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Strong winds off the coast of Santa Barbara, California are referred to as Sundowner winds. These winds can be quite intense. Dr. Dave Fitzjarrald and his technical support team from the Atmospheric Sciences Research Center (ASRC) at the University at Albany, SUNY are testing a hypothesis that postulates that Sundowner winds depend on the presence of critical layers above the mountain crests that control the propagation of gravity waves in the lee of the coastal range. These winds, which can be aloft at a thousand meters or more in and above the boundary layer, haven't yet reached the surface. Yet when these winds occur during a fire episode, which is becoming more and more commonplace, the results can be catastrophic.

The approach that Dr. Fitzjarrald employed might be viewed as radical by some camps. Fitzjarrald's focus was to listen to the wind. Taking advantage of the detailed measurements by other teams in the Sundowner Winds Experiment (SWEX) Project led by Prof. L. Carvalho at UCSB intensive observation period—lidar and radiosondes made by NCAR and San Jose State University teams and aircraft overflights on selected days, among others-- he aims to identify the signature of elevated winds by their surface signature.

"I want to filter out the environmental sounds from the ocean and surf and listen specifically to the wind," states Fitzjarrald. "My goal is to distinguish the local wind noise near the surface to examine how the marine layer moves beneath the convective boundary layer by the late afternoon. Another person's 'noise' will be our signal."

Key to this research was Fitzjarrald's ability to accurately capture wind data at 50 centimeters above the sensor, just above the grasses that line the coast of Santa Barbara County. To accomplish this Fitzjarrald deployed a miniature ultrasonic anemometer, the TriSonica Mini Wind and Weather Sensor, obtained through Applied Technologies, Inc. (ATI). Placing the TriSonica near the surface (Figure 1) allowed Fitzjarrald to capture characteristics of the winds that cause the waving motion of the wild oat grass, known as "honami", and see how the movement of the grass correlates to the turbulent flow field of the winds. This is the surface signal of interest in itself but also what needs to be separated to see the signal from above.

Figure 1: TriSonica Mini ultrasonic sensor on mounting platform just above the oat grass.

Despite its small size, the TriSonica Mini sensor provided Fitzjarrald's team wind speed, direction, temperature, humidity, pressure, tilt, and compass data. It was in fact, the small form factor that appealed to Fitzjarrald in the first place.

"For my research I was looking for a sensor that would operate very close to the ground," Fitzjarrald says. "Larger units would work fine at five to ten meters aloft, but I needed to deploy right down on the surface. The TriSonica Mini proved to be the perfect solution for my needs."

The complexity of what Fitzjarrald is trying to decipher is immense. He is capturing large quantities of data from different sources, (e.g.: sound signals, wind pressure, wind signals, etc.) and attempting to distinguish each source from the other. It has been equated to listening to an orchestral score and breaking out every note, every instrument, tempo changes, and the like.

"Capturing the initial data was the easier step," elaborates Fitzjarrald. "The hard part is in separating and organizing all of these different signals. Some relate to characteristics occurring close to the surface, while other signals come from the strong winds coming down off the mountain. The TriSonica Mini enabled us to look at aerosol from the sea breeze. It proved to be an essential component for my research since I really wanted to know what was going on at 50-centimeters, just above the oat grass."

By investigating features that are near the surface (Figure 2), in the waves of the grass itself, Fitzjarrald hopes to determine what is locally down generated versus what is down generated from a couple of thousand meters above the surface. Their hope is that the ensuing data will allow them to develop a very short-term forecast tool (half an hour to a maximum of two hours) giving people on the ground forewarning of strong winds present above their location based solely on surface measurements rather than relying on costly lidar, radar, or manned aircraft.

Figure 2: Fitzjarrald's instrument array in place. NCAR instrument tower in background.

“The general scientific motivation is to better understand how pressure signals relate to turbulence—local turbulence, surface turbulence, even elevated turbulence at the sheer layer,” Fitzjarrald explains. “It’s a process of peeling away different layers to determine what is of local origin, what came from an intermediate distance, and what is from a long way off. Through all of this we hope to look at when signals are coherent with locally produced noise, or wind through the grass, and when is it infrasound reflecting off something that come from the elevated sheer layer.”

Ultimately, Fitzjarrald and his SWEX colleagues hope their research will provide improved weather warnings which would result in greater understanding and improved predictability with spatiotemporal specificity of where Sundowner winds will be strongest in an effort to minimize property damage and human loss resulting from wildfire hazard scenarios.

It appears the wind may have a great deal to tell us if we are simply willing to listen.