Recent developments for ORCHIDEE's routing scheme

Jan Polcher and Anthony Schrapffer

6th of July 2021

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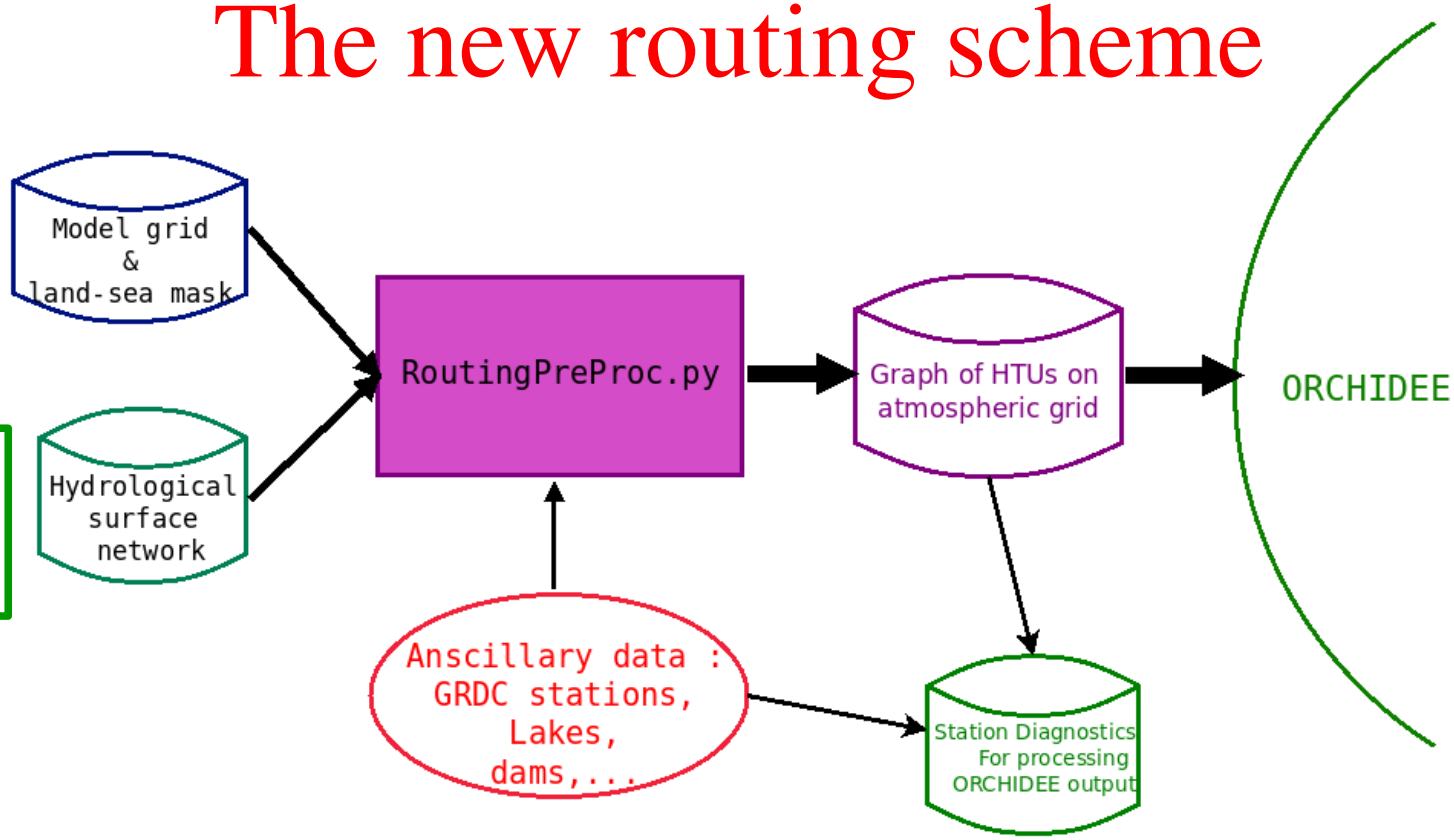
The new routing scheme



- HydroSHEDs (1km)
- MERIT (2km)

- Compared to the original routing we have taken the construction of the routing network out of ORCHIDEE.
- It now runs independently and can be generated for any new atmospheric grid.
- It is parallelized !
- Methods are developed to validate the routing network
- Provides a number of ancillary information on the river network.

