MICRO PROPERTIES OF THE WAVE CLIMATE STATISTICS AND ITS APPLICATIONS

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Spectrum Modeling Method:

Figure 1 and 2 show the observed $H_{1/3}$ (Rumoi) and its spectrum $|F'(f_n)|$.

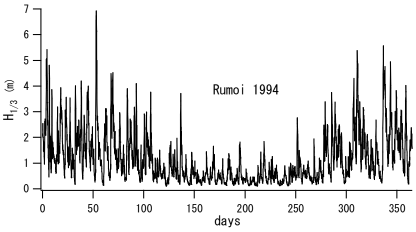

Fig.1 Observed $H_{1/3}$ (Rumoi: coast of the Sea of Japan, one year, every 2 hours)

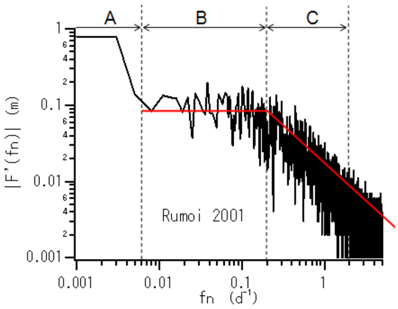

Fig.2 Fourier spectrum of the $H_{1/3}$ (Fig.1)

The spectrum $|F'(f_n)|$ (Fig.2) can be devided into 3 regions (A,B,C). Kimura and Ota (2012, 2013) showed that the spectrum can be approximated with the fundamental few Fourier components (region A), the constant (region B) and $\propto f^{-1}$(region C). $H_{1/3}(t_i)$ is expressed as

$$H_{1/3}(t_i) = H_A(t_i)$$

$$\times\left\{1 + \sum_{n1=3}^{73} (\overline{c}_1 + c_{\sigma 1} R_{n1}) \cos(2\pi f_{n1} t_i + \varepsilon_{n1})\right.$$

$$\left. + \sum_{n2=74}^{731} (\overline{c}_2 + c_{\sigma 2} R_{n2})\, f_{n2}^{-1} \cos(2\pi f_{n2} t_i + \varepsilon_{n2})\right\}$$

$$H_A(t_i) \approx \overline{H}_A(t_i) + H_\sigma R_{n3i}$$

$$\overline{H}_A(t_i) = \frac{1}{2}\overline{a}_0 + \sum_{n=1}^{2} \{\overline{a}_n \sin 2\pi f_n t_i + \overline{b}_n \cos 2\pi f_n t_i\}$$

$$\left.\begin{array}{l} t_i = idt \qquad (i = 0,1,2,\cdots) \\ \varepsilon_{n1} = 2\pi R_{Un1}, \quad \varepsilon_{n2} = 2\pi R_{Un2} \end{array}\right\}$$

R_{n1}, R_{n2} and R_{n3i} are the mutually independent normal random number $N(0,1)$. R_{Un1} and R_{Un2} are uniform random number $[0\sim 1]$.

Figure 3 shows the comparison between the observed (+) and the simulated frequency distribution $P(H_{1/3})$ (black line). Observed data from 7 obserbatories along the Sea of Japan coast are analyzed. All data from another observatories also show the similar spectral properties.

Micro properties of $H_{1/3}$statistics:

The statistical properties of the simulated $H_{1/3}$ show good agreements with the observed properties of $H_{1/3}$.

Monthly number of event $H_{1/3} \gtrapprox H_*$

Figure 4 shows the mean days of the event $H_{1/3} > H_*$ (data: 06:00~18:00 every day) every month ($H_* = 1m, 2m$ and $3m$: Tottori). Symbols show observed data (1991~2008). Lines show the simulated results (10000 years)

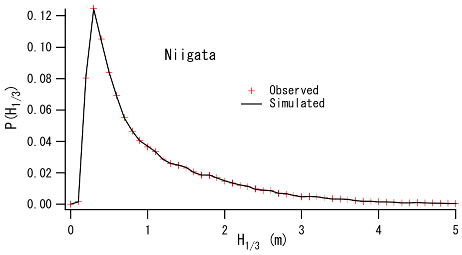

Fig. 3 Observed (+) and simulated (black line) frequency distributions of $H_{1/3}$.

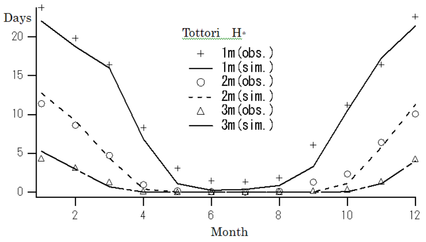

Fig. 4 Mean days of the event $H_{1/3} > H_*$ (Tottori)

Figure 5 shows the mean days of the event $H_{1/3} < H_*$ (data: 06:00~18:00 every day) every month ($H_* = 0.5m$ and $1.0m$: Niigata).

