Washout rate

Luc Patryl - Dan Galeriu

September 6, 2010
1. INTRODUCTION

2. MAIN POINTS

3. CLASSIFICATION OF THE PRECIPITATIONS AND WASHOUT RATE

4. ALGORITHM OF RESEARCH FOR THE BEST RATE

5. CONCLUSION
SOMMAIRE

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2 MAIN POINTS

3 CLASSIFICATION OF THE PRECIPITATIONS AND WASHOUT RATE

4 ALGORITHM OF RESEARCH FOR THE BEST RATE

5 CONCLUSION
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- 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;
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Washout rate

According to the bibliography review, the washout rate depends on 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.
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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.
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CLASSIFICATION OF THE PRECIPITIONS AND WASHOUT RATE

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CONCLUSION
Classification of the precipitations

Some type of liquid (rain, sleet), solid (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.
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Proposed washout rate according to the type of precipitation for using in the simple and robust HTO models.

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Intensity (mm.h(^{-1}))</th>
<th>Washout (s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>drizzle-fog</td>
<td>all</td>
<td>no data</td>
</tr>
<tr>
<td>light rain</td>
<td>$\leq 2.5$ mm.h(^{-1})</td>
<td>$2.5 \times 10^{-4}$</td>
</tr>
<tr>
<td>moderate rain</td>
<td>2.6-7.6 mm.h(^{-1})</td>
<td>$3.6 \times 10^{-4}$</td>
</tr>
<tr>
<td>heavy rain</td>
<td>$&gt; 7.6$ mm.h(^{-1})</td>
<td>$1.0 \times 10^{-3}$</td>
</tr>
<tr>
<td>snow</td>
<td>all</td>
<td>$2.2 \times 10^{-6}$</td>
</tr>
</tbody>
</table>
INTRODUCTION

MAIN POINTS

CLASSIFICATION OF THE PRECIPITIONS AND WASHOUT RATE

ALGORITHM OF RESEARCH FOR THE BEST RATE

CONCLUSION
### 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;
Method to choose the best washout rate

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

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

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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;
The algorithm 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.
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:

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:

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

<p>| | | | | | | |</p>
<table>
<thead>
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<td></td>
</tr>
</tbody>
</table>
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:

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

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

\[ \sigma^i_{T,d,h,t,p,di,v} \quad \text{: Intensity standard deviation} \]
\[ \sigma^\lambda_{T,d,h,t,p,di,v} \quad \text{: Washout rate standard deviation} \]
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:

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

\[
P_i^{T,d,h,t,p,d} = \frac{\sigma_i^{T,d,h,t,p,d}}{\sigma_{\lambda}^{T,d,h,t,p,d}}
\]
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:

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

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

where \( Nb((d, h, t, p, di, v)_T) \) 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;
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:

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.
Method to choose the best washout rate

The algorithm 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:

\[ d_T(i_0, d_0, h_0, t_0, p_0, d_{i_0}, v_0, i, d, h, t, p, d_i, v) = \sqrt{P_i^T \times (i - i_o)^2 + P_d^T \times (d - d_o)^2 + P_h^T \times (h - h_o)^2 + P_t^T \times (t - t_o)^2 + P_p^T \times (p - p_o)^2 + P_{d_i}^T \times (d_i - d_{i_0})^2 + P_v^T \times (v - v_o)^2} \]
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\]

Research the lambda coefficient:
The value of Lambda used in the computation corresponds to the shorter distance described above.
SOMMAIRE

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**Washout rate.**

- need more experiments **with details**;
- database has to be completed;
- washout rates proposed according to rain intensity have to be confirmed;
- algorithm allow to choose the best washout for specific conditions.
Washout rate database uses the international unit. The data are available in the SQLite table defined by:

<table>
<thead>
<tr>
<th>Id</th>
<th>Identifier of the recording</th>
<th>Integer</th>
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</thead>
<tbody>
<tr>
<td>DistanceRelease</td>
<td>Distance from Release to observed point</td>
<td>m</td>
</tr>
<tr>
<td>HeightRelease</td>
<td>Height of Release</td>
<td>m</td>
</tr>
<tr>
<td>Temperature</td>
<td>Temperature of air</td>
<td>K</td>
</tr>
<tr>
<td>Pressure</td>
<td>Atmospheric pressure</td>
<td>Pa</td>
</tr>
<tr>
<td>RdDiameter</td>
<td>Precipitation diameter</td>
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</tr>
<tr>
<td>RdVelocity</td>
<td>Precipitation velocity</td>
<td>m.s(^{-1})</td>
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<tr>
<td>RdIntensity</td>
<td>Precipitation intensity</td>
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</tr>
<tr>
<td>Type</td>
<td>Type of precipitation (rain, snow, fog)</td>
<td>String</td>
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<td>Typical</td>
<td>Typical precipitation</td>
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</tr>
<tr>
<td>WashoutRate</td>
<td>Washout rate</td>
<td>s(^{-1})</td>
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<tr>
<td>Ref</td>
<td>Bibliography references</td>
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</tbody>
</table>
## Washout rate database

<table>
<thead>
<tr>
<th>Index</th>
<th>Washout</th>
<th>Distance&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Height&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Temp. of air</th>
<th>Atm. pressure</th>
<th>Diameter</th>
<th>Velocity</th>
<th>Intensity</th>
<th>Type</th>
<th>Ref.</th>
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<td>1</td>
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<td>s</td>
<td>m</td>
<td>m</td>
<td>K</td>
<td>Pa</td>
<td>m</td>
<td>m.s&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>2</td>
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<tr>
<td>2</td>
<td>4.60 × 10&lt;sup&gt;-4&lt;/sup&gt;</td>
<td>m</td>
<td>m</td>
<td>Pa</td>
<td>m</td>
<td>m</td>
<td>m.s&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
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<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
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<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>1.40 × 10&lt;sup&gt;-3&lt;/sup&gt;</td>
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<td>[?]</td>
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<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>2.10 × 10&lt;sup&gt;-3&lt;/sup&gt;</td>
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<tr>
<td>13</td>
<td>2.30 × 10&lt;sup&gt;-5&lt;/sup&gt;</td>
<td>m</td>
<td>m</td>
<td>m.s&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>mm.h&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>1</td>
<td>Patryl</td>
<td>[?]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Distance from release

<sup>b</sup> Height of release