Recent developments in the routing scheme

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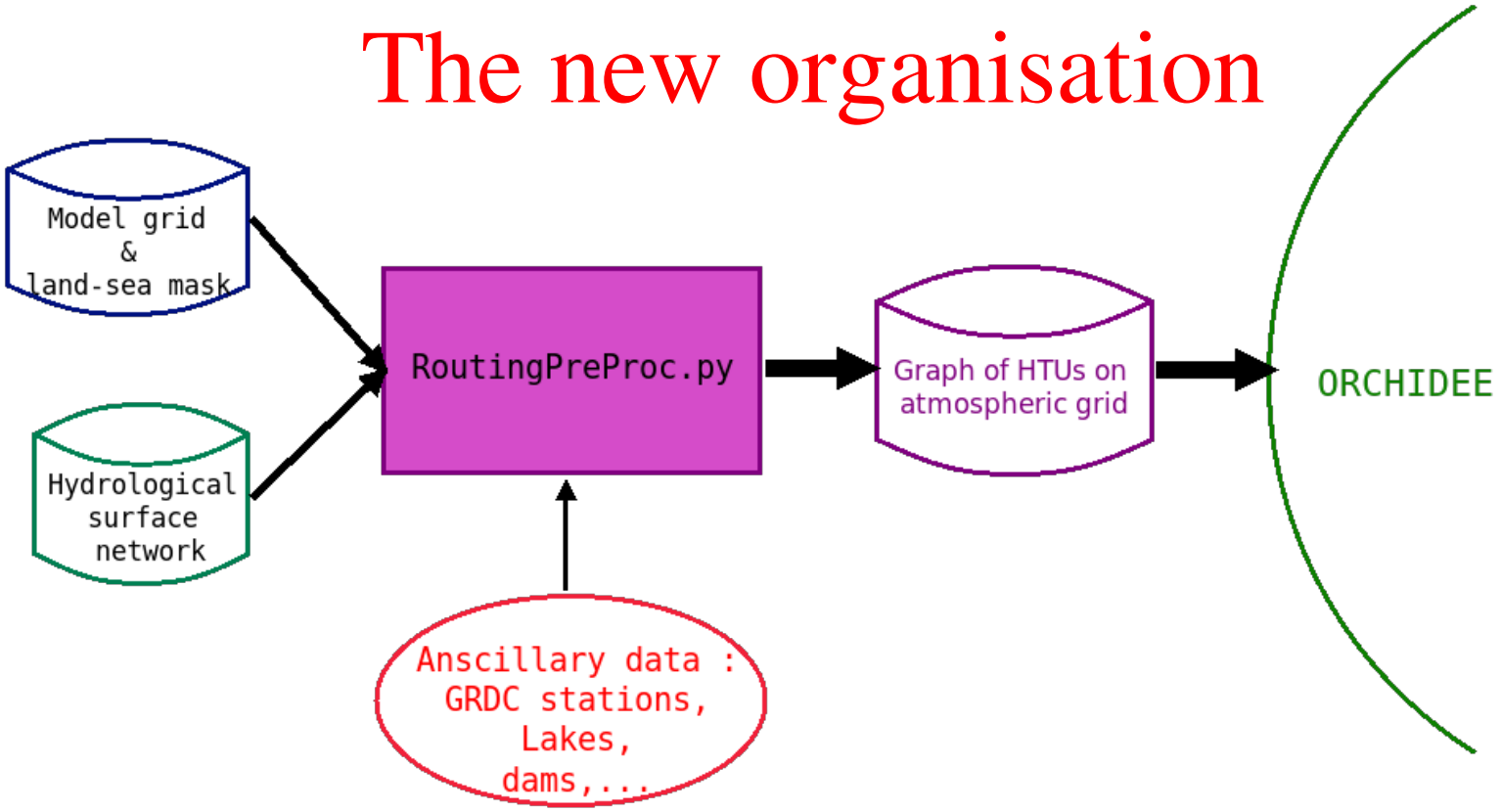
- Reorganizing the routing scheme
- Parallelization of the construction of HTUs
- Integrating diagnostics in the HTUs
- Progress on the time step and definition of parameters.

