Collection and evaluation of marine observations from the International SeaKeepers Society Autonomous VOS Fleet

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The non-profit International SeaKeepers Society was founded by environmentally minded owners of large yachts. They had a strong interest in the health of the oceans and waterways, and were willing to equip their personal vessels with instruments to contribute to scientific research. The autonomous Ocean and Weather Monitoring system collects and transmits weather information and sea surface temperature (SST) every three hours to NWSTG for use by the National Weather Service for forecasting. More extensive data: temperature, conductivity, dissolved oxygen, pH, and Eh, together with relative wind speed and direction, air temperature, relative humidity, barometric pressure, ships position, speed and heading are recorded to the computer hard drive every minute for later downloading to the SeaKeepers database. Today, with the continued support of our founding members, we are becoming involved in equipping commercial vessels, cruise ships, piers and buoys with autonomous ocean and weather monitoring systems.. The data described in this paper are heavily weighted toward cruise ships which operate 24 hours per day and 7 days per week.

The instrumentation installed upon all of these vessels and observing platforms is essentially Identical. Figure 1 shows the components of the system. The computer and instrument modules are stainless steel NEMA-4 enclosures, which can be mounted in a variety of configurations. An INMARSAT std-C transceiver is housed in the computer module. The software collects the data and automatically sends a data message which encodes the 10 minute average immediately before the transmission time for each reporting sensor and sends it to the SeaKeepers data center at the University of Miami.

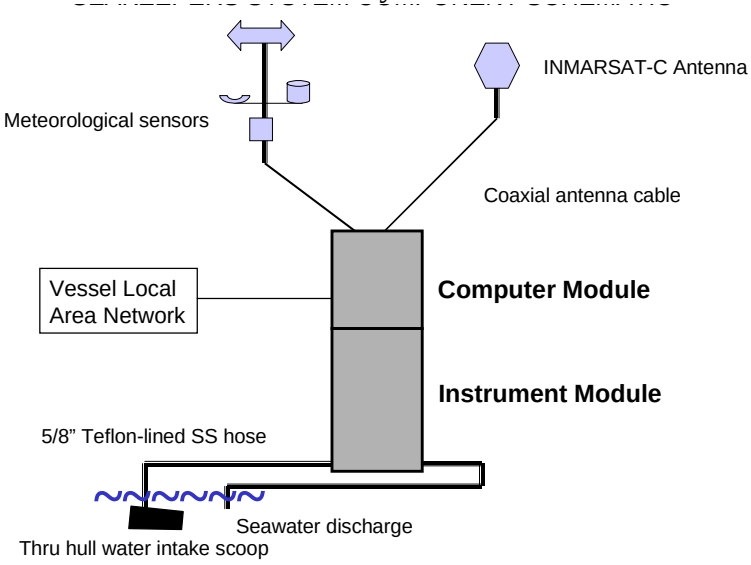

Figure 1. Schematic of the SeaKeepers Ocean and Weather Monitoring System.

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From selected vessels (13 out of 40+ at the time of this report), a subset of these data are formatted in standard WMO FM-13 and FM-62 messages at RSMAS and sent to NWSTG, and then routed to GTS and other locations. Figure 2 shows the position for observations delivered to NWS during 2001. Other systems are being added to the reporting group as their software is upgraded and field tested. The vessels, and other SeaKeepers systems on fixed platforms, are assigned call signs in the format KS*nnn*, to preserve anonymity for the owners of superyachts. The full data set (averaged and high-resolution) will be available at SeaKeepers Web-based data server for use by scientists and educators.

