

Global Shocks and Disruptions to Scottish Peatlands – Diagnosing Carbon-Water interactions and feedbacks.

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Hydro Nation Scholars Programme



Scottish Funding Council
Comhairle Maoinneachaidh na h-Alba



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Introduction

Climate change is altering Scotland’s weather patterns and hydrology, challenging the country’s net-zero goals focused on peatland restoration. Current land use policies lack a clear assessment of hydrological risks associated with peatland restoration and climate change.

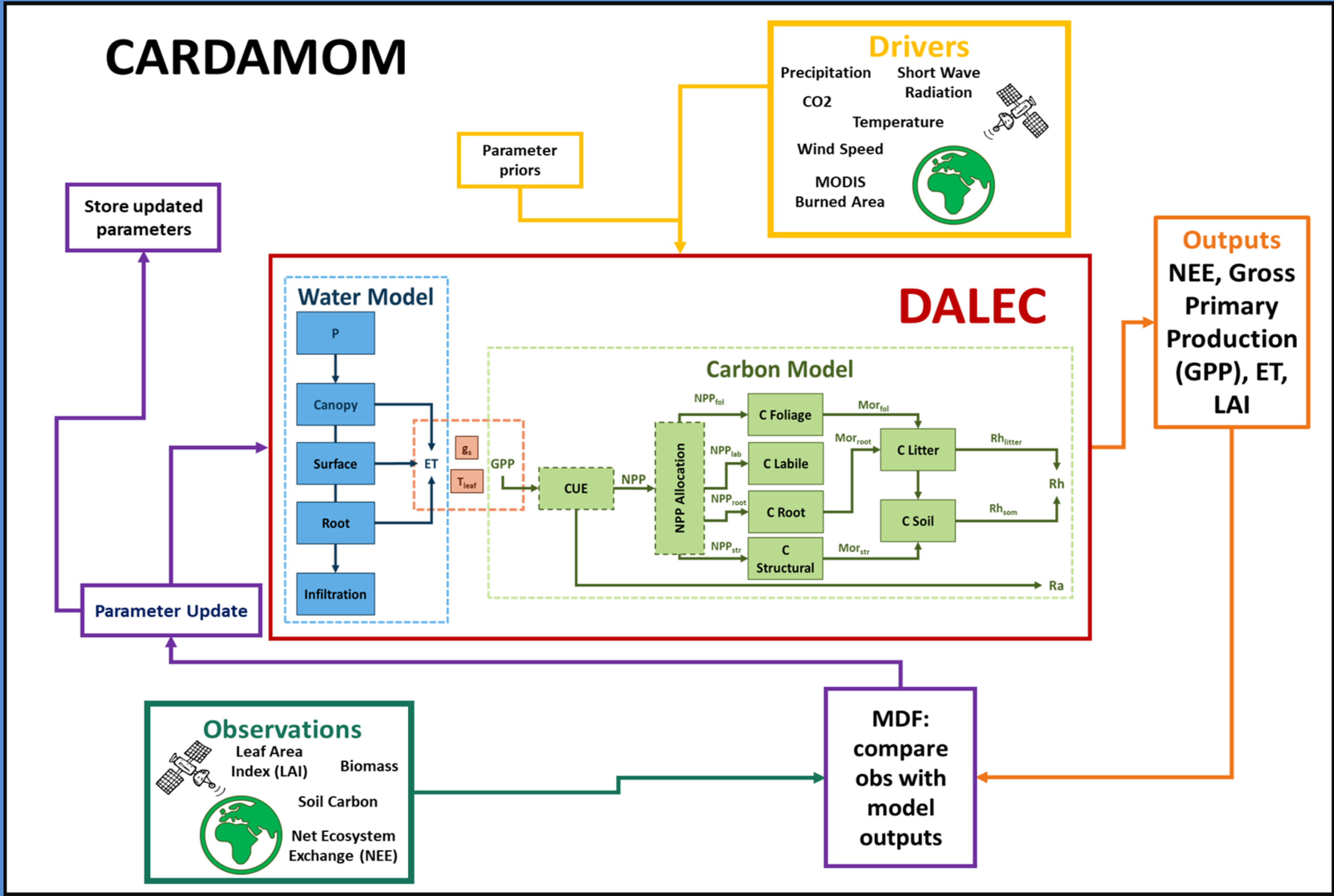
In response to these challenges, this project will address the following questions:

- How well can a model (DALEC) calibrated using remotely sensed data reproduce site-based estimations of C-exchange and water budgets?
- What key variables and data sources are essential for calibrating the updated model at site-level and to reduce model uncertainties?
- Does model complexity determines the capacity to capture C and Water interactions across Scottish peatlands?



