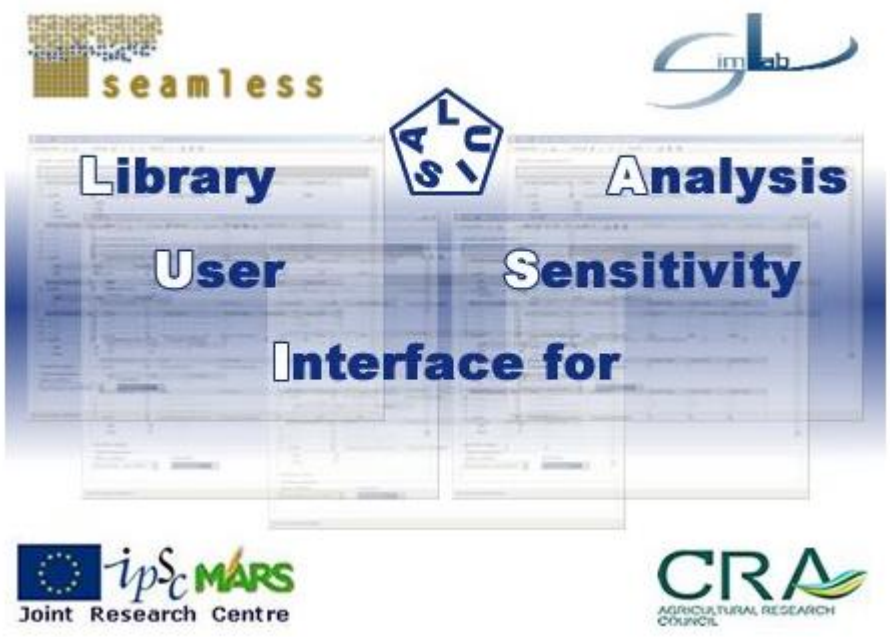
modextreme

agriculture facing extreme climatic events

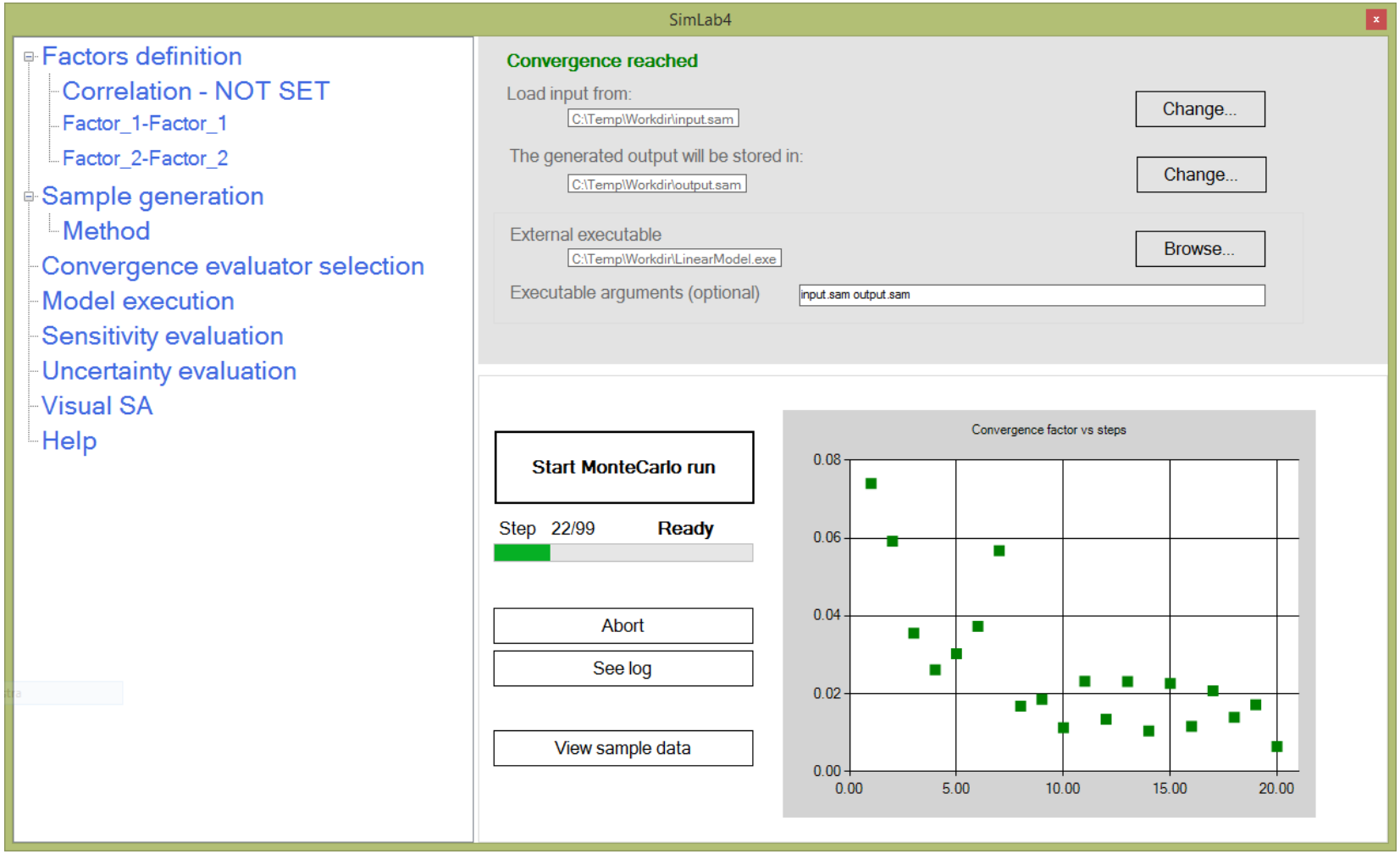
Workshop



The Team of Work Package 2

September 7-8, 2016, JRC

SimLab 4.0 prototype GUI version for beta testing
Also available as C++ library for Windows and Linux
Developed by the JRC in collaboration with GRS
