

# SimSEE

**Series: “SimSEE User Manuals”**

**VOLUME 2**

**Sources.**

Ings. Felipe Palacio, Pablo Soubes y Ruben Chaer.  
*Montevideo - Uruguay.*  
*Septiembre 2019.*

## Index.

1. Introduction.....	7
1.1. What are SimSEE Sources?.....	7
1.2. Registration of a Source with the Room Editor.....	9
1.3. Source Outputs.....	9
1.4. Source Parameters.....	10
1.5. Draw Step and Room Step - Slave Sources.....	10
1.6. Calculated Terminals.....	11
1.7. Values exported for SimRes.....	12
2. Sources available in SimSEE.....	12
3. Constant Source.....	14
3.1. Operation description.....	14
3.2. Static parameters.....	15
3.3. Parámetros dinámicos.....	15
3.4. Published variables for SimRes.....	16
3.5. State variables, Control and Restrictions.....	16
4. Uniform Source.....	17
4.1. Operation description.....	17
4.2. Static parameters.....	18
4.3. Dynamic parameters.....	18
4.4. Published variables for SimRes.....	19
4.5. State variables, Control and Restrictions.....	19
5. Gaussian Source.....	20
5.1. Operation description.....	20
5.2. Parámetros estáticos.....	20
5.3. Parámetros dinámicos.....	20
5.4. Published variables for SimRes.....	21
5.5. State variables, Control and Restrictions.....	21
6. Weibull Source.....	22
6.1. Operation description.....	22
6.2. Static parameters.....	23
6.3. Dynamic parameters.....	23
6.4. Published variables for SimRes.....	24
6.5. State variables, Control and Restrictions.....	24
7. Combination Source.....	25
7.1. Operation description.....	25
7.2. Static parameters.....	26
7.3. Dynamic parameters.....	26
7.4. Published variables for SimRes.....	27
7.5. State variables, Control and Restrictions.....	27
8. Multi-Source Operation Source.....	28
8.1. Operation description.....	28

8.2. Static parameters.....	28
8.3. Dynamic parameters.....	29
8.4. Published variables for SimRes.....	29
8.5. State variables, Control and Restrictions.....	29
9. Multiplication Source.....	30
9.1. Operation description.....	30
9.2. Static parameters.....	31
9.3. Dynamic parameters.....	31
9.4. Published variables for SimRes.....	32
9.5. State variables, Control and Restrictions.....	32
10. CEGH Synthesizer.....	33
10.1. Operation description.....	33
10.2. Static parameters.....	34
10.2.a) Global parameters.....	34
10.2.b) Forecast Cone Parameters.....	36
10.3. Dynamic parameters.....	37
10.4. Published variables for SimRes.....	37
10.5. State variables, Control and Restrictions.....	37
11. Time Source.....	38
11.1. Function description.....	38
11.2. Static parameters.....	38
11.3. Dynamic parameters.....	38
11.4. Variables published for SimRes.....	39
11.5. State variables.....	39
12. Sinusoidal source.....	40
12.1. Function description.....	40
12.2. Static parameters.....	40
12.3. Dynamic parameters.....	40
12.4. Variables published for SimRes.....	41
12.5. Status Variables.....	41
13. MaxMin Source.....	42
13.1. Operation description.....	42
13.2. Static parameters.....	43
13.3. Dynamic parameters.....	43
13.4. Published variables for SimRes.....	43
13.5. State variables, Control and Restrictions.....	44
14. Selector Source.....	45
14.1. Function description.....	45
14.2. Static parameters.....	45
14.3. Dynamic parameters.....	45
14.4. Variables published for SimRes.....	46
14.5. State variables.....	46
15. Time Selector Source.....	47
15.1. Operation description.....	47
15.2. Static parameters.....	48
15.3. Dynamic parameters.....	48
15.4. Published variables for SimRes.....	49
15.5. State variables, Control and Restrictions.....	49





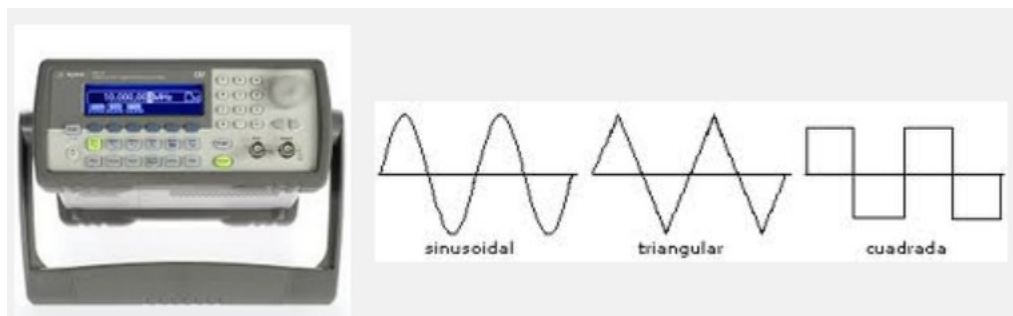


# 1. Introduction.

This is Volume 2 of the “SimSEE User Manuals” and is intended to document the Sources available in SimSEE to serve as a quick reference manual for the user.

## 1.1. What are SimSEE Sources?

Sources are number generating entities. The origin of the word "source" is in the sense of "signal generating source" (see Fig.1).

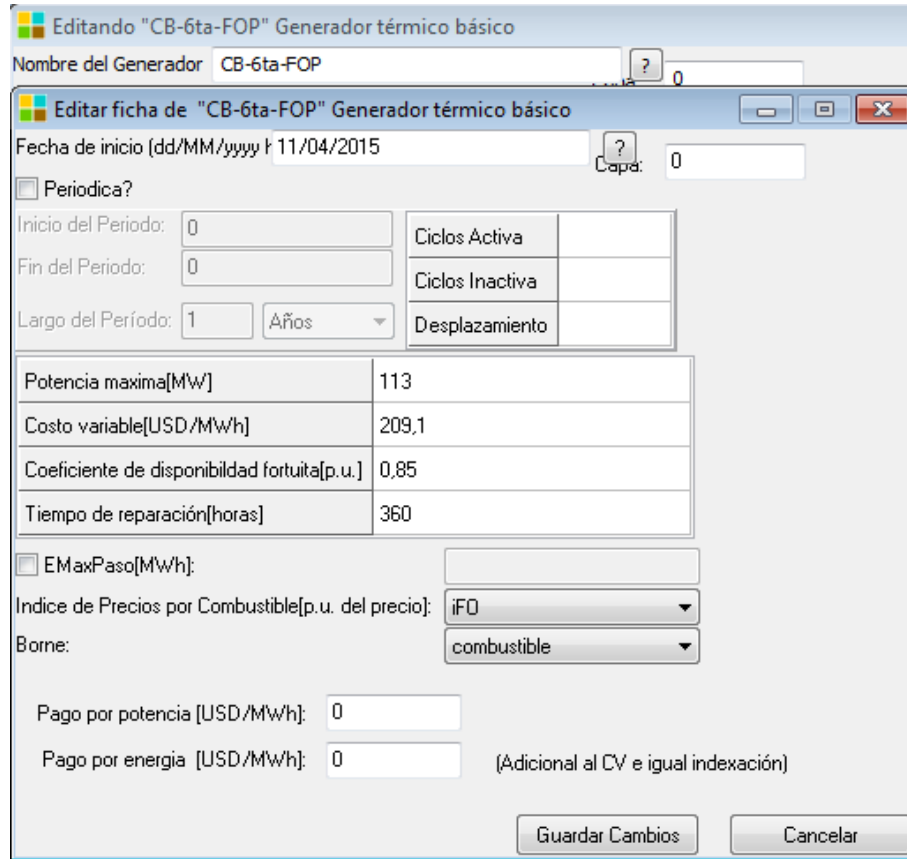


*Fig. 1: Fuente generadora de señales.*

A source has one or more Terminals to which the Actors or other Sources that need to take the values generated by the source can be “wired”. They constitute a tool that allows the user to define different functions, so that their results can be used by the different *Actors* involved in a SimSEE *Playroom*.

For example, it may be desirable that the variable costs specified in the dynamic parameter records of the Thermal Generators, instead of being fixed and invariant values, be affected by an index that takes into account the variation of those prices over time. Thus an index could be obtained that is the result of a function that reflects the type of fuel used by each Actor (Fuel Oil, Gas Oil, Natural Gas, etc.) so that their costs change automatically when considering different price projections for each fuel.

An example of a dynamic parameter record of a generator in which a Source has been specified as an index to affect the variable generation cost is shown in Fig.2. The declared variable cost for the 6th C. Batlle thermal power plant, which operates at Fuel Oil, will be affected by the “iFO” index that will export in its “fuel” terminal a value that will index that variable cost, as well as the payment for energy if it had any defined.



Nombre del Generador: CB-6ta-FOP

Fecha de inicio (dd/MM/yyyy): 11/04/2015

Capa: 0

Periodica?

Inicio del Periodo: 0

Fin del Periodo: 0

Largo del Período: 1 Años

Ciclos Activa	
Ciclos Inactiva	
Desplazamiento	

Potencia maxima[MW]	113
Costo variable[USD/MWh]	209,1
Coefficiente de disponibilidad fortuita[p.u.]	0,85
Tiempo de reparación[horas]	360

EMaxPaso[MWh]:

Indice de Precios por Combustible[p.u. del precio]: iFO

Borne: combustible

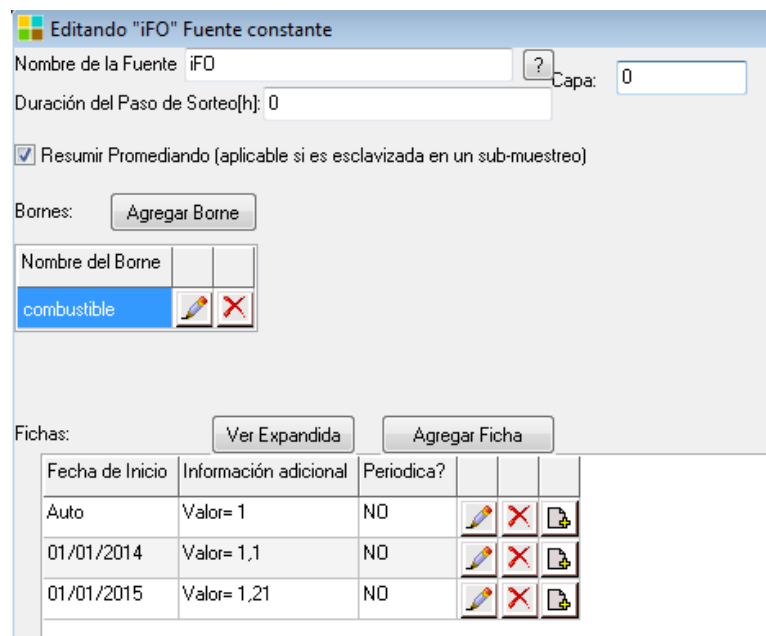
Pago por potencia [USD/MWh]: 0

Pago por energia [USD/MWh]: 0 (Adicional al CV e igual indexación)

Buttons: Guardar Cambios, Cancelar

Fig. 2: Example of using a Source as a price index.

That index can be implemented as a Source that models an expected increase in the prices of said fuel, for example. 10% per year for subsequent years. Fig.3 shows an example.



Nombre de la Fuente: iFO

Duración del Paso de Sorteo[h]: 0

Capa: 0

Resumir Promediando (aplicable si es esclavizada en un sub-muestreo)

Bornes: Agregar Borne

Nombre del Borne		
combustible		

Fichas: Ver Expandida, Agregar Ficha

Fecha de Inicio	Información adicional	Periodica?			
Auto	Valor= 1	NO			
01/01/2014	Valor= 1,1	NO			
01/01/2015	Valor= 1,21	NO			

Fig. 3: Source example with growth index projection.



## 1.2. Registration of a Source with the Room Editor.

See the “Sources Tab” section of Volume 1 of this Manuals for details on how to register a source in the Room Editor.

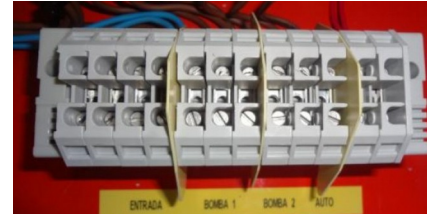
## 1.3. Source Outputs.

The Sources have the results of their operation accessible in a Terminal (analogy suggested with the electrical connection terminals - see Fig.4) to which the entities that require the use of the values generated by the Source can be connected.

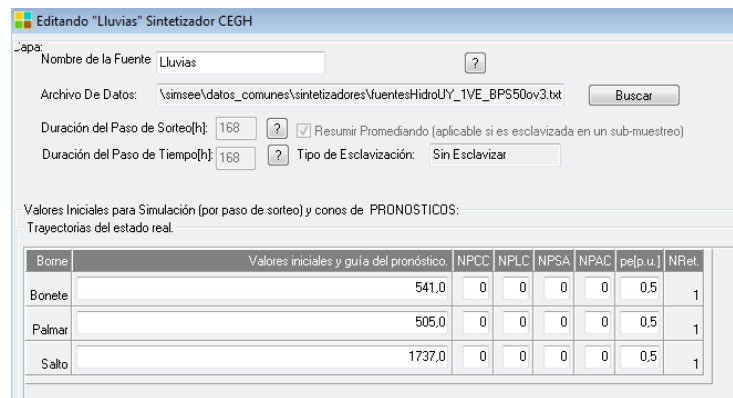
The user can edit the terminals and assign them a name, if desired. Otherwise, they will be called “Default Terminal”. When an Actor (or other Source) uses a Source, it must always indicate its name, and also the “terminal” to which it will be connected. That is to say, it must indicate the Source and the Terminal to which it is connected to take the generated values.

