Mesh refinement in NEMO

Implementation of an agrif zoom in the Indonesian Throughflow

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Outline

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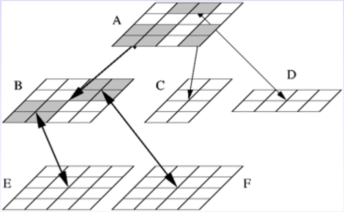
The AGRIF software

AGRIF : Adaptive Grid Refinement In Fortran

- deals with any number of grids
- includes necessary routines to code grid's interactions
- allows any space and time refinement coefficients



Principle : Run the same model on grids with different space/time resolutions

Outline

Introduction

Preparing the child model

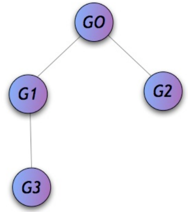
Running the model

Application

AGRIF in NEMO

- Activated thanks to cpp key (key_agrif)
- grid's locations specified in AGRIF_FixedGrids.in

imin	imax	jmin	jmax	spacerefx	spacerefy	timeref
2						
40	70	2	30	3	3	3
110	130	50	80	5	5	3
1						
20	40	8	30	3	3	3
0						
0						



- each grid has its own input and output files
- works in MPI

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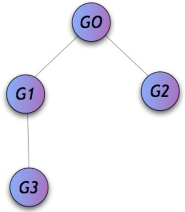

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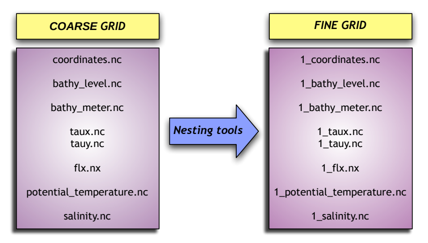
forcings, initial conditions can be made through the « nesting tools »



Features

Goal **: to simplify the design of NEMO-AGRIF configurations**

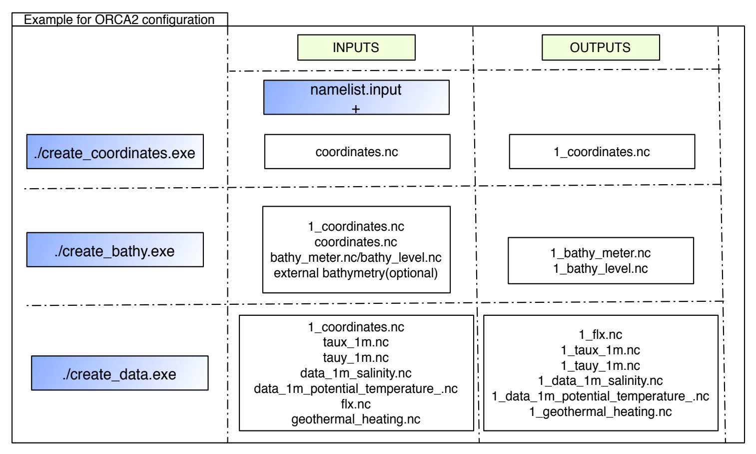
- set of fortran 95 tools especially designed for NEMO
- provides the necessary data sets to run an embedded model
- flexible in order to allow a wide range of external data
- based on a namelist file which contains various available options

Technical aspects

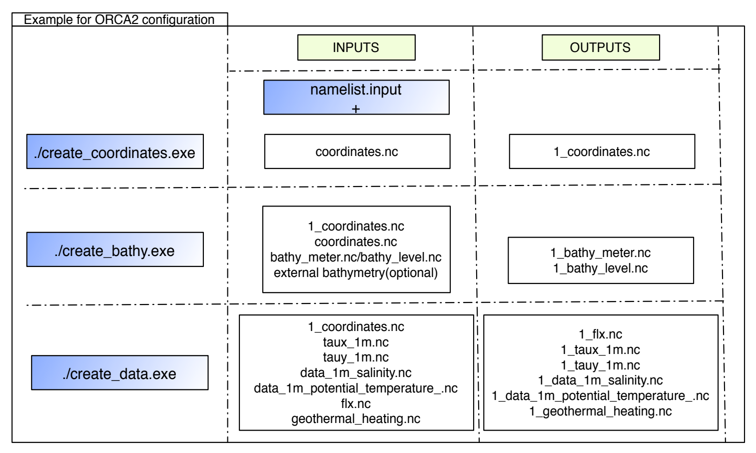
- Interpolation procedure based on SCRIP[1] with optimizations
  - bicubic or bilinear interpolation available for forcing files
  - bilinear, arithmetic or median average for bathymetry
- Smoothing algorithm on the bathymetry (optional)
- partial cells or full cells options
- allow the use of external high resolution database (etopo and OPA format)
- possibility to interpolate a restart file to add a child grid in a previous run

[1] Spherical Coordinate Remapping Interpolation Package

Global framework



Global framework



Summarize : Nesting tools might be useful as a first step before making more complex experiments

Outline

Before running the code

Compiling procedure

- based on the usual NEMO installation and compilation environment.