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Constraints on HTU decomposition

The atmospheric grid is decomposed into “nbasmax” Hydrological Transfer Units (HTU) :

- For each atm. grid box we wish to have has many out-flowing HTUs as there are “large rivers” exiting.

- The HTUs should not be “too large” and respect the structure of the river network.

These constraints can generate too many HTUs within each grid box. Thus a strategy is needed to stay as close as possible to the nbasmax chosen by the user :

- ✔ No river should have two HTUs flowing out in the same direction with a fraction of the grid box < 1/nbasmax.

- ✔ Any large HTU will be subdivided until we reach fractions of grid box smaller or equal to 1/nbasmax.

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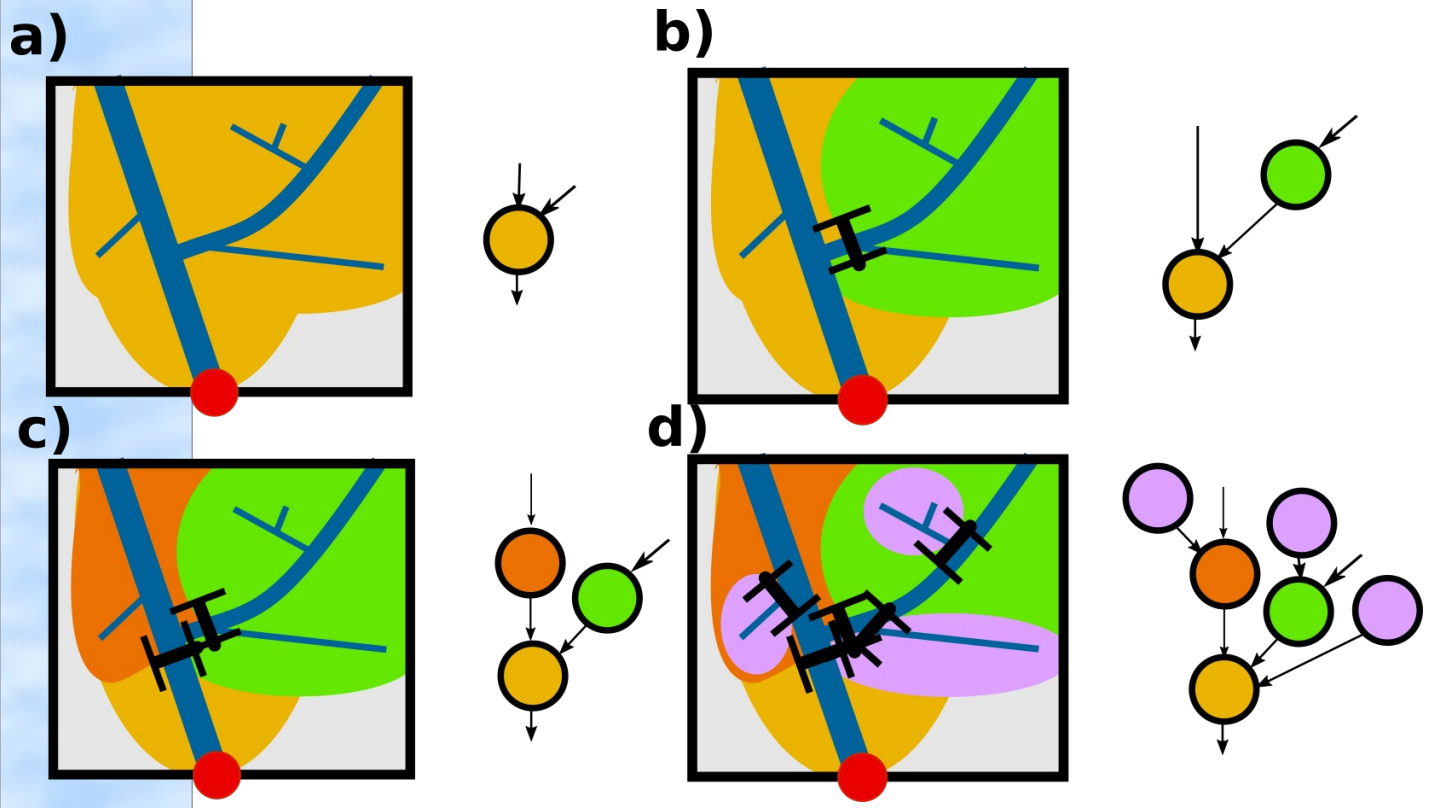
River driven HTU decomposition



