Water Resources Engineering
Assignment

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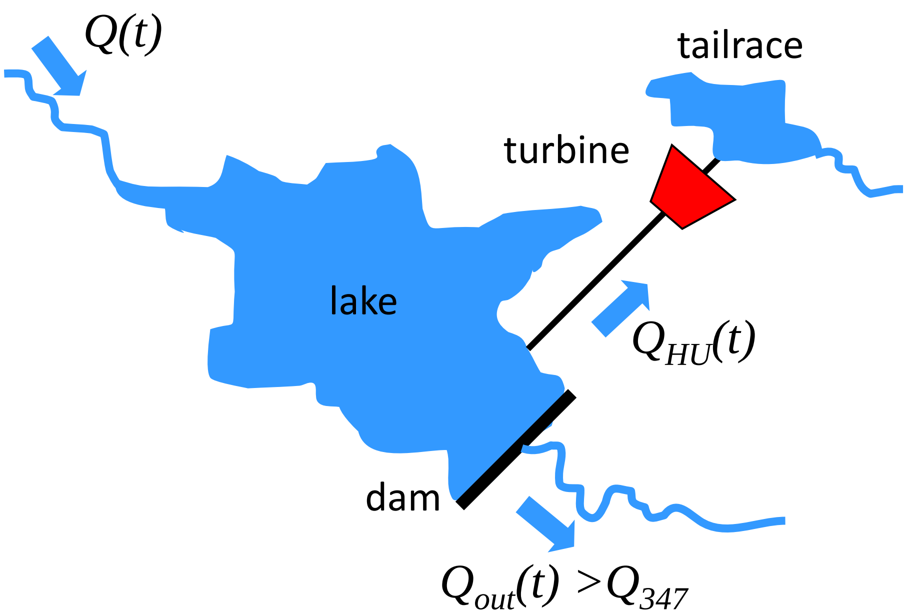
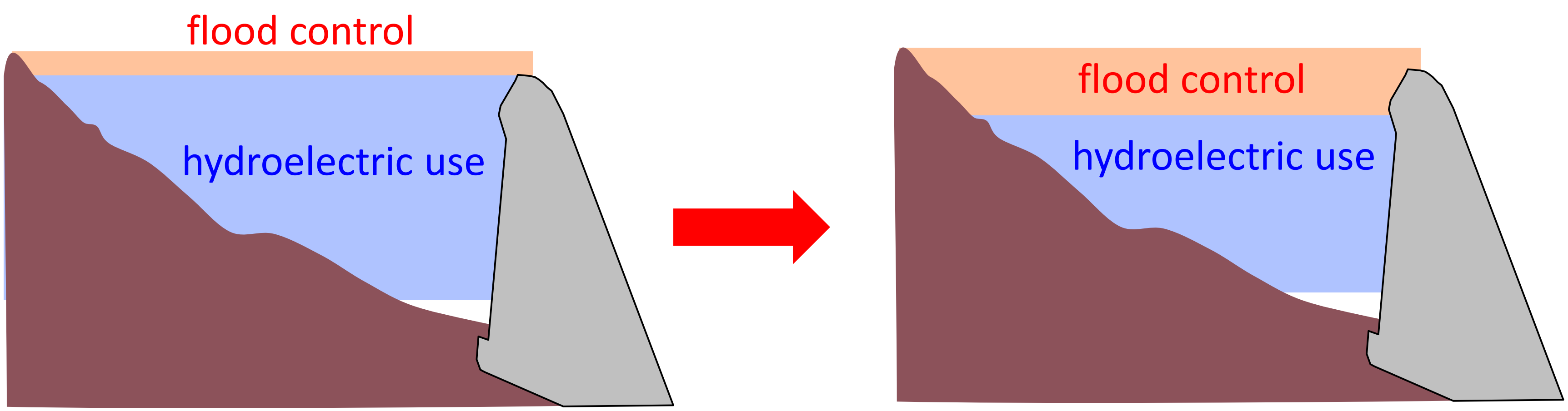
lecture: Tuesday 8.15-10 in room GR B3 30
exercise: Thursday 10.15-12 in room INF 3
office hours: Thursday 12-14 (GR C1 532 – GR C1 564)

