The Breugem and Holthuijsen (2006) shallow water formulation

For shallow water waves with limited fetch (for example, in bays and large inland lakes) that reach their full development quickly, the Breugem and Holthuijsen (2006) formulation works very well. Fully developed wave height for large fetches are constrained only by the wind:

$$H_{max} = \frac{0.2433\left|\vec{V}_{sfc}\right|^2}{g}$$

where $\left|\vec{V}_{sfc}\right|$ is the sustained wind at 10-m height. For limited fetch and depth, they formulated:

$$depth\ term = \tanh\left\{0.343\left(\frac{gD}{\left|\vec{V}_{sfc}\right|^2}\right)^{1.14}\right\}$$

$$fetch\ term = \tanh\left\{0.000414\left(\frac{gF}{\left|\vec{V}_{sfc}\right|^2}\right)^{0.79}\right\}$$

$$H = H_{max}\left\{(depth\ term)\tanh\left[\frac{(fetch\ term)}{(depth\ term)}\right]\right\}^{0.572}$$

where D is the depth and F is the fetch. Note that, since $\tanh x \longrightarrow 1$ if x is large, for deep water the equation reduces to the fetch term, and for large fetches, it reduces to H_{max}. These limiting values can be shown in the following plots:

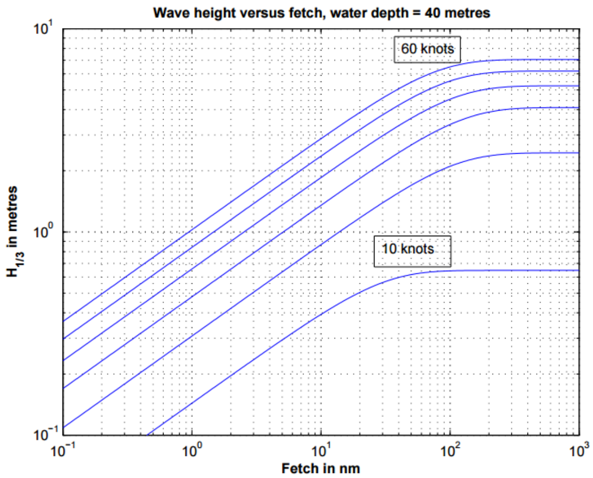


Figure 8: Shallow water nomogram for 40 metres depth.

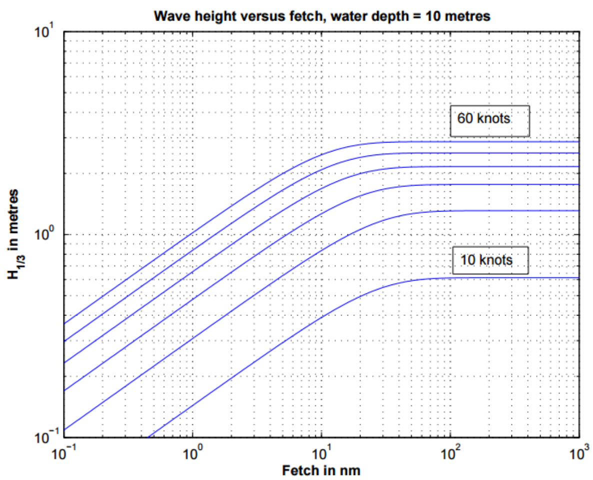
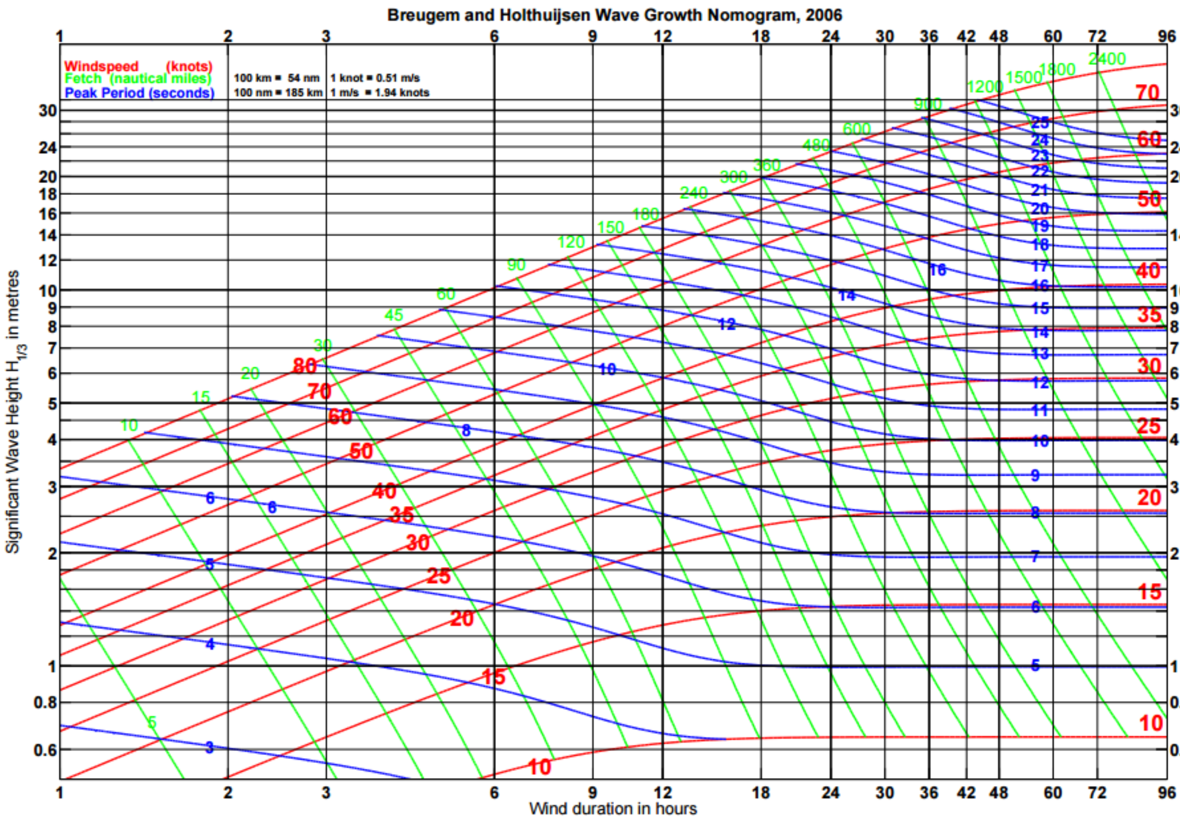


