

Docker to run ARIANE package

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I - Installation of Docker Desktop

Docker is an open platform for developing, shipping, and running applications. It is powerful OS image container manager.

Processes of Docker installation on a desktop machine (for local use) are the following:

1. Go to : <https://docs.docker.com/get-docker/>
2. Choose the adequate docker package for your system: Mac OS in our case
3. Do the installation
4. Create your account on Docker web-page
5. Sing in/connect through your Docker Desktop
6. Search for desired image to pull
7. Go to the terminal and do the following in case of ubuntu image: **docker pull ubuntu**

To learn more: <https://docs.docker.com/get-started/>

II – Basic command lines for Docker

There are some basic commands lines essential for easy use of Docker on local machine, such as:

1. `docker images` → display all available image on the local machine
2. `docker ps` → display all available container on running state
3. `docker ps -a` → to see all container
4. `docker pull` → to install a specific available image from your [docker hub](#)
5. `docker stop ID` → to stop an on running image
6. `docker system prune` → to clean your system
7. `docker build -t name_of_container .` → to build a container with a specified image in current directory
8. `docker run -it --rm docker_image_name bash` → to run a docker image
9. `docker run --rm -it -v <source_directory>:<targeted_directory_in_docker_image> docker_image_name bash`
→ To mount a local directory into the docker image container. Note: "<" and ">" aren't included in the command line

To learn more: - <https://docs.docker.com/get-started/>

- https://github.com/ECCO-GROUP/ECCO-Docker/tree/main/ECCO_v4r4

III – Creation of Dockerfil and run of Docker at local

To build a personal docker image with specific packages for our project, “Dockerfil” is the file to get all needed instructions.

1. Get the “Dockerfil” I’ve sent you and put it in the Directory of your ARIANE project.
2. Modify the file according you: let’s do it together
3. Put the ARIANE code source in the direction where to put the “Dockerfil”, under the subfolder named: **src**
4. Once finished, run the command line **n° 7** from the previous slide

- Notes:
 - set up folder structure for Ariane project on local machine in order to mount it on docker image
 - Use the command line **n° 9** to mount your Ariane project folder from local machine
 - Create an “alias” in “.zshrc” for easy mount and run your docker image for the next call
 - Inside “.zshrc” include: alias name=“**n° 9**”

To learn more: - <https://docs.docker.com/get-started/>
- https://github.com/ECCO-GROUP/ECCO-Docker/tree/main/ECCO_v4r4

IV – ARIANE

Ariane is dedicated to the offline calculation of 3D streamlines in the output **velocity field** of an Ocean General Circulation Model (OGCM) such as **OPA-NEMO**, **ROMS**, **Symphonie** and any ocean model whose equations are based on volume conservation, like **ECCO** for instance. (see <https://ariane-code.cnrs.fr/>)

ARIANE offers two modes of analysis:

- QUALITATIVE mode: for lagrangian particle trajectories analysis
- QUANTITATIVE mode: for water mass transport and stream function analysis

To run one of ARIANE modes analysis, file named **"namelist"** have to be configured properly. The flow field files on **"Grid-C"** are required with the **grid mask file** from the used model.

To learn more: - <https://ariane-code.cnrs.fr/>

V – ARIANE: “namelist” configuration (01)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

Model type:

- NEMO-OPA
 - for model with “z” coordinate at vertical level
- CROCO or ROMS (AGRIF, UCLA, rudgers)
 - for model with “sigma” coordinate at vertical level

RESET ALL

Model

☒ NEMO-OPA
☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

NEMO-OPA item:
imt:
jmt:
kmt:
lmt:
key_periodic: ☐ TRUE ☒ FALSE
key_jfold: ☐ TRUE ☒ FALSE

key_computew: ☒ TRUE ☐ FALSE
key_partialsteps: ☒ TRUE ☐ FALSE

Ariane Namelist Assistant

(place your mouse over words to have more information)

RESET ALL

Model
☐ NEMO-OPA
☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)
tunit: real in seconds
ntfic: integer in number of tunit
tcyc: (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)
☐ TRUE ☐ FALSE

Diagnostic modes
☐ Qualitative ☐ Quantitative

Initial particle positions file
☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)
nmax =

Time integration (forback)
☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)
☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)
☐ TRUE ☒ FALSE

--- Print on screen a beautiful Ariane Namelist ---

V – ARIANE: “namelist” configuration (02)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

Model output data storage frequency (in second):

- **tunit**: time unit for the model output record in second
- **ntfic**: corresponded integer value to get each time record of the model output
- **tcyc**: to be let equal to “0”

Model output data storage frequency (in seconds)

tunit: 86400. real in seconds

ntfic: 30 integer in number of tunit

tcyc: 0. (set to 0. if you don't know its function)

Real

Unit to print ages along trajectories in Ariane outputs (traj_time).

When tcyc=0., Ariane set tcyc=tunit*ntfic*total_number_of_records and traj_time values are defined between 0. and 1.

It is possible to change that playing with tcyc value.

