Recent developments in the routing scheme

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- Refinement of the HTU concept
- Improved diagnostics of the river discharge
- Adding human water management
- Problems still existing in the routing scheme

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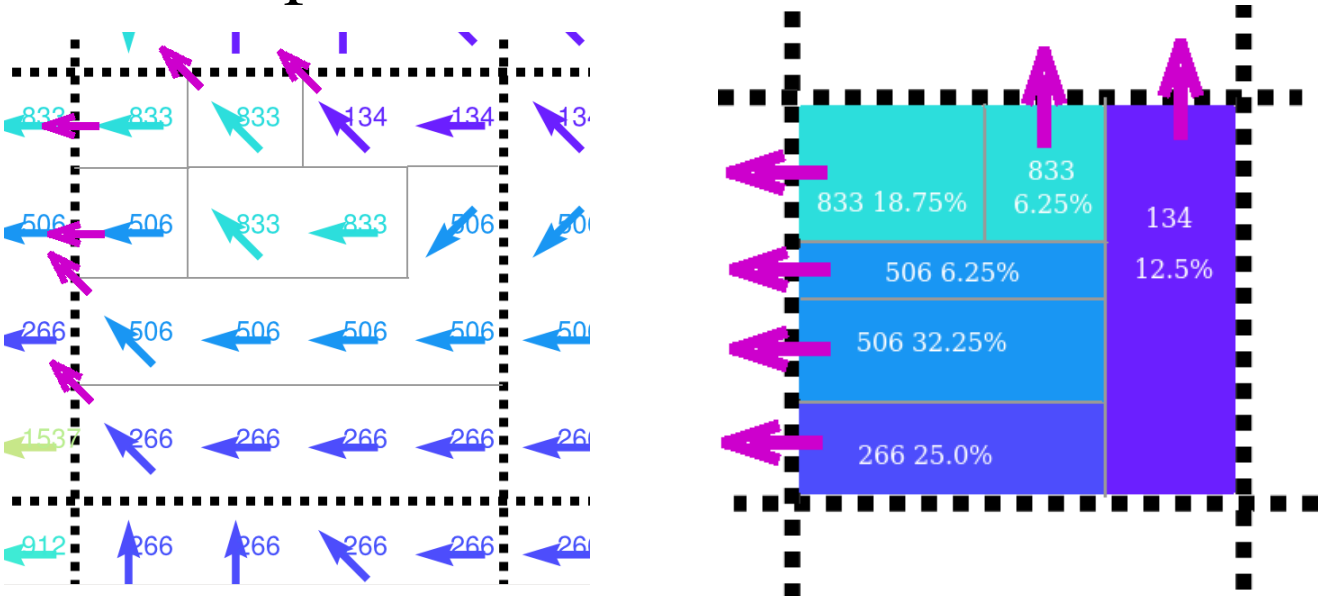
Refining the Hydrological Transfer Unit (HTU) concept

The sub-grid approach is used for the HydroSHEDS 1km resolution description of surface water flow network.



- Super-meshing is applied to interface the detailed river network with the ORCHIDEE's grid (i.e. the one of the atmosphere).
- It preserves the graph of all rivers.
- There is flexibility on the level of detail of the original graph to be preserve.
- Any hypothesis on a regular model grid has been removed.

