Supplementary material for:

SHMIP
The Subglacial Hydrology Model Intercomparison Project

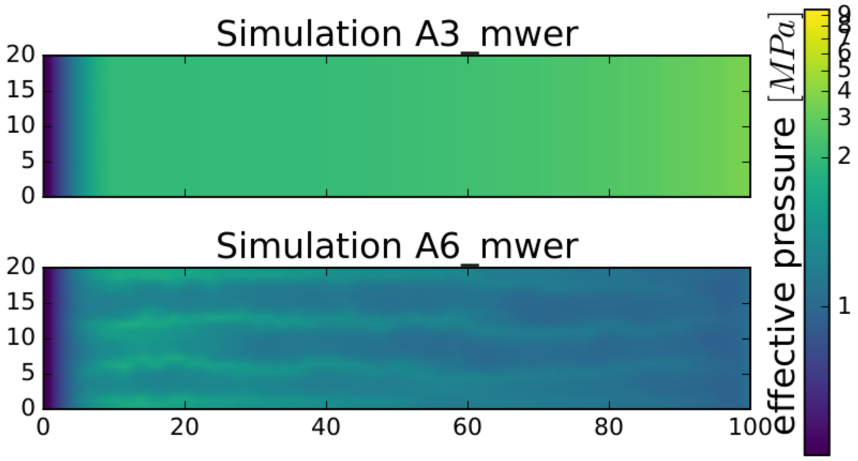
Basile de Fleurian, Mauro A. Werder, Sebastian Beyer, Douglas J. Brinkerhoff, Ian Delaney, Christine F. Dow, Jacob Downs, Olivier Gagliardini, Matthew J. Hoffman, Roger LeB Hooke, Julien Seguinot, Aleah N. Sommers

20th September 2018

This is the content of the SHMIP website at the time of the paper publication.

Subglacial Hydrology Model Inter-comparison Project SHMIP

This project aims at providing a qualitative comparison of subglacial hydrology models by comparing results from a suite of test runs. It is designed such that any subglacial hydrology model producing effective pressure should be able to participate.



Extended submission deadline: 23 June 2017

Quick links:

-**instructions**
-**technical details**
-**critical updates**

Introduction

Over the last few years, a number of subglacial drainage system models have been created and published. However, as it is not known how water actually flows at the ice-bed interface, it is far from clear what physics to include in such models. Consequently many different types of drainage processes are included in these models. A nice overview over the main types of distributed drainage models is given by Bueler & Pelt (2015).

This intercomparison project's **main aim** is to collect a set of model runs which allows to **qualitatively compare the different model behaviours**. This should allow potential users of these models to make a more a qualified decision as to which model to choose for their application. Likewise for model developers, this may help them to assess which processes might be missing in their respective models. Note that this intercomparison does not aim at assessing the correctness of the participating models in any way. In particular this means that no attempt is made to ensure their correct numerical implementation nor their applicability to a certain real world scenario. The former should probably be done by each model individually whereas the latter might be the aim for a future hydro intercomparison exercise.

Note that our aim is quite different from the numerous ice flow intercomparison projects (e.g. Payne & al 2000). In their case it is reasonably clear what the physics are, at least for ice-flow, less so of the boundary conditions. This means that a one to one comparison is possible, whereas here a more qualitative approach is necessary.

Meetings and discussions

1. IGS Chamonix 2014
2. AGU 2014
3. IGS Höfn 2015 (pdf of Basile's presentation)
4. Splinter meeting at EGU 2016 (kick-off)
5. Splinter meeting at EGU 2017 (first results)

Contact

Basile de Fleurian: Basile.DeFleurian@uib.no

Mauro Werder: werder@vaw.baug.ethz.ch

Instructions to participate

Table of Contents

To participate, please find below the description of the experiments. The intercomparison is divided into six suites A-F which themselves consist of several runs, e.g. A1-A6.

There are also **technical details**, such as where to find input-files, how to submit test-runs, how to include your model setup in the official repository, etc.

Table 1: Summary of simulation suites, details are in the text below. The letters hyperlink to the relevant sections.

Suite	Geometry	Temporal	Varying parameter	Remarks
A	sqrt	steady	input volume	maybe fit to A3 and A5
B	sqrt	steady	moulin density	
C	sqrt	diurnal	diurnal amplitude of moulins	use B5 as initial condition (IC)
D	sqrt	seasonal	-4 to +4C temperature	use A1 as IC
E	valley	steady	geometry change	
F	valley	seasonal	-6 to +6C temperature	IC: steady state using only winter discharge

Model parameters and tuning

The aim of this inter-comparison is to obtain results –from models employing a variety of different drainage physics– which are qualitatively comparable. This we hope to achieve by specifying a set of parameters and a tuning strategy, when the parameters are not sufficient or misleading.

Note that we report all quantities in SI-units `kg, m, s`.

Parameters

We distinguish between "physical constants" (first table) and "parameters" (second table). The former should not be used for tuning whereas the latter can be used if needs be. We suggest that most poorly constraint parameters should be used for tuning, i.e. probably the ones directly related to water flow.

The given parameters are based on the ones used by the GlaDS-model (Werder et al. 2013), therefore, please report the different parameters your model uses and we can include them here. Script files containing the parameters are located in the `parameters/` folder in the bitbucket repository.