Filling in the namelists

- NEMO Namelist variables are completely independant in each grid except for temporal management (rdt, nitend, ...)

  $\Rightarrow$ Possibility to adapt namelist options to the resolution of the corresponding grid :

  - Different diffusion terms
  - Different advection schemes
  - Different vertical coordinates

Run Directory

```
xterm
zephir  NEMORUN_ORCA 98 % ls
1_bathy_level.nc                              1_tauy_1m.nc                               flx.nc
1_bathy_meter.nc                              AGRIF_FixedGrids.in                        geothermal_heating.nc
1_coordinates.nc                              ahmcoef                                    namelist
1_data_1m_potential_temperature_nomask.nc     bathy_level.nc                             namelist_ice
1_data_1m_salinity_nomask.nc                  bathy_meter.nc                             opa
1_flx.nc                                      coordinates.nc                             runoff_1m_nomask.nc
1_geothermal_heating.nc                       data_1m_potential_temperature_nomask.nc    STRAIT.dat
1_namelist                                    data_1m_salinity_nomask.nc                 taux_1m.nc
1_namelist_ice                                EMPave.dat                                 tauy_1m.nc
1_taux_1m.nc                                  EMPave_old.dat
zephir  NEMORUN_ORCA 99 %
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1_flx.nc                                     coordinates.nc                              runoff_1m_nomask.nc
1_geothermal_heating.nc                      data_1m_potential_temperature_nomask.nc     STRAIT.dat
1_namelist                                   data_1m_salinity_nomask.nc                  taux_1m.nc
1_namelist_ice                               EMPave.dat                                  tauy_1m.nc
1_taux_1m.nc                                 EMPave_old.dat
zephir  NEMORUN_ORCA 99 %
```
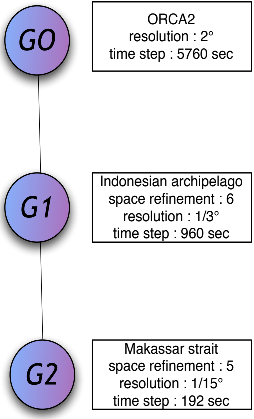
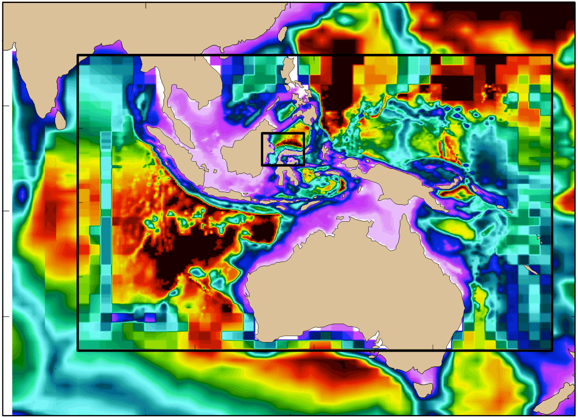

Run Directory

```
zephir  NEMORUN_ORCA 122 % ls
1_bathy_level.nc                              1_taux_1m.nc                                ocean.output
1_bathy_meter.nc                              1_tauy_1m.nc                                opa
1_coordinates.nc                              1_time.step                                 ORCA_1d_00010101_00101231_diagap.nc
1_data_1m_potential_temperature_nomask.nc     AGRIF_FixedGrids.in                         ORCA_2D_y0001m05d26.dimgproc
1_data_1m_salinity_nomask.nc                  ahmcoef                                     ORCA_KZ_y0001m05d26.dimgproc
1_flx.nc                                      bathy_level.nc                              ORCA_S_y0001m05d26.dimgproc
1_geothermal_heating.nc                       bathy_meter.nc                              ORCA_T_y0001m05d26.dimgproc
1_namelist                                    coordinates.nc                              ORCA_U_y0001m05d26.dimgproc
1_namelist_ice                                data_1m_potential_temperature_nomask.nc     ORCA_V_y0001m05d26.dimgproc
1_ocean.output                                data_1m_salinity_nomask.nc                  ORCA_W_y0001m05d26.dimgproc
1_ORCA_2D_y0001m05d26.dimgproc                datrj.out                                   runoff_1m_nomask.nc
1_ORCA_KZ_y0001m05d26.dimgproc                EMPave.dat                                  solver.stat
1_ORCA_S_y0001m05d26.dimgproc                 EMPave_old.dat                              STRAIT.dat
1_ORCA_T_y0001m05d26.dimgproc                 flx.nc                                      taux_1m.nc
1_ORCA_U_y0001m05d26.dimgproc                 geothermal_heating.nc                       tauy_1m.nc
1_ORCA_V_y0001m05d26.dimgproc                 ice.evolu                                   time.step
1_ORCA_W_y0001m05d26.dimgproc                 namelist
1_solver.stat                                 namelist_ice
zephir  NEMORUN_ORCA 123 %
```

