Technique notes for AWIESM-wiso

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The AWIESM-wiso can be run under the framework of ESM-tools, here is an instruction on how to use ESM-tools to compile AWIESM-wiso and run PI and MH experiments.

1 Install ESM-tools

First, make sure you add the following lines to one of your login or profile files, i.e. ∼/.bash_profile, ∼/.bashrc, ∼/.profile, etc.:

export PATH=$PATH: /.local/bin
export LC_ALL=en_US.UTF-8
export LANG=en_US.UTF-8

You can choose to source now your login or profile file, so that the module and export commands are run (e.g. **source ∼/.bash_profile**).

To use the ESM-Tools, written in Python, clone this repository:
git clone https://github.com/esm-tools/esm_tools.git

Then, run the install.sh:
./install.sh
You should now have the command line tools **esm_master** and **esm_runscripts**.

For more details on how to install ESM-tools, please refer to https://github.com/esm-tools/esm_tools.

2 Download and compile AWIESM2.1-wiso

Create a folder called **awiesm-2.1-wiso**, in this folder, download the model codes and runscripts (**codes_runscripts.tar.gz**) from zenodo (in the same repository where this file is in):

Unzip **codes_runscripts.tar.gz**, you can then have 4 new folders called:
fesom-2.0-wiso containing the sourcec codes of the ocean component
oasis containing the source codes of the coupler
namelist_AWIESM2-beta containing namelists of the model
run-script containing two example run-scripts for pre-industrial and mid-Holocene simulations

For the atmosphere component ECHAM6, please first apply for a personal user license at https://code.mpimet.mpg.de/p esm-license, then the isotope-enabled version can be used upon request to Martin.Werner@awi.de.

Once the legal access to the the atmosphere component is achieved, please save it in a new folder called **echam-6.3.05p2-wiso** in **awiesm-2.1-wiso**.

You need to rename **fesom-2.0-wiso** to **fesom-2.1** as this is required for the compilation using ESM-tools.

Now go to the parent folder, i.e., **awiesm-2.1-wiso**, and compile the model with the following command:

esm_master comp-awiesm-2.1-wiso

3 Make changes to AWIESM2.1-wiso

You can modify the source code of all model components which are stored at:
ECHAM: awiesm-2.1-wiso/echam-6.3.05p2-wiso/src/echam
JSBACH: awiesm-2.1-wiso/echam-6.3.05p2-wiso/src/src_jsbach3
Radiation: awiesm-2.1-wiso/echam-6.3.05p2-wiso/src/rad_src
FESOM: awiesm-2.1-wiso/fesom-2.1/src

There are several ways to re-compile the model after making changes, one can go to the "parent" folder of **awiesm-2.1-wiso** and run
esm_master comp-awiesm-2.1-wiso
It will re-compile all model components and often takes a long time. If you would like to compile just one model component (either atmosphere or ocean), just go into the folder awiesm-2.1-wiso and you can see the following files:
comp-echam-6.3.05p2-wiso_script.sh
comp-fesom-2.1-wiso_script.sh
The script comp-echam-6.3.05p2-wiso_script.sh is for compiling the atmosphere component (ECHAM, JSBACH, radiation) and the comp-fesom-2.1-wiso_script.sh is for the ocean (FESOM). After running the script, you need to replace the binary file:
cp echam-6.3.05p2-wiso/bin/echam6 bin/
cp fesom-2.1/bin/fesom.x bin/

4 Run AWIESM2.1-wiso

Set a path as your working folder, where your experiments should run and produce outputs. In this path, you can start simulations.

