Title: Utility of medium range atmospheric river forecasting for water management in northern California

Abstract: Forecasts of heavy and extreme precipitation delivered by Atmospheric River (AR) events are becoming increasingly important for both flood and water supply management in reservoirs across California. This study examines the hypothesis that medium-range forecasts of heavy and extreme precipitation at the basin scale exhibit recurrent, spatial biases that are driven by mesoscale and synoptic scale climate features of associated AR events. This hypothesis is tested in the Sacramento River watershed, where we construct a database of heavy and extreme precipitation events in the watershed across a 36 year period from 1984 to 2019 coincident with data from an ensemble mean of NCEP model subseasonal-to-seasonal reforecasts. For each event we cluster precipitation forecast error across Western North America for lead times ranging from 1 to 16 days. The resulting clusters are used to characterize common, large-scale spatial patterns of precipitation forecast error during the largest observed precipitation events in the Sacramento basin. Integrated vapor transport (IVT), 500 hPa geopotential height anomalies, and landfall characteristics of ARs are composited across days categorized into each error cluster and lead time to further diagnose the causes of precipitation forecast biases. Finally, we investigate the temporal evolution of error clusters to determine whether specific spatial structures of error are persistent across forecast lead times. Our results show that consistent spatial patterns of precipitation forecast error emerge in the historical record that highlight prominent biases in the underlying model reforecasts. Moreover, we find instances where basin-scale, medium-range forecasts of precipitation miss an event entirely, whereas forecasts of climatological variables provide some indication of the event’s occurrence. These results suggest the potential for using medium-range forecasts of mesoscale and synoptic-scale features across the Pacific-North American sector, rather than just local forecasts of basin-scale precipitation, whendesigning forecast-informed reservoirs.