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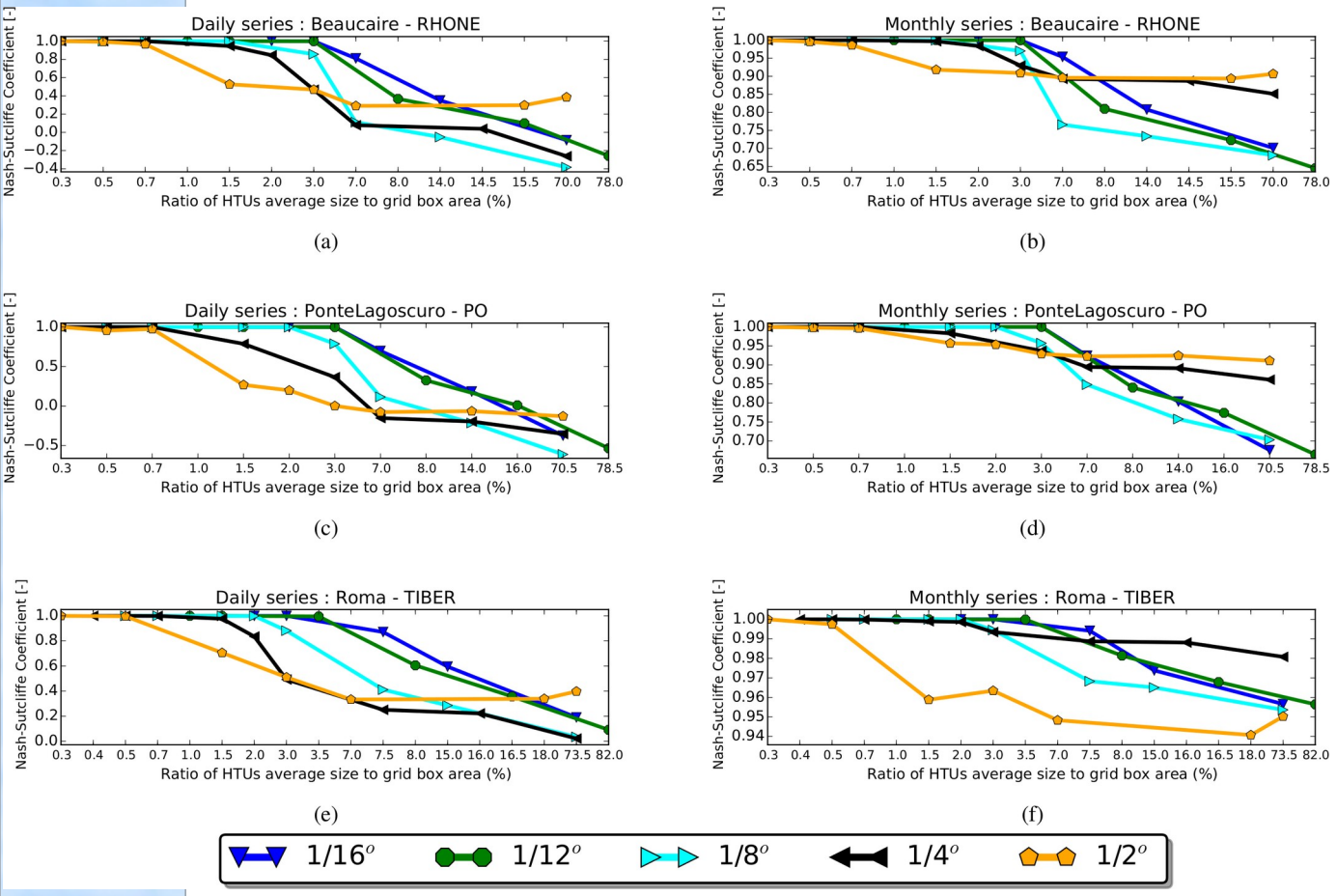
The value of horizontal resolution



In Nguyen et al. 2018 the role of resolution of the routing network is explored.
Given a resolution of the atmospheric grid, the HTU need to have on average 3-7% of the grid area.

- The algorithm for constructing the HTU can be debated.
- To preserve quality of discharge a minimum part of the original graph needs to be represented.
- The HTU concept affords this flexibility.

