When a FAD meets a wave buoy

Figure1. Left: Adrien Moineau and William Sokimi connect the wave buoy to the FAD; Right: the low-profile wave buoy is attached to the FAD and starts sending data. (images: ©SPC)

On 4 March 2021, the Fisheries, Aquaculture and Marine Ecosystems (FAME) Division and the Geoscience, Energy and Maritime (GEM) Division of the Pacific Community (SPC) collaborated with the French Institute of Research for Development (IRD) and local authorities to connect a wave buoy to a fish aggregating device (FAD) deployed off the west coast of New Caledonia. Two days later, Tropical Cyclone Niran hit the coast of New Caledonia, and the wave buoy recorded wave heights of over 7 m. Two months later, the buoy continues to send FAD position data, and wave height, length and direction data, which are useful for oceanographical purposes. The experiment, which will be replicated in several other Pacific Island countries and territories, is already considered a success.

Adding a weather buoy to a FAD

A monitoring wave buoy is an instrument that floats on the ocean's surface and records wave height, direction and position, and transmits these data via satellite to a shore-based station for analysis.

The New Caledonia experiment aimed to measure the wave height for coastal hazard real-time monitoring. The instrument measured a wave height of 7.1 m when Tropical Cyclone Niran passed through, which was significantly higher than the modelled forecast of 5.8 m.

The first two months of this trial have shown that:

- national fisheries agencies responsible for FAD programmes can collaborate with national meteorology authorities to install wave monitoring buoys on FADs;
- a wave buoy can record and transmit wave events during the passage of a significant tropical cyclone;
- the buoy provides the GPS locations of the FAD's surface floats, which describe a standard shape and swing radius, and allows a lost FAD to be tracked for recovery; and
- the buoy provides valuable data for safety-at-sea of fishers and other ocean users.

The benefits for fisheries agencies

The main benefits of linking a wave buoy to a FAD for fisheries agencies are the possibilities to:

- monitor a FAD position in real time;
- understand how the FAD mooring reacts to currents and winds;
- get a more accurate estimate of the anchor position; and
- track the FAD in case of mooring line failure.

The wave buoy is small and light (5 kg) and does not create any drag on the FAD system. It includes a GPS system with real-time iridium data transmission, which is capable of sending data every hour.

A FAD with a mooring rope length of 1920 m was deployed on 22 December 2020 at a depth of 1500 m. The predicted swing scope (the radius of the circle that the surface floats can form around the anchor position) was 1200 m.

Figure 3. Two months of FAD surface float positions (yellow dots), showing two main trends in relation to the estimated FAD anchor position: a southeast zone when the nearshore oceanographic current actively pushes towards this direction; and a northwest zone when the oceanographic current ceases and the usual southeast trade winds are active, pushing the mooring line towards the northwest.

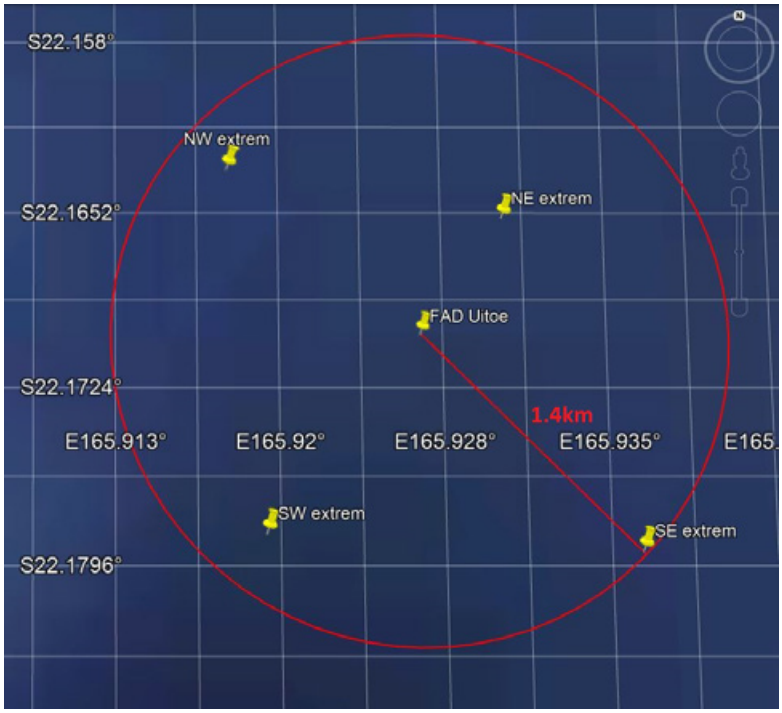

Figure 2. Extreme radius position observed for the FAD.

