P1.95 USEAGE OF DRIFTING BUOYS DATA TO MONITOR TROPICAL CYCLONES IN THE SOUTHWEST INDIAN OCEAN

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1. INTRODUCTION

Since 1996 and the start of the International Buoy Program for the Indian Ocean (IBPIO) every year an average of 10 to 20 drifting buoys are released prior to the cyclone season in the tropical waters of the South Indian Ocean.
In addition to oceanographic data collected, these buoys have also significantly increased the amount of meteorological observations over a wide oceanic area, in a region where ship observations are fairly scarce.
Among the various parameters measured by the drifting buoys, measurements of SST (sea surface temperature) and SLP (sea level pressure) are the most frequent. Air temperatures are occasionally recorded, while few buoys provide wind data.

In addition, in order to improve the synoptic analysis of the pressure field within models, these buoys have proven to be highly useful in monitoring the ITCZ and the cyclogenesis areas. A certain number of these buoys have encountered tropical cyclones during their life time thus becoming passive "hurricane hunters".

Examples of their valuable contribution in terms of TC track and intensity analysis are presented here.

2. SUBMERGENCE

A specific oceanographic parameter called "submergence" can be used as an "eye-detector" when the eye-like central area of light winds is not discernible on satellite imagery.
Buoys are currently designed in such a way that during phenomenal conditions, they stay under water for a longer time than usual. The percentage of time the buoy is underwater defines the percentage of "submergence". This parameter is provided by buoys. Figure 1 shows the submergence of a buoy affected by tropical cyclone Hape on February 12 and 13, 2003. The percentage of submergence rose from 40-50% (average value for moderate seas) to 90% when the eyewall area came in close proximity to the buoy. Then submergence value dropped to 40% before steeply rising back to 90%. This means the buoy has been temporarily located inside the eye (where the sea is calmer), which was not obvious on the IR imagery due to a CDO (Cloud Dense Overcast) configuration hiding the center (see figure 2). Submergence thus allows one to detect the eye during occasions when it is not discernible on the classical imagery.

For TC Hape, the center could be quite precisely located thanks to concomitant microwave imagery from satellite TRMM (see figure 2). The buoy went to less than 15 km from this estimated center, and the measured pressure allowed to accurately estimate the MSLP of the storm, that was a midget system, and so out of usual classification.

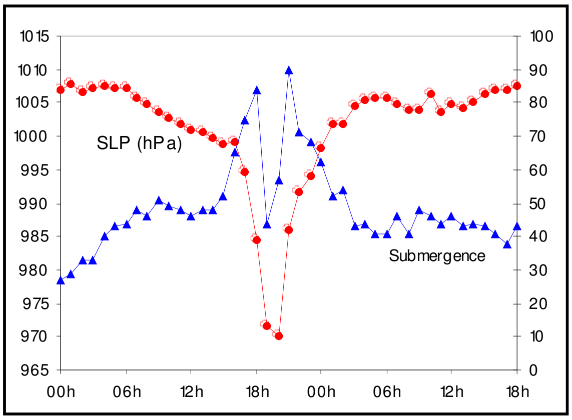

Figure 1: Sea level pressure ( ) (SLP in hPa) and submergence (○) (%) of buoy nr 14538, during TC HAPE (Feb 12-13, 2003).

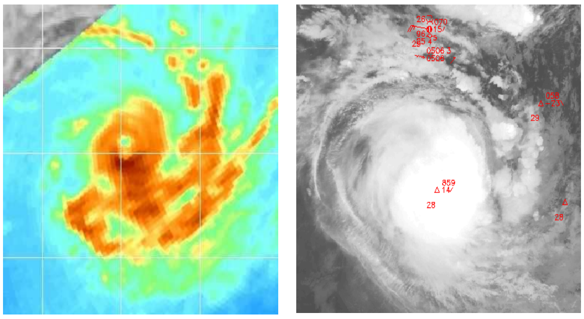

Figure 2: TC HAPE (02/2003), during weakening phase. TRMM 37 GHz, Feb 12, 2003, 1959 UTC (Left). NOAA IR, Feb 12, 2003, 2100 UTC, and buoy nr 14538 (Right).

3. OCEANIC IMPACTS OF TROPICAL CYCLONES

3.1. Strength and direction of sea surface currents.

Drifting buoys have the capability to measure sea surface currents. Strength and direction of these currents are drastically modified in the vicinity of a cyclone. This is shown on figure 3, with compared tracks of TC Kalunde and the buoy nr 14538. During this period the buoy was under Kalunde's influence, the cyclone regularly tracked southwestwards. Ahead of the cyclone, the buoy drifted considerably northwestwards (83 km covered in 24 hours on Feb 10), increasing in velocity 24 hours prior to Kalunde's

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arrival. Crossing Kalunde's path ahead of the eye, the buoy moved around it, changing in direction to northeastwards in response to the rotation of the winds and induced shift of sea surface currents. The buoy's trajectory continued to be eastwards until March 16 when it deflected from its path to form a loop on March 17, before returning to its previous position occupied 10 days earlier.

