# Further adventures with HPM

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# Introduction

- Holocene Peat(land) Model:
  - simulates the development of northern peatland since their early stages
  - Applicable to various areas
- Project: Evaluate the capacity of HPM to reproduce what we know from peatland development during the Holocene
- Comparison with paleo-analysis from James Bay region peatlands (not presented here)
- Analysis of the uncertainty factors (partly presented here)

# Evaluation of HPM to date

- Steve made some comparison against observations and some sensitivity analysis of the model with
  - Data and calibration on Mer Bleue
  - and with precipitation reconstruction from southern Quebec
- Objective in this study:
  - Investigate deeper the influence of the parameters and/or inputs on the model results
  - Capture the weakest points or areas and may be the weakest links between processes to assess the structure of the model and also to assess our knowledge of the system
  - The quality of the model will not be assessed here

# What is known and what is unknown?

- Hypothesis:
  - The model represents the mechanisms of the peatland as they have been presented after long years of field and lab research
  - Some hypothesis might be wrong though and depend for example on the scale on which they have been studied
- Key questions for the modeller:
  - What is driving these processes?
  - The links between the « observed processes in nature » are not well known: Do we represent links in the model that do not exist in that way in nature?
  - What should the boundary conditions of an ‘average’ peatland ecosystem be?
  - Is it possible to describe a complex system in the « right way »?

# Method: Monofactorial analysis

- What difference is made by the choice of a different parameter value?
- Determine the ‘local’ influence of a parameter on an output of the model
- The parameters vary in a specified range
- The initial settings remain the same for every simulation, only one parameter changes at a time: OAT analysis

# Simulations setting

- Base run:

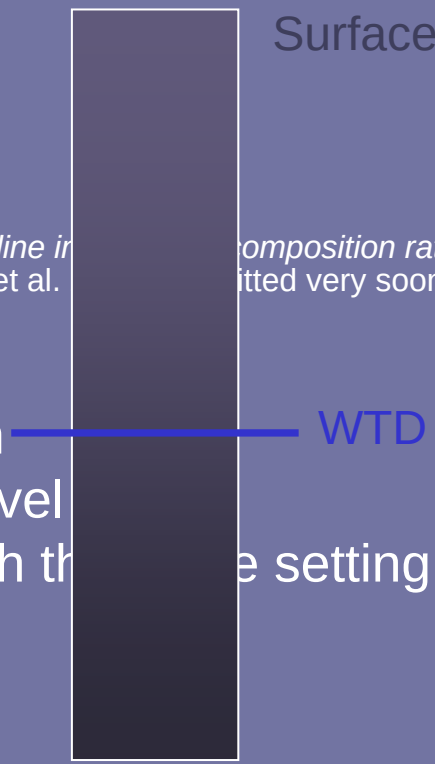
  'Nominal values' are the values considered the most realistic values for the purpose of the model

  Here mostly based on Mer Bleue observations and other literature

- Parameters tested here:
  - Maximal NPP value (nominal value: 3.0 $kg.m^{-2}.yr^{-1}$)
  - Annual precipitations (nominal value: 0.9 $m.yr^{-1}$)
  - Anoxia scale length (nominal value: 0.3 m)

    "*The anoxia scale length parameter (c2, Eq. 9, Table 2) controls the decline ir* *omposition rate of submerged peat as a function of depth below the water table*." (Frolking et al. itted very soon)
  - WTD for minimal ET (nominal value : 0.7m)

    Water table depth for which ET is minimal
- 5000 years simulations to reach the equilibrium
- Precipitations are kept constant at the actual level
- No stochastic process in HPM: a simulation with th e setting, will always give the same result.



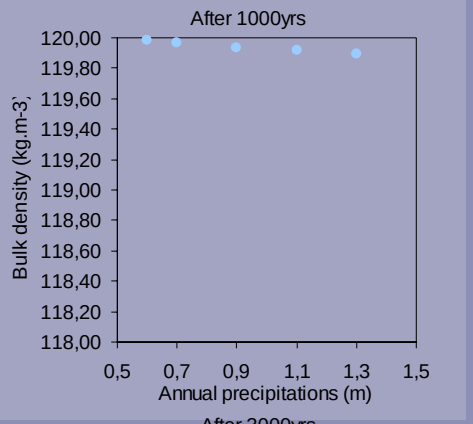
# Outputs

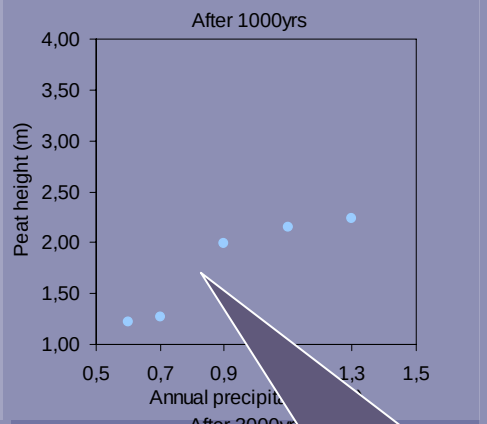
- Different outputs to highlight the influence of the parameters on different sections of the model:
  - Peat height
  - WTD
  - Bulk density
  - Peat mass
- Different states in the simulation are observed
  - After 1000 yrs
  - After 3000 yrs
  - At the end of the simulation after 5000 yrs

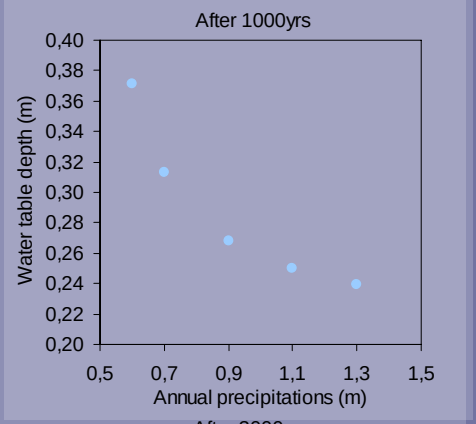
# Fresh results

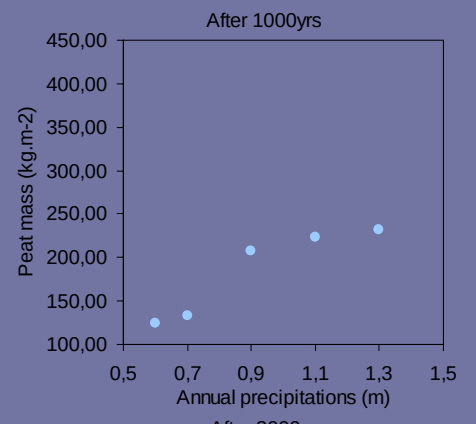
Tracing the parameters influence on the results

