BBGCDB tutorial

First steps

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Abstract

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This tutorial introduces the first steps that are needed to run the Biome-BGCMuSo ecosystem model (and also its predecessor, Biome-BGC) using **The Biome-BGC Projects Database & Management System** (in brief, BBGCDB) and the **BioVeL Portal**.

Model execution is based on the so-called workflow technology [specifically, the Taverna workflow] but this is not important from the point of view of practical application of the model. All you need to know is that the model is executed in a distributed hardware/software environment, where everything happens in computers in the "cloud" (i.e. the computational resources of your computer are not used). **All you need to have is a web browser** (we recommend Mozilla Firefox or Google Chrome). No further software are needed (MS Excel is recommended to quickly visualize model results).

Prior to working with the BBGCDB the User should read the User's Guide for Biome-BGC (or Biome-BGCMuSo, depending on the model to be used).

What do you need to start the work?

Two files are needed for the first simulation (in the simplest case):

1. Meteorology input file
2. Ecophysiological parameters file (EPC)

First, download the two files from this link [zipped]:

http://nimbus.elte.hu/bbgc/tutorial/input.zip

Both are pure text files, which can be edited by any text editor (we recommend to use a text editor that can handle both UNIX and Windows style text files. Under MS Windows we recommend the use of Editpad Lite, which is a great and simple text editor: http://www.editpadlite.com/)

Outlook

Once you will get familiar with the model, creation of both the meteorology and the EPC file will be straightforward. For the time being, let's use these existing files.

A separate tutorial will be available to help the construction of the meteorology input file using the MT-CLIM software.

Note that for Central-Europe the FORESEE database provides all data that is needed to run MT-CLIM:

http://nimbus.elte.hu/FORESEE/map_query/index.html

First steps

In order to manage model simulations in a repeatable and organized way **The Biome-BGC Projects Database & Management System** (BBGCDB) is used:

http://ecos.okologia.mta.hu/bbgcdb/

First, please contact us to **get an account**:

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Ferenc HORVÁTH : horvath.ferenc@okologia.mta.hu

Zoltán BARCZA: zoltan.barcza@ttk.elte.hu

Preparation and uploading input datasets and parameter settings

The first step is the **creation of the LOCATION** for the simulation. The meteorology file will be associated with the **LOCATION**, and the simulation will be also associated with the **LOCATION**.

The study location has to be created only once per site.

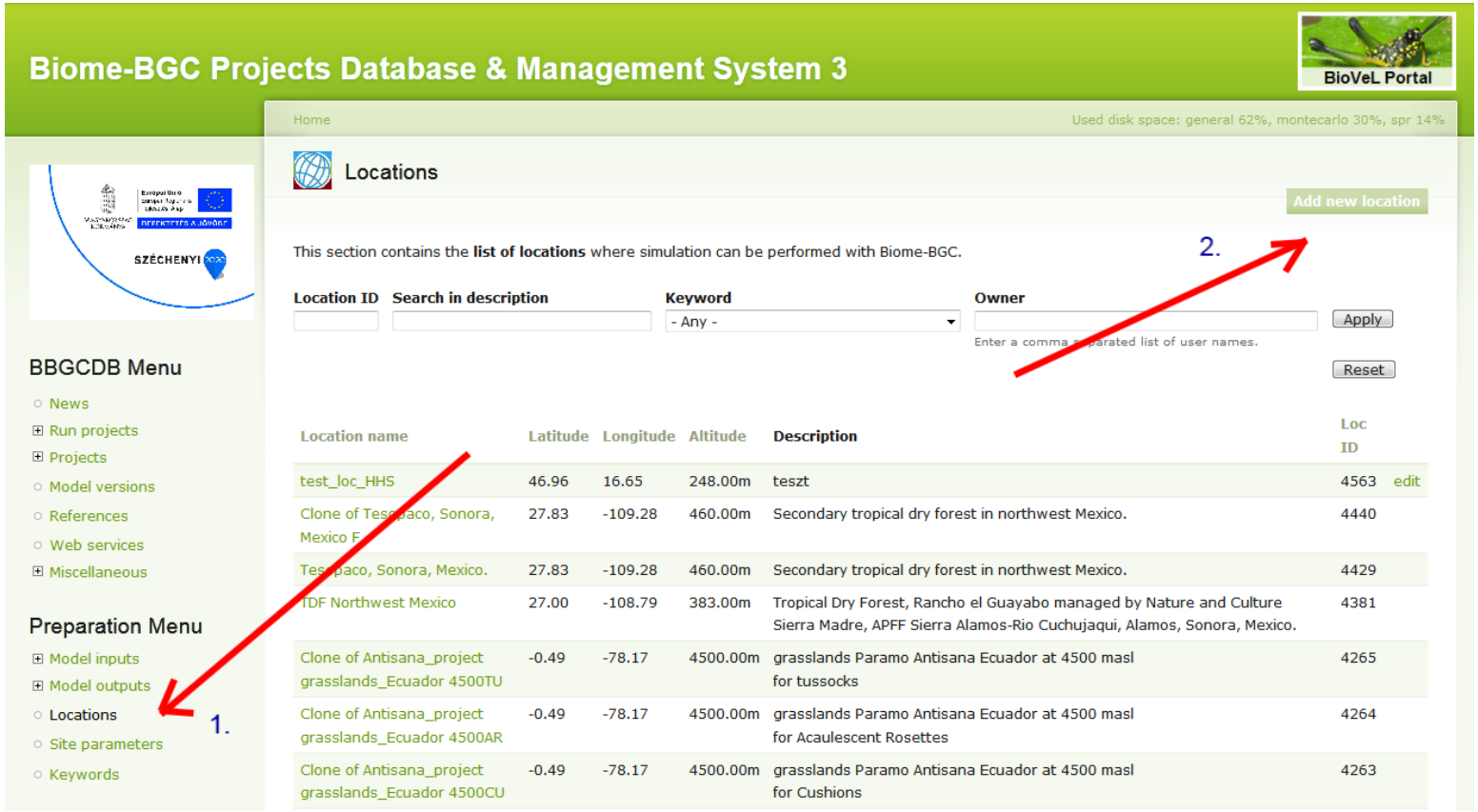
All associated projects (Monte-Carlo Experiment, Sensitivity Analysis) are focusing on a predefined location.

Let’s open the BBGCDB portal at

http://ecos.okologia.mta.hu/bbgcdb/

Preparation and uploading input datasets and parameter settings

At the BBGCDB portal, go to
Preparation Menu → Locations
and there choose '**Add new location**'.



Preparation and uploading input datasets and parameter settings

Fill in the form. Providing the location name is mandatory. List of existing locations can be retrieved by clicking on **Preparation Menu → Locations**. These existing locations are useful to check the content that needs to be provided.

Note that the form needs '**Effective soil depth**' as input. Biome-BGCMuSo does not use this data, but it is still needed as the original Biome-BGC uses it (which is still accessible via BBGCDB).

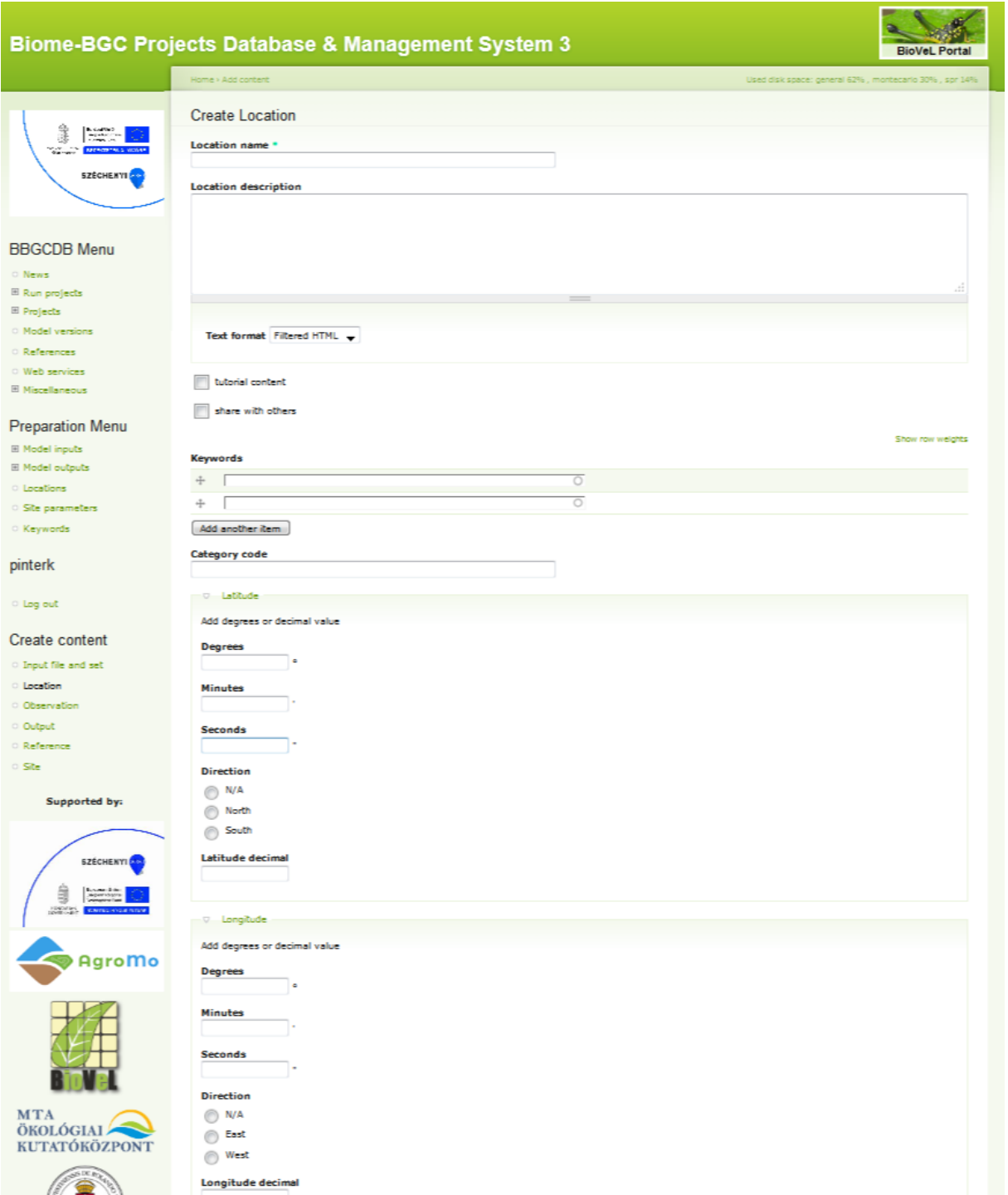
Preparation and uploading input datasets and parameter settings

Runoff parameter and soil moisture related cells can be left blank. In this case the model will estimate them internally.

Note that soil moisture related parameters should be handled jointly: all fields should be defined by the user OR all fields should be set to fill value to protect consistency of the data.

There are many optional input information (keywords, revisioning, authoring) which can be neglected at this time.

Once finished, save the form. The data can be modified later.



