Modelling water level, sphagnum growth and peat accumulation in northern peatlands

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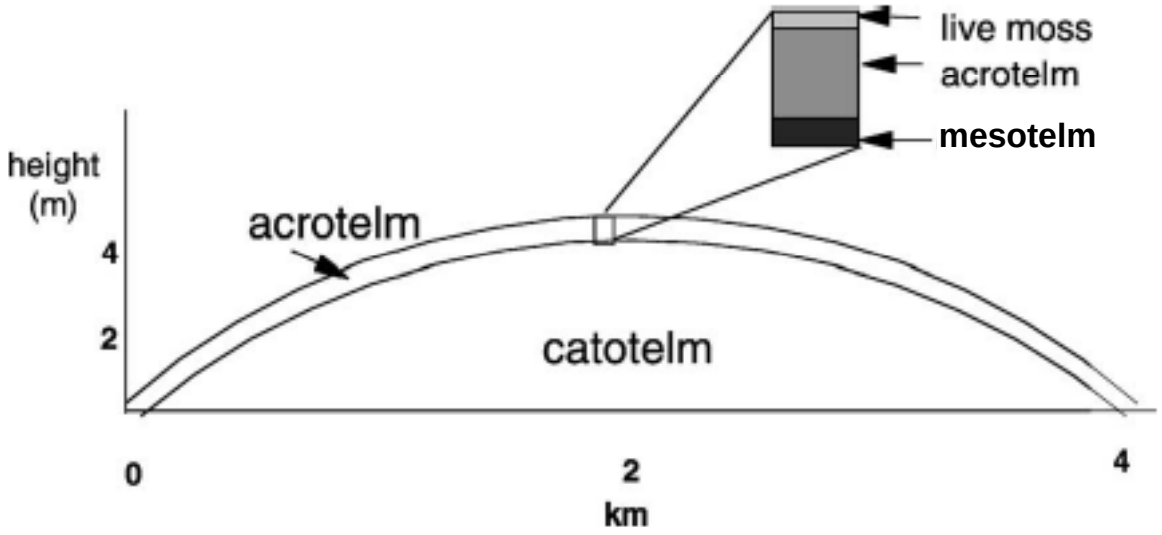
Peatlands

- Peat land/bog is a peat forming wetland lacking significant hydraulic inflows or outflows
- Northern peatlands are often dominated by sphagnum mosses
- Peatlands comprise about one-third of worlds total soil carbon (455 petagrams)
- Globally, it covers 400 Mha (3% of the world's land area)
- Peatlands in Europe occupy about 29 Mha

Conceptual structure of a peatland (Nungesser, 2003)



Objective(s) of the modelling study

- Enhance People and Landscape Model (PALM) by introducing processes of Peatland dynamics
- Adapt or modify CENTURY-based SOC model
- Introduce water-table dynamics
- Introduce sphagnum vegetation module

Methodology

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- A brief review of the existing peatland models (e.g: Clymo, 1992; Yu2001; Nungesser, 2001; Smith et al.,2007, …)
- Select a suitable model/processes
- Introduce the relevant processes into PALM model

Hollow-Hummock model(Nungesser, 2003)

