Investigation of Storm Temporal Patterns using Gridded Meteorological Datasets for Hydrologic Modeling

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INTRODUCTION
Rainfall-runoff models require spatial and temporal patterns of precipitation as input. The duration and intensity of this rainfall directly influences the runoff peak and volume generated. In semiarid watersheds, the spatial and temporal characteristics of extreme storms are typically derived from hydrometeorological reports, storm databases, and frequency analyses available from multiple sources, including, but not limited to, the National Oceanic and Atmospheric Administration, Army Corps of Engineers, and Bureau of Reclamation. The usual format depicting the spatial and temporal patterns is depth-area-duration tables. These tables are typically limited to discrete, 6-hour increments (e.g., Table 1); storm spatial patterns are often limited to storm total isohyetal maps. In reality, we recognize that storms: vary spatially with respect to time; rarely fit into discrete time periods; and, have accumulation rates and often limited to storm total isohyetal maps. In reality, we recognize that storms: vary spatially with respect to time; rarely fit into discrete time periods; and, have accumulation rates and

STUDY AREA
The Friant Dam watershed is located in central California, northeast of Fresno (Figure 1). The focus of extreme precipitation events is the winter season when large scale atmospheric rivers impinge on the mountainous terrain, delivering copious amounts of rain and snow. The synoptic conditions conducive to atmospheric river events can last from several days to several weeks, resulting in multiple significant precipitation events that prime the hydrologic characteristics of the watershed (i.e., soil moisture) for major flooding.

DATA
The CFS-R datasets include precipitation, temperature, wind speed, and humidity. The CFS-R data are available at 6-hour intervals and spatially resolved at 0.5° latitude/longitude. The precipitation data are collected from a network of approximately 3000 stations located within the United States. The CFS-R data are generated by the National Center for Atmospheric Research (NCAR) and are available through the National Oceanic and Atmospheric Administration (NOAA) website.

SYNOPSIS CONSIDERATIONS
To incorporate synthetic considerations into the capture of precipitation event duration, the beginning times for the eight (8) manually analyzed storms were used to extract CFS-R variables at standard atmospheric levels, including additional parameters with level-specific and integrated column values (see Table 2 through 4). Hours within the start/stop times of the eight (8) manually-analyzed storms were considered as a precipitating synoptic event (PE), while the six (6) hours preceding and following those times were defined as non-precipitation hours. By applying a generalized linear modeling (GLM) framework, the definition of a precipitation duration can be defined using logistic regression, whereby the binary time series is modeled as a function of the 29 predictor variables in Table 4. Cross-validation is performed to ascertain the skill of the GLM, using a drop-10 percent approach. The GLM is then fit using all eight (8) storms and then applied to each hour for the period 01 January 1979 to 31 December 2010.

RESULTS
An initial comparison of the CFS-R datasets to manual analyses for three storms (i.e., 1982, 1996/97, and 2002 [not shown]) indicate reasonable representation of the precipitation characteristics for each event (Figure 3). The freezing level height and 1000-hPa temperature time series, proxies for snowfall within the Friant watershed, compare favorably to manual observations. The GLM is then applied to the historical simulation for the period 1979-1981 (right) and 1996-1997 (left) with a Heidke Skill Score (HSS) of only 0.06. The GLM is applied to the historical simulation for the period 1979-1981 (right) and 1996-1997 (left) with a Heidke Skill Score (HSS) of only 0.06.

CONCLUSIONS
We examine the rainfall patterns using a comparison of observational and CFS-R data sets for the Friant watershed in California. While the accumulative properties for the 1982, 1996/97, and 2002 storms captured by the CFS-R data, magnitude differences are evident. Future research should include single cell vs. domain-averaged approaches to evaluate areal smoothing effects. Proxy evaluation of snowfall parameters (i.e., 1000-hPa temperatures and freezing level heights) suggest the CFS-R may prove useful as a surrogate for manual analyses in flood hazard analysis.

The over-prediction of PE during cross-validation of the GLM elucidates the need for an adapted statistical methodology to better mimic storm duration, perhaps by analyzing a single year manually and fitting the GLM seasonally to account for different synoptic/mesoscale forcing mechanisms. Large magnitude, long duration events in the summer may be a result of the GLM failing to capture sub-synoptic scale convective events, but will require further investigation. The GLM also generates reduced durations for events due to the increased temporal clustering of storms. The synoptic period focus of the CFS-R analysis, however, does appear to better capture the synoptic characteristics than the raw data analysis with continuous-only precipitation considerations.

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