

## Explosive deepening of extra-tropical cyclones over the western North Pacific

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During the winter and spring seasons, extra-tropical cyclones (or frontal depressions) develop from time to time in the eastern part of the Asian continent and move eastwards to northeastwards across the western North Pacific. Under favourable atmospheric conditions<sup>[1]</sup>, these cyclones may deepen rapidly to significantly affect marine traffic nearby. A study on the climatology of explosive deepening of extra-tropical cyclones<sup>[2]</sup> reveals that the eastern Sea of Japan and the western North Pacific to the east and southeast of Japan are the preferred areas for such development.

On 8 January 2017, cold air sweeping south over China and the East China Sea resulted in the development of an extra-tropical cyclone to the south of western Japan (Figure 1). The cyclone moved eastward and its central pressure fell from about 1008 hPa to 990 hPa, a drop of 18 hPa within 24 hours. Extensive frontal cloud bands associated with the cyclone covered Japan and the neighbouring seas (Figure 2), with gale to storm force winds affecting the seas south of Japan based on satellite analyses (Figure 3).

On journeys across the high seas, pressure tendency, in addition to the pressure value itself, provides a crucial indication of impending hazardous weather to mariners for timely decision-making and action for navigational safety. As shown in Figure 4 for this case, a buoy and a ship to the east of the cyclone both reported tell-tale signs of significant pressure drops ahead of the onset of deteriorating weather conditions.

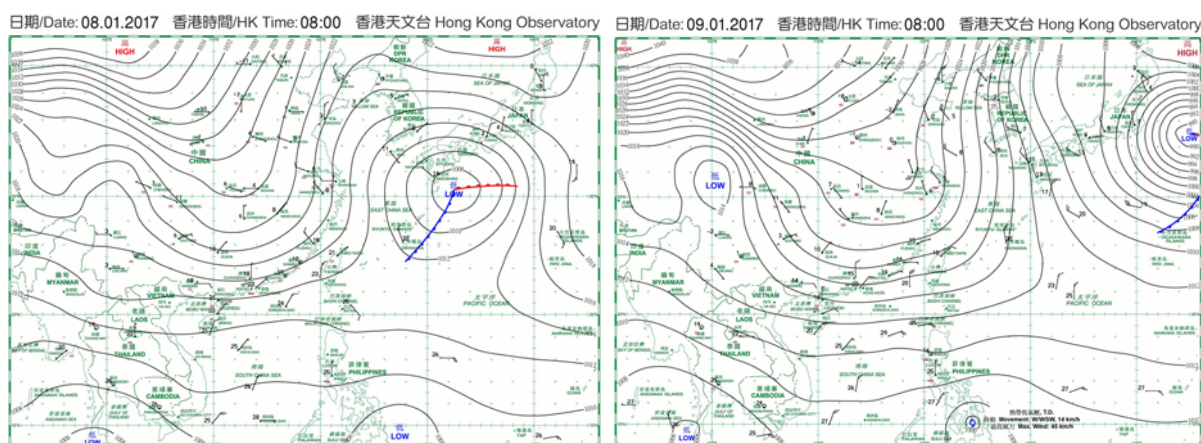


Figure 1. Hong Kong Observatory's Daily Weather Maps for 00 UTC on 8 (left) and 9 January 2017 (right) showing the rapid development of an extra-tropical cyclone over the sea areas south of Japan.

