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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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Supplemental Material

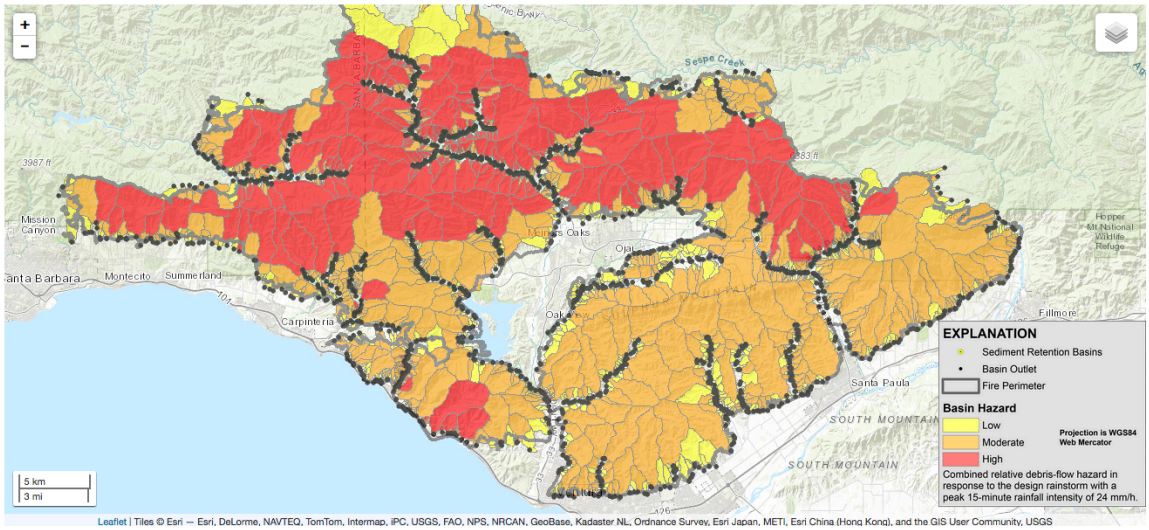

Figure S1: USGS map of debris flow hazard by basin for the Thomas Fire burn area. This map can be accessed at: https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=178

