Using a Snowpack Index to Evaluate Non-Precipitation Changes in Snowpack in the Western United States

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Introduction

Our Snowpack Index (SI) is an indicator of change in the factors that effect the sequestration of winter precipitation in the form of snowpack, beyond precipitation change. This integrates the other climatic factors that effect snowpack, such as temperature, solar radiation, wind, relative humidity, etc. The SI is the percent of average snow water equivalence (SWE) divided by the percent of average precipitation on any given date.

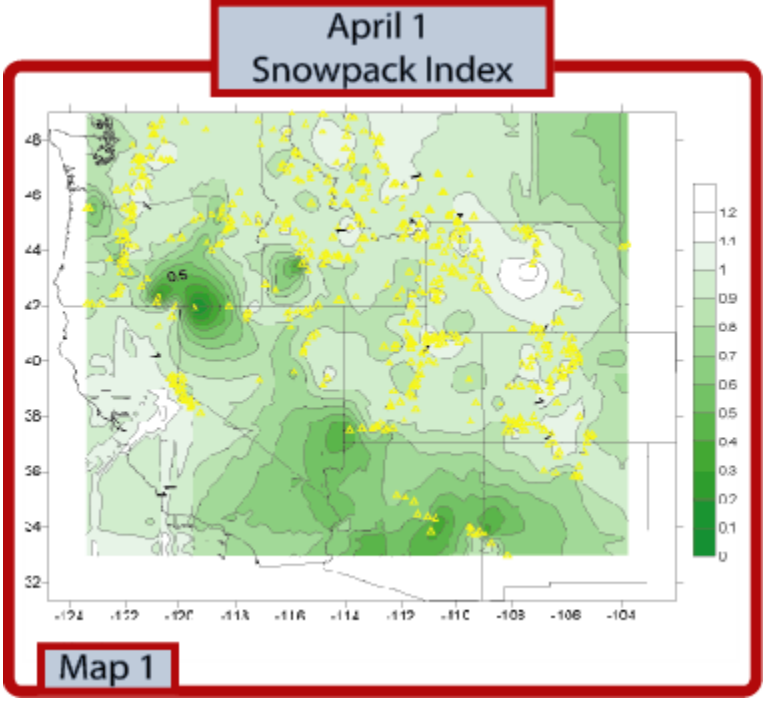
Interpreting the SI

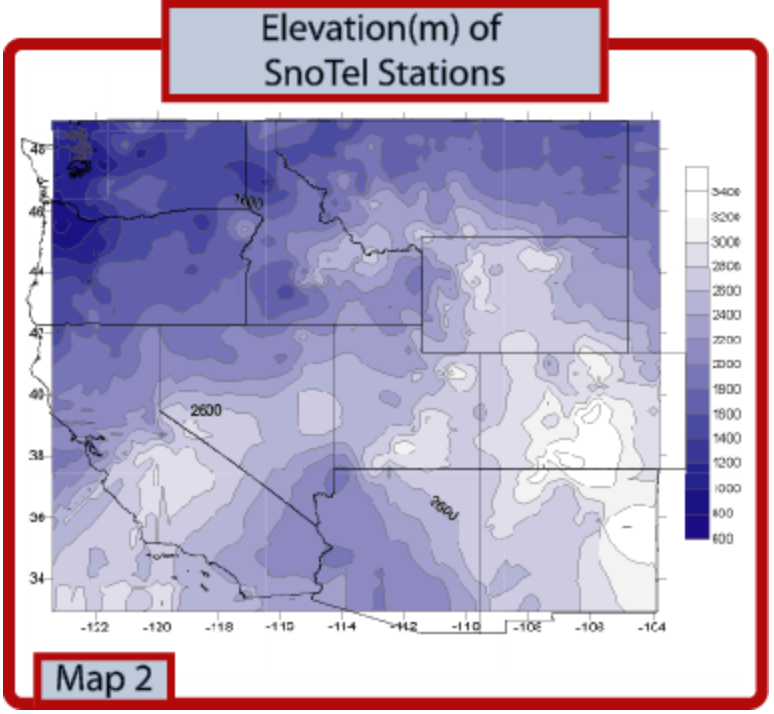
An index value of one indicates that factors (other than precipitation) effecting snowpack development are unchanging, even if the actual snowpack is higher or lower than average. An index value of less than one indicates that less of the winter precipitation is being stored in the snowpack, and a value greater than one indicates more of the winter precipitation is in the snowpack.

