Centre for Agricultural Strategy

The 'greenhouse effect' and UK agriculture

Edited by R M Bennett

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Poster presentation: Modelling greenhouse gas-induced climate change

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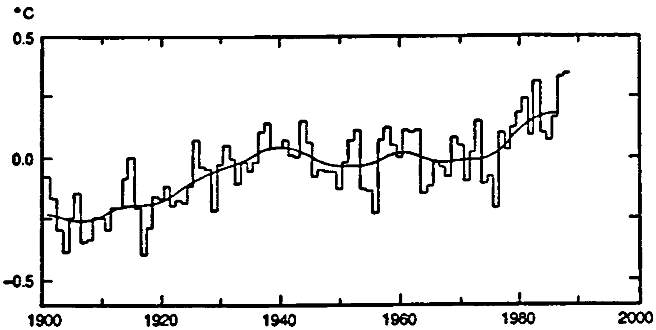
INTRODUCTION

Surface observations of air temperature since 1900 are consistent with an enhanced greenhouse effect (see Figure 1) – although they do not prove it.

Figure 1
Global surface air temperature relative to 1950–79 average



Source: Derived from Jones *et al* (1988).

The 20th century has seen an average increase of 0.5°C in mean global temperature. But the increase has not been steady. There is considerable variation from year to year, and from decade to decade. For example, the period 1940–70 was one of cooling, even though there was an increase in the release of greenhouse gases.

MODELS

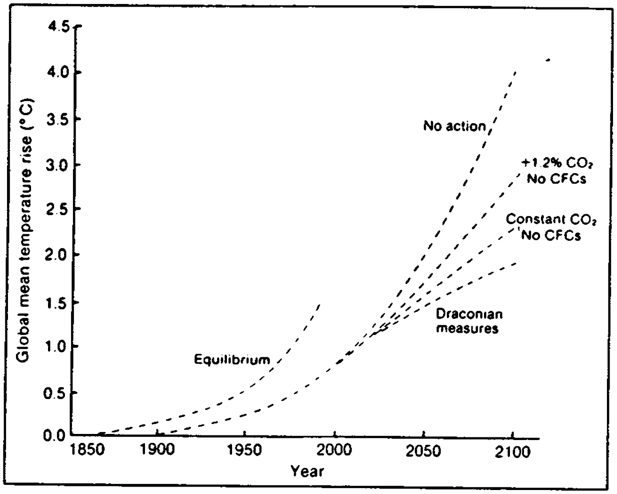
Mathematical models of climate, on the other hand, agree that global warming over the next century is almost inevitable. Basic laws of physics imply that increased CO_2 and other greenhouse gases should lead to global warming, but we need mathematical models of climate to estimate how far temperatures will rise. The answers given by models depend to some extent on the feedback mechanisms which they incorporate.

Equilibrium models predict climate once the whole atmosphere and oceans have responded fully to, say, a doubling of CO_2 concentrations (see Table 1). Transient models take account of the steady increase of greenhouse gases year by year, and of the time taken by the ocean, particularly the deep ocean, to warm up. Transient models provide predictions of the temperature rises we are likely to experience over the next 50–100 years (see Figure 2).

Table 1
Total warming due to the doubling of CO_2

	Process	Total warming (°C)
	Doubling of CO_2	1.2
Add	Increased water vapour	1.7
Add	Reduction of snow and ice cover	2.2
Add	Changes in type and amount of cloud	2.0–5.0

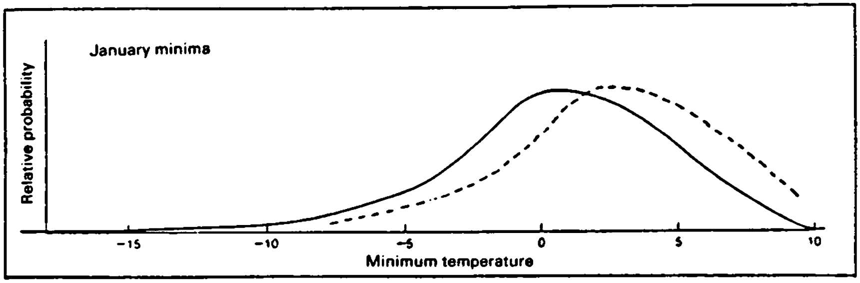
Figure 2
Global mean temperatures 1850–2100 from a one-dimensional model