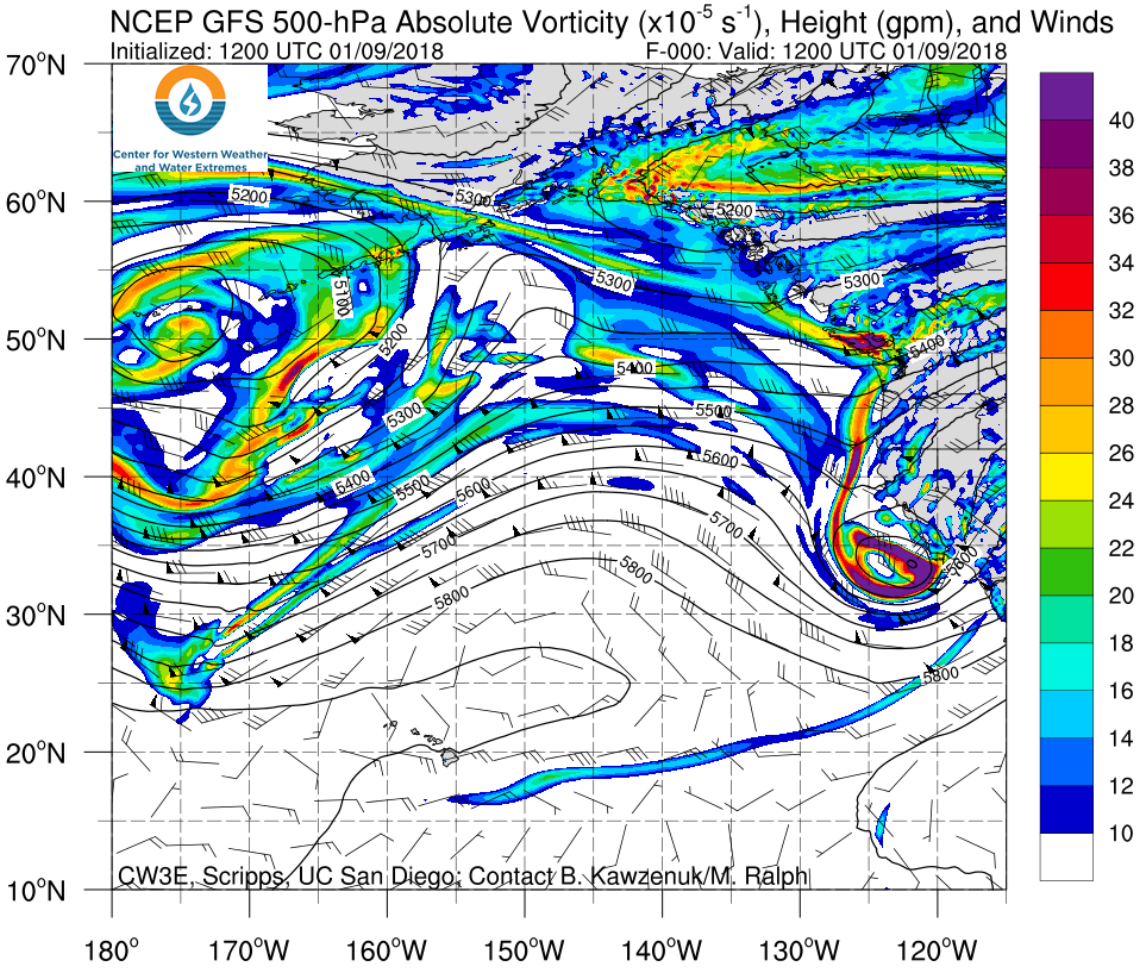

Figure S2: Absolute vorticity field (filled contours) from the National Centers for Environmental Prediction Global Forecast System. The time step shown is the 00 hour forecast for12 UTC, the available model time closest to the actual time of the event (11:30-11:45 UTC). Note area of enhanced vorticity (dark red) rotating into Southern California area. The height field at 500 hPa is also displayed, note closed low pressure system situated at 34° N, 122° W.

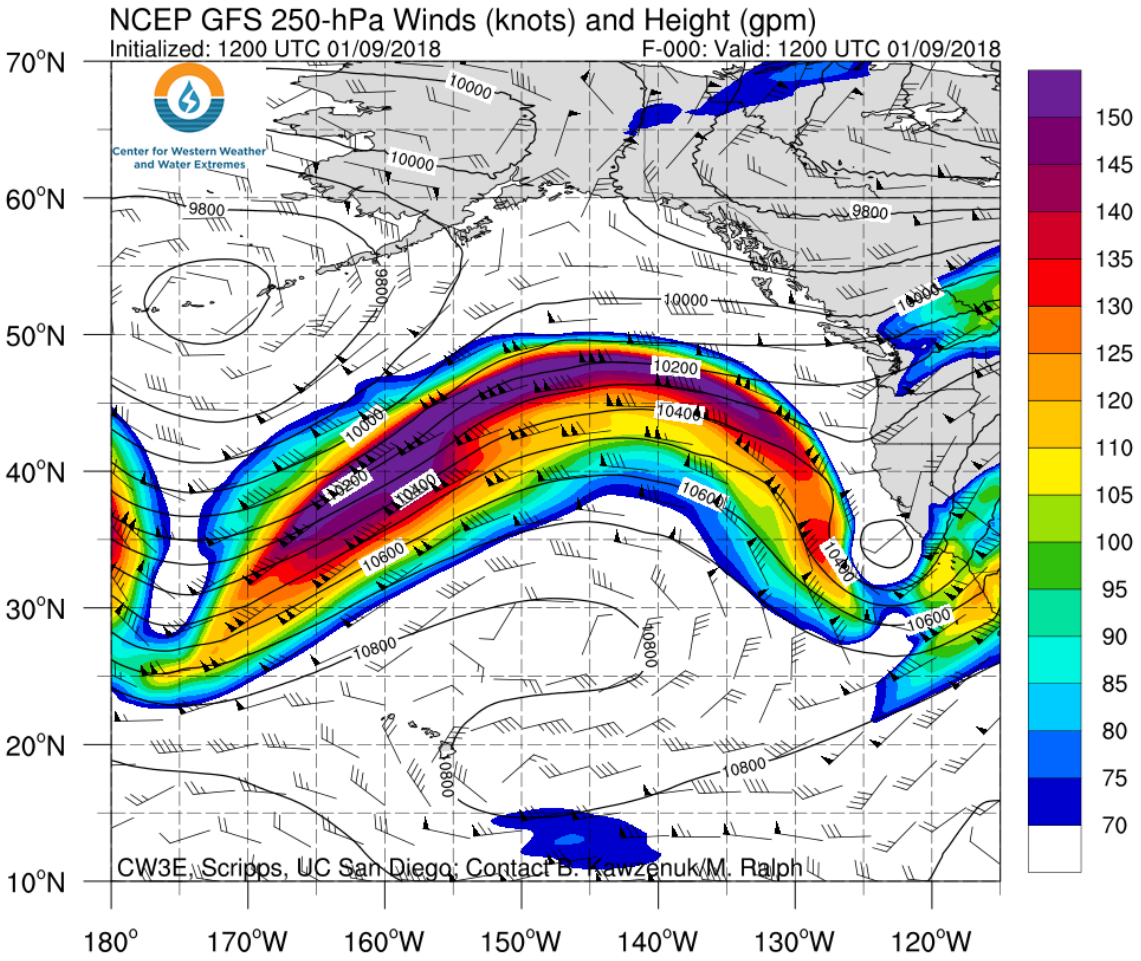

Figure S3: Wind barbs and speed (filled contour) at 250 hPa from the National Centers for Environmental Prediction Global Forecast System. The time step shown is the 00 hour forecast for12 UTC, the available model time closest to the actual time of the event (11:30-11:45 UTC). Note curved jet exit and jet streak exit positioned over Southern California.

