

Christians in Science Lecture 9 at St Peter's Church Farnborough 12th June 2018

'Blue Planet, Blue God – The Day after Tomorrow'

(The Oceans and Climate Change)

Professor Meric Srokosz

Meric Srokosz is Professor of Physical Oceanography at the National Oceanography Centre (NOC) in Southampton and a former Associate Director of The Faraday Institute for Science and Religion in Cambridge (UK). He joined the NOC in 1997 and has been observing and modelling biological/physical interactions in the upper ocean using remote sensing techniques. He has a particular interest in the Agulhas and Madagascar current system. In 2001 he became the Science Coordinator for the NERC Rapid Climate Change Programme (RCCP) which focuses on studying the role of the North Atlantic in possible future rapid changes in the climate. In 2005 he gained a BA in theology and has an interest in relating his knowledge of oceanography to his vision of God's creative purposes for the earth and the oceans in particular. He is an active member of the New Community Church in Southampton and a contributor to the Journal of Science and Christian Belief.

Professor Srokosz described himself as a physical oceanographer with interests in the 'physics' of oceans and the computer modelling of changes to the N Atlantic flows. He began his talk by referring to the biblical account of creation in Genesis chapters 1 and 2 and St John's vision of 'the New Heaven and the New Earth' (Revelation) at the end of time. He described this as God's story with the Earth's story embedded in it and with us the human race somewhere in the middle - a topic to which he would return with a Christian perspective at the end of his talk. He cited some simple facts about the oceans – the top 3 metres contain as much heat as the entire atmosphere, if there were no oceans our climate would be several degrees hotter than it is now due to our carbon dioxide emissions, and the oceans modify our climate(s) through their circulation around the planet (the N Atlantic for example releases heat (picked up from the tropics) equivalent to the output of 30,000 UK power stations).

Meric said he was interested in studying the present situation in the oceans, particularly the N Atlantic, and comparing it with the past. Much historical information can be gleaned from ice cores drilled in Greenland and from sediment cores taken from the sea bed. The ice cores are 'annually banded' and one can go back and look at the snow that was laid down over thousands of years and in particular at the carbon dioxide (CO²) bubbles trapped in the ice core. Warm periods correspond to higher CO² levels. The present day level is just over 400ppm – and rising - compared to 320 ppm in the 1960's and so we are 'pushing the system'. Sediment cores indicate that the climate has been relatively stable over the last 10,000 years. However, today the CO² levels are rising relatively rapidly to levels not seen for millions of years. He showed a clip of a rather dramatic Hollywood film in which the N Atlantic flows shut down leading to violent storms and an ice age in the northern hemisphere in a matter of weeks! Perhaps not terribly likely or realistic, but people are beginning to be seriously concerned about climate change and polar ice melting. However, politicians (particularly in the US) argue they can't do anything about it as the necessary changes will affect the economy!

The oceans are important as they are responsible inter alia for the movement of heat around the world and these ocean flows are vast being many times the total of all river flows. The 'Gulf Stream', for example, brings warm water (from the Tropics) at the surface to the N Atlantic which gives up some of this heat to the atmosphere and hence cools. The water becomes denser as a result

and sinks. The melting of the polar ice will tend to produce more rainfall in northern latitudes and this fresh, and less dense, water could counteract this cooling/sinking effect and potentially upset the circulation flows. We know this has happened in the past from the study of ice and sediment cores and these changes seem to occur on a quite rapid timescale of about 10 years. And so, could polar ice melting lead to a (permanent) disruption of the N Atlantic (NA) flows? The latter are extremely important to the UK and northwest Europe and are responsible for much milder winters than would be expected at our latitude. Should we be worried and 'what will happen the day after tomorrow'? Such concerns led to the setting up of the RCCP in 2004 to see if such changes could happen today. Looking at the changes in (N Atlantic) surface temperatures over the last 100 years or so we can see, as would be expected from global warming, that the NA is warming but a cooler patch has been detected which may suggest that the NA circulation is slowing down. Professor Srokosz (MS) made the point that while **overall** the planet's climate **is warming** the changes will not be uniform. Parts of the northern hemisphere (eg round the UK) may well become cooler due to changes in ocean flows while the southern hemisphere might become disproportionately hotter. An overall (average) increase of 2° (from pre-industrial temperatures) by 2200 is what is predicted but local experience will vary widely. The idea of vineyards becoming commonplace in the UK is wide of the mark. The purpose of the RCCP is to monitor changes in the NA over time.

