by Jan-Petter Mathisen

BUOYED UP

Data collected in the northern seas relies on networks of buoys

Using metocean buoys in the open sea is an efficient and cost-effective method of gathering meteorological data

A global network of 13 weather ships was established in 1948 by the International Civil Aviation Organization (ICAO) to improve the quality of meteorological data at sea. Prior to that, metocean data was solely collected by ships of opportunity, with variable data quality.

Weather ship data is now being superseded by satellites and metocean buoy networks, although buoys are still relatively few and far between. The most important buoy networks are the NOAA-NDBC buoy networks in the USA (covering the east and west coasts of the USA, the Gulf of Mexico and the Hawaiian Islands), and the more recent Canadian network.

Other networks include the Japanese ODAS buoys in the Pacific, Sea of Japan and East China Sea; the Indian National Data Buoy Programme, which is currently probably the largest national program with deep ocean directional buoys used as standard; national networks in Spain, Greece, France, and Italy; the Norwegian network in the Barents Sea; Iceland; and Ireland.

Using buoy measurements for collecting meteorological data is much more cost-efficient than using weather ships. The annual operational cost for the weather ship MS *Polarfront* was US$3.7 million, compared with about US$100,000 for a buoy station. As the main operational cost is vessel hire, for buoy deployment, the cost per buoy depends strongly on the number of buoys in the network and the sailing distance.

In addition to meteorological parameters, some of the buoys also measure oceanographic and water quality parameters such as current and CT profiles, pH and hydrocarbons. This data is also important for climatological studies. By using buoy data as ground truth data, the vertical profile of air temperature and humidity can be obtained using satellite data.

Buoys for different purposes

Fugro OCEANOR's suite of metocean buoys incorporates four buoy types, designed for different purposes and environmental conditions. The Wavescan buoy is the largest, weighing 1,000kg, and is mainly used for deepwater stations with the most severe environmental conditions. The buoy is also well suited as a platform for multipurpose sensors.

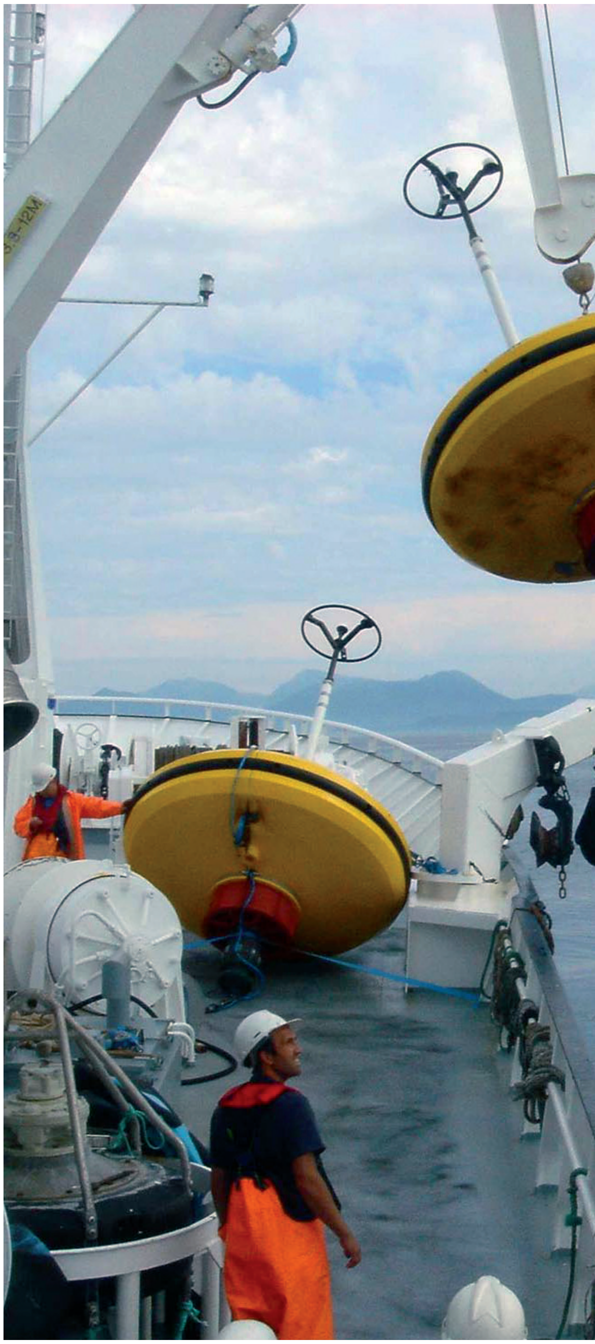
The Seawatch buoy is a vertical stabilised buoy, and is ideal for wind and wind profiling measurements.

The third type – the Midi – is a medium-size buoy for monitoring meteorological and oceanographic parameters.

Since its buoyancy accounts for half of the Wavescan buoy, it is usually applied in coastal locations. If only wave and surface current data are required, the fourth type of buoy, the Mini, is a smaller and more cost-effective alternative.

