

WGI POLICYMAKERS SUMMARY

detailed studies of particular processes will be required through targetted observational campaigns. Examples of such field campaigns include combined observational and small scale modelling studies for different regions, of the formation, dissipation, radiative, dynamical and microphysical properties of clouds, and ground-based (ocean and land) and aircraft measurements of the fluxes of greenhouse gases from specific ecosystems. In particular, emphasis must be placed on field experiments that will assist in the development and improvement of sub-grid-scale parametrizations for models.

The required program of research will require unprecedented international cooperation, with the World Climate Research Programme (WCRP) of the World Meteorological Organization and International Council of Scientific Unions (ICSU), and the International Geosphere-Biosphere Programme (IGBP) of ICSU both playing vital roles. These are large and complex endeavours that will require the involvement of all nations, particularly the developing countries. Implementation of existing and planned projects will require increased financial and human resources; the latter requirement has immediate implications at all levels of education, and the international community of scientists needs to be widened to include more members from developing countries.

The WCRP and IGBP have a number of ongoing or planned research programs, that address each of the three key areas of scientific uncertainty. Examples include:

- **clouds:**
International Satellite Cloud Climatology Project (ISCCP);
Global Energy and Water Cycle Experiment (GEWEX).
- **oceans:**
World Ocean Circulation Experiment (WOCE);
Tropical Oceans and Global Atmosphere (TOGA);
- **trace gases:**
Joint Global Ocean Flux Study (JGOFS);
International Global Atmospheric Chemistry (IGAC);
Past Global Changes (PAGES).

As research advances, increased understanding and improved observations will lead to progressively more reliable climate predictions. However considering the complex nature of the

problem and the scale of the scientific programmes to be undertaken we know that rapid results cannot be expected. Indeed further scientific advances may expose unforeseen problems and areas of ignorance.

Timescales for narrowing the uncertainties will be dictated by progress over the next 10-15 years in two main areas:

- Use of the fastest possible computers, to take into account coupling of the atmosphere and the oceans in models, and to provide sufficient resolution for regional predictions.
- Development of improved representation of small scale processes within climate models, as a result of the analysis of data from observational programmes to be conducted on a continuing basis well into the next century.