The work presented here is on GitLab :
https://gitlab.in2p3.fr/ipsl/lmd/intro/routingpp

The new organisation



- The computation of the HTUs start with the grid on which ORCHIDEE will run (Obtained from atmospheric model or driving data).
- The land-sea mask (contfrac)
- A description of the hydrological network (3 options currently)
- Ancillary elements which need to be placed on the HTU space : Floodplains, Gauging stations, Dams, …
- The output is a routing graph file which is read directly by ORCHIDEE

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Implementation

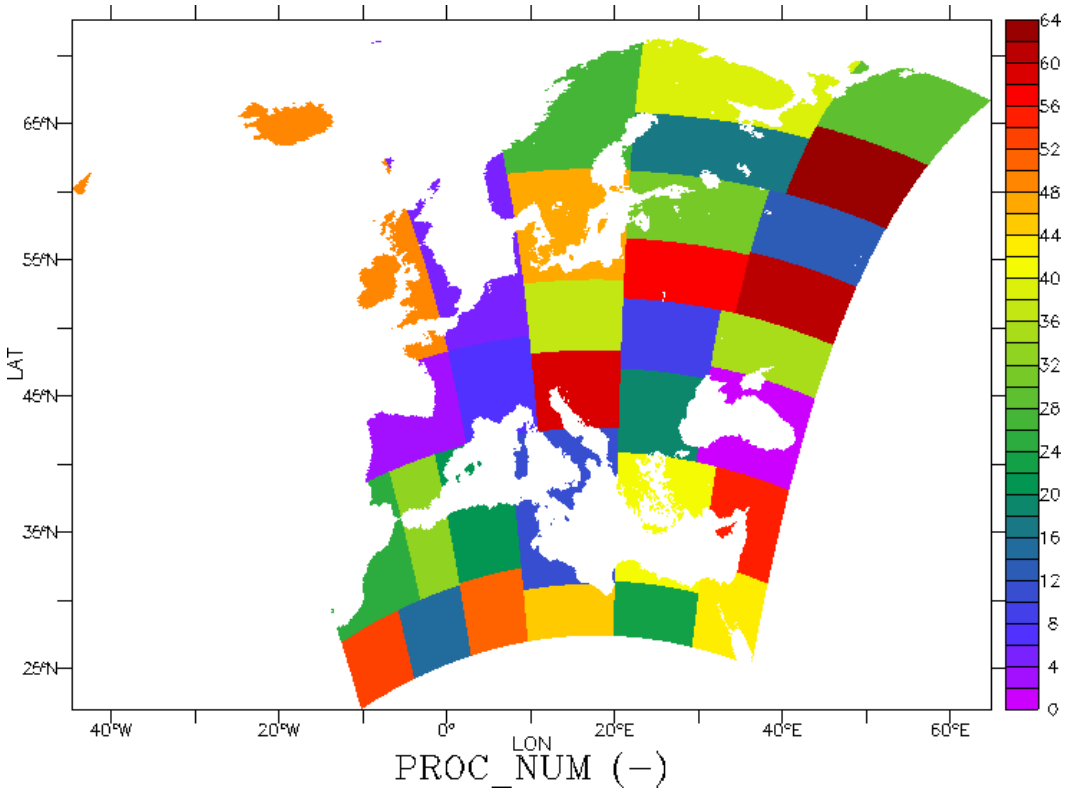
- The code of the RoutingPreProc is a combination of Python and F90.
- The aim was to re-use as much as possible code of ORCHIDEE.
- For the interpolation we used a spherical geometry package from AstroPy … not the best choice !
- At least the interpolations are general and do not make the assumption that we have a local plane.
- Python is not the most efficient solution, but we need anyway as many processors as possible because of the memory needs.

Parallelization

- We re-used the code of Trung Nguyen to generate HTUs
- It runs on regions so it was easy to implement on a domain decomposition.
- We developed a memory oriented domain decomposition. Never is the full hydrological network loaded on one processor.
- Function have been developed to exchange information of the halo's.