Figure 7: Shallow water nomogram for 10 metres depth.

Depth	10 knots	20 knots	30 knots	40 knots	50 knots	60 knots
10 m	0.61m (31nm)	1.3m (31nm)	1.8m (23nm)	2.2m (17nm)	2.5m (15nm)	2.9m (12nm)
20 m	0.65m (35nm)	1.9m (75nm)	2.7m (61nm)	3.4m (48nm)	4.0m (39nm)	4.5m (33nm)
30 m	0.65m (36nm)	2.3m (108nm)	3.5m (103 nm)	4.4m (84nm)	5.2m 70nm)	5.9m (61nm)
40 m	0.65m (36nm)	2.5m (127nm)	4.1m (145nm)	5.2m (127nm)	6.2m (105nm)	7.1m (90nm)
50 m	0.65m (36nm)	2.5m (136nm)	4.6m (187nm)	6.0m (167nm)	7.1m (145nm)	8.2m (124nm)

Table 1: Maximum wave height and necessary fetch (in brackets) as a function of water depth and wind speed. This assumes steady winds and a flat bottom. The fetch is defined as that distance where the wave height is 90% of the maximum wave height.

In deep water, seas take 24-48 hours of a constant wind to reach full development for a given fetch. If fast winds are generally less than a day, the following deepwater nomogram will give you the significant wave height and period for sustained fast winds as a function of fetch. Note that very fast winds or large fetches take even longer for a fully developed sea.



While such a nomogram can be useful and instructive, in the ocean it is recommended a wave model be used instead for forecast guidance.

For wave period T, the equations are:

$$T_{max} = \frac{7.69\left|\vec{V}_{sfc}\right|}{g}$$

$$depth\ term = \tanh\left\{0.1\left(\frac{gD}{\left|\vec{V}_{sfc}\right|^2}\right)^{2.01}\right\}$$

$$fetch\ term = \tanh\left\{0.000000277\left(\frac{gF}{\left|\vec{V}_{sfc}\right|^2}\right)^{1.45}\right\}$$

$$T = T_{max}\left\{(depth\ term)\tanh\left[\frac{(fetch\ term)}{(depth\ term)}\right]\right\}^{0.187}$$

References

Breugem, W., and L. Holthuijsen, 2007: Generalized shallow water wave growth from Lake George. *Journal of Waterway, Port, Coastal, and Ocean Engineering*, **133**, 173.

Holthuijsen, L. H., 2007: Waves in Oceanic and Coastal Waters. Cambridge University Press, 404 pp.