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Example complete location info

In this example we call the site as ‘Tutorial location’.

See the zoomed version of this page on the next five slides.

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BBGCDB Menu
- News
- Run projects
- Projects
- Model versions
- References
- Web services
- Miscellaneous

Preparation Menu
- Model inputs
- Model outputs
- Locations
- Site parameters
- Keywords

pinterk
- Log out

Create content
- Input file and set
- Location
- Observation
- Output
- Reference
- Site

Supported by:

Create Location

Location name *
Tutorial_Hegyhatsal

Location description
Demo location for

This name is only an example, please use a **different name**.

The **„Location description”** can be provided in **„plain text”** or in **„filtered html”** where the following HTML tags are accepted: <a>   <cite> <blockquote> <code>   <dl> <dt> <dd>.

Text format Filtered HTML

tutorial content

share with others

Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!

Use this option if the site is meant to be public.

Keywords

Add another item

Category code

Not used for single runs.

Latitude

Add degrees or decimal value

Degrees °

Minutes '

Seconds "

Direction
- N/A
- North
- South

Latitude decimal
46.96

Give the coordinates in DMS or in decimal degrees, indicate the direction in both cases.

Longitude

Add degrees or decimal value

Degrees
°

Minutes
'

Seconds
"

Direction
- ○ N/A
- ◉ East
- ○ West

Longitude decimal
16.65

Give the coordinates in DMS or in decimal degrees, indicate the direction in both cases.

Altitude *
248 m

Default site parameters

effective soil depth (corrected for rock fraction) *
0.5 m

Note that the form needs '**Effective soil depth**' as input. Biome-BGCMuSo does not use this data, but it is still needed as the original Biome-BGC uses it (which is still accessible via BBGCDB).

sand percentage by volume in rock-free soil *
30 %
Used in model version 4.1.1.

silt percentage by volume in rock-free soil *
50 %
Used in model version 4.1.1.

shortwave albedo *
0.2 DIM

wet+dry atmospheric deposition of N *
0.0002 kgN/m2/yr

symbiotic+asymbiotic fixation of N *
0.0005 kgN/m2/yr

Default site parameters for MuSo

mean annual air temperature *
9 Celsius

mean annual air temperature range *
20 Celsius

measured runoff curve number

Biome-BGCMuSo v4 uses a seven-layer soil submodel. The thickness of the layers is fixed: 0-10 cm, 10-30 cm, 30-60 cm, 60-100 cm, 100-200 cm, 200-300 cm and 300-1000 cm. The thickness of bottom (7th, inactive) layer is defined to be 7 m, which is only important for technical reasons (water movement calculations use finite differences method, so for calculating the gradients we need to specify the distance of layers). The depth of each soil layer is represented by the middle level of the given layer (e.g. the thicknesses of the top soil layer is 0.1 m, therefore it is represented at 0.05 m).

Show row weights

sand percentage by volume in rock-free soil

	%
	%
	%
	%
	%
	%
	%

Show row weights

silt percentage by volume in rock-free soil

	%
	%
	%
	%
	%
	%
	%

Show row weights

bulk density

	g/cm3
	g/cm3
	g/cm3
	g/cm3
	g/cm3
	g/cm3
	g/cm3

Show row weights

SWC at SAT

	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3

Show row weights

SWC at FC

	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3

Show row weights

SWC at WP

	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3

Show row weights

SWC at HW

	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3
	m3/m3

Location link

Title

URL

The link title is limited to 128 characters maximum.

Location contact

Save

After the data input, save the location.

Preparation and uploading input datasets and parameter settings

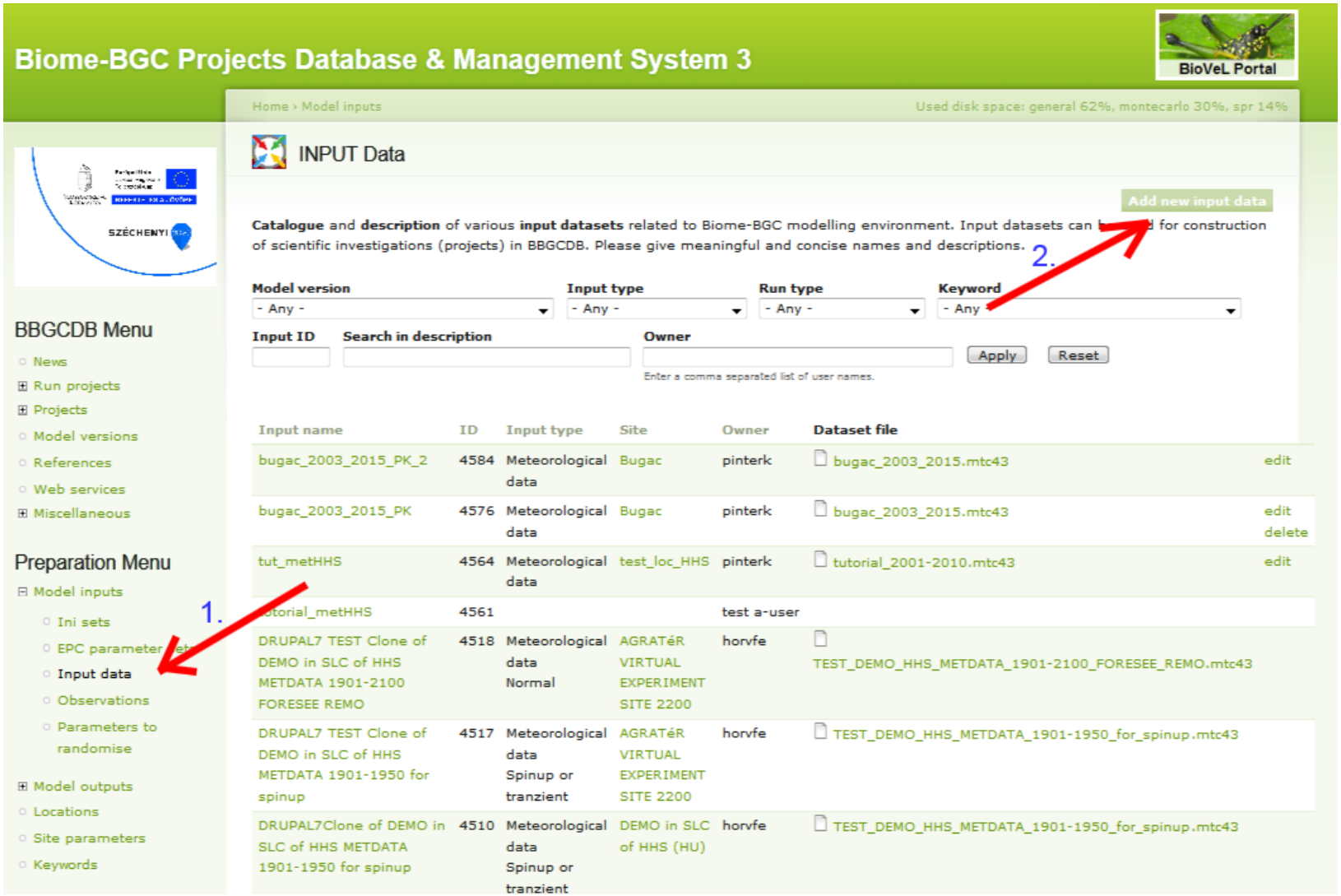
(Outlook: default site parameters can be redefined later by defining new ‘Site parameters’ that refer to a predefined location. Geographical coordinates and altitude can not be changed.)

Now as the location is defined, we can **upload the meteorology file**.

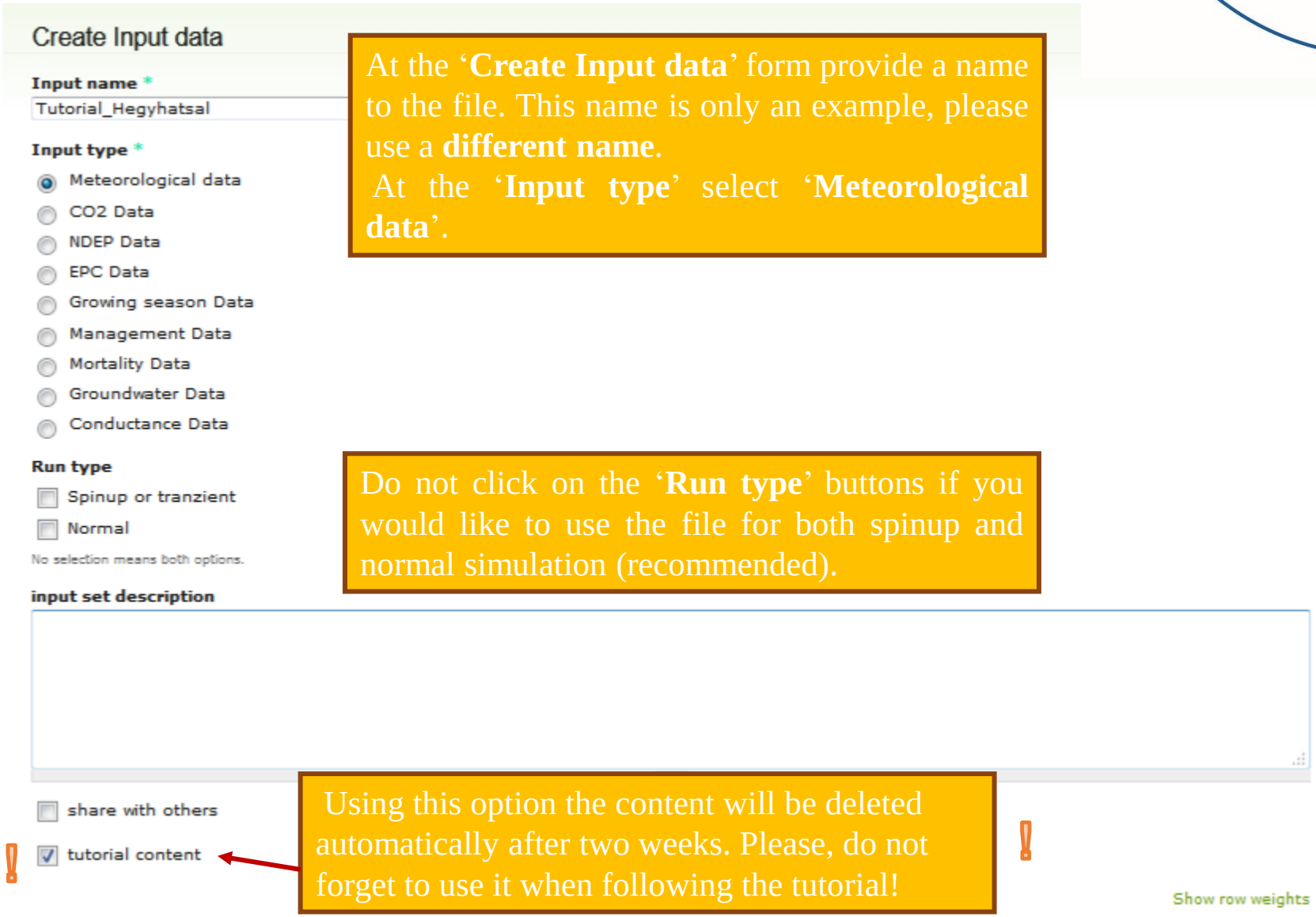
This can be done in
Preparation Menu → Model inputs → Input data
with clicking on ‘**Add new input data**’

