MODELLING BIOSPHERE SYSTEMS UNDER CLIMATE CHANGE FOR RADIOACTIVE WASTE DISPOSAL

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The BIOCLIM project is part of the EURATOM fifth European framework programme. The project was launched in October 2000 for a three-year period. It is coordinated by ANDRA, the French national radioactive waste management agency. The project brings together a number of European radioactive waste management organisations that have national responsibilities for the safe disposal of radioactive wastes, and several highly experienced climate research teams.

The BIOCLIM project is aimed at providing a scientific basis and practical methodology for assessing the possible long term impacts of climate change and associated landform development on the safety of radioactive waste repositories in deep geological formations. Environmental simulations are being conducted to represent possible scenarios for the long term evolution of climate in various European areas within which disposal sites may be established (namely Central Spain, Northeast France and Central England). Two complementary modelling strategies are being used to provide representations of future climatic and vegetational change for up to 106 years. Results obtained from global climate models are being downscaled using regional-scale models, as well as statistical and rule-based techniques, to derive regional/local climates. These results will be used to condition descriptions of potential future biosphere systems through which radionuclides may migrate and lead to potential exposure of man. These biosphere descriptions will be produced using an extension of the methodology developed in the IAEA-sponsored BIOMASS project. Descriptions will be developed both for time-independent biosphere system states and for transitions between those states. Whereas, the development of descriptions of individual states was explored extensively in BIOMASS, much less work was undertaken on state transitions, so substantial innovations in this area are being made within BIOCLIM.

The project is designed to advance the state-of-the-art of biosphere modelling for use in post-closure performance assessments of deep geological repositories for radioactive wastes through five work-packages (WPs).

WP1 - Consolidation of the needs of European waste management agencies

The requirements of the European agencies of the consortium have been reviewed and described and the current methods used to represent environmental change have been summarised. In particular, documents have been produced that:

- Identify the mechanisms and processes that cause long-term climate changes and the environmental consequences of such changes;
- Describe available palaeoenvironmental data for the European regions of interest for further use in the climate simulations.

WP2 – Hierarchical strategy

An existing climate model (LLN-2D NH) of the class characterised as Earth System Models of Intermediate Complexity has been used to simulate the overall long-term evolution of global and European climate. The results from that model are being used as input to more complex models (global and regional) that will produce snapshots of climate and vegetation cover for specific times. Results will be downscaled to the local areas of interest using statistical downscaling procedures. Six simulations are being undertaken using the complex models. These simulations relate to three time periods and are:

- Two simulations of a very near future characterised by either very high or high atmospheric CO2 concentrations (1100ppmv or550ppmv), all other parameters (such as insolation and ice volume) being taken as at the present;
- Possible future super interglacial condition, 67 ky After Present (AP) characterised by high insolation value. Two simulations will test two different atmospheric CO2 concentrations (550ppmv and 350ppmv) and the assumption of no ice sheet present. A third simulation will test the combined impacts of a 350ppmv atmospheric CO2 concentration and an ice sheet volume equivalent to that at present;
- The possible next episode of widespread northern hemisphere glaciation at 178 ky AP characterised by an atmospheric CO2 concentration back to pre-industrial level (275ppmv) and extensive development of Laurentide and Fennoscandian ice sheets.

WP3 – Integrated strategy

A strategy is being developed based on the use of integrated, dynamic climate models that represent most of the physical mechanisms thought to be important in determining long-term climatic variations. A new generation of Earth Models of Intermediate Complexity will be used for this purpose. These models are still in development in climate research laboratories, and using them within the BIOCLIM project will be an interesting challenge. More specifically, the models MoBidiC and CLIMBER will be adapted and applied. These both include atmosphere-ocean components and have simple representations of land vegetation cover. For BIOCLIM, MoBidiC and CLIMBER are being coupled to dynamic ice-sheet models. These coupled model systems will be used to produce a number of transient simulations of the next 200 ky. For this time interval, three numerical experiments have been given priority. These relate to three different scenarios for future atmospheric CO2 concentrations. The time-dependent results will be interpreted in terms of regional climate as well as vegetation changes using statistical and rule-based downscaling procedures.

WP4 – Biosphere system description

The output from the climate models developed in WP2 and WP3 will be interpreted in terms of the requirements of safety assessment models, in order to demonstrate how biosphere systems can be represented in the long-term. In particular, innovative guidance will be provided on how transitions between time-independent biosphere system states can be represented at an appropriate level of detail for performance assessment purposes.

WP5 – Final seminar

The methodologies developed, and results obtained, during the project will be disseminated throughout the international scientific and technical. All deliverables are being made publicly available during the project and a final seminar is being organised for the autumn 2003. This seminar will facilitate dialogue between project participants and other interested parties on the significance and implications of the work

Thirteen report deliverables will be produced from the various work packages and disposed on http://www.andra.fr/bioclim. The final paper will include a summary of progress made to date.

Attach File