Climate change

Two major gatherings of climate scientists in recent months have provided an opportunity to review the latest findings in climate change science.

In Copenhagen, the Scientific Congress in March this year attracted more than 1500 contributions from researchers in more than 70 countries. The first of six key messages from the Congress was the confirmation from recent observations that parameters such as global mean surface temperature and sea-level rise are following the trajectories of the Intergovernmental Panel on Climate Change's worst-case scenarios. The Congress reported that due to the high rates of observed greenhouse gas emissions, the climate system is already moving beyond the patterns of natural variability.

The Congress also stated that there was a significant risk that many of the trends in earth system observations will accelerate, leading to an increasing risk of abrupt or irreversible climatic shifts, and that temperature rises above 2°C would be very difficult for contemporary societies to cope with (http://climatecongress.ku.dk/newsroom/congress_key_messages).

The extensive media coverage of the climate scientists meeting in Copenhagen preceded a gathering of climate scientists closer to home. In Perth, Greenhouse 2009 in March was the largest climate change science conference in Australia this year, with more than 500 delegates. The message from Copenhagen was repeated in Perth – an expanding array of observations indicate that climate is changing faster than expected. Conference delegates also heard that Australia is a climate change hotspot in relation to the projected changes in climate and the impacts that these will have.

Many of the speakers at Greenhouse 2009 provided the message that despite the clarity of the climate change picture that has emerged, ongoing research into the underlying climate science is required. In particular, climate scientists need to improve the downscaling of climate projections to understand changes at local scales, to resolve some of the uncertainties that affect climate projections, and to strengthen our knowledge of the fundamental drivers of our climate such as the El Niño–Southern Oscillation.

These latest findings follow what we have understood for some time. The natural greenhouse effect has been enhanced by an increase in activities such as agriculture and deforestation, and burning fossil fuels for energy and transport since the Industrial Revolution ushered in an era where humans rely on fossil fuels. The carbon dioxide concentration in 2008 of 383 parts per million (ppm) is much higher than the natural range of 172–300 ppm that existed over the past 800 000 years.

Temperatures vary naturally between ice ages and warm periods every 100 000 years or so. However, average northern hemisphere temperatures during the second half of the twentieth century were likely the highest in at least the past 1300 years. There is a greater than 90% chance that global warming since the mid-twentieth century is due to human activities. Global average temperature rose by about 0.74°C over the past 100 years, with rising trends recorded on all continents and in the oceans. As water warms, it expands in volume – this, plus the melting of land-based ice around the world, has caused sea-level rises of about 20 cm from 1870 to 2007.

Estimates accounting for recent emission trends indicate that by 2030 the globe will warm by 0.8–1.5°C, relative to 1990. If emissions peak in 2020 and carbon dioxide equivalent concentrations stabilise at around 600 ppm after 2060, scientists project a warming of 1.1– 2.2°C by 2100. However, if global emissions continue to climb so that carbon dioxide equivalent concentrations exceed 970 ppm by 2100, then temperatures are projected to increase by 2.2–4.7°C by 2100. Projections of sea-level rises for the end of the twenty-first century range from 18 to 79 cm. However, increases in the ice discharge from Greenland and the Antarctic have not been taken into account, which could add metres to rising sea levels over centuries (http://www.csiro.au/science/Climate-Change.html).

In addition to the underlying climate science, both the Copenhagen Scientific Congress and Greenhouse 2009 discussed mitigation, to reduce greenhouse gas emissions; and adaptation, to prepare for impacts that are now inevitable. It is these three areas of climate change research – science, mitigation and adaptation – that CSIRO scientists will cover in this column over coming editions of *Chemistry in Australia*.

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