9. Climate Change in the 20th Century

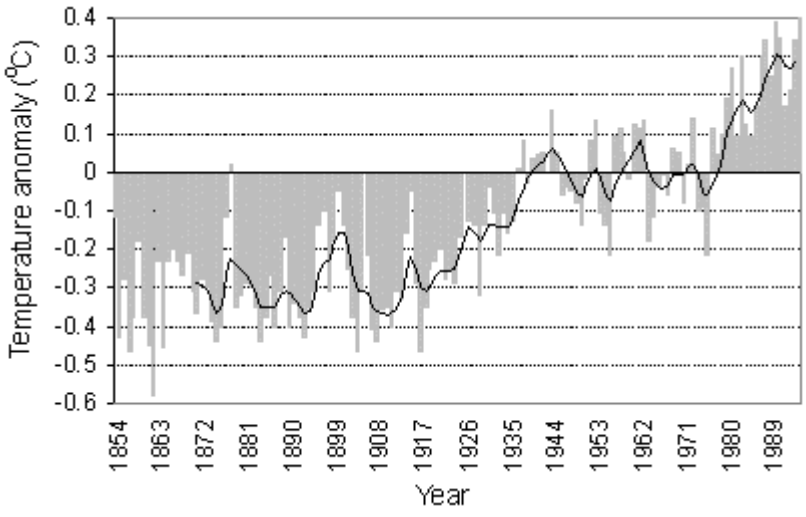
Introduction

There is now considerable evidence that indicates a relationship between the man-made enhancement of the natural greenhouse effect through greenhouse gas emissions and the observed global temperature increase during the twentieth century exists. This fact sheet reviews temperature, and other recent climatic changes which have occurred during the 20th century.

Surface Temperatures Variations

Combined land and ocean temperatures analyses indicate that during the last decade globally averaged surface temperatures have been higher than in any decade in the past 140 years. Over the whole period, a global temperature increase of about 0.6^{o}C has been observed.

Global average surface temperature increase



Temperatures have increased rather differently in the two hemispheres. A rapid increase in the Northern Hemisphere temperature during the 1920s and 1930s contrasts with a more gradual increase in the Southern Hemisphere. Both hemispheres had relatively stable temperatures from the 1940s to the 1970s, although there is some evidence of cooling in the Northern Hemisphere during the 1960s. Since the 1960s in the Southern Hemisphere but after 1975 in the Northern Hemisphere, temperatures have risen sharply.

Whilst globally averaged records offer a means of assessing climate change, it is important to recognise that they represent an over-simplification. Significant latitudinal and regional differences in the extent and timing of warming exist. In addition, winter temperatures and nighttime minimums may have risen more than summer temperatures and daytime maximums.

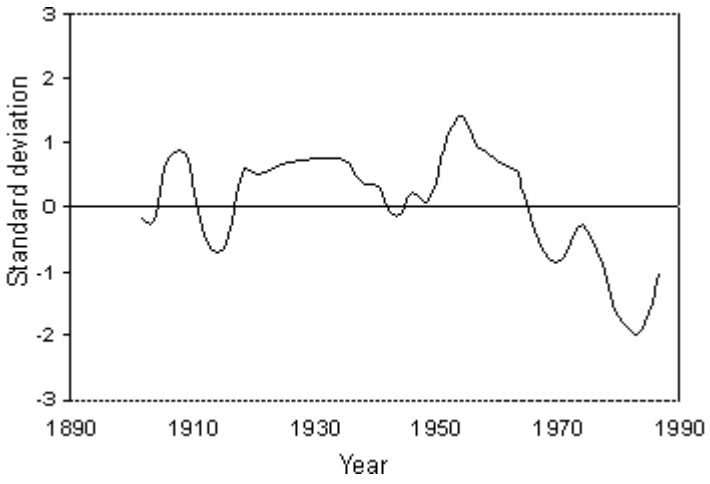
Precipitation Variations

With globally increasing temperatures, increases in global rainfall and other forms of precipitation would be expected, due to the greater rates of evaporation of sea surface water. Unfortunately, no reliable estimates of evaporation increase exist. One problem is the effect of varying wind speed on evaporation rates, which may or may not be related to increases in temperature.

