Woods Hole Oceanographic Institution
Upper Ocean Processes Group

Technical Note

A Portable, Accurate Meteorological System for Ships

The driving forces for the physical processes in the upper ocean are the fluxes of heat and momentum across the air-sea interface. These can be measured directly, but the instruments are not suitable for deployment on a buoy for long periods of time. It is possible to compute them from meteorological parameters, and we have done this for many years. We measure wind speed and direction, air and sea surface temperatures, relative humidity, barometric pressure, short wave solar radiation and long wave radiation on our buoys.

A buoy is a very challenging platform from which to make accurate measurements for 6 to 8 months at a time. Not only do the sensors have to maintain their calibrations but they also have to withstand intense solar radiation in good weather and high winds and salt spray in bad. Because of limited battery capacity on the buoy, the sensors should consume next to no electrical power.

In order to get good data return, we take great care with our sensors and data loggers and usually mount two systems on each buoy for redundancy. Each sensor is calibrated before and after each deployment to quantify any change. Experience has shown, however, that the instruments do occasionally fail in the field and may be damaged during deployment or recovery. Thus, any additional calibration or validation performed in the field can provide information vital for the interpretation of the buoy observations. Shipboard meteorological observations are made for 4 to 6 hours close to the buoy just after deployment and just before recovery for this reason.

After the buoy has been moored, we can intercept its transmissions to Argos satellites, decode its measurements, and compare with shipboard observations. It is essential to know that the measurements are correct and that nothing has been damaged during deployment. At this point, before we sail away, it is possible to replace a sensor. After we leave the site it is exceedingly expensive and usually impossible to return to the buoy until the recovery cruise. If a sensor is damaged during recovery, we may not be able to recalibrate it and there will be no verification that the sensor stayed within specifications during the whole deployment. This leaves the accuracy of all the data recorded from that sensor open to doubt.

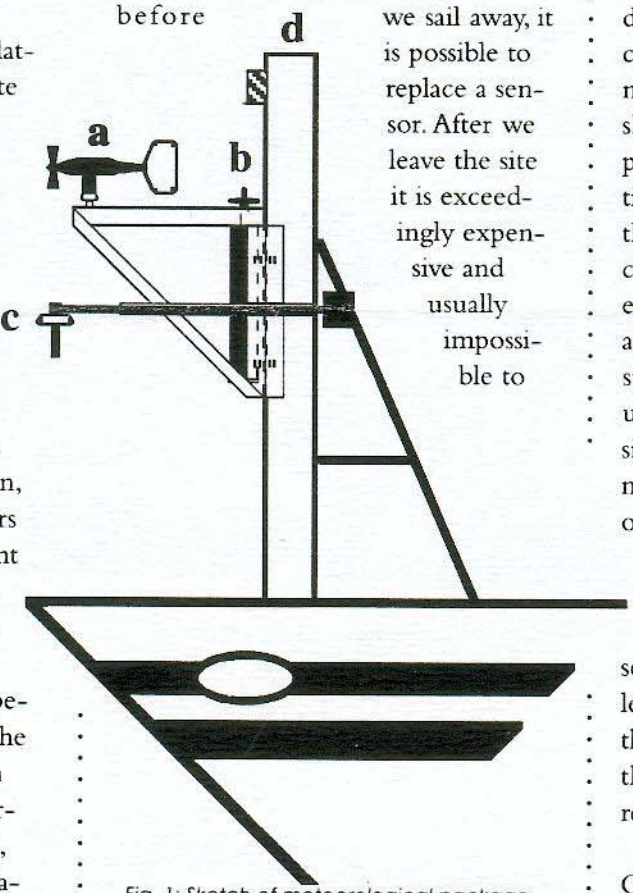

Fig. 1: Sketch of meteorological package mounted on RV Thompson's jack staff.

Although some UNOLS ships are acquiring IMET sensors, most ships still do not have the equipment to make research grade meteorological measurements. We have made measurements with hand-held sensors on deck but any marine meteorologist can tell you how thoroughly a ship modifies the air flowing past it. Sun shining on the ship warms the air passing over it; the effluent from ventilators combines with it and anything affecting air temperature also changes relative humidity. The presence of the ship disturbs wind speed and direction and barometric pressure. Our manual measurements have usually been a source of frustration since the buoy measurements are much more accurate. Accurate meteorological measurements can be made from a ship, however. If the relative wind is within 45-90 degrees of dead ahead and if the sensors are in the bow well above rail level, the presence of the ship has little effect. All ships have a jack staff in the peak of the bow which meets the requirements.

During April 1995, the Upper Ocean Processes Group is redeploy-

ing some moorings in the Arabian Sea. For this cruise on the RV *Thompson*, we developed a compact package for mounting on the jack staff which contains wind speed and direction, air temperature, relative humidity, and barometric pressure sensors. Figure 1 is a sketch of the system mounted on the RV *Thompson' s* jack staff (d). The relative humidity/air temperature sensor (c), a Rotronic MP-100 as is used in the IMET relative humidity module, is aspirated to provide values uncontaminated by solar heating. The wind sensor (a) is an R.M. Young propeller anemometer, also used in the IMET wind module. Barometric pressure is measured with a Rosemount type 1201, a very rugged, reliable and accurate device which consumes too much power for buoy use but is excellent where we can plug into 110 VAC. It senses the pressure through a Gill port (b) to minimize the dynamic effects of the wind. The barometer and CR10 data logger are housed in a cylinder beneath the Gill port. The air temperature, relative humidity and barometric pressure sensors were calibrated shortly before the system was shipped to Oman.

For logging the data we chose a Campbell Scientific Inc. (CSI) model CR10 meteorological data logger. We have had much experience with other CSI data loggers in the laboratory and have confidence in them. This is the smallest of their line and is hermetically sealed in a stainless steel housing. Its 0.2% accuracy in voltage measurements is adequate for the barometric pressure, air temperature and relative humidity sensor outputs, and its pulse counting ability is designed for the Young anemometer. Programming the CR10 is laborious but effective. In our application, the CR10 totals the anemometer counts over 10 s intervals and samples the other parameters every 10 s. The 10 s values are averaged over 1 minute and stored internally. Storage capacity is about 2.5 days. A cable for both power and communications runs back to a laboratory space on the ship. CSI software allows us to display the 10 s samples on a PC in the lab and to upload the stored values to the PC's disk.

With this system we will take measurements for several hours after deploying a mooring and for several hours before recovering it. Having accurate values of the parameters from the ship system will give us greater confidence in the parameters recorded on the buoy.

ACKNOWLEDGMENTS

The meteorological system was developed under ONR contract N00014-90-J- 1490.

This article was written by Dr. Richard E. Payne, who is currently a Research Associate in the Physical Oceanography Department and a member of the Upper Ocean Processes Group at the Woods Hole Oceanographic Institution.

Published by the Upper Ocean Processes Group, Woods Hole Oceanographic Institution, Woods Hole MA 02543-1542.
Contact: Rick Trask, ext. 2395. Design by Jeannine Pires, WHOI Graphics

Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543-1542