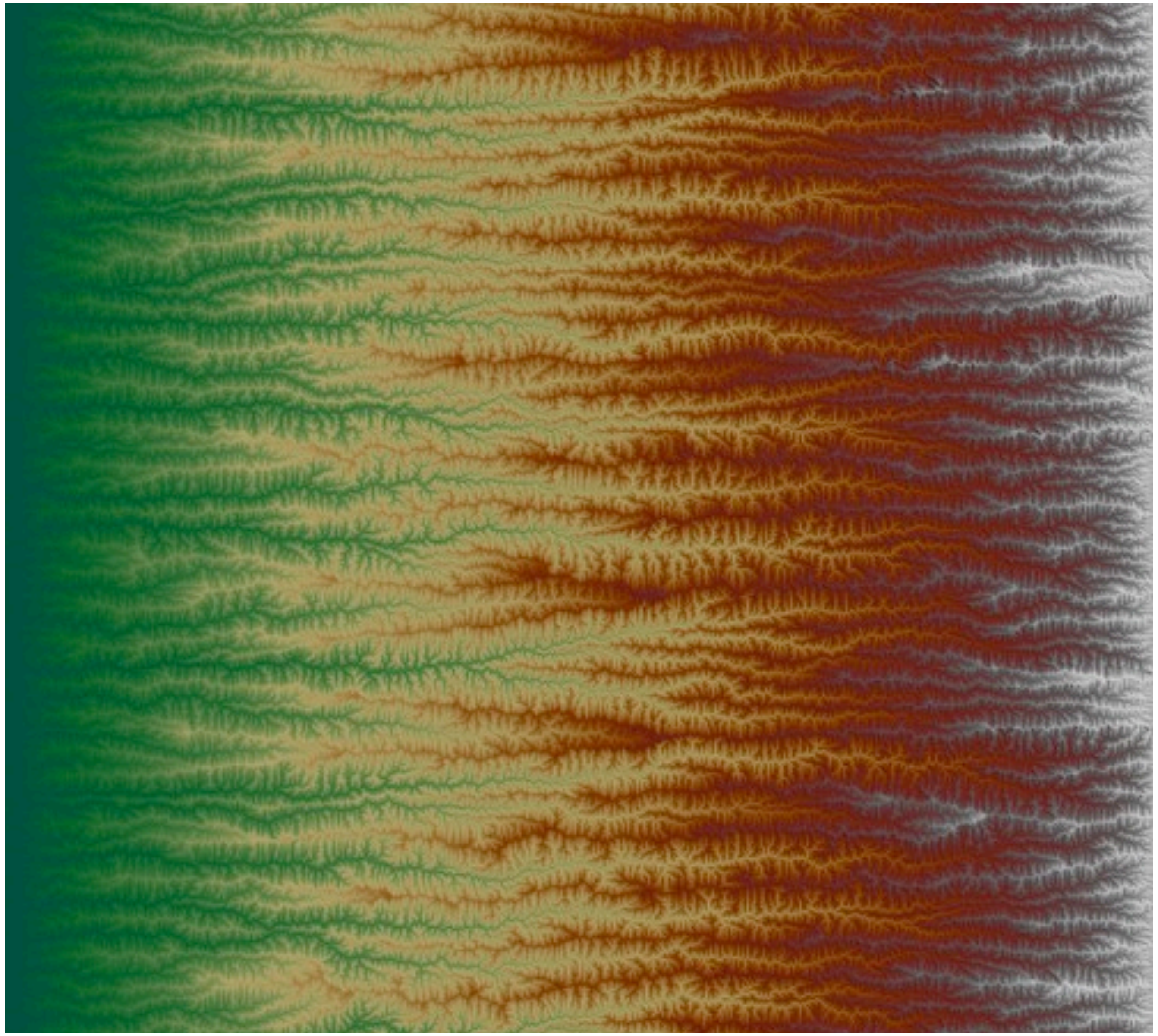
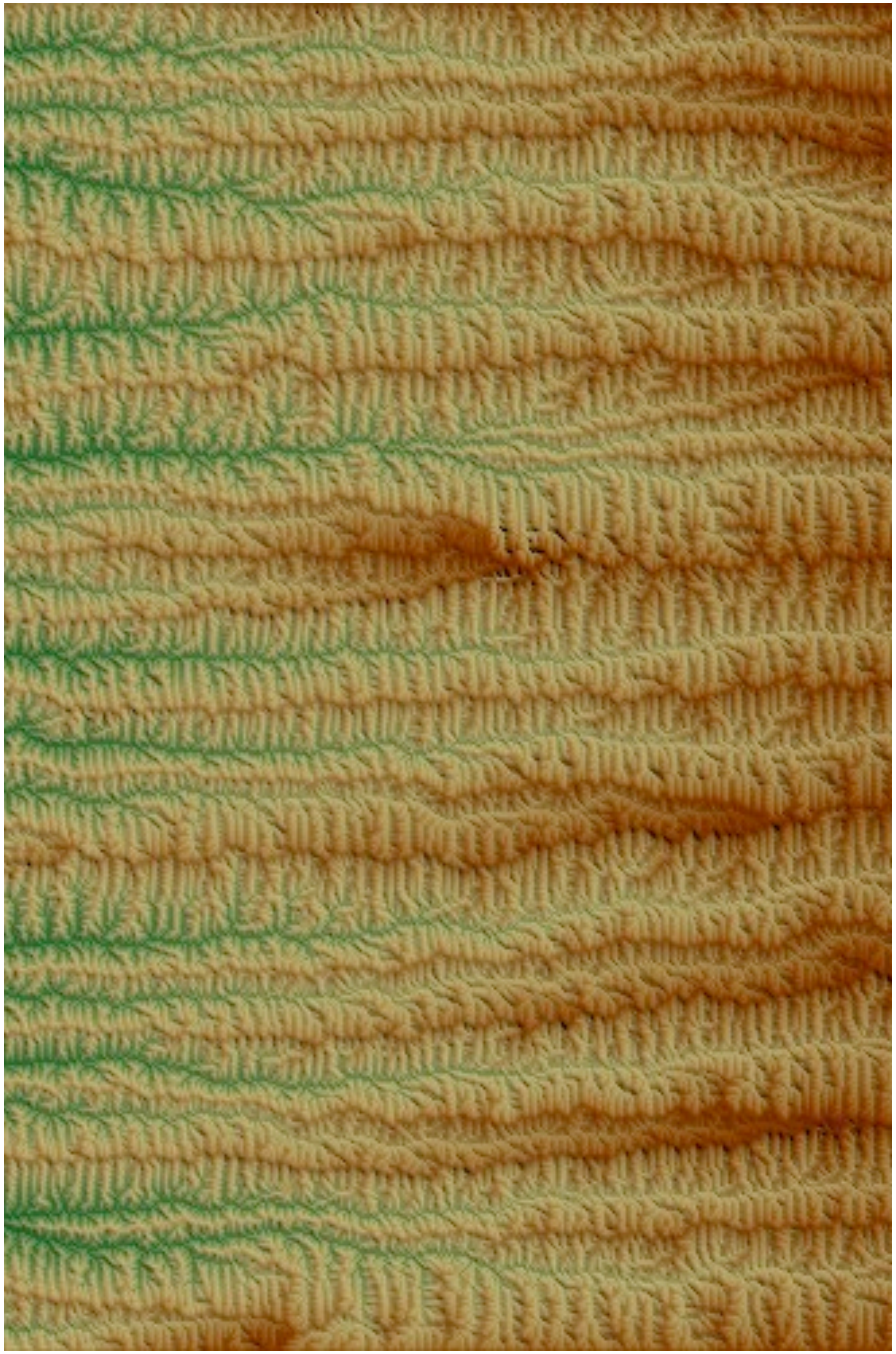
FastScape User Guide



JEAN BRAUN - ISTERRE - UNIVERSITE JOSEPH FOURIER DE GRENOBLE

Purpose

This user guide provides the information necessary to download, install and use **FastScape**, a landscape evolution model (LEM) developed in 2012 by Jean BRAUN. The code is designed to be highly efficient and thus can be used to solve problems on very high resolution meshes. It runs on various platforms and can be obtained either as an executable or source code.



FastScape is an open source software that is freely distributed by the author, Jean BRAUN. If you decide to publish results obtained by using FastScape, you should cite the following publication:

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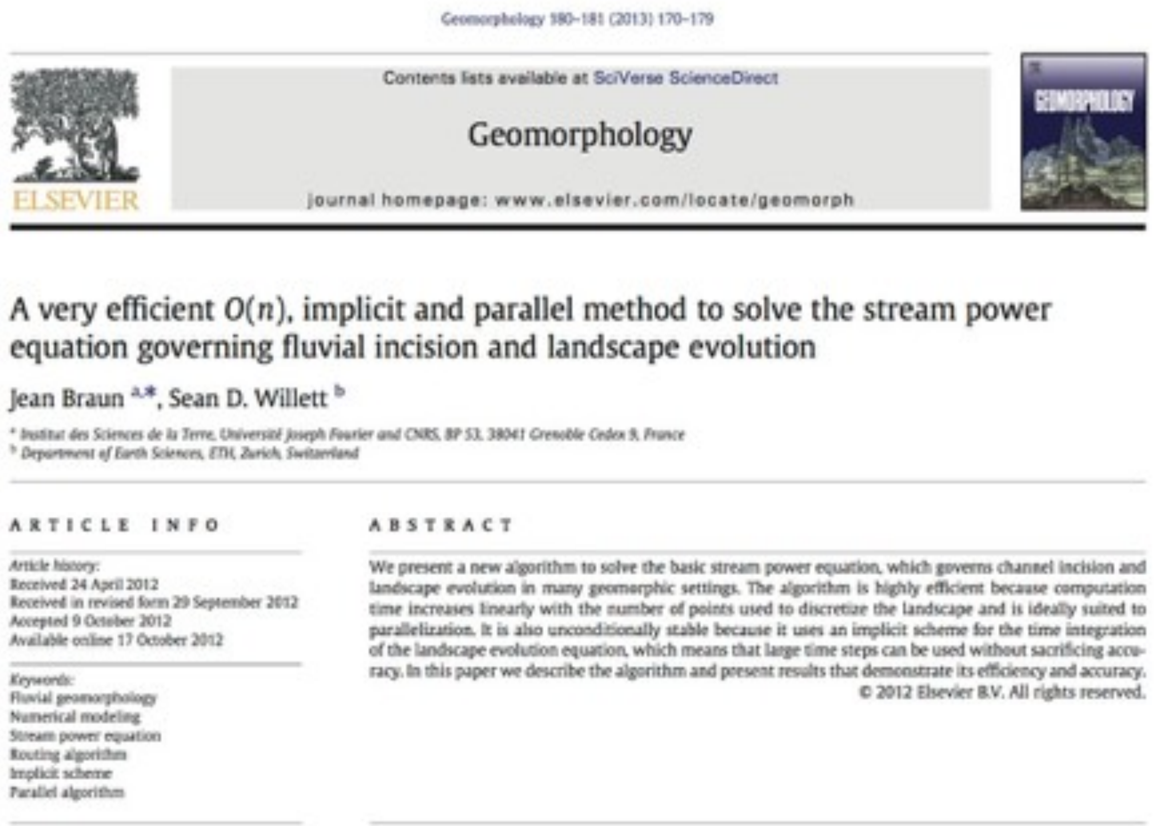

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A very efficient $O(n)$, implicit and parallel method to solve the stream power equation governing fluvial incision and landscape evolution

Jean Braun [a,*], Sean D. Willett [b]

[a] Institut des Sciences de la Terre, Université Joseph Fourier and CNRS, BP 53, 38041 Grenoble Cedex 9, France
[b] Department of Earth Sciences, ETH, Zurich, Switzerland

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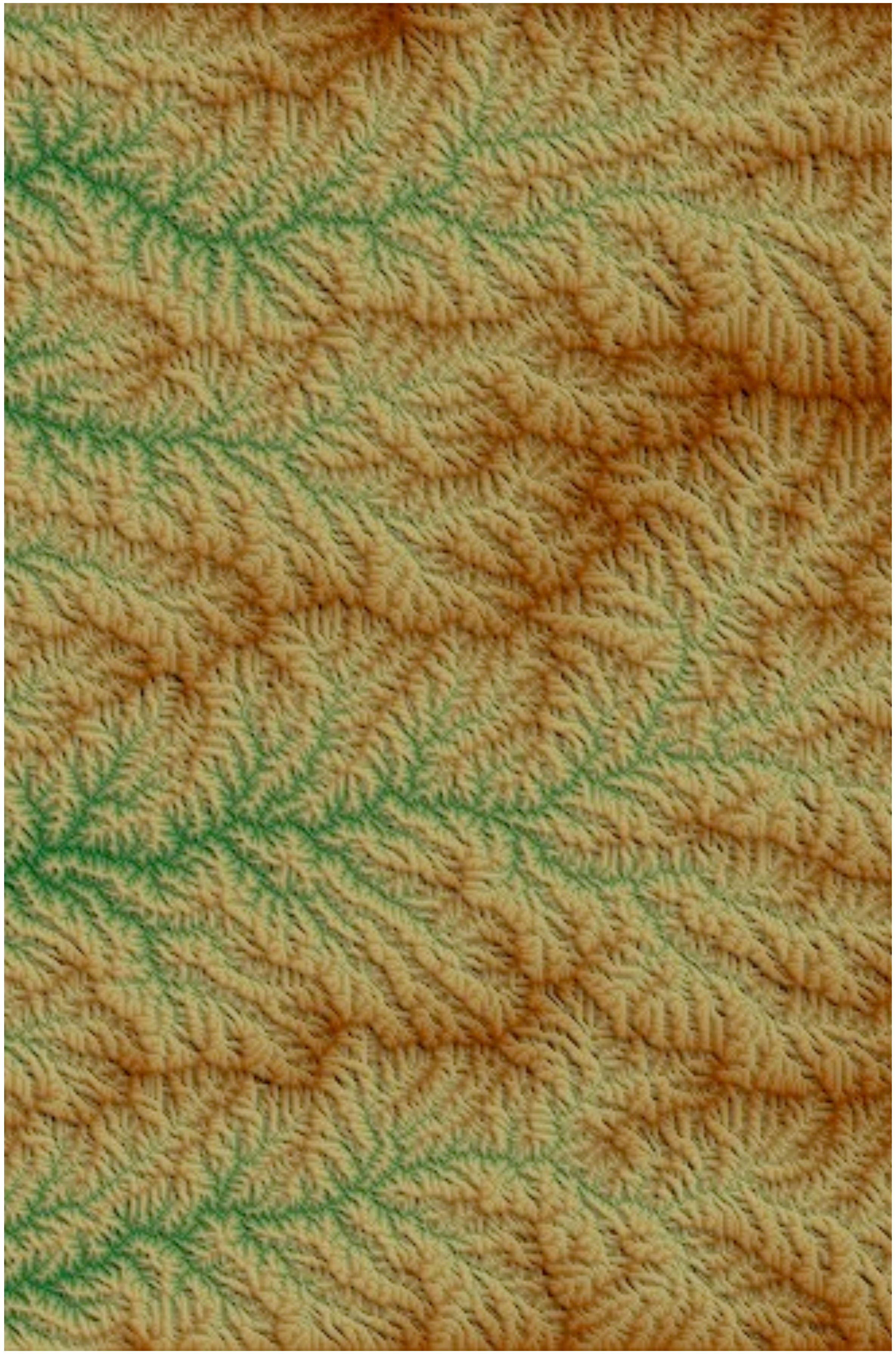
ABSTRACT

We present a new algorithm to solve the basic stream power equation, which governs channel incision and landscape evolution in many geomorphic settings. The algorithm is highly efficient because computation time increases linearly with the number of points used to discretize the landscape and is ideally suited to parallelization. It is also unconditionally stable because it uses an implicit scheme for the time integration of the landscape evolution equation, which means that large time steps can be used without sacrificing accuracy. In this paper we describe the algorithm and present results that demonstrate its efficiency and accuracy.

Downloading and Installing FastScape



In this section we show how and where to download FastScape and how to install it

FastScape can be obtained by contacting Jean Braun by email at Jean.Braun@ujf-grenoble.fr He will mail you the latest version of FastScape.

There is only one version of FastScape at this stage. It has been designed to work on both the MacOSX and Linux environments; work is under way to produce a Windows version.

To install **FastScape**, simply double click the *FastScape_**.tar.gz* file where ** represents the version you have downloaded and it should create a *FastScape_** directory* in which the code and all the other bits will be placed. In the remaining part of this manual, we will call this directory the «FastScape root directory».

If you wish to use the precompiled version (MacOSX only), you might need to download the OpenMP dynamic library as well (libiomp5.dylib) and create a shell variable called DYLD_LIBRARY_PATH and set it to the name of the directory in which you have stored libiomp5.dylib.

There are two situations to consider before producing a working version of **FastScape**: either you have a ForTran compiler on your computer or you don't.

If you don't, you don't need to do anything before running **FastScape**, but there are options that will not be accessible to you, in particular, the options to define a general (complex) initial topography, uplift function, or precipitation pattern. You will be able to change these parameters but within some well specified limits.

If you do , it will take a little bit longer to install **FastScape** but the reward will be a more flexible version: some of the input can be expressed as more general functions but you will need to have a rudimentary knowledge of ForTran to «code» them. In this way, you will install FastScape in what we will refer to later as the «expert mode».

To test whether you can run **FastScape** on your computer (without compiling it), simply open a Terminal (or shell); go to the FastScape root directory using the «cd» command and type:

./FastScape.sh RUN00

This should start **FastScape** and produce an output on the Terminal that indicates that FastScape is running. This default **FastScape** run should take a few tens of seconds to finish, depending on the speed of your processor.

If you have a compiler, you can compile **FastScape**. In order to do so, you first need to provide information about your compiler. Note that, to take advantage of all the features of FastScape, your compiler will need to have access to the OPENMP library. This library is usually included in all modern compilers and can be accessed by specifying a flag in the compilation command.

If you have either the gfortran (Gnu Fortran) or ifort (Intel ForTran) compiler, all you need to do is make sure that the appropriate line in the *Makefile* file is uncommented. If you use the ifort compiler, make sure that the:

include Makefile.ifort

line is uncommented and that the other line:

include Makefile.gfortran

is commented out. Conversely, if you have the gfortran compiler installed, comment out the line concerning the ifort compiler and uncomment the line concerning the gfortran compiler.

If you have another compiler, make a copy of the *Makefile.ifort* compiler, calling it *Makefile.mycompiler* for exemple and edit this file to include the compiler name and options that match your configuration. In the *Makefile*, add an additional line :

include Makefile.mycompiler

and comment out the other two.

