Gusts can be detected by comparing five-second intervals. Wind direction is also measured with a familiar device, the weather vane (although the rooster typically is not included). As the device vanes into the wind, a sensitive potentiometer measures its position relative to some fixed point, and therefore the wind's direction is revealed. In certain conditions of snow or ice, wind sensors can stick or freeze, which will give false readings of low or zero winds or incorrect wind direction.

5. CEILOMETER

The cloud-height sensor transmits a pulse of laser light (at a frequency invisible to humans) up into the sky and measures the time required for the beam to reflect back to a detector. The time between transmission and reception determines the height above the ceilometer of any reflecting particles, such as water or ice crystals in clouds. Because of practical limitations of light intensity, dispersion and reception sensitivity, the upper limit for detecting clouds with this technology as originally installed is 12,000 feet. A ceilometer uses a narrow beam, so if by chance one cloud in an otherwise cloudless sky parks over the sensor, the report will be misleading. In turn, a huge CB could be lurking nearby just out of range of the beam, and that will not be reported. Speaking of which, the unit only reports cloud bases, not the nature of the cloud, which could be benign or deadly. Precipitation can cause the unit to report a cloud base lower than actual. Finally, most ceilometers now in place only measure up to 12,000 feet, so clouds above are ignored. Newer units measure up to 25,000 feet.

Visibility sensor

6. FREEZING RAIN SENSOR

As pilots who know and love this form of precipitation, we should be keenly interested in this measurement device. The sensor uses an ingeniously simple concept to measure when rain freezes. A small probe is made to vibrate rapidly (ultrasonically, in fact) at a precisely known frequency. The frequency of vibration decreases when ice accumulates because the probe becomes heavier. With the accumulation of one-tenth inch of ice, the probe is heated to melt the stuff, ready again to collect anew. How is snow distinguished from freezing rain? If a change in frequency suggests the presence of freezing rain, but precipitation indicator reports snow, then the ACU reports snow; otherwise freezing rain is reported.

Fortunately, this measurement is pretty robust. The only caveat is that measurements subsequent to each melting depend on the rate at which the probe cools to ambient before it can begin a new cycle.

7. VISIBILITY AND DAY/NIGHT SENSOR

Current visibility levels are measured using a Forward Scatter Technique in which a flash of xenon light is transmitted a short distance through the atmosphere, which scatters the light. The light is measured to detect how much light was "lost" due to scattering. The greater the scattering and loss, the lower the visibility. The degree to which the light was extinguished is mathematically converted to a numerical visibility measurement. Day or night is indicated from a simple ambient light detector. The fact that I have never been confused by this last measurement is an indication of superior observational skills. A patch of highly localized fog can cause the sensor to generate a false report of low visibility. Inversely, a thick layer of fog could sit above the sensor, which would report unlimited visibility when in fact the airport is completely obscured. There is also a time delay when conditions change. For example, if the airport quickly improves from less than half-mile to two miles, ASOS will take about nine minutes to catch up. The good news here is that for instrument approaches, we rely not on ASOS but on RVR readings for visibility.

Lightning sensor

8. THUNDERSTORM SENSORS

The technology used here is similar to that found in the commonly installed Stormscope or Strikefinder. Lightning emits a broad spectrum of radio waves, with the jumble of frequencies all being present simultaneously. These "sounds of lightning" are known as sferics. Fortunately for those seeking to detect the distance and location of lightening, the character of a sferic varies in a known way with distance and path of propagation. Measuring devices take advantage of this characteristic variation to present a graphic or textual display of lightning activity. This system suffers from the same frailties as what we have in the cockpit. For example, distance to lightning can be skewed by the strength of the strike. But in general, the report is robust enough for us to know to keep our distance.

9. BAROMETRIC PRESSURE

Depending on the unit, ASOS has two or three pressure transducers; at least two must agree within a tight range of 0.04 inches of mercury to report. A new pressure is calculated every minute. These sensors, with redundancy, have few problems.