Space-time variability of wave characteristics near the coasts of the Southern Kuril Islands

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Abstract. Significant wave heights and most probable wave heights in the nearshore areas of the Southern Kuril Islands are considered in this paper. These characteristics were obtained from data of in-situ measurements of hydrostatic pressure in the depth range from 5 to 25 m. The measurements have been performed in 2008 and 2009. It is shown in the paper that relatively calm sea surface was observed in time period from July till first half of September. Most probable wave heights varied from 0.17 m to 0.27 m and maximal values of significant wave heights varied from 0.75 m to 1m in the depth range from 15 to 25 m. For depths less than 15 m most probable wave heights varied from 0.05 m to 0.1 m and maximal values of significant wave heights varied from 0.68 m to 1m. Time period from second half of September is characterized as stormy period. Maximal values of significant wave height reached 5 m at that time and most probable wave heights varied from 0.1 to 1 m depending on depth and location. Period from January till April can be characterized by high number of moderate storms with maximal value of significant wave heights 1.8 m and most probable wave heights from 0.13 to 0.33 m.

1. Introduction

This paper presents the estimates of sea wave characteristics: most probable wave height and significant wave height (SWH). Estimates were obtained from measurement data collected in 2008-2009 in the nearshore areas of the Southern Kuril Islands. Measurements were carried out by autonomous recorders of hydrostatic pressure (ARW-K12) at 1Hz sample frequency. Instrumentation setup is shown in figure 1. Analysis of collected data and calculation of wave characteristics were performed in specialized program for oceanologic data processing. Program was developed at the Institute of marine geology and geophysics by department of Wave dynamics and seashore currents [1]. The correction adjustment according to [2] was implemented to each recorded time series in due to reconstruct the real wave heights.

2. Experimental data and analysis

Locations of measurement points are shown in figure 2. In 2008 sea wave measurements were performed within the areas of cape Lovtsova (Kunashir Island), capes Van-Der-Lind and Kastrikum (Urup Island) during the period from July to October. The recorders were mounted at 25 m, 21 m and 15 m depth accordingly.

Figures 3 and 4 illustrate the results of collected data processing. Real wave heights are shown in figure 3 and significant wave heights are shown in figure 4. One can see that during the period from 1 of July to 19 of September the sea surface was relatively calm. Most probable wave heights were 27 cm, 22 cm and 12 cm and maximal values of SWH reached 0.75 m, 1 m and 1m accordingly for cape

Kastrikum, cape Van-Der-Lind and cape Lovtsova at that time. The only one storm was observed from 16 to 21 of August. Storm waves had maximal values of SWH about 3.8 m (cape Kastrikum), 2m (cape Van-Der-Lind) and 1.5 m (cape Lovtsova).

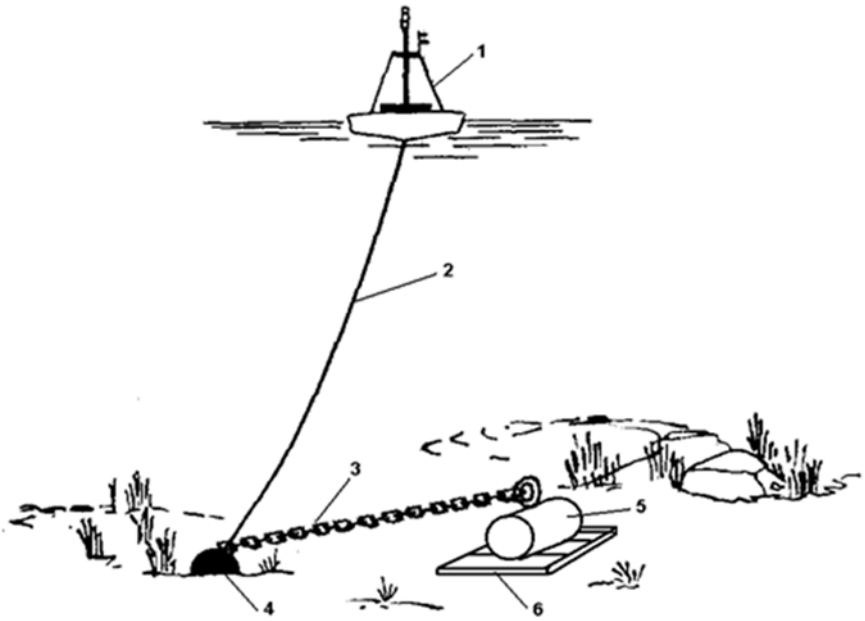

Figure 1. Instrumentation setup: 1 – surface buoy, 2 – buoy rope, 3 – chain, 4 – anchor, 5 – ARW-K12, 6 – mount rack.