To eliminate the existing version of **FastScape**, simply type:

make clean

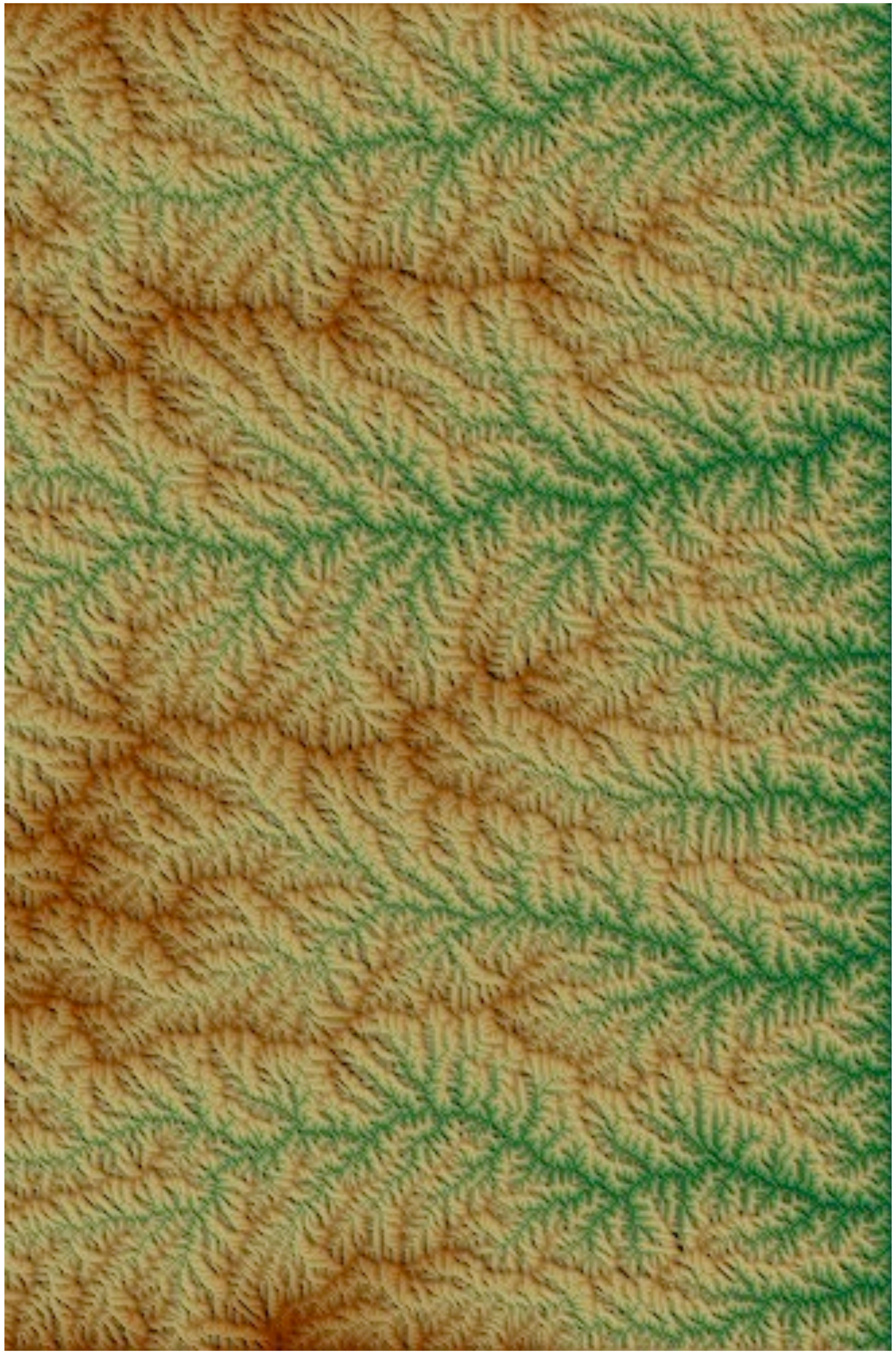
You should be ready to compile **FastScape** and run it. Simply type in the following command in your Terminal:

./FastScape.sh -e RUN00

The compiler should recompile the code and execute it.

Running FastScape

FastScape reads its input from a single input file; this means that each run can be stored in a separate directory where the entire input information as well as the ouput generated by FastScape will be stored. This also means that a single input file contains the entire information necessary to reproduce a FastScape run.



Running **FastScape** is straightforward, once you have defined where you wish to save the output.

To start a new run, simply create a directory names after your run (here we use *RUN01*, but you should be able to use anything you want; avoid funny characters or spaces) :

mkdir RUN01

and run **FastScape**:

./FastScape.sh RUN01

This will create a file named *FastScape.in* in the *RUN01* directory that contains all the ingredients necessary to run the default **FastScape** example.

You can either wait until the run completes or kill it by issuing a *CTRL-c* command at the keyboard.

It is a good idea now to have a peek in the *RUN01/FastScape.in* file by using a basic editor or by simply issuing the command:

more RUN01/FastScape.in

The file is made of a series of lines that are either comments or instructions for **FastScape**. Instructions lines contain an «=» symbol with on the left of the «=» symbol the name of the **FastScape** parameter you wish to set and on the right, its value.

A complete list of all parameters is given in the glossary section of this user guide.

Any other line (including blank lines) is not read by **FastScape** and is considered to be a comment to help you remembering what each run does or the reason for the specific value of a given parameter.

When you run **FastScape**, it starts by echoing the value of each parameter it has read from the input file. You should check that the values echoed are identical to those you have specified in the input file. You could have misspelled a parameter name, for example.

There are a few options that can be specified when running **FastScape**. The «expert» (e) option and the «preview» (p) option.

You can activate the expert mode by using the -e option:

./FastScape.sh -e RUN01

or the preview mode by using the -p option:

./FastScape.sh -p RUN01

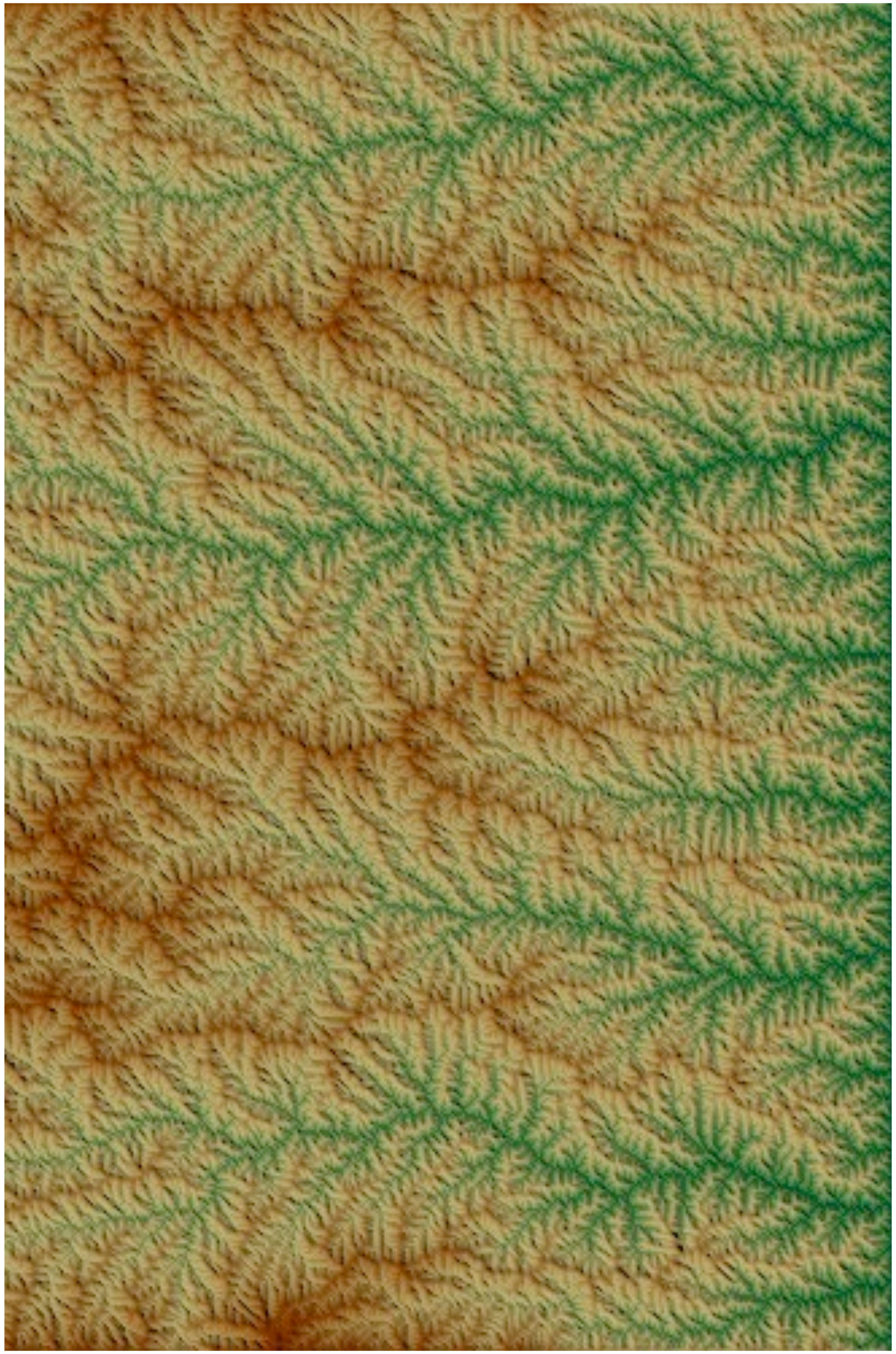
You can also combine them:

./FastScape.sh -ep RUN01

The expert mode assumes that you have a working ForTran compiler on your computer. The code will be recompiled before **FastScape** is run. In expert mode you can add Fortran lines to the input file that will be inserted into the code before it is recompiled. This allows to use more complex functions to describe the initial topography, the uplift rate or the precipitation.

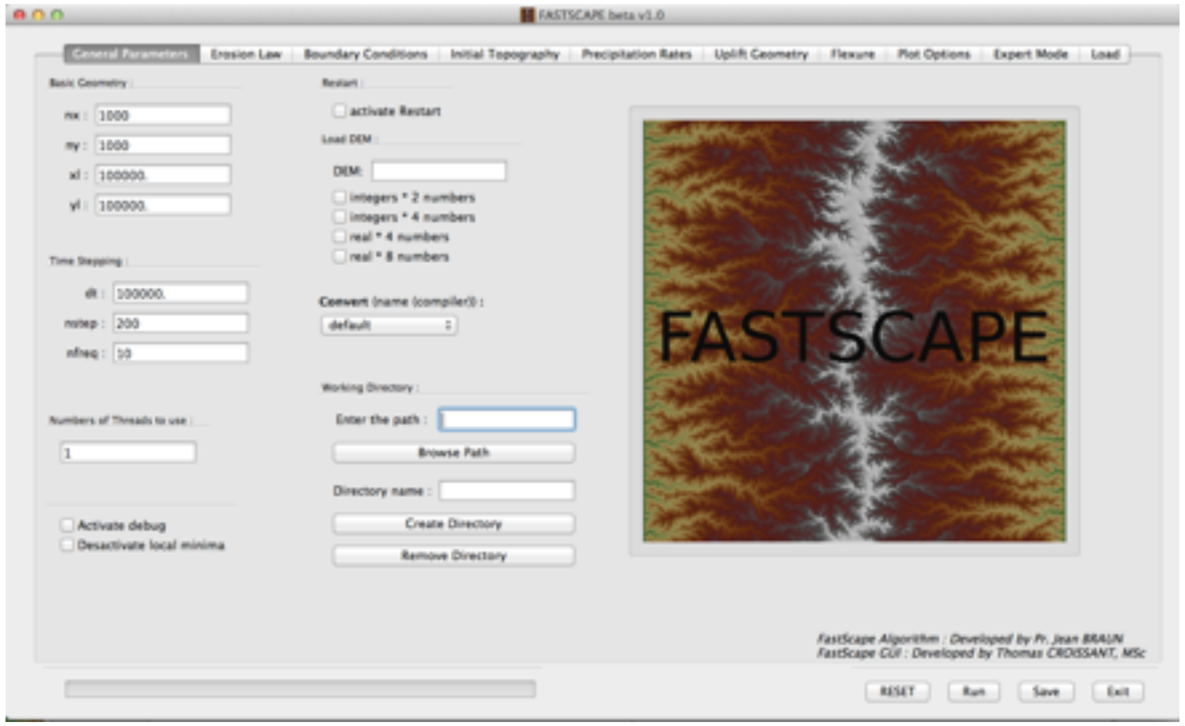
The expert mode requires some basic knowledge of ForTran and the user wishing to use it should imperatively read the sections corresponding to any of the parameters listed above.

Graphical User Interface



Thomas Croissant has developed a graphical user interface (GUI) for FastScape. It provides a friendly graphical environment that shortcuts the editing of the input file.

The GIU comes as a small application named FastScapeGUI. To open it simply double-click it and a window similar to this should appear on your screen:



You will notice right away that it contains a series of tag that correspond to the various input parameters to FastScape. On the first page for example, you can adjust the basic geometrical parameters, the time stepping information and the restart options.

Before using the interface, you will need to specify the path to a working version of FastScape (Working Directory). You must then create a specific directory in which the GUI will create a FastScape.in file that it will subsequently update/modify according to your specifications.

The last tag contains an option to load in a specific FastScape run. You can choose any of the Example runs described in the last chapter of this user guide or any run that you would have saved with the GUI.

It is also in the last tag that you submit the FastScape run. Note that the first time you use the «Run» button a file named *link.sh* will be created. This file allows you to run the FastScape executable. On some computers the file is not created with executable rights. In order to give this file the admin rights you have to type these 2 command lines in your terminal:

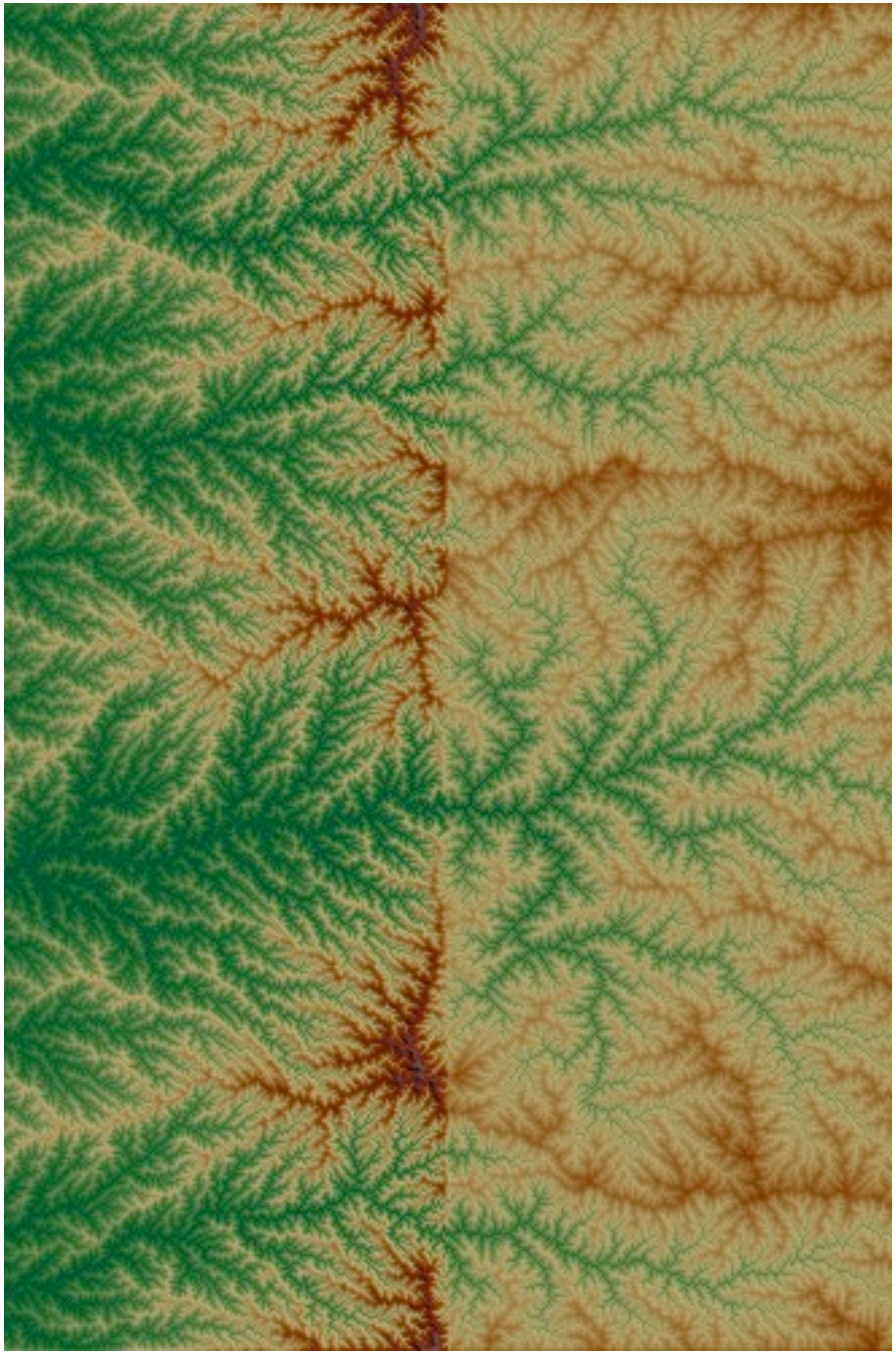
cd /path/to/FastScapefolder

chmod +x link.sh

From this moment you will not need to use the terminal to Run FastScape.

General Setup

This section describes the basic model parameters that describe the geometry of the run, the time stepping, the boundary conditions and a few global flags.



The basic geometry of the problem is specified through the parameters **xl,yl** which are the dimensions of the rectangular domain where the run is performed, expressed in meters.

The resolution of the run are specified in **nx,ny**, the number of grid points in the x- and y-directions, respectively.

The number of time steps is specified in **nstep**, and the time step length is specified as **dt** (expressed in years). Another important parameter is **nfreq**, which specifies the frequency of outputs.

Other important parameters include **boundary_condition** which is a 4 digit integer made of 0's, 1's, 2's and 3's. The four digits correspond to the four sides of the model domain, in the following order:

1. lower
2. right
3. top
4. left

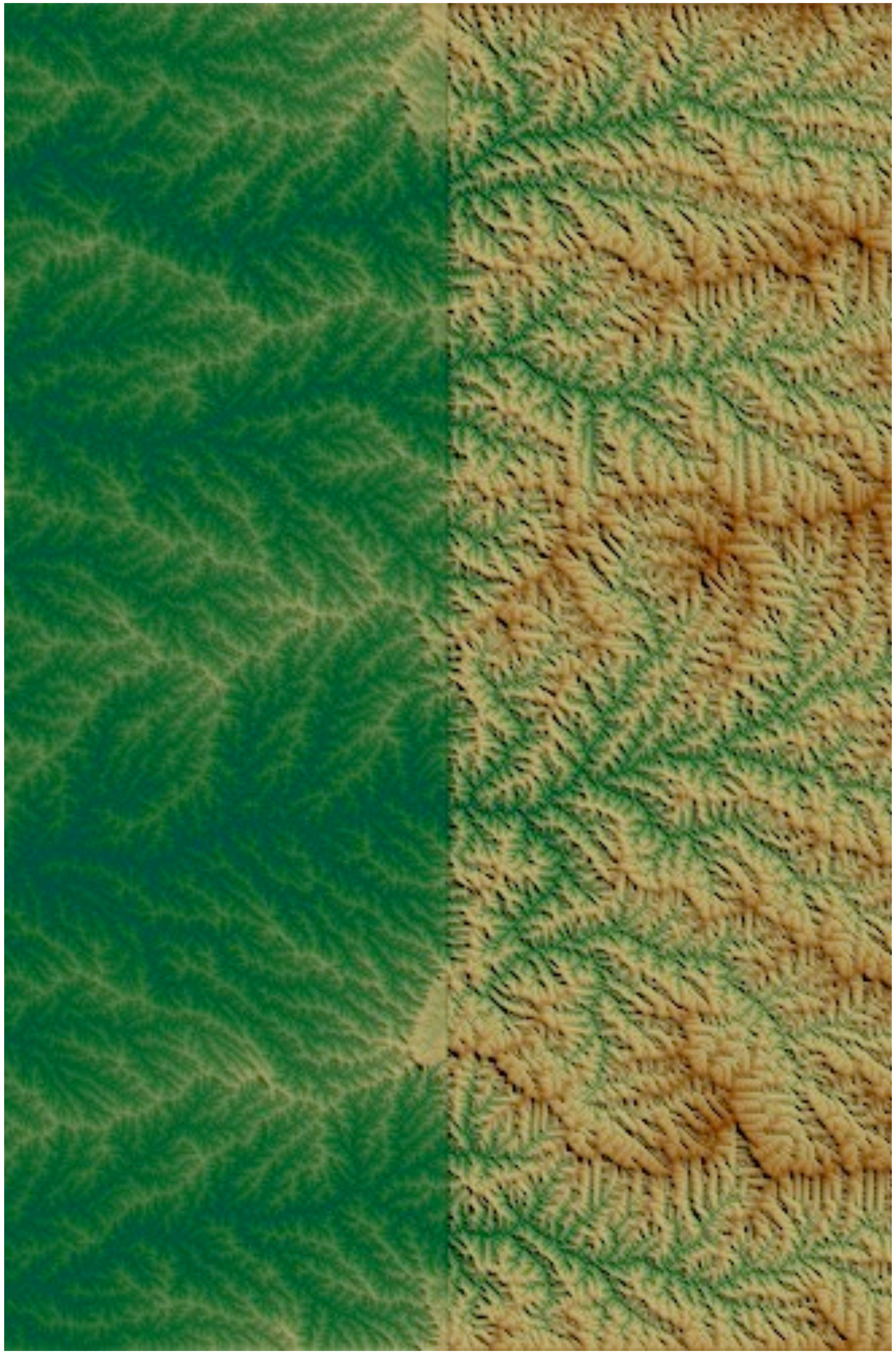
when a boundary is set to 1 it is assumed to be at base level and its height is fixed at 0 through the entire run; when it is set to 0, the boundary is assumed to be reflective (no water will go through it) unless two opposite boundaries (top and bottom or left and right) are set to 0 in which case periodicity is assumed from one side of the model to the other. When two adjacent boundaries are set to 2, the corner they share only is set at base level, the remaining parts of the boundaries are reflective. When a boundary is set to 3, only the center of the boundary is set at base level, the remaining parts of the boundaries are reflective.

