oceanweather inc.
Marine forecasts/hindcasts Research at the air-sea interface

350 Bedford Street, Suite 404
Stamford, CT 06901
**Tel:** 203 661 3091
oceanwx@oceanweather.com
http://www.oceanweather.com

# Oceanweather Field Variable Definitions:

## *Standard Wave Model Output*

**Julian Date** where 1 Jan, 1900 = 2; 2 Jan, 1900 = 3 etc.
**Date** in YYYYMM format
**Date** in DDHHMM format

**WD** Wind Direction (deg from):
From which the wind is blowing, clockwise from true north in degrees (meteorological convention).

**WS** Wind Speed (m/s):
Effective neutral wind at a height of 10 meters, consistent with a 10-minute wind, units in meters/second.

**ETOT or $M_0$** Total Variance of Total Spectrum ($m^2$):
The sum of the variance components of the hindcast spectrum, over all of the spectral bins of the wave model, in meters squared.

**TP** Peak Spectral Period of Total Spectrum (s):
Peak period is the reciprocal of peak frequency, in seconds. Peak frequency is computed by taking the spectral density in each frequency bin, and fitting a parabola to the highest density and one neighbor on each side. If highest density is in the .32157 Hz bin, the peak period reported is the peak period of a Pierson-Moskowitz spectrum having the same total variance as the hindcast spectrum.

**VMD** Vector Mean Direction of Total Spectrum (deg to which):
To which waves are traveling, clockwise from north in degrees (oceanographic convention).

$$\mathrm{VMD} = \tan^{-1} \frac{\int_0^{2\pi}\int_0^{\infty} \sin\theta E(f,\theta)\,df\,d\theta}{\int_0^{2\pi}\int_0^{\infty} \cos\theta E(f,\theta)\,df\,d\theta}$$

**Explanation of sea/swell computation**:
The sum of the variance components of the hindcast spectrum, over all of the spectral bins of the wave model, in meters squared. To partition sea (primary) and swell (secondary) we compute a P-M (Pierson-Moskowitz) spectrum, with a $\cos^3$ spreading, from the adopted wind speed and direction. For each of the spectral bins, the lesser of the hindcast variance component and P-M variance component is thrown into the sea partition; the excess, if any, of hindcast over P-M is thrown into the swell partition.

**ETTSEA** Total Variance of Primary Partition "Sea" ($m^2$)
**TPSEA** Peak Spectral Period of Primary Partition (s)
**VMDSEA** Vector Mean Direction of Primary Partition (deg to which)

**ETTSW** Total Variance of Secondary Partition: "Swell" ($m^2$)
**TPSW** Peak Spectral Period of Secondary Partition (s)
**VMDSW** Vector Mean Direction of Secondary Partition (deg to which)

**MO1 or M01 or $M_1$** First Spectral Moment of Total Spectrum ($m^2/s$):
Following Haring and Heideman (OTC 3230, 1978) the first and second moments contain powers of $\omega = 2\pi f$; thus:

$$M_1 = \sum\sum 2\pi f dS$$

where dS is a variance component and the double sum extended over all of the spectral bins.

**MO2 or M02 or $M_2$** Second Spectral Moment of Total Spectrum ($m^2/s^2$):
Following Haring and Heideman (OTC 3230, 1978) the first and second moments contain powers of $\omega = 2\pi f$; thus:

$$M_2 = \sum\sum (2\pi f)^2 dS$$

where dS is a variance component and the double sum extended over all of the spectral bins.

**HS or HSig** Significant Wave Height (m):
4.000 times the square root of the total variance, in meters.

**DMDIR** Dominant Direction (deg to which):
Following Haring and Heideman, the dominant direction $\psi$ is the solution of the equations

$$A\cos 2\psi = \sum\sum \cos 2\theta\pi dS$$
$$A\sin 2\psi = \sum\sum \sin 2\theta\pi dS$$

The angle $\psi$ is determined only to within 180 degrees. Haring and Heideman choose from the pair ($\psi$, $\psi$+180) the value closer to the peak direction.

**ANGSPR** Angular Spreading Function:
The angular spreading function (Gumbel, Greenwood & Durand) is the mean value of cos($\theta$ - VMD), weighted by the variance component in each spectral bin. If the angular spectrum is uniformly distributed over 360 degrees, this statistic is zero. If uniformly distributed over 180 degrees, this statistic is $2/\pi$. And, if all variance is concentrated at the VMD, it is 1. For the use of this statistic in fitting an exponential distribution to the angular spectrum, see Pearson & Hartley, Biometrika Tables for statisticians, 2:123 ff.
Angular spreading (ANGSPR) is related to $\cos^n(\theta)$ spreading as follows:

n = (2*ANGSPR)/(1-ANGSPR) or alternatively as N = ((2*$INLINE^2$)-1)/(1-$INLINE^2$).

**INLINE** In-Line Variance Ratio:
Called directional spreading by Haring and Heideman, p 1542. Computed as:

$$Rat = \frac{\sum\sum \cos^2(\theta - \psi) ds}{\sum\sum dS}$$

If spectral variance is uniformly distributed over the entire compass, or over a semicircle, Rat = 0.5; if variance is confined to one angular band, or to two band 180 degrees apart, Rat = 1.00. According to Haring and Heideman, $\cos^2$ spreading corresponds to Rat = 0.75.

