The terrestrial biosphere is an important component of the Earth carbon cycle, and its role in the present-day CO$_2$ budget appears to be crucial. In that context, we developed a global geographically referenced biospheric model called SLAVE (Scheme for Large-scale Atmosphere Vegetation Exchange). This model predicts on a $5^\circ \times 5^\circ$ resolution grid the global distribution of nine natural vegetation types, considers the human managed areas, and calculates the seasonal cycle of the main biospheric carbon and nutrients pools and fluxes from climatic variables.

The vegetation scheme is based on correlations between observed distributions of nine vegetation types (perennial ice, desert and semidesert, tundra, coniferous forest, temperate deciduous forest, grassland and shrubland, savannah, seasonal tropical forest, and evergreen tropical forest) and two climatic variables (precipitation and temperature). Empirical relationships between the spatial distribution of each of the nine natural vegetation types and the two climatic variables have been developed. Each vegetation type is allowed to exist within a defined domain of precipitation and temperature. Observed distribution of human managed areas is superimposed on the modelled distribution of potential vegetation types.

SLAVE also computes on a monthly time step, the soil water budget, the distribution of carbon in six pools (herbaceous and woody materials in phytomass, litter and soil), and the main CO$_2$ fluxes between these pools and the atmosphere (Net Primary Production, litterfall, litter and soil respiration). These pools and fluxes are function of climatic variables and vegetation types; they are in turn modulated by the water and nutrient status of the soil and CO$_2$ concentration in the atmosphere.
The development of a global environmental model dealing with essentially all the subsystems shown in figure 1 is undertaken at LPAP. The individual submodels corresponding to the various system components must first be developed separately before the effect of subsystem coupling can be analysed. A two-dimensional model of atmospheric chemistry and climate has been constructed during the initial phase of the programme and has been used to study the potential role of climate-chemistry feedback processes in the atmosphere response to global change. Towards the prediction of future levels of atmospheric carbon dioxide, our activities now focus on the global carbon cycle. We are starting the development of a three-dimensional model describing the exchanges of carbon between the atmosphere, the ocean, the vegetation and the soil. The submodule describing land vegetation is already running at a global scale, but needs to be validated. To this end, we plan to use satellite data from future space missions (POLDER onboard ADEOS and VEGETATION onboard SPOT4) in conjunction with in situ measurements in a number of selected sites. A three-dimensional model of atmospheric CO₂ transport is also used at this stage to validate the seasonal cycle of the biosphere (vegetation-soil) model. In the same context, a model of soil hydrology is

![Diagram of major components of the global environment and their mutual interactions. Modelling this system and its response to natural and anthropogenic perturbations is the main objective of this research.](image)
developed to limit vegetation growth and soil respiration during dry periods. Coupling water and carbon cycles is important to understand the evolution of both climate and carbon stocks in vegetation and soils. In the future, the biosphere and the atmospheric CO₂ transport modules will be coupled to a threedimensional model of the oceanic carbon cycle the development of which has been initiated. The resulting coupled model will be used to study the budget of carbon dioxide over periods ranging from years to centuries. Climate simulations will also be performed to predict temperature and precipitation fields consistent with the atmospheric CO₂ level calculated by the carbon cycle model. To be complete, an additional research activity is conducted in parallel and consists in model reconstructions of the carbon cycle evolution at glacial-interglacial and geological timescales.

References