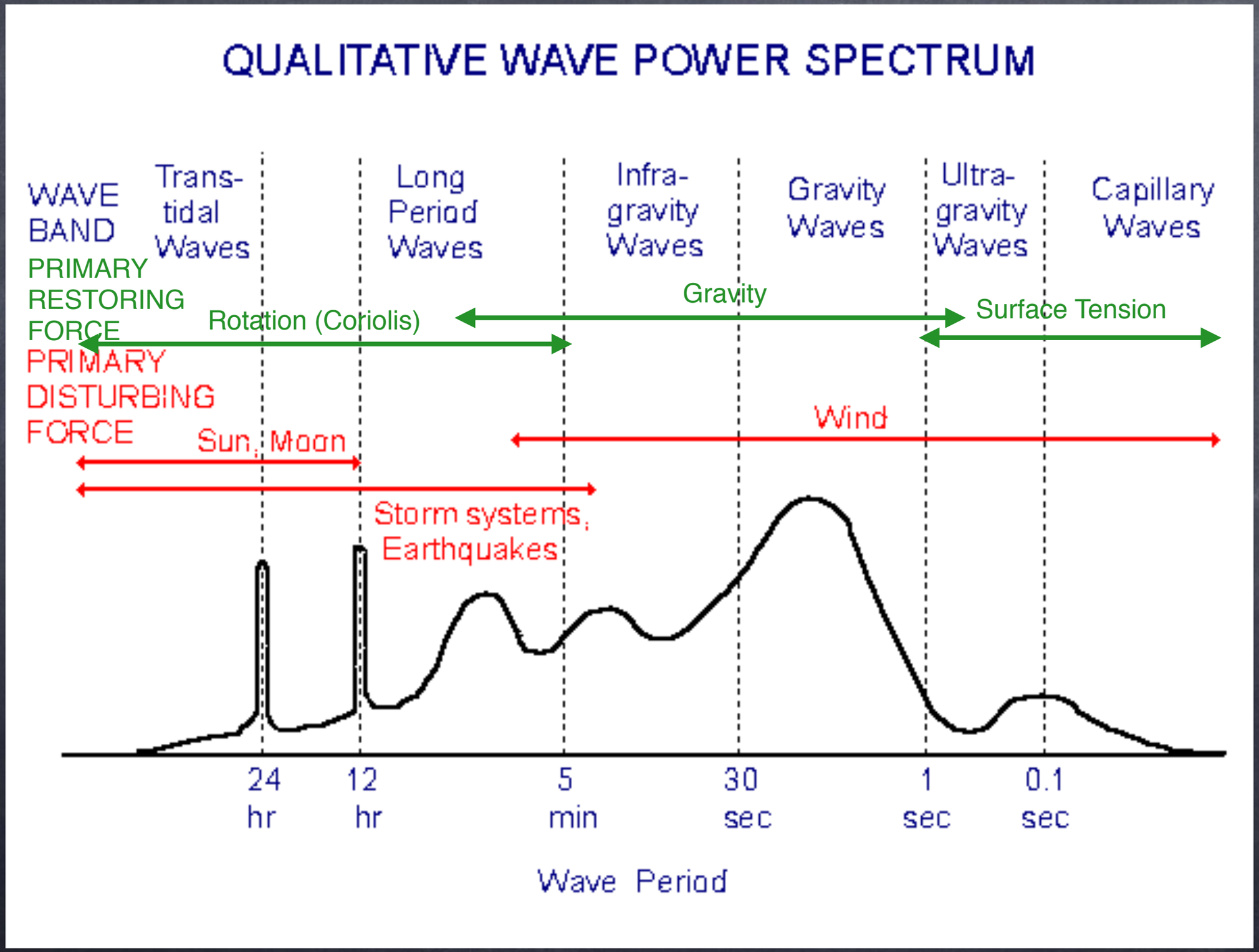
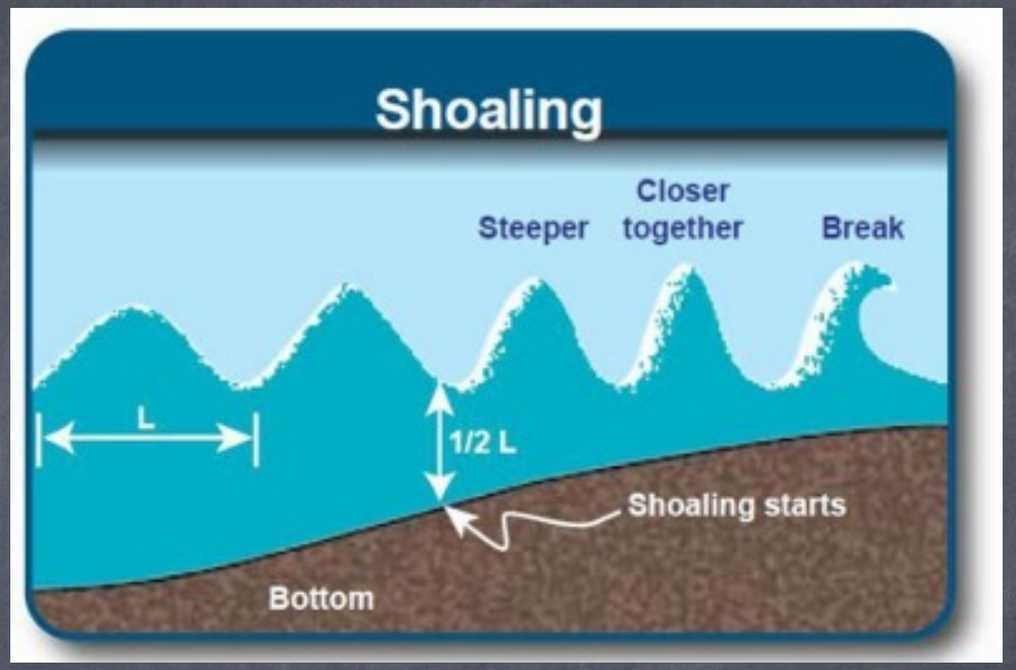