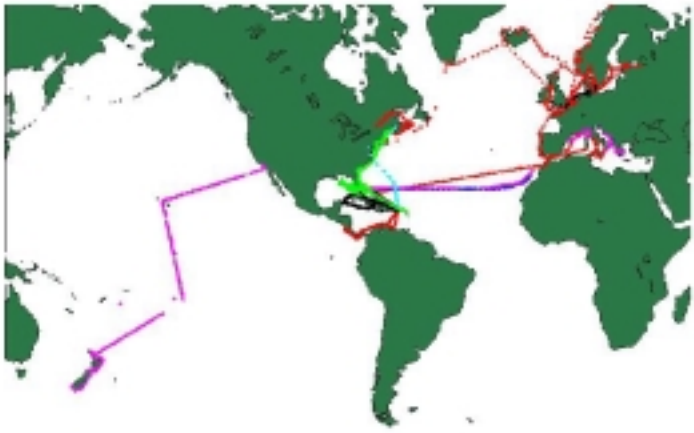

Figure 2. Map of SeaKeepers observations delivered to NWS during 2001.

Membership in the International SeaKeepers Society has continued to grow. Systems are operating on three cruise ships, two research vessels, 30 yachts, a pier, and are being installed in new yachts, commercial tankers. A low-energy version is being developed for fixed buoys, in cooperation with the National Data Buoy Center (NDBC).

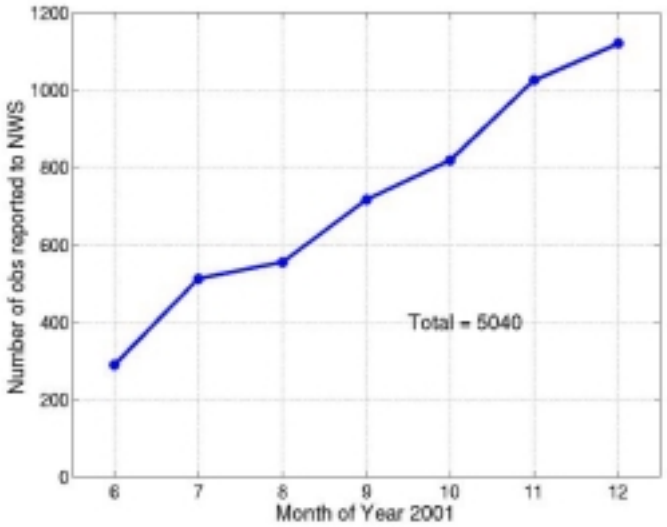

Figure 3. Number of weather observations reported from SeaKeepers vessels by month.

Data Analysis

Each point in the following series of graphs represents one vessel, the error bars represent the repeatability of the data from that vessel. The "Y" axis on each graph represents the average difference from the NCEP model, while the "X" axis indicates the number of observations reported from that ship.

