Washout rate

Luc Patryl - Dan Galeriu

September 6, 2010

SOMMAIRE

SOMMAIRE

energie atomique • energies alternatives

energie atomique • energies alternatives

Objectives: in 2010 january, the workgroup WG7 decided :

- to provide a simple and robust tritium model;
- to define the washout rate which has to be used by models according to several representatives rains;
- number of experimental data allowing to determine a washout rate is very low;
- leads to theoretical models often based on too few experimental data;

energie atomique • energies alternatives

Objectives: in 2010 january, the workgroup WG7 decided :

- to provide a simple and robust tritium model;
- to define the washout rate which has to be used by models according to several representatives rains;
- number of experimental data allowing to determine a washout rate is very low;
- leads to theoretical models often based on too few experimental data;

energie atomique • energies alternatives

Objectives: in 2010 january, the workgroup WG7 decided :

- to provide a simple and robust tritium model;
- to define the washout rate which has to be used by models according to several representatives rains;
- number of experimental data allowing to determine a washout rate is very low;
- leads to theoretical models often based on too few experimental data;

Objectives: in 2010 january, the workgroup WG7 decided :

- to provide a simple and robust tritium model;
- to define the washout rate which has to be used by models according to several representatives rains;
- number of experimental data allowing to determine a washout rate is very low;
- leads to theoretical models often based on too few experimental data;

According to the bibliography review, the washout rate depends of several parameters:

Release characteristics: height of release, distance from release;

Precipitation characteristics: type of precipitation (rain, snow, fog, hail, sleet), intensity of precipitation, drops size distribution, drops diameter, drops velocity, duration of crossing of the plume by drops;

Atmospheric characteristics: atmospheric pressure, temperature, humidity, dispersion.

energie atomique • energies alternatives

According to the bibliography review, the washout rate depends of several parameters:

Release characteristics: height of release, distance from release;

Precipitation characteristics: type of precipitation (rain, snow, fog, hail, sleet), intensity of precipitation, drops size distribution, drops diameter, drops velocity, duration of crossing of the plume by drops;

Atmospheric characteristics: atmospheric pressure, temperature, humidity, dispersion.

energie atomique • energies alternatives

According to the bibliography review, the washout rate depends of several parameters:

Release characteristics: height of release, distance from release;

Precipitation characteristics: type of precipitation (rain, snow, fog, hail, sleet), intensity of precipitation, drops size distribution, drops diameter, drops velocity, duration of crossing of the plume by drops;

Atmospheric characteristics: atmospheric pressure, temperature, humidity, dispersion.

According to the bibliography review, the washout rate ranges:

- from 10^{-5} to 10^{-3} s^{-1};
- light rain: 10^{-4} and heavy rain: 10^{-3} s^{-1};
- snow: 2.10^{-5} s^{-1};
- drizzle-fog: no data, no washout.

energie atomique • energies alternatives

energie atomique • energies alternatives

According to the bibliography review, the washout rate ranges:

- from 10^{-5} to 10^{-3} s^{-1};
- light rain: 10^{-4} and heavy rain: 10^{-3} s^{-1};
- snow: 2.10^{-5} s^{-1};
- drizzle-fog: no data, no washout.

energie atomique • energies alternatives

According to the bibliography review, the washout rate ranges:

- from 10^{-5} to 10^{-3} s^{-1};
- light rain: 10^{-4} and heavy rain: 10^{-3} s^{-1};
- snow: 2.10^{-5} s^{-1};
- drizzle-fog: no data, no washout.

energie atomique • energies alternatives

According to the bibliography review, the washout rate ranges:

- from 10^{-5} to 10^{-3} s^{-1};
- light rain: 10^{-4} and heavy rain: 10^{-3} s^{-1};
- snow: 2.10^{-5} s^{-1};
- drizzle-fog: no data, no washout.

energie atomique • energies alternatives

energie atomique • energies alternatives

Some type of liquid (rain, sleet), solide (hail) or mixed precipitations lead to a wet deposition. According to the American Meteorology Society:

- drizzle-fog: drops are generally less than 0.5 mm in diameter, are very much more numerous;
- light rain: the rate of fall varying between a trace and 2.5 mm.h^{-1}, the maximum rate of fall being no more than 0.25 mm in six minutes;
- moderate rain: from 2.6 to 7.6 mm.h^{-1} , the maximum rate of fall being no more than 0.76 cm in six minutes;
- heavy rain: over 7.6 mm.h^{-1} or more than 0.76 mm in six minutes;
- snow: precipitation in the form of crystalline water ice of all size.

energie atomique • energies alternatives

Some type of liquid (rain, sleet), solide (hail) or mixed precipitations lead to a wet deposition. According to the American Meteorology Society:

- drizzle-fog: drops are generally less than 0.5 mm in diameter, are very much more numerous;
- light rain: the rate of fall varying between a trace and 2.5 $mm.h^{-1}$, the maximum rate of fall being no more than 0.25 mm in six minutes;
- moderate rain: from 2.6 to 7.6 $mm.h^{-1}$, the maximum rate of fall being no more than 0.76 cm in six minutes;
- heavy rain: over 7.6 $mm.h^{-1}$ or more than 0.76 mm in six minutes;
- snow: precipitation in the form of crystalline water ice of all size.