MS described in some detail the mechanics of his project which involves taking measurements at latitude 26.5° from the N American coast across to Africa. A 5km cable complete with instruments, buoyancy and an anchor, is towed behind a small ship and measurements of temperature and salinity taken at designated moorings and at various depths. Analysis of the data obtained uses the principle of geostrophy (as used in weather forecasting) to determine the flow of water (the current) at various positions and depths - on our rotating planet the ocean flow, like air movements along isobars, is deflected at right angles to the pressure gradient. The results for 2004-2014 were in general quite 'normal' with anticipated oscillations due to seasonal and fresh water effects. However, in the winter of 2009-10 there was a quite marked (30%) and unexpected (temporary) dip in the circulation of the NA and this corresponded to, and was partly responsible for, the severe winter of that year. Were the circulation of the NA to have remained at that level we would expect to have many more severe winters and to observe rising sea levels - of the order of one metre near New York (in 2009/10 a rise of 13mm was in fact detected). The current change is about 3mm per year as the earth warms with signs that there is a slow decline in circulation. Also as less heat is being circulated northwards more of the heat will remain in the south contributing to more disturbed weather (hurricanes). Work on the RCCP continues.

So, what **will** happen 'the day after tomorrow'? We will not see an ice-age but global warming **will** continue – MS emphasised that there was absolutely **no question** about that despite the doubters. The temperature chart since the 1880s clearly shows this with years 2014-2017 being the warmest on record. Temperatures (air) are rising across the globe and more CO² is being absorbed – 26% into the oceans, 31% into trees and vegetation with 43% remaining in the atmosphere and contributing to global warming via the greenhouse effect. The additional CO² in the oceans renders them more acidic (with a lower pH) which affects plants, algae and coral. Of this additional heat that mankind is producing on the planet only 7% is taken up by 'what we see', namely polar ice melting, warming of the atmosphere and the land mass, the rest (93%) is being absorbed by the oceans, without which we would be in a sorry state. Many species in the oceans such as plankton and fish are temperature-dependent and are being affected by the rising sea temperatures – for example cod seem to be moving outside Iceland's 200 mile limit. Coral reefs are also being devastated both by the rising temperatures and the increasing acidity of the oceans which causes more of the structural calcium carbonate to be dissolved. There appears also to be an increasing frequency of hurricanes and the rising sea levels are a great concern. Satellite data clearly shows that the latter is occurring and that, unfortunately, it will affect the poorer nations first. 10 million people, for example, live in the fertile delta area of Bangladesh and these people will be displaced by the one metre rise in sea levels

predicted to occur by the end of 2100. Similarly, the Arctic sea ice is shrinking with the creation of new sea passages.

At the end of his talk MS returned to the question of what the **Christian viewpoint/perspective** might be on the changes to our planet. He referred again to the Creation account in Genesis and St John's vision in Revelation. God has created and will re-create at the end of time whenever that might be. In the meantime we have to think about what our response should be. MS' view was that God's plan does not just focus on our salvation but aims to rescue the whole of Creation and, in the light of this, he asked 'what should **we** be doing now?' There are many theological books on this topic including his own 'Blue Planet, Blue God', where he discusses not just theological points but argues for changes in world trade, economics and global relationships. He referred also to Jesus' two great commandments that we should love God and our neighbour. The earth is His (Psalm 24) and it is His gift to us. Trashing someone's property one would think would be incompatible with any claim to love that person and so by dumping CO² into the atmosphere and plastics into the ocean we could be said to be trashing God's planet and certainly not to be expressing our love for Him. Our treatment of the planet is a measure of our relationship with our Creator God and it matters. Similarly, our cavalier use of carbon-based fuels is leading to global warming with a concomitant increase in droughts, floods and storms plus rising sea levels, which particularly harm the poorest people on earth. Can these actions be compatible with caring for the poor and showing love for our neighbour? And so in conclusion, MS said his understanding of God's story and the Earth's story presented a challenge to him both as a scientist, as he tries to understand what is happening to the planet, and as a professing Christian, in deciding how he should live out his life and simultaneously care for the planet. We likewise need to decide how **we** will react to these challenges.