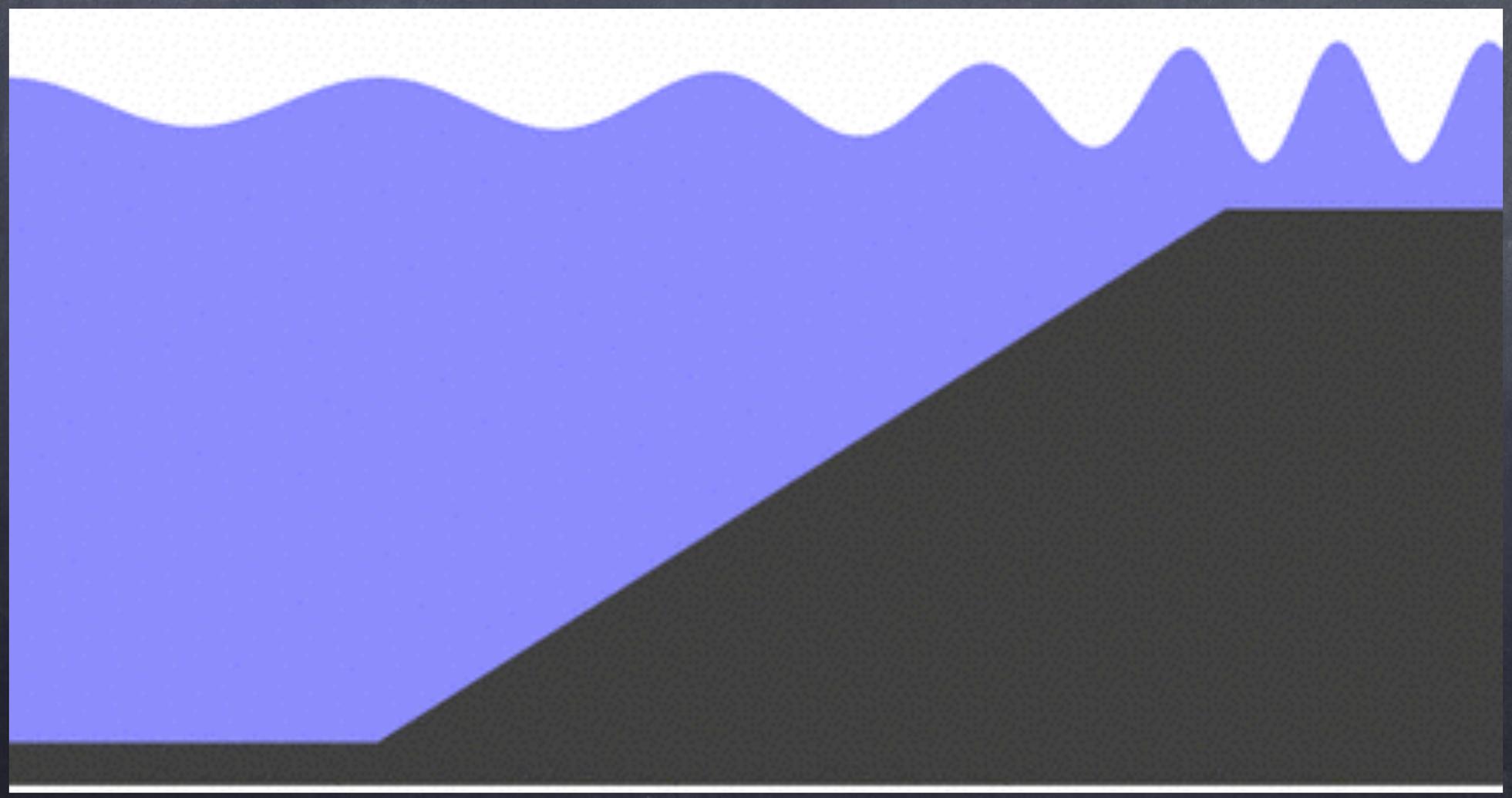
OCE/MPO 603: Gravity WAVES

