Alaskan Glacier Laser Altimetry

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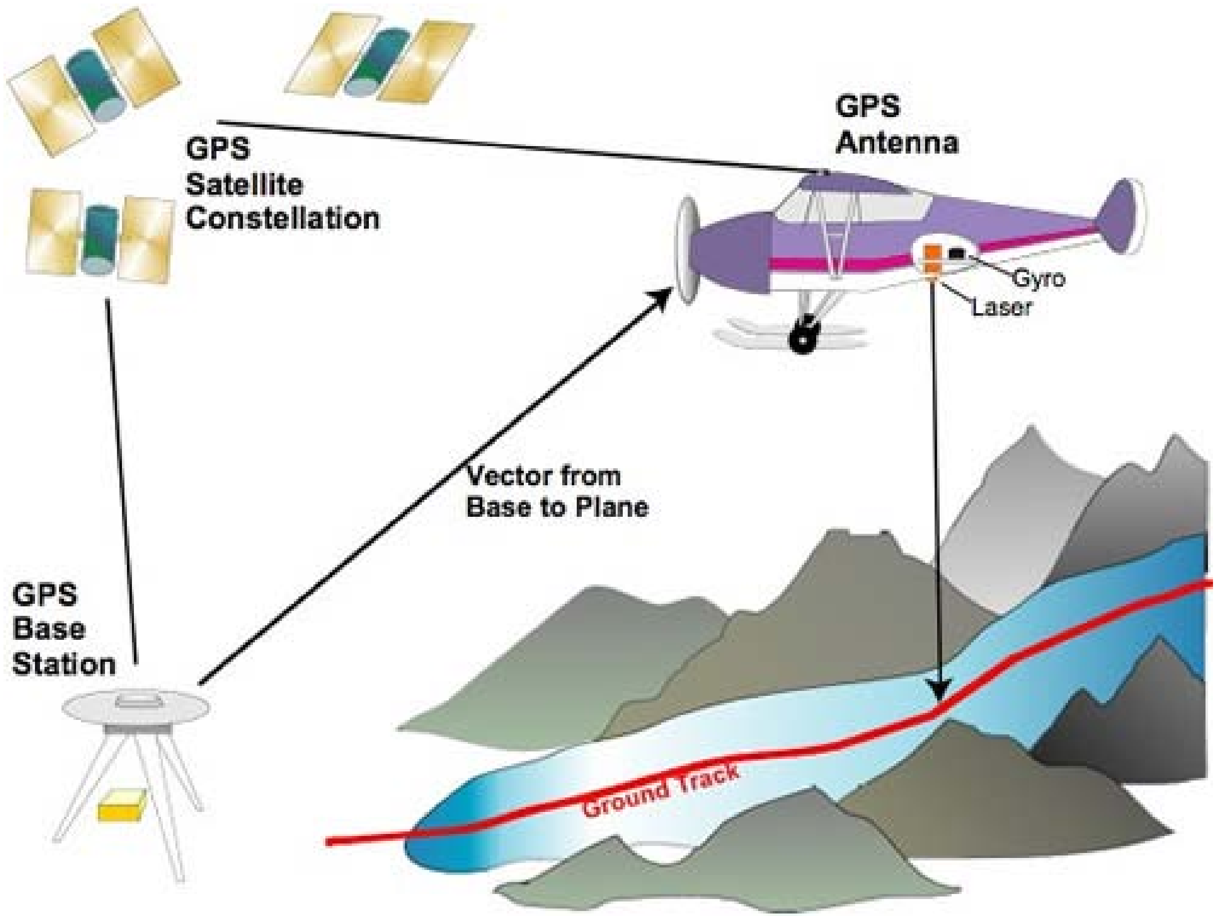
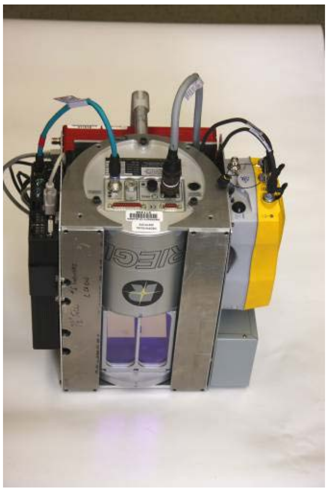
Only a handful of glaciers in Alaska are monitored using traditional mass balance methods. Reasons for this include the difficulty in access and harsh conditions that characterize most of the glaciers in Alaska, as well as the shear size and extent of glacier ice cover in Alaska. By the early 1990's, Keith Echelmeyer had recognized both a wide variability in Alaskan glacier response to climate change, and the possibility that Alaskan glacier contribution to global sea level rise was underestimated. A solution devised by Keith, Will Harrison and Jim Mitchell was to expand the number of sampled glaciers through the use of airborne surveys. Starting in 1993, Scientists at UAF-GI began using a laser altimetry system to measure surface elevation changes of glaciers throughout Alaska and western Canada *(Echelmeyer et al. 1996).*

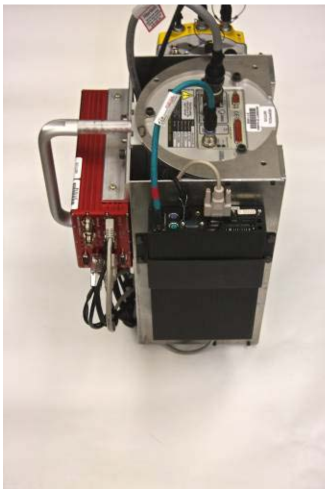
This system was designed to fit in the back of a variant of the Piper Supercub (PA-12), a two-passenger airplane nimble enough to navigate the steep, narrow terrain of mountain valley glaciers. The altimetry system consists of a highly accurate Global Positioning System (GPS) receiver, a laser, and a gyroscope. The GPS records the position of the plane every second as it flies down a glacier, the laser continually measures the distance between the plane and the glacier surface, and the gyroscope measures the direction in which the laser is pointing. Combining data from these instruments, elevation profiles of the surface of the glacier are created that are accurate to better than half a meter. These surface profiles are used to calculate long-term changes in glacier thickness by comparing them with U.S. Geological Survey (USGS) topographic maps made 50 years ago. Even after taking into account the inaccuracies of the old maps, the glaciologists have found that most glaciers have thinned hundreds of meters in the last five decades. The researchers have also repeated the same flight lines after 5 to 10 years. By comparing data from these repeated flights they are able to obtain short-term measures of glacier change that are much more accurate. In this ten-year period, they have seen substantial increases in the rate of thinning, on many glaciers in Alaska and western Canada *(Arendt et al.2002).*



Schematic of how the system works

The system has evolved somewhat over the 15 years since the first system was built, but the operating principles have remained unchanged. Since 2005 we have adopted the system to larger, more powerful aircraft (Cessna 185 and Dehavilland Single Otter).





Scanning LIDAR system – Main Components:
RIEGL LMS-Q240i scanning laser altimeter
Oxford Technical Solutions Inertial+2 inertial mearuement unit (IMU)
Trimble GPS receiver
Small form factor PC (from Cappucciono PC) for data logging

Some of the above text was lifted from a general overview article published in the Alaska Park Science Journal (Kenai Fjords Special Issue Spring 2004 (Volume 3 Issue 1)). A download of pdf of the laser altimetry article can be done here.

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Arendt, A.A., K.A. Echelmeyer, W.D. Harrison, C.S. Lingle, and B. Valentine, 2002. Rapid wastage of Alaska glaciers and their contribution to rising sea level. Science, 297, 382-386.