Protocol for Freshwater forcing experiments with NEMO in climate models

Marion DEVILLIERS

May 21, 2022

1   Objective

Greenland has experienced an increasing melting over the last decades. As CMIP5 models do not include properly Greenland Ice sheet melting, we made available a realistic dataset of freshwater fluxes including ice and tundra runoff and icebergs melting from Greenland and surrounding glaciers and ice caps from 1840 to 2016. A simple extrapolation of these fluxes is also avaialbe until 2100. This should help to assess the impact of a realistic melting over the circulation and the convection in the North Atlantic and possibly on the AMOC on the historical runs of the IPSL-CM6-LR coupled system as well as on the scenario experiments. Results of the freshwater forcing experiment performed with the IPSL-CM6-LR model over the 1920-2014 period with a ten-member ensemble are presented in [Devilliers et al.,] (submitted in December 2019).

2   Construction of an original dataset

Raw data A raw dataset from [Bamber et al., 2018] is available on a regional 5x5 km grid, for the period 1958 to 2016. It provides monthly values of tundra and ice runoff from Greenland ice sheet and surrounding glaciers, along with a solid component: the flux of ice crossing the grounding line of marine-terminating glaciers around the margins of the Greenland ice sheet. The annual cumulated global fluxes are plotted in figure 1.

Icebergs The Altiberg icebergs database project [Tournadre et al., 2015] provides a spatial evolution of the icebergs on both north and south poles from 1993 to 2012. The time-averaged icebergs spatial distribution of the Altiberg project was applied to the solid ice component of the raw data from [Bamber et al., 2018].

Extension in the past To account for the large melting of the 1920s, the fluxes were then extended to several decades in the past, using a linear regression of the annual fluxes from [Bamber et al., 2018] over the annual ice runoff reconstruction of [Box and Colgan, 2013] for the period both data have in common (1958-2012). The final dataset is presented in figure 2.

Future scenario experiment To study the impact of possible future Greenland melting, fluxes were also extended to the future until 2100 to make it possible to launch some projections with two simple extrapolations of Greenland melting (figure 3), one made to be used with ssp245 scenario (black line), the other for the ssp585 scenario (red line).

Freshwater forcing experiment The monthly fluxes were redistributed on the eORCA grid, using a nearest neighbor algorithm. We present in the next sections the steps to overwrite the freshwater fluxes around Greenland and surrounding regions in the ocean-ice model NEMO-LIM ([Madec, 2008] and [Rousset et al., 2015]) of the EC-Earth3 and the IPSL-CM6-LR coupled models for historical runs and scenario experiments.
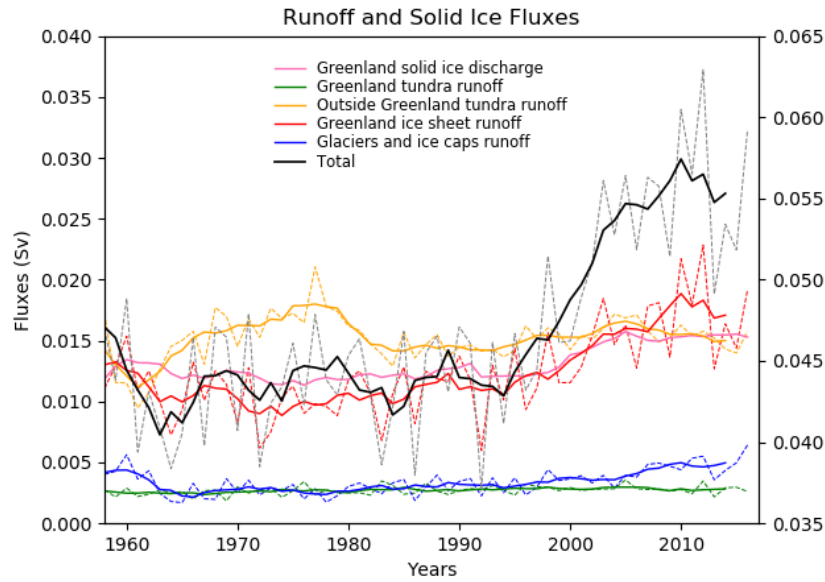
Figure 1: Freshwater fluxes (in Sv.) from Greenland ice sheet and glaciers outside of Greenland from [Bamber et al., 2018]. Solid lines are 5-years moving averages, dashed lines are the mean annual values. The total flux from all sources is shown by the solid black line plotted against the right-hand Y axis.
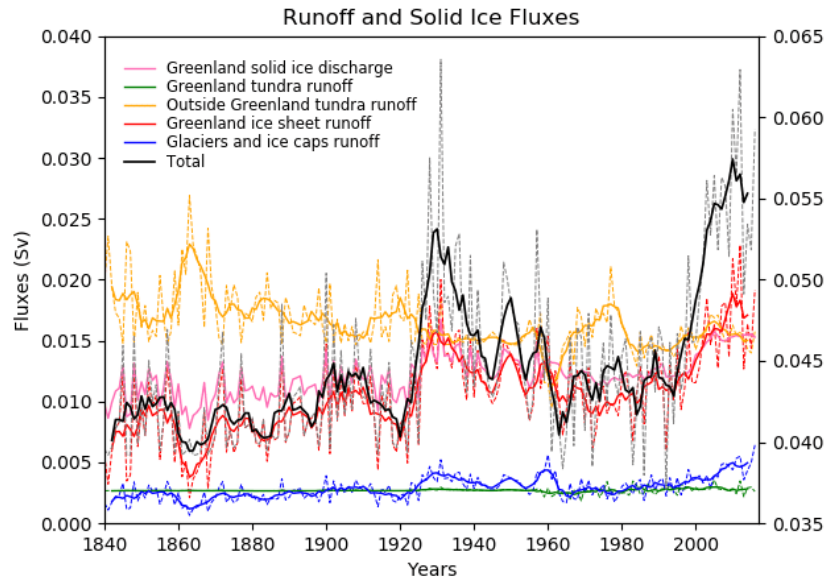