Surface Waves

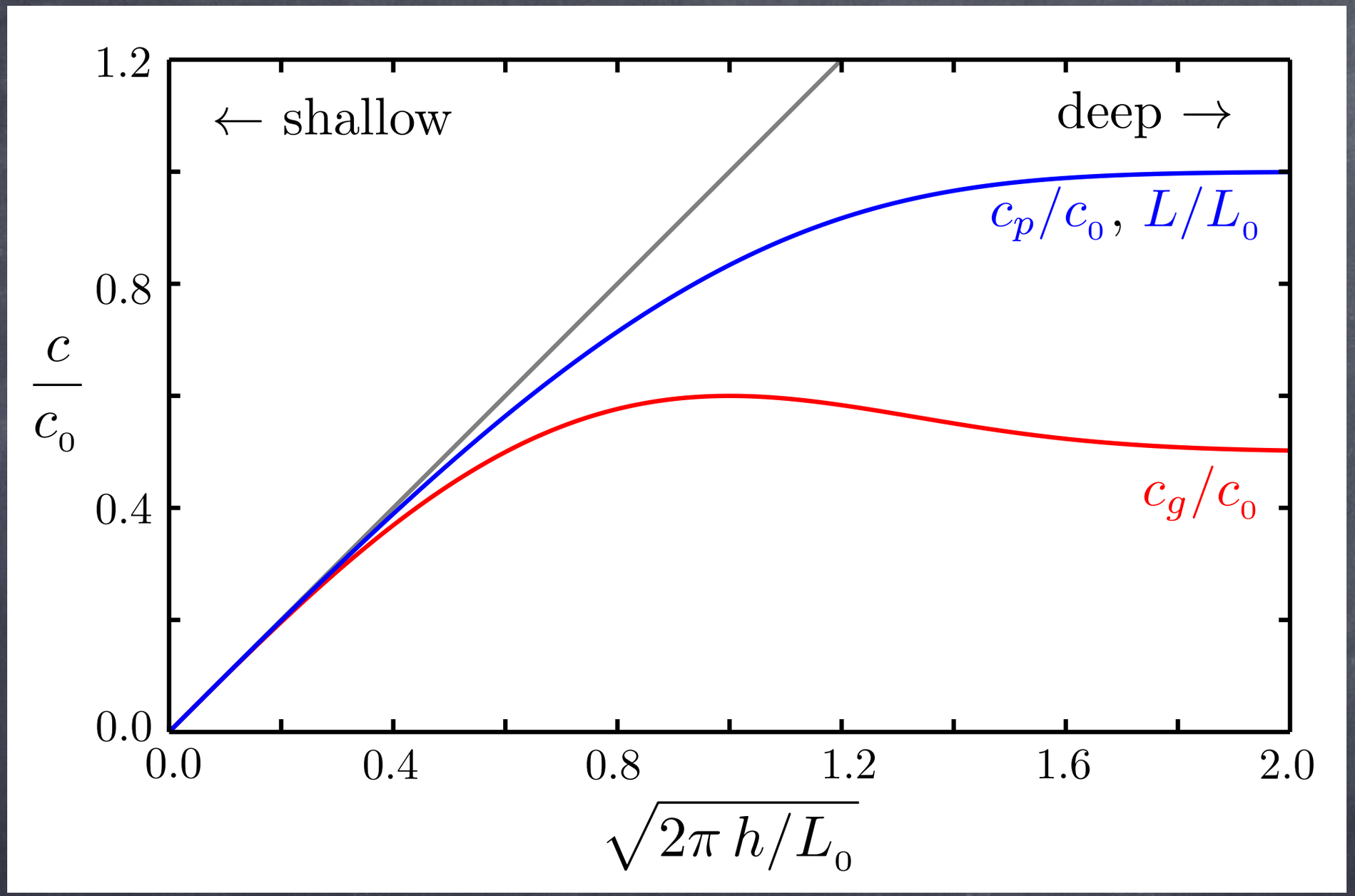


Wave shoaling





Wave shoaling



The phase velocity c_p (blue) and group velocity c_g (red) as a function of water depth h for surface gravity waves of constant frequency. Quantities have been made dimensionless using the gravitational acceleration g and period T, with the deep-water wavelength given by $L_0 = gT^2/(2\pi)$ and the deep-water phase speed $c_0 = L_0/T$. The grey line corresponds with the shallow-water limit $c_p = c_g = \sqrt{(gh)}$. The phase speed – and thus also the wavelength $L = c_pT$ – decreases monotonically with decreasing depth. However, the group velocity first increases by 20% with respect to its deep-water value (of $c_g = c_0 = gT/(4\pi)$) before decreasing in shallower depths. WIKIPEDIA

