

Wave and Swell Observations at Sea

LUI Wing Hong

Wave and swell are the two major sea state observations reported routinely by voluntary observing ships (VOS) at sea. Waves are raised by winds blowing locally (Figure 1); the stronger the winds, the higher the waves. Swells (Figure 2) are caused by winds far away, winds that generate waves in a distant region. When these waves propagate to reach a certain location, they are called swells. A common example is the swell observed over the coastal waters generated by winds of a distant tropical cyclone (Figure 3). Swells travel at a speed much faster than the movement of the tropical cyclone itself and in the past have been taken as a precursor sign for an approaching typhoon.



Figure 1 Waves generated by strong winds over the western North Pacific



Figure 2 Swell propagating in the ocean (photo source: <https://www.flickr.com/photos/geezaweezer/14425762191/>)

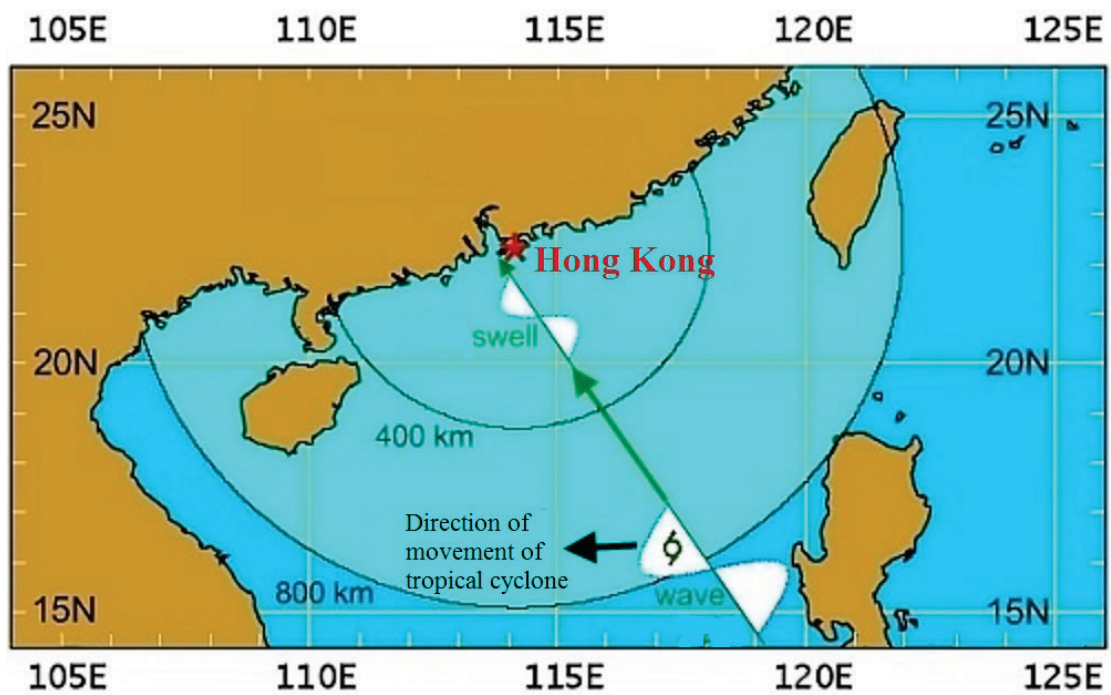


Figure 3 Swells propagating towards the coast of Guangdong from a distant tropical cyclone

Wave and swell observation reports consist of three parameters: direction from which the wave/swell is coming, period and height. Wave/swell height is defined as the vertical distance between the trough and crest of a wave, and wave/swell period refers to the time between the passages of two successive wave/swell crests passing a fixed point (Figure 4).

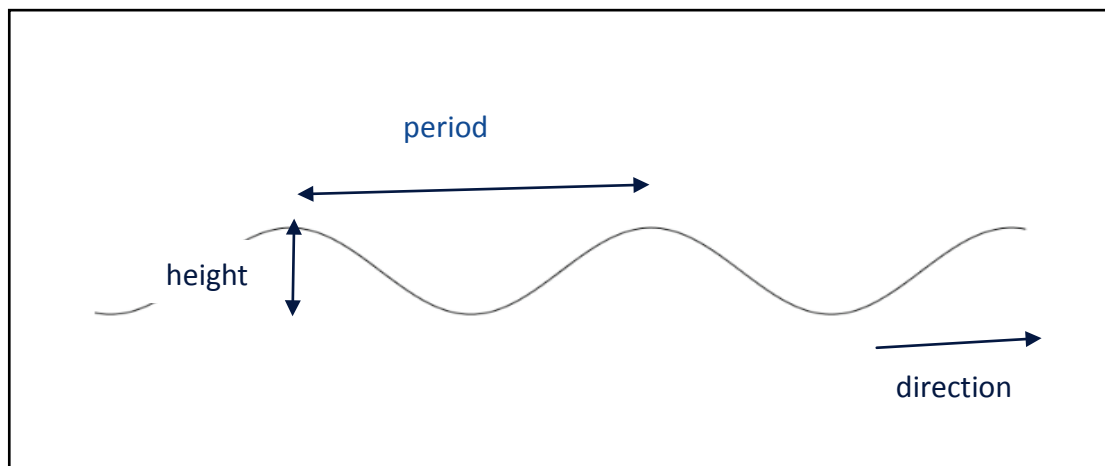


Figure 4 Illustration of wave/swell direction, height and period

Conventionally, wave and swell observations are taken by an observer on board a Voluntary Observing Ship (VOS) by visual estimation of a number of waves, following practices established under the World Meteorological Organization (WMO) guidelines^[1].