(see next slide)

Preparation and uploading input datasets and parameter settings



Preparation and uploading input datasets and parameter settings



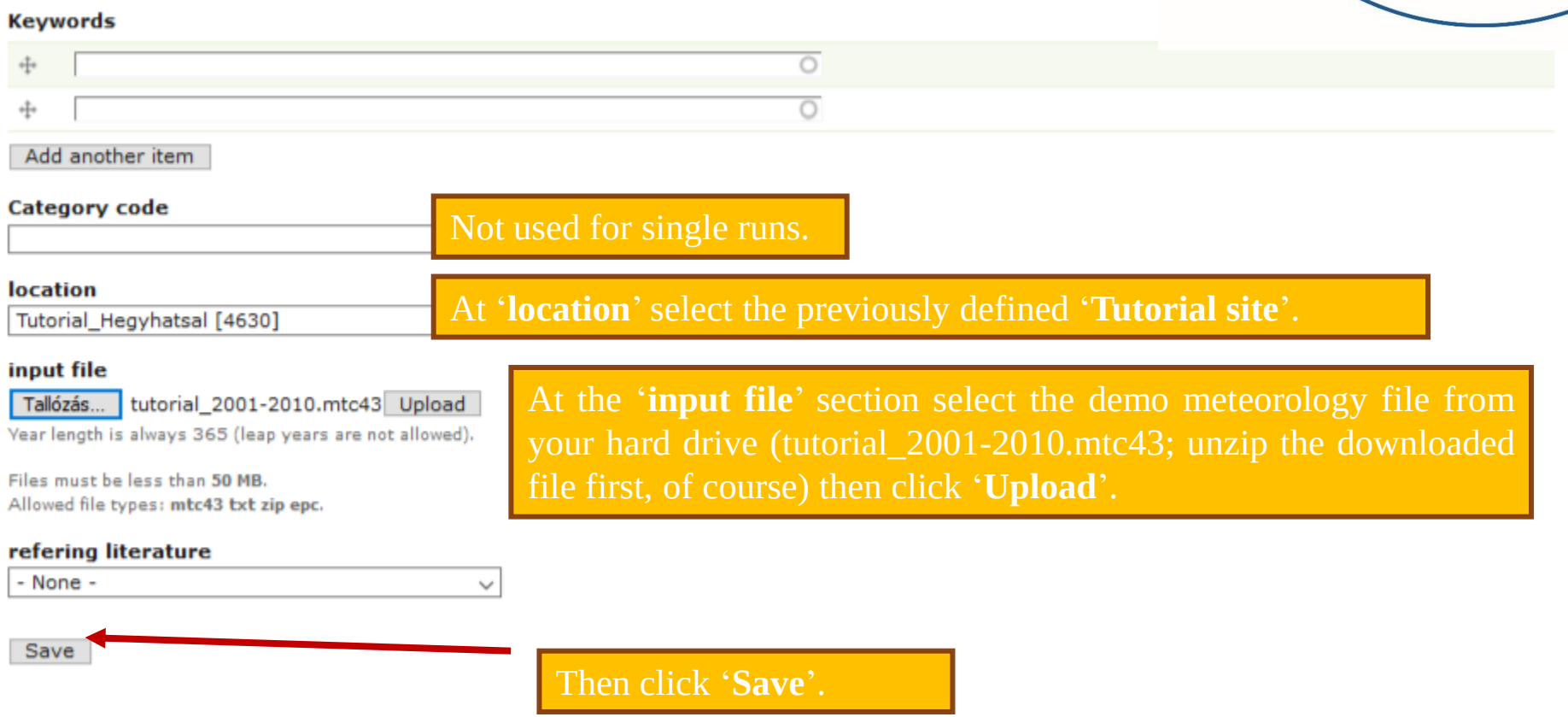
At the '**Create Input data**' form provide a name to the file. This name is only an example, please use a **different name**.

At the '**Input type**' select '**Meteorological data**'.

Do not click on the '**Run type**' buttons if you would like to use the file for both spinup and normal simulation (recommended).

Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!

- Preparation and uploading input datasets and parameter settings

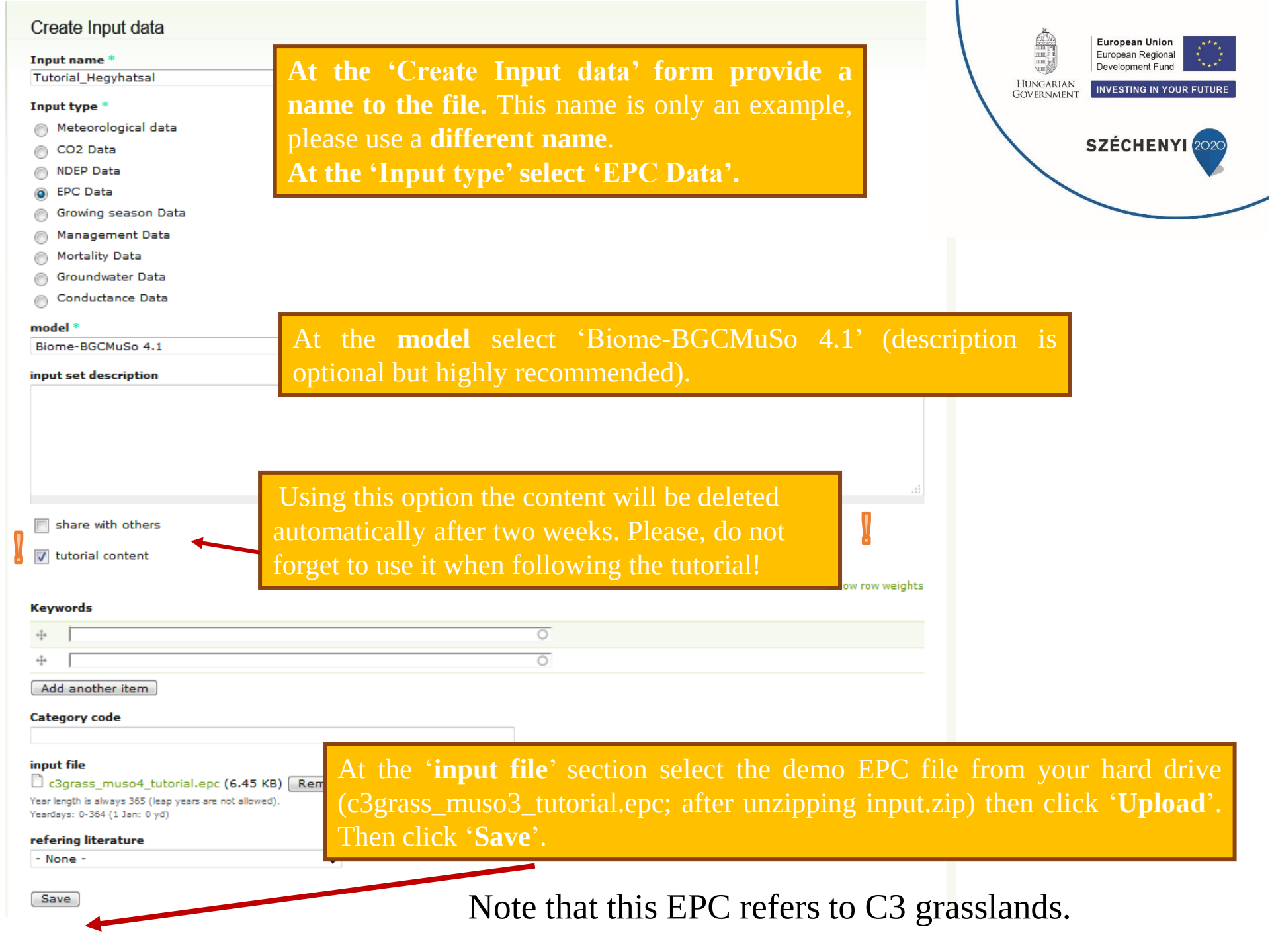


Preparation and uploading input datasets and parameter settings

Now we have a location with meteorology (the latter is called as ‘Tutorial meteorology’ in this document).

Now the ecophysiological parameters have to be supplied.

This can be done once again in
Preparation Menu → Model inputs → Input data
with clicking on ‘**Add new input data**’.


Create Input data
Input name *
Tutorial_Hegyhatsal
Input type *
Meteorological data
CO2 Data
NDEP Data
EPC Data
Growing season Data
Management Data
Mortality Data
Groundwater Data
Conductance Data
model *
Biome-BGCMuSo 4.1
input set description
share with others
tutorial content
Keywords
Add another item
Category code
input file
c3grass_muso4_tutorial.epc (6.45 KB)
Year length is always 365 (leap years are not allowed).
Yeardays: 0-364 (1 Jan: 0 yd)
refering literature
- None -
Save
At the 'Create Input data' form provide a name to the file. This name is only an example, please use a different name.
At the 'Input type' select 'EPC Data'.
At the model select 'Biome-BGCMuSo 4.1' (description is optional but highly recommended).
Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!
At the 'input file' section select the demo EPC file from your hard drive (c3grass_muso3_tutorial.epc; after unzipping input.zip) then click 'Upload'. Then click 'Save'.
Note that this EPC refers to C3 grasslands.