A decomposition which favours le length of the river segments is tested. The areas of HTUs will be very variable. But river segment length is maximized.

The average river parameters (length and elevation changes) are closer to observations.
The stream topoindex can be computed from average parameters of the stream within the HTU.
The fast and slow reservoirs should have another characteristic.

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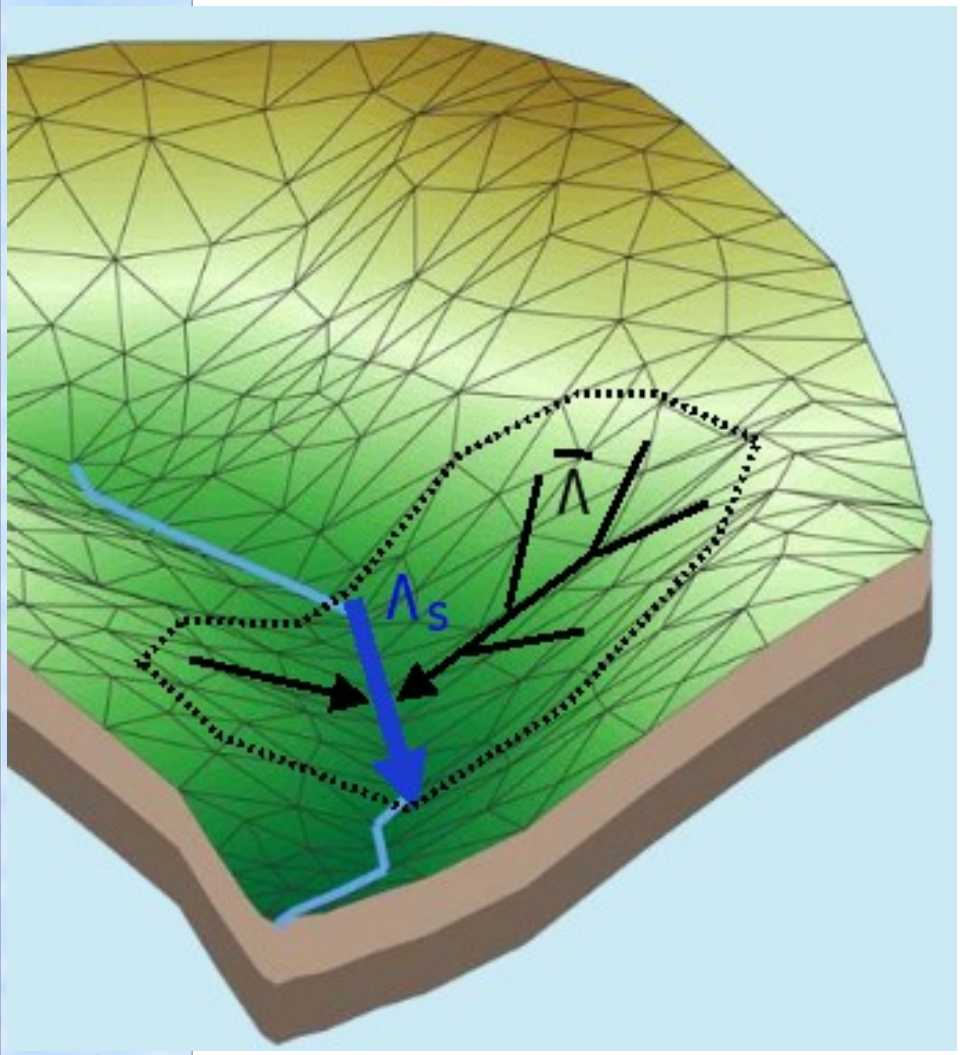
Parameters of river driven HTUs



- **River segment** (blue)
  - The stream reservoir which transports water from one HTU to the next.
  - Its topoindex is computed on average properties :

$$\Lambda_s = \sqrt{\frac{D_s^3}{dz_s}}$$

- **Small scale tributaries** (black)
  - Applies to the fast and slow reservoirs,
  - Flows into the downstream stream reservoir,
  - Topoindex obtained by averaging the original data (Agnès's method).

