ENSEMBLES – a European project for climate change modelling

ENSEMBLE-based Predictions of Climate Changes and their Impacts

Ulrich Cubasch

Meteorologisches Institut

Freie Universität Berlin

Germany

Structure

- Review of TAR results
- New developments
- IPCC recommendations for the AR4
- ENSEMBLE – The European climate modelling project

Review of TAR results

A New Set of IPCC Emissions Scenarios (SRES Scenarios)

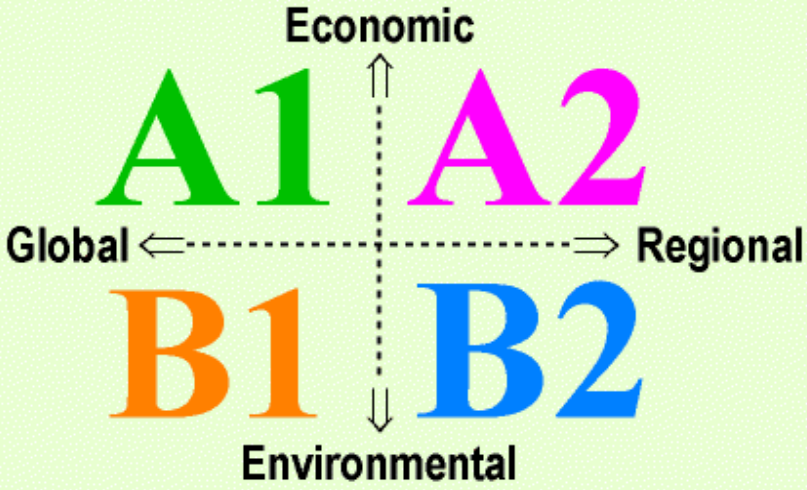
A1 A world of rapid economic growth and rapid introduction of new and more efficient technology.

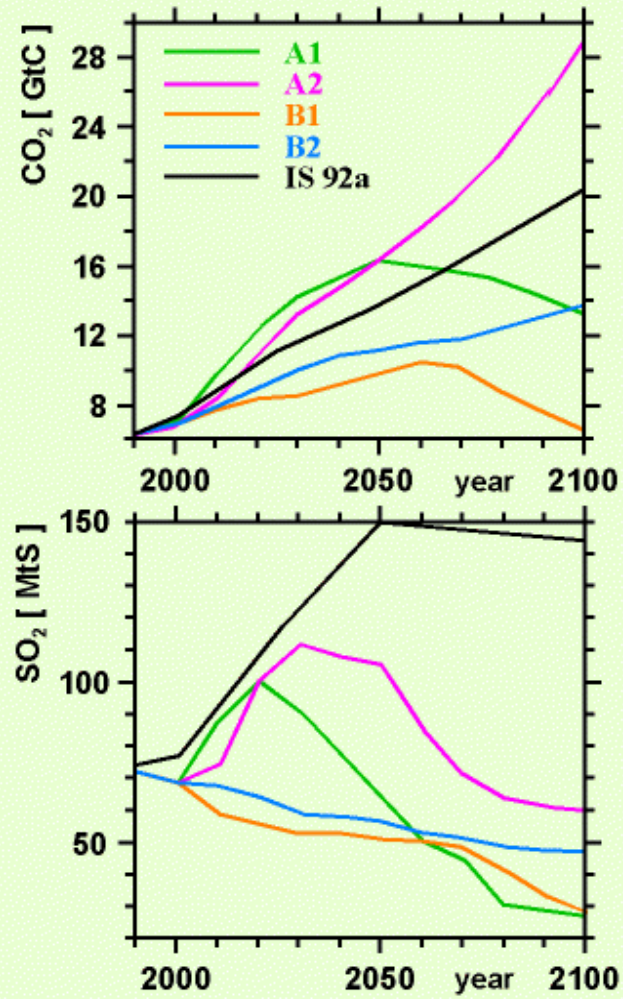
A2 A very heterogeneous world with an emphasis on family values and local traditions.

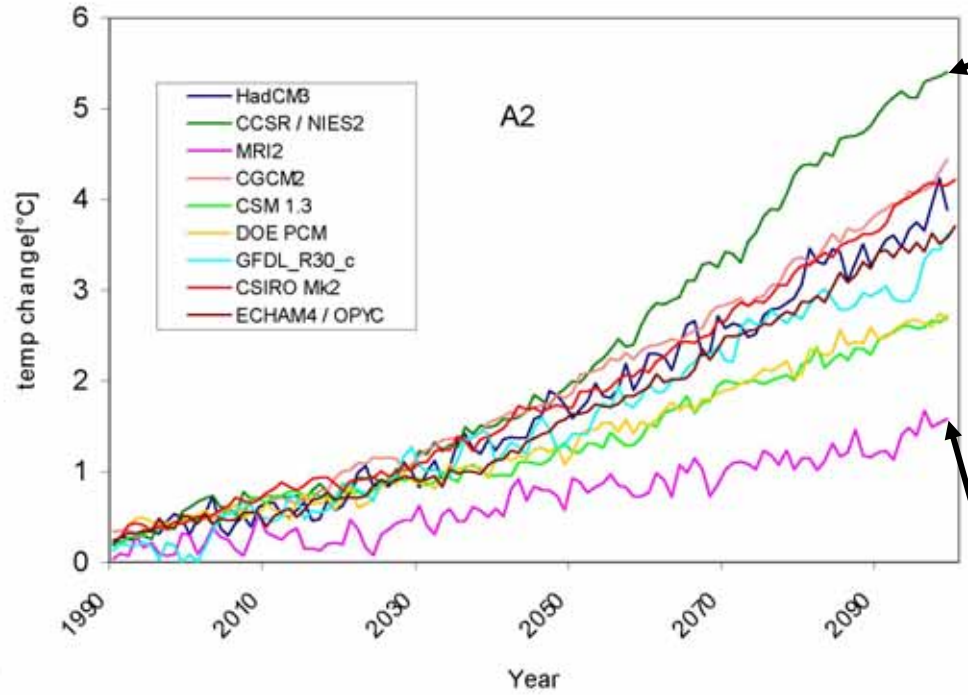
B1 A world of "dematerialization" and introduction of clean technologies.

