Barometry and Altimetry

The Kestrel 4000® pocket weather station can be used both as an altimeter, and as a barometer. There is scope for confusion here, and this document is intended to clarify what is being measured and displayed on the “BARO” and “ALTITUDE” screens.

First some definitions:

Barometer

An instrument for measuring atmospheric pressure, used especially in weather forecasting.

Altimeter

An instrument for determining elevation, especially an aneroid barometer used in aircraft that senses pressure changes accompanying changes in altitude.

Station Pressure

The pressure measured at a station. A “station” can be any location. It might be your house, the top of a mountain, or on the shore.

Barometric Pressure

The station pressure adjusted in proportion to the altitude of the station. For the special case of the station at sea level, station pressure and barometric pressure are the same.

Weather Reports

When weather forecasters and observers report pressure, they *always* report barometric pressure. If you happen to live at high altitude, for instance in Denver or Salt Lake City, the reported pressure will be *much* higher than the station pressure. Airports too report pressure, and again it is barometric, not station pressure they report. When an air traffic controller gives a pilot flying at many thousands of feet above him an “altimeter setting” it is the barometric pressure that is used.

There is a compelling reason to report all atmospheric pressure measurements as barometric, rather than station values: The isobars on weather charts would be meaningless except over the sea, and over those land areas happening to be at sea level. Any hill or mountain would produce a local lowering of pressure (station pressure) and the isobars would shift with the terrain. Since a change in altitude of only a few hundred feet corresponds to a large change in station pressure, weather analysis would be greatly complicated.

Using the K 4000 “BARO” screen

The reading on a mercury barometer will change if the altitude of the barometer is changed. The reading on the K4000 BARO screen will also change. The indicated pressure for a mercury barometer (the height of the mercury column) is necessarily *station pressure* – the actual pressure at whatever altitude the barometer happens to be. To determine barometric pressure from station pressure, a calculation is performed which has the effect of reducing station altitude to sea level. If the station is above sea level, the barometric pressure will be *higher* than the station pressure, if the station is below sea level, the barometric pressure will be *lower* than station pressure.

Although a mercury barometer cannot directly indicate barometric pressure (except at sea level), the K4000 (or any electronic pressure gage) can, because the conversion from station to barometric pressure can be done electronically.

To measure and display *barometric pressure* on the BARO screen, your K4000 must know the local altitude. With this information it performs the calculation which converts station pressure to barometric pressure.

To display *barometric pressure* simply set the reference altitude in the BARO screen to your altitude.

To measure and display *station pressure* on the BARO screen, set the reference altitude to zero.

Using the “ALTITUDE” Screen

Because the pressure of the earth’s atmosphere changes in a regular, and well characterized way with altitude, it is possible to use a barometer to measure altitude.

The K4000 (and other electronic instruments) store the details of what is known as the “ICAO Standard Atmosphere”. The Standard Atmosphere is a model and, subject to certain assumptions, specifies an altitude for any pressure. A moment’s thought will show that the actual atmosphere is almost never standard, and that therefore errors in pressure based altimetry are to be expected[1].

To measure and display altitude on the K4000, the local barometric pressure must be known, and entered in the reference screen. Frequently this value is NOT known, and herein lies one of the two fundamental problems with pressure altimetry. The other is the sometimes significant deviation of the atmosphere from the assumed standard atmosphere[2].

Using the “Baro. Cal” Screen[3]

It must be understood that this screen is fundamentally different from the BARO and ALTITUDE screens. It allows field adjustment of the pressure transducer sensitivity. This is NOT the same as adjusting the reference pressure in the altitude screen. It has the effect of correcting the response of the pressure transducer for any long term drift following our initial factory calibration. For example, suppose that after one year, a K4000 consistently indicates lower (or higher) barometric pressure than the reported value (assuming of course that the correct reference altitude has been set). If the discrepancy is more than 2 hPa (~0.06” of mercury) it would make sense to calibrate the pressure transducer. *By far* the best way to do this is to return the unit to NK, where we have precision NIST traceable pressure transducers. An alternative, which under some circumstances could make matters worse[2], not better, is to first check that the reference altitude in the BARO screen is set to the actual site altitude, than to set the value in the Baro. Cal screen to the reported barometric pressure.

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[1] Sometimes these errors are of no consequence. Sometimes they can have serious consequences. Aviation affords examples of both: Two pilots using the same altimeter setting (i.e. the same barometric pressure given to them by ATC) will be at the same height when their altimeters read the same. Thus if the object is to avoid hitting other airplanes, the altimeter readings are just what is needed. If, on the other hand, the object is to avoid hitting mountains, errors in the altimeter reading arising from divergence of the actual atmosphere from the standard atmosphere can be deadly.

[2] On very cold or very hot days, altitude errors can be hundreds of feet. When the atmosphere is very cold, or the pressure is very high, altitude readings will err on the low side. Under cold and high pressure conditions errors are even greater. The converse is also true: When the atmosphere is very hot, and or the pressure low, altitude readings err on the high side.

[3] Valid for all software releases up to 2.08.