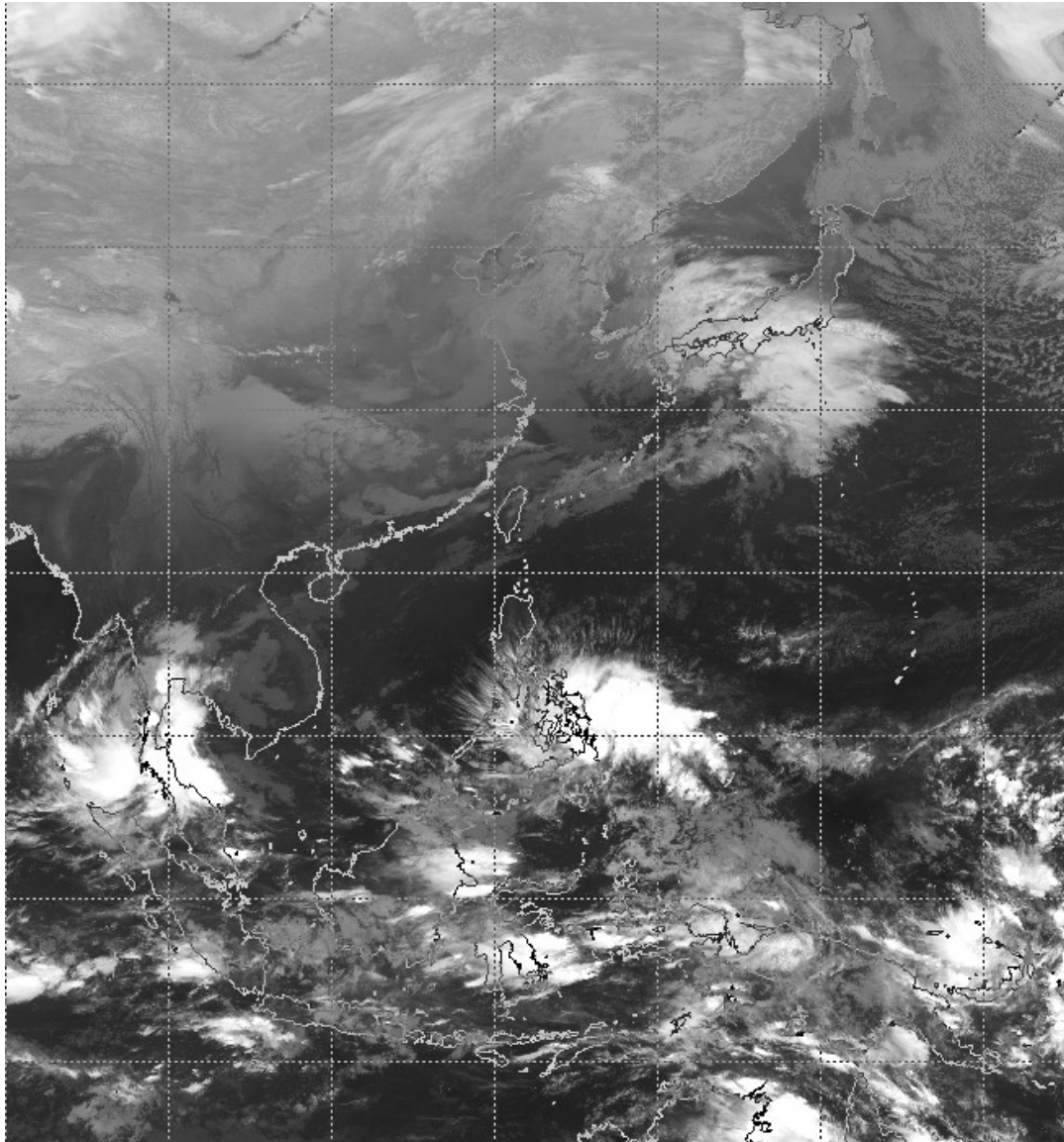


Figure 2. Infra-red satellite imagery at 00 UTC on 8 January 2017 showing extensive cloud bands over Japan and the neighbouring seas associated with a developing extra-tropical cyclone (image originally captured by Himawari-8 of Japan Meteorological Agency).