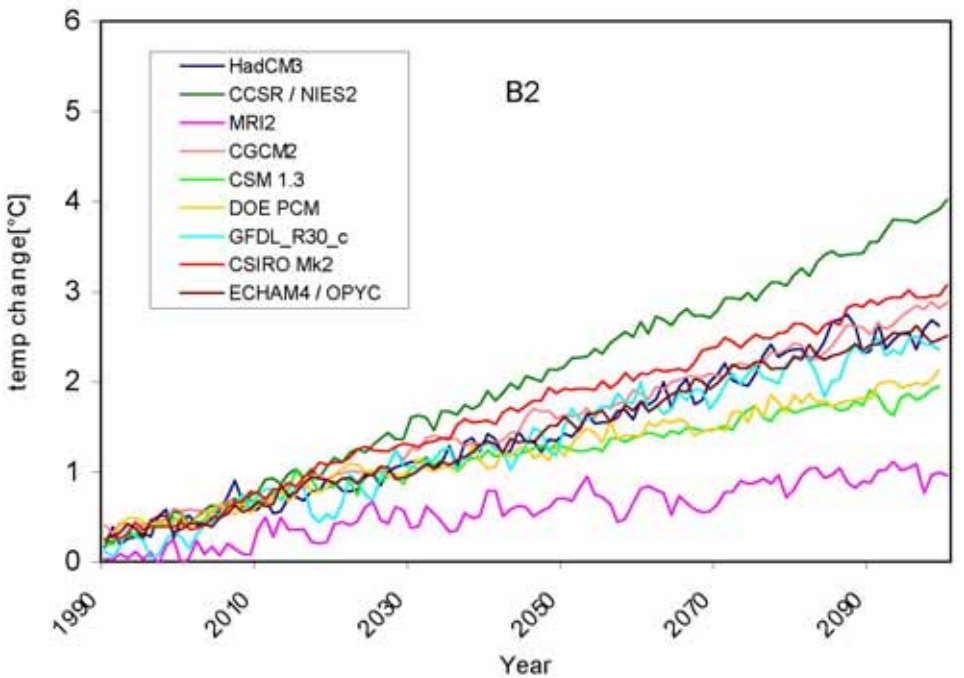
B2 A world with an emphasis on local solutions to economic and environmental sustainability.

IS 92a " business as usual " scenario (1992).







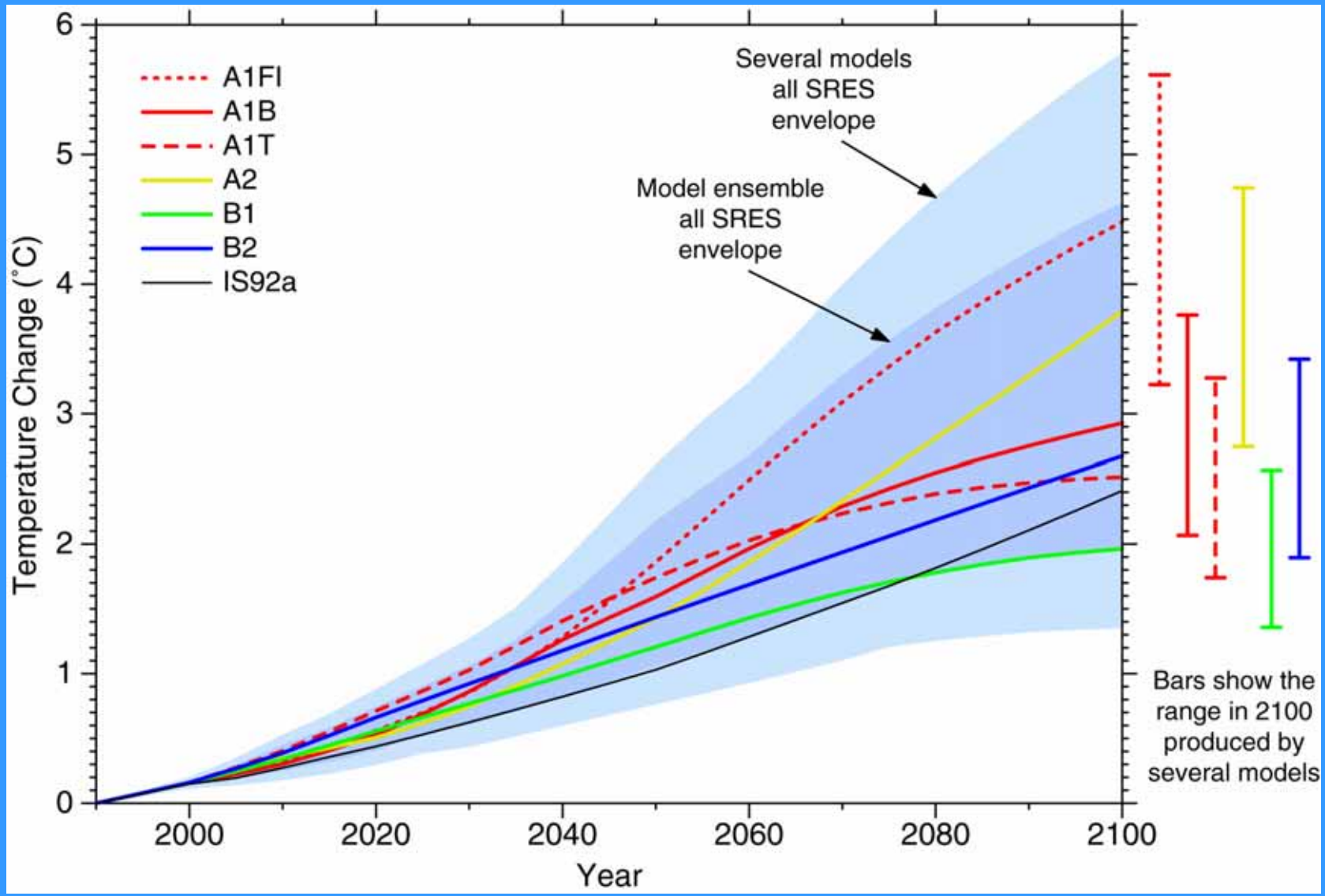


CCSR/NIES

The globally averaged change of the near surface temperature relative to the years 1961-1990, simulated by 3d globally coupled ocean-atmosphere models

