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S-MOF

User manual

Code release V 0.1

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Executive summary

This document is the quick user manual for the open-source space-time disaggregation tool S-MOF (Spatial-Method-Of-Fragments) version 0.1. The code is a scientific tool for the disaggregation of daily into hourly values in space and time for precipitation and temperature. The tool can be seen as the spatial interpretation of the univariate method of fragments (MOF), which has been proposed for precipitation (Mehrotra et al., 2012; Sharma and Srikanthan, 2006; Westra et al., 2012). Similar tools for space-time disaggregation have been presented by Mezghani and Hingray (2009) or Qin and Lu (2014) The code in the version 0.1. disaggregates precipitation and temperature separately. In the related journal article (under revision) a joint disaggregation (i.e. same day is used for the disaggregation of precipitation and temperature) was also applied for demonstration purposes. As the joint disaggregation turned out to be less performant, it has not yet been uploaded to github. If users still want to apply a joint disaggregation, please get in touch with us for the code. If only temperature or precipitation need to be disaggregated, the related parts in the code need to be commented out (not automatized yet).

History of model versions

Version	Date	Information
0.0	November 2017	First version created by Korbinian Breinl in MATLAB R2016a
0.1	July 2018	Second version created by Korbinian Breinl in MATLAB R2016a

Table of Contents

1. Data requirements and input files

1.1. Data requirements

S-MOF requires for files, which are (i) daily precipitation, (ii) daily temperature, (iii) hourly precipitation and (iv) hourly temperature.

1.2. Input files

1.2.1. Daily precipitation file (Daily_rain.csv)

This file contains the daily precipitation records for disaggregation. The file is a comma separated .csv file. The first column of the file contains the dates of precipitation records in the format YYYY-MM-DD. The second and/or following columns contain the precipitation records in mm. The header is “date” for the date column and “S1”, “S2”, “S3” etc. for the precipitation records, depending on the number of sites modelled. The precipitation records do not have to complete, i.e. (complete) days can be missing. An example precipitation input file Daily_rain.csv is given below (for five precipitation gauges):

```
Date,S1,S2,S3,S4,S5
19/11/1991,2,0.6,1.4,0.4,1
20/11/1991,5,7.8,7,5.8,5.6
21/11/1991,1.8,13.4,0.2,1.6,1.8
22/11/1991,6.2,7.2,1.2,3,1
23/11/1991,5.2,1,1.8,1,1.8
24/11/1991,0.2,10.2,0,1,0
25/11/1991,0,0.2,0,0,0
26/11/1991,0,0.2,0,0,0
27/11/1991,0,0,0,0,0
28/11/1991,0,0,0,0,0
29/11/1991,0,0,0,0,0
(…)
```

1.2.2. Daily temperature file (Daily_temp.csv)

This file contains the temperature records for disaggregation. The file is a comma separated .csv file. The first column of the file contains the dates of temperature records in the format YYYY-MM-DD. The second and/or following columns contain the temperature records in mm. The header is “date” for the date column and “S1”, “S2”, “S3” etc. for the precipitation records, depending on the number of sites modelled. The temperature records do not have to complete, i.e. (complete) days can be missing. An example temperature input file Daily_temp.csv is given below (for five temperature gauges):

```
Date,S1,S2,S3,S4,S5
19/11/1991,-0.1,2.6,4.2,-1.0,-1.2
20/11/1991,0.7,3.4,4.8,0.3,0.1
21/11/1991,0.7,3.3,6.0,0.0,-0.1
```

```
22/11/1991,1.2,4.0,7.1,-0.2,0.0
23/11/1991,0.8,4.4,6.5,-0.6,0.2
24/11/1991,0.6,3.6,6.5,0.3,-0.1
25/11/1991,1.8,5.2,6.0,0.8,1.3
26/11/1991,0.7,4.3,4.1,0.6,0.2
27/11/1991,1.2,3.6,2.9,1.5,0.4
28/11/1991,1.8,3.8,2.7,2.5,1.0
29/11/1991,2.5,4.4,2.6,3.4,1.8
```

1.2.3. Hourly precipitation file (Hourly_rain.csv)

The hourly precipitation file has the same formatting as the daily precipitation file, but each day consists of 24 lines with the same date format, which is YYYY-MM-DD.

1.2.4. Hourly temperature file (Hourly_temp.csv)

The hourly precipitation file has the same formatting as the daily precipitation file, but each day consists of 24 lines with the same date format, which is YYYY-MM-DD.

