Wind and Wave Distribution around a Tropical Cyclone

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Tropical cyclone is a major hazardous weather system for ships travelling in the oceans. Even in this age of advanced technology, navigating around the eye of a tropical cyclone is still extremely dangerous and poses quite a challenge to the crews. While reliable prediction of cyclone intensity and movement is of paramount importance, a good understanding of the wind and wave distribution in the vicinity of the tropical cyclone is also essential to the mariners for safe voyage.

Over the northern hemisphere, tropical cyclones normally travel from east to west and with the air flowing towards the centre of a tropical cyclone in a counter-clockwise direction, high winds and waves are normally most prominent on the right-hand side of the moving cyclone (known as the “dangerous semicircle”) where the speed of forward movement of the cyclone itself is added on top of the wind circulating around the cyclone. In contrast, the winds and waves on the left-hand side (known as the “navigable semicircle”) will be somewhat reduced by the forward movement of the cyclone. Figure 1 is a schematic illustrating the dangerous and navigable semicircles around a tropical cyclone in the northern hemisphere, and Figure 2 is an example showing the wind distribution around Super Typhoon Meranti over the western North Pacific in September 2016. Based on similar considerations, with the air rotating around a cyclone in a clockwise fashion in the southern hemisphere, the dangerous semicircle is to the left and the navigable semicircle to the right of a moving cyclone over the southern oceans.

The distribution of winds and waves around a tropical cyclone will also be affected by the co-existence of other major weather systems. For example, the presence of the subtropical ridge of high pressure over the western North Pacific will tend to enhance the pressure gradient, and hence the winds and waves, over the northeastern quadrant of tropical cyclones (Figure 3). Similarly, an intensifying continental anticyclone and surges of the northeast monsoon over southern China in autumn or winter will also enhance the winds and waves to the northwest of tropical cyclones venturing into the northern part of the South China Sea (Figure 4).

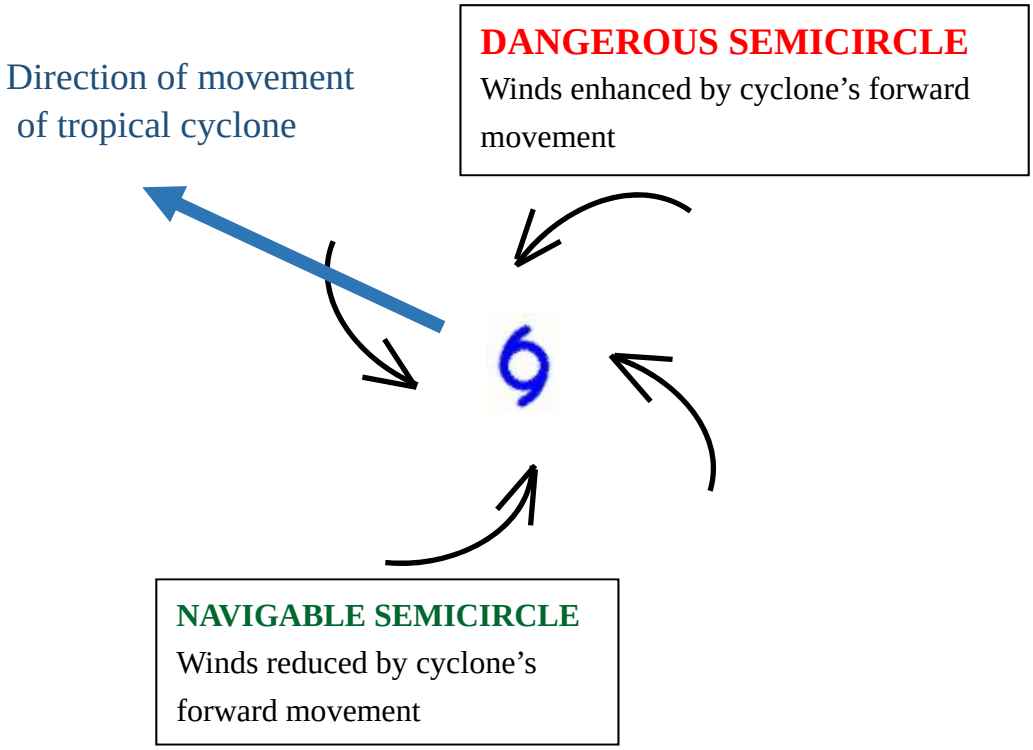

Figure 1. Schematic illustrating the dangerous and navigable semicircles around a tropical cyclone in the northern hemisphere. The black arrows show the general wind direction around the cyclone.