A few flags control the overall behavior of the run:

- **debug** (or verbose) : when set to 1, FastScape produces more output to the screen to help debugging;
- **local_minima**: when set to 0 local minima are not «resolved»
- **num_threads**: number of threads (processors) used for the run

Chapitre 6

Erosion Laws



In the current version of FastScape two fluvial erosion laws are incorporated; in the future this will be expanded to include other fluvial erosion laws but also hill-slope processes.

The main parameter controlling the geomorphic law is called **law**. It accepts the following values:

- law=1 corresponds to the unit stream-power law assuming a linear slope dependence (n=1)

$$\frac{\partial h}{\partial t} = -K_f \phi^m S$$

- law=2 corresponds to the general unit stream-power law

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n$$

- law=3 corresponds to the $\xi - q$ model of Davy and Lague (2009)

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n + \frac{Q_S}{\alpha Q_W}$$

where QS and QW are sedimentary and water discharge respectively.

For both laws, the important parameters are **kf** (the K coefficient/constant), and **m** (the discharge exponent). Discharge is expressed in cubic meters per year and slope has no unit. In FastScape, discharge, , is the product of area by precipitation rate or, in the case of non-uniform precipitation the surface integral over the drainage area of the precipitation rate.

For law=2, the user must also specify the value of the **n** parameter (slope exponent).

For law=3, the user must specify the value of the **alpha**, a parameter that varies between 0 and infinity. Small values of alpha imply a transport-limited law while a value of alpha larger than one will lead to a detachment-limited law. At this stage, the linear dependence on slope (n=1) only has been implemented for law=3.

For law 1 and 2, the user can also specify whether to use the explicit form of the finite difference implementation of the PDE by specifying a negative value for law (=-1 or =-2). The default is to use the implicit form. In the case of the implicit formulation, the user may also specify whether a finite number of iterations must be used or not. The fixed number of iterations to be used, regardless of convergence, is specified through the parameter **nk**. If nk is set to zero a convergence criterion is used and the tolerance **tol** can be specified (in meters).

The erosion law is not applied to points of the landscape that are below **sea_level**, a parameter that can be adjusted; one can also define a minimum drainage area, **area_min**, for the fluvial incision law to be used; below that critical area, no erosion is applied or hill slope processes only if **kd** is specified (see below).

Variations of the constant kf with depth can also be imposed, using a series of variables:

strati_fn, strati_topn, strati_bottomn

where *n* can take a value between 1 and 9. The code will compute how much has been eroded since the beginning of the run and will check that total incision whether it falls between strati_top*n* and strati_bottom*n*, in which case the factor kf will be locally multiplied by strati_f*n*.

A flag called **reference_surface** can be used to determine if the stratigraphy (the top and bottom depth of each layer) is computed from a reference height z=0 (**reference_surface** = 0) or from the initial topography (**reference_surface** = 1). By default it is set to 0.

Hillslope processes are modeled using a simple linear diffusion model:

$$\frac{\partial h}{\partial t} = K_D \frac{\partial^2 h}{\partial x^2} + K_D \frac{\partial^2 h}{\partial y^2}$$

The diffusivity, **KD**, can be set by the user.

Another option is to specify a critical slope (in degrees), **Sc**, that cannot be surpassed at any point on the landscape. One can also specify a variability in that slope, **DSc**.

Variations of the constant **kd** with depth can also be imposed, using a the same series of variables as for **kf**:

strati_fn, strati_topn, strati_bottomn

where *n* can take a value between 1 and 9. The code will compute how much has been eroded since the beginning of the run and will check that total incision whether it falls between **strati_topn** and **strati_bottomn**, in which case the factor **kd** will be locally multiplied by **strati_fdn**.

Uplift Rate

There are two ways to specify the uplift rate: by interpolation of values specified at the corners of the mesh (or along its sides and centre) or by describing the uplift rate through a piece of ForTran code. The second option is only accessible when FastScape is used in expert mode.

One of the main driver of landscape evolution is tectonic uplift. In **FastScape**, the user can specify an uplift function that varies in space and time in one of two ways.

By interpolation:

In this case, the user can defined the uplift function as a constant, a bi-linear function or the combination of 4 bi-linear functions. The parameter **uplift_n** determines which of the three options is used (0=constant, 1=bi-linear, 2=4bi-linear).

If uplift_n=0, the user must specified uplift_v1 which is the uniform uplift rate

if uplift_n=1, the user must specify the value of the uplift function at the four corners of the rectangular domain ‘uplift_v1, uplift_v2, uplift_v3 and uplift_v4) in an anti-clockwise manner starting at the bottom left corner. The resulting uplift function will be defined as a bilinear interpolation of these 4 values inside the domain.

If uplift_n=2, the user must specify 16 values of the uplift function (**uplift_v1 to uplift_v16**) corresponding to the values of the uplift function at the four corners of four quarters of the rectangular domain. In each quarter, the count starts at the bottom left corner. The resulting uplift function is defined by four distinct bi-linear functions. This allows to specify non smooth functions.

Note that it may be practical to imposed that any of the **uplift_vn** value be equal to another, i.e. **uplift_vm**. This can be specified in the input file in the following way :

uplift_vn = uplift_vm

The only limitation is that n must be smaller than n. Note that this syntax can be used for any parameter whose name finishes by an integer, such as **initial_topography_vn** or **precipitation_vn**.

The time dependency is imposed by defining the value of a time function at **uplift_nt** different times. For each time, the user can also specify the time, **uplift_t1 to uplift_t9** and the value of a function **uplift_f1 to uplift_f9** that will multiply the uplift rate obtained from the geometrical function described above.

By writing a short ForTran code:

The user can specify the uplift_rate function by inserting a piece of code in the input file that is contained between two marker lines:

!/uplift_start/

USER FORTRAN CODE TO DEFINE uplift

!/uplift_stop/

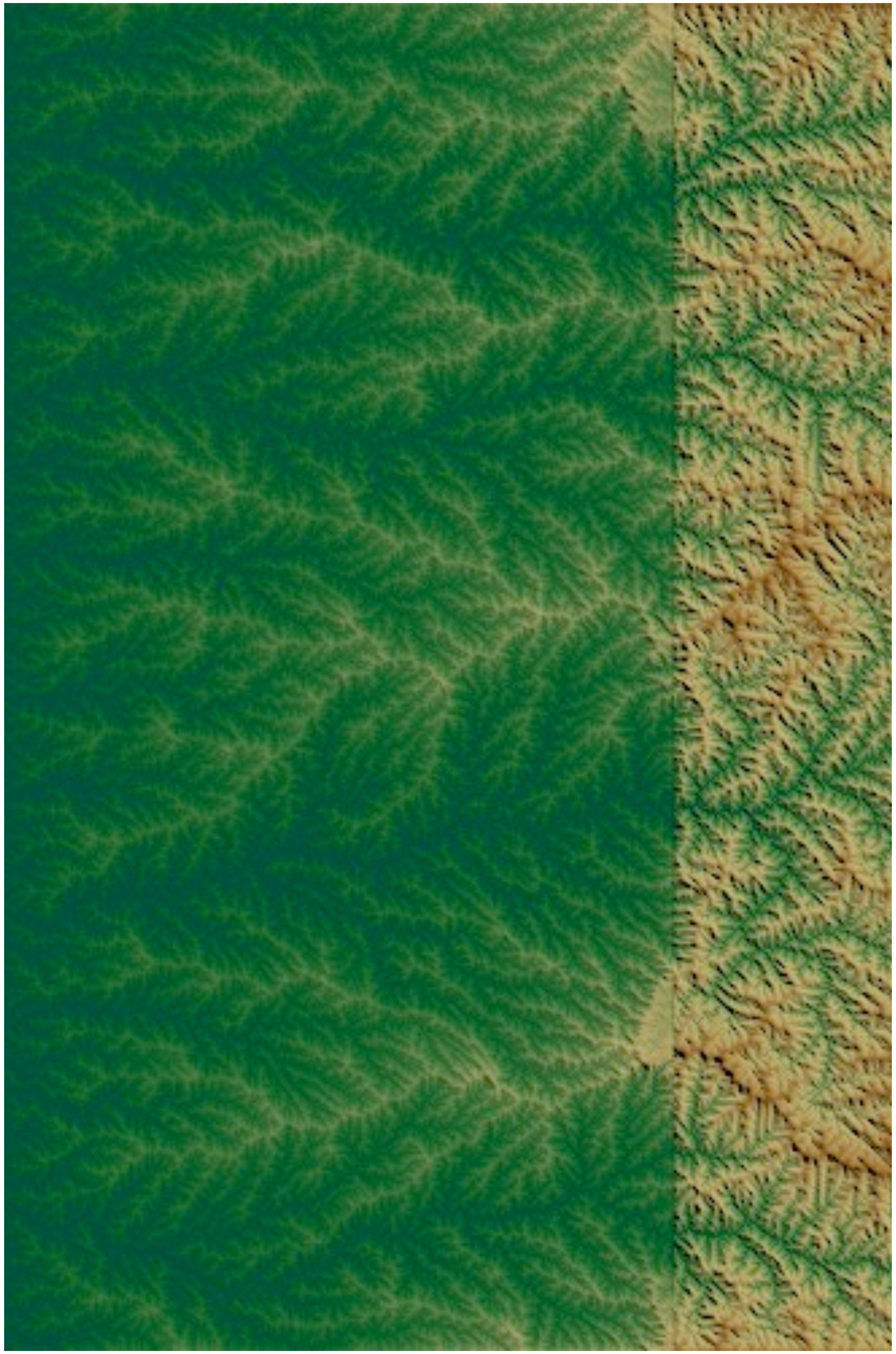
The code must define a variable called «uplift».

Some rules apply: only a finite number of variables can be used, including x, y which contain the position, time which has the current time, xl and yl which contain the dimensions of the domain and a series of working arrays called w1,...,w10 (floating point) and i1,...,i10 (integer).

Note that this second option can only be used in expert mode.

Initial Topography

Initial topography is the topography at the start of a model run. Similarly to the uplift rate function, it can be set to a constant, a bi-linear function or a group of four bi-linear functions. Expert users can also define it through a small ForTran code. Note that the initial topography can be set by restarting a run (see restart option) or reading in a DEM.



The initial topography plays an important role by setting the initial drainage geometry. Even though the topography itself can rapidly be erased by erosion and uplift, the drainage geometry does not evolve readily with time and can thus persist much longer than the original topography itself.

In **FastScape**, the user can specify the initial topography in one of two ways.

By interpolation:

In this case, the user can defined the initial topography as a constant, a bi-linear function or the combination of 4 bi-linear functions. The parameter **initial_topography_n** determines which of the three options is used (0=constant, 1=bi--linear, 2=4bi-linear).

If initial_topography_n=0, the user must specified initial_topography_v1 which is the uniform initial topography

if initial_topography_n=1, the user must specify the value of the initial initial topography function at the four corners of the rectangular domain (initial_topography_v1, initial_topography_v2, initial_topography_v3 and initial_topography_v4) in an anti-clockwise manner starting at the bottom left corner. The resulting initial topography function will be defined as a bilinear interpolation of these 4 values inside the domain.

If initial_topography_n=2, the user must specify 16 values of the initial topography function (**initial_topography_v1 to initial_topography_v16**) corresponding to the values of the initial topography function at the four corners of four quarters of the rectangular domain. In each quarter, the count starts at the bottom left corner. The resulting initial topography function is defined by four distinct bi-linear functions. This allows to specify non smooth functions.

By writing a short ForTran code:

The user can specify the initial topography function by inserting a piece of code in the input file that is contained between two marker lines:

!/initial_topography_start/

USER FORTRAN CODE TO DEFINE h

!/initial_topography_stop/

The code must define a variable called «h» that will be used to define the initial topography.

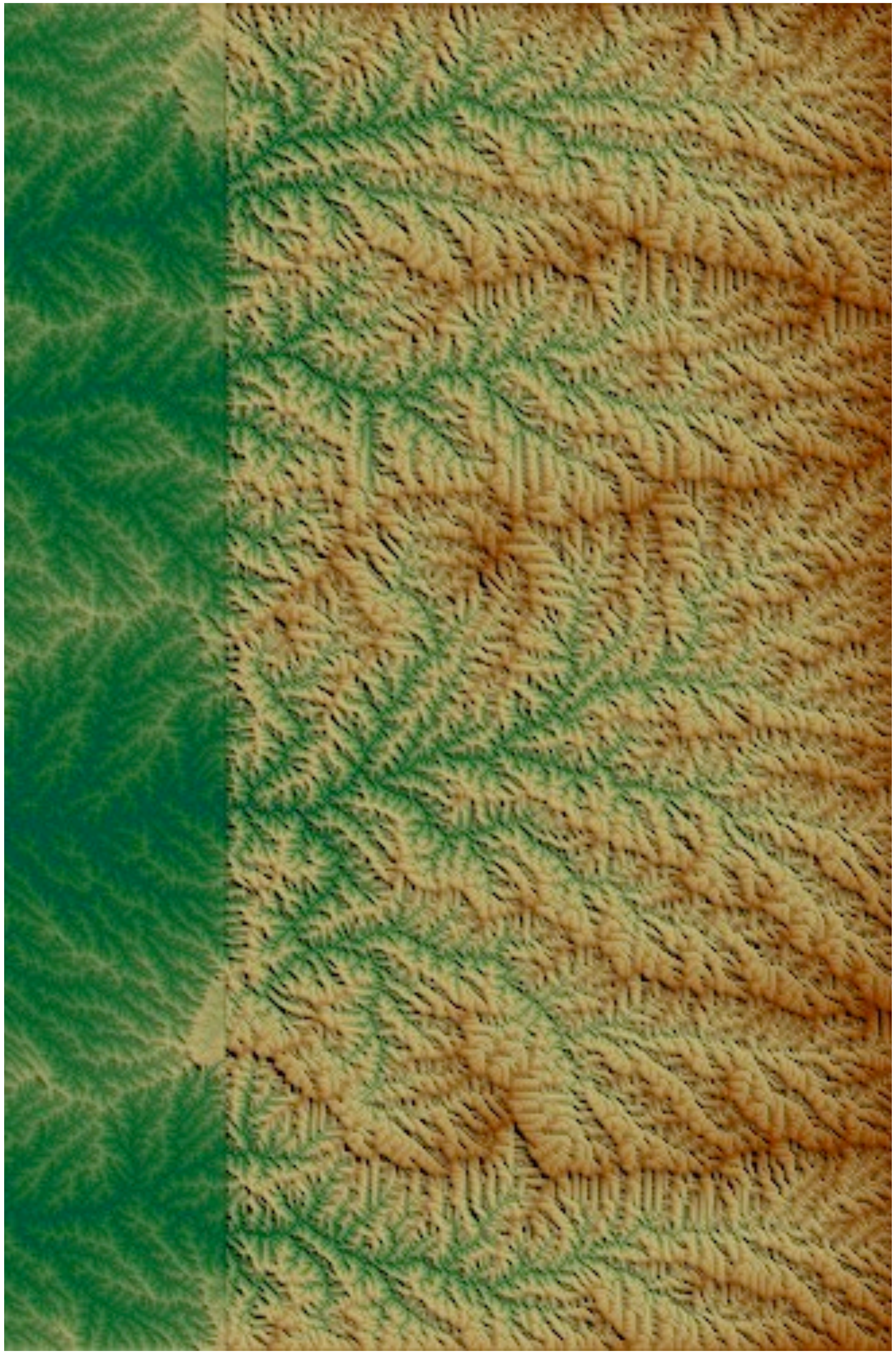
Some rules apply: only a finite number of variables can be used, including x, y which contain the position, xl and yl which contain the dimensions of the domain and a series of working arrays called w1,...,w10 (floating point) and i1,...,i10 (integer).

Note that this second option can only be used in expert mode.

The user can also use the restart option (see later) to specify the initial topography, by either restarting a FastScape job or by reading a topography from a DEM.

Dynamic Topography

Dynamic topography can be introduced as a forcing term in FastScape by imposing a vertical stress at the base of the thin elastic plate model described in the previous chapter. The net result is a surface topography that is filtered by the elastic isostatic model.



In **FastScape**, the user can specify a dynamic topography that varies in space and time. The dynamic topography is transformed in a vertical stress boundary condition that is applied at the base of the thin elastic plate modeled described in the previous chapter. The resulting topography is the isostatically filtered version of the prescribed dynamic topography.

The dynamic topography is imposed by writing a short ForTran code:

The user can specify the dynamic topography by inserting a piece of code in the input file that is contained between two marker lines:

!/dynamic_topography_start/

USER FORTRAN CODE TO DEFINE dynamic topography

!/dynamic_topography_stop/

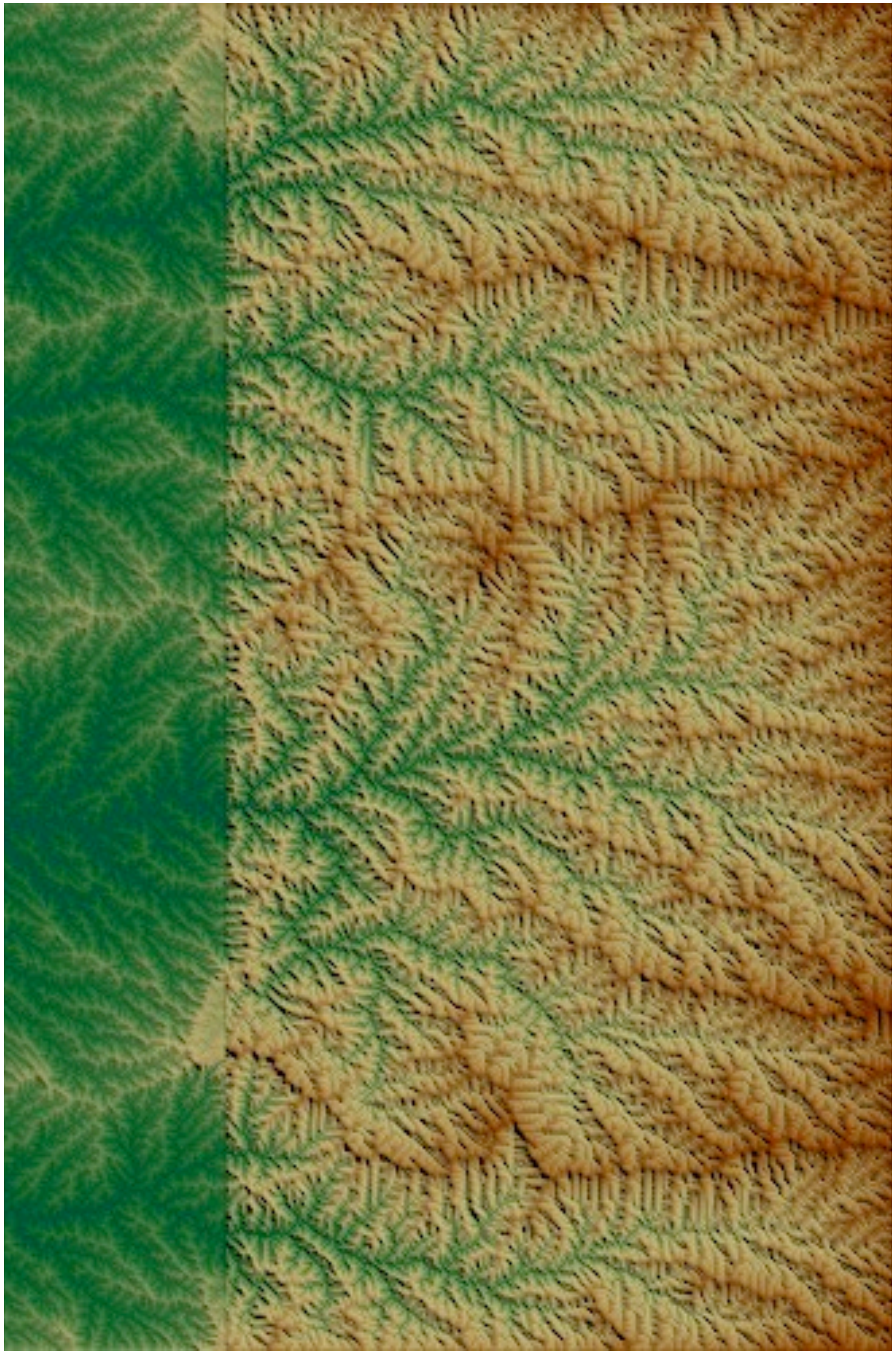
The code must define a variable called «h».