It better defines the properties of the streams which are key for the stability of the numerical scheme.

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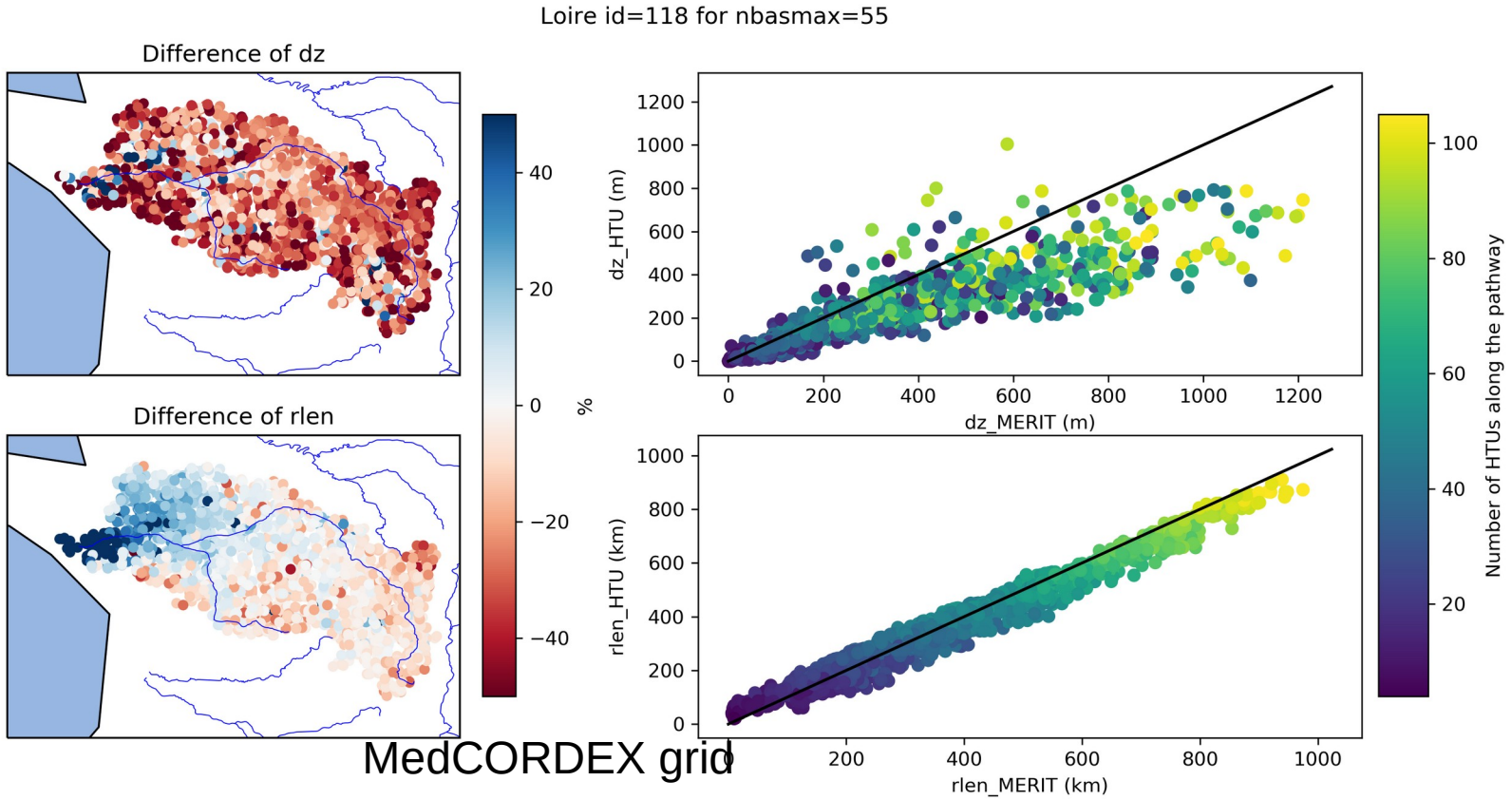
Validating River geometry

- To validate the geometry, we select at random pairs of points on the rivers of the HTU graph.
- These same pairs are also located on the MERIT network.
- The distance and elevation change of each pair along the river are computed along the river.



