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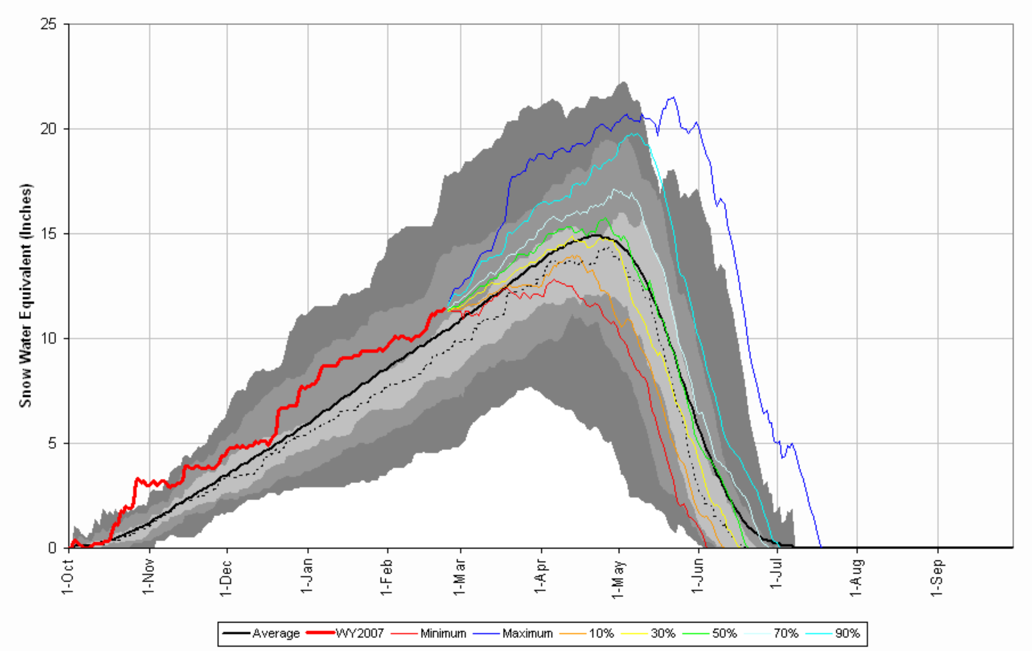
