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Value of seasonal flow forecast to reservoir operation for water supply in snow-dominated catchments

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The recursive application of forecasting and optimization can make management strategies more flexible and efficient by improving the potential for anticipating, and thus adapting, to adverse events. In the field of reservoir operation, this means enriching the information base on which release decisions are made. At a minimum, this includes the available reservoir storage, but reservoir management can greatly benefit from consideration of other pieces of information as, for instance, weather and flow forecasts. However, the utility or value of inflow forecasts is directly related to forecast quality. In this work, we focus on snow-dominated water resource systems, where the prediction of the volume and timing of snowmelt can greatly enhance the operational performance. We use the Oroville-Thermalito reservoir complex in the Feather River Basin, California, as a case study to explore the effect of forecast quality on optimal release strategies. We use Deterministic Dynamic Programming to optimize medium-range and seasonal reservoir operation based on different forecasts of reservoir inflows. We determine maximum reservoir operation performance by forcing the optimization with observed inflows, which is equivalent to a perfect forecast. The forecast quality is then progressively degraded to relate forecast skill to changes in release decisions and to determine the minimum forecast skill that is required to affect decision-making. We generate forecasted inflow sequences using the Variable Infiltration Capacity (VIC) hydrology model. Forecast initial conditions are created using observed meteorology, while inflow forecasts are based on seasonal climate forecasts. Although the forecast skill level is specific to the Feather River basin, the methodology should be transferable to other systems with strong seasonal runoff regimes. We assess the transferability of the case study results to other systems using alternative reservoir characteristics of the Oroville-Thermalito reservoir system as a surrogate for alternate reservoir configurations. Specifically, we explore the sensitivity of reservoir operation performance to the ratio of reservoir mean inflow volume to reservoir capacity and downstream demand requirements.