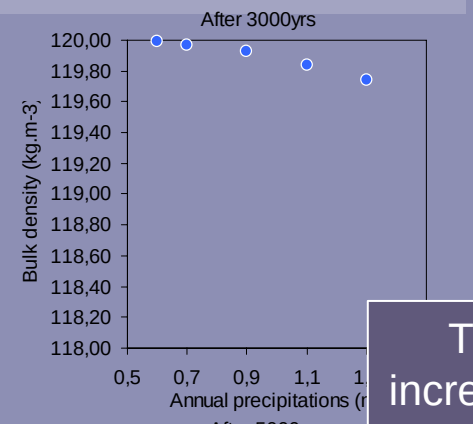
# Parameter: Annual precipitations

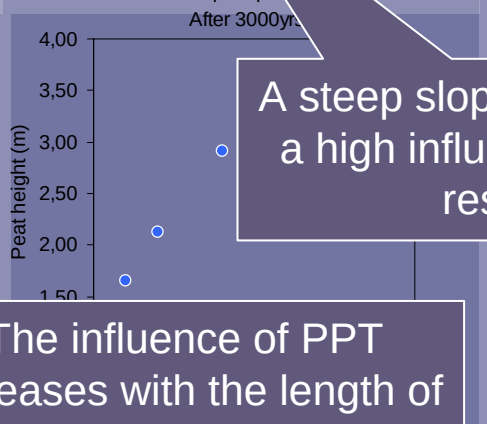


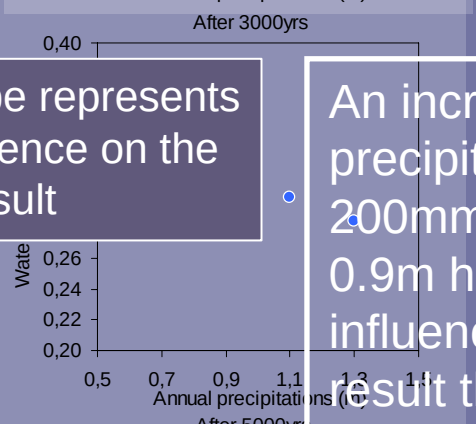



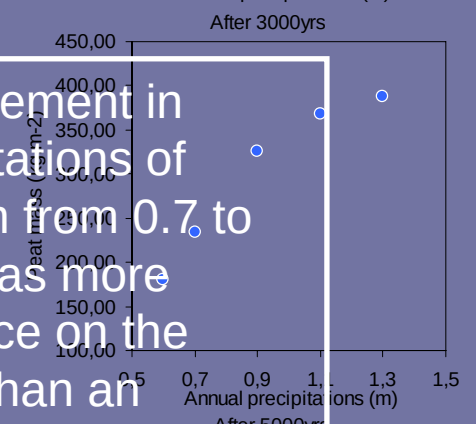



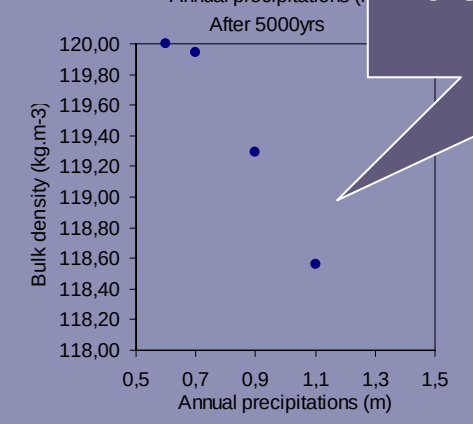



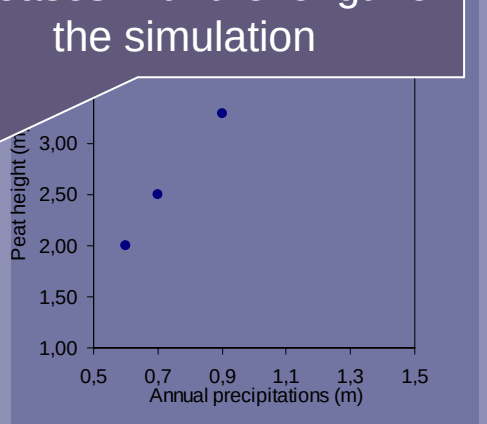



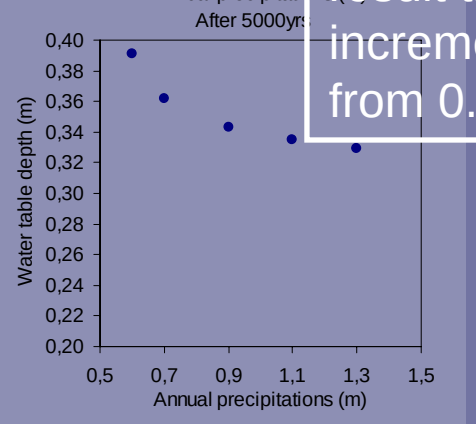



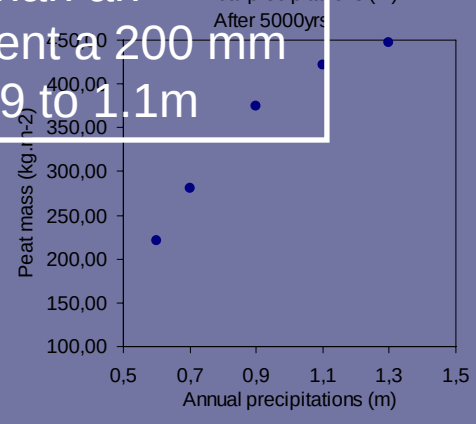



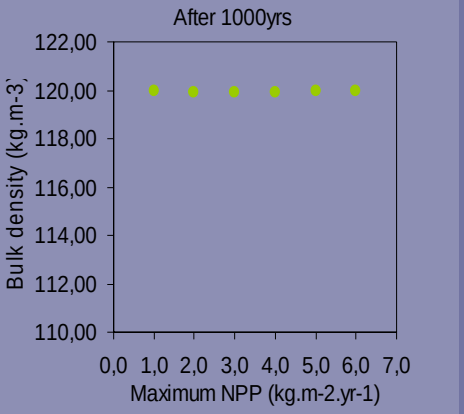



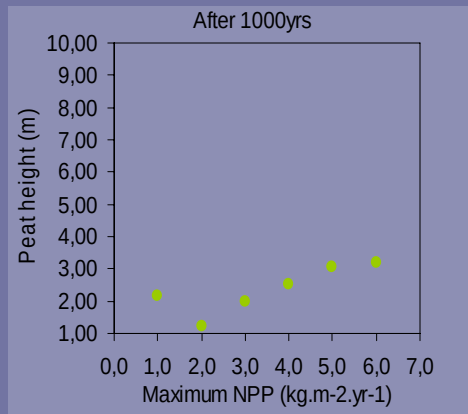

A steep slope represents a high influence on the result

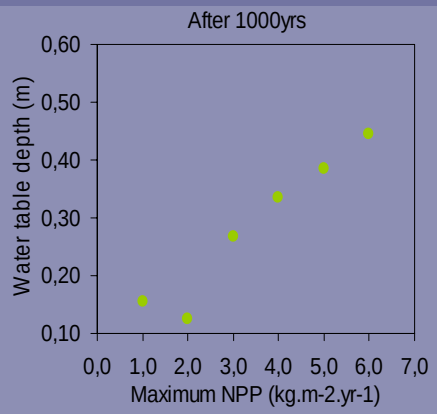
The influence of PPT increases with the length of the simulation

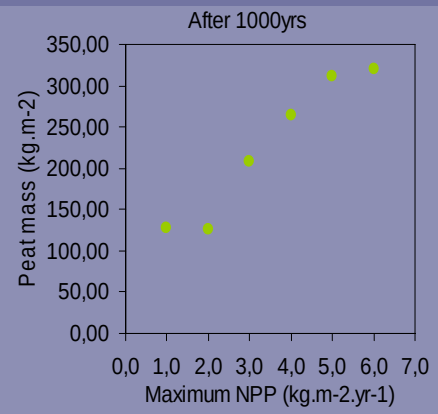
An increment in precipitations of 200mm from 0.7 to 0.9m has more influence on the result than an increment a 200 mm from 0.9 to 1.1m