Figure 2: Extended freshwater fluxes (in Sv.) obtained from [Bamber et al., 2018] and [Box and Colgan, 2013]. Solid lines are 5-years moving averages, dashed lines are the mean annual values. The total flux from all sources is shown by the solid black line plotted against the right-hand Y axis.
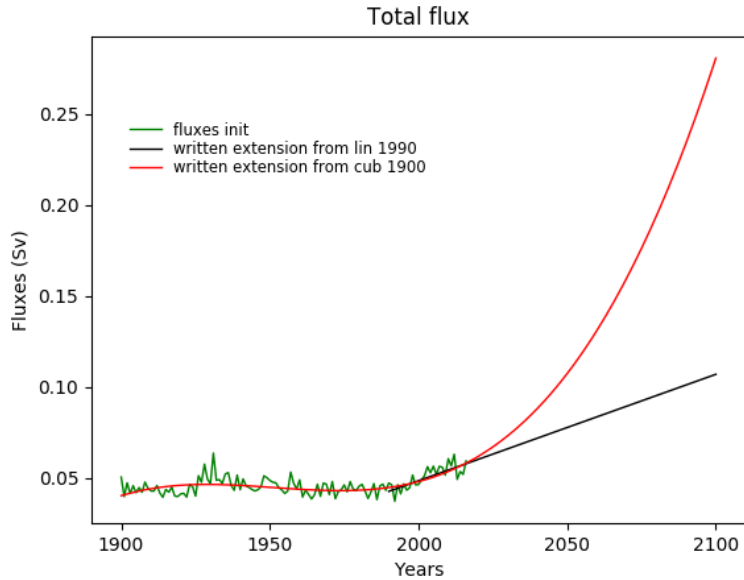
Figure 3: Linear and cubic extrapolation of the total melting flux from Greenland and surrounding regions.

3 Description of the external files used for the hosing experiment

The files of freshwater fluxes (runoff and icebergs compiled) consist in a series of netcdf files available for the ORCA1 and eORCA1.2 mesh grids. The main files are named **runoffs_forcing_y{*year*}.nc**, from the year 1840 to 2016, with 12 time-steps (monthly fluxes). The variable name is *sorunoff_f*. The values of *sorunoff_f* are zero outside of the zone where runoffs are forced. This zone is localized with the file: **mask_runoffs.nc**. In this file, the *mask* variable has the value zero in our zone of forcing and 1 elsewhere. For the IPSL-CM6-LR model, a last file is used in order to keep the same global calving values as the historical run, it is named **Iceberg_forcing.nc** and is applied outside of the forcing zone.