The code has been applied to large problems :

- Iberian Peninsula at 3km (Lambert conformal)
- Europe at 11km Cassini projection.
- South America at 20km (Lambert conformal)



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The hydrological surface network

The RoutingPreProc has been tested and evaluated with the following hydrological surface networks :

- Vörösmarty & Fekete : global at 0.5° ... The description as used up to now in ORCHIDEE.
- MERIT (Yamasaki et al.) global at 2km.
- HydroSHEDS (Lehner et al.) near-global at 1km. Used up to now in regional configurations of ORCHIDEE.

Either one can be used and will produce equivalent routing-graph files which can be read by ORCHIDEE.

Now that memory usage is better mastered MERIT could be used a 90m if needed for some application.

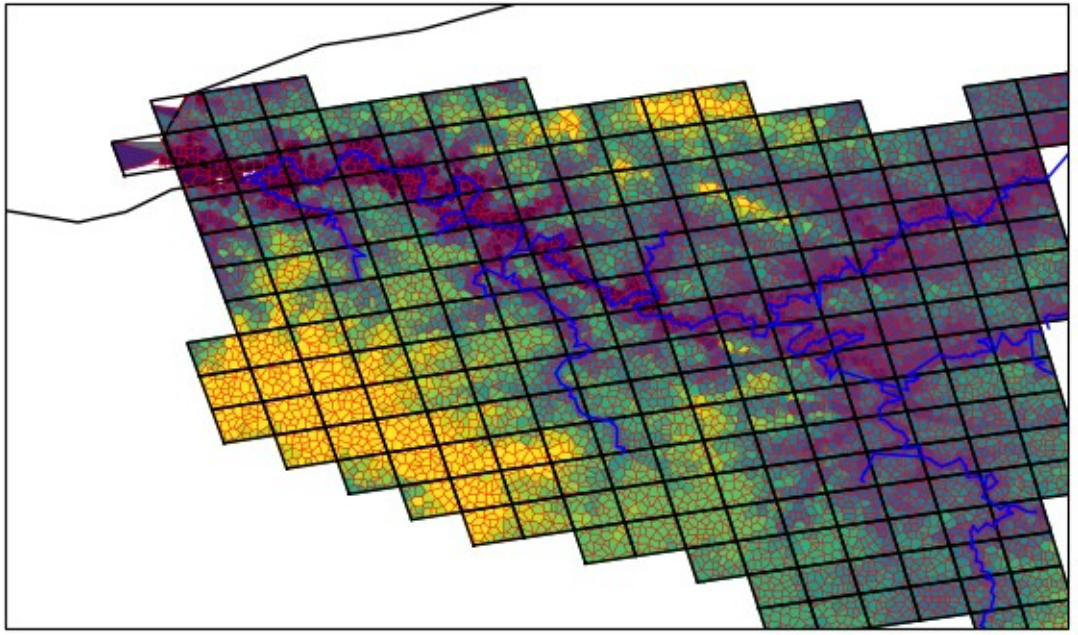
Ancillary information

- Once the graph of the rivers is built on the atmospheric grid various information are placed.
- Floodplains are placed and their parameters computed.
- A metadata base of gauging stations (GRDC + Spain + Brazil + Argentina+ …) is read so they can be placed.
- An ASCII file of stations, dams can be read so that they are placed.
- The transposed graph is computed and saved.
- This provide information for ORCHIDEE to simulate new processes or output diagnostics at the correct position with the river graph.

Diagnostic tool

- We have developed a diagnostic tool which allows to navigate within basins and explore the graph of the river.
- HTUs are represented as Voronoi diagram based on their centre of gravity.
- The ancillary information can also be displayed.

The Seine on the 11km Euro-CORDEX grid (Black lines).
HTUs are delineated with red lines.