EC Tower picture from Auchencorth Moss ICOS Station.

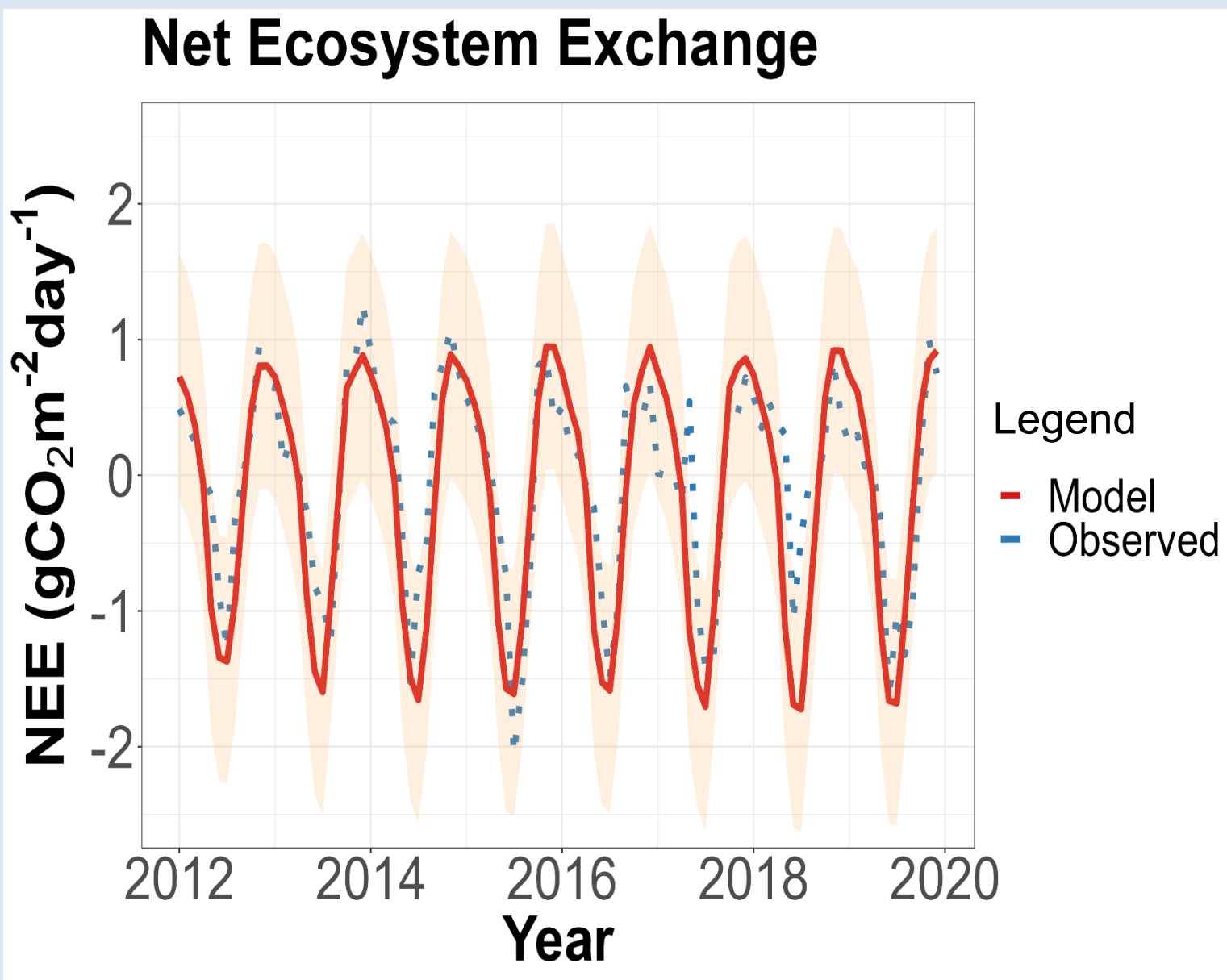
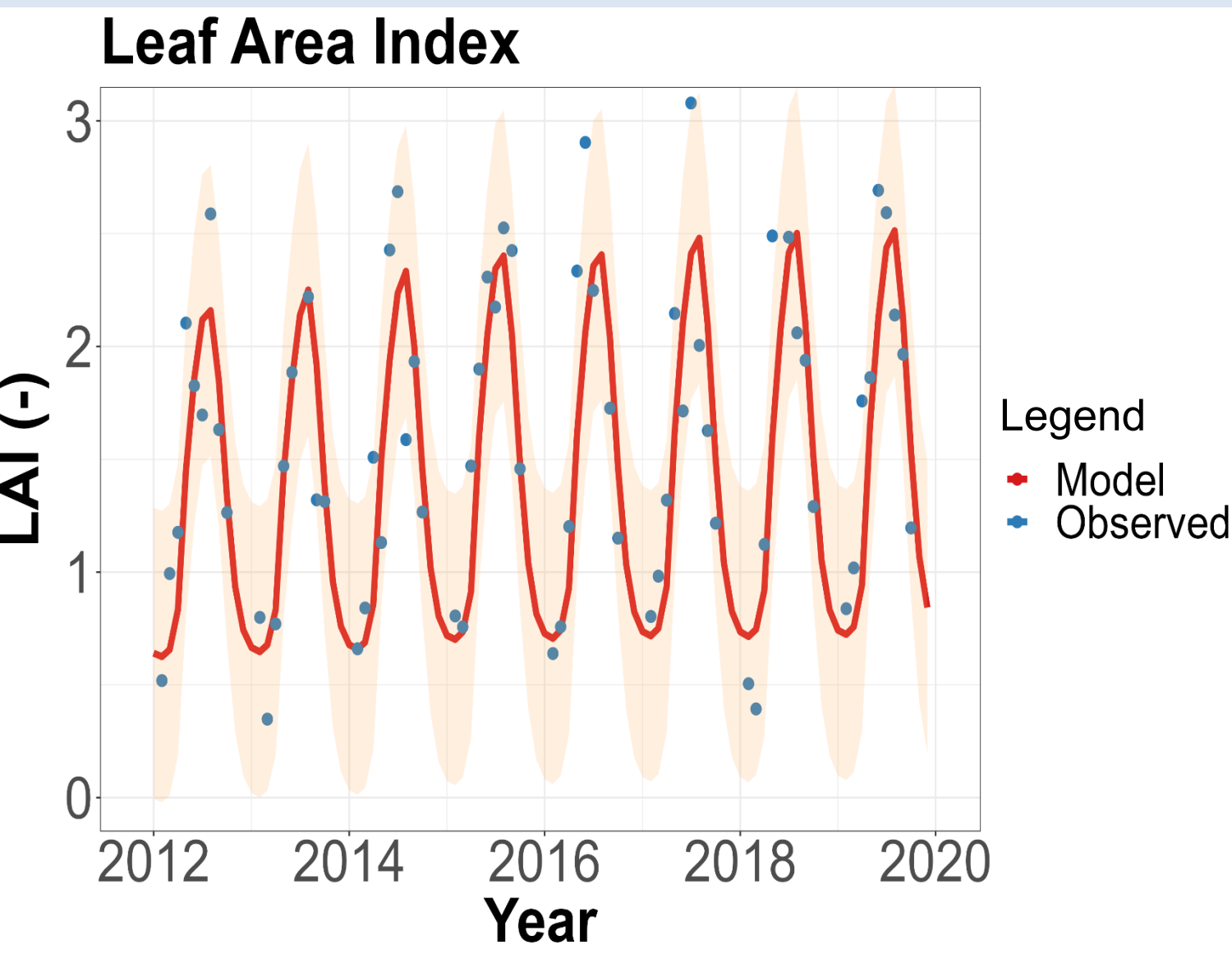
Methods