Preparing the simulation

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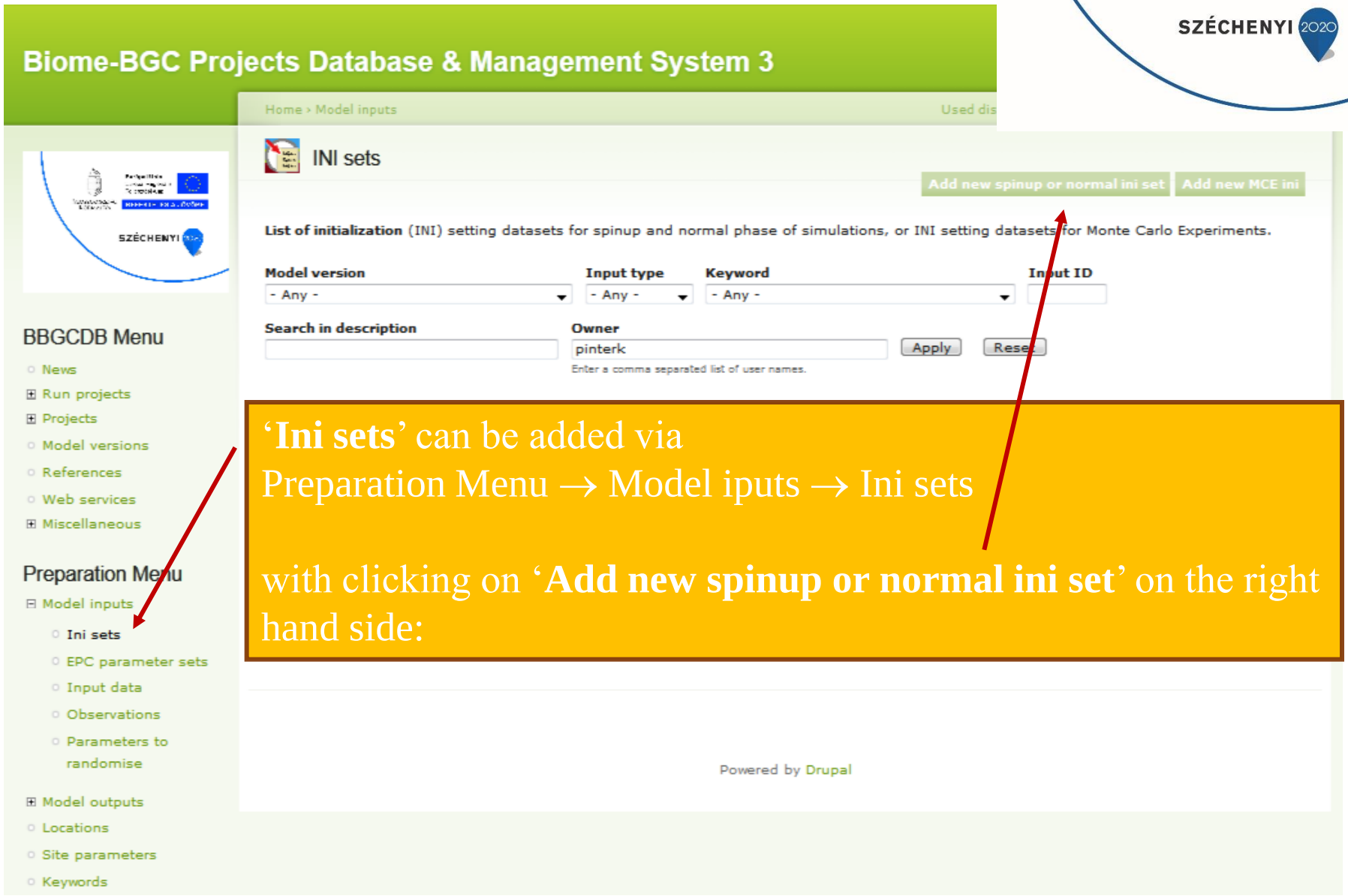
Now let's **prepare the model simulation**!

In terms of Biome-BGC, this means the creation of initialization files ('**Ini sets**' in BBGCDB) that control the spinup (self-initialization or equilibrium) and the consecutive normal run.

See the User's Guide of Biome-BGC for details!

Preparing the simulation



'**Ini sets**' can be added via
Preparation Menu → Model iputs → Ini sets

with clicking on '**Add new spinup or normal ini set**' on the right hand side:

Preparing the simulation

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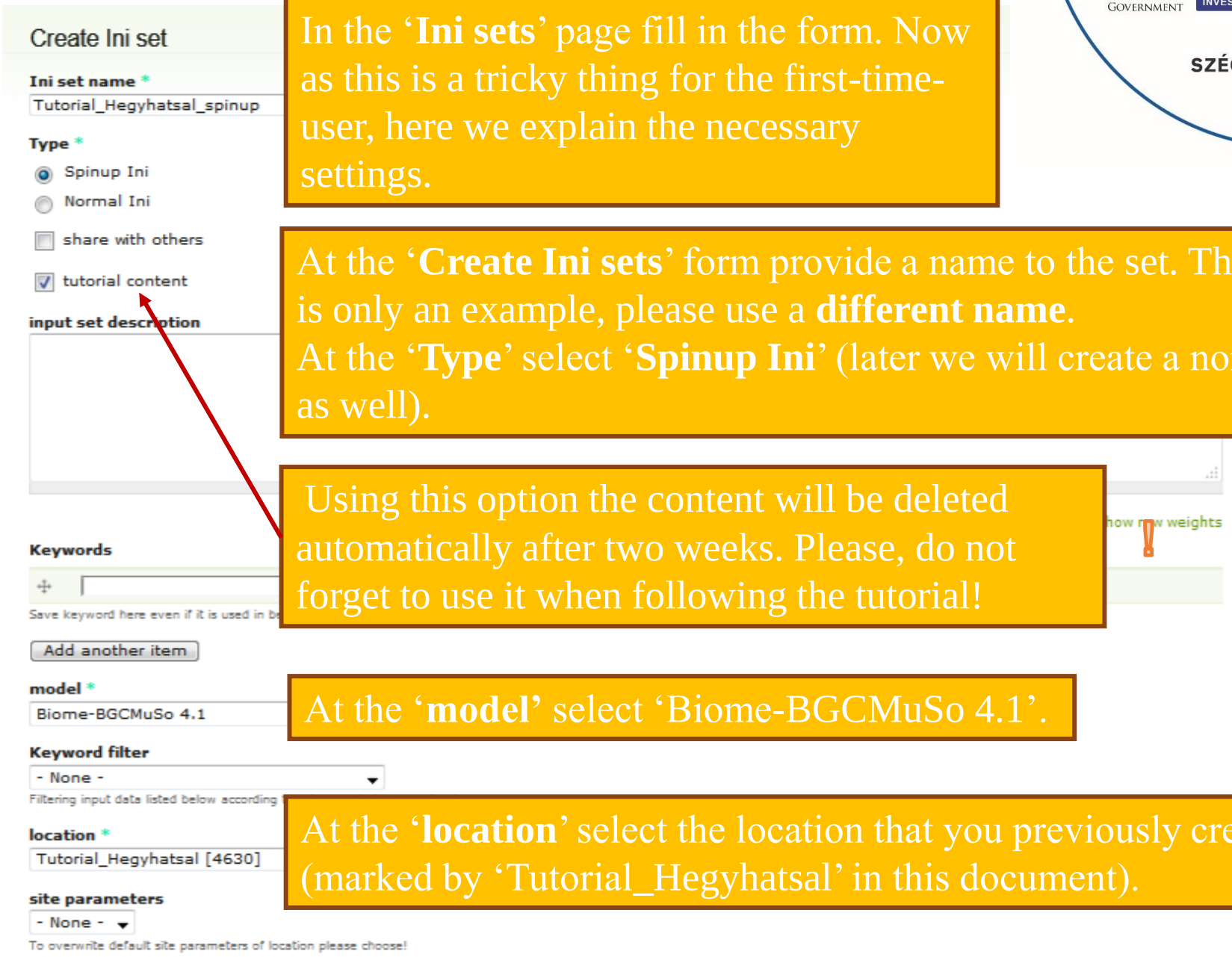


In the '**Ini sets**' page fill in the form. Now as this is a tricky thing for the first-time-user, here we explain the necessary settings.

At the '**Create Ini sets**' form provide a name to the set. This name is only an example, please use a **different name**.
At the '**Type**' select '**Spinup Ini**' (later we will create a normal ini as well).

Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!

At the '**model**' select 'Biome-BGCMuSo 4.1'.

At the '**location**' select the location that you previously created (marked by 'Tutorial_Hegyhatsal' in this document).

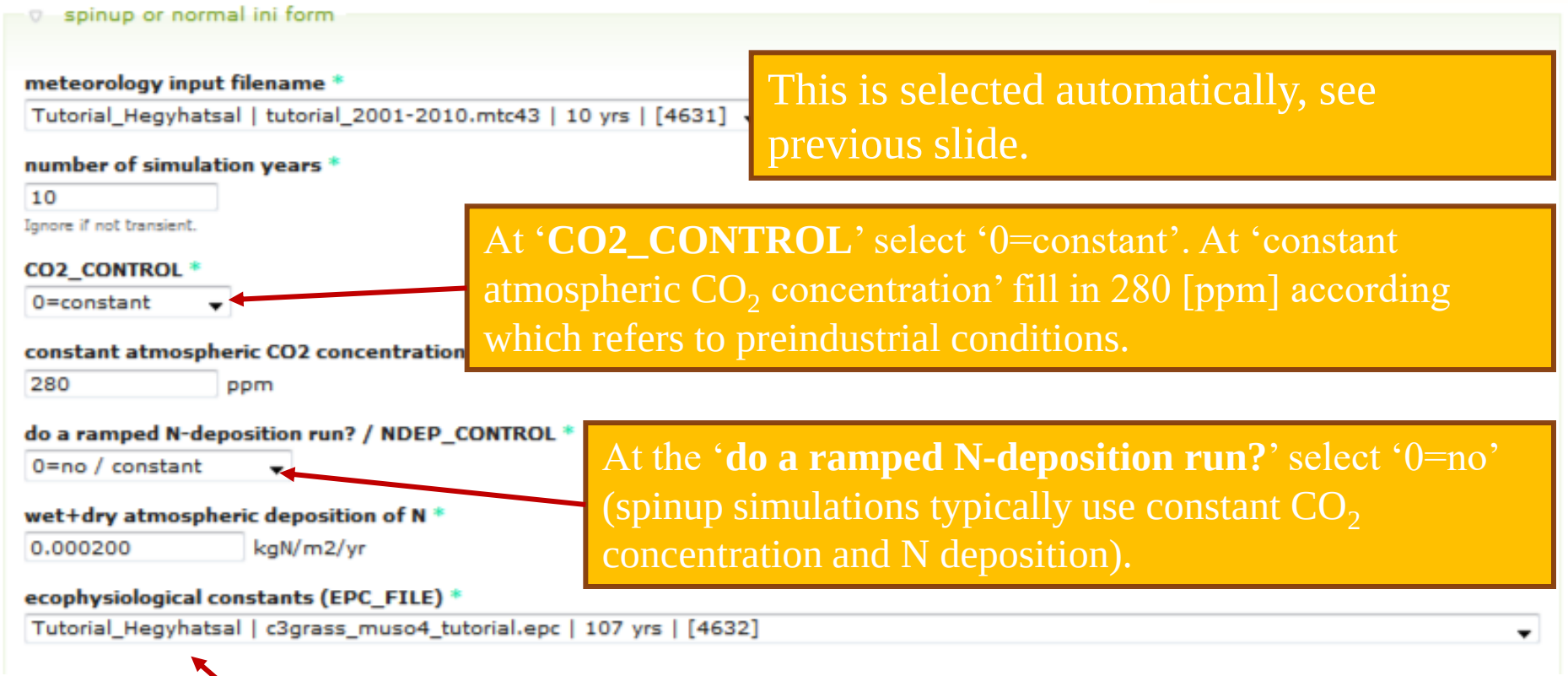
Preparing the simulation

Now let's move to the next big section called '**spinup or normal ini form**'.

In a typical situation Users have to select the meteorology file that he/she or somebody else uploaded previously. In this Tutorial the '**meteorology input filename**' is selected automatically, as BBGCDB related the location to the meteorology. So in our case 'Tutorial meteorology' should be selected.

Due to the intelligent data handling in BBGCDB the form 'knows' that we have 10 years of meteorology data. As we work on spinup simulation, the '**number of simulation years**' is in fact irrelevant, as the spinup meteorology is re-used by the model until equilibrium.

Preparing the simulation



This is selected automatically, see previous slide.

