Climate change: what can we do about it

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Climate Change: What Can We Do About it

Changements climatiques: que faire?

Klimaveränderung – was können wir unternehmen?

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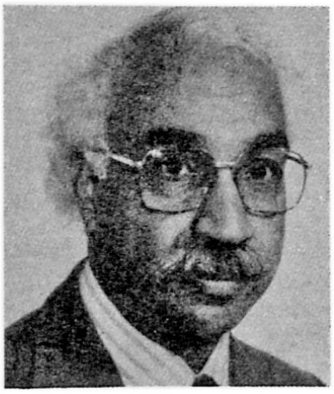

N. Sundararaman, born 1937, got his Ph.D. in meteorology from the University of California at Los Angeles, USA. After working as a professor for some time, he became the Manager of the Air Quality Division of the US Federal Aviation Administration. His work encompasses ozone depletion and climate change.

SUMMARY

Given that the atmospheric concentrations of the greenhouse gases (GHGs) ar likely to continue for some time to come, some global warming appears inevitable. While international efforts are underway to eventually stabilize GHG concentrations, adaptation should become an important part of the response options. Bridge and structural engineers have a vital role to play here.

RESUME

Une mise en garde globale devient inévitable, puisque les concentrations atmosphériques de gaz, combinées avec l'effet de serre, risquent de se poursuivre dans les années à venir. Bien que des efforts soient en cours à l'échelon international pour stabiliser ces concentrations de gaz, il est nécessaire de s'adapter à la situation actuelle. Les ingénieurs civils ont un rôle vital à jouer dans ce domaine.

ZUSAMMENFASSUNG

Bei den gegebenen Konzentrationen von Treibhausgasen in der Atmosphäre, mit der wir wohl noch eine ganze Weile werden leben müssen, scheint eine globale Erwärmung unvermeidlich. Trotz gegenwärtiger, internationaler Anstrengungen, ihre Konzentration langfristig unter Kontrolle zu bringen, sollte eine Anpassung an die Klimaveränderung zur wichtigen Handlungsoption werden. Brücken und Hochbauingenieuren kommt dabei eine wichtige Rolle zu.

1. INTRODUCTION

1.1 The views expressed in this paper are my own and do not in any way reflect the official positions of the Intergovernmental Panel on Climate Change (IPCC) or of its sponsoring organizations, viz., the World Meteorological Organization and the United Nations Environment Programme. This paper is based on the findings of the IPCC First Assessment Report [1] and the 1992 IPCC Supplement [2].

1.2 It may be noted that SI units are not used this paper.

2. THE GREENHOUSE EFFECT - SCIENTIFIC EVIDENCE

2.1 There is ample scientific evidence that the greenhouse effect is valid:

- From observations of the atmospheric compositions of the planets Mars and Venus, their surface temperatures can be deduced using the greenhouse theory. The calculated temperatures compare very well with observed values as may seen from the table below.

	Main GHGs	Calculated temperatures, °C		Observed temperatures, °C
		Without GHE	With GHE	
VENUS	>90% CO_2	-46	523	477
MARS	>80% CO_2	-57	10	-47

Note: GHG - greenhouse gases; GHE - greenhouse effect.

Table 1 Planetary temperatures - comparison of observations and calculations using greenhouse theory

- Atmospheric concentrations of carbon dioxide and methane over the past 160,000 years can be deduced from ice cores; corresponding temperature values can be obtained from deuterium data. The concentrations for both gases correlate exceptionally well with the temperatures as can be seen from figures 1 and 2 below.

3. CALCULATIONS OF CLIMATE CHANGE

3.1 The so-called coupled general circulation models (CGCMs) are used to calculate changes in temperature and other climate variables (precipitation, soil moisture etc.). The models include atmospheric and oceanic processes, some of them parameterized. The parameterizations constantly undergo evaluation and improvement. Nevertheless, the models are the only tools available to project future climatic states (in this paper, only changes in temperature will be discussed). About half a dozen of these models are in existence today.