CARDAMOM Schematic for model (DALEC) calibration.

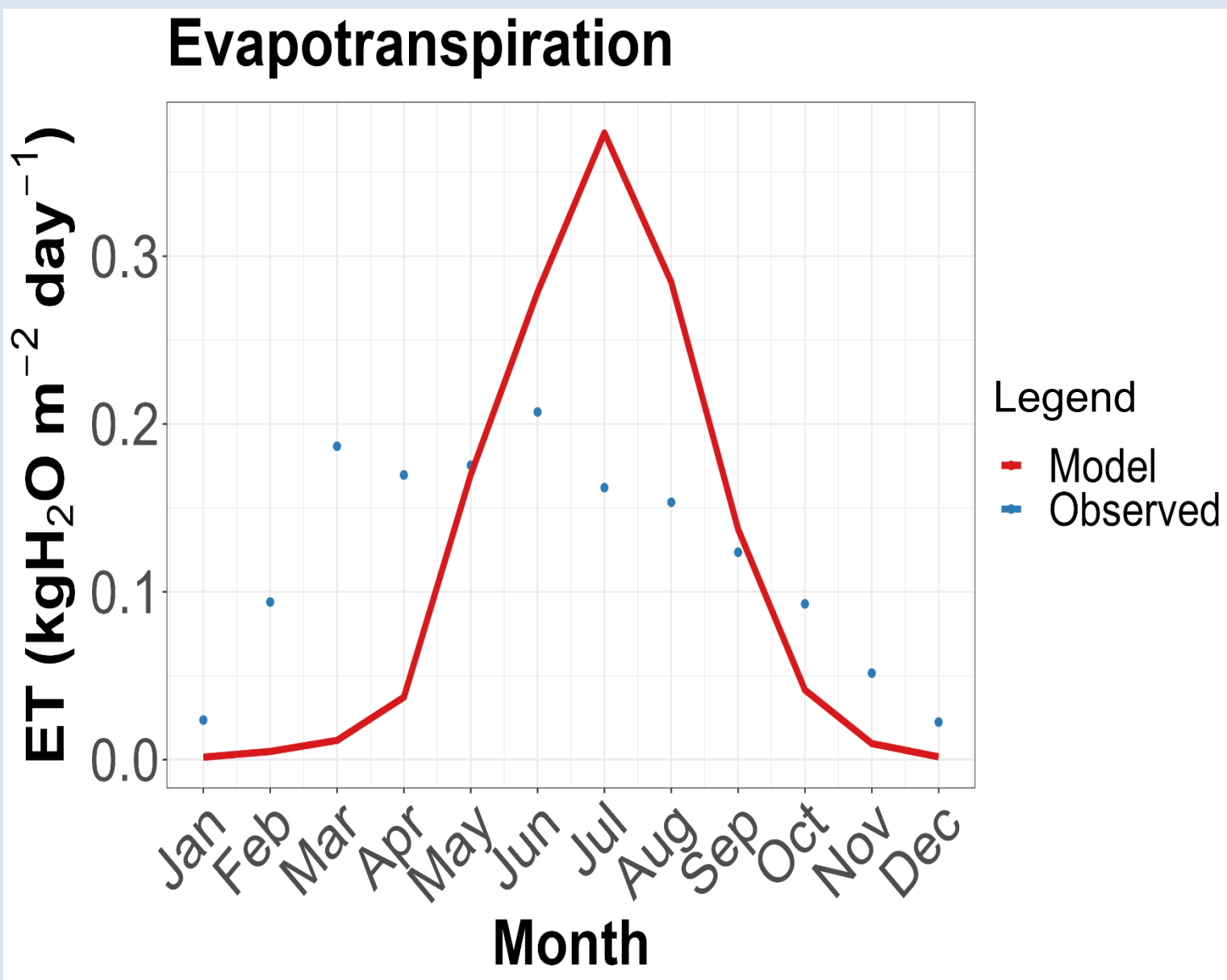