Some rules apply: only a finite number of variables can be used, including x, y which contain the position, time which has the current time, xl and yl which contain the dimensions of the domain and a series of working arrays called w1,...,w10 (floating point) and i1,...,i10 (integer).

Note that this option can only be used in expert mode.

It also requires that flexure/isostasy be turned on, i.e. **flexure**=1

Precipitation Rate



Precipitation can vary in space and time and, at every time step, is integrated over drainage area to compute local discharge. In this version, the precipitation function can be defined in two ways, similar to the uplift rate function.

The other main control on landscape evolution (apart form the geometry of the landscape) is precipitation. In **FastScape**, the user can specify a precipitation function (in meters per year) that varies in space and time in one of two ways.

By interpolation:

In this case, the user can defined the precipitation function as a constant, a bi-linear function or the combination of 4 bi-linear functions. The parameter **precipitation_n** determines which of the three options is used (0=constant, 1=bi--linear, 2=4bi-linear).

If precipitation_n=0, the user must specified **precipitation_v1** which is the uniform precipitation rate

if precipitation_n=1, the user must specify the value of the precipitation function at the four corners of the rectangular domain : **precipitation_v1, precipitation_v2, precipitation_v3 and precipitation_v4**) in an anti-clockwise manner starting at the bottom left corner. The resulting precipitation function will be defined as a bilinear interpolation of these 4 values inside the domain.

If precipitation_n=2, the user must specify 16 values of the precipitation function (**precipitation_v1 to precipitation_v16**) corresponding to the values of the precipitation function at the four corners of four quarters of the rectangular domain. In each quarter, the count starts at the bottom left corner. The resulting precipitation function is defined by four distinct bi-linear functions. This allows to specify non smooth functions.

The time dependency is imposed by defining the value of a time function at **precipitation_nt** different times. For each time, the user can also specify the time (**precipitation_t1 to precipitation_t9**) and the value (**precipitation_f1 to precipitation_f9**) of a function that will multiply the precipitation rate obtained from the geometrical function described above.

By writing a short ForTran code:

The user can specify the precipitation function by inserting a piece of code in the input file that is contained between two marker lines:

!/precipitation_start/

USER FORTRAN CODE TO DEFINE precipitation

!/precipitation_stop/

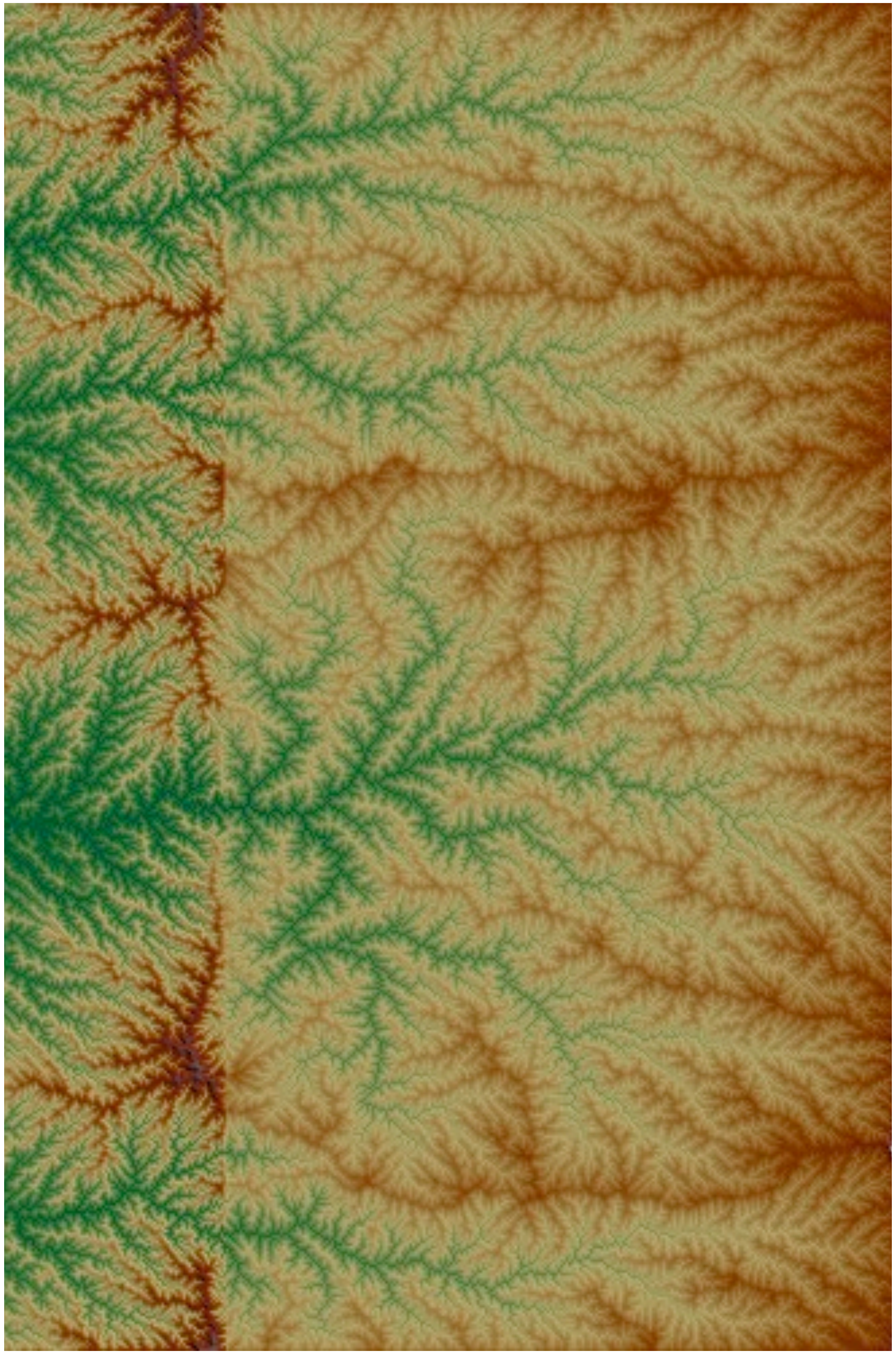
The code must define a variable called «precipitation».

Some rules apply: only a finite number of variables can be used, including x, y which contain the position, time which has the current time, xl and yl which contain the dimensions of the domain and a series of working arrays called w1,...,w10 (floating point) and i1,...,i10 (integer).

Note that this second option can only be used in expert mode.

Flexure

Erosion can be sufficient to lead to isostatic rebound. In FastScape, a flexural module has been introduced to simulate flexural isostatic rebound.



Erosion by an amount Δh results in unloading the lithosphere by an amount :

$$\Delta h \rho g$$

where ρ is crustal rock density and g is the acceleration of gravity. In **FastScape**, this load is applied to a thin elastic plate model to compute the resulting flexural isostatic rebound, according to:

$$D\frac{\partial^4 \Delta u}{\partial x^4} + D\frac{\partial^4 \Delta u}{\partial y^4} + 2D\frac{\partial^4 \Delta u}{\partial x^2 \partial y^2} = \Delta \rho g \Delta u + \rho g \Delta h$$

where $\Delta\rho$ is the difference between asthenospheric and crustal density and

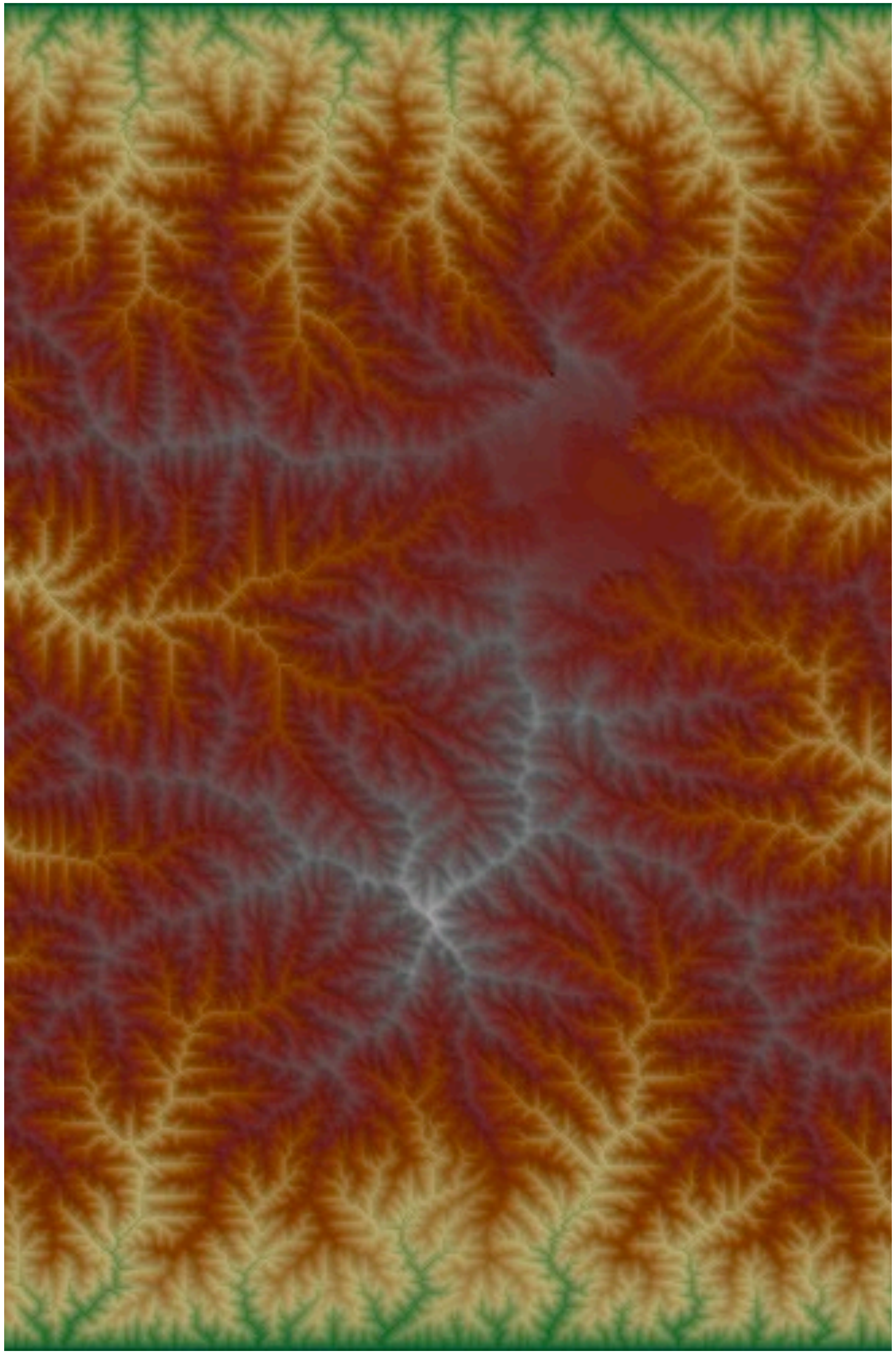
$$D = \frac{ET_e^3}{12(1-\nu^2)}$$

Flexural isostasy is turned on when the flag **flexure** is set to 1. The user may also define the elastic thickness, **thickflex**, in meters, Young Modulus, **ym**, in Pascals, Poisson's ratio, **pratio**, crustal density, **rhocflex**, in kg per cubic meter, the asthenospheric density, **rhoaflex**, in kg per cubic meter, and **meanflex**, a flag to decide whether the isostasy is cylindrical in case cyclic boundary conditions are used.

When meanflex is set to 1, **FastScape** will determine whether two opposing boundaries have their condition set to 0 (which means that cyclic boundary conditions between these two boundaries will be used) and, in such a case will only calculate the isostatic response by averaging the load (and the response) in that direction. This is to avoid edge effects.

Intrusions

Intrusions are vertical cylinders that can be given different properties (density and/or hardness) and introduced in the model.



To include intrusions in the model, you need to specify their geometry, their position and their properties. You can specify up to 100 intrusions in any single model run.

The coordinates of the center of the intrusion i are specified (in m) in the **granite_xi** and **granite_yi** parameters. The depths of the top and bottom of the intrusion are controlled by the **granite_topi** and **granite_bottomi** parameters (in m; default values are 0 and 1000 k m respectively, such that by default the granite is an almost infinite vertical cylinder); its size by the two radii **granite_rxi** and **granite_ryi** (in m) to produce an elliptical shaped cylinder. If only granite_rxi is specified, the cylinder has a circular cross-section (granite_ry is forced to be equal to granite_rx). Note that the default values for granite_rxi and granite_ryi are 0.

The properties of the granite i are specified through the **granite_drhoi** and **granite_dki** parameters. **granite_drhoi** represents the density anomaly of granite i (with respect to the ambient density specified by the parameter rhocflex), expressed in kg/m3. The default value for **granite_drhoi** is 0. Note that the density anomaly has an effect on the solution only if flexure calculations are activated (**flexure** = 1).

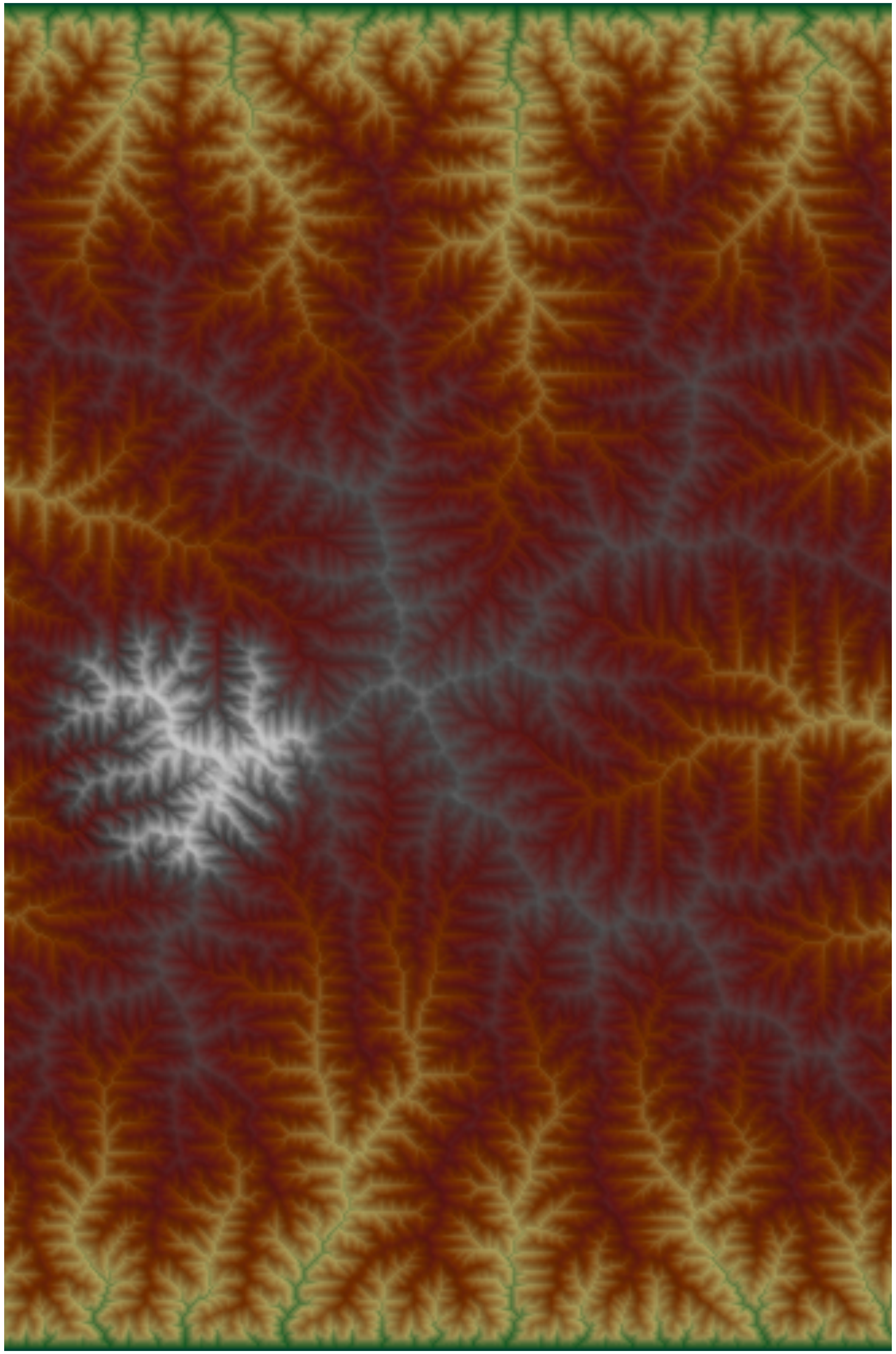
The hardness of the granite can also be modified by adjusting the **granite_dki** parameter (dimensionless ratio). Inside the granite, the fluvial incision parameter (**kf)** will be multiplied by **granite_dki**. The default for **granite_dki** is thus 1.

The diffusivity of the granite can also be modified by adjusting the **granite_dkdi** parameter (dimensionless ratio). Inside the granite, the diffusivity or transport parameter parameter (**kd**) will be multiplied by **granite_dkdi.** The default for **granite_dkdi** is thus 1.

If two granite intrusions overlap, the order in which they appear in the input file matters, with the last one in the last setting up the value of **granite_drhoi**, **granite_dkdi** and **granite_dki.**

Pecube

Output files can be generated by FastScape to use as input files for Pecube a software designed to compute the thermal evolution in the Earth’s crust beneath a complex, evolving topography



FastScape generates surface topography files that can be used as surface boundary conditions for Pecube a piece of software used to compute the thermal evolution of the Earth's crust beneath a complex, finite amplitude and time evolving surface topography, in order to calculate the ages of rocks that end up at the surface of the Earth today or at a given time in the past.

This software is commonly used to interpret low-temperature thermochronological data such as fission track or U-Th/He in apatite, especially with the purpose of constraining the time evolution of surface topography or the time of formation of a given geomorphic feature (a valley or a mountain top).