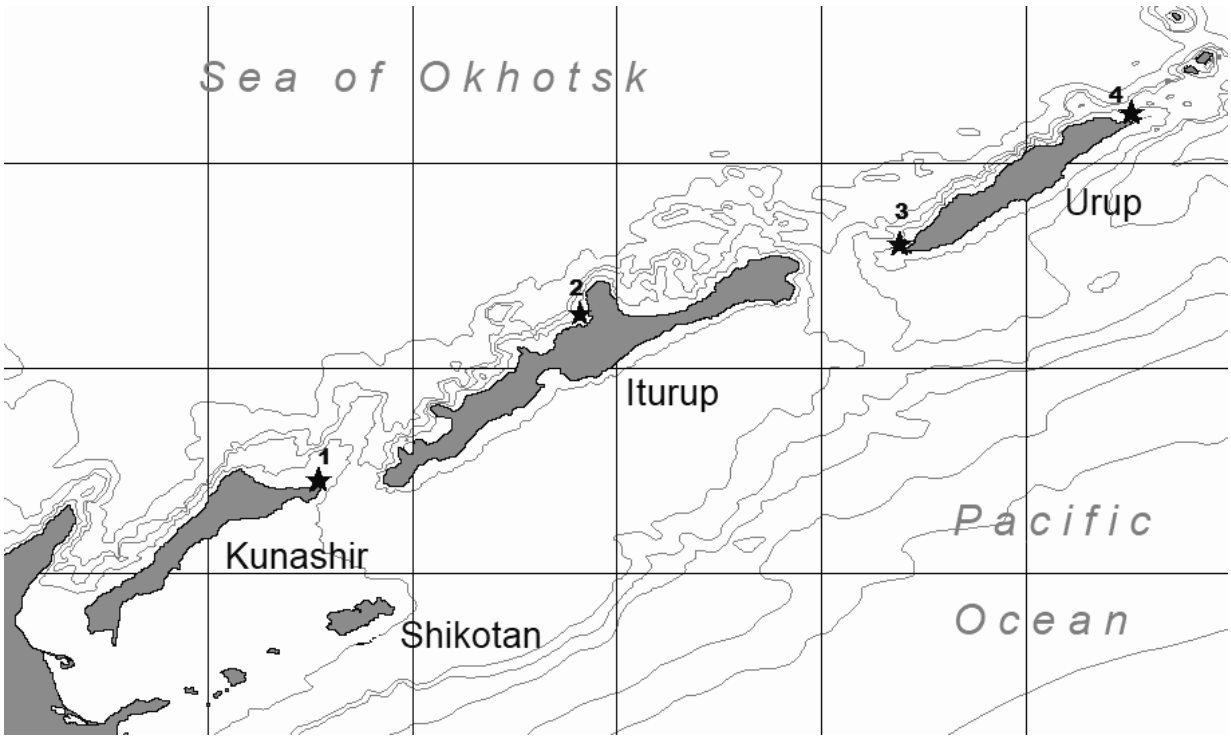

Figure 2. Locations of observation points: 1 – cape Lovtsova, 2 – Kurilsk, 3 – cape Van-Der-Lind, 4 – cape Kastrikum.

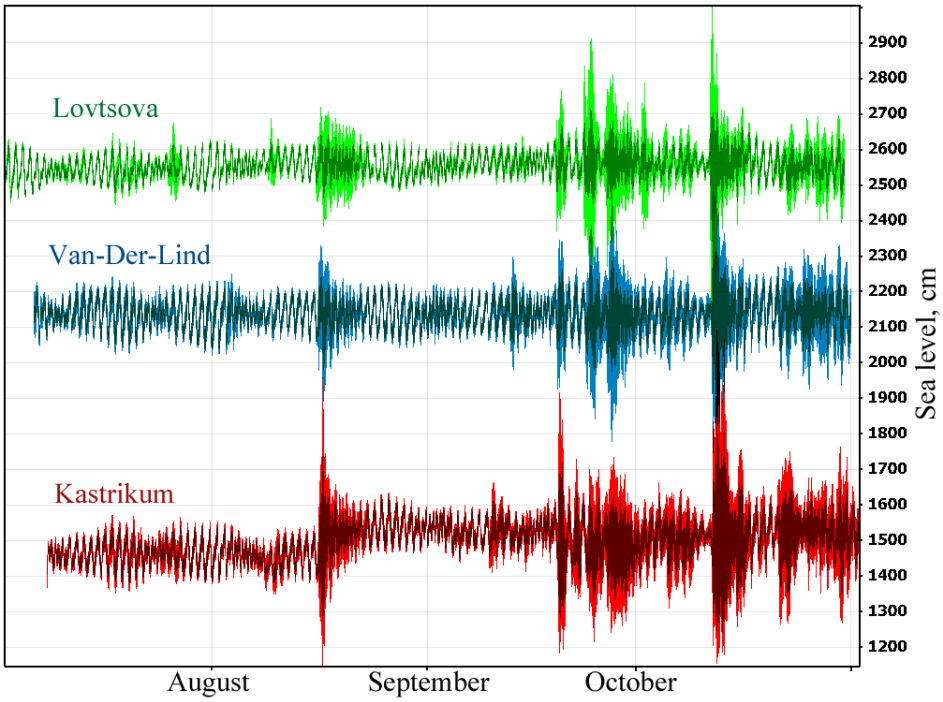

Figure 3. Sea level oscillations captured in 2008.