All the files are available on the irene machine (IPSL) in this repository:
> $RUNOFF = /ccc/store/cont003/gen7403/devillim/RUNOFF

on the freya machine (DMI) in this repository:
> $RUNOFF= /data/mde/RUNOFF

Files from 2017 to 2100 correspond to the black line of figure 3, there also stored here:

> $RUNOFF/Forecast_forcing_lin/

While files for the extreme melting scenario (red line in figure 3), are stored here:

> $RUNOFF/Forecast_forcing_cub/

Note: There is **no need to modify the path or copymove the files**.

4 Setting-up the freshwater forcing for the EC-Earth3 model

Install-Compile EC-Earth3 in the path of your choice, named hereafter $PATH_EC

Then, there are three .F90 files to modify.

4.1 Modification of the Fortran files

4.1.1 sbccpl.F90

In the repository:
> $PATH_EC/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/WORK

- at line 411, set the variable *l_rnfcpl* to *.false.* to allow the reading of the runoff flux from OASIS:

  l_rnfcpl = .false.

- line 1476-1479:

  IF(srcv(jpr cal)%laction) THEN ! calving (put in emp_tot and emp_oce)
        zemp_tot(:,:) = zemp_tot(:,:) - frcv(jpr_cal)%z3(:,:,1)
        zemp_oce(:,:) = zemp_ oce(:,:) - frcv(jpr_cal)%z3(:,:,1)
  ENDIF

  should be replaced by:

  IF(srcv(jpr_cal)%laction) THEN ! calving (put in emp_tot and emp_oce) + Mask the forcing area
        ! =========================
        CALL iom_open ('mask_runoffs', inum) ! open file
        CALL iom_get (inum, jpdom_data, 'mask', msk_rnf_f) ! read the mask
        CALL iom_close(inum)
        ! =========================
        zemp_tot(:,:) = zemp_tot(:,:) - frcv(jpr_cal)%z3(:,:,1)*msk_rnf_f(:,:)
        zemp_oce(:,:) = zemp_oce(:,:) - frcv(jpr_cal)%z3(:,:,1)*msk_rnf_f(:,:)
  ENDIF

4.1.2 sbcrnf.F90

In the repository:
> $PATH_EC/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/WORK
Copy the version of the modified subroutine sbcrnf.F90 (on freya machine) from:
> /home/mde/EC-Earth3_dmi/ece3.3.0-cmip6-historical/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/WORK/sbcrnf.F90

If you want to do it by hand, there are several modifications to make, the results of the *diff* command is given in section 6 as supplementary information.

4.1.3 runoff_mapper_mod.F90

In the repository:
> $PATH_EC/sources/runoff-mapper/src
We set the calving values to zero around Greenland since they are integrated in the runoff variable.

line 175,177 We add:
if (j<251 .and. j>200 .and. i>360 .and. i<505) then

CalvingOCE(i,j) = 0.0 ! Setting the calving to zero around Greenland for our freshwater experiments
endif

Or (more simple maybe): Modify the file: runoff_maps.nc to set all the Greenland output points to -1 or copy to your repository the file already modified from here on Freya:
/home/mde/runoff_maps.NoCavlingID_GrIS.nc

4.1.4 Compilation

Re-compile the sources step:
> cd $PATH_EC/sources/runoff-mapper/src
> ./make
> cd $PATH_EC/sources//nemo-3.6/CONFIG
> ./makenemo clean
> ./makenemo [...]
copy $PATH_EC/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/BLD/bin/nemo.exe to run repository if needed (if job does not start from scratch)

4.2 Job installation

To prepare the run scripts, there are modifications to be made with several files. You have to create ece-esm_exp_FWF.sh and run_exp_FWF.job and modify ecconf.cfg with your paths. Reminder: the runoff forcing files are available here: $RUNOFF = /ccc/store/cont003/gen7403/devillim/RUNOFF

My repository is named hereafter: $MDE = /home/mde/EC-Earth3_dmi/ece3.3.0-cmip6-historical/runtime/classic/