Diagnostic modes

RESET ALL

Model

- ☐ NEMO-OPA
- ☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)

tunit: 86400. real in seconds

ntfic: 0 integer in number of tunit

tcyc: 0. (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)

- ☐ TRUE ☐ FALSE

Diagnostic modes

- ☐ Qualitative ☐ Quantitative

Initial particle positions file

- ☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)

nmax = 1000

Time integration (forback)

- ☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)

- ☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)

- ☐ TRUE ☒ FALSE

V – ARIANE: “namelist” configuration (03)

Ariane Namelist Assistant

(place your mouse over words to have more information)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

Read or not sequentially the input data (key_sequential):

- Always True to better use the resources of the PC
- maxcycle: number of cycle to read the input series dataset
 - Insert a wished integer: 1, 2, 3, ...

Read or not sequentially the input data (key_sequential)

☒ TRUE ☐ FALSE

maxcycles:

For my example, I used **maxcycles=100**

RESET ALL

Model

- ☐ NEMO-OPA
- ☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)

tunit: real in seconds
ntfic: integer in number of tunit
teyc: (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)

☐ TRUE ☐ FALSE

Diagnostic modes

☐ Qualitative ☐ Quantitative

Initial particle positions file

☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)

nmax =

Time integration (forback)

☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)

☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)

☐ TRUE ☒ FALSE

V – ARIANE: “namelist” configuration (04)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

Diagnostic mode (Qualitative or Quantitative):

- **Qualitative** is for trajectories analysis
- **Quantitative** is for water mass transport and stream function analysis with sections configuration

Diagnostic modes

☒ Qualitative ☐ Quantitative

delta_t QUALITATIVE diagnostics:

- frequency**
- particles are placed "by hand" in space and time (initial_positions.txt file).
 - particles are advected by Ariane using current velocity from model outputs.
- nb_output**
- particle positions along their trajectories are saved following your
- key_region** prescriptions.

Diagnostic modes

☒ Qualitative ☐ Quantitative

delta_t: 86400.

frequency: 30

nb_output: 30

key_region: ☐ TRUE ☒ FALSE

Frequency higher the model output is not recommended

RESET ALL

Model

- ☐ NEMO-OPA
- ☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)

tunit: 86400. real in seconds

ntfic: 0 integer in number of tunit

tcyc: 0. (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)

☐ TRUE ☐ FALSE

Diagnostic modes

☐ Qualitative ☐ Quantitative

Initial particle positions file

☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)

nmax = 1000

Time integration (forback)

☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)

☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)

☐ TRUE ☒ FALSE

V – ARIANE: “namelist” configuration (05)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

Initial partial position file:

- A text file for the “nobin” mode to be inserted for the initial position for Ariane experience
 - **initial_positions.txt**

Initial particle positions file

☒ nobin ☐ bin ☐ subbin

Correct input is either 'nobin' or 'bin' or 'subbin'.

Initial positions can be diagnosed in several ways:

1. 'natural' way ('nobin'):

- Qualitative diags : ASCII positions read on file 'initial_positions.txt'.
- Quantitative diags: automatic positioning on section 1 provided in file 'sections.txt'.

2. 'binary' initial positions ('bin'):

initial particle positions are read on file 'ariane_initial.nc'.

'ariane_initial.nc' can be a 'ariane_positions_quantitative.nc' file from a former quantitative experiment or a 'ariane_trajectories_qualitative.nc' file from a former qualitative experiment.

You can select in this file the initial or final positions recorded as start positions in your new ariane experiment.

3. 'subset' of binary initial positions ('subbin'):

initial positions are read on file 'ariane_initial.nc' and a list of indices ('subset.txt' file) defines the subset of indices to use. Indices in subset.txt file HAVE TO BE in ascending order!

'ariane_initial.nc' can be a 'ariane_positions_quantitative.nc' file from a former quantitative experiment or a 'ariane_trajectories_qualitative.nc' file from a former qualitative experiment.

- Number of particle to use
- Mode of integration

RESET ALL

Model

☐ NEMO-OPA
☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)

tunit: real in seconds
 ntfic: integer in number of tunit
 tcyc: (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)

☐ TRUE ☐ FALSE

Dagnostic modes

☐ Qualitative ☐ Quantitative

Initial particle positions file

☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)

nmax =

Time integration (forback)

☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)

☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)

☐ TRUE ☒ FALSE

V – ARIANE: “namelist” configuration (06)

To do so, go to the following link:

<http://ariane.lagrangian.free.fr/namelist/namelist.html>

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

- Fill out with the grid information fil

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

-- MESH --

dir_mesh: '/home/OJH/Data/CMENS/Grid_information'

fn_mesh: 'rys12v1_daily_grid_PSY4V3R1_mesh_hgr.nc'

nc_var_xx_tt: 'glamt'

nc_var_xx_uu: 'glamu'

nc_var_yy_tt: 'gphit'

nc_var_yy_vv: 'gphiv'

nc_var_zz_ww: 'gdepw_0'

nc_var_e2u: 'e2u' [Scale factor representation in a C grid cell!](#)

nc_var_e1v: 'e1v'

nc_var_e1t: 'e1t'

nc_var_e2t: 'e2t'

nc_var_e3t: 'e3t' (a nemov3 option is also available in Ariane)

nc_var_tmask: 'tmask'

nc_mask_val: 0. (real value)