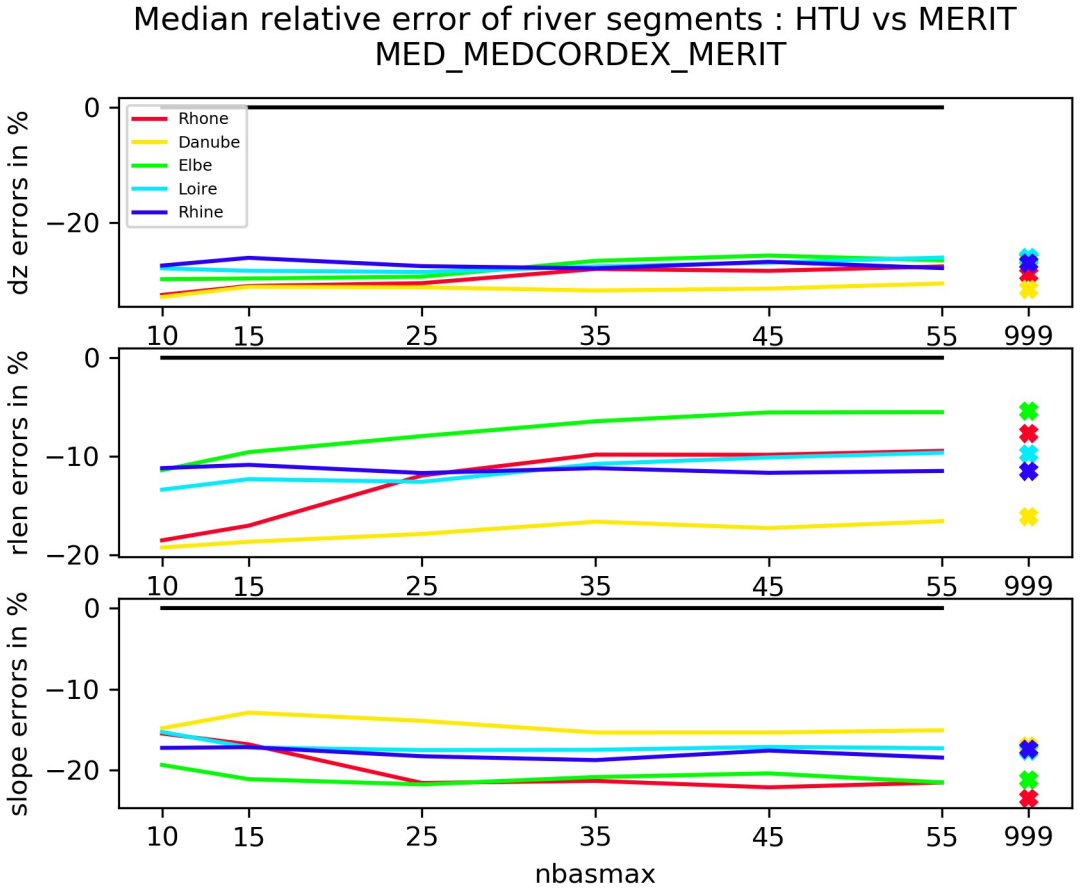
MedCORDEX grid

- Distance (rlen) is well preserved in the HTU decomposition .
- Elevation change (dz) has some errors.

