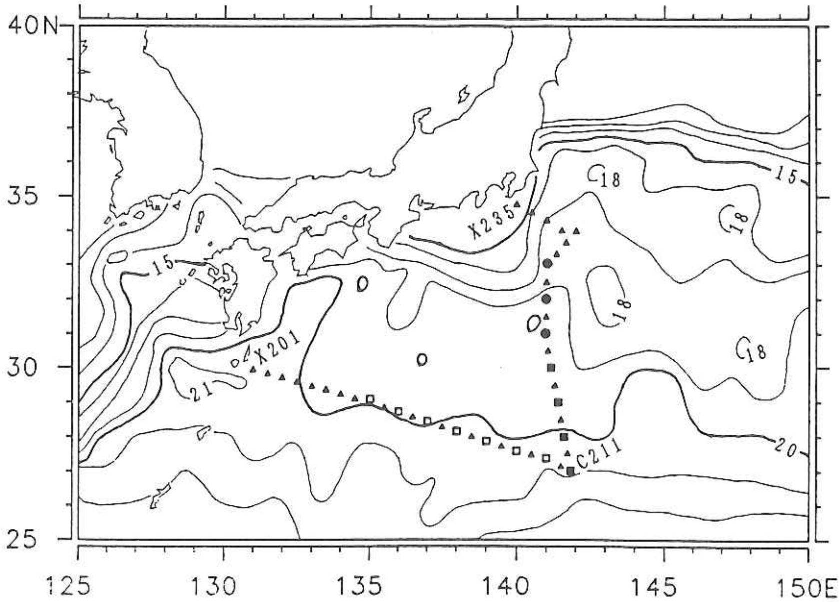


Fig. 6.5.1 Distribution of stations. Squares indicate stations with CTD and RMS, circles CTD and triangles XBT. Solid squares and circles indicate simultaneous XBT observations. Superposed contours are sea surface temperature for the first ten days in February 1991 according to THE TEN-DAY MARINE REPORT (Japan meteorological Agency, 1991b)

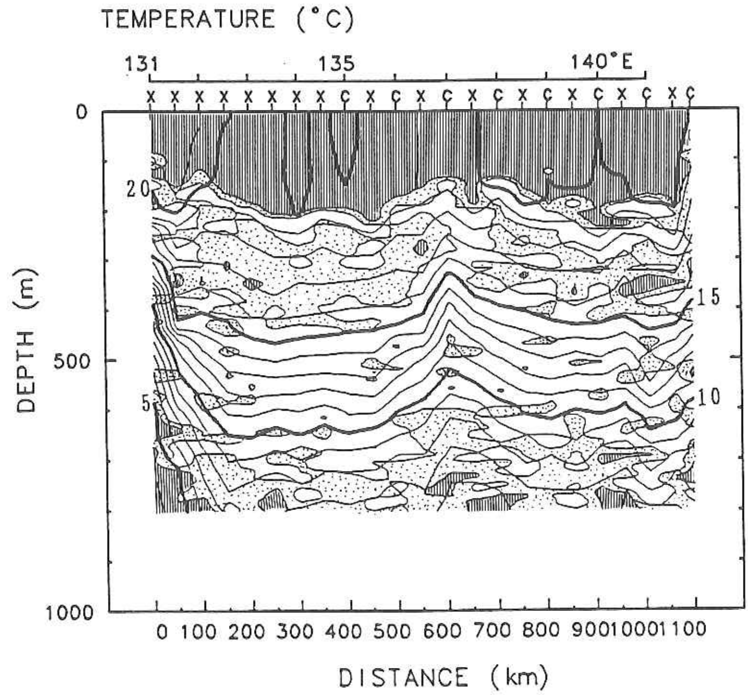
respectively. The depths of the XBT data were calculated by the empirical equation proposed by Hanawa and Yoritaka (1987). A temperature gradient lower than $2x10^{-2}$ $^{o}Cm^{-1}$ with temperature ranging roughly from 15 to 20^{o}C is a good tracer of STMW (Hanawa et al., 1988). A considerably thick mixed layer reaching to 200-250m in depth is visible as a surface layer of temperature gradient lower than $1x10^{-2}$ $^{o}Cm^{-1}$ in both sections. Subsurface STMW can also be seen as low-temperature-gradient layer ranging from 1 to $2x10^{-2}$ $^{o}Cm^{-1}$ between the surface layer and the main thermocline.

Figures 6.5.2b and 6.5.3b show vertical profiles of AOU along the A line and B line, respectively. The mixed layer with a vertically homogeneous AOU is apparent. Most of this layer has an AOU of 0-0.2 mll^{-1} which implies slight undersaturation of oxygen. The vertical extent of this mixed layer in each station corresponds very well to that of the temperature-gradient-based mixed layer. That is, as for the ocean region dealt with here, the mixed layer defined by the temperature profile has a uniform oxygen which is slightly undersaturated. This character of mixed-layer AOU confirms the conclusion about AOU in the STMW formation area based on hydrographic data with less vertical resolution by Suga and Hanawa (1990).

Some of the AOU profiles have a homogeneous layer with values ranging from 0.7 to 0.9 mll^{-1} underneath the surface layer. This layer corresponds with the subsurface temperature gradient minimum. This low-temperature-gradient layer is regarded as STMW formed in the last winter which has suffered considerable dissipation. The difference of AOU between the surface mixed layer and this layer is probably due to biological consumption (Suga et al., 1989).

6.5.4 Discussion

The major part of the sections taken in the present cruise were situated in the zonal area between the Kuroshio and the Subtropical Front where STMW is formed climatologically (Hanawa, 1987; Suga and Hanawa, 1990; Bingham, 1991). The mixed layer tended to be thicker where the main thermocline was deeper consistent with the climatological feature (Suga and Hanawa, 1990). This implies that the evolution of the wintertime mixed layer is controlled by the large-scale oceanic structure. On the other hand, areas of anomalously thick mixed layer also appear at 140^{o}E along the A line and at 29^{o}N along the B



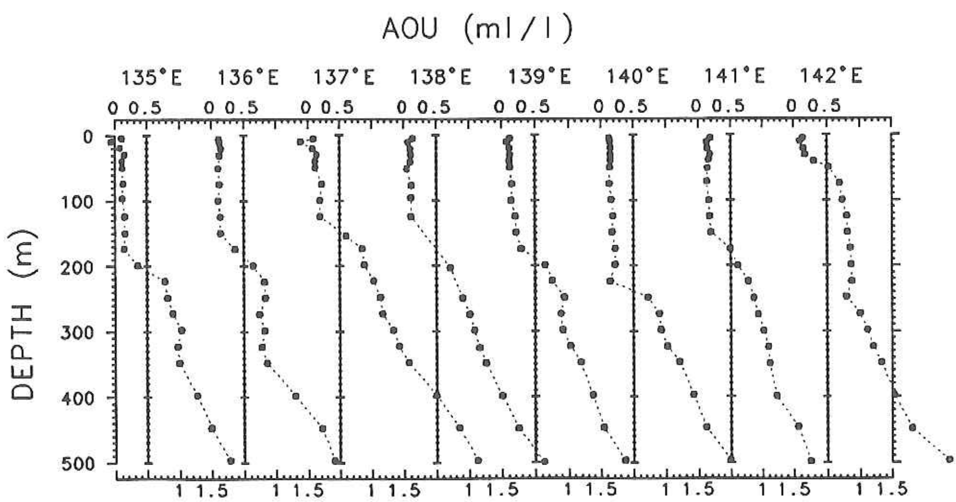


Fig. 6.5.2 (a) A temperature section along the A line (from X201 through C211). Hatching and stippling indicate layers of vertical temperature gradient lower then $1x10^{-2o}Cm^{-1}$ and $2x10^{-2o}Cm^{-1}$, respectively. (b) Vertical profiles of AOU at stations along the A line.

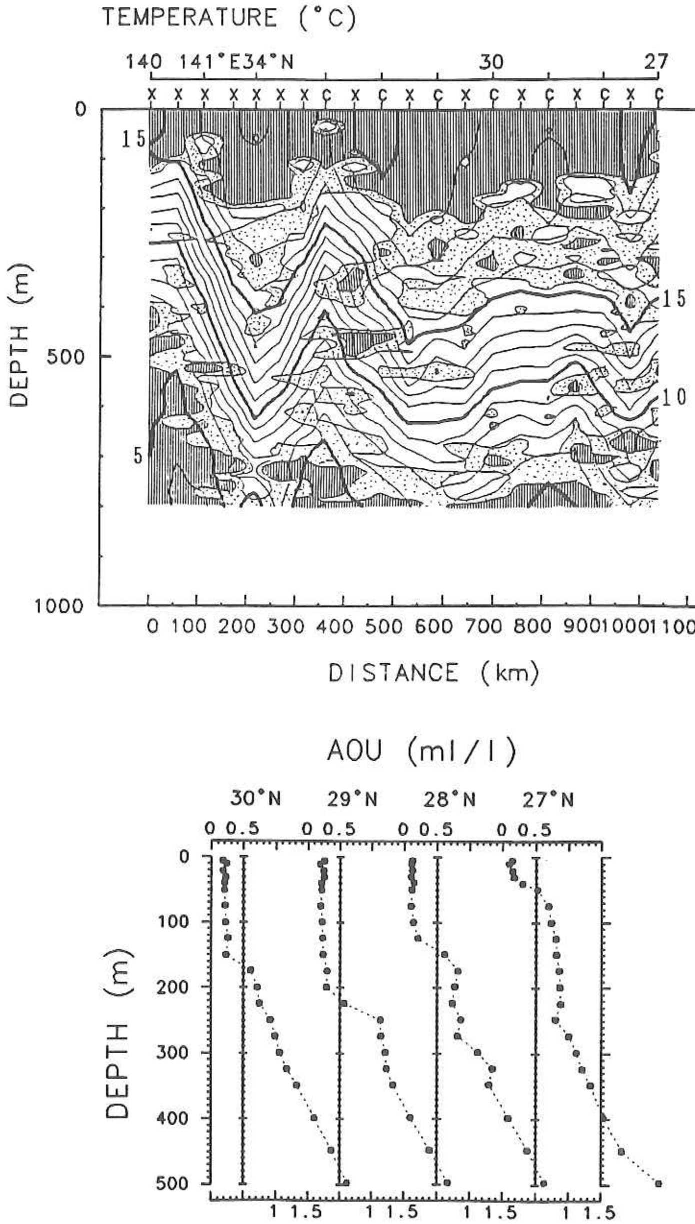


Fig. 6.5.3 As in Fig. 6.5.2 but along the B line (from C211 through X235).

line. This observation suggests that meso-scale features also influence the formation of STMW.

The mixed layer in the present sections was thinner and warmer than normal. We cannot tell the amount and properties of STMW formed by the end of the winter because the observation was made in the middle of the winter. However, the winter of 1991 was reported to have been relatively mild near Japan (Japan Meteorological Agency, 1991a). The sea surface temperature in the STMW formation zone did not decrease as much as usual (Japan Meteorological Agency, 1991b). Thus the present observation of the wintertime mixed layer can be categorized as occurring in a mild winter.

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7. Observations on heat contents of surface mixed layer by three surface buoy systems.

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7.1 Introduction

To investigate the seasonal variation of heat contents, the three-dimensional mixing processes, and the effect of heat advection on the heat contents in the upper ocean in the cooling season, a cooperative experimental study on ocean mixed layer (OMLET) was planned by three OMLET buoy groups, in the recirculation region of the Kuroshio south of Japan. The main purpose is to obtain time series of temperatures and current velocities in the upper layer of ocean. For five months from September 1990 to January 1991, surface mooring buoys were deployed at three vertexes of an equilateral triangle with a side of about 40km:

OCE (29° 05.0'N, 134° 50.2'E, 4770m)

RIAM (29° 05.0'N, 135° 09.4'E, 4990m)

ORI (28° 49.8'N, 134° 58.2'E, 4830m)

where OCE represents Department of Ocean Civil Engineering, Kagoshima University, RIAM Research Institute for Applied Modern Kyushu University, and ORI Ocean Research Institute, University of Tokyo. The locations of the buoy stations were monitored by the Argos System. Details of the observational data are described separately by the three buoy groups.

7.2 Observation at Sta. OCE.

Fig.2 shows the surface buoy system used by Department of Ocean Civil Engineering of Kagoshima University. The system was placed at Sta.OCE on 7 September 1990 by the Training Ship Keitenmaru belonging to Kagoshima University. Unfortunately, the line connected to the surface buoy was cut at a depth between 60m and 80m from the sea surface(Fig.2) on 28 September 1990 and then the surface buoy began to drift. However, the surface buoy and the instruments equipped with the line were fortunately recovered by the research vessel Chibamaru belonging to Chiba Prefectural Experimental Fishery Station at the site(32° 08.49'N,134° 50.29'E) south of the Murotomisaki in the morning of October 8, 1990. The other instruments connected to the subsurface buoy were recovered by the Research Vessel Hakuhomaru at Sta.OCE on 14 January 1991. Temperature records are not obtained from 4 thermometers fixed at 20m, 40m, 600m and 1700m below the sea surface. The thermometer fixed to the depth of 80m from the surface was broken on 16 September 1990.

The records of the temperatures and the velocities measured during 20 days from 8 to 28 September 1990 before the beginning of the surface buoy drift are shown in Fig.3 and Fig.4, respectively.

7.3 Observation at station RIAM

Fig. 5 shows the surface buoy mooring system deployed by RIAM. The measurements were made for 73 days from September 8 to November 20, when this buoy was broken off from the mooring line and began to drift. Fortunately, the buoy was recovered together with all the instruments, except for the 200m current meter. Three Typhoons (No.9019, 9020, 9021) approached the buoy stations during the buoy deployment, and took nearly the same course near the buoy stations (Fig. 6).

Fig. 7 shows time series of temperature profiles measured from the near-surface to 200m depth at a spacing of 10m. The sensors at 130 and 140m failed in recording. A temperature decrease of 2oC at the sea surface from 15 to 20 in September is due to the mixing by Typhoon 9019. It is interesting to find that the thermocline temperature increased by about 3 C. Fig. 8 shows the time series of east component of currents at 4 depths of 20, 50, 100, and 150m. An interesting fact is that the inertial currents were not excited by the strong local wind on Sept. 19, when No.9019 approached the buoy most closely, but the strongest inertial currents were observed about 2 days after the passage of

No.9019, suggesting that the inertial oscillation propagated from its source toward the buoy station. Fig. 9 shows the progressive vector diagrams relative to the daily mean current at a depth of 150m, from which we can see typical inertial oscillation.

7.4 Observation at Sta. ORI

A schematic of surface mooring buoy system deployed at Sta. ORI is shown in Fig. 10. A pyranometer with a solid state memory, belonging to Tohoku University group, was also attached to the upper frame of the buoy. The mooring was made in the scheduled period between 9 September 1990 and 15 January 1991, and the buoy system was recovered with all instruments in completely.

Fig. 11 shows daily mean values of the temperature at 0.5m, 20m, 40m, 60m, 50m, 80m, 100m, 120m, 140m, 160m, 180m and 200m from the surface measured by RMT thermometers but 50m by a thermometer mounted on an ACM current meter. Reversing of temperature values at the layers deeper than 100m occurred, unfortunately, from the over buoyancy of five glass ball floats just below the 200m RMT(Fig. 10), then it should be corrected by using the data of pressure sensor attached at 190m.

Fig. 12 shows hourly values of horizontal two components of the current velocity obtained by an ACM current meter moored at 50m layer, U and V indicate east-west and north-south components respectively. Unfortunately, data of the ACM moored at 150m was not obtained by a instrument trouble.

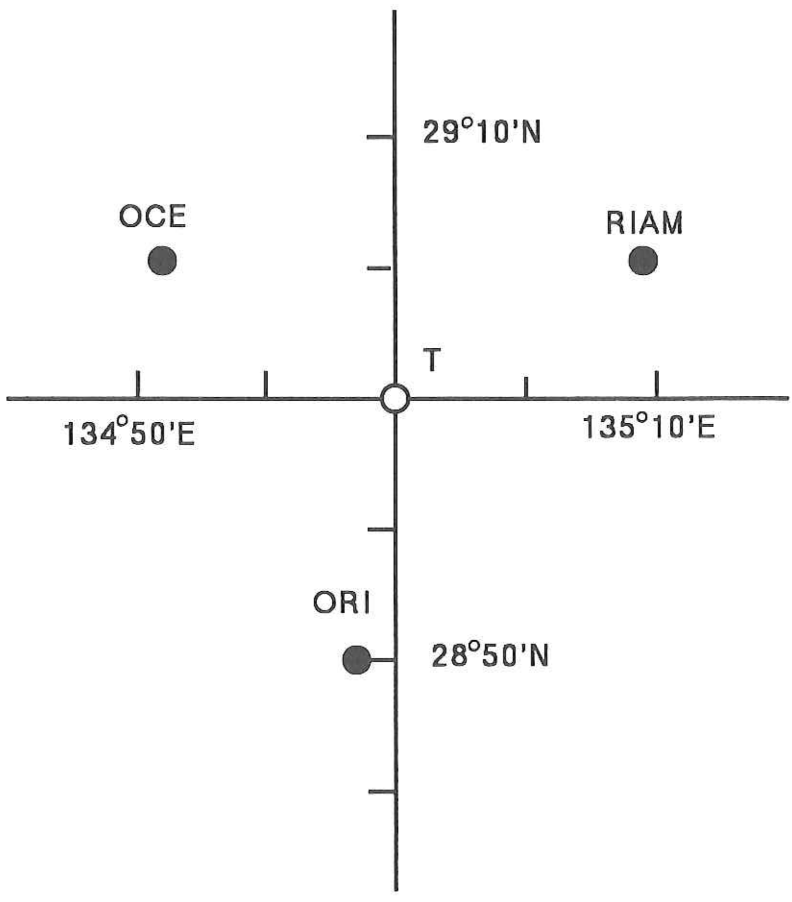

Fig. 7.1 Surface buoy stations.

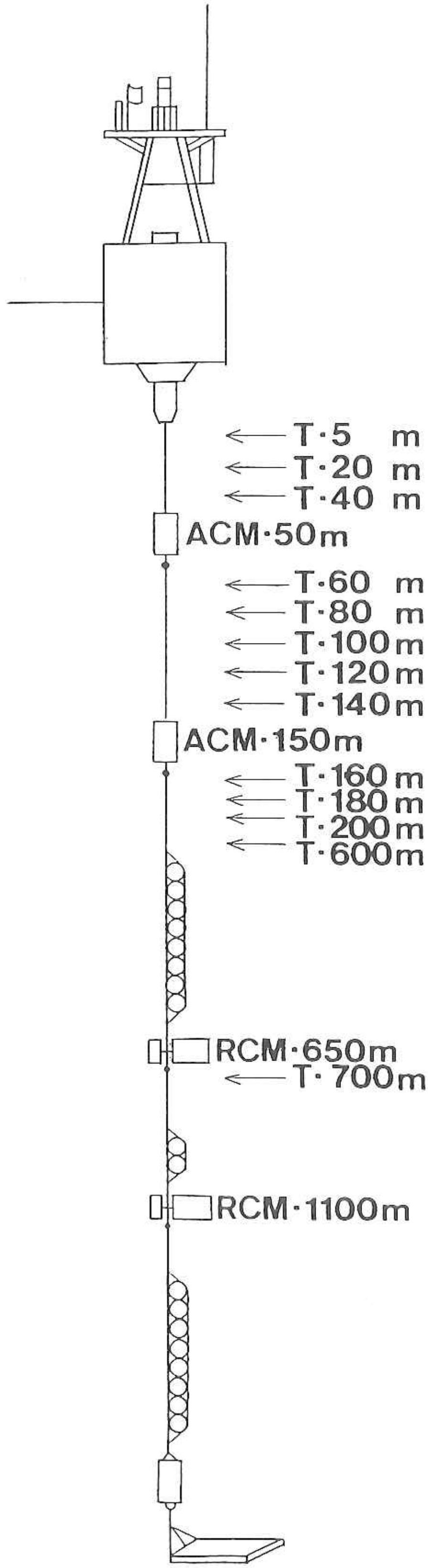

Fig. 7.2 Mooring system at Sta. OCE.

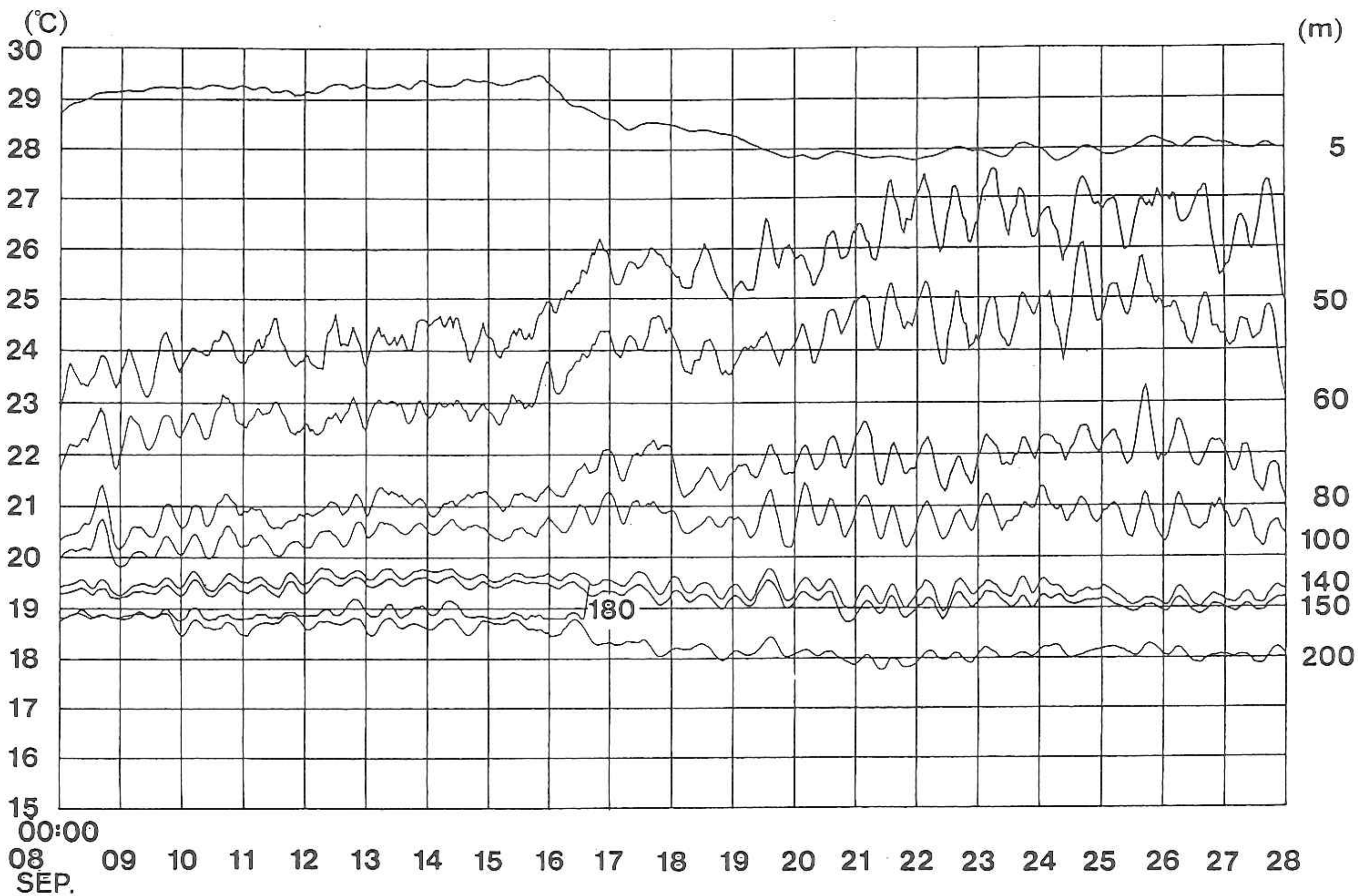

Fig. 7.3 Temperature records measured at Sta. OCE.