Assignment: management of a multipurpose reservoir

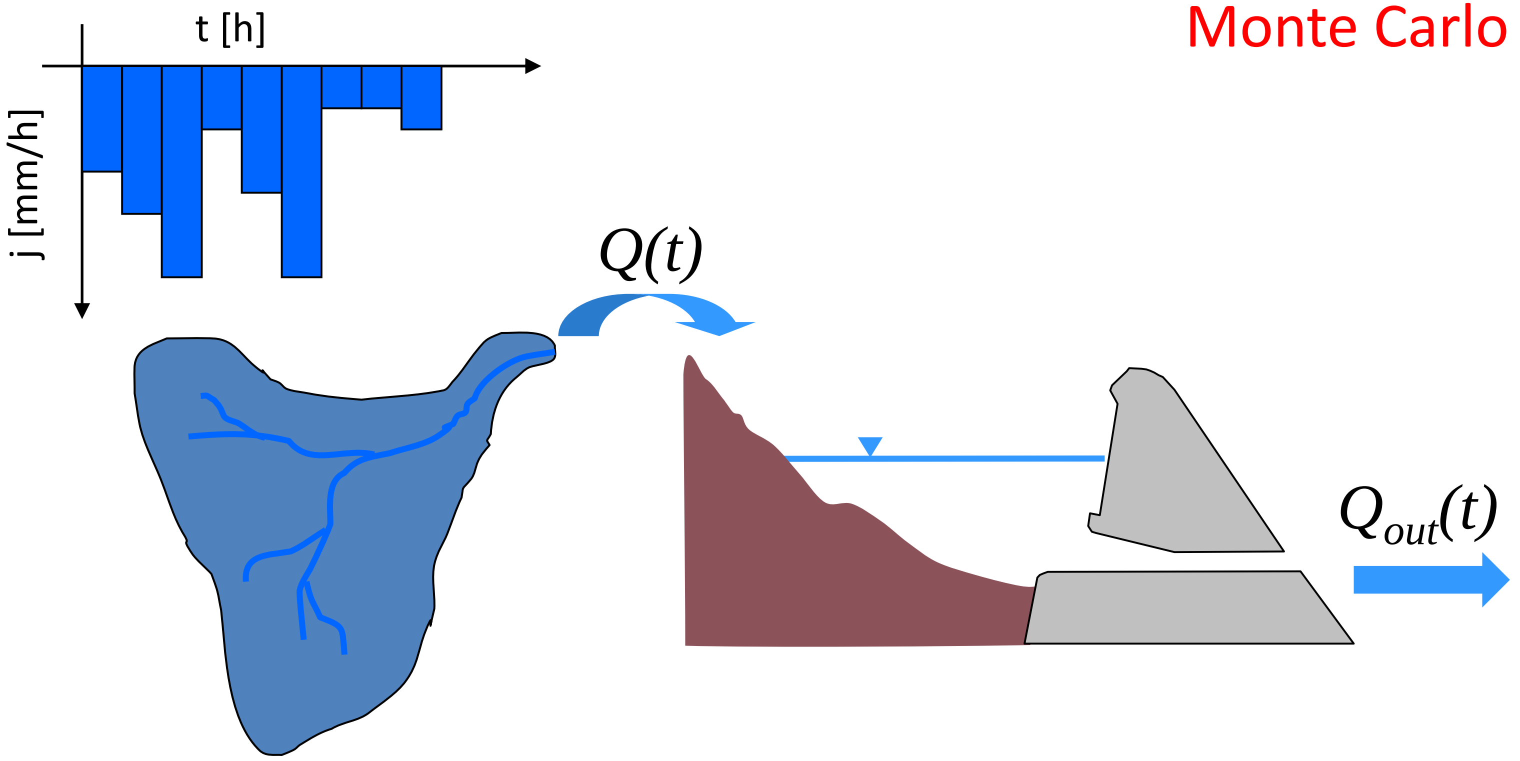


Evaluate the feasability of improving the flood control operations of an exixting reservoir of a hydropower plant.

A larger fraction of the storage needs to be preserved for flood control and cannot be used for hydroelectric generation.