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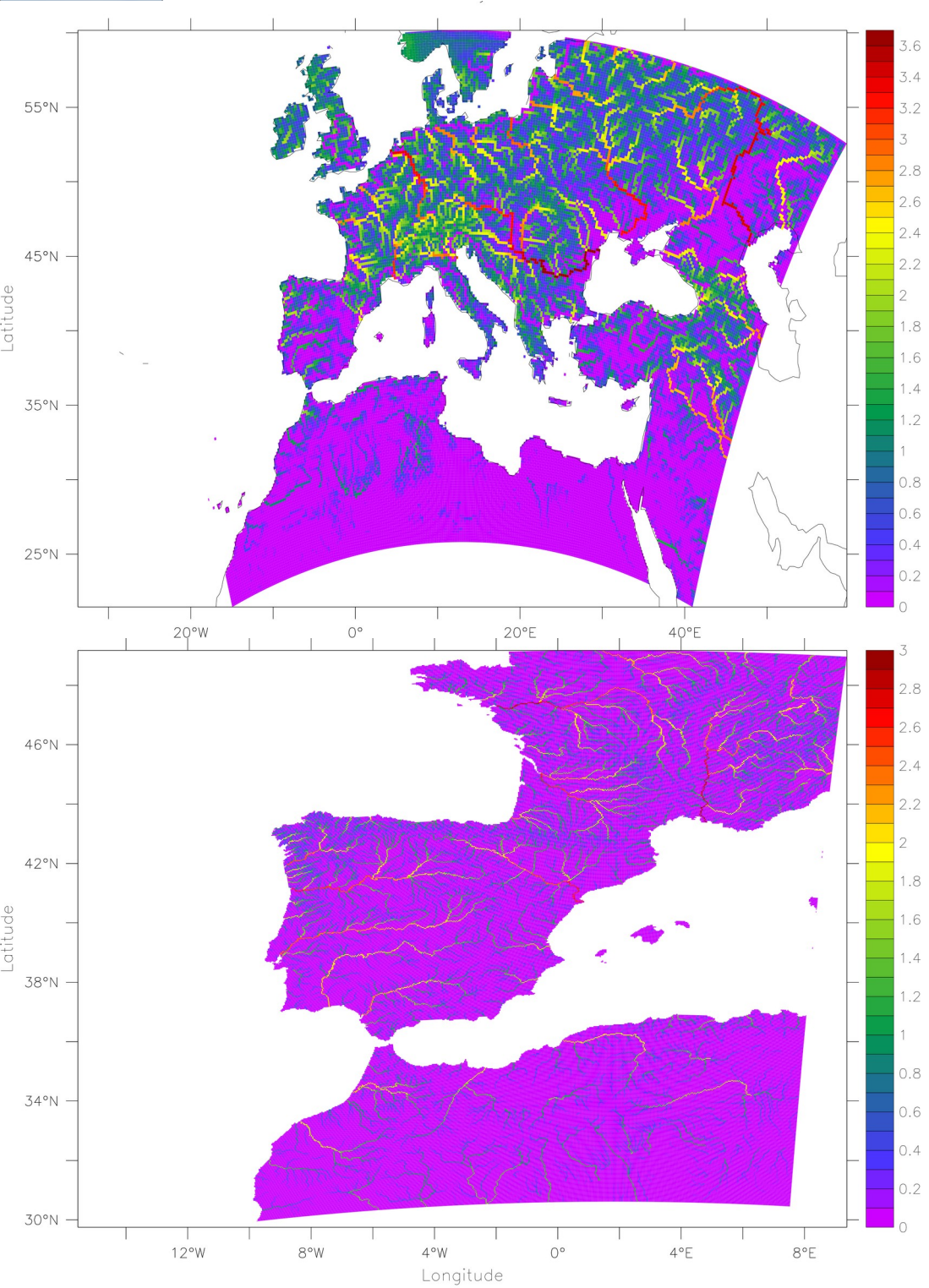