4.1 Pre-industrial (PI) control simulation

An run-script example to run a PI simulation is here:
run-script/pi.yaml

Here is a detailed explanation of the script:

general: this section define general information of the run.
setup_name: "awiesm" default, don't change
version: "2.1-wiso" default, don't change
with_wiso: False do you want to run the simulation with isotopes
compute_time: "01:55:00" the maximum compute time. The run will stop once the time limit is reached.
initial_date: "2000-01-01" The first model year/month/day of the simulation, the year must be large than (or equal to) 1000
final_date: "2300-12-31" The last model year/month/day of the simulation
base_dir: "/home/a/a270064/bb1029/AWIESM2.1-EXP/" Please change it to the path of your working folder!!!
nmonth: 0 default, only change it if you would like to restart the simulation every month, instead of every year.
nyear: 1 the run restarted every model year
account: "ab0246" your working project, where the CPU consumed from.
use_venv: False default, don't change

echam: this section define general information of the atmosphere configuration.
lresume: 0 0 means a cold start, 1 means a warm start (continued from a previous run). If lresume=1, you need to define the following 4 lines.
ini_parent_exp_id: "pi_fix" the name of the experiment you would like to restart from (only valid of lresume=1).

fake_initial_date: "2133-01-01" The restart date, it tells esm.tool which restart files should be read from the previous simulation (only valid of lresume=1).

ini_parent_date: "$((${fake_initial_date} - ${echam.time_step}seconds))" default, don't change (only valid of lresume=1).

ini_parent_dir: "/home/a/a270064/bb1029/awiesm_exp/pi_fix70/restart/echam/" the folder containing the echam restart files (only valid of lresume=1).

restart_unit: "years" default, only change it if you would like to restart the simulation every month, instead of every year.

nproca: 48 default, don't change

nprocb: 16 default, don't change

nprocar: 0 switch off concurrent radiation, default, don't change

nprocbr: 0 switch off concurrent radiation, default, don't change

namelist_changes: the following controls the namelists

namelist.echam: the following controls namelist.echam

parctl: the following controls the "parctl" part of namelist.echam

nproca: 48 default, don't change

nprocb: 16 default, don't change

nprocar: 0 switch off concurrent radiation, default, don't change

nprocbr: 0 switch off concurrent radiation, default, don't change

runctl: the following controls the "runctl" part of namelist.echam

default_output: True default, don't change

putdata: [1, 'months', 'last', 0] time frequency of model output, higher frequency can make the model slower.

radctl: the following controls the "radctl" part of namelist.echam

lrad_async: False switch off concurrent radiation, default, don't change

awiesm: this section define general information of the model version and path.

postprocessing: true default, don't change

scenario: "PALEO" default, don't change

model_dir: "/home/a/a270064/esm_tools/awiesm-2.1-wiso/" change it to the path of your model, it tells esm-tool where to read the binary files of the model.

fesom: this section define general information of the ocean configuration.

lresume: 0 0 means a cold start, 1 means a warm start (continued from a previous run). If lresume=1, you need to define the following 3 lines.

ini_parent_exp_id: pi_fix the name of the experiment you would like to restart from (only valid of lresume=1).

ini_parent_dir: "/home/a/a270064/bb1029/awiesm_exp/from_ollie/pi_fix/restart/fesom/" the folder containing the echam restart files (only valid of lresume=1).

ini_parent_date: "2113-12-31" The restart date, it tells esm.tool which restart files should be read from the previous simulation (only valid of lresume=1).

nproc: 384 how many CPUs are used for fesom

version: "2.1-wiso" default, don't change

res: "CORE2" default, don't change

ALE_scheme: 'linfs' use the non-linear free surface scheme, default, don't change

pool_dir: "/pool/data/AWICM/FESOM2" default, don't change

mesh_dir: " /home/a/a270064/bb1029/inputs/awicm2_final384/" default, only change it if you intend to use a different mesh.

namelist_dir: "/home/a/a270064/ab0246/files_for_Xiaoxu_Notes/namelist_AWIESM2-beta/" the path to default fesom namelists.

restart_rate: 1

restart_unit: "y" These two lines means the run will be restarted every 1 year. You can change it as you want. It should be consistent with the information defined in the general section.

