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FLUID ENVELOPE OF PLANET EARTH

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ABSTRACT

The main centers of interest of CNRS-Section 12 cover five research areas : ocean and atmosphere dynamics, climate, atmospheric chemistry, marine biology and biogeochemistry, land surfaces and terrestrial waters. The major unifying challenge of research in those fields is to provide the scientific basis for decision-making to the political and socio-economical communities with respect to several major issues for the sustainable development of our planet for the next millennium : environmental problems (climate, air quality, water resources and quality, food security both on land and oceans), mineral resources and energy issues, natural hazards (hydrometeorological and geomorphological), waste disposal options. Processes and phenomena being studied do rely on methods, tools and concepts which are natural to our scientific community, from the local or microscopic scale to the global scale.

Over the last 15 years, a major part of the French research in this field has been implemented through active participations to the international research effort coordinated by the World Climate Research Programme (WCRP) and the International Geosphere Biosphere Programme (IGBP), as well as to European Union initiatives in this domain, taking also into account the specificity of the French community.

Emphasis is put on the multidisciplinary character of all the research topics relevant to global change issues. Indeed, one has to consider physical, chemical and biological couplings which take place within each subsystem and between the different subsystems of the fluid envelope of our planet. Thus, the coupling between atmospheric chemistry, radiative transfer and thermodynamics, atmospheric and ocean dynamics are central to the characterisation of present climate and its evolution. The coupling between the marine biological pump of carbon and mesoscale turbulence and dynamics in the ocean is crucial for the assessment of the ocean, sink of atmospheric CO2. The coupling between vegetation and terrestrial ecosystem dynamics, turbulence and evapotranspiration, air and water flows near the soil, and geo-morpho-pedogenetic processes is necessary to address water and carbon budgets on land.

Multidisciplinary approaches address progressively more and more global challenges, such as the coupled modelling of the ocean-atmosphere system now well underway in France. Such an integrative effort will be a major focus of our programmes in the future.

Following a description of major recent advances and research plans of the French community, the conjuncture report of CNRS-Section 12 focuses on the strategic tools which are crucial to the development of these carefully designed research activities. Emphasis is put of the synergy between long-term observations of our present and past environment, large scale field experiments, instrumental developments (such as remote sensing, aircraft and ship platforms) and modelling efforts of the geosphere-biosphere system at global and regional scales. This has been made possible through a growing awareness that all research topics and disciplines are aiming at understanding different aspects of the functioning of our planet. This is largely due to the implementation of a coherent national programmatic effort on global change issues, coordinated by the Institut National des Sciences de l'Univers (INSU) and based on a common strategy of the different agencies involved in this effort.

This integrative framework should be strengthened in the future through reinforced interactions with disciplines and scientific communities which are still poorly involved in Earth Science research and are administratively in other scientific Departments of CNRS. Taking a few examples, chemistry and spectroscopy are essential for climate studies, functional ecology and microbiology are necessary to understand biogeochemical cycling, evolutionary ecology is needed to assess how the evolution of biomes is controlled by climatic and physical forcing, new tools from molecular biology hold promising advances in biological oceanography, physical geography is essential for defining spatial patterns of functional units at all scales, etc. Finally, links with the socio-economical sciences are crucial for the assessment of human contributions and responses to climatic and environmental changes, such as land-use, at local, regional and global scales and, for the evaluation of the risks for human societies associated with natural hazards.

Whereas global change research has made significant progress over the last ten years and provided insight on the mechanisms by which human activites disturb the environment, a major integrated interdisciplinary research effort is now required to simulate the transient behaviour of the Climate and Geosphere-Biosphere system in the future and assess conditions allowing sustainable development of planet Earth.