The surface evolution computed by FastScape is passed to Pecube in a series of topoi file (i refering to a given time step in a prescribed succession).

Pecube needs also to know how rocks end up at the surface by imposed tectonic rock uplift which is computed in FastScape from the geometry and timing of uplift, as wellas isostatic rebound. It is passed to Pecube in a set of separate files called uplifti for time i.

Finally Pecube could be receiveing output from landscape evolution models such as FastScape that compute surface temperature (for exemple, models based on ice or glacial erosion need to know surface temperature to solve the ice balance equation). This information is passed to Pecube through a set of tempi files.

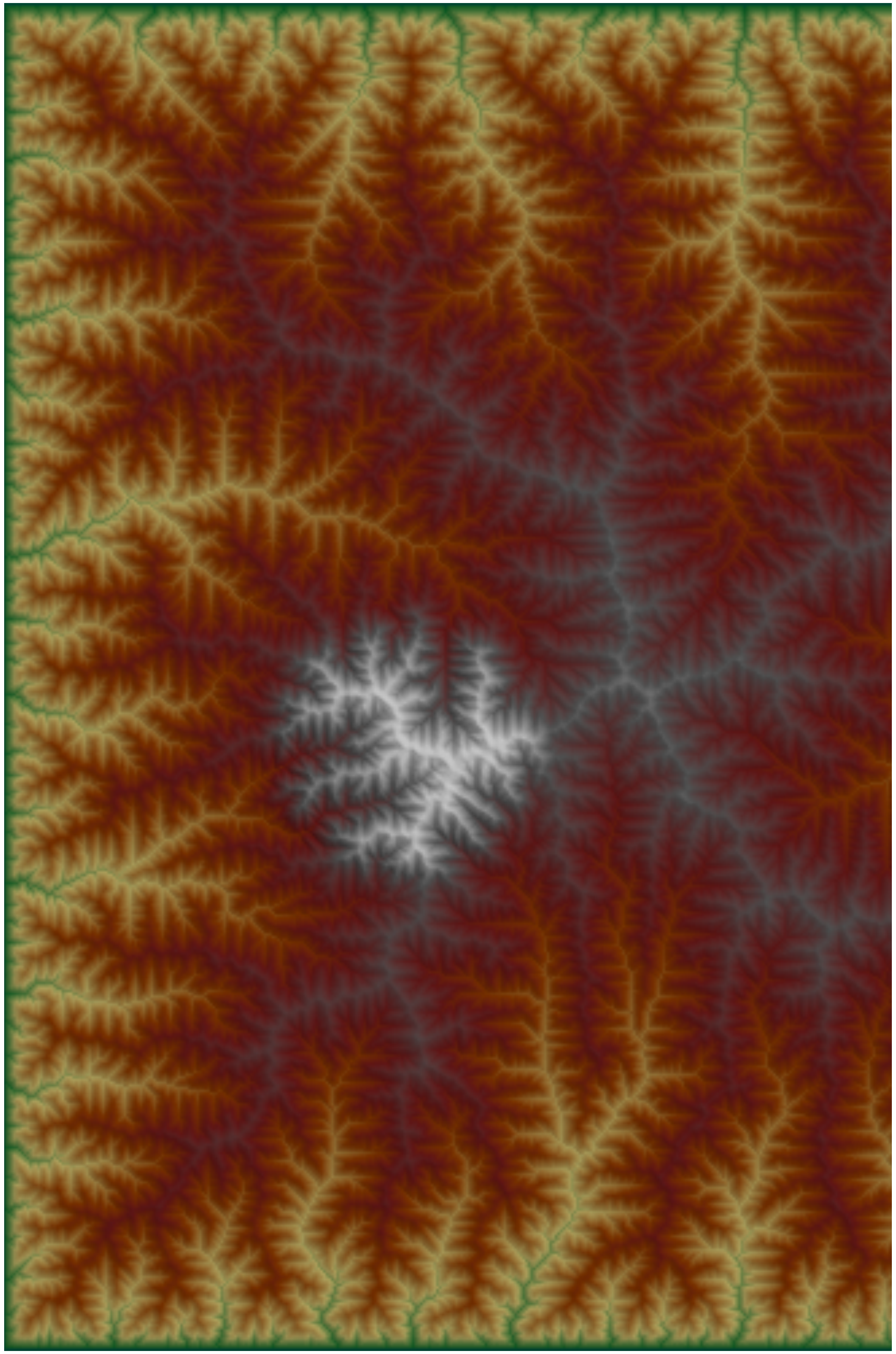
There are a few parameters that need or may be set in the FastScape input file to control the interface between Pecube and FastScape.

The frequency of output files is set by **Pecube_nfreq**. The resolution of the output files is set by **Pecube_nx** and **Pecube_ny**. By default the entire surface produced by FastScape is used, but a subset can be selected through the definition of the parameters **Pecube_xmin**, **Pecube_xmax**, **Pecube_ymin** and **Pecube_ymax**.

Chapitre 14

Thermochron

One of the most widely used method to constrain landscape evolution is low-T thermochronology. FastScape can generate age estimates at specific locations and for several thermochronometers to be compared to observations.



Knowing the history of erosion at any given point of the landscape, FastScape can compute the thermal history of rocks at the surface of the model and, subsequently, their cooling age for four thermochronometric systems: apatite and zircon fission track, and apatite and zircon helium. FastScape solves the heat conduction/advection/production equation in 1D to obtain thermal histories which are then used to obtain ages by solving the Fission Track annealing equation and the solid-state He diffusion equation.

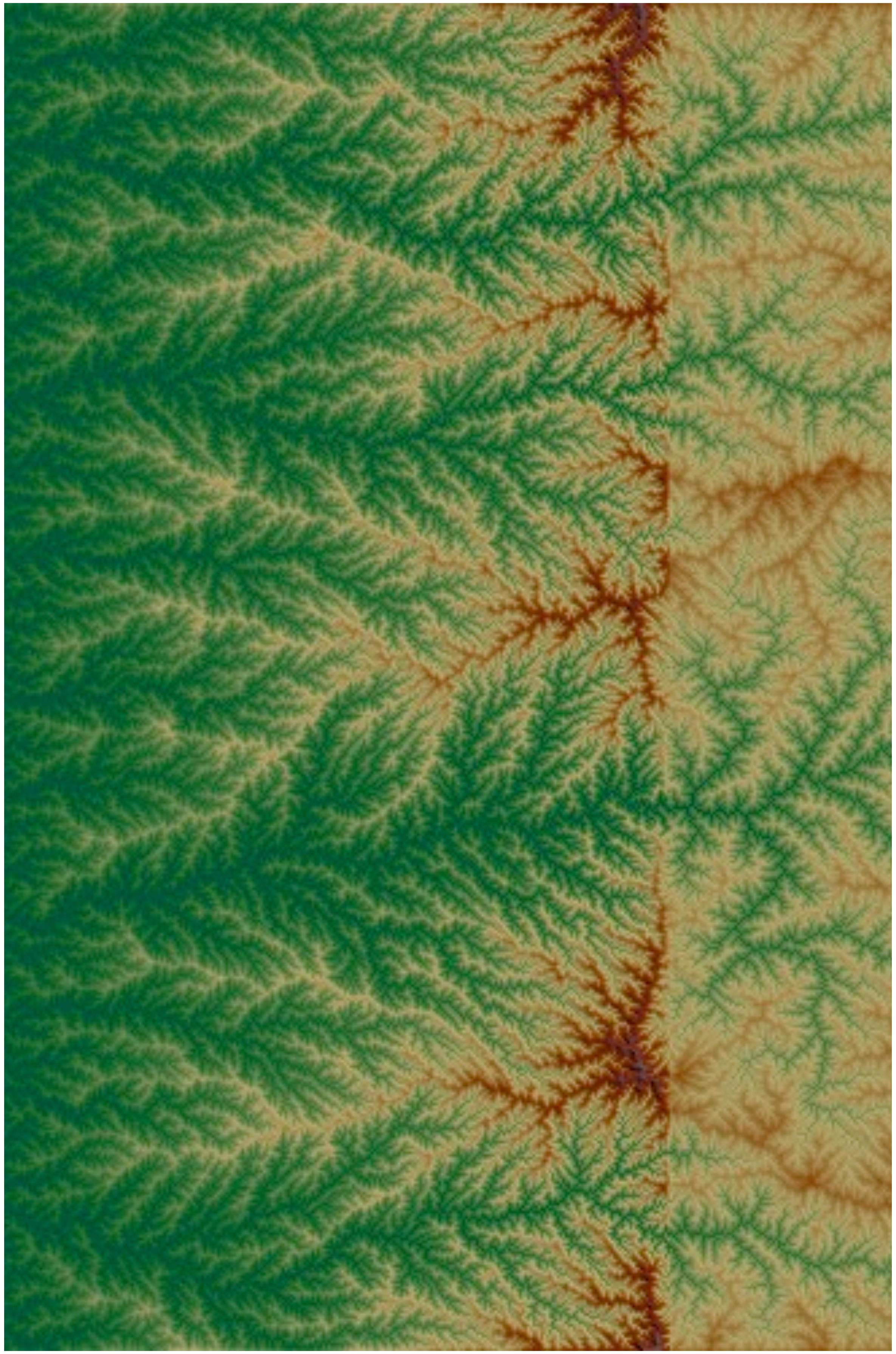
The user must specify the number of sites, **nage**, where ages will be computed. Default is 0 in which case no thermal computation is performed.

For each site, the user may specify (where i is an index going fro; 1 to nage): **age_xi,age_yi**, the x-y coordinates (in m) of the site where the ages are to be computed; **age_sizei** the grain size (in m) to be used to compute the He ages; **age_afti,age_dafti**, an observed apatite fission track age and its error/uncertainyty (in yr); **age_zfti,age_dzfti**, an observed zircon fission track age and its error/uncertainty (in yr); **age_ahei,age_dhei**, an observed apatite Helium age and its error/uncertainyty (in yr); **age_zhei,age_dzhei**, an observed zircon He age and its error/uncertainty (in yr)

In addition to these site specific parameters/observations, the user can also specify more "global" parameters needed to solve the heat equation. These include **L_age**, the thickness of the thermal model (in m), i.e. where the basal boundary condition is applied, **tmin_age,tmax_age** (in ^oC) the surface and basal temperature boundary condition, respectively, **heat_age** (in W/m^3) the amount of radiogenic heat production uniformly distributed over a depth **zheat_age** (in m), **cond_age** (no dimension) a multiplication factor for the thermal diffusivity (assumed to be 25 km^2/Myr or 10^{-6} m^2/s) applied over a depth of **zcond_age** (in m) to allow the user to specify the thermal blanketing effect of a low/high conductivity sedimentary/volcanic layer.

Controlling Output

Facing the user of **FastScape** is the difficulty to display/see the output, simply because of its high resolution. **FastScape** is able to display the results of a model run by creating bmp (image) or vtk (3D perspective) or dem files of a large number of fields, as well as some statistics/metrics/cross-sections that are produced in PDF format.



Every **nfreq** time steps, **FastScape** will produce image files of the solution displaying the topography, erosion rate, total erosion/sedimentation, discharge, catchment geometry and precipitation rate. To control which field is output, a series of flag have been set up.

plot_topo for the topography; **plot_erosion** for total/accumulated erosion, **plot_rate** for erosion rate, **plot_uplift** for surface uplift rate, **plot_rock_uplift** for rock uplift rate, **plot_sedim** for total sedimentation or sediment thickness, **plot_discharge** for dicharge, **plot_catchment** for catchment geometry, **plot_slope** for slope (in degrees), **plot_curvature** for curvature, **plot_steepnessindex** for steepness index, **plot_concavity** for concavity and **plot_precipitation** for precipitation rate.

When any of these flags is set to 1 (or -1), the corresponding field will be outputed every **nfreq** step in an image (.bmp) file in the corresponding RUN directory.

Another flag, **plot_all**, can also be used to ease the use of the other flags. If **plot_all** is set to 1, all plot flags are set to 1, except those that are explicitely set to 0; converserly, if **plot_all** is set to 0, all plot flags are set to 0 except those that are explicitely set to 1.

For each field, the user can specify the range (min,max) of values that is used to create the image. These parameters are **topo_min and topo_max**, **erosion_min and erosion_max**, **rate_min and rate_max**, **uplift_min and uplift_max**, **rock_uplift_min and rock_uplift_max**, **sedim_min and sedim_max**, **discharge_min,discharge_max**, **slope_min and slope_max**, **curvature_min and curvature_max**, **steepnessindex_min and steepnessindex_max**, **concavity_min and concavity_max**, **precipitation_min and precipitation_max**.

For each field, one can also set the plot flag to -1, which is equivalent to setting it to 1, except that the range of values that is used to create the image is not set by the user, but adjusted dynamically to the min-max values of the field at the given time step.

Other outputs can be obtained from **FastScape**. Each of these outputs can be obtained by setting the values of one or more of the five digits of a flag called **metric**. These include :

- 10000: min, mean and max topography in the x- and y-directions;
- 01000: the topography along two lines running in the x- and y-directions and centered along the middle of the domain of integration;
- 00100: slope-discharge relationship (beware as this produces very large files)
- 00010: cumulative histograms or CDFs of Height, Slope, Curvature and Discharge
- 00001: Flux vs time information

The frequency at which these outputs are calculated and sotred as .txt files is given by **nmetric**; its default value is **nfreq**.

If the user has installed the R (statistical) package on his/her computer, **FastScape** will use it to produce .PDF files (graphs) of the corresponding .txt files.

The topography metrics use the topo_min and topo_max range unless plot_topo is set to -1, in which case a dynamic range is used.

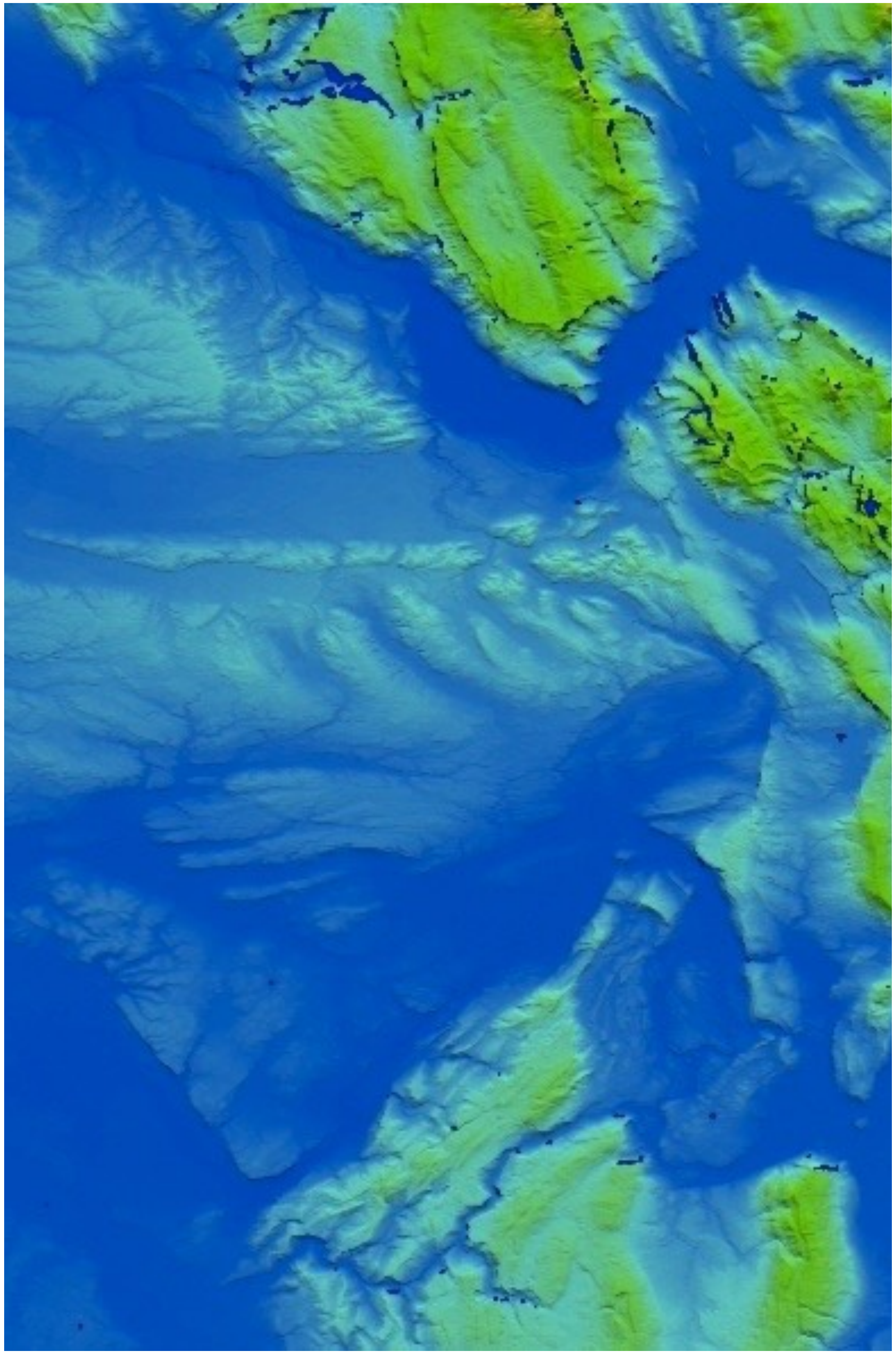
The **vtk** flag can be specified to direct FastScape to create vtk (3D perspective view) files that can be visualized using third party, free software such as paraview or mayavi.

The **plot_DEM** flag can be specified to generate DEM files of the topography that can be read by GIS software such as ArcView or Grass.

All (.bmp) images are grey shaded with topography with the field being contoured/coloured superimposed on the grey shaded image. The vertical exaggeration used to compute the shading can be adjusted through the **vex** parameter, which is also used to set the vertical exaggeration of the 3D, perspective views created in the vtk files.

Restarting and DEM start

FastScape can be restarted from the end of a previous run. It can also use binary DEM files (SRTM, ...) as initial topography input files.



The **restart** option allows to start a FastScape run where a previous one ended, using the value of the restart flag (0 = no restart; 1 = restart).

In case **restart** = 1, FastScape will read a file named RESTART in the run (RUN01, for example) directory. This is a binary file that contains the current elevation, as well as the position of the basement, the total erosion and the total flexural uplift. These are the only variables that need to be strored to continue a run, outside those that are specified in the input file.

If one uses the **restart** option, one should also change the total number of times steps to be larger than what it was at the end of the previous, restarted run. In this way FastScape will continue numbering the steps onward.

When the **restart** flag is negative, the initial topography is read from a DEM file. The name of the DEM is «DEM» by default but can be specified in the **DEM** variable in the input file.

When **restart** = -1, the DEM is assumed to be stored in a binary, direct access file as a series of nx*ny integer*2 number;

restart = -2 assumes integer*4 numbers;

restart = -3 assumes real*4 numbers;

restart = -4 assumes real*8 numbers.