Data

The snowpack SSWE and precipitation data use up to 545 SnoTel stations throughout the western United States, operated by the National Conservation Resource Service. The base period (average) for the SI and all percentages is 1971-2000, and the comparison period is 1981-1999. The precipitation data are cumulative totals from October 1. SWE and precipitation on the first of each month, January-June, are used.

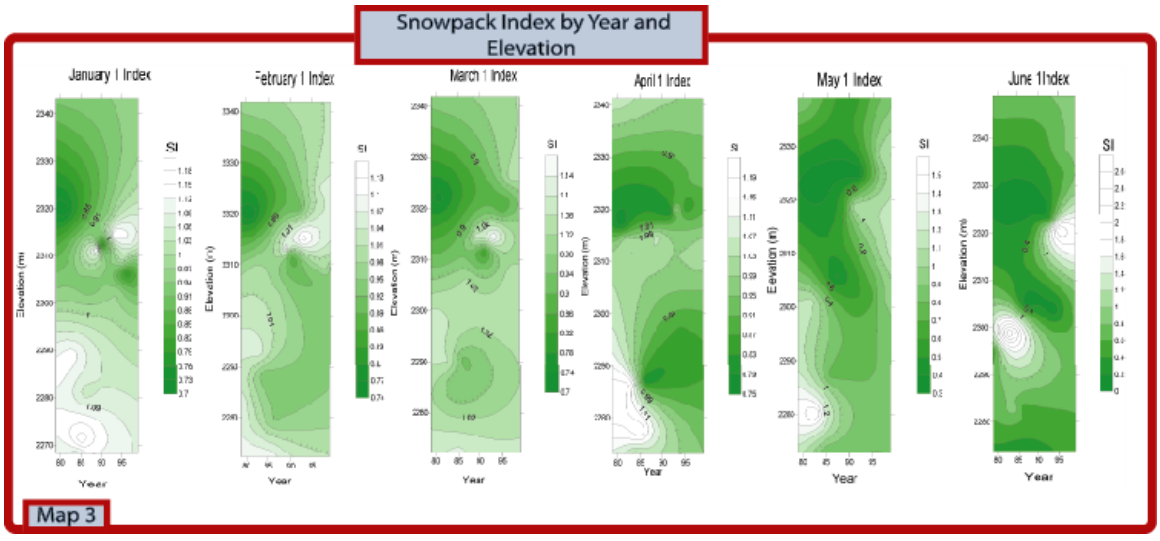
Highlights



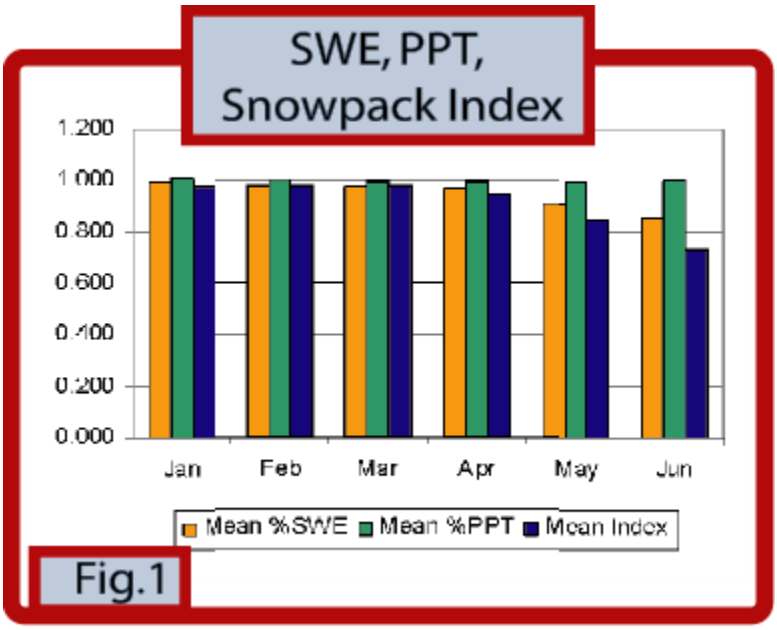


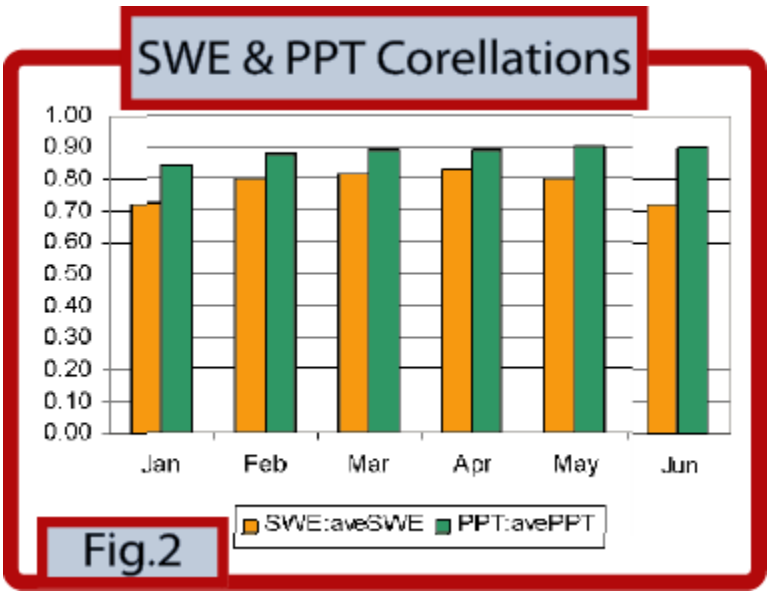
The Western United States as a Whole

Map 1 shows the highest index values (more conductive to snowpack development) lie in a geographical band that runs diagonally NW-SE through the interior western US. The lowest index values are in a parallel band west of the high index band,closer to the Pacific coast. This spatial distribution