Shallow water wave

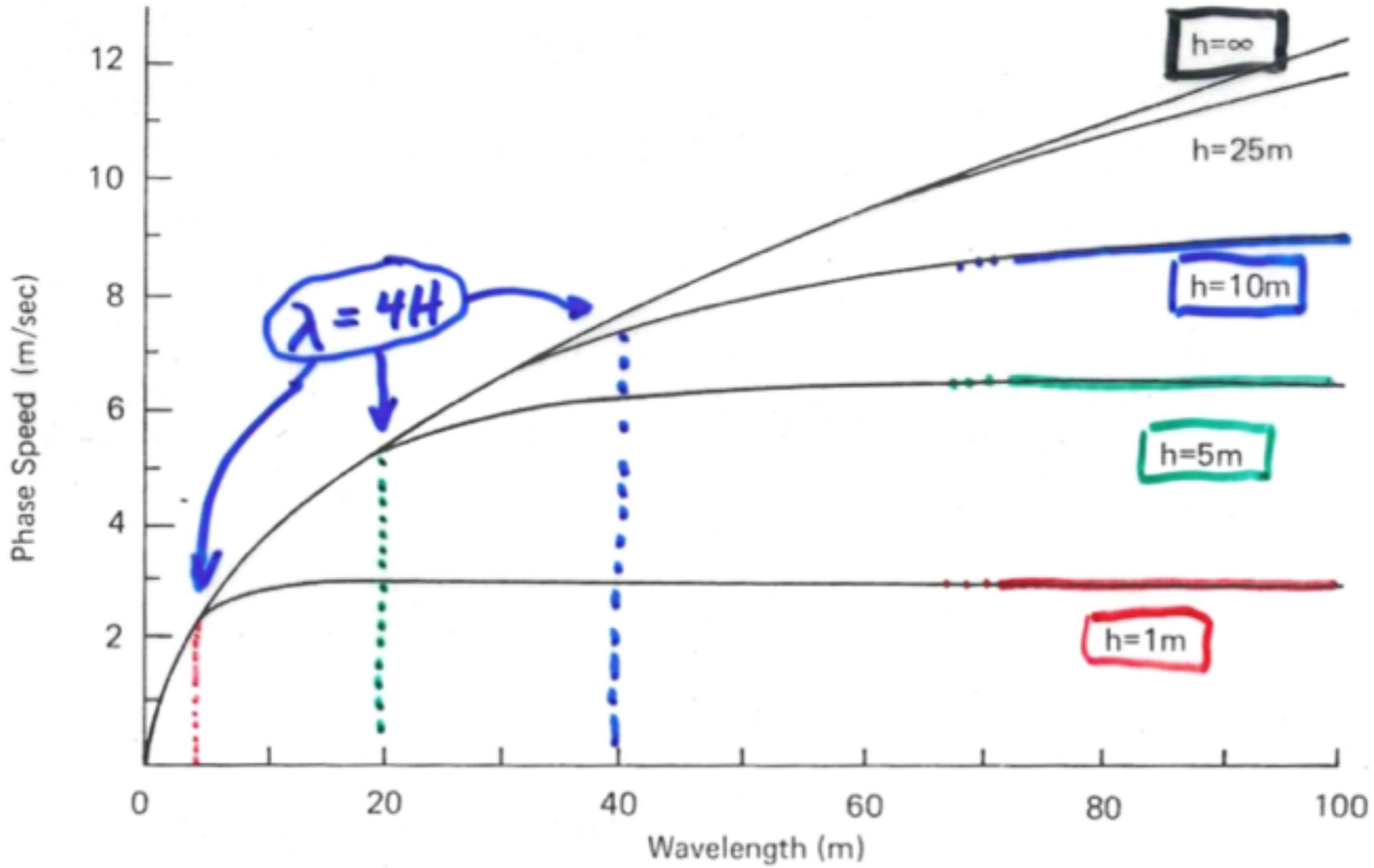
