eSCAPE: parallel global-scale landscape evolution model

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Summary

eSCAPE is a parallel landscape evolution model, built to simulate Earth surface dynamics at global scale and over geological times. The model is primarily designed to address problems related to geomorphology, hydrology, and stratigraphy, but it can also be used in related fields.

eSCAPE accounts for both hillslope processes (*soil creep using linear diffusion*) and fluvial incision (*stream power law*). It can be forced using spatially and temporally varying tectonics (vertical displacements) and climatic conditions (precipitation changes and/or sea-level fluctuations).

The model computes flow accumulation using multiple flow direction over unstructured grids based on an adaptation of the implicit approach proposed by Richardson & Perron (Richardson, Hill, & Perron, 2014). An extension of the parallel priority-flood depression-filling algorithm from (Barnes, 2016) to unstructured mesh is used to simulate sedimentation in upland areas and internally drained basins. Marine sedimentation is based on a diffusion algorithm similar to the technique proposed in pybadlands (Salles, Ding, & Brocard, 2018).

Dependencies & examples

eSCAPE installation requires several libraries and instructions are provided in the code website. The easiest way to get started is with the provided Docker container https://hub.docker.com/u/geodels/ using Kitematic.

A set of four examples is provided (eSCAPE-demo) and illustrates the different capabilities of the code from synthetic to regional, to continental and to global scale models. The code relies on a simple input script based on YAML syntax.

The following example shows how the model is called in Python:

```
> import eSCAPE as sim

# Reading input file
model = sim.LandscapeEvolutionModel(inputfile.yml,verbose=False,showlog=False)

# Running model
model.runProcesses()

# Cleaning model
model.destroy()
```
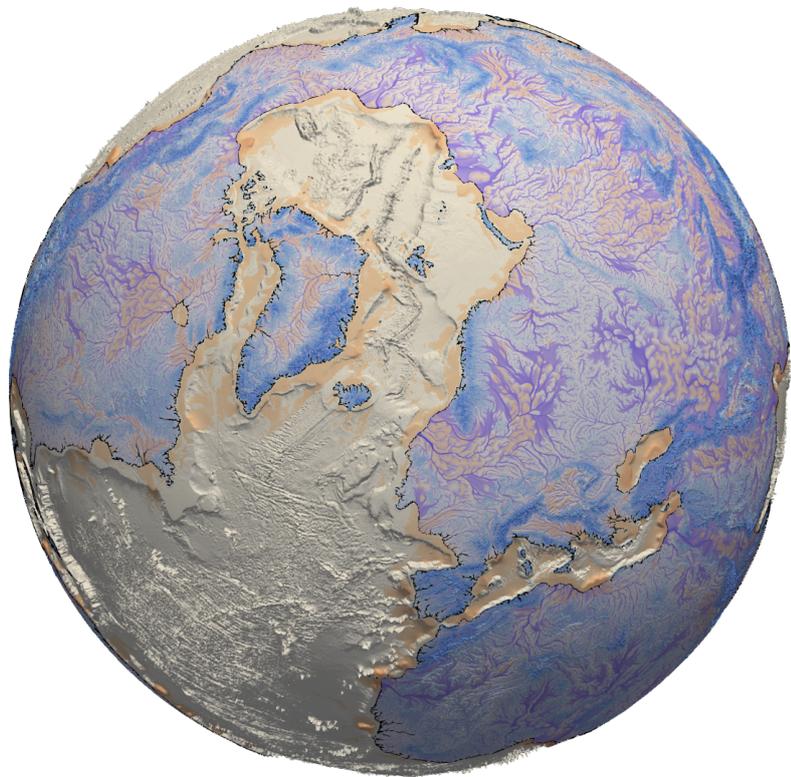
Figure 1: Example of **eSCAPE** output showing Earth evolution in the future after 100,000 years of constant sea-level and uniform precipitation.

References

Barnes, R. (2016). Parallel priority-flood depression filling for trillion cell digital elevation models on desktops or clusters, *96*, 56–68. doi:10.1016/j.cageo.2016.07.001

Richardson, A., Hill, C. N., & Perron, J. T. (2014). IDA: An implicit, parallelizable method for calculating drainage area. *Water Resources Research*, *50*(5), 4110–4130. doi:10.1002/2013WR014326

Salles, T., Ding, X., & Brocard, G. (2018). PyBadlands: A framework to simulate sediment transport, landscape dynamics and basin stratigraphic evolution through space and time. *PLOS ONE*, *13*(4), 1–24. doi:10.1371/journal.pone.0195557