To fix ideas, Fig.5 shows the form of a Source that models the contributions of hydraulic flows to the Bonete, Palmar and Salto dams and Fig.6 shows the form of the Actor who uses it.

When a “Hydraulic Generator” Actor needs to use the results of contributions generated by this Source, he must indicate which of the 3 Terminals or outputs he chooses: if for example. it is the Bonete central, it will choose the “Bonete” terminal in order to have as input the output that the Source presents in that terminal, as shown in Fig.6.



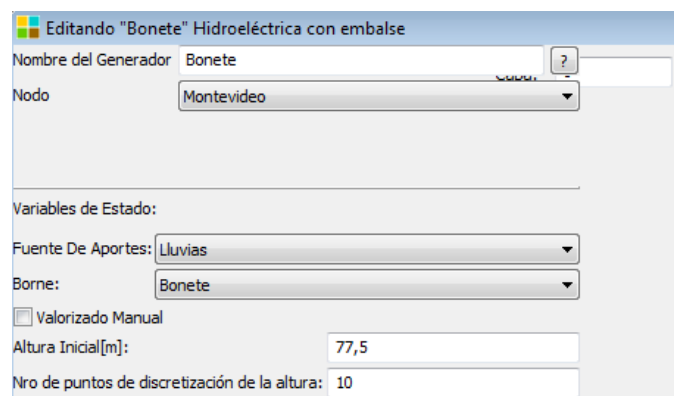
*Fig. 4: Bornera.*



Editando "Lluvias" Sintetizador CEGH  
 Mapa: Nombre de la Fuente: Lluvias  
 Archivo De Datos: \\simsee\datos\_comunes\sintetizadores\ FuentesHidroUY\_1VE\_BP550ov3.txt [Buscar]  
 Duración del Paso de Sorteo[h]: 168 [?]  Resumir Promediando (aplicable si es esclavizada en un sub-muestreo)  
 Duración del Paso de Tiempo[h]: 168 [?] Tipo de Esclavización: Sin Esclavizar  
 Valores Iniciales para Simulación (por paso de sorteo) y conos de PRONOSTICOS:  
 Trayectorias del estado real.

Borne	Valores iniciales y guía del pronóstico.	NPCC	NPLC	NPSA	NPAC	pe[p.u.]	NRet.
Bonete	541.0	0	0	0	0	0.5	1
Palmar	505.0	0	0	0	0	0.5	1
Salto	1737.0	0	0	0	0	0.5	1

*Fig. 5: Ejemplo fuente de aportes hidráulicos a Bonete, Palmar y Salto Grande.*



Editando "Bonete" Hidroeléctrica con embalse  
 Nombre del Generador: Bonete  
 Nodo: Montevideo  
 Variables de Estado:  
 Fuente De Aportes: Lluvias  
 Borne: Bonete  
 Valorizado Manual  
 Altura Inicial[m]: 77,5  
 Nro de puntos de discretización de la altura: 10

*Fig. 6: Example of use of the Source of contributions by the Bonete plant.*

## **1.4. Source Parameters.**

Sources are configured by parameters that can be static or dynamic. Static parameters are defined in the main form of the source and dynamic parameters are defined in specific forms for editing the dynamic parameter records associated with the type of Source.

The fixed parameters common to all Sources are: the **Name**, which allows you to specify an identifier with which to refer to the Source, the **Layer**, which allows you to indicate the layer to which the Source belongs and the **Draw Step**, which is described in section 1.5. The rest of the static and dynamic parameters are specific to each type of Source and are detailed in the corresponding sections.

## **1.5. Draw Step and Room Step - Slave Sources.**

A static parameter common to all Sources is the "Duration of the Draw Step (h)". It indicates the cadence in hours for which the Source model was designed.

To set ideas, if a source was configured to generate the average weekly value of the hydraulic flows to the dams, its "natural rate" will be 168 h and when configuring that source it should be set as Duration of the Draw Step (h) 168 hours.

However, this source can be used in a room whose integration time is weekly, monthly, daily, hourly or any other. So, if the passage of the room (this is the integration step) does not coincide with the cadence for which the particular source was designed, some adaptation of the behavior of the source must be made (or not use it in a room whose passage is not equal to the draw of the source). SimSEE provides a powerful automatic source adaptation mechanism described later in this section.

By default, when registering a Source, it is set to 0 (zero), indicating that the draw step will have the same duration of the Simulation step, in which case a value will be drawn in each of its steps and there will be a SYNCHRONOUS SOURCE adapted to the passage of the Room without any auxiliary mechanism.

If the draw step is different (greater or lesser) from the passage of time of the Room, the adaptation mechanism is activated and the Source will be "enslaved" by another Source that will generate the values according to the Room steps.

If the passage of time in the Room is less than the Source draw step, an OVER-SAMPLED SOURCE will be available (in the sense that values are required more frequently than the natural rate of the source). The enslavement mechanism involves creating another source capable of taking the original source as a slave, sampling it with its natural cadence and generating values with the frequency required by the passage of time in the Room, linearly interpolating between two values obtained from the enslaved Source.

If the time step of the Room is greater than the draw step of the Source, there will be a SUB-SAMPLED SOURCE (in the sense that values are required less frequently than the natural cadence of the source). The enslavement mechanism involves creating another Source capable of collecting the values ge-

nerated by the original Source within the Room time step and summarizing them in a single value, available to entities that want to use it. Regarding the way of performing the summary, SimSEE implements two mechanisms: 1) Make a simple average of the collected values and 2) Randomly select any of the collected values with equal probability. The user must select which of the two mechanisms best models the behavior of the modeling process. These two summarizing options have special significance when the enslaved Source is a source that represents a stochastic process. As an example, suppose a Source that tries to model the hourly power of the set of wind farms installed in national territory and that this source is used in a weekly step room. If there is sufficient filtering capacity of the system to absorb all variations of the wind power, the averaging mechanism may be used, but if there are doubts about the ability of the system to absorb the variations, the mechanism of selecting a random value is preferable. as a way to have maximum variance in the value. In practice it may be worthwhile, if in doubt, to execute in the two modalities because reality is surely between the two and thus have a measure of the error made in modeling.

In both enslavement mechanisms, a Source is created with the same definition of terminal as the original, which supplants the original and enslaves it. All entities that were connected to the original are automatically connected to the slave source at the Simulator's runtime.

The edition form of the CEGH Synthesizer Type Sources (see Fig.5) explicitly shows a "type of enslavement" box that, in the case of the Synchronous Source, will indicate "Unclaimed", for the Oversampled Source it will indicate "Oversampled" and in the case of the Subsampled Source it will indicate "Subsampled". In case of being "Subsampled", the box that allows to mark or unmark "Summarize averaging" is activated. If the type of summary is marked it will be averaging and otherwise it will be any of the random values.

An example of an Oversampled Source is a CEGH synthesizer that generates weekly average hydraulic flow rates of contributions to be used as input by the "Hydroelectric Generators" Actors in a daily step Room.

An example of a Subsampled Source is a CEGH synthesizer that generates hourly wind speeds used in a weekly time step Room.

## **1.6. Calculated Terminals.**

This section describes a feature of the SimSEE platform that although it may be transparent to the user, it is relevant to understand the generic operation of the Sources.

When the user connects an Entity (Actor or Source) to a terminal of a Source, it does so to one of the terminals published by the Source. There are times when the value that one would like to have on the part of the Entity is not exactly that generated by the Source but that it would be desirable to

have a value transformed by a certain characteristic function of the Entity that is connected.

A typical example of this is the wind farms connected to an hourly wind source. The Source generates hourly wind speeds in its terminals, the Wind Farm would have to transform the speed into Power hour by hour using the characteristic Speed-Power curve of the aero-generators and then integrate that power to calculate the available energy for each time band inside of the time step.

With the objective of “independentizing” as far as possible the models of the Actors of the work of carrying out the transformation and integration, SimSEE has implemented in a generic way the possibility that the Entity that connects to a Source requests it to add a Calculated terminal to the terminal of the Source and for that it provides the Source with the transformation function that must be applied to the terminal to which it is connected to generate the Calculated Terminal. This mechanism allows to take advantage of the application of the enslavement mechanisms described in sec. 1.5 that is applied over the entire terminal block.

### **1.7. Values exported for SimRes.**

All sources export their terminal directly into the SimRes simulation results file (for more details on the file see section 4.5 “Results Files” in Volume 1 of the SimSEE User Manuals).

The variables corresponding to the terminal block are exported with the name "Terminal [1]", "Terminal [2]", ... and so on until the terminal block is completed.

The content of each terminal of the terminal block is indicated in the description of the specific models.

## **2. Sources available in SimSEE.**

The *Source* models currently available on the SimSEE platform are:

- Constant Source. (sec. Error: no se encontró el origen de la referencia)
- Uniform Source. (sec. Error: no se encontró el origen de la referencia)
- Gaussian Source. (sec. Error: no se encontró el origen de la referencia)
- Weibull Source. (sec. Error: no se encontró el origen de la referencia)
- Combination Source. (sec. Error: no se encontró el origen de la referencia)
- Product Source. (sec. Error: no se encontró el origen de la referencia)
- CEGH Synthesizer. (sec. Error: no se encontró el origen de la referencia)
- Tiempo Source. (sec. Error: no se encontró el origen de la referencia)
- Sinusoid Source. (sec. Error: no se encontró el origen de la referencia)
- Maxmin Source. (sec. Error: no se encontró el origen de la referencia)
- Selector Source. (sec. Error: no se encontró el origen de la referencia)

- Time selector Source. (sec. Error: no se encontró el origen de la referencia)

They cover a wide spectrum of functionalities, from modeling different probability distributions (uniform, Gaussian, Weibull), through the implementation of a set of basic functionalities (linear combination, product, sinusoid, maxmin, selector), to a particular case of Sources that allow modeling and reproducing the statistical behavior of historical data series (CEGH synthesizer)