3.2 The time evolution of the future atmospheric concentrations of the greenhouse gases is a very critical input to the models.

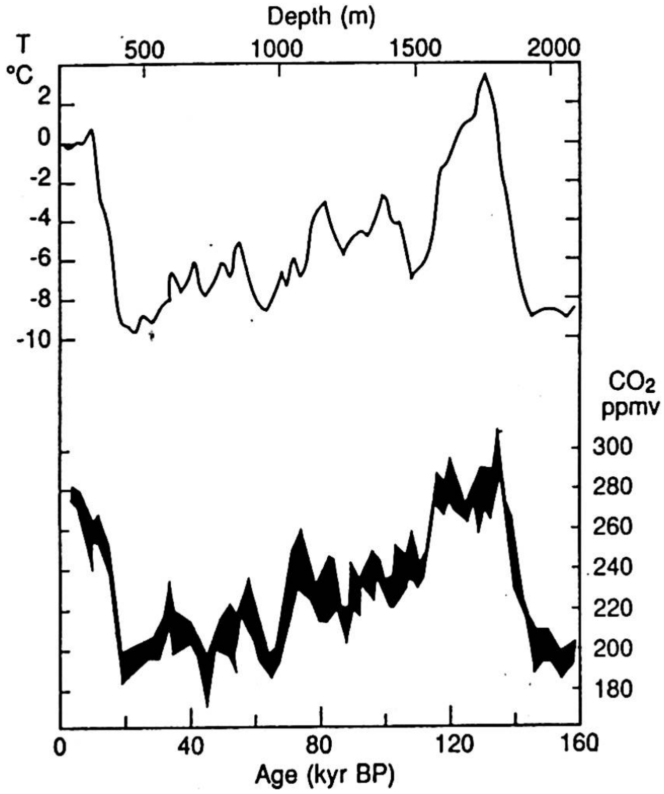

Figure 1 CO_2 concentrations (bottom) and estimated temperatures (top) in the last 160,000 years

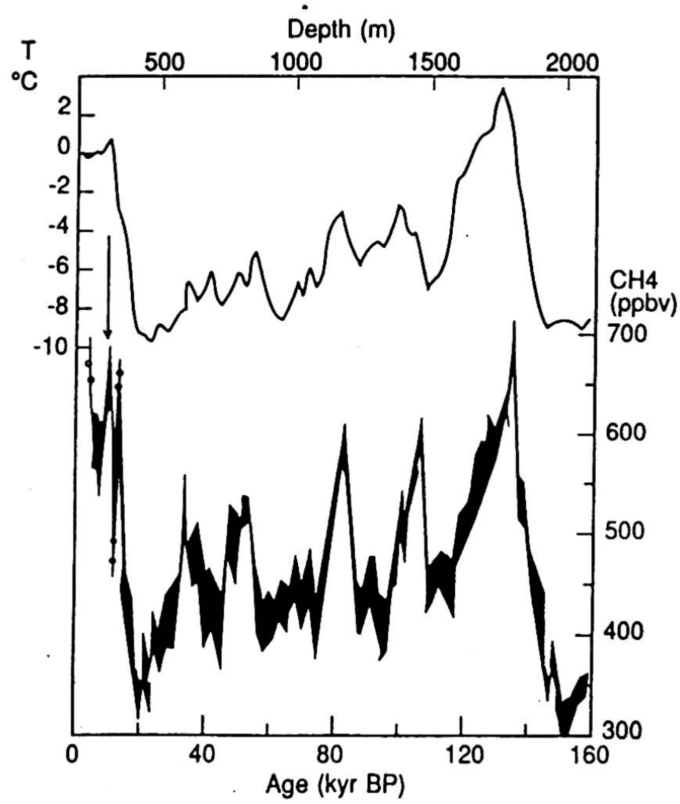

Figure 2 Methane concentrations (bottom) and estimated temperatures (top) in the last 160,000 years

Such evolution is very hard to forecast since many socio-economic factors such as rates of economic growth and the means to satisfy the latter's energy and other needs would influence future emissions of the greenhouse gases. In addition, a detailed knowledge of the chemical and other sinks of the gases is needed in order to calculate the amounts that would remain in the atmosphere. The task becomes mammoth and fraught with large uncertainties when time horizons of a century or more - typical of global warming due to greenhouse gases - are considered.