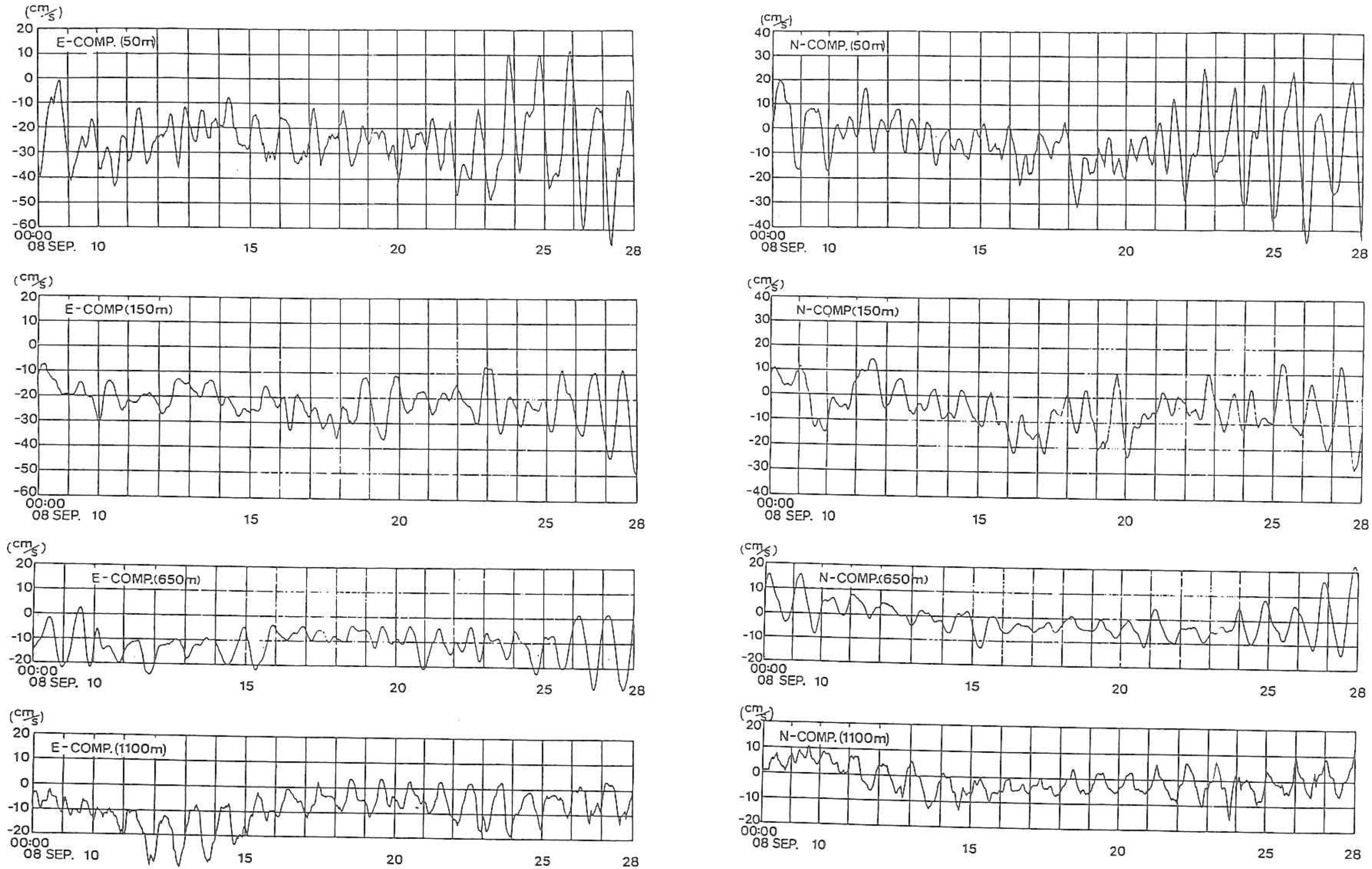

Fig. 7.4 Velocity records measured at Sta. OCE.

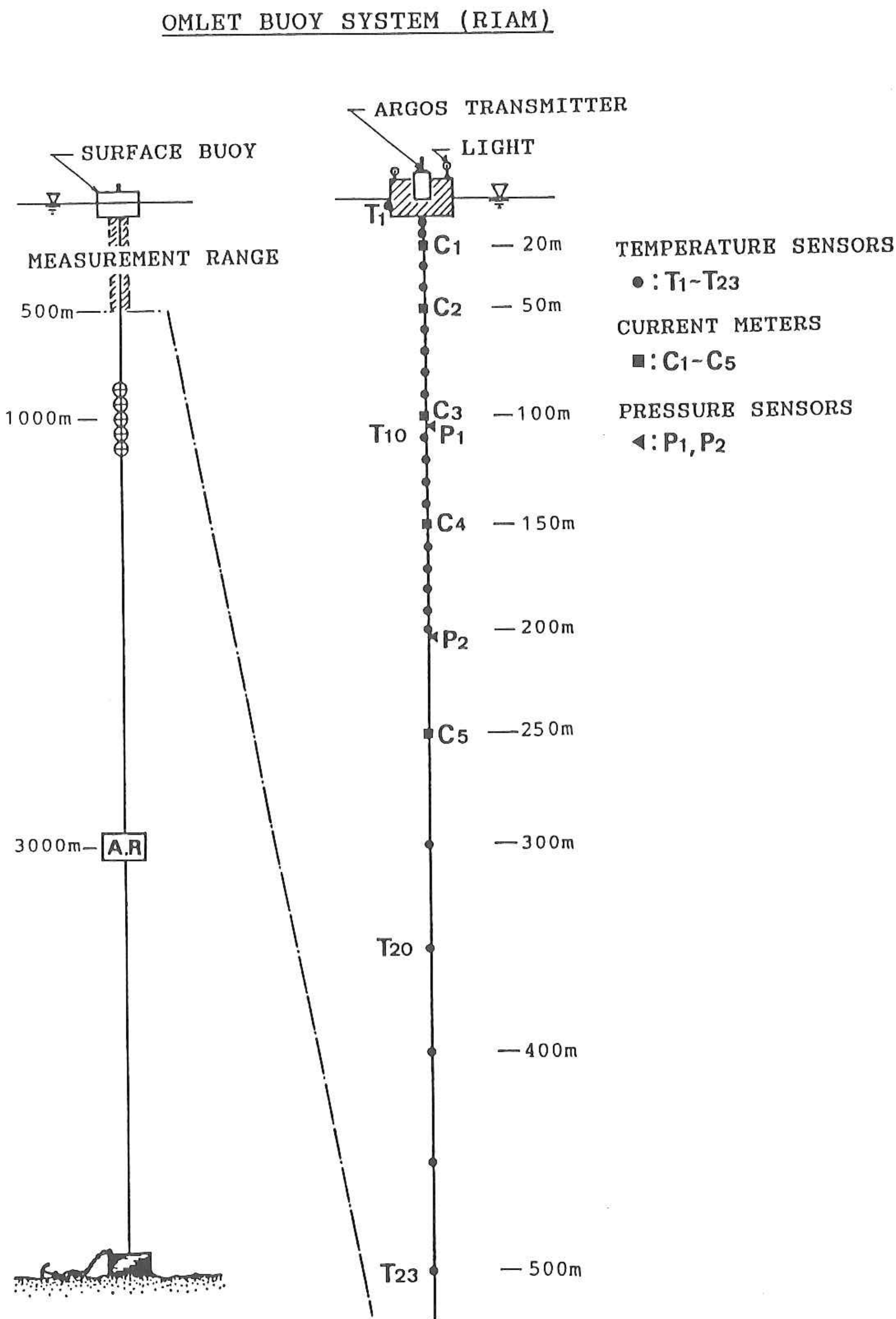

Fig. 7.5 OMLET Buoy System deployed by RIAM.

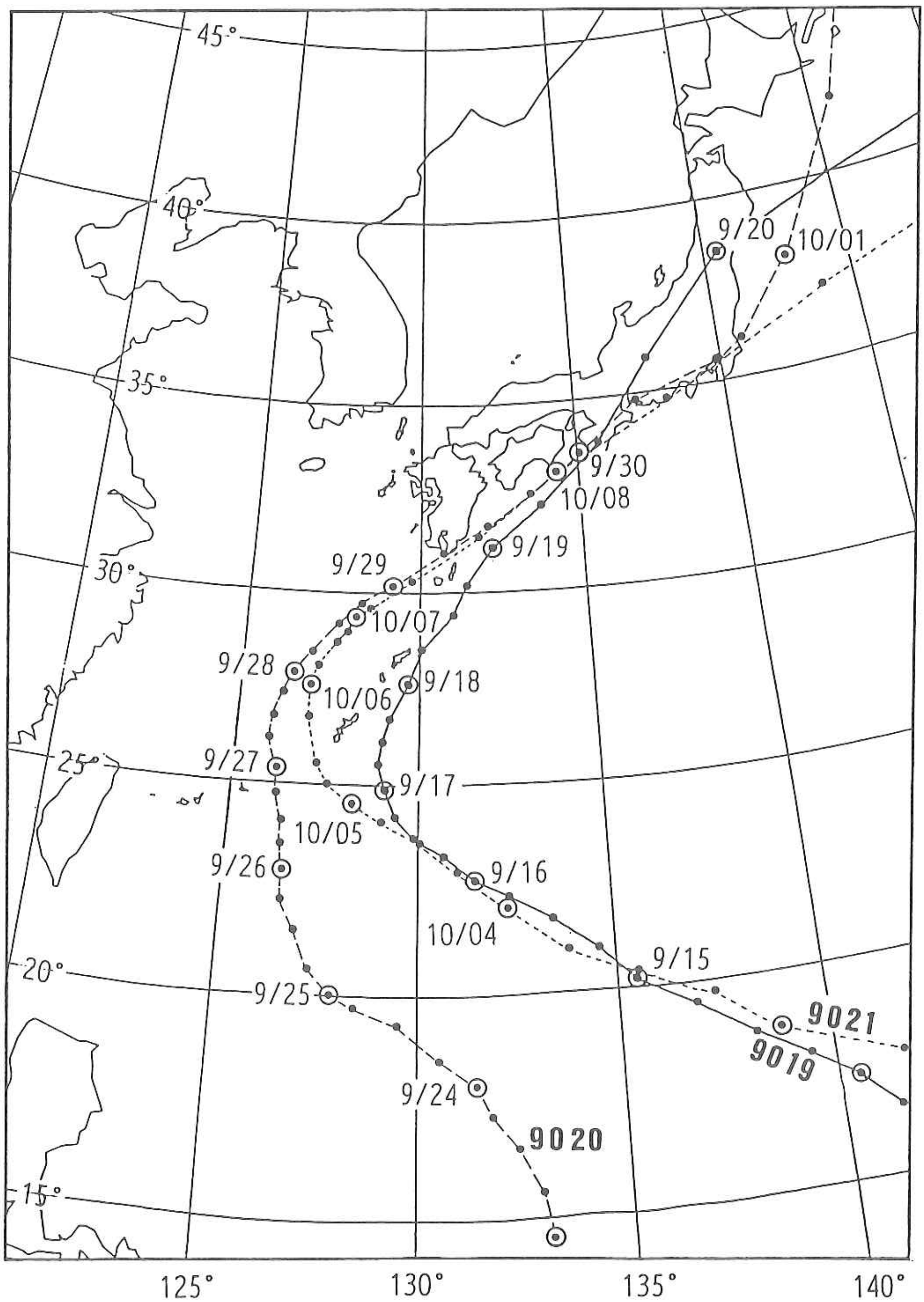

Fig. 7.6 The routes of three Typhoons (No. 9019, 9020, 9021) during the buoy deployment period.

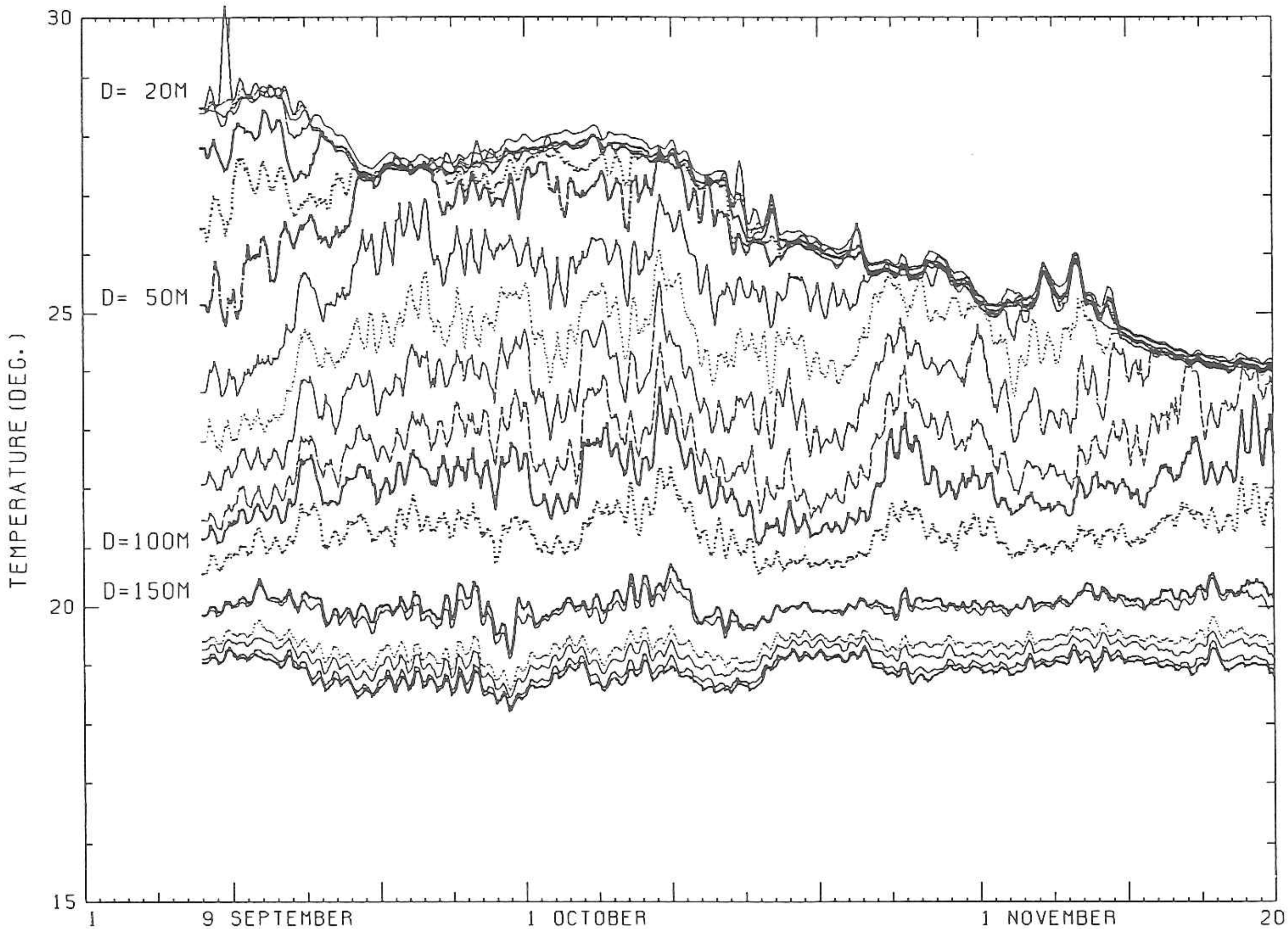

Fig. 7.7 12-H LOW PASS FILTERED TEMPERATURE DATA AT TANGO IN 1990

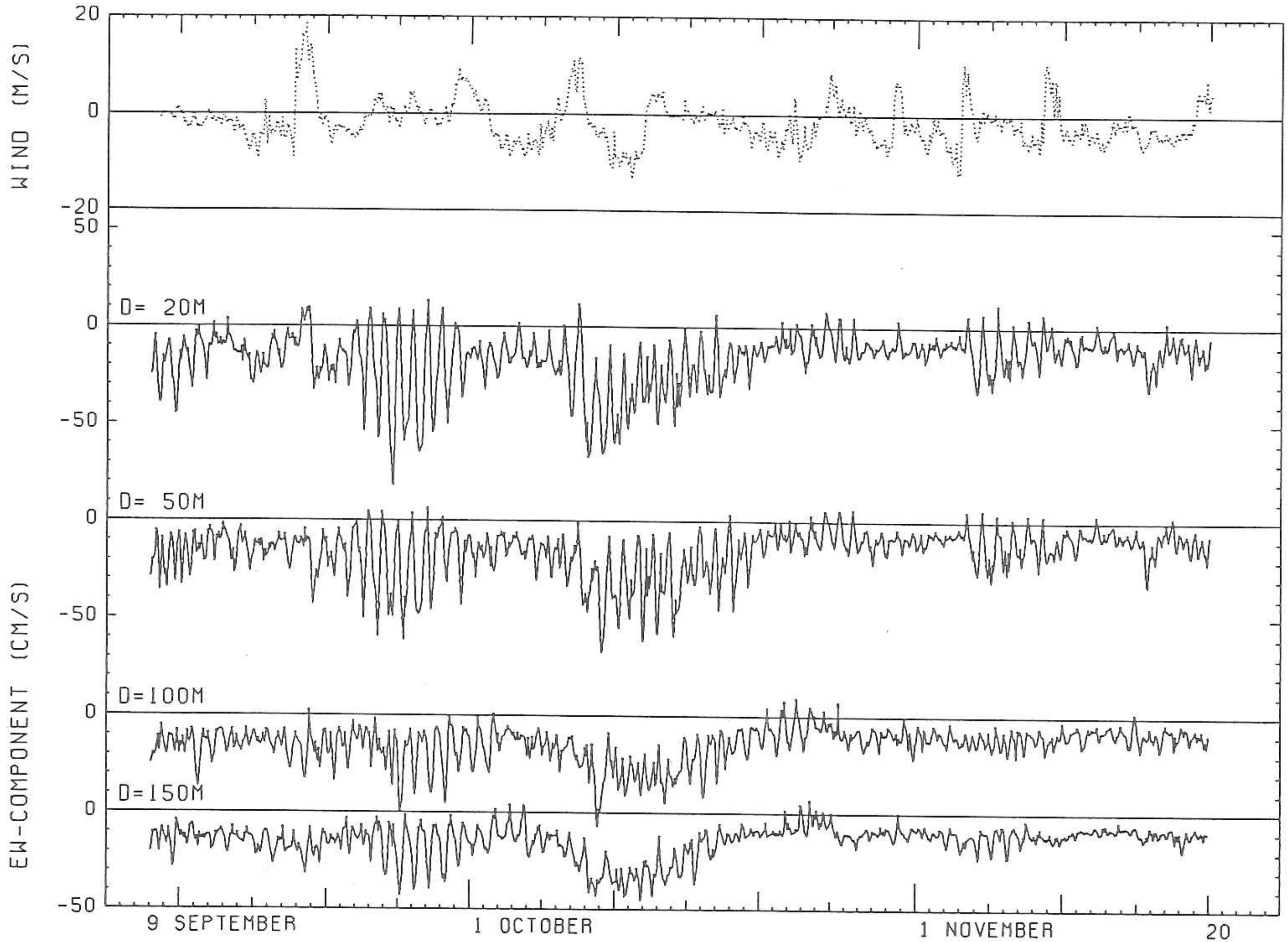

Fig. 7.8 RAW CURRENT DATA AT TANGO IN 1990

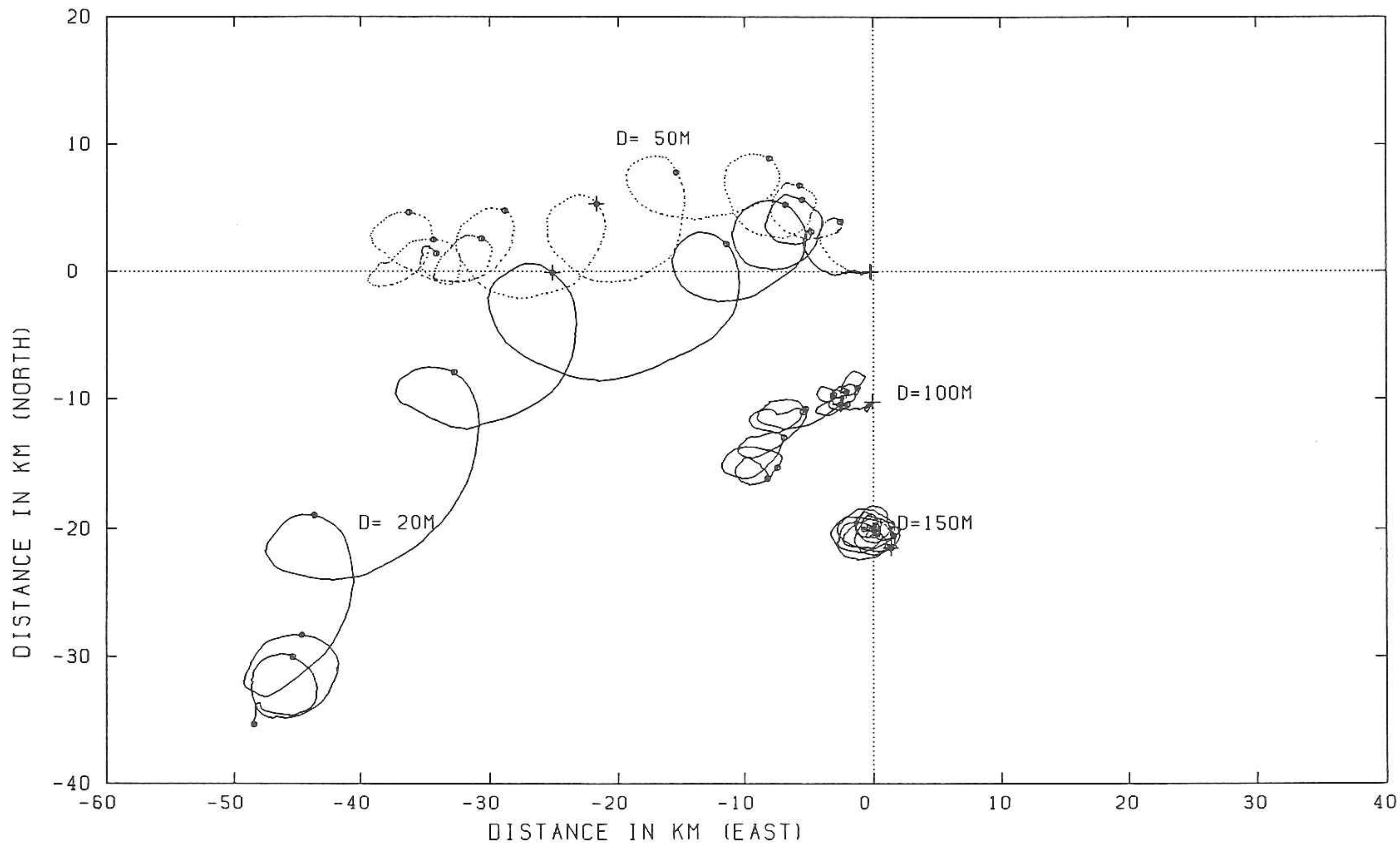

Fig. 7.9 PROGRESSIVE RELATIVE CURRENT VELOCITIES V(D)-V(150M)
RECORD PERIOD: 21 - 30 SEP. 1990 (10 DAYS)