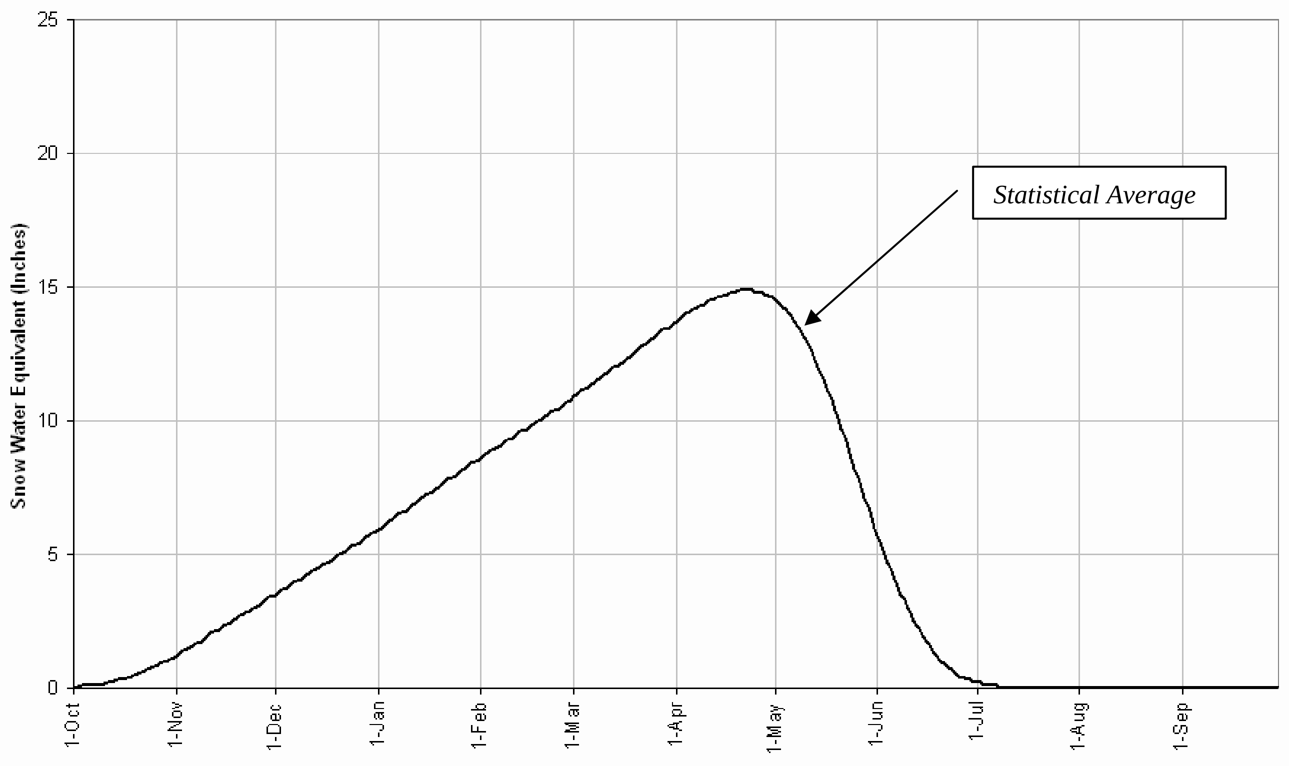
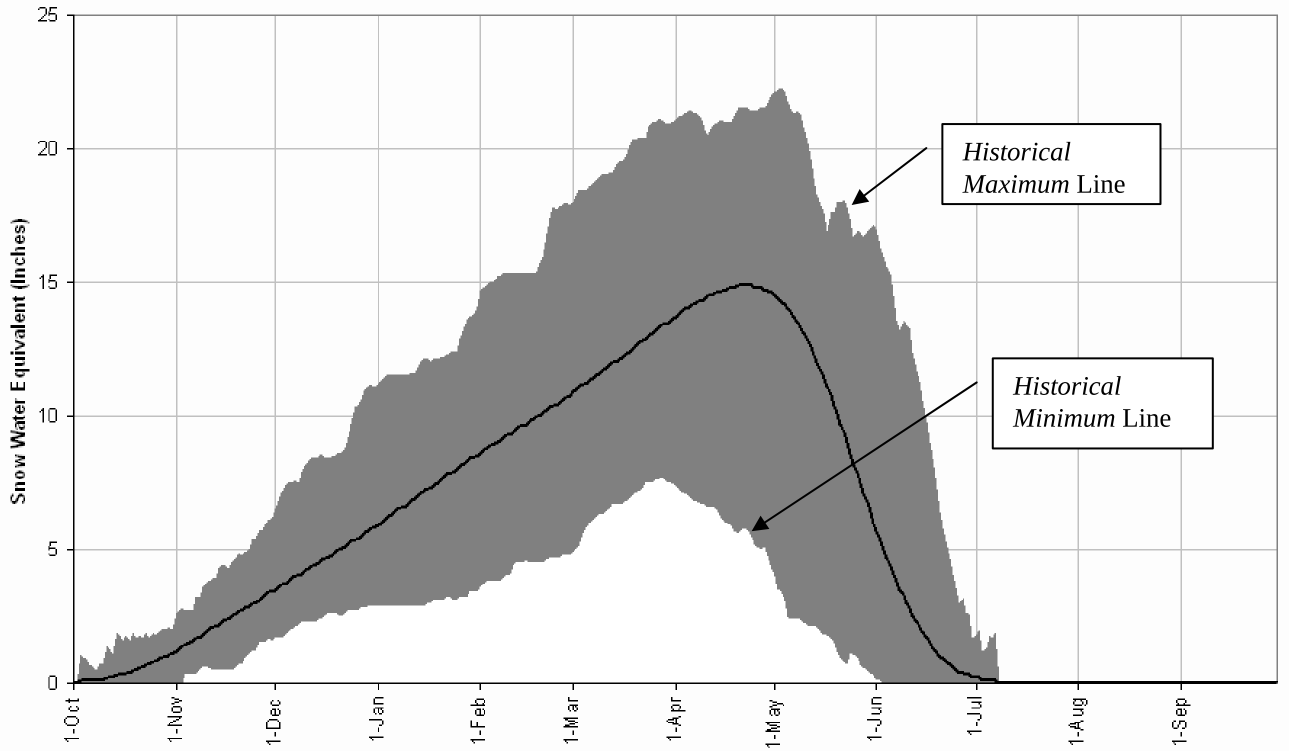


