# An effect of the averaging time and recording interval on mean wind speeds and significant wave heights

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## Background and Objective

- Hindcasting of extreme wind speed and wave height may cause underestimation.
  - Typically, the temporal resolution of these models are lower than ten minutes (wind) or one hour (wave).
  - Conversion of averaging time or evaluation time is needed.
- Historical wave measurement data are not continuous.
  - The effect of sampling intervals on the extreme value has to be clarified.

- Larsen and Mann (2006) discussed these issues on wind speed based on measurement.
  - The applicability to tropical cyclones (typhoons) are not clear.
  - The effect on significant wave height are not discussed.

This study aims to investigate the effect of averaging time and sampling intervals on the extreme wind speed and wave height by using the measurement data.

# Difference of the averaging time of wind speed

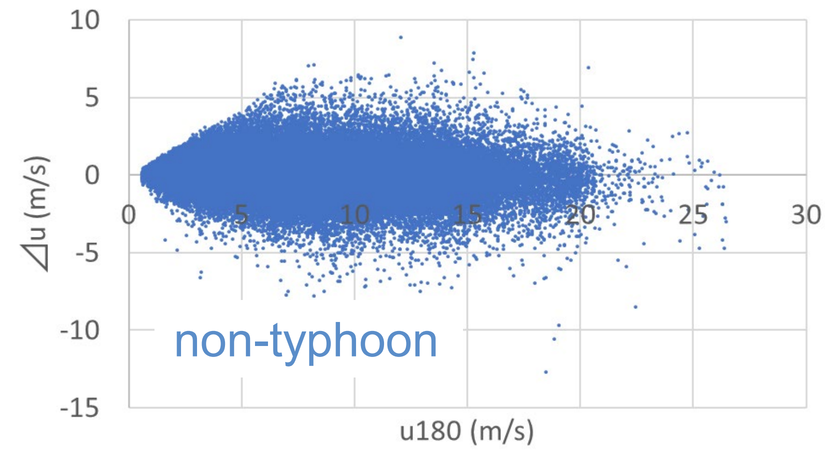
By using the measured wind speed at Fukushima FOrWarD (Floating Offshore Wind Farm Demonstration) project, the difference between 10 minutes average wind speed ($u_{10}$) and M minutes average wind speed ($u_M$) (M>10) is analyzed.

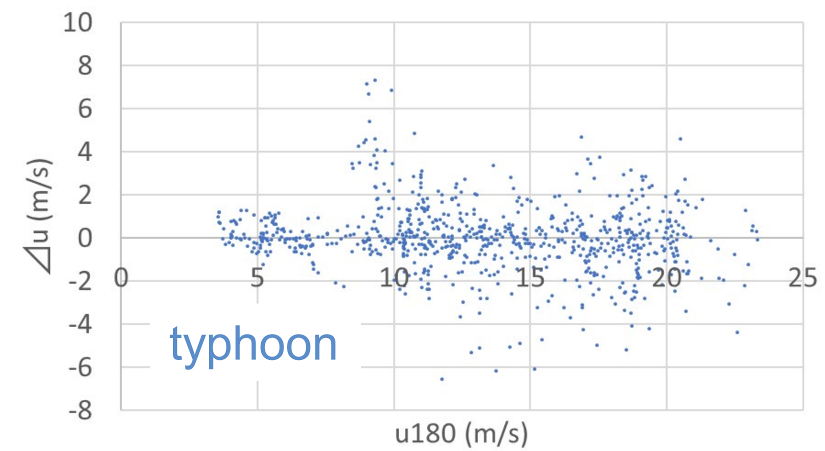
$$\Delta u_M = u_M - u_{10}$$

The difference $\Delta u_M$ is plotted as function of $u_M$. An example of M=180 is shown.

In each M minute average wind speed bin, the distribution of $\Delta u_M$ are modelled by using normal distribution.