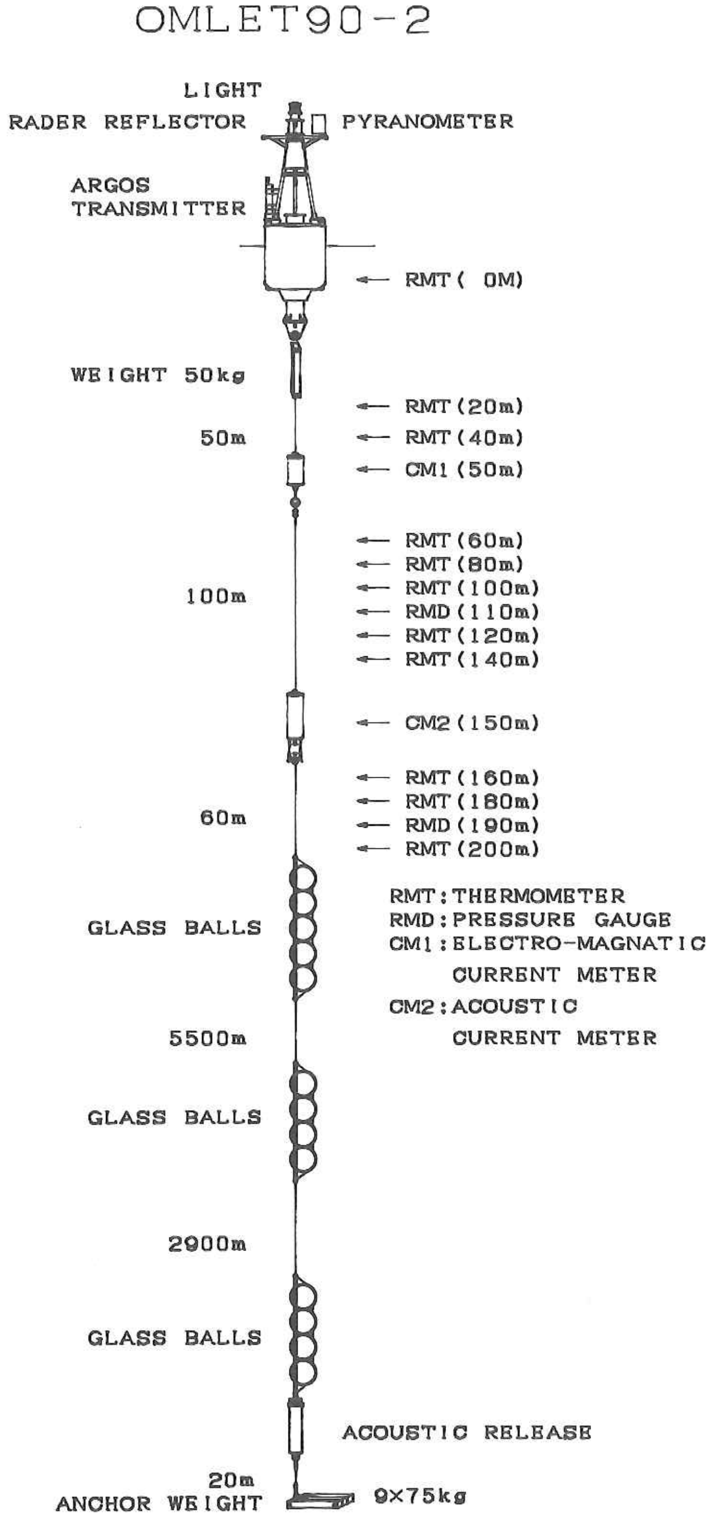

Fig. 7.10 Mooring Buoy System deployed by ORI.

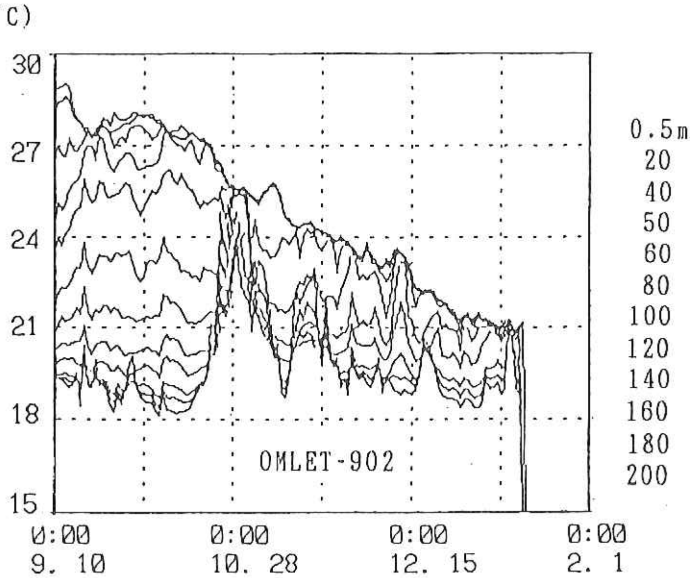

Fig. 7.11 Daily mean temperature upper 200m.

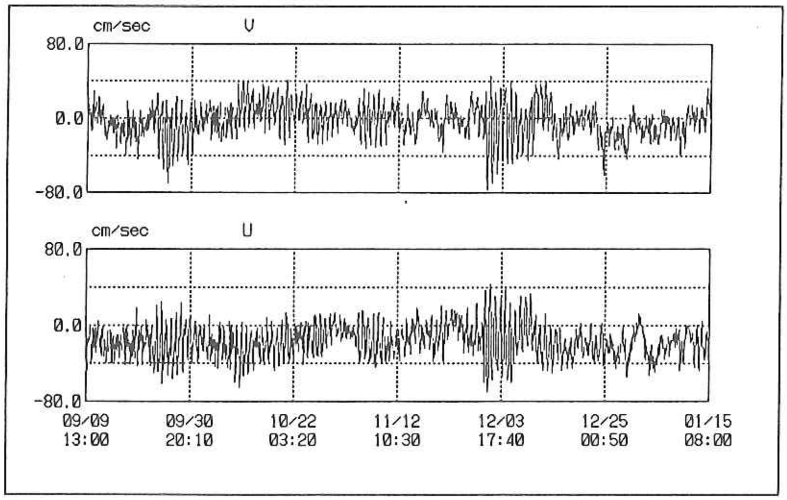

Fig. 7.12 Hourly values of current velocity components.
V(top) and U(bottom) indicate north(+)-south(-) and east(+)-west(-) components, respectively.

8. Turbulent dissipation in ocean surface mixed layer

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Investigation of the correlation between ocean surface forcing and turbulent dissipation in ocean mixed layer is very important for understanding the mixing process of ocean mixed layer. The main purpose of the present experiment is to survey a diurnal chages of the turbulent kinetic energy dissipation in the mixed layer. The energy dissipation rate is determined by measuring profile of vertical microscale velocity shear. The microstructure profiler (MSP) is the main instuments for this purpose.

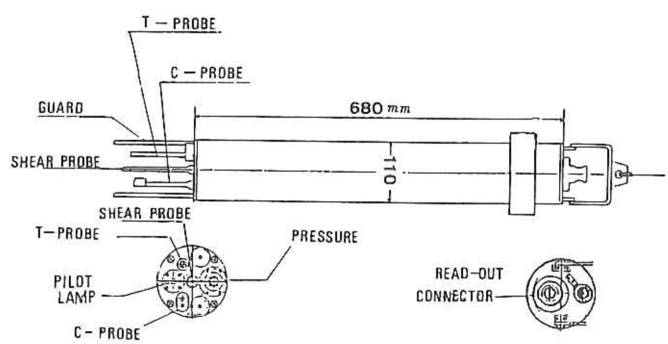

Fig.8.1. Schematic vies of the MSP.

The free-fall microscale profiler can measure vertical profile of velocity shear, temperature gradient, conductivity gradient, together with the vertical profile of temperature and conductivity with time interval of 10 milli-seconds. The nominal fall-speed is about 50 cm/s (Fig.8.1).

The MSP cast started at 16:00 (JMT) on January 17 and finished at 16:30 (JMT) on January 19 at the fixed station; 29^{o}N, 135^{o}E. During this successive survey, 16 microstructure profiles were taken at three hours intervals, except two midnight casts at

01:00 on Jan. 18 and 01:00 on Jan. 19.

Rate of kinetic energy dissipation can be calculated from variance of measured shear profile using the following formula:

$$\varepsilon(z) = \frac{15}{2}\nu\overline{\left(\frac{\partial u'}{\partial z}\right)^2}$$

where ν is kinematic viscosity of sea water, and $\overline{(\partial u'/\partial z)^2}$ is the shear variance over a vertical bin. In the present estimate, the variance was estimated using 1024 vertical data points.

MSP04

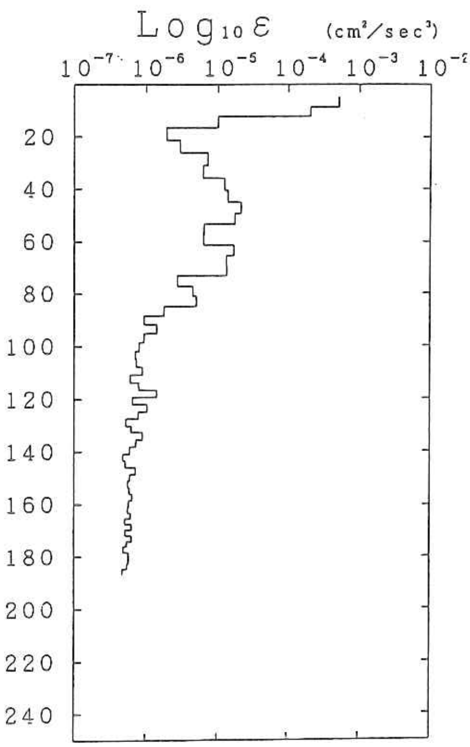

Fig.8.2. Vertical profile of log(ε) on January 17, 1991 at 2230 JMT.

MSP05

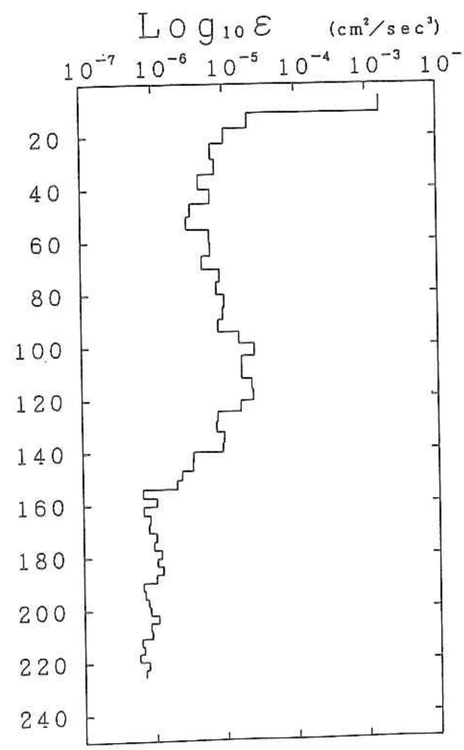

Fig.8.3. Vertical profile of log(ε) on January 17 1991 at 0430 JMT.

Figure 8.2 shows a typical profile of dissipation rate at 22:30 JMT on Jan. 17. The highest dissipation in the near surface layer may be due to turbulence of strong surface shear. The second higher peak can be seen around 50 to 70 m. The dissipation gradually decreases to 10^{-6} cm^2/s^3 at the layer of

100 m, and keeps nearly constant dissipation in the deeper layer. However, the dissipation profile suffers considerable change due to surface forcing or turbulent diffusion. Figure 8.3 shows the dissipation profile taken at about six hours after the profile of Fig. 8.2. The second peak seen in Fig. 8.2 was transfered to the layer of 120 m.

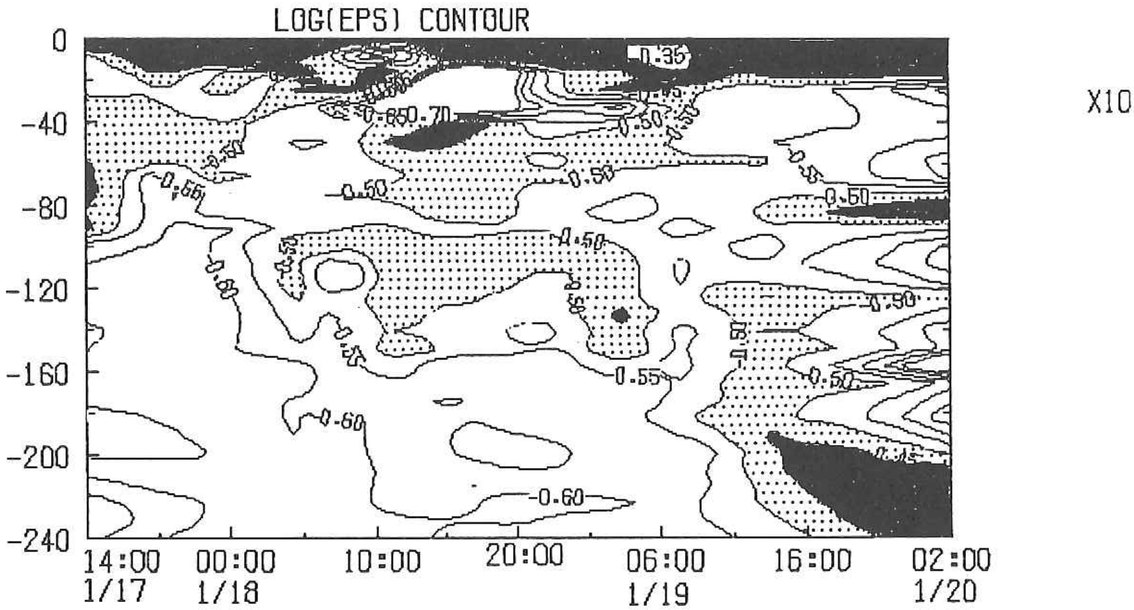

Fig.8.4. Contours of log(ε). The dark shade, log(ε)>-4.5; The lighter shade, -5.0≤ log(ε) ≤-4.5

Figure 8.4 shows the variation of the estimated log(ε) - profiles contoured with 0.5 intervals. The dark shaded region shows the layer of log(ε)≥-4.5, and the lighter shaded one shows -5.0≤log(ε)<-4.5. The contour line of log(ε)=-4.5 penetrates to the depth of 35 m at midnight, and rises to near surface at noon.

9. Retrieval of the receivers for tracking of the SOFAR floats in the Shikoku Basin

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The Kuroshio, the western boundary current of the North Pacific Ocean, is flowing in the upper layer of the Shikoku Basin entering through Tokara Strait and going out over Izu Ridge. Although the water depth of Tokara Strait and Izu Ridge is hundreds meters, the Kuroshio has a deep current structure in the Shikoku Basin. The circulation at mid-depth in the Shikoku Basin is much different from that at the surface measured with the GEK and the satellite-tracking of surface drifters.

Current records at limited numbers of moored stations are subject to the bottom control and to the flows associated to the water masses. A Lagrangian measurement of current is most requisite to elucidate the deep circulations in the Shikoku Basin.

A neutral float tracked by acoustic signal of 780 Hz is used for the measurement (Taira et al., 1990). Two floats balanced to drift at 1500 m depth were released on 17 April 1988, and another two at 1500 m depth on 3 November 1988. In June 1989, eight floats were released: two floats at 1000 m depth, two at 2000 m depth, two at 3000 m depth and two at 4000 m depth.

Since April 1988, the tracking was made by mooring the SOFAR receivers at three stations. For the fifth mooring, the receivers were moored in April 1990 at R1(32° 28'N 136° 03'E), R2(28° 58'N, 133° 30'E), and R3(29° N, 136° E) in the Shikoku Basin. The mooring lines of the SOFAR receivers are shown in Figure 9.1. The recovery of the receivers were made on 12, 14 and 23 April 1991. The obtained trajectories are found in Yanagimoto (1992).

References

Taira,K., S.Kitagawa, K.Uehara, H.Ichikawa, H.Hachiya and T.Teramoto(1990): Direct measurements of mid-depth circulation in the Shikoku Basin by tracking SOFAR floats. J. Oceanogr. Soc. Japan, 46, 296-306.

Yanagimoto, D., (1993): Observation of mid-depth circulation in the Shikoku Basin by tracking the SOFAR floats. Master Thesis, University of Tokyo, 48p.

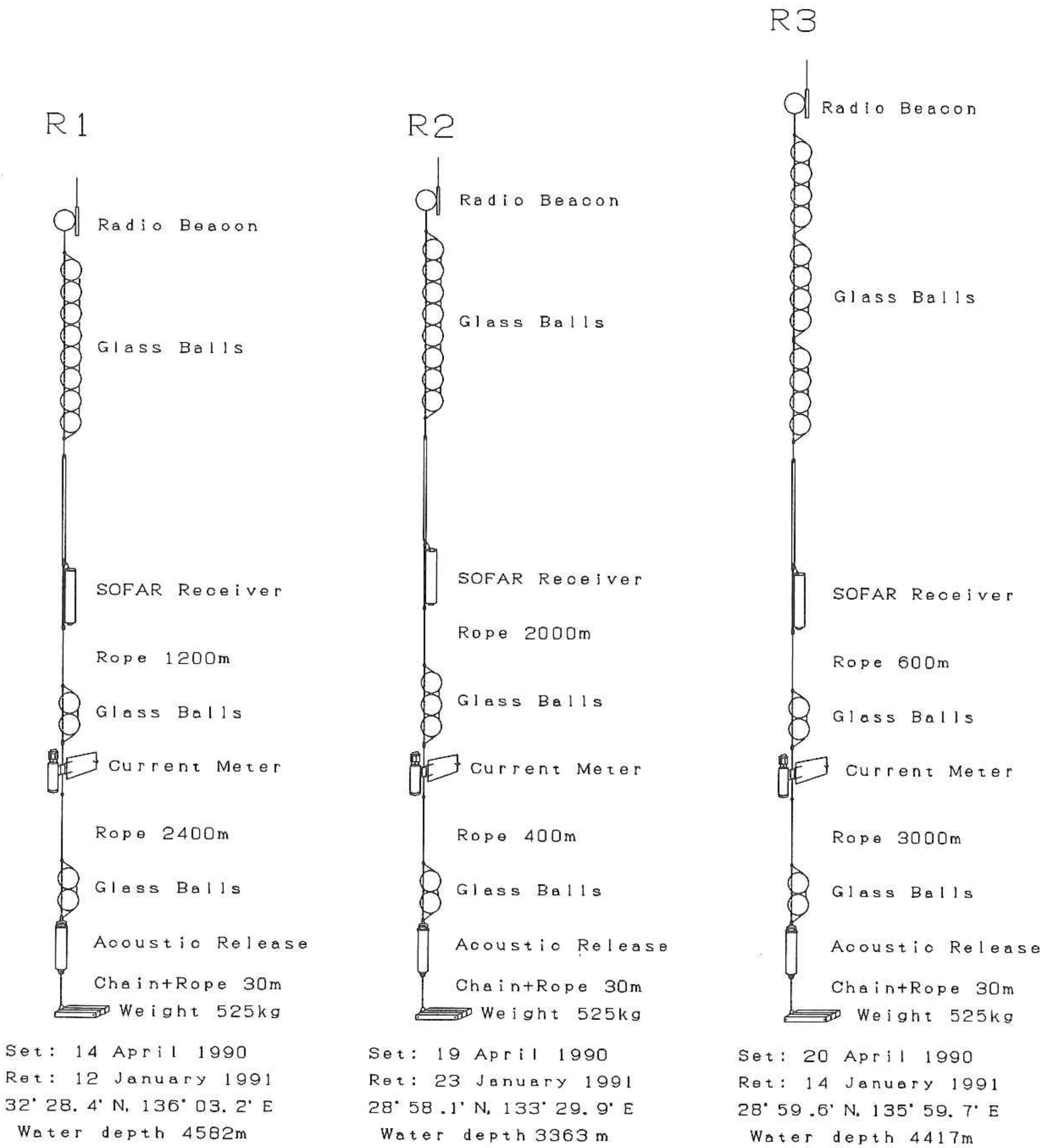

Figure 9.1 Mooring of the SOFAR receivers

10. Estimation of surface current vector of the Kuroshio using NOAA AVHRR image

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10.1 Objective

Numerous attempts have been made to estimate sea surface velocities using satellite infrared and visible images. Some of them are the tracking of oceanographic features appeared in the sequential thermal infrared images, the pattern matching by cross correlation and the estimation of geostrophic current vectors using a single thermal infrared image. In every attempt and trial it is the surface velocity of a depth of few meters which have been studied for satellite image analysis. However, in the case of flow with a strong vertical gradient of velocity such as the flow under the dominant wind conditions, surface velocities may not be representative for the flow field under study and it may be difficult to distinguish between the geostrophic component and the Ekman drift component.

During the period of KH91-1 R/V Hakuhoumaru cruise acoustic doppler current profiler data were obtained simultaneously with NOAA AVHRR images. Then the component of transport(depth of 120 meters) which is the right angle to the observation lines were calculated and the balance of transport to the south of Honshuu, Japan was gained in the closed sea area with the coastal boundary. It is our goal to see if the satellite thermal image with some wind stress inputs (for example,from scatterometer) can be used to estimate the surface transport to the depth of wind frictional influence and the balance of transport can be assessed by the transport model based on the thermal wind equations in oceanography.

10.2 Surface transport to the south of Honshuu, Japan

Acoustic doppler current profiler mounted on R/V Hakuhoumaru measures the speed and direction of current vector of three different depths every minute. The components of current vector which are the right angle to the observation lines are integrated to the depth of 120 meters and averaged every ten minutes. Fig.10.2.1 illustrates such components of transport along with three observation lines. These are KO-OM(Kouchi-OM), OM-OG(OM-Ogasawara) and OG-TO(Ogasawara-Tokyo) respectively and forms the closed sea area with coastal boundary of Honshuu. On the line of KO-OM the transport to the closed sea area exceeds the one out of the closed sea area and the former corresponds to the path of the Kuroshio about 200Km width. Though the characteristics of the transport are not visible along the line of OM-OG, it can be seen that the transport out of the closed sea area near the coast corresponds to the path of the Kuroshio and the transport to the closed sea area may indicate the counter-current of the Kuroshio along the line of OG-TO.