A User's Guide for the Interpretation of Basinwide Snowpack Projection Graphs



Let's begin by looking at the long-term average of the accumulation of snow water equivalent (SWE) in the snowpack within a watershed. The line in the graph above indicates the daily *statistical average* of all SNOTEL sites in the basin.

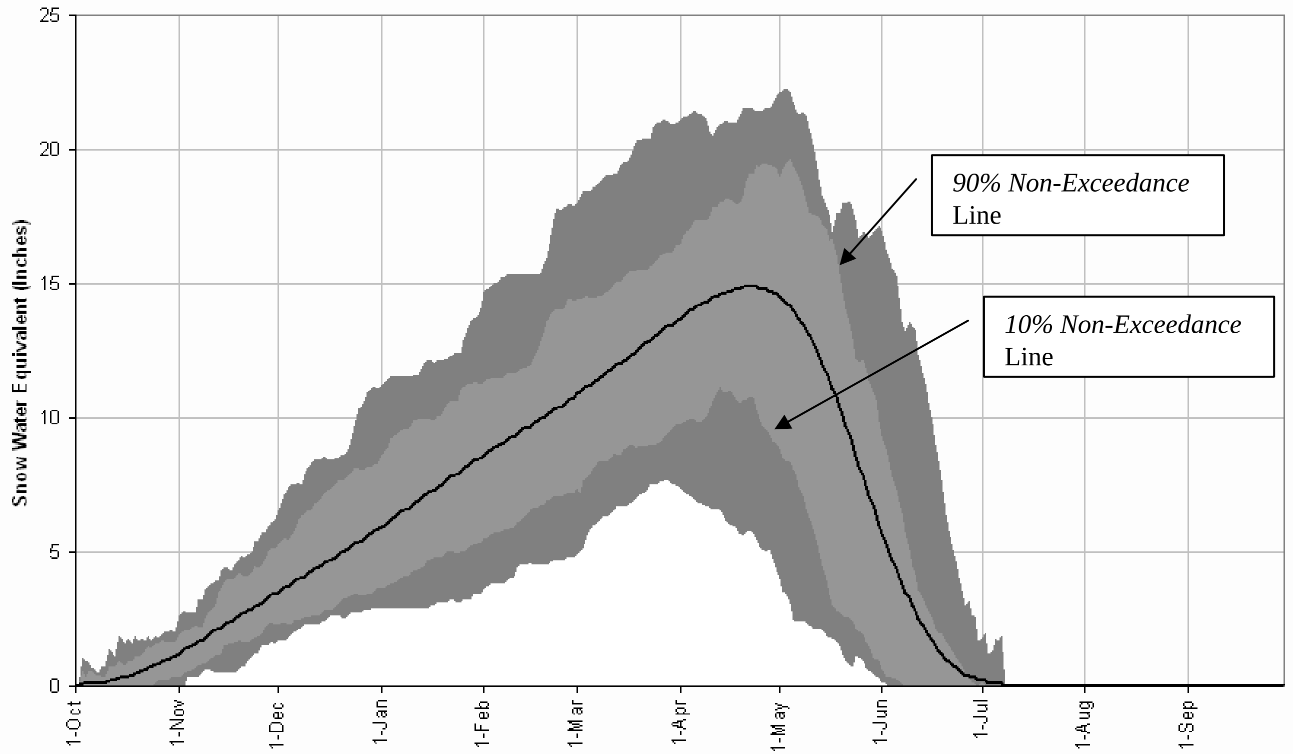


Now let's add two lines to the graph. The lower line shows the *historical minimum* accumulation of SWE that has occurred throughout the year. This information is determined by analyzing the historical data record of all the SNOTEL sites in the basin. Note that this line is *not* showing just the single driest year on record, but plots the lowest, or minimum, snowpack accumulation, for each day of the year regardless of the year in which it might have occurred. So, in reality what's plotted along this line may be composed of multiple year's where SWE dropped to record low values for a period of time.

Conversely, the upper line shows the *historical maximum* accumulation of SWE. Like the line representing the basin's minimum snowpack, this line is based upon the historical snowpack record and shows each day's maximum SWE accumulation. Once again, we're plotting maximum SWE values in the basin, regardless of the year in which they occurred. These basic principals will apply to all the lines we'll add later to this graph, with the exception of our current SWE data and the statistical average line.

If we were to drop below the minimum line or exceed the maximum line we'd be setting a new record minimum or maximum accumulation in the basin for that time period.

