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OCEAN VOYAGING
**A LONG-AGO
PASSAGE TO
MEXICO**

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NAVIGATION



The digital age: barometers vs. barographs

STORY AND PHOTOS BY ANN HOFFNER

A side-by-side
look at five
air pressure
weather tools

When I crossed the Pacific Ocean on my Peterson 44, *Oddly Enough*, I wrote about local weather, the kind experienced in our exclusive part of the ocean where available forecasts covered too wide an area to be useful, and there's no one else to observe and interpret changes.

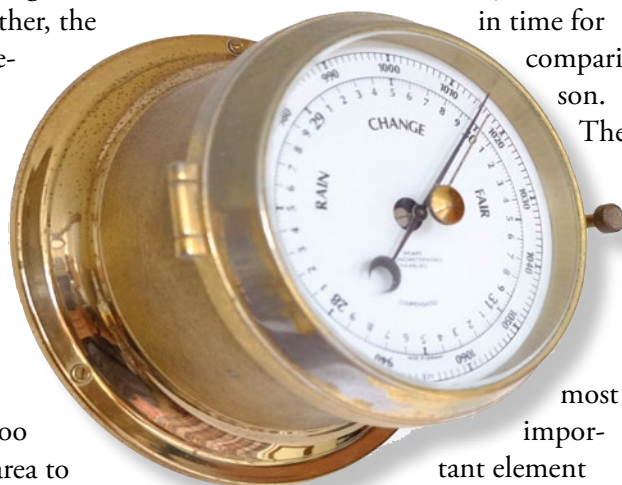
Besides your eyes and some form of collecting far-away data, what is the most important weather instrument to have on a boat? The answer is simple: a barometer.

"This is the classic instrument for understanding and predicting local weather," says John Rousmaniere in *Desirable and Undesirable Characteristics of Offshore Yachts*. Why? Because air pressure is a function of atmospheric conditions, and atmospheric conditions cause what we call weather: wind, temperature, precipitation, clouds.

Yet everyone knows that

a single barometer reading only has meaning in relationship — i.e., if there's another barometer reading separated in time for comparison.

The



most

important

element

for predicting weather is looking at trends, not absolute numbers. Frequent readings, Rousmaniere says, are necessary to understand what the barometer is telling us. The solution to the need for noting trends is to have a recording barometer, a device that makes a record of pressure readings over time. Then if you don't pay attention until weather deteriorates, you still have a record. The old-fashioned recording barographs with pen and paper drums are expensive and vulnerable in their glass cases, and generally only true devotees carry them on cruising boats.

Mintaka Innovations manufactures a line of digital

barographs sold by Weems & Plath. Like traditional barographs, they can both record air pressure and store it, in this case in 256KB of internal storage. The latest addition, the new Mintaka Star, now has GPS function. It's a propitious time to explore what digitalization means for these eminently useful weather instruments.

Small sensors

The advent of micro-electro-mechanical systems (MEMS) sensors made digital instruments like the Mintaka Star possible. MEMS were invented in the mid-20th century but took off after the new millennium with all kinds of consumer-accessible monitoring systems, such as Nest connected homes. MEMS are also present in smartphones — for example, the sensors that detect when you turn the phone and thus that the screen needs to be reoriented. MEMS sensors use electricity to measure changes in mechanical systems, and software collects and interprets their data and sends it to a monitoring station. In the case of a barometer using a MEMS sensor, the mechanical system contains a silicon wafer

The classic ship's barometer is an aneroid unit like this Wempe barometer, which requires no electrical power, operating on air pressure alone.

that reacts to changing air pressure, and the ease with which electrical current can be transmitted through the wafer over time is translated into barometric readings.

Before digital barometers, the state of the art was the aneroid barometer, which came into general use in the mid-1800s. A bulkhead aneroid barometer along with matching clock is de rigueur for a well-trimmed sailboat. Aneroid barometers require no power source to operate. A sealed metal box that responds to changing air pressure by expanding or contracting is attached to a spring that moves a needle around a dial, which is the part we see. A second stationary needle indicates which way the pressure is tending since it was last reset to the primary needle's position. The primary needle moves in response to pressure — but before reading, if you tap the glass, it jumps into its actual place. There's nothing on the barometer to indicate when the last reading was made.

Pen and paper barographs use aneroid barometers to measure air pressure and record it on paper attached to a drum, which these days uses the power in a AA battery to revolve. The drum takes a week to make one revolution, after which the paper must be replaced.