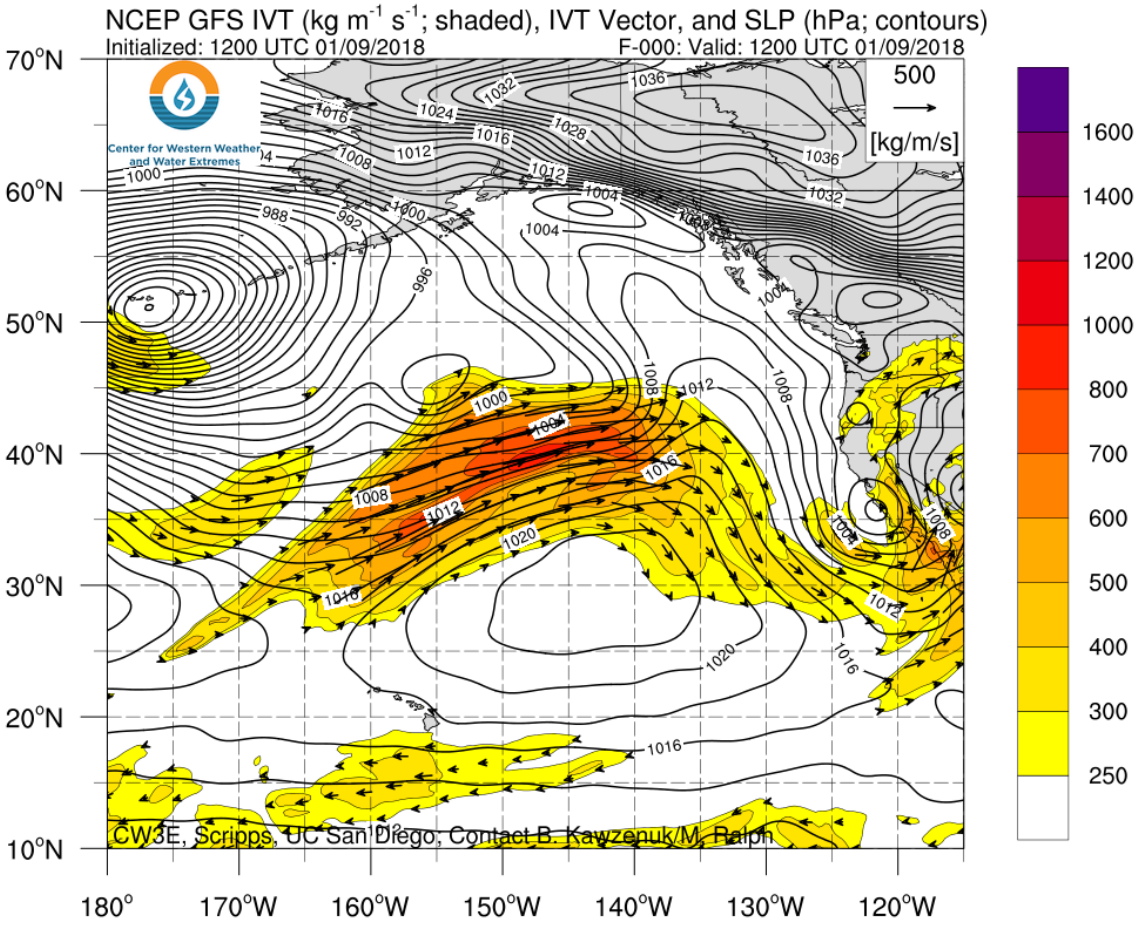

Figure S4: Integrated water vapor transport (IVT) from the National Centers for Environmental Prediction Global Forecast System. The time step shown is the 00 hour forecast for12 UTC, the available model time closest to the actual time of the event (11:30-11:45 UTC). IVT of approximately 400 kg m^{-1} s^{-1} is observed in the vicinity of Southern California.