TFuenteConstante

TFuenteUniforme

TFuenteGaussiana

TFuenteWeibull

TFuenteCombinacion

TFuenteProducto

TFuenteSintetizadorCEGH

TFuenteTiempo

TFuenteSinusoide

TFuenteMaxMin

TFuenteSelector

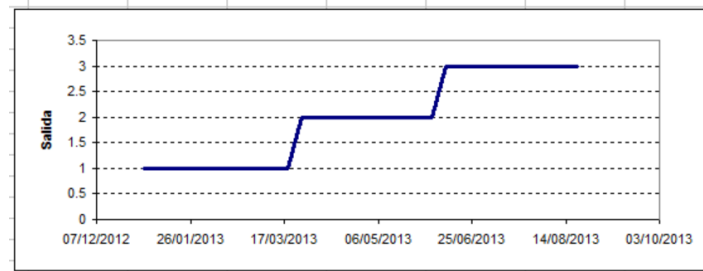
TFuenteSelector\_horario

**Nueva por documentar:**

TFuenteOperacionMultiFuente

## 3. Constant Source.

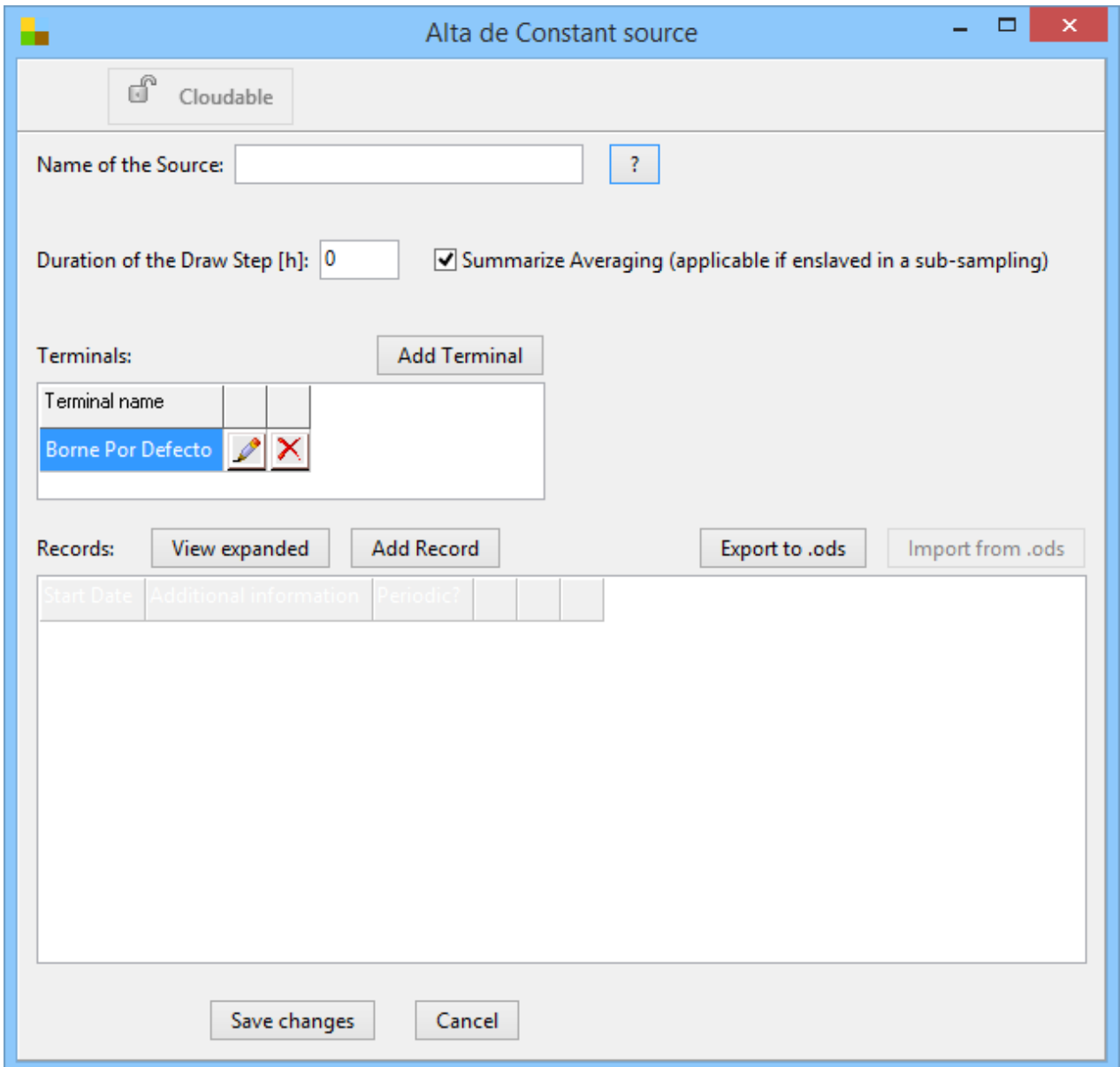
Constant Sources generate “constant by sections” values in their output terminal. The “constant” value is specified as a dynamic parameter tab, so it can be modified over time (see Fig. 7).



*Fig. 7: Example of Constant Source output.*

### **3.1. Operation description.**

The registration form of the Constant Sources is presented below:





Alta de Constant source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Borne Por Defecto		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

### **3.2. Static parameters.**

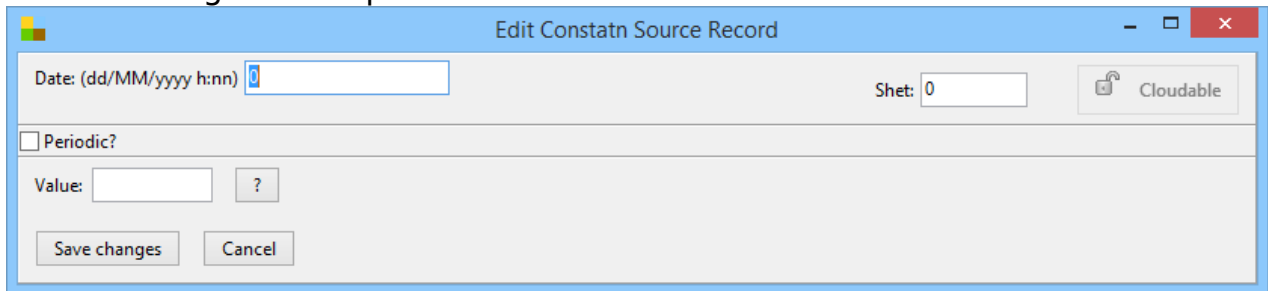
The static parameters are the Source Name and the Duration of the draw step.

### **3.3. Parámetros dinámicos.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of

technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The output value of the terminal must be specified in the “Value” box.

### ***3.4. Published variables for SimRes.***

The Source allows to publish the following variables:

<b><i>Name</i></b>	<b><i>Time Post</i></b>	<b><i>Description</i></b>
Terminal[1]	No	Value of Terminal output.

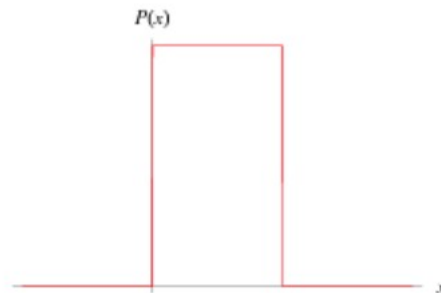
### ***3.5. State variables, Control and Restrictions.***

The source does not add state variables to the optimization problem.



## 4. Uniform Source.

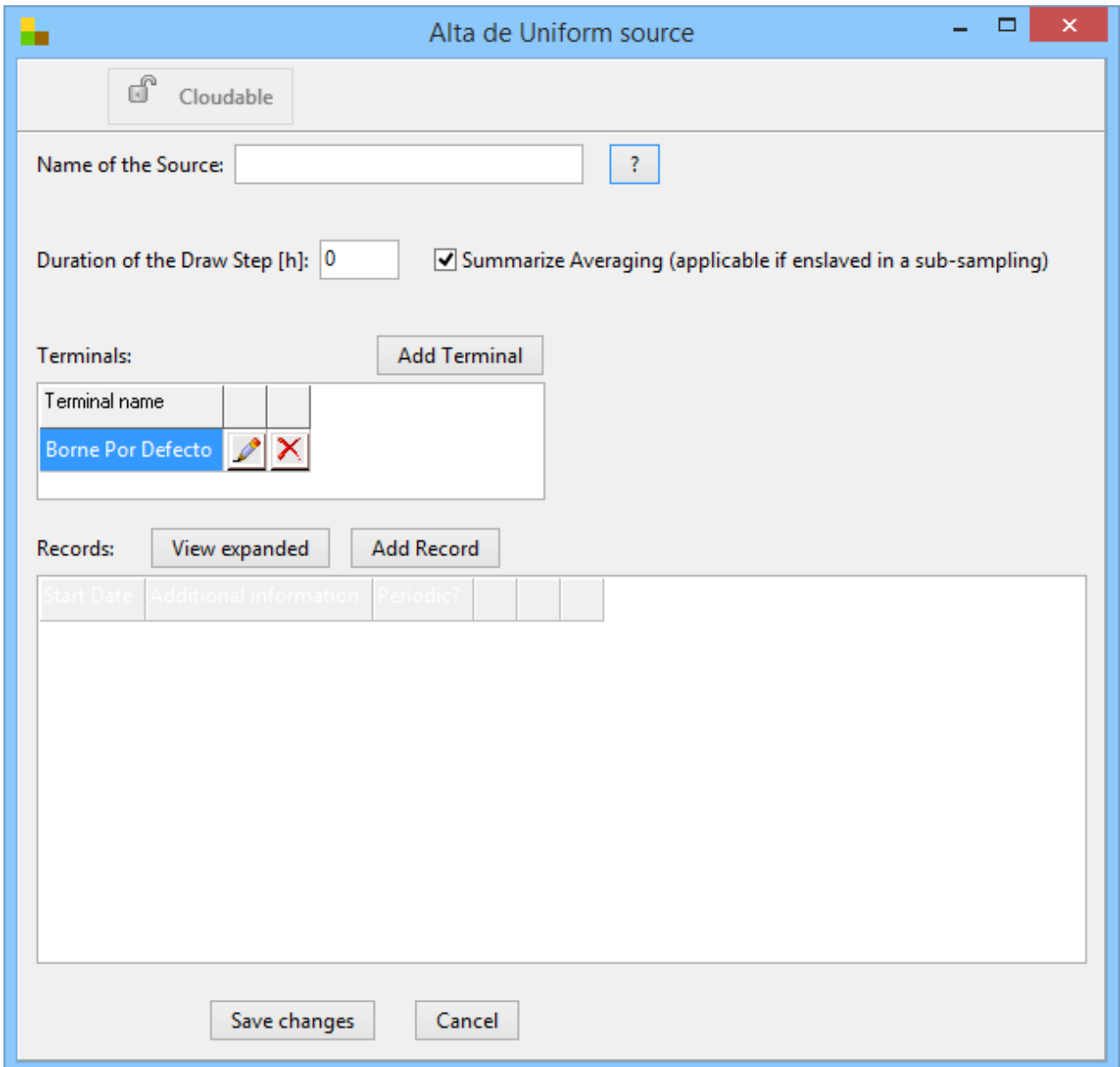
Uniform Sources generate random values uniformly distributed over a range that is specified by user as a dynamic parameter (Fig. 8).



*Fig. 8: Uniform distribution*

### **4.1. Operation description.**

The registration form of the Time Selector Source is presented below:





Alta de Uniform source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Borne Por Defecto		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

#### **4.2. Static parameters.**

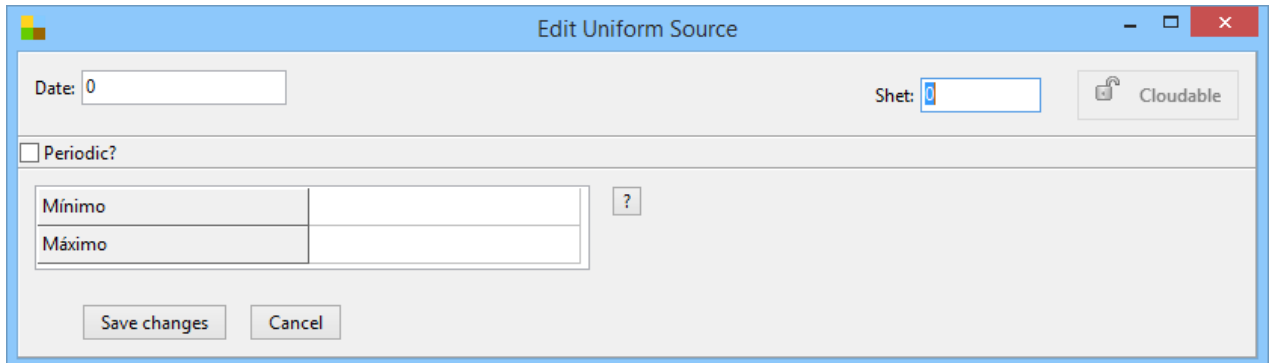
The static parameters are the Source Name and the Duration of the draw step.

#### **4.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of

technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The “Minimum” and “Maximum” parameters specified in the form correspond to the low and upper bounds of the Uniform Distribution.

#### **4.4. *Published variables for SimRes.***

The Source allows to publish the following variables:

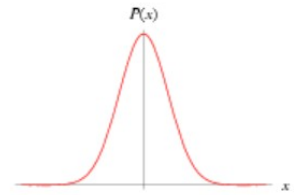
<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

#### **4.5. *State variables, Control and Restrictions.***

The source does not add state variables to the optimization problem.

## 5. Gaussian Source.

This Source generates random values that present a Gaussian Distribution (see Fig. 9). The expected value and variance must be specified, so that the source generates values with that distribution.

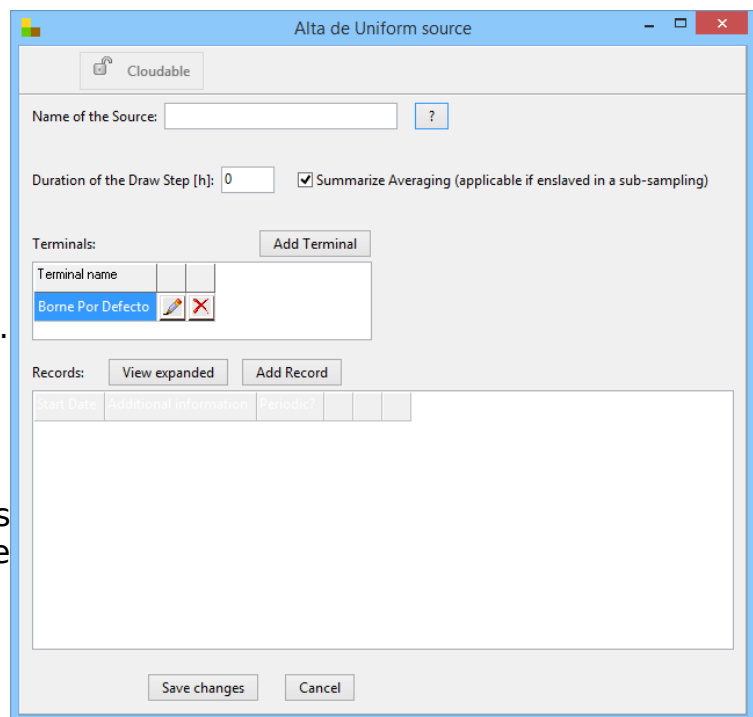


*Fig. 9: Normal distribution.*

### 5.1. Operation description.

The registration form of the Gaussian Source is presented below:

The general features of the Source are described in the document General Characteristics of the Sources.