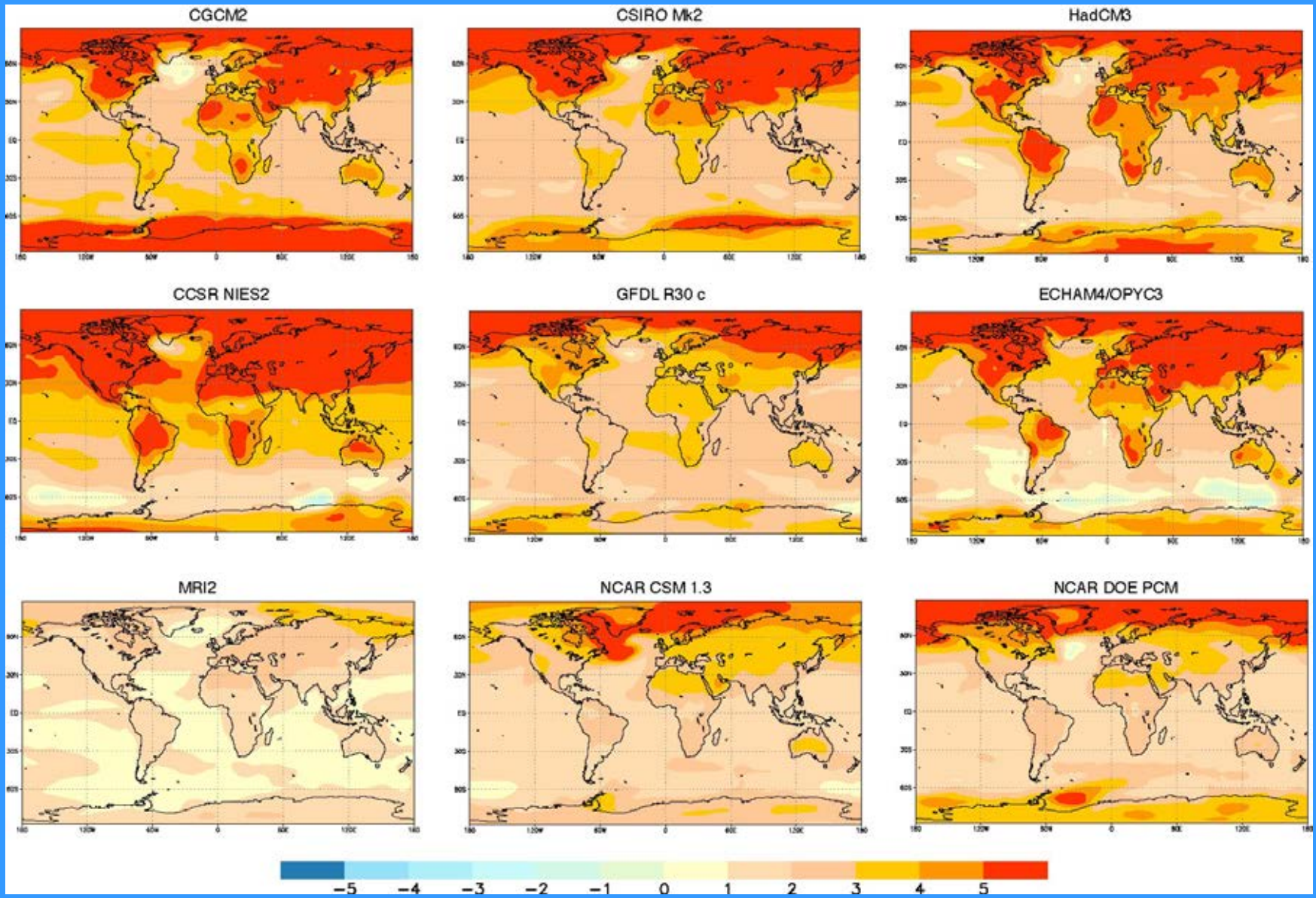
MRI

veritas
iustitia
libertas



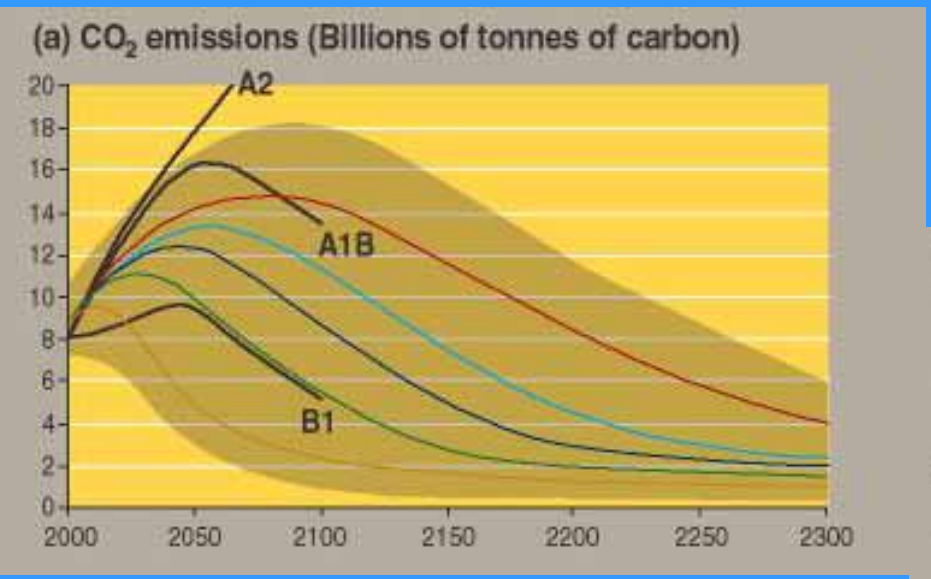
The temperature change for all SRES scenarios simulated by a simplified model representing all the 3d-models