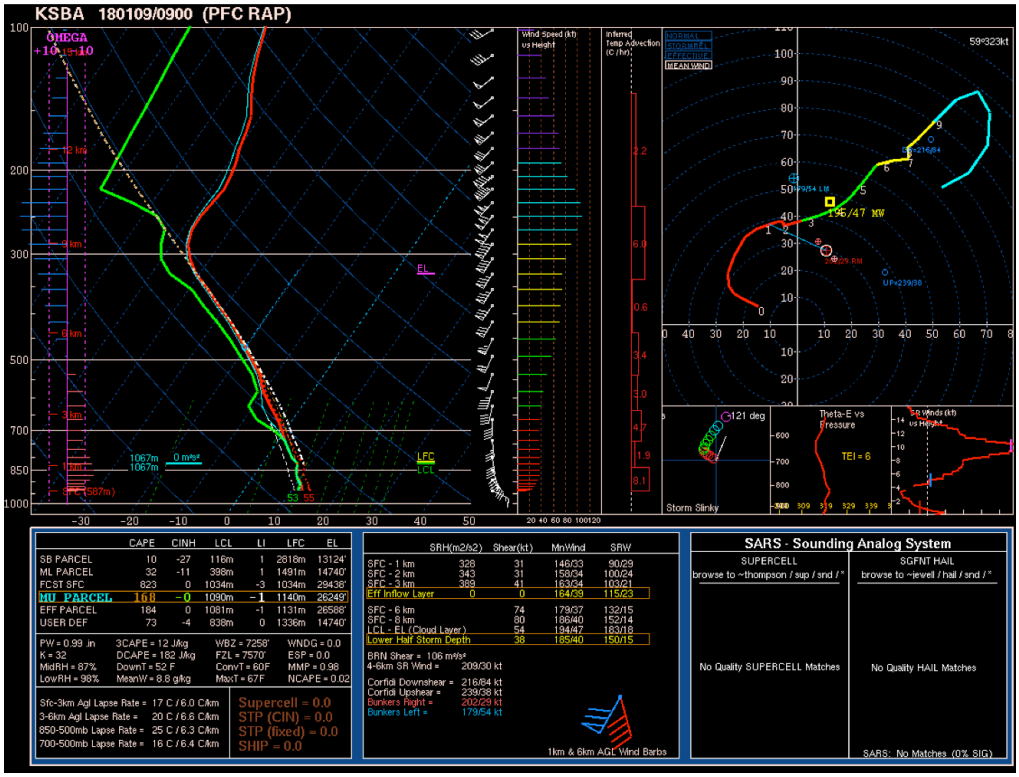

Figure S5: Sounding from the Rapid Refresh model (RAP; http://rapidrefresh.noaa.gov) for Santa Barbara Airport (KSBA) at 9:00 UTC 9 January, the closest timestep preceding the PFDF event. Most unstable parcel CAPE is 168 J kg^{-1}, and mixed layer CAPE is 32 J kg^{-1} Obtained from National Severe Storms Lab.

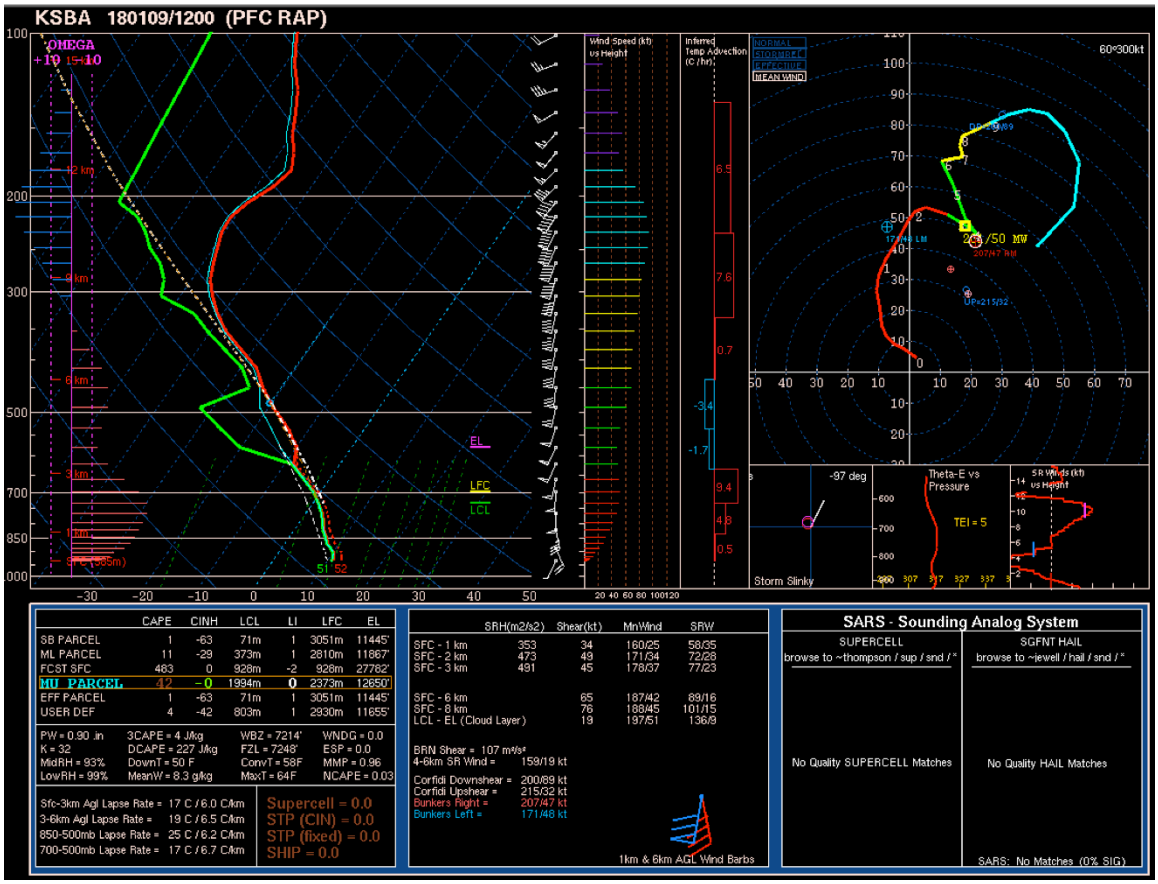

Figure S6: Sounding from the Rapid Refresh model (RAP; http://rapidrefresh.noaa.gov) for Santa Barbara Airport (KSBA) at 12:00 UTC 9 January, the closest timestep following the PFDF event. Most unstable parcel CAPE is 42 J kg^{-1}, and mixed layer CAPE is 11 J kg^{-1}. Obtained from National Severe Storms Lab.