Table 2: Physical constants

Name	Value
Density water	1000 kg m^{-3}
Density glacier (ice+firn)	910 kg m^{-3}
Accel. gravity	9.8 m s^{-2}
Latent heat of fusion	334 kJ kg^{-1}
Specific heat capacity water	4220 j kg^{-1} K^{-1}
Clausius-Clapeyron constant	7.5e-08 K Pa^{-1}
Seconds per year	365 *24 *60 *60 s

Table 3: Parameters

Name	Value	Reference/remarks
Ice flow		
Glen's n	3	
Ice flow constant A	3.375e-24 Pa^{-3} s^{-1}	see note after table
Ice sliding speed	1e-6 m s^{-1}	Werder et al. 2013
Bedrock bump wave-length	2 m	Werder et al. 2013
Bedrock bumps height	0.1 m	Werder et al. 2013
Water flow		
Turbulent flow exponent α	1.25	Werder et al. 2013
Turbulent flow exponent β	1.5	Werder et al. 2013
Conductivity sheet k_s	0.005 $m^{7/4}$ $kg^{-1/2}$	Werder et al. 2013
Sheet-width contributing to R-channel melt	2 m	Werder et al. 2013
Englacial void fraction	0 (sqrt) 1e-3 (valley)	Werder et al. 2013
Conductivity R-channel k_c	0.1 $m^{3/2}$ $kg^{-1/2}$	Werder et al. 2013

Name	Value	Reference/remarks
Darcy-Weisbach equivalent of k_c	0.195	for semi-circular R-channel

Note that the ice flow constant A is for the usual channel closure relation of the form $\frac{\partial S}{\partial t} = \frac{2A}{n^n} S N^n$ with channel cross-sectional area S, effective pressure N and Glen's n. This is how A is usually defined, e.g. in Cuffey & Paterson 2010. In the GlaDS paper a closure relation of the form $\frac{\partial S}{\partial t} = A' S N^n$ is used, and the value of the constant is then $A' =$ 2.5e-25 Pa^{-3} s^{-1}.

Tuning

To obtain comparable results for different models we suggest to use test case A3 and A5 as a "common ground", which is achieved by tuning models to the output of GlaDS (see figures below and provided as ascii files for A3 and A5). The focus should lie on tuning to the effective pressure N, but sheet q and channel discharge Q can also be used (please indicate in the questionnaires).

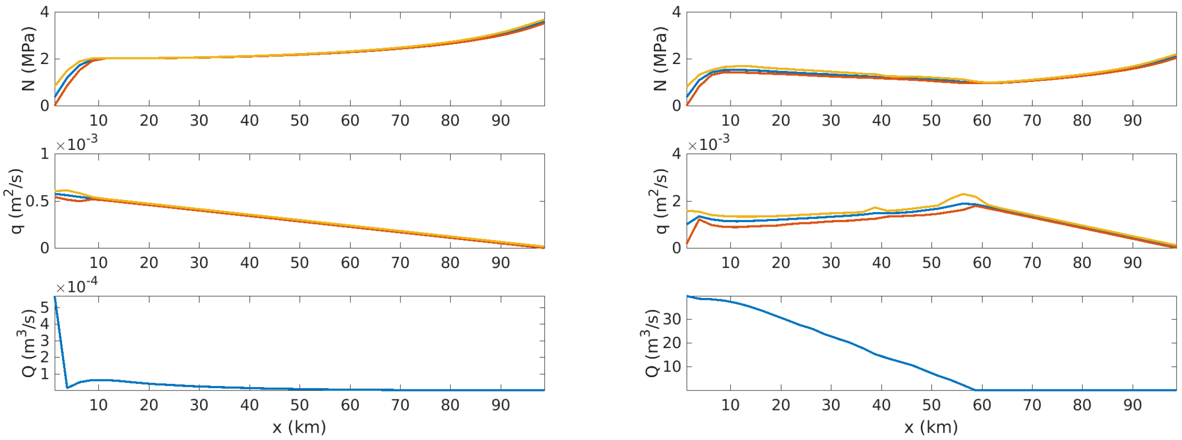


Figure 1: Model run A3 (left) and A5 (right) of GlaDS: effective pressure (mean enveloped by min/max), sheet discharge (mean enveloped by min/max), and channel discharge (max).

The parameters thus obtained are then used for the subsequent experiments. A3 is chosen as a case where GlaDS (for the used parameters) produces a distributed system only, whereas A5 features channelisation up to around mid-domain.

Models which do not include both inefficient and efficient drainage may need to use a different set of parameters to tune to A3 and A5. Or may choose to only apply the model to part of the test cases.

If you feel that your model should not or cannot be tuned to A3 and/or A5, then run the model with the most appropriate set of parameters. However, in such a case it is encouraged to submit two sets of results: one tuned as best as possible and one using the most natural set of parameters.

Geometries & boundary conditions

The test geometries have been defined in a simple way to allow the participation of both flowline/flowband and 2D map plane models. The reference implementation can be found in the file topo.jl, which also contains plotting routines for visualisations. In the same folder implementations in other programming languages can also be found (please contribute if you write a new one).

"sqrt": ice-sheet margin-like geometry

This geometry is used for the suites A-D and mirrors a synthetic land-terminating ice sheet margin as was used in Werder et al. 2013, but with a few modifications. The domain is 100km long in the x direction and 20km wide in the y direction with the terminus along $x = 0$. The bedrock is a flat surface at 0m elevation and the surface is defined by a square root function[1]:

```
surface(x,y) = 6*( sqrt(x+5e3) - sqrt(5e3) ) + 1
bed(x,y) = 0
```

This means that the maximal ice thickness is 1521m, and minimal 1m.