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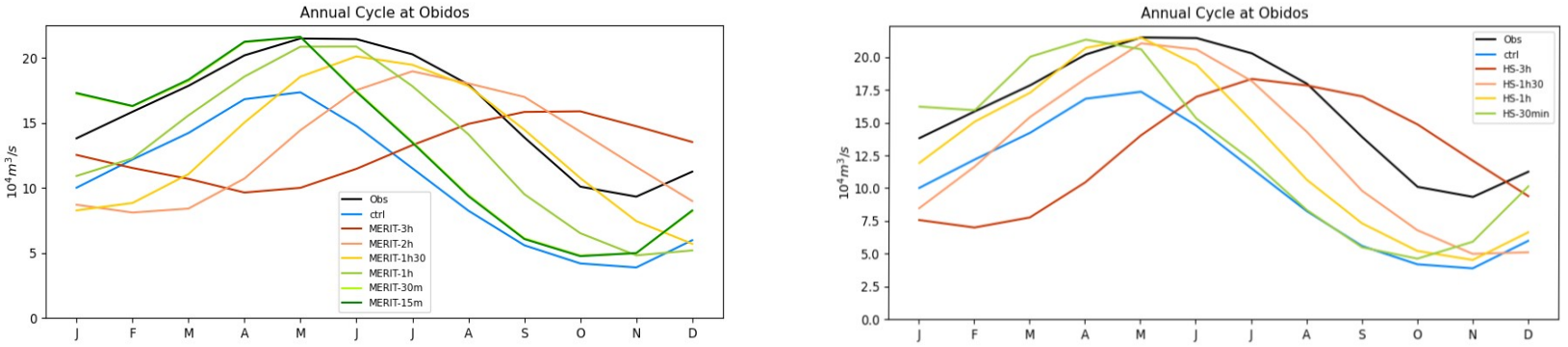
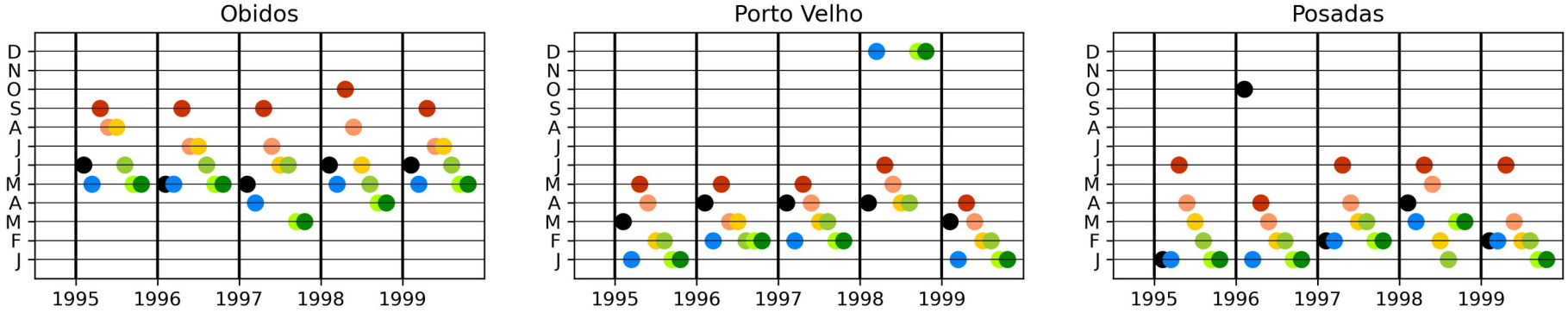
Using the routing-graph file

- We started from the routing.f90 routine of the Trunk (April 2020) and deleted the entire part for the construction of the HTUs. A huge simplification of the module !
- A simple routine now reads the routing-graph file and uses it.
- Diagnostics of the HTUs with gauging stations are sent to XIOS. This implementation could be improved !
- The old HTU diagnosics (river_desc.nc) could be deactivated … to be discussed.
- This version of routing.f90 works without problem, only the parallelization is sub-optimal.