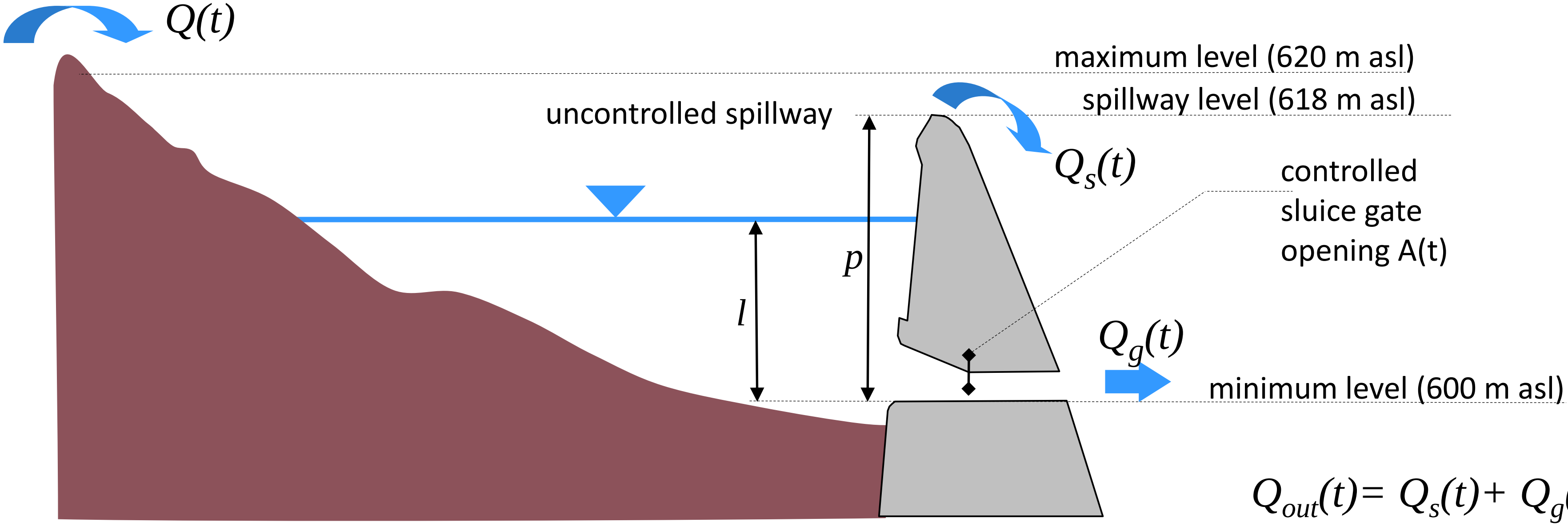
Monte Carlo approach



Step

- Develop and calibrate a continuous hydrological model to transform rainfall into discharge. The model is fitted based on the available dataset.
- Generate rainfall time series with the same statistical properties of the observed ones.
- Simulate the reservoir routing whitout flood control practice.
- Implement flood control practice
- Measure the energy produced and the flooding probability for different values of volume allocated for flood control

devices for flow release



$$Q_{out}(t) = Q_s(t) + Q_g(t)$$

discharge curve

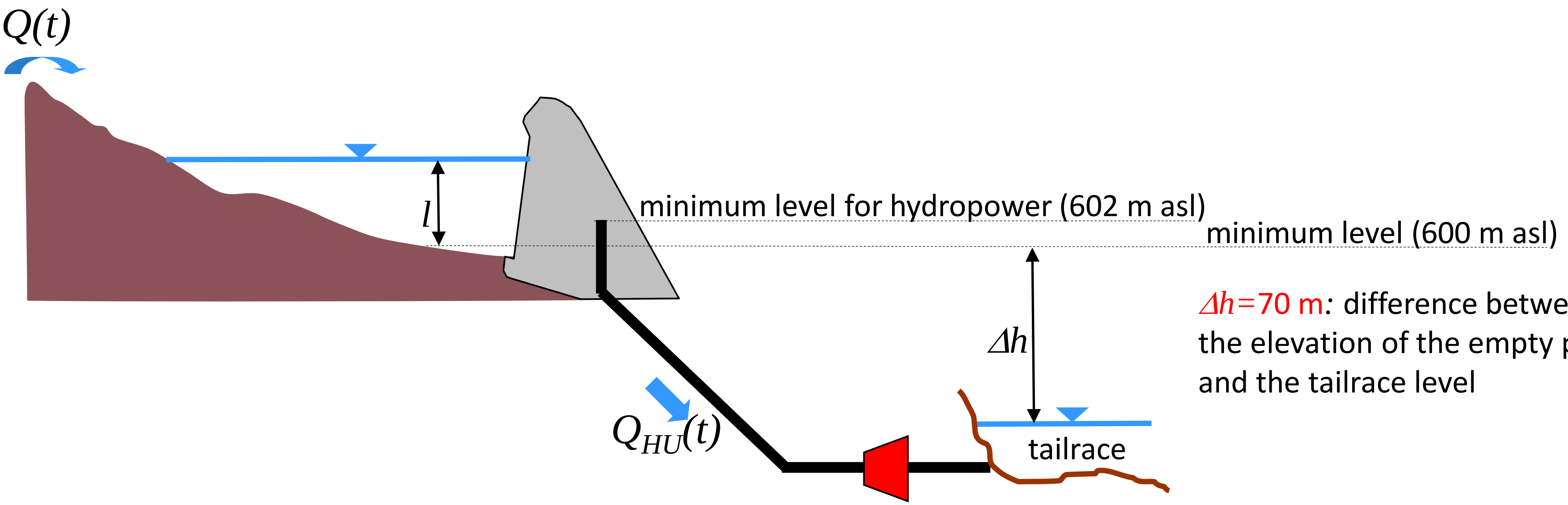
$$Q_{out}(l) = \begin{cases} C_{qg} A \sqrt{2gl} & l \leq p \\ C_{qg} A \sqrt{2gl} + C_{qs} L \sqrt{2g(l-p)^3} & l > p \end{cases}$$