One dimensional models (1D) should use the following functions:

```
# 1D models
surface(x) = surface(x,0)
bed(x) = 0
width(x) = 20e3
```

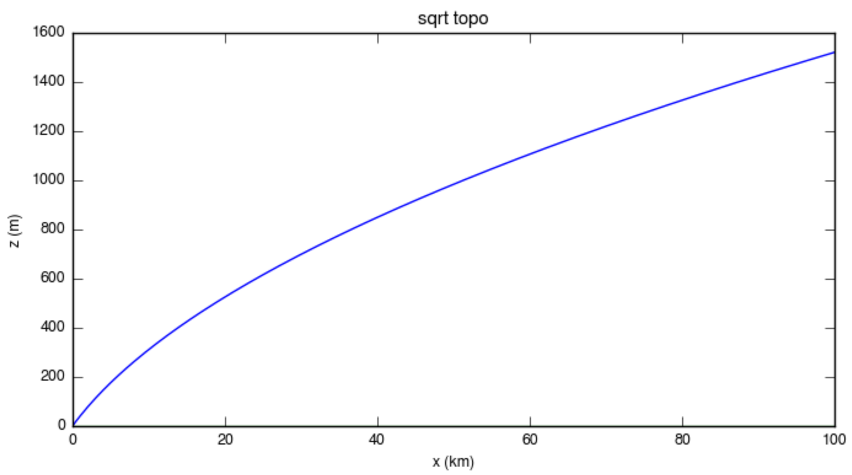


Figure 2: Side view of `sqrt` topography

"sqrt": boundary conditions

The boundary conditions should be set such that there is no influx along the interior boundaries (i.e. $y=0$, $y=20$km, $x=100$km). Water pressure should not need specifying along the interior edges, if your model requires this, please mention it in the questionnaires. At the margin edge ($x=0$), set pressure to 0Pa. No boundary condition on the flux should be needed, allowing for free outflow.

"valley": Bench Glacier-like geometry

The two suites E & F are performed on a 2D valley geometry to investigate the impact of the smaller glacier-size and of the bedrock shape on the behavior of the models. The geometry is based on the shape of Bench Glacier (Alaska, approximately 6km by 1km). The bed-geometry has one parameter `para` which determines whether the bed has an overdeepening or not, with `para=0.05` mimicking Bench Glacier with no overdeepening.

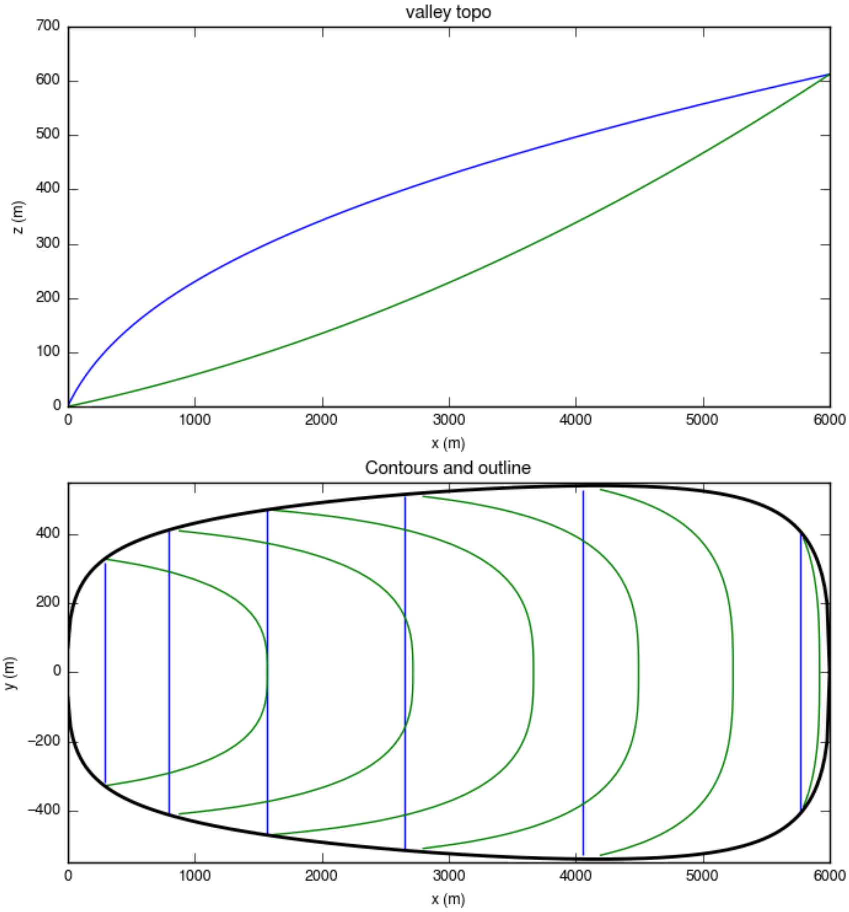


Figure 3: `valley` topography with `para=0.05`: side view (top) and map view (bottom, contours 100m).