SOME POTENTIAL IMPACTS ON AGRICULTURE OF A 2°C WARMING

Fewer frosts
Figure 3 shows the potential impact on minimum January temperature.

Figure 3
Potential impact of a 2°C warming on minimum January temperature



Sea level changes
Global sea level rise from the present to 2040 is likely to be in the range 20 to 50 cm.

Earlier start to the growing season
The start of the growing season is taken as the date on which mean 30 cm soil temperature exceeds 6°C. A mean 2°C rise in temperature would bring that date forward in England and Wales by between 2 and 3 weeks, depending on distance from the coast. Figure 4 shows the potentially earlier growing season by area, with a 2°C temperature rise.

Increased evaporation
In the UK, and particularly in winter, humidity and temperature have a greater effect on evapotranspiration (PT) than sunshine and windspeed. The graphs in Figure 5, based on data from a site in the East Midlands, show mean annual progress charts under a 2°C warmer climate, for potential soil moisture deficit (PT minus rainfall) and for drainage into the soil (rainfall minus PT).

Figure 4
The potential earlier start to the growing season in England and Wales, following a 2°C temperature rise.

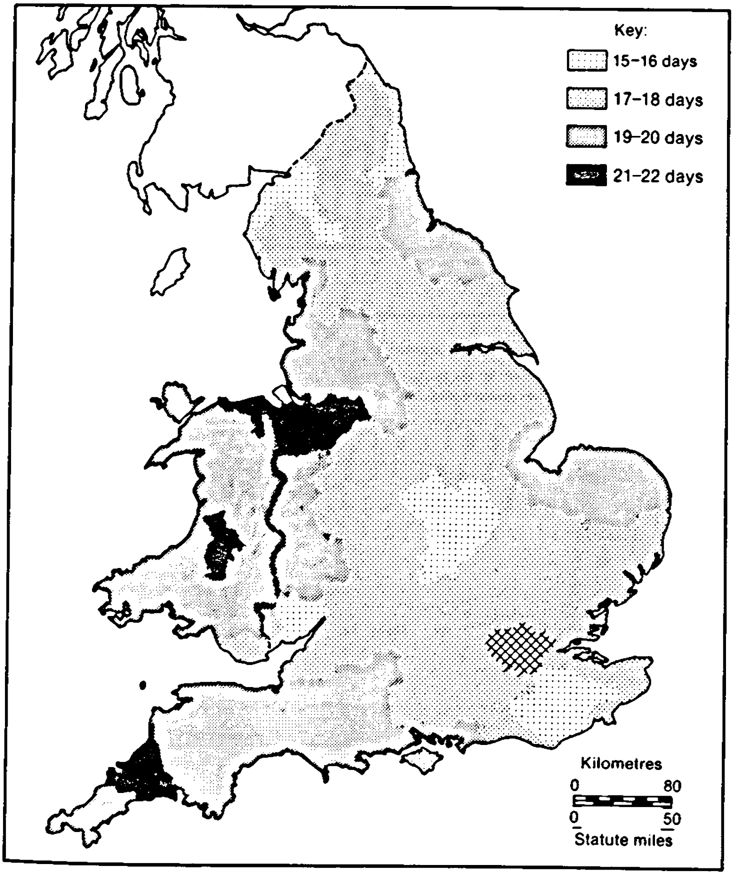


Figure 5
Mean annual progress charts for potential soil moisture deficit and for drainage into the soil, under a 2°C warmer climate.