Available soon on JRC web-site: https://ec.europa.eu/jrc/en/samo/simlab



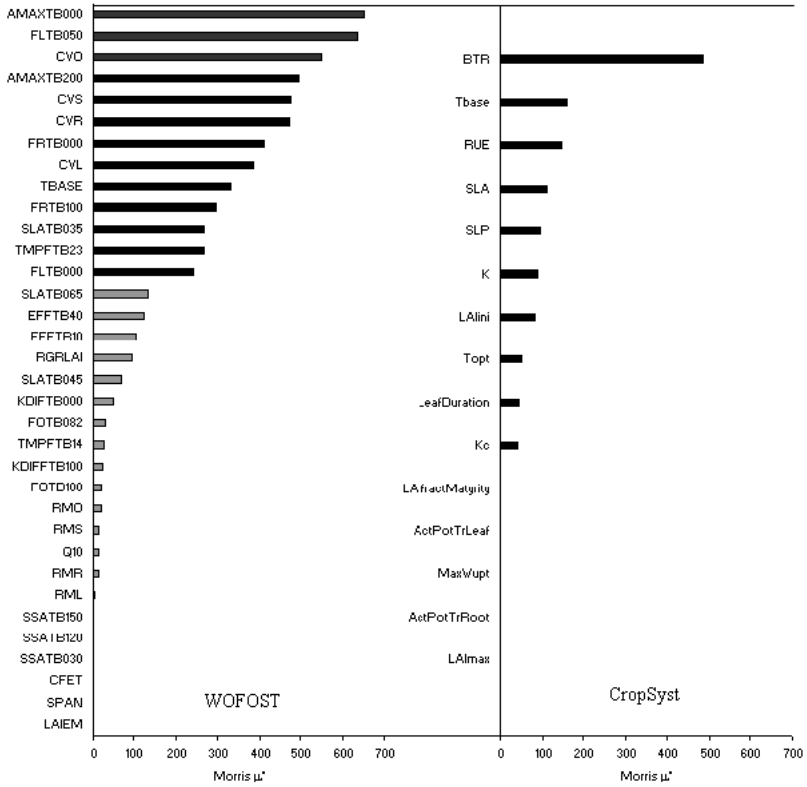
What does it do?

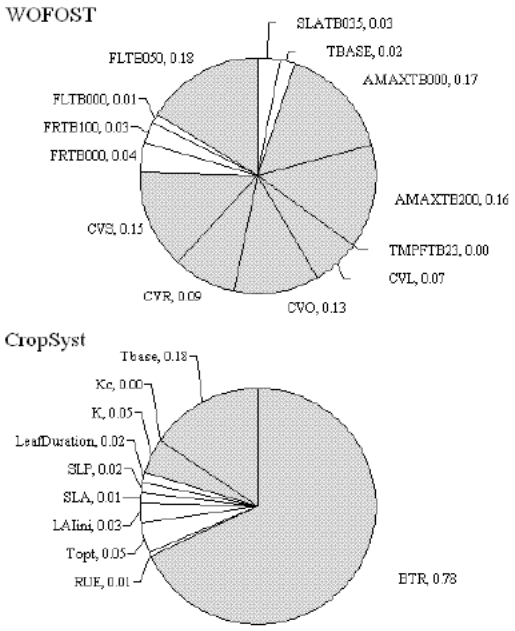
Sensitivity analysis represents how a model reacts, in terms of output variation, to changes in input parameters or variables. Relevant parameters are those shown to largely affect the dependent variable.

