Muller Faculty Research Development Program Grant for 2014, Final Report:

Travel for Damage Survey of a Fire Whirl of Tornadic Strength

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Introduction

The purpose of this project was to conduct a detailed survey of the damage path (Figure 1) of unusually large and intense fire whirls that occurred on the "Eiler Fire" in a remote area of northern California on August 2, 2014, with the aim of collecting a data set that can be analyzed to improve understanding of this potentially deadly phenomenon. The event came to my attention through an

Figure 1. Swath of downed trees from a very large and intense fire whirl during the "Eiler Fire" in the Hat Creek area of California. Burned timber on Jim Brown's ranch is in the foreground.

article on fire whirls by myself and Dr. Chris Herbster, slated for the Nov.-Dec. 2014 issue of Weatherwise Magazine. Specifically, very large and strong fire whirls were observed and photographed by Jim Brown, a retired BLM firefighter, as they approached his ranch from the south. Fire whirls are whirlwinds of flame, combusting debris, and smoke that range from dust-devil size up to the size and strength of tornadoes, and are implicated in extreme, and sometimes deadly, fire behavior. This event has generated interest in both the firefighting and fire weather communities due to its magnitude.

Project Equipment and Activities

It was imperative that this project be pulled together quickly as logging/timber-salvage operations were imminent—normally, a longer period for planning and preparations would be desirable. The rapid approval for this grant was crucial to its success, as it enabled us to ramp up quickly and formulate a

strategy to complete the survey without interference from logging operations, which commenced even before the survey was completed. The equipment purchases and travel plans for this project were made subsequent to grant approval on September 3, and prior to when travel commenced on September 6. I spent September 7 familiarizing myself with the new equipment and related software, and we began the actual survey on September 8. Equipment purchased for the project consisted of a GPS-enabled Nikon D5300 digital SLR camera with 18 mm-55 mm lens and ancillary items for $1079 (recommended by Scott Spratt of the National Weather Service who uses this model for tornado damage surveys), a Garmin GPSMAP 78sc handheld GPS and ancillary items for $300 (recommended by Chris Herbster), and downloadable topographic maps of the region for the GPS for $100. Other expenses were travel-related. The total cost was $2817.26 out of $3250 budgeted for the project.

Jim acted as my host (saving on per diem and lodging costs), guide, and assistant for the first four days of the survey, and was invaluable in helping to assure the success of the project. Also thanks to Jim I was able to stay at the ranch for an additional three days in his absence in order to complete further observations. We developed our protocol for conducting the survey and taking observations "on the fly." Each day we travelled to the damage locations by car and truck, then observations were made by walking the damage path, covering many miles over rugged terrain during the course of the week. Observations consisted of noting damage, mostly in the form of snapped, uprooted, and/or sand-blasted trees, marking a "waypoint" on the GPS, and taking one to several photos at that location (Figure 2).

Figure 2. Jim Brown marking a "waypoint" while I photograph the damage. The snapped trees are signs of tornadic-level winds.

The compass feature of the GPS was used to log the direction of one or more downed trees at each waypoint location. Special attention was given to crisscrossing downed trees, as they will provide insight into changes in the rotational wind patterns during the progressive movement of the whirls. A sampling of snapped tree diameters and "throw" distances was made in a few cases to help in wind speed estimation. Handwritten notes were made for each observation collected, noting waypoint number, photograph numbers, direction(s) of downed trees, other information on damage, and whether we thought this location marked the edge or the interior of the damage path, or was outside the path. Each evening all photographs and GPS waypoints were downloaded to my computer and backed up on an external drive to ensure security of the data.