Much of the discussion in the ensuing Q/A session centred on the question of climate change and what might be done to arrest/slow it. Is there any way that climate change can be reversed? Has research been done on the various sources (power generation, transport, buildings, agriculture etc) of CO² and other greenhouse gases and their relative contributions to the total? Should we not concentrate on minimising emissions from the major sources such as power stations using fossil fuels? Is there any point in running a battery-powered vehicle (in Germany!) when the battery is recharged using non-green electricity produced from a power station fuelled by (imported) coal? MS replied that, yes, climate change could be reversed, but only very slowly, and only by dramatically cutting our CO² emissions by using alternative sources of energy. The Paris accord of 2016 signed by the majority of developed countries, including the US (now being reneged on?), was a very positive geopolitical step forward but in itself inadequate to deal with the problem. The key thing is to stop putting **more** CO² into the atmosphere. There are a number of things we can do **now** if there is the political will, but MS was also keen to emphasise the 'little things' we can all do. He conceded that more nuclear power stations could be an option for the short/medium term and building zero-carbon housing would help. Transport, heating, lighting and the use of air-conditioning were all areas to be worked on. We should also look carefully at the '**carbon footprint**' of products, processes and activities to see how 'green' they are. Electric vehicles are only 'green' if powered by 'green' electricity and are tomatoes flown into the UK from Spain as 'green' as those grown in greenhouses at home? Methane is a much more 'powerful' greenhouse gas than CO² and so cutting our consumption of beef from cattle (which produce large quantities of methane) would help, although methane is not as persistent a gas in the atmosphere. And, yes, growing large numbers of trees and other carbon-capturing vegetation would also help although mainly during the growth phase.

Can we continue to rely on the 'conveyor belt' system of ocean currents? Could it be broken leading to the possibility of another Ice Age? Yes, the 'conveyor belt' system **could** break down and we know from palaeolithic data that it has happened in the distant past. It is unlikely to lead to an Ice Age now due to the amount of CO² in the atmosphere. Geothermal currents, produced for example from 'black smokers' (where water is circulating down into the earth's crust), are only really

significant at the bottom of the oceans. How do we communicate the scale of the (global warming) problem, and possible solutions, to the general public and to the churches in particular? And how do oceanographers tackle the question? And as a society are we relying too heavily on scientists to solve our problems when in reality the problems are more of a 'behavioural' nature? MS replied that 'he was trying' (!), for example by publicising his book and giving talks to 'anyone who would listen', and not exclusively to churches. But it is difficult to persuade the public at large as they feel as individuals there is very little they can do and getting politicians involved is even more difficult due to the short-term nature of their agendas. The timescales of change are relatively large but the issues **will** affect our children and grandchildren and in many ways are much more important than Brexit or the next election. We have to aim to leave behind a planet in a fit state for future generations and we cannot just rely on scientists to do that. As Christians we need to address behavioural problems and as scientists to link science with our faith. We are called by God to act responsibly which includes tackling the problem of waste and the 'throw-away' society. Finally MS was asked by a very young person what advice he (MS) could offer as to what **he** (the young person) should do about the environment – and the answer was, of course, to train to become a scientist, engineer, or technician in order to work out better solutions to today's problems!

John Ray thanked Meric for his fascinating talk. The next CIS meeting of the Surrey Heath Group will be on October 16th 2018 at High Cross Church, Camberley where Professor John Bryant will talk about '**Bioethics and Genetic Modification**' - '*What we can do and what we should do*'.

John Wood