***Non-Standard Wave Model Output:***

**WS3s** Extratropical Wind Gust (3 sec) (m/s):
Extratropical 3-second wind at a height of 10 meters computed from the ISO_19901-2015 relationship in section A.7.3.2 which is based on Frøya measurements, units in meters/second.

**WS3sT** Tropical Wind Gust (3 sec) (m/s):
Tropical 3-second wind at a height of 10 meters computed from the ISO_19901-2015 relationship in section A.7.3.3 which is ESDU-based, units in meters/second.

**MO-1** Negative First Order Spectral Moment of Total Spectrum ($m^2/s^{-1}$):
Following the first and second moments which contain powers of ω = 2πf from Haring and Heideman (OTC 3230, 1978) the -1st spectral moment is defined as:

$$M_{-1} = \sum\sum (2\pi f)^{-1} dS$$

where dS is a variance component and the double sum extend over all frequency by direction spectral bins.

**MO4 or M04 or $M_4$** Fourth Spectral Moment of Total Spectrum ($m^2/s^4$):
Following Haring and Heideman (OTC 3230, 1978) the first and second moments contain powers of ω = 2πf; thus:

$$M_4 = \sum\sum (2\pi f)^4 dS$$

where dS is a variance component and the double sum extended over all of the spectral bins.

**T01 or TM** Significant Period of Total Spectrum (s)
The significant or mean period (seconds) is the mean of the zero up-crossing periods associated with significant wave height. It is calculated using the total variance ($M_0$, see ETOT) and the first moment ($M_1$):

$$T_{01} = 2\pi\left(\frac{M_0}{M_1}\right)$$

**T02 or TZ** Mean Zero-Crossing Period of Total Spectrum (s):
The wave period theoretically equivalent with mean zero-downcrossing period Tz. It is calculated using the total variance ($M_0$, see ETOT) and the second moment ($M_2$):

$$T_{02} = 2\pi\sqrt{\left(\frac{M_0}{M_2}\right)}$$

**TE (T-10)** Energy Wave Period of Total Spectrum (s):
The energy wave period (seconds) is the variance-weighted mean period of the one-dimensional period variance density spectrum. It is calculated using the total variance ($M_0$, see ETOT) and the negative first moment ($M_{-1}$):

$$T_e = T_{m-10} = 2\pi\left(\frac{M_{-1}}{M_0}\right)$$

**TC** Mean Period between Maxima of Total Spectrum or Mean Crest Period (s):
This statistical mean period is calculated using the second ($M_2$) and fourth ($M_4$) moments:

$$T_c = 2\pi\sqrt{\left(\frac{M_2}{M_4}\right)}$$

**PWD** Peak Wave Direction of Total Spectrum (deg to which):
The discrete directional bin with maximum energy in degrees (oceanographic convention).

***Hydrodynamic Model Output (including ADCIRC):***

**HSURt or WL or SSH** Total Surge Height or Water Level or Sea Surface Height (cm):
Storm driven water elevation simulated by the ADCIRC model with respect to mean sea level in cm. Tidal forcing included.

**CSt** Total Current Speed (cm/s):
Magnitude of storm driven vertically averaged current simulated by ADCIRC, in cm/s. Tides are included.

**CDt** Total Current Direction (deg to which):
Direction of storm driven vertically averaged current simulated by ADCIRC in degrees to which the currents are traveling, clockwise from north (oceanographic convention). Tides are included.

**HSURr** Residual Surge Height (cm):

Residual/wind-driven only contribution to water level with respect to mean sea level in cm.

**CSr** Residual Current Speed (cm/s):
Magnitude of residual/wind-driven only vertically averaged current, in cm/s.

**CDr** Residual Current Direction (deg to which):
Direction of residual/wind-driven vertically averaged current in degrees to which the currents are traveling, clockwise from north (oceanographic convention).

**SLP** Mean Sea Level Pressure (mb)
Mean sea level pressure in millibars.

**Salin** Salinity (PSU)
Saltiness of the water in PSU.

**TSea** Sea Water Temperature (deg C or K)
Water temperature in degrees Celsius or Kelvin.

***TXPO (GROW-TIDE) Output:***

**HSURi** Tide Surge Height (cm):
Tide contribution to the water level with respect to mean sea level in cm.

**CSi** Tide Current Speed (cm/s):
Magnitude of the tidal current speed, in cm/s.

**CDi** Tide Current Direction (deg to which):
Direction of the tidal current in degrees to which the currents are traveling, clockwise from north (oceanographic convention).

***Kantha and Clayson (1994) 1-D Current Simulation Output:***

**VS** Surface Current Speed (cm/s):
1-D Surface current speed in cm/s, no tides.

**DZ** Zero Depth (m):
1-D Depth at which current speed equals zero in meters.

**DH** Mid-Depth (m):
1-D Depth of break in current profile in meters.

**VH** Mid-Depth Current Speed (cm/s):
1-D Current speed at Mid-Depth in cm/s.

**VDIR** 1-D Current Direction (deg to which):
1-D Vector average current direction, clockwise from north in degrees (oceanographic convention)

***JONSWAP parameters (Hasselmann et al., 1973):***

**TotJSHs** JONSWAP HS (m):
Significant wave height in meters predicted by JONSWAP gamma

**TotJSTp** JONSWAP Peak Period (s):
Peak period in seconds predicted by JONSWAP gamma

**TotJSGam** JONSWAP Gamma:
Peak enhancement factor

***References:***

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