At '**CO2_CONTROL**' select '0=constant'. At 'constant atmospheric CO_2 concentration' fill in 280 [ppm] according which refers to preindustrial conditions.

At the '**do a ramped N-deposition run?**' select '0=no' (spinup simulations typically use constant CO_2 concentration and N deposition).

At the '**ecophysiological constants (EPC_FILE)**' select the EPC that was uploaded previously (we called it 'Tutorial EPC' in this document).

Preparing the simulation

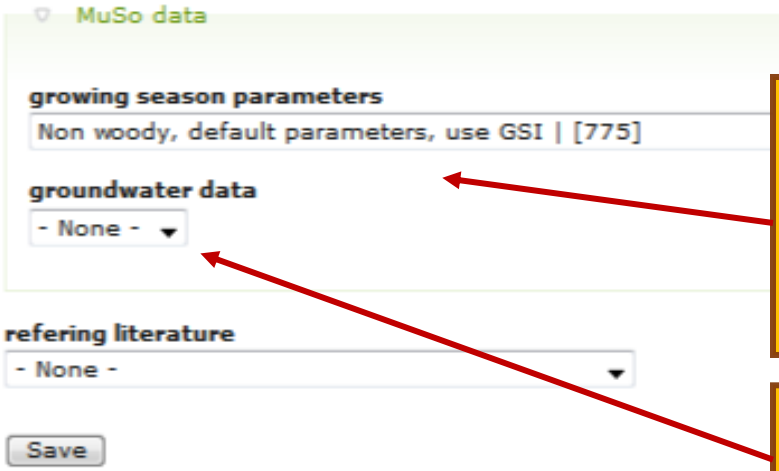
Outlook: within BBGCDB **location** and **site parameters** are handled separately. Basic site parameters are fixed (geographical location, altitude), while other site parameters (N deposition, soil properties) might be changed by defining site-specific data that belongs to the same location defined earlier. This can be done by

Preparation Menu → Site parameters → Add new site parameters.

During ini set construction alternative site parameters can be selected (not shown in this tutorial). Different N deposition during normal and spinup simulation is a typical reason for Site parameter definition.

Preparing the simulation

The next section is '**MuSo data**'. Here we can define 'growing season parameters'.
(outlook: this can be defined by the User under Preparation Menu → Model iputs → Input data → Add new input data, as 'Growing season data' as Input type).



Now select 'Non woody, default parameters, use GSI'. This setting refers to the HSGSI limits used in Hidy et al. (2012)* for grassland simulations.

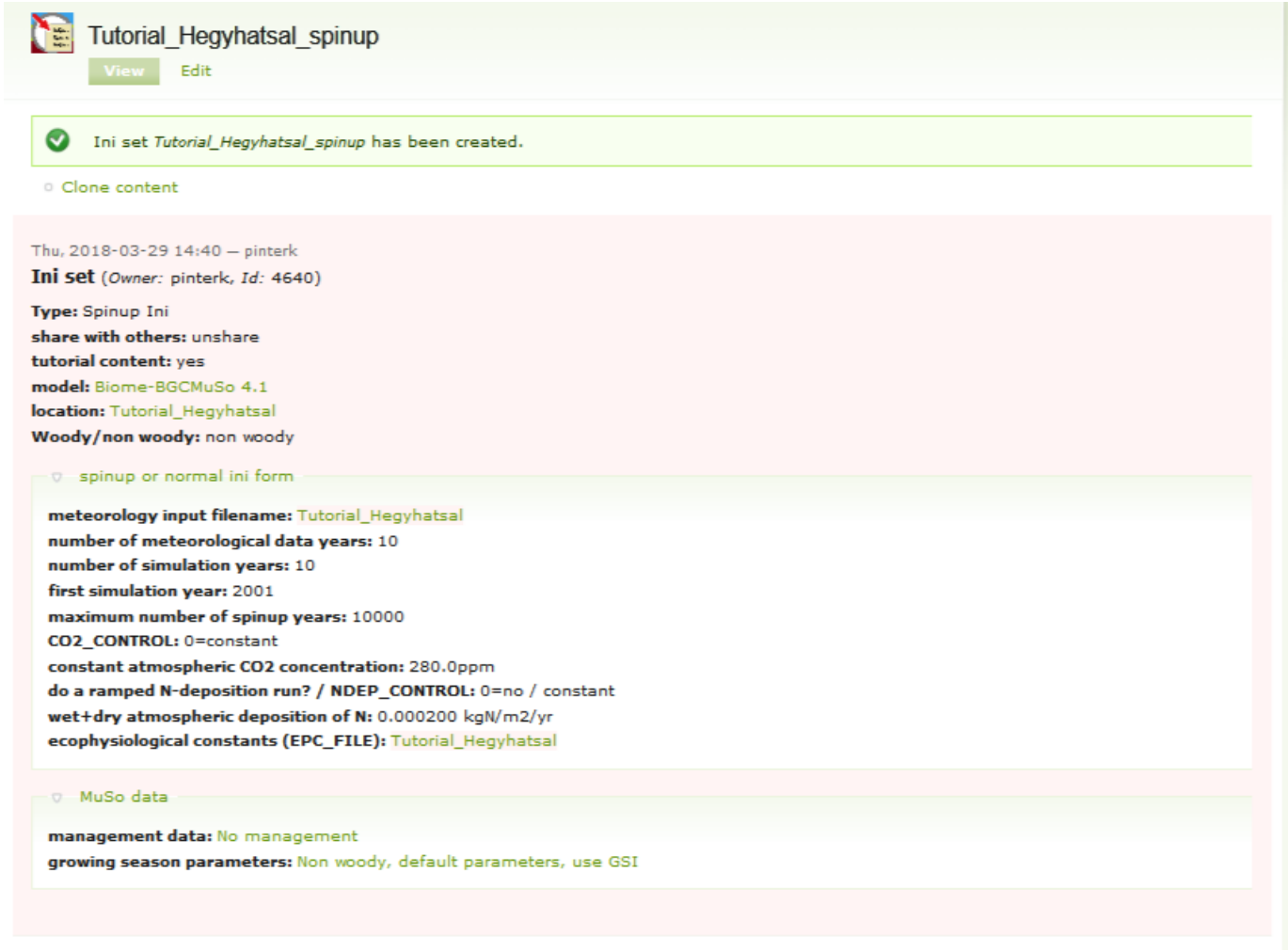
These settings control the phenological cycle. At 'groundwater data' select '-None-'.

Click „Save"

* doi:10.1016/j.ecolmodel.2011.11.008

Preparing the simulation

After saving the form, in the summary page review the settings.



Preparing the simulation

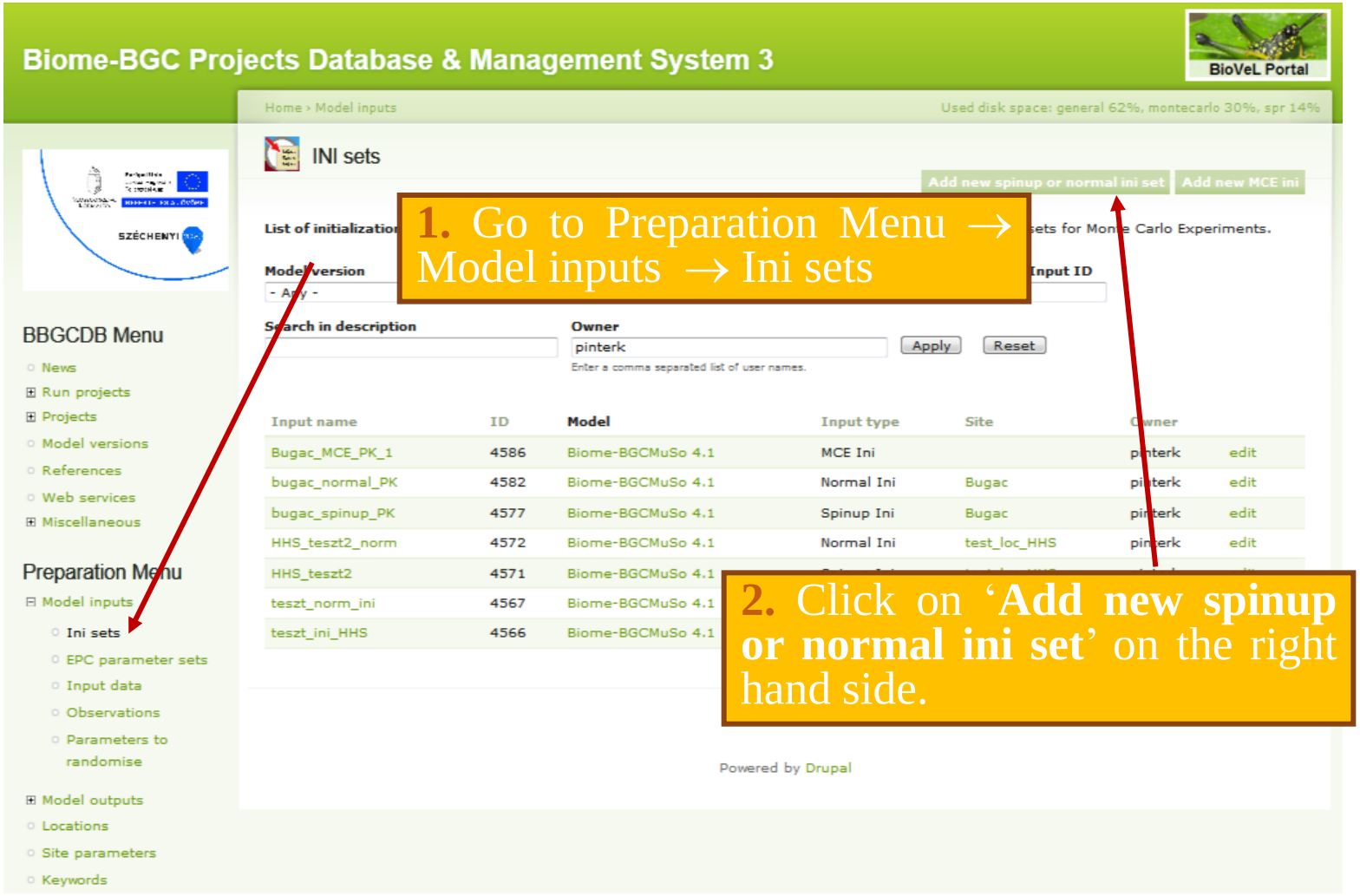
BBGCDB lists the first year of the meteorology file that was uploaded (2001 in this example). In our case this 10-years-long dataset is used for spinup, as we did not upload meteorological data for other time periods. This is a typical way for doing spinup, though we know that we provide meteorological data under changing climate.

Maximum number of spinup years means the maximum length of the equilibrium run. Equilibrium is typically found within 2-3000 years during the spinup.

