Abstract

A new laser air-motion sensor measures the true airspeed with an uncertainty of less than $0.1\,\mathrm{m\,s^{-1}}$ (standard error) and so reduces uncertainty in the measured component of the relative wind along the longitudinal axis of the aircraft to about the same level. The calculated pressure expected from that airspeed at the inlet of a pitot tube then provides a basis for calibrating the measurements of dynamic and static pressure, reducing standard-error uncertainty in those measurements to less than 0.3 hPa and the precision applicable to steady flight conditions to about 0.1 hPa. These improved measurements of pressure, combined with high-resolution measurements of geometric altitude from the Global Positioning System, then indicate (via integrations of the hydrostatic equation during climbs and descents) that the offset and uncertainty in temperature measurement for one research aircraft are $+0.3 \pm 0.3^{\circ}\mathrm{C}$. For airspeed, pressure and temperature these are significant reductions in uncertainty vs. those obtained from calibrations using standard techniques. Finally, it is shown that the new laser air-motion sensor, combined with parametrized fits to correction factors for the measured dynamic and ambient pressure, provides a measurement of temperature that is independent of any other temperature sensor.