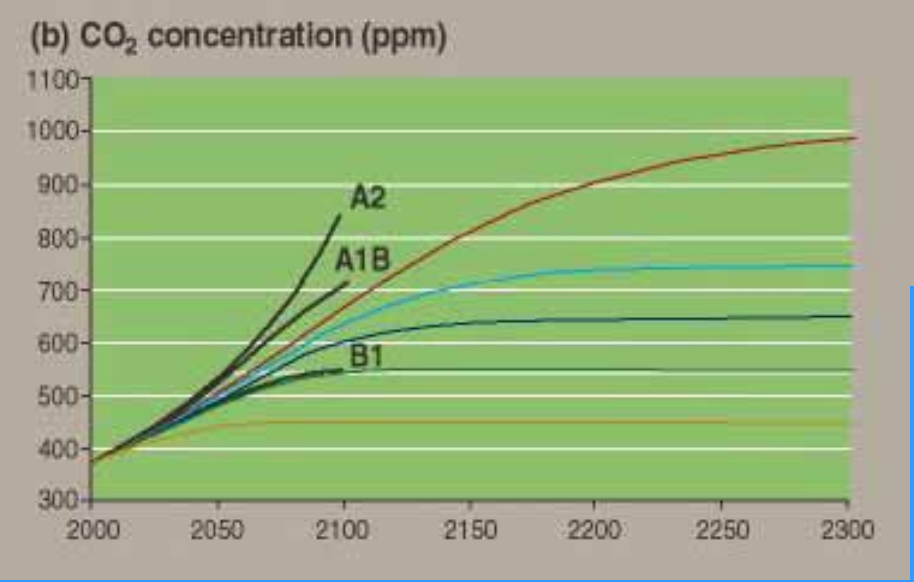
veritas
iustitia
libertas

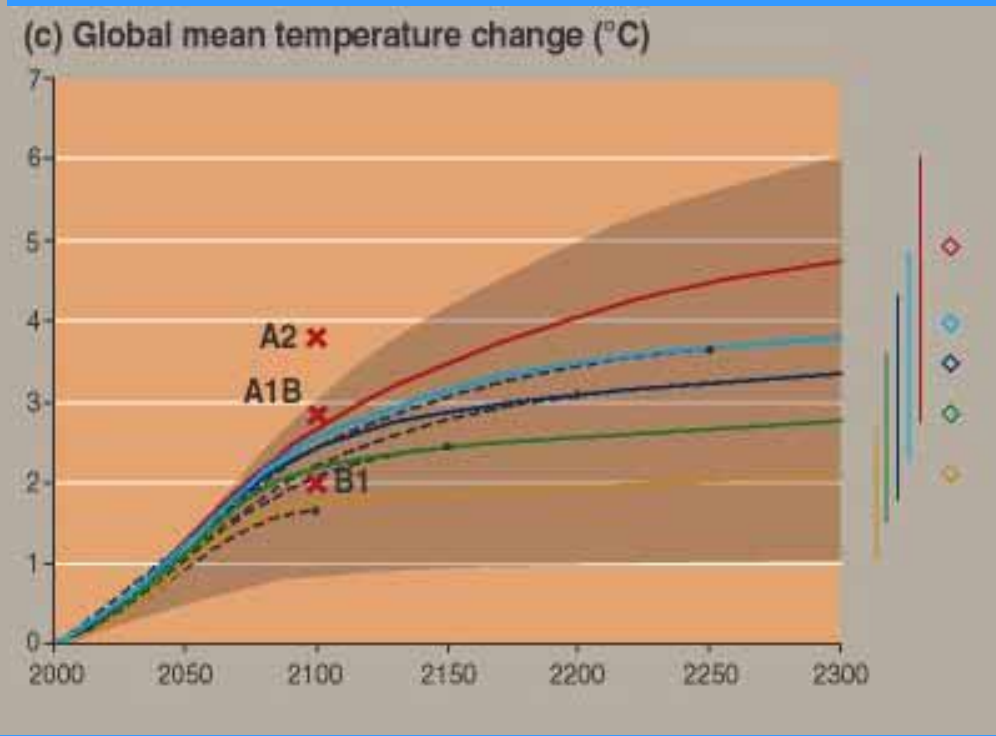


The global temperature change for the SRES A2 scenario

veritas
iustitia
libertas





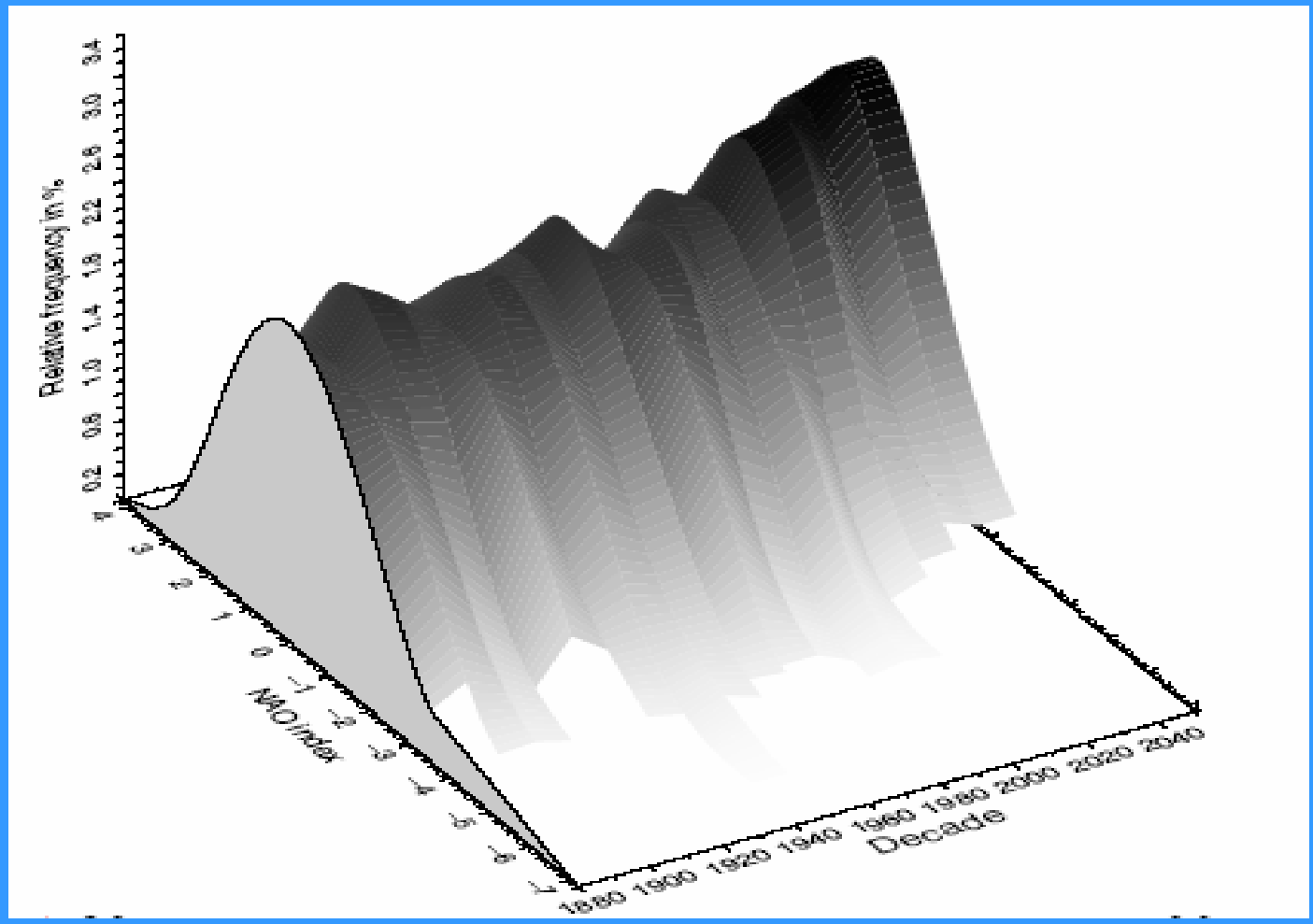


CO_2 emissions, concentration and temperature evolution for various stabilization scenarios

