

Analysis of turbulence and extreme current velocity values in a tidal channel – Appendix I

Since both Naru Strait and Tanoura Strait are open to the Pacific Ocean and the Sea of Japan by its southern and northern mouth, respectively, waves could have a significant impact on the velocity fluctuations. For this reason, wave conditions at the area of study were analysed from the data measured by a Nortek AWAC in Naru Strait (32 49 34 N, 128 54 47 E) from October 3rd 2014 for 3 months. Wave measurement was complemented with wind data for the same time period extracted from the JMA (Japan Meteorologic Agency) station on Fukue Island, located at (32 41 36 N, 128 49 36 E) at 25.1 meters above sea level.

Hourly averaged wave and wind conditions are presented in Fig. A-1. Significant wave height is kept below 1 m for low wind velocities (under 3 m/s). For stronger wind conditions, wave height increases, with a maximum value over 3.3 m. This dependence is clearer for winds from the southeast, which can be observed in December, when wave heights close to 3 m are reached for wind velocity values under 10 m/s. This effect is mitigated for southerly winds, as can be noted at the beginning of October, with significant wave heights near 2.7 m for wind velocities over 15 m/s. For northerly winds (around October 20th), wind impact seems to be negligible, with wind velocities close to 5 m/s and significant wave heights under 0.3 m. The mean wave period for this month is 5.4 s and it presents a trend similar to that observed for the significant wave height, increasing with strong winds from the southeast. Nevertheless, for this parameter the fluctuation is less pronounced. Similar results are expected for the Tanoura Strait.

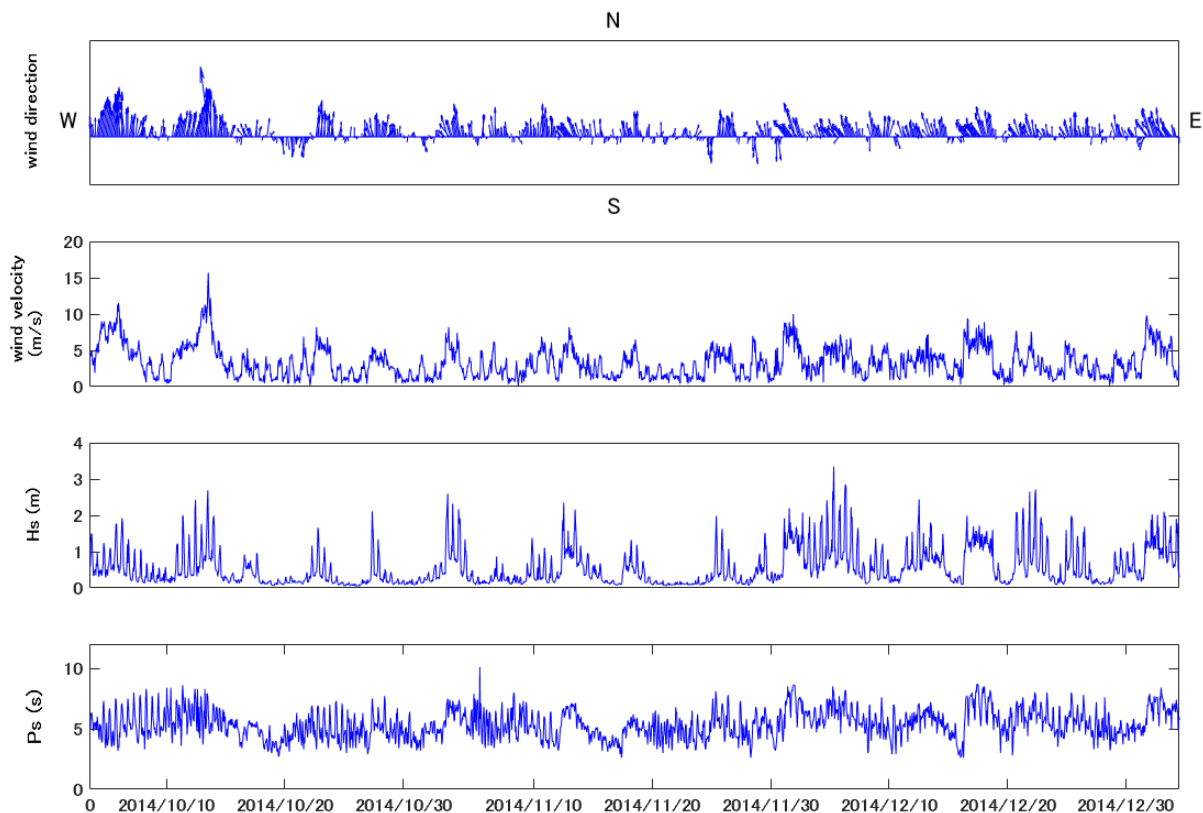


Fig. A-1 Hourly averaged wind direction, wind speed, significant wave height and wave period for a 3 months interval from October 3rd in 2014.

Focusing on the ADV measuring period from November 17th to November 24th, hourly averaged wind direction and velocity and significant wave height are shown in Fig. A-2.