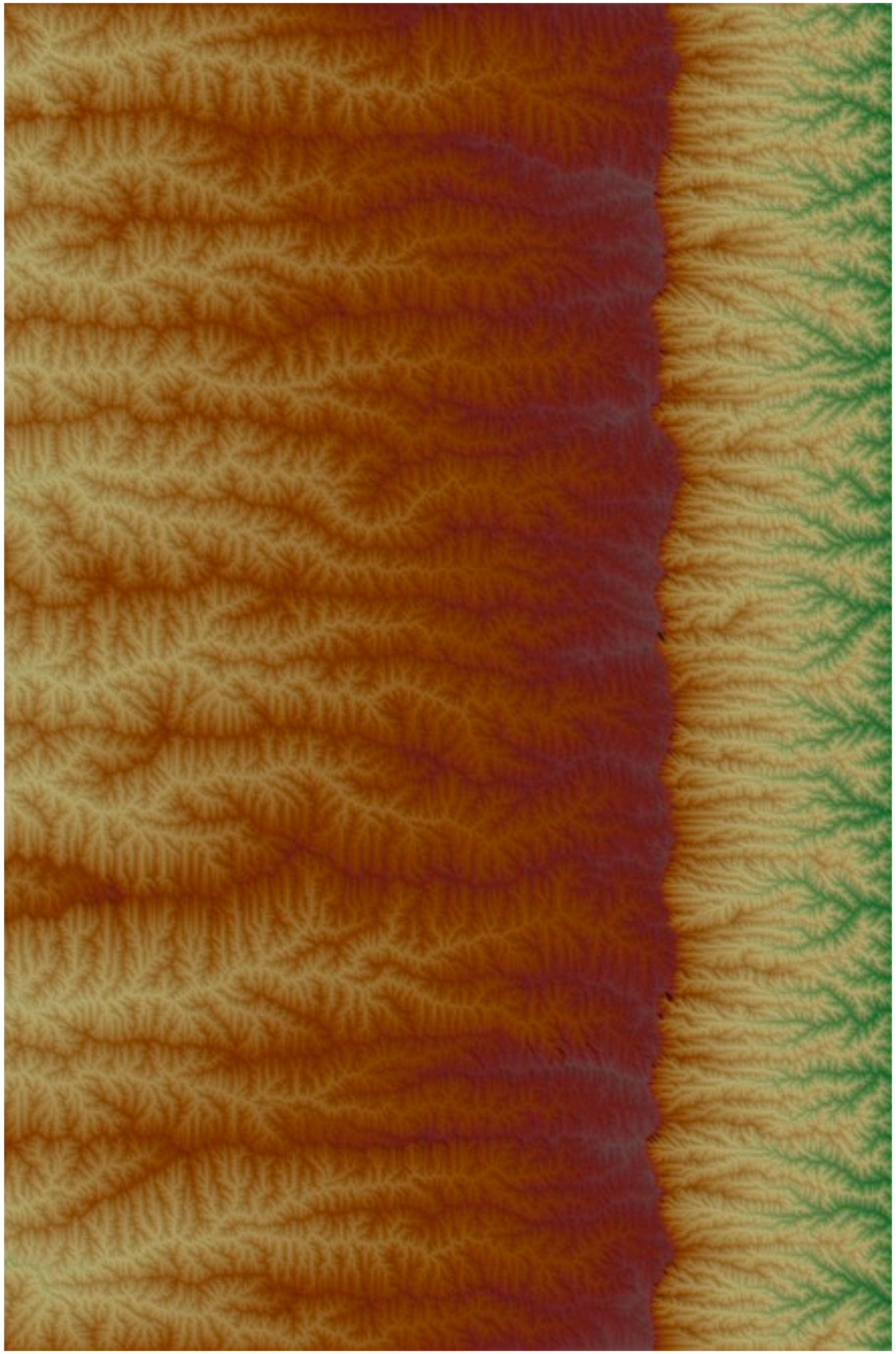
Because the way binary numbers are stored in files may vary from one system to the other, an extra variable can be specified, called **convert**, that allows the binary file to be in the following format:

- default, big_endian, cray, fdx, fgx, ibm, little_endian, vaxd, vaxg if the code is compiled with ifort
- default, swap, big_endian and little_endian if the code is compiled with gfortran

When restart is negative (the user is reading the initial topography from a DEM), any part of the landscape that is below a parameter called **base_level** is set to base level, i.e. the corresponding nodes are used as base level nodes to compute the drainage network; they are also not included in the erosion calculations

Example Runs

FastScape is provided with a series of example runs that should help the user understand its use and the meaning of the various parameters.



REF01

```
nx =   1000
ny =   1000
xl =    100000.
yl =    100000.
dt =    100000.00
nstep =    200
nfreq =    200
num_threads =      1
law = 1
m =   0.400000
kf =   0.100000E-04
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =    1.00000
initial_topography_n = 0
initial_topography_v1 =    5.000
uplift_n = 0
uplift_v1 =   0.100000E-03
plot_all = 0
plot_topo = 1
topo_min= 0
topo_max=1500
```

Brief description:

Basic run with flat plateau uplift, uniform precipitation, flat initial topography at 5 m, resolution of 1000x1000 and 200 time steps of 100 Kyrs each. Linear erosion law

REF02

```
nx =   1000
ny =   1000
xl =    100000.
yl =    100000.
dt =    100000.00
nstep =    200
nfreq =    10
num_threads =       1
law = 1
m =   0.400000
kf =   0.100000E-04
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =     1.00000
initial_topography_n = 0
initial_topography_v1 =     5.000
uplift_n = 0
uplift_v1 =   0.100000E-03
uplift_nt = 4
uplift_t1 = 0
uplift_f1 = 1
uplift_t2 = 10.e6
upflit_f2 = 1
uplift_t3 = 10.e6
uplift_f3 = 0.5
uplift_t4 = 20.e6
uplift_f4 = 0.5
plot_all = 0
plot_topo = 1
```

Brief description:

Basic run with flat plateau uplift, uniform precipitation, flat initial topography at 5 m, resolution of 1000x1000 and 200 time steps of 100 Kyrs each. Linear erosion law. The difference with the previous run is the decrease in uplift rate imposed from 10 Myr onward.

REF03

```
nx =   1000
ny =   1000
xl =    100000.
yl =    100000.
dt =     100000.00
nstep =    200
nfreq =    10
num_threads =       1
law = 1
m =   0.400000
kf =   0.100000E-04
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =    1.00000
initial_topography_n = 0
initial_topography_v1 =    5.000
uplift_n = 1
uplift_v1 =   0.1e-3
uplift_v2 =   0.11E-3
uplift_v3 =   0.11E-3
uplift_v4 =   0.1e-3
uplift_nt = 4
uplift_t1 = 0
uplift_f1 = 1
uplift_t2 = 10.e6
upflit_f2 = 1
uplift_t3 = 10.e6
uplift_f3 = 0.5
uplift_t4 = 20.e6
uplift_f4 = 0.5
plot_all = 0
plot_topo = 1
```

Brief description:

Basic run with a slightly inclined plateau uplift, uniform precipitation, flat initial topography at 5 m, resolution of 1000x1000 and 200 time steps of 100 Kyrs each. Linear erosion law. Decrease in uplift rate imposed from 10 Myr onward.

REF04

```
nx =   1000
ny =   1000
xl =    100000.
yl =    100000.
dt =    100000.00
nstep =    200
nfreq =    10
num_threads =       1
law = 1
m =   0.400000
kf =   0.100000E-04
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =    1.00000
initial_topography_n = 0
initial_topography_v1 =    5.000
!/uplift_start/
uplift=1.e-4+0.1e-4*x/xl
if (time.gt.10.e6) uplift=uplift/2.
!/uplift_stop/
plot_all = 0
plot_topo = 1
```

Brief description:

Identical to the previous run, except that the uplift function is generated by using a piece of ForTran code inserted into the input file. Note that this run needs the code to be run in expert mode.

REF05

```
nx =   1000
ny =   1000
xl =    100000.
yl =    100000.
dt =    100000.00
nstep =    200
nfreq =    10
num_threads =      1
law = 1
m =   0.500000
kf =   0.100000E-04
boundary_condition = 1111
precipitation_n = 0
precipitation_v1 =    1.00000
initial_topography_n = 0
initial_topography_v1 =    5.000
uplift_n = 2
uplift_v1 =   1.e-4
uplift_v2 =   1.E-4
uplift_v3 =   1.E-4
uplift_v4 =   1.e-4
uplift_v5 =   1.e-4
uplift_v6 =   1.E-4
uplift_v7 =   1.E-4
uplift_v8 =   1.e-4
uplift_v9 =   2.e-4
uplift_v10 =   2.E-4
uplift_v11 =   2.E-4
uplift_v12 =   2.e-4
uplift_v13 =   2.e-4
uplift_v14 =   2.E-4
uplift_v15 =   2.E-4
uplift_v16 =   2.e-4
uplift_nt = 4
uplift_t1 = 0
uplift_f1 = 1
uplift_t2 = 10.e6
upflit_f2 = 1
uplift_t3 = 10.e6
uplift_f3 = 0.5
uplift_t4 = 20.e6
uplift_f4 = 0.5
plot_all = 0
plot_topo = 1
plot_erosion = 1
erosion_min = 0
erosion_max = 3000.
plot_discharge = 1
discharge_min = 4
discharge_max = 9
metric = 11111
nmetric = 200
```

Brief description:

Fault offset specified by a set of four bilinear uplift functions to create a discontinuity. More output options are activated, including the metrics calculations, and range of values for most of the ouput fields.

REF06

```
nx =   1000
ny =   200
xl =    1000000.
yl =    200000.
dt =     100000.00
nstep =    500
nfreq =    25
num_threads =      1
law = 2
m =   0.3
n = 0.7
kf =   0.100000E-04
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =    1.00000
!/uplift_start/
w1=xl/4.
w2=1000./10.e6
uplift=0.
if (x.gt.w1.and.time.lt.10.e6) uplift=w2*(x-xl)/(w1-xl)
!/uplift_stop/
initial_topography_n = 0
intial_topography_v1 =   0.
flexure = 1
meanflex = 1
plot_all = 0
plot_topo = 1
metric = 10000
topo_min=-100
topo_max=2000
```

Brief description:

Escarpment retreat. An escarpment defined by an uplift function (expert mode needed) migrates through time. Note the use of the non-linear stream-power law (n=0.7), as well as the flexure parameter.

REF07

```
nx =   1000
ny =   200
xl =    1000000.
yl =    200000.
restart = 0
dt =    100000.00
nstep =    400
nfreq =    10
num_threads =      1
law = 2
m =   0.3
n = 0.7
kf =   0.200000E-04
strati_f1 = .3
strati_top1 = 500
strati_bottom1 = 1000
boundary_condition = 0101
precipitation_n = 0
precipitation_v1 =    1.00000
!/uplift_start/
w1=xl/4.
w2=1000./10.e6
uplift=0.
if (x.gt.w1.and.time.lt.10.e6) uplift=w2*(x-xl)/(w1-xl)
!/uplift_stop/
initial_topography_n = 0
intial_topography_v1 =   0
flexure = 1
meanflex = 1
plot_all = 0
plot_topo = 1
metric = 10000
topo_min=-100
topo_max=2000
plot_strati = 1
strati_min = .3
strati_max = 2
plot_rate = 1
rate_min = -9
rate_max = -3.
vtk = 1
vex=20
```

Brief description:

Escarpment retreat. An escarpment defined by an uplift function (expert mode needed) migrates through time. Note the use of the non-linear stream-power law (n=0.7), as well as the flexure parameter. Same as previous run, except for the stratigraphy that is imposed with a three times harder layer buried between depths 500 and 1000 m. Note also the vertical exaggeration set for the vtk files.

Age_afti,age_dafti

double precision

default: -999,-999

Observed apatite fission track age and its uncertainty (in yr) at location Age_xi,Age_yi.

Related Glossary Terms

Age_ahei,age_dhei, Age_hi, Age_sizei, Age_xi,age_yi, Age_zfti,age_dzfti, Age_zhei,age_d-zhei, Nage

---

Index Find Term

Chapitre 14 - Thermochron

Age_ahei,age_dhei

double precision

default: -999,-999

Observed apatite Helium age and its uncertainty (in yr) at location Age_xi,Age_yi.

Related Glossary Terms

Age_afti,age_dafti, Age_hi, Age_sizei, Age_xi,age_yi, Age_zfti,age_dzfti, Age_zhei,age_d-zhei, Nage

---

Age_hi

double precision

default: -99999

Topographic height at location Age_xi,Age_yi. If for any of the thermochronological data the height information is given, FastScape will run twice as long and the location age_xi,age_yi will be adjusted the second time around (by as much as dx_age,dy_age) to try to find a new location where the synthetic height is closest to the observed height

---

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_sizei, Age_xi,age_yi, Age_zfti,age_dzfti, Age_zhei,age_dzhei, Dx_age,dy_age, Nage

---

Index Find Term

Age_sizei

double precision

default: 0

Observed apatite grain size (in m) used to compute He ages at location Age_xi,Age_yi.

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_hi, Age_xi,age_yi, Age_zfti,age_dzfti, Age_zhei,age_dzhei, Nage

---

Index Find Term

Chapitre 14 - Thermochron

Age_xi,age_yi

double precision

default: -999,-999

Location (in m) of where thermochronological observations exist and/or where FastScape will estimate ages.

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_hi, Age_sizei, Age_zfti,age_dzfti, Age_zhei,age_dzhei, Dx_age,dy_age, Nage

---

Index Find Term

Chapitre 14 - Thermochron

Age_zfti,age_dzfti

double precision

default: -999,-999

Observed zircon fission track age and its uncertainty (in yr) at location Age_xi,Age_yi.

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_hi, Age_sizei, Age_xi,age_yi, Age_zhei,age_d-zhei, Nage

Index Find Term

Chapitre 14 - Thermochron

Age_zhei,age_dzhei

double precision

default: -999,-999

Observed zircon Helium age and its uncertainty (in yr) at location Age_xi,Age_yi.

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_hi, Age_sizei, Age_xi,age_yi, Age_zfti,age_dzfti, Nage

---

Index Find Term

Chapitre 14 - Thermochron

Alpha

double precision

default: 1

Constant used in the $\xi - q$ law of Davy and Lague (2009):

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n + \frac{Q_S}{\alpha Q_W}$$

Termes connexes du glossaire

Kf, Law, M, N, Tol

Index Find Term

Chapitre 6 - Erosion Laws

Area_min

double precision (in m²)

default: 0

Minimum drainage area necessary for fluvial incision to be computed and applied to the topography

Related Glossary Terms

KD, Kf

Index Find Term

Chapitre 6 - Erosion Laws

Base_level

double precision

default : 0

Height (in meters) of «base level». This parameter is used only when **restart**<0. Any node that is below **base_level** is supposed to be a base level node for the computation of the drainage network. Those nodes are not affected by erosion.

Related Glossary Terms

Restart

Boundary_condition

Integer

default: 0001

A 4 digit code to set the boundary conditions along the four borders of the integration domain, strarting from the bottom boundary (y=0), right boundary (x=xl), top boundary (y=yl) and left boundary (x=0). If the code is set to 1, the corresponding boundary is set at base level (its height is set to zero and does not change through time). Of the code is 0, the boundary is a reflective boundary (no condition is imposed on height, but the water cannot leave through this boundary). If two facing boundaries are set to 0, the boundary condition is assumed to be periodic (whatever water leaves through one side comes back in the integration domain through the other side)

Termes connexes du glossaire

Meanflex, Xl,yl

Index Find Term

Chapitre 5 - General Setup

Concavity_min and concavity_max

double precision

default: 0, 1

Range used to compute the concavity image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_concavity=-1.

Termes connexes du glossaire

Plot_concavity

Cond_age

double precision

default: 1

Factor multiplying the heat diffusivity above zcon_age in the solution of the 1D heat equation performed to compute synthetic thermochronological ages.

Related Glossary Terms

Nage, Zcond_age

Index Find Term

Chapitre 14 - Thermochron

Convert

character

default : native

To convert DEM, binary files that may have been created on a different platform. This flag can be specified when the restart flag is used with a negative value (the initial topography is read from an external, binary file) and/or the DEM file name is specified.

Possible values include:

default, big_endian, cray, fdx, fgx, ibm, little_endian, vaxd, vaxg if the code is compiled with ifort

default, swap, big_endian and little_endian if the code is compiled with gfortran

Termes connexes du glossaire

DEM, Restart

Index Find Term

Chapitre 16 - Restarting and DEM start

Curvature_min and curvature_max

double precision

default: -5e-3, 5e-3

Range used to compute the curvature image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_curvature=-1.

Termes connexes du glossaire

Plot_curvature

Debug

integer

default: 0

An integer flag (0 or 1) to activate (debug=1) or not (debug=0) debugging information being sent to the screen during a **FastScape** run. During production runs, it is not recommended to set the **debug** flag to 1, as this will necessarily reduce **FastScape**'s performance.

Termes connexes du glossaire

Drag related terms here

Index Find Term

DEM

character

default: DEM

Name of the DEM file containing the initial topography when the restart flag is negative. The DEM file is a binary, direct access file containing nx*ny height values stored as integer*2 (restart=-1), integer*4 (restart=-2), real*4 (restart=-3) or real*8 (restart=-4).

Termes connexes du glossaire

Convert, Nx,ny, Restart

Index Find Term

Chapitre 16 - Restarting and DEM start

Discharge_min,discharge_max

double precision

default: log10(dx*dy*precip_max), log10(xl*yl*precip_max) in cubic meter/yr

Range used to compute the logarithm of the discharge image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_discharge=-1.

Termes connexes du glossaire

Plot_all, Plot_discharge

DSc

double precision

default: 0

Variability in critical repose angle Sc (in degrees). FastScape will generate critical angle values that differ from place to place by calling the random_number generator routine and multiplying the resulting random number scaled to be between -1 and 1 by **dSc** and add it to **Sc** before testing if local slope is larger than critical slope.

Related Glossary Terms

Sc

Index Find Term

Chapitre 6 - Erosion Laws

Dt

double precision

default: 100000

Time step length in years.

Termes connexes du glossaire

Nstep

Index Find Term

Chapitre 5 - General Setup

Dx_age,dy_age

double precision

default: 0, 0

Thermochronological ages can also be used to constrain an inversion/optimisation performed with **FastScape**. One of the potential problem arises from the random nature of the final landscape that is predicted. It is futile to hope to reproduce the details of a given landscape, such as the exact position of valleys and divides. In view of this limitation, it is difficult to use the direct comparison between predicted and observed ages to build the misfit function on which the inversion/optimisation is based. To circumvent this, we have added a series of parameters that force **FastScape** to reposition the location of the thermochronological data/observations so that the final height predicted on the synthetic landscape are as close as possible to the observed height. To use this option, the user must therefore include, for each age location and in addition to position, ages and error on ages, the topographic height, **age_hi** of where the observation was made. Two additional parameters are needed to limit the search for a point of similar height in the synthetic landscape. These are dx_age and dy_age which are distances (in m) that define the region (in the vicinity of each point of coordinates **age_xi** and **age_yi**) that will be searched.

Related Glossary Terms

Age_hi, Age_xi,age_yi, Nage

Index Find Term

Erosion_min and erosion_max

double precision

default: 0, topo_max

Range used to compute the erosion image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_erosion=-1.

Termes connexes du glossaire

Plot_all, Plot_erosion

Flexure

integer

default : 0

Flag to enable the calculation of an isostatic (flexural) response to erosional unloading.

Termes connexes du glossaire

Granite_drhoi, Meanflex, Pratio, Rhoaflex, Rhocflex, Thickflex, Ym

---

Index Find Term

Granite_bottomi

double precision

default : 1000000 m (100 km)

Depth in meters of the bottom granitic intrusion i.

Termes connexes du glossaire

Granite_dkdi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_topi, Granite_xi, Granite_yi

---

Index Find Term

Chapitre 12 - Intrusions

Granite_dkdi

double precision

default : 1

Diffusivity contrast of granitic intrusion i; the fluvial erosion coefficient Kd will be multiplied by granite_dkdi in granitic intrusion i (no unit)

Related Glossary Terms

Granite_bottomi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_topi, Granite_xi, Granite_yi, KD

Index

Find Term

Granite_dki

double precision

default : 1

Hardness contrast of granitic intrusion i; the fluvial erosion coefficient Kf will be multiplied by granite_dki in granitic intrusion i (no unit)

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_topi, Granite_xi, Granite_yi, Kf

---

Index Find Term

Granite_drhoi

double precision

default : 0 kg/m3

Density anomaly (in kg/m3) of granitic intrusion i

Termes connexes du glossaire

Flexure, Granite_bottomi, Granite_dkdi, Granite_dki, Granite_rxi, Granite_ryi, Granite_topi, Granite_xi, Granite_yi, Rhocflex

Index Find Term

Granite_rxi

double precision

default : 0 m

Radius of granitic intrusion i in the x-direction (in m) to form an elliptical shaped vertical cylinder

---

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_dki, Granite_drhoi, Granite_ryi, Granite_topi, Granite_xi, Granite_yi

---

Index Find Term

Granite_ryi

double precision

default : 0 m

Radius of granitic intrusion i in the y-direction (in m) to form an elliptical shaped vertical cylinder

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_topi, Granite_xi, Granite_yi

Index

Find Term

Granite_topi

double precision

default : 0 m

Depth in meters of the top of granitic intrusion i.