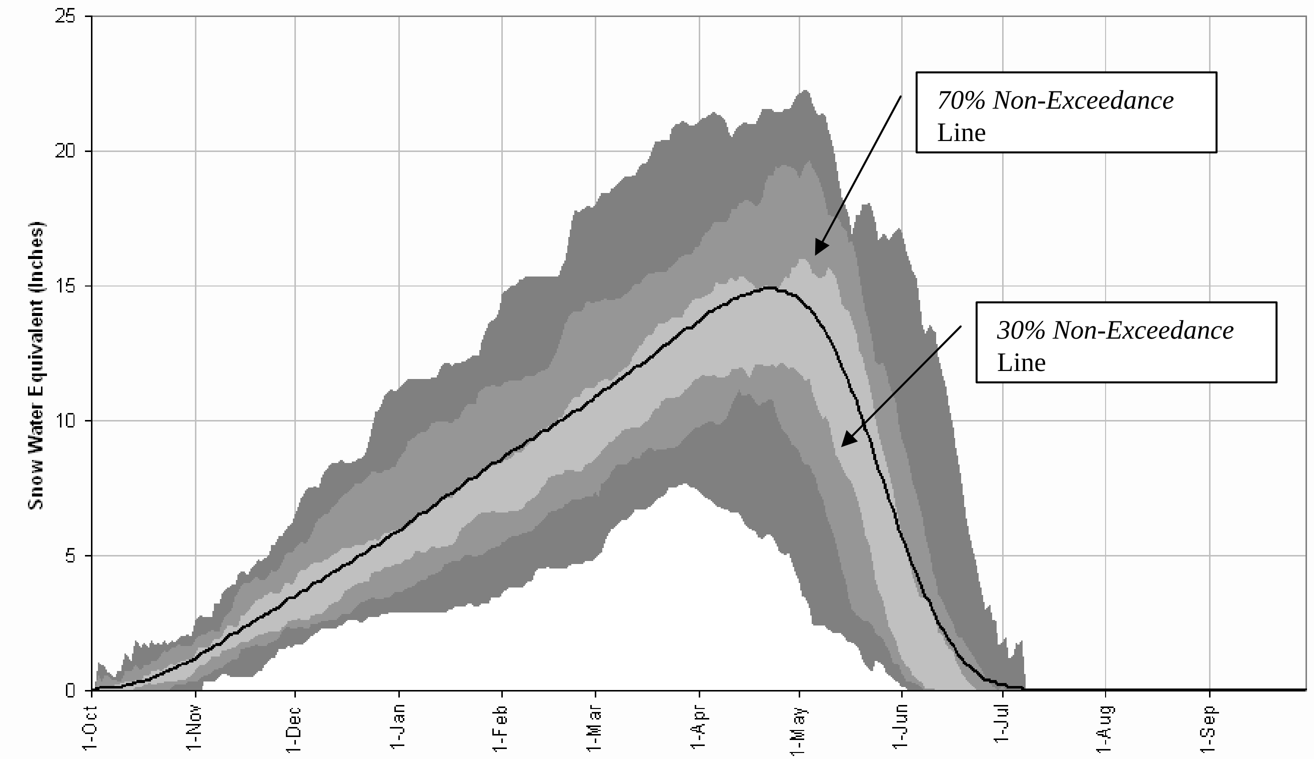
One caution to keep in mind is that we're working with a pretty limited set of historical data. SNOTEL sites have only been in existence since about 1980, so we just now have about 20 to 25 years of data in our historical analysis. If we had say, 100 years of SNOTEL data, our confidence in this analysis would be much more improved, but at the same time, we'd most likely have a wider range of variability in our lines.