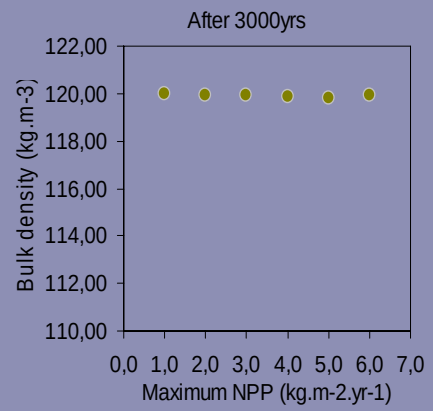
# Parameter: Maximum NPP

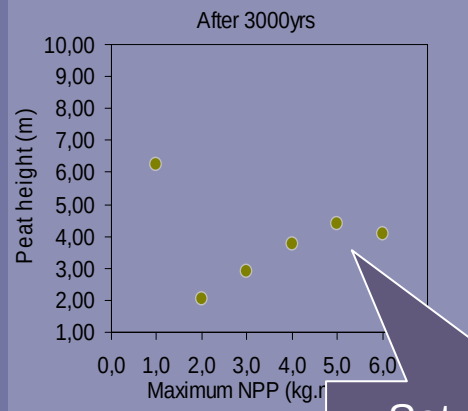


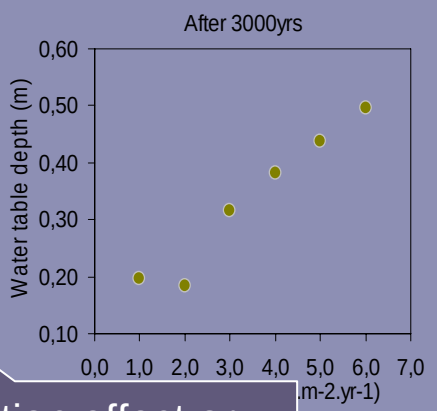



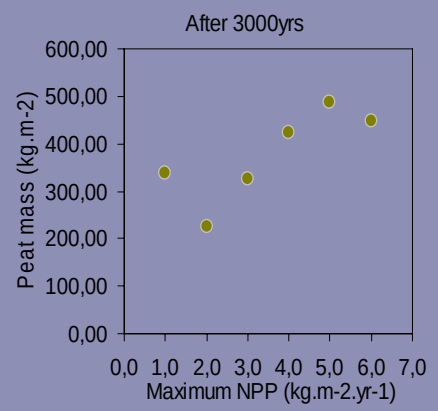



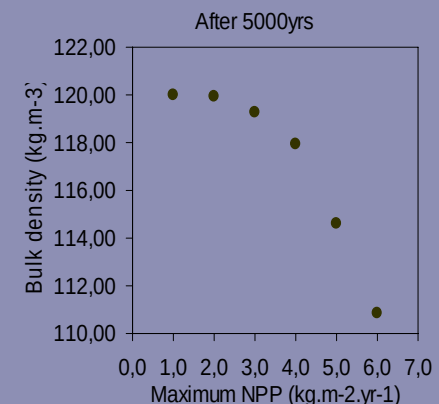



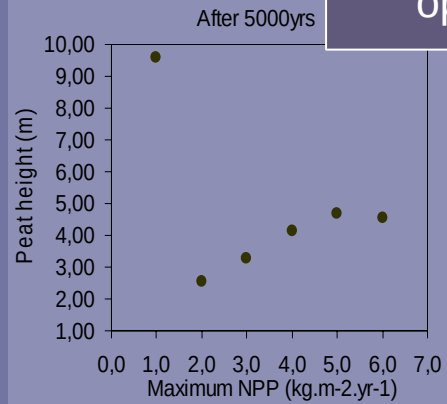



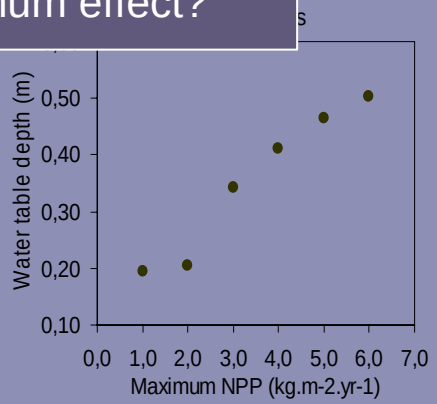



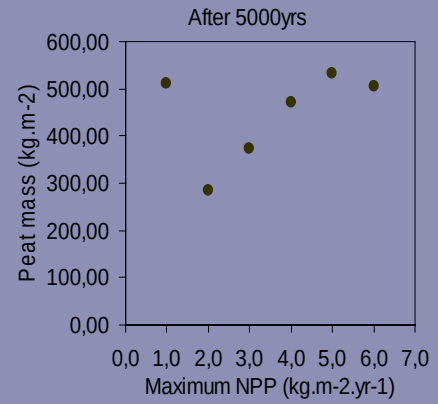




Saturation effect or optimum effect?

