Supplement of

GREB-ISM v1.0: A coupled ice sheet model for the Globally Resolved Energy Balance model for global simulations on timescales of 100 kyr

Zhiang Xie et al.

Correspondence to: Zhiang Xie (zhiang.xie@monash.edu)

The copyright of individual parts of the supplement might differ from the article licence.
Global Resolved Energy Balance - Ice Sheet Model
User Manual

Zhiang Xie
April 4, 2022

Contents
1 Requirements 2
2 Install 2
3 File System 2
   3.1 Input .................................................. 2
   3.2 Job Script .............................................. 2
   3.3 Model Source Code ..................................... 3
   3.4 Model output .......................................... 3
4 Instruction for Running Experiment 3
5 Post-process 3
1 Requirements

- Unix-like system (e.g., Linux, MacOS)
- GNU GCC (gfortran). The GREB-ISM code is written by Fortran90. So Fortran compiler is required.

2 Install

The full GREB-ISM is managed on GitHub. So the user can either download Zip file from GitHub (Download Code button) or use command (Git required):
git clone https://github.com/YMI33/GREB-ISM.git

3 File System

3.1 Input

GREB-ISM/input: Binary files for model input; For binary files, detailed information can be found in description file (.ctl).

| File name                                         | Description                                      |
|---------------------------------------------------|--------------------------------------------------|
| CO2/                                              | Historical CO\textsubscript{2} concentration data |
| Tocean.clim.bin                                   | Mean deep ocean temperature                      |
| bedmachine.bed.rock.bin                           | Bed rock data                                     |
| erainterim.atmospheric_humidity.clim.bin           | Mean atmospheric humidity                         |
| erainterim.meridional_wind.850hpa.clim.bin        | Mean meridional wind speed                        |
| erainterim.omega.vertmean.clim.bin                | Climatological mean of vertical wind speed (omega) |
| erainterim.omega_std.vertmean.clim.bin            | Climatology standard deviation of vertical wind speed (omega) |
| erainterim.tsurf.1979-2015.clim.bin                | Mean surface temperature                          |
| erainterim.windspeed.850hpa.clim.bin               | Mean wind speed                                   |
| erainterim.zonal_wind.850hpa.clim.bin              | Mean zonal wind speed                             |
| global.topography.t31.gad                         | Surface elevation                                 |
| ice.height.first-guess.clim730.bin                | Reference ice thickness                           |
| icesheet_input/                                   | Paleoclimate surface temperature in Greenland and Antarctica |
| isccp.cloud_cover.clim.bin                        | Cloud cover                                       |
| ncep.soil_moisture.clim.bin                       | Soil wetness                                      |
| orbital.parameters.last5mill.yrs.nocomments.txt   | Orbital parameters in last 5 million years        |
| precip.AWI-ESM.LGM.730clim.gad                    | Mean precipitation during Last Glacial Maximum    |
| precip.NCEP-DOE.730clim.gad                       | Mean precipitation                               |
| solar_radiation.clim.bin                          | 24hrs mean solar radiation                       |
| ts.AWI-ESM.LGM.730clim.gad                        | Mean surface temperature during Last Glacial Maximum |
| woce.ocean_mixed.lay.e_depth.clim.bin             | Mixed layer depth height                          |

3.2 Job Script

GREB-ISM/job-script: C-shell job script for running model
3.3 Model Source Code

GREB-IS/SM/src: source code for model

| File name             | Description                                                                 |
|-----------------------|-----------------------------------------------------------------------------|
| greb.atmosphere.f90   | Atmosphere module (radiation, hydro-cycle and orbital forcing)              |
| greb.main.f90         | Main routine (Parameter setting, main loop, file input/output)              |
| greb.ocean.f90        | Ocean module (sea ice, deep ocean and sea level)                            |
| ice-sheet.f90         | Ice sheet module (surface mass balance and ice dynamics)                    |
| model_verify.f90      | Benchmark experiments for Ice Sheet Model (EISMINT I/II)                     |

3.4 Model output

GREB-IS/SM/experiment: directory for storing experiment results

4 Instruction for Running Experiment

1. Edit job script in GREB-IS/SM/job-script/
2. Change environment variable WDIR to the absolute path of your GREB-IS/SM change experiment setting (EXP: experiment number, KVRSTART: start date of experiment, etc.)
3. Run job script
4. After the first run finishes, rerun the job by restart file to continue experiment

Note: For running ice sheet model standalone experiments, the user needs to change environment variables both in run.greb.icealone.csh and run.greb.icealone.restart.csh. For coupled experiment, the restart file can be generated automatically.

5 Post-process

GREB-IS/SM output is stored in binary format by GrADS format. You can easily read the data by CTL files in the same directory through GrADS. A overall CTL file for all scenario experiment results will be automatically generated in the same directory, named as "greb.exp-EXP.NAME.scenario.ctl" and "greb.exp-EXP.NAME.scenario.gmean.ctl", where $EXP is experiment number, $NAME is experiment name.

Note:

- The GREB-IS/SM does not output the initial condition. So the experiment 00000 represents the first GREB output, 00001 for second and so on.
- The output date can be read by Python 3 using py3grads. The CDO transformation from GrADS to NetCDF file is not supported since ice flow velocity is multi-layers.
The CTL file for individual scenario will not be automatically generated. The user can write one if it is needed.
A template for an experiment (experiment number: 200, experiment name: pi-control-340, output number: 00000) is like below:

```plaintext
dset `greb.exp−200.pi−control−340.00000.scenario.bin
undef 9.e27
xdef 96 linear 0 3.75
ydef 48 linear −88.125 3.75
zdef 4 levels 1 0.57 −0.57 −1
tdef 12 linear 15jan0001 1mo
vars 16
tsurf 1 0 surface temperature
tatmos 1 0 atmosphere temperature
tocean 1 0 ocean temperature
vapor 1 0 water vapor
mask 1 0 land−sea mask
precip 1 0 precipitation
albd 1 0 surface albedo
glacier 1 0 ice surface temperature
iceh 1 0 ice thickness
zs 1 0 ice surface height
mass 1 0 mass balance
adv 1 0 advection term
calv 1 0 calving
vx 1 0 ice flow zonal velocity
vy 1 0 ice flow meridianal velocity
tice 4 0 ice temperature in different layers
endvars

Template for global mean output:

dset `greb.exp−200.pi−control−340.00000.scenario.gmean.bin
options template
undef 9.e27
xdef 1 linear 0 3.75
ydef 1 linear −88.125 3.75
zdef 1 linear 1 1
tdef 12000 linear 15jan0001 1mo
vars 7
tsurf 1 0 surface temperature
tatmos 1 0 atmosphere temperature
tocean 1 0 ocean temperature
vapor 1 0 water vapor
mask 1 0 land−sea mask
albd 1 0 albedo
precip 1 0 precipitation
slv 1 0 sea level
endvars
```

5