Record trajectories also in a text file (+NetCDF file)

☐ TRUE ☒ FALSE

- Keeping this line as “FALSE” is recommended

RESET ALL

Model

- ☐ NEMO-OPA
☐ CROCO or ROMS [AGRIF, UCLA, rudgers]

Model output data storage frequency (in seconds)

tunit: 86400. real in seconds

ntfic: 0 integer in number of tunit

tcyc: 0. (set to 0. if you don't know its function)

Read or not sequentially the input data (key_sequential)

☐ TRUE ☐ FALSE

Diagnostic modes

☐ Qualitative ☐ Quantitative

Initial particle positions file

☒ nobin ☐ bin ☐ subbin

Maximum number of particle(s)

nmax = 1000

Time integration (forback)

☒ Forward ☐ Backward

Velocity file description (on screen when a model is selected)

Temperature and Salinity tracers (key_alltracers)

☐ TRUE ☒ FALSE

NEMO-OPA Meshmask, CROCO or ROMS Grid (on screen when a model is selected)

Record trajectories also in a text file (+NetCDF file)

☐ TRUE ☒ FALSE

VI – ARIANE: QUALITATIVE mode experiment (01)

ARIANE'S "QUALITATIVE" mode experiment require:

- Dataset on Grid-C configuration
- "namelist" fil containing the experiment configuration
- "initial_positions.txt" fil to initialize the particles location in space and time

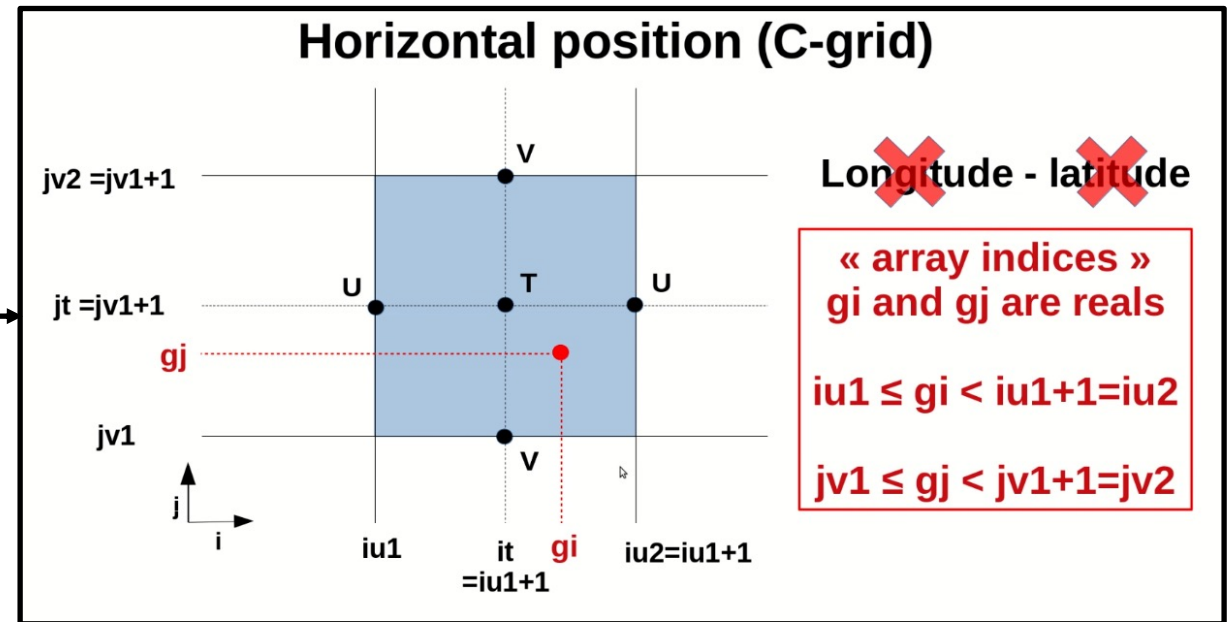
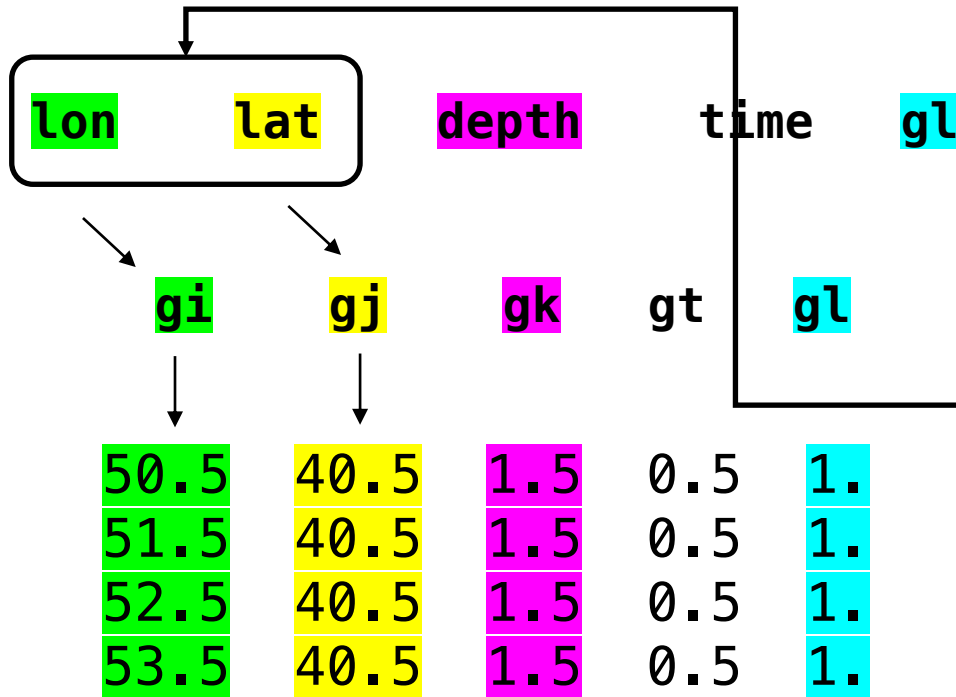


