

FEATURE ARTICLE I

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# Global Warming, Climate Change, and YOU

## (Are Disruptive Weather Patterns a Sign of the Times?)

Since the last ice age ended about 14,000 years ago, the earth's surface temperature (atmosphere and oceans) has been in a warming trend. Over long periods of time, the planet's temperature is not stable or uniform, but instead goes through cycles of cooling (ice ages) and warming (see Figure 1). Even within our current warming trend, there have been cooling cycles including the "Little Ice Age" in the northern hemisphere from roughly 1400AD to 1800AD. So yes, the planet is undergoing a cycle of "global warming," which isn't so bad considering humans are warm blooded mammals and don't do very well during ice ages...

However, concerns about global warming have increased greatly over the last few years, primarily because it appears that the average temperature of the planet has been increasing at a much faster rate than expected. Reasonably accurate measurements show that the average global temperature near the earth's surface increased by as much as 1.3°F over the last 100 years (see Figure 2). But if current climate model projections come true, the earth could warm another 2° to 10°F by the end of this century. On a geologic time scale, increases in earth's temperature of several degrees in less than a hundred years are very unusual, and this could have drastic consequences for life on earth in general, and for highly populated areas in particular - because of melting polar ice caps, coastal flooding, and climate change (droughts, desertification, etc.)

An apparent cause of rapid global warming has been identified (Figure 3). Certain gases and aerosols (primarily CO<sub>2</sub> and CH<sub>4</sub>) in the upper atmosphere are blocking re-radiation of heat from the sun back out into space, thus trapping heat near the planet's surface. This is referred to as the 'greenhouse effect' and the suspect gases are called 'greenhouse gases.' The accumulation of greenhouse gases is mainly attributable to the rapid industrialization of human society since the early 1800s, the use of fossil

fuels (coal, crude oil, natural gas) as a primary source of energy, and the cutting down and burning of forests for agriculture (deforestation). More than 5 billion tons of CO<sub>2</sub> are released into the air on an annual basis in the USA alone. It is estimated that worldwide CO<sub>2</sub> release in 2007 increased 0.6% to 19 billion tons worldwide. Measured atmospheric CO<sub>2</sub> levels are approaching 400 PPM, a concentration not reached in the last 500,000 years or so, as estimated from geologic records (mostly ice cores).

As mentioned previously, it is very likely that rapid global warming is going to cause significant changes to existing climatic patterns, depending on the region of the earth where you live. Our 'climate' is defined as the long-term average of weather conditions - seasonal average temperatures, rain and snow patterns, wind, etc. Our 'weather' is defined as the day-to-day condition of the atmosphere, and is a more chaotic,

non linear system (and thus harder to predict!). Until recently, we have viewed regional climate conditions as fairly stable and predictable. Now, with the advent of rapid global warming, we have changed that perception. For example, in northern Illinois we may see our humid/continental ("semi-cool") climate convert to a more humid/subtropical or semi-arid/subtropical climate. In terms of the turfgrasses, we may have weather

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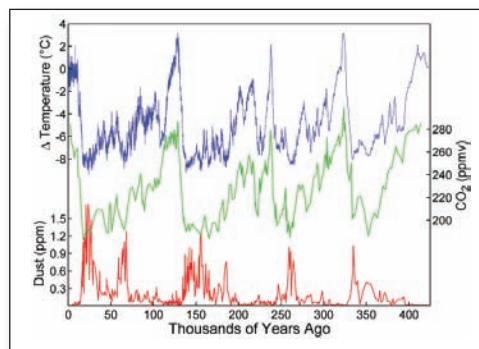


Figure 1.  
420,000 years of ice core data from Vostok, Antarctica research station. Current period is at left. High dust levels are correlated to cold, dry periods. (<http://en.wikipedia.org/wiki/Image:Vostok-ice-core-petit.png>)

conditions more like those currently experienced in the transition zone (think St Louis area or southern Illinois). We have had a few summers like that already, but these environmental conditions could become the norm in the next 25-50 years. (see Figure 4) Do we have zoysiagrass in our future??? Buffalograss roughs, anyone???

Actually, what may be more likely in our near-term weather future are wider (wilder) swings in our day-to-day weather events. When the atmosphere holds more heat energy, severe storms are more likely to occur. Spring and summer thunderstorms could become more severe, with higher winds and more frequent tornados. Heavy, flooding rains could occur more frequently with these severe thunderstorms. Summer heat waves could be more severe and long-lasting (e.g. 1995), and high temperatures could persist into September and October. When cold weather fluctuations occur, snow and ice storms could be worse than we have experienced.

After the last few months of cold and snow, it's a little hard to believe global warming is an imminent threat. But don't confuse a short-term weather fluctuation with the bigger issues of climate change. It seems we've caught a break with a recent fluctuation in the 'southern oscillator' El Nino/La Nina phenomenon. The southern Pacific Ocean water temperature has cooled over the last 12 months or so ('La Nina'), and this is correlated with cooler temperatures in the north eastern and north central USA. Note that the southern oscillator is not the cause of this weather change, but an indicator of a probable weather change to come! Water temperatures in the Pacific Ocean and the Gulf of Mexico, along with surface and subsurface ocean currents have a very strong and complex interaction with the atmosphere to affect our weather. The long-term trend is still hotter... El Nino will return!