Inconsistent measurements

Logbooks on *Oddly Enough* show that we took barometer readings when offshore, but inconsistently. My interest was stymied by the lack of a historical record, and I couldn't see spending \$1,000 on a barograph. Then one year when we were stateside for Christmas, Tom bought me a digital weather station. The anemometer blew off the mast, the rain gauge was useless underway, but the barometer kept a history and a torturous route allowed me to transfer the information to the computer. But, without a good way to organize it, I again lost interest.

In 2011, the latest Galaxy smartphone added a MEMS to measure air pressure. Smartphones use barometric readings



The lineup of barometers used for the review. From left, the Starpath barometer phone app, an Observer aneroid, a digital home weather station, a Wempe aneroid and the Mintaka Star.

to modify GPS data to increase location accuracy by factoring in altitude. This has made possible a multitude of apps that record barometric pressure but generally only when the app is actively running or the user clicks on it.

Which leads, finally, back to the problem of history

and the addition of a digital barograph.

Five models

For this review, I chose two aneroid barometers, a digital home weather station and a smartphone in addition to the Mintaka Star. For the phone app, I chose the Starpath Marine Barometer, which is designed for marine users. Since I wasn't going to move locations, I calibrated all five devices as close as possible to local pressure, as well as to each other. The baros were lined up on a shelf, and I set my phone alarm to mark four periods daily, three of which coincided with UTC times used by the National Weather Service for surface analyses and

forecasts: 7 a.m., 1 p.m., 7 p.m. and 11 p.m. local time, the fourth time set so I'd be sure to be awake. When the alarm went off, I noted pressure readings off the aneroids and weather station, manually logged the pressure on the phone app and the Star, and recorded

them all in a notebook. After a week and a half, I captured the readings into a scatter graph. As you can see, they gave pretty similar readings, close enough for small boat work at sea.

What became very clear during the week was the vast difference between a simple barometer like the aneroids, the

Observing Ship Program by cruise ships, cargo vessels and research vessels that collect data for marine weather forecasting. Though the original Duo was a full-fledged barograph in itself, it could only interface with a computer via USB, so the Duo+ was given Wi-Fi capability. Last year, the new Star unit added GPS.

The Mintaka Star is a charcoal gray plastic box, 4 inches square and 1.4 inches deep, with four green buttons and a small display screen. Data from the Star's two barometric sensors is

read at one-second intervals and averaged to determine

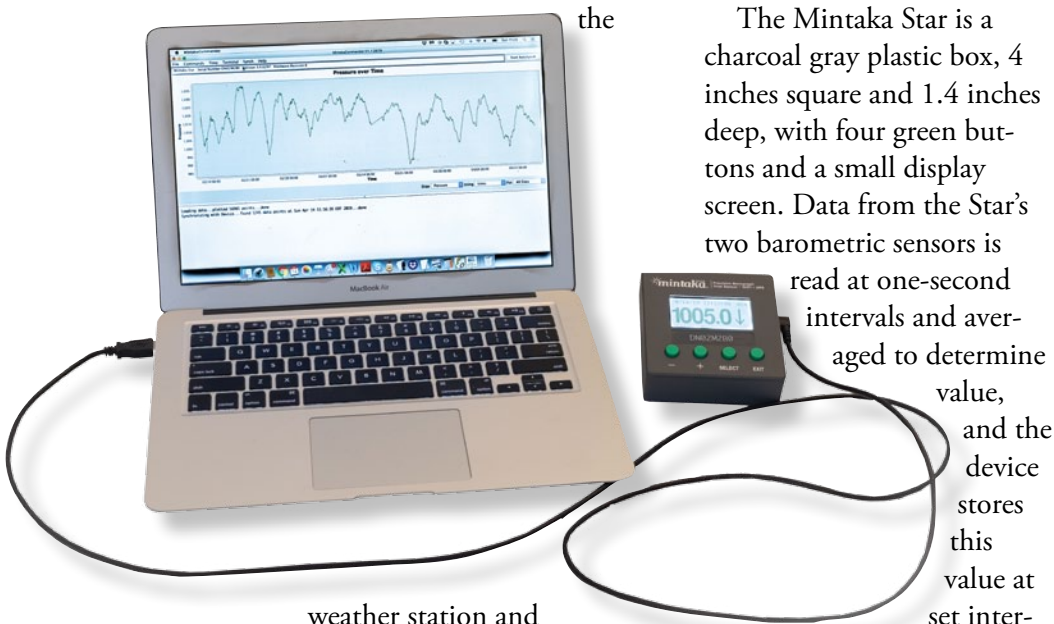
value, and the device stores this value at set intervals ranging