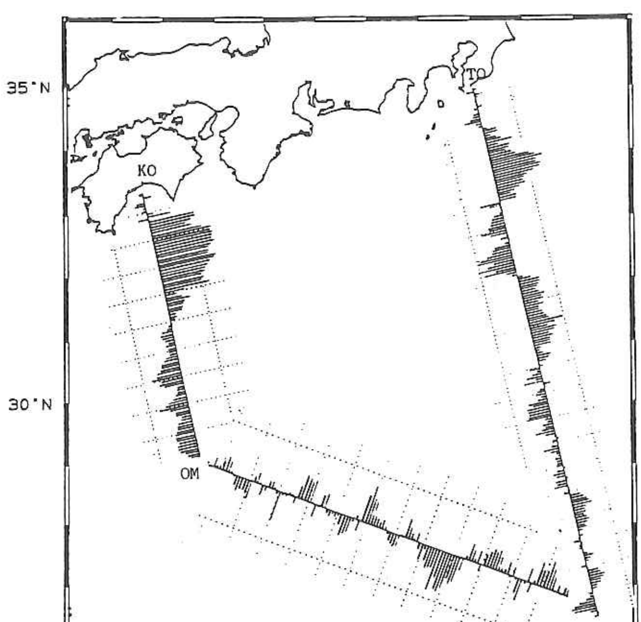

Fig.10.2.1 Component of the surface transport right to the observation lines.

Table 10.2.1 Balance of the surface transport for each observation line.

KO - OM	+10.2 Sv
OM - OG	-5.7 Sv
OG - TO	-11.2 Sv
S U M	-6.7 Sv

Tab.10.2.1shows the balance of the transport in each observation line and in the closed sea area. + denotes the transport to the closed sea area and - denotes the transport out of the closed sea area. The balance of the transport in the closed sea area is -6.7Sv and it means that the transport out of the area exceeds the one to the area. This implies that the extra transport caused by the wind stress to the sea surface may be added to the geostrophic transport.

10.3 Thermal wind equations and the transport model

Thermal wind equations in oceanography with wind stress are given as follows.

$$-g\frac{\partial \rho}{\partial x}=\frac{\partial(\rho f v)}{\partial z}+\frac{\partial}{\partial z}\left(\frac{\partial \tau_x}{\partial z}\right) \quad (1)$$
$$g\frac{\partial \rho}{\partial y}=\frac{\partial(\rho f u)}{\partial z}+\frac{\partial}{\partial z}\left(\frac{\partial \tau_y}{\partial z}\right)$$

The equations integrated twice in the vertical coordinate are

$$-g\iint_{-h}^{0}\frac{\partial \rho}{\partial x}dz=fM_y+\tau_x \quad (2)$$
$$g\iint_{-h}^{0}\frac{\partial \rho}{\partial y}dz=fM_x+\tau_y$$

$$但し M_x=\int_{-h}^{0}\rho u\,dz,\ M_y=\int_{-h}^{0}\rho v\,dz$$

Since Ekman transport is non-geostrophic,

$$fM_{yE}=-\tau_x \quad (3)$$
$$fM_{xE}=-\tau_y$$

Since "thermal wind transport" is free from friction,

$$fM_{yT}=-g\iint_{-h}^{0}\frac{\partial \rho}{\partial x}dz \quad (4)$$
$$fM_{xT}=g\iint_{-h}^{0}\frac{\partial \rho}{\partial y}dz$$

Provided that the right terms of equations(3) can be estimated using scatterometer data and the right terms of equations(4) can be estimated using thermal infrared images, it is possible that the surface transport to the depth of wind frictional influence in the closed sea area is derived using the satellite data and the transport model.

11.Air-Sea Gas Exchange in the western North Pacific

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The transfer of gases across the air-sea interface has an important role in the climate change. In this cruise we measured Rn-222, Ra-226 and dimethyl sulfide (DMS) in seawater to estimate the gas exchange rate and the flux of DMS to the atmosphere across the air-sea interface.

11.1 Determination of gas exchange rate

The radon deficiency method is the most powerful and useful in the field for the estimate of gas exchange rate across the sea surface. This technique was developed by Breocker(1965) and used extensively in the GEOSECS program (Peng et al., 1979). The radioisotopes, Ra-226 (half-life 1600 yr) and its daughter Rn-222 (half-life 3.8 d), are at radioactive equilibrium in the deep ocean. However, the deficiency in the radon activity is found in the near sea surface layer because the radon escapes to the atmosphere across the air-sea interface. This deficiency would largely depend on the weather condition.

We collected three times ten seawater samples each on 17, 20 and 22 January 1991 at a station near 135°E, 29°N and measured Rn-222 and Ra-226 concentrations and we recorded the weather condition during the period. The Measurements of Rn-222 and Ra-226 activities have not yet finished. The results will be used to calculate the gas exchange rate. The obtained gas exchange rate will be used to compute the amounts of respective gases exchanged at the surface and to discuss the relation between the rate and the weather condition.

11.2 DMS in the ocean and the marine atmosphere

DMS is an important sulfur compound when we consider the sulfur cycle in the atmosphere, which can escape to the atmosphere across the air-sea interface. The concentration of DMS in seawater varies rather widely with depth, area, season and so on. In this cruise we measured the DMS concentration in seawater at 12 stations in the western North Pacific, using FPD-GC on board the ship. We also observed the concentration of DMS in the maritime air during the cruise. The results are summarized in Tables 11.1a and 11.1b together with those of CS_2. The DMS concentration in the upper ocean (0 to 150m) is about 20 ng-S/l with a small variatioin, whereas the atmospheric concentrations of DMS varied widely. This may be due to the largely seasonal and areal variations of the DMS flux across the sea surface and the oxidation process of DMS in the atmosphere.

11.3 Distribution of carbon dioxide in seawater

Carbon dioxide is the most important green house gas in the atmosphere. When we discuss the fate of carbon dioxide, we pay much attention on the ocean, because it is the biggest reservoir. The change may be recorded in the total carbon dioxide concentration in seawater. However, the change should be very small and we must determine it with high accuracy and precision. In this cruise we tested the determination method of total carbon dioxide in sea-water, which was a coulometric method.

The Water samples were collected at Stas. OC-5 and C201. A part of the results is given in Table 11.2. These results indicate that the data obtained by this method is useful to discuss the carbon dioxide problem.

Table 11.1a. Summarized DMS and CS_2 concentrations in seawater.

Depth(m)	DMS(ng-S/l)	CS_2(ng-S/l)
0	21±5	1.0±0.3
5-30	21±8	1.0±0.2
50	22±8	1.3±0.5
100	17±6	1.1±0.3
150-500	9±7	0.9±0.3

Table 11.1b. Summarized DMS and CS_2 concentrations in the atmosphere.

	DMS	CS_2
Number	30	29
Range (ng-S/m^3)	0-50	9-720
av. (ng-S/m^3)	16	130
S.D. (ng-S/m^3)	12	132

Table 11.2 TCO_2 at Sta. OC5.

Depth (m)	TCO_2 concentration (μM) No.1	No.2	av.	Δ(No.1-No.2)
0	2017.2	2018.3	2017.8	1.1
5	2017.0	2016.7	2016.9	0.3
25	-	2013.5	2013.5	-
50	2018.6	2017.6	2018.1	1.0
75	-	2018.1	2018.1	-
100	2014.7	2017.0	2015.9	2.3
125	2018.9	2016.8	2017.9	2.1
150	2019.3	2018.8	2019.1	0.5
175	2021.3	2018.6	2020.0	2.7
200	2031.3	2030.2	2030.8	1.1
300	2075.2	2070.9	2073.1	4.3
400	2096.7	2093.3	2095.0	3.4
600	2179.6	2179.0	2179.3	0.6
800	2280.3	2282.0	2281.2	1.7
1000	2341.4	2358.4	2349.9	17.0

These data are not corrected for the <u>in situ</u> water temperature.

Appendix I
Routine surface meteorological data during the period from 11 to 24 January (Leg.I), and the period from 28 January to 4 Feburuary (Leg.II).

Note:

1) Latitude

2) Longitude

3) W.D Wind Direction

4) W.F Wind Speed (m/s)

5) F Wind Force

0:	calm (wind speed 0.0-0.2 m/s)	7:	high wind (13.9-17.1 m/s)
1:	light air (0.3-1.5 m/s)	8:	gale (17.2-20.7 m/s)
2:	light breeze (1.6-3.3 m/s)	9:	strong gale (20.8-24.4 m/s)
3:	gentle breeze (3.4-5.4 m/s)	10:	whole gale (24.5-28.4 m/s)
4:	moderate breeze (5.5-7.9 m/s)	11:	storm (28.5-32.6 m/s)
5:	fresh breeze (8.0-10.7 m/s)	12:	hurricane (more than 32.7 m/s)
6:	strong breeze (10.8-13.8 m/s)		

6) We Weather

b:	blue sky, cloud amount 0-2	o:	vercast sky
bc:	blue sky with detached cloud 3-7	p:	passing shower
c:	cloudy 8-10	q:	squall
d:	drizzing rain	r:	rain
e:	wet without rain	s:	snow
f:	fog	t:	thunder
g:	gloomy	u:	ugly weather
h:	hail	v:	unusual visibility
l:	lighting	w:	dew
m:	mist	z:	haze

7) Bar. Surface pressure (hPa)

8) V Visibility

0:	0- 50 m	dense fog	5:	2- 4km	visibility poor
1:	50- 200 m	thin fog	6:	4- 10km	moderate
2:	200- 500 m	fog	7:	10- 20km	good
3:	500-1000 m	moderate fog	8:	20- 50km	very good
4:	1- 2km	thin fog or mist	9:	more than 50 km	exceptional

9) Se Sea condition

0:	dead Calm	5:	rather rough
1:	very smooth	6:	rough
2:	smooth	7:	high
3:	slight	8:	very high
4:	moderate	9:	phenomenal

10) Sw Swell

0:	no swell	4:	rough swell
1:	slight swell	5:	heavy swell
2:	moderate swell	6:	very heavy swell
3:	rather rough swell	7:	abnormal swell

11) A.T. Atmospheric temperature (C˚)

12) S.T. Sea surface temperature (C˚)

13) Td. Dew point temperature (C˚)

(01/11) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14						bc							
15						o		6	1	0			
16						o		6	1	1			
17	35° 05.5'E	139° 41.9'E	NE	5.1	3	o	1011.6	6	1	1	10.5	14.4	-0.7
18	34° 54.5'E	139° 27.7'E	ENE	3.9	3	o	1011.7	6	2	1	11.2	16.8	2.3
19	34° 43.8'E	139° 14.8'E	NE	5.0	3	o	1011.6	6	2	1	11.6	16.6	4.5
20	34° 33.0'E	139° 01.0'E	N	0.3	1	o	1011.9	6	2	1	11.2	16.4	1.8
21	34° 23.2'E	138° 45.8'E	NE	4.1	3	o	1011.8	6	2	3	10.7	16.1	0.7
22	34° 13.3'E	138° 30.8'E	ENE	6.1	4	o	1011.5	6	3	3	10.5	15.8	1.0
23	34° 03.2'E	138° 15.9'E	E	4.1	3	o	1011.6	6	2	3	9.8	15.9	1.8

(01/12) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	33° 53.1'E	138° 00.8'E	E	3.0	2	o	1011.2	6	2	3	9.4	14.3	1.8
1	33° 42.8'E	137° 46.3'E	N	3.9	3	r	1010.6	7	2	3	9.6	15.7	2.3
2	33° 32.0'E	137° 31.4'E	NNE	3.8	3	o	1010.2	7	2	3	9.9	16.0	3.8
3	33° 21.4'E	137° 16.5'E	N	6.5	4	o	1009.7	7	2	3	10.3	15.5	3.0
4	33° 10.6'E	137° 01.7'E	NNE	7.3	4	r	1009.3	7	2	3	10.4	15.7	4.0
5	33° 00.6'E	136° 48.2'E	NNE	5.7	4	r	1010.0	7	2	3	10.4	19.8	6.3
6	32° 51.7'E	136° 35.6'E	NNE	7.2	4	o	1010.5	7	2	3	11.5	21.2	6.1
7	32° 42.4'E	136° 22.4'E	NNE	9.1	5	o	1010.4	7	2	3	12.6	21.1	6.1
8	32° 32.6'E	136° 09.0'E	NNE	7.5	4	bc	1011.0	7	2	3	12.9	21.3	5.5
9	32° 27.9'E	136° 04.4'E	NE	5.8	4	c	1011.8	7	2	3	13.1	20.8	6.4
10	32° 27.8'E	136° 05.1'E	NNE	4.1	3	c	1012.4	7	2	3	13.0	21.0	5.6
11	32° 27.3'E	136° 05.9'E	NNE	5.7	4	bc	1011.7	7	2	3	13.2	21.0	5.7
12	32° 28.7'E	136° 03.2'E	E	4.8	3	bc	1010.8	7	2	3	13.5	21.5	5.6
13	32° 28.3'E	136° 03.6'E	E	10.4	5	bc	1010.0	7	2	3	15.1	21.6	5.5
14	32° 28.4'E	136° 03.4'E	E	11.1	6	bc	1009.7	7	3	3	14.5	21.6	5.3
15	32° 27.5'E	136° 04.0'E	E	11.0	6	bc	1009.7	7	4	3	14.3	21.3	4.8
16	32° 14.3'E	135° 59.5'E	E	12.9	6	c	1010.3	7	4	3	14.1	21.2	5.4
17	32° 00.3'E	135° 55.2'E	E	13.6	6	bc	1010.8	7	4	3	14.3	21.1	3.7
18	31° 46.1'E	135° 51.1'E	E	16.3	7	c	1011.5	7	4	3	14.2	21.0	5.2
19	31° 32.1'E	135° 46.7'E	E	15.2	7	l	1012.6	7	4	3	14.2	20.3	4.5
20	31° 18.1'E	135° 42.5'E	N	16.4	7	c	1013.0	7	4	3	14.5	21.0	6.8
21	31° 05.4'E	135° 38.3'E	ENE	12.6	6	c	1014.1	7	4	3	12.8	21.1	6.9
22	30° 51.3'E	135° 34.2'E	E	14.4	7	bc	1014.3	7	4	3	14.0	20.6	5.6
23	30° 36.8'E	135° 30.0'E	NNE	18.3	8	bc	1015.1	7	4	3	13.1	20.4	7.9

(01/13) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	30° 22.2'E	135° 25.8'E	NNE	16.4	7	bc	1015.7	7	4	3	13.3	20.3	8.3
1	30° 07.6'E	135° 21.3'E	NNE	16.5	7	bc	1016.0	7	5	3	13.3	20.3	7.9
2	29° 52.9'E	135° 16.8'E	NNE	16.6	7	bc	1016.5	7	5	3	14.3	20.7	6.3
3	29° 37.8'E	135° 12.4'E	NNE	15.5	7	bc	1017.0	7	5	3	14.1	20.6	5.2
4	29° 23.1'E	135° 08.1'E	NNE	14.8	7	bc	1016.5	7	5	3	14.3	20.6	5.2
5	29° 08.3'E	135° 03.7'E	NNE	13.3	6	bc	1016.6	7	5	3	14.4	20.8	5.8
6	28° 53.3'E	134° 59.2'E	NNE	13.4	6	c	1017.5	7	5	3	14.9	20.8	5.8
7	28° 50.7'E	134° 58.0'E	NNE	10.9	6	o	1018.4	7	5	3	14.2	21.0	5.1
8	28° 50.4'E	134° 58.3'E	NNE	12.9	6	c	1018.5	7	5	3	15.0	21.0	6.4
9	28° 57.7'E	134° 53.9'E	NNE	13.1	6	bc	1019.1	7	5	3	14.5	21.1	5.2
10	29° 05.7'E	134° 49.8'E	NNE	12.5	6	c	1019.3	7	5	3	14.5	21.7	4.3
11	29° 04.3'E	134° 50.2'E	NNE	11.7	6	bc	1018.8	7	5	3	15.2	21.4	6.8
12	29° 03.7'E	134° 50.8'E	NNE	12.9	6	bc	1018.2	7	5	3	14.7	21.3	5.8
13	29° 04.9'E	134° 49.8'E	N	12.9	6	c	1017.7	7	5	3	14.9	21.3	7.4
14	29° 04.1'E	134° 50.5'E	NNE	9.6	5	bc	1018.0	7	5	3	14.6	21.0	5.1
15	29° 03.7'E	134° 50.3'E	NNE	12.5	6	c	1018.4	7	5	3	15.2	21.3	7.5
16	29° 03.3'E	134° 50.0'E	NNE	13.3	6	bc	1018.5	7	5	3	14.3	21.3	5.3
17	29° 02.3'E	134° 50.3'E	N	12.5	6	c	1018.4	7	5	3	14.8	21.0	6.0
18	29° 02.3'E	134° 52.8'E	NNE	13.4	6	o	1018.9	7	5	3	14.6	21.0	6.4
19	29° 05.1'E	135° 09.3'E	N	14.5	7	c	1019.6	7	5	3	14.8	21.2	6.8
20	29° 04.4'E	135° 15.7'E	N	10.4	5	bc	1020.1	7	5	3	14.7	21.1	5.5
21	29° 03.6'E	135° 24.1'E	N	10.2	5	bc	1020.2	7	5	3	14.5	20.8	4.7
22	29° 01.2'E	135° 33.4'E	N	11.6	6	bc	1019.7	7	5	3	15.0	20.7	7.0
23	29° 00.6'E	135° 43.0'E	N	13.9	6	bc	1019.8	7	5	3	15.0	20.6	6.5

(01/14) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 00.1'E	135° 52.2'E	N	14.0	7	bc	1020.0	7	5	3	14.7	20.7	6.1
1	28° 59.5'E	135° 58.3'E	N	10.8	6	bc	1020.0	7	5	3	14.4	20.8	3.6
2	28° 58.6'E	136° 02.7'E	N	10.0	5	bc	1019.5	7	5	3	14.1	20.5	4.2
3	28° 56.6'E	136° 06.4'E	E	14.3	7	bc	1019.5	7	5	3	14.5	20.6	5.4
4	28° 57.1'E	136° 05.2'E	E	14.6	7	bc	1019.4	7	5	3	14.0	20.7	4.6
5	28° 58.7'E	136° 01.7'E	N	15.6	7	c	1019.8	7	5	3	13.8	20.6	5.6
6	29° 00.2'E	135° 58.1'E	NNE	13.0	6	bc	1020.3	7	5	3	13.6	20.7	8.1
7	28° 59.5'E	135° 59.4'E	NNE	11.7	6	c	1021.0	7	5	3	13.6	20.7	5.3
8	29° 00.3'E	135° 59.0'E	NNE	12.5	6	c	1021.6	7	5	3	13.3	20.6	4.7
9	29° 01.8'E	135° 55.2'E	NNE	11.5	6	bc	1022.4	7	5	3	13.0	20.7	4.0
10	28° 58.9'E	135° 55.8'E	NE	7.6	4	c	1023.0	7	4	3	13.0	20.5	3.9
11	28° 58.3'E	135° 56.6'E	NNE	11.3	6	bc	1022.1	7	5	3	13.4	20.7	4.6
12	28° 59.5'E	135° 58.4'E	NNE	9.2	5	bc	1021.3	7	5	3	13.0	20.7	3.9
13	28° 59.6'E	135° 59.1'E	NNE	8.4	5	c	1020.8	7	5	3	13.6	20.7	3.0
14	28° 59.3'E	135° 59.0'E	NNE	8.6	5	bc	1020.9	7	4	3	14.0	21.1	2.0
15	28° 59.3'E	135° 58.7'E	NNE	7.0	4	c	1021.3	7	3	3	13.8	20.7	3.1
16	28° 59.3'E	135° 58.5'E	NNE	8.2	5	c	1021.1	7	3	3	14.1	20.9	3.1
17	28° 59.5'E	135° 58.3'E	N	6.0	4	c	1021.7	7	3	3	13.6	20.8	4.0
18	28° 59.3'E	135° 56.9'E	N	7.5	4	bc	1021.5	7	3	3	13.6	20.4	2.9
19	28° 57.8'E	135° 47.8'E	NNE	4.6	3	bc	1022.4	7	3	3	13.4	20.3	1.3
20	28° 56.1'E	135° 38.0'E	NE	4.8	3	bc	1022.3	7	3	3	13.5	20.4	2.3
21	28° 53.3'E	135° 28.6'E	NNE	4.0	3	bc	1022.2	7	3	3	13.5	20.4	3.3
22	28° 50.2'E	135° 19.2'E	E	2.6	2	bc	1021.5	7	3	3	13.7	20.6	2.4
23	28° 49.5'E	135° 09.4'E	E	6.2	4	c	1021.8	7	3	3	13.8	20.6	4.0

(01/15) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	28° 49.8'E	134° 59.6'E	E	3.9	3	bc	1021.2	7	3	3	13.6	21.6	3.0
1	28° 49.3'E	134° 59.5'E	NNE	4.8	3	c	1021.0	7	2	3	13.9	21.1	3.8
2	28° 48.7'E	134° 59.2'E	NNE	4.2	3	c	1020.6	7	2	3	14.0	21.2	4.8
3	28° 48.0'E	134° 59.0'E	NNE	4.8	3	r	1020.5	7	2	3	13.9	21.1	6.5
4	28° 47.1'E	134° 58.7'E	NE	3.5	3	r	1020.2	7	2	3	14.0	21.1	6.1
5	28° 46.3'E	134° 58.3'E	NE	2.8	2	r	1020.0	7	2	3	13.9	20.9	5.9
6	28° 45.3'E	134° 57.9'E	NE	8.1	5	r	1020.1	7	3	3	13.4	21.1	8.8
7	28° 50.6'E	134° 58.3'E	NE	7.1	4	r	1021.0	7	3	3	13.8	20.8	7.8
8	28° 50.6'E	134° 58.1'E	NE	11.6	6	r	1021.8	7	3	3	12.4	21.2	8.4
9	28° 50.6'E	134° 57.8'E	NNE	12.1	6	r	1022.6	6	3	3	12.9	21.1	7.9
10	28° 50.3'E	134° 57.2'E	NNE	12.2	6	r	1023.3	6	3	3	13.0	20.8	8.3
11	28° 49.6'E	134° 56.3'E	NE	12.0	6	r	1022.1	6	3	3	13.3	21.3	10.1
12	29° 02.5'E	134° 52.3'E	NE	9.8	5	r	1021.9	6	4	3	12.9	20.9	7.8
13	29° 17.4'E	134° 48.1'E	NNE	11.5	6	r	1021.4	6	4	3	12.6	20.4	7.4
14	29° 32.0'E	134° 44.1'E	NE	13.0	6	o	1021.4	6	4	3	13.1	20.4	4.5
15	29° 45.7'E	134° 39.9'E	NNE	13.6	6	bc	1022.3	7	5	3	12.7	20.5	1.4
16	29° 59.8'E	134° 36.3'E	NE	12.5	6	c	1023.2	7	5	3	11.8	20.1	3.0
17	30° 13.5'E	134° 32.4'E	NNE	11.8	6	c	1023.6	7	5	3	11.6	20.3	2.8
18	30° 27.3'E	134° 28.7'E	NNE	12.3	6	bc	1024.2	7	5	3	11.0	20.2	0.3
19	30° 41.7'E	134° 24.6'E	NE	10.8	6	bc	1024.9	7	5	3	10.8	20.3	0.7
20	30° 56.6'E	134° 20.5'E	N	9.4	5	bc	1025.3	7	4	3	10.8	20.3	-0.1
21	31° 11.7'E	134° 16.3'E	N	8.7	5	bc	1025.7	7	4	3	10.6	19.7	-1.7
22	31° 26.3'E	134° 11.6'E	N	6.6	4	bc	1025.7	7	3	3	10.9	21.2	-0.7
23	31° 41.6'E	134° 07.8'E	NE	7.0	4	bc	1026.5	7	3	3	10.6	21.5	0.5