1) Relevant parameters
2) Model balance
3) Indications for model simplification

Model balance example

Paddy rice Northern Italy





Confalonieri R., 2010





Local vs global sensitivity

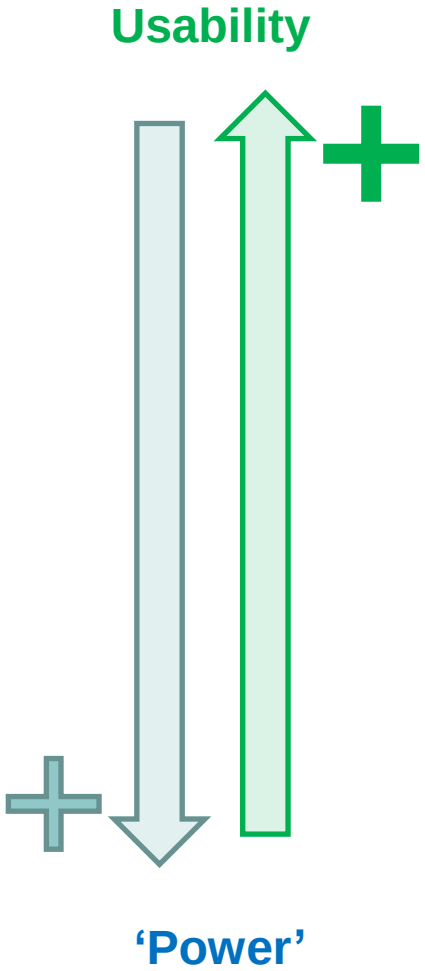
Local SA examines the local response of the output(s) by varying input parameters one at a time while holding other parameters at central values ($S_x = \Delta y/\Delta x$)

Global SA examines the global response (averaged over the variation of all the parameters) of model output(s) by exploring a finite (or even an infinite) region





Sensitivity methods



Three categories:

- screening methods:

Morris

- regression based:

LP-Tau

Latin Hypercube

Random

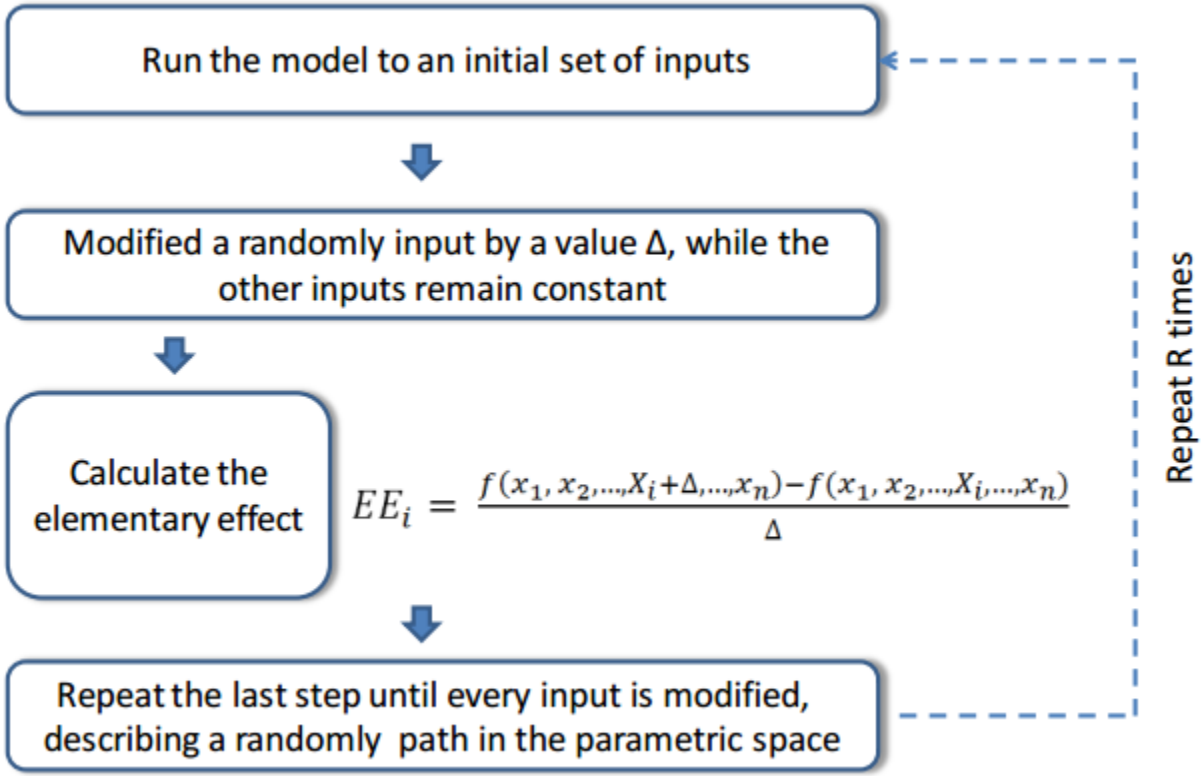
- variance based:

Sobol

FAST

Sensitivity methods - Screening

Morris, one-step-at-a-time method (OAT):



Sensitivity methods - Screening

μ : main effect of the input factor on the output;

σ : interaction with other factors or the nonlinear effects

Sensitivity methods – Regression based

1) Based on Sampling

2) Pearson and Spearman Coefficient on (y_j, x_{ij}) couples ($j = 1, \ldots, m$), m = sample size.

3) SRC or PCC calculated on:

$$y = b_0 + \sum_{i=1}^{n} b_i \cdot x_i + \varepsilon$$

y : output;

x_i : factors, with $i = 1, \ldots, n$;

b_i : coefficient for each factor;

ε : random error.

