**SHIMMER ReadMe, 6th May 2016**

**1. Hardware and Software Requirement**

SHIMMER is written and can be executed in the free open source computing environment and programming language R, which is available for download on the web (<http://www.r-project.org/>). SHIMMER uses the adaptive time-step solver “lsoda” from the deSolve package (Soetaert et al., 2010) **which must also be installed**. On a standard desktop computer running R, the model usually takes less than 1 min to simulate 10 years of succession.

**2. Download SHIMMER**

A package named “SHIMMER”, containing the source code of SHIMMER as well as example input and testing data is available at <http://jamesbradleyweb.weebly.com/research.html> under the sub-heading “SHIMMER” (click “**Download SHIMMER .zip package**”).

The package contains one folder named “demo”, containing 2 sub-folders:

1) demo\_MAC (if you are running RStudio on a Mac)

2) demo\_WIN (if you are running R on Windows)

The differences in the code are minor – mostly to do with plotting.

Within these two folders are further sub-folders:

* “SHIMMER”: containing the model source code for a single run of SHIMMER.
* “input\_data\_Svalbard”: containing the following time-series of forcings:
  + par.csv – solar radiation (already accounting for inhibition by snow)
  + temp.csv – soil temperature
  + snow.csv – snow depth
  + ICS1.csv – input (deposition) of C substrate (labile)
  + ICS2.csv – input (deposition) of (refractory)
  + IPON1.csv – input (deposition) of organic N (labile)
  + IPON2.csv – input (deposition) organic N (refractory)
  + IPOP1.csv – input (deposition) organic P (labile)
  + IPOP2.csv – input (deposition) organic P (refractory)
  + IDIN.csv – input (deposition) DIN
  + IDIP.csv – input (deposition) DIP
* “observations”: field data.
  + “C\_aut.dat”: total autotrophic microbial biomass
  + “C\_het.dat”: total heterotrophic microbial biomass
  + “CS.dat”: total organic carbon

The entire “demo” folder should be copied to a local computer such that the directory is: “C:/RFolder/model/demo/” (Windows) **or** “/Users/jamesbradley/Documents/RFolder/model/demo/” (Macintosh) **or** the folder paths contained in SHIMMER.R script should be modified (*path*, *path\_root*, *pathdr* and *pathte*) according to where the “demo” folder is copied to.

**3. Source Code Files Description**

This section provides a brief description of all source code files present in the sub-folder “SHIMMER”. This should be read alongside the SHIMMER (1.0) *Geoscientific Model Development* publication (Bradley et al., 2015) for clarity on variables, parameters, balance equations etc.

*SHIMMER.R*

* Specify length of model run here (nyears) (note: must be a positive integer).
* Execute this code (copy and paste into R Console window) to run the model.

*Library > SHIMMER\_set\_parameter\_values.R*

* Specify parameter values here.
* The default settings of the model correspond to the Midtre Lovénbreen forefield, Svalbard (Bradley et al., 2016).
* See Bradley et al. (2015) for a description of parameters.

*Library >* SHIMMER\_NEW\_load\_and\_make\_drivers.R

* Load the forcing data and replicate for duration of model run (nyears).
* Note: forcing data must be specified as daily values (as per examples).

*Library >* *SHIMMER\_set\_start\_values.R*

* Specify initial conditions here (starting value for each state-variable).

*Library >* *SHIMMER\_NEW\_model\_definition.R*

* Contains the equations which formulate the model.

*Library >* *SHIMMER\_compute\_totals.R*

* Derive rates from time-series of output variables.

*Library >* *SHIMMER\_construct\_array.R*

* Construct 3-D array from output variables.

*Library >* *SHIMMER\_basic\_plots.R*

* Examples of basic plots of model output.

**4. Model Operation**

In R, specify working directory to: “C:/RFolder/model/demo/demo\_WIN/SHIMMER/” (if using Windows. For Mac, change path as appropriate).

Open SHIMMER.R script and execute in console (note: package “deSolve” (Soetaert et al., 2010) must be installed).

To run the model, copy and paste the *SHIMMER.R* script into the R Console window.

**5. Output**

Model output is created as variables within R (out, out2 and out\_array). By default, they are not saved locally, however this can be done by using a command such as:

**write.table(out,file=paste("out","model\_run.csv",sep="\_"),sep=",",row.names=FALSE)**

The dataframe “out” is a 2-D time-series of output data comprised of columns for each output (variables, totals and rates), and rows for each day simulated. All units are in µg g-1 dry soil or equivalent.