Over a period of two months, the FAD's recorded position revealed that the FAD's surface floats could be positioned up to 1.4 km from its deployed location and a maximum of 2.5 km was recorded between two positions (Fig. 2). The anchor is, therefore, probably 200 m away, in a southeast direction, from its estimated landing position. This could be another benefit of the position data provided by the wave buoy: determining the exact position of the FAD anchor.

During the passage of Tropical Cyclone Niran, the GPS tracking system on the buoy indicated that the FAD had swung 900 m northeast from its last recorded position, just an hour before.

Figure 4. Two sets of ocean state measures provided by the wave buoy.

Benefits for ocean users

The main benefits of the information provided by the wave buoy to ocean users are the possibility to get ocean weather observation data in real time with the sea state (safety at sea); and know the current FAD location.

Data provided by the wave buoy can also be tailored for navigational safety purpose in various places such as inter-island channels, lagoons, passes, and favourite fishing spots. Ocean state data are crucial information and can be used as a safety parameter for ocean users and fishers at their favourite FAD site.

Figure 4 gives an example of sea state data recorded at two different times. Case 1 (choppy seas, 20 kt of wind and 2 m wave height) is certainly not ideal to be out at sea fishing from a small boat, while case 2 (smooth glassy seas, 3.9 kt of wind and 1 m wave height) seems to be the perfect conditions to go out fishing!

Benefits for the oceanographical and meteorological agencies

The main benefits of linking a wave buoy to a FAD for meteorological and oceanographical agencies are the possibilities to:

- access observation real-time ocean data for wave prediction and coastal inundation warning;
- provide more accurate "sea bulletins";
- collect extreme weather event data during tropical cyclones;
- improve global numerical wave models by comparing observed and predicted wave data;
- understand nearshore oceanographic current patterns; and
- follow nearshore sea temperature evolution in real time.

Ocean sea surface temperature (SST) is a crucial parameter for monitoring upcoming coral bleaching events. Corals are vulnerable to bleaching when SST exceeds the temperatures normally experienced during the hottest months of the year by +1.0°C. SST is one of the parameters monitored for potential cyclone genesis during cyclone seasons.

Figures 5–8 give three examples of the type of information provided by the wave buoy, and their possible uses.

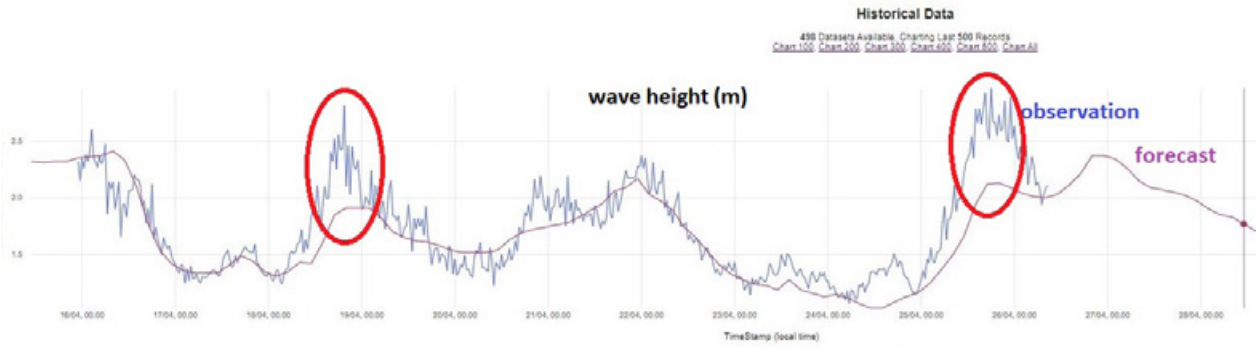

Figure 5. Difference between wave heights observed and wave heights predicted with the Météo France wave model.