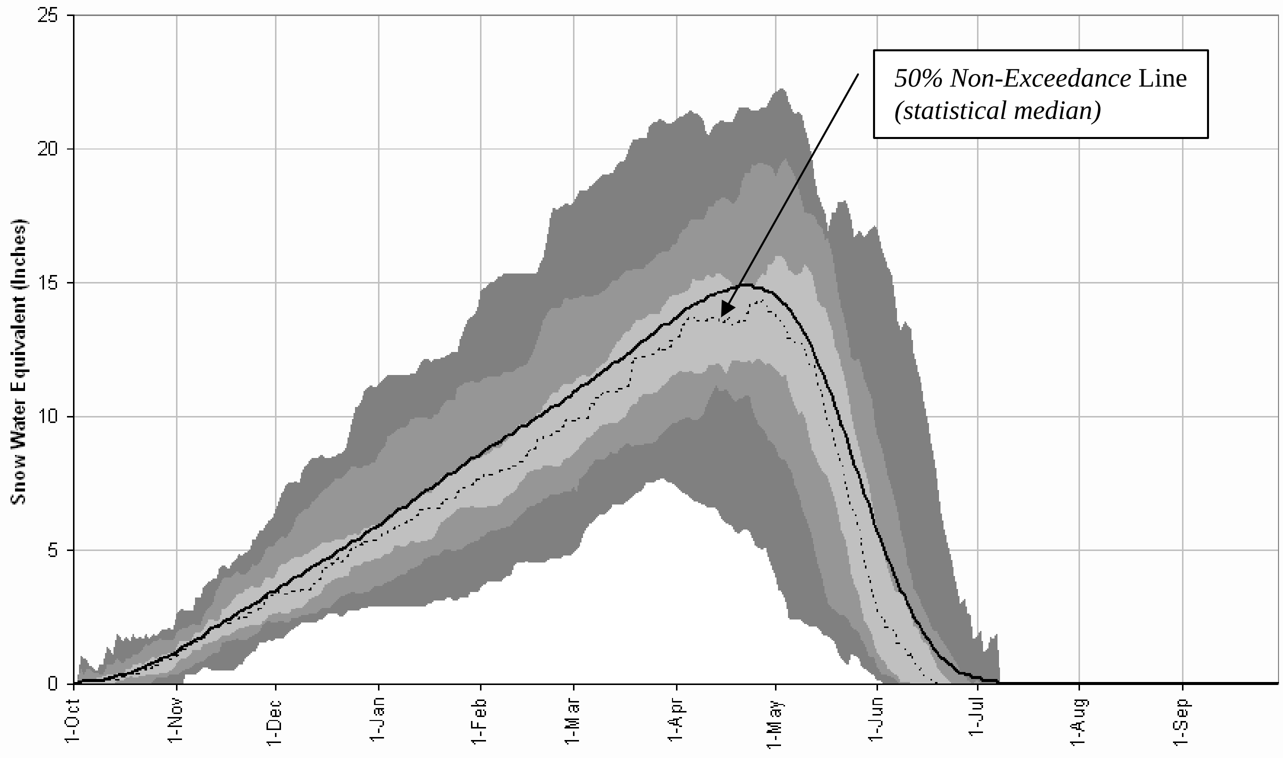
In the illustration above, two more lines have been added to our graph. Once again, these lines are derived from the historical snowpack record of the basin.

The line inserted between the average line and the minimum line is what we call the *10% non-exceedance* line. This sets the boundary where the probability of SWE being less than this amount will only occur only 10% of the time.

The line inserted between the maximum accumulation line and the average line is called the *90% non-exceedance* line. This represents the boundary in the historical record in which 90% of the time any day's SWE value will be below this value.