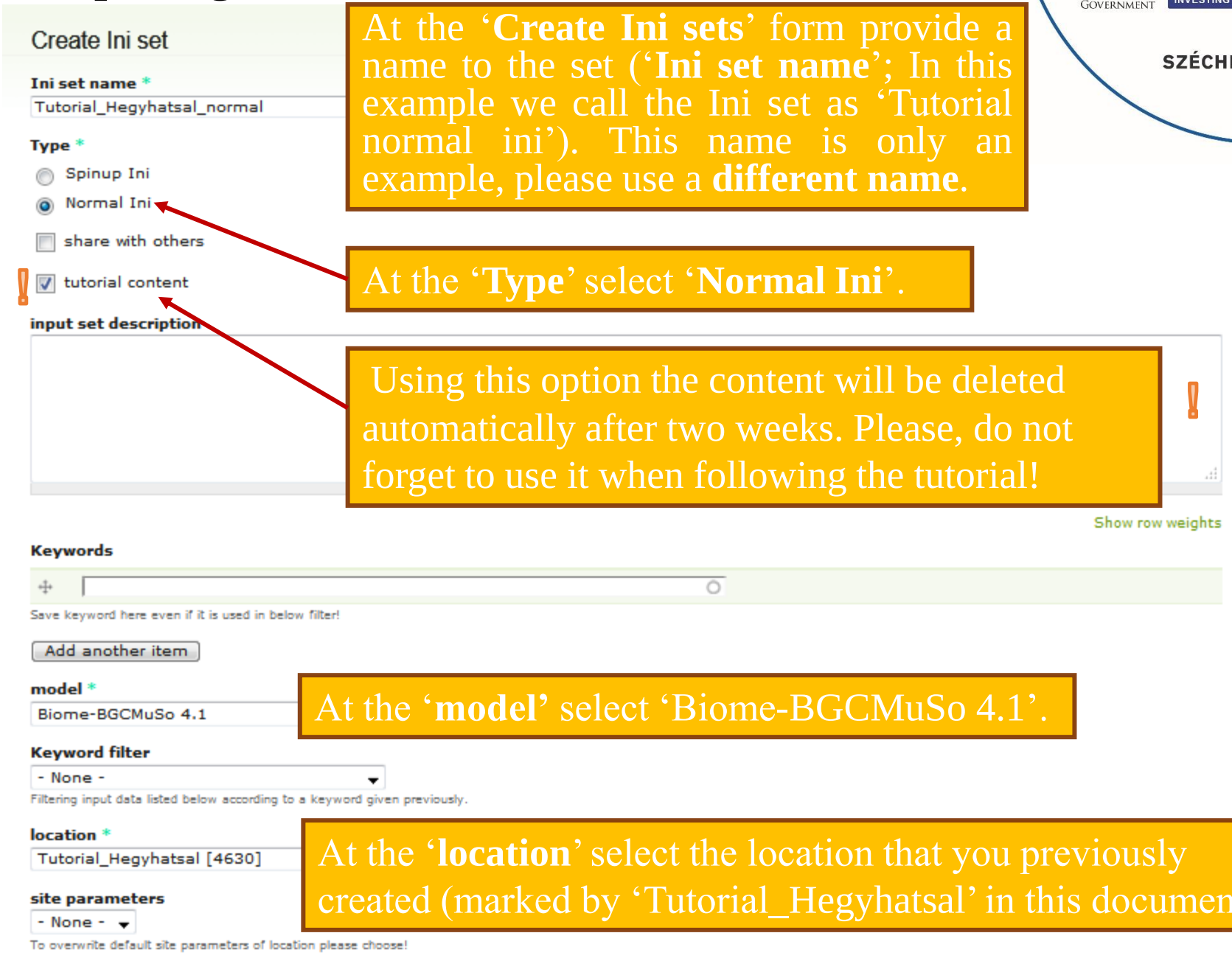
It is clear from the summary page that clay content of the soil is calculated as the residual of sand and silt.

Preparing the simulation

Now we have **to create another ini set**, which will control tl
normal simulation (this is what the User actually needs). Th
can be done in the same way as we did it for the Spinup ini.



Preparing the simulation



At the '**Create Ini sets**' form provide a name to the set ('**Ini set name**'; In this example we call the Ini set as 'Tutorial normal ini'). This name is only an example, please use a **different name**.

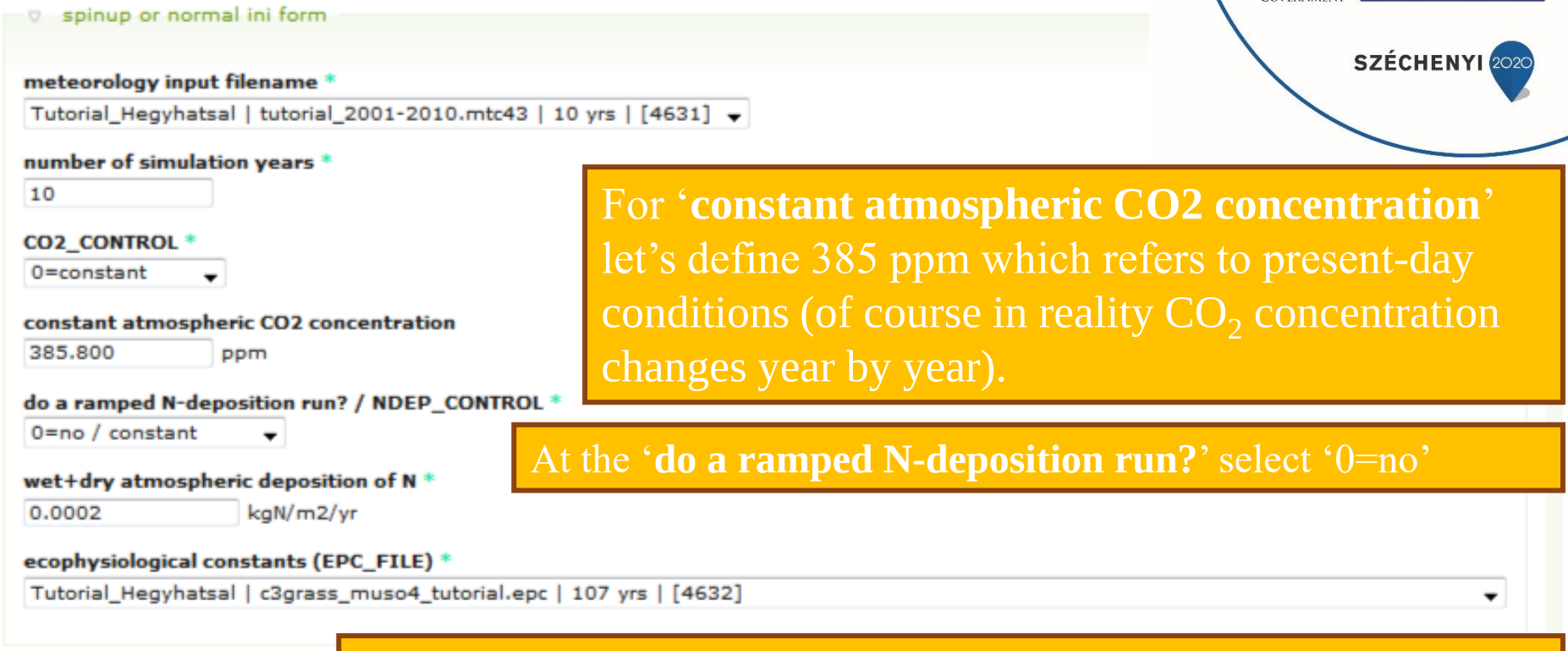
At the '**Type**' select '**Normal Ini**'.

Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!

At the '**model**' select 'Biome-BGCMuSo 4.1'.

At the '**location**' select the location that you previously created (marked by 'Tutorial_Hegyhatsal' in this document).

Preparing the simulation



For '**constant atmospheric CO2 concentration**' let's define 385 ppm which refers to present-day conditions (of course in reality CO_2 concentration changes year by year).

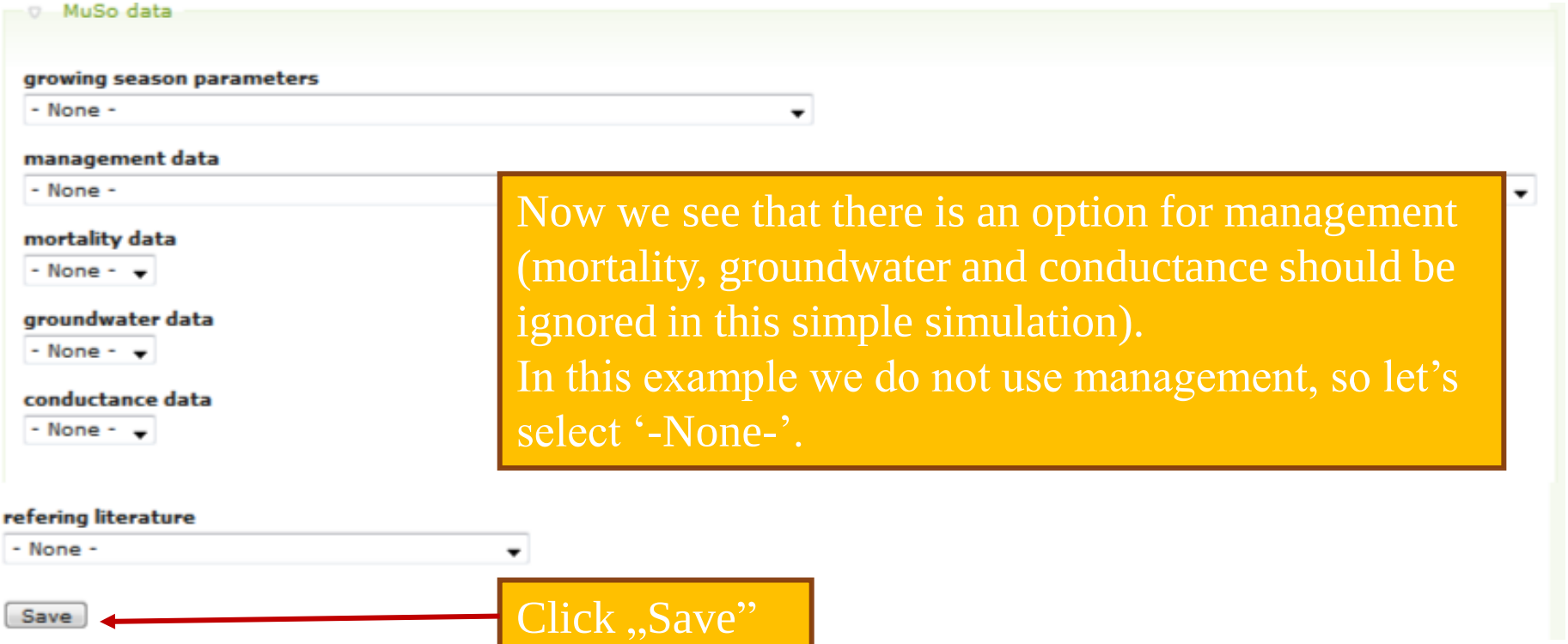
At the '**do a ramped N-deposition run?**' select '0=no'

At the '**ecophysiological constants (EPC_FILE)**' select the EPC that was uploaded previously (we called it 'Tutorial EPC' in this document).