veritas
iustitia
libertas

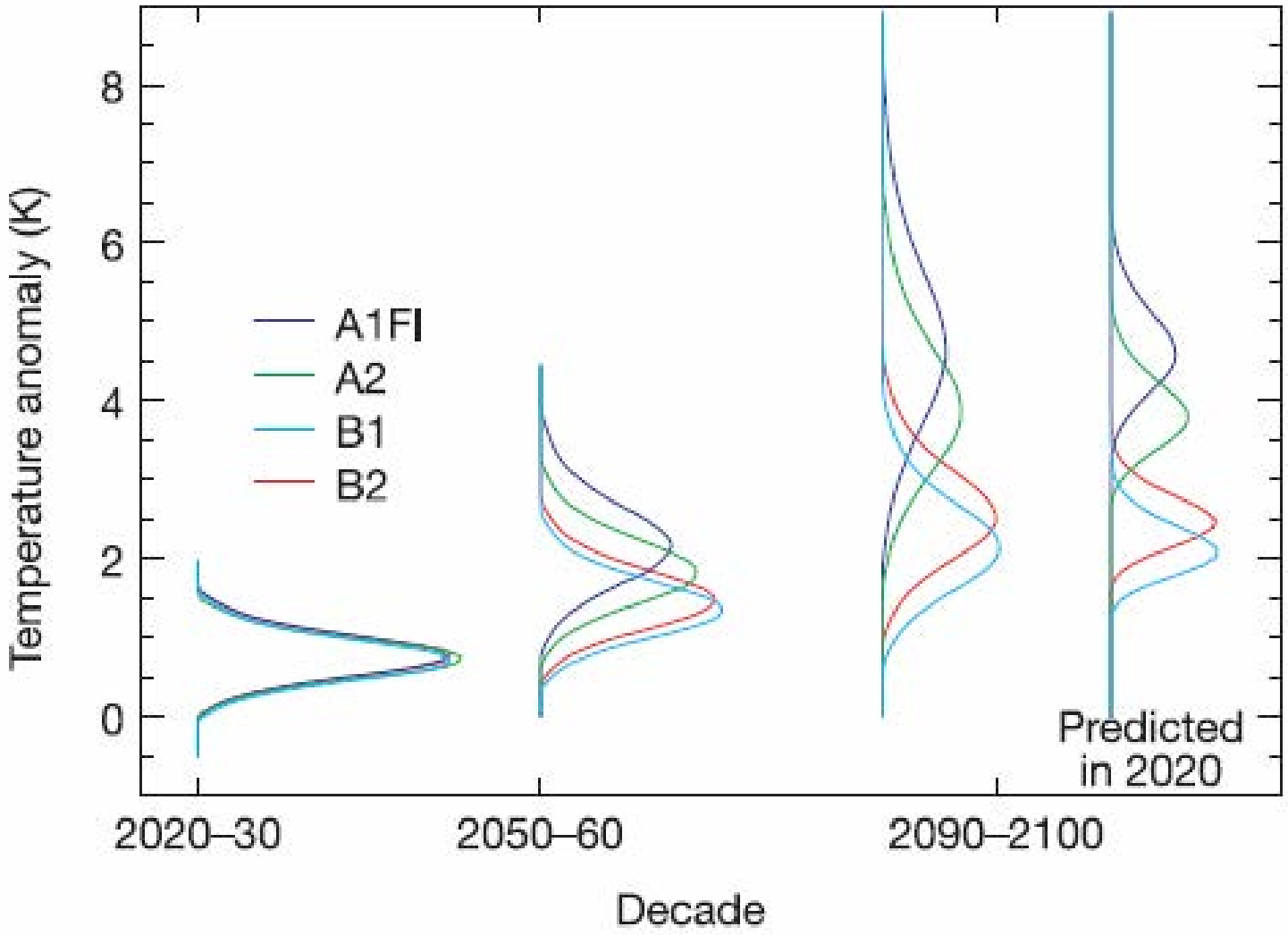
New developments

Probabilistic approach



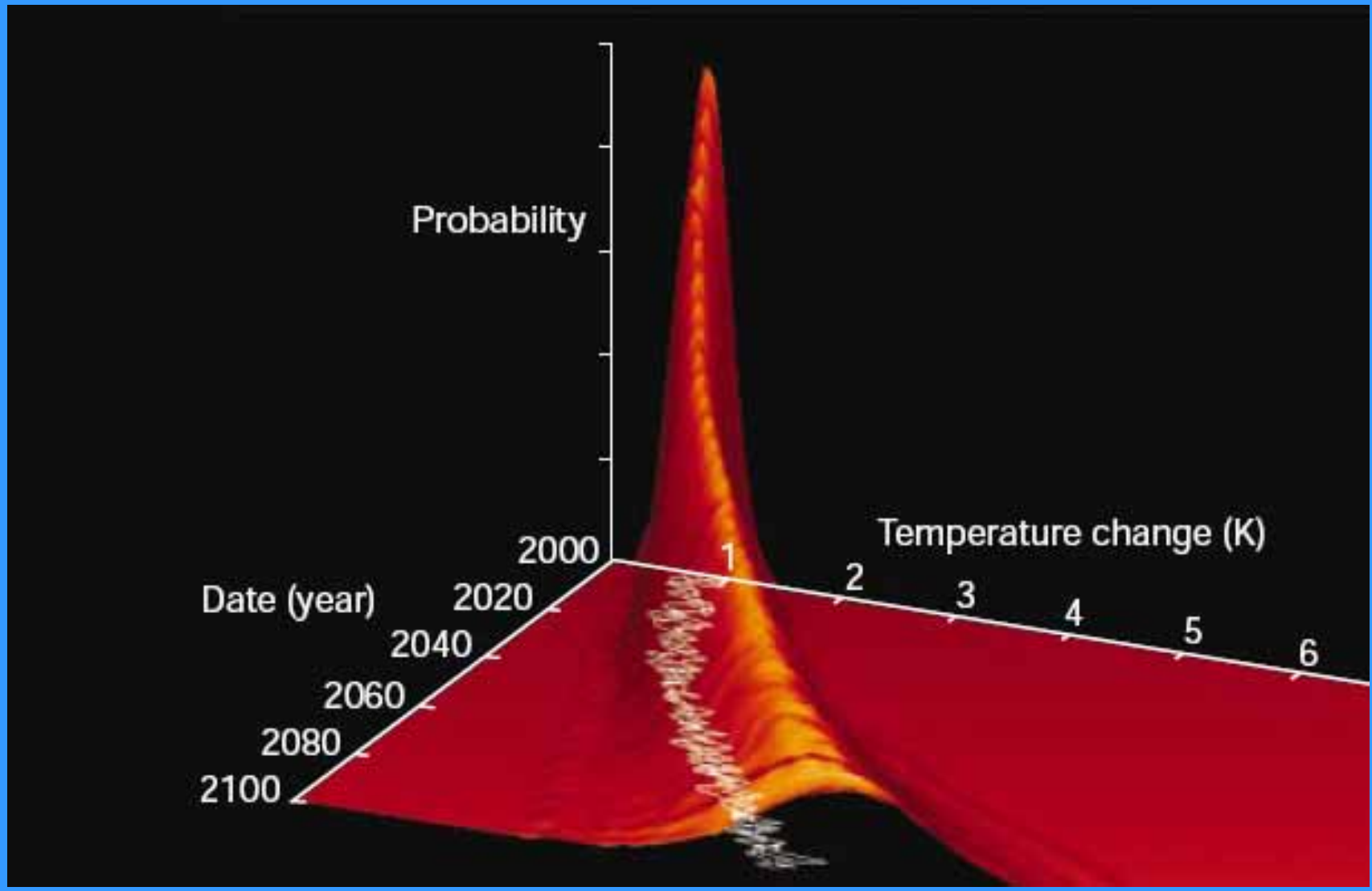
Decadal probability density functions (PDF) of a transient greenhouse gas ensemble: each PDF consists of 160 NAO index realisations.