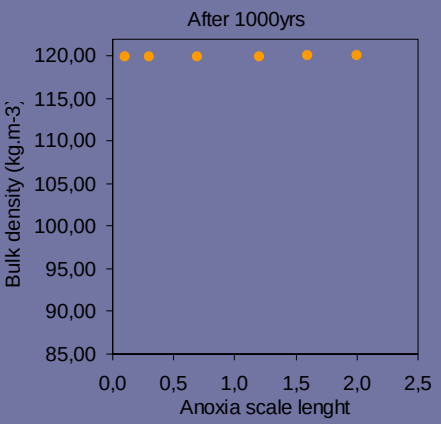


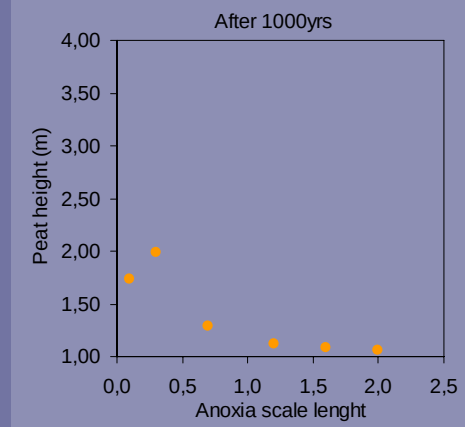



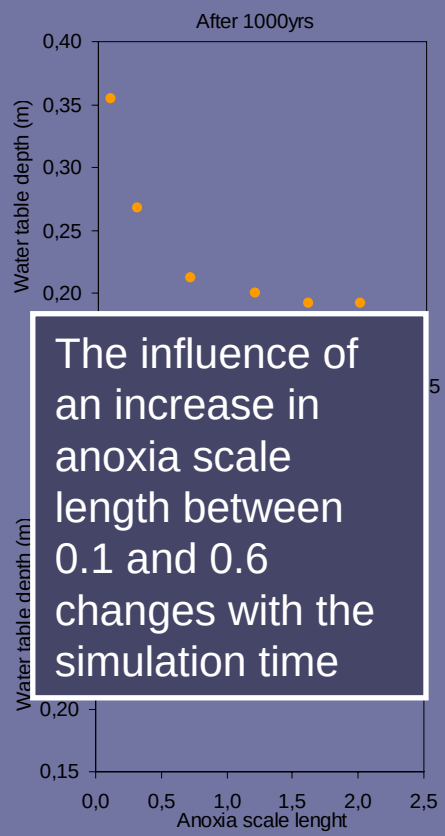



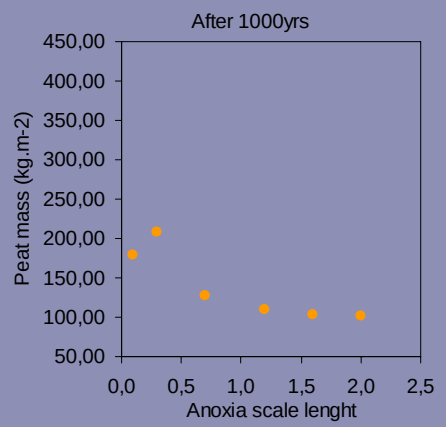



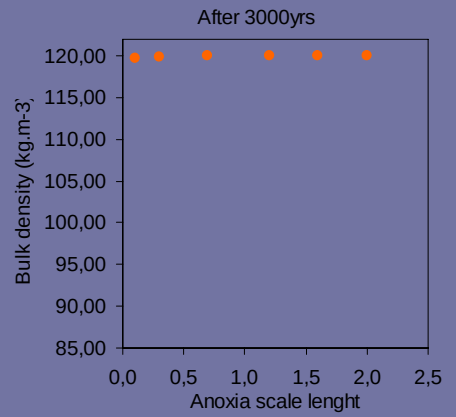
# Parameter: Anoxia scale length

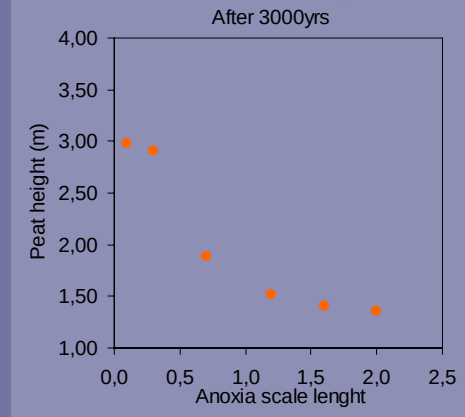


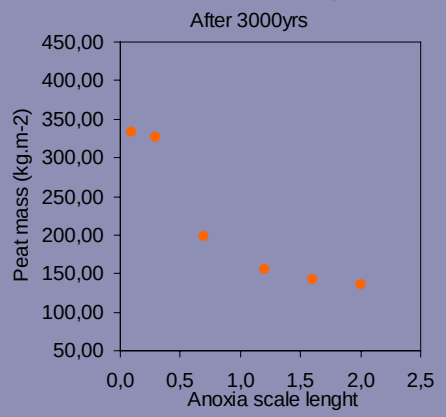



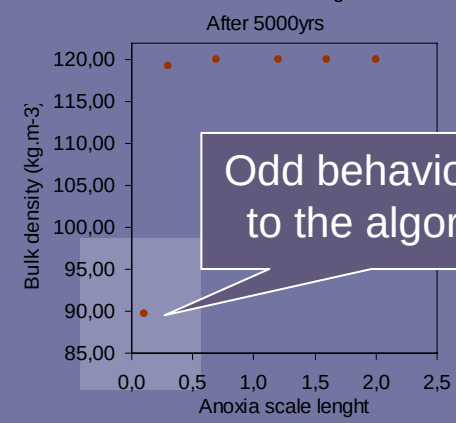



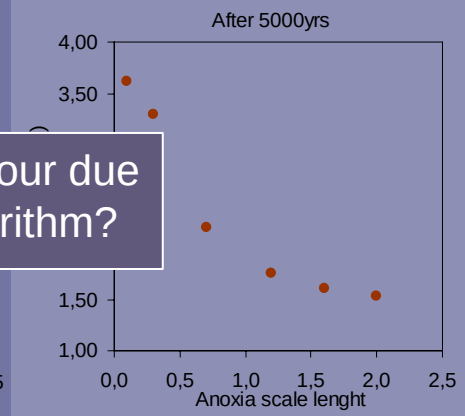



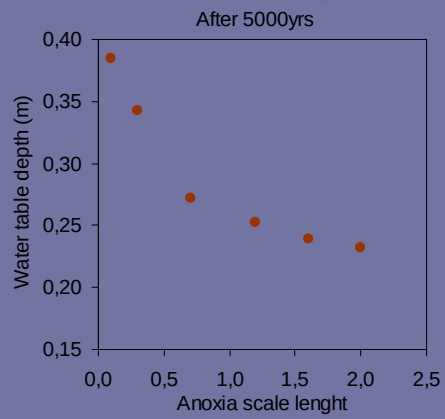



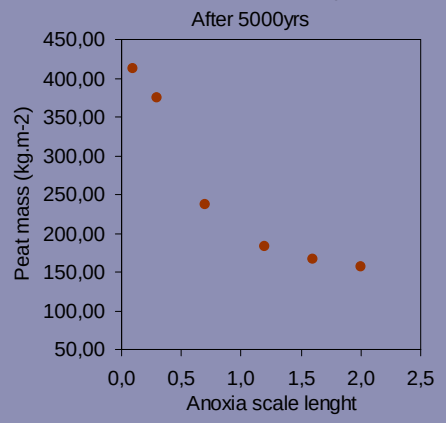



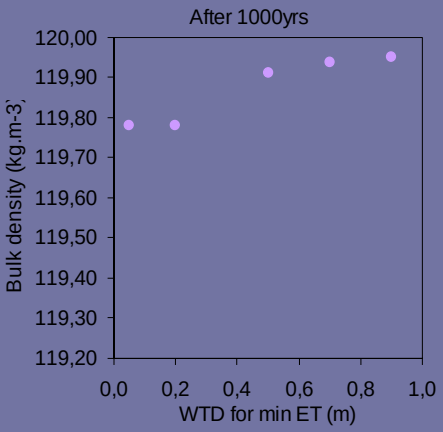



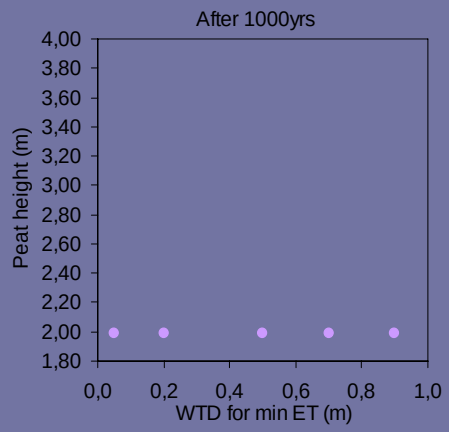



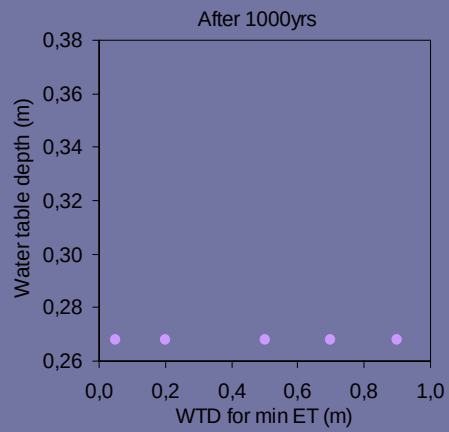

The influence of an increase in anoxia scale length between 0.1 and 0.6 changes with the simulation time

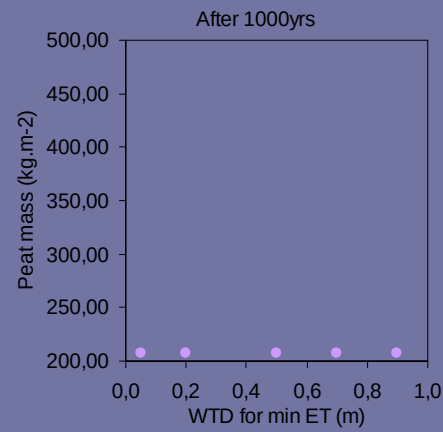
Odd behaviour due to the algorithm?