Resampling ***X*** many times (f.i., m)

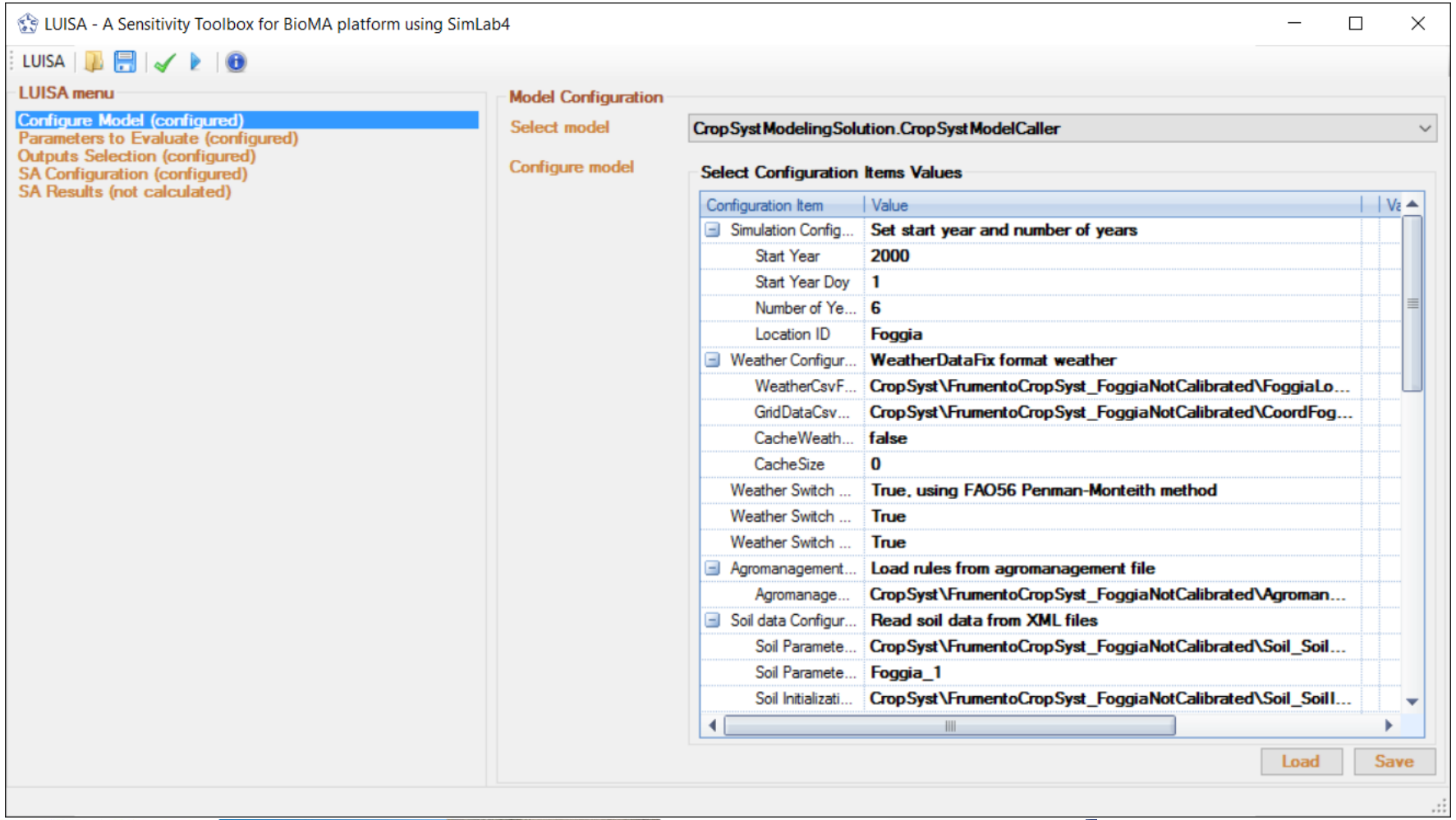
Sensitivity methods - Sobol

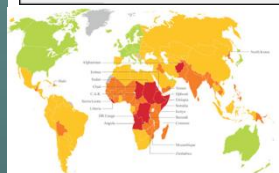
is a variance-based technique, meaning that the variance of the model output can be **decomposed** into terms of increasing dimension, called partial variances, representing the contribution of each single input (but even pairs, triplets, etc.) to the overall uncertainty of the model output

First-order sensitivity index: is the contribution to the output variance of the main effect of *i-th* factor, hence it measures the effect of varying X_i alone, but averaged over variations in other input parameters.

Total-effect index: measures the contribution to the output variance of X_i, including all variance caused by its interactions, of any order, with any other input variables.