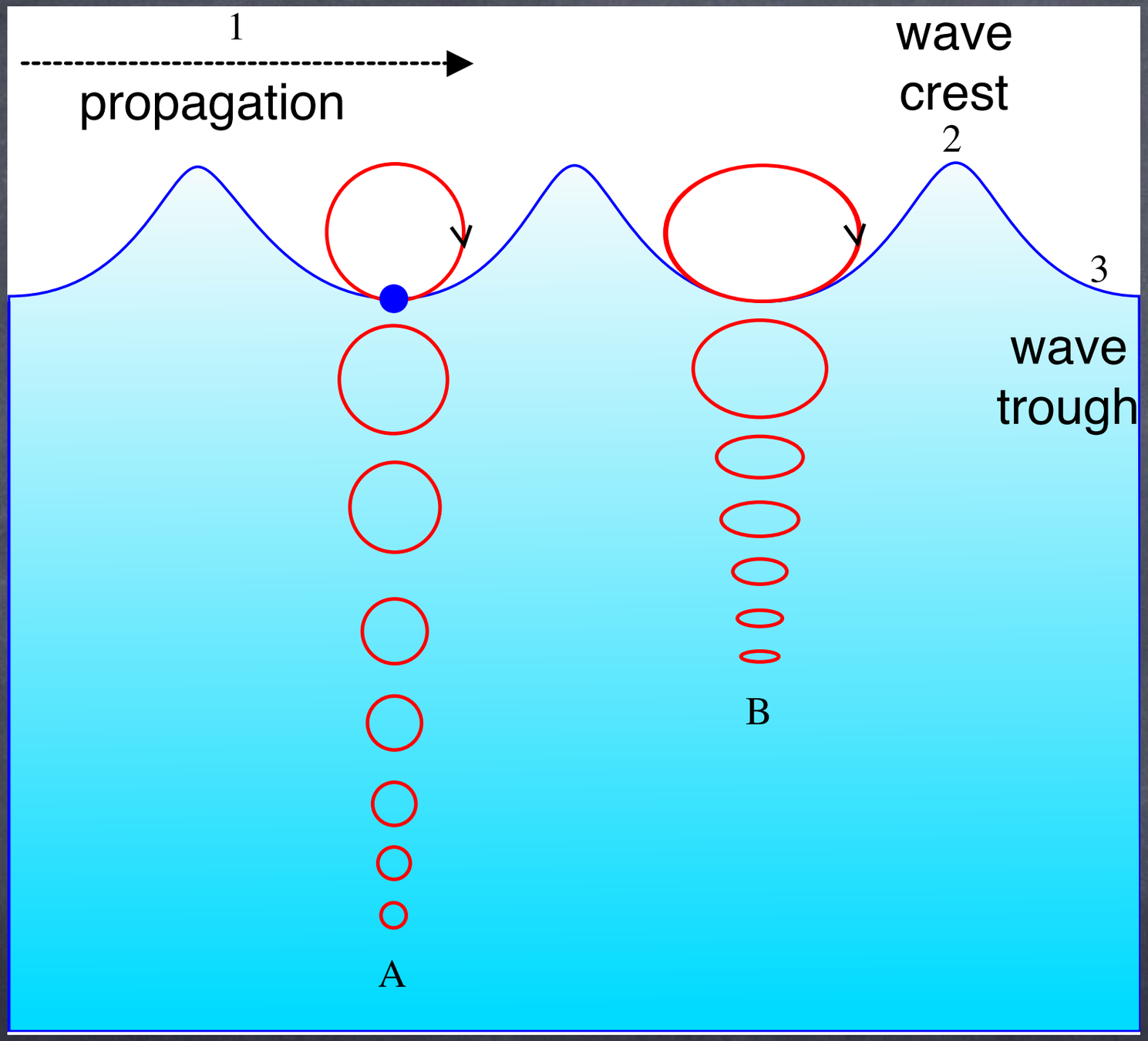