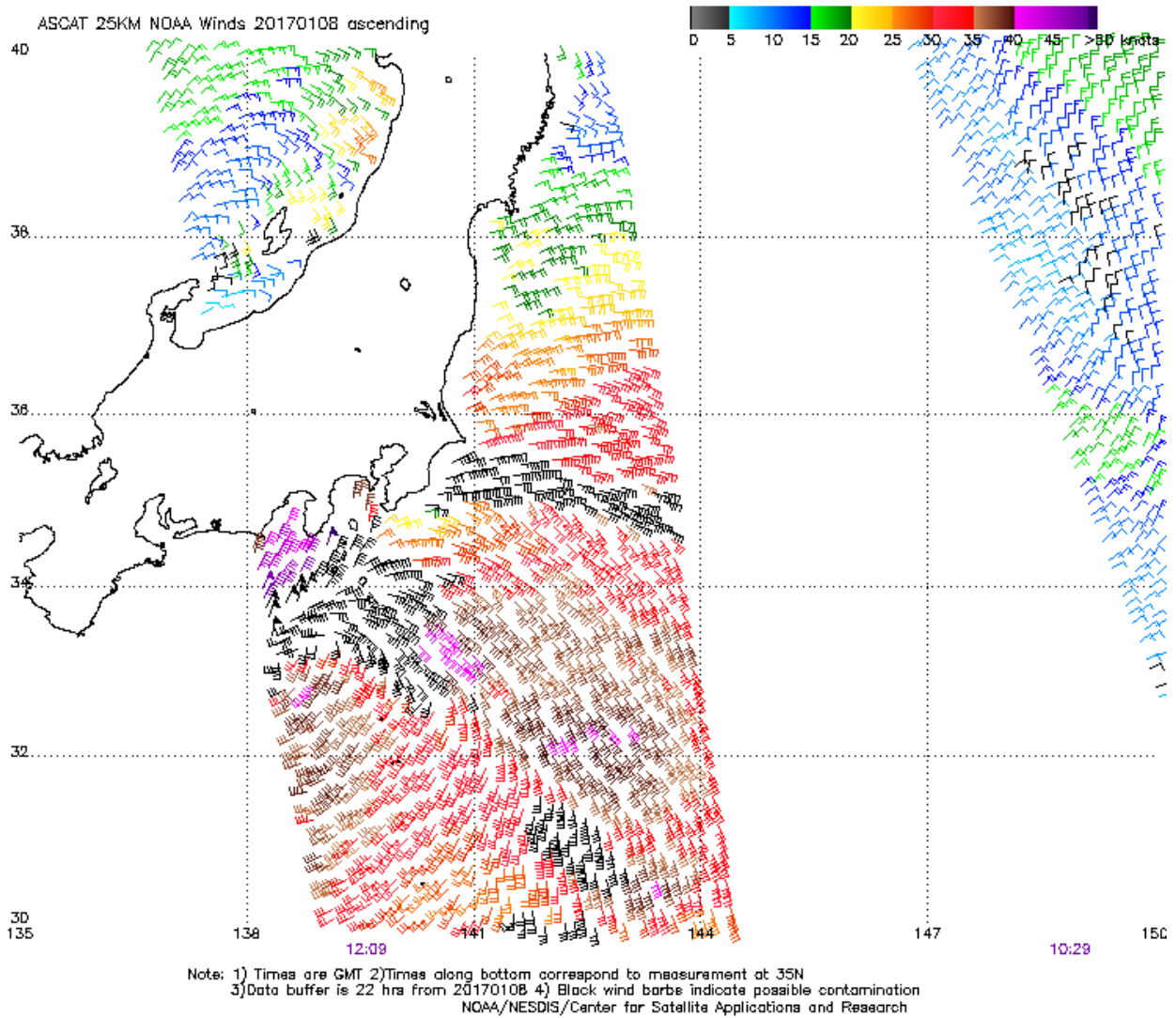


Figure 3. Ocean surface vector winds around 12 UTC on 8 January 2017 as captured by the European ASCAT system showing gale to storm force winds associated with a developing extra-tropical cyclone south of Japan (courtesy of NOAA / NESDIS Center for Satellite Applications and Research, <https://manati.star.nesdis.noaa.gov/datasets/QuikSCATData.php>).