3.3 Thus, assumptions have to be made about future emissions of the greenhouse gases. Such assumptions are known as emissions scenarios; they are more in the nature of working hypotheses and are not predictions of future emissions. In this sense, then, there are no predictions of future climate. (This, however, is not to say that climate is not predictable - quite the contrary.)

3.4 The IPCC considered 4 emissions scenarios in its first assessment [1] to illustrate the effects of different response options. One of them (the Business-as-Usual scenario or Scenario A) assumes that no action is taken to stabilize the concentrations of the greenhouse gases. The others correspond to an equivalent doubling of atmospheric CO_2 over the pre-industrial value (of 280 parts per million by volume) assumed to occur in the years 2030, 2060 and 2090 respectively. (The radiative effect of all greenhouse gases is often expressed in terms of the concentrations of CO_2 that would be required to produce the same effect - this is the concept of "equivalent CO_2".) They are all shown in figure 3.

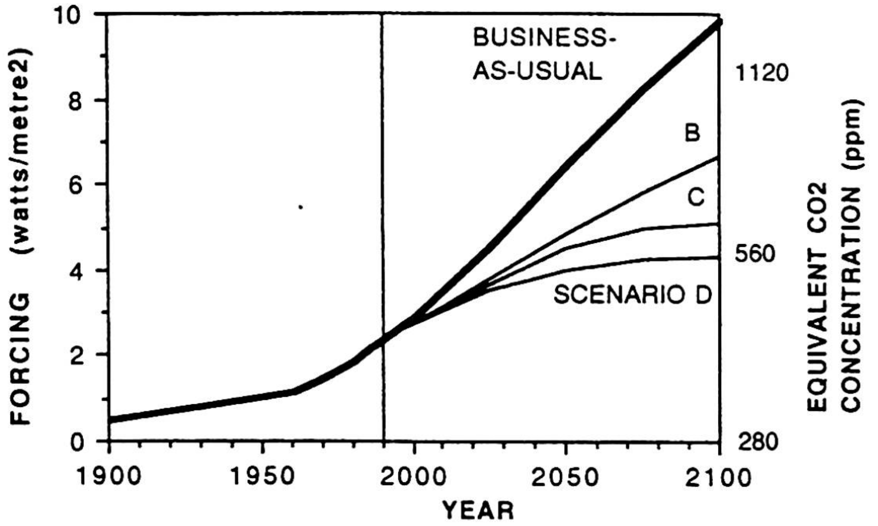

Figure 3 IPCC Emissions scenarios

3.5 The IPCC calculations of increases in the global average temperatures corresponding to the Business-as-Usual scenario is given in figure 4. The range of estimates given, from high to low, indicates the uncertainty in the calculations. The uncertainties arise from feedback mechanisms (such as, for example, of the shrinking ice and snow leading to reduced reflection back to space of incoming solar radiation). The calculations of temperature increases as well as increases in mean sea level rise for 3 of the 4 scenarios are given in table 2.

4. THE CONCEPT OF THE "REALISED" CLIMATE CHANGE

4.1 In figure 4, it may be noticed, the ordinate is labelled "realised temperature rise". This is an important concept and has some implications for responding to global warming. It is best illustrated by the following example.