C_{qg}: sluice gate discharge coefficient

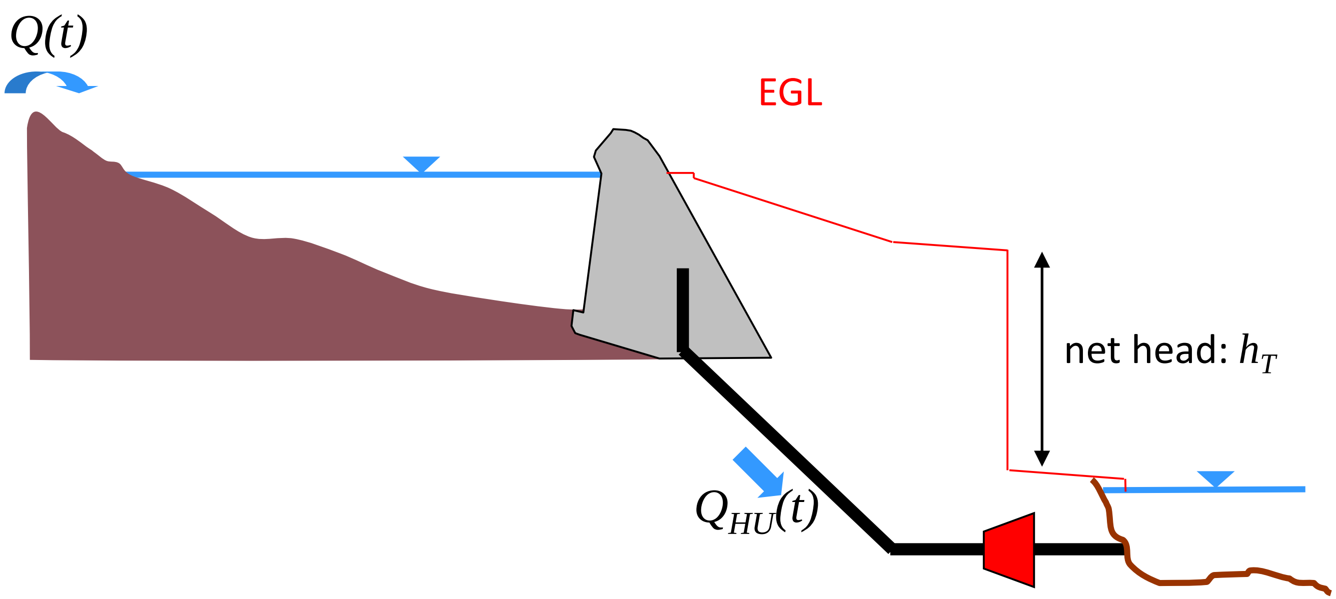
C_{qs}: spillway discharge coefficient

L: spillway effective length

hydropower production



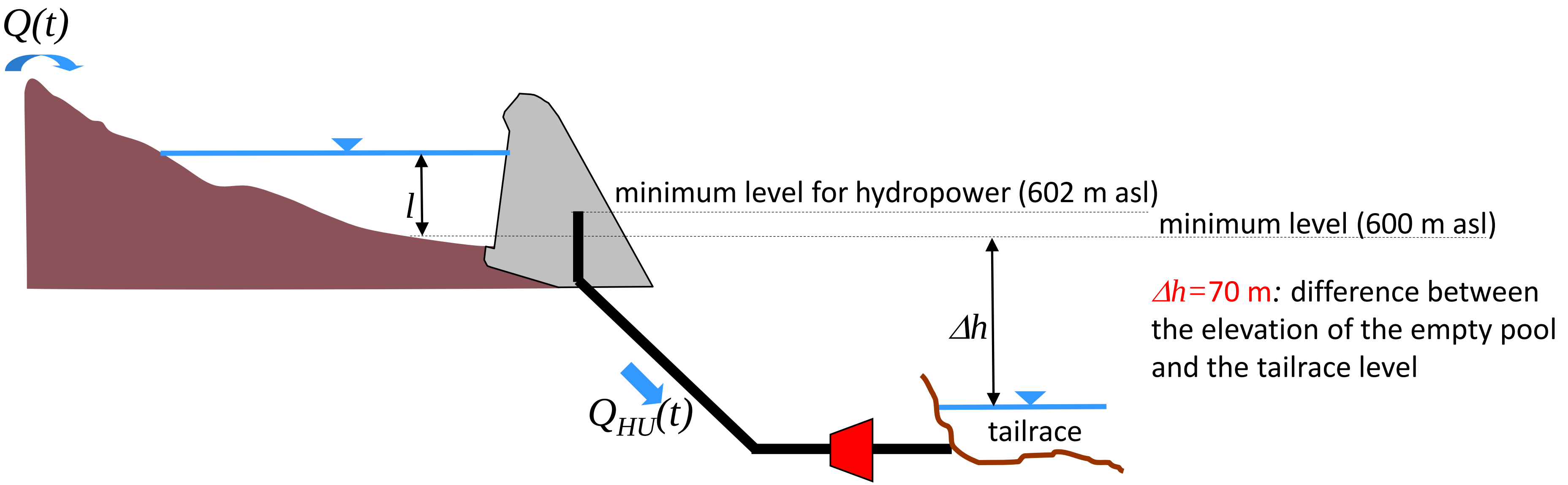
Δh=70 m: difference between the elevation of the empty pool and the tailrace level



turbine power generation

$$P = \eta \gamma Q_{HU} h_T$$

hydropower production



The power plant works only during peak hours (from 11.00 to 18.00, 7 hours).

If at the beginning of the day (midnight) the level in the reservoir is above the minimum level for hydroelectrical use, the plant will work during that day, otherwise it won't. When the turbine is working, Q_{HU} is always equal to the design discharge (55 m^3/s).

To compute the net head of the turbine, account for frictional head losses along the pipe, entrance head loss (half of the kinematic term) and exit head loss (one kinematic term).

storage equation

$$\frac{dV(t)}{dt} = Q(t) - Q_{out}(l(V(t))) - Q_{HU}(t)$$

where V is the volume stored in the reservoir, Q is the generated discharge time series, Q_{out} is the sum of the discharge through the sluice gate and the spillway, Q_{HU} is the discharge used for hydropower generation. Suggested timestep of integration: 1 hour. Other fluxes (e.g. Evaporation) are negligible.