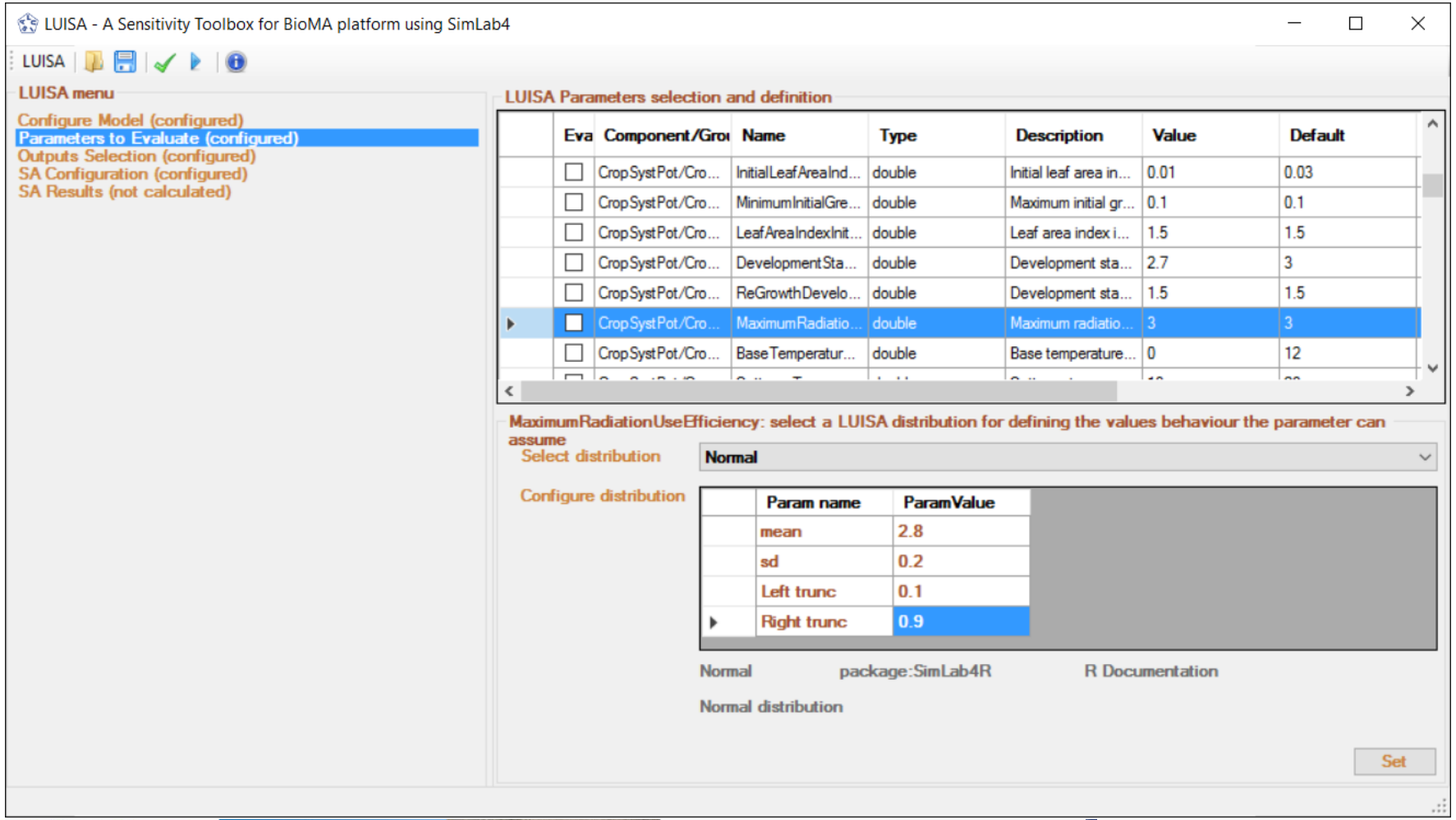
LUISA - GUI


LUISA - A Sensitivity Toolbox for BioMA platform using SimLab4
LUISA
LUISA menu
Configure Model (configured)
Parameters to Evaluate (configured)
Outputs Selection (configured)
SA Configuration (configured)
SA Results (not calculated)
Model Configuration
Select model
CropSystModelingSolution.CropSystModelCaller
Configure model
Select Configuration Items Values
Configuration Item
Value
Simulation Config...
Set start year and number of years
Start Year
2000
Start Year Doy
1
Number of Ye...
6
Location ID
Foggia
Weather Configur...
WeatherDataFix format weather
WeatherCsvF...
CropSyst\FrumentoCropSyst_FoggiaNotCalibrated\FoggiaLo...
GridDataCsv...
CropSyst\FrumentoCropSyst_FoggiaNotCalibrated\CoordFog...
CacheWeath...
false
CacheSize
0
Weather Switch ...
True, using FAO56 Penman-Monteith method
Weather Switch ...
True
Weather Switch ...
True
Agromanagement...
Load rules from agromanagement file
Agromanage...
CropSyst\FrumentoCropSyst_FoggiaNotCalibrated\Agroman...
Soil data Configur...
Read soil data from XML files
Soil Paramete...
CropSyst\FrumentoCropSyst_FoggiaNotCalibrated\Soil_Soil...
Soil Paramete...
Foggia_1
Soil Initializati...
CropSyst\FrumentoCropSyst_FoggiaNotCalibrated\Soil_SoilI...
Load
Save