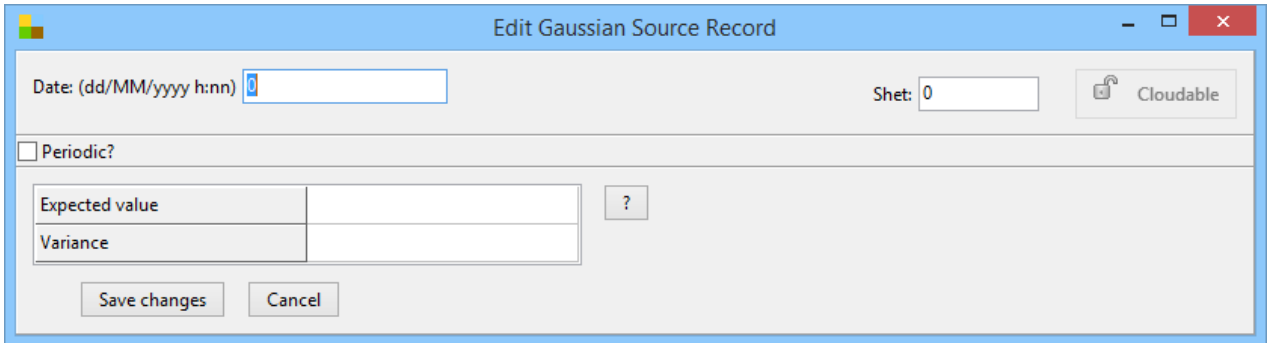
### 5.2. Parámetros estáticos.

The static parameters are the Source Name and the Duration of the draw step.

### 5.3. Parámetros dinámicos.

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The "Expected Value" and "Variance" of the normal distribution must be specified.

#### **5.4. *Published variables for SimRes.***

The Source allows to publish the following variables:

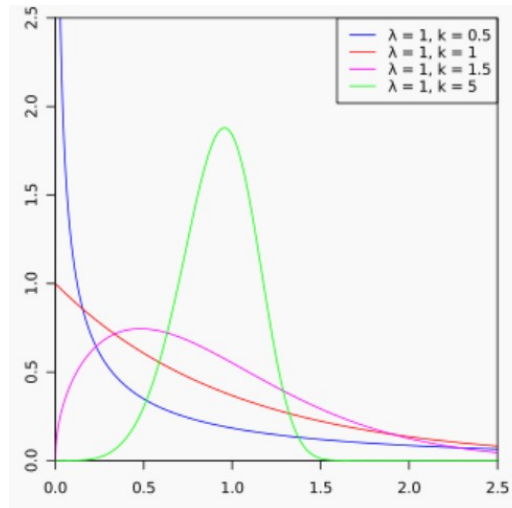
<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

#### **5.5. *State variables, Control and Restrictions.***

The source does not add state variables to the optimization problem.

## 6. Weibull Source.

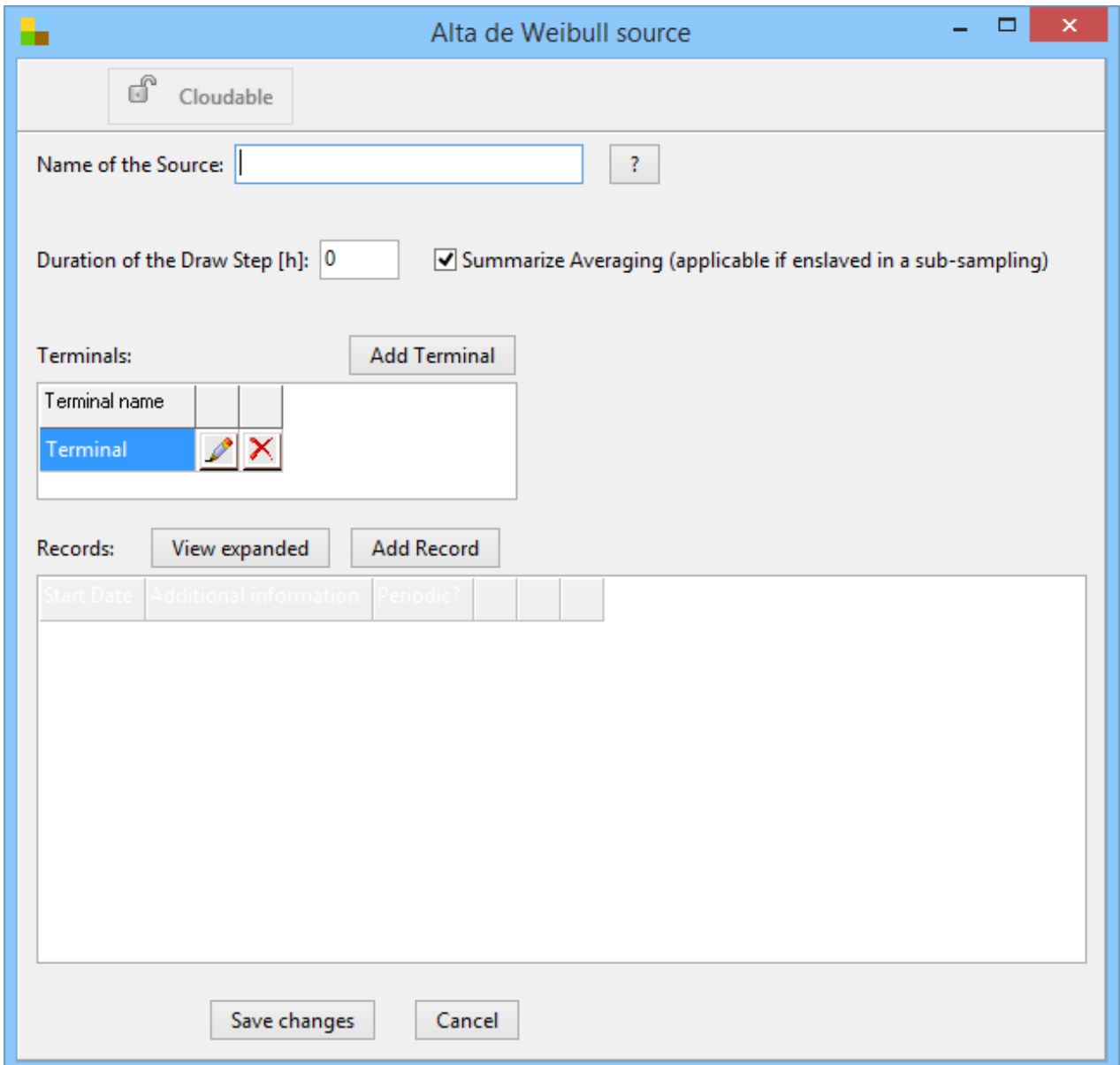
This Source generates a random Weibull variable as shown in Fig. 10. The Expected value ( $\mu$ ) and constant  $k$  (form factor) of the Weibull probability density function must be specified.



*Fig. 10: Weibull probability density function*

### 6.1. **Operation description.**

The registration form of the Weibull Source is presented below:





Alta de Weibull source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Terminal		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

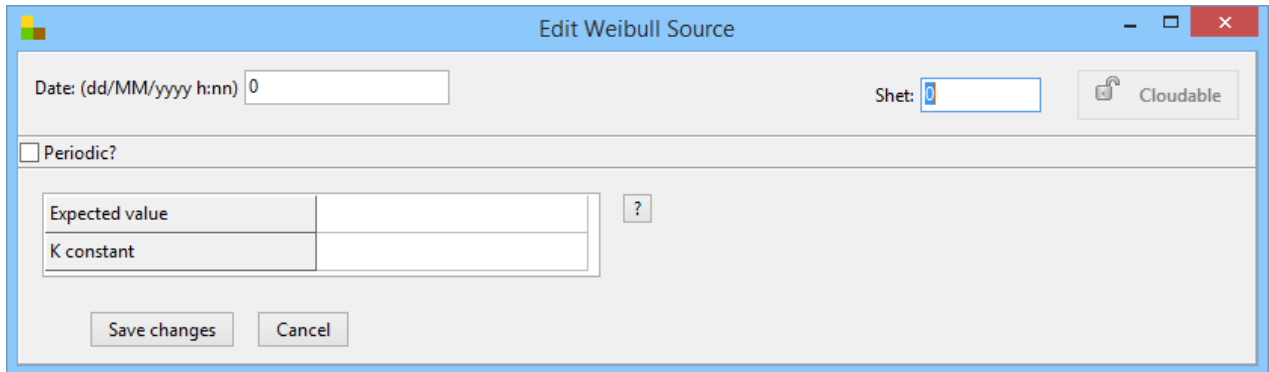
### **6.2. Static parameters.**

The static parameters are the Source Name and the Duration of the draw step.

### **6.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The Expected value ( $\mu$ ) and constant  $k$  (form factor) of the Weibull probability density function must be specified.

The cumulative distribution function of the Weibull distribution used by the Source is:

$$F(x; k, \lambda) = \begin{cases} 1 - e^{-(x/\lambda)^k}; & \text{si } x \geq 0 \\ 0; & \text{si } x = 0 \end{cases}$$

Where  $k$  is the “shape parameter” and  $\lambda$  the “scale parameter”.

The expected value of the Weibull distribution can be calculated as:

$$E(X) = \lambda \Gamma\left(1 + \frac{1}{k}\right)$$

#### **6.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

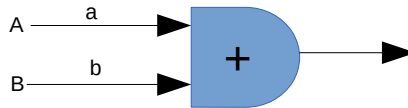
#### **6.5. State variables, Control and Restrictions.**

The source does not add state variables to the optimization problem.



## 7. Combination Source.

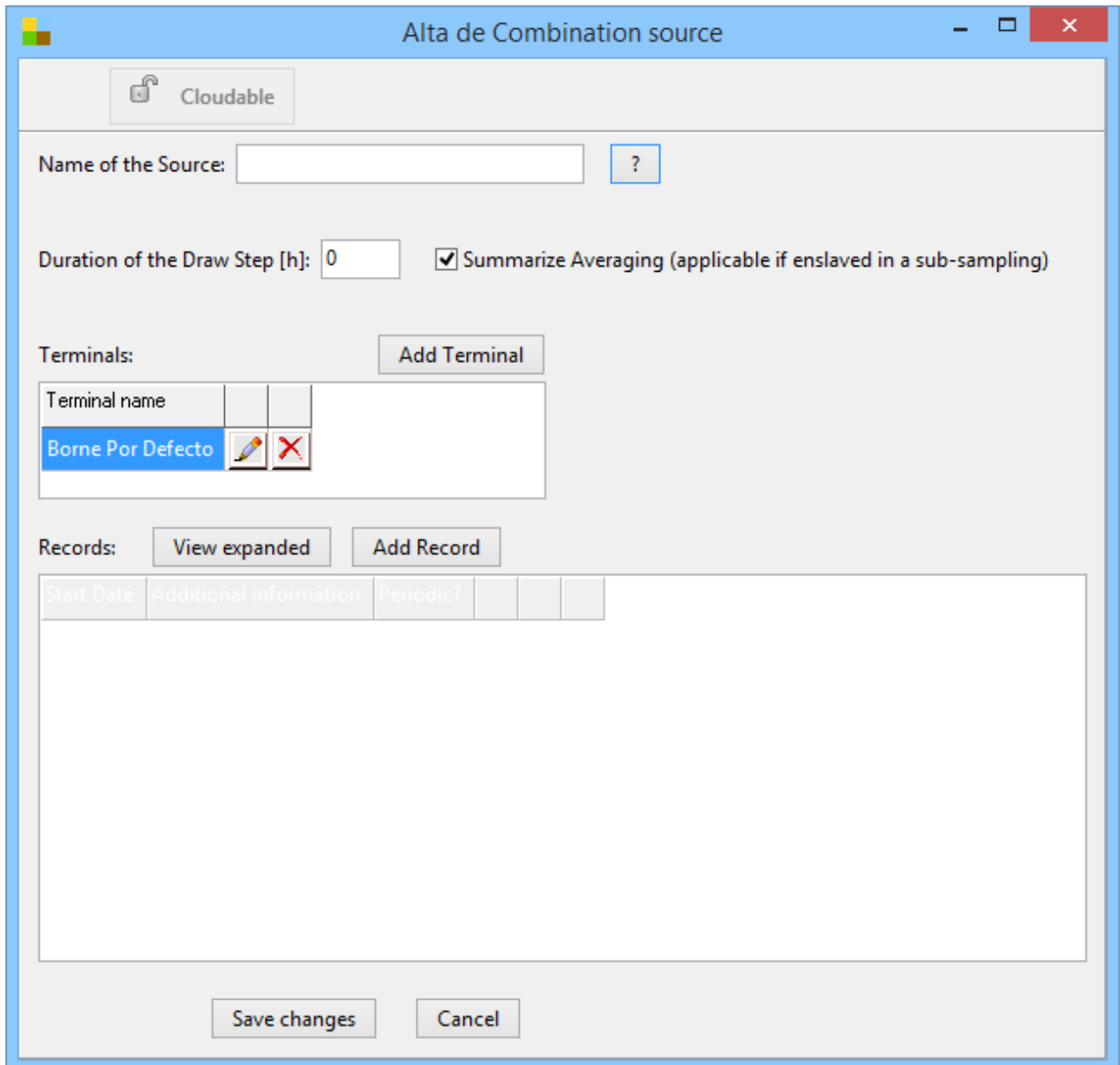
This Source generates an output value as a result of adding two terminals of other Sources with weighting coefficients, as shown in Fig. 11.