Now you know a little about global warming and the potential for climate change. So, what are you gonna do about it? First of all, we need to continue to promote golf courses as benefitting the environment. Green space is good! We need more plants to pull CO2 out of the atmosphere and reduce greenhouse gases. Also, golf course turf helps cool surrounding environments in urban areas (blacktop and concrete get hot!). We also need to support development of alternative

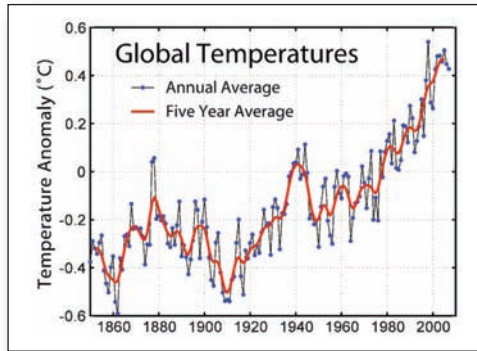


Figure 2.  
Global mean surface temperature anomaly relative to 1961-1990 mean. ([http://en.wikipedia.org/wiki/Image:Instrumental\\_Temperature\\_Record.png](http://en.wikipedia.org/wiki/Image:Instrumental_Temperature_Record.png))

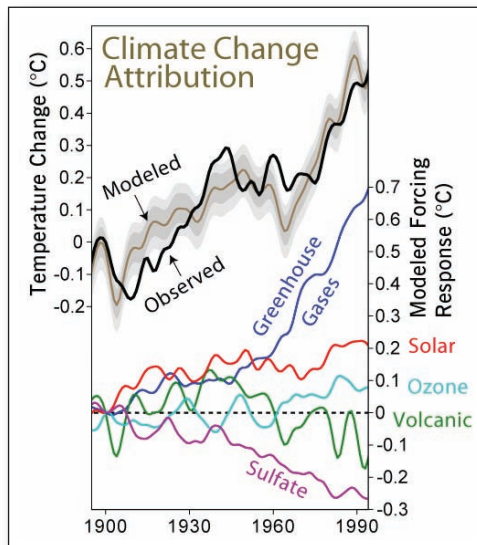


Figure 3.  
Graph of a global climate model that reconstructs the historical temperature record and the degree to which the associated temperature changes can be decomposed into various 'forcing' factors. ([http://en.wikipedia.org/wiki/Image:Climate\\_Change\\_Attribution.png](http://en.wikipedia.org/wiki/Image:Climate_Change_Attribution.png))

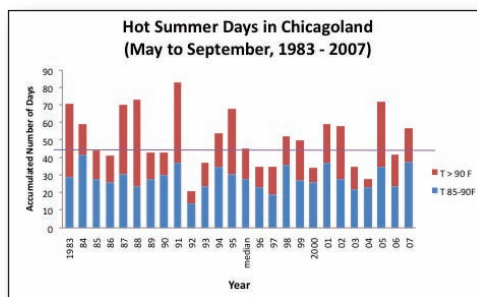


Figure 4.  
Bar chart of the number of days per year where the daily high temperature exceeded 85F or 90F in the Chicago area (data from Aurora and O'Hare Stations). Note that the frequency of hot summers does not appear to be increasing over this 25 year time span...

energy sources and utilization of equipment that has electric or hybrid electric motors, or runs on biofuels or diesel alternatives. (Hey, how about a windmill instead of a cell phone tower next to the maintenance shop??? Just kidding..)

Another thing to think about is planning for weather extremes. Does your course sit near a flood plain, or is it part of a flood control plan? Are there areas on the course where drainage improvements can be made or emergency flood water can be stored? What about drought planning and the potential for irrigation water restrictions if the weather patterns go the other way? Are there alternative sources of water available to use for irrigation (e.g. recycled or wastewater/effluent sources)? If you haven't already, you may want to consider renovating key turf areas with some of the newer, heat tolerant types of cool season turf.

I am sure you can think of a thousand more questions about global warming and the implications for golf turf management. It may be a few years before some of these issues become critical, but you may want to start thinking about, and planning for, some of the potential problems we will face on the golf course if our weather takes a turn for the worse. Anything we can do to ease our COs loading of the atmosphere should help... just don't hold your breath!

Author's note: This is a fairly simplistic look at global warming and climate change issues. For a deeper understanding of the atmospheric and oceanic science of global warming - and surrounding controversies - I suggest the following resources:

Websites: [www.wikipedia.org](http://www.wikipedia.org) (search 'global warming' or 'climate change')  
[www.nytimes.com](http://www.nytimes.com) (search articles/blog by Andrew C. Revkin)

Books: The Discovery of Global Warming by Spencer R. Weart (2003 Harvard University Press, Cambridge MA)

Storm World: Hurricanes, Politics, and the Battle Over Global Warming by Chris Mooney (2007 Harcourt Press)