Image: © Nicolas GRIMA, French scientist/LOPS

! Note: Never put particle in the Grid-C corner

VI – ARIANE: QUALITATIVE mode experiment (02)

ARIANE'S "QUALITATIVE" mode experiment require:

- Dataset on Grid-C configuration
- "namelist" fil containing the experiment configuration
- "initial_positions.txt" fil to initialize the particles location in space and time

lon	lat	depth	time	gl
gi	gj	gk	gt	gl
50.5	40.5	1.5	0.5	1.
51.5	40.5	1.5	0.5	1.
52.5	40.5	1.5	0.5	1.
53.5	40.5	1.5	0.5	1.

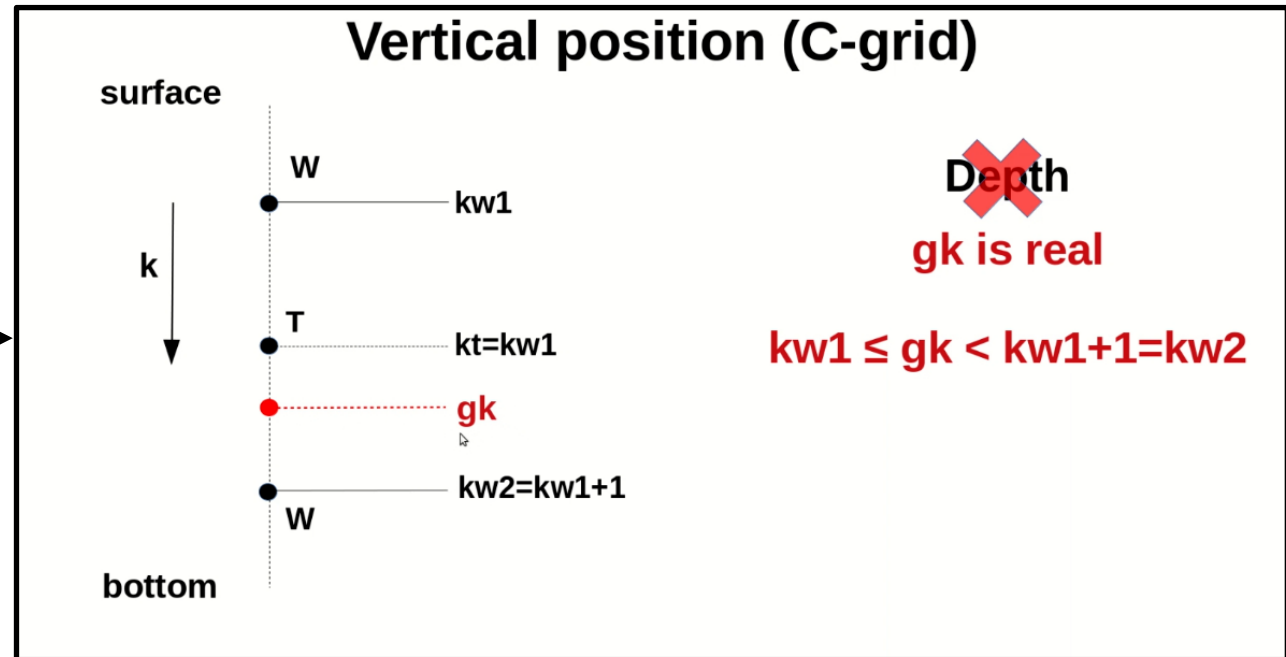


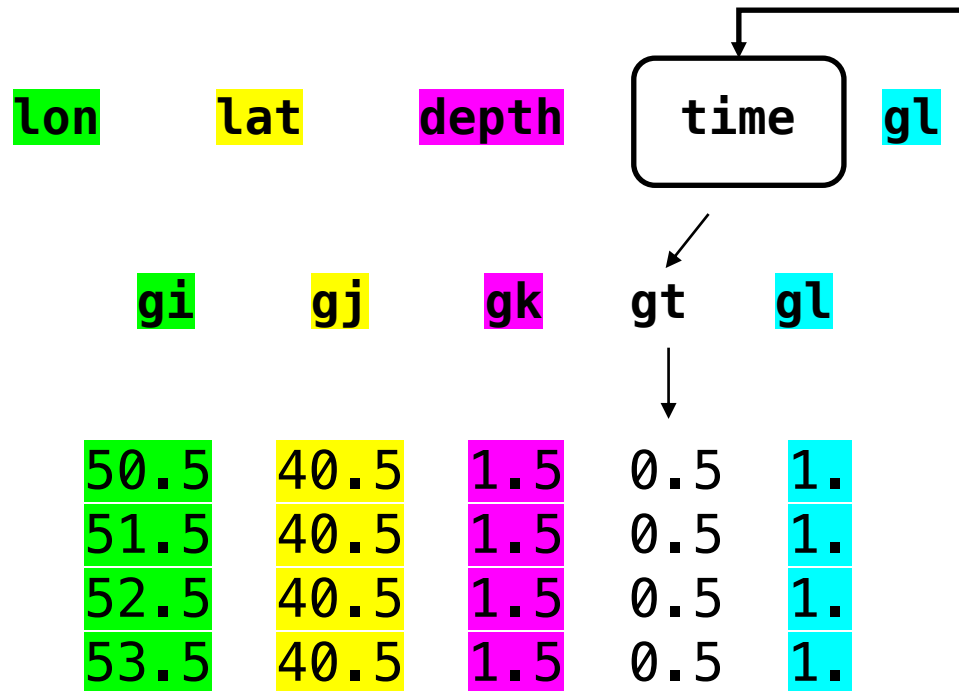
Image: © Nicolas GRIMA, French scientist/LOPS

! Note: Never put particle in the Grid-C corner

VI – ARIANE: QUALITATIVE mode experiment (03)

ARIANE'S "QUALITATIVE" mode experiment require:

- Dataset on Grid-C configuration
- "namelist" fil containing the experiment configuration
- "initial_positions.txt" fil to initialize the particles location in space and time



Time position

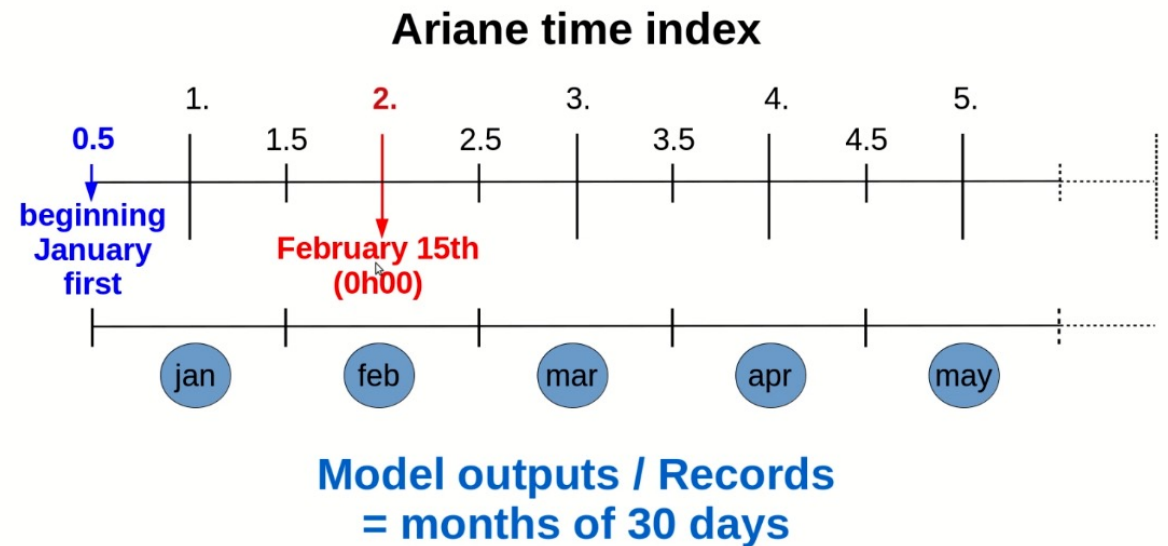


Image: © Nicolas GRIMA, French scientist/LOPS

! Note: Never put particle in the Grid-C corner

VI – ARIANE: QUALITATIVE mode experiment (04)

ARIANE'S "QUALITATIVE" mode experiment require:

- Dataset on Grid-C configuration
- "namelist" fil containing the experiment configuration
- "initial_positions.txt" fil to initialize the particles location in space and time

lon	lat	depth	time	gl
gi	gj	gk	gt	gl
50.5	40.5	1.5	0.5	1.
51.5	40.5	1.5	0.5	1.
52.5	40.5	1.5	0.5	1.
53.5	40.5	1.5	0.5	1.

1 for transport associate to the particule (gt=1.0)

This parameter is always set as "1" for Ariane to make water mass transport calculus. So, do not miss it!!!

! Note: Never put particle in the Grid-C corner

VII – Lunch an ARIANE QUALITATIVE mode experiment

To lunch ARIANE'S "QUALITATIVE" mode experiment, we need:

- “namelist”
- “initial_positions.txt”
- A symbolic link to Ariane’s executable file inside the experiment project folder
 - `ln -s /home/OJH/ariane_compiled/bin/ariane`

“initial_positions.txt”

gi



gt



50.5

40.5

1.5

0.5

1.