The defining functions are

```
surface(x,y) = 100(x+200)^(1/4) + 1/60*x - 2e10^(1/4) + 1
bed(x,y, para) = f(x,para) + g(y) * h(x,para)
```

with the helper functions `f(x,para)`, `g(x,para)`, and `h(x,para)`. `f` determines the flow-line geometry and it is constructed such that `f(6e3, para)==surface(6e3,0)`, i.e. the ice thickness is always 0 at the upper end of the glacier (=6e3m). `g` determines the cross-sectional geometry which is modified by `h`. The function `h` is chosen such that the glacier outline is independent of `para`. They are given by

```
para_bench = 0.05
f(x,para) = (surface(6e3,0) - para*6e3)/6e3^2 * x^2 + para*x
g(y) = 0.5e-6 * abs(y)^3
h(x, para) = (-4.5*x/6e3 + 5) * (surface(x,0)-f(x, para)) /
              (surface(x,0)-f(x, para_bench)+eps())
```

The half-width is given by

```
outline(x) = ginv( (surface(x,0)-f(x,0.05))/(h(x,0.05)+eps()) )
ginv(x) = (x/0.5e-6).^(1/3) # the inverse of g
```

which gives a maximum full-width of approx. 1080m.

1D simulations with flowline and flowband models should be performed using the centre-line of the valley as their flowline. The geometry is given by

```
# 1D models
surface(x) = surface(x,0)
bed(x,para) = f(x,para)
width(x) = 2*outline(x)
```

"valley": boundary conditions

At the terminus ($x = 0, y = 0$ or a small region around this point), set pressure to 0Pa. If boundary condition on the flux are needed too, set to free outflow. Along all of the remaining boundary, zero-flux conditions should be specified. If additionally conditions on the pressure are needed, set it to 0Pa.

Water forcings

These change from suite to suite and are described below. The reference implementation is in the file sources.jl, which also contains plotting routines for visualisations. In the same folder implementations in other programming languages can also be found (please contribute if you write a new one).

Test runs specifics

The different tests are designed to allow the participation of a large range of models. The complexity of the test-sets generally increases and each participant should perform as many tests as her/his model allows. See Table 1 for an overview.

Suite A: sqrt, steady

Test cases A is performed using different steady and spatially uniform water inputs into the `sqrt` geometry. The aim is to show simple steady state configurations and to allow for model tuning, see Model tuning. The water input values are as follows:

Table 4: This table summarise the different source term values used for the run of test case A.

Run Name	Source term (m/s)
A1	7.93e-11
A2	1.59e-09
A3	5.79e-09
A4	2.5e-08
A5	4.5e-08
A6	5.79e-07

To obtain the source in m/d multiply by 86400, and for m/a by 31536000 (i.e. one year is defined to have 365 days). For flowline models, multiply the source by 20km to obtain the total for the width.

Suite B: sqrt, moulins, steady

The importance of input localisation is investigated in test B. To reach this goal, the spatially uniform input which was used in the preceding simulation is replaced by a moulin input described by an input flux and an input location. The simulations are run to steady state from the given water input (which has the same total as the one of simulation A5 plus distributed basal input equivalent to A1). The varying parameter here is the number of moulins that is used and so the amount of water that is injected into each moulin decreases with increasing number of moulins. Moulins positions are specified on a regular 1km grid to allow the participation of models based on regular or unstructured grids. The moulins need not be placed at the exact specified location but as close as possible. The location and input of each moulins is given in a `.csv` with four columns (moulin index, X position [m], Y position [m], input value [m^3/s]). For each simulation, the position of each moulin is defined at random excluding the boundary grid points and the ones in the first five kilometres from the glacier terminus. Additionally to the moulin input, use distributed input as in model run A1 (i.e. representing a small basal melt contribution).

Table 5: This table summarise the number of moulins and file containing their location and input values for the different experiments.

Run Name	Num. of Moulins	File Name	Additional distributed source (m/s)
B1	1	`B1_M.csv`	7.93e-11
B2	10	`B2_M.csv`	7.93e-11
B3	20	`B3_M.csv`	7.93e-11

Run Name	Num. of Moulins	File Name	Additional distributed source (m/s)
B4	50	B4_M.csv	7.93e-11
B5	100	B5_M.csv	7.93e-11

1D flowband models should collapse all moulins onto the flow-line and sum the input of colocated moulins as needed.

Suite C: sqrt, moulins, diurnal

Test C is designed to investigate the effect of the diurnal melting cycle on the response of the subglacial drainage system, i.e. short time scale dynamics. The starting point for this experiment is the steady state achieved in simulation B5 (i.e. a steady input into moulins). The amplitude of the runoff is changed for the different simulations of the test. The runoff into each moulin is given by

```
runoff(t, ra) = max(0, moulin_in * (1 - ra*sin(2*pi*t/day)))
```

with time `t` (s) and `day` is seconds per day. The background moulin input (`moulin_in`, the runoff for experiment B5: B5_M.csv) is modulated by a sine function, set to zero if negative. The value of the relative amplitude (`ra`) of the signal is given on the table bellow for the different experiments of the test. Added to this is a distributed basal input as in A1:

```
runoff_basal(t) =  7.93e-11 # m/s
```

The model should be run until a periodic state is reached, then one day is submitted with output interval 1h.

Table 6: This table summarise the values of `ra` used to model the different steps of suite C.

Run Name	Relative amp. `ra`
C1	1/4
C2	1/2
C3	1
C4	2

Again, 1D flowband models should collapse all moulins onto the flow-line.

Suite D: sqrt, seasonal

Test case D simulates the seasonal evolution of the drainage system, i.e. the long time scale evolution. This test uses initial conditions from test case A1 which represent the water input during winter. From this starting point, a seasonal cycle is applied to the water input. The model should be run for enough years until it settles into a periodic state. Once this state is reached, please provide output for one year at daily resolution. The forcing is computed from a simple degree day model driven by a temperature parameterization.

