## Supplemental Material

The primary purpose of this supplement is to provide further, more detailed justification of the four indices chosen for the classification tree presented in the full manuscript.

Figure 1 demonstrates the superior descriptive capacity of the tree with all four indices included as compared with the tree that is created from the exclusion from each of the four variables. Four separate trees are created (each uses a different combination of three of the four indices), and the variance at each level of the tree is measured. When these results are compared with the decrease in variance by employing all four indices, it is clear that none of these four indices can be removed without a substantial loss of descriptive power.

Figures 2 through 5 present groups of regime curve images in which three of the four indices are very similar, but yet the holistic nature of the catchments differ dramatically, thus verifying the importance of the one index that differs.

The two catchments in figures 2a. and 2b. are very similar in terms of aridity index, and their peak days for rainfall/runoff. However, the mountainous catchment in Montana (2a.) receives precipitation quite evenly throughout the year, while the Midwestern catchment in Iowa (2b.) receives more rainfall during summer months. The winter precipitation in Montana forms snowpacks, leading to peak runoff in the form of melt water in early June. The catchment in Iowa sees its runoff maximized during the same week as well – but the driver is rainfall, not melting. This distinction is nicely distinguished by the variable “seasonality,” yet thoroughly missed by the other three variables.

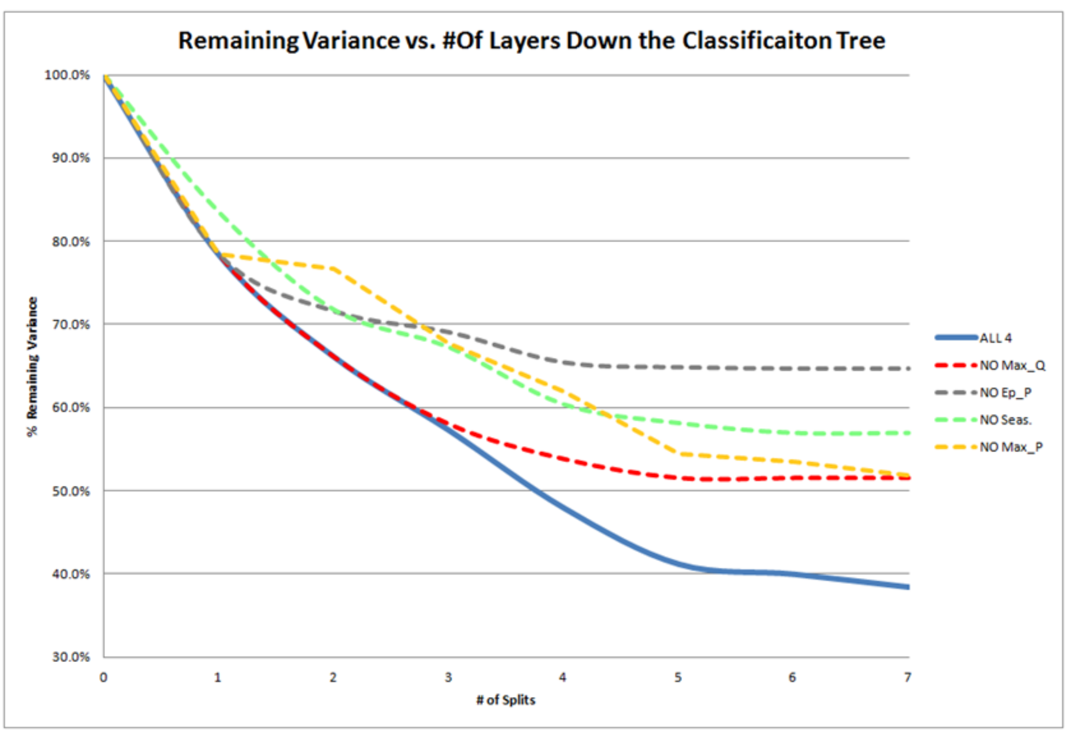
The catchments in figures 3a through 3c are virtually identical in terms of seasonality, as none of them display a strong seasonal signature for rainfall apart from a slightly higher quantity of winter precipitation. All three catchments display peak rainfall within essentially one week in early January and peak runoff within the same week of late-May/early-June. Without knowledge of aridity, these catchments would almost certainly fall within the same class. However, in looking at the catchment in 3c., the quantity of melt-driven runoff is nearly a full order of magnitude larger than the catchment in 3a. The difference is nicely explained by the substantial differences in aridity index.

