Irregular waves

1. Measurement of waves
2. Wave observation network
3. Irregular waves (wave height and period)
4. Wave spectrum. Wave statistics


Waves are observed by surfers, swimmers tourist on the beach. Experienced crew members onboard ships observe and report wave height, direction and period to meteorological institutions around the world. Scientists and engineers too are watching the waves! They want to record every detail of the moving sea surface ...
The WAVERIDER buoy at sea. The buoy measures its own vertical acceleration to estimate the sea-surface motion (photo courtesy of Datawell, Haarlem, the Netherlands).
Two measurement techniques with a wave pole: electrical resistance and electrical capacitance (photo courtesy of the Institute of Marine Sciences, Venice, Italy).

A pressure transducer, current meter or inverted echo-sounder mounted at the sea bottom (they may also be mounted at some depth on a platform piercing the water surface).
2. Wave observation network.
Figure 6
The RON network since July 2002 with location of 14 Triaxis buoys
The up-and-down motion of the sea surface in a storm, as experienced by a buoy, i.e., the sea-surface elevation at one location as a function of time.

The definition of a 'wave' in a time record of the surface elevation with downward zero-crossings (upper panel) or upward zero-crossings (lower panel).
3. Irregular waves (wave height and period).

The definition of wave height and wave period in a time record of the surface elevation (the wave is defined with downward zero-crossings).

The relationship between the visually estimated significant wave height and period and the measured significant wave height and period (after Nordenström, 1969). The standard deviation of the measured values is about 15% of the mean of the measurements at every value of $H_e$ or $T_e$. 
2. *Wave spectrum.*

The observed surface elevation and its amplitude and phase spectrum.

*many harmonic components*  

The summation of many harmonic waves, with constant but randomly chosen amplitudes and phases, creates a random sea surface.
The (ir)regular character of the waves for three different widths of the spectrum.

The random waves moving in time, i.e., the sum of a large number of harmonic wave components, travelling across the ocean surface with different periods, directions, amplitudes and phases (after Pierson et al., 1955).
The two-dimensional spectrum of wind-generated waves (shown in polar co-ordinates).

An interpretation of the wave spectrum off the Dutch coast when a northerly swell, generated by a storm off the Norwegian coast, meets a locally generated westerly wind sea.
Questions

1. What are the main categories of measurement techniques used to measure waves?
2. Give examples of in situ instruments to measure waves?
3. When talking about irregular waves, how do you define a wave?
4. How is the significant wave height defined? Why is it called “significant wave height”?
5. Define the zero-crossing period.
6. “The overall appearance of the waves can be inferred from the shape of the spectrum”. True or false?
7. The significant wave height can be derived from the spectral information. How?