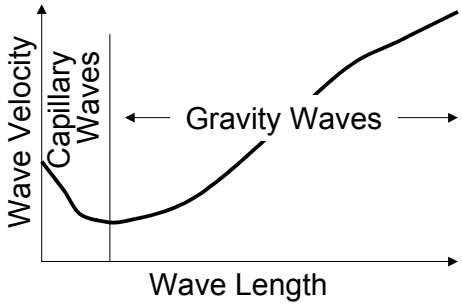
Waves and Wave Dynamics

Ocean waves are driven by either capillary action (i.e., surface tension resulting from the electrical polarization of water molecule) or gravity. This is because of the marine microlayer — ocean's top 10^{-10} m to 3 mm thick layer that participates in energy transfer at the ocean-atmosphere interface.



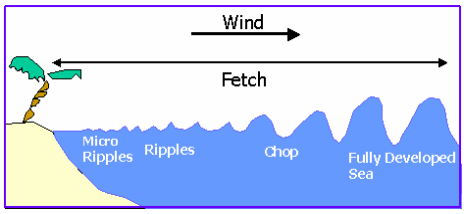
Waves

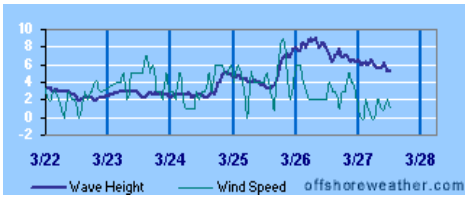
- transmit energy, not matter (only light displays this duality);
- comprise alternate rises and falls, and are describable as simple/ complex sinusoidal functions (and can be therefore defined in terms of amplitude and wavelength or period);
- interfere or add up either constructively or destructively; and
- propagate by
  - gravity at the density interfaces (the longer they are the faster they travel) or
  - capillary action through surface tension (the longer they are the slower they travel)

The gravity-driven ocean waves can be

- wind generated,
- tsunamis and
- tidal
- seiches

Wind generated waves





Visit http://www.offshoreweather.com/ for a buoy report or any coastal wind and wave data

- obtain energy from the wind, transfer it across expanse of the ocean or bay and deliver it to the nearshore coastal region. Here the energy is the focused and can cause erosion, generate nearshore currents and sediment transport patterns.
- travel faster, carry more energy and reach deeper when they are long, and therefore slow down on approaching the shore;
- break on reaching the shore, because of successive interference, depending on the slope-geometry e.g.,
  - spilling breakers for a gentle shore- slope,
  - plunging breakers with moderate shore-slope, and
  - surging breakers when the shore-slope is steep.
- travel in groups, the individual waves being faster than the group as a whole, so that the group gets sorted out into an ordinary swell; and
- have periods of 1-100 sec and contain most of wave energy. (tides have the longest periods, ~10,000 sec, and are the next in terms of total energy contained.

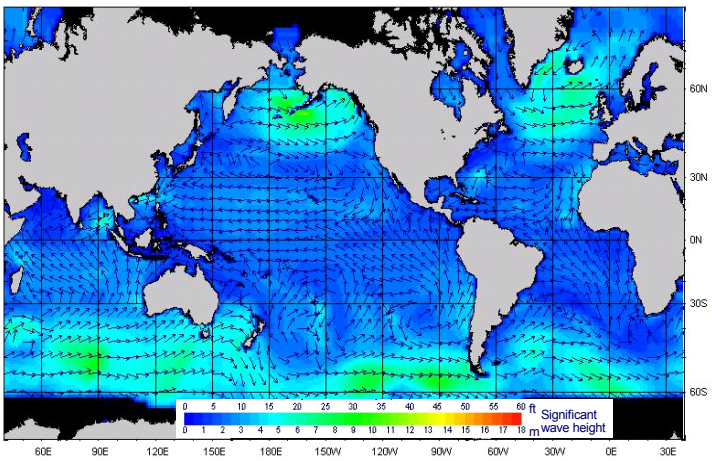
Why Waves Break?

Waves break when they reach the shore and enter water that is approximately 1.3 times as deep as the wave is high. At this depth the wave becomes unstable and crest is thrown forward into what we observe as white water and turbulence. The reason a wave breaks is that the wave becomes overly steep, particularly at the peak of its crest. This over steepening is due to the water particles in the wave crest exceeding the velocity of the wave form. In this situation the crest surges ahead resulting in the breaking wave.

An Example:

This example and the description in the box are from: http://dnr.cbi.tamucc.edu/wiki/Waves/BreakingWaves

The Gulf of Mexico and specifically Texas barrier island beaches are sculpted by spilling breakers and the currents generated by these waves. Spilling breakers are waves that gradually peak until the crest becomes unstable and cascades down in bubble and foam known to most as "white water". Plunging breakers describes a wave where the wave face becomes vertical and then curls over plunging forward and downward as an intact mass of water (such waves are generally observed on the Hawaiian and California coasts). Surging breakers look like they are going to plunge but then the base of the wave runs up the beach face resulting in the collapse and disappearance of the crest.



Significant wave height and direction, as on Oct 15, 2000

Do wind direction and fetch matter?

Yes. For the Los Angeles harbor, for instance, if prevailing wind is from the South, then the fetch of San Pedro Channel is ~20 nautical miles.

http://www.oceanweather.com/data/global.html