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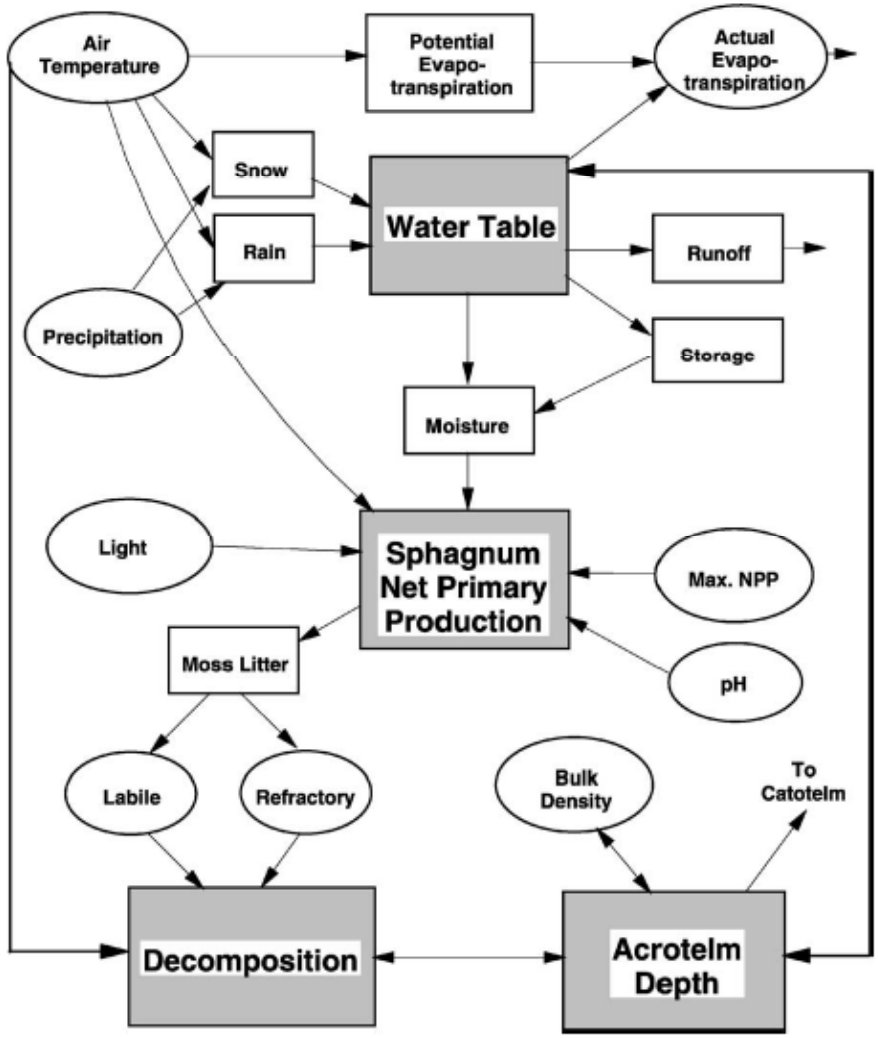
Three sub-models:

1. Hydrology
2. Sphagnum growth
3. Peat accumulation



Inputs

- Temperature, precipitation
- Elevation
- Initial WT above an arbitrary datum
- Hydraulic gradient
- bulk density of peat layers
- volumetric water content of the peat
- Initial depths of each peat layers

Hydrology model

WT is measured in two ways:

1. Absolute WT level (+ve always) above an arbitrary datum
2. WT depth relative to the surface of the peat (can be +ve or -ve)

WT depth relative = Absolute WT depth-Peat body

Peat body = acrotelm depth – Cum. Av. WTdepth change

Net water flow (cm /day)=

[Rain+ Snow melt-AET-OverlandFlow-seepage-(dPeat* (total porosity-effective porosity)]

WT depth adjustment

1. WT above the peat surface:

   WTadj = net flow

2. WT is below peat surface and added water keeps the WT still below the peat surface:

   WTadj: = net flow*eff. porosity

3. WT is below peat surface and added water raises the WT above the peat surface:

   WTadj: = (Rel. WT* eff. porosity)+ (net flow-Rel.WT)

4. WT is above peat surface and added water causes the WT to fall below the peat surface:

   WTadj: = (net flow + Rel.WT)*eff.prorosity -Rel. WT

Sphagnum growth model (Nungesser, 2003)