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_xi, Granite_yi

---

Granite_xi

double precision

default : 0 m

Y-Position in meters of granitic intrusion i.

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_topi, Granite_yi

Granite_yi

double precision

default : 0 m

Y-Position in meters of granitic intrusion i.

Termes connexes du glossaire

Granite_bottomi, Granite_dkdi, Granite_dki, Granite_drhoi, Granite_rxi, Granite_ryi, Granite_topi, Granite_xi

---

Index Find Term

Chapitre 12 - Intrusions

Heat_age

double precision

default: 0

Assumed radiogenic heat production (in W/m^3) used above zheat_age in the solution of the heat equation performed to compute synthetic ages.

Related Glossary Terms

Nage, Zheat_age

Initial_topography_n

Integer

default: 0

Flag to set how the initial topography is defined using the interpolation functions (not used if a Fortran code is used in the input file to specify the initial topography). Possible values are:

- 0 = uniform initial topography specified in initial_topography_v1
- 1 = bi-linear function, using the values of the function at the four corners of the integration domain (initial_topography_v1 to initial_topography_v4)
- 2 = four bi-linear functions, using the values of the function at the four corners of four rectangles (quarters) of the integration domain (initial_topography_v1 to initial_topography_v16)

Termes connexes du glossaire

DEM, Initial_topography_v1 to initial_topography_v16, Restart

---

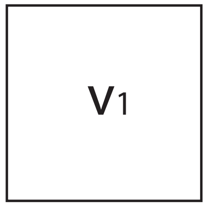
Index Find Term

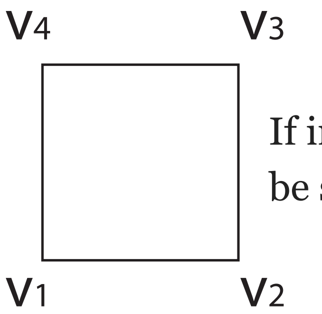
Initial_topography_v1 to initial_topography_v16

double precision

default: 0,...,0

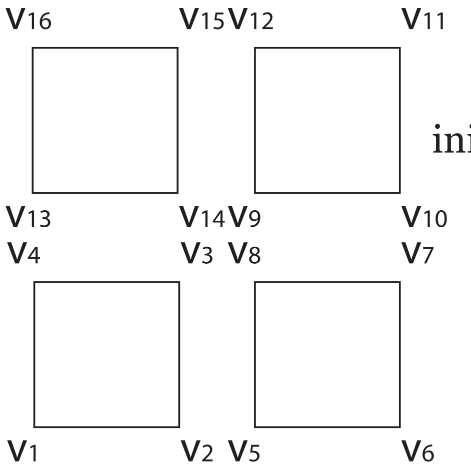
If initial_topography_n = 0, only initial_topography_v1 needs to be specified to set the uniform initial topography.





If initial_topography_n = 1, only initial_topography_v1 to v4 need to be specified to set the bilinear initial topography:

If initial_topography_n = 2, initial_topography_v1 to initial_topography_v16 need to be specified to set the quad-bilinear initial topography:



Termes connexes du glossaire

Drag related terms here

Index Find Term

KD

double precision

default: 1e-2

Constant used in the diffusion law representing hillslope processes:

$$\frac{\partial h}{\partial t} = K_D \frac{\partial^2 h}{\partial x^2} + K_D \frac{\partial^2 h}{\partial y^2}$$

Termes connexes du glossaire

Area_min, Granite_dkdi, Law

Index Find Term

Kf

double precision

default: 1e-5 (law=1) or 1e-5 (law=2)

Constant used in the unit stream power law:

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n$$

Termes connexes du glossaire

Alpha, Area_min, Granite_dki, Law, M, N, Nk, Tol

L_age

double precision

default: $120\ 10^3$

Assumed thickness of the thermal model (in m) used to compute ages. This is where the basal boundary condition tmax_age is imposed

Related Glossary Terms

Nage, Tmin_age,tmax_age

Index Find Term

Chapitre 14 - Thermochron

Law

integer

default: 1

Flag to set the fluvial erosion law (1 or 2). The main difference is that, when law=1, the slope exponent is set to 1, which greatly simplifies the solution of the erosion PDE using an implicit method.

If law is negative (-1 or -2), an explicit method is used to integrate the erosion PDE in time.

When law = 2, the implicit integration scheme requires that an iteration procedure be used; in this case the user can specify either a fixed number of iterations (nk), or a tolerance (tol)

Termes connexes du glossaire

Alpha, KD, Kf, M, N, Nk, Tol

Local_minima

integer

default : 1

Flag to impose that the local minima be neglected (local_minima=0) and water is locally lost, or resolved (local_minima=1) and water is conserved, i.e. all precipitated water has to leave the integration domain through the base level boundaries.

Termes connexes du glossaire

Drag related terms here

M

double precision

default : 0.5 (if law=1) or 1/3 if (law=2)

Discharge exponent in stream power law:

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n$$

Termes connexes du glossaire

Alpha, Kf, Law, N, Nk, Plot_concavity, Tol

Index Find Term

Chapitre 6 - Erosion Laws

Meanflex

integer

default : 0

Flag to decide whether the isostasy is cylindrical in case cyclic boundary conditions are used.

When meanflex is set to 1, **FastScape** will determine whether two opposing boundaries have their condition set to 0 (which means that cyclic boundary conditions between these two boundaries will be used) and, in such a case, will only calculate the isostatic response by averaging the load (and the response) in that direction. This is to avoid edge effects.

Termes connexes du glossaire

Flexure, Pratio, Rhoaflex, Rhocflex, Thickflex, Ym

Index Find Term

Chapitre 11 - Flexure

Metric

integer

default: 00000

Each of the digits of metric can be set to 0 or 1 :

- 10000: min, mean and max topography in the x- and y-directions;
- 01000: the topography along two lines running in the x- and y-directions and centered along the middle of the domain of integration;
- 00100: slope-discharge relationship (beware as this produces very large files)
- 00010: option not available yet
- 00001: Flux vs time information

The frequency at which these outputs are calculated and sotred as .txt files is given by **nmetric**; its default value is **nfreq**.

Termes connexes du glossaire

Nfreq, Nmetric, Plot_all

Misfit.R

R script stored in the NA sub-directory that can be used to display the fit to the data/observations for any value of the input parameters. For example, to display how the best model (with the lowest misfit) fits the observations, first create a RUN directory (for example called RBEST) in which the FastScape.in input file includes the value of the model parameters of the best model; then run FastScape.sh -e RBEST. Copy the observation files (ages, height, slope, curvature, volume) into the RBEST directory; and finally run Misfit.R. This should create a series of plots comparing predictions and observations.

Related Glossary Terms

Drag related terms here

Index Find Term

N

double precision

default : 2/3

Slope exponent in stream power law:

$$\frac{\partial h}{\partial t} = -K_f \phi^m S^n$$

Only used when law = 2

Termes connexes du glossaire

Alpha, Kf, Law, M, Nk, Plot_concavity, Tol

Index Find Term

Chapitre 6 - Erosion Laws

Nage

integer

default : 0

Number of locations where thermochronological data exist and/or age must be calculated

Related Glossary Terms

Age_afti,age_dafti, Age_ahei,age_dhei, Age_hi, Age_sizei, Age_xi,age_yi, Age_zfti,age_dzfti, Age_zhei,age_dzhei, Cond_age, Dx_age,dy_age, Heat_age, L_age, Tmin_age,tmax_age, Zcond_age, Zheat_age

Index Find Term

Chapitre 14 - Thermochron

Nfreq

integer

default : nstep

Image (.bmp) file output frequency.

Termes connexes du glossaire

Discharge_min,discharge_max, Erosion_min and erosion_max, Nmetric, Nstep, Plot_all, Plot_catchment, Plot_concavity, Plot_curvature, Plot_discharge, Plot_erosion, Plot_precipitation, Plot_rate, Plot_rock_uplift, Plot_sedim, Plot_slope, Plot_steepnessindex, Plot_topo, Precipitation_min and precipitation_max, Rate_min and rate_max, Sedim_min and sedim_max, Strati_fn, strati_fdn, strati_topn, strati_bottomn, Topo_min and topo_max, Vex

Index

Find Term

Nk

integer

default: 0

Number of iterations to be used in the iterative Newton-Raphson scheme used to solve the non-linear implicit time integration equation.

If nk=0, the number of iterations is not set, but depends on convergence beyond a given tolerance, tol.

This is only used when law=2.

Termes connexes du glossaire

Kf, Law, M, N, Tol

Index Find Term

Nmetric

integer

default : nfreq

Metric file output frequency.

Termes connexes du glossaire

Metric, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

Nstep

integer

default : 200

Number of time steps of length dt

Termes connexes du glossaire

Nfreq, Nmetric

Index Find Term

Chapitre 5 - General Setup

Num_threads

integer

default: 1

Number of threads/processors on which the run is to be performed. The larger num_threads, the faster the run will be executed, up to a certain point that will depend on the architecture of your computer (bus speed)

If you set this number to be larger than the number of threads/processors available on your computer, the run will stop and let you know the maximum number of threads allowed

---

Termes connexes du glossaire

Drag related terms here

Index Find Term

Nx,ny

integer

default: 1000,1000

Spatial resolution of the model specified as the number of points used to discretized the domain of integration in the x- and y-direction, respectively. The total number of points is thus nx times ny.

Note that each array in the code will take nx by ny by 8 bytes of memory. So if you set nx and ny to 10,000, each array will take 800 Mb of memory (~1Gb). There are approximately 20 arrays of such size in FastScape, which means that the main limitation to the resolution you can use will be the available RAM.

Termes connexes du glossaire

Xl,yl

Index Find Term

Chapitre 5 - General Setup

Pecube_nfreq

integer

default : 0 (pas de sortie pour Pecube)

Pecube (topo, uplift and temp) file output frequency

Termes connexes du glossaire

Pecube_nx, Pecube_ny, Pecube_xmax, Pecube_xmin, Pecube_ymax, Pecube_ymin

---

Index Find Term

Chapitre 13 - Pecube

Pecube_nx

integer

default: nx

x-spatial resolution of the input files prepared for input to Pecube.

Termes connexes du glossaire

Pecube_nfreq, Pecube_ny, Pecube_xmax, Pecube_xmin, Pecube_ymax, Pecube_ymin

Pecube_ny

integer

default: ny

y-spatial resolution of the input files prepared for input to Pecube.

Termes connexes du glossaire

Pecube_nfreq, Pecube_nx, Pecube_xmax, Pecube_xmin, Pecube_ymax, Pecube_ymin

Index Find Term

Chapitre 13 - Pecube

Pecube_xmax

double precision

default : 0

X-position of the top right corner of the box defining the subset of the topography that is sent for input to Pecube

Termes connexes du glossaire

Pecube_nfreq, Pecube_nx, Pecube_ny, Pecube_xmin, Pecube_ymax, Pecube_ymin

Index Find Term

Chapitre 13 - Pecube

Pecube_xmin

double precision

default : 0

X-position of the left bottom corner of the box defining the subset of the topography that is sent for input to Pecube.

Termes connexes du glossaire

Pecube_nfreq, Pecube_nx, Pecube_ny, Pecube_xmax, Pecube_ymax, Pecube_ymin

Index Find Term

Chapitre 13 - Pecube

Pecube_ymax

double precision

default : xl

X-position of the top right corner of the box defining the subset of the topography that is sent for input to Pecube

---

Termes connexes du glossaire

Pecube_nfreq, Pecube_nx, Pecube_ny, Pecube_xmax, Pecube_xmin, Pecube_ymin

---

Index Find Term

Chapitre 13 - Pecube

Pecube_ymin

double precision

default : 0

Y-position of the left bottom corner of the box defining the subset of the topography that is sent for input to Pecube

---

Termes connexes du glossaire

Pecube_nfreq, Pecube_nx, Pecube_ny, Pecube_xmax, Pecube_xmin, Pecube_ymax

---

Index Find Term

Chapitre 13 - Pecube

Plot_all

integer

default : 1

Flag that forces all other output flags (plot_topo, plot_sedim, plot_precipitation, plot_erosion, plot_discharge, plot_catchment) to be set to 1, unless they are explicitely set to 0.

Termes connexes du glossaire

Nfreq, Plot_catchment, Plot_concavity, Plot_curvature, Plot_discharge, Plot_erosion, Plot_precipitation, Plot_rate, Plot_rock_uplift, Plot_sedim, Plot_slope, Plot_steepnessindex, Plot_topo, Rock_uplift_min and rock_uplift_max, Uplift_min and uplift_max

Index Find Term

Plot_catchment

integer

default : 1 (unless plot_all is set to 0)

Flag to plot catchment geometry in files names catchmentxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

Plot_concavity

integer

default : 1 (unless plot_all is set to 0)

Flag to plot concavity (m/n ratio) in files names Concavityxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Concavity is defined as the slope of the local slope-area relationship. It should be equal to m/n.

Termes connexes du glossaire

Concavity_min and concavity_max, M, N, Nfreq, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

Plot_curvature

integer

default : 1 (unless plot_all is set to 0)

Flag to plot curvature (in per meters) in files names Curvaturexxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Curvature_min and curvature_max, Nfreq, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

plot_DEM

integer

default: 0

Flag to force FastScape to create DEM files in addition to the bmp image files, but only of the topography.

DEM files can be visualized using third party software such as ArcView or Grass.

The DEM files are accompanied by header files (.HDR) that contains geometric information for the GIS software to position the DEM. Here the information is such that the DEM is placed at lat-lon=0°-0°.

Termes connexes du glossaire

Drag related terms here

Index Find Term

Chapitre 15 - Controlling Output

Plot_discharge

integer

default : 1 (unless plot_all is set to 0)

Flag to plot log10(discharge) (in cubic meters per year) in files names dischargexxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Discharge_min,discharge_max, Nstep, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

Plot_erosion

integer

default : 1 (unless plot_all is set to 0)

Flag to plot total erosion (in meters) in files names erosionxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Erosion_min and erosion_max, Nfreq, Plot_all

Index Find Term

Chapitre 15 - Controlling Output

Plot_precipitation

integer

default : 1 (unless plot_all is set to 0)

Flag to plot precipitation rate (in meters per year) in files names precipitationxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all, Precipitation_min and precipitation_max

Plot_rate

integer

default : 1 (unless plot_all is set to 0)

Flag to plot the logarithm of erosion rate (in meters/year) in files names ratexxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all, Rate_min and rate_max

Index Find Term

Chapitre 15 - Controlling Output

Plot_rock_uplift

integer

default : 1 (unless plot_all is set to 0)

Flag to plot the rock uplift rate (in meters/year) in files names RockUpliftxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Related Glossary Terms

Nfreq, Plot_all, Rock_uplift_min and rock_uplift_max, Vtk

Index Find Term

Chapitre 15 - Controlling Output

Plot_sedim

integer

default : 1 (unless plot_all is set to 0)

Flag to plot total sedimentation (or sediment thickness) (in meters) in files names sedimxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all, Sedim_min and sedim_max

Index Find Term

Chapitre 15 - Controlling Output

Plot_slope

integer

default : 1 (unless plot_all is set to 0)

Flag to plot slope in files names Slopexxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all, Slope_min and slope_max

Index Find Term

Chapitre 15 - Controlling Output

Plot_steepnessindex

integer

default : 1 (unless plot_all is set to 0)

Flag to plot Steepness Index in files names SteepnessIndexxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Steepness index is defined here as:

$k_{sl} = SA^{m/n}$

Termes connexes du glossaire

Nfreq, Plot_all, Steepnessindex_min and steepnessindex_max

Index Find Term

Chapitre 15 - Controlling Output

Plot_topo

integer

default : 1 (unless plot_all is set to 0)

Flag to plot topography (in meters) in files names topoxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Termes connexes du glossaire

Nfreq, Plot_all, Topo_min and topo_max, Vex

Index Find Term

Chapitre 15 - Controlling Output

Plot_uplift

integer

default : 1 (unless plot_all is set to 0)

Flag to plot the surface uplift rate (in meters/year) in files names Upliftxxxxx.bmp in the RUN directory, where xxxxx is the time step number.

Related Glossary Terms

Uplift_min and uplift_max, Vtk

Index Find Term

Chapitre 15 - Controlling Output

Pratio

double precision

default: 0.25

Lithospheric Poisson's ratio used in the calculation of the flexural isostatic response

---

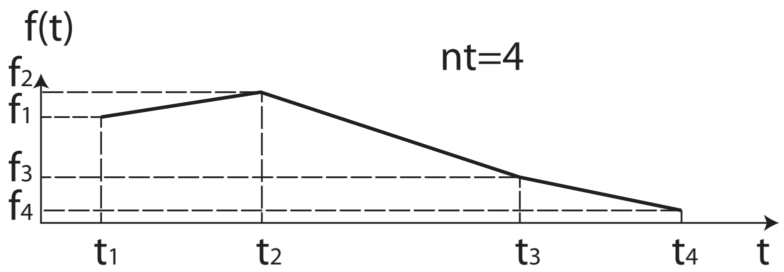
Termes connexes du glossaire

Flexure, Meanflex, Rhoaflex, Rhocflex, Thickflex, Ym

Index Find Term

Chapitre 11 - Flexure

Precipitation_f1 to precipitation_f9



double precision

default : 0,...,0

Used to define a time function that will multiply the precipitation function obtained by interpolation (precipitation_n=0 to 2).

The time function is obtained for all time t, by simple linear interpolation between set values and times given by precipitation_f1 to precipitation_f9 and precipitation_t1 to precipitation_t9

This is not used when the uplift is specified through a user-supplied ForTran code.

Termes connexes du glossaire

Precipitation_n, Precipitation_nt, Precipitation_t1 to precipitation_t9, Precipitation_v1 to precipitation_v16, Precipitation.f90

Index Find Term

Chapitre 10 - Precipitation Rate

Precipitation_min and precipitation_max

double precision

default: 0, 1 m per year

Range used to compute the precipitation image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_precipitation=--1.

Termes connexes du glossaire

Plot_all, Plot_precipitation

Precipitation_n

integer

default : 0

Interpolation level used to build the precipitation function.

precipitation_n = 0 : uniform value (precipitation_v1 is used)

precipitation_n = 1 : bilinear function (precipitation_v1 to v4 are used)

precipitation_n = 2 : 4 bi-linear function (precipitation_v1 to v16 are used)

This is not used when the precipitation is specified through a user-supplied ForTran code.

Termes connexes du glossaire

Precipitation_f1 to precipitation_f9, Precipitation_nt, Precipitation_t1 to precipitation_t9, Precipitation_v1 to precipitation_v16, Precipitation.f90

Index Find Term

Chapitre 10 - Precipitation Rate

Precipitation_nt

integer

default : 0

Number of points used to define the time function that multiplies the precipitation function when it is built by interpolation.

This is not used when the precipitation is specified through a user-supplied ForTran code.

When precipitation_n is not specified, the time function is constant and =1

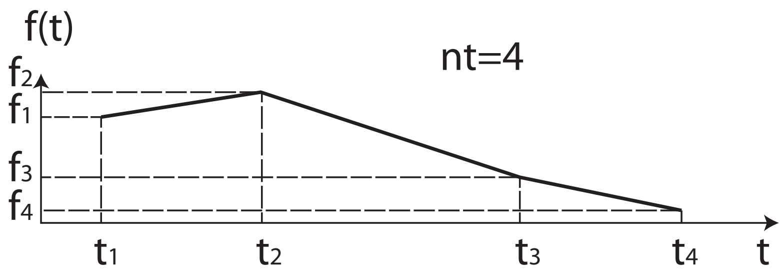
Termes connexes du glossaire

Precipitation_f1 to precipitation_f9, Precipitation_n, Precipitation_t1 to precipitation_t9, Precipitation_v1 to precipitation_v16, Precipitation.f90

Index Find Term

Chapitre 10 - Precipitation Rate

Precipitation_t1 to precipitation_t9



double precision

default : 0,...,0

Used to define a time function that will multiply the precipitation function obtained by interpolation (precipitation_n=0 to 2).