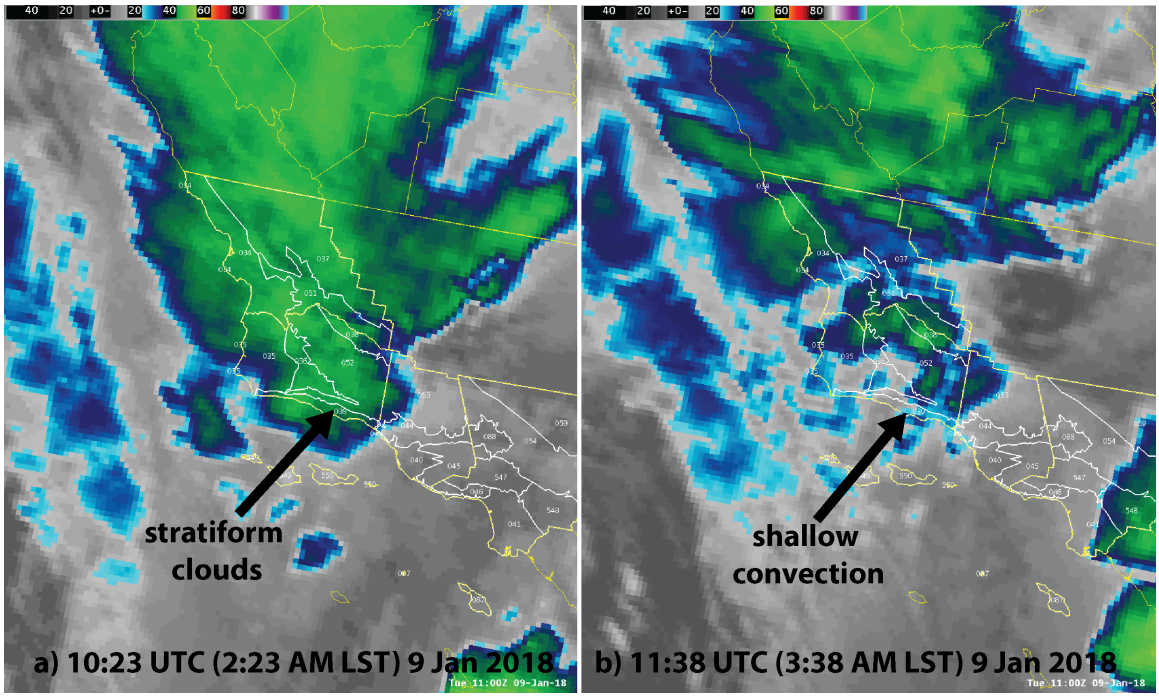

Figure S7: Satellite imagery from GOES East of southern California showing cloud top temperature in degrees Celsius. Prior to the event (a), stratiform precipitation processes were dominant as indicated by stratiform clouds. Near the time of the event (b), convective precipitation processes dominated as indicated by convective cumuliform clouds. The arrow points to the vicinity of Montecito and Carpinteria.