restart_first: 1 default, don't change

namelist_changes: the following controls the namelists

namelist.config: the following controls namelist.config

paths: the following controls the "paths" part of namelist.config

ClimateDataPath: "/home/a/a270064/bb1029/inputs/hydrography/" where to read the initial conditions for a cold-start run, which is usually stored in phc3.0_winter.nc (for temperature and salinity), and in wiso.nc (for isotopes).

geometry: the following controls the "geometry" part of namelist.config

force_rotation: False does fesom need to rotate the mesh inside the mode? If the mesh is already rotated, then set it to False, otherwise to True.

ncar_bulk_z_wind: remove_from_namelist default, don't change

ncar_bulk_z_tair: remove_from_namelist default, don't change

ncar_bulk_z_shum: remove_from_namelist default, don't change

jsbach: this section define general information of the land surface module JSBACH.

input_sources: the following line defines the input file for JSBACH

jsbach_1850: "/home/a/a270064/bb1029/inputs/mesh_core2/tarfilesT63/input/jsbach /jsbach_T63CORE2_11tiles_5layers_1850.nc" define the input file for JSBACH

oasis3mct: this section define general information of the coupler OASIS

lresume: 0 0 means a cold start, 1 means a warm start (continued from a previous run). If lresume=1, you need to define the following 3 lines. Note that lresume=0 leads to slow model speed for the first model year.

ini_parent_exp_id: "mh_fix" doesn't matter

ini_parent_date: "22731231" doesn't matter

ini_restart_dir: "/home/a/a270064/bb1029/AWIESM2.1-EXP/pi_beta1/restart/oasis3mct/" It defines the path to the restart files, esm-tool will copy a2o_flux and o2a_flux from this folder.

After necessary modification to the run-script (i.e., pi.yaml), you can start your PI simulation with:

esm_runscripts pi.yaml -e [exp_name]

Replace [exp_name] with the name of your experiment.

4.2 Mid-Holocene (MH) simulation

To perfrom MH or LIG simulations, one can stick to the run-script of PI, just with some minor changes in the echam section:

For MH (example file: **run-script/mh.yaml**):

runctl:

default_output: True

putdata: [1, 'months', 'last', 0]

l_orbvsop87: False set it to False so the orbital parameters (cecc, cobld, clonp) can be updated from the following settings.

radctl:

lrad_async: False

CO2VMR: 264.36e-6 set CO2 concentration

CH4VMR: 0.56466e-6 set CH4 concentration

N2OVMR: 0.26065e-6 set N2O concentration

cecc: 0.0186818 set eccentricity

cobld: 24.104767 set obliquity

clonp: 180.917664 set perihelion

yr_perp: -99999 this line is necessary, I don't know why.

jsbach:

input_sources:

jsbach_1850: "/home/a/a270064/bb1029/inputs/mesh_core2 /jsbach_T63CORE2_11tiles_5layers_natural-veg.nc" For paleo simulation, crops and pastures should be removed from the vegetation.

5 Check your simulations

5.1 Status of the jobs

Run **squeue -u [user_id]** to see the status of your simulations.

In my case:
[a270064@levante1 work]$ squeue -u a270064
JOBID PARTITION NAME USER ST TIME NODES NODELIST(REASON)
2741450 compute lig_beta a270064 R 2:34 9 l[10309-10311,10316-10321]
2741439 compute pi_beta a270064 R 3:35 9 l[30113-30121]

It means 2 jobs "lig_beta" and "pi_beta" are running with the job ID of 2741450 and 2741439 respectively. You can see the experiment folders "lig_beta" and "pi_beta" in the [base_dir] defined in general section of the run-script.