of index values appears to be quasi-related to elevation (Map 2) moderated by latitude, and storm tracks. The index values tend to be higher at higher elevations, and at higher latitudes.

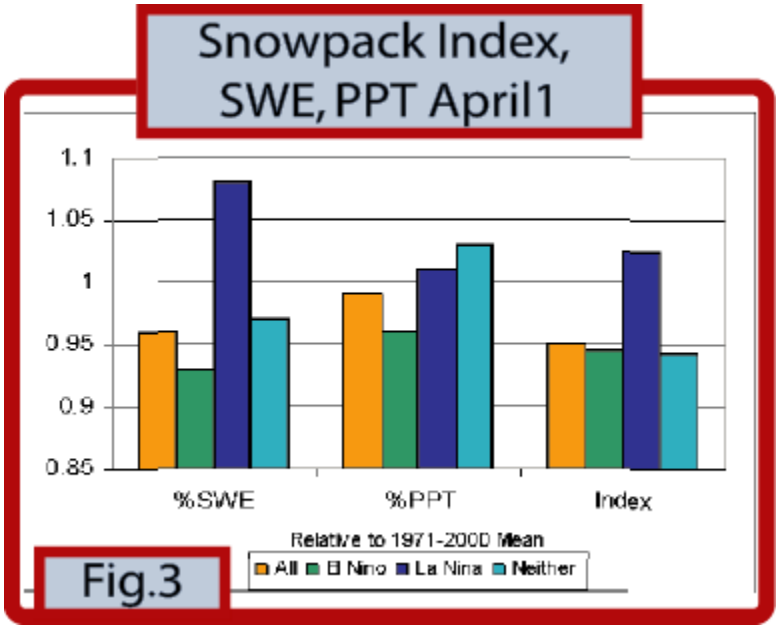


The relationship between time, elevation, and the Snowpack Index for the western US, are shown in Map 3. There is a trend toward lower index values at lower elevations in Jan, Feb, Apr, May, and a trend toward higher values at higher elevations in Jan, Feb, Mar. During early to mid winter (Jan-Mar), an increased SI at mid-elevations in the 1990's suggests that more of the winter precipitation was sequestered in the snowpack. In early spring (Apr-May), the SI declines at lower elevations,suggesting that less of the winter precipitation is banked in the snowpack. June has two high index centers that may be related to the Jan-Mar pattern.





