

COMBINE

AT A GLANCE

Title: Comprehensive Modelling of the Earth System for Better Climate Prediction and Projection

Instrument: FP7, Collaborative and large-scale Integrating Project

Total Cost: 11,423,157.54 €

EC Contribution: 7,922,679.90 €

Duration: 48 months

Start Date: 1.5.2009

Consortium: 23 partners from 14 countries

Project Coordinator: Max Planck Institute for Meteorology, Max-Planck-Gesellschaft (Germany)

Project Web Site: www.combine-project.eu

Key Words: Earth system model, processes, initialization, decadal climate prediction, climate projection, impacts, scenarios, climate policies

THE CHALLENGE

One of the most pressing questions of the current time is to predict the future of the Earth environment. This question arises from the realization that human activities have a sizable impact on our planet, the Earth. The COMBINE project brings together leading European modelling centres to face the challenge of building the next generation of Earth System Models (ESMs), to advance the capabilities of climate prediction and projection. COMBINE follows previous European Commission large-scale projects, such as ENSEMBLES from FP6, on being a strong European effort. In COMBINE, model development aims at incorporating our most advanced knowledge of the Earth System. Pioneering applications of ESMs in new areas of research, such as decadal climate prediction, are a core aspect of the project.

PROJECT OBJECTIVES

The overarching objectives of the COMBINE project are:

- To advance the prediction capabilities of ESMs by including critical physical and biogeochemical processes ("new components") into the models.
- To represent more accurately the forcing mechanisms and the feedbacks determining the magnitude of climate change in the 21st century.
- To assess, improve and implement new strategies of ocean and sea-ice initialization techniques for decadal climate prediction.
- To combine ESMs and integrated assessment models to find revised CO₂ emission scenarios, including those scenarios constructed on the basis of climate policy.
- To assess climate change impacts on water availability and agriculture, globally and more specifically in three selected regions: The Arctic, the Eastern Mediterranean and the Amazon basin, where different feedbacks are important.



METHODOLOGY

The project workflow is subdivided in 8 work packages (WPs). WP1 to 4 are dedicated to development and validation of new components: Carbon and nitrogen cycles, the coupling of aerosols, cloud microphysics and chemistry, stratospheric dynamics, and cryospheric processes. Ocean and sea-ice initialization techniques are tackled in WP5. The effects of combined new components are investigated systematically by means of dedicated numerical experiments in WP6 and 7. Respectively, WP6 analyses the effect of the new components on decadal climate prediction, thus also incorporating the methods developed in WP5. WP7 uses simulations of centennial climate projections to investigate the effect of the new components on climate related feedbacks. WP8 explores the outputs of climate predictions and projections for impact analyses, at the global and regional scales. WP8 also combines the ESM outputs and integrated assessment modelling to find revised CO₂ emission scenarios.

RESULTS

The COMBINE partners have advanced significantly on developing the scientific and technical foundations for incorporating new components in ESMs. The first phase of the COMBINE numerical experiments has been completed. The main results achieved so far are:

- Implementation and testing of land use changes and wildfire impacts, processes for the terrestrial and oceanic nitrogen cycles, and processes related to methane emissions from permafrost and wetland changes.
- Evaluations of cloud-radiation and aerosol-cloud effects and land use impacts on tropospheric chemistry.
- Incorporation of tropical and polar stratospheric dynamical variability in ESMs.
- Improved understanding of processes regulating ice-sheet surface energy and mass balances; increased realism of the representation of surface snow processes in both ice-sheet and sea-ice models.
- A new ocean re-analysis has been conducted using up-to-date quality-controlled ocean observation data sets and atmospheric forcing fluxes, with significant progress in sea-ice assimilation.
- Decadal prediction and centennial projection following the Coupled Model Inter-comparison Project phase 5 (CMIP5) protocols completed with the relevant COMBINE ESMs. The decadal experiments have been initialized using observation based ocean state estimates.

The combined results of the new ESMs and integrated assessment models will provide new information to the policy makers on the necessary reduction in CO₂ emissions for reaching defined targets in global warming, with implications for international climate negotiations. The results obtained will contribute not only to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, but also directly to European climate policies. Harmonisation and standardisation of climate simulations and model data will contribute to further strengthen the European climate modelling community and the European voice in international climate negotiations.

PROJECT PARTNERS	COUNTRIES
Max-Planck-Gesellschaft	DE
Met Office	UK
Centre National de la Recherche Scientifique	FR
Centro Euro-Mediterraneo per i Cambiamenti Climatici	IT
Météo-France - Centre National de Recherches Météorologiques	FR
Het Koninklijk Nederlands Meteorologisch Instituut	NL
University of Bergen	NO
Danish Meteorological Institute	DK
European Centre for Medium-Range Weather Forecast	UK
Eidgenössische Technische Hochschule Zürich	CH
Finnish Meteorological Institute	FI
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (Planbureau voor de leefomgeving)	NL
Swedish Meteorological and Hydrological Institute	SE
Wageningen University & Research Centre	NL
University of Helsinki	FI
European Centre for Research and Advanced Training in Scientific Computation	FR
Université Catholique de Louvain	BE
University of Bristol	UK
University of Kassel - Centre for Environmental Systems Research (CESR)	DE
Technical University of Crete	GR
Cyprus Research and Educational Foundation	CY
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University of Exeter	UK



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