Blame Utah's worst air on the North Pole

Cold winters have brought a big chill to America and, along with such conditions; Utah has experienced some of the most prolonged air quality degradation in the nation.

Blame it on the Arctic Oscillation.

The Arctic Oscillation is a unique pattern of natural climate variability and was in a negative phase – a particular mode that can bring in cold, snowy weather to both the central US and central Europe. In fact, the Climate Prediction Center of NOAA (the National Oceanic and Atmospheric Administration) has published data that shows the Arctic Oscillation index reached -5.5 in late December and again in January – the most negative since 1950. Figure 1 shows the values of the Arctic Oscillation index from October 2009 thru February 2010. The widespread cold winter in both sides of the Atlantic Ocean has been attributed to, at least in part, the unusual strength of the Arctic Oscillation.

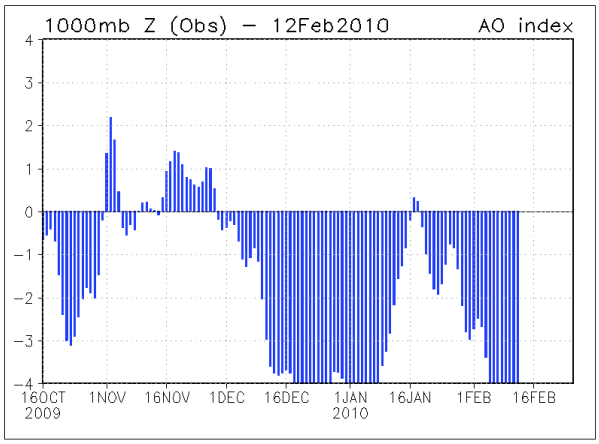

Figure 1 -- Arctic Oscillation Index, Oct 2009 – Feb 2010

What is this Arctic Oscillation?

The Arctic Oscillation describes an atmospheric "seesaw" pattern in surface pressure between the mid and high latitudes in the northern hemisphere. It involves the strengthening and weakening of the polar vortex — the counterclockwise rotation of air surrounding the North Pole. The change in the polar vortex leads to the modification of two giant low pressure systems over the North Pacific Ocean and the North Atlantic Ocean. In the negative phase of the Arctic Oscillation, these low pressure systems deepen and the area between them – the high pressure – becomes even more pronounced. It is this developing high pressure that persists over the West and the Intermountain west – an extraordinary event that while it mostly results in nice clear sky conditions, has a more sinister side to it.

So what does this Arctic Oscillation have to do with Utah's red-air days?

Air quality, as determined by the density of tiny particles in the air, fluctuates with atmospheric inversions. Inversions occur when a layer of warm air sits on top of a layer of colder air, preventing the particulate pollution from rising away from the surface. What many Utahans may not know is that inversions are normal and happen nearly every day! They typically form in the early morning hours, but then “break” by mid-morning as the sun warms the surface.

Sometimes, however, conditions will cause the inversions to persist all day, even all week. It is these inversions that tend to be problematic.

Such inversions rely on a "favorable" weather pattern for support — specifically, high pressure west of (or over) Utah that persists for a long period of time, say two weeks. As noted earlier, when the Arctic Oscillation moves into a negative phase, it strengthens the high pressure ridge over the West Coast; this is why we have those extended bad-air periods. At the same time, “cleansing” low pressure systems coming in off of the Pacific are blocked and cold air is allowed to build over Canada. The resulting cold air mass eventually collapses and it is this that subsequently swipes the Central and Eastern parts of the US all the way to southern climes.

Forecasting such long-lived inversions and bad air quality isn't easy. "We found that long-duration inversions are attached to a certain climate mode which normally repeats itself every 30 days, but this isn't good news for weather forecasting because such a time scale exceeds the capability of modern weather prediction models", said Dr. Robert Gillies, State Climatologist and Director of the Utah Climate Center at Utah State University. Scientists have found that the Arctic Oscillation also exhibits a repeating pattern about every one month, but its cause remains largely unclear.

Looking at the recent model output (as seen in Figure 2) the projection, Gillies says, “… suggests that we are entering into another negative phase of the Arctic Oscillation which will bring us at least another week of persistent inversions, but for the remaining days of February the inversion conditions should be weaker than has occurred earlier this winter”.

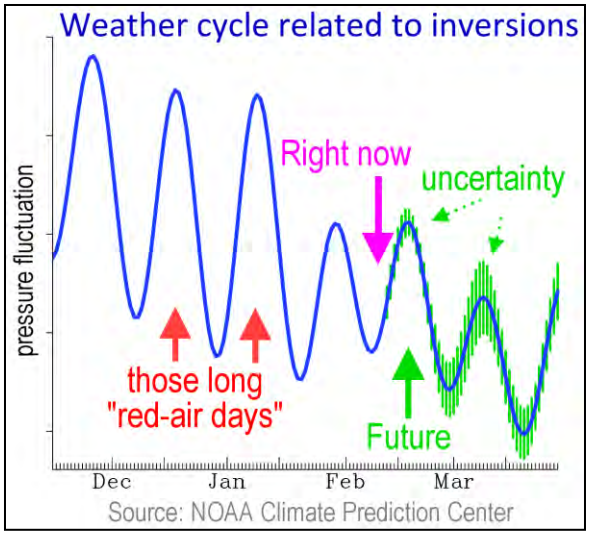

Figure 2 -- Model Projections of High Pressure Development over Utah, Nov. 2009 - Mar. 2010