Outlook: In a more complex simulation annually varying CO_2 concentration can be used during model simulation (after creation of input data called 'CO2 data'). Also, it is possible to use annually varying N deposition. Se User's Guide for explanation, and also check out the new 'transient' option of the spinup simulation.

Preparing the simulation

The '**MuSo, other data**' section differs from the one that we filled in during the creation of the Spinup ini.



Now we see that there is an option for management (mortality, groundwater and conductance should be ignored in this simple simulation).
In this example we do not use management, so let's select '-None-'.

Click „Save"

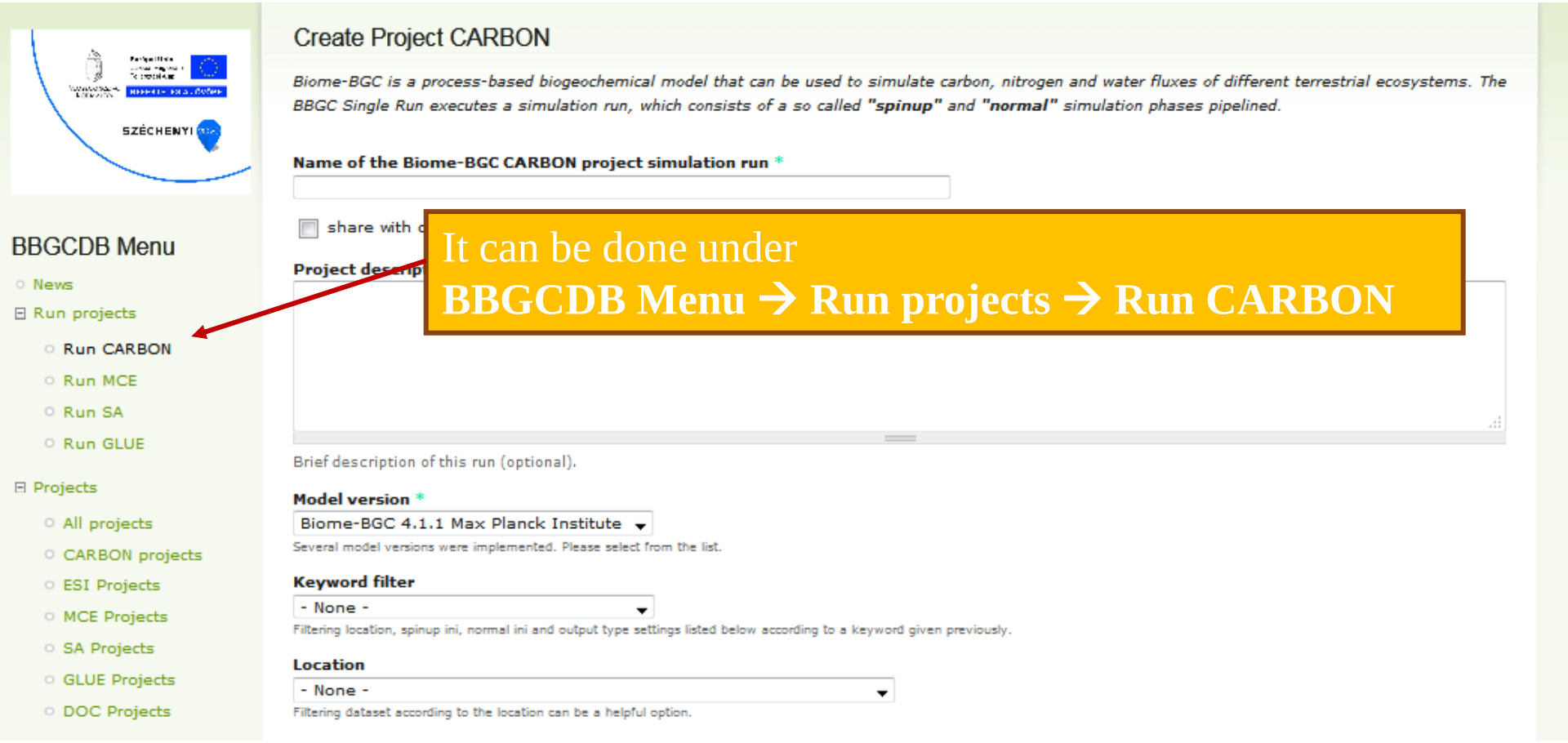
Outlook: management data (e.g. mowing, fertilization, etc.) can be defined by the User under Preparation Menu → Model inputs → Input data → Add new input data as 'Management data' as Input type.

Preparing the simulation

Save the form! The summary page shows all settings. Let's review the page to make sure that the settings are good.

Running the simulation

Now, we are ready to run our first simulation!



Running the simulation

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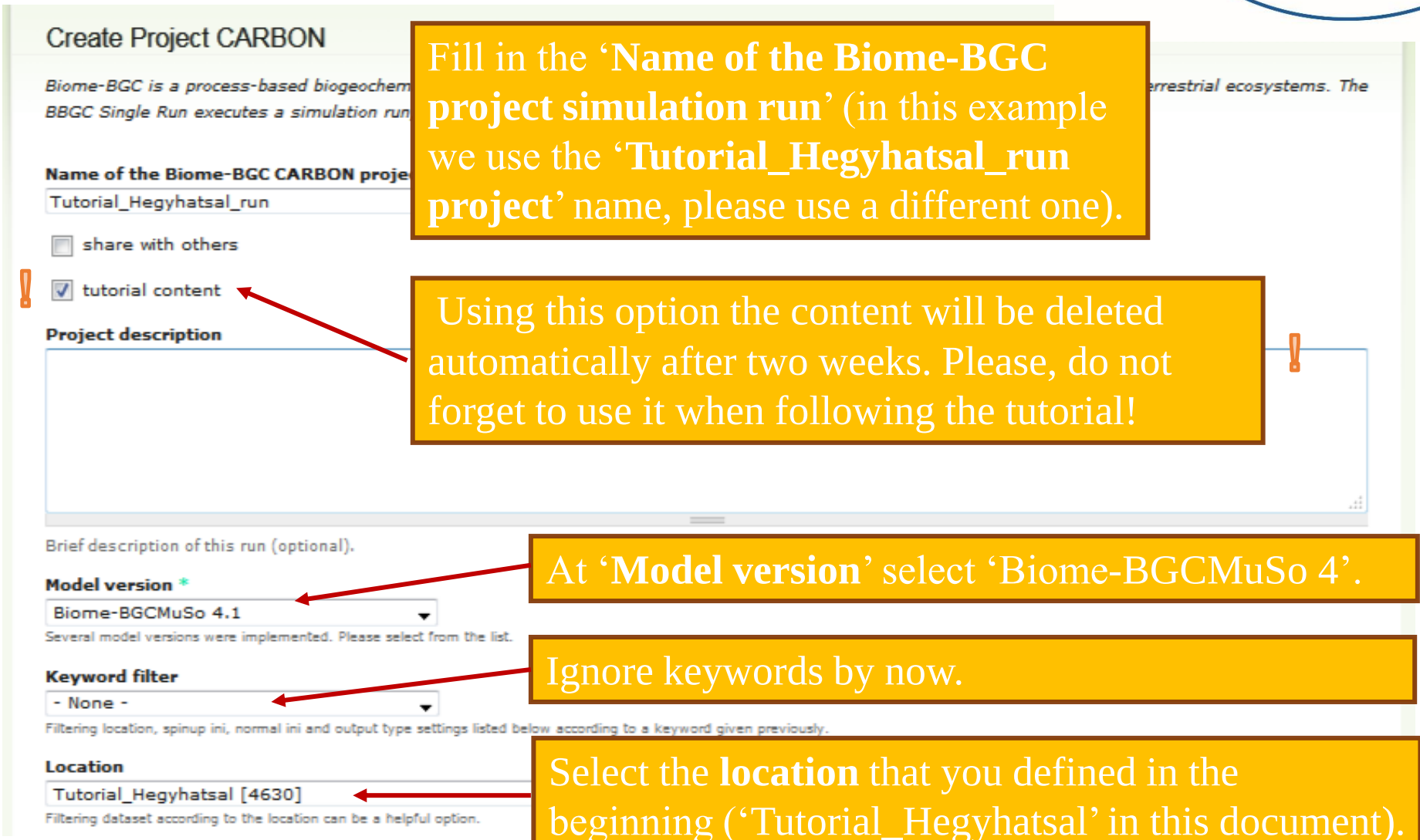


Fill in the '**Name of the Biome-BGC project simulation run**' (in this example we use the '**Tutorial_Hegyhatsal_run project**' name, please use a different one).

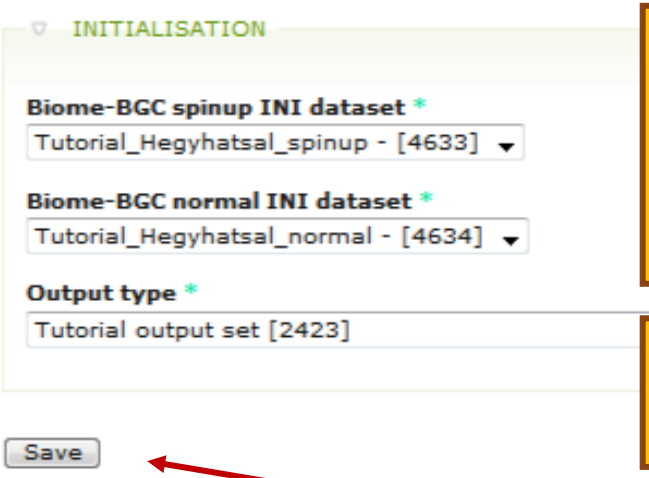
Using this option the content will be deleted automatically after two weeks. Please, do not forget to use it when following the tutorial!

At '**Model version**' select 'Biome-BGCMuSo 4'.

Ignore keywords by now.

Select the **location** that you defined in the beginning ('Tutorial_Hegyhatsal' in this document).

Running the simulation



Within the 'INITIALISATION' block select predefined '**Biome-BGC spinup INI dataset**' and '**Biome-BGC normal INI dataset**'. In this tutorial we called them 'Tutorial spinup ini' and 'Tutorial normal ini'.

