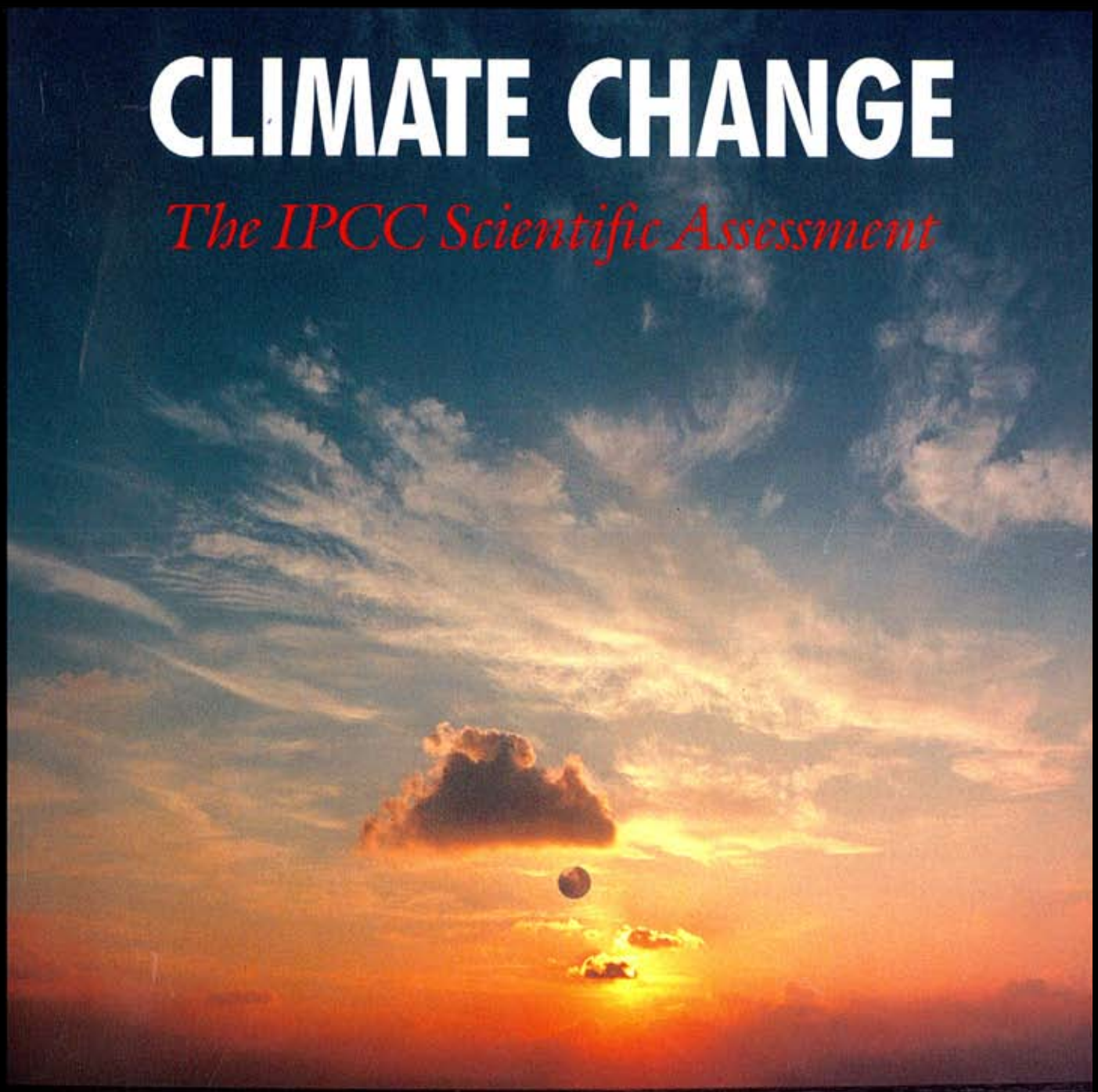
CLIMATE CHANGE

The IPCC Scientific Assessment



WORLD METEOROLOGICAL ORGANIZATION/UNITED NATIONS ENVIRONMENT PROGRAMME

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

	Surface Pressure (Relative to Earth)	Main Greenhouse Gases	Surface temperature in absence of Greenhouse effect	Observed Surface Temperature	Warming due to Greenhouse Effect
VENUS	90	> 90% CO_2	46°C	477°C	523°C
EARTH	1	~0 04% CO_2 ~1% H_2O	-18°C	15°C	33°C
MARS	0 007	> 80% CO_2	-57°C	-47°C	10°C

atmospheric levels of carbon dioxide, methane, and nitrous oxide were much lower during the ice ages than during interglacial periods It is likely that changes in greenhouse gas concentrations contributed, in part, to the large (4 - 5°C) temperature swings between ice ages and interglacial periods

The Enhanced Greenhouse Effect

An increase in concentrations of greenhouse gases is expected to raise the global-mean surface-air temperature which, for simplicity, is usually referred to as the global temperature' Strictly this is an *enhanced* greenhouse effect - above that occurring due to natural greenhouse gas concentrations The word enhanced is frequently omitted, but should not be forgotten in this context

Changes in the Abundances of the Greenhouse Gases

We know, with certainty, that the concentrations of naturally occurring greenhouse gases in the atmosphere have varied on palaeo time-scales For a thousand years prior to the industrial revolution the abundances of these gases were relatively constant However as the world s population increased, emissions of greenhouse gases such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, and tropospheric ozone have increased substantially due to industrialisation and changes in agriculture and land-use Carbon dioxide, methane, and nitrous oxide all have significant natural and man-made sources, while the chlorofluorocarbons (CFCs) are recent man-made gases **Section 1** of the report summarises our knowledge of the various greenhouse gases, their sources, sinks and lifetimes, and their likely rate of increase

Relative Importance of Greenhouse Gases

So far as radiative forcing of the climate is concerned, the increase in carbon dioxide has been the most important (contributing about 60% of the increased forcing over the last 200 years), methane is of next importance contributing about 20%, chloroflourocarbons contribute about 10% and all the other gases the remaining 10% **Section 2** of the report reviews the contributions of the different gases to radiative forcing in more detail

Feedbacks

If everything else in the climate system remained the same following an increase in greenhouse gases, it would be relatively easy to calculate, from a knowledge of their radiative properties, what the increase in average global temperature would be However, as the components of the system begin to warm, other factors come into play which are called feedbacks These factors can act to amplify the initial warming (positive feedbacks) or reduce it (negative feedbacks) Negative feedbacks can reduce the warming but cannot produce a global cooling The simplest of these feedbacks arises because as the atmosphere warms the amount of water vapour it holds increases Water vapour is an important greenhouse gas and will therefore amplify the warming Other feedbacks occur through interactions with snow and sea-ice, with clouds and with the biosphere **Section 3** explores these more fully

The Role of the Oceans

The oceans play a central role in shaping the climate through three distinct mechanisms Firstly they absorb carbon dioxide and exchange it with the atmosphere (**Section 1** addresses this aspect of the carbon cycle) Secondly, they exchange heat water vapour and