Choosing the right time-step for the routing



Discharge at Obidos (Amazon) for MERIT (left) and HydroSHEDS (right) at different time-steps



Peak month for each year between 1995 and 1999 for MERIT at different time-steps

- The river discharge is sensible to the routing time step
- It is related to :
  - *nbasmax parameter (maximal number of HTUs per grid cell)*
  - *the resolution of the ORCHIDEE grid (the forcing resolution)*
  - *The hydrological database used (MERIT, HydroSHEDS, Fekete)*
  - *The size of the basins : larger basins require lower time-step*

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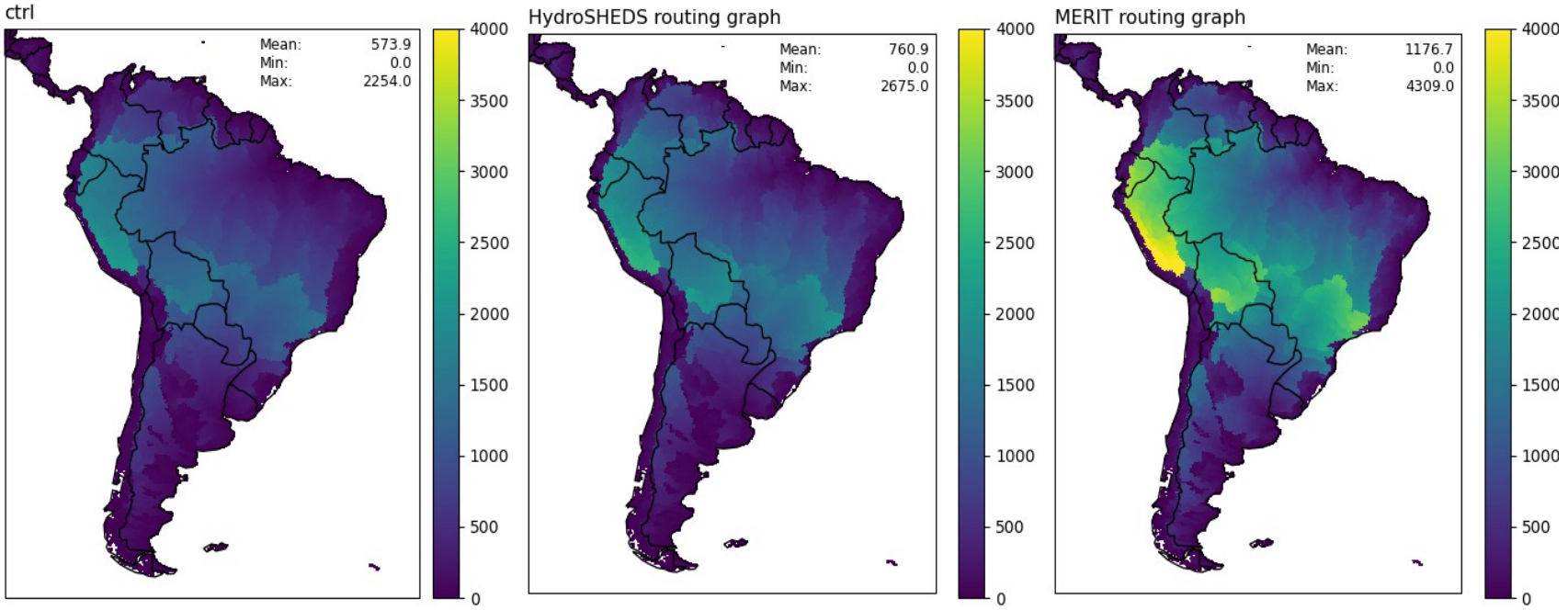
Differences between the routing graph



Maximum for each grid point of the accumulated topoindex until reaching the outflow

- The resolution of HydroSHEDS is at 1km
- The resolution of MERIT is at 2km
- This will have on impact on the calculation of topoindex
- This is why the time constant may be adjusted depending on the hydrological information used

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Conclusion

- Separating out of ORCHIDEE the calculation of the HTU graph simplifies the routing :
  - *The computation can optimize its memory usage.*
  - *It does not block the execution of the model.*
  - *A number of ancillary information can be integrated in the graph.*
  - *Parameters are also estimated so that the routing does not need to be tuned to the new configuration (grid+land-sea mask)*
- A few issues are still open :
  - *Parameter estimation needs to be wrapped-up : time step and time constants.*
  - *Routing.f90 needs to be better parallelized as we will be using shorter time steps.*

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