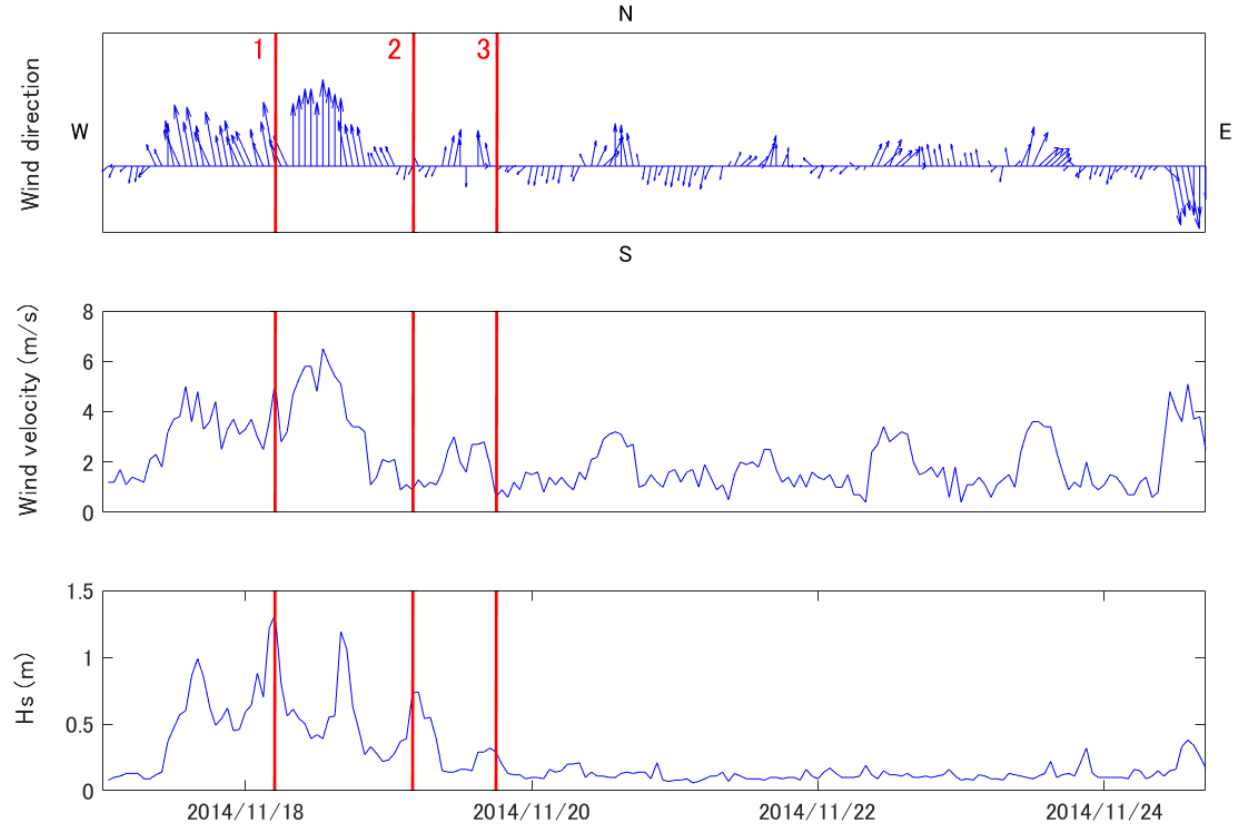


Fig. A-2 Wind direction, wind velocity and significant wave height measured at Fukue Station (JMA) during the ADVs measuring period.

In order to evaluate the impact of wind and waves on the flow, 3-minute signals collected at P2 (Naru Strait) with similar tidal current characteristics (approximately 0.8 m/s mean velocity and flood tide) and under different wave and wind conditions, both in terms of magnitude and direction, are compared. The first of them is measured on November 18th at 05:30h, when hourly averaged wind velocity is 5.2 m/s, significant wave height 1.32 m and 3-minute averaged tidal current velocity 0.804 m/s. The second sample is extracted from the conditions occurring on November 19th at 04:10h. Wind and tidal current averaged velocities are 0.9 m/s and 0.760 m/s, respectively, and wave height 0.73 m. The third one represents calm wave conditions ($H_s = 0.29$ m/s) for a tidal current equivalent to the previous cases (0.802 m/s) and occurs on November 19th at 18:10h. Information about the three comparators, marked in red in Fig. A-2, is summarized in Table A-1 and histograms of streamwise, transverse and vertical components of tidal current velocity for the three analysed conditions are presented in Fig. A-3.