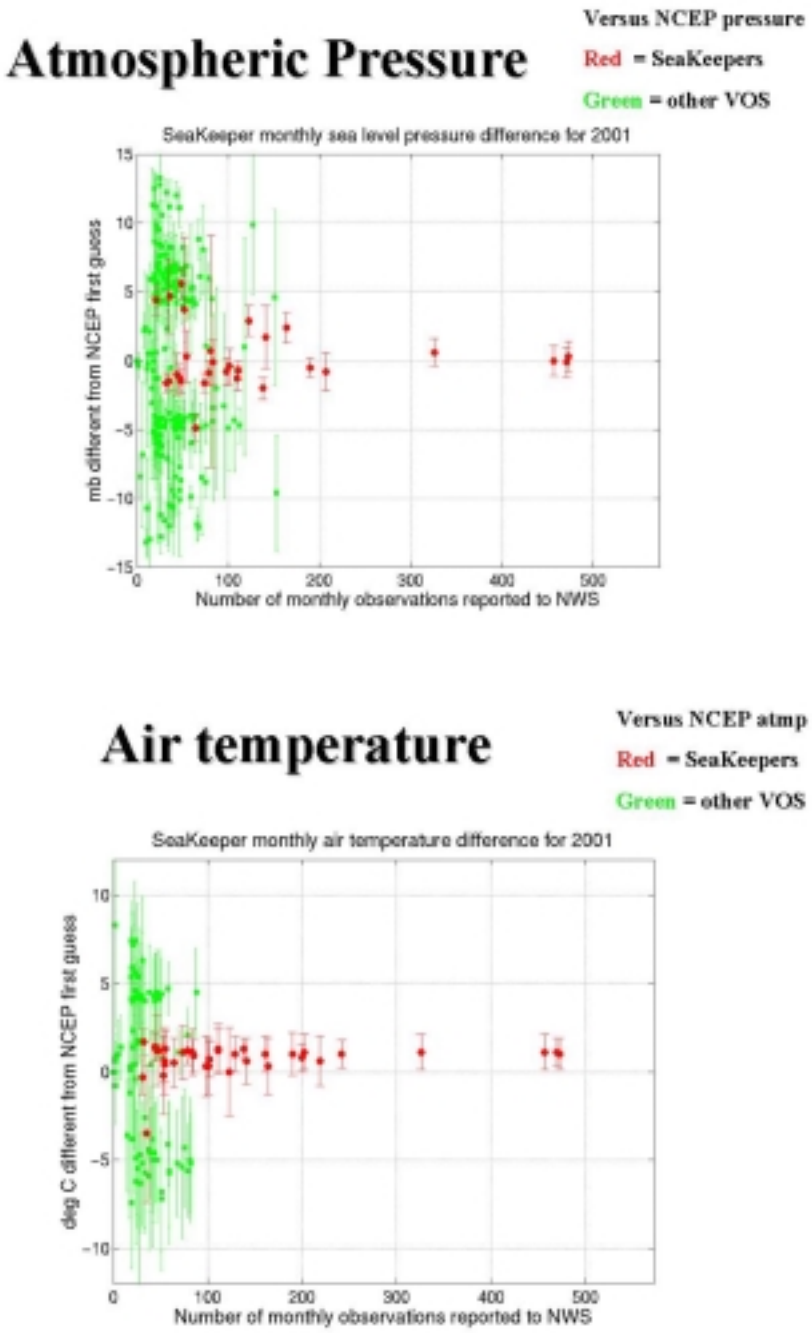

Figure 4. Comparison of SeaKeepers and VOS fleet data to the NCEP model predictions

It is immediately apparent that the SeaKeepers data shows excellent accuracy, data repeatability, and data quantity for atmospheric temperature and pressure (figure 4). Wind speed and direction observations (figure 5)are more difficult, and while the SeaKeepers data compares well with the entire VOS fleet, the quality is not as good as the pressure and temperature data when compared to the NCEP model. We believe that this problem is attributable to several different sources and we shall attempt to explore some of them here.

