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MOSAIX

MOSAIX is a small set of fortran routines, bash scripts, python scripts and xml files allowing to generate coupling weights for the IPSL Earth System Model. It is under development, and recently used in production runs used by the production runs. It aims to replace the old MOSAIC software. It uses XIOS as a library to compute weights. In the present state, it can handle ORCA, LMDZ lon/lat and DYNAMICO grids.

MOSAIX can generate second order conservative interpolation weights. They are used in place of bilinear interpolation by OASIS-MCT.

As MOSAIX uses XIOS, it works in parallel, using MPI distributed memory.

Compatibility with MOSAIC

- Weights are **not** fully compatible with the weights generated by MOSAIC. The precision of the interpolation (conservation) is improved. The ocean mask interpolated on the atmosphere grid is slightly different.
- Run-off** : runoff weights are computed with a different algorithm, the result can be quite different.
- Calving** : In IPSLCM6, the calving was integrated for each latitude of the grid on the LMDZ grid. Weights were use to aggregate several latitudes to compute an integral over a latitudinal band.. This is not possible with DYNAMICO, and was abandon for rectilinear LMD grid. The atmosphere model must send the integral over a region (presently latitudinal bands). The final result should be the same as with MOSAIC.

XIOS

MOSAIX is known to work with XIOS revision 2286

XIOS : <http://forge.ipsl.fr/ioserver/svn/XIOS/trunk>

Extraction : svn co <http://forge.ipsl.fr/ioserver/svn/XIOS/trunk> XIOS

Licensing

MOSAIX is under CeCILL_V2 licence. See Licence_CeCILL_V2-en.txtfile for an english version of the licence and Licence_CeCILL_V2-fr.txt for a french version.

Permission is hereby granted, free of charge, to any person or organization obtaining a copy of the software and accompanying documentation covered by this license (the Software) to use, reproduce, display, distribute, execute, and transmit the Software, and to prepare derivative works of the Software, and to permit third-parties to whom the Software is furnished to do so, all subject to the following warning :

Warning

Warning, to install, configure, run, use any of MOSAIX software or to read the associated documentation you'll need at least one (1) brain in a reasonably working order. Lack of this implement will void any warranties (either express or implied). Authors assumes no responsibility for errors, omissions, data loss, or any other consequences caused directly or indirectly by the usage of his software by incorrectly or partially configured

Known problems

- ?

Future work

Geographical distribution of the calving for the northern hemisphere.

Validation

MOSAIX and the old method MOZAIC are very similar for temperature, albedo, ice cover and heat and water fluxes. However, MOSAIX generates weights that are slightly different from those generated by MOZAIC. The global conservation is better.

For wind stress, the old method relies on OASIS bilinear interpolation (from the Scrip library). MOSAIX generates 2nd order weights.

For runoff, the method is different. We have run three simulations with IPSLCM6 LR to check the new weights :

- TEST.CM6.MOSAIX.11 : old MOZAIC weights

- TEST.CM6.MOSAIX.18 : new MOSAIC weights with runoff parameters atmCoastWidth=2 oceCoastWidth=3 searchRadius=600.0. Weight files are IGCM/CPL/IPSLCM6/eORCA1.2xLMD144142/rmp_*MOSAIX_v0.nc
- TEST.CM6.MOSAIX.19 : new MOSAIC weights with runoff parameters atmCoastWidth=2 oceCoastWidth=2 searchRadius=550.0. Weight files are IGCM/CPL/IPSLCM6/eORCA1.2xLMD144142/rmp_*MOSAIX_v1.nc

Results available at `tgcc:$CCCSTOREDIR/../../gencmip6/p86caub/IGCM_OUT/IPSLCM6/DEVT/piControl`

An intermonitoring is available at http://webservices2017.ipsl.fr/interMonitoring/tmp/interMonitoring_plot01_pAPyBD_prod/

A CESMEP atlas is under preparation.

Code availability

- Web : <https://forge.ipsl.fr/igcmg/browser/TOOLS/MOSAIX>
- SVN : `svn co http://forge.ipsl.fr/igcmg/svn/TOOLS/MOSAIX MOSAIX`
- SVN : `svn co svn+ssh://<login>@forge.ipsl.fr/ips1/forge/projets/igcmg/svn/TOOLS/MOSAIX MOSAIX`

Portability

MOSAIX been developed and extensively used on Irene (TGCC) Skylake computer, using the Intel compilation tools.

MOSAIX is supposed to work on any computer where XIOS works.

It has been tested on Mac OS X, using gcc as a compiler. It is fragile, as regularly XIOS updates break the compatibility.

Requirements

- Fortran compiler, C++ compiler, MPI library.
- A working [XIOS](#) library. Revision 1615 is known to work.
- fcm version 1.2
- NetCDF fortran librairies. See [XIOS](#) for a suitable version.
- Python, version ≥ 3.6 with [netCDF4](#) and [numpy](#) modules. Python version ≥ 2.7 might work, but has not been tested recently.
- Bash version ≥ 4 .
- [NCO](#). Version 4.6.0 is known to work.

Input files

MOSAIX needs files describing the grid of the models. See `CreateWeightsMask.bash` and the bottom of this page.

Output files

All netCDF files have a detailed header.

- Weight files `rmp_*`. Should have a rather explicit name. The name is configurable at the beginning of `CreateWeightsMask.bash`.
- Diagnostic file used for debug `dia_*.nc` for each `rmp` file, except for runoff and calving. Debug information are directly in weight files in this last case.
- Grid description file for OASIS-MCT `grids.nc`, `areas.nc` and `masks.nc`.
- A file containing the fraction of ocean in each atmosphere grid box. For instance `ICO40_grid_maskFrom_eORCA1.2.nc`.
- A `README` file. Includes a checksum for each generated files.