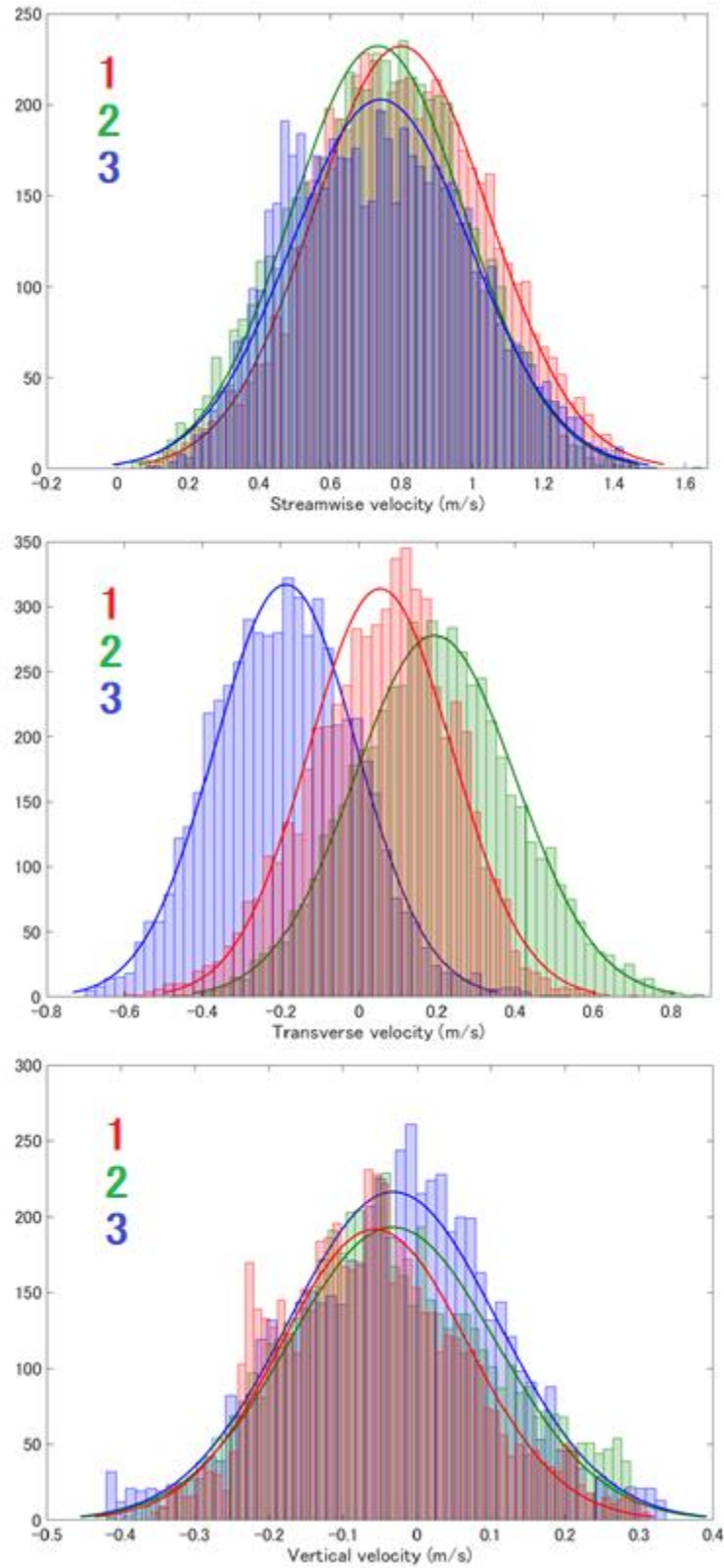


Fig. A-3 Histograms of streamwise, transverse and vertical components of velocity for the 3-minute data gap corresponding with wind and wave conditions 1, 2 and 3 at P2.

Table A-1. Wind speed, wind direction and mean tidal current velocity (3-minute) in P2 (Naru Strait) for the three compared conditions.

	Date and time	Hs (m)	Wind speed (m/s)	Wind direction	Tidal Current Velocity (m/s)
1	2014/11/18 05:30	1.32	5.2	SSE-NNW	0.804
2	2014/11/19 04:10	0.73	0.9	NE-SW	0.760
3	2014/11/19 18:10	0.29	0.7	ENE-WSW	0.802

Table A-2. Streamwise, transverse and vertical 3-minute period standard deviation and statistical range in P2 (Naru Strait) for the three compared wind conditions.

	Streamwise standard deviation (m/s)	Streamwise statistical range (m/s)	Transverse standard deviation (m/s)	Transverse statistical range (m/s)	Vertical standard deviation (m/s)	Vertical statistical range (m/s)
1	0.247	1.307	0.184	1.125	0.126	0.651
2	0.244	1.353	0.206	1.185	0.140	0.676
3	0.252	1.266	0.182	1.090	0.141	0.744

As can be observed in Fig. A-3 and corroborated in Table A-2, current conditions for the three components of velocity are similar both in terms of standard deviation and statistic ranges for the three evaluated wind conditions. This second parameter is calculated as the difference between percentile 99.9 and percentile 0.1 in order to avoid unrepresentative points. For 5.2 m/s winds from SSE and $H_s = 1.32$ m, velocity fluctuation appears to be comparable to that observed for lower winds from the north and $H_s = 0.73$ m (2) or $H_s = 0.07$ m (3).

Due to the similar geographic and meteorological conditions, analogous conclusions can be expected for P1 in Tanoura. Thus, it can be said that wave and wind effect on the flow at the measuring depth (3 meter from the bottom in both cases) is negligible at both points.