The time function is obtained for all time t, by simple linear interpolation between set values and times given by precipitation_f1 to precipitation_f9 and precipitation_t1 to precipitation_t9

This is not used when the uplift is specified through a user-supplied ForTran code.

Termes connexes du glossaire

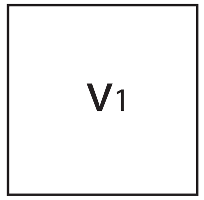
Precipitation_f1 to precipitation_f9, Precipitation_n, Precipitation_nt, Precipitation_v1 to precipitation_v16, Precipitation.f90

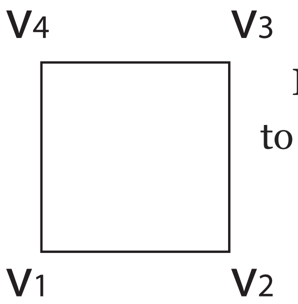
Precipitation_v1 to precipitation_v16

double precision

default: 0,...,0

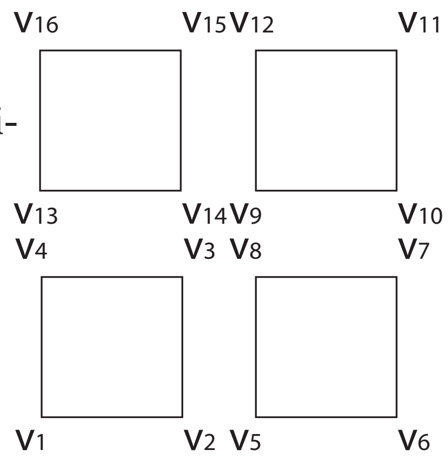
If precipitation_n = 0, precipitation_v1 needs to be specified to set the uniform precipitation.





If precipitation_n = 1, only precipitation_v1 to v4 need to be specified to set the bilinear precipitation:

If precipitation_n = 2, precipitation_v1 to precipitation_v16 need to be specified to set the quad-bilinear precipitation:



Termes connexes du glossaire

Precipitation_f1 to precipitation_f9, Precipitation_n, Precipitation_nt, Precipitation_t1 to precipitation_t9, Precipitation.f90

Index Find Term

Precipitation.f90

Expert mode only

This function is built from the two sections of code stored in precipitation_start and precipitation_stop and a third section potentially provided by the user in the input file and sandwiched between the two lines:

!/precipitation_start/

!/precipitation_stop/

The code should be written in ForTran90 using a fixed set of variables: x, y, time, xl, yl, nx, ny, dx, dy and working variables w0 to w9 (double precision) and i0 to i9 (integer). It should return a variable named precipitation that contains the function precipitation(x,y,time) in m/yr. Example:

w1=1.d-5

*precipitation=w1*x/xl*

Termes connexes du glossaire

Precipitation_f1 to precipitation_f9, Precipitation_n, Precipitation_nt, Precipitation_t1 to precipitation_t9, Precipitation_v1 to precipitation_v16

Index Find Term

Rate_min and rate_max

double precision

default: -9 and -3

Range used to compute the rate image (.bmp) files. Note that the logarithm (in base 10) is plotted.

These values are not used and the range is dynamically adjusted if plot_rate=-1.

Termes connexes du glossaire

Plot_all, Plot_rate

Reference_surface

Integer

default : 1

Flag to set whether the initial surface (reference_surface = 1) or an arbitrary surface at z=0 is used to compute the depth to the various stratigraphic layers used to introduce variations in erosion parameters kf and kd

Related Glossary Terms

Strati_fn, strati_fdn, strati_topn, strati_bottomn

Index

Find Term

Restart

integer

default = 0

restart flag. When restart = 1, FastScape continues a previous run by reading its initial topography, basement topography, total erosion and total flexure from a file named RESTART stored in the run directory.

Beware that the RESTART file is overwritten every time FastScape saves an output (i.e. every nfreq time step, even if it is not the final time step). This allows to restart jobs that have been interrupted by a system crash or a power shutdown.

restart can also take negative values (-1 to -4) in which case, FastScape will read its initial topography from an external binary file (typically a DEM such as a SRTM file). Various format are permitted.

Termes connexes du glossaire

Base_level, Convert, DEM, Nfreq

Index Find Term

Rhoaflex

double precision

default : 3300 (kg per cubic meter)

Asthenospheric density used for the isostatic flexural calculations

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Termes connexes du glossaire

Flexure, Meanflex, Pratio, Rhocflex, Thickflex, Ym

Rhocflex

double precision

default : 2750 (kg per cubic meter)

Crustal density used for the isostatic flexural calculations

Termes connexes du glossaire

Flexure, Granite_drhoi, Meanflex, Pratio, Rhoaflex, Thickflex, Ym

---

Index Find Term

Rock_uplift_min and rock_uplift_max

double precision

default: -9 and -3

Range used to compute the rock uplift image (.bmp) files. Note that the logarithm (in base 10) is plotted.

These values are not used and the range is dynamically adjusted if plot_rock_uplift=-1.

Related Glossary Terms

Plot_all, Plot_rock_uplift

Index Find Term

Chapitre 15 - Controlling Output

Sc

double precision

default: -1

Critical angle of repose in degrees. If larger than 0, topographic height of each point of the landscape is compared to that of its receiver node and modify so that it does not allow for slopes that are larger than **Sc**

Related Glossary Terms

DSc

Index Find Term

Chapitre 6 - Erosion Laws

Sea_level

double precision

default : 0

Height (in meters) of «sea level», i.e. below which the erosion law is not applied.

Termes connexes du glossaire

Law

Sedim_min and sedim_max

double precision

default: 0, topo_max

Range used to compute the sediment thickness image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_sedim=-1.

Termes connexes du glossaire

Plot_all, Plot_sedim

Slope_min and slope_max

double precision

default: 0, 60

Range used to compute the slope image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_slope=-1.

Termes connexes du glossaire

Plot_slope

Steepnessindex_min and steepnessindex_max

double precision

default: 0, 1e4

Range used to compute the steepness index image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_steepnessindex=-1.

Termes connexes du glossaire

Plot_steepnessindex

Strati_fn, strati_fdn, strati_topn, strati_bottomn

double precision

default: 1, 1, 0, 0

A series of four values used to define a stratigraphy, i.e. variation of the rock erodibility with depth. The code will check whether the total erosion at any given point fits between each pair of strati_top*n* and strati_bottom*n*, in which case the kf factor will be multiplied by strati_f*n* and kd will be multiplied by strati_fdn. This means that the stratigraphy is assumed to be parallel to the top surface at the start of the run.

Termes connexes du glossaire

Law, Reference_surface

Thickflex

double precision

default : 20e3 m (20 km)

Effective elastic thickness used for the isostatic flexural calculations

Termes connexes du glossaire

Flexure, Meanflex, Pratio, Rhoaflex, Rhocflex, Ym

Index Find Term

Chapitre 11 - Flexure

Tmin_age,tmax_age

double precision

default: 0, 1350

Surface and basal temperature boundary conditions (in ºC) used in the solution of the heat equation to compute ages. tmax_age is imposed at a depth L_age.

Related Glossary Terms

L_age, Nage

Index Find Term

Chapitre 14 - Thermochron

Tol

double precision

default: 1e-6 m

Tolerance used in the Newton-Raphson scheme used to integrate the evolution equation in the case of an implicit implementation and a non-linear slope dependence of the erosion law (law≠1).

It is only used when nk=0 and law=2

Termes connexes du glossaire

Alpha, Law, N, Nk

Index Find Term

Chapitre 6 - Erosion Laws

Topo_min and topo_max

double precision

default: 0, 1000 m

Range used to compute the topography image (.bmp) files.

These values are not used and the range is dynamically adjusted if plot_topo=-1.

Termes connexes du glossaire

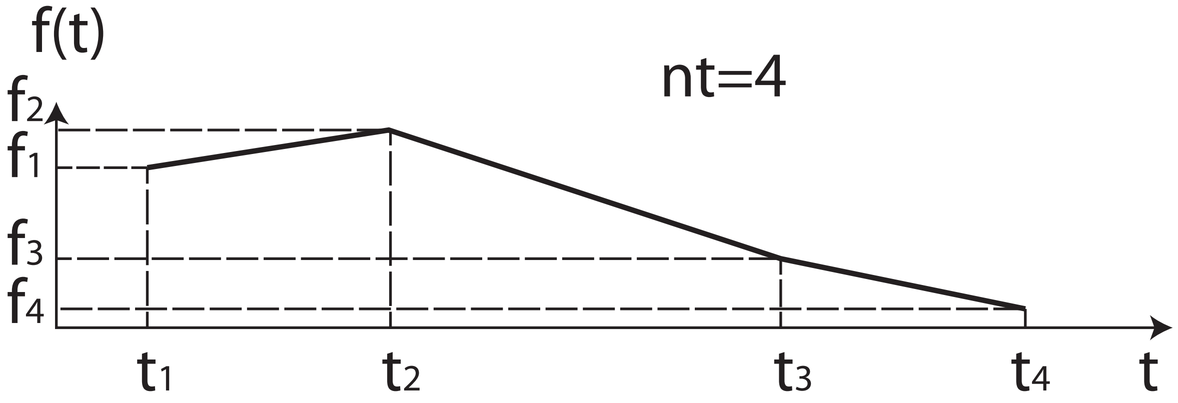
Plot_all, Plot_topo

Uplift_f1 to uplift_f9

double precision

default : 1,...,1

Used to define a time function that will multiply the uplift function obtained by interpolation (uplift_n=0 to 2).



The time function is obtained for all time t, by simple linear interpolation between set values and times given by uplift_f1 to uplift_f9 and uplift_t1 to uplift_t9

This is not used when the uplift is specified through a user-supplied ForTran code.

Termes connexes du glossaire

Uplift_n, Uplift_nt, Uplift_t1 to uplift_t9, Uplift_v1 to uplift_v16, Uplift.f90

Index Find Term

Chapitre 7 - Uplift Rate

Uplift_min and uplift_max

double precision

default: -9 and -3

Range used to compute the surface uplift image (.bmp) files. Note that the logarithm (in base 10) is plotted.

These values are not used and the range is dynamically adjusted if plot_uplift=-1.

Related Glossary Terms

Plot_all, Plot_uplift

Index Find Term

Chapitre 15 - Controlling Output

Uplift_n

integer

default : 0

Interpolation level used to build the uplift function.

uplift_n = 0 : uniform value (uplift_v1 is used)

uplift_n = 1 : bilinear function (uplift_v1 to v4 are used)

uplift_n = 2 : 4 bi-linear function (uplift_v1 to v16 are used)

This is not used when the uplift is specified through a user-supplied ForTran code.

Termes connexes du glossaire

Uplift_f1 to uplift_f9, Uplift_nt, Uplift_t1 to uplift_t9, Uplift_v1 to uplift_v16, Uplift.f90

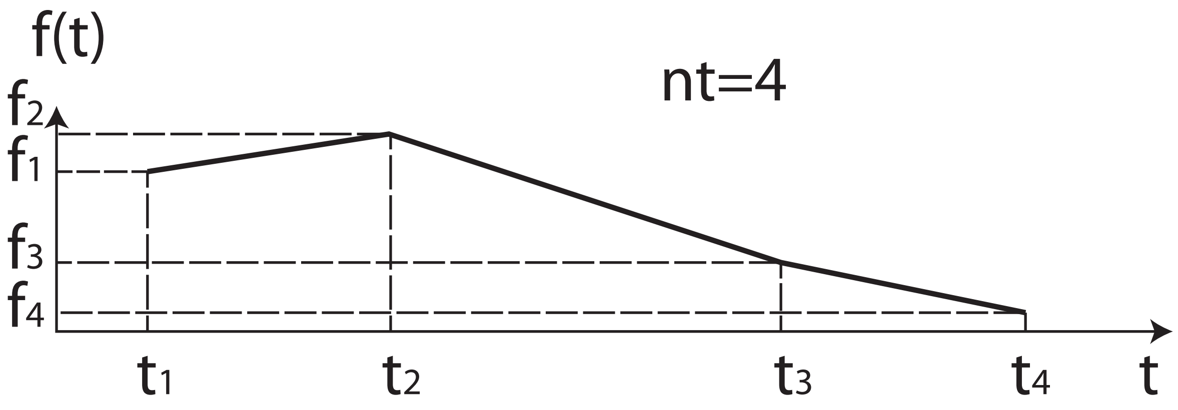
Index Find Term

Uplift_nt

integer

default : 0

Number of points used to define the time function that multiplies the uplift function when it is built by interpolation.



This is not used when the uplift is specified through a user-supplied ForTran code.

When uplift_n is not specified, the time function is constant and =1

Termes connexes du glossaire

Uplift_f1 to uplift_f9, Uplift_n, Uplift_t1 to uplift_t9, Uplift_v1 to uplift_v16, Uplift.f90

Index Find Term

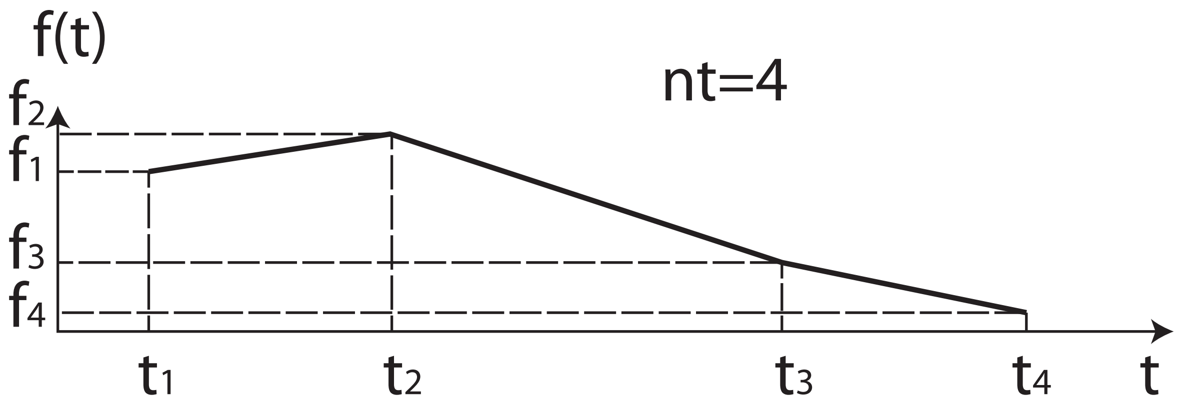
Chapitre 7 - Uplift Rate

Uplift_t1 to uplift_t9

double precision

default : 0,...,0

Used to define a time function that will multiply the uplift function obtained by interpolation (uplift_n=0 to 2).



The time function is obtained for all time t, by simple linear interpolation between set values and times given by uplift_f1 to uplift_f9 and uplift_t1 to uplift_t9

This is not used when the uplift is specified through a user-supplied ForTran code.

Termes connexes du glossaire

Uplift_f1 to uplift_f9, Uplift_n, Uplift_nt, Uplift_v1 to uplift_v16, Uplift.f90

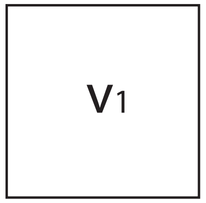
Index Find Term

Chapitre 7 - Uplift Rate

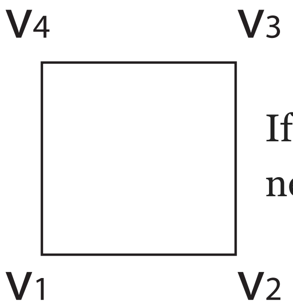
Uplift_v1 to uplift_v16

double precision

default: 0,...,0

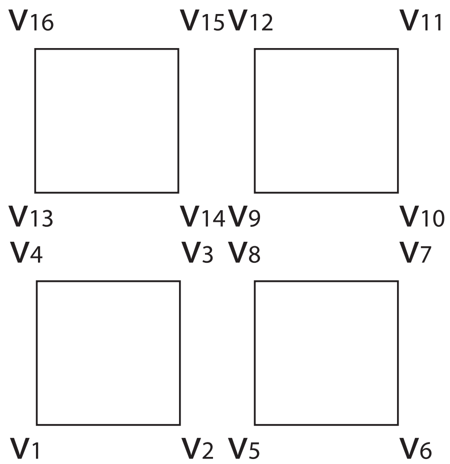


If uplift_n = 0, uplift_v1 needs to be specified to set the uniform uplift.



If uplift_n = 1, only uplift_v1 to v4 need to be specified to set the bilinear uplift:

If uplift_n = 2, uplift_v1 to uplift_v16 need to be specified to set the quad-bilinear uplift:



Termes connexes du glossaire

Uplift_f1 to uplift_f9, Uplift_n, Uplift_nt, Uplift_t1 to uplift_t9, Uplift.f90

Index Find Term

Uplift.f90

Expert mode only

This function is built from the two sections of code stored in uplift_start and init_stop and a third section potentially provided by the user in the input file and sandwiched between the two lines:

!/uplift_start/

!/uplift_stop/

The code should be written in ForTran90 using a fixed set of variables: x, y, time, xl, yl, nx, ny, dx, dy and working variables w0 to w9 (double precision) and i0 to i9 (integer). It should return a variable named uplift that contains the function uplift(x,y,time) in m/yr. Example:

w1=1.d-5

*uplift=w1*x/xl*

Termes connexes du glossaire

Uplift_f1 to uplift_f9, Uplift_n, Uplift_nt, Uplift_t1 to uplift_t9, Uplift_v1 to uplift_v16

Index Find Term

Vex

double precision

default : 2

Vertical exaggeration applied to the topography to compute the grey shading of the (.bmp) image files and the 3D perspective of the vtk files.

Termes connexes du glossaire

Plot_all, Plot_topo

Index Find Term

Chapitre 15 - Controlling Output

Vtk

integer

default: 0

Flag to force FastScape to create vtk files in addition to the bmp image files.

VTK files can be visualized using third party software such as paraview (http://www.paraview.org/) or mayavi (http://mayavi.sourceforge.net/).

Such files contain information to build the modeled landform as a 3D object that can be visualized interactively. The fields that have been activated (plot_...) appear as fields that can be superimposed onto the 3D object.

Termes connexes du glossaire

Nfreq, Plot_all, Plot_catchment, Plot_discharge, Plot_erosion, Plot_precipitation, Plot_rate, Plot_rock_uplift, Plot_sedim, Plot_topo, Plot_uplift

---

Index Find Term

Chapitre 15 - Controlling Output

Xl,yl

double precision

default : 100e3, 100e3 (100 km X 100 km)

Size in meters of the integration domain in the x- and y-direction respectively.

Termes connexes du glossaire

Nx,ny

Index Find Term

Chapitre 5 - General Setup

Ym

double precision

default : 1e11 (Pa)

Young modulus used for the isostatic flexural calculations

Termes connexes du glossaire

Flexure, Meanflex, Pratio, Rhoaflex, Rhocflex, Thickflex

Index Find Term

Chapitre 11 - Flexure

Zcond_age

double precision

default: 35 10^3

Depth (in m) over which the conductivity multiplying factor cond_age is used in the solution of the heat equation to compute ages.

Related Glossary Terms

Cond_age, Nage

Index Find Term

Chapitre 14 - Thermochron

Zheat_age

double precision

default: 35 10^3

Depth (in m) over which the radiogenic heat production heat_age is applied in the solution of the heat equation to compute ages.

Related Glossary Terms

Heat_age, Nage

Index Find Term

Chapitre 14 - Thermochron