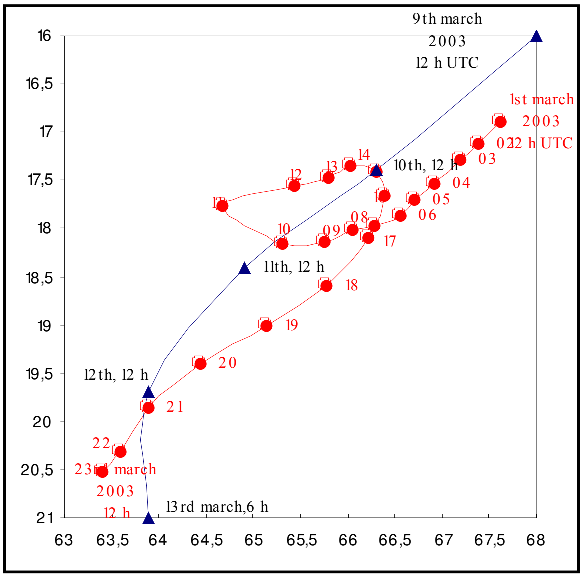

Figure 3: Compared trajectories of Kalunde ( ) and buoy nr 14538 (○).

3.2. Sea surface temperatures.

Cyclones are good examples of ocean-atmosphere interaction, with immediate and direct feedback. The more intense the cyclone is and the slower its motion is, the greater the induced SST cooling will be. Figure 4 shows the SST falling from 28°C before Kalunde's passage, down to 24,5°C after. We can identify the SST decline, which occurred in the wake of the TC *i.e.* after Kalunde's closest point of approach of the buoy (more than 2/3rd of the SST fall occurring after the SLP minimum).

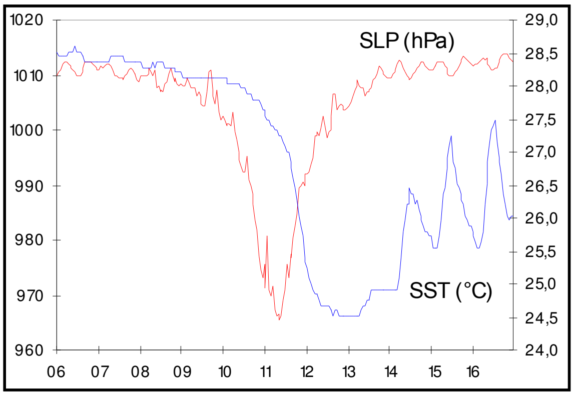

Figure 4: Sea level pressure (SLP in hPa) and sea surface temperature (SST in °C) measured by buoy nr 14538 during Kalunde's event, between March 06 and 16, 2003.

Figure 4 shows as well SSTs slowly rising after Kalunde's passage (with strong diurnal oscillations due to the destruction of the ocean mixed layer).

3. WIND AND DRIFTING BUOYS

Drifting buoys able to measure wind use a specific technique called WOTAN (Wind Observation Through Ambient Noise). A hydrophone submerged at 10 m deep "listens to" the noise of the wind at the sea surface. Then an algorithm estimates the 10 mn averaged wind at 10 m high, thanks to the acoustic energy measured at specific frequencies. A problem in this measurement can be the existence of heavy precipitations which contaminate the wind data, leading to enhanced noise pollution. Figure 5 shows the wind measured by the buoy nr 14532, reaching storm force winds and backing from southeasterly to northeasterly as TC Kesiny tracks nearby.

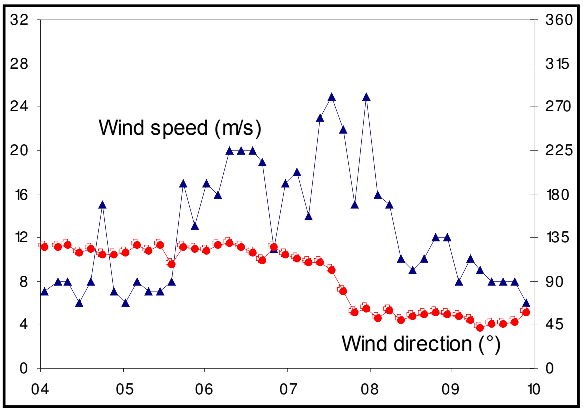

Figure 5: Wind speed ( ) (m/s) and wind direction (○) (degrees) measured by the buoy nr 14532 in the vicinity of Storm Kesiny, in may 2002.

As shown on figure 6, northeasterly sheared Kesiny was loosing intensity and low level center was not obvious on IR imagery. Buoy provided then precious wind data helping locate it. In this shear configuration, the buoy was outside the deep convection and thus no heavy precipitations contaminated the measure.

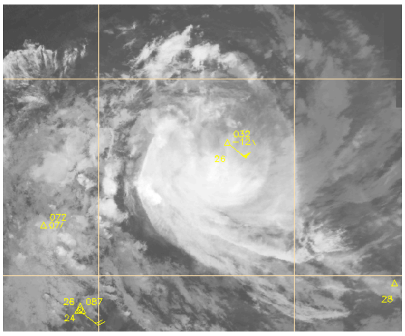

Figure 6: Tropical storm Kesiny, NOAA12, May 07, 2002, 1339Z, and buoy nr 14532.

3. CONCLUSIONS

Drifting buoys have provided a great deal of interest in monitoring TCs, especially in regions like Indian Ocean, where oceanographic data are sparse. In addition, buoys provide further ground-truth observations in this specific basin.