Scripts and codes

- **CreateWeightsMask.bash**. Creates the weights to interpolate between atmospheric and ocean grid. Weight files are suitable for OASIS-MCT. Creates the fraction of ocean in atmospheric grid cells. Uses parallel processing with MPI. Has a configuration section at the beginning.
- **CreateOasisGrids.bash**. Creates files `grids.nc`, `areas.nc` and `masks.nc` with information from both models, suitable for OASIS-MCT. Mono CPU. Launched by `CreateWeights.bash`.
- **update_xml.py**. Python script used to perform on the fly editing of xml files. Used by `CreateWeights.bash`. More information with `python update_xml.py -h`.

- **iodef_atm_to_oce.xml** and **iodef_oce_to_atm.xml**. xml files read by `interpol.f90`. These files are edited by `update_xml.py`.
- **MOSAIX/src/MOSAIX/interpol.f90**. Fortran source using the XIOS library.
make_mosaix. Small script for compiling **interpol.f90**. You need to compile XIOS first. Uses compiler, compiler options and libraries defined by XIOS.

```
make_xios [options]
options :
  [--xios path] : path to XIOS. Default is ../XIOS
  [--full]      : to regenerate dependencies and recompile from scratch
Example : ./make_mosaix --xios ../XIOS
```

- **RunoffWeights.py**. Python code to generates weights for run-off. Launched by `CreateWeights.bash`. More information with `python RunOffWeights.py -h`.

1) Defines a coastal band on land in the atmosphere model. For LMDZ rectilinear grids, the width of this band is parametrized, in grid points. For ico grids, the band contains only point with a fraction of ocean in]0,1[.

2) Defines a coastal band on ocean in the ocean model. The width of this band is parametrized.

3) An atmosphere point of the coastal band is linked to an ocean point in the coastal band if the distance between the two is less than `searchRadius`.

- **CalvingWeights.py**. Python code to generates weights for calving. Launched by `CreateWeights.bash`. More information with `python CalvingWeights.py -h`.

1) The atmosphere model integrate the calving over on specific regions. Presently the regions are three latitudinal bands with limits 90°S/40°S/50°N/90°N.

2) The weights distribute the calving in the ocean in the corresponding latitudinal bands. By default, the distribution is uniform.

3) For the southernmost band, it is possible to use a geographical distribution read in a file. These files are currently available for eORCA1 and eORCA025.

Grids

- *[tuv]orc*. ORCA grid at *[TUV]* points. Masked on land, with area equal to grid box surface.
- *tlmd*. LMD rectilinear grid at scalar (physics) point. Masked on land, with area equal to grid box surface.
- *tico*. LMD icosahedron grid at scalar (physics) point. Masked on land, with area equal to grid box surface.
- *olmd*. LMD rectilinear grid at scalar (physics) point. Not masked, with areas set to 1.
- *oico*. LMD icosahedron grid at scalar (physics) point. Not masked, with areas set to 1.
- *corc*. ORCA grid at *T* point. Masked on land, duplicated (from periodicity) point masked, with area equal to grid box surface.
- *oorc*. ORCA grid at *T* point. Masked on land, duplicated (from periodicity) point masked, with area equal 1.

Generating input grid files

Generating icosahedral grid in double precision using XIOS:

Here are the main changes:

- File `context_lmdz.xml` :

```
.....
<domain_definition>
  <domain id="dom_glo" data_dim="2" />
  <domain id="dom_glo_p8" domain_ref="dom_glo" prec="8" />
  <domain id="greordered" domain_ref="dom_glo">
    <reorder_domain invert_lat="true" shift_lon_fraction="0"/>
  </domain>
</domain_definition>
```

```

...
<grid_definition>
.....
  <grid id="grid_glo">
    <domain domain_ref="dom_glo" />
  </grid>

  <grid id="grid_glo_p8">
    <domain domain_ref="dom_glo_p8" />
  </grid>
.....

```

- File field_def_lmdz.xml :

```

<field_definition level="1" prec="4" operation="average" freq_op="lts" enabled=".true." default_value="9.96921e+36" domain="dom_glo">
  <field_group id="fields_2D_p8" grid_ref="grid_glo_p8" prec="8">
    <field id="aire_p8" field_ref="aire" long_name="Grid area p8" unit="-" />
    <field id="fract_oce_p8" field_ref="fract_oce" long_name="Fraction oce p8" unit="1" />
    <field id="fract_sic_p8" field_ref="fract_sic" long_name="Fraction sic p8" unit="1" />
    <field id="fract_oce_plus_sic_p8" long_name="Fraction oce plus sic p8" unit="1" />
    <field id="mask_oce_plus_sic_p8" long_name="Masque oce plus sic p8" unit="1" />
  </field_group>
[...]
```

- File file_def_histmth_lmdz.xml :

```

<file_definition>
  <file_group id="defile">
    <file id="grid_p8" name="grid_p8" output_freq="1d" sync_freq="10d" output_level="2" enabled="true" timeseries="none">
      <field_group grid_ref="grid_glo_p8" ts_enabled="true" freq_op="1d" expr="@this">
        <field field_ref="aire_p8" level="1" operation="once" />
        <field field_ref="fract_oce_p8" level="1" operation="once" />
        <field field_ref="fract_sic_p8" level="1" operation="once" />
      </field_group>

      <field_group grid_ref="grid_glo_p8" ts_enabled="true" freq_op="1d" >
        <field field_ref="fract_oce_plus_sic_p8" level="1" > fract_oce + fract_sic </field>
        <field field_ref="mask_oce_plus_sic_p8" level="1" > ((fract_oce + fract_sic) &gt; 0) ? 1 : 0 </field>
      </field_group>
    </file>
.....

```