51.5

40.5

1.5

0.5

1.

52.5

40.5

1.5

0.5

1.

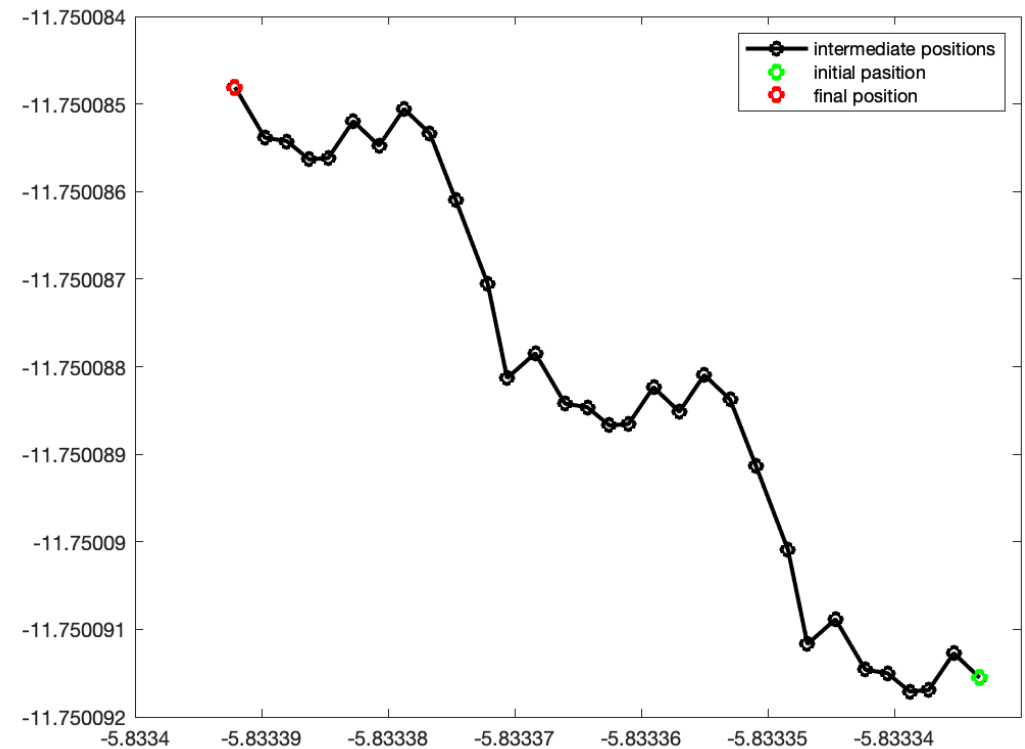
53.5

40.5

1.5

0.5

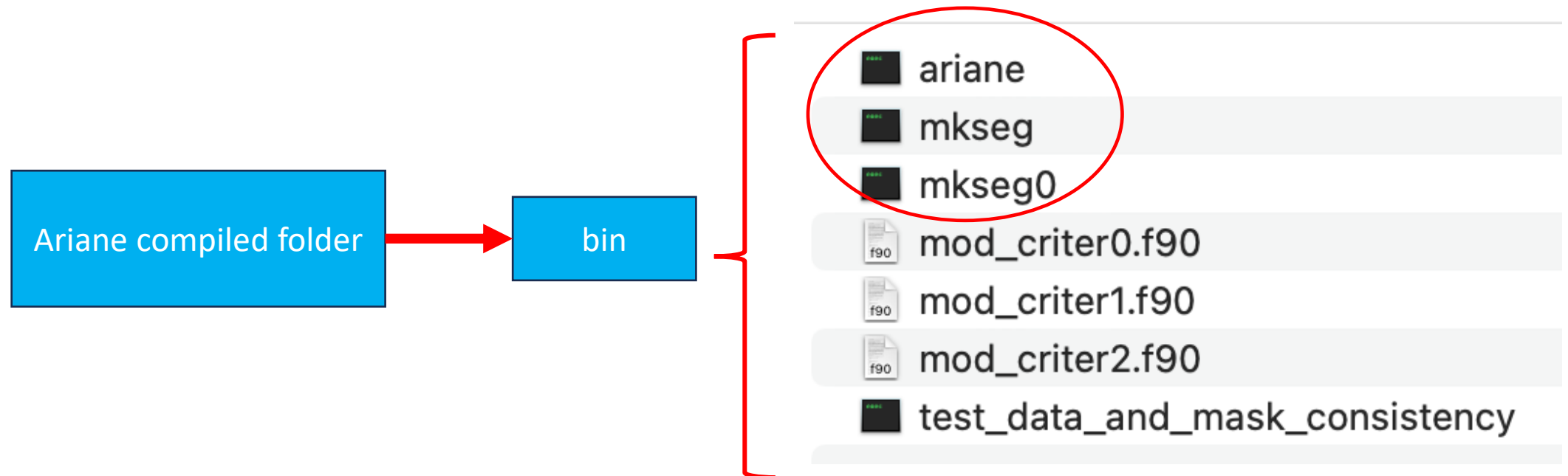
1.