Then last modifications are:
1. copy $MDE/ctrl/namelist.nemo.ref.FWF.sh to $PATH_EC/runtime/classic/ctrl/
2.
> cd $PATH_EC/runtime/classic/ctrl/
> mkdir FWF
> cp $MDE/ctrl/FWF/field_def_nemo-opa.xml ./FWF/.
7. let *year* be the starting year of your experiment, then copy $RUNOFF/runoffs_forcing_y{year-1}.nc to the run repository
8. in the run repository, copy runoffs_forcing_y{year-1}.nc to runoffs_forcing.nc
9. copy mask_runoffs.nc from the path $RUNOFF to the run repository
10. if the run is a restart, copy file_def_nemo-opa.xml (to get calving and friver in your outputs) and namelist_ref and namelist_cfg to the run repository from one of my run repositories, for instance: /data/mde/ecearth3_exp/fw14

4.3 Ready to go

After completing all the steps of section 4.1 and 4.2, the job is ready to be submitted:

> cd EC-Earth3/runtime/classic/
> qsub run_exp_FWF.job

For any technical issue, please contact me: mde@dmi.dk

5 Setting-up the freshwater forcing for the IPSL-CM6-LR model

5.1 Modification of the Fortran files

Starting from an installed and pre-compiled version of IPSL-CM6-LR. There are two .F90 files to modify before recompiling the model.

5.1.1 sbccpl.F90

In the repository:
> /modIPSL/modeles/NEMOGCM/CONFIG/ORCA1_LIM3_PISCES/WORK/

Copy the file sbccpl.F90 modified (V1.8 of IPSL-CM6-LR) from:
> /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/modeles/NEMOGCM/CONFIG/ORCA1_LIM3_PISCES/
WORK/sbccpl.F90

Or make the following changes by hand:

- at line 411, set the variable *l_rnfcpl* to FALSE to allow the reading of the runoff flux from OASIS:

  l_rnfcpl = .FALSE.

- comment the lines 1473 to 1476.

  ! IF(srcv(jpr_cal)%laction) THEN ! calving (put in emp_tot and emp_oce)
  ! zemp_tot(:,:) = zemp_tot(:,:) - frcv(jpr_cal)%z3(:,:,1)
  ! zemp_oce(:,:) = zemp_oce(:,:) - frcv(jpr_cal)%z3(:,:,1)
  ! ENDIF

5.1.2   sbcrnf.F90

In the repository:
> /modIPSL/modeles/NEMOGCM/CONFIG/ORCA1_LIM3_PISCES/WORK/

Copy the version of the modified subroutine sbcrnf.F90 (V1.8 of IPSL-CM6-LR) from:
> /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/modeles/NEMOGCM/CONFIG/ORCA1_LIM3_PISCES/
WORK/sbcrnf.F90

If you want to do it by hand, there are several modifications to make, the results of the *diff* command is given in section 7 as supplementary information.

5.1.3   Compilation

Do not forget to recompile the model after modifications of the Fortran files.

> cd /modIPSL/config/
> gmake

5.2   Job installation

5.2.1   opa9.card

Copy the COMP repository from the experiment you wish to do. For an historical experiment with melting for the 1.8 version of the model, copy the repository 'historical_melting':

> cp -r /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/EXPERIMENTS/IPSLCM/historical_melting
/modIPSL/config/IPSLCM6/.

For a scenario experiment with reasonnable melting (black line in figure 3) and ssp245 scenario for the 1.8 version of the model, copy the repository 'scenario_melting':

> cp -r /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/EXPERIMENTS/IPSLCM/scenario_melting
/modIPSL/config/IPSLCM6/.

For a scenario experiment with a more important melting (red line in figure 3) and ssp585 scenario for the 1.8 version of the model, copy the repository 'scenario_extr_melting':

> cp -r /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/EXPERIMENTS/IPSLCM/scenario_extr_melting /modIPSL/config/IPSLCM6/.

For other experiments, copy the COMP repository of the experiment:

> cp -r /modIPSL/config/IPSLCM6/EXPERIMENTS/IPSLCM/*name_experiment* /modIPSL/config/IPSLCM6/.

and add to opa9.card the boundary files needed for the hosing experiment:

[BoundaryFiles]
List= ()
ListNonDel= (${R_IN}/OCE/IPSLCM6/${opa9_UserChoices_ORCA_version}/coordinates.nc,.),\
        (${R_IN}/OCE/IPSLCM6/${opa9_UserChoices_ORCA_version}/coordinates_xios.nc,.),\
        (${R_IN}/OCE/IPSLCM6/${opa9_UserChoices_ORCA_version}/
${opa9_UserChoices_ORCA_version}_bathy_meter.nc , bathy_meter.nc), \
        (${R_IN}/OCE/IPSLCM6/${opa9_UserChoices_ORCA_version}/
runoffs_${opa9_UserChoices_ORCA_version}_depths.nc , runoffs_eORCA1.0_depths.nc),\
        (/ccc/store/cont003/gen7403/devillim/RUNOFF/runoffs_forcing_y${year}.nc
**, runoffs_forcing_y${year}.nc), **
        (/ccc/store/cont003/gen7403/devillim/RUNOFF/mask_runoffs.nc,.),
        (/ccc/store/cont003/gen7403/devillim/RUNOFF/Iceberg_forcing.nc,.),
...