*Fig. 11: Combination Source.*

### **7.1. Operation description.**

The registration form of the Combination Source is presented below:





Alta de Combination source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Borne Por Defecto		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

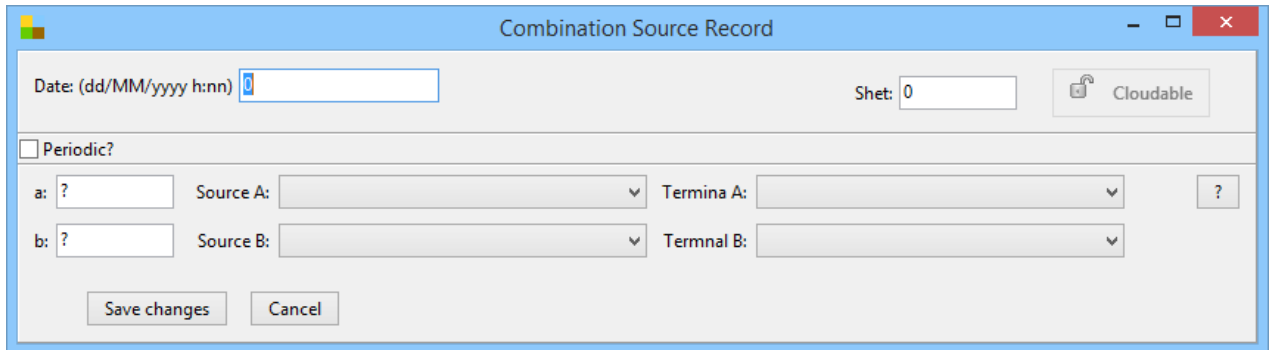
### **7.2. Static parameters.**

The static parameters are the Source Name and the Duration of the draw step.

### **7.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The Sources A and B and the selected terminals A and B to combine must be specified in the form. It must also be specified the weighting coefficients (a and b) that are applied to the respective Terminals (A and B) of the Sources. The value of the output Terminal ( *TerminalR* ) is obtained as the weighted linear combination of both input terminals, as shown in Fig. 11.

$$TerminalR = a \cdot TerminalA + b \cdot TerminalB$$

ec.1 Combination Source operation equation.

#### **7.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

#### **7.5. State variables, Control and Restrictions.**

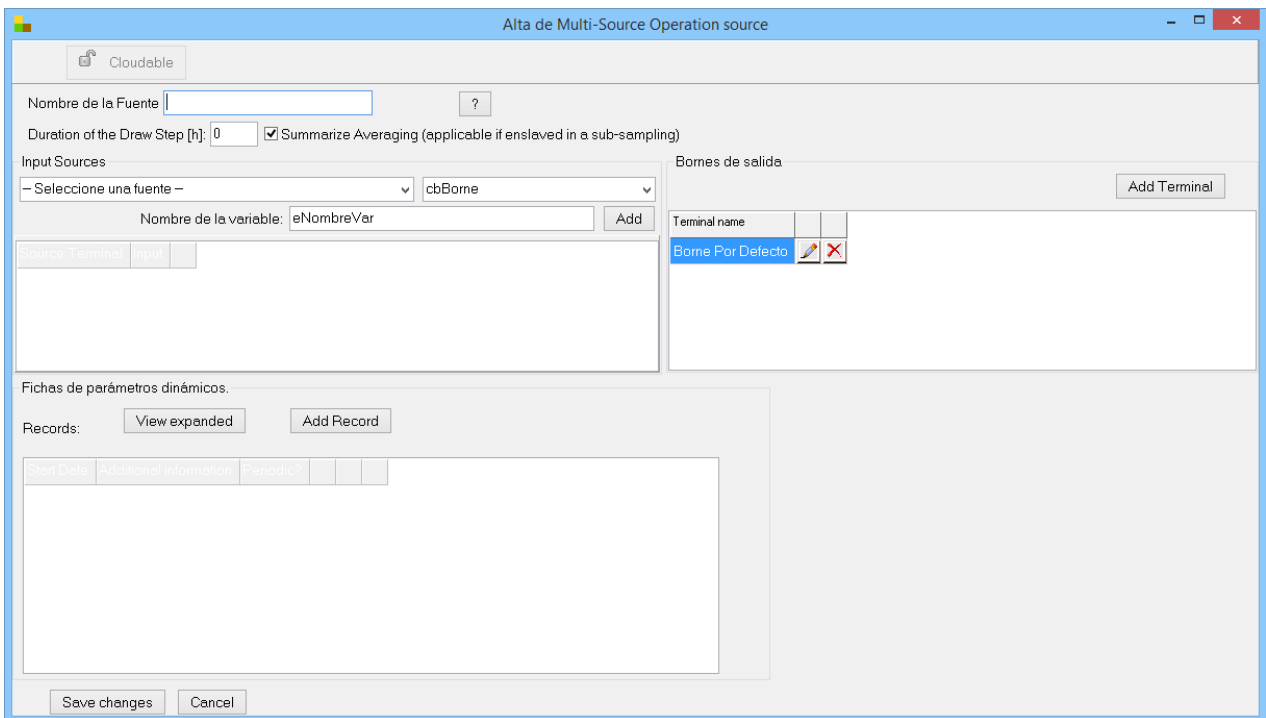
The source does not add state variables to the optimization problem.

## 8. Multi-Source Operation Source.

This Source allows operations between user-defined sources in an expression editor.

### 8.1. *Operation description.*

The registration form of the Multi-Source Operation Source is presented below:



The general features of the Source are described in the document General Characteristics of the Sources.

### 8.2. *Static parameters.*

The main static parameters are the Source Name and the Duration of the draw step.

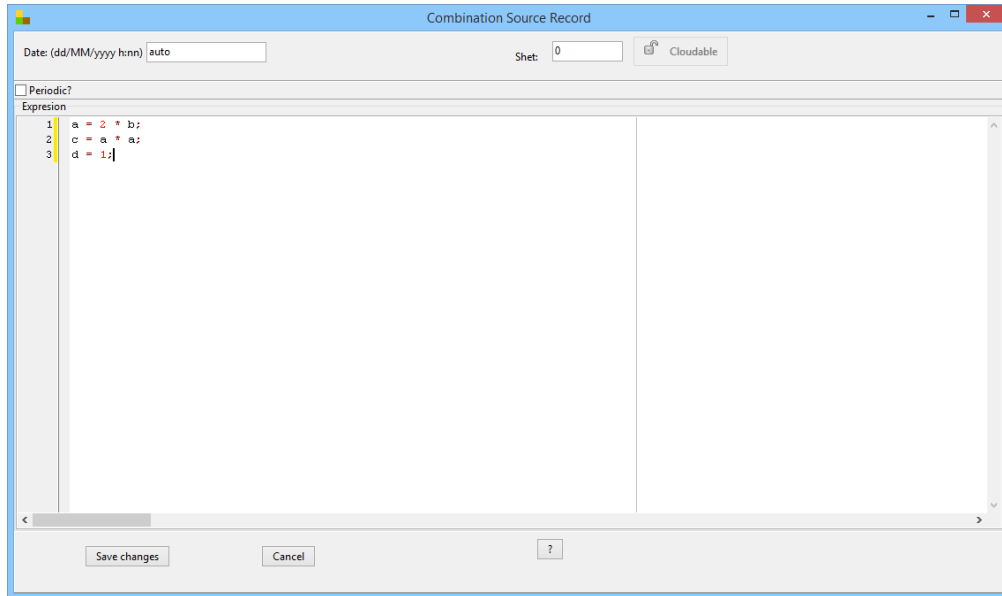
In the "Input sources" panel, you must select the terminals associated with the sources that will be considered as inputs of the operations. Each terminal must be assigned to a "Variable Name" and added to the list of input variables by pressing the "Add" button.

In the "Output terminals" panel you must create the terminals that will be considered as source outputs. To do this you must press the "Add Terminal" button and then edit the default name by pressing the pencil button.

### **8.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



In the "Expression" panel you must add the operations you want to perform on the input variables to obtain the user-defined output variables.

### **8.4. Published variables for SimRes.**

The Source allows to publish the following variables:

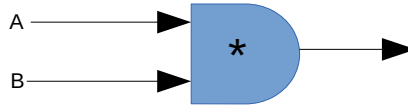
<b>Name</b>	<b>Time Post</b>	<b>Description</b>
NameTerminal_i	No	Source value of Terminal i.

### **8.5. State variables, Control and Restrictions.**

The source does not add state variables to the optimization problem.

## 9. Multiplication Source.

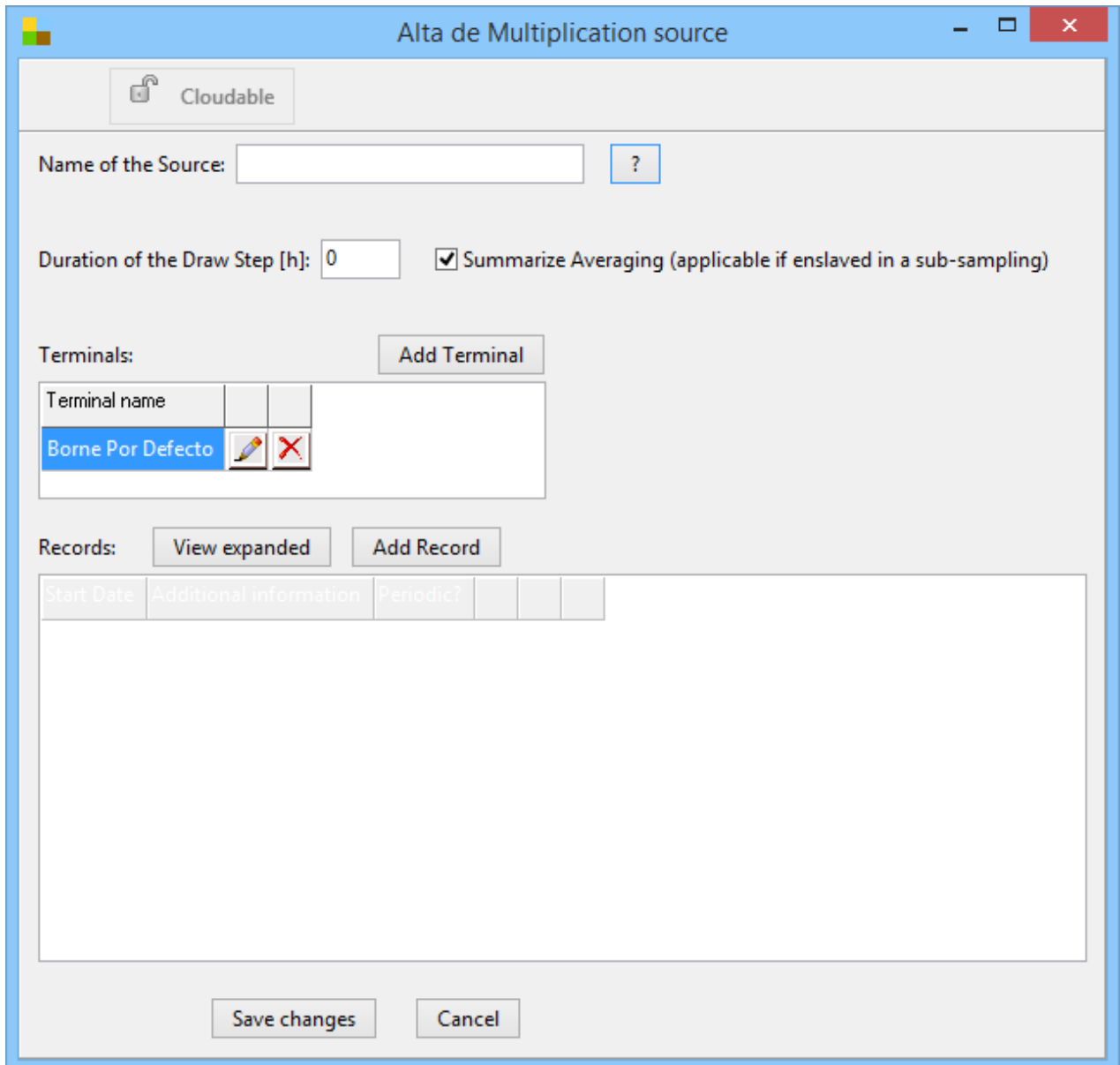
The Multiplication Source calculates the product of the values of two terminals of two Sources as shown in Fig. 12. Source and terminals of Sources must be specified by user.



*Fig. 12: Multiplication Source.*

### **9.1. Operation description.**

The registration form of the Multiplication Source is presented below:





Alta de Multiplication source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Borne Por Defecto		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

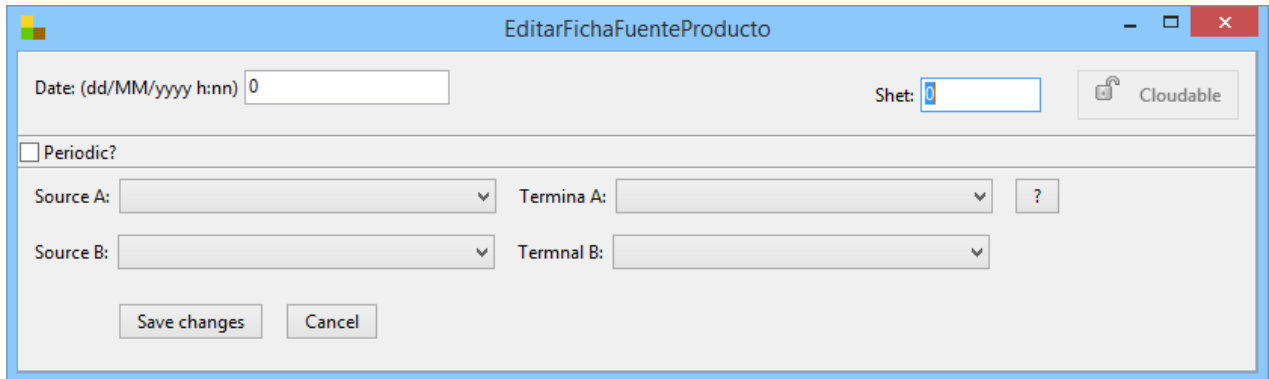
### **9.2. Static parameters.**

The static parameters are the Source Name and the Duration of the draw step.