(01/16) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	31° 57.1'E	134° 03.4'E	NNE	10.2	5	bc	1026.5	7	3	3	9.7	21.4	-1.1
1	32° 12.9'E	133° 58.9'E	NE	8.7	5	bc	1026.4	7	3	3	9.3	21.4	-1.0
2	32° 29.7'E	133° 54.0'E	NNE	7.5	4	bc	1026.7	7	3	3	8.9	21.1	-1.3
3	32° 45.3'E	133° 49.0'E	N	6.4	4	bc	1027.2	7	3	3	8.6	18.4	-3.6
4	33° 00.9'E	133° 45.0'E	N	5.3	3	b	1026.7	8	3	3	8.6	18.9	-1.1
5	33° 14.7'E	133° 46.2'E	NE	3.8	3	b	1026.6	8	3	2	7.7	19.1	-0.6
6	33° 25.6'E	133° 39.1'E	NNE	5.3	3	b	1026.8	8	3	1	5.6	16.1	-1.7
7	33° 25.1'E	133° 38.9'E	NNE	4.0	3	bc	1027.1	8	3	1	5.4	16.1	-0.9
8	33° 27.9'E	133° 37.5'E	N	3.2	2	bc	1027.9	8	2	1	4.8	15.7	-2.9
9	33° 30.0'E	133° 33.8'E	NNE	2.7	2	bc	1028.5	8	1	1	4.0	13.4	-2.8
10	33° 32.3'E	133° 33.5'E	NNE	0.5	1		1028.7				5.0	15.4	-4.3
11	33° 32.3'E	133° 33.5'E	NE	1.2	1		1027.9				6.6	14.7	-5.9
12	33° 32.3'E	133° 33.5'E	E	0.8	1	bc	1026.8				9.1	15.0	-3.4
13	33° 32.3'E	133° 33.5'E	NE	3.6	3		1025.7				9.3	15.2	-1.6
14	33° 32.3'E	133° 33.5'E	NE	2.4	2		1025.3				9.6	15.3	-3.6
15	33° 32.3'E	133° 33.5'E	NE	2.1	2		1024.8				10.1	15.5	-2.6
16	33° 32.3'E	133° 33.5'E	NNE	2.2	2	o	1024.8				10.5	15.8	-1.2
17	33° 30.2'E	133° 33.6'E	NE	1.3	1	o	1024.9				10.6	14.1	-1.0
18	33° 20.9'E	133° 38.9'E	NE	2.9	2	c	1024.8	7	1	1	11.2	16.1	-1.8
19	33° 05.9'E	133° 44.5'E	ENE	6.1	4	c	1024.9	7	2	1	11.9	18.8	0.0
20	32° 50.8'E	133° 49.7'E	ENE	7.9	4	bc	1024.9	7	3	1	12.1	18.6	2.9
21	32° 36.2'E	133° 55.0'E	E	5.0	3	bc	1025.0	7	3	1	12.1	18.7	2.1
22	32° 22.0'E	134° 00.5'E	NNE	3.5	3	bc	1024.8	7	2	1	12.1	18.8	0.6
23	32° 08.0'E	134° 05.2'E	N	1.7	2	b	1024.5	7	2	1	12.4	20.4	0.6

(01/17) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	31° 54.1'E	134° 09.8'E	ENE	1.6	2	b	1024.1	7	2	1	12.7	21.3	1.6
1	31° 39.7'E	134° 15.4'E	ENE	4.0	3	bc	1023.1	8	2	1	13.7	20.6	2.5
2	31° 25.2'E	134° 20.7'E	NE	5.8	4	bc	1022.5	8	2	1	14.6	20.9	3.8
3	31° 10.3'E	134° 25.8'E	NNE	5.5	4	bc	1022.5	8	2	1	14.5	20.0	4.3
4	30° 55.8'E	134° 30.8'E	E	5.3	3	bc	1021.9	8	3	1	14.5	20.4	3.0
5	30° 41.0'E	134° 35.9'E	NNE	4.8	3	c	1021.5	8	3	1	14.9	20.3	3.0
6	30° 26.2'E	134° 41.1'E	N	6.3	4	bc	1021.3	8	3	1	15.1	20.4	4.8
7	30° 11.2'E	134° 46.3'E	E	6.6	4	c	1021.2	8	3	1	15.2	20.0	5.8
8	29° 56.2'E	134° 51.4'E	E	7.0	4	c	1021.0	8	3	1	15.8	20.4	6.8
9	29° 41.5'E	134° 56.5'E	E	8.7	5	bc	1020.8	8	3	1	16.6	20.4	8.6
10	29° 27.2'E	135° 01.3'E	ENE	9.4	5	bc	1020.2	8	3	1	17.2	20.2	9.2
11	29° 13.0'E	135° 06.2'E	E	9.8	5	c	1019.6	8	3	1	17.7	20.7	11.0
12	29° 06.1'E	135° 08.3'E	N	9.3	5	c	1018.8	8	3	1	18.4	20.9	11.5
13	29° 06.5'E	135° 07.4'E	N	5.4	3	o	1017.3	8	3	1	18.5	21.1	11.7
14	29° 06.8'E	135° 07.3'E	NNE	6.0	4	r	1016.3	7	3	1	18.8	20.9	12.2
15	29° 07.4'E	135° 07.2'E	NNE	10.6	5	o	1015.2	7	4	3	19.2	20.7	13.3
16	29° 08.3'E	135° 07.5'E	NE	10.7	5	r	1016.3	6	4	3	17.3	20.5	14.8
17	29° 09.1'E	135° 08.1'E	ENE	10.4	5	r	1016.5	6	4	3	17.1	20.5	15.3
18	29° 09.5'E	135° 08.1'E	E	7.5	4	o	1017.1	6	4	3	17.9	20.7	13.7
19	29° 09.9'E	135° 06.6'E	N	13.4	6	r	1017.5	6	4	3	17.0	20.7	11.9
20	29° 09.7'E	135° 06.6'E	NNE	9.7	5	r	1017.3	6	4	3	17.3	20.7	10.5
21	29° 09.1'E	135° 08.1'E	NNE	9.3	5	o	1017.8	7	4	3	17.4	20.8	10.3
22	29° 10.1'E	135° 07.2'E	NNE	11.4	6	bc	1018.3	7	4	3	17.1	20.6	8.1
23	29° 09.5'E	135° 07.3'E	NNE	10.4	5	b	1018.3	7	4	3	17.1	20.2	8.8

(01/18) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 09.4'E	135° 07.7'E	NNE	10.6	5	bc	1018.3	7	4	3	17.1	20.7	7.2
1	29° 10.5'E	135° 06.6'E	NE	10.0	5	bc	1018.4	8	4	3	16.1	20.4	8.6
2	29° 07.9'E	135° 07.9'E	NE	9.7	5	c	1018.6	8	4	3	16.1	20.4	8.9
3	29° 07.0'E	135° 08.3'E	ENE	10.4	5	bc	1018.7	8	4	3	15.2	20.4	6.7
4	29° 08.7'E	135° 07.5'E	NE	10.9	6	c	1019.3	8	4	3	14.8	20.4	7.3
5	29° 08.0'E	135° 07.3'E	NE	11.4	6	bc	1019.4	8	4	3	14.7	20.5	6.5
6	29° 07.6'E	135° 07.7'E	NE	11.5	6	bc	1020.1	8	4	3	14.2	20.9	5.4
7	29° 08.6'E	135° 06.7'E	NE	9.8	5	c	1020.8	8	4	3	13.6	20.6	3.0
8	29° 08.7'E	135° 06.0'E	NE	9.5	5	bc	1021.5	8	4	3	13.6	20.4	5.2
9	29° 08.2'E	135° 07.6'E	NNE	9.0	5	c	1022.7	8	4	4	13.2	20.5	1.8
10	29° 09.7'E	135° 07.1'E	NE	8.9	5	bc	1022.7	8	4	4	13.3	20.5	2.1
11	29° 09.3'E	135° 06.6'E	NNE	8.6	5	bc	1022.3	8	4	4	13.9	20.6	3.6
12	29° 09.6'E	135° 06.4'E	NE	8.1	5	bc	1021.1	8	4	4	13.6	20.5	2.8
13	29° 11.7'E	135° 04.7'E	NE	8.5	5	bc	1020.9	8	4	4	13.6	20.6	3.2
14	29° 09.7'E	135° 06.8'E	NNE	7.7	4	bc	1021.1	8	4	4	13.7	20.2	5.2
15	29° 07.4'E	135° 08.8'E	NE	8.2	5	c	1021.0	8	4	4	13.8	20.6	3.3
16	29° 09.7'E	135° 07.1'E	NE	9.5	5	c	1021.7	8	4	4	13.8	20.6	4.8
17	29° 09.5'E	135° 06.6'E	ENE	8.1	5	c	1022.1	8	4	4	13.9	20.5	6.4
18	29° 08.9'E	135° 06.5'E	ENE	9.0	5	c	1022.5	8	4	4	13.6	20.3	5.7
19	29° 08.5'E	135° 07.8'E	NE	8.6	5	bc	1022.8	8	4	4	13.7	20.6	6.5
20	29° 08.1'E	135° 07.7'E	N	7.6	4	c	1023.5	8	4	4	13.9	20.5	6.4
21	29° 07.5'E	135° 07.6'E	NE	8.0	5	bc	1024.2	8	4	4	13.7	20.5	5.4
22	29° 09.0'E	135° 06.8'E	ENE	8.7	5	bc	1024.4	8	4	4	13.9	20.5	5.9
23	29° 08.5'E	135° 06.6'E	NNE	6.1	4	bc	1024.2	8	4	4	14.2	20.3	6.0

(01/19) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 07.8'E	135° 06.2'E	NNE	7.9	4	bc	1024.0	8	4	4	14.4	20.2	5.1
1	29° 08.9'E	135° 07.6'E	NE	8.4	5	bc	1024.0	8	4	4	14.4	20.6	6.4
2	29° 08.1'E	135° 06.8'E	NNE	6.5	4	bc	1023.9	8	4	4	14.2	20.7	6.0
3	29° 07.5'E	135° 05.8'E	NE	7.4	4	c	1024.2	8	4	4	14.5	20.4	5.0
4	29° 09.1'E	135° 08.2'E	NE	7.3	4	r	1024.2	7	4	4	14.3	20.5	7.8
5	29° 08.4'E	135° 07.2'E	NNE	8.3	5	bc	1025.1	8	4	4	14.1	20.5	7.0
6	29° 07.5'E	135° 06.0'E	NNE	8.0	5	c	1025.8	8	4	4	14.0	20.5	5.4
7	29° 08.7'E	135° 07.9'E	NE	9.4	5	c	1026.6	8	4	4	13.8	20.7	5.0
8	29° 08.3'E	135° 06.6'E	NE	7.0	4	bc	1026.7	8	4	4	13.9	20.3	4.2
9	29° 07.5'E	135° 06.7'E	NE	5.8	4	bc	1027.6	8	3	4	13.8	20.6	3.8
10	29° 08.8'E	135° 06.3'E	NNE	6.2	4	bc	1027.7	8	3	4	14.3	20.7	4.5
11	29° 08.6'E	135° 05.2'E	NNE	6.4	4	bc	1027.2	8	3	4	14.9	20.7	6.3
12	29° 08.7'E	135° 07.8'E	NNE	5.3	3	bc	1026.5	8	3	3	14.6	20.7	6.8
13	29° 09.3'E	135° 08.4'E	NE	6.8	4	bc	1025.8	8	3	3	14.9	20.3	6.7
14	29° 09.2'E	135° 07.8'E	NE	6.7	4	bc	1026.0	8	3	3	14.2	20.5	4.5
15	29° 09.3'E	135° 07.1'E	ENE	4.4	3	bc	1026.1	8	2	3	14.7	20.5	3.6
16	29° 10.7'E	135° 08.2'E	NE	4.5	3	bc	1025.9	8	2	3	14.3	20.5	3.3
17	29° 07.3'E	135° 11.4'E	ENE	5.8	4	bc	1026.3	8	2	3	14.4	20.2	3.5
18	29° 02.5'E	135° 15.4'E	ENE	4.6	3	bc	1026.6	8	2	3	14.9	20.1	3.5
19	29° 05.4'E	135° 17.2'E	ENE	5.7	4	bc	1026.8	8	2	3	14.6	20.2	3.7
20	29° 10.7'E	135° 21.2'E	ENE	5.9	4	bc	1027.3	8	2	3	14.7	20.7	4.2
21	29° 10.6'E	135° 19.4'E	E	4.2	3	bc	1027.4	8	2	3	14.5	20.5	2.9
22	29° 10.7'E	135° 20.5'E	ENE	5.4	3	bc	1027.1	8	2	3	14.6	20.4	3.3
23	29° 11.0'E	135° 11.5'E	ENE	5.3	3	bc	1027.1	8	2	3	14.8	20.2	5.1

(01/20) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 10.3'E	135° 10.2'E	ENE	3.9	3	bc	1026.6	8	2	3	14.9	20.4	5.0
1	29° 11.6'E	135° 10.0'E	N	5.7	4	bc	1025.9	8	2	3	15.4	20.2	4.3
2	29° 10.7'E	135° 09.9'E	N	4.1	3	bc	1026.1	8	2	3	15.4	20.2	5.8
3	29° 11.0'E	134° 59.9'E	NNE	3.1	2	bc	1025.8	8	2	3	15.3	20.5	5.4
4	29° 10.1'E	135° 01.2'E	NNE	6.8	4	c	1024.7	8	2	3	15.5	20.6	5.5
5	29° 09.9'E	134° 59.9'E	NE	5.5	4	c	1024.7	8	2	3	15.7	20.2	6.4
6	29° 11.1'E	135° 00.2'E	NNE	5.2	3	bc	1024.9	8	2	3	16.1	20.2	5.7
7	29° 10.6'E	134° 59.2'E	NNE	4.7	3	bc	1025.7	8	2	3	16.2	20.2	7.3
8	29° 11.0'E	134° 49.3'E	NE	4.5	3	c	1025.4	8	2	3	16.4	20.2	8.0
9	29° 10.9'E	134° 45.9'E	N	6.8	4	bc	1025.1	8	2	1	16.7	20.6	8.2
10	29° 10.9'E	134° 45.9'E	NNE	5.8	4	bc	1025.4	8	2	1	17.1	20.6	8.7
11	29° 11.1'E	134° 38.0'E	NNE	7.1	4	bc	1024.5	8	2	1	17.5	20.6	9.5
12	29° 08.8'E	134° 39.5'E	NNE	5.8	4	bc	1023.9	8	3	1	17.5	20.2	10.2
13	29° 02.8'E	134° 43.7'E	NNE	4.7	3	o	1022.9	8	3	1	17.6	20.9	10.4
14	29° 05.0'E	134° 45.2'E	NNE	4.5	3	o	1022.8	8	3	1	17.6	20.6	10.2
15	29° 06.4'E	134° 49.7'E	ENE	2.0	2	r	1023.2	8	2	1	17.7	20.6	9.6
16	29° 06.3'E	134° 50.9'E	NNE	4.9	3	c	1021.7	7	2	1	17.8	20.1	10.8
17	29° 05.6'E	134° 48.7'E	NNE	5.1	3	r	1022.4	7	2	1	17.8	20.8	11.0
18	29° 02.9'E	134° 54.5'E	NNE	5.9	4	r	1021.9	7	2	1	17.8	20.2	11.7
19	29° 00.9'E	134° 56.1'E	NNE	7.0	4	c	1021.5	7	2	1	18.5	20.2	12.7
20	28° 59.7'E	134° 56.6'E	NE	4.7	3	o	1021.7	7	2	1	19.1	20.5	12.6
21	29° 02.3'E	135° 03.9'E	NE	7.4	4	o	1021.4	7	3	1	19.0	20.6	12.7
22	29° 01.8'E	135° 04.1'E	NE	9.0	5	bc	1021.5	7	3	3	19.1	20.5	12.8
23	29° 02.9'E	135° 04.9'E	NE	8.7	5	bc	1020.8	7	3	3	19.6	20.1	13.5

(01/21) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	28° 57.3'E	135° 08.8'E	NE	9.3	5	c	1020.1	7	3	3	19.3	20.1	13.9
1	28° 56.0'E	135° 09.6'E	ENE	8.8	5	c	1019.6	8	3	3	19.4	20.1	13.6
2	28° 56.6'E	135° 08.2'E	ENE	9.3	5	r	1019.1	7	3	3	19.0	20.1	14.7
3	28° 55.1'E	135° 10.0'E	NE	10.4	5	r	1019.1	7	3	3	19.2	20.4	14.3
4	28° 53.3'E	135° 11.4'E	ENE	10.9	6	r	1018.8	7	4	3	19.3	20.4	14.9
5	28° 53.4'E	135° 12.4'E	ENE	9.9	5	r	1018.3	7	4	3	19.0	20.4	15.6
6	28° 54.6'E	135° 11.0'E	ENE	10.6	5	r	1018.1	7	4	3	19.0	20.5	15.9
7	28° 55.4'E	135° 09.3'E	ENE	10.3	5	r	1017.6	7	4	3	19.1	20.2	15.1
8	28° 54.7'E	135° 00.2'E	ENE	13.5	6	r	1017.1	7	4	3	19.7	20.6	16.5
9	28° 55.0'E	134° 58.7'E	E	10.7	5	r	1017.8	6	4	3	19.0	20.8	16.5
10	28° 53.5'E	134° 58.4'E	ENE	12.0	6	r	1016.8	6	4	3	19.3	20.8	17.2
11	28° 54.6'E	134° 49.7'E	E	14.3	7	o	1015.6	7	4	3	20.6	20.7	17.0
12	28° 54.2'E	134° 49.5'E	E	14.3	7	o	1013.7	7	4	3	20.9	20.7	17.2
13	28° 46.3'E	134° 54.7'E	E	14.0	7	r	1013.2	7	5	3	20.8	21.0	17.4
14	28° 48.7'E	134° 59.4'E	N	14.0	7	r	1012.5	6	5	3	20.5	20.1	18.2
15	28° 48.4'E	135° 01.0'E	NNE	11.2	6	r	1012.4	5	5	3	20.7	20.6	18.2
16	28° 46.5'E	134° 60.0'E	NNE	14.7	7	o	1011.9	6	5	3	20.9	20.8	17.1
17	28° 46.7'E	135° 05.2'E	NNE	14.6	7	c	1011.8	6	5	3	20.9	20.3	17.3
18	28° 45.1'E	135° 03.8'E	NNE	13.9	6	o	1012.0	7	5	3	20.5	20.5	17.5
19	28° 39.7'E	135° 00.9'E	NNE	12.0	6	c	1012.1	7	5	3	21.0	20.9	18.3
20	28° 37.9'E	135° 00.1'E	NNE	11.2	6	c	1012.1	7	5	3	20.8	21.1	18.3
21	28° 42.4'E	135° 01.8'E	NE	9.4	5	bc	1011.6	7	4	3	20.8	20.9	17.8
22	28° 42.0'E	135° 00.9'E	ENE	10.8	6	bc	1012.0	7	4	3	20.7	20.9	18.1
23	28° 48.9'E	135° 03.7'E	ENE	10.8	6	bc	1011.6	7	4	3	20.5	20.3	17.7

(01/22) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	28° 56.5'E	135° 06.9'E	ENE	10.0	5	bc	1011.2	7	4	3	20.3	20.3	17.8
1	29° 04.1'E	135° 10.2'E	ENE	10.7	5	b	1010.6	8	4	3	20.1	20.4	17.5
2	29° 03.4'E	135° 09.9'E	ENE	9.9	5	bc	1010.7	8	4	3	20.1	20.4	16.7
3	29° 01.7'E	135° 08.7'E	ENE	11.3	6	bc	1010.8	8	4	3	20.1	20.5	16.1
4	29° 01.6'E	135° 04.9'E	E	12.5	6	bc	1010.6	8	4	3	20.0	20.5	15.6
5	29° 03.5'E	135° 08.2'E	E	10.3	5	r	1010.6	7	4	3	19.9	20.6	16.0
6	29° 05.2'E	135° 12.1'E	E	12.3	6	bc	1011.2	8	4	3	20.2	20.6	14.1
7	29° 04.9'E	135° 13.9'E	E	10.5	5	o	1011.7	8	4	3	19.8	20.6	15.0
8	29° 05.2'E	135° 11.0'E	N	10.2	5	c	1011.7	8	4	3	19.8	20.6	14.2
9	29° 05.6'E	135° 10.1'E	E	11.4	6	bc	1012.3	8	4	3	19.9	20.5	13.8
10	29° 06.0'E	135° 08.8'E	N	13.3	6	bc	1013.0	8	4	3	19.6	21.1	13.4
11	29° 06.0'E	135° 08.4'E	E	10.9	6	bc	1012.4	8	4	3	19.8	21.0	13.0
12	29° 05.7'E	135° 07.7'E	NE	10.9	6	bc	1012.2	6	4	3	18.9	20.5	13.7
13	29° 05.9'E	135° 06.9'E	NNE	11.0	6	c	1012.1	7	4	3	18.5	20.4	12.9
14	29° 06.1'E	135° 08.5'E	NNE	10.8	6	bc	1012.1	7	4	3	18.5	20.3	12.1
15	29° 05.9'E	135° 10.6'E	NNE	11.0	6	c	1012.4	6	4	3	18.3	20.7	12.4
16	29° 08.0'E	135° 08.3'E	NE	8.6	5	c	1012.6	7	4	3	17.9	20.6	12.6
17	29° 08.3'E	135° 07.6'E	NE	12.0	6	c	1013.7	7	4	3	16.7	20.4	12.9
18	29° 07.7'E	135° 08.0'E	ENE	9.1	5	c	1014.6	7	4	3	17.5	20.2	11.7
19	29° 08.0'E	135° 08.1'E	ENE	5.5	4	c	1015.1	7	4	3	17.2	20.2	11.4
20	29° 08.4'E	135° 07.9'E	N	9.4	5	c	1015.7	7	4	3	17.3	20.4	10.5
21	29° 08.3'E	135° 07.4'E	N	8.8	5	bc	1016.3	7	4	3	17.1	20.4	10.1
22	29° 09.7'E	135° 07.1'E	N	9.0	5	bc	1016.6	7	4	3	17.0	20.5	9.9
23	29° 08.1'E	134° 52.6'E	N	8.8	5	bc	1016.7	7	4	3	17.1	20.1	9.4