Figure 10.5. Wave speed as a function of water depth h and wavelength Λ. The water depth determines the limiting wave velocity, that of a shallow water wave.

Motion of a particle in an ocean wave.



A = At deep water. The elliptical motion of fluid particles decreases rapidly with increasing depth below the surface.
B = At shallow water (ocean floor is now at B). The elliptical movement of a fluid particle flattens with decreasing depth.

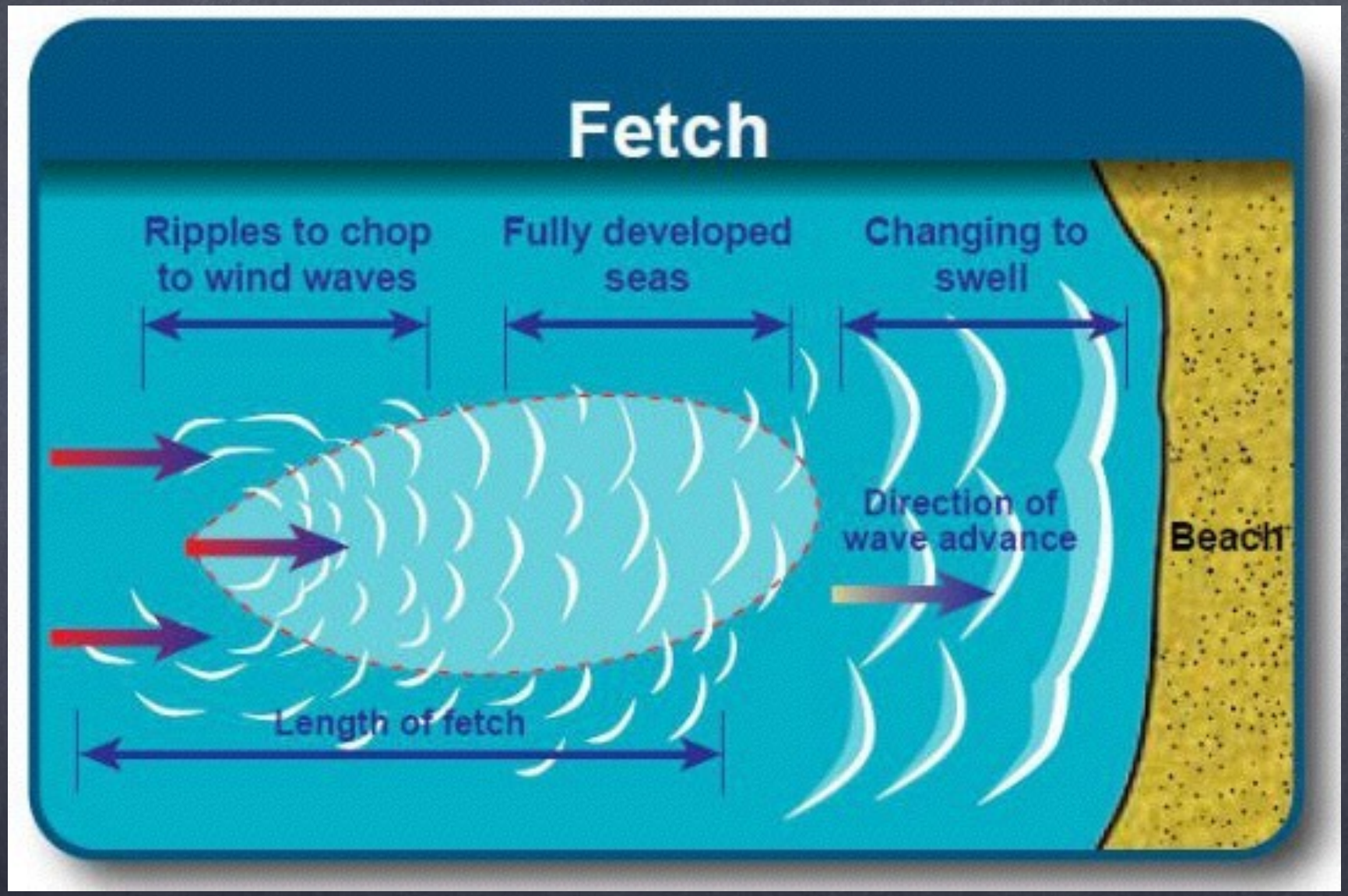
Wave Growth

Three factors control and limit wave growth

1. Wind speed
2. Wind duration