5.2.2 config.card

Copy the config.card from the experiment you wish to do. For an historical experiment with melting for the 1.8 version of the model, copy the repository:

> cd /modIPSL/config/IPSLCM6/
> cp /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/EXPERIMENTS/IPSLCM/
historical_melting/config.card .

For scenarios with melting, choose the appropriate config.card in the repository described above in subsection 5.2.1.

Adapt JobName, ExpType, DateBegin, DateEnd, RestartDate, RestartJobName, RestartPath according to your experiment.

Then install the job:
> ../../libIGCM/ins_job

5.2.3 namelist_ORCA1_cfg

The namelist *namelist_ORCA1_cfg* in the repository:

> /modIPSL/config/IPSLCM6/*Jobname*/PARAM/namelist_ORCA1_cfg

must be modified. Overwrite it with the modified version (for the V1.8 of IPSL-CM6-LR) available here:

> /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/CM61-LR-hist-melting/
PARAM/namelist_ORCA1_cfg

Or to modify it by hand, follow the next steps:
- *ln_rnf* should be set to TRUE (line 120) to allow the reading of the runoff even in coupled mode
  $ln\_rnf = .true.$
- add the lines (l.143):
  $sn\_rnf\_f =' runoffs\_forcing', -1,' sorunoff\_f', .true., .false.,' yearly', '','',''$
  $sn\_iceb\_f =' Iceberg\_forcing.nc', -1,' calving', .true., .true.,' yearly', '','',''$
  to include new files for the forcing.

5.2.4 file_def_nemo-opa.xml

Before launching the job, it is possible to force the model to write U and V velocities outputs (not stored by default) by changing in the same repository as *namelist_ORCA1_cfg* the file *file_def_nemo-opa.xml*.

A version of the modified file (V1.8 of IPSL-CM6-LR) can be copied from here:

> /ccc/work/cont003/gen7403/devillim/modipsl_V1.8/config/IPSLCM6/CM61-LR-hist-melting/
PARAM/file_def_nemo-opa.xml

To modify the file by hand, change the value of 'level' from 2 to 1 in the description of uo and vo as detailed below:

line 297:

<field field_ref="uoce" name="uo" long_name="sea_water_x_velocity" operation="average" freq_op="1mo" level="**1**" >
@uoce_e3u / @e3u </field>

and line 310:

<field field_ref="voce" name="vo" long_name="sea_water_y_velocity" operation="average" freq_op="1mo" level="**1**" >
@voce_e3v / @e3v </field>

5.3 Ready to go

After completing all the steps of section 5.1 and 5.2, the job is ready to be submitted:

> cd /modIPSL/config/IPSLCM6/*Jobname*/
> ccc_msub *Jobname*

For any technical issue, please contact me: mde@dmi.dk

References

[Bamber et al., 2018] Bamber, J. L., Tedstone, A. J., King, M. D., Howat, I. M., Enderlin, E. M., van den Broeke, M. R., and Noel, B. (2018). Land ice freshwater budget of the arctic and north atlantic oceans: 1. data, methods, and results. *Journal of Geophysical Research: Oceans*, 123(3):1827–1837.

[Box and Colgan, 2013] Box, J. E. and Colgan, W. (2013). Greenland ice sheet mass balance reconstruction. part iii: Marine ice loss and total mass balance (18402010). *Journal of Climate*, 26(18):6990–7002.

[Devilliers et al.,] Devilliers, M., Swingedouw, D., Mignot, J., Deshayes, J., Garric., G., and Ayache, M. A realistic greenland and surroundings melting in a coupled climate model. *Climate Dynamics*.

[Madec, 2008] Madec, G. (2008). *NEMO ocean engine*. Note du Pôle de modélisation, Institut Pierre-Simon Laplace (IPSL), France, No 27, ISSN No 1288-1619.