(01/23) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 06.0'E	134° 35.2'E	N	7.0	4	bc	1017.2	7	4	3	16.9	20.1	9.7
1	29° 03.8'E	134° 17.7'E	N	7.3	4	bc	1017.3	8	4	3	17.2	20.3	9.4
2	29° 01.9'E	133° 59.8'E	ENE	7.9	4	c	1017.8	8	4	3	17.2	20.5	8.2
3	28° 59.6'E	133° 42.0'E	N	8.1	5	bc	1017.7	8	4	3	17.0	20.2	8.5
4	28° 57.7'E	133° 30.4'E	NNE	6.5	4	o	1018.2	8	4	3	17.2	20.8	8.3
5	28° 56.6'E	133° 29.6'E	NNE	8.3	5	o	1018.9	7	4	3	16.5	20.8	10.8
6	28° 58.3'E	133° 30.2'E	N	8.8	5	o	1019.8	7	4	3	16.9	20.7	8.3
7	28° 57.0'E	133° 29.4'E	N	8.9	5	o	1020.6	7	4	3	17.0	20.6	8.2
8	28° 57.8'E	133° 29.8'E	NNE	10.7	5	r	1021.8	7	4	3	16.4	20.8	10.2
9	28° 58.3'E	133° 29.1'E	NNE	8.0	5	o	1022.8	7	4	3	16.1	20.4	7.9
10	28° 57.7'E	133° 28.8'E	NNE	9.8	5	c	1023.2	7	4	3	16.0	20.7	6.6
11	28° 57.3'E	133° 28.7'E	N	10.2	5	c	1022.9	7	4	3	16.4	20.5	7.1
12	28° 56.9'E	133° 28.2'E	NNE	10.6	5	bc	1022.0	7	4	3	16.5	20.4	8.4
13	29° 00.8'E	133° 11.7'E	NNE	12.1	6	c	1021.8	7	4	3	15.9	20.4	7.2
14	29° 04.7'E	132° 55.0'E	NNE	11.7	6	bc	1021.6	7	4	3	15.8	20.0	7.2
15	29° 09.3'E	132° 38.9'E	NE	12.9	6	bc	1021.5	7	4	3	15.7	20.1	7.5
16	29° 13.1'E	132° 22.2'E	NE	11.8	6	c	1021.8	7	4	3	15.5	20.0	6.9
17	29° 17.0'E	132° 05.4'E	NE	10.5	5	bc	1022.9	7	4	3	14.9	20.8	6.4
18	29° 21.1'E	131° 48.2'E	NE	10.5	5	c	1023.8	7	4	3	14.8	21.2	6.9
19	29° 25.1'E	131° 30.7'E	ENE	8.6	5	bc	1024.6	7	4	3	14.2	21.4	4.6
20	29° 30.1'E	131° 14.0'E	ENE	10.1	5	bc	1024.8	7	4	3	14.8	21.4	6.8
21	29° 34.3'E	130° 58.4'E	ENE	9.4	5	bc	1024.7	7	4	3	14.8	21.4	6.1
22	29° 38.5'E	130° 41.5'E	E	9.3	5	bc	1024.4	7	3	3	15.0	21.9	7.1
23	29° 42.7'E	130° 24.3'E	E	9.1	5	bc	1024.9	7	3	3	15.1	21.9	4.7

(01/24) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 44.7'E	130° 06.4'E	E	9.8	5	bc	1023.9	7	3	3	15.6	21.9	7.0
1	29° 58.2'E	130° 10.2'E	NNE	9.8	5	bc	1023.3	8	4	3	15.2	22.1	5.2
2	30° 12.2'E	130° 14.9'E	NNE	12.9	6	c	1022.7	8	4	3	15.2	21.9	6.0
3	30° 26.2'E	130° 20.2'E	NNE	2.3	2	o	1022.5	8	3	1	14.4	21.3	4.8
4	30° 40.5'E	130° 26.6'E	N	10.0	5	o	1021.8	8	4	3	14.4	20.0	5.8
5	30° 55.2'E	130° 33.0'E	N	9.4	5	o	1022.5	8	4	3	13.8	18.5	8.0
6	31° 09.0'E	130° 40.7'E	NE	7.3	4	o	1022.5	8	3	1	12.0	16.7	6.0
7	31° 23.5'E	130° 40.7'E	N	10.7	5	o	1022.0	8	2	1	11.3	15.8	5.6
8	31° 30.3'E	130° 37.2'E	ENE	5.7	4	o	1022.4	8	2	1	12.4	16.1	5.3
9	31° 33.3'E	130° 35.4'E	ENE	1.8	2	o	1022.2	8	1	1	12.6	16.3	4.7
10						o		8	1	1			
11													
12													
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18													
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23													

(01/28) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14	31° 33.4'E	130° 35.0'E	NE	3.2	2	bc	1024.9	6	1	0	10.4	16.3	-3.0
15	31° 19.1'E	130° 42.5'E	NNE	1.7	2	bc	1024.4	7	1	0	10.5	15.8	-2.2
16	31° 05.2'E	130° 37.6'E	NE	0.9	1	bc	1024.2	7	1	0	10.9	17.4	-2.7
17	30° 49.7'E	130° 39.2'E	ENE	8.8	5	c	1023.9	7	2	1	11.6	19.2	3.9
18	30° 34.7'E	130° 43.3'E	ENE	10.3	5	o	1023.8	7	3	1	12.4	20.7	5.0
19	30° 18.2'E	130° 47.9'E	ENE	10.3	5	o	1023.4	7	3	1	12.4	20.8	5.0
20	30° 02.0'E	130° 52.6'E	NE	9.5	5	c	1024.5	7	3	1	13.9	21.5	6.3
21	29° 56.1'E	131° 09.1'E	NE	10.1	5	c	1023.9	7	3	3	14.1	21.8	6.6
22	29° 51.8'E	131° 26.8'E	NE	9.7	5	o	1023.7	7	3	3	14.1	21.4	5.4
23	29° 47.5'E	131° 44.3'E	NE	10.7	5	o	1023.5	7	4	3	14.0	21.5	5.8

(01/29) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 43.6'E	132° 01.8'E	NE	10.1	5	o	1023.0	7	4	3	13.9	21.0	7.5
1	29° 39.2'E	132° 18.9'E	ENE	8.1	5	c	1023.1	7	3	3	14.1	20.8	7.1
2	29° 34.9'E	132° 36.6'E	NE	9.0	5	o	1023.0	7	3	3	13.7	19.9	7.7
3	29° 30.7'E	132° 54.0'E	NE	8.2	5	o	1021.9	7	3	3	14.3	20.5	7.7
4	29° 26.8'E	133° 10.7'E	NE	4.8	3	o	1022.0	8	2	3	14.3	20.0	5.5
5	29° 23.6'E	133° 27.2'E	ENE	4.0	3	o	1021.9	7	2	3	14.1	19.9	5.7
6	29° 19.1'E	133° 43.6'E	ENE	3.3	2	o	1022.8	7	2	3	14.1	20.1	5.7
7	29° 14.6'E	134° 00.2'E	NE	5.3	3	o	1022.8	7	2	3	14.0	20.3	5.7
8	29° 10.6'E	134° 16.5'E	NE	6.1	4	o	1023.5	8	2	3	14.1	20.0	5.8
9	29° 06.5'E	134° 32.4'E	ENE	4.8	3	c	1023.6	8	2	3	14.3	20.0	5.1
10	29° 03.9'E	134° 49.3'E	ENE	4.4	3	o	1023.9	8	2	3	14.6	20.0	5.4
11	29° 05.0'E	135° 00.1'E	NE	3.4	3	o	1023.9	8	2	3	14.9	20.7	6.1
12	29° 05.3'E	135° 00.0'E	NE	4.2	3	c	1023.2	8	2	3	14.7	20.6	5.3
13	29° 07.8'E	135° 01.9'E	NE	3.6	3	c	1022.1	8	2	3	14.7	20.5	5.3
14	29° 05.2'E	135° 00.1'E	NE	4.6	3	c	1022.0	8	2	3	14.8	20.3	5.5
15	29° 03.9'E	134° 58.0'E	NE	4.3	3	o	1022.0	8	2	3	14.6	20.5	5.5
16	29° 06.9'E	134° 59.0'E	NNE	4.5	3	o	1022.3	8	2	3	14.6	20.6	5.5
17	29° 04.7'E	135° 00.6'E	NE	4.8	3	o	1022.6	8	2	3	14.8	20.5	6.0
18	29° 04.7'E	135° 00.6'E	NNE	3.9	3	o	1022.8	8	2	3	14.9	20.4	6.3
19	29° 07.9'E	135° 02.1'E	NE	5.0	3	o	1023.3	8	2	3	14.8	20.4	7.1
20	29° 03.4'E	134° 59.5'E	NNE	4.9	3	o	1023.4	8	2	3	14.9	20.3	6.1
21	29° 03.4'E	134° 58.8'E	NE	7.6	4	r	1023.6	7	2	3	14.5	20.6	8.7
22	29° 05.9'E	135° 00.5'E	NNE	7.6	4	o	1023.6	8	2	3	14.5	20.4	7.4
23	29° 04.8'E	135° 00.0'E	NNE	6.7	4	o	1023.4	8	2	3	15.1	20.7	8.3

(01/30) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 04.8'E	135° 00.1'E	NNE	7.2	4	o	1023.1	8	2	3	14.8	20.7	8.2
1	29° 07.5'E	134° 60.0'E	N	6.1	4	o	1023.1	8	2	3	14.5	20.5	6.8
2	29° 07.5'E	134° 59.9'E	N	6.6	4	o	1022.8	8	2	3	15.1	20.3	8.5
3	29° 03.4'E	135° 00.2'E	ENE	3.9	3	o	1022.9	8	2	3	14.9	20.6	6.8
4	29° 05.9'E	135° 00.1'E	NNE	5.9	4	o	1022.4	8	2	3	14.9	20.6	6.3
5	29° 04.7'E	135° 00.3'E	N	6.2	4	o	1022.0	8	2	3	15.1	20.3	5.3
6	29° 04.8'E	135° 00.7'E	NNE	6.0	4	o	1022.3	8	2	3	15.0	20.6	3.9
7	29° 08.3'E	135° 01.5'E	NE	5.9	4	o	1021.6	8	2	3	14.8	20.4	5.3
8	29° 02.7'E	134° 59.4'E	NNE	6.1	4	o	1022.8	8	2	3	15.1	20.5	5.8
9	29° 02.4'E	134° 58.8'E	NE	8.5	5	r	1023.3	7	2	3	14.6	20.8	8.0
10	29° 04.4'E	135° 01.0'E	NE	6.1	4	o	1023.7	7	2	3	15.0	20.3	7.8
11	29° 04.8'E	134° 60.0'E	NNE	6.2	4	r	1023.4	7	2	3	15.1	20.3	6.9
12	29° 05.0'E	135° 00.0'E	NE	5.3	3	r	1022.3	7	2	3	14.8	20.5	6.5
13	29° 08.6'E	135° 00.8'E	N	5.0	3	o	1021.6	8	2	3	14.8	20.3	3.8
14	29° 02.2'E	134° 59.7'E	ENE	3.7	3	c	1021.4	8	2	3	15.0	20.4	5.2
15	29° 01.8'E	134° 59.0'E	NE	5.2	3	c	1021.4	8	2	3	14.8	20.7	5.7
16	29° 04.3'E	134° 57.8'E	NNE	4.8	3	o	1021.4	8	2	3	14.9	20.7	5.7
17	29° 04.5'E	135° 00.4'E	NE	4.8	3	o	1021.6	8	2	3	15.3	21.0	6.9
18	29° 04.5'E	135° 00.8'E	NE	5.0	3	o	1021.6	8	2	3	15.1	20.6	5.8
19	29° 04.0'E	135° 00.7'E	ENE	5.9	4	r	1021.8	8	2	3	15.3	20.6	7.3
20	29° 03.3'E	135° 00.5'E	NE	7.0	4	o	1022.2	8	2	3	15.4	20.6	6.8
21	29° 02.8'E	135° 00.1'E	NE	6.6	4	o	1022.2	8	2	3	14.9	20.5	4.3
22	29° 05.7'E	134° 58.9'E	NE	7.8	4	c	1022.0	8	2	3	14.8	20.7	4.5
23	29° 06.3'E	135° 00.2'E	NE	5.8	4	c	1021.7	8	2	3	15.0	20.7	6.1

(01/31) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	29° 05.7'E	135° 00.2'E	NE	6.4	4	bc	1021.6	8	2	3	15.1	20.7	6.8
1	29° 05.0'E	135° 00.3'E	NNE	7.2	4	bc	1021.4	8	2	3	14.6	20.6	7.1
2	29° 04.0'E	135° 00.8'E	NE	8.3	5	bc	1021.3	8	3	3	14.6	20.7	6.9
3	29° 03.4'E	135° 00.3'E	NNE	9.9	5	bc	1020.8	8	3	3	14.5	20.4	5.9
4	29° 03.2'E	135° 00.2'E	NE	11.4	6	bc	1020.3	8	3	3	14.3	20.4	5.3
5	29° 05.3'E	135° 00.4'E	NE	10.6	5	bc	1020.1	8	3	3	14.5	20.3	5.6
6	29° 05.5'E	135° 01.4'E	NE	8.9	5	bc	1020.0	8	3	3	14.6	20.8	3.7
7	29° 04.8'E	135° 01.6'E	NE	7.8	4	bc	1019.9	8	3	3	15.0	20.5	5.7
8	29° 03.7'E	135° 01.7'E	NE	5.0	3	c	1020.7	8	3	3	14.9	20.5	4.3
9	29° 03.1'E	135° 01.5'E	NE	5.8	4	c	1021.1	8	3	3	14.6	20.3	4.7
10	29° 05.7'E	134° 59.9'E	NE	5.1	3	o	1020.9	8	3	3	14.5	20.4	4.4
11	29° 05.4'E	135° 00.9'E	NE	5.7	4	o	1020.4	8	3	3	14.9	20.3	5.6
12	28° 58.1'E	135° 15.6'E	NNE	4.9	3	o	1020.1	8	3	3	14.9	20.0	5.2
13	28° 51.3'E	135° 30.1'E	NE	2.1	2	bc	1018.8	8	2	3	15.3	20.2	5.3
14	28° 51.1'E	135° 30.4'E	N	5.6	4	bc	1018.3	8	2	3	15.4	20.0	5.5
15	28° 51.4'E	135° 29.8'E	NNE	4.8	3	bc	1018.2	8	2	3	15.5	20.3	5.7
16	28° 52.4'E	135° 28.4'E	NE	5.6	4	c	1018.2	8	3	3	14.8	20.3	7.5
17	28° 49.2'E	135° 38.6'E	NE	5.8	4	o	1018.4	8	2	3	14.8	19.9	7.2
18	28° 44.2'E	135° 56.0'E	NNE	5.2	3	o	1018.3	8	2	3	15.0	19.9	6.7
19	28° 42.4'E	136° 00.0'E	N	4.0	3	o	1018.2	8	2	3	15.3	19.9	6.7
20	28° 39.2'E	136° 11.6'E	NNE	4.2	3	o	1018.1	8	2	3	15.3	19.8	7.0
21	28° 36.0'E	136° 23.1'E	NE	2.1	2	o	1017.5	8	2	3	15.1	20.2	7.2
22	28° 37.7'E	136° 20.1'E	ENE	1.9	2	bc	1017.2	8	2	3	15.1	20.1	6.7
23	28° 33.2'E	136° 34.8'E	E	3.2	2	o	1017.3	8	2	3	15.3	19.8	7.3

(02/01) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	28° 28.3'E	136° 52.3'E	NE	3.7	3	o	1016.7	8	2	3	15.3	19.8	8.1
1	28° 25.9'E	137° 00.3'E	NNE	3.1	2	o	1016.0	8	2	3	15.5	19.8	8.3
2	28° 22.7'E	137° 11.4'E	NNE	5.6	4	o	1015.7	8	2	3	15.8	19.7	9.3
3	28° 18.1'E	137° 28.7'E	NE	4.8	3	o	1015.3	8	2	3	16.0	19.8	9.3
4	28° 12.5'E	137° 41.7'E	NE	8.5	5	o	1014.4	8	2	3	16.9	20.7	9.7
5	28° 09.2'E	137° 59.5'E	NE	8.4	5	r	1014.5	7	2	3	17.1	21.0	9.8
6	28° 09.2'E	138° 00.3'E	ENE	5.6	4	c	1014.1	7	2	3	16.4	21.3	11.4
7	28° 05.3'E	138° 13.9'E	NE	5.2	3	r	1014.1	7	2	3	15.8	21.0	12.1
8	28° 00.5'E	138° 30.9'E	NE	12.3	6	o	1013.9	7	3	3	18.6	20.9	12.2
9	27° 55.8'E	138° 46.1'E	NE	9.3	5	r	1014.1	7	3	3	18.1	20.8	11.5
10	27° 54.1'E	138° 43.9'E	NE	12.5	6	r	1014.2	6	4	3	16.6	21.2	13.3
11	27° 52.3'E	138° 59.4'E	NE	12.1	6	r	1013.4	6	4	3	17.4	20.4	13.8
12	27° 52.0'E	139° 00.3'E	NE	9.9	5	r	1012.3	6	4	3	17.6	20.8	14.8
13	27° 48.3'E	139° 14.1'E	E	12.8	6	o	1011.5	6	4	3	17.8	20.8	13.7
14	27° 43.6'E	139° 30.6'E	ENE	11.7	6	bc	1011.3	7	4	3	18.3	20.4	13.3
15	27° 39.6'E	139° 43.9'E	NE	7.4	4	c	1010.8	6	4	3	17.3	21.0	15.0
16	27° 39.3'E	139° 42.4'E	E	9.8	5	o	1010.7	6	4	3	18.4	21.1	14.1
17	27° 35.9'E	139° 57.2'E	E	10.4	5	o	1011.3	7	4	3	19.2	20.2	13.3
18	27° 35.1'E	140° 00.7'E	E	9.9	5	o	1011.3	6	5	3	18.9	20.1	13.4
19	27° 32.6'E	140° 12.8'E	E	12.3	6	c	1012.0	7	5	3	19.1	20.5	12.9
20	27° 28.8'E	140° 31.1'E	E	12.4	6	c	1012.3	7	5	3	19.4	20.4	12.3
21	27° 25.7'E	140° 38.7'E	E	10.2	5	o	1012.1	7	5	3	19.3	21.1	12.7
22	27° 27.0'E	140° 37.3'E	E	9.8	5	r	1012.2	7	4	3	18.4	20.9	12.8
23	27° 23.6'E	140° 53.2'E	E	10.0	5	o	1012.5	7	4	3	18.8	20.9	13.1

(02/02) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	27° 22.1'E	141° 00.2'E	E	10.8	6	c	1011.9	7	4	3	19.5	20.9	12.7
1	27° 19.8'E	141° 06.0'E	ENE	13.1	6	o	1012.2	7	4	3	19.0	20.6	12.9
2	27° 12.9'E	141° 21.3'E	E	10.8	6	o	1011.8	7	4	3	18.9	21.1	12.4
3	27° 05.5'E	141° 37.7'E	E	11.5	6	o	1012.1	7	4	3	19.1	20.5	12.4
4	26° 59.9'E	141° 50.3'E	E	10.7	5	o	1011.9	7	4	3	19.7	20.5	12.3
5	27° 00.4'E	141° 51.0'E	E	11.6	6	o	1012.3	7	4	3	19.0	20.1	13.0
6	27° 13.7'E	141° 47.5'E	E	13.6	6	bc	1012.4	8	5	3	18.6	20.3	11.9
7	27° 26.8'E	141° 44.2'E	N	12.6	6	o	1013.3	8	5	3	17.8	21.1	11.8
8	27° 40.8'E	141° 41.0'E	NNE	9.2	5	c	1014.3	8	5	3	17.0	20.4	11.4
9	27° 54.7'E	141° 37.8'E	E	7.3	4	c	1014.1	8	4	3	16.3	19.5	11.4
10	27° 59.7'E	141° 37.0'E	NNE	5.8	4	bc	1014.3	8	4	3	16.8	19.4	11.7
11	28° 00.3'E	141° 35.8'E	NNE	11.7	6	bc	1013.7	8	4	3	17.2	19.7	10.7
12	28° 04.3'E	141° 34.5'E	N	10.7	5	bc	1012.9	8	4	3	17.2	19.7	9.4
13	28° 18.4'E	141° 32.0'E	N	11.6	6	c	1012.3	8	4	3	16.6	19.4	9.1
14	28° 32.4'E	141° 29.5'E	N	13.1	6	bc	1012.0	8	4	3	16.7	19.6	9.2
15	28° 46.0'E	141° 26.5'E	E	13.5	6	bc	1011.8	8	5	3	16.7	19.6	7.4
16	28° 59.6'E	141° 23.4'E	NNE	14.6	7	bc	1012.4	8	5	3	16.3	19.4	6.0
17	28° 59.8'E	141° 23.9'E	NNE	11.6	6	bc	1013.3	8	5	3	16.3	19.8	6.5
18	29° 08.4'E	141° 22.1'E	N	12.9	6	c	1013.8	8	5	3	16.2	19.6	6.6
19	29° 22.2'E	141° 18.6'E	N	14.0	7	c	1013.7	8	5	3	16.1	19.3	6.5
20	29° 35.6'E	141° 15.4'E	NNE	11.3	6	bc	1014.5	8	5	3	15.4	19.5	8.4
21	29° 47.5'E	141° 12.2'E	N	12.1	6	bc	1014.8	8	5	3	14.3	19.3	8.2
22	29° 59.8'E	141° 09.9'E	NNE	9.8	5	c	1015.6	8	5	3	14.0	18.9	6.4
23	29° 59.1'E	141° 09.2'E	N	12.4	6	c	1015.4	8	5	3	13.4	19.1	7.1