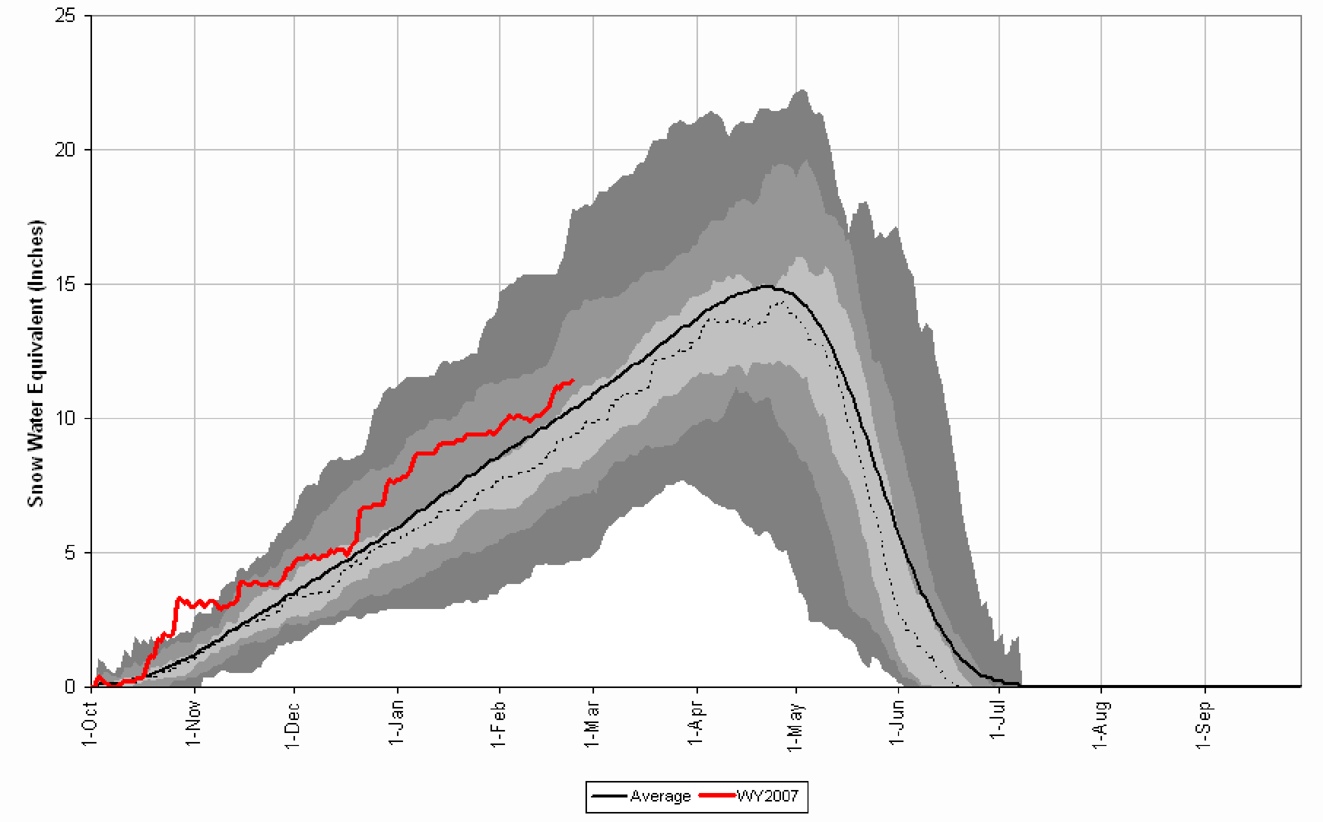
Once again we add two more lines to our graph. These new lines are the *30% non-exceedance* and *70% non-exceedance* lines. As before, they represent the boundary in the historical record in which 30% of the time we can expect to have less SWE than the values shown by the 30% non-exceedance line; and 70% of the time we can expect to have less SWE than the value shown by the 70% non-exceedance line.



In the graph above we have added one additional line. This dotted line represents the *50% non-exceedance* line. As before, this line divides the historical data record down the middle. We can expect to be below this line 50% of the time. This line also represents the *statistical median* of our historical data.

Note that while this line roughly tracks along with the average line, they are *not* the same. Here's the difference: The **average** or the **arithmetic mean** is the sum of all the members of the sample divided by the number of items in the sample. Meanwhile, the **median** is the middle value of the set of numbers. For example, given 10, 10, and 1 as your dataset, the arithmetic mean is 7 (21 divided by 3). However, the median value is 10 (drop a 10 from the high end and the 1 from the low end, which leaves the remaining 10).