The temperature at 0m elevation is given by

```
temp(t) = -16*cos(2*pi/year*t)- 5 + DT
```

Where the temperature (`temp`) is function of the time (`t`) and `year=31536000` is the number of second per year. The different runs of this suite are achieved by modifying the value of delta-temperature `DT` as presented in the table bellow.

The runoff (distributed) is then computed from the following degree day model formulation

```
runoff(z_s,t) = max(0, (z_s*lr+temp(t))*DDF) + basal
```

where `z_s` is the surface elevation, `lr=-0.0075 K/m` is the lapse rate and `DDF=0.01/86400 m/K/s` is the degree day factor. `basal=7.93e-11 m/s` is a basal melt rate equal to the source of scenario A1.

Scripts are available for the computation of these forcings on the Bitbucket repository: Julia (reference), matlab

Table 7: This table summarise the values of `DT` used to model the different steps of experiment D.

Run Name	Temp. Param. Val. `DT`
D1	-4
D2	-2
D3	0
D4	+2
D5	+4

Suite E: valley, bed-topography

Test case E is designed to investigate the effect of bedrock slope on the models. The common base for this experiment is the synthetic valley geometry modelled after the Bench Glacier geometry. The different simulations of this test are achieve by altering the shape of the bedrock to define a more or less pronounced overdeepening, see section "valley": Bench Glacier-like geometry. The water input on this experiment is uniformly distributed at the bed of the glacier with a value of 1.158e-6 m/s (twice the rate of scenario A6).

Table 8: This table summarise the different slopes used in run E.

Run Name	Factor `para`	Remarks
E1	0.05	Bench Glacier reference geometry
E2	0	

Run Name	Factor `para`	Remarks
E3	-0.1	Starting to have an overdeepening
E4	-0.5	Overdeepening around supercooling threshold
E5	-0.7	

It is suggested that models which include a pressure-melt term, run this experiment with and without this term.

Suite F: valley, seasonal

Test F runs a seasonal forcing for the synthetic Bench Glacier using topography parameter `para=0.05` as in E1 (and all other parameters as in the Suite E). The water forcing mirrors Test D. First run your model to a steady state with water input as in A1 (`m=7.93e-11`); use this steady state to start all the model runs from. The model should be run for enough years until it settles into a periodic state. Once this state is reached, please provide output for one year at daily resolution. The forcing functions are as in *Suite D* but with different temperature forcings:

Table 9: This table summarise the temperature forcings for run F (uses topography parameter `para=0.05`).

Run Name	Temp. Param. Val. `DT`
F1	-6
F2	-3
F3	0
F4	+3
F5	+6

Footnotes:

[1] All code examples use Julia syntax. Its concise one-line function definitions, such as `f(x) = x^2`, allow short code snippets. All the presented functions are included in the reference implementations topo.jl and sources.jl, which also contain plotting routines for visualisation.

Technical details

This document specifies all the technical details.

Getting the reference code

The code for this intercomparison project hosted on https://bitbucket.org/shmip/, in particular the code is https://bitbucket.org/shmip/hydro_intercomparison. The latter contains the reference implementations of topography and water source functions `input_functions`, and a list of default parameters `parameters/`.

If you are familiar with the version control software git, you should fork & clone this repository. If you are not, then download it from here, or learn git (here is a good tutorial).

Contributing your model setup to the repository

You are encouraged to contribute the model setups you use to run the test to the repository https://bitbucket.org/shmip/hydro_intercomparison. You can either do this by forking and making a pull request, or by submitting a zip-file of the folder containing the setup with the test results. Please name the folder/zipfile with `firstname-lastname`.

Output variables

The output variables are given in below table. It also specifies which variables are required, any others can left away if not applicable. More details on their sizes, etc. can be gathered from the NetCDF-file specification, see *Output file format: NetCDF*. Effective pressure N should be given as the one which the ice "feels". There can be several distributed water layer thicknesses for multi-layer models, for instance GlaDS has two: the water sheet h, and the englacial storage layer $hstore$. If the model contains channels then the size of the channels should be given in S. The discharges of the sheet is given in q and of the channels in Q.

Please provide all variables which you think are relevant for your model. This may mean that new ones need to be introduced (as well as unused ones left away). If a new variable is needed, please contact Mauro and Basile to figure out a good variable name. For example, your model may have a till layer, then the variables $htill$ (effective water thickness in till) and $qtill$ (discharge through till) would probably be good. We will add extra variables to below table as we receive results, so please check back to see whether yours have appeared.

Table 1: Table of output dimensions and variable names. Please order them in the NetCDF file as in this table. `index*` in the shape represent the index of the coord on which the variable is defined. This table will be updated with new variable names as needed. Before your submission, please check back to make your variables consistently named.

Variable	Description (also `long_name`)	Units	Required	Remarks	shape
Dimensions					

Variable	Description (also `long_name`)	Units	Required	Remarks	shape
`time`	time		yes	unlimited is fine	
`dim`	spatial dimension of the model		yes		
`n_nodes_ch`	number of nodes per channel segment		no	fixed to 2 (?)	
`index1`	number of nodes		yes		
`index2`	number of cells		no		
`index_ch`	number of channels		no		
Coordinates					
`time`	time	s	yes		(`time`)
`coords1`	node coordinates	m	yes	*horizontal*	(`dim`, `index1`)
`coords2`	cell midpoint coordinates	m	no		(`dim`, `index2`)
`coords_ch`	channel midpoint coordinates	m	no		(`dim`, `index_ch`)
`connect_ch`	channel connectivity		no	with respect to index1	(`nb_nodes3`, `index_ch`)
Variables					
`B`	bed elevation	m	yes		(`index*`)
`H`	ice thickness	m	yes		(`index*`)
`W`	domain width	m	1D models only		(`index*`)
`N`	effective pressure	Pa	yes		(`time`, `index*`)
`h`	water sheet thicknesses	m	no		(`time`, `index*`)
`hstore`	stored water effective layer thickness	m	no		(`time`, `index*`)
`q`	water sheet discharge	m^2/s	no	absolute value	(`time`, `index*`)

