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EVIDENCE OF CLIMATE AND TEMPERATURE CHANGE AND SEA LEVEL RISE

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ABSTRACT
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The purpose of this presentation is to provide an overview of the greenhouse effect. The range of scientific uncertainties will be emphasised and their implications for future changes in global climate and sea level discussed.

The atmospheric concentrations of carbon dioxide, methane, nitrous oxide and the CFCs - the principal greenhouse gases - have been increasing. CO2 is the main greenhouse gas and has increased by about 25% over the last 200 years. The other greenhouse gases have also increased in atmospheric concentration. Climate models tell us that, because of these increases, the world should have warmed by 0.4-1.3°C. Has it?

The record of global-mean temperature changes indicates that the world has indeed warmed, by about 0.5°C over the last 100 years. However, there is no direct evidence that this is due to the "greenhouse effect". Other factors - e.g. volcanic eruptions, ocean current changes and solar variations - also influence climate on the decadal/century timescale. Until these various influencing factors are understood and all accounted for, it cannot be said with certainty that the observed warming is due to greenhouse gases. Nevertheless, the greenhouse effect surely is a likely candidate.

How much will the world warm in the future? This depends on three major factors, about which there is considerable uncertainty. The first is the future concentration of greenhouse gases. An equivalent doubling of the pre-industrial CO2 concentration is a conventional measure. With a "business-as-usual" scenario, a doubling is likely to occur around the year 2030. With stringent policies, this could be delayed to about the year 2050, and with continuation of growth in the rate of emissions, such a doubling could occur as early as around 2015.

The second major factor is the "climate sensitivity", that is, the equilibrium change in global-mean temperature for a CO2 doubling, as determined from complex climate models. The current scientific consensus is that the value of the climate sensitivity lies within the range 1.5-4.5°C.

The third factor is the rate of heat uptake by the oceans. The deeper layers of the oceans take time to warm; this causes a lag (delay) in actual (or "transient") global warming. The faster the transfer of heat to the deeper ocean, the slow the surface warming.

Taking all three factors and their ranges of uncertainty into account, projected ranges of future global warming can be made. The year 2030 is a useful "target" date. The most "optimistic" set of assumptions results in a 2030 projection of 0.5°C warmer than today; the most "pessimistic" set yields 2.5°C warmer. The

"best" estimate is that the world will be about 1-2°C warmer by the year 2030.

Will sea level rise? There is general agreement in the scientific community that a rise is indeed likely. This would be due to thermal expansion of the oceans as they warm, and to the increased melting of land-based ice, particularly the small alpine glaciers. The best estimate (relating to the warming estimates noted above) is that sea level will be roughly 15-30cm higher than today by the year 2030. Given the uncertainties, the rise could be as little as 5cm, or as much as over 40cm.

What can we do? In general, there are four response modes: do nothing (let society adapt, passively, while continuing research); distribute the effects (compensate those who are most ill-effected); reduce vulnerability (e.g. vacate floodable land, change land use or crop varieties); and/or reduce greenhouse gas emissions. The last mode becomes necessary if hope to slow global climate change. But even if stringent emission control policies were implemented today, we could not stop global warming within the next half century at least; because of the inertia of the climate systems, we have already committed ourselves to substantial changes, like it or not.

Perhaps the most important way in which societies will be affected by climate change is through changes in the frequency of extreme climate events - floods, droughts, storm surges, etc. And because such events are, by definition, rare, it may take quite a while for society to perceive - and therefore adapt - to such changes.

In conclusion, there are difficult choices which confront society. Decisions to reduce gas emissions or to take precautionary adjustments to lessen vulnerability imply costs - costs which are borne today. However, the benefits, are not likely to accue to us, but to our children and to our childrens' children. If we are to avoid changes in climate inexperienced in thousands, if not millions, of years, steps will have to taken soon and with the knowledge that we, ourselves, may not be around to see the rewards of our investment.