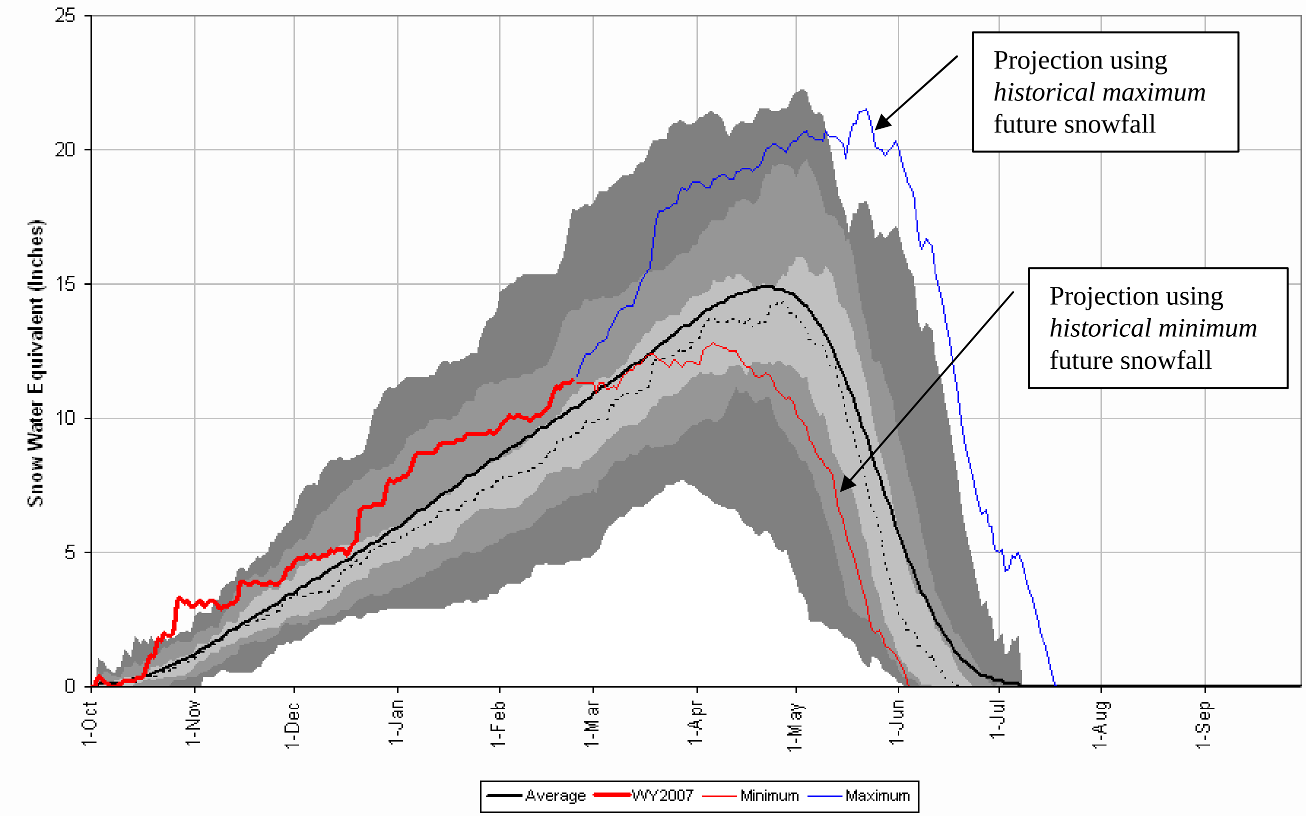
This completes our graph of the probabilities of occurrence within the historical data. Now let's compare how this year's snowpack compares to the historical information.



In this graph, the SWE data for the current water year is added to our graph with the red line. For the most part, it fits within our expected range of values. However, there is one exception. Look at this year's data for late October. We actually exceeded the maximum limits of all previous years of data for a brief period. This probably won't happen very often and <u>will</u> change the shape of the maximum line when this year's data is thrown into the mix of historical data for graphs in future years.

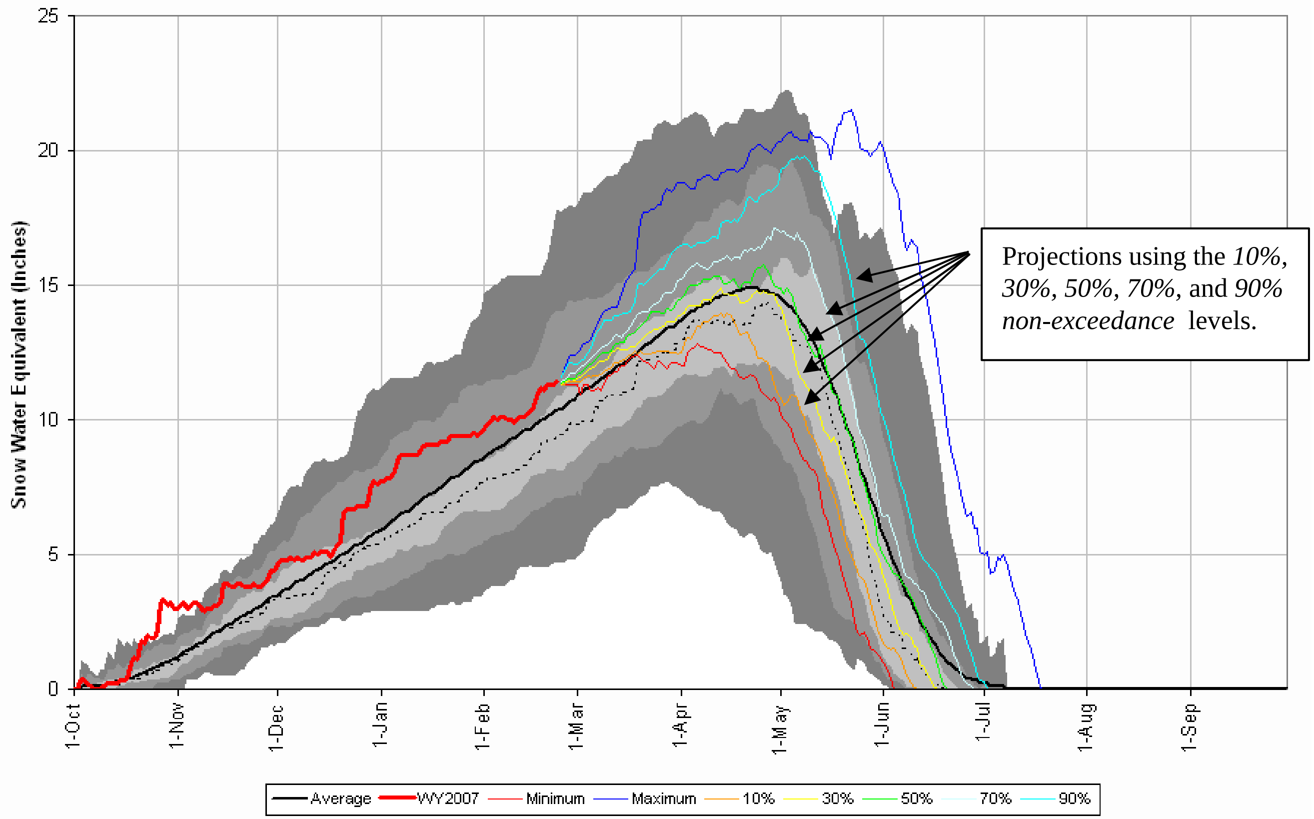
Throughout this year's accumulation we can compare our performance with the expected historical range of values. The increase in SWE during late December and early January improved the snowpack from near median conditions to a snowpack that you would only expect to see in one out of every ten years. At the end of the current year's line (around Feb 23), we can see that conditions have dropped back down to about a 70% non-exceedance, or just within the top 30% of historical years.