Paeth et al, 1999 – in the TAR



Probability density functions of temperature change simulated with the Hadley Centre model

Stott and Kettleborough, 2002



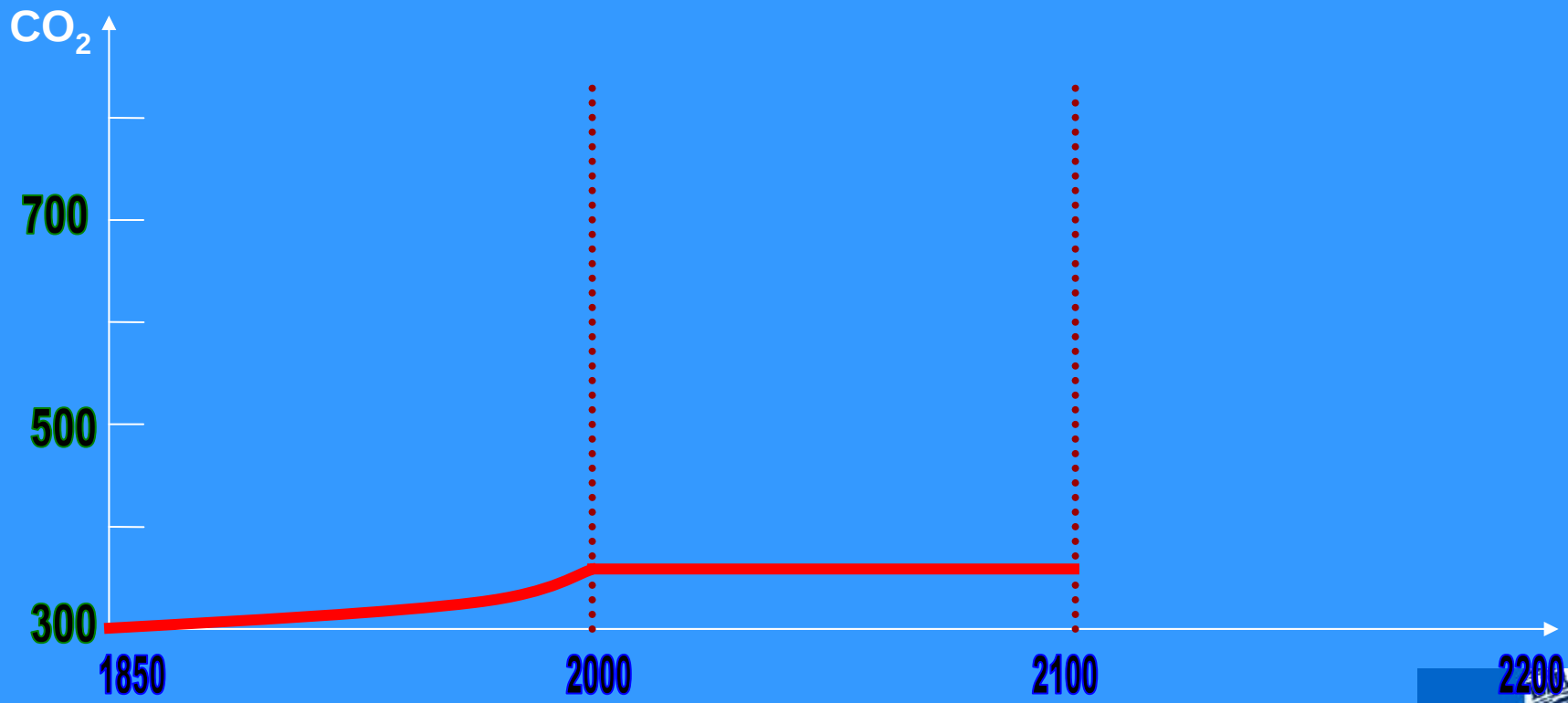
Probability density distribution of climate projection

Allen & Ingram, 2002

IPCC recommendations for the AR4

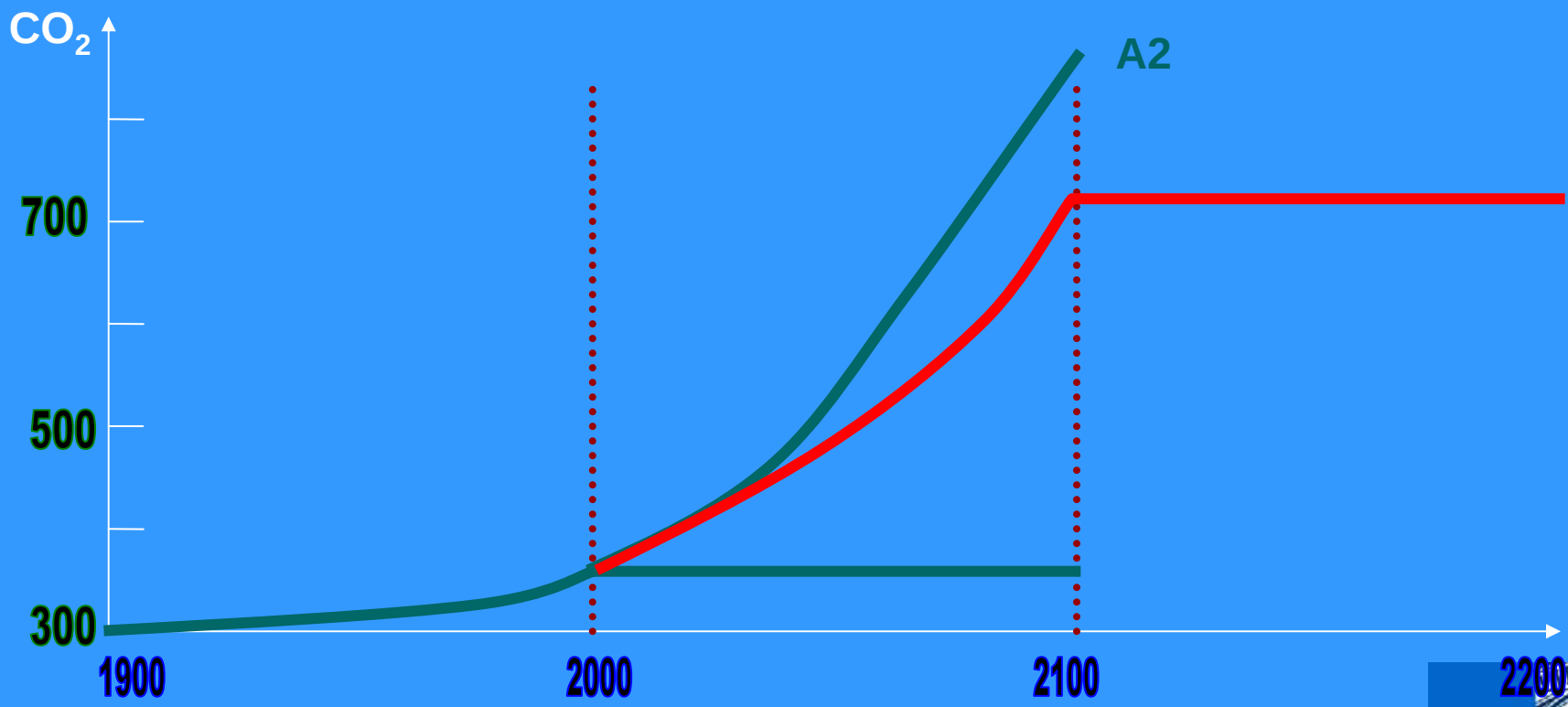
Experiment 1 (20C3M)