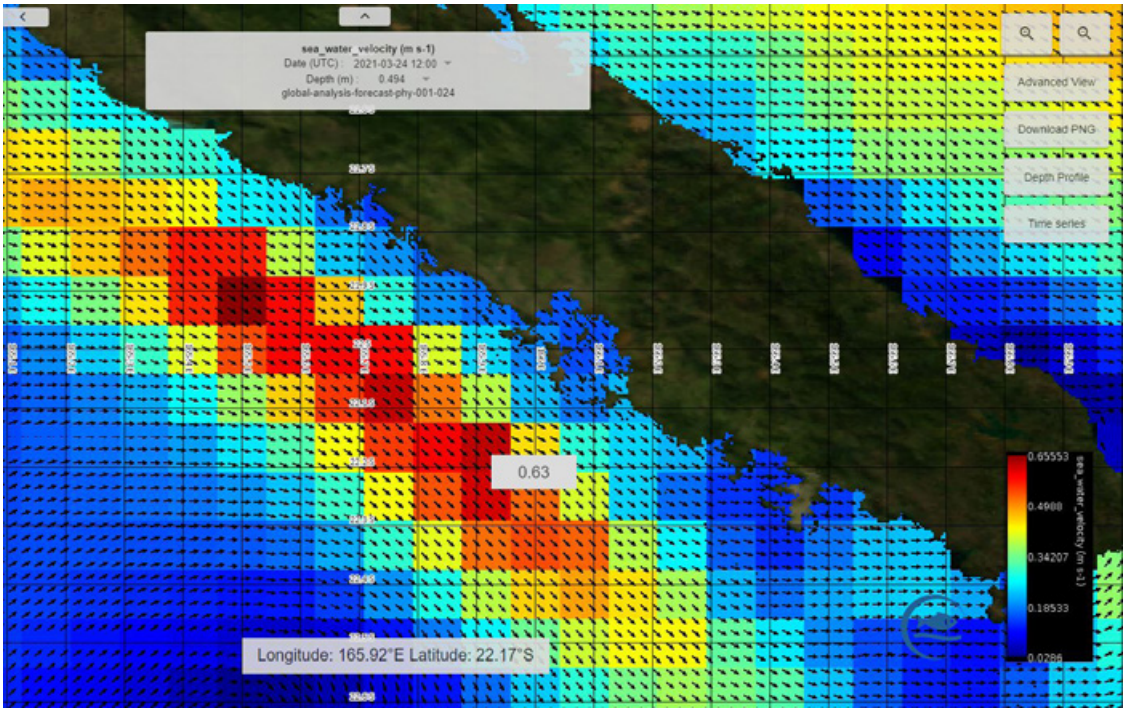

Figure 6. FAD positions recorded in the northwest of the FAD mooring zone by the GPS embedded in the wave buoy confirmed the occurrence of a strong oceanographic current of 0.6 kt towards the southeast, predicted by a MERCATOR[3] numerical model.