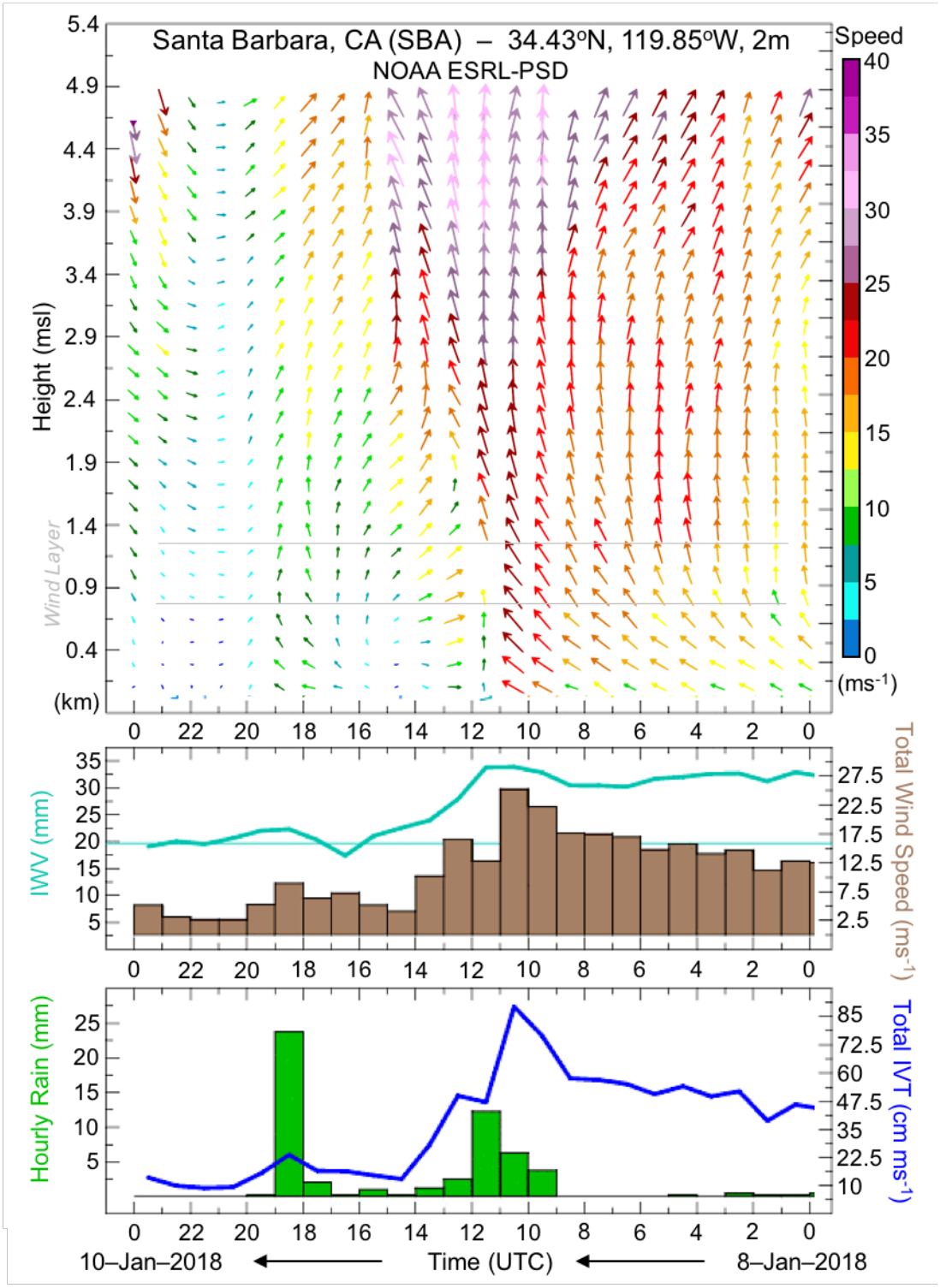

Figure S8: Observations from the 449 MHZ profiler at Santa Barbara Airport (KSBA; approximately 20 km west of Montecito) from 00 UTC 8 January to 00 UTC 10 January. Time moves from right to left. The top frame shows the vertical wind profile. The frontal passage at this location occurs between 10 and 12 UTC where there is a marked shift in low level wind speed and direction. The middle panel

shows total wind speed as brown bars and integrated water vapor (IWV) as teal line. The bottom frame shows hourly precipitation at KSBA as green bars and total integrated water vapor transport (IVT) as blue line. Note peak in IVT between 10 and 12 UTC and subsequent rapid decline. Due to the fragmented nature of the narrow cold frontal rainband, the feature did not impact KSBA with as high intensity precipitation as was observed in the vicinity of Montecito.

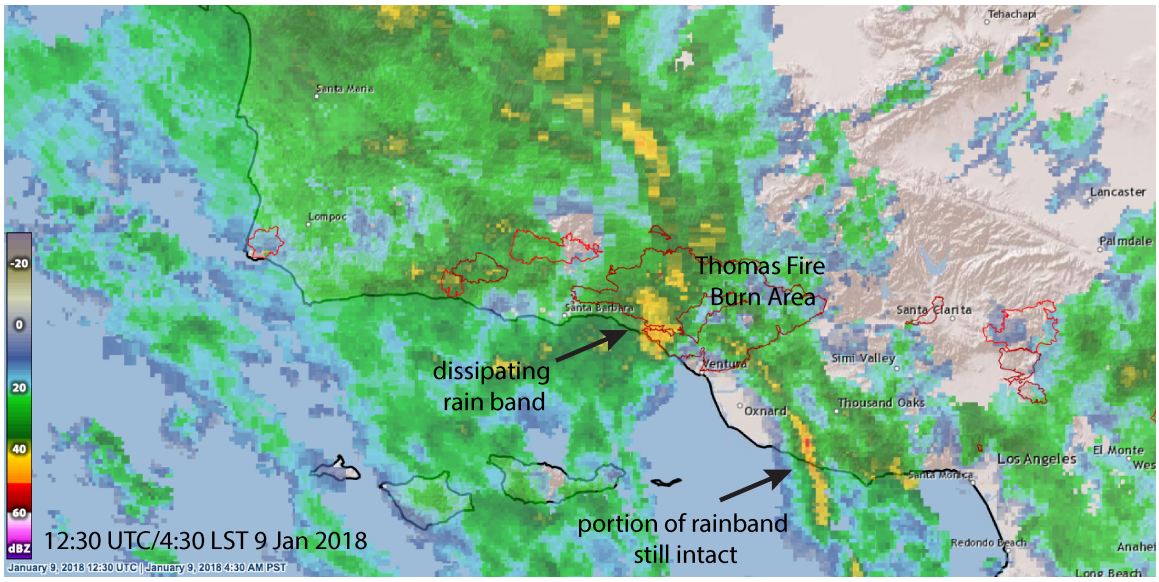

Figure S9: Radar imagery showing the narrow cold frontal rainband began to dissipate over the central portion of the Thomas Fire burn area around 4:30 LST 9 January 2018. A portion rainband along the cold front moved across the Oxnard Plain intact. Burn areas shown are from 2016 and 2017.