(02/03) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	30° 00.2'E	141° 07.1'E	NNE	10.5	5	c	1015.9	8	5	3	12.7	19.1	5.9
1	30° 08.0'E	141° 05.8'E	NNE	10.2	5	o	1015.5	7	5	3	13.3	18.8	6.4
2	30° 20.7'E	141° 04.4'E	N	11.8	6	c	1015.6	7	5	3	13.1	18.9	3.6
3	30° 32.6'E	141° 01.2'E	NNE	12.4	6	c	1015.7	7	5	3	12.7	19.8	5.6
4	30° 44.6'E	140° 59.3'E	NNE	14.5	7	o	1016.6	7	5	3	12.3	19.7	4.3
5	30° 56.6'E	140° 57.3'E	NNE	15.3	7	bc	1017.0	8	5	3	11.9	20.1	2.5
6	30° 59.7'E	140° 58.2'E	NNE	12.5	6	c	1018.0	8	5	3	11.9	20.3	2.5
7	31° 01.1'E	140° 58.8'E	N	12.5	6	c	1017.9	8	5	3	11.8	19.9	1.6
8	31° 13.7'E	140° 58.5'E	NNE	12.2	6	c	1017.8	8	5	3	11.5	20.2	2.0
9	31° 20.2'E	140° 57.0'E	NNE	11.1	6	c	1018.7	8	5	3	11.5	20.1	2.3
10	31° 25.6'E	140° 57.5'E	N	11.3	6	c	1018.6	8	5	3	11.6	20.0	1.7
11	31° 39.1'E	140° 58.8'E	E	12.5	6	bc	1018.2	8	5	3	11.0	19.8	1.3
12	31° 53.2'E	140° 59.0'E	N	11.3	6	c	1017.4	8	5	3	10.7	20.4	1.5
13	32° 00.4'E	140° 59.9'E	N	10.6	5	c	1016.9	8	5	3	10.7	21.0	0.8
14	32° 07.8'E	141° 00.3'E	N	12.5	6	bc	1016.1	8	5	3	10.8	20.5	1.0
15	32° 22.9'E	140° 59.8'E	E	11.3	6	bc	1016.1	8	5	3	10.5	20.3	1.7
16	32° 38.7'E	140° 59.7'E	E	10.3	5	o	1015.8	8	5	4	10.5	20.1	2.8
17	32° 54.3'E	140° 59.8'E	E	11.9	6	o	1016.1	8	5	4	9.9	18.0	2.3
18	33° 00.9'E	141° 00.4'E	E	10.0	5	o	1016.5	8	5	4	10.6	18.8	1.4
19	33° 06.2'E	141° 05.7'E	E	11.0	6	c	1015.9	8	5	4	10.3	19.3	3.2
20	33° 17.5'E	141° 17.4'E	E	10.9	6	o	1015.9	8	5	4	10.7	20.0	3.1
21	33° 26.6'E	141° 28.2'E	ENE	11.9	6	o	1015.8	8	5	4	11.0	19.7	3.3
22	33° 38.5'E	141° 38.6'E	ENE	11.9	6	c	1015.2	8	5	4	11.3	18.8	3.5
23	33° 50.1'E	141° 50.1'E	ENE	11.6	6	o	1013.9	8	5	4	11.5	19.5	3.7

(02/04) KH-91-01 Meteorological data

J	Latitude	Longitude	W.D	W.F.	F	We	Bar.	V	Se	Sw	A.T.	S.T.	Td.
0	34° 00.3'E	142° 00.2'E	ENE	9.2	5	c	1013.1	8	5	4	11.5	19.8	2.3
1	34° 01.3'E	142° 00.0'E	ENE	8.6	5	o	1012.3	7	5	3	11.8	19.5	2.3
2	34° 01.7'E	142° 00.2'E	ENE	9.7	5	o	1011.8	7	4	3	11.6	19.4	2.1
3	34° 02.2'E	141° 60.0'E	ENE	7.6	4	o	1011.4	7	4	3	11.5	19.5	3.0
4	34° 01.8'E	141° 50.8'E	ENE	12.4	6	o	1010.8	7	4	3	11.5	19.0	2.1
5	34° 02.0'E	141° 35.6'E	ENE	12.5	6	o	1010.2	7	4	3	11.0	19.5	2.3
6	34° 01.1'E	141° 30.6'E	E	11.1	6	o	1010.0	8	4	3	11.8	19.4	1.7
7	34° 02.4'E	141° 30.8'E	ENE	10.9	6	o	1009.7	8	4	3	12.1	19.0	0.3
8	34° 03.3'E	141° 30.6'E	ENE	7.2	4	o	1009.4	8	4	3	11.4	18.9	1.0
9	34° 03.9'E	141° 30.4'E	ENE	7.1	4	r	1009.1	8	4	3	11.3	18.8	2.8
10	34° 07.0'E	141° 26.7'E	ENE	12.9	6	o	1008.2	8	5	3	11.0	18.8	2.7
11	34° 14.2'E	141° 11.0'E	E	10.6	5	o	1007.4	8	4	3	11.0	19.3	3.5
12	34° 21.4'E	140° 54.8'E	N	9.0	5	c	1006.7	8	4	3	10.1	18.7	1.0
13	34° 28.9'E	140° 38.7'E	E	8.2	5	bc	1005.8	8	4	3	10.0	16.8	0.9
14	34° 36.2'E	140° 22.7'E	E	7.4	4	bc	1005.6	8	4	3	10.1	15.3	0.9
15	34° 43.3'E	140° 07.2'E	E	4.1	3	bc	1005.7	8	2	3	9.5	14.9	0.9
16	34° 50.6'E	139° 51.2'E	NE	0.7	1	bc	1005.5	8	2	3	9.7	15.3	-0.8
17	35° 03.3'E	139° 44.2'E	ENE	2.0	2	bc	1005.5	8	2	1	9.3	14.4	-1.6
18						bc		8	2	1			
19						bc		8	3	1			
20						c							
21													
22													
23													

Appendix II

Aerological data by Omega-sonde system during the period from 15 JST 12 January to 21 JST 23 January in Leg I, and from 09 JST 29 January to 09 JST 4 February in Leg. II.

Note:

1) Press: Pressure (hPa)
2) Hght: Geopotential height (m)
3) Temp: Temperature (C˚)
4) Hum: Relative humidity (%)
5) Td: Dew point temperature (C˚)
6) dd: Wind direction (degree)
7) ff: Wind speed (m/s)

91011215(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	90	13.2	52	3.6	286	9.3
850.0	1423	0.2	66	-5.4	267	11.5
700.0	2946	-11.1	22	-28.7	274	22.2
500.0	5474	-21.1	4	-53.0	258	49.1
400.0	7083	-32.3	6	-58.2	256	55.6
300.0	9102	-36.7	2	-69.8	255	74.6
250.0	10358	-39.4	1	-76.4	257	82.4
200.0	11861	-47.4	2	-77.6	263	90.0
150.0	13705	-60.1	2	-87.0	259	71.1
100.0	16192	-68.0	2	-92.9	252	54.9
70.0	18337	-65.4	3	-88.6	246	15.1
50.0	20413	-60.9	1	-91.5	234	12.3
30.0	23661	/////	///	//////	////	//////

91011321(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	172	12.6	54	3.6	302	11.4
850.0	1504	0.4	79	-2.8	291	14.6
700.0	3035	-7.3	30	-22.0	294	32.0

91011403(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	164	11.8	45	0.3	295	16.2
850.0	1492	-0.5	73	-4.7	305	14.4
700.0	3026	-5.6	9	-33.6	294	29.6
500.0	5575	-22.8	3	-56.6	294	39.3
400.0	7214	-18.7	6	-47.6	272	81.0
300.0	9329	-29.7	3	-61.7	266	82.1
250.0	10602	-40.0	4	-67.2	269	78.9
200.0	12085	-51.3	5	-74.4	263	78.8
150.0	13901	-63.5	3	-87.2	259	77.8
100.0	16324	-76.4	3	-97.2	262	55.7
70.0	18412	-71.4	4	-91.7	265	26.6
50.0	20419	/////	///	//////	////	//////

91011409(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	189	10.6	48	0.1	324	11.9
850.0	1513	-1.7	85	-3.9	316	12.8
700.0	3051	-4.4	5	-38.6	311	20.2
500.0	5619	-19.3	8	-45.5	293	34.9
400.0	7253	-22.6	8	-48.1	272	68.5
300.0	9354	-29.5	2	-64.6	269	80.2
250.0	10625	-40.4	6	-64.5	269	79.9
200.0	12105	-52.7	8	-72.3	268	78.9
150.0	13912	-63.9	3	-87.5	257	78.9
100.0	16347	-74.1	2	-97.5	266	51.8
70.0	18420	-73.8	4	-93.6	264	29.5
50.0	20423	-62.3	2	-88.6	263	20.3
30.0	23621	-55.4	1	-87.6	229	4.7

91011415(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	183	11.4	43	-0.7	296	7.4
850.0	1509	-1.2	74	-5.2	320	7.7
700.0	3051	-4.6	12	-29.8	298	13.5
500.0	5622	-21.8	53	-28.9	279	26.0
400.0	7259	-24.3	14	-44.4	278	65.1
300.0	9355	-30.8	5	-58.5	265	83.4
250.0	10623	-39.8	7	-62.9	269	84.7
200.0	12104	-52.5	7	-73.1	271	80.4
150.0	13915	-63.9	5	-84.4	259	79.7
100.0	16337	-73.8	4	-93.6	274	54.5
70.0	18426	-69.4	5	-88.8	275	24.9
50.0	20420	/////	///	//////	////	//////

91011421(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	194	11.5	46	0.3	305	5.1
850.0	1521	-0.8	76	-4.5	276	6.8
700.0	3066	-5.1	10	-32.1	269	18.8
500.0	5636	-17.4	17	-36.7	284	34.6
400.0	7276	-21.9	12	-43.8	278	65.8
300.0	9372	-32.1	5	-59.5	268	81.4
250.0	10637	-41.1	3	-70.1	270	80.6
200.0	12111	-53.6	9	-72.2	273	82.9
150.0	13918	-64.1	4	-85.9	263	77.6
100.0	16332	-74.7	3	-95.9	270	58.5
70.0	18431	-69.2	4	-90.0	274	23.8
50.0	20435	-65.6	3	-88.8	268	19.2
30.0	23649	-54.7	1	-87.1	276	13.4

91011503(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	180	12.2	52	2.7	310	4.4
850.0	1510	-0.3	92	-1.4	293	7.3
700.0	3046	-4.7	92	-5.8	266	18.5
500.0	5630	-18.7	84	-20.7	273	39.1
400.0	7273	-17.2	17	-36.6	276	76.5
300.0	9381	-31.1	9	-53.9	267	76.8
250.0	10642	-42.4	7	-64.9	264	76.0
200.0	12120	-51.5	6	-73.3	270	76.6
150.0	13923	-66.4	9	-82.9	265	74.7
100.0	16338	-74.4	5	-92.9	267	54.3
70.0	18425	-68.4	6	-87.0	258	22.4
50.0	20442	/////	///	//////	////	//////

91011509(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	194	10.3	73	5.7	346	13.9
850.0	1520	0.7	94	-0.2	334	12.5
700.0	3056	-7.9	90	-9.3	262	8.2
500.0	5633	-18.0	83	-20.2	267	43.0
400.0	7277	-20.8	46	-29.4	277	75.6
300.0	9368	-31.9	39	-41.3	264	79.5
250.0	10625	-42.6	36	-51.9	268	75.8
200.0	12113	-49.7	32	-59.3	271	74.3
150.0	13936	-64.1	25	-74.2	257	68.8
100.0	16350	-75.2	20	-85.6	270	49.7
70.0	18441	-72.2	26	-81.2	267	26.3
50.0	20469	-64.6	36	-72.1	283	11.4

91011515(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	187	10.6	44	-1.1	329	10.9
850.0	1509	-2.1	79	-5.2	318	11.1
700.0	3038	-5.6	3	-44.3	282	27.2
500.0	5604	-20.6	14	-41.3	258	41.1
400.0	7242	-22.4	10	-45.9	269	68.6
300.0	9307	-34.7	19	-50.4	266	88.1
250.0	10554	-44.7	19	-59.1	265	88.9
200.0	12028	-49.7	3	-76.6	274	93.1
150.0	13846	-63.5	4	-85.5	266	84.7

91011521(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	218	8.2	37	-5.6	5	7.3
850.0	1528	-4.2	60	-10.8	342	10.0
700.0	3055	-7.1	1	-54.9	322	17.8
500.0	5601	-22.4	1	-65.0	298	31.1
400.0	7208	-29.8	5	-57.7	275	54.3
300.0	9236	-37.6	16	-54.4	269	88.9
250.0	10479	-41.2	1	-77.7	271	85.0
200.0	11971	-50.1	1	-83.9	270	90.6
150.0	13802	-59.7	1	-90.6	269	82.3
100.0	16272	-66.6	1	-95.6	279	52.0
70.0	18412	-69.9	1	-98.0	271	36.3
50.0	20453	-62.2	1	-92.4	254	20.3
30.0	23682	/////	///	//////	////	//////

91011621(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	213	9.9	52	0.5	284	6.1
850.0	1532	-2.2	80	-5.2	281	10.1
700.0	3059	-6.8	8	-35.7	266	16.4
500.0	5597	-22.6	75	-25.8	265	32.5
400.0	7205	-33.3	15	-51.3	272	40.5
300.0	9191	-43.4	29	-54.4	268	74.5
250.0	10403	-47.4	6	-70.1	266	78.9
200.0	11875	-50.0	1	-83.8	264	84.4
150.0	13712	-59.8	1	-90.7	264	79.5
100.0	16209	-63.9	1	-93.7	267	53.2
70.0	18404	-68.0	1	-96.6	262	33.1
50.0	20461	-61.4	1	-91.9	272	21.9
30.0	23697	-52.0	1	-85.2	261	21.0
20.0	26338	/////	///	//////	////	//////

91011703(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	194	12.5	50	2.4	215	6.9
850.0	1526	0.2	78	-3.2	278	4.8
700.0	3062	-5.6	5	-39.5	274	17.9
500.0	5620	-19.3	59	-25.3	261	37.5
400.0	7249	-26.8	10	-49.5	270	56.2
300.0	9258	-41.8	36	-51.1	267	75.9
250.0	10473	-47.5	15	-63.3	263	79.7
200.0	11939	-50.9	1	-84.4	264	84.2
150.0	13776	-61.0	1	-91.6	265	75.7
100.0	16260	-67.9	1	-96.5	257	57.1
70.0	18392	-63.5	2	-89.5	258	23.0
50.0	20456	-63.3	1	-93.2	261	14.7

91011709(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	181	14.2	48	3.4	196	10.3
850.0	1522	1.9	82	-0.8	212	7.5
700.0	3072	-5.3	90	-6.7	261	15.4
500.0	5658	-17.7	54	-24.8	270	39.7
400.0	7310	-25.1	19	-42.2	265	54.1
300.0	9332	-41.4	27	-53.3	266	68.9
250.0	10550	-45.8	5	-70.1	258	78.0
200.0	12029	-50.5	7	-71.4	263	84.9
150.0	13857	-60.7	1	-91.4	264	70.5
100.0	16320	-71.4	1	-99.1	267	45.1
70.0	18426	-69.4	1	-97.6	257	28.9
50.0	20453	-62.3	1	-92.5	269	12.8

91011715(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	144	17.5	66	11.1	202	14.3
850.0	1504	6.4	78	2.9	239	16.0
700.0	3070	-3.2	93	-4.2	269	22.3
500.0	5670	-13.9	30	-27.8	264	45.7
400.0	7329	-25.7	21	-41.7	259	50.9
300.0	9348	-41.3	42	-49.3	264	67.0
250.0	10573	-46.4	10	-65.5	261	75.4
200.0	12038	-49.6	2	-79.2	264	87.3
150.0	13867	-62.3	1	-92.5	265	71.3
100.0	16318	-72.4	1	-99.8	266	44.3
70.0	18416	-71.2	2	-95.3	254	25.6
50.0	20428	-59.4	1	-90.4	258	14.7
30.0	23660	-53.0	1	-85.9	240	13.3

91011721(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	157	15.5	57	7.0	312	12.2
850.0	1509	7.2	4	-32.4	282	12.6
700.0	3079	-2.0	94	-2.8	261	22.4
500.0	5675	-17.8	65	-22.8	263	38.5
400.0	7310	-28.3	49	-35.8	258	51.3
300.0	9316	-40.3	26	-52.6	262	70.1
250.0	10544	-47.2	22	-60.1	259	74.9
200.0	12014	-51.3	17	-65.7	264	84.5
150.0	13843	-60.5	13	-75.5	265	67.7
100.0	16311	-70.3	11	-84.9	257	46.1
70.0	18414	-71.1	13	-84.6	260	26.8
50.0	20450	-61.3	18	-74.0	253	11.8
30.0	23669	/////	///	//////	////	//////

91011803(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	164	13.6	56	5.0	351	10.8
850.0	1503	1.7	84	-0.7	298	7.5
700.0	3070	-1.1	1	-51.1	279	18.0
500.0	5670	-17.2	51	-25.0	279	34.1
400.0	7310	-27.5	24	-42.0	258	49.1
300.0	9319	-40.5	15	-57.4	263	64.2
250.0	10549	-42.8	5	-67.7	262	75.3
200.0	12029	-49.2	4	-74.3	262	81.4
150.0	13855	-60.7	5	-81.9	269	71.9
100.0	16316	-70.7	4	-91.2	263	45.3
70.0	18429	-70.1	5	-89.4	271	29.8
50.0	20460	-61.3	3	-85.5	267	17.5
30.0	23720	-52.0	1	-85.2	271	10.9
20.0	26336	/////	///	//////	////	//////

91011809(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	188	11.4	50	1.4	325	8.1
850.0	1512	-1.8	92	-2.9	326	10.4
700.0	3079	-1.2	2	-45.0	286	17.0
500.0	5673	-18.2	55	-25.1	270	33.6
400.0	7303	-29.5	28	-42.3	269	41.8
300.0	9308	-38.1	3	-67.9	259	58.2
250.0	10549	-42.0	2	-73.6	264	69.9
200.0	12043	-48.4	2	-78.3	259	78.4
150.0	13884	-59.6	2	-86.6	266	68.5
100.0	16361	-69.6	1	-97.8	271	46.4
70.0	18496	-70.0	1	-98.1	264	27.4
50.0	20549	-60.9	1	-91.5	280	12.9
30.0	23784	/////	///	//////	////	//////

91011815(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	182	11.7	52	2.2	2	9.6
850.0	1512	5.7	4	-33.5	340	13.7
700.0	3074	-2.6	5	-37.2	306	17.9
500.0	5667	-18.5	72	-22.3	264	32.4
400.0	7297	-28.6	20	-44.7	268	45.8
300.0	9291	-40.8	5	-66.2	261	51.5
250.0	10522	-44.0	3	-72.3	265	61.9
200.0	12008	-47.8	2	-77.9	262	75.3
150.0	13861	-58.8	2	-86.0	267	65.3
100.0	16335	-70.2	2	-94.6	274	44.1
70.0	18459	-70.9	3	-92.9	260	23.5
50.0	20485	-62.7	2	-88.9	275	8.3
30.0	23715	-53.3	2	-81.9	246	10.6

91011821(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	206	11.7	58	3.7	344	7.6
850.0	1536	2.2	23	-16.8	346	10.4
700.0	3093	-3.6	5	-38.0	306	15.9
500.0	5676	-18.9	59	-24.9	280	33.6
400.0	7300	-31.5	32	-42.9	273	31.2
300.0	9290	-40.5	4	-67.6	272	45.1
250.0	10524	-44.0	3	-72.3	266	61.9
200.0	12012	-46.0	1	-81.0	271	68.3
150.0	13872	-57.7	2	-85.2	262	59.5
100.0	16365	-69.2	2	-93.8	282	40.1
70.0	18474	-70.8	3	-92.8	271	23.4
50.0	20509	-63.0	1	-93.0	271	13.8
30.0	23730	/////	///	//////	////	//////

91011903(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	207	12.1	46	0.9	58	7.0
850.0	1537	-0.5	87	-2.4	1	6.4
700.0	3089	-2.6	3	-42.2	299	13.3
500.0	5677	-18.1	35	-29.9	280	29.7
400.0	7304	-30.9	42	-39.7	286	37.2
300.0	9297	-38.5	4	-66.1	277	58.0
250.0	10542	-41.0	3	-70.1	274	71.1
200.0	12039	-49.3	3	-76.3	276	76.3
150.0	13872	-59.1	3	-83.8	273	55.7
100.0	16343	-69.6	3	-91.9	278	32.9
70.0	18454	-70.1	4	-90.7	273	27.4
50.0	20487	-64.4	3	-87.9	280	7.6

91011909(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	233	11.0	52	1.5	49	6.7
850.0	1557	-0.9	77	-4.4	44	6.6
700.0	3109	-3.6	4	-40.1	310	9.4
500.0	5696	-18.3	58	-24.6	283	25.7
400.0	7322	-31.2	45	-39.3	289	32.6
300.0	9330	-35.3	3	-65.8	277	62.5
250.0	10577	-43.5	4	-69.9	275	74.1
200.0	12061	-49.9	3	-76.8	271	77.3
150.0	13882	-61.1	3	-85.3	270	65.7
100.0	16354	-69.5	3	-91.8	269	31.2
70.0	18473	-70.8	3	-92.8	283	19.3
50.0	20496	-65.7	2	-91.2	268	8.8
30.0	23712	-56.2	2	-84.1	241	2.1

91011915(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	225	12.0	50	1.9	63	7.3
850.0	1554	-0.3	88	-2.0	356	3.0
700.0	3110	-2.3	2	-45.7	280	8.2
500.0	5709	-16.9	55	-23.8	280	20.7
400.0	7341	-29.9	43	-38.6	280	29.8
300.0	9369	-36.2	1	-74.3	280	57.9
250.0	10618	-42.5	7	-65.0	280	80.7
200.0	12097	-50.7	2	-80.0	275	75.3
150.0	13916	-62.9	2	-89.1	281	73.9
100.0	16364	-69.6	2	-94.1	275	49.7
70.0	18480	-69.6	2	-94.1	253	18.9
50.0	20510	-64.0	1	-93.7	242	5.5
30.0	23721	/////	///	//////	////	//////

91011921(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	236	12.2	47	1.2	63	6.6
850.0	1566	-0.1	87	-2.0	36	3.6
700.0	3123	-2.0	14	-26.0	272	10.6
500.0	5731	-17.6	61	-23.3	282	25.2
400.0	7365	-28.7	42	-37.7	290	38.0
300.0	9403	-33.2	9	-55.5	275	76.8
250.0	10662	-42.0	11	-61.1	282	80.0
200.0	12145	-51.1	3	-77.7	275	74.3
150.0	13964	-62.1	4	-84.3	281	70.6
100.0	16408	-73.2	3	-94.7	286	49.0
70.0	18484	-69.0	5	-88.5	258	21.5
50.0	20516	-62.7	3	-86.5	251	11.9

91012003(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	222	13.0	53	3.7	107	6.0
850.0	1557	0.7	88	-1.1	119	4.9
700.0	3122	0.3	49	-9.2	290	12.3
500.0	5730	-17.5	68	-22.0	277	23.1
400.0	7362	-29.0	63	-33.9	280	35.3
300.0	9409	-33.1	12	-53.0	277	77.7
250.0	10666	-42.3	12	-60.7	283	77.9
200.0	12151	-50.4	4	-75.2	282	73.6
150.0	13975	-62.4	3	-86.3	287	67.9
100.0	16412	-72.8	3	-94.4	277	45.8
70.0	18475	-74.4	4	-94.1	280	28.3
50.0	20484	-63.1	4	-85.1	260	16.5