Variable	Description (also long_name)	Units	Required	Remarks	shape
S	channel cross-sectional area	m^2	no		(time, index_ch)
Q	channel discharge	m^3/s	no		(time, index_ch)
Ee	EPL thickness	m	no		(time, index*)

Output file format: NetCDF

Model output has to be provided in NetCDF files following below conventions (for easier post-processing). Files can be in either NetCDF version 3 or version 4 (classic format). We hope that we have found a one-size-fits all NetCDF layout, **however, it is likely that this format will change** to accommodate bugs and different model. **We strongly suggest that you keep the original model output around** to be able to re-save them, at least until this exercise has finished.

The file naming convention for the submitted files is the following: `scenario#_1-initial+3-letter-author[_version].nc` for example `A2_mwer.nc` or `A2_mwer_2.nc` (if submitting several results for a run).

You can and **should check that your NetCDF output is correctly formatted** by running the `python SHMIPncTest.py A1.nc` code which is provided in Toolbox.

Your NetCDF file should have (approximately) the following header:

```
netcdf sqrt_ch1_mesh4 {
dimensions:
  time = 81 ; \\ can be unlimited
  dim = 2 ;  \\ spatial dimensions
  n_nodes_ch = 2 ; \\ how many nodes to make a channel edge.  Fixed(?
  index1 = 2650 ; \\ index into coords1
  index2 = 5031 ; \\ index into coords2
  \\ if you got more coordinates add index3, etc, add them here
  index_ch = 7680 ; \\ index into channel coordinates coords_ch
variables:
  double time(time) ;
    time:units = "s" ;
    time:long_name = "time" ;
  double coords1(dim, index1) ; \\ specify what the coordinates point
    coords1:units = "m" ;
    coords1:long_name = "node coordinates" ;
  double coords2(dim, index2) ;
    coords2:units = "m" ;
    coords2:long_name = "cell midpoint coordinates" ;
  double coords_ch(dim, index_ch) ; \\ coords_ch should point to chann
    coords_ch:units = "m" ;
```

```
    coords_ch:long_name = "channel midpoint coordinates" ;

  \\ connectivity of channels.  Needs to be wrt to index1!
  double connect_ch(nodes_per_ch, index_ch) ;
    connect_ch:units = "" ;
    connect_ch:long_name = "channel connectivity" ;

  \\ Geometry variables, if possible give them on coords1
  \\ Required
  double B(index1) ;
    B:units = "m" ;
    B:long_name = "bed elevation" ;
  double H(index1) ;
    H:units = "m" ;
    H:long_name = "ice thickness" ;
  double W(index1) ;   \\ only needed and required for 1D models
    W:units = "m" ;
    W:long_name = "domain width" ;
  double N(time, index1) ; \\ required
    N:units = "Pa" ;
    N:long_name = "effective pressure" ;

  \\ Additional variables (not required)

  \\ index1 variables
  double h(time, index1) ;
    h:units = "m" ;
    h:long_name = "water sheet thickness" ;
  double hstore(time, index1) ;
    hstore:units = "m" ;
    hstore:long_name = "stored water effective layer thickness" ;

  \\ index2 variables
  double q(time, index2) ;
    q:units = "m^2/s" ;
    q:long_name = "water sheet discharge" ;

  \\ index_ch variables
  double S(time, index_ch) ;
    S:units = "m^2" ;
    S:long_name = "channel cross-sectional area" ;
  double Q(time, index_ch) ;
    Q:units = "m^3/s" ;
    Q:long_name = "channel discharge" ;

// global attributes:
    :title = "werder_sqrt_ch1_mesh4" ; \\ free-form title
    :meshtype = "unstructured" ;  \\ "unstructured", "structured", "l
    :channels_on_edges = "yes" ;  \\ "yes" or "no"
    :institution = "Mauro A Werder, ETHZ" ; \\ your name(s) and insti
    :source = "GlaDS: f015c8703ad61ed9f92ace68e2f05bcb3522cf86 GHIP: 
    :references = "http://shmip.bitbucket.io/" ; \\ fixed
```

```
}
```

Notes:

- The output variables are provided as point clouds, i.e. at (x,y)-points (or just x in 1D). This should hopefully allow any type of model to submit data, irrespective of mesh (or no mesh).
- Several sets of coordinates are possible, say one for cell-centres, one for cell-edges, etc. For each set have a dimension `index1`, `index2`, etc.
- For channels there is the special dimension `index_ch`.
- For channels, provide a connectivity `connect_ch` as well as channel mid-point coordinates `coords_ch` (if possible). The channel connectivity matrix has the form: column `n` should give the index (in `index1`) of the two endpoint nodes. Indices are zero-based, i.e. they are running from 0 to n-1.
- Provide all variables which you think are relevant for your model output, see section *Output variables*. Required is only effective pressure `N` (and the specified bed elevation `B` and ice thickness `H`, to check for correctness).
- All variables need the attributes `units` and `long_name`.
- If you don't have some particular variables, then leave them away. For instance, if you don't have channels, then leave away `index_ch`, `coords_ch`, `connect_ch`, etc.
- All output should be provided in SI units (m, kg, s) and derived (e.g. Pa). Don't use prefixes, say G or k.

