Snow Depth Prediction for 2012

By Bruce A. Peterson

The maximum depth of the winter snow in the Australian Alps varies from year to year. If these variations were random, then the best guess for next year's maximum snow depth would be the average depth. However, if a linear trend and some cyclical factors are present, then it should be possible to quantify these, and make a better guess.

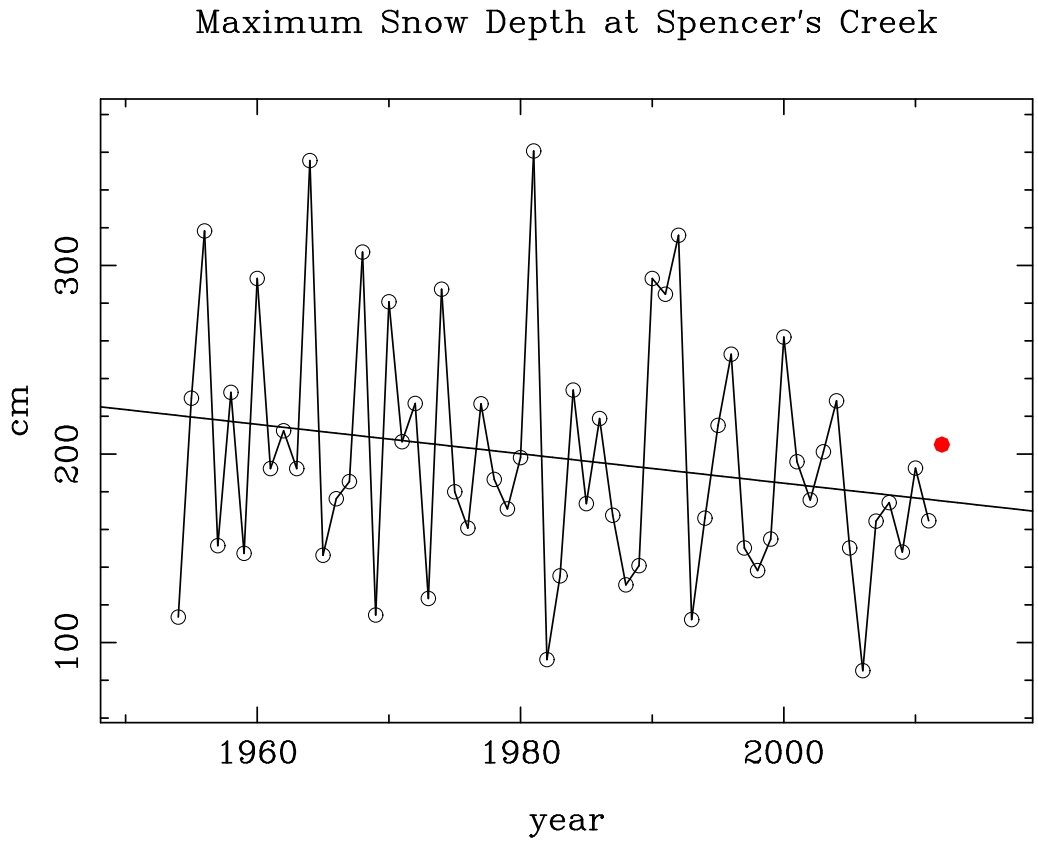

Figure 1. – Maximum snow depth in cm for each year (open circles joined by line) as measured by the Snowy Mountains Hydro-Electric Authority at Spencer's Creek in the Australian Alps, and the predicted 2012 maximum snow depth using maximum entropy and linear prediction (red filled circle). The sloping line represents the linear least squares fit to the measured show depths.

From inspection of Fig. 1, it appears that an exceptionally good year is often (but not always) followed by several poor years, and that there appears to be a systematic decrease in snow depth with time. I have analyzed the year to year fluctuations assuming that, in addition to a purely random component, there are periodic components which can be derived from the historical measurements, and that these can be used to predict future behavior. In addition to random

fluctuations, a decrease of 0.8 cm/year and cyclic components with periods of about 4 years and were found, and used to predict the maximum snow depth for next year.