OK now, what's in store for the future? We can use our historical data to project future scenarios, given where we are today.



In this graph, we've added two more lines that emanate from our current accumulation line. These lines use the maximum and minimum data we derived from the historical data to project how these future scenarios would appear if our snowpack tracked at these levels for the remainder of the season. Keep in mind that we're using today's known accumulation levels and projecting forward from there.

We can see that following the line for maximum future snowfall will yield a new record level of snowpack by mid-May, but the peak value would not exceed the historical peak value. Also, given this scenario, our melt out wouldn't occur until mid-July, a record-late meltout. On the flip side though, if we have a minimum future snowfall, we can see that our peak SWE would fall somewhere around the 40% non-exceedance value (about mid-way between the 50% and 30% non-exceedance lines), where 6 out of 10 years historically would be greater. While our melt out will be much earlier than average, or the median, it would not be a record early melt out.



In our final plot, we've added five more lines that emanate from our current accumulation line. These lines use our previous 10%, 30%, 50%, 70%, and 90% non-exceedance data to project how these future scenarios would appear if our snowpack tracked at these levels for the remainder of the season. With these additional lines we now have the old adage…"a picture is worth a thousand words." There is a multitude of information that can now be gleaned about future from this graph. For example, one could say that median future precipitation will produce a peak SWE accumulation near the 70% non-exceedance level, where 7 out of 10 years would have lower snowpacks. Or, that we only need future precipitation that follows the 30% non-exceedance line to reach our average peak SWE. Or, our odds of reaching an average peak accumulation this year is about 70%, definitely in our favor. Just a note of caution…when using these projections, the user should not interpret these as a forecast for a specific event. In our example our projected median snowpack line reaches a maximum on April 26th at 16.2 inches of SWE. That's should not be interpreted as our expected peak snowpack. Since this is our 50% non-exceedance line, all we can interpret this as is a 50% chance we'll be above, and a 50% chance we'll be below any point along this line.

Also, the user may want to build in some assurances. Let's say, "What happens if, like last year, we see very little snowpack accumulation?" One might follow the 10% exceedance line and to estimate how future events might unfold. There's nearly an endless way of looking at how the future might play out. These products become especially useful when snowpack conditions deviate further and further away from average or normal conditions. Given a dry start to the year, if the maximum projection remains below the average line, it would take a future snowpack accumulation that has not been seen in the data record to bring conditions back to normal.

These snowpack projection graphs are a useful tool to help water users anticipate what the future might hold for the coming runoff season. Different users have different information needs and these graphs provide a wide scope of information to assist in planning.