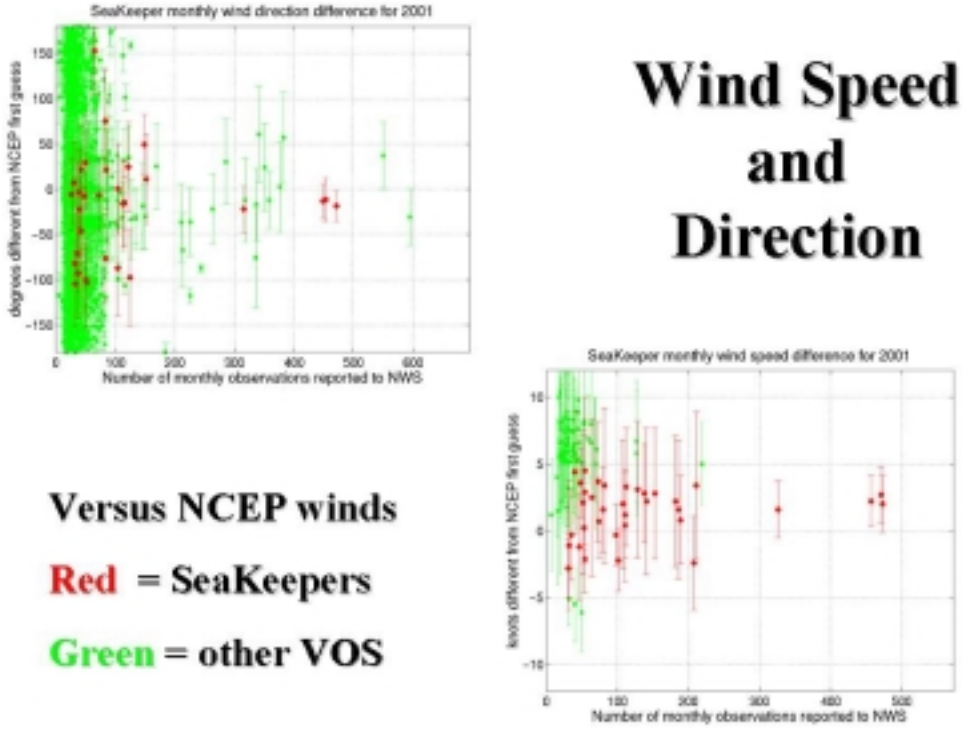

Figure 5. Comparison of SeaKeepers and the VOS fleet wind data to the NCEP predictions

With one or two notable exceptions, the wind speed and direction error rates are higher near shore, the area where one would expect the NCEP open ocean models to be least reliable (Figure 6)

Figure 6. Topographic influence on gross wind error

There is a better correlation between the SeaKeepers data and QuikSCAT satellite winds and a strong inverse correlation between difference between the observed values and those predicted by the models with distance from the coast (Figure 7).

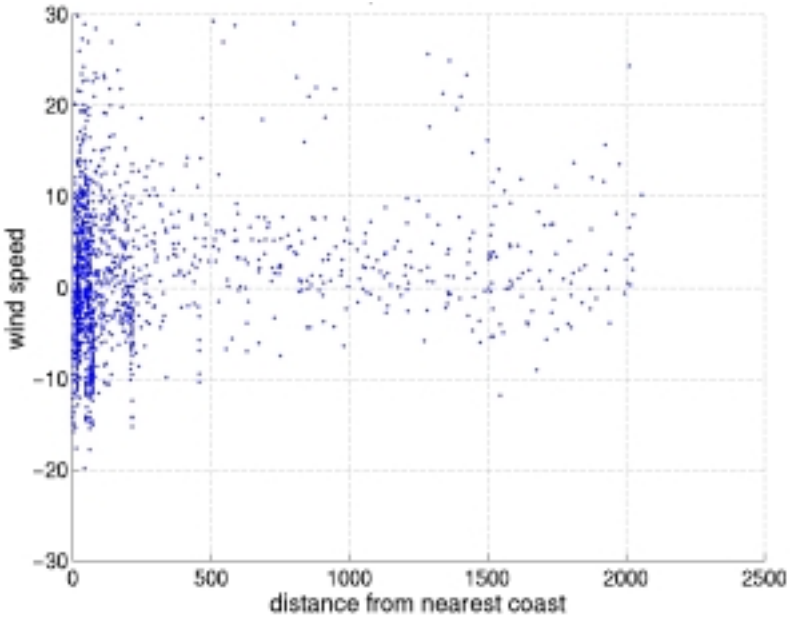

Figure 7. Wind Speed difference from QuikSCAT model predictions, for all SeaKeepers vessels

We have singled out one vessel, Carnival Triumph, whose repetitive course and apparent large measured differences have made us suspicious. The lowest quality is indicated wind direction , wind speed differences being localized to near the Cuban coast where presumably other sources of wind observation are limited. The high incidence of large direction differences on the southeasterly outbound leg of the Eastern Caribbean route led us to more closely examine the placement of the anemometer. There appears, from examination of wind speed and wind direction differences vs relative wind direction, to be a total absence of reported wind from 150 to 350 degrees relative to the bow of the vessel. A vessel steaming at 20 knots, as this one routinely does, would not be expected to report much in the way of relative wind from 90 to 270 degrees. The absence of incident winds in the 270 to 359 quadrant was surprising until we more closely examined the location of the wind sensor relative to a 4 inch diameter tripod mast which sits in exactly this quadrant relative to the wind sensor (Figure 8.). The anemometer will be repositioned and this type of data analysis repeated to quantify the effect.

