PresentationAbstract for:

Lower Atmosphere Observing Facilitites Workshop

An Optical Fiber-Based Laser Velocimeter for Measuring Mean and Fluctuating Wind Components From an Aircraft

Scott M. Spuler, Donald H. Lenschow, Richard B. Friesen, William A. Cooper, Michael P. Spowart, and James Ranson

Earth Observing Laboratory
National Center for Atmospheric Research
Boulder, CO 80301

and

Dirk Richter

Institute of Arctic and Alpine Research
University of Colorado
Boulder, CO 80309-0450

Accurate measurement of both mean and fluctuating wind components from an aircraft is essential for many climate-related observational studies of the atmosphere. Yet, there has been a long-standing limitation in flow measurement accuracy achievable by traditional in situ sensors such as pressure probes or vanes due to flow distortion induced by the aircraft that modifies both the speed and direction of the oncoming flow. These systems require inflight calibration by flight maneuvers and thus temporal and spatial invariance of the flow field is assumed, which is never truly the case. Therefore, even with "perfect" in situ measurements, the ultimate velocity measurement accuracy is limited by the unsteady flow field. Laser sensing offers a solution to this problem by providing absolute measurements (better than 0.1 m/s) of the along-beam velocity component remotely in undisturbed air via the Doppler shift measured from aerosol backscatter. The advent of optical fiber-based laser systems has made robust remote velocity measurement feasible on airborne platforms. A laser air motion sensor (LAMS) that takes advantage of this technology is under development at the National Center for Atmospheric Research (NCAR). A single-beam version configured to measure the wind component along the longitudinal airplane axis was successfully deployed in 2010. This system has already been used to calibrate the dynamic pressure and the pressure-based true airspeed measurements on the aircraft. It has also been used, in

combination with the static and dynamic pressure measurements, to determine air temperature independent of the airplane thermometers, and thus has the potential to independently calibrate the airborne thermometers. A three-dimensional LAMS is currently under development that will have the capability of measuring both mean and fluctuating air velocity components with unprecedented accuracy. Applications for this system include more accurate vertical flux measurements of both momentum and scalars and vertical wind shear, as well as integrated quantities such as mesoscale divergence and vorticity. Accurate flux measurements of latent and sensible heat and greenhouse gases are necessary for surface energy budget studies and for quantifying carbon dioxide exchange and methane release at the Earth's surface; these are all essential measurements for many climate-related studies.