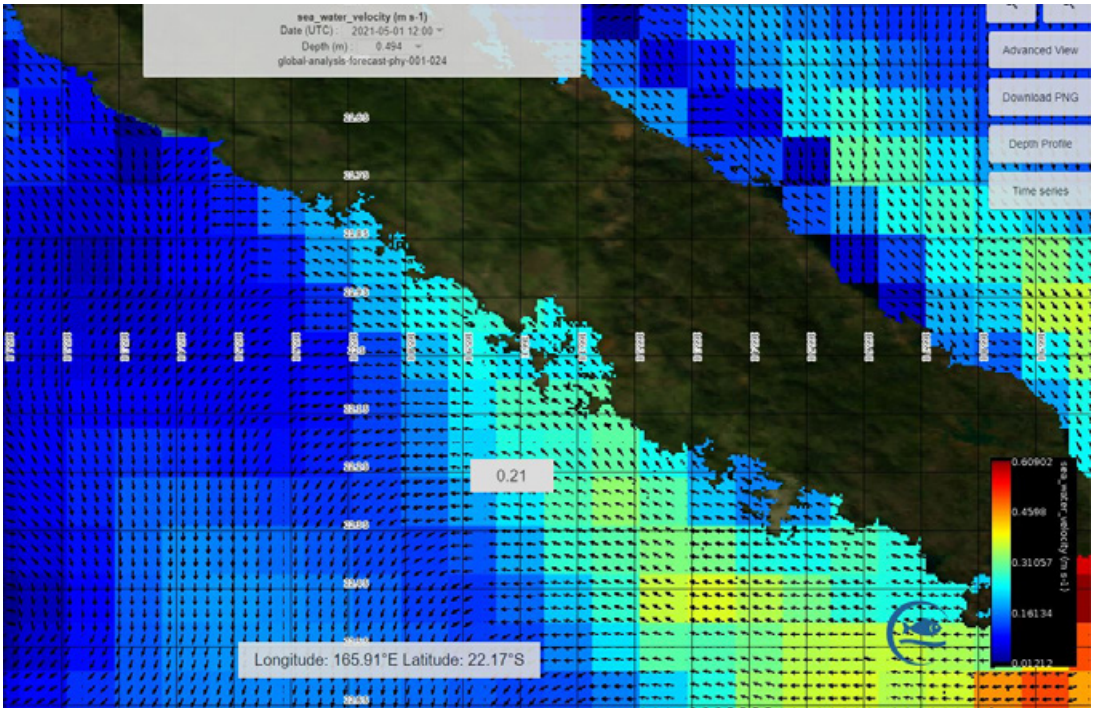

Figure 7. FAD positions recorded in the northwest of the FAD mooring zone by the GPS embedded in the wave buoy confirmed the occurrence of a weak oceanographic current of 0.2 kt towards the northwest, predicted by a MERCATOR[3] numerical model.

[3] https://view-cmems.mercator-ocean.fr/GLOBAL_ANALYSIS_FORECAST_PHY_001_024

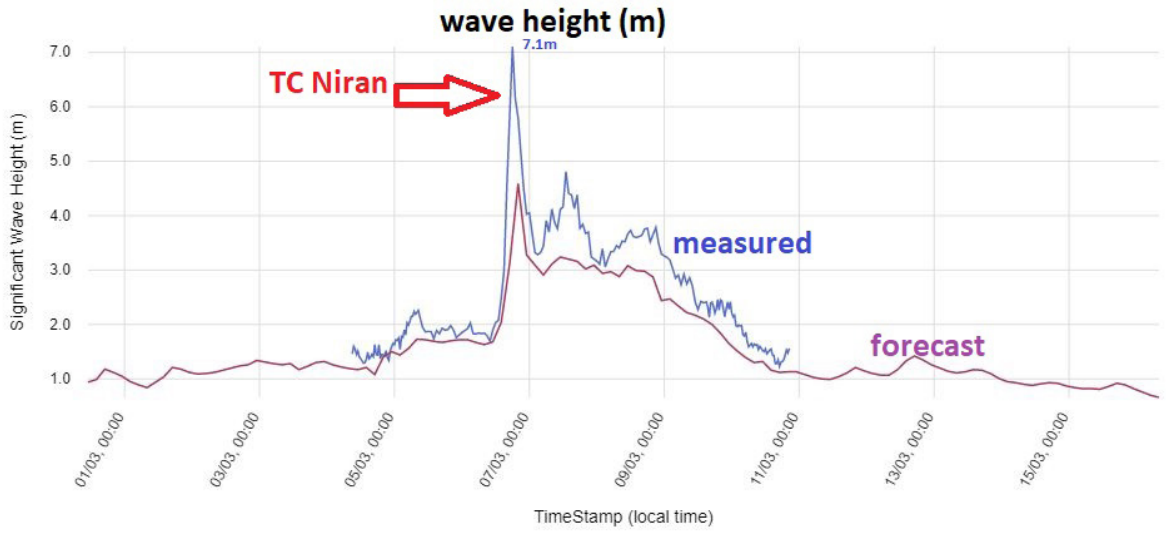

Figure 8. Difference between wave heights observed and wave heights predicted with the Météo France Wave Model during the passage of Tropical Cyclone Niran.

Other possible benefits for climate observations

Small wave buoy systems, as the one used in New Caledonia, can be equipped with ocean parameters sensors to record ocean temperature, pH, current and other data, providing real-time data to monitor anomalies such as warm water events that provoke coral bleaching.

Using the existing Pacific Islands FAD network, a great ocean observation network could be put in place relatively easily. All moorings are already in place (the FADs), they just need the addition of small wave buoys.

Regional collaboration benefit

The Pacific Ocean represents 20% of the global ocean area. There are more than 300 platforms providing wave observations globally but less than 1% are in installed in the Pacific Small Island Developing States.

Recently, projects focused on tailored early warning system for coastal communities' inundation forecast in the Pacific Islands region have been able to increase this thin number of ocean observation equipment deployed in the Pacific.

More regional and multi-sectoral partnerships, such as the ones that allowed this FADs or swell buoy to take place, are needed to extend the area surveyed, increase the benefits to a wider range of stakeholders and, in the end, improve the safety of coastal populations and ocean users.

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