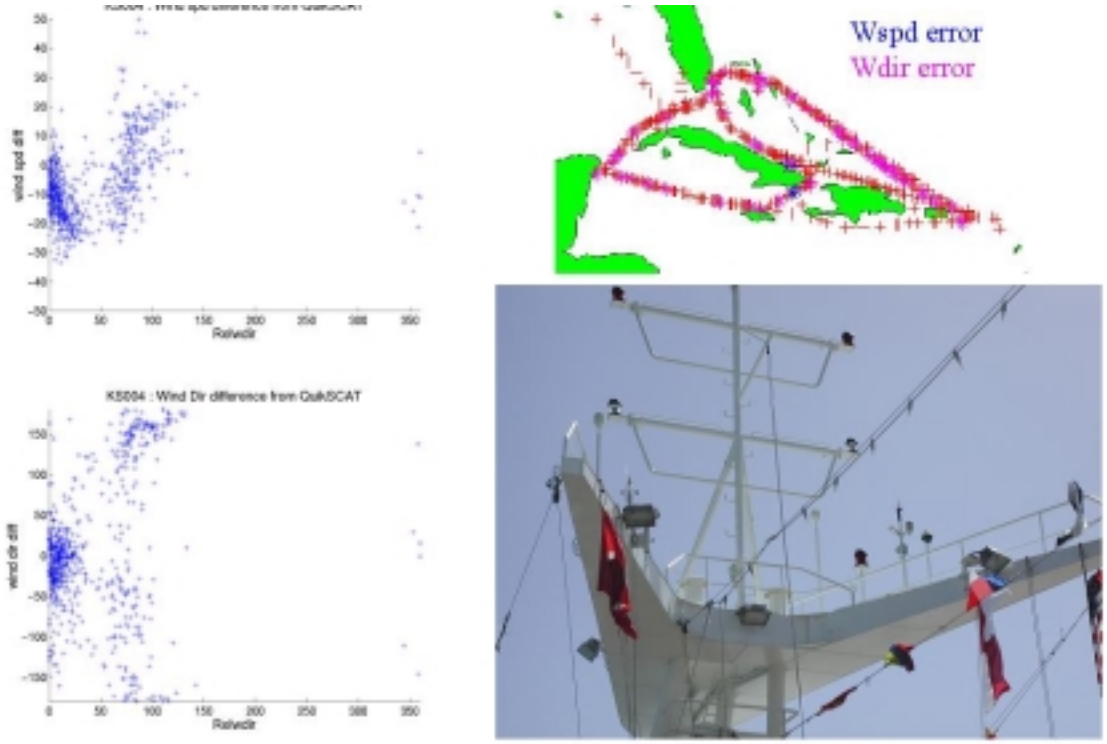

Figure 8. Wind bias in observations from Carnival Triumph

Generally the SeaKeepers Sea Surface temperature data is good and in excellent agreement with the NCEP model Figure 9). The small bias on the more numerous reporting ships could be an indication of the nonrepresentative depth of measurements on the cruise ships, typically 7 to 10 meters below sea level. For all high data volume vessels, the night time agreement is superior to the daytime data sets indicating that diurnal surface heating could be playing a significant role Figure 10)..