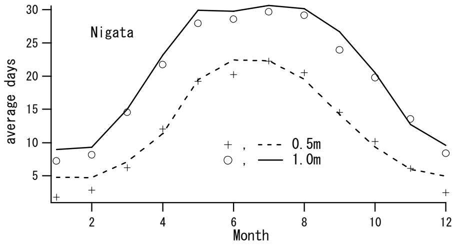

Fig. 5 Mean days of the event $H_{1/3} < H_*$(Niigata)

Run of the event $H_{1/3} \gtrapprox H_*$

Figure 6 shows frequency distribution of the runs of event $H_{1/3} > 3m$ in 24 hours (Wajima and Hamada).

Appropriate start date of construction works:

Figure 7 shows examples of the relations between the necessary days (including non-work days) and the start date for 60 and 90 days repair work (Rumoi).

Comparison between statistics of extreme wave height and wave climate.

Extreme value statistics give the relation between the return period R (years) and corresponding wave height $H_{1/3R}$ as

$$R = 1/\{1 - F(H_{1/3R})\}$$

where $1 - F(H_{1/3R})$ is the probability function of the annual maximum wave height. Total hours T_{ttlR} of the event $H_{1/3} > H_{1/3R}$ which takes place in R years is given from the wave climate statistics.as

$$T_{ttlR} = R \times 24 \times 365 \times \int_{H_R}^{\infty} P(H_{1/3})\, d\, H_{1/3}\ \ (hours)$$

Figure 8 shows the relations between R years annual maximum wave height $H_{1/3R}$ and T_{ttlR} for $H_{1/3R}$.

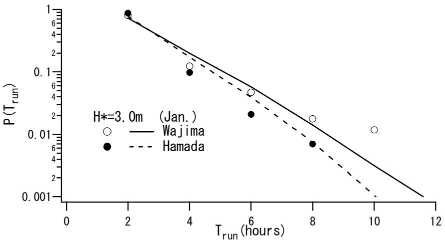

Fig.6 Run of the event $H_{1/3} > 3m$ (Wajima, Hamada)

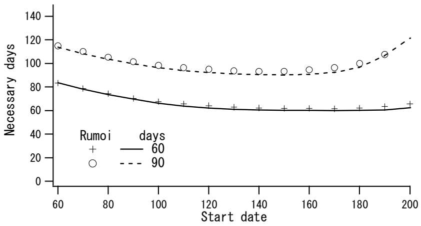

Fig.7 Necessary days for 60 and 90 days construction works (symbols : observed, lines : simulated ; Rumoi).

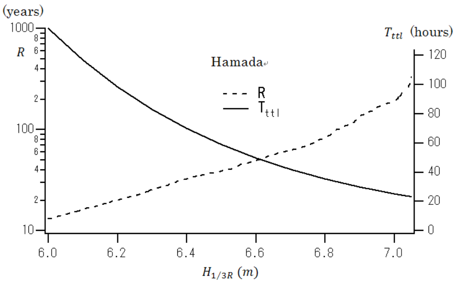

Fig.8 Relations between $R{\sim}H_{1/3R}$ (broken line, left axis) and $T_{ttl}{\sim}H_{1/3R}$ (solid line, right axis) (R = 50years , $H_{1/3R} = 6.6m,\ T_{ttlR} = 50hr$)

Grobal climate change

Grobal climate change may also bring wave climate changes. Figure 9 shows the large part $(H_{1/3} \geq 3.0m)$ of $P(H_{1/3})$ assuming $\pm 10\%$ linear yearly changes in 50 years from the present annual average $H_{1/3}$ (Kimura and Ota, 2012,2013).

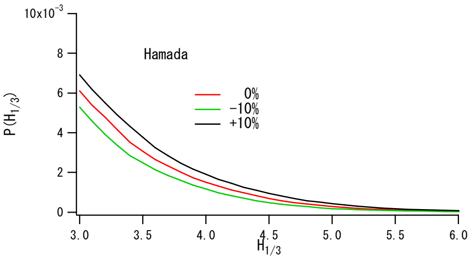

Fig. 9 Wave climate change due to the grobal climate change

Referece

Kimura, A. T. Ota (2012): Statistical estimation of wave climates in a monsoon region, *Proc. 33rd ICCE, Management* 20, 1-15.

Kimura, A. T. Ota (2012): Statistical properties of wave climate and its applications, *Proc. Coasgtal Eng. JSCS*, **69**, I_116-I_120. (in Japanese)