Some type of liquid (rain, sleet), solide (hail) or mixed precipitations lead to a wet deposition. According to the American Meteorology Society:

- drizzle-fog: drops are generally less than 0.5 mm in diameter, are very much more numerous;
- light rain: the rate of fall varying between a trace and 2.5 $mm.h^{-1}$, the maximum rate of fall being no more than 0.25 mm in six minutes;
- moderate rain: from 2.6 to 7.6 $mm.h^{-1}$, the maximum rate of fall being no more than 0.76 cm in six minutes;
- heavy rain: over 7.6 $mm.h^{-1}$ or more than 0.76 mm in six minutes;
- snow: precipitation in the form of crystalline water ice of all size.

Some type of liquid (rain, sleet), solide (hail) or mixed precipitations lead to a wet deposition. According to the American Meteorology Society:

- drizzle-fog: drops are generally less than 0.5 mm in diameter, are very much more numerous;
- light rain: the rate of fall varying between a trace and 2.5 mm.h^{-1}, the maximum rate of fall being no more than 0.25 mm in six minutes;
- moderate rain: from 2.6 to 7.6 mm.h^{-1} , the maximum rate of fall being no more than 0.76 cm in six minutes;
- heavy rain: over 7.6 mm.h^{-1} or more than 0.76 mm in six minutes;
- snow: precipitation in the form of crystalline water ice of all size.

Some type of liquid (rain, sleet), solide (hail) or mixed precipitations lead to a wet deposition. According to the American Meteorology Society:

- drizzle-fog: drops are generally less than 0.5 mm in diameter, are very much more numerous;
- light rain: the rate of fall varying between a trace and 2.5 mm.h^{-1}, the maximum rate of fall being no more than 0.25 mm in six minutes;
- moderate rain: from 2.6 to 7.6 mm.h^{-1} , the maximum rate of fall being no more than 0.76 cm in six minutes;
- heavy rain: over 7.6 mm.h^{-1} or more than 0.76 mm in six minutes;
- snow: precipitation in the form of crystalline water ice of all size.

Proposed washout rate according to the type of precipitation for using in the simple and robust HTO models.

Precipitation	Intensity ($mm.h^{-1}$)	Washout (s^{-1})
drizzle-fog	all	no data $>$ rain ?
light rain	≤ 2.5 $mm.h^{-1}$	2.5×10^{-4}
moderate rain	2.6-7.6 $mm.h^{-1}$	3.6×10^{-4}
heavy rain	> 7.6 $mm.h^{-1}$	1.0×10^{-3} ?
snow	all	2.2×10^{-6}

energie atomique • energies alternatives

energie atomique • energies alternatives

How choose the best washout rate for a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters ;
2. Collect the data ;
3. Algorithm of search for the best rate;

energie atomique • energies alternatives

How choose the best washout rate for a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters;
2. Collect the data;
3. Algorithm of search for the best rate;

energie atomique • energies alternatives

How choose the best washout rate for a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters ;
2. Collect the data ;
3. Algorithm of search for the best rate;

How choose the best washout rate or a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters ;
2. Collect the data ;
3. Algorithm of search for the best rate;

How choose the best washout rate or a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters;
2. Collect the data;
3. Algorithm of search for the best rate;

energie atomique • energies alternatives

How choose the best washout rate or a meteorological conditions given into a database ?

1. Create a data base by taking into account the main parameters ;
2. Collect the data ;
3. Algorithm of search for the best rate;

energie atomique • energies alternatives

The algoritm of research for washout rate is based on the following hypothesis:

- washout rate is specific for a type of precipitation: Only the data corresponding to the studied precipitation can be taken into account in the research;
- the relative influence of the parameteres is not the same for each washout rate. The weight assigned to each of these parameters must be defined separately of each washout rate;
- the database can be completed and the weights of each of the parameters will be calculated dynamically to be the most adapted to the available data.

energie atomique • energies alternatives

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 1. For every group (type, distance, height, temperature, pressure, diameter, velocity) present in the base, we list the available pairs (intensity, washout rate);

□

Evaluation of the weight of each parameter:

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 2. The group (type, distance, height, temperature, pressure, diameter, velocity) is taken into account only if at least two experimental values are available;

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 3. Two ranges are obtained: the range of intensity and the range of washout;

□

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 4. the standard deviation of each of these ranges are calculated:

$$\sigma^{i}_{T,d,h,t,p,di,v} \quad : \quad \text{Intensity standard deviation}$$

$$\sigma^{\lambda}_{T,d,h,t,p,di,v} \quad : \quad \text{Washout rate standard deviation}$$

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 5. For each group, the weight of the intensity is obtained with the following formula:

$$P^i_{T,d,h,t,p,d,} = \frac{\sigma^i_{T,d,h,t,p,di,v}}{\sigma^\lambda_{T,d,h,t,p,di,v}}$$

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 6. Then, the middleweight of the intensity are calculated for this type of precipitation:

$$P^i_T = \frac{1}{Nb\big((d,h,t,p,di,v)_T\big)} \sum_{(d,h,t,p,di,v)} P^i_{T,d,h,t,p,di,v}$$

where $Nb\left((d,h,t,p,di,v)_T\right)$ is the number of group for which we were able to calculate the standard deviation.