- Forced 20th century simulation to 2000
- Fix all concentrations at year 2000 values (CO_2 ~ 360 ppm)
- Run for 21st century to 2100



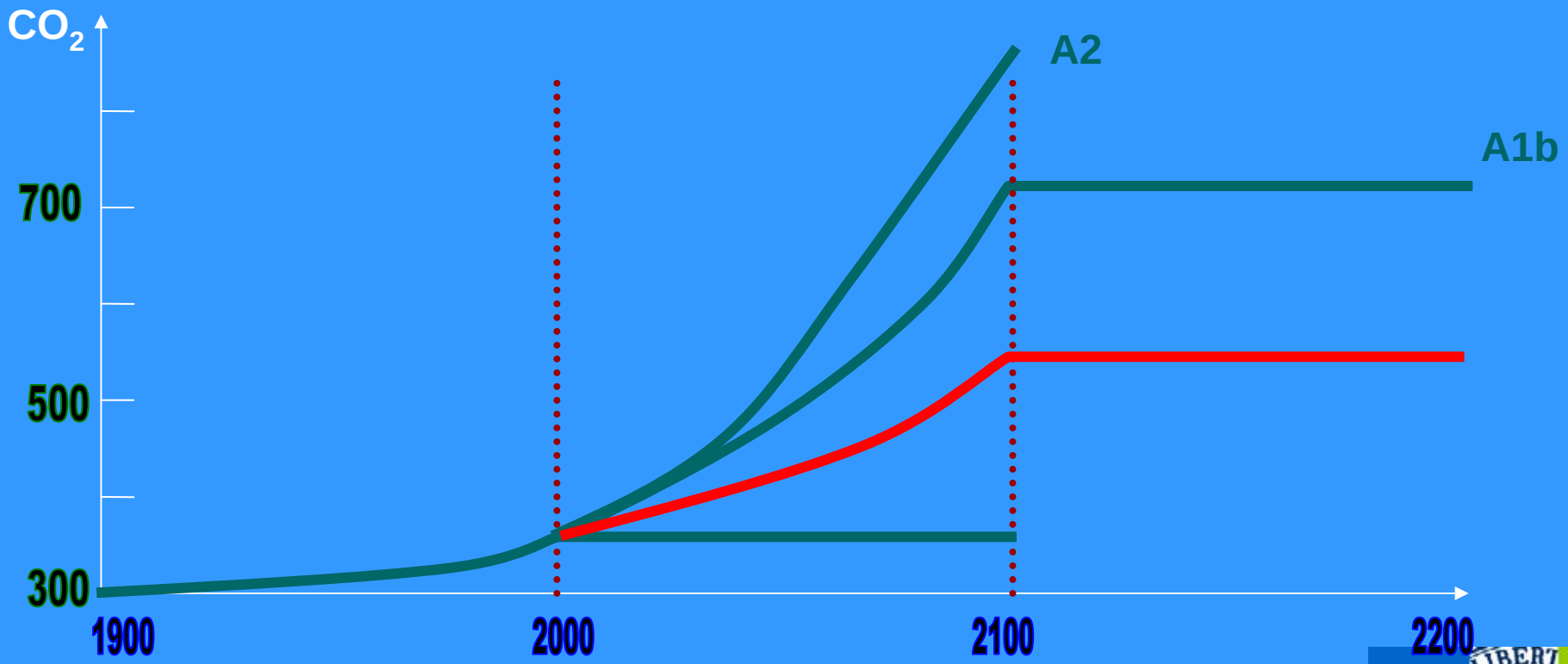
Experiment 2 (750 ppm stabilization)

- Scenario A1b
- Run for 21st century to 2100 (CO_2 ~ 720 ppm)
- Fix all concentrations at this level to 2200



