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Attractors of ecosystem compartment models: qualitative behaviour of local and global matter cycles

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Dynamic properties of open and closed compartment ecosystem models where some flow functions are saturated and the rest are selected as linear or of Lotka-Volterra type are investigated. Stability and bifurcations of equilibria and existence of regular and chaotic oscillatory regimes for this class of dynamic models as the typical problem in dynamic system theory are the main subjects of attention. A number of the global carbon cycle compartment schemes built by an aggregated data from a number of high-dimensional diagrams initiate series of a closed dynamic models and their modifications from a considered class based on the minimal four-dimensional system. To study the functioning of the global carbon cycle an existence, stability and bifurcations of equilibria and periodic solutions are considered using the total amount of carbon and the rates of anthropogenic input and land-use to the atmosphere as bifurcation parameters. Embedding of equation for the simplest climatic factor - the globally averaged annual temperature of the surface - and linking it with main intercompartment flows modify the model and allow one to obtain climate-induced boundaries of stability domains for possible equilibria of global carbon cycle. Temperature

variation in accordance with different climatic scenarios, as well as human perturbations trend,

initiates the transition scheme from one stable attractor to another thus simulating probable

tendencies in functioning of coupled climatic and biotic machines on the Earth.

More different oscillatory regimes, regular and chaotic, as well as a mechanism leading

to the strange attractor formation, can be found for the open model of organic matter cycling

in a bog ecosystem confirming complexity and nonlinearity of ecosystem functioning. Bifurcation

diagrams are constructed in two critical parameters: atmospheric carbon dioxide assimilation rate

increasing under the climate change, and the rate of carbon output from dead organics and litter

due to human activities. There are four possible equilibria interpretable as raised bog, meadow,

forest and transformed ecosystem. CO2 concentration increase leads the current state of mesotrophic

bog to loose stability with appearing of oscillatory dynamics and further evolution to a chaotic attractor. Another chaotic attractor is formed from the forest equilibrium and exists in the same area of phase space where current equilibrium is stable. This work is supported by the grant 05-05-65137- of Russian Foundation for Basic Research.