Questionnaires

You are asked to complete some small questionnaires: one for the whole inter-comparison and one for each suite.

Whole inter-comparison:

- Name of the model & citation
- Name of the modeller(s)
- On what computer was the model run
- Parallel or serial model
- Is the model available? If so, where?
- What revision/version of the model was used?
- Other remarks

Model tuning:

- What model parameters were set as given in section Parameters?
- Was the model tuned to A3 and/or A5? To N? q? Q?
- What parameters where used for the tuning? Values?
- What are the values of any additional model parameters?

For each suite A-F:

- How long was the model run for (model-time)?
- Are any parameters different from the ones used in Suite A?
- Remarks

For each run:

-CPU time used for the run.
-How confident are you of model convergence?

Uploading your results

Result data upload is be handled through the ETH-Zurich site https://cifex.ethz.ch/. Once your results are ready, please request a guest account from Mauro Werder (valid for one month).

Providing feedback

If you feel that this web-site needs clarification, then please email us or, better, file a bug report at https://bitbucket.org/shmip/shmip-website-source/issues?status=new&status=open. If there is a problem with the model setup, then file a bug report at https://bitbucket.org/shmip/hydro_intercomparison/issues?status=new&status=open.

UP | HOME

Critical updates

Most likely we will need to clarify things on the website, fix some bugs, or update the instructions otherwise at some stage. This document keeps track of all these updates.

A diff of the web-site source since the CRYOLIST announcement on <2016-10-14 Fri> can be found here.

Time-line and updates:

<2018-02-27 Tue> Fixed the value of the ice-flow constant again, now A and A' are consistent.

<2017-06-07 Wed> Clarified the value of the ice-flow constant: now stating the conventional one.

<2017-05-16 Tue> Extended submission deadline to 23.6.2017

<2017-01-06 Fri> Added submission deadline to homepage. Clarified model run B: the small

<2016-11-07 Mon> In Suite D, change degree day factor units to SI units

<2016-10-14 Fri> Official project launch

UP | HOME

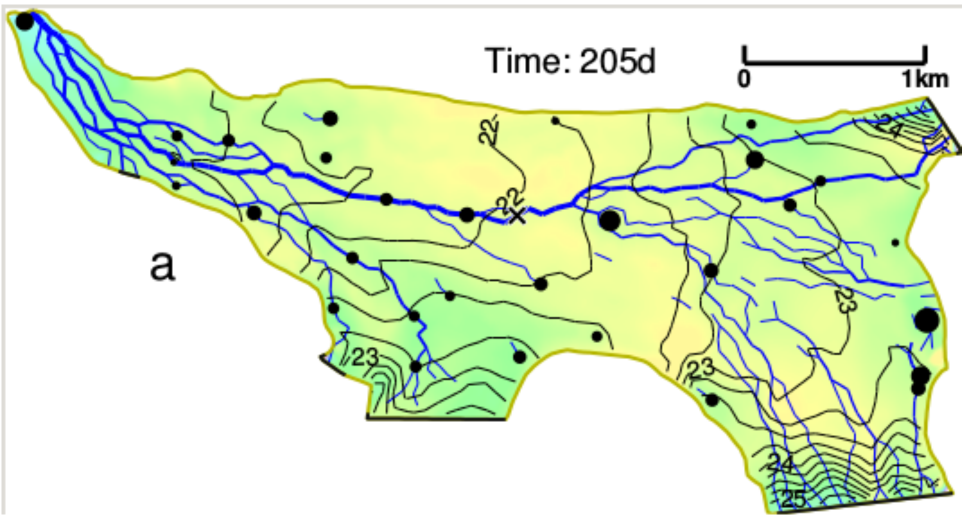
Meeting in Chamonix, May 2014

[2014-05-30 Fri]

Glacier hydrology inter-comparison

To discuss:

- -what's the point?
  - -present a model comparison to the community
- -what should be compared?
- -who wants to be involved?
- -what are the goals?
- -time frame?



Inter-comparisons (ICs)

- -"exact" ICs:
  - -compare models with same/similar physics
- -"general" ICs
  - -compare models with different physics
- -1D & 2D plan-view (3D?)
- -Other things which we may want to include in the far future:
  - -ice flow
    - -what flow models
  - -groundwater flow
  - -surface/englacial hydrology
  - -ocean
  - -etc

Inputs

- -Input fields:
  - -bed and surface
  - -melt forcing
  - -ice flow speed
  - -moulins
- -Physical parameters:
  - -how to set parameters in physically different models?
    - -fitting: calibrate parameters to fit some (steady) state. Then predict some others?
      - -what do we want to fit?
        - -outflow
        - -eff. pressure
        - -measurable parameters vs full fitting
    - -mathematical translation?

IC tests

-what do we want to test/compare?
-how many ICs do we want?

Synthetic:

-**box ice sheet margin** (start with this only)
-flat valley glacier (+ overdeepening)
-mountain glacier (Hoffman et al 2013)
-Tide water glacier

Real:

-Russell/Leverett
-Gorner
-Arolla

Forcings

-**steady** (start with this)
-diurnal
-seasonal
-seasonal + diurnal
-jokulhlaup
-processed met-data

Outputs & metrics

How to compare the model outputs?