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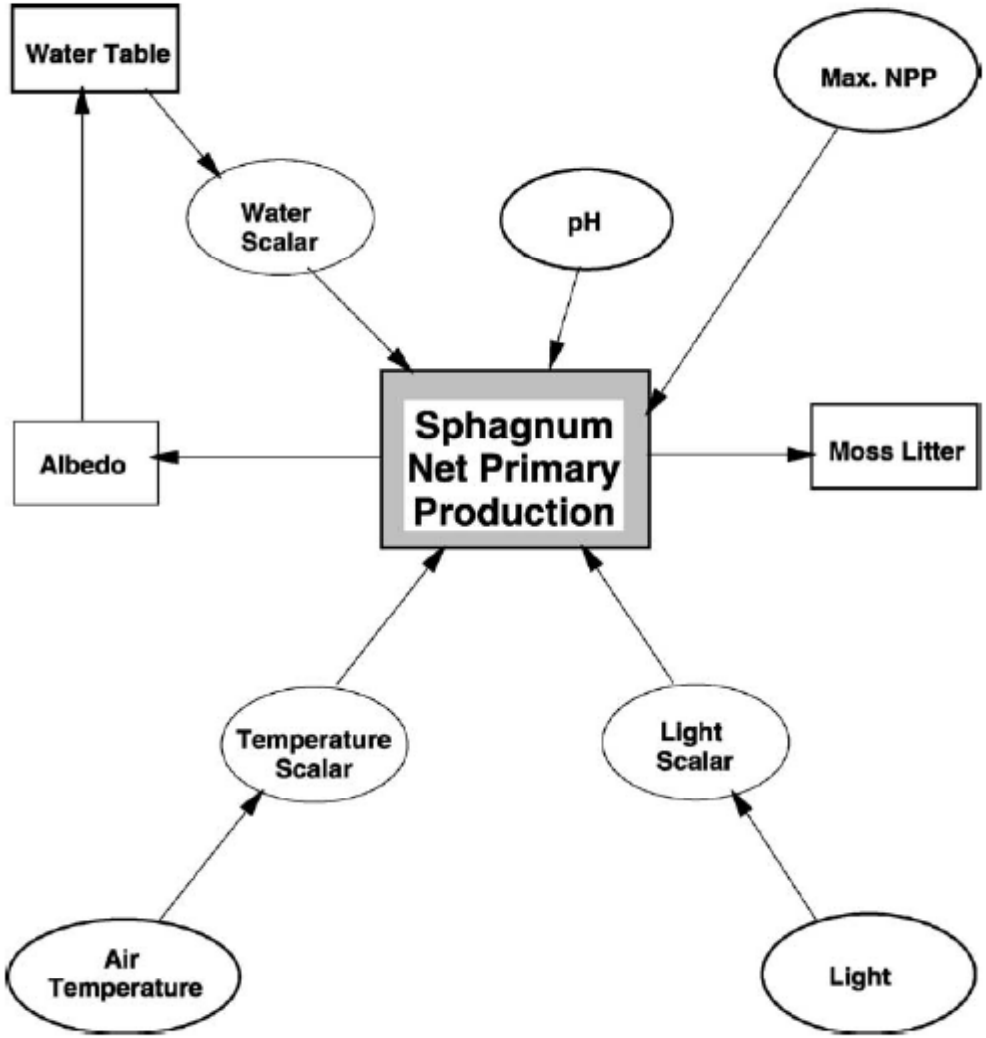
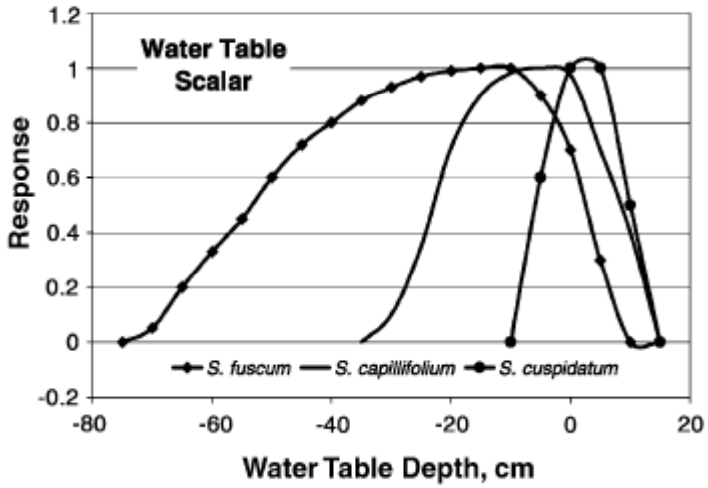