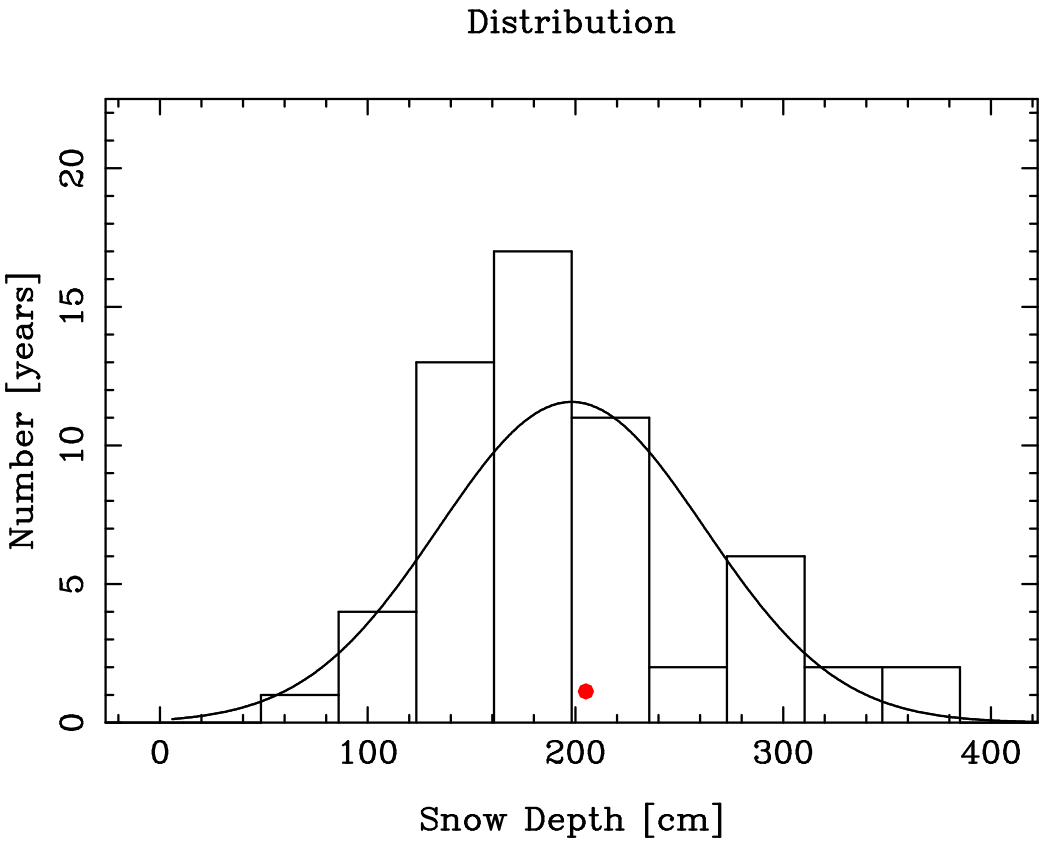

Figure 2. – Distribution of maximum snow depths. Actual values are represented by the solid line histogram. For comparison, a random distribution with the same average value and variance is represented by the curved line. The predicted 2012 value is 6.8 cm above the average, and is shown as a red filled circle.

As can be seen in Fig. 2, years with low snow depths occur more often than expected from purely random variations, as do exceptional years with depths exceeding the average by more than 100 cm. Slightly above average years occur with the expected frequency.

The prediction for 2012, based on the measurements from 1954 through 2011, is for a maximum snow depth of 205.0 cm, only 6.8 cm more than the 198.2 cm 58 year average, but 29.9 cm above the 175.1 cm expected from the decreasing linear trend, and 40.4 cm above the 164.6 cm in 2010.

We can expect 2012 to be a little better than 2011, and close to the 58 year average.

