CACTUS: an interactive hydrological modelling tool for simulating hydrological scenarios in a customisable catchment area

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Introduction

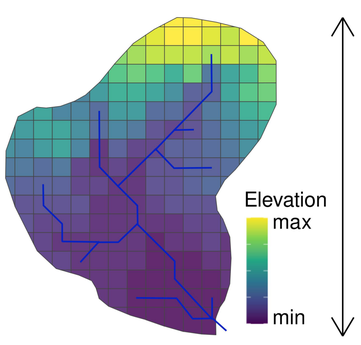
Hydrological modelling is a valuable tool for water resource management, particularly for **exploring climate change adaptation strategies**. However, implementing spatially distributed models on real basins is **complicated and time-consuming** (ranging from a few days to several months), making them hard for the general public to understand and unsuitable for demonstration purposes.

CACTUS (CustomisAble CaTchment model for water Use Scenarios) is a set of interactive and simplified hydrological modelling tools designed to facilitate **science communication** on:

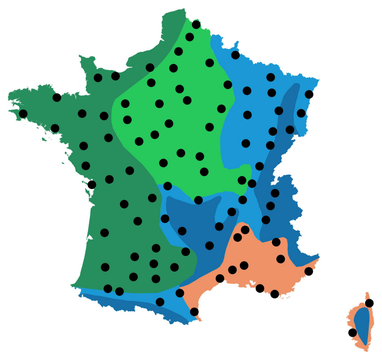
- catchments hydrological responses to climate and land use change scenarios
- the functioning of spatially distributed hydrological models

CACTUS

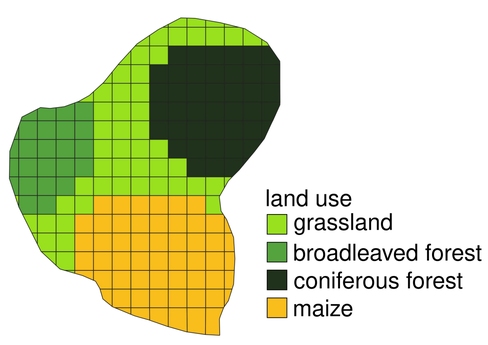
CACTUS is a RShiny app that allows users to **customise** the characteristics of a simplified virtual catchment with a fixed geometry (185 cells, 14 reaches), **run** the JAMS-J2000 hydrological model [1], and **visualise the simulation results**.



1. Enter the surface (< 5000 km²), minimal and maximal elevations



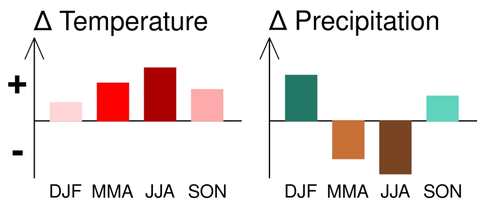
2. Select a present climate based on 90 reference cities *(SAFRAN reanalysis)*



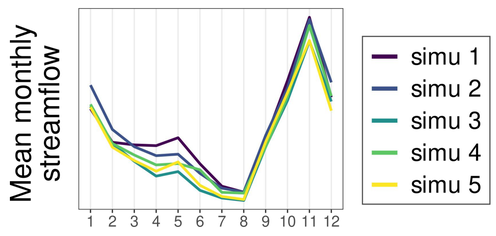
3. Select and locate pre-parameterised classes of land use *(17 classes)*, soils *(60)* and geogoly *(7)*

Simulation

4. Run the model *(40-years simulation at daily time step)*



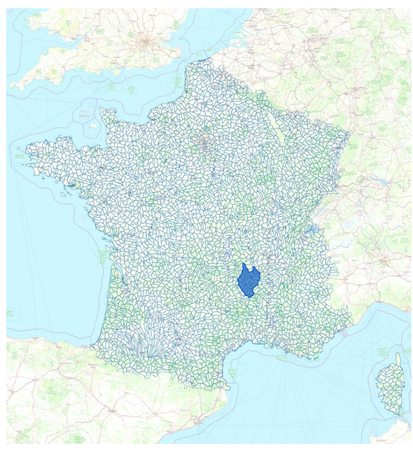
5. Run the model again, this time with customised scenarios of climate perturbations or land use changes.



6. Compare up to 5 simulations *(types of results: hydrological regime; contributions to streamflow; snow,soil and, groundwater storage variations; hydric stress; hydrological extremes)*

prepCACTUS

prepCACTUS is a separate RShiny app designed to easily **retrieve parameterisation data**, for all types of French catchments.



Selection of a catchment in prepCACTUS

Databases:

- HydroBASINS *(watersheds and area)*
- SAFRAN *(elevations and present climate)*
- Corine Land Cover 2018 *(land use)*
- Soil Geographical Data Base of France *(soils)*
- BDLisa *(geology)*
- Explore2 *(climate change projections)*

Demo videos

CACTUS

prepCACTUS

How does CACTUS compare to other models?