The buoys are equipped as standard with wind, air pressure, air temperature, and humidity sensors, but other sensors can be included, such as solar radiation, irradiance, and precipitation. Except for the air pressure sensor, which is located within the buoy hull, the meteorological sensors are located 3.5m above the sea surface for the Wavescan and Seawatch buoys, and at 2.8m for the Midi.

The wave sensor and data logger are located within the buoy hull, together with the control electronics. Currents can be measured using single-point current meters or Acoustic Doppler Profilers (ADCP) ranging up to 500m, depending on the frequency. For deeper water, upward-looking ADCPs are used, which can be bottom-mounted or attached to the mooring. The data is then transmitted to the buoy via an acoustic link. The temperature/salinity (CT) profile is recorded by sensors attached to the mooring line, and transferred to the buoy by inductive cable. Water quality parameters can also be added. The Wavescan buoy is especially suited for this, with water quality sensors mounted in a well in the buoy hull, so that the sensors can be recovered for service and cleaning while the buoys are at sea. The buoys are powered by solar panels with internal back-up batteries. Data is



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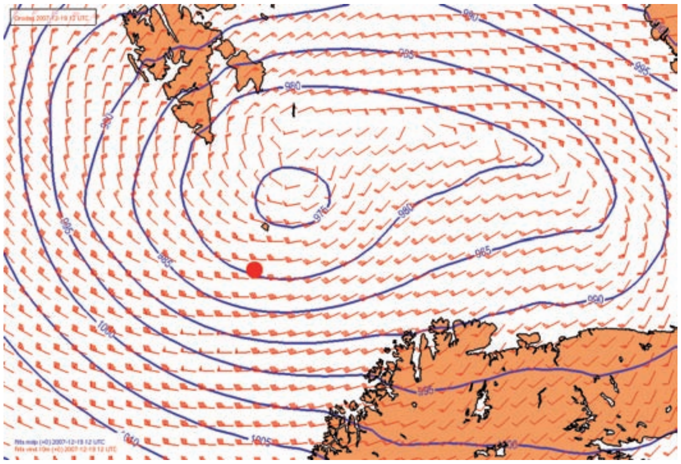
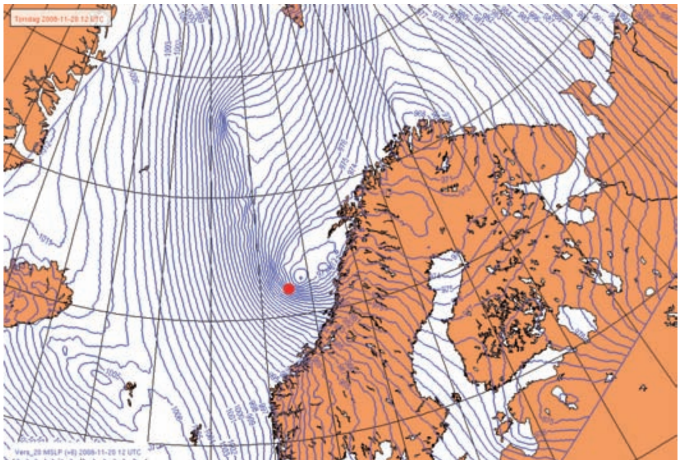




Far left: Deployment of a Wavescan buoy

Top left: Weather map based on model results from the HIRLAM model at the Norwegian Meteorological Institute on December 19, 2007 at 12 UTM. Red dot location of the Wavescan buoy

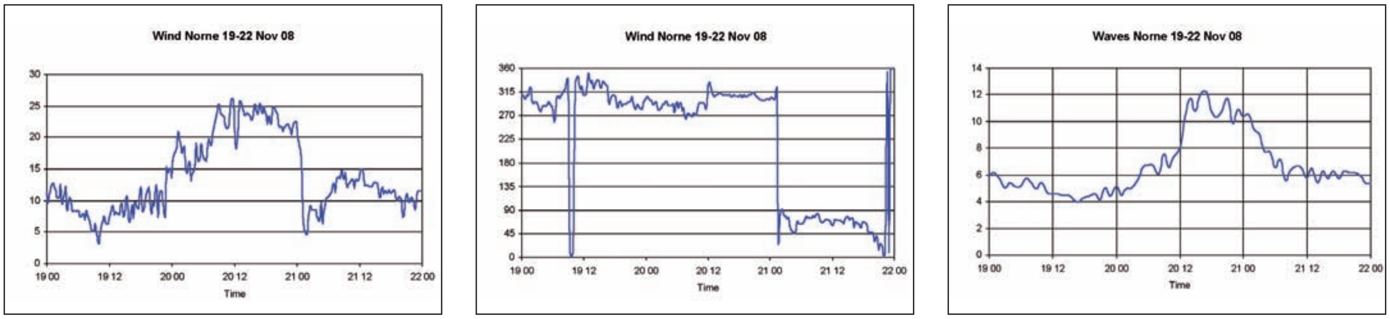
Bottom left: Weather map based on model results from the HIRLAM model at the Norwegian Meteorological Institute. Red dot location of the Norne FPSO

transmitted to shore by satellites (Inmarsat-C, Iridium and Argos), UHF and VHF radio, and cell phone.