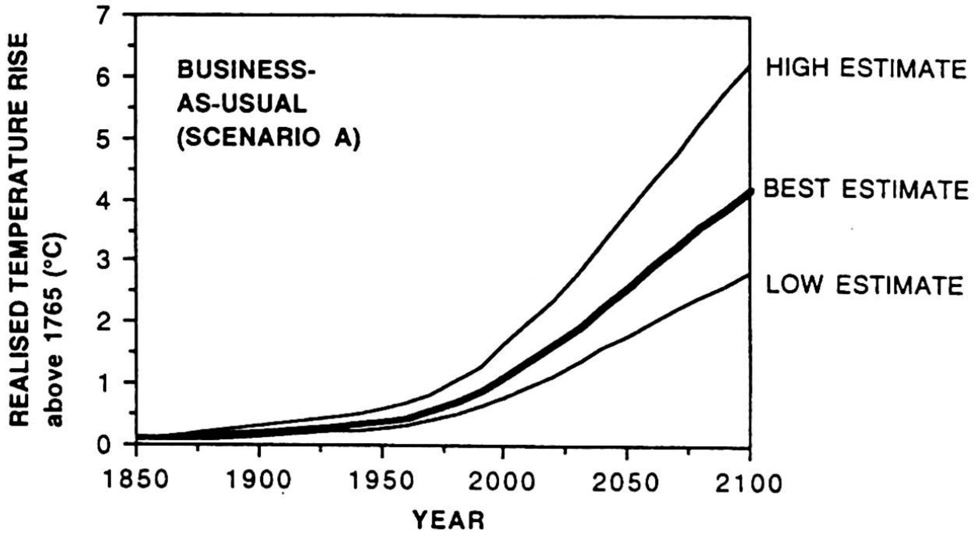

Figure 4 Calculated increase in the global mean temperature for the Business-as-Usual emissions scenario

Emissions scenario	Rate of increase of temperature °C/decade	Rate of increase of sea level cm/decade
Business-as-Usual	0.3 (0.2-0.5)	6 (3-10)
Scenario B	0.2	4
Scenario C	0.1	3.5

Table 2 Calculated rates of increase in the global average temperature and mean sea level for a few IPCC emissions scenarios (The numbers in parentheses indicate the uncertainty range)

4.2 Barring unusual weather phenomena, the daily maximum in the temperature usually occurs around 2 or 3 o'clock in the afternoon. The cause of the temperature is the forcing by the sun. The forcing maximum is at local noon but the maximum in temperature is only observed a few hours later. That is, the "commitment" to maximum temperature is made at noon but at noon the "realised" temperature is less than the maximum, i.e., that which is already "committed" for happening. The reason of course is the time lag in the response of earth-atmosphere to the solar forcing.

4.3 The same concept applies to global warming. In the case of the daily temperatures, the lag is of the order of an hour or so. In the climate case, the lag can be several decades to centuries (because of the huge heat capacity of the oceans).

4.4 Thus, as long as greenhouse gases continue to increase in the atmosphere - and at present all observations indicate monotonic increases in CO_2, methane, nitrous oxide, the chlorofluorocarbons, all of them with greenhouse properties - the temperatures would be less than what would be "committed" to. This is more readily understood in the case of sea level rise.

5. IMPORTANCE OF ADAPTATION AS RESPONSE TO CLIMATE CHANGE

5.1 Given the nature of the "realised" effects, a certain amount of warming (and associated impacts) would appear inevitable. It would be quite a while before the concentrations of the greenhouse gases can be stabilized, assuming that such a goal is aimed for and steadily pursued. In the meanwhile, the greenhouse gases emissions would continue, increasing with time the greenhouse forcing.

5.2 Thus, it would be prudent to include adaptation in the measures to respond to climate change. Adaptation should be deemed an important part - perhaps the major part in the next two or three decades - of the available options. This has to be done at primarily the national level. But in order to adapt, and adapt at least cost (assistance in this regard to the developing countries is another matter altogether and is not discussed here), better knowledge of the impacts of climate warming on the physical and socio-economic systems would be necessary. The bridge and structural engineers have a vital role to play in this effort.

6. CONCLUSION

6.1 It is an observational fact that greenhouse gases are increasing in their atmospheric concentrations today. The trend is likely to continue for some time to come (given, for example, that the time scale of restructuring energy systems is a few decades). And, at any given time, the temperature increase would be always less than what is committed for. Thus, adaptation becomes an important option to manage climate change. This requires a good knowledge of the impacts of climate change on the physical and socio-economic systems. The IABSE could contribute constructively in this effort.

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