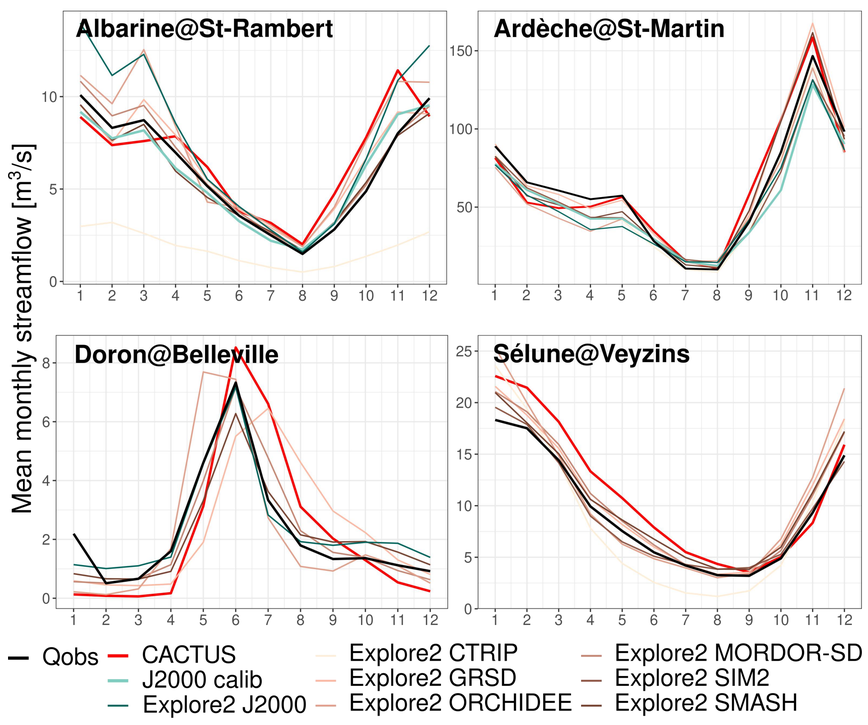
Comparison of CACTUS simulations with :

- observed streamflows
- streamflows simulated with calibrated J2000 models
- streamflows simulated with models from the Explore2 project [2] (present and future climate)

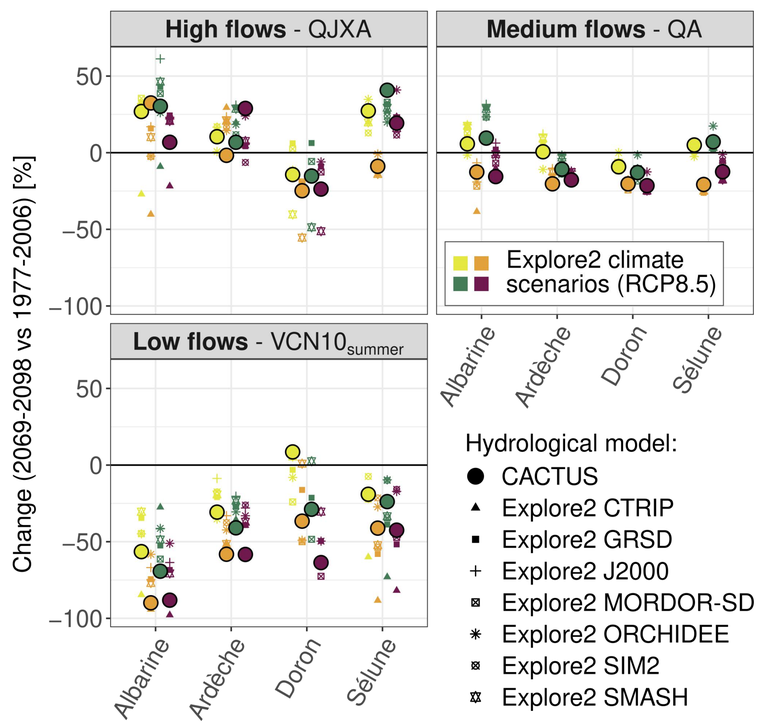
4 test catchments:

- Albarine (210 km²) *mid-mountain catchment*
- Ardèche (2260 km²) *pluvial regime with heavy floods in autumn*
- Doron (60 km²) *small alpine catchment*
- Sélune (770 km²) *pluvial lowland agricultural catchment*

Hydrological regime under present climate



Future projections of streamflow indicators



Conclusions

- **Very fast catchment modelling** (< 10 sec to run J2000 with CACTUS, only takes a few minutes to parameterise a catchment from scratch and run 4 climate change scenarios)
- **Good performances** on the simulation of hydrological regimes and projected changes (high, medium, and low flows)

Perspectives

- Bringing the CACTUS and prepCACTUS applications **online** (during 2026)
- Adding the representation of water uses in CACTUS (see poster by N. Pellerin et al.) to allow simulations of **water management scenarios**

References

[1] Krause, P. (2002). Quantifying the impact of land use changes on the water balance of large catchments using the J2000 model. Physics and Chemistry of the Earth. *https://doi.org/10.1016/S1474-7065(02)00051-7*

[2] Sauquet, E., Evin, G., Siauve, S., Aissat, R., Arnaud, P., Bérel, M., Bonneau, J., Branger, F., Caballero, Y., et al. (2025). A large transient multi-scenario multi-model ensemble of future streamflow and groundwater projections in France. EGUsphere [preprint]. *https://doi.org/10.5194/egusphere-2025-1788*