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Brief communication: Meteorological and climatological conditions associated with the 9 January 2018 post-fire debris flows in Montecito and Carpinteria, California, USA

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Abstract. The Thomas Fire burned 114 078 ha in Santa Barbara and Ventura counties, southern California, during December 2017–January 2018. On 9 January 2018, high-intensity rainfall occurred over the Thomas Fire burn area in the mountains above the communities of Montecito and Carpinteria, initiating multiple devastating debris flows. The highest rainfall intensities occurred with the passage of a narrow rainband along a cold front oriented north to south. Orographic enhancement associated with moist southerly flow immediately ahead of the cold front also played a role. We provide an explanation of the meteorological characteristics of the event and place it in historic context.

1 Introduction

The Thomas Fire was ignited on 4 December 2017 and burned 114 078 ha in Santa Barbara and Ventura counties in southern California before it was 100 % contained on 12 January 2018. It became the largest wildfire in California's modern history. Soil burn severity was predominately moderate with small areas mapped as high in the northern and western portions of the burn area (CAL FIRE, 2018). In combination with the steep terrain and underlying geology, the United States Geological Survey (USGS) rated watersheds north of the Santa Barbara coastal plain and Ojai as having high debris flow hazard based on a design rainstorm that has a 15 min rainfall intensity of 24 mm h^{-1} (USGS, 2018a; Fig. S1 in the Supplement).

In the first significant rainfall event of the wet season on 9 January 2018, high-intensity rainfall occurred over the westernmost portion of the Thomas Fire burn area between 11:30 and 12:00 UTC (03:30–04:00 LST). Rainfall rates exceeded the USGS 15 min design storm (USGS, 2018a) by more than 3-fold at some locations. Large-magnitude debris flow surges were triggered in multiple watersheds, overwhelming debris basins and issuing onto urbanized alluvial fans including the communities of Montecito and Carpinteria (Fig. 1). The debris flows were devastating, resulting in 23 deaths, 246 structures destroyed, and 167 damaged (County of Santa Barbara, 2018). Preliminary loss estimates for residential and commercial property alone have exceeded USD 421 million (California Department of Insurance, 2018).

Over the past 3 decades, more than a dozen notable post-fire debris flow (hereafter "PFDF") events have been observed across the Transverse Ranges of southern California (Oakley et al., 2017), where steep terrain, highly erodible soils, and frequent wildfires create favorable conditions for PFDFs (Wells II, 1987). In the Montecito area specifically, damaging PFDFs occurred following both the Coyote Fire of 1964 and Romero Fire of 1971 (U.S. Army Corps of Engineers, 1974).

This paper describes the meteorological origins of the high-intensity precipitation leading to the 9 January 2018 debris flow and places the event in a climatological context.