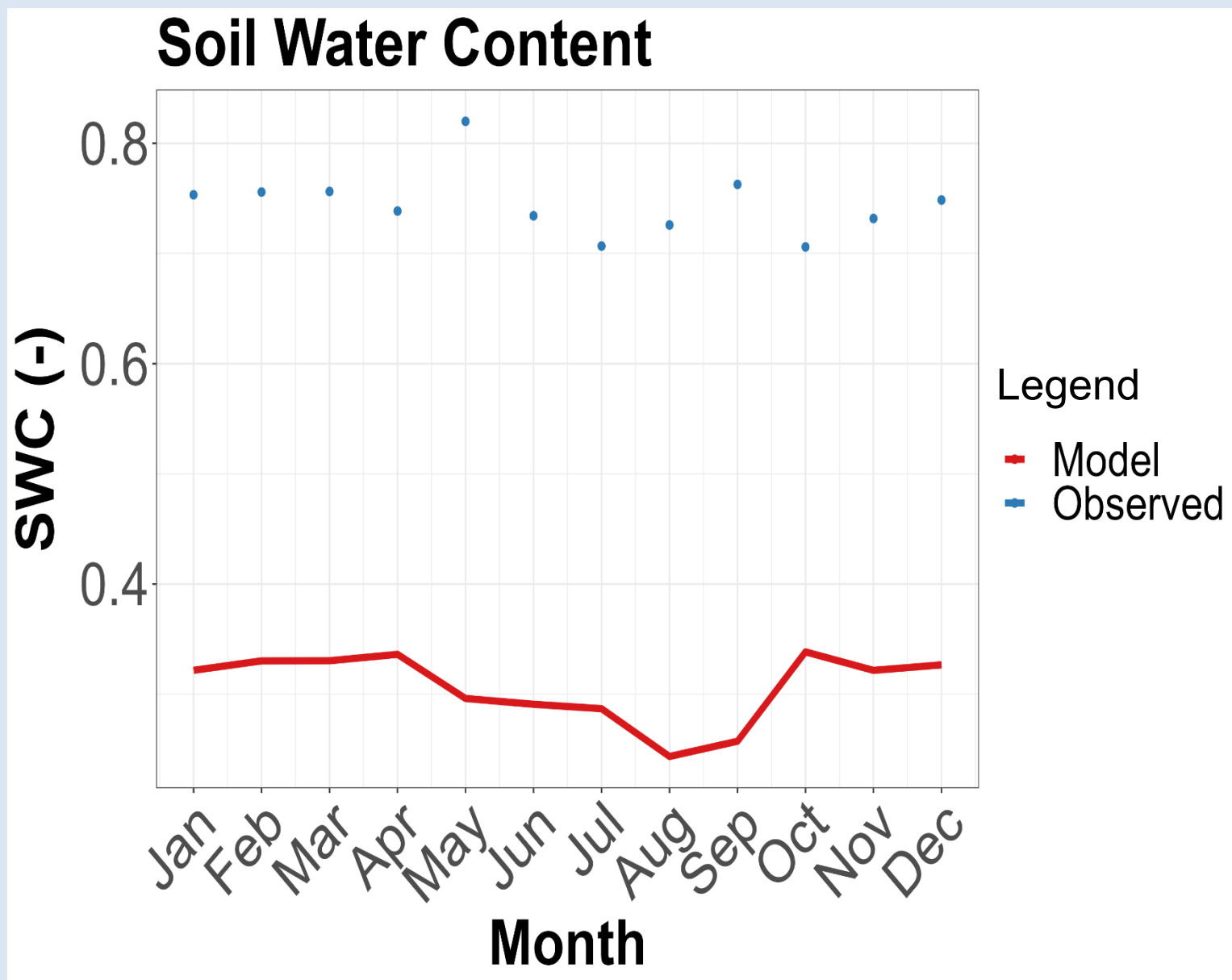
Previous Results