1.2.5. Coordinates files (…_LL.csv)

There are four related files:

Daily_rain_LL.csv
Daily_temp_LL.csv
Hourly_rain_LL.csv
Hourly_temp_LL.csv

These files contain the coordinates of the gauges so that the tool can calculate the distances between sites, when interpolation is required. Formatting requires no header.

```
55.4889,14.3172
55.8633,13.6689
56.0131,14.8488
56.0304,12.7653
56.1977,16.4036
56.8464,14.8324
(…)
```

1.2.6. Model parameters (param.yml)

This file defines all model parameters required for the simulations. The required values have to be written between the colon and the hashtack of each line. The file can be altered in any text editor. An example model parameter file param.yml is given below:

```
# ------------------------
# Copyright (c) 2017, Korbinian Breinl
# All rights reserved.
#
# Model parameter file S-MOF
# ------------------------

wind    :   30
nn       :   7
historical  : off
int_rain: adv
int_temp: simple
```

In the following, all parameters are explained in detail.

wind

This is an integer value defining the window of all days around the day t of disaggregation. For example, if *t* represents the 1st of January and *wind*=14, all days between the 18th of December and the 15th of January are considered for disaggregation

nn

This is an integer value that defines the number of nearest neighbors used for the disaggregation, i.e. if *nn*=7, the seven closest vectors are used for the disaggregation and one of them is sampled. The nearest neighbour algorithm introduces noise to the simulations.

historical

If the observations (i.e. aggregated historical hourly values as daily input) are disaggregated, S-MOF will recreate the actual observations. For this reason, if disaggregating the (aggregated) hourly observations, the value must set to “on” to avoid the recreation of the actual observations. The parameter can be set to “off” if the daily variables come from another source than the observations, for example from a daily stochastic weather generator.

int_rain / int_temp

The tool automatically recognizes whether there is an imbalance between daily and hourly observations sites. If this is the case, the user must specify whether a simple (“simple”) or advanced “adv”) interpolation is desired. Simple means the nearest gauge with hourly records is selected for disaggregation, advanced means a weighted hyetograph/temp cycle from the three nearest hourly gauges is used for disaggregation.

2. Preparing and running a simulation

The following files are required for a simulation. The file param.yml and the four files with the daily and hourly weather observations have to be prepared by the user (see above).

File	Description	Comment
Daily_rain.csv	.csv file with daily precipitation	To be prepared by user
Daily_temp.csv	.csv file with daily temperature	To be prepared by user
Hourly_rain.csv	.csv file with hourly precipitation	To be prepared by user
Hourly_temp.csv	.csv file with hourly temperature	To be prepared by user
Daily_rain_LL.csv	.csv with coordinates (Lat,Lon) of daily rainfall	To be prepared by user
Daily_temp_LL.csv	.csv with coordinates (Lat,Lon) of daily temp	To be prepared by user
Hourly_rain_LL.csv	.csv with coordinates (Lat,Lon) of hourly rainfall	To be prepared by user
Hourly_temp_LL.csv	.csv with coordinates (Lat,Lon) of hourly rainfall	To be prepared by user
read_file.m	Routine to read the weather observations (four .csv files)	
read_param.m	Routine to read parameter values from the file param.yml	
haversine.m	Haversine distances for distances between sites (when interpolation is used)	Created by Josiah Renfree
S_MOF.m	**Main application**	

All files as described in section 2 have to be copied into a common folder. The simulation is run by executing the file S_MOF.m. The simulated (disaggregated) precipitation and temperature time series are written out into new .csv files.

3. Errors and solutions

In case of very small values of “wind” (i.e. small window around the day of disaggregation) or large values of “nn” (i.e. many nearest neighbors) the code may fail as it does not find enough nearest neighbours for the disaggregation. In that case, the user must widen up the window and set higher values for “wind” or reduce the number of nearest neighbors “nn”. The issue can be expected at large spatial scales (i.e. a high diversity of the daily/hourly precipitation snapshots) or in very dry climates (large number of unique daily/hourly precipitation snapshots). For other error messages, please get in touch.

4. References

Mehrotra, R., Westra, S., Sharma, A., Srikanthan, R., 2012. Continuous rainfall simulation: 2. A regionalized daily rainfall generation approach. Water Resources Research 48.

Mezghani, A., Hingray, B., 2009. A combined downscaling-disaggregation weather generator for stochastic generation of multisite hourly weather variables over complex terrain: Development and multi-scale validation for the Upper Rhone River basin. Journal of Hydrology 377(3-4) 245-260.

Qin, X.S., Lu, Y., 2014. Study of Climate Change Impact on Flood Frequencies: A Combined Weather Generator and Hydrological Modeling Approach. Journal of Hydrometeorology 15(3) 1205-1219.

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