from 15 seconds to 24 hours. The green buttons can be used to shuffle between displays, including a graph that can show either pressure over time, pressure tendency (rate of change) or average pressure (useful in the tropics). Or, the display can show current air pressure, time from an internal clock or a GPS summary of navigation information along with current air pressure and tendency. GPS data read and stored with

pressure readings is useful at sea so barometer data can be compared as the boat moves. A nifty side effect of having both Wi-Fi and GPS capability is that the Star's NMEA transmitting feature allows it to send GPS information to a computer charting program. I tried it successfully on OpenCPN, where the location information showed up as an active waypoint.

The Star will also show a history of pressure, and you can cycle through the time intervals to see what's been recorded. Internal memory keeps data for a long time, up to 120 days for 24-hour readings, but eventually when the storage limit of individual files is reached, new readings replace old readings. To make sure the data is not lost, and for a host of other reasons, the Star can be accessed by computer via USB connection or through the Internet. The Star can function as its own access point, meaning it doesn't require a router to communicate via Wi-Fi (which is useful at sea), but for the Internet to connect to the Star — for instance, for firmware updates — it needs to be switched to station mode and given router and password information.

A major reason to work with the Star via computer is to overcome the limitations of trying to make sense



The Mintaka Star connected to Ann Hoffner's laptop via USB cable.

weather station and the phone app, and a barograph like the Star. If I wasn't around, the pressure on the baros didn't get recorded. I could have ignored the Star and it would still make a record.

The Star is Mintaka's third barograph. Jerry and Susan Barber started Seattle-based Mintaka Innovations (Mintaka is the westernmost star in Orion's belt) and in 2014 came out with the Duo, widely used in the National Weather Service Voluntary

of all this great data on an approximately 1.25-by-2.5-inch screen. Once connected by USB cable or wirelessly through Wi-Fi, the user can access the Star via its own homepage with its own URL and see what the display screen shows. With Mintaka Commander, a downloadable software packet that updates the Star and provides theoretically unlimited data storage, the user can set data limits to see trends at various times and manipulate what's shown in the graph. The Commander software can be used with or without the Star being connected to the computer, but it can only sync with the device to download new data when connected.

The downside of all of this capacity is finickiness. Not as a barograph — one could quickly set up and run the Star to keep track of pressure, GPS, etc., without finagling. But the powerful aspects, such as NMEA transmissions

and Mintaka Commander and homepage, are a bit challenging to master. This is partly because it's hard to cover all possible combinations of connections and software that might come up in a manual, and partly because — as I found in working with the barograph — there are glitches that simply don't surface until someone other than the developer uses it. To some degree, the Star has the drawbacks of all marine equipment in being of necessity produced in