- Mean value is 0
- Standard deviation is a function of $u_M$ ($\sigma(u_M, M)$)




Typhoon:

- distance to the centre of the typhoon < 500km
- central pressure < 985hPa

# Modelling of the standard deviation of the difference

The standard deviation of the difference $\sigma(u_M, M)$ is plotted against $u_M$ for M=180 as an example. $\sigma(u_M, M)$ can be modelled as follows:

For non-typhoon:

$$\sigma(u_M, M) = b(M)u_M + c(M)$$

For typhoon:

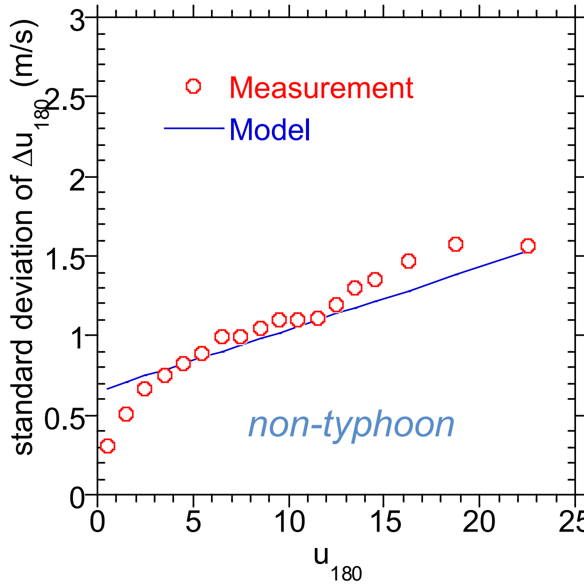
$$\sigma(u_M, M) = a(M)u_M$$

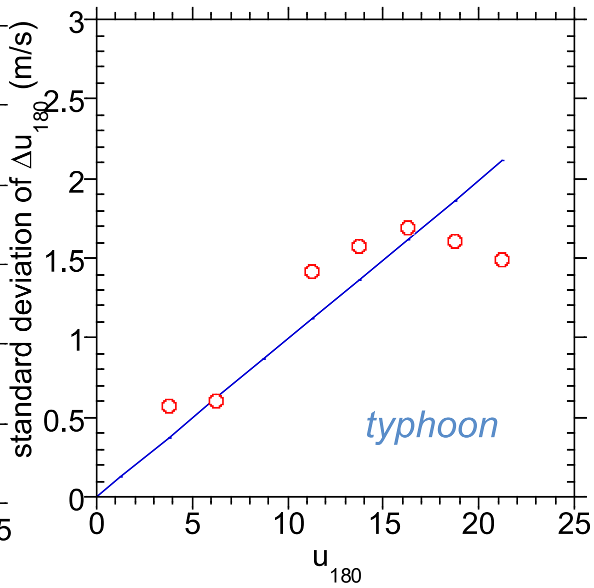
$a(M)$, $b(M)$ and $c(M)$ are modelled empirically.

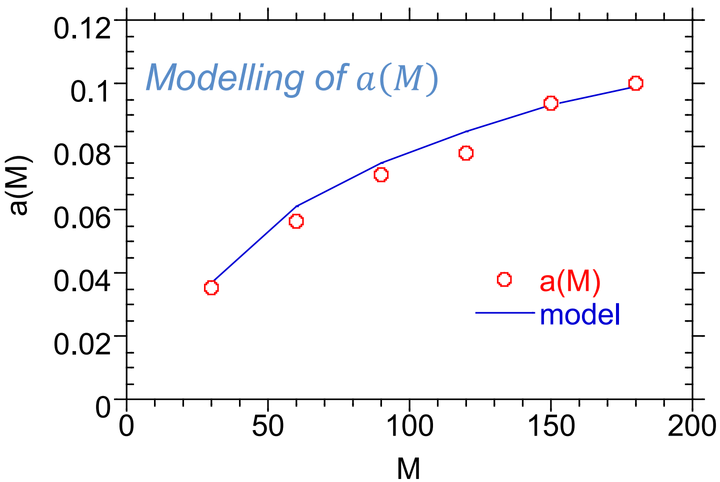
$$a(M) = -0.0388\ln\left(\frac{60}{M}\right) + 0.0575$$