3. Wind fetch = distance over which wind blows from a constant direction

"Fully developed sea" = when wave growth is not duration or fetch limited; eventually waves reach an equilibrium between energy input by the wind and dissipation+dispersion of energy

"Significant wave height" = average height of the 1/3 highest waves


Fetch
Ripples to chop to wind waves
Fully developed seas
Changing to swell
Direction of wave advance
Beach
Length of fetch

Wave energy spectra for fully-developed seas

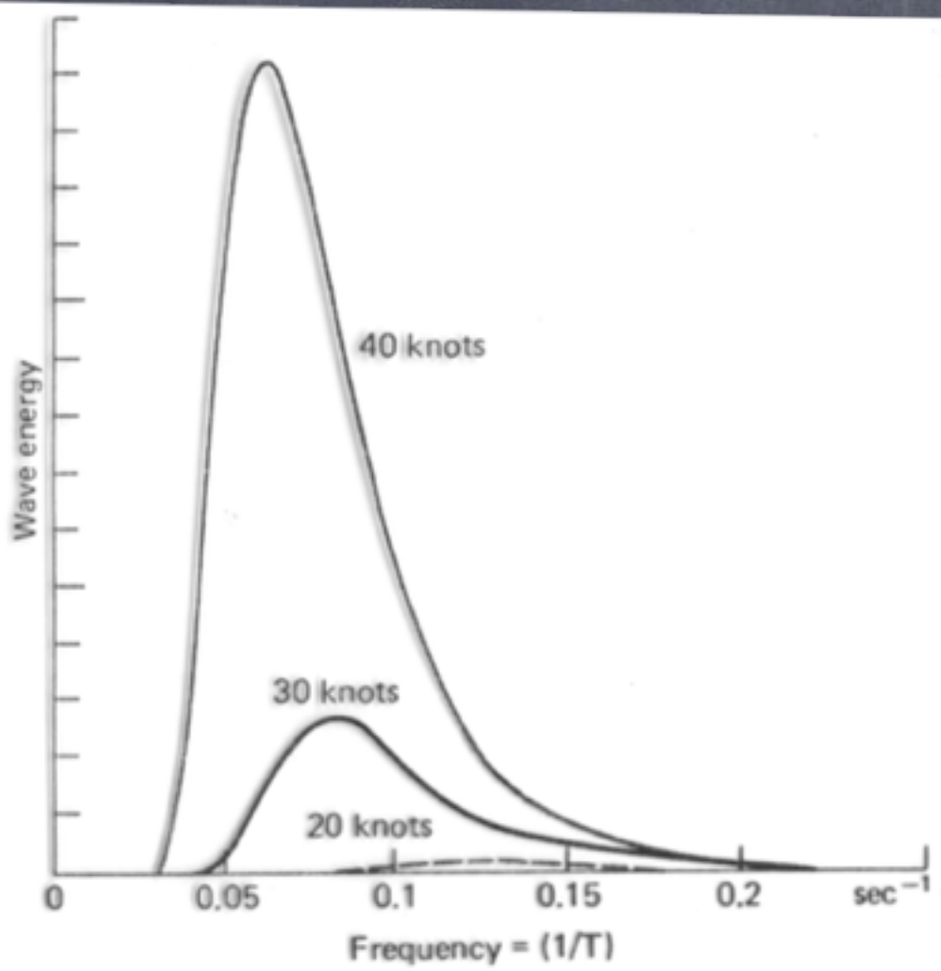
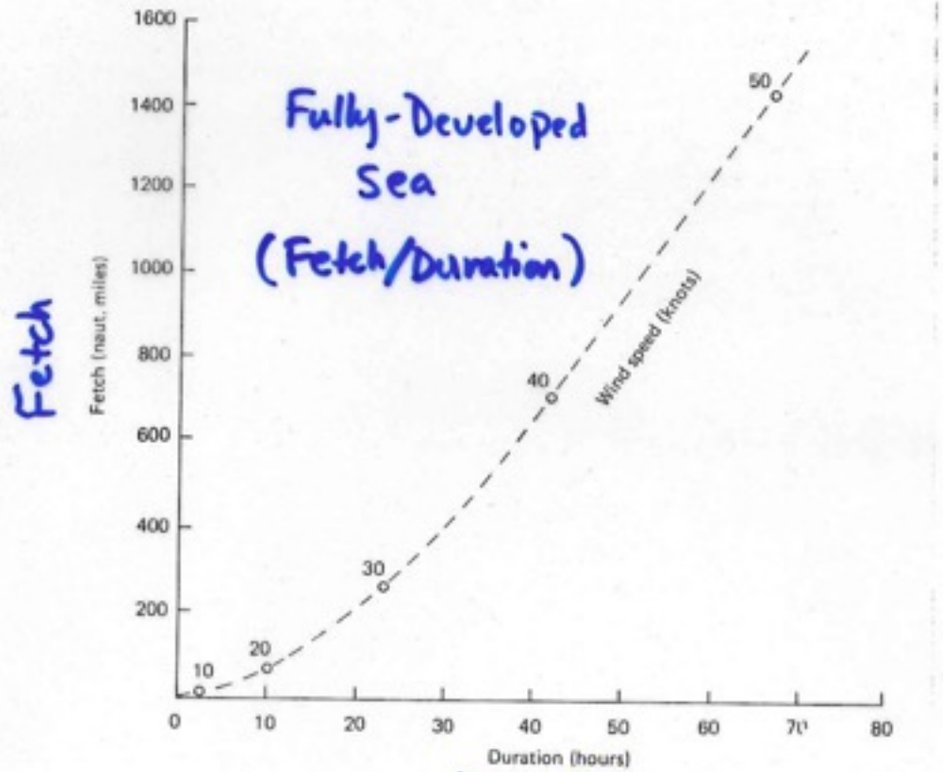
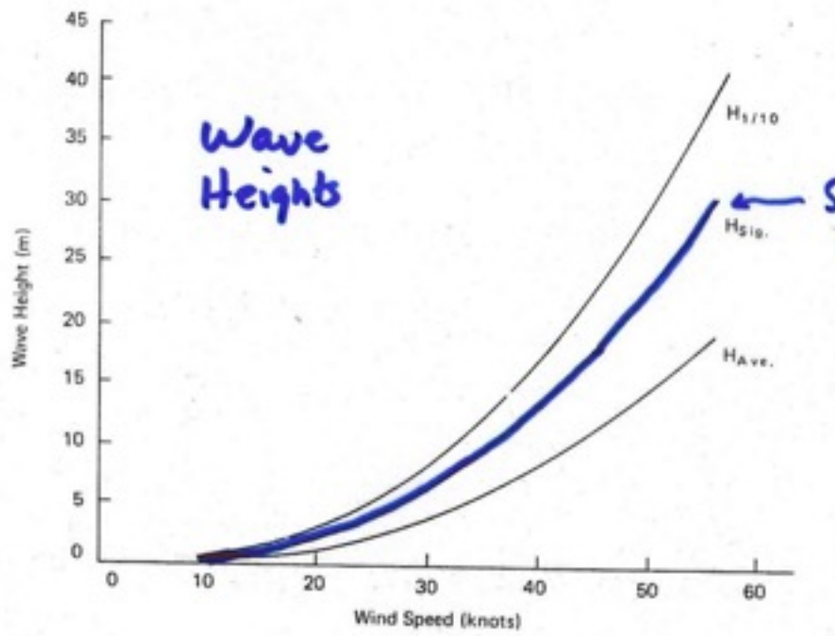


