NASA Langley's Airborne Doppler Wind Profiling Algorithm

Novel method enables accurate, real-time parameter estimation in noisy environments

Scientists at NASA's Langley Research Center have developed an algorithm, Airborne Wind Profiling Algorithm for Doppler Wind Lidar (APOLO), which offers highly accurate, real-time measurement of wind parameters (i.e., direction and speed) by airborne wind lidar sensors. APOLO enables the extraction of accurate wind speed and direction from noisy flight environments and provides correction for instrument installation biases. The algorithm has been incorporated into a supporting software package that displays accurate airborne Doppler wind lidar data and offers several data post-processing and display functionalities. The offset compensation and parameter extraction technology could be used in a variety of applications where the motion and orientation of a lidar sensor may result in data inaccuracy. NASA is seeking licensees that may benefit from integration of the compensation algorithm and data post-processing software into existing or developing systems.

Benefits

- Is applicable to any dynamic lidar platform that also employs global positioning and inertial navigation systems (GPS/INS)
- Provides meaningful, accurate airborne Doppler wind lidar data
- Compensates for instrument offsets
- Renders wind profiling data for long-time trend color displays
- Enables side-by-side comparison of wind profile data with dropsonde-collected data for validation purposes upon their availability
- Wind profile data can be "sliced and saved" for user-defined altitude and observation periods

partnership opportunity

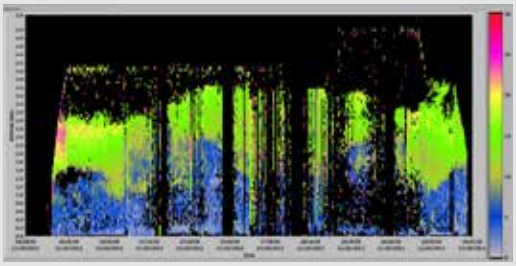

Figure 2 – Panoramic display of wind speed using APOLO offset compensation in the data post-processing module.

Applications

The technology has several potential applications:

- Aircraft safety—clear air turbulence and aircraft wake detection systems
- Wind energy—3-dimensional wind mapping for offshore turbine placement optimization and economic analysis
- Wind energy—upward-looking buoy-mounted lidar for offshore turbine placement optimization and economic analysis
- Meteorology—study of weather and wind patterns
- Aerial geographic surveys— aircraft-mounted imaging and mapping lidar
- Oceanographic surveys—shipborne mapping and navigation lidar

The Technology

APOLO and its supporting data processing package were developed for NASA's Doppler Aerosol Wind (DAWN) lidar to compile three-dimensional wind profiles for improved hurricane forecasting models. The data acquisition and processing software displays wind profile parameters that include Doppler shift, power distribution, wind direction, and wind velocity. Doppler shift created by aircraft motion is measured by the internal navigation and GPS system and is fed to a signal processing system that utilizes APOLO for real-time removal of aircraft effects from wind measurements. APOLO also corrects instrument offsets that arise from GPS/INS unit misalignment, lidar telescope misalignment, and scanner installation bias. Offset compensation routines, based on the minimum mean square error principle, estimate offset angles using ground-return lidar data to compensate for their adverse effect to wind parameter estimation. APOLO utilizes two perpendicular lines of sight Doppler shift observations, compensation for aircraft motion along each line of site, then a vector sum to determine wind parameters. The technology has been utilized in a flight environment, and wind vectors have been measured from altitudes as high as 10-km. Plots of wind speed data produced by the lidar data analysis package are provided in the figures below. Similar plots of wind direction as a function of altitude are also generated from the lidar measurements.

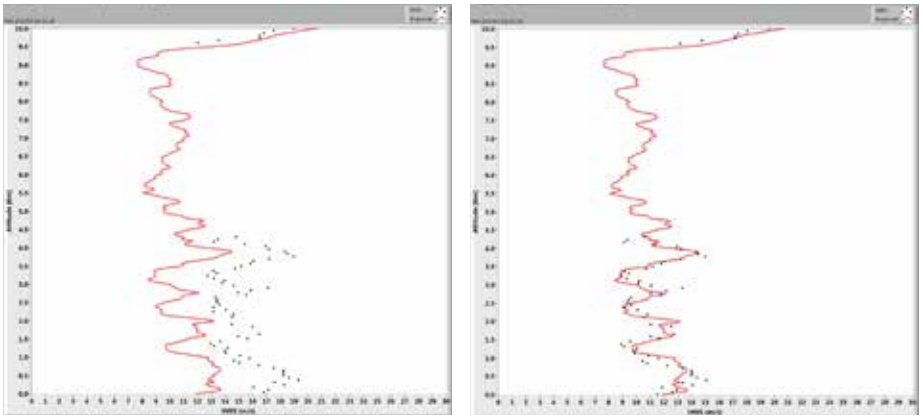

Figure 1 – Offset compensation comparison for headwind speed using APOLO. Data collected on September 1, 2010, during NASA's Genesis and Rapid Intensification Processes (GRIP) hurricane mission. Altitude = 10,608 meters. Left without offset compensation. Right with offset compensation. Red line represents dropsonde data; black dots are lidar-collected data.

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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