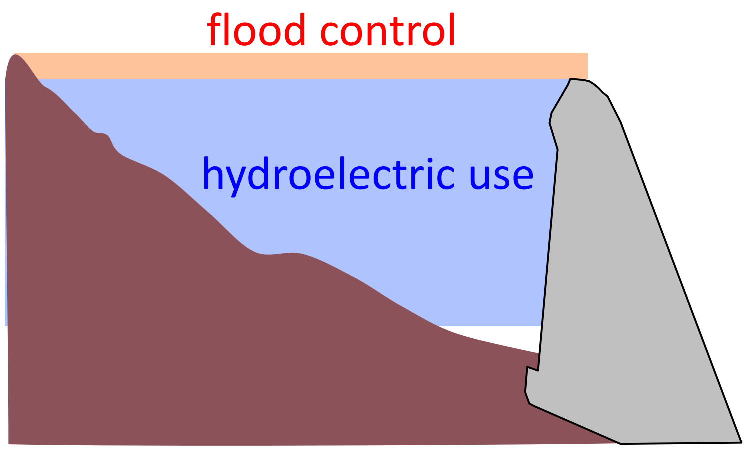
Tasks

Starting form the area rating curve, derive the volume rating curve (as in exercise 2).

Compute the minimum flow target (discharge that is exceeded 95% of the time) of the generated discharge.

Integrate the storage equation with an Euler explicit method.

Q_{out} must always be equal to or greater than the minimum flow target.



This week we focus of the of the functioning of the reservoir before the implementation of the flood control practice.

All the volume can be used for hydropower production.

At every timestep, the opening of the sluice gate is computed so that the flow through the gate equals the minimum flow target.

Compute the average energy produced in one year.

Next week we will see how to control the opening of the gate to implement the flood control practice.

Tip: start simulating the system for a period shorter than 100 years (e.g. 10 years). When everything looks ok, go for the long simulation (100 years of simulation takes about 1 minute of computational time) (plot refers to an other case)