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

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Global Resolved Energy Balance - Ice Sheet Model User Manual

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Contents

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_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_laye_depth.clim.bin	Mixed layer depth height

3.2 Job Script

GREB-ISM/job-script: C-shell job script for running model

File name	Description
greb-ice-sheet.exp-scenario.newstart.com	ice sheet - climate coupled experiments
run.greb.icealone.(restart).csh	ice sheet model standalone experiments
run.greb.imodel.verify.csh	EISMINT I/II

3.3 Model Source Code

GREB-ISM/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-ISM/experiment: directory for storing experiment results

4 Instruction for Running Experiment

1. Edit job script in GREB-ISM/job-script/
2. Change environment variable WDIR to the absolute path of your GREB-ISM change experiment setting (EXP:experiment number, KYRSTART: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-ISM 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-ISM 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:

```
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
glcier 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 albdo
precip 1 0 precipitation
slv    1 0 sea level
endvars
```