The model parameters were effectively calibrated to reproduced observed LAI

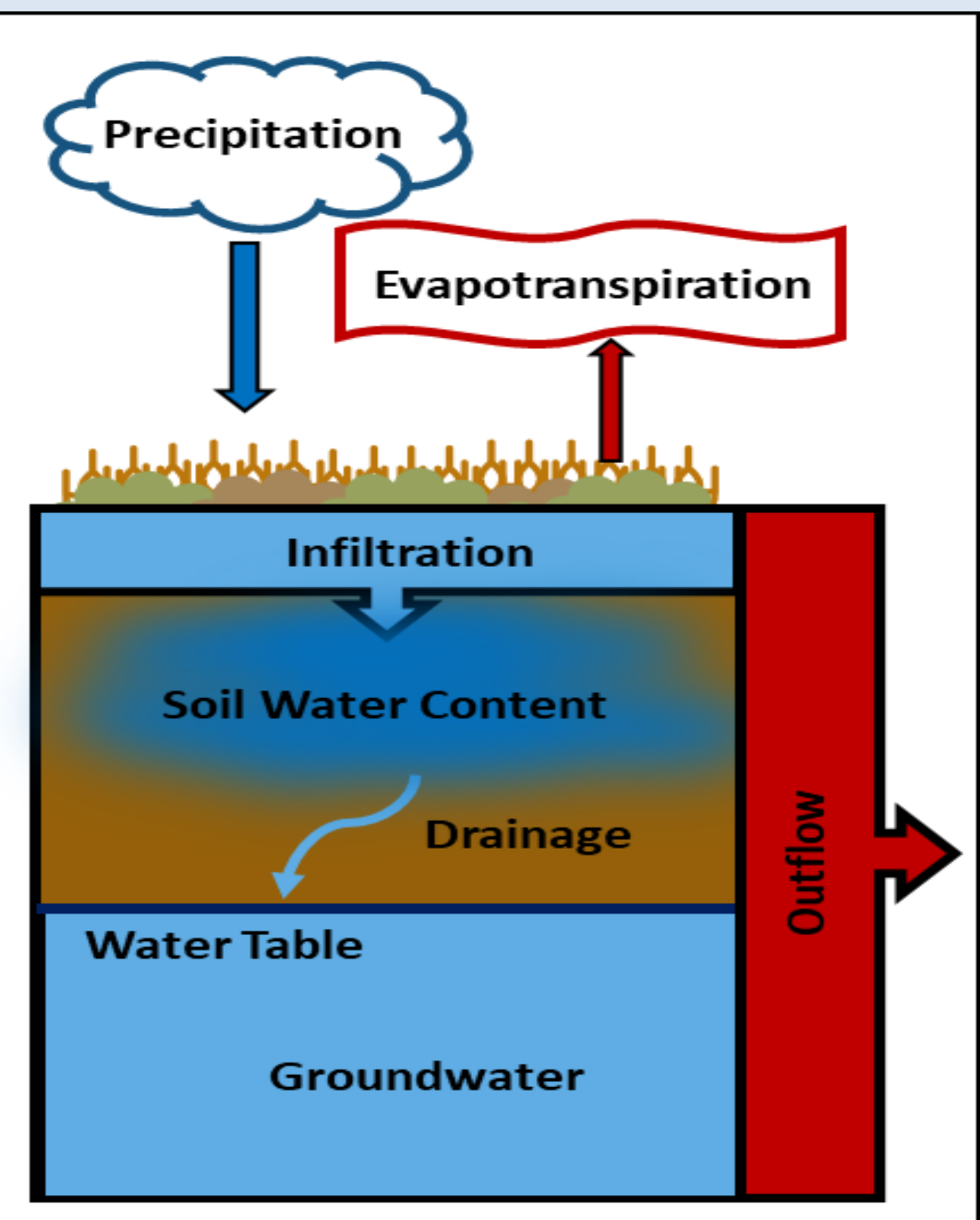


The model was able to reproduce independent estimates of Net Ecosystem CO2 Exchange.

The model is underperforming when it comes to reproduce independent water balance variables such as Soil Water Content and ET



Water Cycle and Soil Hydrology



Update Soil hydrology equations to the Van-Genuchten Model:

- Hydraulic Conductivity:

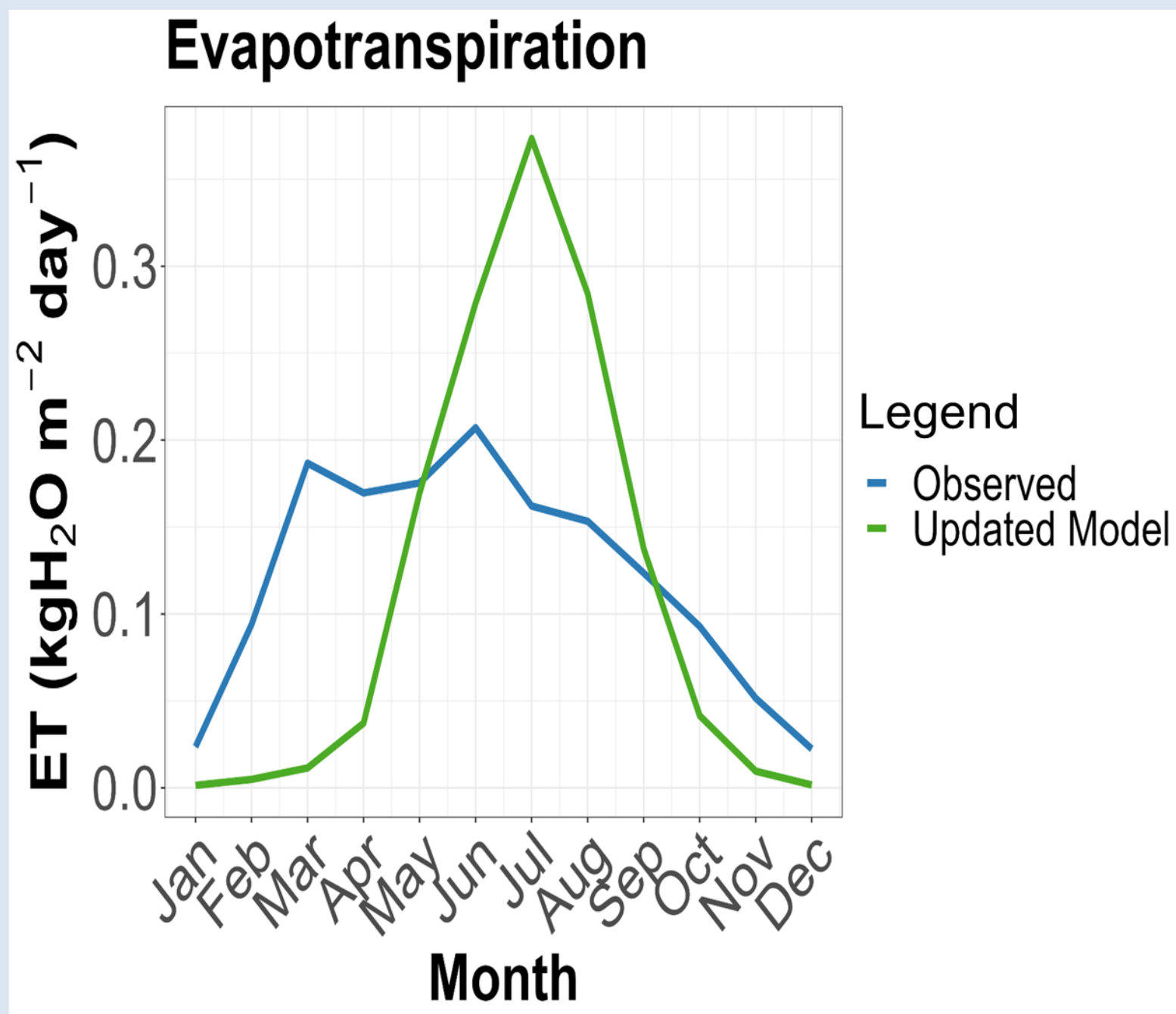
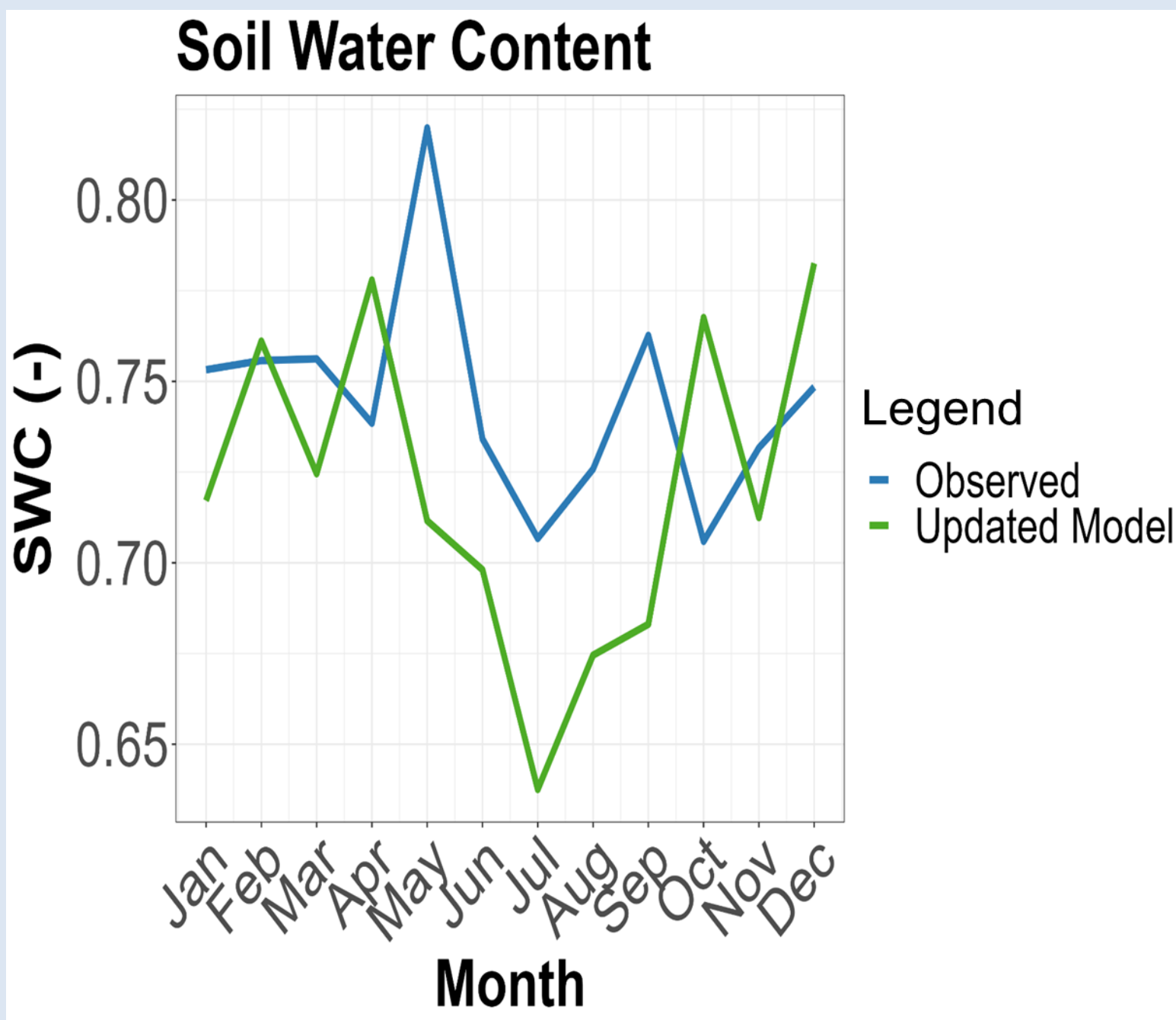
$$K(\theta) = K_s \sqrt{\theta_f} \left(1 - \left(1 - \theta_f^{\frac{1}{m}} \right)^m \right)^2$$

