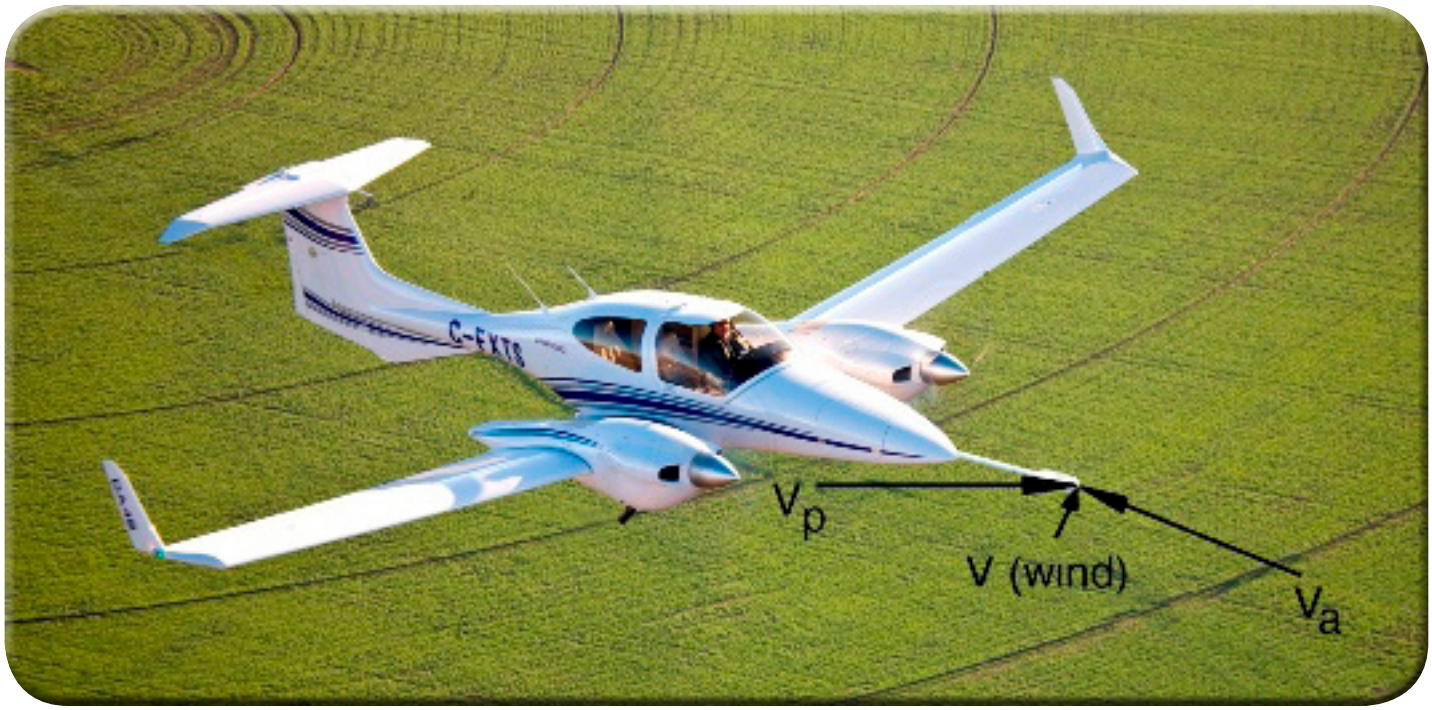
Air Resources Laboratory

Best Aircraft Turbulence Probe

Improving Short-term and Long-term Weather and Climate Forecasts

The Best Aircraft Turbulence (BAT) probe is a custom-designed wind sensor that is mounted to the front of an aircraft to make high frequency measurements of atmospheric pressure, air temperature, and atmospheric turbulence—chaotic, three-dimensional flow of winds that drive the upward and downward transport of mass, momentum, and energy between the surface of the Earth and the lower part of the atmosphere (or boundary layer). Heat, water vapor, carbon dioxide, and other gases are exchanged between land and water surfaces and the atmosphere, and these exchanges drive both the weather and the climate. Quantifying these exchanges and their spatial variation is important to improving short-term and long-term weather and climate forecasts. The BAT probe has proven to be a highly-adaptable and versatile sensor used in many boundary layer studies and in a variety of meteorological conditions.