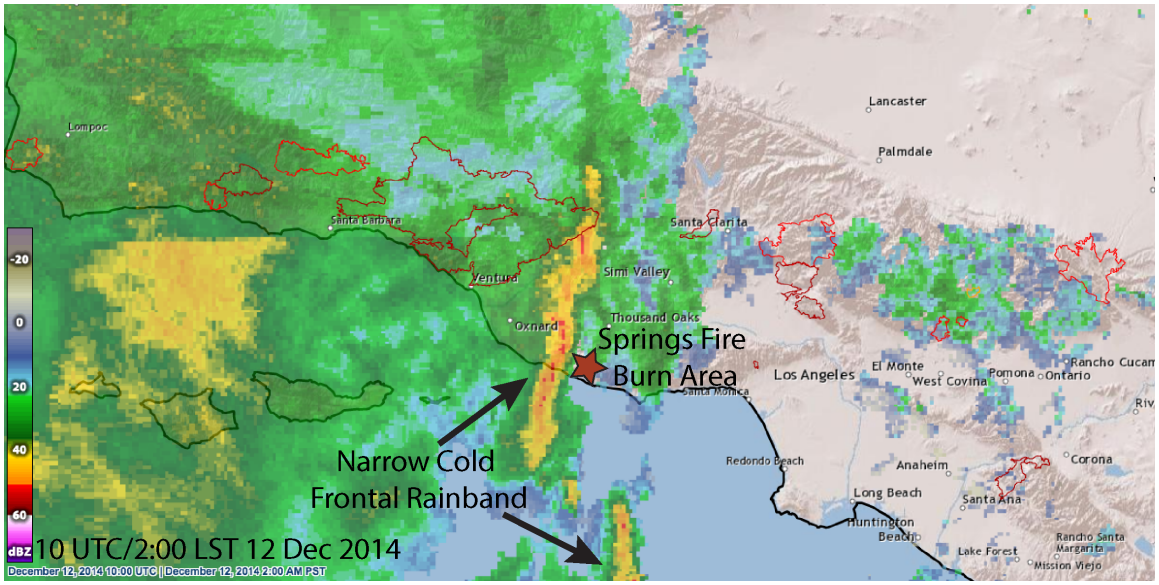

Figure S10: Radar imagery showing a narrow cold frontal rainband impacting the Springs Fire burn area in Camarillo Springs on 12 December 2014. The burn areas

outlined in the figure are from 2016 and 2017; the Springs Fire perimeter is not shown but location is represented with a red star.

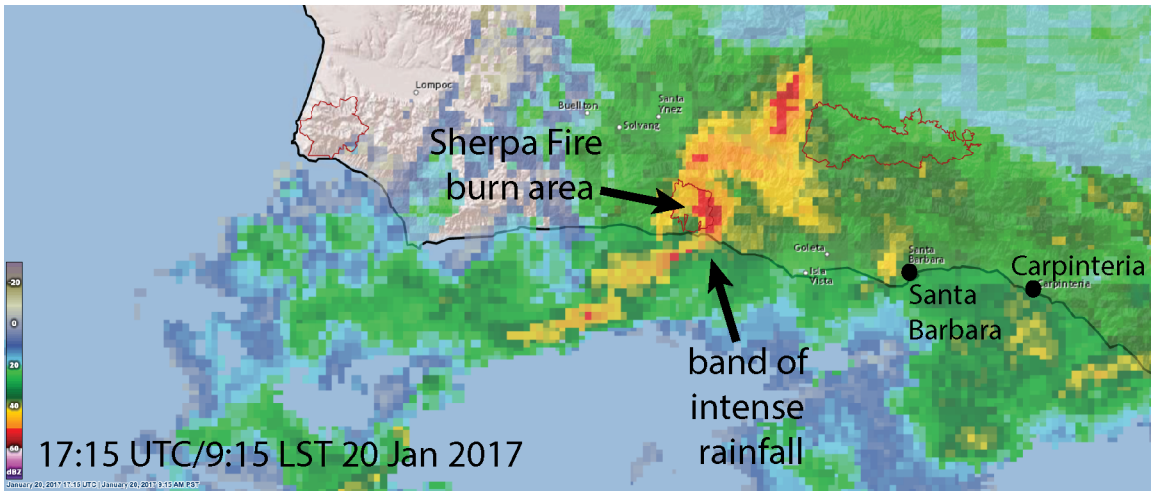

Figure S11: Radar imagery showing a band of intense precipitation impacting the Sherpa Fire burn area on 20 January 2017. The burn areas outlined in the figure are from 2016.

