COMET Final Report

University: University of Nevada, Reno

Name of University Researcher Preparing Report: Dr. Tim Brown, Nick Nauslar, Andrew Joros

NWS Office: Reno WFO

Name of NWS Researcher Preparing Report: Jim Wallmann, David Myrick

Partners or Cooperative Project: COMET Partners Project

Project Title: A Dry Thunderstorm Forecasting Index (DTFI)

UCAR Award No.: Z12-98070

Date: 4/30/13

SECTION 1: PROJECT OBJECTIVES

A better understanding of the differences between dry and wet thunderstorms represents the main objective for the research project. A better understanding will help improve forecasting of dry thunderstorms in the western United States. The development of a Dry Thunderstorm Forecasting Index (DTFI) for use by western NOAA National Weather Service Forecast Offices will aid forecasters in determining dry thunderstorm potential.

An analysis of lightning and atmospheric data will help distinguish which parameters identify dry thunderstorm potential. Select historical large dry thunderstorm events will be used as cases to refine and test the DTFI, and the Index will be tested operationally during the 2012 warm season (June through September). The High Resolution Rapid Refresh (HRRR) model will be the primary model used for the application of the DTPI during the 2012 warm season.

Probabilistic products provided by SREF will be evaluated alongside the DTFI. The DTFI will be put on the SREF website and be available to forecasters during the 2012 warm season. Forecasters can then warn and inform fire management about impending ignitions from lightning with more certainty. This will allow fire management to make logistical decisions about resources in advance of impending ignitions, which will improve and streamline fire suppression efforts and potentially save fire agencies money.

SECTION 2: PROJECT ACCOMPLISHMENTS AND FINDINGS

Nick Nauslar and Andrew Joros gathered North American Regional Reanalysis (NARR), North American Land Data Assimilation Systems (NLDAS), and National Lightning Detection Network (NLDN) data from 1995-2009 and implemented MathWorks' MATLAB to analyze the data. These years were chosen due to the lightning data staying relatively homogeneous after the major upgrade in 1995 and before the change in lightning providers in 2010. The study area approximately ranged from the beginning of the Rocky Mountains to the Pacific coast and from the Mexico-U.S. border to the Canada-U.S. border. During the time period, a 32 km grid for the entire domain was developed to match the NARR grid. Several atmospheric variables including vertical velocity, relative humidity, mixing ratio, precipitation, water vapor, and lapse rates were analyzed at multiple levels on this grid. A statistical analysis was performed to separate dry and wet cases by using percentiles of lightning strikes and precipitation. Then atmospheric variables were gathered for all the dry and wet events to ascertain possible predictor variables and thresholds via statistical analyses including multiple linear regression.

To the researchers disappointment, no thresholds were apparent. Additionally, the most important variables were vertical velocity and mixing ratio within the 700 hPa to 500 hPa layer. This does not shed any new light on high-based thunderstorms. However, due to the thorough analysis, dry thunderstorms are very regional. In other words, the patterns and values of certain variables are characteristic to certain sub-regions within the western United States. To investigate further, the northwest portion of the Great Basin was examined (SE

Oregon, SW Idaho, northern Nevada). While no clear thresholds were established for this area, the collaborators believe that better insight may be gained by breaking the western United States into sub-regions via physical geographic features and atmospheric patterns.

We also examined lightning patterns of Red Flag Warnings for dry lightning from the Reno, Boise, and Elko WFOs from 2005-2009. There were no consistent, discernable differences among the variables for hits, misses, and false alarms. When comparing hits and misses, there were no consistent differences among the variables when examining quantiles, means, medians, minimums, and maximums. To further investigate possible relationships, we only examined grid boxes with lightning strikes. However, there were still no differences among the variables for hits, misses, and false alarms. Additionally, no thresholds were found.

SECTION 3: BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER

The operational partners learned a few valuable lessons during this project. The struggles to find variables that would differentiate between dry and wet thunderstorms are rooted in the lack of an adequate surface precipitation network confirming what many forecasters already assumed. In addition, the regional nature of some parameters shows how the environment between dry and wet thunderstorms can rapidly change from one event to another. As a result, the subjective nature of some thresholds that are loosely used by forecasters to determine wet or dry thunderstorms are still of some use.

As a part of this project, forecasters at the NWS Reno office more closely examined dry lightning parameters available from the High Resolution Rapid Refresh (HRRR) and NCEP's Short Range Ensemble Forecast (SREF) during the 2012 summer fire weather season. Subjective evaluation of HRRR lightning threat and SREF 3-h dry thunderstorm potential suggest that these products can be used to identify potential dry lightning threat regions. To filter false alarms, these parameters need to be evaluated in conjunction with locally developed dry lightning procedures at WFO Reno.

SECTION 4: BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER

The university partners learned many valuable lessons in undertaking this complicated problem. The scope should have been more narrow and specific especially for the time and money allotted. The amount of data examined was extensive. Additionally, new analysis techniques were employed and the difficulties and struggles encountered did provide a lesson learned when implementing relatively unfamiliar techniques. While the main research result was not achieved as desired, some useful information was gleaned from the project including the regional nature of dry thunderstorms and the importance of scale both temporally and spatially. This proves that one index with thresholds of a set of variables may not be appropriate for wide scope use. The scale of dry thunderstorms is wide ranging. Microscale to synoptic scale processes influence dry thunderstorm formation with equal importance. This makes it difficult to examine a wide range of events objectively. Case study analysis may prove better unless a comprehensive sensitivity study examines every important variable at each varying temporal and spatial scale.

Precipitation datasets do not handle the complex terrain very well on a larger scale. NARR and NLDAS both have deficiencies in the western United States, but to use actual observations is not effective for this type of analysis given the sparse network of weather stations in the western United States. Additionally, Parameter-elevation Regressions on Independent Slopes Mode (PRISM) precipitation data is not yet available in a daily format.

SECTION 5: PUBLICATIONS AND PRESENTATIONS

Nick Nauslar and Andrew Joros presented preliminary findings at the NWS Reno WFO's 2012 Fire Workshop. We are currently writing a Technical Attachment for the NWS describing the lessons learned from this project.

SECTION 6: SUMMARY OF PARTNER INTERACTIONS AND ROLES

The university partners gathered all of the data and performed all of the analysis for the project. The operational partners provided input and guidance into which variables to examine for dry thunderstorms and feedback during several progress meetings throughout the project. The operational partner's role would have been larger if a DTFI would have been established since the operational testing would have been conducted by them. The operational partners will be assisting the university partners in the writing of the NWS Technical Attachment.