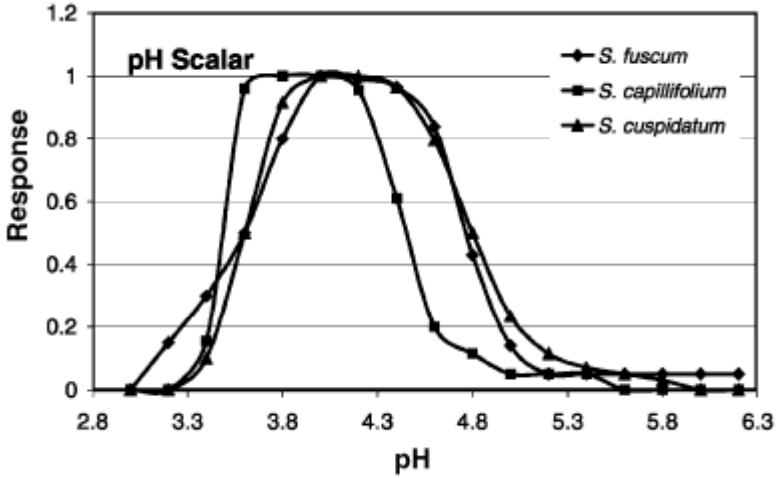
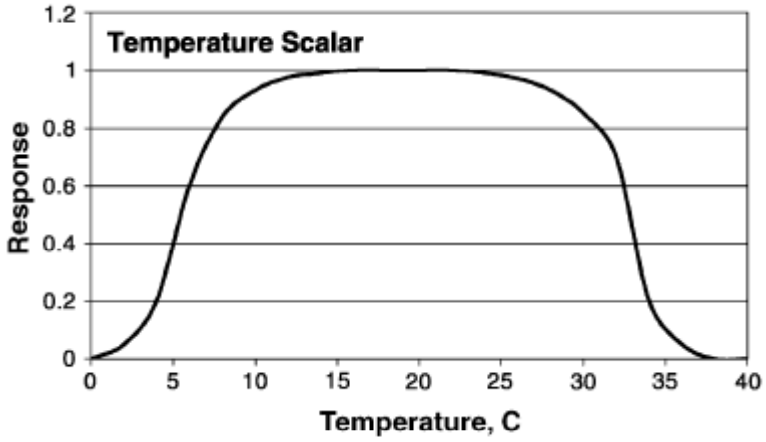
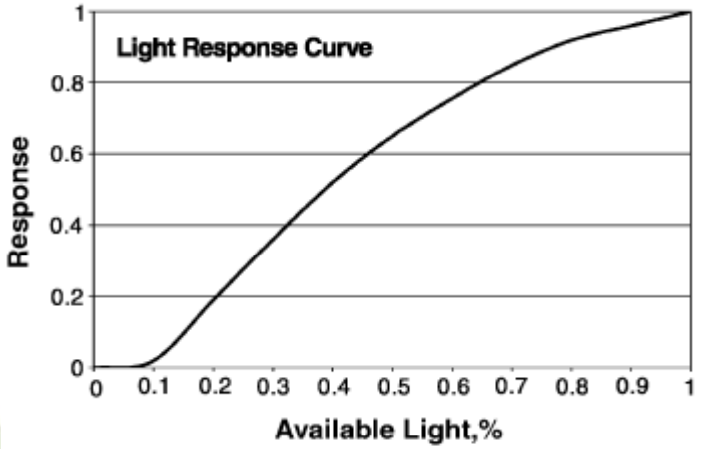