Several large-scale analyses of precipitation changes in both hemispheres have been carried out. These have demonstrated that during the last few decades precipitation has tended to increase in the mid-latitudes but decrease in the Northern Hemisphere subtropics. A striking precipitation decrease occurred in the African Sahel between the 1960s and 1980s. This dramatic desiccation has been linked to changes in ocean circulation and tropical Atlantic sea surface temperatures. Nevertheless, the accuracy of other precipitation records should be treated with caution. Precipitation is more difficult to monitor than temperature due to its greater

geographical variability. Other uncertainties in the data set may be due to the collection efficiency of raingauges.

Precipitation changes in the Sahel



Tropospheric and Stratospheric Temperatures Changes

Lower atmosphere (tropospheric) and upper atmosphere (stratospheric) temperatures are central to the problem of greenhouse warming, because climate models predict that temperature changes with enhanced concentrations of greenhouse gases will have a characteristic profile in these layers, with warming in the mid-troposphere and cooling in the much of the stratosphere. The cooler stratospheric temperatures would be an expected consequence of the increased trapping of energy from the Earth in the troposphere. Over the globe as a whole, mid-tropospheric temperatures have increased between the 1970s and 1990s, in parallel with surface temperature. Temperatures in the lower stratosphere on the other hand have decreased, as expected, especially since 1980.

Variations in the Cryosphere

Variations in cryospheric variables, such as snow, ice and glacial extent occur in response to changes in temperature, sunshine, precipitation, and for sea-ice changes in wind. Since 1966 Northern Hemisphere snow cover maps have been produced using National (U.S) Oceanographic and Atmospheric Administration (NOAA) satellite imagery. Consistent with the surface and tropospheric temperature measurements is the decrease (by about 10%) in snow cover and extent since the late 1960s. There has been a widespread retreat of mountain glaciers in non-polar regions during the 20th century. Variations in sea-ice extent have also been reported, with spring and summer sea-ice extent in the Northern Hemisphere decreasing by between 10 an 15% since the 1950s. Furthermore, considerable interest in retreating sea ice has been generated by the disintegration, in the last few years, of the Larsen Sea Ice Shelf adjacent the Antarctic continent. In view of the rapidity at which it is taking place, such an event has been viewed as a signal of global warming.

Variations in Atmospheric Circulation

The atmospheric circulation is the main control behind regional changes in wind, temperature, precipitation, moisture and other climatic variables. Variations in many of these are quite strongly related through large-scale features of the atmospheric circulation. Changes in a number of circulation features, including El Niño events in the south-east Pacific, mid-latitude Northern Hemisphere westerlies and the location and intensity of the low pressure system in the North Pacific and North Atlantic, may all be related to the more general global warming of the twentieth century. Certainly, warm El Niño events have been more frequent, persistent and intense since the mid 1970s, compared with the previous 100 years.

Cloudiness

Increased global cloudiness, as for increased global evaporation and precipitation, would be an expected consequence of higher global temperatures. It is likely that there has been a 2% increase in cloud cover over mid - to high latitude land areas during the 20th century. In most areas the trends relate well to the observed decrease in daily temperature range (since cloudier nights tend to be warmer and cloudier days cooler).

Conclusion

By studying the instrumental records of a number of climate elements, scientists have revealed a global climate change during the 20th century. Most significantly, global average surface temperature has risen by between 0.4 and 0.8^{o}C since about 1860. Other trends in precipitation, tropospheric temperatures and ice volume have also been observed. It is very likely that such climatic changes are the result of man's interference with the climate, through increased concentrations of atmospheric greenhouse gases.