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Snow data assimilation in regional scale seasonal hydrologic forecasts

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In the western U.S., approximately 70 percent of the annual runoff of the major rivers originates as winter snowpack in mountainous areas. Therefore, there is the potential to forecast seasonal runoff quite accurately at the time of maximum snow accumulation in spring through knowledge of the water stored in the snowpack (snow water equivalent, or SWE). However, direct observations of SWE are spatially sparse, owing to access and measurement difficulties. On the other hand, satellite data – specifically, snow covered area (SCA) estimated from various visible band sensors, and SWE estimated from appropriate microwave frequencies, have their own problems. SCA estimates are limited to cloud free conditions, and are complicated by the presence of vegetation, especially forest cover. Microwave-based SWE observations are limited to conditions of dry snow, relatively thin snowpacks, and require knowledge of snow microphysical properties, especially grain size and density. We assess the utility of these three sources of snow data, both separately and taken together, using the University of Washington's Westwide seasonal hydrologic forecast system. The Westwide system predicts, in real time, SWE and soil moisture over the western U.S. at one-eighth degree latitude-longitude spatial resolution, and on a monthly update cycle, predicts streamflow for lead times up to one year at a set of over 100 forecast points located in the major river basins of the region. We evaluate alternative strategies for assimilating point SWE observations from the U.S. Natural Resources Conservation Service's SNOTEL network, as well as the standard SCA derived from the MODIS instrument on board the EOS Terra satellite, and SWE from the EOS Aqua instrument, both in terms of their influence on the prior (model-based) SWE estimates, and on runoff forecasts at selected forecast points in the Westwide system.