



Atmospheric Systems Corporation
24900 Anza Dr., Unit D
Santa Clarita, CA 91355

+1.661.294.9621 (office)
+1.661.294.9667 (fax)
sales@minisodar.com

A Brief Statement of Airport Applications for Doppler SODAR systems

Doppler SODAR

Operating similar to a sonar the Doppler SODAR (Sonic Detection and Ranging) directly measures the atmospheric wind speed and direction at multiple altitudes simultaneously. These systems utilize the Doppler effect imposed on the received acoustic signal echoed by the atmosphere for the wind measurements. The Doppler effect is the common observation that the acoustic signal frequency increases (decreases) for motion toward (away) from a receiver. By applying this principle and considering the geometry of the Doppler SODAR system it becomes a cost effective and easily maintained "invisible tower" for wind measurements.

Wind Shear

Wind shear is a generic term referring to any rapidly changing wind currents. This change can be associated with either the wind speed or direction. A type of weather phenomenon called "microbursts" can produce extremely strong wind shear, posing great danger to aircraft. These are local, short-lived downdrafts that radiate outward as they rush toward the ground. As a downdraft spreads down and outward from a cloud, it creates an increasing headwind over



the wings of an oncoming aircraft. This headwind causes a sudden leap **JFK International Airport field site**

in airspeed, and the plane lifts. If the pilots are unaware that this speed

increase is caused by wind shear, they are likely to react by reducing engine power. However, as the plane passes through the shear, the wind quickly becomes a downdraft and then a tailwind. This reduces the speed of air over the wings, and the extra lift and speed vanish. Because the plane is now flying on reduced power, it is vulnerable to sudden loss of airspeed and altitude. The pilots may be able to escape the microburst by adding power to the engines. But if the shear is strong enough, they may be forced to crash. .



Atmospheric Systems Corporation
24900 Anza Dr., Unit D
Santa Clarita, CA 91355

+1.661.294.9621 (office)
+1.661.294.9667 (fax)
sales@minisodar.com

About 500 fatalities and 200 injuries from wind shear related crashes occurred between 1964 and 1985. This involved at least 26 civilian aircraft. Since 1985 wind shear related accidents have been reduced but numerous near accidents continue to occur in which the aircraft recover control prior to ground contact.

Wind shear poses the greatest danger to aircraft during takeoff and landing, when the plane is close to the ground and has little time or room to maneuver. During landing, the pilot has already reduced engine power and may not have time to increase speed enough to escape the downdraft. During takeoff, an aircraft is near stall speed and thus is very vulnerable to wind shear.

Microburst related wind shear often occurs during thunderstorms. But it can also arise in the absence of rain near the ground.

A Viable Enhancement

The AeroVironment SODAR directly measures both the horizontal and vertical wind fields at the critical flight altitudes (less than 150 meters). Field tests have demonstrated that these measurements can be obtained during both landing and takeoff. This cost effective, easily maintained ground based unit has demonstrated its ability to generate wind reports at the time intervals required for its incorporation as part of the LLWAS (i.e. Low Level Wind Shear) network.

A further feature of the SODAR is that it also directly measures the vertical wind motion. A clear air down burst does not have the visual identification of enhanced rainfall patterns. In this case the SODAR is one of the few instruments capable of the direct measurement of the strong downward motion. Since the SODAR measures this motion at elevations of 150 to 200 meters it can provide controllers with additional warning prior to that obtained with the conventional LLWAS network.

Wake Vortex Detection

Another atmospheric phenomena that can be detected using SODAR technology is the wake vortex that is produced by aircraft during landing. The persistence of some of these wakes along the landing runway has resulted in the loss of aircraft following behind. Most often the situation is associated with a smaller aircraft following a larger aircraft (such as a 747 or equivalent). During the past 10 years Doppler SODAR has demonstrated its ability to detect the strong upward and downward motion that is characteristic of these vortices. The detection of the presence of the wake vortex as well as being able to monitor the duration of the wake vortex is a critical feature for a monitoring system.

Alternative designs of the SODAR (termed Bistatic SODAR) are also capable of real time monitoring of the



Atmospheric Systems Corporation
24900 Anza Dr., Unit D
Santa Clarita, CA 91355

+1.661.294.9621 (office)
+1.661.294.9667 (fax)
sales@minisodar.com

ability of the atmosphere to sustain these vortices. It is well known that there are certain atmospheric conditions that are transported away from the runway.

The Next Step

The SODAR technology is rapidly maturing. Most recently the USAF has purchased quantities of the AeroVironment miniSODAR for the purpose of providing real time support for rocket launch operations at Cape Canaveral and Vandenburg AFB. SODAR systems now need to be included as active part of the new technology deployed as safety enhancements for aircraft take off and landing operations.

To date the focus of funded research has been to explore on the more costly technologies such as electromagnetic radar and light-based laser systems. In part the expectation is that these technologies have the potential of offering significant advancements. However their operation and data interpretation remains dependent upon highly skilled technical staff.

While the radar systems such as the NEXRAD systems are very successful for the detection of wind motion above 150 meters there is a data gap in the region between the lower altitude seen by the NEXRAD and the wind flow patterns detected by the LLWAS network of tower mounted anemometers. It is this region that is best addressed with the SODAR especially the miniSODAR which produces the

conditions during which these wake vortices persist and other conditions during which they decay rapidly or required high spatial and temporal measurements of horizontal and vertical wind. The AeroVironment commercial miniSODAR system is capable of producing these measurements in 5 meter intervals in 10 to 40 second time intervals that are needed to provide the aircraft pilot with adequate warning to make corrections to the flight path.

This year AeroVironment, Inc. has initiated an internally funded research and development project to extend the operational capability of the miniSODAR as an **all weather wind sensor**. In this configuration the miniSODAR is expected to be able to measure winds in most (if not all) weather conditions.

Finally AeroVironment has established a close working relationship (based on the mutual transfer of technology) with the NOAA Environmental Laboratories in Boulder, CO designed to significantly advance SODAR systems in general. This relationship is crafted to introduce the most recent technological advances into commercial Doppler SODAR systems. AeroVironment believes that this partnership is the foundational basis for the introduction of SODAR technology (especially the miniSODAR) into operational applications such as those associated with airport activities.