The catchments in figures 4a and 4b display a very similar quantity of seasonality with respect to precipitation, comparable aridity, and peak runoff during the same week. However, these catchments are distinguished by the fact that the catchment in 4a receives its precipitation during winter, out-of-phase with respect to PE, and thus, accumulates snow which exits as melting snow months later. The catchment in 4b, because its precipitation pattern peak is shifted almost exactly ½ year from the catchment on the left, receives precipitation in-phase with PE, and produces, despite the similar timing, dramatically less runoff.

The catchments in figures 5a and 5b are both located in Washington. Both present significant seasonality, extremely humid climates, and seasonal precipitation that arrives out-of-phase with PE, peaking on the very same day in late November. However, these two catchments present distinctly different climates as one emits maximum runoff in December (5a) and the other peaks in June (5b). This implies a differing mechanism of runoff – 5a receives runoff from winter rainfall that exits immediately (low residence time), shown by the Q regime curve mirroring the P regime curve, while 5b produces runoff from winter rainfall and even more notably from spring melt, thus producing a Q regime curve that does not follow P.

## Supplemental Figures

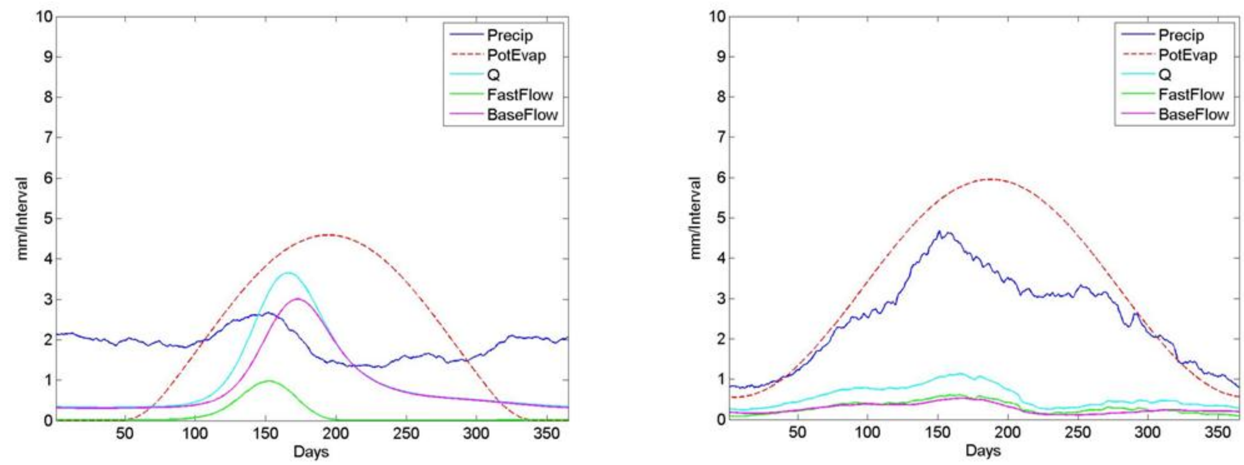
Figure 1: Decreasing entropy down the tree –performance with each variable removed



Figures 2a. and 2b: Different seasonality measurements

(Left) #203, Montana – Ep/P ~ 1.1, MaxDayP = 152, MaxDayQ = 165… Seasonality ~ 0.15