### **9.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



Source and terminals of Sources must be specified by user in the form. The result terminal  $TerminalR$  is obtained by multiplying the inputs terminals A and B as shown in ec.2.

$$TerminalR = TerminalA \cdot TerminalB$$

ec.2 Multiplication Source result.

#### **9.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

#### **9.5. State variables, Control and Restrictions.**

The source does not add state variables to the optimization problem.



## 10. CEGH Synthesizer.

The "CEGH Synthesizer" Sources are useful to model multivariable stochastic processes in which it is necessary to represent the correlation between the variables both instantaneously and with their past.

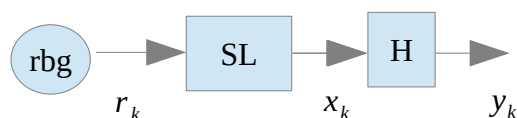
The use of this model is essential for the SimSEE platform because it allows modeling phenomena such as hydraulic contributions to dams, wind speeds, solar radiation, dependence on demand with temperature, etc..

The acronym CEGH means "Correlations in Gaussian Space with Histogram". The reader who requires to deepen the theoretical aspects can read the Technical Report: *Chaer, Ruben. (2015). Fundamentos del modelado CEGH de procesos aleatorios. 10.13140/RG.2.1.4637.8081.* ([https://www.researchgate.net/publication/279515834\\_Fundamentos\\_del\\_modelado\\_CEGH\\_de\\_procesos\\_aleatorios](https://www.researchgate.net/publication/279515834_Fundamentos_del_modelado_CEGH_de_procesos_aleatorios))

### 10.1. Operation description.

To create a CEGH model based on historical data series (for example, historical water inflows to dams), the "AnalisisSerial" [SimSEE\_mu5\_AnalisisSerial] program must be used. This program is supplied with the SimSEE platform.

The operating scheme of a CEGH synthesizer is shown in Fig. 13.



*Fig. 13: CEGH synthesizer.*

The first block of the diagram in Fig. 13 corresponds to the Gaussian white noise generator "rbg" that generates a vector  $r_k$  with independent components that feeds the linear system "SL". The "SL" system output  $x_k$  is a vector whose components are self-correlated as an effect of the linear system. The fact that components of  $r_k$  are independent Gaussians imply that the components of  $x_k$  are also Gaussian (although correlated and affected by system "SL") because linear systems generate Gaussian outputs when they are fed by Gaussian white noise. Finally, the "H" block transforms the  $x_k$  Gaussians into the  $y_k$  vector by reproducing the Histograms of amplitudes of the process to be modeled.

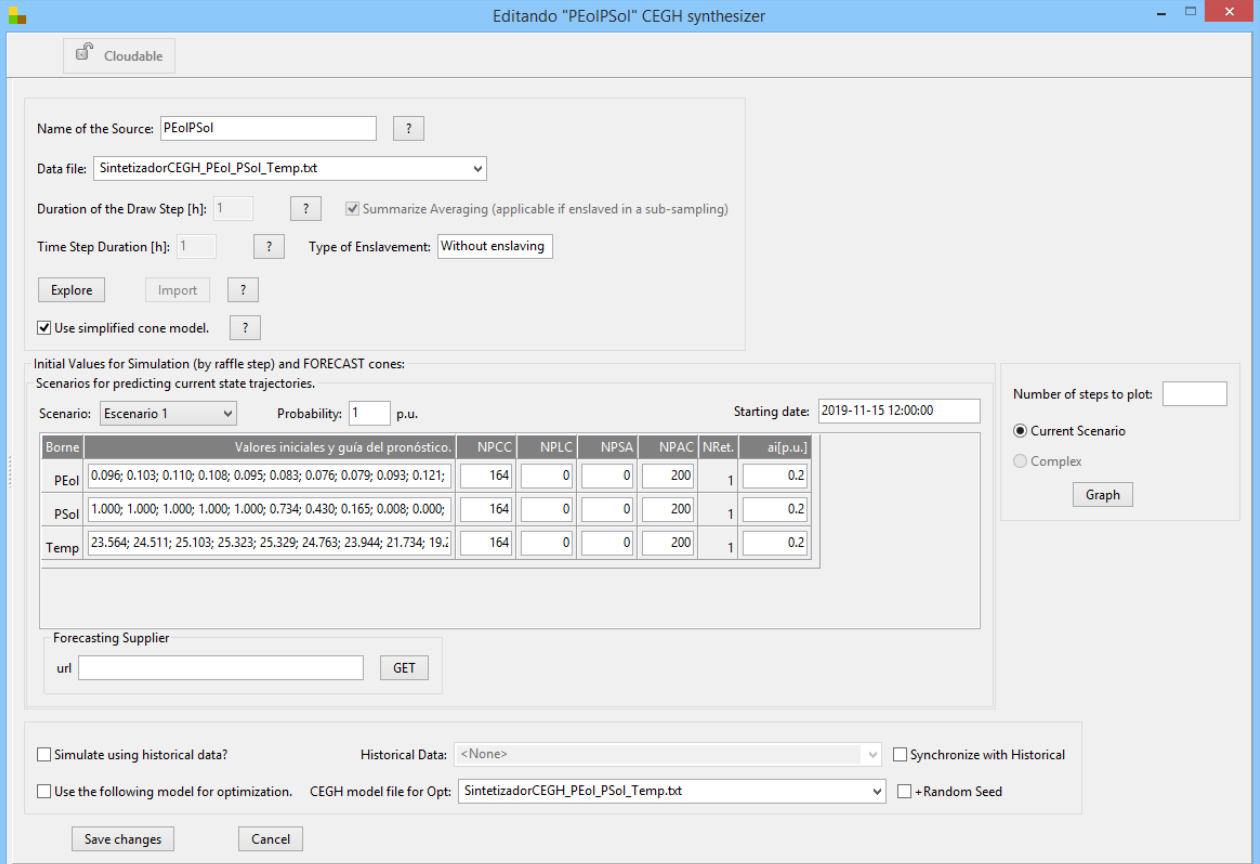
The main idea of the CEGH synthesiser is to find a transformation  $H^{-1}$  that transform the input data series used for the identification of the model to output series in a “Gaussian world” and in that Gaussian world to identify the linear system “SL” that when fed by Gaussian white noise it generates the same global Gaussian process. This identification is done by the AnalisisSerial program.

The idea behind the CEGH synthesiser is to find a model capable of generating series with the same histogram of the original series and that maintain the correlation between the series and the series with themselves.

## 10.2. Static parameters.

### 10.2.a) Global parameters

An example of the main form of a Synthesizer Source is shown in Fig. 14. There is a box in the form to specify the Name of the Source.



The screenshot shows a software window titled "Editando 'PEoIPSoL' CEGH synthesizer". It features a "Cloudable" icon in the top left. The main interface includes several input fields and checkboxes:

- Name of the Source:** PEoIPSoL
- Data file:** SintetizadorCEGH\_PEoIPSoL\_Temp.bt
- Duration of the Draw Step [h]:** 1
- Summarize Averaging (applicable if enslaved in a sub-sampling)
- Time Step Duration [h]:** 1
- Type of Enslavement:** Without enslaving
- Buttons: Explore, Import
- Use simplified cone model.

Below these fields, there is a section for "Initial Values for Simulation (by raffle step) and FORECAST cones: Scenarios for predicting current state trajectories." It includes a "Scenario" dropdown (Escenario 1), "Probability: 1 p.u.", and "Starting date: 2019-11-15 12:00:00".

Borne	Valores iniciales y guía del pronóstico.	NPCC	NPLC	NPSA	NPAC	NRet.	ai[p.u.]
PEoI	0.096; 0.103; 0.110; 0.108; 0.095; 0.083; 0.076; 0.079; 0.093; 0.121;	164	0	0	200	1	0.2
PSoI	1.000; 1.000; 1.000; 1.000; 1.000; 0.734; 0.430; 0.165; 0.008; 0.000;	164	0	0	200	1	0.2
Temp	23.564; 24.511; 25.103; 25.323; 25.329; 24.763; 23.944; 21.734; 19.;	164	0	0	200	1	0.2

At the bottom, there is a "Forecasting Supplier" section with a "url" field and a "GET" button. Further down, there are checkboxes for "Simulate using historical data?", "Use the following model for optimization.", and "Synchronize with Historical". The "CEGH model file for Opt:" is set to "SintetizadorCEGH\_PEoIPSoL\_Temp.bt".

Fig. 14: CEGH synthesiser form.

The file containing the CEGH model (generated from the Analisisserial program) must be specified at the top of the form in the “Data File” line. The

CEGH model must be chosen from the list of files added to the room in the "Files" editor tab.

When the CEGH file is loaded, the "Duration of the draw step" and "Type of enslavement" boxes are completed automatically. In the example of Fig. 14, as the duration of the Draw Step coincides with the Simulation Step (set by the Room) there is no enslavement of the Source.

By clicking on the "Export" button a file in .xlt format (plain text, separated by tabs) is created in the SimSEE temporary folder. This file contains the forecast cone data in a format that can be interpreted by the CEGH source and be edited, adjusting biases, Guide and factors and subsequently imported by clicking on the "Import" button. If it is desired to use the imported file for the CEGH Source, the "Use simplified cone model" box must be unchecked. Warning: This function is recommended only for advanced users. For linear cone adjustments, guide or start date changes it is recommended to use the lower panel that is enabled when checking the box "Use simplified cone model".

Below, in the panel "Initial Values for Simulation and FORECASTS cones" the forecast scenarios with their respective probabilities of occurrence must be specified. Basically, the Synthesizer forecast cones allows to define for each terminal of all the scenarios a 50% probability Guide and an attenuator of the variance. The number of steps in which the guide is considered and the speed with which the values skewed by the forecast depend only on the model output based on historical information are regulated with the NPPC, NPLC, NPSA and NPAC parameters as described in 10.2.b.

The "Simulate with Historical data" checkbox enables to use the historical series from a file selected in the corresponding combobox.

The "Synchronize with Historical" checkbox is rarely used and allows to reproduce a specific section of the story in order to check what the system's behavior might have been. The Room simulation Horizon must be included in the horizon covered by the loaded historical data.

The historical series are only considered for the Simulation stage. The selected CEGH model is always used for the Optimization stage.

At the end of the form you can specify another CEGH model file to be used only at the Optimization stage instead of the file specified at the top of the form. This functionality was incorporated to be able to calculate an Operation Policy (calculation that takes place during Optimization) with a given model of a stochastic process and then to be able to perform the simulation with another model, as a way of estimating the benefit of improving the information of a model. When simulating with historical data a loop is made so that when the historical data end is reached it starts again from the beginning. The first chronicle used for the simulation corresponds to the first year of historical data, the second to the second year and when the end of data is reached it starts over from the beginning. If the "+ Random Seed" box is checked, instead of starting the simulation considering the historical data of the first year, simulation starts considering the data of year

corresponding to the random seed. This is a way to consider a specific chronicle when simulating a single chronicle.

## 10.2.b) Forecast Cone Parameters

As mentioned above, for each scenario it is possible to specify a "Forecasting cone"; a row for each output terminal of the CEGH Synthesizer source. The first column "Terminal" contains the names of the source output terminals. The second column "Initial values and forecast guide" must be completed by an array of numbers separated by ";" (semicolon) which must contain the initial values of the filter and a 50% probability Guide for each Terminal of the Source. The specified values of the array will be used for each draw step of the Source (the draw step duration may be different to Simulation time step). The number of initial values must be the same as the memory of the model. The initial value of the vector is associated with the "Starting Date" specified at the top of the panel.

The column "NRet" specifies the number of delays and therefore indicates how many values are necessary to initialize the CEGH model.

If more values than the NRet necessary to set the initial value of the linear system are introduced, they will be used as a guide for a "forecast cone". The "NPCC", "NPLC", "NPSA", "NPAC" and "ai" parameters will determine the shape of the cone.

The parameters that affect the calculation of biases and attenuators of the model are the values introduced as "forecast guide", as well as the NPCC, NPLC, NPSA and NPAC parameters. The NPCC and NPLC parameters determine how the mediatrix of cone is calculated. The NPSA and NPAC parameters determine the opening dynamics of the cone. The parameters specifications are detailed below:

- Forecast Guide: Vector containing the forecast values in addition to those necessary to initialize the filter. This vector will set the "mediatrix" of the evolution of the dynamic CONE of each Terminal output of the Source. By default, the input data vector set for each Terminal the 50% probability of exceeding value. For future versions of SimSEE, it is expected to be able to change the probability of exceeding value in the column "pe [p.u.]" to a value other than 0.5, but in the current SimSEE version is fixed in 0.5 (50 %).
- NPCC: Number of Cone Control Steps. During this amount of draw step duration steps, the cone mediatrix is forced to follow the input guide's values. The NPCC number of steps in addition to the number of initial values must be equal to large of the Forecast Guide.