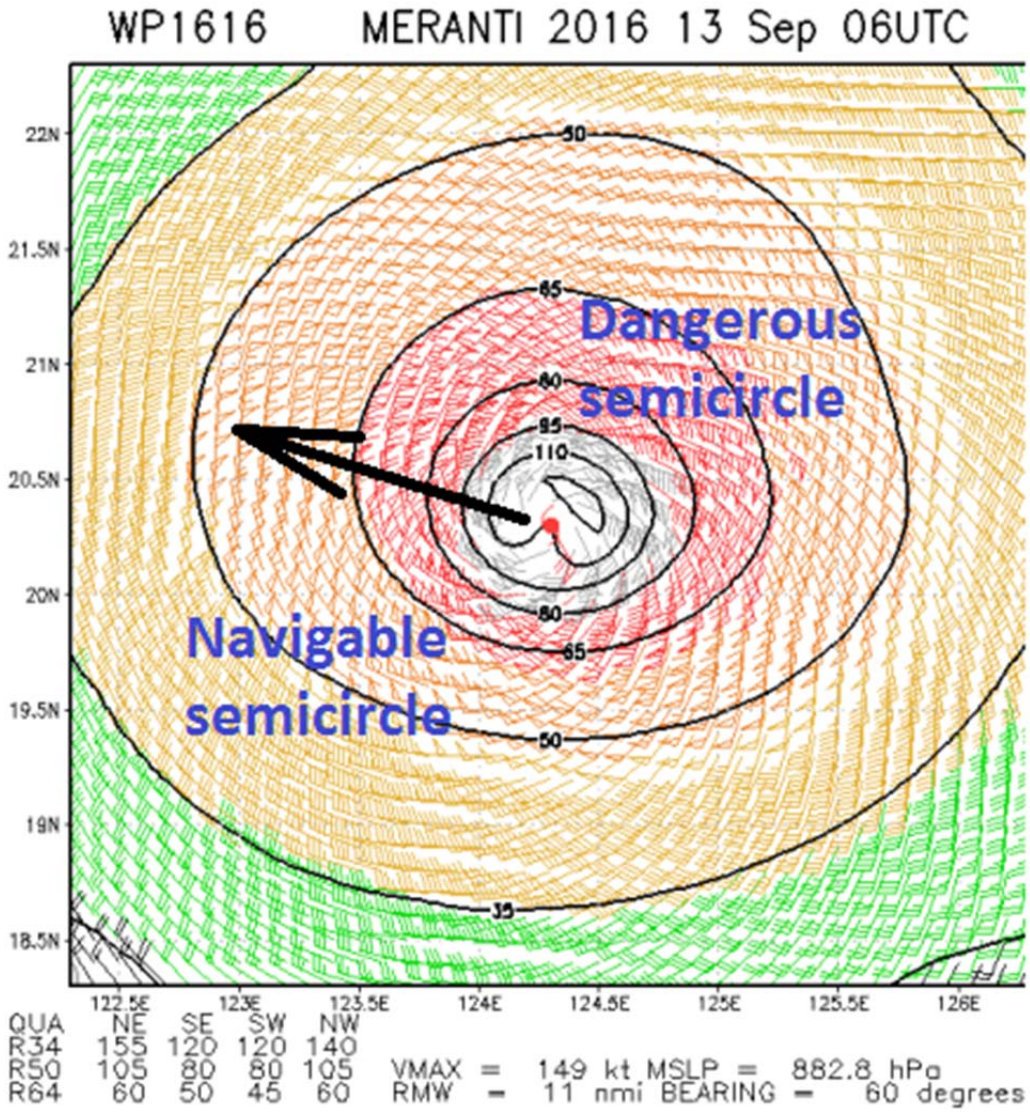

Figure 2. Wind distribution around Super Typhoon Meranti over the western North Pacific at 2 pm on 13 September 2016, with isotachs in knots and the location of the eye in red spot. The black arrow indicates the direction of movement of Meranti at the time. The information at the bottom of the figure shows that the coverage of gale force 34-kt winds (R34), storm force 50-kt winds (R50) and hurricane force 64-kt winds (R64) is most extensive over the dangerous semicircle on the right-hand side of the moving tropical cyclone (courtesy of NOAA, http://www.ssd.noaa.gov/PS/TROP/mtcswa.html).