Here is a list of sub-folders in your experiment folder:
analysis: not important, it's empty
bin: it contains the binary files of the model
config: history run-scripts, namelists etc of each model year.
couple: not important, it's empty
forcing: history forcing data of each model year
input: necessary input files to run the model
log: history log files of each model year
mon: not important, it's empty
outdata: important, it contains the model output data
restart: history restart files of each model year
scripts: your main run-script and some other files generated by esm-tool
src: not important, it's empty
unknown: a lot of unknown files, clean it regularly as it occupy a lot of space
viz: not important, it's empty
Besides, you might see a lot of **run_*** folders, where the experiment is/was running. Please delete those run_* folders regularly, except the last run_* folder (as your experiment is now running in it).

5.2 Cancel a simulation

To kill a job, just use **scancel [job_id]**

5.3 Continue a simulation

If your job is canceled and your would like to resume it, go to your experiment folder, then go to the sub-folder "scripts", you can see your run-script there, submit it.

5.4 If a simulation stops automatically

It might means that the final_date (defined in the general section of your run-script) is reached, your can prolong the final_date and continue the run.

It can also means that the upper time limit is reached, in this case just increase the time limit compute_time (defined in the general section of your run-script).

Errors can also lead to break of simulations, for troubleshooting please refer to the next section.

6 Troubleshooting

Some useful log files for you to check the simulation:
run_*/work/atmout it gives information about the echam component
run_*/log/*log it gives information about both fesom and echam
History logs for each integrated model year can be found in **log** of your experiment folder.

Here I list the most common errors according to my experience:

6.1 Overflow

Go to the last run_* folder, check work/atmout, if you see an error message related to "overflow", then you need to increase "enstdif" in your namelist.echam:

vi work/namelist.echam
add the following in namelist.echam:
dynctl
enstdif = 1.00001
/
then:
cd ../scripts
sbatch *.run

6.2 Job neither runs nor stops

If you find that your job hang before the integration until the time limit is reached, and log files give no error message, it is hard to know the reason. I only know that it might be caused by using a rotated/unrotated fesom mesh but set force_rotation (in fesom section of the run-script) to True/False, just correct the setting and try again.

6.3 Blow up

If your log file tell you the model blows up, you can see a blow-up NetCDF file in **run_*/work**, please check the data and see what is the problem (mostly due to salinity/temperature/sea surface height exceeding the a certain range).

Reduce the time step of fesom might help to solve the problem. It the error occurs at the beginning of a cold-start simulation, try the following:

(1) make sure you have lresume=0 in oasis3mct section of your run-script. (If lresume=1, it might lead to blowup error if the restart files are from a simulation using a different ocean mesh or runing with a different number of CPUs).

(2) If (1) does not help, then it might means that the temperature/salinity gradient in your initial condition is too sharp in some area, horizontally or vertically. Try to smooth your initial condition.

6.4 oclook: no ocean cell found for HD grid cell

Please refer to section **??**.

6.5 liquid water content above field capacity

FATAL ERROR in digest_evapotrans crash
Please refer to section **??**.

6.6 cuadjtq (1): lookup table overflow

FATAL ERROR in cuadjtq (1): lookup table overflow with WARNING! high wind speed in the highest vertical layer.
Please refer to section **??**.

6.7 1385423270394660728

If the log file gives you an error number of 1385423270394660728. It means that the number of the surface nodes defined in your run-script is not identical to the mesh you are using. You need to define it correctly (in fesom section: **nx:** [**number_of_nodes**]).

6.8 13854232708188029 75

This error number means at least one of your restart files for the coupler (oasis) is missing.

(1) If it happens in the first model year, please check the ini_restart_dir in oasis3mct section of your run-script to see if there are **o2a_flux** and **a2o_flux** files in the path.

(2) If it happens in the second model year, it is likely due to the fact that esm-tool did not correctly produce **a2o_flux** for the first model year. I don't know how to solve it technically but my trick is to manually copy a **a2o_flux** file from other experiment and paste it into **restart/oasis3mct**. Note that if your run is with isotopes, then the a2o_flux must be copied from another run with isotopes too.

7 Good luck!