Air Resources Laboratory
Best Aircraft Turbulence Probe

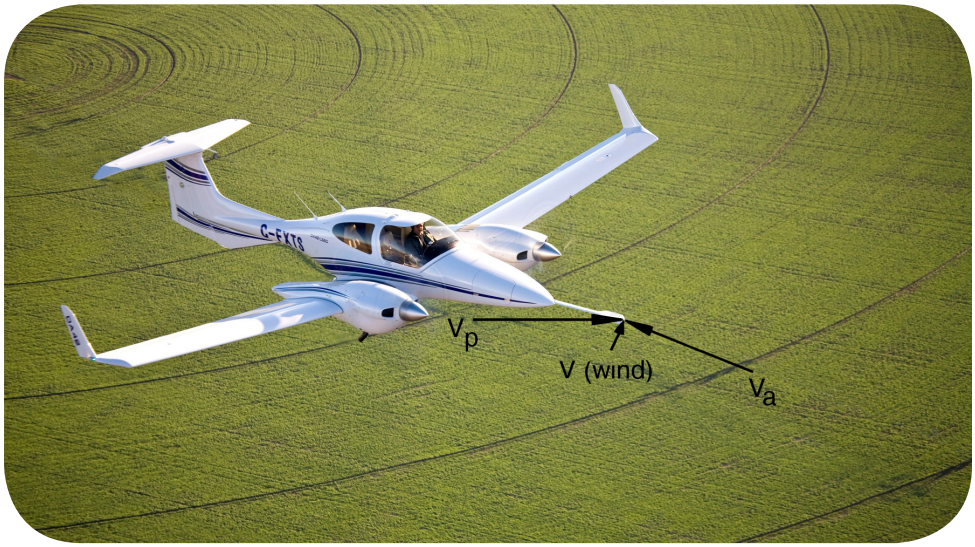
What It Is

The Best Aircraft Turbulence (BAT) probe is a custom-designed wind sensor that is mounted to the front of a moving platform to make high-frequency measurements of atmospheric pressure, air temperature, and three-component wind with respect to the Earth. Typically the moving platform is an aircraft, but the sensor has also been used on boats, and could be used on cars or any other vehicle. The BAT probe works by measuring air speed and direction with respect to the platform, while a complementary system composed of GPS and accelerometers (GPS/INS) simultaneously measures the platform velocity with respect to the Earth. Combining the data yields the final pressure, temperature, and wind information.

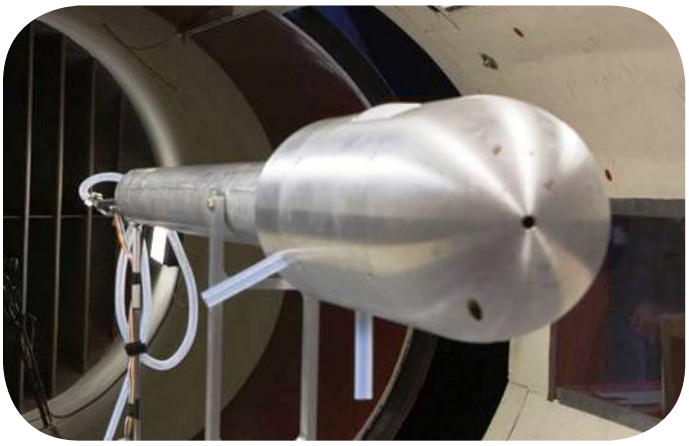
Theory

$$V_{(wind)} = V_{a\ (air\ )} - V_{p\ (platform)}$$

Vector V_a is measured by the BAT probe, while vector V_p is measured by GPS/INS installed on the moving platform (aircraft). $V_{(wind)}$ is 3-D wind with respect to Earth



BAT probe placed on the nose of a small aircraft. Image shows measurements collected. (photo: NOAA)



BAT probe (photo: NOAA)

What It Is Used For

Originally developed in the early 1990s by the Air Resources Laboratory's Atmospheric Turbulence and Diffusion Division (ATDD), the BAT probe has been instrumental in allowing fluxes of mass, momentum, and energy to be measured from small aircraft. This provides vital information about the spatial mean

and variability of these fluxes. The BAT probe has also been used to characterize turbulence parameters for boundaries of large-scale dispersion studies, and to perform turbulence measurements in a wide variety of weather phenomena including hurricanes. The technology has been transferred to a variety of aircraft flying at altitudes ranging from 10 m to 14,000 m and at speeds ranging from 35 m/s to 150 m/s. Heaters can be installed for the severe cold of high altitudes and latitudes. Pumping systems can be fitted to expel water from the probe after passage through rain.

Currently ATDD is collaborating with the Anderson Group from Harvard University to study CO_2 and CH_4 fluxes over the permafrost region of the North Slope of Alaska, where such fluxes may soon strongly increase with Arctic warming and contribute to larger concentrations of greenhouse gases in the atmosphere.

Why It Is Important

The BAT probe provides an efficient way to measure turbulent winds that drive the exchange of mass, momentum, and energy between the surface of the Earth and the atmosphere. Quantifying these exchanges and their spatial variation in the planetary boundary layer is critical to bridging the gap between the exchanges measured by isolated towers and those measured globally by satellites, thereby achieving the global coverage required for climate studies.

The BAT probe has proven to be a highly-adaptable and versatile instrument used in many field studies and in a variety of meteorological conditions. It is an indispensable tool in ATDD's study of the boundary layer and the atmosphere.

For More Information:

Atmospheric Turbulence and Diffusion Division
www.atdd.noaa.gov
Air Resources Laboratory
www.arl.noaa.gov

NOAA/ARL
Atmospheric Turbulence
and Diffusion Division
456 S. Illinois Ave
Oak Ridge, TN 37830
Phone: (865).576.3500

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