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Xarray-simlab: a generic framework to build, inspect, customize and run computational models in an interactive environment

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In geosciences as well as in many other scientific domains, researchers rely more and more on the use of computer models to better understand complex phenomena. Yet, as new simulation experiments are designed and tested, the growing development of these models often leads to "monolithic" codes and i/o interfaces of increasing complexity, raising issues of maintainability and error-proneness. To prevent these issues while still encouraging experimentation, we have developed a generic tool named xarray-simlab (https://github.com/benbovy/xarray-simlab). This open-source Python package provides both a lightweight framework for building and/or customizing models from pluggable components and an extension of xarray (a popular package for n-dimensional labeled arrays, based on the netCDF data model) to easily setup and run simulations. The advantage of Python is here twofold: (1) often viewed as a « glue » language, it is easy to warp in Python existing codes that are written in compiled languages such as C, C++ or Fortran and (2) we can work in an interactive environment and leverage a very large ecosystem of scientific libraries not only for analyzing or visualizing model outputs, but also for building and running models, which may greatly reduce the friction that is usually introduced by command-line interfaces. The framework allows to build models very quickly and dynamically from many components by automating aspects such as workflow dependencies and model input detection. It has also potential to automate other aspects like parallel execution of model components, command-line interface and/or graphical interface. It aims to ultimately help researchers forget technical aspects and stay focused on scientific developments. Although this tool is not restricted to any specific domain, we show how we have successfully used xarray-simlab to build, inspect and explore an extensible model of landscape evolution.