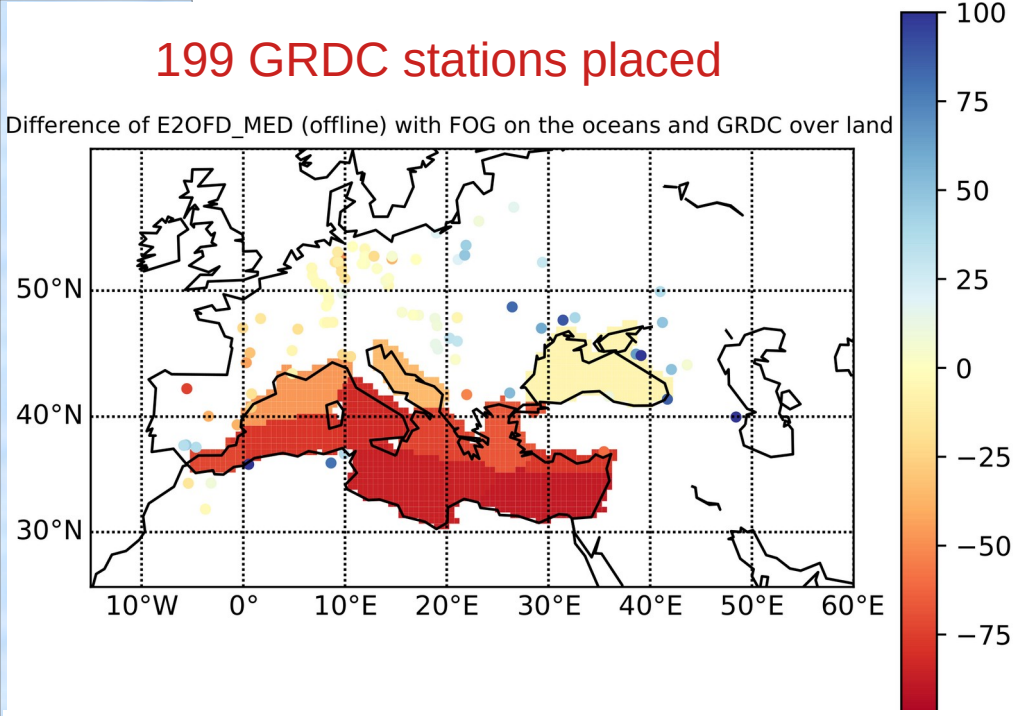
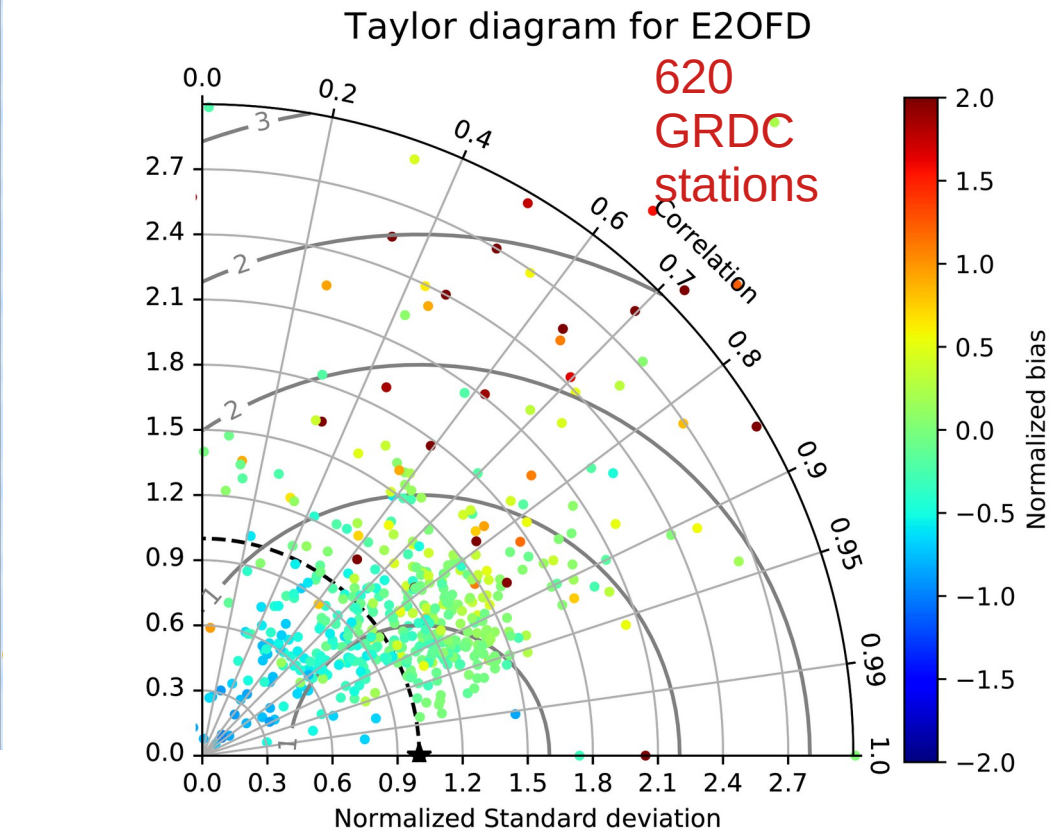