Metrics:

-effective pressure in a area
-flux
-storage

Others: lateral average, elevation bands, statistics

Drainage system morphology:

-channel spacing
-lateral variation in N

Technical:

-file formats: NetCDF

Specifics

-who wants to participate?
    -Mauro, Tim, Ian, Christian, Basile, Matt, Gag
-time frame
    -hydro workshop: first week of October?
-Mauro makes a web-site
-publication
-name:
    -SHINT STORM
    -GHIP

Participants

-Tim Creyts
-Ian Hewitt
-Christian Schoof
-Basile de Fleurian
-Matt Hoffman
-Olivier Gagliardini
-Gwenn Flowers
-Jesse Johnson
-Mauro Werder

UP | HOME

Meeting at AGU Fall Meeting, Dec 2014

[2014-12-18 Thu]

I can't find the minutes anymore, but below the agenda.

Agenda

Aimed at models which:

- -compute pressure
- -compute flux
- -what's the point?
  - -present a model comparison to the community
  - -allow them to select the best model
  - -describe what they are aimed at
  - -test cases should be exciting!
    - -test cases
    - -seasonal
    - -moulin switch
    - -1D and 2D should be the same
  - -model specific notes:
    - -what are its parameter regime
- -tuning:
  - -steady state
  - -step change
- -what should be compared?
  - -effective pressure
  - -hydrograph
  - -total volume of water in system
  - -lumped metrics vs spatial metrics
- -no spatially varying parameters
- -what are the goals?
- -time frame?
- -how should we name it?
- -this will define standard test runs for now and in the future

Participants

- -Tim Creyts
- -Ian Hewitt
- -Basile de Fleurian
- -Olivier Gagliardini
- -Mauro Werder
- -Ed Bueler
- -others…

Minutes of meeting at EGU 2016, April 2014, Vienna

[2016-04-21 Thu]

About a dozen people participated. Basile de Fleurian presented a project overview. Mauro Werder explained details about the individual experiments. Most of the discussion centred around the model setups. (I (Mauro) also included here some bits of discussion I had after the meeting.)

Model run setups

- Merge experiments A&B. Instruct to fit on low and high melt scenario (A3, A5). If needed by the model, allow to use two parameter sets for low and high input. This also means that there is no need to refer to channelised vs distributed drainage at all.
- Provide setup for flow-line models: width function, width integrated discharge, figure out how to do moulins.
- Provide questionnaires for participants:
    - one for the whole exercise. Fields: model type and intent, programming language, remarks.
    - one for each model run. Fields: remarks, model run time, needed degrees of freedom.
- Interest of ocean modellers for a tide-water example glacier. But was decided to not extent the current suite of experiments.

Model outputs

- Specified NetCDF file format
- Effective pressure
- Mass conservation:
    - frontal discharge
    - amount of water stored in the system
- If someone wants to submit results for different parameters, then these should be submitted as different test-sets, e.g. Mauro-1, Mauro-2, etc.

Timeline

Participants were happy about the proposed time-line:

- Beta-testing this Summer (2016).
- Official call for participation in August 2016.
- Results of participants to be submitted by end of November 2016.
- Winter 2017: figuring out an evaluation and comparison strategy and compilation of results.
- Presentation of the results at EGU 2017 and a splinter meeting to discuss the results and the planned publication.
- Publication submission in the Summer 2017.

Further steps

- Participants/interested parties send an email; one low-volume email list for interested parties; one list for experiment participators.

Misc

- -It was suggested to rename the project to "SHIP" or similar. (renamed to `SHMIP` [2016-07-05 Tue])
- -Discussed that this intercomparison does not aim at assessing model correctness (this is assumed) but at a providing qualitative comparison between models.

Minutes of meeting at EGU 2017, Vienna

[2017-04-28 Fri]

This is a brief summary of the SHMIP-activities during the EGU 2017 meeting in Vienna (24-28 April).

Talk in "Modelling Ice Sheets and Glaciers" session (Thu, 27.4.2017)

Our presentation of preliminary results from 11 models was well received and feedback was that many are well excited about this MIP. Also, many commented that SHMIP was the best of the MIP names so far. The presentation is uploaded as are the extended results presented at the splinter meeting.

SHMIP splinter meeting (Fri, 28.4.2017) minutes

Splinter meeting agenda-slides

Main Points:

-deadline for model results submission extended to **23 June 2017**
-first paper draft end of August
-publication of all model results under an open access licence
-possible additional request for data submission:
    -discharge-across-cross-section
    -area fraction of efficient system

Results:

First, Mauro presented additional results which did not fit the talk (link given above). Discussion suggested that additional evaluations should include:

-discharge
-area fraction of efficient system
-seasonal: when is max/min efficient system extent
-diurnal: when is max/min eff. pressure

Future:

There was a discussion on how to run a future SHMIP with real-world data. The tentative plan is to:

-first put data together, make it available, and publish it as data-paper
    -important data: melt input, proglacial discharge, subglacial pressure measurements, tracer experiments
    -possible glaciers: Arolla (Switzerland), Gornergletscher (Switzerland), Russell (Greenland), South Glacier (Yukon), Kennicott (Alaska), Bench (Alaska)
-then run the SHMIP

Misc:

-Angelika offered her help if we need to get some glacier velocities at some point.

-Workload was OK but the participant are not willing to rerun any simulations at this point so we should do with the variables we have.
-Olivier proposed to put the model set-ups under CC on a voluntary basis
-The website is considered as a good and reliable information source

Participants:

Julien Seguinot, Ugo Nanni, Olivier Gagliardini, Mauro Werder, Basile de Fleurian, Ian Delaney, Sebastian Beyer, Angelika Humbert (in seating order)