Climate Change 6 — Has Climate Already Changed?

As we review some current signs of climate change, we will not be concerned with temporary local changes, such as the drought in the Southeastern U.S. in 2007. There is no telling if a local change is part of a larger pattern until many years have passed. Rather, we will be concerned with broad, slow changes with global implications that have lasted for decades. The changes mentioned below are all described in the Executive Summary of the IPCC report.[i]

Warmer temperatures:

- Of the 12 hottest years on record, 11 of them have occurred since 1995.
- The atmosphere has warmed .76°C (1.4°F) over the last 100 years. The warming has accelerated: it is now .13°C (.23°F) per decade.
- The temperature increase has also occurred in the oceans to a depth of at least 3000 ft. Water expands slightly as it warms, causing sea levels to rise.
- Temperature in the Arctic has been rising at twice the global rate. The area covered by permafrost has been shrinking.
- Cold days, cold nights, and frosts have decreased. Hot days, hot nights, and heat waves have increased.

Water cycle changes:

- Mountain glaciers and polar ice caps[ii] are melting, and the rate of melting is accelerating.
- Continent-sized ice fields in Greenland and Antarctica are melting.
- Sea levels rose at an average rate of 1.4 mm/yr between 1961 and 1993. Between 1993 and 2003, they rose at an average rate of 3.1 mm/yr. (about 1/9 in.).
- Atmospheric water vapor content has increased since at least the 1980s (recall that slight warming caused by CO_2 leads to increases in atmospheric water vapor, and that is the main engine of global warming — see the previous several white papers).
- Long-term alterations in precipitation (trends affecting large regions that have continued for more than 100 years) have been observed. Parts of North and South America, northern Europe, and southern and central Asia are wetter. The Sahel, the Mediterranean, southern Africa, and parts of southern Asia are dryer. In general, precipitation is highly variable year-to-year and place-to-place.
- Arctic and Antarctic oceans are getting less salty (consistent with fresh water inflow from melting ice caps). Equatorial waters are getting more salty (consistent with greater evaporation due to higher temperatures).
- Mid-latitude westerly winds have increased (that includes the U.S.).
- More intense and longer droughts have been observed in tropical and subtropical regions.
- The frequency of heavy precipitation events has increased over most land areas.

The changes described above are consistent with those predicted by climate change models, offering support for the conclusions of those models. Notice, however, that they are not the kind of apocalyptic pronouncements bandied about in the popular media. In the next white paper we will discuss the potential for such apocalyptic outcomes.

[i] IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 5ff.

[ii] The polar ice cap is a layer of ice that sits on the Arctic Ocean. Ice in a glass of ice tea does not cause the glass to overflow as it melts because, before it melted, the ice was already taking-up space in the tea. The ice changes to liquid, but doesn't take up much more space. Similarly, ice in the polar ice caps is already in the ocean. When it melts, it does not take up that much more space, so it does not make the oceans rise greatly. To make the oceans rise, the melting ice must be sitting on land, like a glacier or like the Greenland and Antarctic ice sheets. They are not already in the ocean, so when they melt, their volume is added to the ocean, causing it to rise.