Current applications

The new routing scheme is mostly used in regional climate studies :

- MEDCORDEX (20km resolution)
- Km-scale atmospheric studies (3km resolution)
- Regional data assimilation (0.5°)

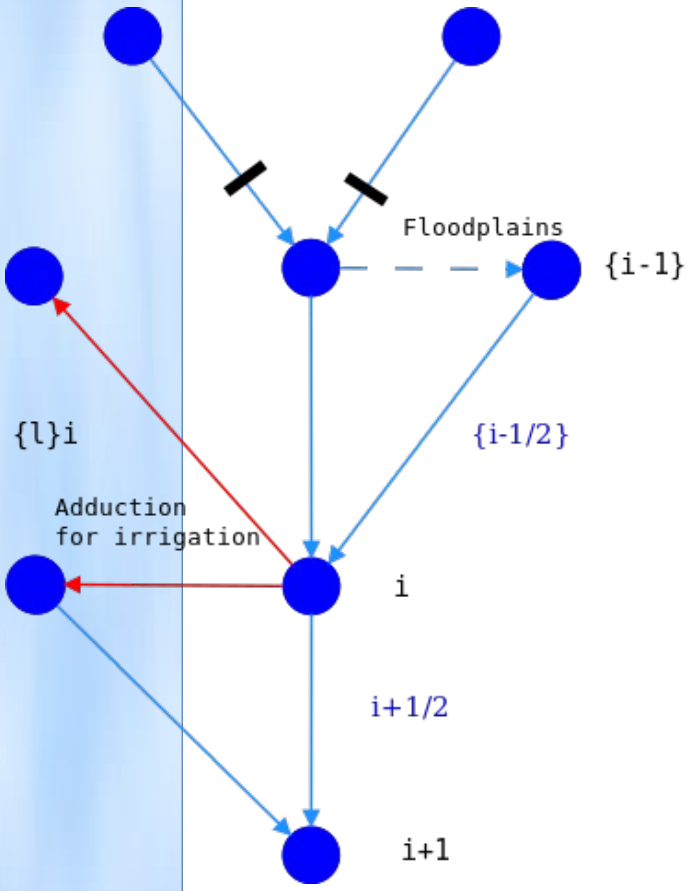




HTU level diagnostics

- Placing gauging stations on the model grid has always been a challenge.
- We have moved to placing the station within the model at the HTU level.
- Many more stations can correctly be sampled.
- The application shown is an off-line run with E2OFD (0.25°)

Modelling water value classes in ORCHIDEE



- The routing scheme predicts 4 value classes with the following priority:
  - *Ecological flow*
  - *Domestic water*
  - *Agricultural needs*
  - *Energy production*
- For analysis purposes the model continues to predict a natural flow.
- Runoff and drainage generate ecological flow in the graph.
- Regulation points (dams) can transfer water to other classes.
- Water bodies (regulated or not) revert all classes to ecological flow.

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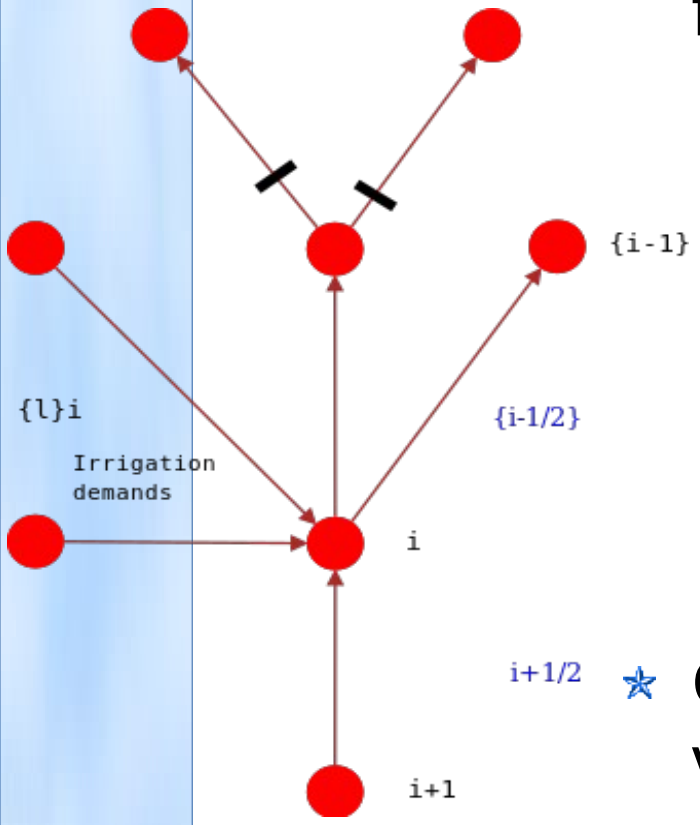
Modelling water demands