91012009(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	218	14.2	56	5.6	106	7.6
850.0	1564	5.4	24	-13.6	139	6.5
700.0	3132	-0.8	73	-5.0	256	13.1
500.0	5740	-16.2	56	-23.0	283	20.7
400.0	7381	-25.6	38	-35.8	282	41.2
300.0	9443	-33.8	12	-53.6	280	69.4
250.0	10699	-42.1	9	-62.8	280	70.4
200.0	12186	-50.9	4	-75.6	283	68.4
150.0	14008	-61.7	2	-88.2	291	59.1
100.0	16432	-74.6	2	-97.9	270	42.7
70.0	18479	-77.7	4	-96.7	285	20.1
50.0	20495	-62.1	2	-88.5	295	15.4
30.0	23728	/////	///	//////	////	//////

91012015(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	205	15.6	60	7.9	76	5.1
850.0	1555	4.0	79	0.7	196	5.5
700.0	3115	-1.3	94	-2.1	30	1.4
500.0	5733	-15.3	81	-17.8	196	2.7
400.0	7385	-24.2	46	-32.6	////	//////
300.0	9452	-33.1	17	-50.0	////	//////
250.0	10715	-39.4	4	-66.8	////	//////
200.0	12203	-50.3	4	-75.1	////	//////
150.0	14021	-63.1	4	-85.1	////	//////
100.0	16440	-75.9	3	-96.8	////	//////
70.0	18480	/////	///	//////	////	//////

91012021(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	188	17.1	65	10.5	155	8.2
850.0	1548	8.5	59	1.0	206	5.6
700.0	3132	-0.1	94	-0.9	250	11.6
500.0	5749	-15.9	48	-24.4	278	27.3
400.0	7404	-22.8	53	-29.8	283	43.9
300.0	9482	-31.6	22	-46.4	281	68.5
250.0	10750	-40.2	15	-57.1	278	65.1
200.0	12241	-49.6	11	-67.5	280	58.3
150.0	14064	-64.1	8	-81.7	282	58.2
100.0	16461	-75.7	7	-92.1	276	45.8
70.0	18516	-77.2	8	-92.6	271	19.1
50.0	20485	-64.9	10	-80.9	275	8.5

91012103(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	167	17.8	70	12.3	153	11.9
850.0	1533	8.3	81	5.2	224	6.6
700.0	3118	0.2	95	-0.5	241	11.3
500.0	5758	-13.2	86	-15.0	273	24.3
400.0	7422	-24.7	78	-27.4	276	36.2
300.0	9489	-32.3	37	-42.2	280	66.9
250.0	10750	-41.1	28	-52.7	279	64.0
200.0	12237	-50.5	22	-63.0	279	60.8
150.0	14057	-63.5	17	-76.3	284	55.3
100.0	16471	-77.2	13	-89.9	272	42.9
70.0	18495	-79.1	14	-91.1	272	23.3
50.0	20477	-66.5	21	-77.5	289	7.3

91012109(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	152	18.3	76	14.0	175	17.1
850.0	1522	9.4	92	8.2	212	15.3
700.0	3113	1.7	94	0.8	251	14.7
500.0	5758	-12.6	88	-14.2	262	19.4
400.0	7427	-23.3	75	-26.5	284	37.1
300.0	9498	-32.1	37	-42.0	282	68.0
250.0	10764	-40.7	28	-52.3	285	60.4
200.0	12252	-49.8	24	-61.7	286	58.2
150.0	14078	-62.6	19	-74.7	278	47.7
100.0	16485	-77.2	16	-88.7	272	41.1
70.0	18533	-79.6	17	-90.4	273	15.5
50.0	20522	-64.0	31	-72.6	255	8.5

91012115(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	115	19.8	83	16.8	185	19.5
850.0	1491	10.5	92	9.3	234	23.8
700.0	3091	3.4	95	2.7	255	29.6
500.0	5730	-12.5	32	-25.8	266	35.3
400.0	7410	-20.0	20	-37.3	287	44.0
300.0	9493	-32.7	20	-48.2	278	58.5
250.0	10752	-42.5	17	-58.1	285	59.4
200.0	12228	-51.7	16	-66.5	287	59.7
150.0	14034	-64.8	13	-79.2	281	49.9
100.0	16416	-75.2	12	-88.6	286	24.1
70.0	18433	/////	///	//////	////	//////

91012121(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	109	20.1	79	16.4	262	15.9
850.0	1494	12.0	80	8.7	263	17.6
700.0	3102	4.7	73	0.3	259	27.5
500.0	5750	-10.0	1	-56.8	265	35.9
400.0	7441	-17.9	5	-48.7	278	52.8
300.0	9536	-31.0	8	-54.8	277	57.1
250.0	10803	-39.0	3	-68.6	279	55.5
200.0	12295	-51.5	6	-73.3	283	53.6
150.0	14115	-63.5	2	-89.5	279	47.8
100.0	16505	-78.7	3	-99.0	262	36.3
70.0	18532	-79.1	4	-97.9	279	21.7
50.0	20505	-66.8	5	-86.7	269	13.9

91012203(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	100	19.3	78	15.4	276	14.9
850.0	1474	11.3	56	2.9	272	19.6
700.0	3071	3.5	21	-16.8	269	27.0
500.0	5718	-11.2	2	-51.8	272	40.0
400.0	7406	-18.0	5	-48.7	274	57.0
300.0	9509	-30.3	6	-56.6	277	58.0
250.0	10778	-40.2	5	-65.7	279	57.2
200.0	12265	-50.7	4	-75.4	279	52.7
150.0	14083	-64.3	2	-90.1	274	48.7
100.0	16470	-78.8	4	-97.6	260	37.1
70.0	18511	-76.7	5	-94.8	277	19.0
50.0	20474	-65.9	6	-84.9	278	14.1
30.0	23678	/////	///	//////	////	//////

91012209(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	108	18.7	68	12.7	288	10.5
850.0	1476	8.9	64	2.5	287	17.5
700.0	3061	-0.2	70	-5.0	281	20.5
500.0	5701	-10.5	6	-41.4	272	44.4
400.0	7398	-17.8	7	-45.5	276	54.2
300.0	9497	-30.1	3	-62.0	275	54.1

91012215(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	110	17.4	57	8.8	321	9.3
850.0	1470	7.1	74	2.8	308	13.9
700.0	3045	0.3	50	-8.9	285	19.5
500.0	5681	-10.0	2	-51.0	276	45.7
400.0	7378	-16.4	12	-39.3	267	63.2
300.0	9490	-29.8	9	-52.8	270	62.2
250.0	10763	-38.6	3	-68.3	267	58.8
200.0	12261	-50.0	3	-76.8	270	53.8
150.0	14077	-65.7	4	-87.2	270	57.5
100.0	16470	-78.8	3	-99.1	261	46.8
70.0	18523	-74.7	5	-93.1	273	21.9
50.0	20492	-64.2	3	-87.7	257	14.4
30.0	23681	/////	///	//////	////	//////

91012221(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	141	16.0	61	8.5	355	6.3
850.0	1491	4.2	84	1.7	322	8.4
700.0	3047	-2.1	47	-11.9	287	18.7
500.0	5682	-12.2	15	-33.7	273	49.7
400.0	7372	-17.6	7	-45.4	271	63.4
300.0	9474	-28.8	4	-58.7	272	64.4
250.0	10754	-38.2	3	-68.0	270	62.7
200.0	12250	-49.9	2	-79.4	271	60.9
150.0	14061	-63.1	5	-83.8	273	59.6
100.0	16451	-76.2	4	-95.5	261	44.6
70.0	18497	-75.3	6	-92.6	271	26.8
50.0	20493	-64.4	4	-86.2	284	15.0
30.0	23688	/////	///	//////	////	//////

91012303(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	157	15.7	51	5.6	355	7.7
850.0	1506	4.5	56	-3.5	333	8.9
700.0	3058	-1.1	5	-36.1	310	14.2
500.0	5673	-9.3	2	-50.5	284	48.4
400.0	7365	-18.5	3	-53.5	274	62.6
300.0	9463	-30.5	8	-54.4	270	63.9
250.0	10742	-38.1	2	-70.8	272	62.9
200.0	12235	-51.2	5	-74.3	270	62.0
150.0	14052	-63.0	2	-89.1	272	55.6
100.0	16431	-77.0	5	-95.0	268	46.5
70.0	18485	-74.6	6	-92.0	269	25.7
50.0	20475	-67.9	3	-90.6	292	15.0
30.0	23661	/////	///	//////	////	//////

91012309(YY/MM/DD/HH)

Press	Hght	Temp	Hum	Td	dd	ff
hpa	gpm	C	%	C	deg	m/s
1000.0	191	13.9	58	5.8	4	11.4
850.0	1533	2.8	94	1.9	329	5.8
700.0	3079	-5.0	44	-15.4	296	11.7
500.0	5685	-12.8	20	-31.2	286	51.5
400.0	7362	-19.9	4	-52.1	274	61.4
300.0	9466	-29.0	4	-58.9	269	61.6
250.0	10744	-38.1	2	-70.8	268	59.2
200.0	12237	-50.9	4	-75.6	273	59.0
150.0	14063	-63.3	2	-89.4	276	51.1
100.0	16456	-75.2	4	-94.7	272	34.7
70.0	18512	-74.0	5	-92.6	265	22.7
50.0	20495	-64.9	3	-88.2	283	10.5

91012315(YY/MM/DD/HH)

Press	Hght	Temp	Hum	Td	dd	ff
hpa	gpm	C	%	C	deg	m/s
1000.0	189	13.2	58	5.1	32	11.7
850.0	1525	1.0	93	0.0	350	5.8
700.0	3080	-2.6	1	-52.1	314	12.6
500.0	5694	-13.4	16	-34.0	286	42.4
400.0	7361	-21.2	4	-53.1	272	58.8
300.0	9458	-31.4	10	-53.2	269	64.9
250.0	10734	-38.3	2	-70.9	268	63.2
200.0	12227	-51.3	3	-77.8	276	64.9
150.0	14046	-63.4	1	-93.3	275	58.1
100.0	16444	-75.7	4	-95.1	265	40.2
70.0	18502	-75.3	4	-94.8	267	27.2
50.0	20482	-68.6	2	-93.4	278	13.2
30.0	23684	-55.1	1	-87.4	305	2.7

91012321(YY/MM/DD/HH)

Press	Hght	Temp	Hum	Td	dd	ff
hpa	gpm	C	%	C	deg	m/s
1000.0	209	12.2	56	3.7	78	10.7
850.0	1542	2.9	11	-24.7	76	7.8
700.0	3099	-3.2	1	-52.4	304	5.2
500.0	5706	-15.7	58	-22.1	279	34.0
400.0	7360	-21.3	3	-55.5	270	52.2
300.0	9451	-30.4	10	-52.4	265	67.3
250.0	10722	-39.8	6	-64.0	265	67.0
200.0	12212	-51.0	3	-77.6	270	67.1
150.0	14020	/////	///	//////	////	//////

91012909(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	202	12.0	56	3.5	43	5.3
850.0	1533	1.0	92	-0.2	293	6.3
700.0	3081	-3.4	53	-11.6	278	17.1
500.0	5667	-17.1	9	-42.7	278	37.5
400.0	7304	-28.2	69	-32.2	254	41.7
300.0	9317	-38.4	53	-44.5	254	74.5
250.0	10565	-40.7	4	-67.8	260	81.2
200.0	12066	-48.8	3	-75.9	253	81.0
150.0	13897	-61.8	3	-85.8	253	66.3
100.0	16333	-72.6	4	-92.7	267	39.1
70.0	18474	-64.9	3	-88.2	272	13.9
50.0	20519	-62.6	2	-88.8	258	7.4
30.0	23747	/////	///	//////	////	//////

91012915(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	189	12.7	55	3.9	29	5.3
850.0	1524	2.1	72	-2.4	299	5.1
700.0	3068	-5.0	73	-9.1	270	14.9
500.0	5665	-15.7	16	-35.9	277	39.9
400.0	7308	-27.1	67	-31.4	262	50.8
300.0	9327	-38.5	56	-44.1	252	67.8
250.0	10575	-40.6	4	-67.7	261	80.6
200.0	12076	-48.7	2	-78.5	258	79.8
150.0	13911	-62.0	3	-86.0	260	72.0
100.0	16358	-70.4	3	-92.5	262	41.5
70.0	18484	-66.2	3	-89.2	262	17.7
50.0	20520	-62.4	2	-88.7	290	6.6

91012921(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	201	12.8	62	5.7	29	4.9
850.0	1538	2.0	94	1.1	345	4.6
700.0	3080	-7.6	83	-10.0	279	17.7
500.0	5665	-15.2	15	-36.1	269	37.8
400.0	7310	-26.5	69	-30.5	253	50.4
300.0	9336	-38.7	60	-43.6	248	72.2
250.0	10576	-43.1	16	-59.1	258	80.5
200.0	12061	-49.7	5	-73.2	259	85.2
150.0	13884	-62.4	4	-84.6	261	76.0
100.0	16359	-66.5	3	-89.5	251	44.0
70.0	18460	-67.0	4	-88.2	267	23.1
50.0	20512	-61.0	3	-85.2	234	1.6

91013003(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	199	13.0	58	5.0	5	5.0
850.0	1535	1.7	75	-2.2	311	6.0
700.0	3080	-2.4	6	-35.3	276	15.0
500.0	5669	-17.4	18	-36.2	277	36.2
400.0	7310	-26.7	19	-43.5	258	54.3
300.0	9341	-39.1	59	-44.2	242	68.9
250.0	10574	-44.5	13	-61.9	257	81.8
200.0	12055	-49.8	3	-76.7	258	86.1
150.0	13878	-61.4	3	-85.5	262	73.2
100.0	16358	-67.4	2	-92.4	256	49.0
70.0	18488	-64.4	1	-94.0	266	19.0
50.0	20540	-62.7	2	-88.9	279	5.4

91013009(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	199	12.8	63	6.0	29	9.4
850.0	1536	1.9	93	0.9	339	6.8
700.0	3077	-7.4	70	-11.9	256	17.7
500.0	5640	-22.0	79	-24.7	268	31.8
400.0	7259	-27.9	1	-68.6	254	51.8
300.0	9273	-39.2	4	-66.6	248	69.7
250.0	10521	-40.2	1	-77.0	259	81.7
200.0	12018	-49.0	1	-83.1	261	81.8
150.0	13869	-57.4	1	-89.0	263	63.7
100.0	16355	-68.4	1	-96.9	268	49.9
70.0	18489	-64.0	1	-93.7	270	15.8
50.0	20539	-63.8	1	-93.6	284	6.4
30.0	23761	/////	///	//////	////	//////

91013015(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	185	13.0	53	3.7	333	5.3
850.0	1519	1.7	76	-2.1	294	9.2
700.0	3063	-7.0	87	-8.8	271	22.3
500.0	5638	-15.3	6	-45.0	298	38.5
400.0	7283	-27.1	5	-55.6	289	45.6
300.0	9287	-42.8	3	-71.4	266	50.2
250.0	10519	-41.0	2	-72.9	262	73.8
200.0	12010	-48.8	1	-83.0	261	79.4
150.0	13852	-58.4	1	-89.7	273	67.0
100.0	16333	-67.1	1	-96.0	273	42.2
70.0	18475	-66.7	1	-95.7	256	19.2
50.0	20522	-60.9	1	-91.5	296	10.1
30.0	23742	/////	///	//////	////	//////

91013021(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	193	12.9	48	2.2	328	8.4
850.0	1528	1.4	69	-3.7	284	7.3
700.0	3064	-8.5	34	-21.6	285	15.6
500.0	5663	-15.9	27	-30.7	297	36.2
400.0	7308	-27.4	19	-44.1	281	40.9
300.0	9306	-43.6	12	-61.8	271	50.4
250.0	10544	-42.1	2	-73.7	261	72.5
200.0	12033	-48.9	1	-83.0	265	76.4
150.0	13868	-60.1	1	-90.9	267	61.7
100.0	16323	-67.6	1	-96.3	273	41.3
70.0	18473	-68.6	1	-97.0	270	25.8
50.0	20515	-62.0	1	-92.3	316	7.8
30.0	23734	-55.7	1	-87.8	87	5.2

91013103(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	182	12.1	51	2.3	314	9.6
850.0	1516	1.9	73	-2.4	281	13.1
700.0	3055	-5.7	42	-16.6	281	16.2
500.0	5671	-15.7	30	-29.4	283	39.1
400.0	7314	-27.2	24	-41.8	270	40.0
300.0	9317	-43.5	29	-54.5	271	46.5
250.0	10548	-43.8	4	-70.1	263	70.5
200.0	12040	-47.2	1	-81.8	263	71.5
150.0	13887	-59.1	1	-90.2	265	62.5
100.0	16338	-70.5	1	-98.4	263	39.4
70.0	18461	-65.1	2	-90.7	281	22.0
50.0	20513	/////	///	//////	////	//////

91013109(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	184	12.8	48	2.1	327	5.5
850.0	1519	0.2	87	-1.7	305	10.3
700.0	3051	-7.0	53	-15.0	274	19.4
500.0	5662	-15.3	10	-40.2	273	35.8
400.0	7301	-28.9	17	-46.5	272	42.1
300.0	9304	-43.1	29	-54.2	265	47.7
250.0	10537	-40.7	2	-72.7	264	71.8
200.0	12035	-48.9	1	-83.0	264	64.6
150.0	13879	-57.8	1	-89.3	264	52.1
100.0	16331	-67.5	2	-92.5	271	43.0
70.0	18470	-69.6	2	-94.1	291	17.2
50.0	20523	-62.7	1	-92.8	325	6.4

91013121(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	156	13.7	55	4.8	317	4.4
850.0	1495	2.2	93	1.2	268	10.3
700.0	3043	-2.8	61	-9.3	281	22.7
500.0	5642	-16.5	50	-24.5	270	38.6
400.0	7285	-28.0	25	-42.1	267	50.8
300.0	9305	-33.0	2	-67.1	268	66.3
250.0	10580	-38.1	1	-75.6	271	76.0
200.0	12089	-46.8	1	-81.6	266	66.9
150.0	13937	-60.4	1	-91.1	269	62.2
100.0	16366	-73.6	2	-97.2	275	43.6
70.0	18486	-66.1	3	-89.2	276	17.3
50.0	20519	-64.1	2	-90.0	291	3.2

91020109(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	127	17.0	60	9.2	239	12.8
850.0	1483	5.0	93	4.0	260	11.5
700.0	3044	-3.1	94	-3.9	276	20.8
500.0	5639	-16.5	48	-25.0	269	33.0
400.0	7283	-26.4	36	-37.1	269	57.7
300.0	9365	-28.2	18	-45.3	273	70.1
250.0	10654	-35.7	13	-54.5	270	68.4
200.0	12160	-48.7	10	-67.4	266	67.3
150.0	13985	-63.7	7	-82.2	259	60.6
100.0	16408	-74.0	7	-90.7	271	31.5
70.0	18468	-71.0	9	-86.7	294	15.9
50.0	20510	-67.2	10	-82.9	308	3.6
30.0	23670	/////	///	//////	////	//////

91020121(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	108	18.3	66	11.9	276	12.6
850.0	1472	6.9	91	5.5	261	19.0
700.0	3043	-1.6	65	-7.3	266	22.3
500.0	5667	-12.4	11	-37.0	273	48.5
400.0	7325	-25.9	14	-45.7	266	57.5
300.0	9427	-27.8	1	-68.6	270	68.1
250.0	10712	-37.6	1	-75.2	266	66.9
200.0	12208	-49.7	1	-83.6	261	66.5
150.0	14040	-62.1	1	-92.4	257	54.5
100.0	16447	-73.9	1	-100.9	267	34.9
70.0	18496	-72.6	1	-100.0	264	17.1
50.0	20521	-64.5	1	-94.1	232	4.0

91020209(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	127	14.3	75	9.9	313	10.2
850.0	1476	4.9	90	3.4	284	18.7
700.0	3036	-2.9	77	-6.4	278	22.6
500.0	5665	-14.9	57	-21.5	271	40.1
400.0	7317	-21.0	22	-37.2	263	57.0
300.0	9424	-28.7	20	-44.8	266	64.1
250.0	10704	-37.8	19	-53.1	265	65.4
200.0	12200	-49.0	13	-65.7	258	66.6
150.0	14026	-61.8	10	-78.3	254	61.6
100.0	16456	-72.9	10	-87.7	267	35.4
70.0	18513	-73.1	12	-86.8	264	21.1
50.0	20534	-69.0	18	-80.7	250	2.7

91020221(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	131	13.4	56	4.8	297	11.6
850.0	1470	2.2	54	-6.1	284	16.3
700.0	3012	-2.6	14	-26.5	285	24.8
500.0	5601	-18.4	25	-33.7	273	41.6
400.0	7236	-25.8	3	-58.8	269	59.9
300.0	9331	-26.9	1	-68.0	270	80.4
250.0	10613	-38.8	2	-71.3	262	80.6
200.0	12113	-49.2	1	-83.2	262	78.4
150.0	13931	-63.7	2	-89.7	256	75.2
100.0	16386	-71.6	1	-99.2	263	47.9
70.0	18486	-72.1	2	-96.0	258	24.8
50.0	20522	-63.2	1	-93.1	246	5.8
30.0	23718	/////	///	//////	////	//////

91020309(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	162	9.3	46	-1.7	302	9.0
850.0	1478	-3.2	87	-5.1	318	11.3
700.0	2999	-6.8	13	-30.7	300	20.8
500.0	5572	-18.3	11	-41.7	293	34.7
400.0	7195	-31.5	26	-44.8	275	39.9
300.0	9193	-29.9	1	-70.0	////	//////
250.0	10478	-37.4	1	-75.1	268	93.2
200.0	11975	-49.8	2	-79.3	267	91.1
150.0	13812	-59.4	2	-86.4	269	74.6
100.0	16304	-67.6	2	-92.6	260	51.3
70.0	18434	-68.4	2	-93.2	273	24.9
50.0	20487	/////	///	//////	////	//////

91020321(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	135	8.5	53	-0.5	278	11.3
850.0	1449	-3.0	95	-3.7	264	12.7
700.0	2970	-8.4	14	-31.2	262	18.0
500.0	5517	-20.9	59	-26.8	273	33.6
400.0	7130	-32.1	26	-45.3	271	35.0
300.0	9103	-38.6	5	-64.5	275	68.3
250.0	10353	-40.1	2	-72.2	273	84.5
200.0	11858	-47.5	2	-77.6	270	87.3
150.0	13712	-57.2	2	-84.8	264	65.3
100.0	16216	-65.9	2	-91.3	274	46.9
70.0	18374	-65.4	2	-90.9	263	24.0
50.0	20451	-60.9	2	-87.6	284	8.4

91020409(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s
1000.0	87	9.8	49	-0.4	269	11.6
850.0	1406	-1.8	79	-5.0	279	14.6
700.0	2929	-8.8	93	-9.7	252	31.8
500.0	5464	-22.8	68	-27.1	265	38.6
400.0	7062	-34.7	12	-54.4	270	45.9
300.0	9025	-42.6	6	-66.2	271	70.3
250.0	10262	-41.5	3	-70.4	273	94.1

00000000(YY/MM/DD/HH)

Press hpa	Hght gpm	Temp C	Hum %	Td C	dd deg	ff m/s