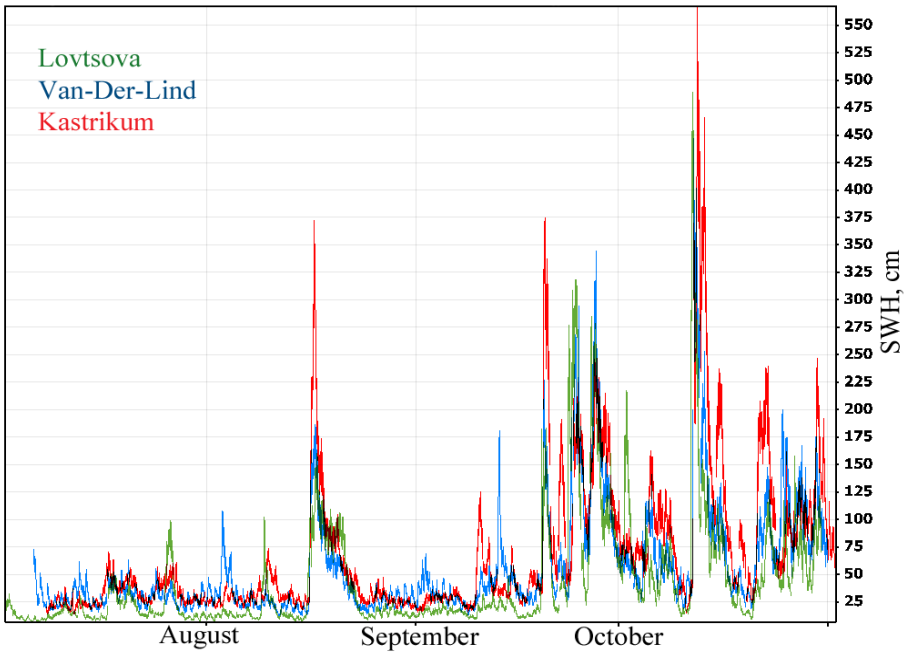

Figure 4. Significant wave heights.

The time period from 20 of September to 31 of October has been marked by high number of storms with SWH more than 1 m. Most probable wave heights at that period were about 1 m, 40 cm and 33 cm and maximal values of SWH reached 5.7 m, 4.5 m и 4.9 m accordingly for cape Kastrikum, cape Van-Der-Lind and cape Lovtsova.

Most probable wave heights and maximal SWH observed from July to October the 2008 are summarized in table 1 below.

Table 1. Most probable wave heights and maximal SWH observed in July – October 2008.

	Most probable wave height in calm weather, cm	Most probable wave height in stormy weather, cm	Maximal SWH in calm weather, m	Maximal SWH in stormy weather, m
Kastrikum	27	100	0.75	5.7
Van-Der-Lind	22	40	1	4.5
Lovtsova	12	33	1	4.9

In 2009 the measurements were held from January to April and from July to October. From January till April autonomous recorders were mounted within the areas of cape Van-Der-Lind and port of Kurilsk (Iturup Island) at the depths 8 m and 10 m accordingly. This period was stormy as well as the period September – October in 2008 (see figure 5). Maximal values of SWH and most probable wave heights appeared in the nearshore area of Kurilsk (see table 2).