1	2	3	4	5	6
Station	**Elev. (ft)**	**9 Jan 2018 Event 5 min max (in)**	**Recurrence Interval of 9 Jan 2018 5 min max** *from NOAA Atlas 14*	**Station record 5 min obs. (in)**	**Period considered for station record**
Stanwood FS	670	10.67 mm *0.42 in*	50 Year (25-200)	13.21 mm *0.52 in* (2014/15)	1953-2017
El Deseo	3300	11.68 mm *0.46 in*	25 Year (10-50)	12.45 mm *0.49 in* (2004/05)	1969-2017
Doulton Tunnel	1775	***15.24 mm*** *0.60 in*	100 Year (25-1000)	12.7 mm *0.50 in* (2014/15)	1965-2017
Jameson Dam	2230	***15.24 mm*** *0.60 in*	25 Year (25-1000)	13.46 mm *0.53 in* (1997/98)	1965-2017
Edison Trail	1650	8.89 mm *0.35 in*	5 Year (5-10)	12.45 mm *0.49 in* (2004/05)	1993-2017 **short length*
Carpinteria	32	***9.14 mm***	10 Year	9.14 mm	1964-2017

FS		*0.36 in*	(10-25)	*0.36 in* (1968/69)	
Montecito	150	***13.72 mm*** *0.54 in*	200 Year (100-1000)	7.62 mm *0.3 in* (2009/10)	2009-2017 **short length*

Table S1: Columns 1-5 provide data from Santa Barbara County Public Works Department's (SBCPWD) rain gauge network. Columns 1 and 2 provide the station name and elevation. Column 3 provides the 5-minute maximum precipitation value observed during the 9 January 2018 debris flow. Values that set new records for the station are given in bold. Column 4 gives the average recurrence interval extracted from NOAA Atlas 14 based on the latitude and longitude of each station. The number in parentheses in this column indicates the span of average recurrence intervals that contain the 9 Jan 2018 observed value in their 90% confidence interval. Column 5 provides the 5-minute precipitation record for that station prior to the 9 Jan 2018 event and the Water Year (September-August) in which it occurred in parentheses. Column 6 describes the length of the station record used to determine the values in column 5. Note the relatively short records (<30 years) for Edison Trail and Montecito. Station records are available from SBCPWD at http://www.countyofsb.org/pwd/rainintensity.sbc.

1	**2**	**3**	**4**	**5**	**6**
Station	**Elev. (ft)**	**9 Jan 2018 Event 15 min max**	**Recurrence Interval of 9 Jan 2018 15 min max** *from NOAA Atlas 14*	**Station record 15 min obs.**	**Period considered for station record**
Stanwood FS	670	13.97 mm *0.55 in*	10 Year (10-25)	30.23 mm *1.19 in* (1983/84)	1953-2017
El Deseo	3300	16.26 mm *0.64 in*	5 Year (5-10)	23.11 mm *0.91 in* (2004/05)	1969-2017
Doulton Tunnel	1775	***26.16 mm*** *1.03 in*	100 Year (25-1000)	22.35 mm *0.88 in* (2014/15)	1965-2017
Jameson Dam	2230	***25.15 mm*** *0.99 in*	25 Year (10-500)	24.38 mm *0.96 in* (1997/98)	1965-2017
Edison Trail	1650	19.81 mm *0.78 in*	25 Year (10-50)	23.11 mm *0.91 in* (2004/05)	1993-2017 **short length*
Carpinteria FS	32	***21.84 mm*** *0.86 in*	50 Year (25-1000)	16.76 mm *0.66 in*	1964-2017

				(1974/75)	
Montecito	150	***18.54 mm*** *0.73 in*	50 Year (25-1000)	10.67 mm *0.42 in* (2015/16)	2009-2017 **short length*

Table S2: As in Table 1 for 15-minute precipitation records.

1	**2**	**3**	**4**	**5**	**6**
Station	**Elev. (ft)**	**9 Jan 2018 Event 1h max (in)**	**Recurrence Interval of 9 Jan 2018 1h max** *from NOAA Atlas 14*	**Station record 1h obs. (in)**	**Period considered for station record**
Stanwood FS	670	17.27 mm *0.68 in*	1 Year	60.96 mm *2.40 in* (1983-84)	1953-2017
El Deseo	3300	24.38 mm *0.96 in*	1 Year	47.24 mm *1.86 in* (2004-05)	1969-2017
Doulton Tunnel	1775	39.12 mm *1.54 in*	10 Year (5-25)	57.15 mm *2.25 in* (1972-73)	1965-2017
Jameson Dam	2230	37.85 mm *1.49 in*	5 Year	55.88 mm *2.20 in* (1965-66)	1965-2017
Edison Trail	1650	36.83 mm *1.45 in*	10 Year (5-10)	40.13 mm *1.58 in* (1994-95)	1993-2017 **short length*
Carpinteria FS	32	35.05 mm *1.38 in*	25 Year (10-50)	42.93 mm *1.69 in* (1994-95)	1964-2017
Montecito	150	***24.13 mm*** *0.95 in*	5 Year (2-5)	20.57 mm *0.81 in* (2015/16)	2009-2017 **short length*

Table S3: As in Table 1 for 1h precipitation records.