Fugro OCEANOR buoys are in operation worldwide, from equatorial waters to the high Arctic.

Barents Sea network

The area of the Barents Sea is some 1.3 million km^2, which is almost twice the size of the North Sea, but there are only a few systematic in-situ meteorological observations between Bear Island in the west and Novaya Zemlja in the east. To gather data to support weather forecasting, particularly small-scale polar lows, which can cause problems for offshore operations, Statoil deployed two Wavescan metocean buoys in the western and central Barents Sea during the winter of 2007. In addition, the Norwegian Coastal Administration and the Norwegian Radiation Protection Authority deployed another buoy off the northern Norwegian coast at the end of 2007. An additional purpose of this buoy was to make data available operationally in the event of ship traffic-related accidents.



Time series of wind speed, direction and significant wave height during the period November 19-22, 2008

Data from the buoys is routinely used by several meteorological agencies for the verification of forecasting models.

The Vera storm

Vera was a polar low that developed off the coast of northern Norway in the afternoon of November 19, 2008, and moved southward off the Norwegian coast. The central pressure of the low was 970hPa and did not vary much with time. At midday the next day, Vera passed the floating production vessel at the Norne oil field, located about 80km (50 miles) north of the Heidrun oil field in the Norwegian Sea. A Seawatch Mini buoy was deployed alongside the vessel to record the wave conditions, while wind measurements were monitored and recorded on the vessel. The wave data is used for operational monitoring for the shuttle tankers. All data was recorded every 20 minutes. Wave data and sea surface temperature are transmitted to the vessel by radio, while wave and meteorological data are transmitted to the Norwegian Meteorological Institute.

When the storm passed Norne, there were large gradients in the air pressure ahead of this low, leading to strong winds. At the tail of the low, the wind was weaker. As the low passed Norne, the significant wave height increased from 6.5m to 12m within only four hours, and 16 hours later the wave height had reverted to 6.5m. Similarly, the windspeed increased rapidly from 10m/s to 25m/s within only 10 hours. There was, however, a rapid drop in windspeed from 22m/s to 6m/s in 80 minutes, around midnight on November 21. One hour later, the wind had veered 130°. This shows that small-scale polar lows exhibit rapid changes in wind conditions, while changes in wave conditions are on a longer timescale.

The Rita storm

Rita developed west of Greenland on December 18, 2007, and moved eastward across the Barents Sea, reaching the Norwegian county of Finnmark on December 20, causing considerable damage along the coast. At midday on December 19, the low was located north of Bear Island (see weather map) associated with winds up to 50kts in the western part of the Barents Sea.

The Wavescan buoy observed 10m winds at sensor height and these have been adjusted to 10m. The peak windspeed on December 19 reached 19m/s, in accordance with the weather map. At the same time, the significant wave height reached 12m. The windspeed decreased rapidly to 4m/s by the end of December 20, and on December 21, the winds had changed to southerly.

Future developments

Fugro OCEANOR continually upgrades its buoys to include new sensors and technology. The company is also developing a new buoy concept whereby the wind profile will be measured using lidar. This buoy will have various applications, such as obtaining data for design and operation of wind farms, in addition to obtaining near-surface wind profiles, which can be assimilated into weather forecasting models. Buoy data will be transferred to the Norwegian Meteorological Institute, to be distributed by the GTS system.

Fugro OCEANOR's four types of buoy have undoubtedly proved their worth throughout the world. ∎

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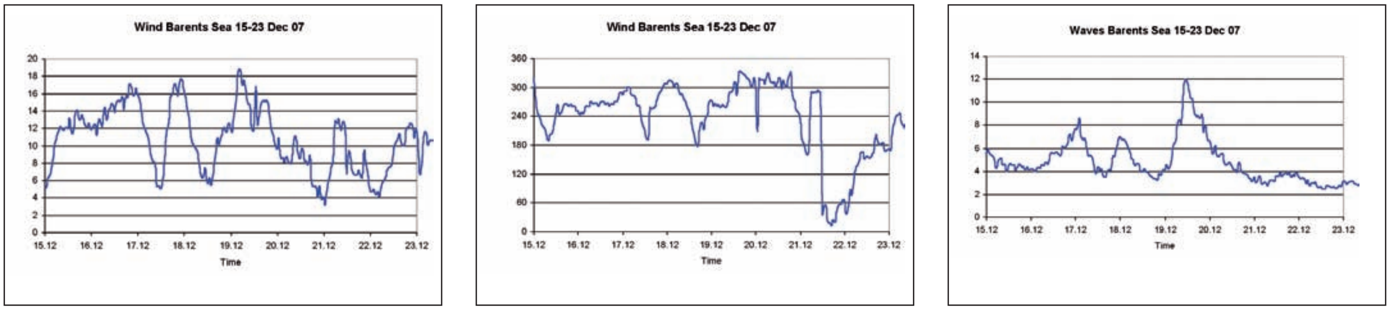

Time series of wind speed, direction and significant wave height during the period December 15-23, 2007.