Waves and swell may be present simultaneously, propagating in the same or different directions with different heights and periods. However, waves and swell look subtly different. Swell marches in longer lines and appears less steep and more 'stretched' than waves (Figure 2). They also behave differently as swell will not normally break in open water, whereas waves will. Furthermore, waves always travel in the same direction as the wind is blowing while swell continues to move under winds and waves that have long since changed direction and it can even head in the opposite direction as the wind and waves.

The direction from which the waves/swells are coming is most easily found by sighting along the wave crests and then turning 90 degrees to face the advancing waves. The observer is then facing the direction from which the waves are coming.

For taking wave/swell period, the observer identifies a small object such as a patch of foam on the sea surface and counts the time taken for it to move from one wave crest to the next using a stop watch. The average time for the small object moving through a number of waves as far as it is still within the sight of the observer is then taken as the wave/swell period. Another method is to observe the pitch and roll of the ship's bow and measure the time taken for the bow to move between two consecutive extreme positions (highest/lowest or rightmost/leftmost). This approach is particularly useful at night when the waves are difficult to be observed.

Wave/swell heights can best be estimated when the ship's rolling and pitching is least. The wave/swell height is then the height of the observer's eye above the ship's water line (Figure 5(a)). Errors may be introduced when the ship is rolling (Figure 5 (b)).

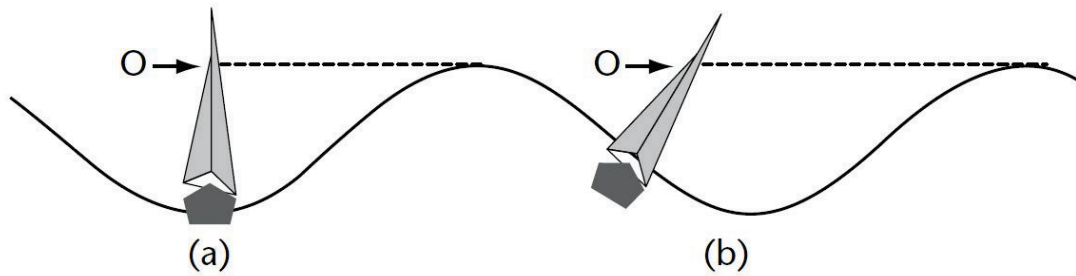


Figure 5 Estimation of wave height on board a VOS: 'O' represents the position of the observer's eye (extracted from WMO-No. 8).

Observations of waves and swells received from VOS are very useful to weather forecasters in analyzing the weather situation and in issuing marine forecasts, particularly over the data-sparse oceans where the ship's observations may be the only source of information (Figure 6).

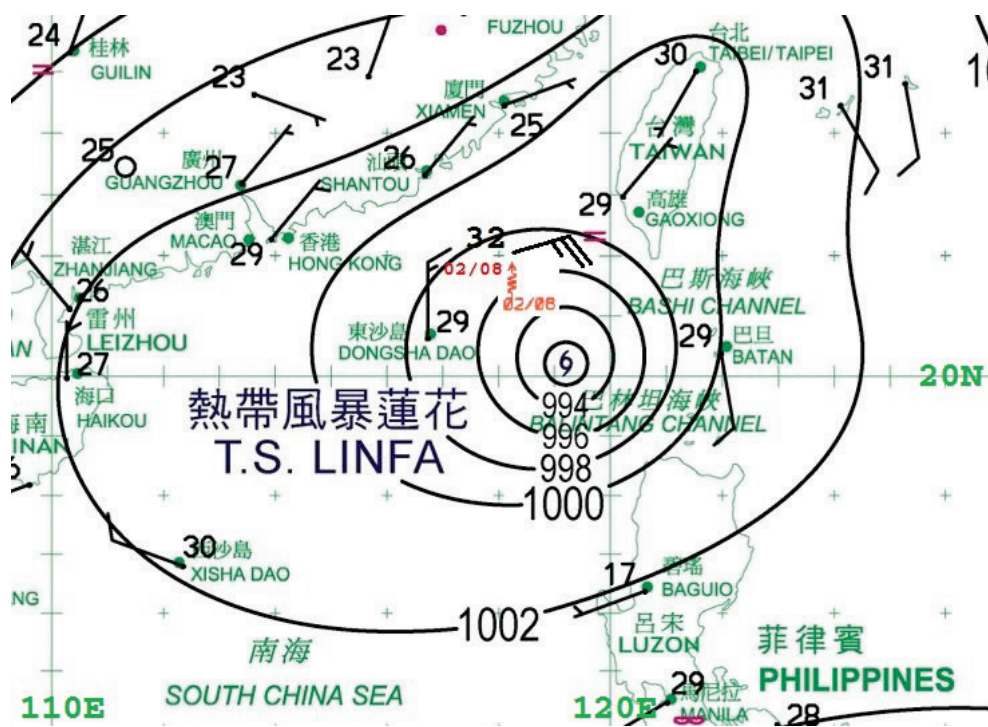


Figure 6 The Observatory's surface weather chart around 8 am local time on 7 July 2015 near Tropical Storm Linfa showing a ship report near 22.1°N 118.3°E with wind wave of a period of 2 seconds and a height of 4 metres (plotted as 02/08). The direction of wind wave was taken to be the same as the wind direction. The swells, generated from Linfa, were reported to be coming from the south with a period of 2 seconds and a height of 4 metres (plotted as 02/08).

Reference:

[1] WMO Guide to meteorological instruments and methods of observation;
WMO-No. 8 (2008 edition, updated in 2010), Part II, Chapter 4