VIII – Lunch an ARIANE QUANTITATIVE mode experiment (01)

Ariane “QUANTITATIVE” mode experiment perform water mass transport evaluation from initial location to the targeted location over the study area. In other words, “QUANTITATIVE” mode experiment examine the amount of water mass transported from the starting section to other section enclosing the domain of study. No particles trajectory are recorded, however initial and finale positions of particles are saved. They can be used to perform “QUALITATIVE” mode experiment to get trajectories.

- To do so, the pathways of files “**mkseg0**”, “**mkseg**” have to be known for the purpose of creating symbolic link like in the case “**ariane**” executable file.



VIII – Lunch an ARIANE QUANTITATIVE mode experiment (02)

To lunch ARIANE'S "QUANTITATIVE" mode experiment, we need:

- A symbolic link to Ariane's executable file inside the experiment project folder
 - `ln -s /pathway_to_ariane_compiled_folder/bin/ariane`
- "namelist"
- "initial_positions.txt"
- "section.txt" generated via `mkseg0` and `mkseg`
- `region_limits`, for that `keep key_reducmen=True`
- Dataset to be used

Steps of Quantitative mode experiment

1. Configure the "namelist" file
2. Create a symbolic link for "ariane"
3. Create a symbolic link for "mkseg0" from the same folder like "ariane"
4. Execute "./mkseg0" to get the file named "segrid"
5. Open "segrid" with "nedit" and set up sections for the analysis
6. Create a symbolic link for "mkseg" from the same folder like "ariane"
7. Execute "./mkseg" to get the file named "sections.txt"
8. Read "sections.txt" and rename all sections at your convenient
9. ==> add a section as lid: Sec_number i_0 i_max j_0 j_max 0 0 "lid"
10. Execute "./ariane"
11. View "stats.txt" (first to read after "./ariane" finish) and analyze

- **ariane** → `/home/ariane/Ariane/bin/ariane`
- **namelist**
- **sections.txt** ← segrid { mkseg0
mkseg
- **region_limits** → key_reducmem=True (in namelist file)
Memory optimization

Image: © Nicolas GRIMA, French scientist/LOPS

VIII – Lunch an ARIANE QUANTITATIVE mode experiment (03)

- At the end of the experiment, additional files will be generated as listed below     

- “stats.txt” is the first file to read. It contains statistical information of the performed experiment.
- “ariane_positions_quantitative.nc” contains particles’ positions information of the experiment. This file may be used when performing “Qualitative” mode experiment from output of the a “Quantitative” mode experiment.
- “ariane_statistics_quantitative.nc” contains statistical information of the experiment.

Notes:

- Some particles may not reach a section by the end of the experiment. Those particles are called “lost particles”. The amount of water mass transport lost can be found in “stats.txt”: see label **lost**
- Particles that come back to the starting section are labeled as **“Meanders”**

Quantitative exp.: output files

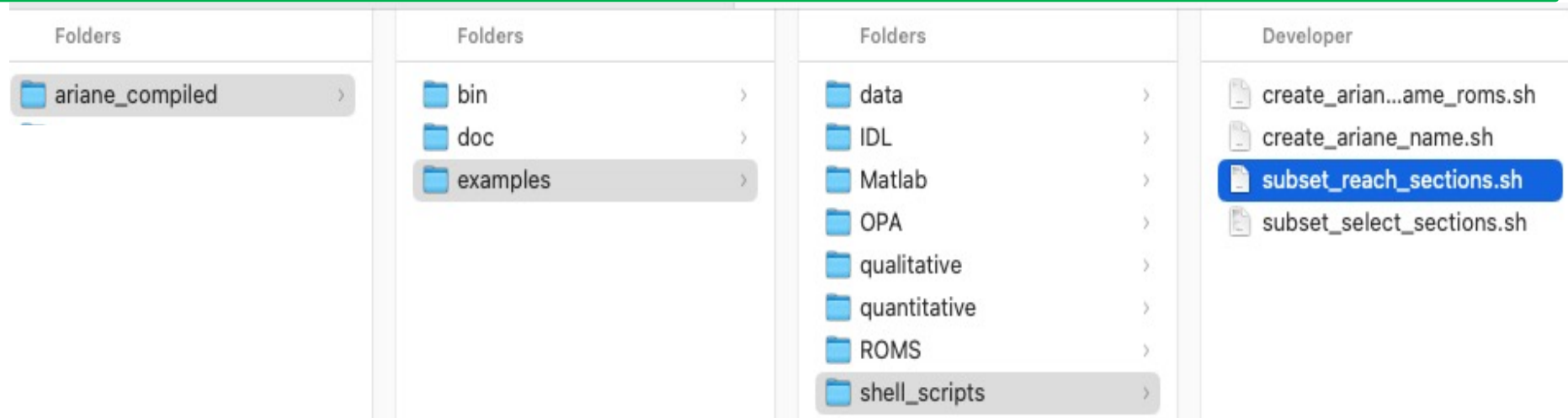
- **stats.txt** (← **first to read!**)
- **mod_criter[0 1 2].f90**
- **ariane_positions_quantitative.nc**
- **ariane_statistics_quantitative.nc**
- arianes_output.txt
- arianes_memory.log