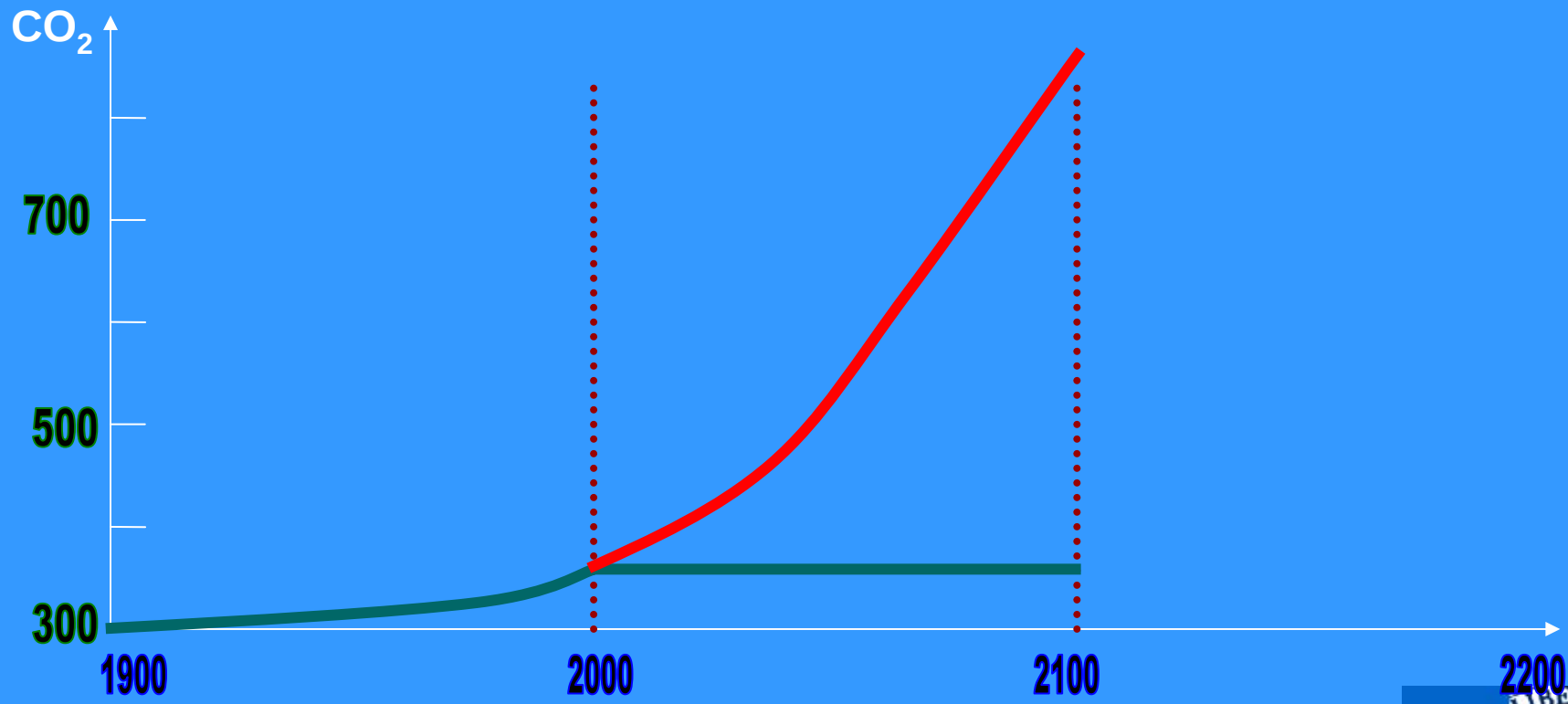
Experiment 3 (550 ppm stabilization)

- Scenario B1
- Run for 21st century to 2100 (CO_2 ~ 550 ppm)
- Fix all concentrations at this level to 2200



Experiment 4

- Scenario A2
- Run for 21st century to 2100 (CO_2 ~ 860 ppm)



Experiments for IPCC AR4

Approved by IPCC

Letter of S. Solomon 8.12.2003

0. Control simulation

- Forced 20th century simulation + fixed concentrations for 21st century (**20C3M**)
- Beginning with 1., but then Scenario A1b for 21st century + fixed concentrations for 22nd century (750 ppm stabilization)
- Beginning with 1., Scenario B1 for 21st century + fixed concentrations for 22nd century (550 ppm stabilization)
- Scenario A2 for 21st century
- 1% CO_2 increase per year until doubling and quadrupling, then fixing concentration (CMIP)
- 2*CO_2 equilibrium run with a slab ocean

ENSEMBLE – The European climate modelling project

after D. Griggs, Hadley Centre (project coordinator)

ENSEMBLES

- A five year project under EC Framework Programme VI
- Funding from EC of 15 million Euros
- 72 partners from EU, candidate countries, Switzerland, Australia, US
- Eight Research Themes

ENSEMBLES

Strategic Objectives

- Develop an ensemble prediction system based on the principal state-of-the-art high resolution, global and regional Earth System models, validated against quality controlled, high resolution gridded datasets for Europe, to produce for the first time, an objective probabilistic estimate of uncertainty in future climate at the seasonal, decadal and longer timescales
- Quantify and reduce uncertainty in the representation of physical, chemical, biological and human-related feedbacks in the Earth System
- Maximise the exploitation of the results by linking the outputs to a range of applications, including agriculture, health, food security, energy, water resources, insurance and risk management

ENSEMBLES

Scientific Objectives 1

- Build an integrated European capability to predict climate changes, and consequent socio-economic impacts, on seasonal, decadal and longer timescales, using a probabilistic multi-model approach to climate scenario construction.
- Assemble Earth System models including the various components and the interactions between them.
- Develop high resolution regional climate models for Europe along with quality controlled gridded climate datasets for Europe
- Advance understanding of the key processes and feedbacks that govern changes in climate, and related consequences, with particular attention to extreme events and the possibility of abrupt climate change.

ENSEMBLES

Scientific Objectives 2

- Develop a comprehensive approach to the validation of climate change ensembles and the impact assessments, which includes the exploitation of seasonal to decadal predictability studies, thereby providing for the first time a sound, quantitative measure of the confidence in future scenarios
- Estimate quantitatively the predictability of climate changes and variations, especially those associated with flood and drought, on timescales of seasons, decades and beyond, and to provide better estimates of the likelihood of abrupt, catastrophic climate change in the coming century.
- Provide detailed probabalistic assessments of the impacts of climate change at high resolution over Europe.
- Disseminate the knowledge gained during the project to policy makers, scientists, and the public.

ENSEMBLES Research Themes

RT	Name	Co-ordinators
0	Project integration, management and promotion	Dave Griggs
1	Development of the Ensemble Prediction System	James Murphy, Tim Palmer
2A	Production of seasonal to decadal hindcasts and climate change scenarios (Model Engine Part 1)	Guy Brasseur, Jean-François Royer
2B	Production of Regional Climate Scenarios for Impact Assessments (Model Engine Part 2)	Clare Goodess, Daniela Jacob
3	Formulation of very high resolution Regional Climate Model Ensembles for Europe	Jens Christensen, Markku Rummukainen
4	Understanding the processes governing climate variability and change, climate predictability and the probability of extreme events	Julia Slingo, Herve le Treut
5	Independent comprehensive evaluation of the ENSEMBLES simulation-prediction system against observations/analyses	Antonio Navarra, Albert Klein Tank
6	Assessments of impacts of climate change	Jean Palutikof, Andy Morse
7	Scenarios and Policy Implications	Richard Tol, Roberto Roson
8	Dissemination, Education, and Training	Martin Beniston, Christos Giannakopolous

Models and institutes involved in ENSEMBLES scenario experiments

institute	model
GCAM	HadGEM 1^0 atm, $1/3^0$ oc
Hadley	HadGEM new
INGV	ECHAM5-OPA
IPSL + UCL-ASTR	IPSL-model
CNRM	Arpege + ISPL oc
FUB	EGMAM T30L39 at, T42 eq.ref. oc
MPIMET	ECHAM5 MA +OM1
DMI	ECHAM5 MA +OM1
NERSC	Bergen model
UiO	Oslo model

ENSEMBLES

- Currently at contract negotiation stage
- Project will be managed by a Management Board under the terms of a Consortium Agreement
- Expected start date 1 April 2004?
- First meetings have already been held because of the tight deadlines imposed by IPCC

Summary

- Everything is geared up and ready to go for the IPCC AR4 challenge