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Exploration of long-term reanalysis of Sierra Nevada snowpack inferred from snow covered area information

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The spatial heterogeneity of the mountain snowpack and a continuously changing climate affects a variety of processes including surface water discharge. An apparent shift in ablation time and loss of snow water equivalent (SWE) in the Sierra Nevada range in California (CA), U.S.A. has been reported from several past studies based on downstream flow and/or point scale in-situ observations records. Understanding the geophysical controls and interannual variability of the spatial patterns of snow accumulation and ablation are critical for predicting the effects of climate variability on the snowpack water storage. Therefore, a continuous space-time characterization of snow distribution that uses spatially and temporally extensive remotely sensed information is necessary to improve our ability to predict and monitor this vital resource in complex mountainous terrain. Toward this end, this research generates spatial and temporal SWE estimates over a snow-dominated watershed located in the Southern Sierra Nevada, CA. We use a reanalysis data assimilation approach that is capable of merging remotely sensed Snow Covered Area (SCA) data into snow prediction models, while at the same time accounting for the limitations of each. SCA information derived from the long-term record of Landsat-5 Thematic Mapper measurements are used. The assimilation of SCA into the land surface model, coupled together with a snow depletion model, predicts continuous (in space and time) SWE at a high spatial resolution. The resulting SWE dataset from the reanalysis framework, and its relation to physiographic properties, is studied to explore specific information related to how snow accumulation and snow melt has evolved and been effected by climate variability and change. In particular, the analysis focuses on highlighting how patterns related to different physiographic components respond to observed climate signals (e.g. Pacific Decadal Oscillation (PDO) and the Oceanic El Niño Index (ONI)) and observed temperature trends. Time series tools are employed to detect correlations in the specific temporal patterns; spatial analysis of correlations and trends are performed in order to aggregate sub-basin regions characterized by similar temporal responses. This research provides a demonstration for the method to be extended to other regions, where in-situ observation may not be present.