Role of nbasmax on the river segment geometry

On a 20km grid we compared the HTU graphs for different nbasmax values between 10 & 55 and a few rivers in Europe :

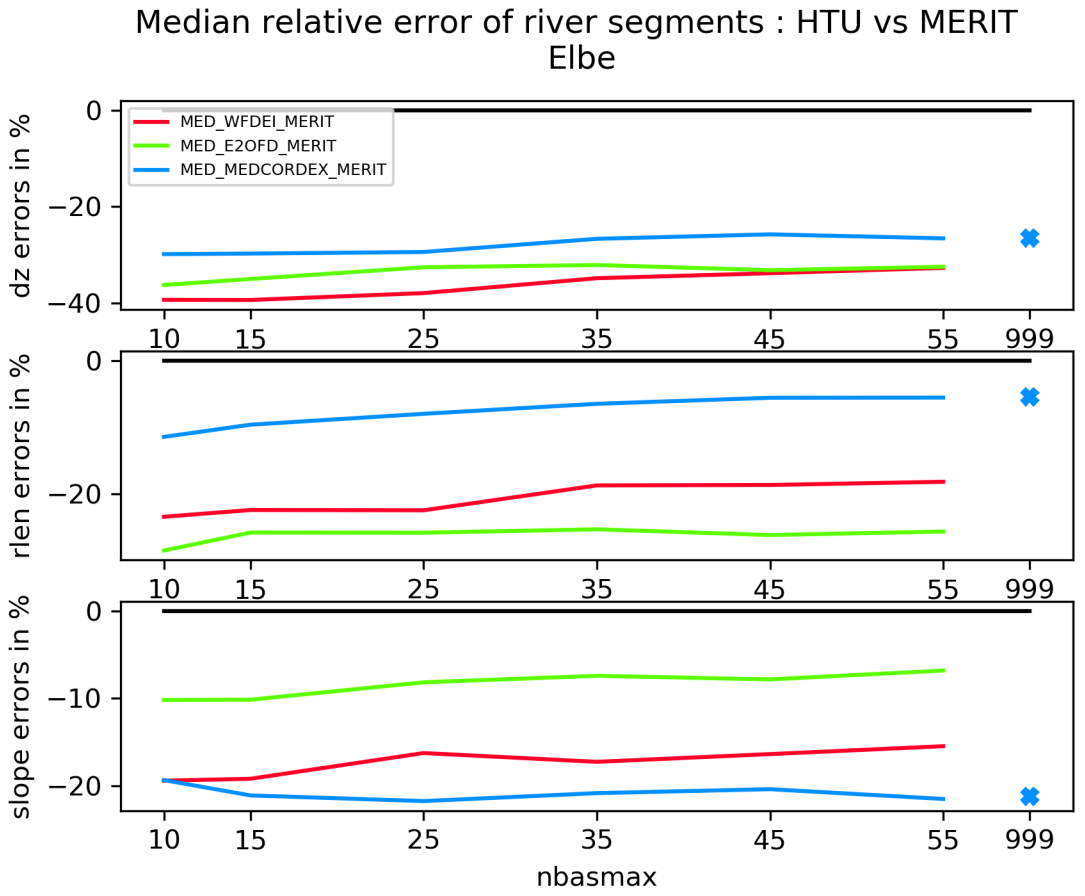
- *For low nbasmax dz and slopes are generally better.*
- *rlen is generally better for high nbasmax.*
- *The large errors in dz is probably still a bug somewhere !!*



The role of the atmospheric grid

We can also examine how the errors evolve with the atmospheric grid :

- WFDEI = 0.5° regular lat/lon grid
- E2OFD = 0.25 regulat lat/lon grid
- MEDCORDEX = 20km Lambert projection



