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Mesoscale Dynamics Resulting in the Formation of the Cedar Fire (2003) on the Lee Slope of the Santa Ana Mountains

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Abstract Text:

An intense and devastating fire known as the Cedar Fire occurred in the region of San Diego, California, from October 23 to 29, 2003. The fire began in the Cuyamaca Mountain within the Cleveland National Forest. It is the third-largest wildfire in the history of California (2nd deadliest, 4th more destructive). The fires were ignited by human intervention and made worse by Santa Ana winds. Large and severe wildfires often occur when there is a northeasterly dry wind blowing over the lee slope of the Santa Ana Mountains, known as the Santa Ana wind. Although the behavior of the wildfires has been studied over the last few decades, the dynamic processes over the lee slope of the Santa Ana Mountains at very fine scales of motion are still not well understood, e.g, turbulent mixing associated with wave breaking, thus deserve further study. After analyzing the numerical modeling results with relatively fine resolution (e.g., 600 m), we find that when the Cedar Fire occurred at about 00Z Oct. 26, 2003, there existed a two-layer atmosphere over the lee slope. In the lower layer (below 950 mb), the air was cooler and moister, which originated from the northwest, i.e., from the Pacific Ocean. The temperature increased with height, reached its maximum at about 950 mb, and then decreased adiabatically above. In the upper layer, the air is much dryer and originated from the northeast, which was associated with the upper-level, synoptic high-pressure system, as demonstrated in Huang et al. (2009). This fine-resolution modeling result is consistent with the observed sounding at San Diego. Employing numerical simulations, we find that the following two processes produce the mesoscale environment conducive to the formation of Cedar Fire: (1) the synoptic-scale descending air associated with the upper-level high pressure poleward of Southern California helped remove the cooler and moister layer near the surface and (2) the adiabatic heating associated with the northeasterly severe downslope wind further dried the air near the surface.

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