(Right) #91, Iowa – Ep/P ~ 1.3, MaxDayP = 151, MaxDayQ = 166…Seasonality ~ 0.39

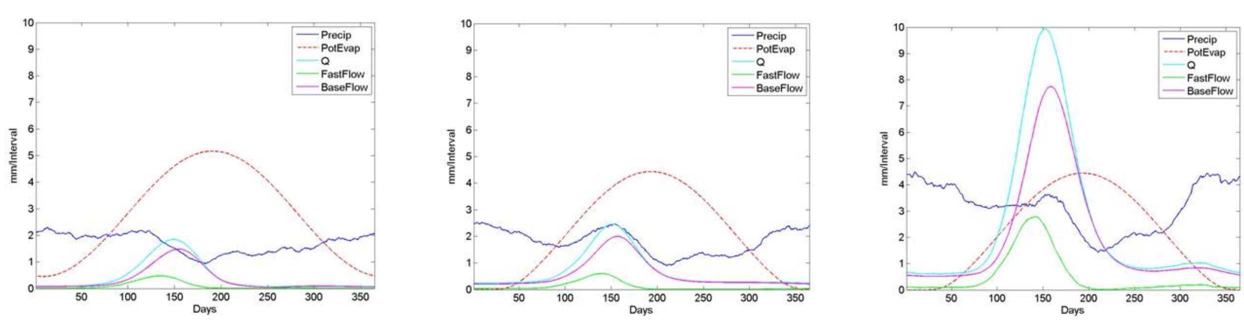



Figures 3a. , 3b. , and 3c: Different aridity indices

(Left) #243, Colorado – Seasonality ~ 0.19, MaxDayP = 13, MaxDayQ = 148…Ep/P ~ 1.7

(Center) #300, Montana – Seasonality ~ 0.23, MaxDayP = 5, MaxDayQ = 151… Ep/P ~ 1.2

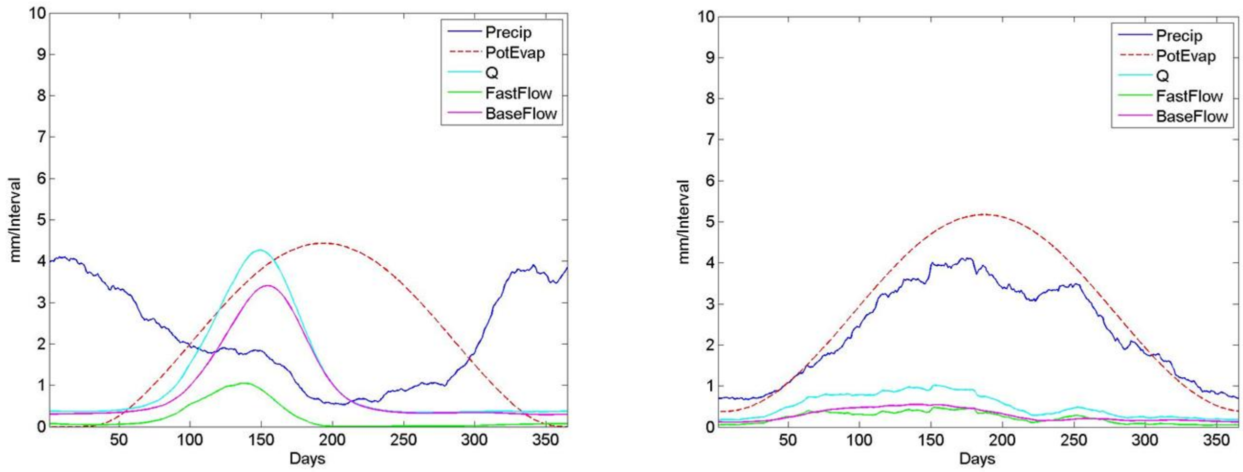
(Right) #342, Montana – Seasonality ~ 0.23, MaxDayP = 10, MaxDayQ = 153… Ep/P ~ 0.7



Figures 4a. and 4b: Different day of peak precipitation

(Left) #162, Idaho – Seasonality ~ 0.48, Ep/P ~ 1.0, MaxDayQ = 149… MaxDayP = 8

(Right) #388, Iowa – Seasonality ~ 0.45, Ep/P ~ 1.2, MaxDayQ = 152… MaxDayP = 175




Figures 5a. and 5b: Different day of maximum streamflow

(Left) #346, Washington – Seasonality ~ 0.52, Ep/P ~ 0.38, MaxDayP = 330… MaxDayQ = 344

(Left) #392, Washington – Seasonality ~ 0.49, Ep/P ~ 0.35, MaxDayP = 330… MaxDayQ = 159