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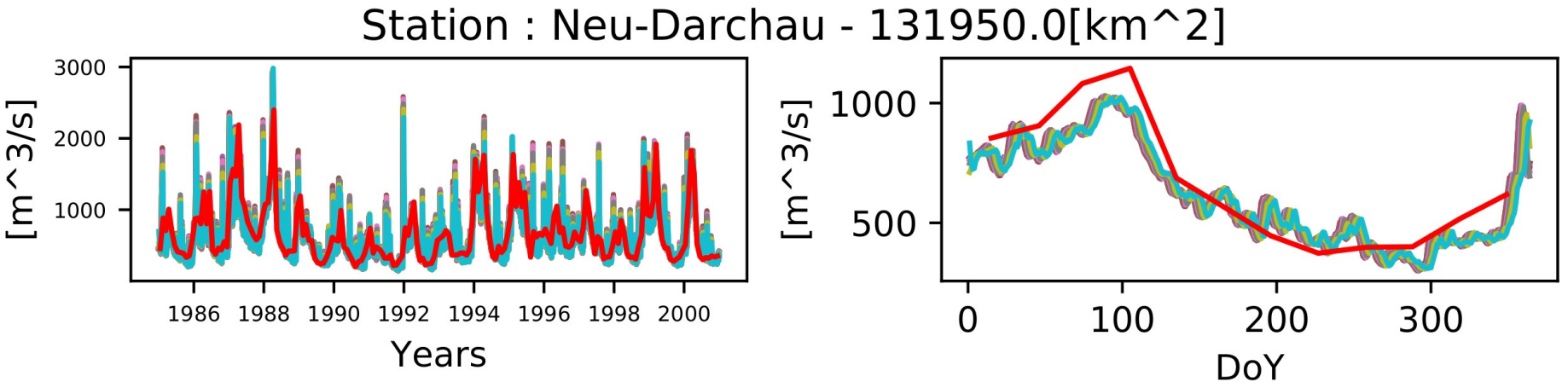
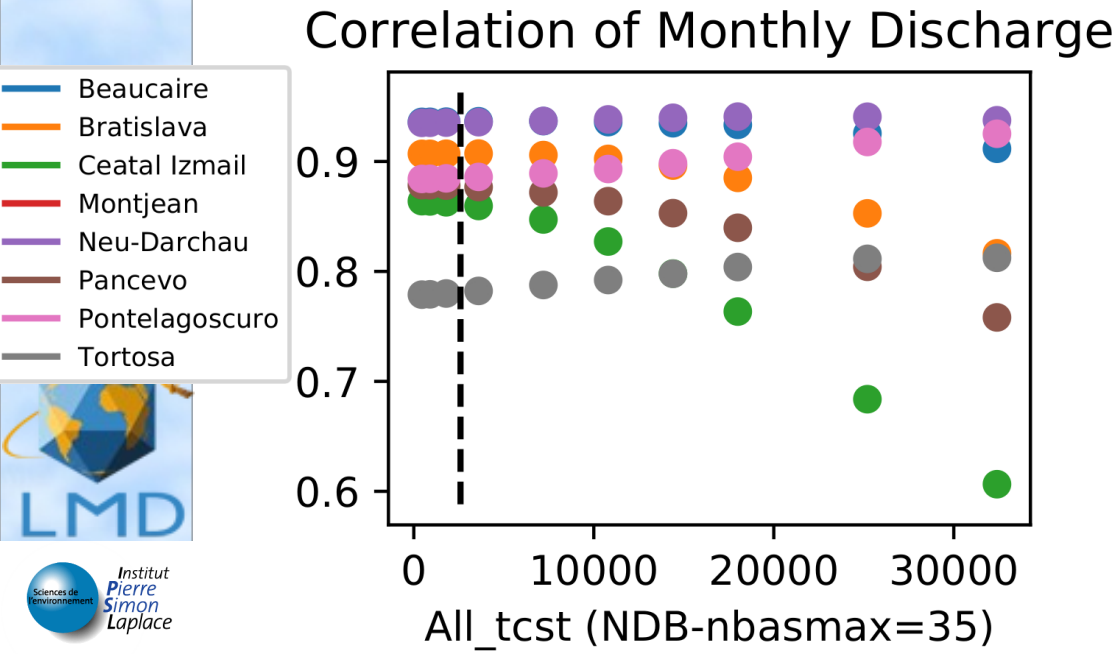
Selecting a time step

Discharge simulated at 0.5° with the WFDEI_GPCC forcing for different time steps. The Elbe here :





- As the time step increases the quality of the simulated discharge decreases.
- The predicted value (vertical bar) is based on the distribution of CFL criteria for the various HTU.

Conclusion

- The methodology is ready to build graphs of HTUs on atmospheric grids.
- It can be done at reasonable cost because the method is now implemented in parallel.
- The tools are ready to quantify the error introduced by simplifying the river networks.
- The simulated discharge is acceptable and we know the numerical limits for the time step which has to be used.
- Some small errors probably still exist in the evaluation of the quality of the network !!

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