LUISA - GUI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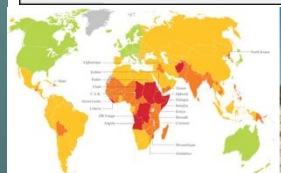
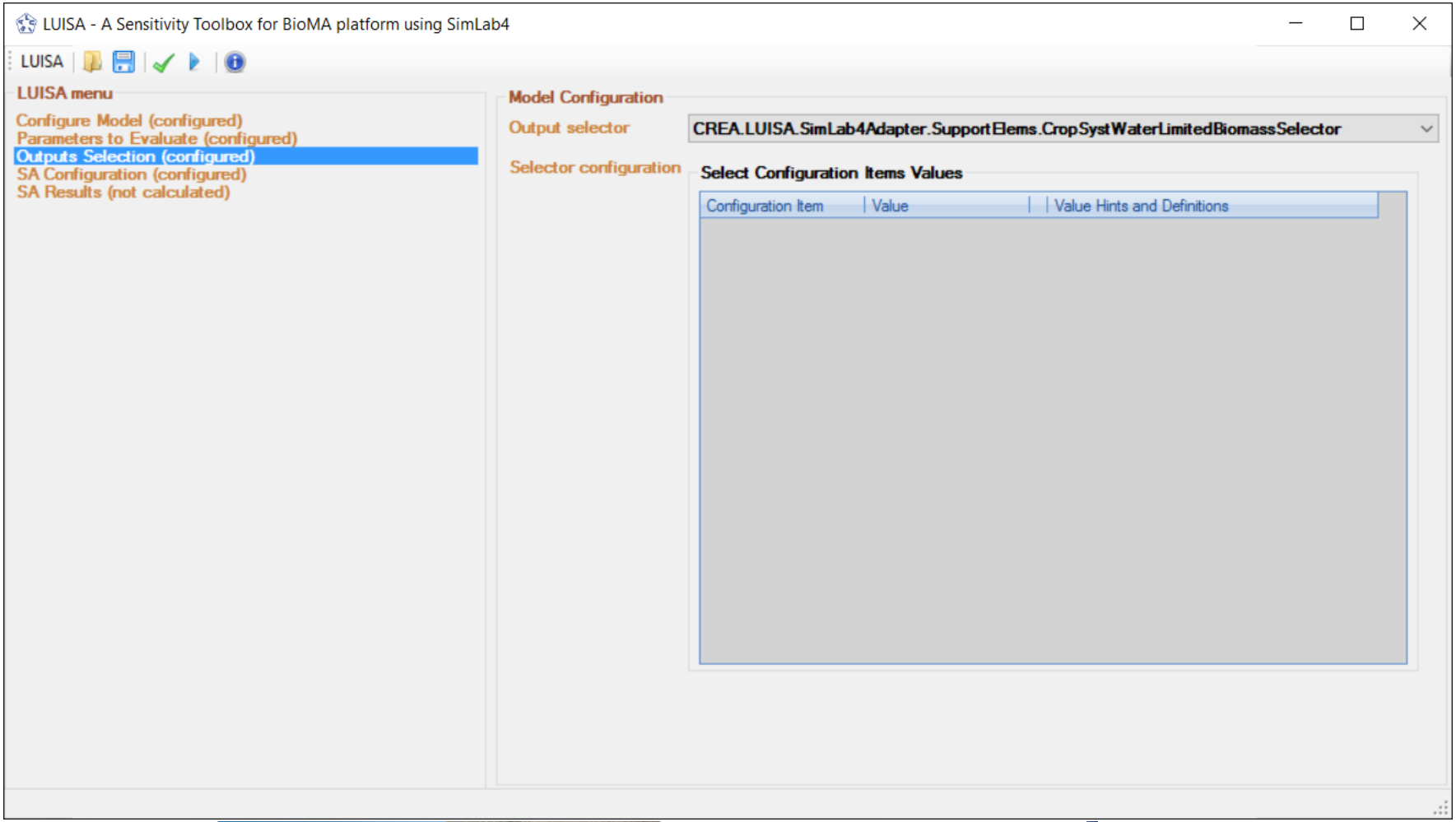
Parameters to Evaluate (configured)
Outputs Selection (configured)
SA Configuration (configured)
SA Results (not calculated)
LUISA Parameters selection and definition
Eva
Component/Gro
Name
Type
Description
Value
Default
CropSystPot/Cro...
InitialLeafAreaInd...
double
Initial leaf area in...
0.01
0.03
MinimumInitialGre...
Maximum initial gr...
0.1
LeafAreaIndexInit...
Leaf area index i...
1.5
DevelopmentSta...
Development sta...
2.7
3
ReGrowthDevelo...
MaximumRadiatio...
Maximum radiatio...
BaseTemperatur...
Base temperature...
0
12
MaximumRadiationUseEfficiency: select a LUISA distribution for defining the values behaviour the parameter can assume
Select distribution
Normal
Configure distribution
Param name
ParamValue
mean
2.8
sd
0.2
Left trunc
0.1
Right trunc
0.9
Normal
package:SimLab4R
R Documentation
Normal distribution
Set