[Rousset et al., 2015] Rousset, C., Vancoppenolle, M., Madec, G., Fichefet, T., Flavoni, S., Barthélemy, A., Benshila, R., Chanut, J., Levy, C., Masson, S., and Vivier, F. (2015). The louvain-la-neuve sea ice model lim3.6: global and regional capabilities. *Geoscientific Model Development*, 8(10):2991–3005.

[Tournadre et al., 2015] Tournadre, J., Bouhier, N., Girard-Ardhuin, F., and Rmy, F. (2015). Antarctic icebergs distri-butions 1992-2014. *Journal of Geophysical Research: Oceans*, 121(1):327–349.

6 Detailed modifications of sbcrnf.f90 for EC-Earth3

see on freyja:

> diff /home/mde/EC-Earth3_dmi/ece3.3.0-cmip6-historical-noFWF/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/MY_SRC/sbc
/home/mde/EC-Earth3_dmi/ece3.3.0-cmip6-historical/sources/nemo-3.6/CONFIG/ORCA1L75_LIM3/WORK/sbcrnf.F90

Add those lines:

47a48
TYPE(FLD_N), PUBLIC :: sn_rnf_f !: information about the additionnal forced river runoff file to be read
66a68
REAL(wp), PUBLIC, ALLOCATABLE, SAVE, DIMENSION(:,:) :: msk_rnf_f !: river mask (hori.) for forced runoff
67a70
TYPE(FLD), ALLOCATABLE, DIMENSION(:) :: sf_rnf_f ! structure: additionnal forced river runoff (file information, fields read)
86a92
& msk_rnf_f (jpi,jpj), &
120c126,128
CALL fld_read (kt, nn_fsbc, sf_rnf_f) ! Read forced Runoffs data and provide it at kt

Here we change the runoff calculation:

129c137,142
! (origin) rnf(:,:) = rn_rfact * (sf_rnf(1)%fnow(:,:,1)) * tmask(:,:,1) ! updated runoff value at time step kt
! We combine original runoff from coupling and updated ones for Greenland and
! surrounding glaciers and ice caps (where mask_rnf_f is 0): sf_rnf_f and we change the redistribution of the icebergs
rnf(:,:) = msk_rnf_f(:,:) * rnf(:,:) + (1. - msk_rnf_f(:,:)) * sf_rnf_f(1)%fnow(:,:,1) * tmask(:,:,1) ! tundra and ice runoff
! WRITE(numout,*) 'runoffs and icebergs overwritten'

Then add those lines:

267c280,281 & sn_rnf_f
321c337,358
ALLOCATE(sf_rnf_f(1), STAT=ierror) ! Create sf_rnf_f structure (runoff inflow)
IF(lwp) WRITE(numout,*)
IF(lwp) WRITE(numout,*) ' forced runoffs inflow read in a file'
IF(ierror > 0) THEN
CALL ctl_stop('sbc_rnf_f: unable to allocate sf_rnf_f structure') ; RETURN
ENDIF
ALLOCATE(sf_rnf_f(1)%fnow(jpi,jpj,1))
IF(sn_rnf_f%ln_tint) ALLOCATE(sf_rnf_f(1)%fdta(jpi,jpj,1,2))
CALL fld_fill(sf_rnf_f, (/ sn_rnf_f /), cn_dir, 'sbc_rnf_init_f', 'read runoffs data', 'namsbc_rnf')
503a541,548
!
! ! ========================
! ! Mask for forced runoffs
!
! ========================
!
CALL iom_open ('mask_runoffs', inum) ! open file
CALL iom_get (inum, jpdom_data, 'mask', msk_rnf_f) ! read the mask
CALL iom_close(inum) ! close file

7 Detailed modifications of sbcrnf.f90 for IPSL-CM6-LR

47a48,49
> TYPE(FLD_N) , PUBLIC :: sn_rnf_f *!: information about the additionnal forced river runoff file to be read*
> TYPE(FLD_N) , PUBLIC :: sn_iceb_f *!: information about the additionnal forced icebergs file to be read*
66a69
> REAL(wp), PUBLIC, ALLOCATABLE, SAVE, DIMENSION(:,:) :: msk_rnf_f *!: river mask (hori.) for forced runoff*
67a71,72