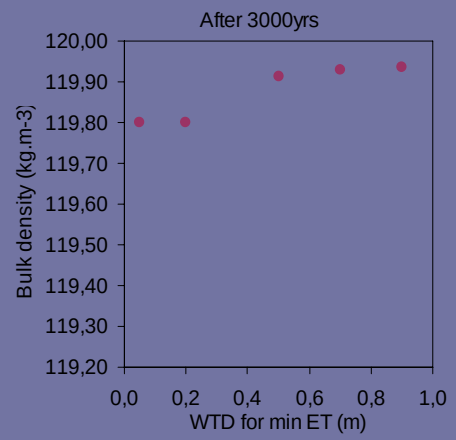
# Parameter: Water table level for min ET

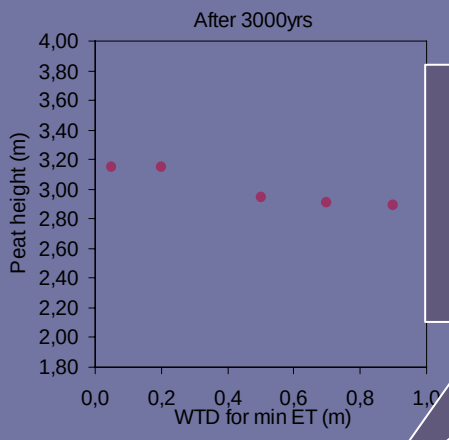


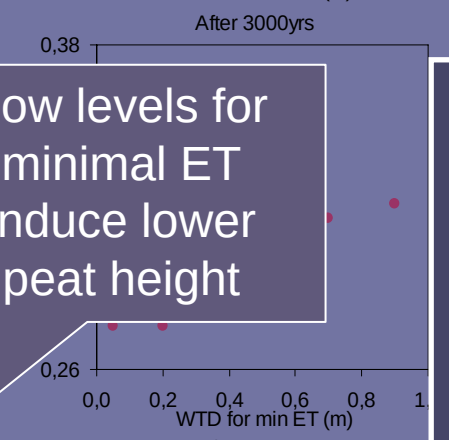



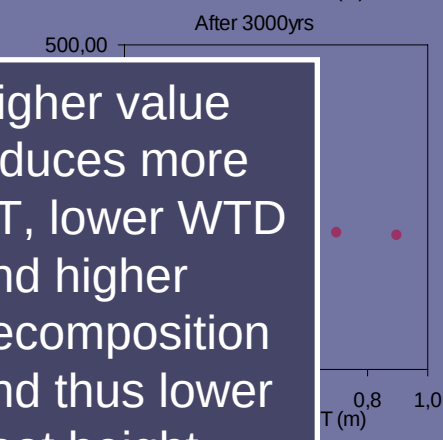



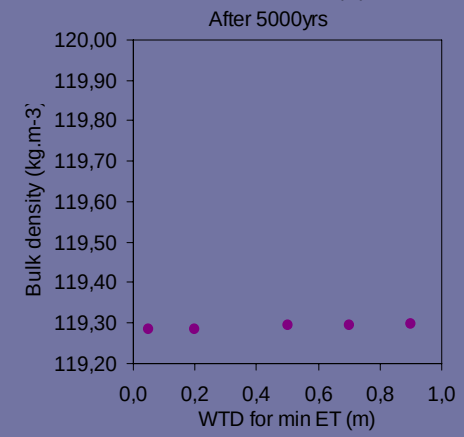



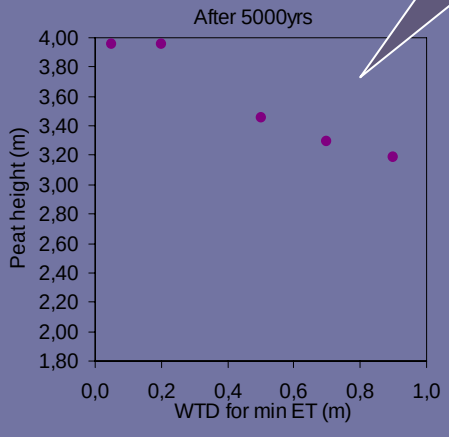



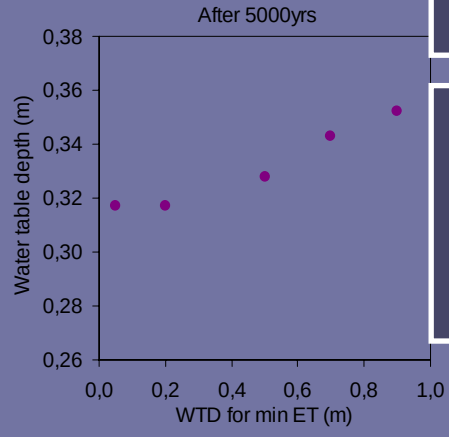



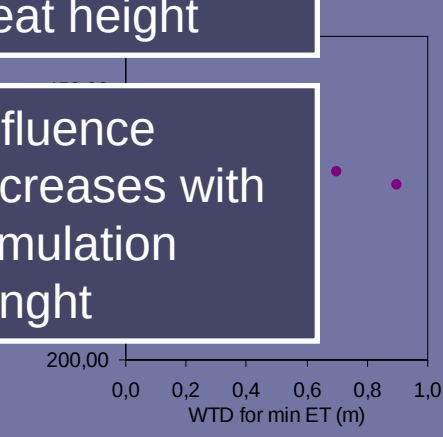



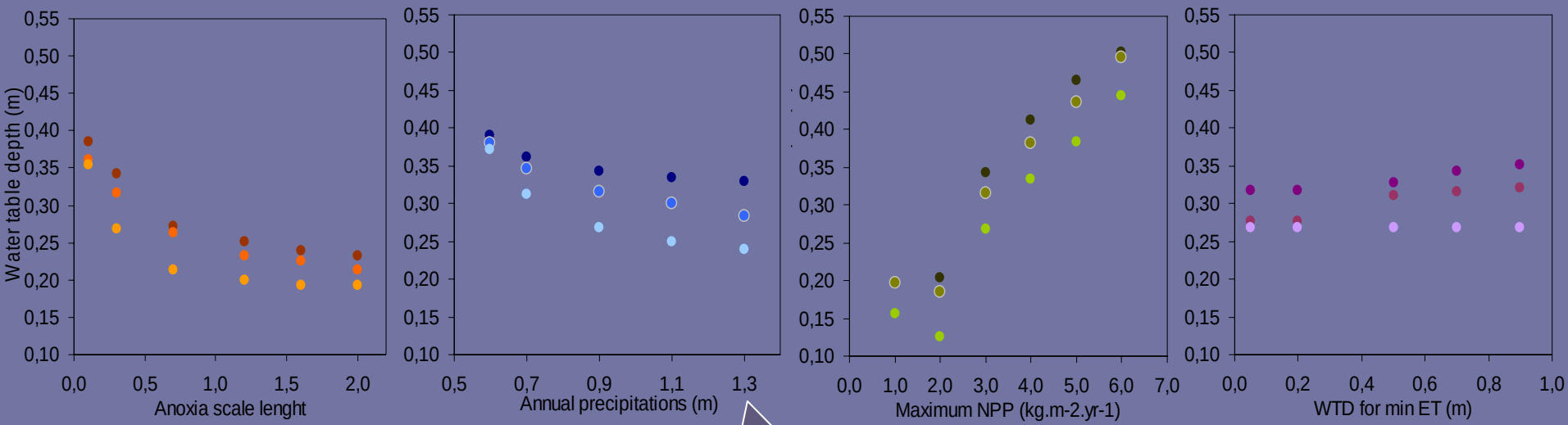




Low levels for minimal ET induce lower peat height

Higher value induces more ET, lower WTD and higher decomposition and thus lower peat height