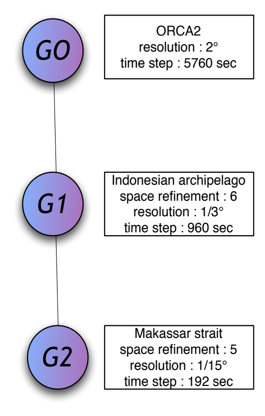
Outline

Configuration (1)





Configuration (2)



Computational cost

- ORCA2 : 182x149 points → 2%
- grid 1 : 262x274 points → 28%
- grid 2 : 119x304 points → 70%

Forcing files creation

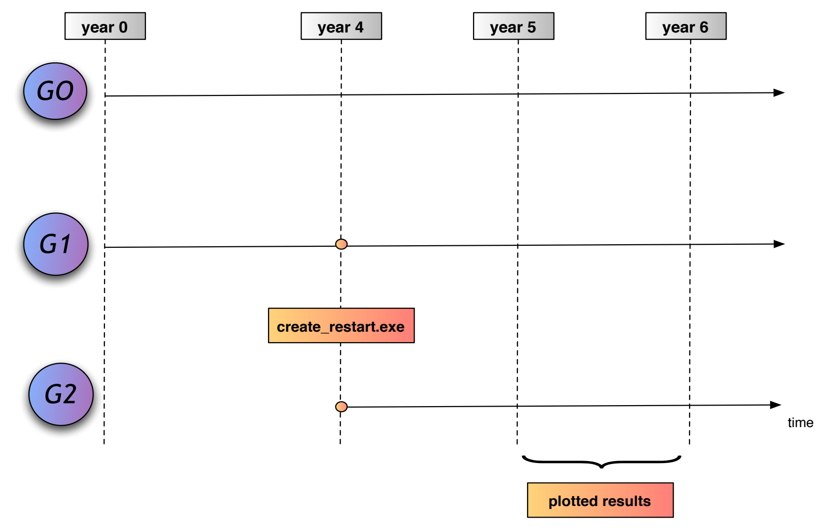
through « nesting tools »

- External bathymetry :
  - ORCA025 for G1 + bilinear interpolation
  - etopo2 for G2 + median average
- Climatological fields : interpolated from global ORCA2 forcings (bicubic interpolation)
- Vertical coordinate : partial cells
  - e3zps_min = 40.
  - e3zps_rat = 0.25

Configuration (3)

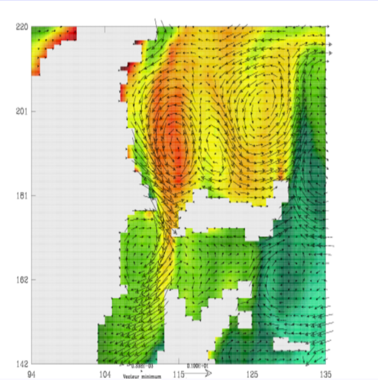
	advection scheme	advection for tracers	advection on momentum
G0	2nd order centered	laplacian iso-neutral	laplacian iso-neutral
G1	**3rd order upwind**	laplacian iso-neutral	bilaplacian horizontal
G2	**3rd order upwind**	laplacian iso-neutral	bilaplacian horizontal

Configuration (4)

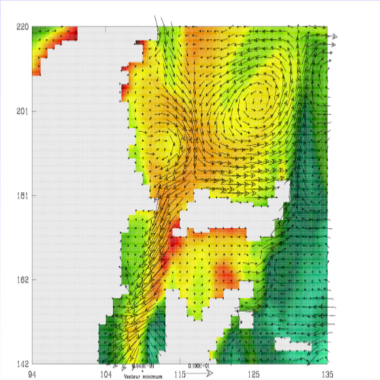


Influence of 2way nesting

- mean fields (September)



fine grid (level 1) only



fine grid (level 1) + fine grid (level 2)

Movie

- From January 0006 up to January 0007
- G2 + 10 points of G1 surrounding G2
- surface temperature and currents

Website and documentation

http ://www.lodyc.jussieu.fr/NEMO/ (Pre-Post processing packages part)