LUISA - GUI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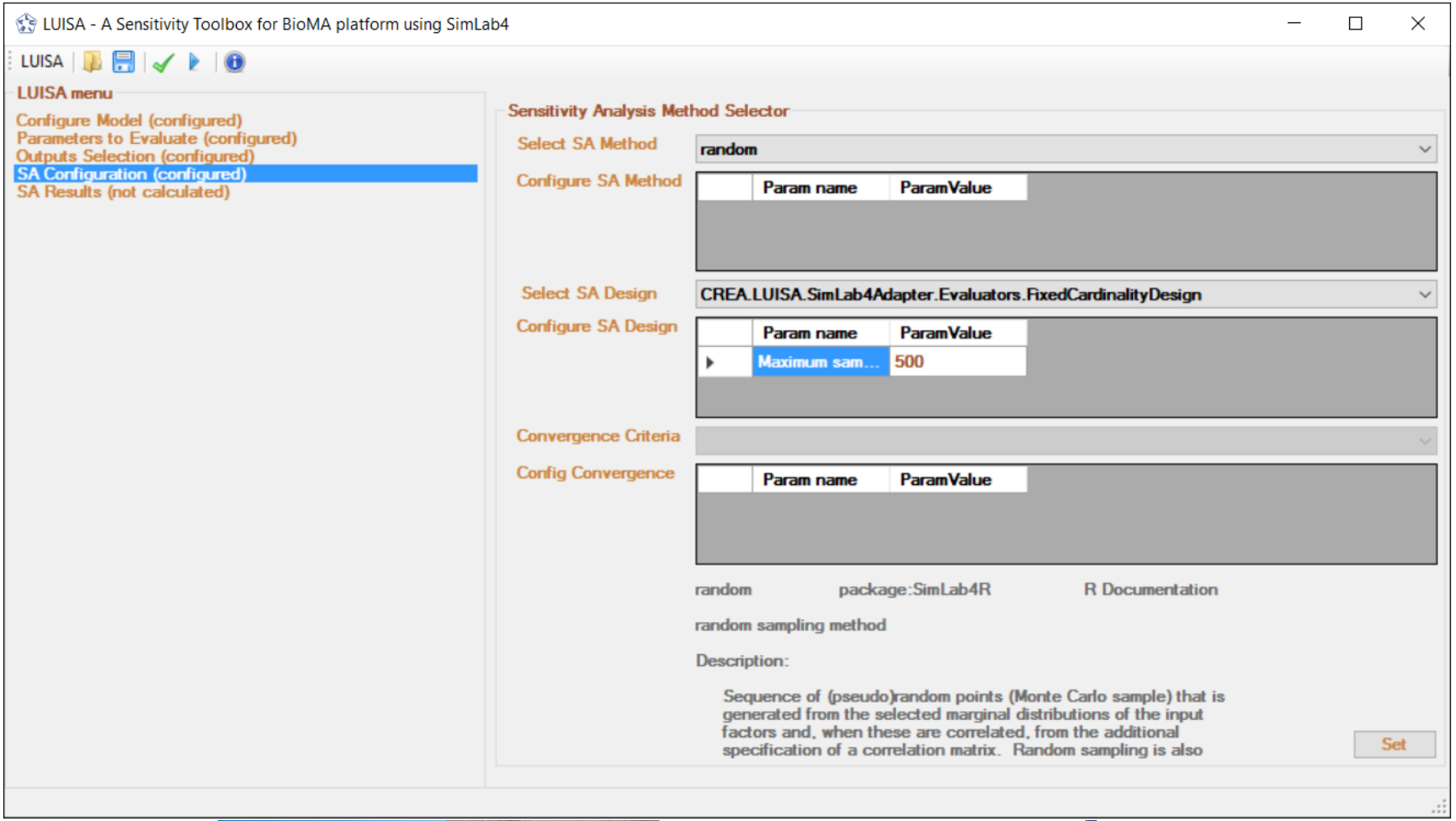
Configure Model (configured)
Parameters to Evaluate (configured)
Outputs Selection (configured)
SA Configuration (configured)
SA Results (not calculated)
Model Configuration
Output selector
CREA.LUISA.SimLab4Adapter.SupportElems.CropSystWaterLimitedBiomassSelector
Selector configuration
Select Configuration Items Values
Configuration Item
Value
Value Hints and Definitions

LUISA - GUI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LUISA menu
Configure Model (configured)
Parameters to Evaluate (configured)
Outputs Selection (configured)
SA Configuration (configured)
SA Results (not calculated)
Sensitivity Analysis Method Selector
Select SA Method
random
Configure SA Method
Param name
ParamValue
Select SA Design
CREA.LUISA.SimLab4Adapter.Evaluators.FixedCardinalityDesign
Configure SA Design
Param name
ParamValue
Maximum sam...
500
Convergence Criteria
Config Convergence
Param name
ParamValue
random
package:SimLab4R
R Documentation
random sampling method
Description:
Sequence of (pseudo)random points (Monte Carlo sample) that is generated from the selected marginal distributions of the input factors and, when these are correlated, from the additional specification of a correlation matrix. Random sampling is also
Set