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 7. If this number is invalid (for example if among the available experimental data, no one was measured by only varying the intensity), then the value to 1 is fixed arbitrarily ;

□

energie atomique • energies alternatives

For example, for distance, height, temperature, pressure, diameter, velocity, we screen the available washout rate values to study their influence:

- 8. We make the same operation to calculate :

P_T^d	:	Weight of the distance for the type of precipitation
E_T^d	:	Average of the temperature the type of precipitation

P_T^h	:	Weight of the height or release for the type of precipitation
E_T^h	:	Average of the height or release for the type of precipitation

and so on for all parameters.

energie atomique • energies alternatives

The algoritm of research for washout rate is based on the following hypothesis:

The distance between the conditions of simulation and available experimental data is calculated with the relation:

$$d_T(i_0,d_0,h_0,t_0,p_0,di_0,v_0,i,d,h,t,p,di,v)=$$
$$\sqrt{P_T^i\times(i-i_o)^2+P_T^d\times(d-d_o)^2+P_T^h\times(h-h_o)^2+P_T^t\times(t-t_o)^2+P_T^p\times(p-p_o)^2+P_T^{di}\times(di-di_o)^2+P_T^v\times(v-v}$$

energie atomique • energies alternatives

The algoritm of research for washout rate is based on the following hypothesis:

The distance between the conditions of simulation and available experimental data is calculated with the relation:

$$d_T(i_0,d_0,h_0,t_0,p_0,di_0,v_0,i,d,h,t,p,di,v)=$$
$$\sqrt{P^i_T\times(i-i_o)^2+P^d_T\times(d-d_o)^2+P^h_T\times(h-h_o)^2+P^t_T\times(t-t_o)^2+P^p_T\times(p-p_o)^2+P^{di}_T\times(di-di_o)^2+P^v_T\times(v-v$$

□

`Research the lambda coefficient:`

The value of Lambda used in the computation corresponds to the shorter distance described above.

SOMMAIRE

energie atomique • energies alternatives

energie atomique • energies alternatives

Washout rate.

- need more experiments with details;
- database has to be completed ;
- washout rates proposed according to rain intensity have to be confirmed
- algoritm allow to choice the best washout for specific conditions

Washout rate database uses the international unit. The data are available in the SQLite table defined by:

Id	:	Identifier of the recording		Integer
DistanceRelease	:	Distance from Relase to observed point	m	Double
HeightRelease	:	Height of Release	m	Double
Temperature	:	Temperature of air	K	Double
Pressure	:	Atmospheric pressure	Pa	Double
RdDiameter	:	Precipitation diameter	m	Double
RdVelocity	:	Precipitation velocity	$m.s^{-1}$	Double
RdIntensity	:	Precipitation intensity	$m.s^{-1}$	Double
Type	:	Type of precipitation (rain, snow,fog)		String
Typical	:	Typical precipitation		String
WashoutRate	:	Washout rate	s^{-1}	Double
Ref	:	Bibliography references		String

Index	Washout	Distance[a]	Height[b]	Temp. of air	Atm. pressure	Diameter	Velocity	Intensity	Type	Re
	s	m	m	K	Pa	m	$m.s^{-1}$	$mm.h^{-1}$		
1	7.30×10^{-5}							2	rain	[?]
2	4.60×10^{-4}							2	rain	[?]
3	3.60×10^{-4}							4	rain	[?]
4	2.00×10^{-4}							1	rain	[?]
5	1.00×10^{-4}							1	rain	[?]
6	1.00×10^{-3}							25	rain	[?]
7	1.41×10^{-4}					2.00×10^{-4}			rain	[?]
8	5.64×10^{-5}					5.00×10^{-4}			rain	[?]
9	2.82×10^{-5}					1.00×10^{-3}			rain	[?]
10	2.00×10^{-5}					1.40×10^{-3}			rain	[?]
11	1.66×10^{-5}					1.70×10^{-3}			rain	[?]
12	1.34×10^{-5}					2.10×10^{-3}			rain	[?]
13	2.10×10^{-5}							1.1	snow	[?]
14	2.60×10^{-5}							1	snow	[?]
15	1.75×10^{-5}							1		Pa
...										

[a] Distance from release

[b] Height of release