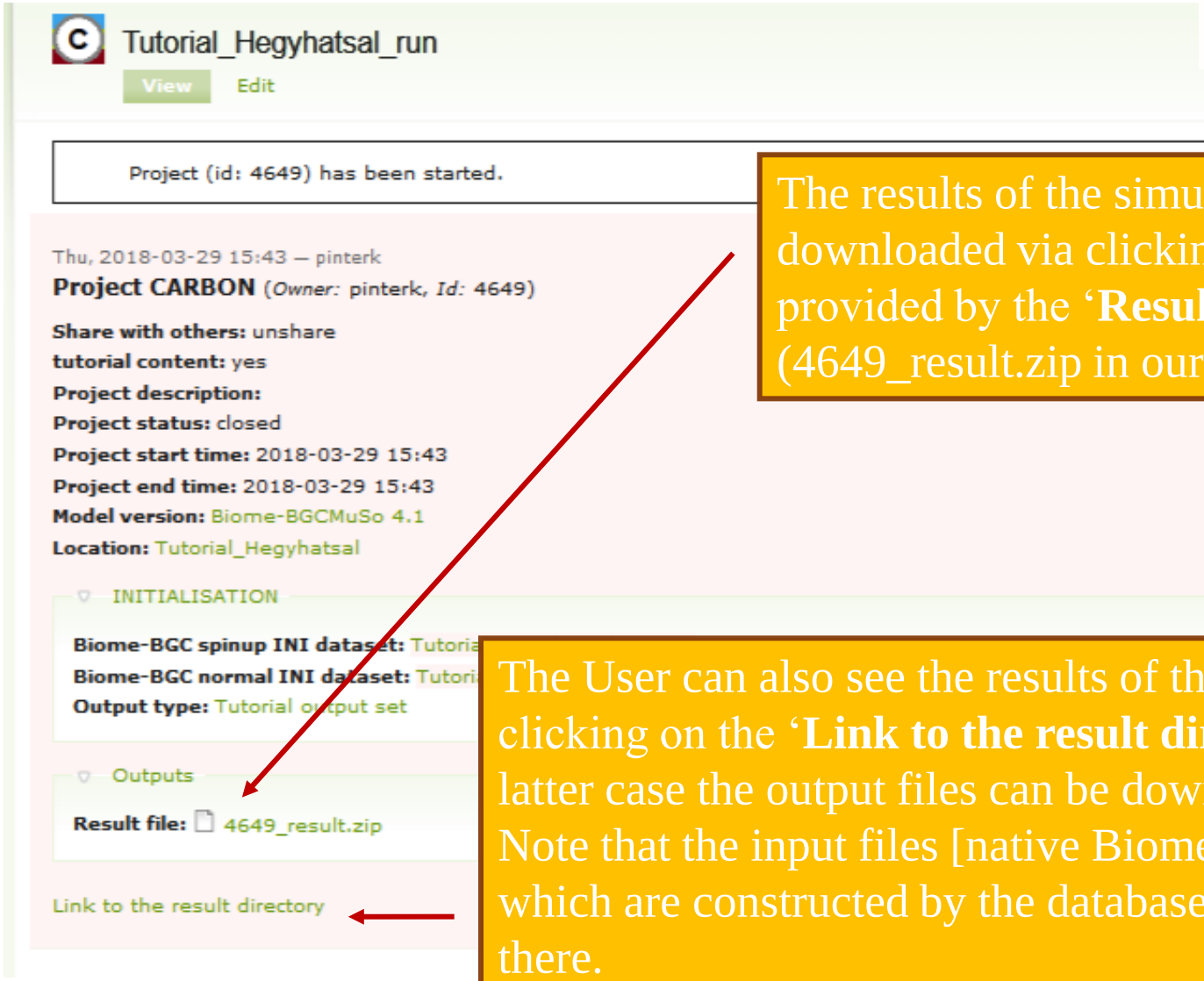
The final moment is the selection of '**Output type**'. For the sake of simplicity, select 'Tutorial output set'.

Then click '**Save**'.

Outlook: At a later stage you will be able to define your own output type using the Preparation Menu → Model outputs → Output sets
with clicking on '**Add new output set**'.

Running the simulation

Working with the results



The results of the simulation can be downloaded via clicking on the link provided by the '**Result file**' section (4649_result.zip in our example).

The User can also see the results of the simulation by clicking on the '**Link to the result directory**' link. In this latter case the output files can be downloaded one by one. Note that the input files [native Biome-BGCMuSo files, which are constructed by the database] are also found there.

Postprocessing with Excel

After downloading, unzip the result file (4649_result.zip in this tutorial). As the presented project focused on daily data, we will visualize data from the **dayout.csv** file.

Note that originally Biome-BGC provides so-called ‘flat binary’ files (i.e binary files without header, for further details see Section 4.1 in the user guide) as output (exception is the annual summary file). BBGCDB converts the results to csv for simple post-processing.

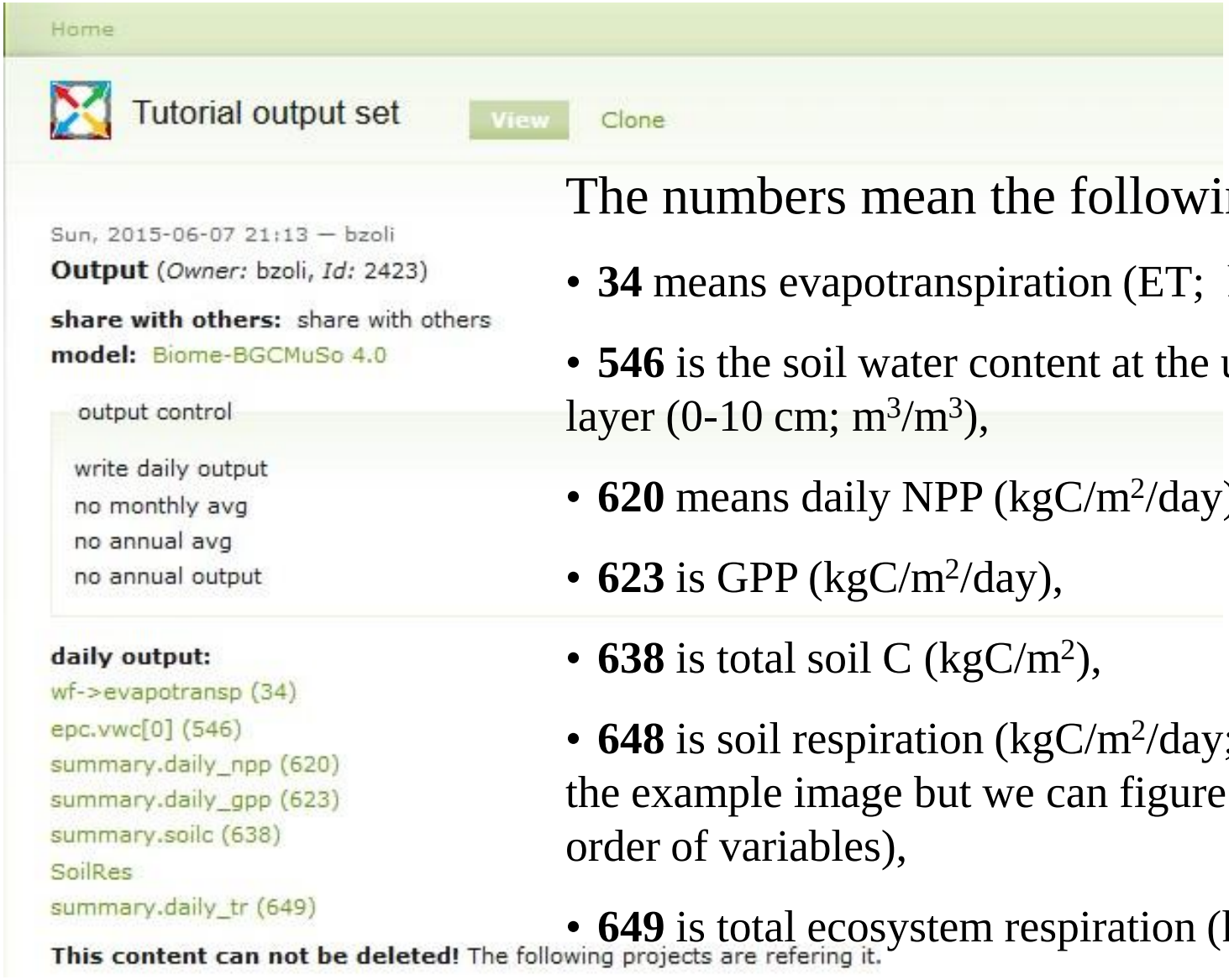
Postprocessing with Excel

If we open the **dayout.csv** file in Excel we will get the daily resolution model results in columns.

Year is the first column, day of year is the second column (note that each year consists of 365 days according to the model logic; see User's Guide), then the different output variables are listed.

In the first line numbers denote the specific output variables. The meaning of the numbers can be retrieved by clicking on the link after **Output type** (in our case ;Tutorial output set') on the summary page of the project at BBGCDB!

Working with the results

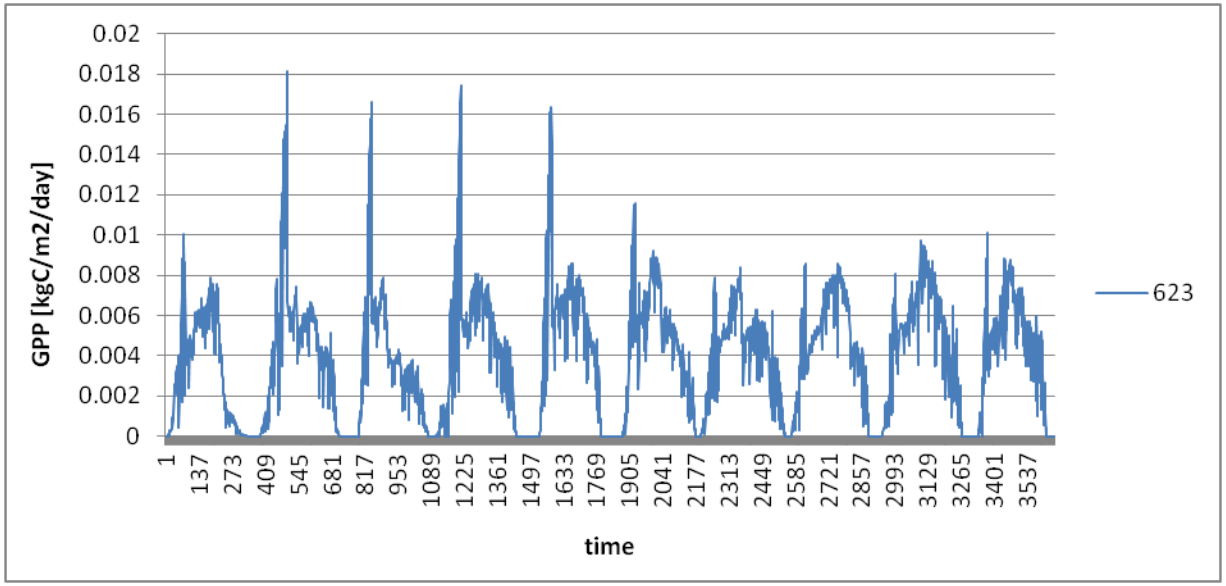


The numbers mean the following:

- **34** means evapotranspiration (ET; $kgH_2O/m^2/day$),
- **546** is the soil water content at the uppermost soil layer (0-10 cm; m^3/m^3),
- **620** means daily NPP ($kgC/m^2/day$),
- **623** is GPP ($kgC/m^2/day$),
- **638** is total soil C (kgC/m^2),
- **648** is soil respiration ($kgC/m^2/day$; not visible in the example image but we can figure it out from the order of variables),
- **649** is total ecosystem respiration ($kgC/m^2/day$).

Postprocessing with Excel

Let's quickly plot GPP with Excel (variable 623)!



Let's finish this tutorial with this image!

Working with the results

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Congratulations – you have successfully completed your first Biome-BGCMuSo simulation using our infrastructure!