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Column Name | Description |
| *time* | Day of simulation | *cum\_I\_Sub* | Cumulative C substrate input |
| *A1* | A1 biomass | *cum\_G\_X* | Cumulative C substrate from losses (G) and exudates (X) |
| *A2* | A2 biomass | *years* | Year of simulation |
| *A3* | A3 biomass | *A\_total* | Total autotrophic biomass |
| *H1* | H1 biomass | *H\_total* | Total heterotrophic biomass |
| *H2* | H2 biomass | *S\_total* | Total C substrate |
| *H3* | H3 biomass | *Cmic\_total* | Total microbial biomass |
| *S1* | C substrate (labile) | *PON\_total* | Total organic nitrogen |
| *S2* | C substrate (refractory) | *POP\_total* | Total organic phophorus |
| *DIN* | Dissolved Inorganic Nitrogen | *cum\_A* | Cumulative growth (production) of autotrophs |
| *DIP* | Dissolved Inorganic Phosphorus | *cum\_H* | Cumulative growth (production) of heterotrophs |
| *PON1* | Organic Nitrogen (labile) | *rate\_A1* | Daily A1 growth rate |
| *PON2* | Organic Nitrogen (refractory) | *rate\_A2* | Daily A2 growth rate |
| *POP1* | Organic Phosphorus (labile) | *rate\_A3* | Daily A3 growth rate |
| *POP2* | Organic Phosphorus (refractory) | *rate\_H1* | Daily H1 growth rate |
| *cum\_A1* | Cumulative growth (production) of A1 | *rate\_H2* | Daily H2 growth rate |
| *cum\_A2* | Cumulative growth (production) of A2 | *rate\_H3* | Daily H3 growth rate |
| *cum\_A3* | Cumulative growth (production) of A3 | *rate\_DIC\_A* | Daily DIC from autotrophs |
| *cum\_H1* | Cumulative growth (production) of H1 | *rate\_DIC\_H* | Daily DIC from heterotrophs |
| *cum\_H2* | Cumulative growth (production) of H2 | *rate\_DIN* | Daily DIN assimilation |
| *cum\_H3* | Cumulative growth (production) of H3 | *rate\_nf* | Daily nitrogen fixation |
| *cum\_DIC\_A* | Cumulative DIC from autotrophs | *rate\_A* | Daily autotrophic growth (production) |
| *cum\_DIC\_H* | Cumulative DIC from heterotrophs | *rate\_H* | Daily heterotrophic growth (production) |
| *cum\_DIN* | Cumulative DIN assimilated into biomass | *rate\_I\_Sub* | Daily C substrate input |
| *cum\_nf* | Cumulative nitrogen fixed | *rate\_G\_X* | Daily loss (*G*) and exudate (X) input |
|  |  | *rate\_G* | Daily loss (*G*) (necromass) input |
|  |  | *rate\_X* | Daily exudate (*X*) input |

The dataframe “out2” is a 2-D time-series of annual totals (or rates), comprised of columns for each output, and rows for each year simulated. All units are in µg g-1 dry soil or equivalent.

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Column Name | Description |
| *year* | Year of simulation | *annual\_DIC\_A* | Total annual DIC efflux from autotrophs |
| *annual\_A1* | Total annual A1 production (biomass growth) | *annual\_DIC\_H* | Total annual DIC efflux from heterotrophs |
| *annual\_A2* | Total annual A2 production | *annual\_DIN* | Total annual DIN assimilated from soil |
| *annual\_A3* | Total annual A3 production | *annual\_nf* | Total annual nitrogen fixed from air |
| *annual\_H1* | Total annual H1 production | *annual\_A* | Total annual autotrophic production |
| *annual\_H2* | Total annual H2 production | *annual\_H* | Total annual heterotrophic production |
| *annual\_H3* | Total annual H3 production |  |  |

The array “out\_array” is a 3-D array of data from “out”. The columns (x- axis) represent each output variable, total and rate, the rows (y-axis) represent each day of the year (1-365), and the depth (z-axis) represents each year. For example, out\_array[2,5,3] is the biomass of A1 (the 2nd column in out) for the 5th day of the 3rd year. All units are in µg g-1 dry soil or equivalent. The purpose of the array is that it is simpler to average and sum data across specific time-intervals.

**References**

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