

# The Earth Science Box Modeling Toolkit (ESBMTK)

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Box modeling is a versatile tool to explore earth systems processes, ranging from transient changes in the marine carbonate system to the long-term evolution of biogeochemical cycles. The Earth Science Box Modeling Toolkit (ESBMTK) is a Python library that provides an object-oriented approach for the development of Harvardton-Bear-type box models. ESBMTK classes facilitate declarative model definition that also serves as the model documentation. ESBMTK provides abstractions for a variety of processes, e.g., gas exchange across the air-sea interface, marine carbonate chemistry (water column and sediments) or isotope calculations. Class instances can then simply be combined to build a model. While there is no graphical interface, this approach significantly reduces coding complexity and model development time. Crucially, the model structure is independent of the numerical implementation. Instead, the model is parsed to dynamically create the necessary equation systems that can be passed to ODE solver libraries like ODEPACK. Separating model description from numerical implementation results in well-documented model code, and combines the computational efficiency of state-of-the-art numerical libraries with the ease of use of Python.

ESBMTK interfaces with pyCO2SYS in order to provide access to a wide variety of equilibrium constants parametrizations. Originally envisioned as a teaching tool, it is currently being used in several research projects. The library is under constant development, but the basic API is stable and fully documented. ESBMTK is open source, and available via GitHub <https://github.com/uliw/esbmtk> and easily installed via pypi or conda-forge.