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Event-response ellipses: connection between hydrologic events and streamflow response

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Event-response ellipses are presented as a method for quantifying the relative extent to which hydrologic events are physically buffered by dynamic storage processes at the catchment scale. Hydrologic events and responses are evaluated by generating event-response ellipses that can be used to characterize and compare catchment-scale dynamic storage processes and assess the completeness of components used in the water balance. Event-response ellipses allow for role of dynamic, short-term storage to be quantified and compared between seasons and between catchments. This method is first presented as an idealization of the system: a time series of a hydrologic event (e.g. snowmelt) as a portion of a sinusoidal wave function. The event function is then related to a response function, which is the original event function modified mathematically through phase and magnitude shifts to represent hydrologic response (e.g. streamflow out of the catchment). The direct relation of these two functions creates an event-response ellipse with measurable characteristics (e.g. eccentricity, angle). The ellipse characteristics integrate the timing and magnitude difference between hydrologic event and response to quantify physical buffering through dynamic storage. The event-response ellipse method is applied to eleven snowmelt seasons in two well-instrumented headwater snowmelt-dominated catchments. Results show average daily values over the time period produce different ellipse characteristics for the two catchments. Individual daily values for each year were also used to produce ellipses for each snowmelt season. These individual snowmelt season fitted ellipses required more with increased scatter relative to the values averaged over the eleven year time period. This scatter is also an important result: this shows incomplete water balance in the catchment and may provide insight into when hydrologic processes contributing to components of the water balance are missing.