I computed the maximum entropy and linear prediction values made with a varying number of poles, and found that the minimum of root-mean-square differences between the predicted and actual values was obtained using only 4 poles.

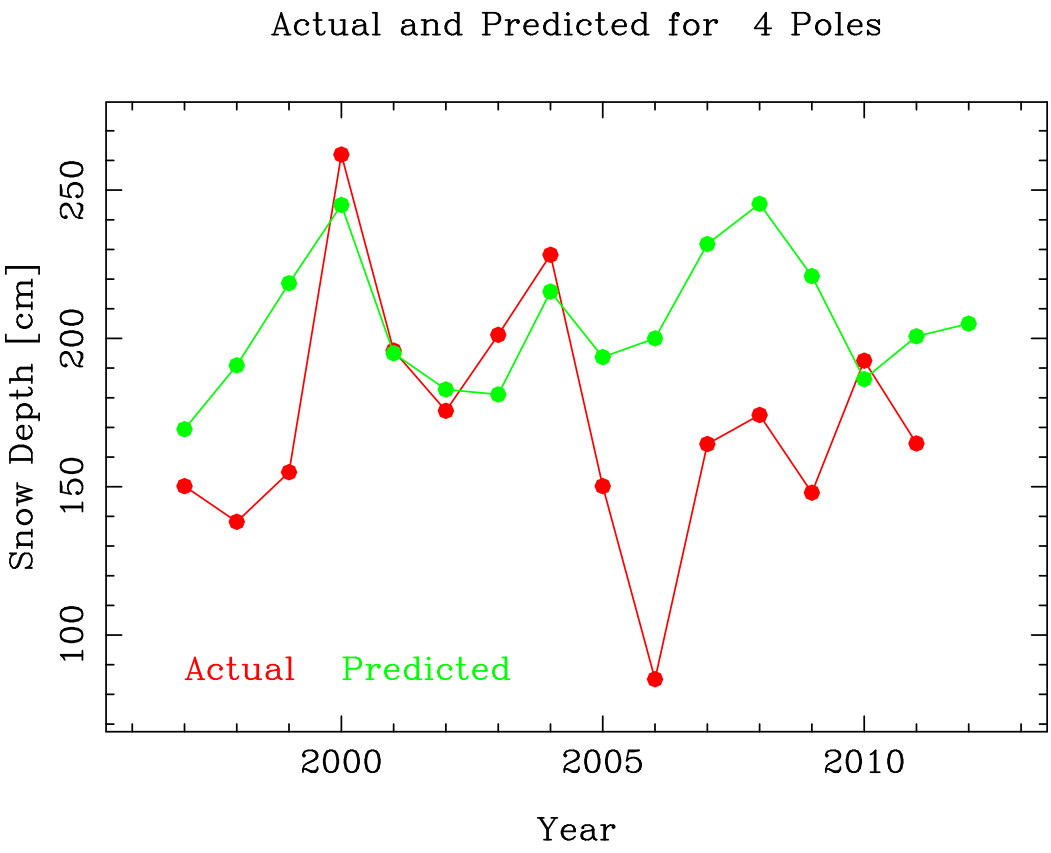

Figure 3. – A Comparison of Predicted and Actual Snow Depths. Each prediction uses all of the historical data up to, but not including, the year being predicted. The actual depth is that measured for the year being predicted.

The predictions for 2005 through 2009 are much higher than the actual depths. One suggested explanation was that the lower snow depths were being caused by the cloud seeding that started in 2004. However, the 2004 and 2010 actual depths are near those predicted from the historical data, and a minimum of seeding was done in the lowest year, 2006. A different explanation might be that global warming has increased the temperature sufficiently for the precipitation to fall as rain instead of as snow. Note that in 2010, most of the snow came in a short period of very cold weather, so the agreement in 2010 could still be consistent with this explanation. In 2011 the maximum snow depth came in August, and the warm weather produced poor snow conditions and no September accumulation.