

Measuring Tropospheric Winds from Space Using a Coherent Doppler Lidar Technique

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Abstract: The global measurement of tropospheric wind profiles has been cited by the operational meteorological community as the most important missing element in the present and planned observing system. The most practical and economical method for obtaining this measurement is from low earth orbit, utilizing a Doppler lidar (laser radar) technique. Specifically, this paper will describe the coherent Doppler wind lidar (CDWL) technique, the design and progress of a current space flight project to fly such a system on the Space Shuttle, and plans for future flights of similar instruments. The SPARCLE (SPAcE Readiness Coherent Lidar Experiment) is a Shuttle-based instrument whose flight is targeted for March, 2001. The objectives of SPARCLE are three-fold: Confirm that the coherent Doppler lidar technique can measure line-of-sight winds to within 1-2 m/s accuracy; Collect data to permit validation and improvement of instrument performance models to enable better design of future missions; and Collect wind and backscatter data for future mission optimization and for atmospheric studies. These objectives reflect the nature of the experiment and its program sponsor, NASA's New Millennium Program. The experiment is a technology validation mission whose primary purpose is to provide a space flight validation of this particular technology. (It should be noted that the CDWL technique has successfully been implemented from ground-based and aircraft-based platforms for a number of years.) Since the conduct of the SPARCLE mission is tied to future decisions on the choice of technology for free-flying, operational missions, the collection of data is intrinsically tied to the validation and improvement of instrument performance models that predict the sensitivity and accuracy of any particular present or future instrument system. The challenges unique to space flight for an instrument such as SPARCLE and follow-ons include: Obtaining the required lidar sensitivity from the long distance of orbit height to the lower atmosphere; Maintaining optical alignments after launch to orbit, and during operations in "microgravity"; Obtaining pointing knowledge of sufficient accuracy to remove the speed of the spacecraft (and the rotating Earth) from the measurements; Providing sufficient power (not a problem on the Shuttle) and cooling to the instrument. The paper will describe the status and challenges of the SPARCLE project, the value of obtaining wind data from orbit, and will present a roadmap to future instruments for scientific research and operational meteorology.

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