- Soil Water Potential

$$\psi(\theta) = -\frac{1}{\alpha} \left(\theta_f^{\frac{1}{m}} - 1 \right)^{\frac{1}{n}}$$

	K_{s-ref} ($m\ s^{-1}$)	n	α (m^{-1})	θ_s ($m^3\ m^{-3}$)	θ_r ($m^3\ m^{-3}$)
Coarse	1.23×10^{-5}	1.89	7.5	0.41	0.065
Medium	2.89×10^{-6}	1.56	3.6	0.43	0.078
Fine	7.22×10^{-7}	1.31	1.9	0.41	0.095
Peat	2.45×10^{-5}	1.38	5.07	0.90	0.15

Parameters from literature for the Van-Genuchten Eq.



- Initial Test of the Updated Model version using the Van-Genuchten Model to independent measurements shows a better reproduction of the Water Balance components when compared with previous results.
- Model development is ongoing to further improve the simulation of the Hydrological cycle and its coupling with the C cycle.

Next Steps

1. Incorporation of additional eddy covariance data from different peatland sites to use for independent testing of the model, as well as model “in-situ” inputs.
2. Conduct calibration and validation of the new model version at peatland sites and different scales.
3. Explore the impacts of different peatland degradation levels.
4. Exploration and development of different future scenarios for land use and climate forecast.

References

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[4] Morrison, R.; Cooper, H.M.; Artz, R.; Burden, A.; Callaghan, N.; Coyle, M.; Cumming, A.M.J.; Dixon, S.; Helfter, C.; Kaduk, J.; Levy, P.; McNamara, N.; Oakley, S.; Page, S.E.; Rayment, M.; Ridley, L.M.; Worrall, F.; Evans, C.D. (2021). <https://doi.org/10.5285/b8c9fd3d-f9ea-4fd8-9557-9022884f711d>

This work is being funded by the HydroNation Scholars Programme, hosted by the University of Edinburgh, under the supervision of Prof Mathew Williams (UoE), Prof Roxane Andersen (UHI), and Dr Luke Smallman (UoE). Eddy Covariance data is available through EIDC (<https://doi.org/10.1038/s41586-021-03523-1>).