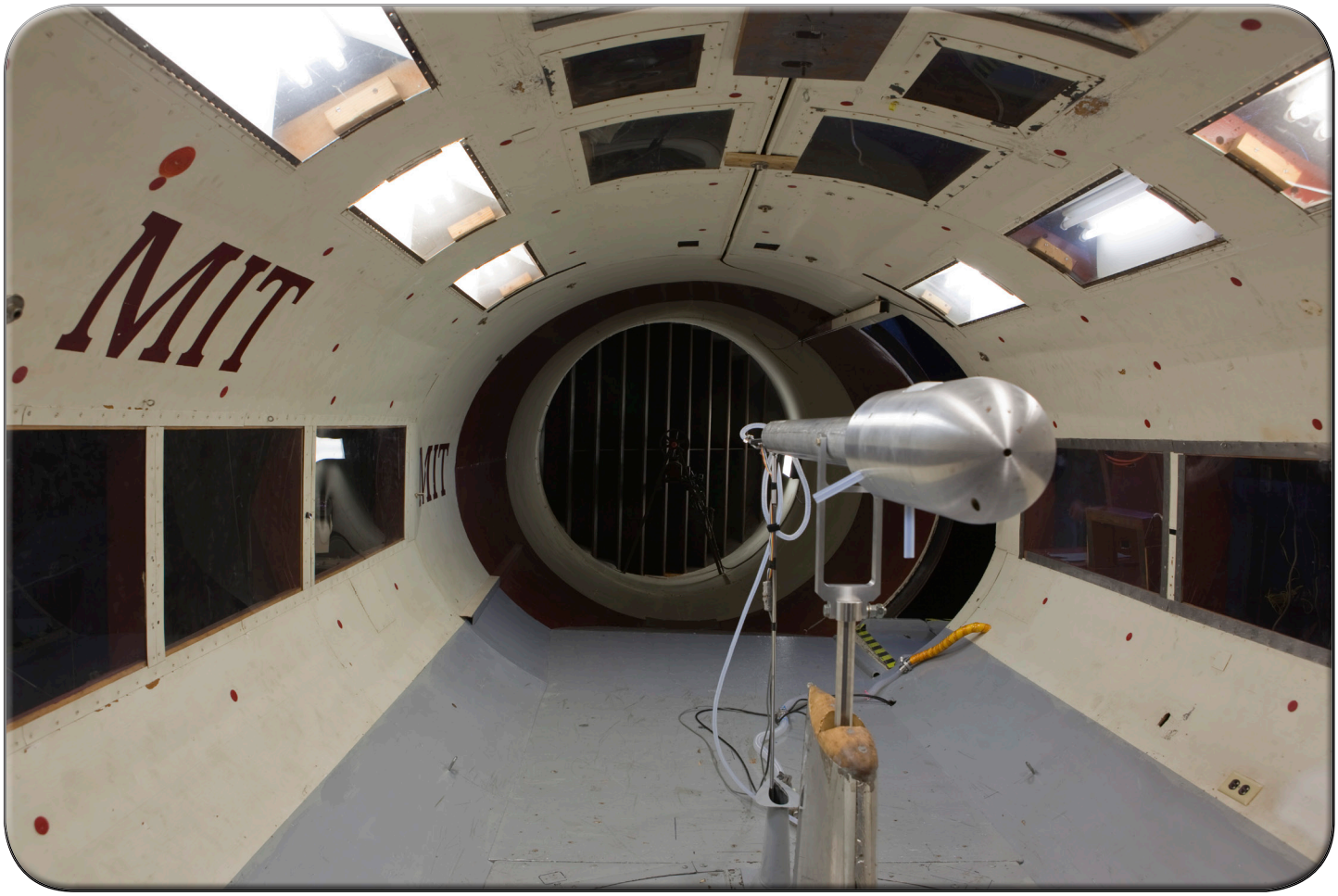
Originally developed in the early 1990s by the Air Resources Laboratory's Atmospheric Turbulence and Diffusion Division (ATDD), the BAT probe has been instrumental in allowing measurements to be made from small aircraft. The probe has also been used to characterize turbulence parameters for boundaries of large-scale dispersion studies and to perform turbulence measurements in a wide variety of weather phenomena, including hurricanes.



As shown in the picture above, the BAT probe is mounted to the front of an aircraft to make high-frequency measurements of atmospheric pressure, air temperature, and three-component wind with respect to the Earth. The sensor has also been used on other moving platforms, such as boats, and it could be used on cars or other vehicles. The BAT probe works by measuring air speed and direction (V_a) with respect to the platform, while a complementary system simultaneously measures the platform velocity (V_p) with respect to the Earth. Combining the data yields the final pressure,

temperature, and wind information. The technology has been transferred to a variety of aircraft flying at altitudes ranging from 10 meters to 14,000 meters and at speeds ranging from 35 meters per second to 150 meters per second. 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.

The BAT probe is an indispensable tool for ATDD scientists in the study of the boundary layer and the atmosphere. A hallmark of the BAT probe is its low cost and adaptability to nearly any airplane. The probe has been extensively tested in the Wright Brothers Wind Tunnel at the Massachusetts Institute of Technology (photo below), allowing ATDD to fully characterize the performance of the BAT probe. Currently, ATDD is collaborating with the Anderson Group from Harvard University to study carbon dioxide and methane 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.



For More Information:

Atmospheric Turbulence and Diffusion Division
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