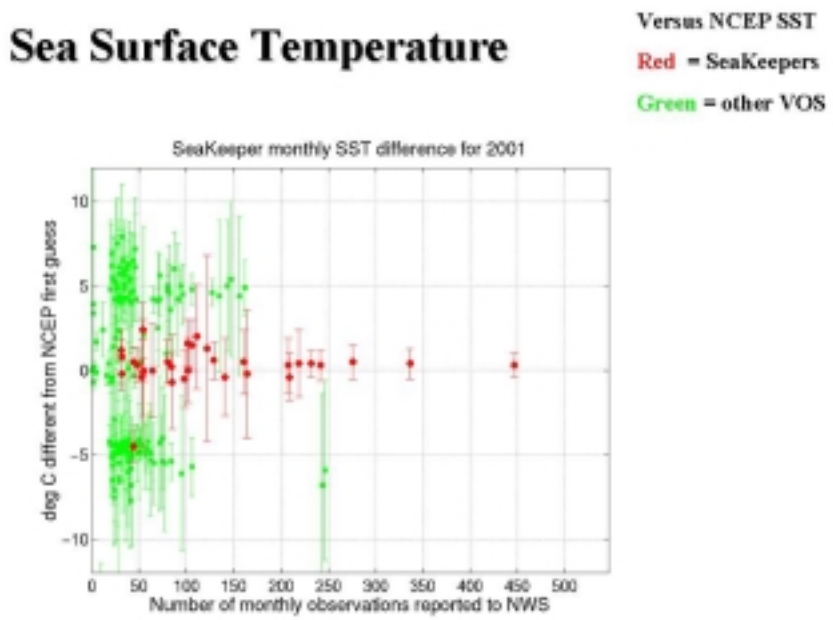

Figure 9. Sea Surface Temperature observations compared to the NCEP model

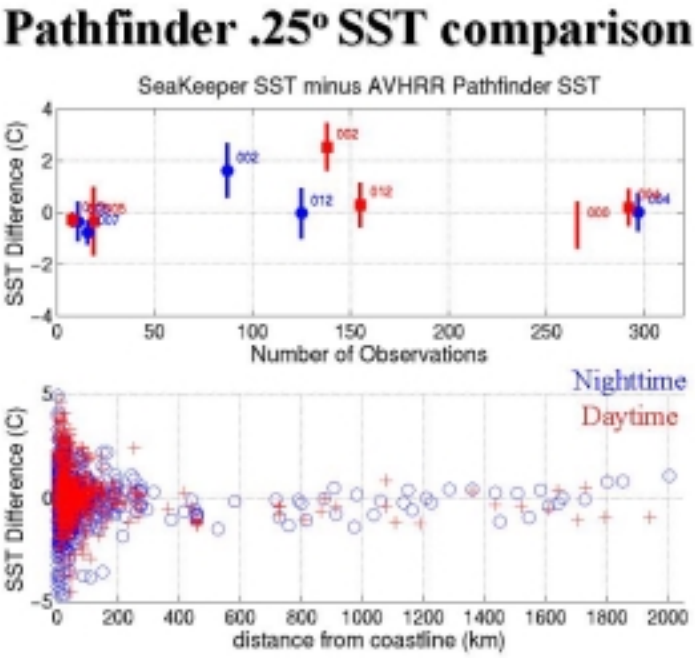

Figure 10. Day/night errors comparison. The numbers on the upper plot identify specific SeaKeepers vessels by call sign.

Future directions:

Improve quality control procedures
Expand the number of SeaKeepers systems reporting to the NWS.
Deployments in coastal moored buoys and piers.
Installations on more freighters and container ships, for routine continuous reporting.

Summary

The international fleet of SeaKeepers vessels are now routinely collecting large numbers of good quality meteorological and oceanographic measurements. The data are being delivered shoreside in real time. While the observations are "good" compared to the VOS fleet in general, these measurements can be made better by improved QA/QC procedures and identifying problems with particular vessels. Continued and expanded deployments of the SeaKeepers instrument system is warranted, and should provide a large database of world-wide oceanographic and meteorological observations. A particular value of the use of private yachts as volunteer observing platforms is the opportunity to collect data from less frequented areas of the oceans, away from shipping lanes and major commercial ports.