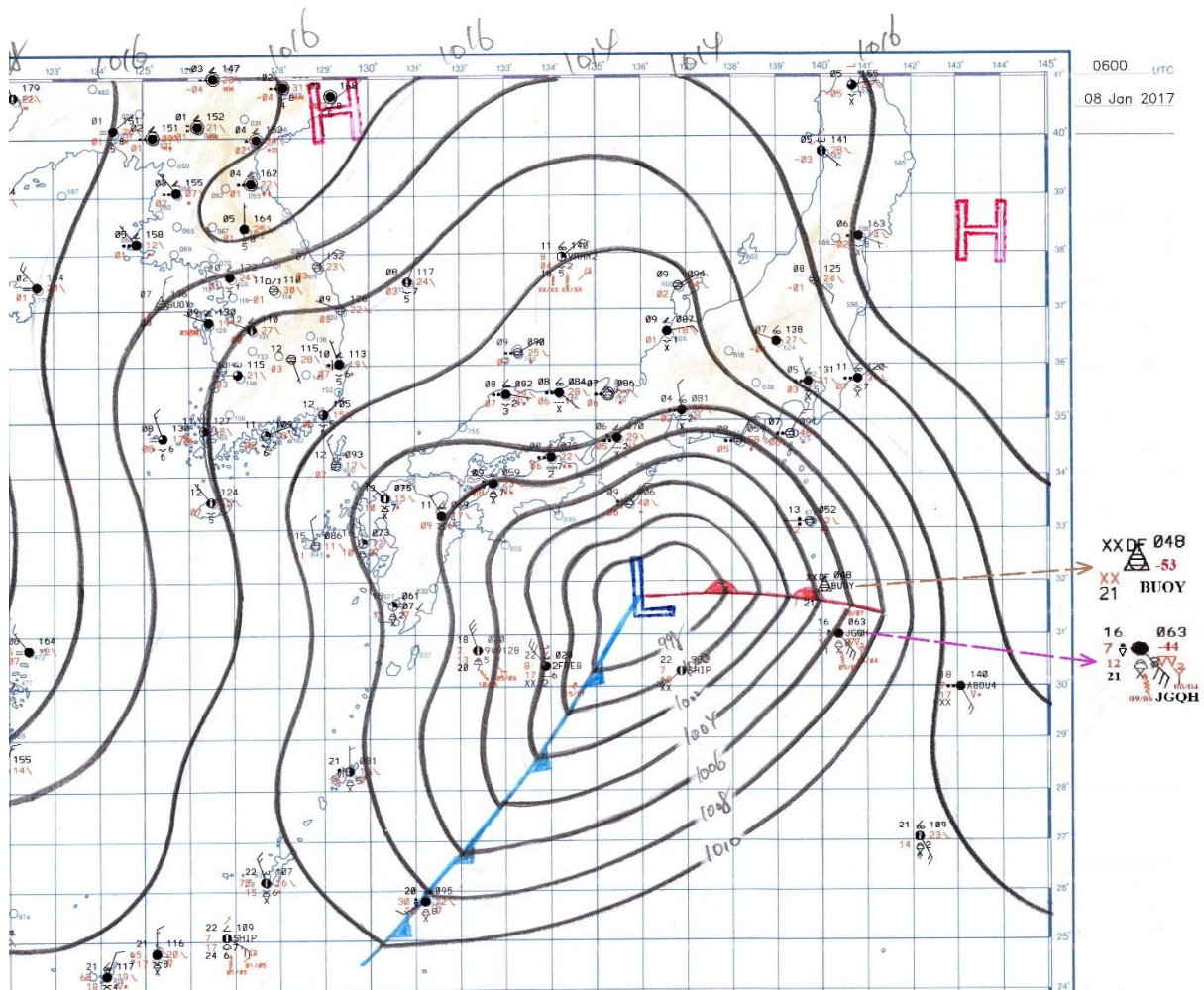


Figure 4. Analysed weather map at 06 UTC on 8 January 2017 showing significant pressure drops as reported by a buoy and a ship to the east of an extra-tropical cyclone south of Japan. The buoy (position 31.9°N 140.1°E) reported a pressure drop of 5.3 hPa in the past three hours while the ship with call-sign JGQH (position 31.0°N 140.4°E) reported a 3-hour pressure drop of 4.4 hPa.

#### References:

[1] Synoptic-Dynamic Climatology of the Bomb, Frederick Sanders and John R. Gyakum, Department of Meteorology, Massachusetts Institute of Technology, Cambridge 02139, Monthly Weather Review, October 1980.

[2] Climatology of Explosive Cyclones off the East Asian Coast, Shou-jun Chen and Ying-hwa Kuo, National Center for Atmospheric Research, Boulder, Colorado, Pai-zhong Zhang and Qi-feng Bai, Inter-Mongolia Weather Bureau, Hohhot, China, 15 June 1991 and 27 March 1992.