Influence increases with simulation lenght

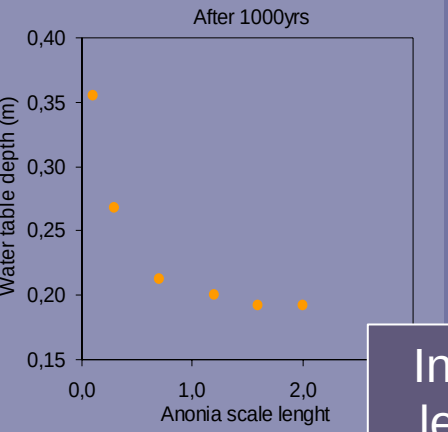
# Output: Influence on WTD

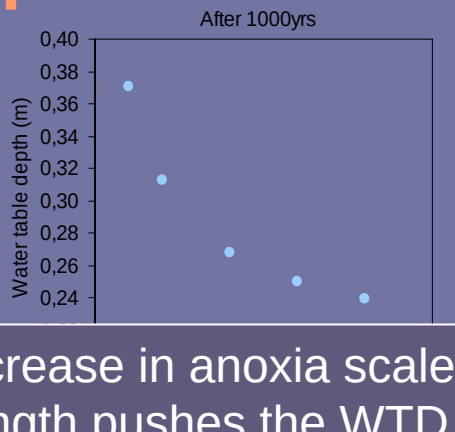


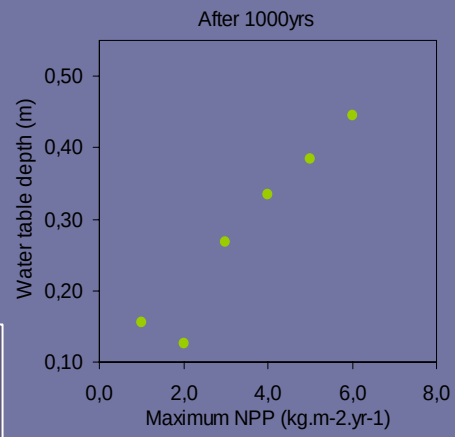

- Higher precipitations have a stronger impact on the WTD at 1000yrs than later
- Whereas low precipitations have always the same impact

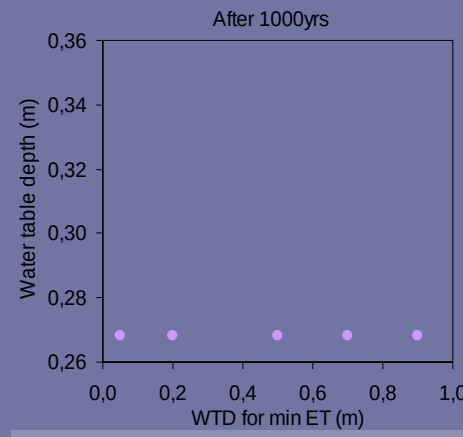
Light feedback effect of the min ET level on the WTD