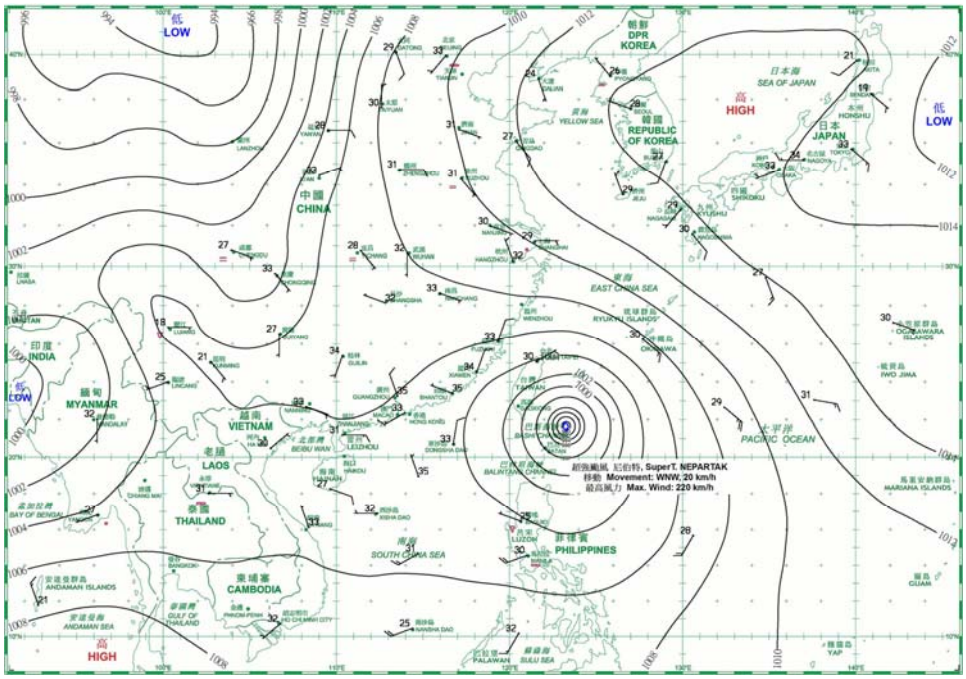

Figure 3. Weather map at 2 pm on 7 July 2016 showing the packed isobars (higher pressure gradient) over the northeast quadrant of Super Typhoon Nepartak stacking up against the subtropical ridge of high pressure over the western North Pacific.

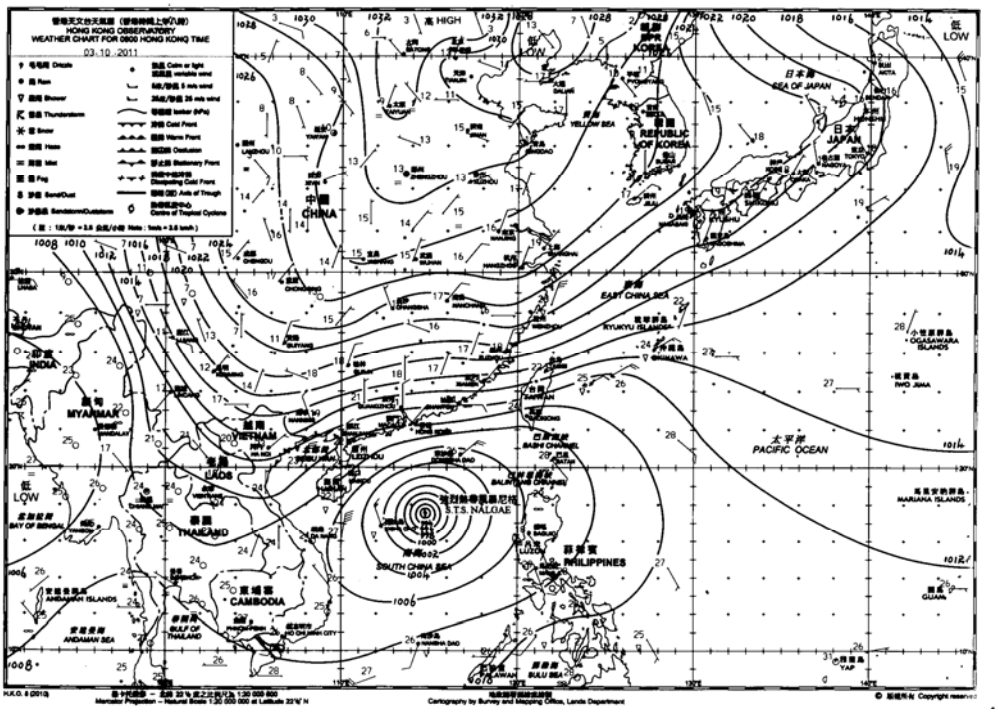

Figure 4. Weather map at 8 am on 3 October 2011 showing the packed isobars (higher pressure gradient) over southern China and the northern part of the South China Sea under the combined effect of Severe Tropical Storm Nalgae and the northeast monsoon.