Water, temperature, pH and light response









Peat accumulation model (Nungesser, 2003)

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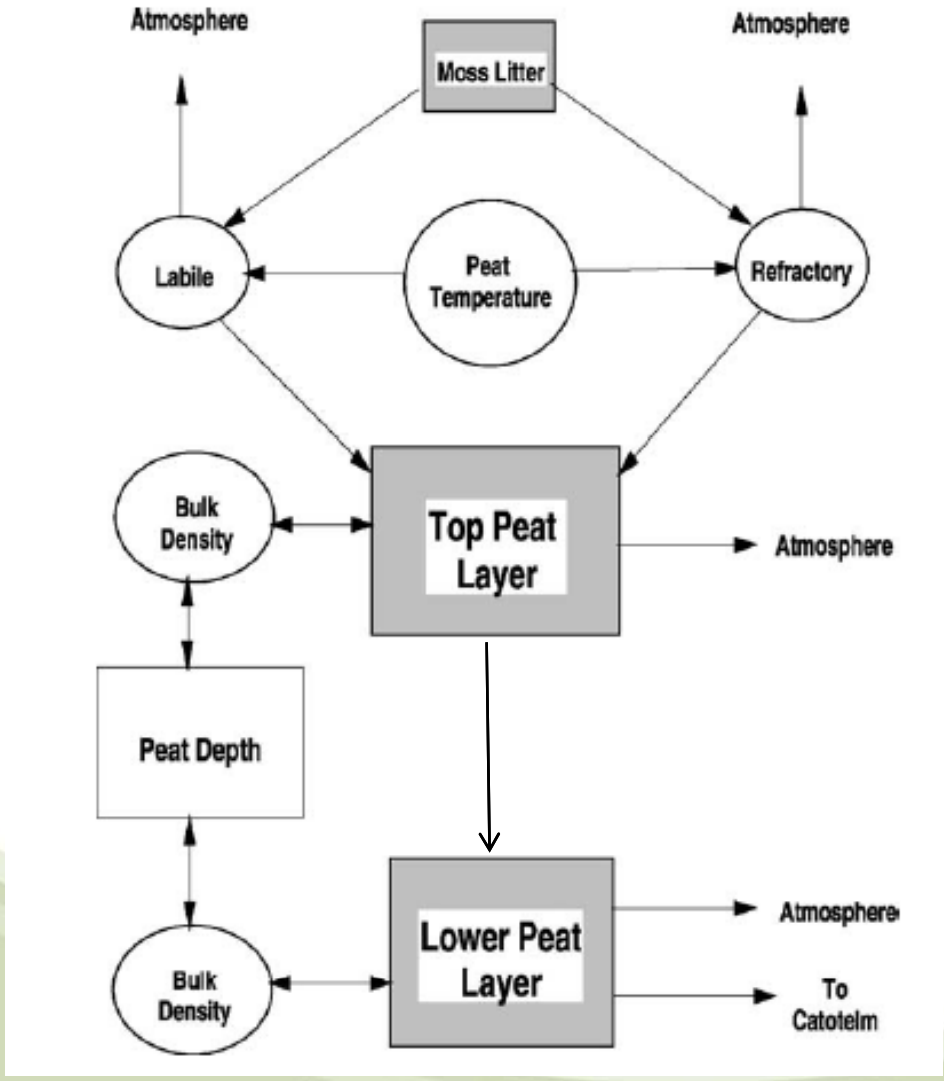
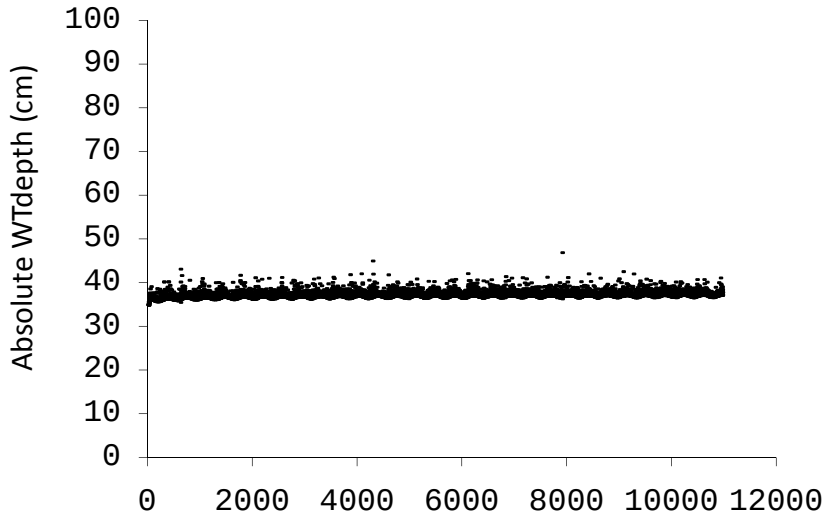
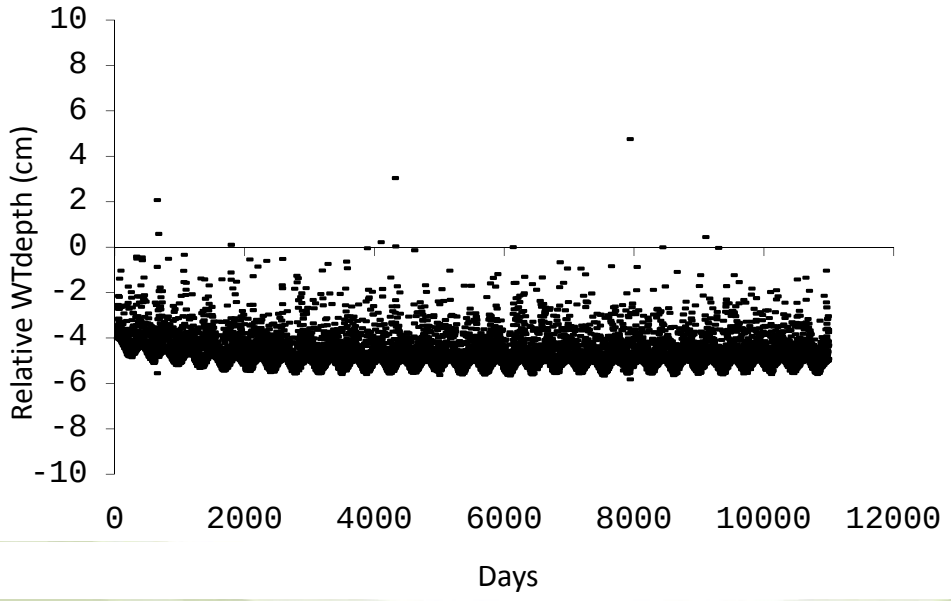