# Output: Influence on WTD

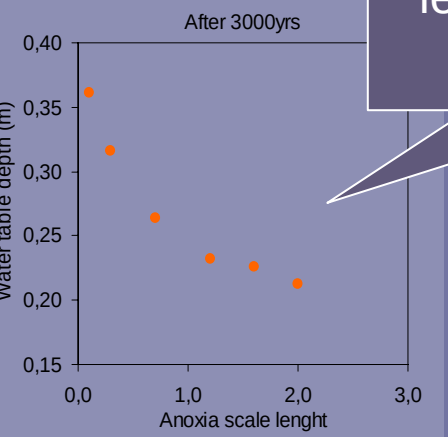


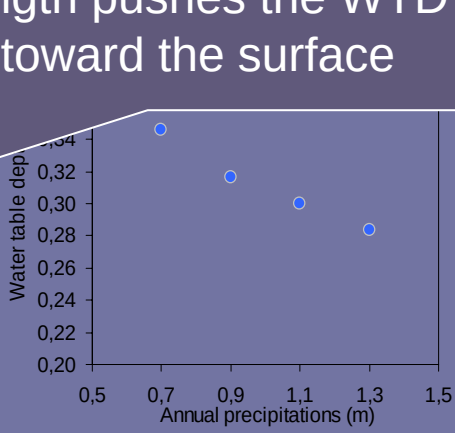



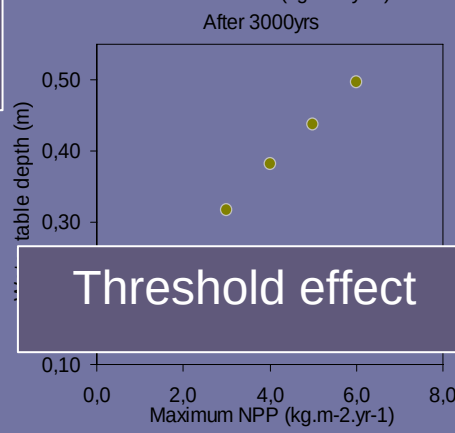



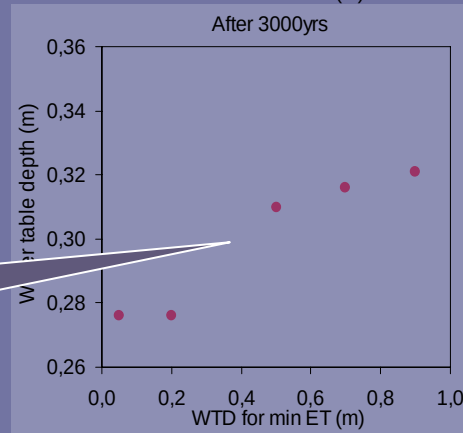

Increase in anoxia scale length pushes the WTD toward the surface

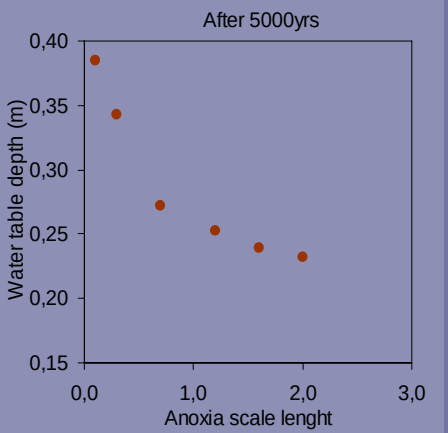


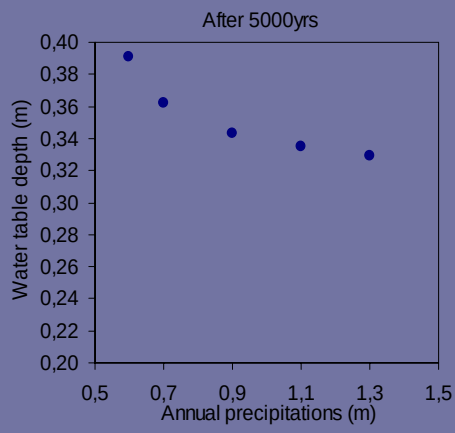



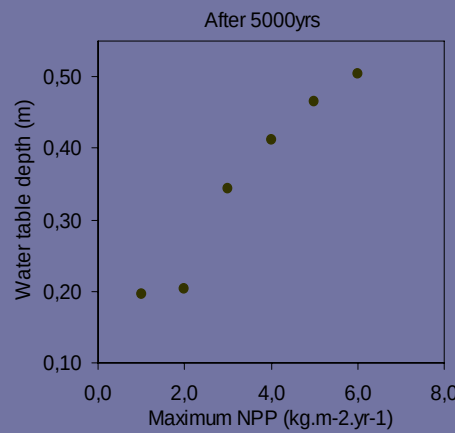



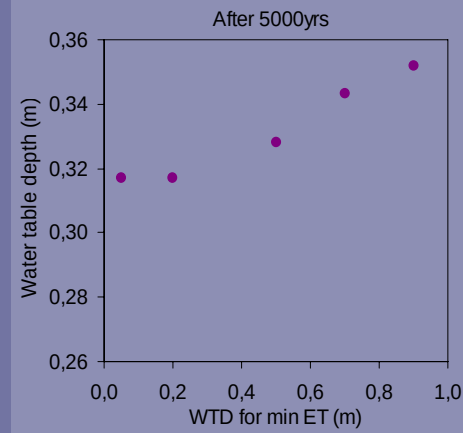

Threshold effect



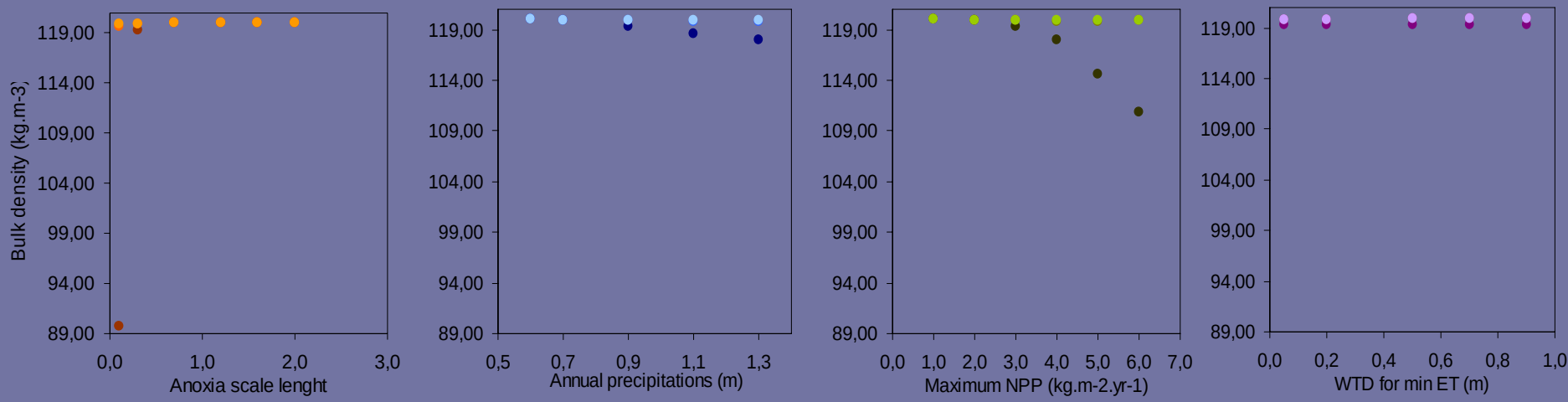



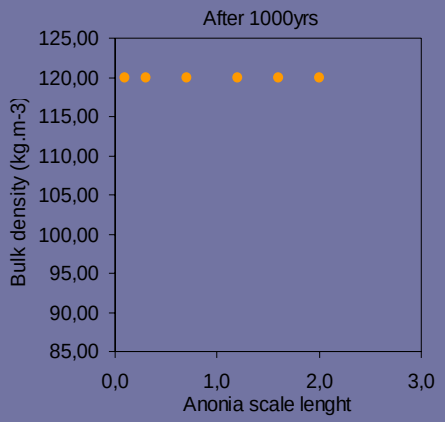



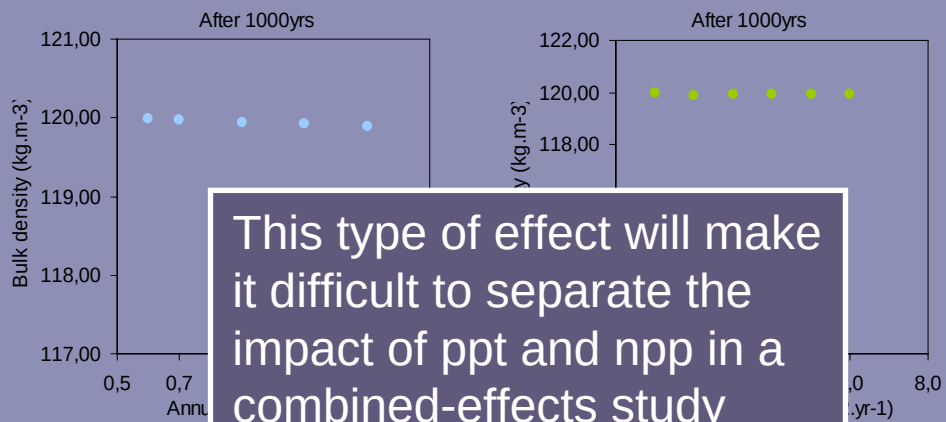



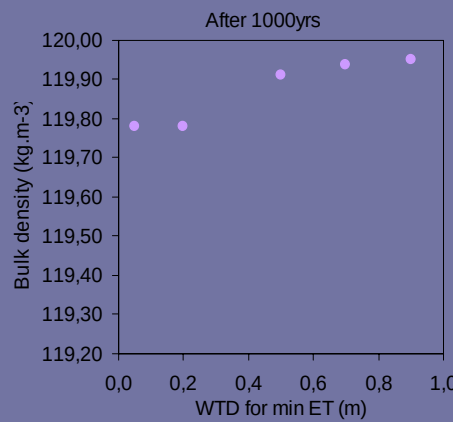
# Output: Influence on bulk density

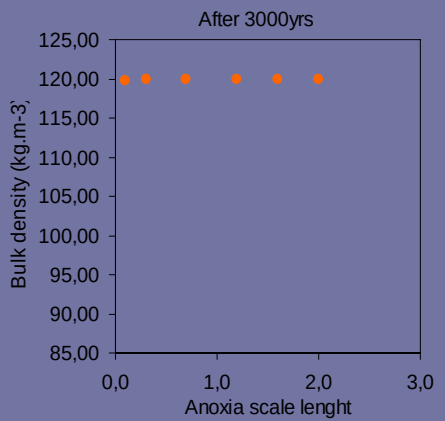


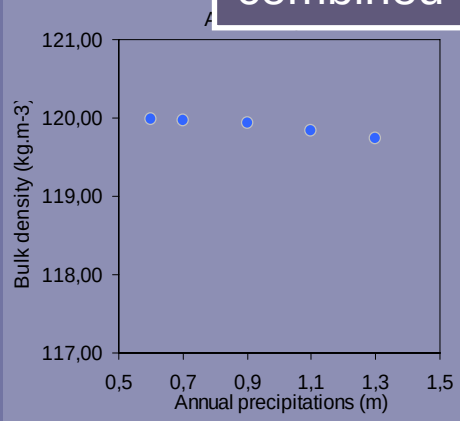
# Output: Influence on bulk density

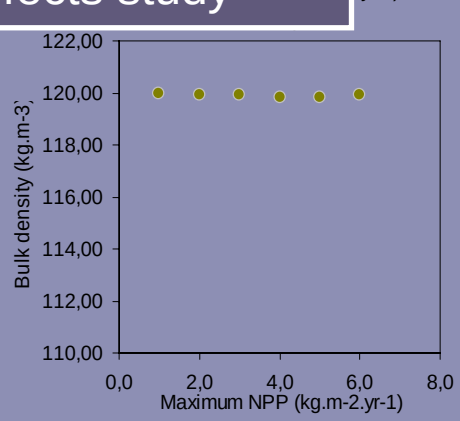


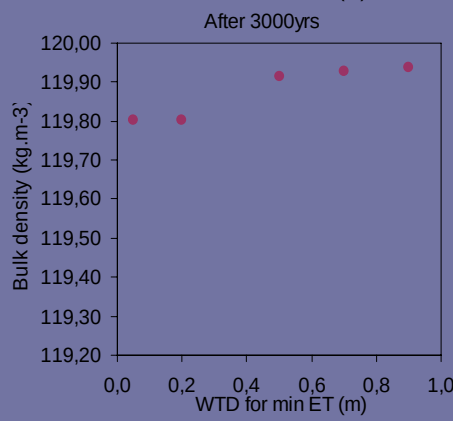



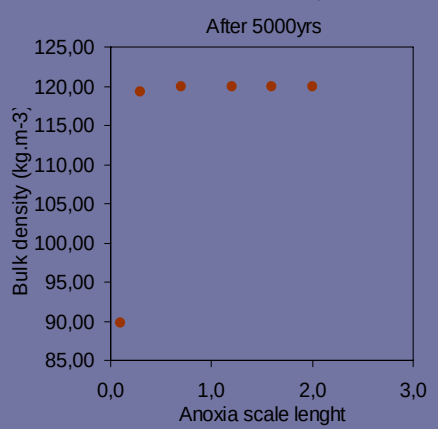



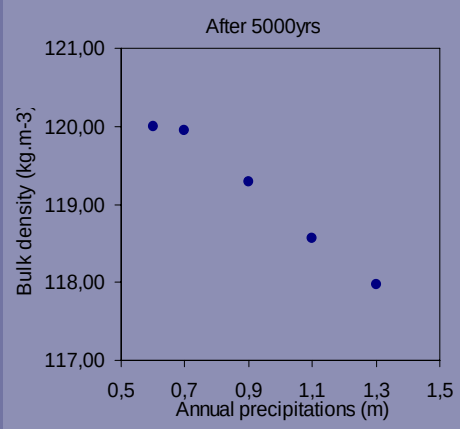



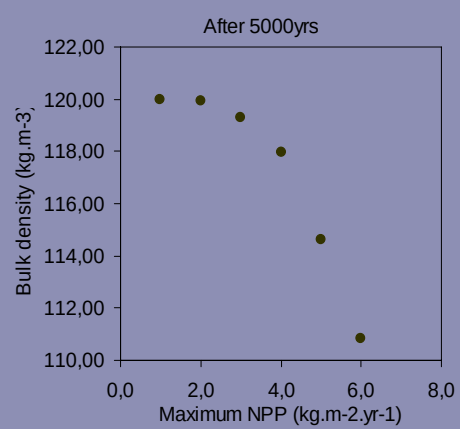



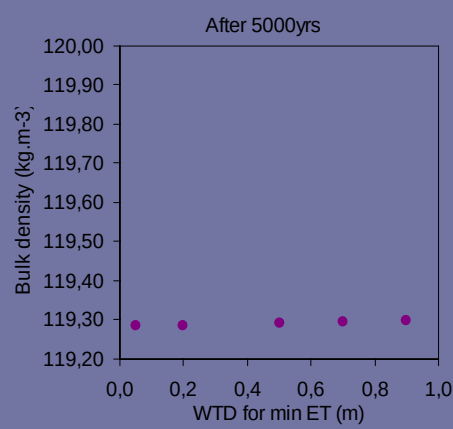



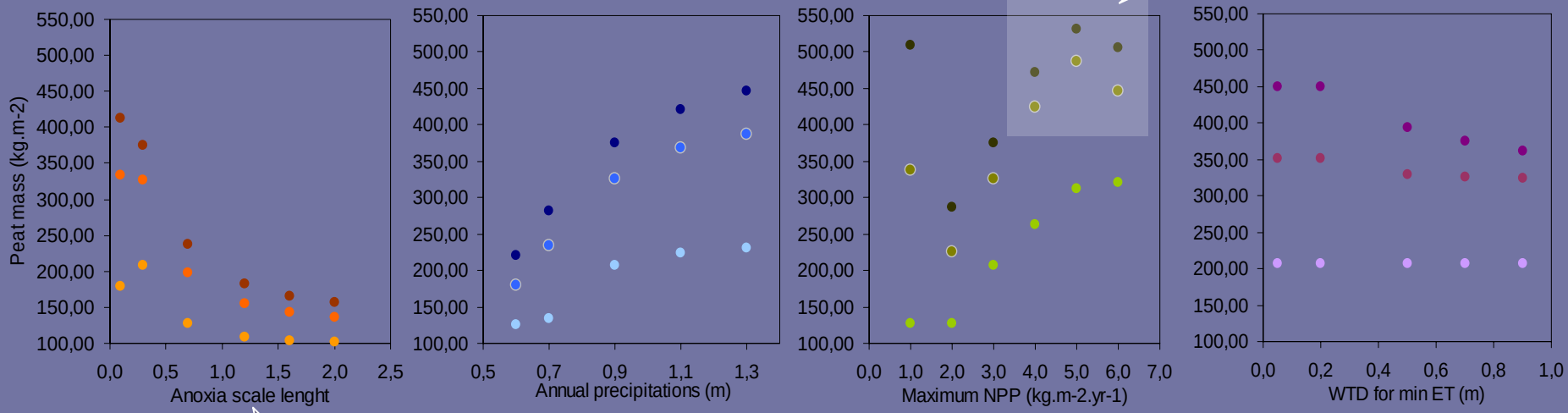




This type of effect will make it difficult to separate the impact of ppt and npp in a combined-effects study

# Output: Influence on peat mass




Optimum for long term simulations?

Lower anoxia scale length values increase peat mass : less decomposition

Changes in low ppt values have greater impact for the 3000yrs and 5000yrs simulations

# Conclusion

- NPP seems to have a great impact on the simulation results (both on WTD and on Peat height/mass).
- PPT seems to have an important influence on the results too.
- Both parameters (especially ppt) are difficult to determine with precision.
- It is important to investigate the impact of the parameters at different stages during the development of the peatland
- It raises more questions than it gives answers?
- For the moment, yes.
- Need to look further in the results to make sure the logic is maintained

# Next steps

- Quantify the impact of each parameter
- Integrate the combined effects of the parameters on the model outputs
- Use a variance-based technique
- Rank the parameters and the combination of parameter after their influence on the results