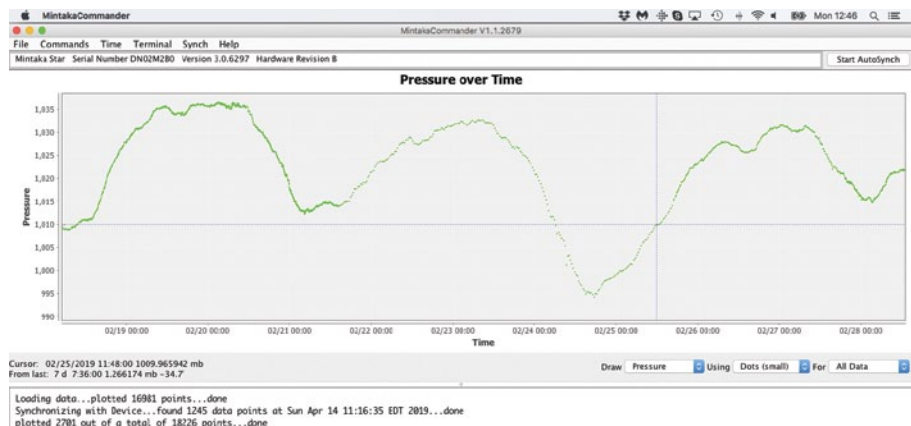
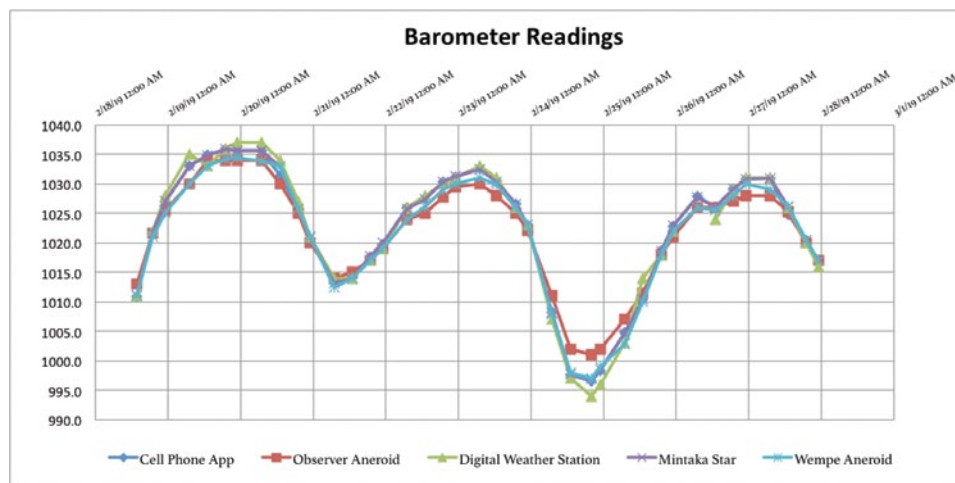
small quantities. I found that over time I became familiar with the quirks; none of them impeded my use of the device or of my appreciation for its power and sophistication.

Jerry Barber has been very patient in ironing out issues with me and clearly knows his device. I would recommend it to anyone interested in weather.

Other barometers

The other four barometers in my review were interesting in their own right and deserve consideration. In the app/gadget world, the smartphone baro is easy and accurate; 95 percent of the time, it read the same as the Star. Most everyone carries

Above, readings from the five units plotted over time show that the units recorded similar readings. The largest divergence in readings was at the lowest pressure. Below left, the Mintaka unit can be used as a digital recording barograph, making a graphic plot of changes over time.



a smartphone these days, and since it's collecting data from the phone's own sensor, the app doesn't require Wi-Fi or cellular service to work.

The Starpath Marine Barometer app is free, and there are other free barometer apps available, along with some pro versions for a fee. But the smartphone barometer has the disadvantage of any digital device; namely, it doesn't work if the battery is dead. Also, the apps I used to record only do so while the phone is running and not in sleep mode, which is why I don't put them in the barograph category.

The battery-powered weather station displayed more information than I wanted, like digital graphics of weather conditions that were difficult to sync with pressure. Home weather stations are usually not specialized; most gather temperature, rain, humidity and wind data. The collection devices for rain and wind aren't practical on a boat. Some allow downloading to a computer and some will keep short-term histories. It produced mostly accurate

air pressure readings, though occasionally they went wild before self-correcting.

Weems & Plath markets a stand-alone marine digital barometer that is similar to the home weather station. I did not include one in this review.

The Wempe aneroid barometer I used for the review needs no power to operate. In fact, there's not much that would keep it from operating unless you disabled the innards. It went about its work accurately without my intervention. Except for a small battery to keep the clock going, the Star relies on outside power through a USB cable, through 120V and 12V electric, or through direct wiring into a boat's house bank. These days, cruisers rarely find themselves without electricity of some sort, and Jerry says the Star uses only 2.4 amps per day, even when running Wi-Fi. But the Wempe aneroid is also more than 30 years old and still accurate.

As far as price goes, you can buy a ship's aneroid barometer for

\$150 to \$350 depending on looks and size. Digital home weather stations sell for \$50 to over \$300 depending on range of options, including connectivity. Smartphone barometer apps are usually free but can contain ads (though Starpath doesn't seem to).

The Mintaka Star sells for \$799 from Weems & Plath, and the Duo+ without GPS can be purchased for \$699. Pen and paper barographs can range from \$1,200 to over \$2,000.

My conclusion is that the Mintaka Star doesn't replace the aneroid barometer or remove the need to have one on your bulkhead. But as any weather mariner will tell you, it's not the absolute pressure number but the change over time that matters, and in which direction. For that, it's nice to have a barograph. ■

Ann Hoffner is an experienced voyager who spent years sailing aboard her Peterson 44, Oddly Enough, with her husband, Tom Bailey.



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