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## How are significant wave height, dominant period, average period, and wave steepness calculated?

Significant wave height, **WVHT**, is approximately equal to the average of the highest one-third of the waves, as measured from the trough to the crest of the waves. **WVHT** is calculated using:

$$WVHT = 4. \times \sqrt{m_0}$$

where  $m_0$  is the variance of the wave displacement time series acquired during the wave acquisition period. However, since wave displacement time series are not returned from NDBC's wave measurement systems, variance is calculated using the nondirectional wave spectrum according to the following relationship:

$$m_0 = \sum_{f_l}^{f_u} (S(f) \times d(f))$$

where the summation of spectral density, **S(f)**, is over all frequency bands, from the lowest frequency  $f_l$  to the highest frequency,  $f_u$ , of the [nondirectional wave spectrum](#) and **d(f)** is the bandwidth of each band. NDBC wave analysis systems typically sum over the range from 0.0325 to 0.485 Hz with frequency bandwidths varying from 0.005 Hz at low frequencies to 0.02 Hz at high frequencies. Older systems sum from 0.03 Hz to 0.40 Hz with a constant bandwidth of 0.01Hz. For more info, see [Description of NDBC wave spectra](#) and [How are spectral wave data derived from buoy motion measurements](#).

Dominant or peak wave period, **DPD**, is the period corresponding to the frequency band with the maximum value of spectral density in the nondirectional wave spectrum. It is the reciprocal of the peak frequency,  $f_p$ :

$$DPD = 1/f_p$$

Dominant period is representative of the higher waves encountered during the wave sampling period. NDBC computes average period (**APD**) using:

$$APD = \sqrt{m_0/m_2}$$

$$m_2 = \sum_{f_l}^{f_u} (S(f) \times d(f) \times f^2)$$

and  $m_0$  as previously defined.

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Greater detail on the processing of NDBC wave data can be found in the [Nondirectional and Directional Wave Data Analysis Procedures PDF](#).

Average periods (**APD**) for Scripps's buoys are derived from the zeroth moment divided by the first moment of the reported energy spectrum. See the CDIP Document pages at <https://cdip.ucsd.edu>.

Average periods for the buoys of the United Kingdom, Ireland, and France that are displayed on NDBC's web pages compute average periods from a zero-crossing method.

NDBC also provides estimates of the height and period of [wind-seas and swell](#) on each station page by applying the above process to the respective wind-sea and swell portions of the wave spectrum.

The algorithm used to estimate wave steepness is taken from work done by William Buckley, discussed in a paper that appeared in the *Naval Engineers Journal*, September 1988, titled "Extreme and Climatic Wave Spectra for Use in the Structural Design of Ships" with further explanation in "Buoy Wave Extremes" by David Gilhousen in *Mariners Weather Log*, V.37#4, Fall 1993. The algorithm involves the relationship between significant wave height ( $H_s$ ) and dominant wave period (**DPD**), or more precisely, its inverse - the peak wave frequency ( $f_p$ ).

The algorithm follows:

```
val = exp(-3.3 * ln( $f_p$ ))
if  $H_s$  > (val/250)
    steepness = 'very steep';
elseif  $H_s$  > (val/500)
    steepness = 'steep';
elseif  $H_s$  > (val/1000)
    steepness = 'average';
else
    if(SwH or WWH is missing)
        steepness = 'N/A';
    elseif SwH >= WWH
        steepness = 'swell';
    else
        steepness = 'average';
    endif
endif
```

where SwH and WWH are the respective significant heights of the swell and wind waves. N/A will also appear if the  $H_s$  is less than 0.8 meters or missing.

For more information about wave steepness, see:

*An Introduction to Sea State Forecasting* by Graham Britton, published by NOAA in 1981. Chapter 10 discusses steepness and can be viewed by clicking this link - [Sea State Forecasting](#).

Coastal Engineering Manual, Part II (available at: <https://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals/u43544q/636F617374616C20656E67696E656572696E67206D616E75616C/>), US Army Corps of Engineers.

Guide to Wave Analysis and Forecasting, (available at: [https://library.wmo.int/?lvl=notice\\_display&id=7700#.ZBI1BXZOLPZ](https://library.wmo.int/?lvl=notice_display&id=7700#.ZBI1BXZOLPZ)) World Meteorological Organization.

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