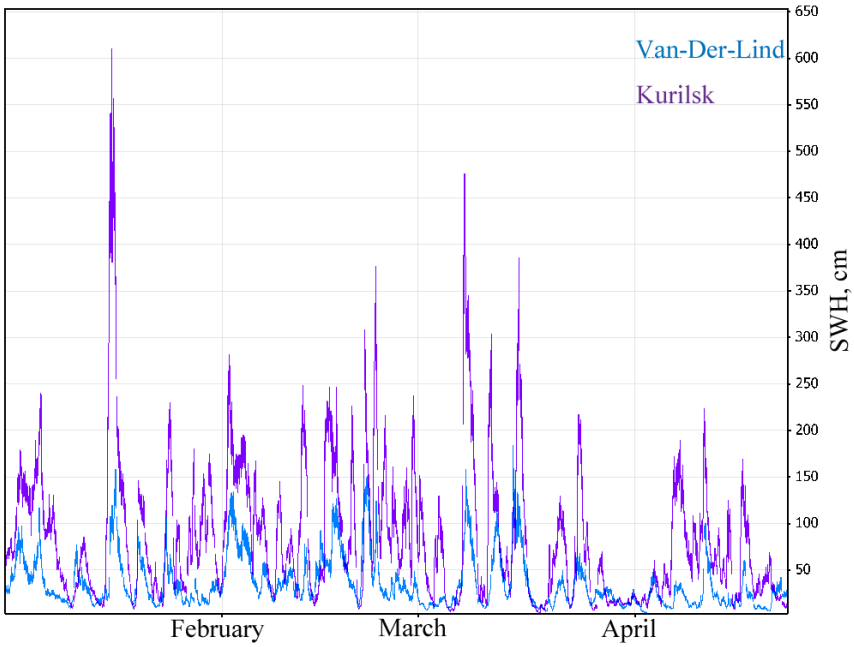

Figure 5. Significant wave heights.

Table 2. Most probable wave heights and maximal SWH observed in January – April 2009.

	Most probable wave height, cm	Maximal SWH, m
Van-Der-Lind	13	1.8
Kurilsk	33	6

From July to October recorders were mounted within the areas of cape Van-Der-Lind, cape Lovtsova and port of Kurilsk at the depths of 8 m, 6 m, and 5 m accordingly. Time period from July to the first week of September can be characterized as a calm period with most probable wave heights 10 cm, 5 cm

and 4.5 cm and maximal SWH 0.5 m, 0.6 m and 0.75 m accordingly for cape Van-Der-Lind, cape Lovtsova and port of Kurilsk. But from 8 of September the values of most probable wave heights increased to 21 cm, 10 cm and 11 cm and SWH rose to 0.7 m, 1.4 m and 1.7 m accordingly for cape Van-Der-Lind, cape Lovtsova and port of Kurilsk (see figure 6).

Most probable wave heights and maximal SWH observed from July to October the 2008 are summarized in table 3 below.

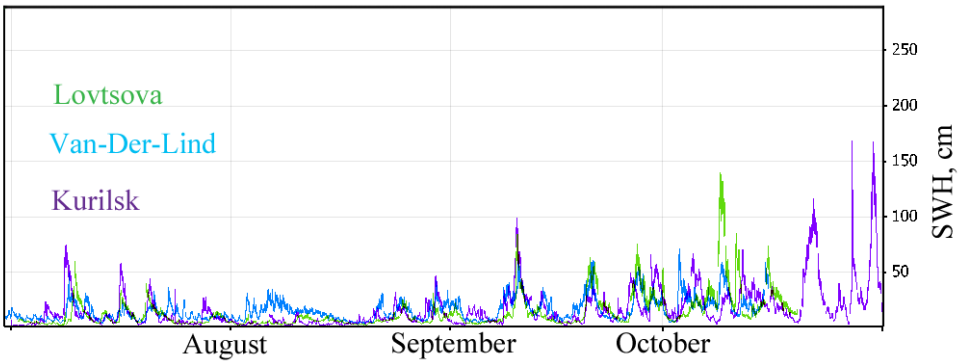

Figure 6. Significant wave heights.

Table 3. Most probable wave heights and maximal SWH observed in July – October 2009.

	Most probable wave height in calm weather, cm	Most probable wave height in stormy weather, cm	Maximal SWH in calm weather, m	Maximal SWH in stormy weather, m
Van-Der-Lind	10	21	0.68	0.75
Kurilsk	4.5	7	1	0.7
Lovtsova	5	10	0.84	1.4

3. Conclusions

Performed analysis of characteristics of sea waves in the nearshore areas of the Kunashir, Iturup and Urup islands shows that relatively calm sea is observed in time period from July till the first half of September, then from second half of September up to January a high number of storms including strong storms are observed and period from February till April can be characterized as a period with high number of moderate storms.

In calm period most probable wave heights varied from 4.5 cm at the area of Kurilsk port up to 27 cm at the area of cape Kastrikum. Maximal values of SWH during this period were in the range 0.68 m – 1 m depending on depth and location.

Most strong storms with maximal SWH around 5.7 m (cape Kastrikum), 4.5 m (cape Van-Der-Lind), 4.9 m (cape Lovtsova) and 6 m (Kurilsk) were observed during the period from second half of September to January.

High number of moderate storms with maximal value of SWH less then 2m was registered in February – April. But several storms registered in Kurilsk area had maximal values of SWH in range from 3 to 4.7 m at this time.

References

[1] Plekhanov F A and Kovalev D P 2016 *J. Geoinformatika* **1** 44–53
[2] Zaslavskii M M and Krasitskii V P 2001 *J. Oceanolgy* **41** 195–200