- For each of the water classes a demand function is formulated at each grid point :
  - Ecological flow : total water in river cannot fall below the 90% quantile.
  - Domestic demand : To be implemented
  - Irrigation : based on the difference between potential and actual transpiration of crops.
  - Energy : to be implemented.
- Grid-box demands are transferred to the vertices following the adduction network.
- All unsatisfied demands are propagated up-stream (Daily time step).
- Dams respond with their management rules to unsatisfied demands integrated over downstream vertices and resources.

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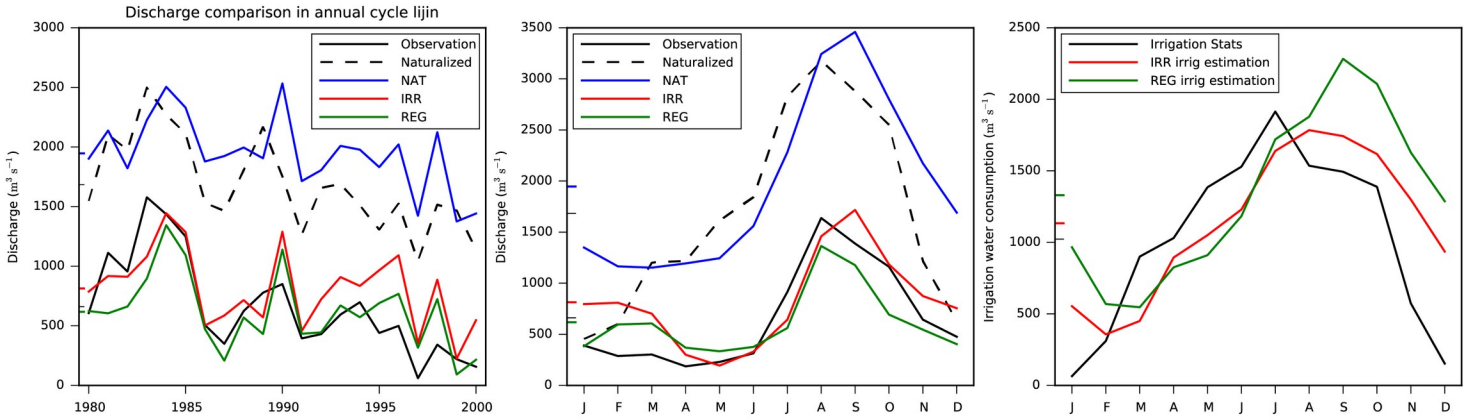
First results



Discharge at the most downstream station : Lijin

- We have demonstrated that human water management can be represented with a supply/demand approach within ORCHIDEE's.
- It allows to predict the management used for each dam.
- The model simulates the natural as well as actual river discharge.
- This part of Xudong's thesis is being prepared for publication.
- Because of the parallelisation of ORCHIDEE, it could only be implemented as a prototype.

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Current issues with the routing scheme

- **Hydrological data issues** :
  - HydroSHEDS is not yet available globally at 1km resolution.
  - A global HydroSHEDS would be about 20Gb.
  - The MERIT data at 100m resolution also exists (170Gb) .
- **Parallelisation of the HTU construction algorithm** :
  - To construct the HTUs large data volumes need to be handled.
  - To achieve this on current machines parallel processing is imperative
  - The parallelisation of ORCHIDEE is not adapted to this task.
- **Parallelisation of model execution** :
  - The new routing is called at hourly or more frequent intervals.
  - The data exchange currently implemented in ORCHIDEE slows down the model considerably.
  - As more horizontal exchanges are added (water demands) the parallelisation will become even more critical.

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