Figure 9-14 Wave energy spectra produced the winds blowing over unlimited fetches long enough to produce a fully arisen sea. No matter how much longer the wind blows, these spectra will not change, provided that the wind speed remains constant at the value shown next to the corresponding spectral curves. Note that high winds produce seas containing waves of longer periods than are present in seas generated by low winds. This is indicated by a shift of the spectral peak (maximum energy) toward lower frequencies (longer periods).



Fully-Developed Sea (Fetch/Duration)

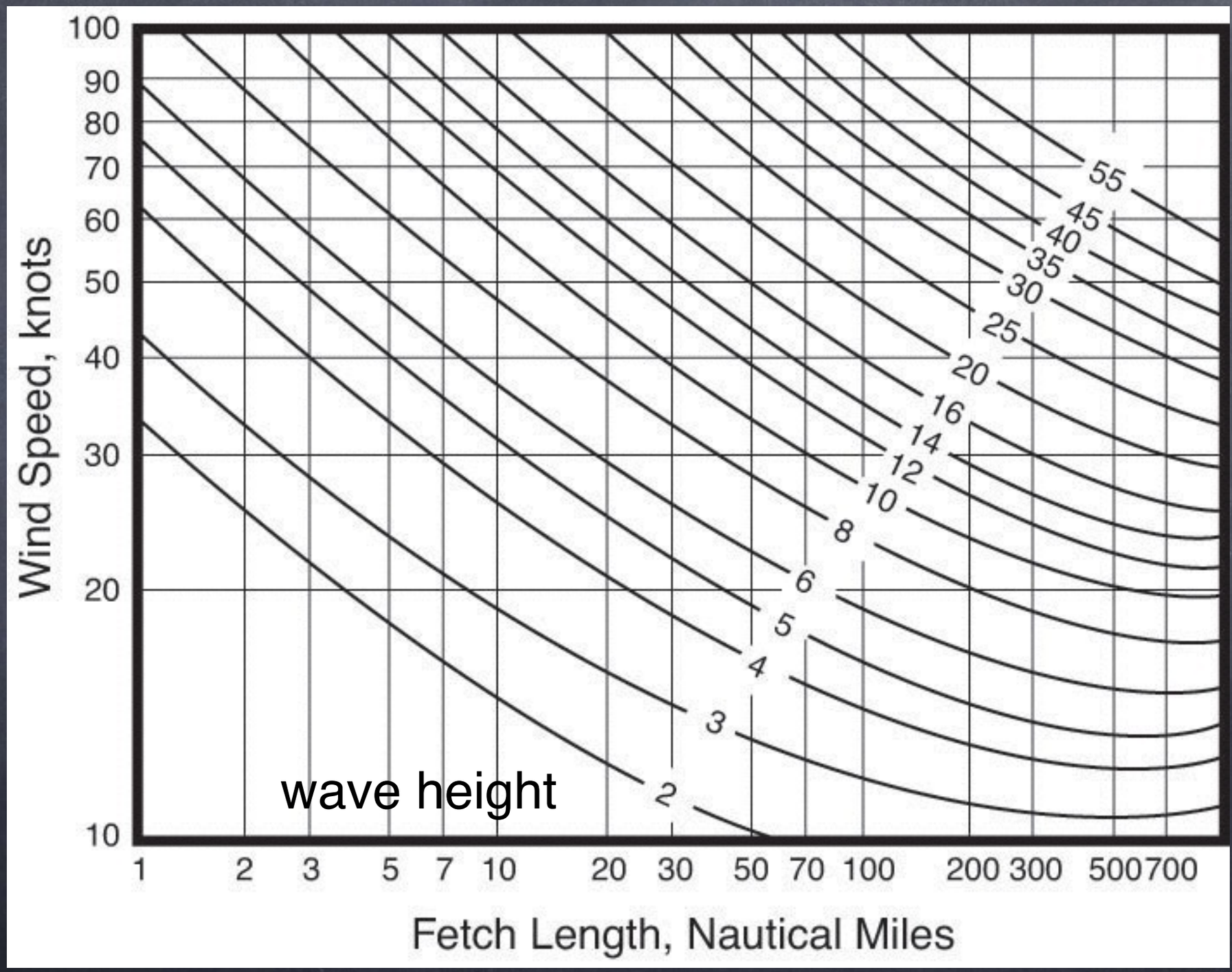
Duration



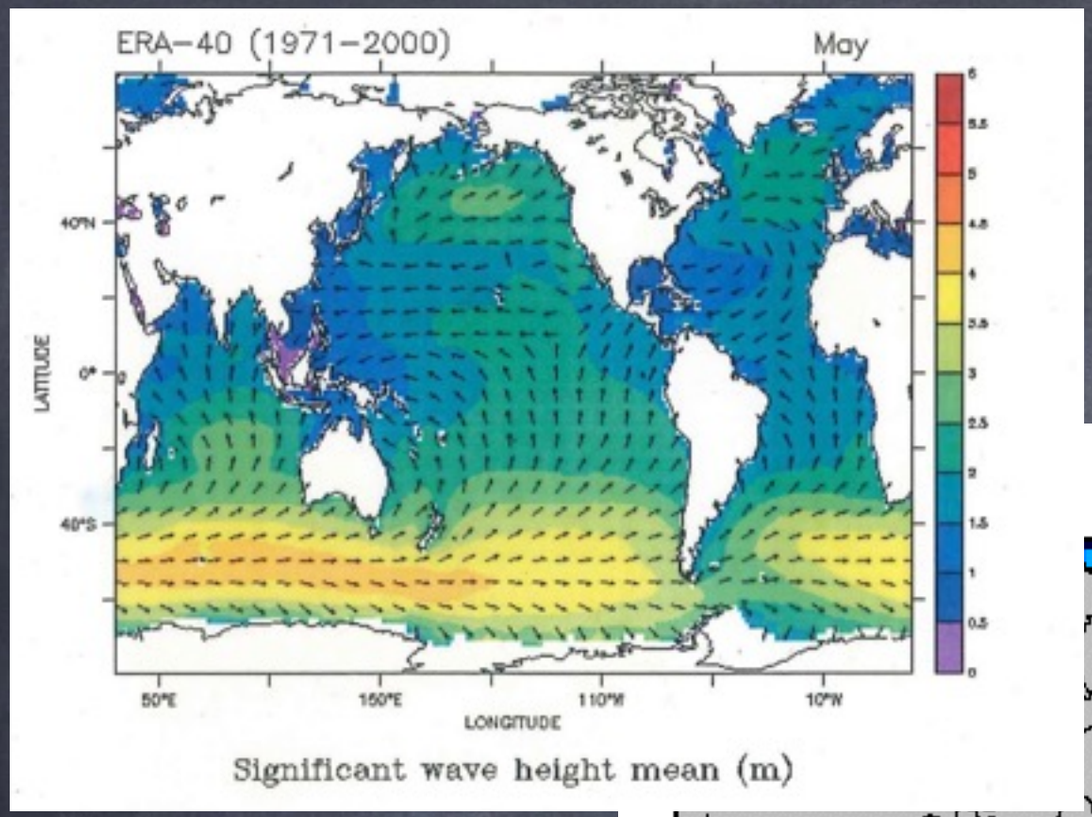
Wave Heights

← Significant Wave Height (1/3)

Sverdrup-Munk-Bretschneider Nomogram



(most Sverdrup-Munk-Bretschneider nomograms also include lines showing wave period and wind duration)



Significant wave height mean (m)