> TYPE(FLD), ALLOCATABLE, DIMENSION(:) :: sf_iceb_f *! structure: iceberg forcing (file information, fields read)*
> TYPE(FLD), ALLOCATABLE, DIMENSION(:) :: sf_rnf_f *! structure: additionnal forced river runoff (file information, fields read)*
86a92
>   &   msk_rnf_f (jpi,jpj) , &
120c126,128
< CALL fld_read (kt, nn_fsbc, sf_rnf) *! Read Runoffs data and provide it at kt (runoffs + iceberg)*
—
> CALL fld_read (kt, nn_fsbc, sf_rnf) *! Read Runoffs data and provide it at kt (runoffs + iceberg)*
> CALL fld_read (kt, nn_fsbc, sf_iceb_f) *! Read Icebergs data and provide it at kt*
> CALL fld_read (kt, nn_fsbc, sf_rnf_f) *! Read forced Runoffs data and provide it at kt*
129c137,142
< rnf(:,:) = rn_rfact * (sf_rnf(1)%fnow(:,:,1)) * tmask(:,:,1) *! updated runoff value at time step kt*
—
> !rnf(:,:) = rn_rfact * (sf_rnf(1)%fnow(:,:,1)) * tmask(:,:,1) *! updated runoff value at time step kt*
> *! We combine original runoff from coupling and updated ones for Greenland and*
> *! surrounding glaciers and ice caps (where mask_rnf_f is 0): sf_rnf_f and we change the redistribution of the icebergs*
> rnf(:,:) = msk_rnf_f(:,:) * rnf(:,:) + (1. - msk_rnf_f(:,:)) * sf_rnf_f(1)%fnow(:,:,1) * tmask(:,:,1) *! tundra and ice runoff*
> rnf(:,:) = rnf(:,:) + sf_iceb_f(1)%fnow(:,:,1) * tmask(:,:,1) *! icebergs*
> WRITE(numout,*) 'runoffs and icebergs overwritten'
136c149
<
—
> !
267c280,281
<   &   ln_rnf_depth_ini , rn_dep_max , rn_rnf_max, nn_rnf_depth_file
—
>   &   ln_rnf_depth_ini , rn_dep_max , rn_rnf_max, nn_rnf_depth_file, &
>   &   sn_rnf_f , sn_iceb_f
311a326 > !
321c336,356
<
—
> !
> ALLOCATE(sf_rnf_f(1), STAT=ierror) *! Create sf_rnf_f structure (runoff inflow)*
> IF(lwp) WRITE(numout,*)
> IF(lwp) WRITE(numout,*) ' forced runoffs inflow read in a file'
> IF(ierror > 0) THEN
> CALL ctl_stop('sbc_rnf_f: unable to allocate sf_rnf_f structure') ; RETURN
> ENDIF
> ALLOCATE(sf_rnf_f(1)%fnow(jpi,jpj,1))
> IF(sn_rnf_f%ln_tint) ALLOCATE(sf_rnf_f(1)%fdta(jpi,jpj,1,2))
> CALL fld_fill(sf_rnf_f, (/ sn_rnf_f /), cn_dir, 'sbc_rnf_init_f', 'read runoffs data', 'namsbc_rnf')
> !
> ALLOCATE(sf_iceb_f(1), STAT=ierror) *! Create sf_iceb_f structure (iceberg forcing)*
> IF(lwp) WRITE(numout,*)
> IF(lwp) WRITE(numout,*) ' iceberg forcing read in a file'
> IF(ierror > 0) THEN
> CALL ctl_stop('sf_iceb_f: unable to allocate sf_iceb_f structure') ; RETURN
> ENDIF
> ALLOCATE(sf_iceb_f(1)%fnow(jpi,jpj,1)) > IF(sn_iceb_f%ln_tint) ALLOCATE(sf_iceb_f(1)%fdta(jpi,jpj,1,2))
> CALL fld_fill(sf_iceb_f, (/ sn_iceb_f /), cn_dir, 'sbc_rnf_iceb', 'read icebrg forcing data', 'namsbc_rnf')
> !
503a539,546
> !
> ! ! =======================
> ! ! Mask for forced runoffs
> ! ! =======================
> !

```
> CALL iom_open ( 'mask_runoffs', inum )  ! open file
> CALL iom_get ( inum, jpdom_data, 'mask', msk_rnf_f )  ! read the mask
> CALL iom_close( inum )
```