- NPLC: Number of Cone Release Steps. Number of steps, after completing the NPCC steps, in which the bias of each Terminal decays from the value of the last NPCC step to zero. The decay of bias is linear.
- NPSA: Number of Steps Without Opening. Number of "deterministic" steps at the beginning of the cone, these means, the amount of steps in which the forecast is considered to be deterministic. During the NPSA steps the cone is a single curve without cone opening and the "noise attenuators" are null. The NPSA value must be less than or equal to the NPCC value.
- NPAC: Number of Cone Opening Steps. Number of steps in which the "noise attenuators" rise from 0 (deterministic) to 1 (historical data series variance).
- ai: Initial "noise attenuators" (per unit).

Button "Graph" prints on screen a plot containing the frequencies of exceedance of the output series. If "Current scenario" is checked, the outputs from the current scenario are plotted; If "Complex" is checked, the scenario probability of occurrence weighted average is plotted. The "Number of steps to be plotted" must be specified to select the time window of the plot.

### **10.3. Dynamic parameters.**

The CEGH Synthesizer Sources have no dynamic parameters.

### **10.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
RB_TerminalName_i	No	White noise inputs of Terminal i.
Wa_TerminalNumber_i	No	White noise inputs of Terminal i for the expansion of reduced state variables.
X_TerminalName_i	No	Current step gaussian value of the state variable of Terminal i.
Y_TerminalName_i	No	Current step State variable value of Terminal i.
Xs_TerminalName_i	No	Next step gaussian value of the State Variable of Terminal i.
Ys_TerminalName_i	No	Next step value of the State Variable of Terminal i.
BC	No	Calculated Terminals.
XRed	No	Reduced State Variable.

### **10.5. State variables, Control and Restrictions.**

The state variables of the CEGH Synthesiser and its discretizations have to be specified in the CEGH model file.

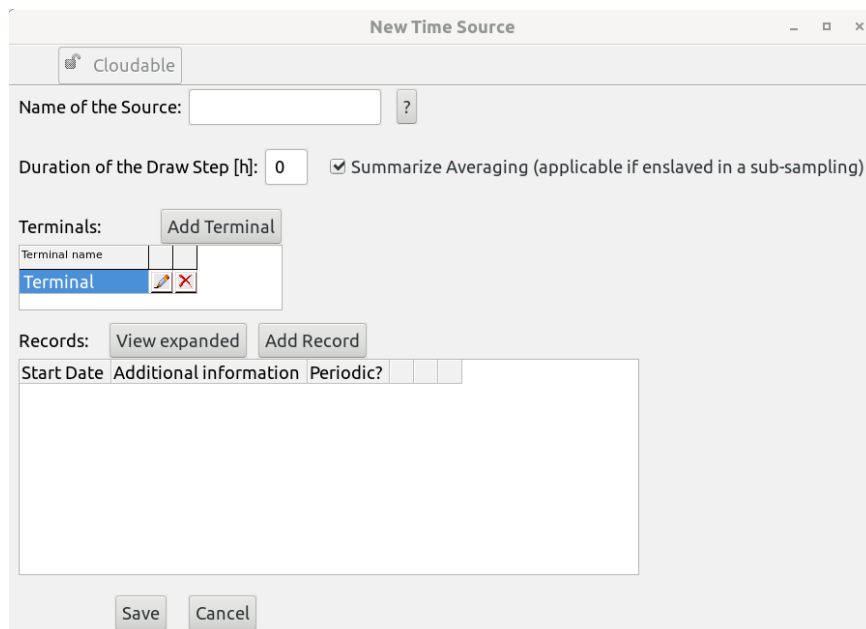
# 11. Time Source.

This Source generates the value in hours elapsed from a given moment that the user can specify. That is, it generates the distance in hours between the start of the current simulation / optimization step and a specified “temporary marker”.



## 11.1. *Function description.*

The registration form of the Time Source is presented below:



**New Time Source**

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Terminal		

Records:

Start Date	Additional information	Periodic?		

The general functionalities of the Source are described in the document General Characteristics of the Sources.

## 11.2. *Static parameters.*

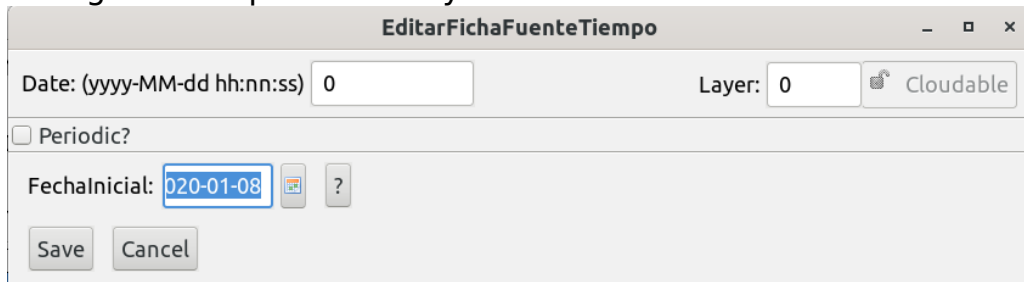
The static parameters are the Source Name, Layer and Duration of the draw step.

## 11.3. *Dynamic parameters.*

The dynamic parameters of the Source are defined within the Dynamics Parameters Records. When instantiating a new Dynamic Parameter Record, the validity start date of said Record and its periodicity must be defined.

Additionally, a list of technical parameters that define the characteristics of the Source must be specified.

The registration panel of a Dynamic Parameters Record is shown below:



You must specify the “Initial Date” from which the distance in hours to the current simulation / optimization step is measured.

### ***11.4. Variables published for SimRes.***

The Source allows publishing the following variables by post or time step:

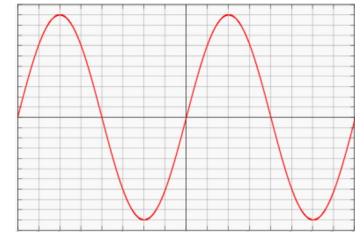
<b><i>Name</i></b>	<b><i>Time banded</i></b>	<b><i>Description</i></b>
Borne[1]	No	Salida de la fuente.

### ***11.5. State variables.***

The source does not add status variables to the optimization problem.

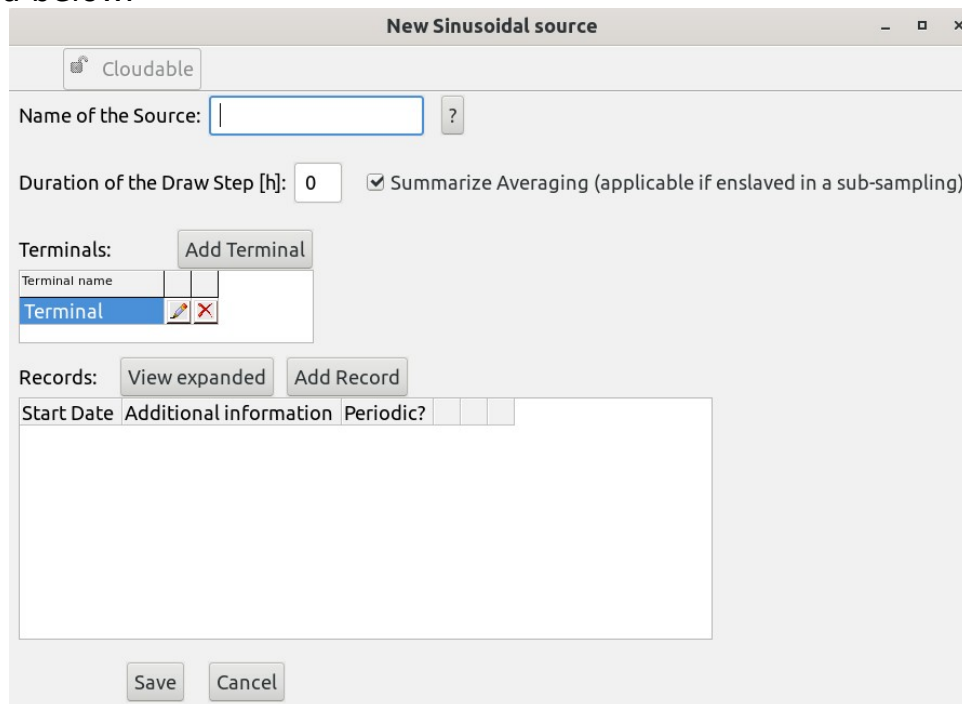
## 12. Sinusoidal source.

This source implements the sine and cosine functions at the output of another source selected as input.



### 12.1. *Function description*

The Sinusoidal Source registration form is presented below:



**New Sinusoidal source**

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Terminal		

Records:

Start Date	Additional information	Periodic?			

The general functionalities of the Source are described in the General Characteristics of the Sources section.

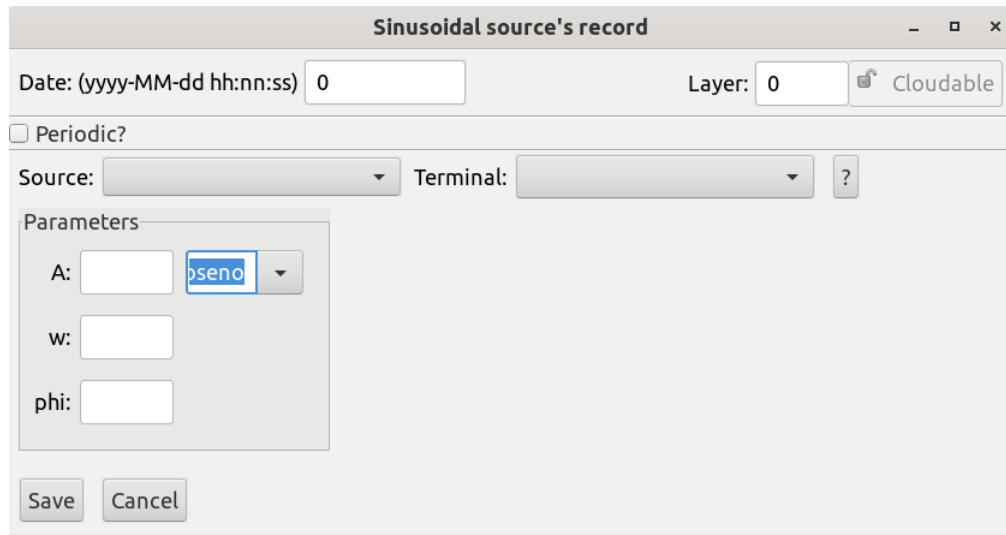
### 12.2. *Static parameters.*

The static parameters are the Origin Name and the Duration of the draw step.

### 12.3. *Dynamic parameters.*

The entry / editing form of a dynamic parameters tab is as shown below:





The source and terminal to which the sinusoidal function will be applied must be specified. You must also select between the sine or cosine function.

The following parameters must be specified:

- A: coefficient that modulates the amplitude of the sinusoid.
- w: Coefficient that modulates the angular frequency of the sinusoid.
- phi: coefficient that indicates the change of sinusoidal phas

The result will be as follows, depending on whether the cosine or sine function is selected respectively in the drop-down menu:

$$A * \cos(w * x - phi) \quad \text{or} \quad A * \sin(w * x - phi)$$

Depending on whether "cosine" or "sine" has been selected respectively and where "x" is the value taken by the source specified in the specified terminal.

#### **12.4. Variables published for SimRes.**

The Source allows publishing the following variables by publication or time step:

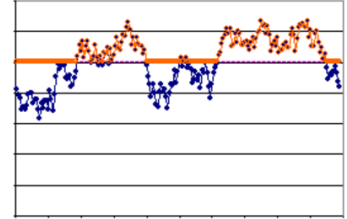
<b>Name</b>	<b>Time-banded</b>	<b>Description</b>
Borne[1]	No	Output of the source

#### **12.5. Status Variables.**

The source does not add status variables to the optimization problem.

## 13. MaxMin Source.

This Source selects the Minimum or Maximum between the output of a Source and a user-defined value.



### 13.1. Operation description.

The registration form of the Time Selector Source is presented below:

- □ ×
Alta de MaxMin source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals: Add Terminal

Terminal name		
Borne Por Defecto		

Records: View expanded Add Record

Start Date	Additional information	Periodic?		

Save changes Cancel

The general features of the Source are described in the document General Characteristics of the Sources.