LUISA - GUI

LUISA - A Sensitivity Toolbox for BioMA platform using SimLab4

LUISA

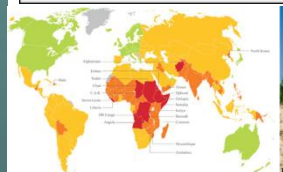
LUISA menu

Configure Model (configured)
Parameters to Evaluate (configured)
Outputs Selection (configured)
SA Configuration (configured)
SA Results (calculated)

SA Results

Drag a column header here to group by that column.

tput	Execution ID	SA index	Model Input	SA Value
groundBiom...	2000 - 1 - 6 - ...	PEAR	MaximumRadiationUseEfficien...	0.75799048822...
groundBiom...	2000 - 1 - 6 - ...	PEAR	OptimumTemperatureForGrowth	-0.4782406773...
groundBiom...	2000 - 1 - 6 - ...	PEAR	SpecificLeafArea	0.38137195506...
groundBiom...	2000 - 1 - 6 - ...	PEAR	TranspirationBiomassCoefficient	0.01478279612...
groundBiom...	2000 - 1 - 6 - ...	PEAR	ExtinctionCoefficientSolarRad...	0.25005257663...
groundBiom...	2000 - 1 - 6 - ...	PEAR	BaseTemperatureForGrowth	-0.0309709840...
groundBiom...	2000 - 1 - 6 - ...	PEAR	DaysToStartVernalization	-0.0083258617...
groundBiom...	2000 - 1 - 6 - ...	PEAR	DaysToCompleteVernalization	-0.0615021119...
groundBiom...	2000 - 1 - 6 - ...	SPEA	MaximumRadiationUseEfficien...	0.75440959869...
groundBiom...	2000 - 1 - 6 - ...	SPEA	OptimumTemperatureForGrowth	-0.4646381763...
groundBiom...	2000 - 1 - 6 - ...	SPEA	SpecificLeafArea	0.37410384220...
groundBiom...	2000 - 1 - 6 - ...	SPEA	TranspirationBiomassCoefficient	0.01568500024...
groundBiom...	2000 - 1 - 6 - ...	SPEA	ExtinctionCoefficientSolarRad...	0.2454912690994
groundBiom...	2000 - 1 - 6 - ...	SPEA	BaseTemperatureForGrowth	-0.0348861100...
groundBiom...	2000 - 1 - 6 - ...	SPEA	DaysToStartVernalization	0.00020620883...
groundBiom...	2000 - 1 - 6 - ...	SPEA	DaysToCompleteVernalization	-0.0630599702...
groundBiom...	2000 - 1 - 6 - ...	SRC	MaximumRadiationUseEfficien...	0.72889166953...
groundBiom...	2000 - 1 - 6 - ...	SRC	OptimumTemperatureForGrowth	-0.4730095500...
groundBiom...	2000 - 1 - 6 - ...	SRC	SpecificLeafArea	0.40522042516...
groundBiom...	2000 - 1 - 6 - ...	SRC	TranspirationBiomassCoefficient	0.06097572600...
groundBiom...	2000 - 1 - 6 - ...	SRC	ExtinctionCoefficientSolarRad...	0.25848831622...
groundBiom...	2000 - 1 - 6 - ...	SRC	BaseTemperatureForGrowth	-0.0109765933...
groundBiom...	2000 - 1 - 6 - ...	SRC	DaysToStartVernalization	-0.0012447850...
groundBiom...	2000 - 1 - 6 - ...	SRC	DaysToCompleteVernalization	-0.0008569307...





Results – Sobol method on CS

SA Results

Model Outp... | SA index

Model Output	Execution ID	SA index	Model Input	SA Value
Model Output : WLAbovegroundBiomass				
SA index: Sobol First Order				
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	MaximumRadiationUseEfficiency	0.60530197978...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	OptimumTemperatureForGrowth	0.16445297061...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	SpecificLeafArea	0.19317290920...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	TranspirationBiomassCoefficient	0.01396142228...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	ExtinctionCoefficientSolarRadiation	-0.0555483188...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	BaseTemperatureForGrowth	0.00057935906...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	DaysToStartVernalization	0
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol First Order	DaysToCompleteVernalization	0
SA index: Sobol Total Orders				
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	MaximumRadiationUseEfficiency	0.57509412076...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	OptimumTemperatureForGrowth	0.23169446704...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	SpecificLeafArea	0.16452166284...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	TranspirationBiomassCoefficient	0.00407531414...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	ExtinctionCoefficientSolarRadiation	0.06759833782...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	BaseTemperatureForGrowth	0.00012563276...
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	DaysToStartVernalization	0
WLAbovegroundBiom...	2000 - 1 - 6 - ...	Sobol Total Orders	DaysToCompleteVernalization	0