$$b(M) = -0.0240\ln\left(\frac{60}{M}\right) + 0.0317$$

$$c(M) = -0.0193\ln\left(\frac{60}{M}\right) + 0.0304$$



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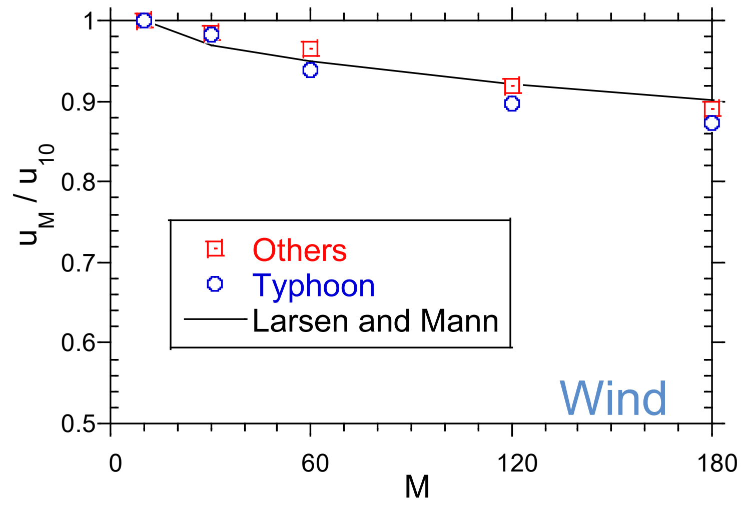
# Effect of averaging time on extreme wind speed

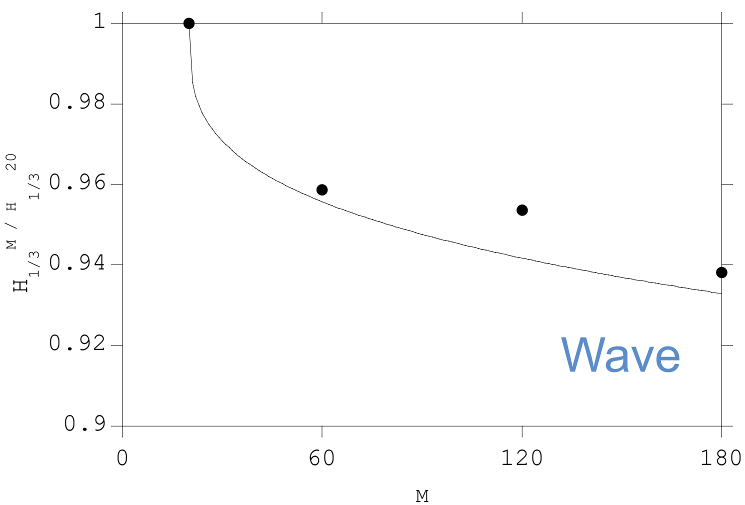
From the time history of the M minutes average wind speed, the time history of 10 minutes average wind speed is generated by adding random value which follows the proposed statistical model.

The ratio of the M minutes average maximum wind speed to the 10 minuets value are calculated.

- For non-typhoon case, the results shows good agreement with the results by Larsen and Mann.
- For typhoon case, the results is different from Larsen and Mann and the ratio shows smaller value.

Similar models are proposed for significant wave height, where the difference between typhoon and non-typhoon are not visible.



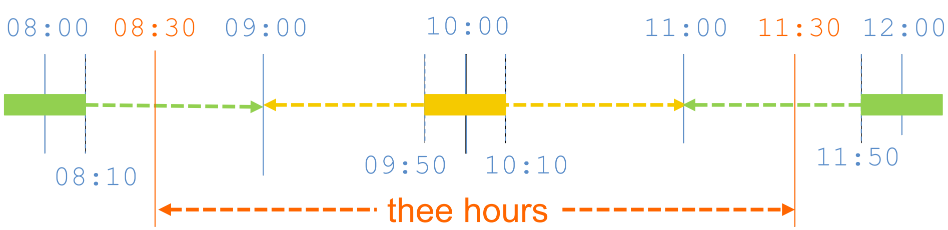
# Effect of recording interval

In Japan, historical wave data are recorded as 20 minutes statistical value every two hours.
e.g. 07:50-08:10, 09:10-10:10..

- The extreme values are underestimated.

From this intermittent data, three hour continuous value is estimated by using following equation.

$$H_{1/3}^{180,i} = \sqrt{\frac{1}{6}\left[\left(\widehat{H}_{1/3}^{20,i-1}\right)^2 + 4\left(\widehat{H}_{1/3}^{20,i}\right)^2 + \left(\widehat{H}_{1/3}^{20,i+1}\right)^2\right]}$$




The extreme values of estimated three hour statistics show good agreement with that of continuous data.