Model results





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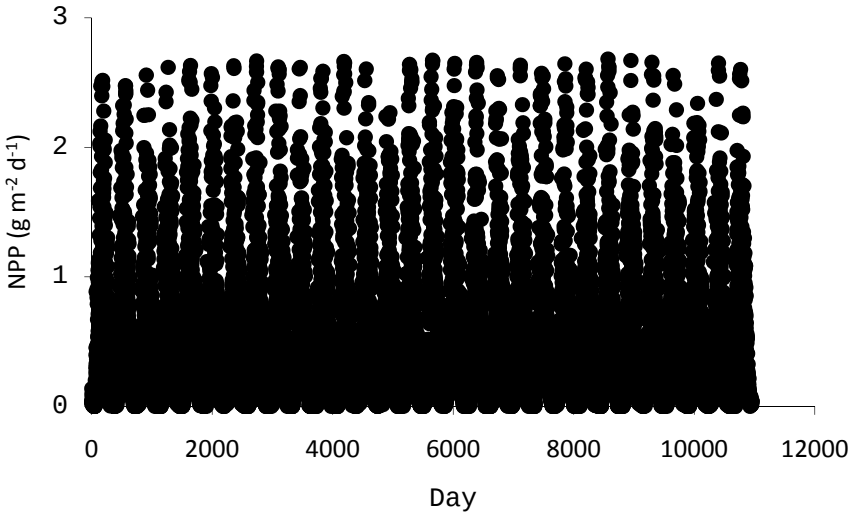

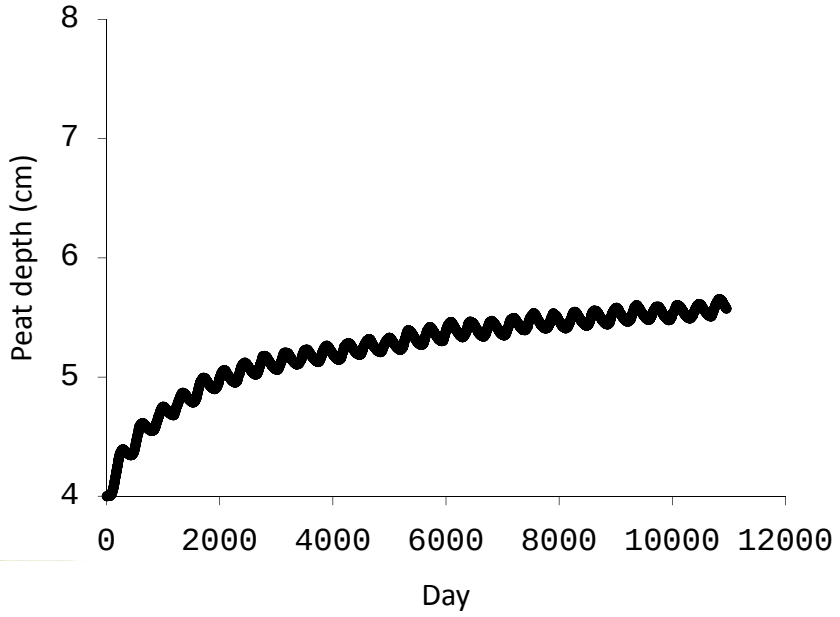

Way forward-Challenges

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- Lack of data to calibrate and test the model
- Incompatibility of the pool and/peat layer structure of the models
- Introducing WT dynamics into the PALM model