Image: © Nicolas GRIMA, French scientist/LOPS

VIII – Lunch an ARIANE QUANTITATIVE mode experiment (04)

- To run Ariane “Quantitative” experiment by ignoring the lost particles, the process is as follow:

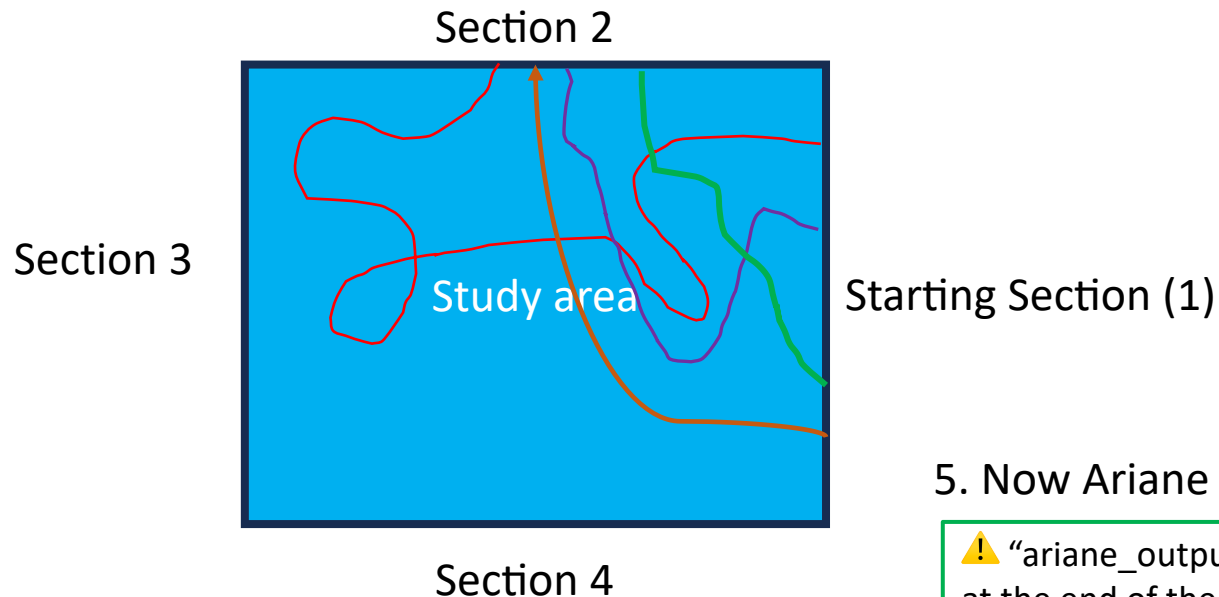
1. Copy the files “**namelist**”, “**sections.txt**”, “**region_limits**” from the initial experiment to the folder of the no-lost particles experiment.
2. Edit “**namelist**” by changind bin = ‘nobin’ to **bin = ‘subbin’**
3. Create a symbolic link for “**ariane**” executable fil
4. Create a symbolic link for “**ariane_positions_quantitative.nc**” : this symbolic link must be named as “**ariane_initial.nc**”
→ For this purpose, do: **ln -s pathway_to_ arian_positions_quantitative.nc arian_initial.nc**
5. Copy the file “**subset_reach_sections.sh**” from your arian_compiled folder (see below). Make sure that this file can be execute in your experiment folder. This script depends on [NCO package](#) to properly work.
→ Execute: **./subset_reach_sections.sh** to make arian considering no lost particles only for the experiment
6. Now, Ariane can be lunched: **./ariane**



IX – QUALITATIVE experiment from QUANTITATIVE one

The idea here is to get particles trajectories from starting section to other sections. To run Ariane “Qualitative” experiment from “Quantitative” experiment, the process is nearly the same like in the previous slide:

1. Copy the files “**sections.txt**” and “**region_limits**”, and make a symbolic link for “**ariane**” in the folder of your new experiment.
2. Edit “**namelist**”: choose “**Qualitative**” mode and set **bin** = ‘**subbin**’
3. Create a symbolic link for “**ariane_positions_quantitative.nc**” with the name as “**ariane_initial.nc**”
4. Create a symbolic link for “**subset_select_sections.sh**” (this file is in the same folder as “**subset_reach_sections.sh**”)
 - ❖ Notes: “**subset_select_sections.sh**” allow selection of particles from starting section to a specific interception section, in order to get trajectories between two sections.



- ❖ By executing the following command, only particles that reached “section 2” are selected for generating the file “**subset.txt**” which will be used for the experiment:

```
./subset_select_sections.sh 2
```

General syntax

```
./subset_select_sections.sh number_of_section
```

5. Now Ariane experiment can be lunched: **./ariane > ariane_output.txt 2>&1**

⚠ “**ariane_output.txt**” saved the displayed info when Ariane is running. To check, open this file at the end of the experiment.

In case of any question, don't hesitate to email me !!

(odilon.joel.Houndegnonto@jpl.nasa.gov

Or

Odilon.Houndegnonto@gmail.com)