The SI declines every month, but the decline in Jan-Mar is quite small compared to May and June (Fig. 1). This decline is due to less SWE rather than less precipitation. Average SWE is most likely to occur on April 1, whereas average precipitation is most likely to occur on May 1, and June 1 (Fig. 2). La Nina is the only ENSO pase to have a positive effect on the SI (snowpack conductive). This is due to an increase is SWE, not precipitation (Fig. 3).



Regional analysis for April 1 [bounded by 40 N latitude, and 112 W longitude]
La Nina in the northwest (NW) is the only combination of ENSO phase and region, to have SI values above one (Fig. 4). The southeast (SE) and southwest (SW) regions have their highest SI during El Nino, but even then show SI values of less than one, although they receive above average precipitation. In general, areas south of 40N have the lowest SI, and show the most change in SI. The NE shows the least change, and is closest to average. Figure 5 shows that SI variability is least in the NE, and greatest in the NW.

This may indicate regional ENSO influence, as the NE region shows the least variability between the phases of any region in the west.

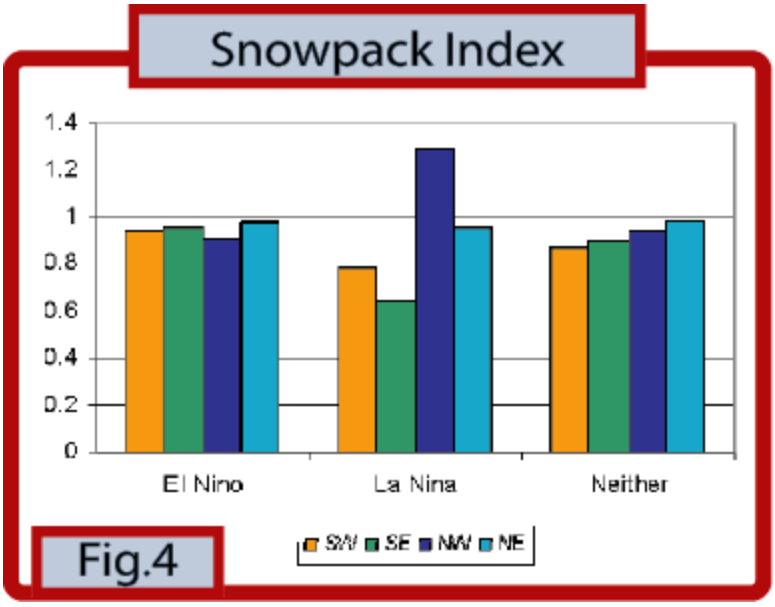


Fig.4

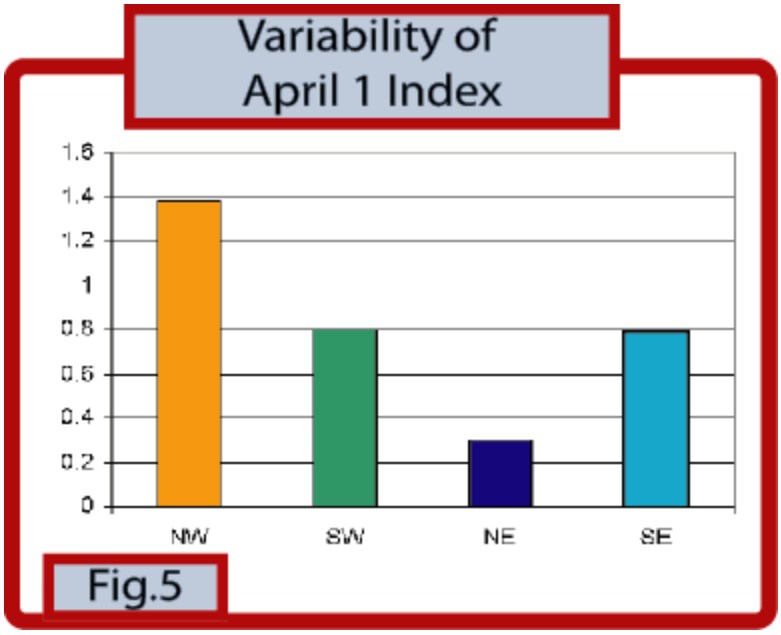


Fig.5

Questions for Future Work

What are the SI characteristics for each mountain range?

What are the non-precipitation climatic factors, and their relative importance to the SI?