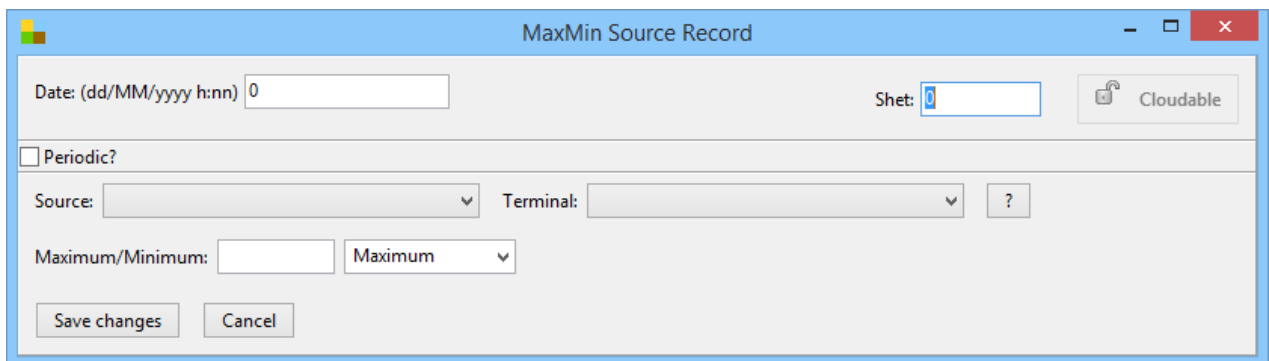
### **13.2. Static parameters.**

The static parameters are the Source Name and the Duration of the draw step.

### **13.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The Source and Terminal to be considered must be specified in the form. It must also be selected between the Maximum or Minimum function.

It must be specified the default value in the “Maximum /Minimum” box that will be taken as a reference for comparison with the output value of the selected Source.

Depending on whether the “Minimum” or “Maximum” function is selected from the drop-down menu, the result will be:

$$\text{Min}(x, \text{value}) \text{ or } \text{Max}(x, \text{value})$$

Where  $x$  is value of the Terminal and  $\text{value}$  the value specified by the user.

### **13.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

### **13.5. State variables, Control and Restrictions.**

The source does not add state variables to the optimization problem.

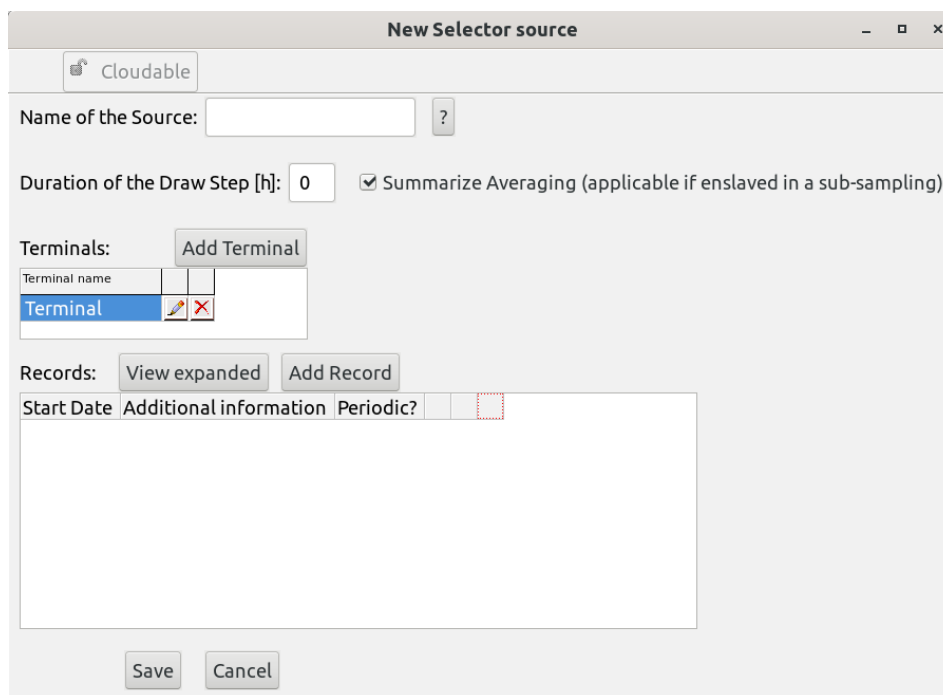
## 14. Selector Source.

This Source compares the values of the Terminals of two Sources A and B (inputs) and switches the Terminal output to the value of another Source C in case  $A > B$  or to the value of another Source D in case  $A \leq B$ .



### 14.1. *Function description.*

The registration form of the Selector Source is presented below:




### 14.2. *Static parameters.*

The static parameters are the Source Name and Duration of the draw step.

### 14.3. *Dynamic parameters.*

The form to create / edit a dynamic parameters record is as follows:



The 4 Sources must be specified, the two that you want to compare and the two that are selected according to the result of the comparison and the Terminals that you want to use from each of the sources. The result will be as follows, according to the result of the comparison between Sources A and B.

```

If ( A > B) then
    Output = C
else
    Output = D
    
```

Where A, B, C and D are the values that take the 4 Sources specified in the specified terminals.

#### **14.4. Variables published for SimRes.**

The Source allows publishing the following variables by post or time step:

<b>Name</b>	<b>Banded-time</b>	<b>Description</b>
Borne[1]	No	Output of the source.

#### **14.5. State variables.**

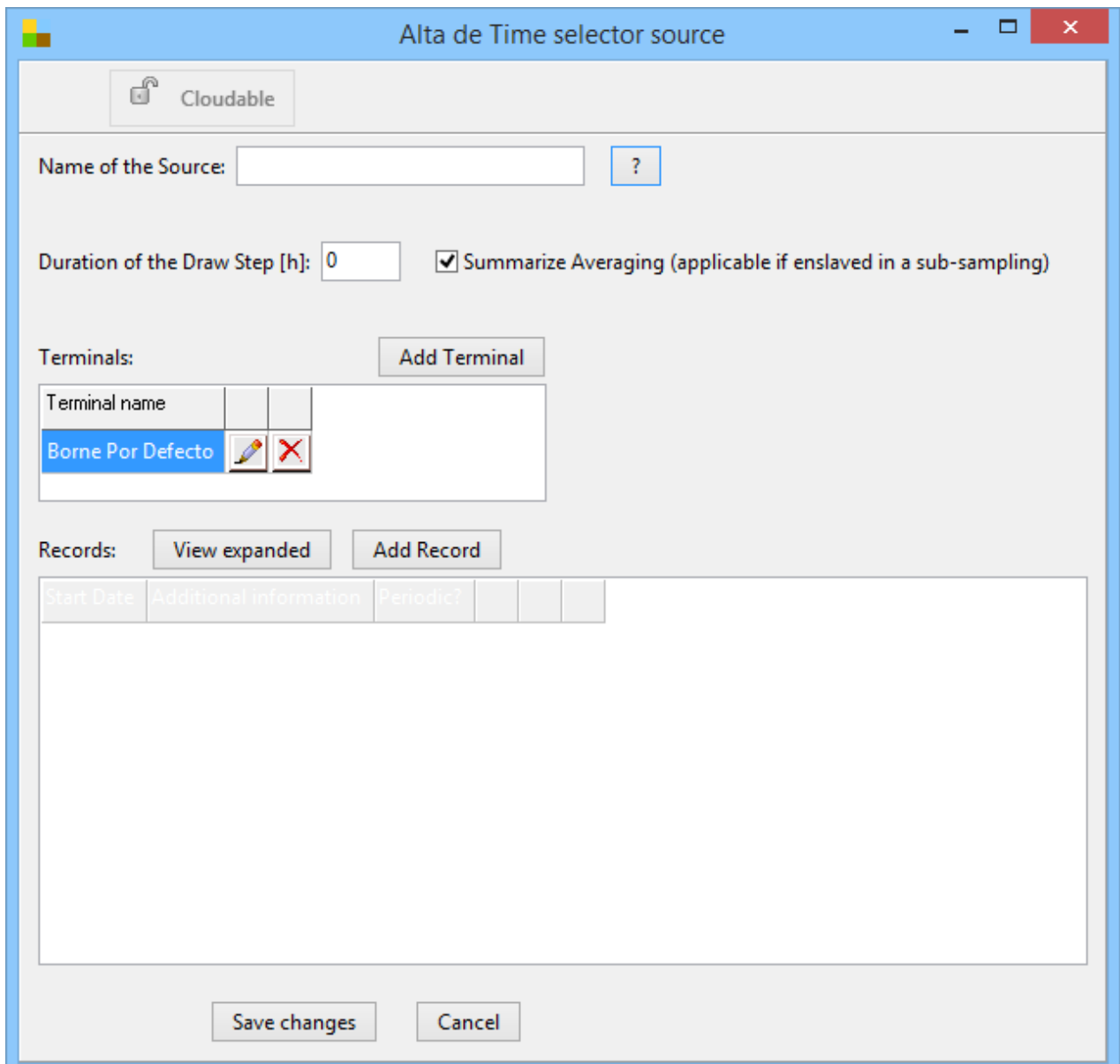
The source does not add status variables to the optimization problem.

## 15. Time Selector Source.

This Source generates an output value by selecting it from the value of the terminal of a set of up to 4 specified Sources, based on the time and type of start day of the simulation step.

### 15.1. *Operation description.*

The registration form of the Time Selector Source is presented below:





Alta de Time selector source

Cloudable

Name of the Source:  ?

Duration of the Draw Step [h]:   Summarize Averaging (applicable if enslaved in a sub-sampling)

Terminals:

Terminal name		
Borne Por Defecto		

Records:

Start Date	Additional information	Periodic?			

The general features of the Source are described in the document General Characteristics of the Sources.

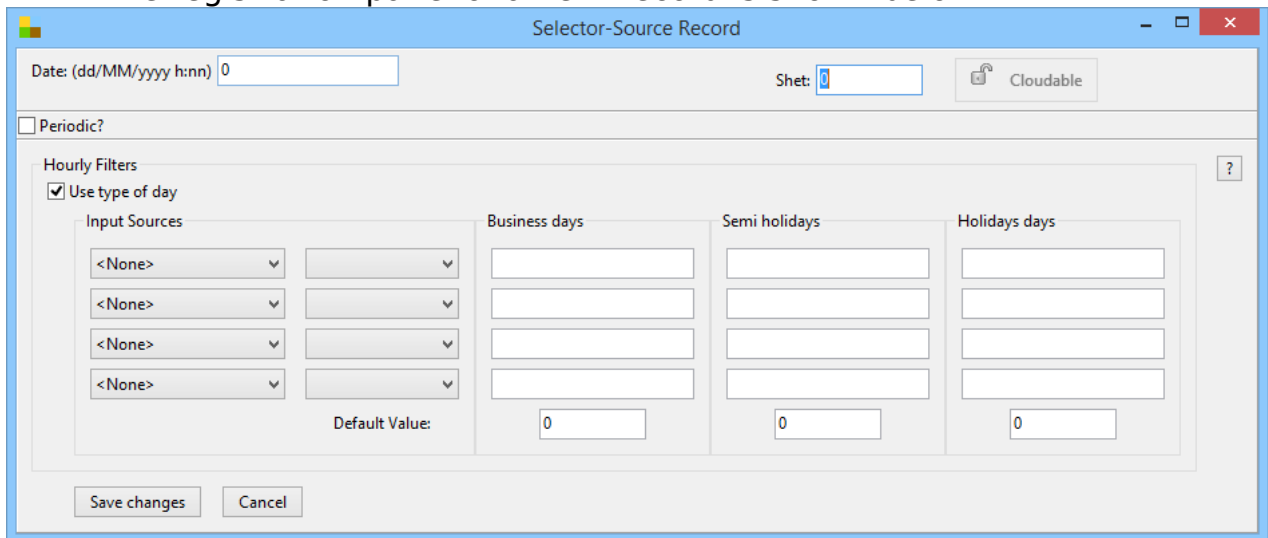
## **15.2. Static parameters.**

The static parameters are the Source Name and the Duration of the draw step.

## **15.3. Dynamic parameters.**

The dynamic parameters of the Source are defined within the Records panel, when adding a new Record. In a new dynamic parameters Record, the effective start date and its periodicity must be defined. Additionally, a list of technical parameters that define the characteristics of the Actor must be specified.

The registration panel of a new Record is shown below:



The “Hourly Filters” panel allows you to specify up to 4 Sources and their terminals, with 3 columns on the right: “Business days” (Monday to Friday), “Semi-holiday days” (Saturdays and non-mandatory holidays) and “Holidays days” (Sundays and mandatory holidays).

The “Use type of day” checkbox enables or disables the use of the type of day based on the type of day the step begins. If it is checked, the schedule filter will apply considering the values in each column of type of day. If it is NOT checked, only the values on column “Business days” are considered regardless of the type of day.

The 3 columns on the right represent the hourly filters for business days, semi-holidays and holidays respectively. In the columns you must enter at each line the beginning of the time step hour (s) at the for which you want the source corresponding to that line to be considered; the value of the selected source in the specified terminal will be the one that is copied in the output of the Time Selector Source in each time step.

These means that at each time step the column of the time filter is selected according to the type of day (or the one corresponding to business



days if the “Use type of day” checkbox is unchecked) and the start hour of the step is searched starting from the first down to the last line. At the line in which the start hour of the step is found, the source value and terminal specified on the left part of that line will be copied to the source's output. If the start hour of the step does not match any of the time filters specified in the column, none of the specified sources are selected and the "Default value" at the bottom of the active column is copied to the output.

#### **15.4. Published variables for SimRes.**

The Source allows to publish the following variables:

<b>Name</b>	<b>Time Post</b>	<b>Description</b>
Terminal[1]	No	Value of Terminal output.

#### **15.5. State variables, Control and Restrictions.**

The source does not add state variables to the optimization problem.