San Diego State University (SDSU) and the Global Change Research Group (GCRG) have been carrying out various aspects of ecological research on Arctic ecosystems since the early 1970s. The GCRG is currently heading a comprehensive study involving an integrated framework of multi-scale aircraft and satellite remote sensing, micrometeorological and CO₂ and CH₄ flux measurements, and hydro-ecological process model simulations over a 350-km North-South transect spanning the dominant Arctic topographic and land cover units of northern Alaska. An extensive soil moisture manipulation involving a 60-hectare tundra flooding/draining experiment near Barrow, Alaska, is also underway. This research examines how biological and physical processes interact to control carbon uptake, storage and release in Arctic tundra ecosystems and how the self-organizing nature of these interactions varies across multiple spatial and temporal scales. Approximately 25% of the world’s soil organic carbon reservoir is stored at high northern latitudes in permafrost and seasonally-thawed soils, a region that is currently undergoing unprecedented warming and drying, as well as dramatic changes in human land use. Understanding how changes in annual and inter-annual ecosystem productivity interact and potentially offset the balance and stability of the Arctic soil carbon reservoir is of utmost importance to global climate change science.

Since 1999, a light aircraft, the Sky Arrow, has been employed to extend the ground-based measurements over a larger area. The Sky Arrow 650TCN is an FAA certified aircraft from the Italian aircraft manufacturer, Iniziative Industriali Italiane (3I). One of the key components needed to measure CO₂ and energy fluxes from the Sky Arrow is wind speed. To calculate wind speed, the motion of the aircraft relative to both the air and the ground must be known as precisely as possible. Airspeed is calculated from a gust probe with pressure sensors and a fluid dynamics model. Ground speed is calculated with GPS attitude, accelerometers and post-processed differential GPS position and velocity measurements. Wind speed is calculated by subtracting the ground speed from the airspeed. Long flight lines of 100 km or more close to the ground (10 m AGL) and the need for high frequency data (up to 50 Hz) make it necessary to do differential GPS corrections in post processing. The availability of reliable, high speed (10 Hz) GPS data from the UNAVCO base stations in Barrow and Atqasuk have greatly improved the precision and robustness of the ground speed calculations.

References


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Figure 1. The current Alaska study area is indicated by a rectangular overlay of AVHRR satellite data. Permanent, ground-based measurements are located at Barrow, Atqasuk, and Ivotuk. The red dots indicate UNAVCO GPS base stations used by SDSU aircraft operations.

Figure 2. Rommel Zulueta, a private pilot and Ph.D. student, flies the SDSU Sky Arrow past an eddy covariance tower on the tundra south of Barrow, Alaska.