Over the course of seven days at the site, over 320 observations were made and approximately 1400 photos taken. Figure 3 is a mosaic of images from Google Earth in which I plotted our observation

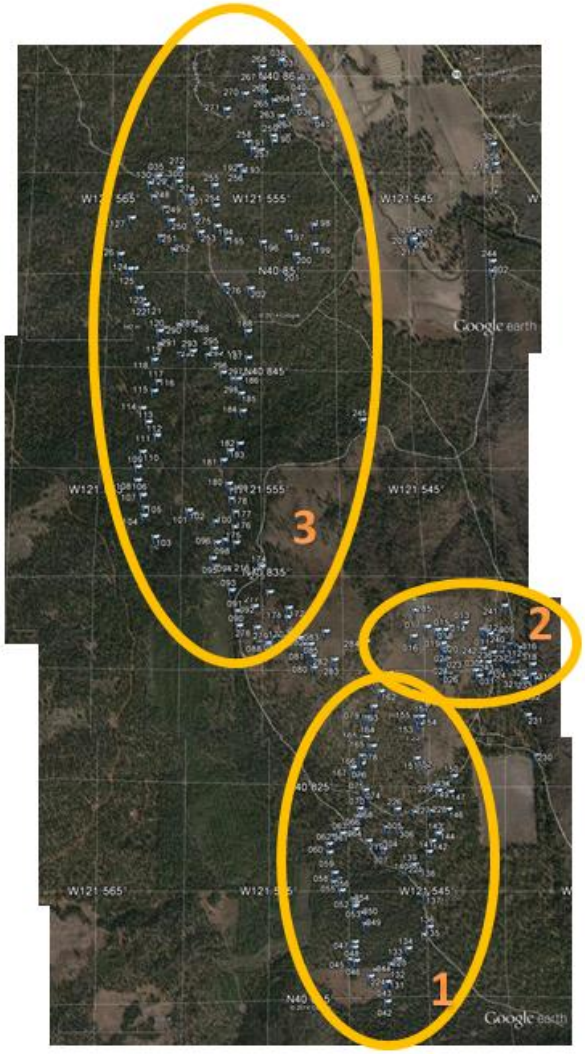

Figure 3. Mosaic of Google Earth images showing locations of survey observations. We were surprised to discover three separate and distinct damage paths (labeled "1," "2," and "3").

locations. The detailed survey revealed that there was not just one damage path, but actually three separate and distinct paths, the longest of which was over 3.5 km with a width of up to 0.5 km. Interestingly, this is consistent with the visual observations made by Jim Brown during the event. He noted two rotating smoke plumes (see Figure 4), indicative of large whirls, as the fire advanced from the south toward his location, then watched the whirls dissipate. As the fire continued to advance further northward along the hillside toward his ranch, the large fire whirl

Figure 4. Two separate rotating smoke plumes observed by Jim Brown from his ranch as the Eiler fire progressed northward. Two regions of snapped trees near the locations of these plumes were identified in our survey.

that caused the damage swath in Figure 1 formed. These eyewitness observations may account for the three separate paths of Figure 3. We plan to apply photogrammetric techniques to compare the rotating plumes in this and other images with the data collected during the survey.

With the assistance of Chris Herbster, an Excel spreadsheet of the GPS waypoint data has been created. I am currently adding the handwritten observations to the spreadsheet. This will create a database suitable for analysis and further investigation, including geolocated estimates of wind direction, and in a few cases, wind speed.

Broader Impacts

As mentioned previously, there has been much interest in the Eiler fire whirl event within the firefighting and fire weather communities. On day three of our survey we were joined by U.S. Forest Service meteorologist John Snook, Manager of the Northern California Predictive Services Unit, who spent the afternoon walking part of the damage path with us and discussing our observations. I also have corresponded with Michelle Evans, Warning Coordination Meteorologist for the Sacramento office of the National Weather Service, who has responsibility for reporting and classifying the event. I have been invited by Dr. Craig Clements, director of San Jose State University's Fire Weather Research Lab, to give a seminar on the Eiler fire whirls. This may be feasible by leveraging my trip to the AGU Fall Meeting in San Francisco during December (to present unrelated research). Additionally we (Chris Herbster and myself) have discussed collaborating on a preliminary article for Fire Management Today (FMT) with Jason Forthofer of the US Forest Service Missoula Fire Sciences Lab, a fire whirl expert, whose research focusses on fire behavior. FMT is a publication of the U.S. Forest Service; as the analysis progresses, we plan to publish in a refereed meteorological journal as well. We also plan to explore external funding opportunities for further analysis.

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