Global Shocks and Disruptions to Scotland's Surface Waters – a systems-based scenario analysis of emerging pressures

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I. Introduction

Climate change is affecting Scotland's weather patterns and hydrology. The country has set ambitious net-zero goals, which include initiatives such as tree planting and peatland restoration to create carbon sinks. There is currently a challenge in balancing multiple objectives, including Net-Zero policies, Scotland's Biodiversity Strategy, agriculture, forestry, and the growth of the rural economy, all while understanding the hydrological impact of climate and land use changes. Current land use policies lack a clear assessment of hydrological risks associated with tree growth, food production, and peatland restoration.

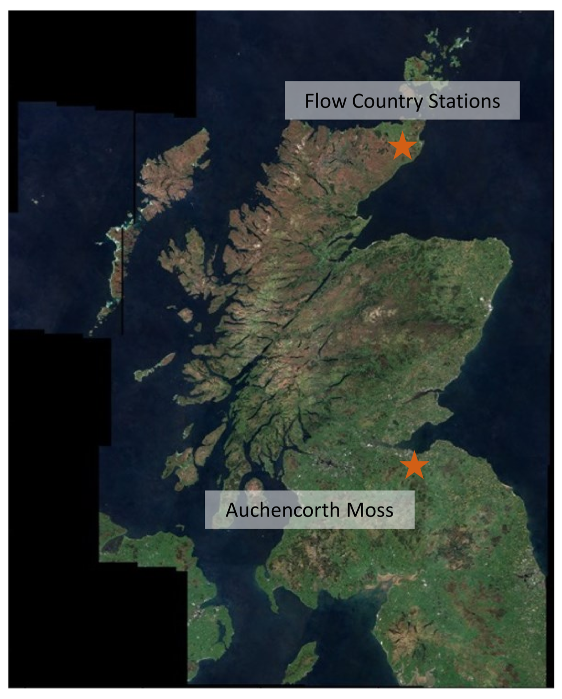
OBJECTIVE: By implementing a systems approach and a land surface simulation model, we aim to analyse how soil moisture and carbon dynamics will change in response to various future climate and land use scenarios, and how these changes will impact **Scotland's surface water resources** across mineral and organic soils.

II. Scales of Study

We will utilize site-specific Eddy covariance data at **local scale**, while incorporating satellite and remote sensing data at a **regional scale.**

Figure (A) shows a map of Scotland with relevant **Eddy Covariance tower** locations represented by star symbols.

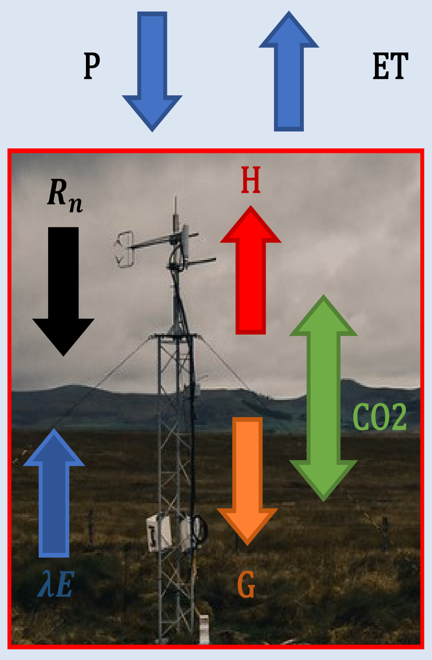
(A)



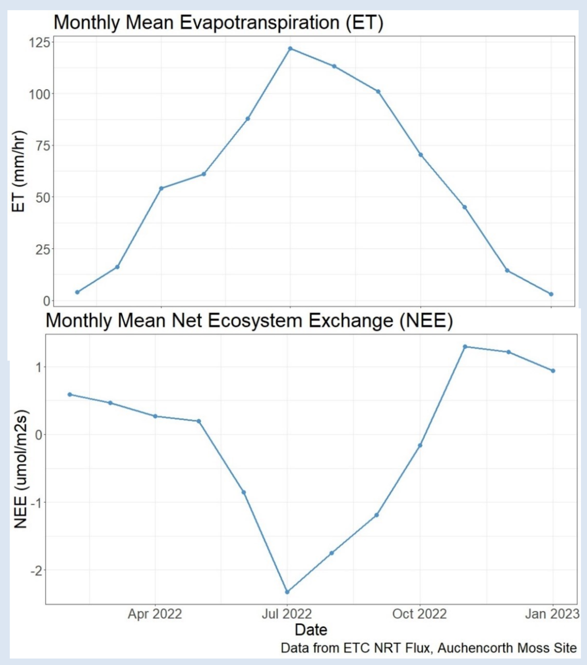
High Resolution Imagery Map of Scotland created by Dr. David Milodowski (UoE).

III. Eddy Covariance (EC) Method

The EC method estimates heat (H, G), water vapor (λE, ET) and CO2 fluxes withing the atmospheric boundary layer and **provides observations between NEE CO2 and Water Balance dynamics.**



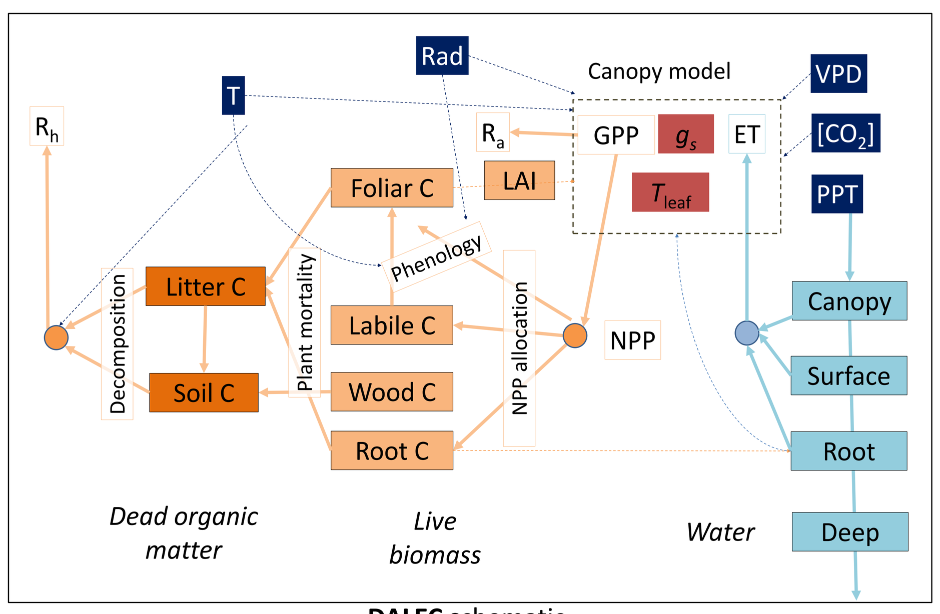
EC Tower picture from ICOS Station Auchencorth Moss.



IV. DALEC

The Data Assimilation Linked Ecosystem Carbon Model (DALEC) simulates ecosystem carbon (red) and water dynamics (blue) and can account for factors such as photosynthesis (**GPP**) and evapotranspiration (**ET**).

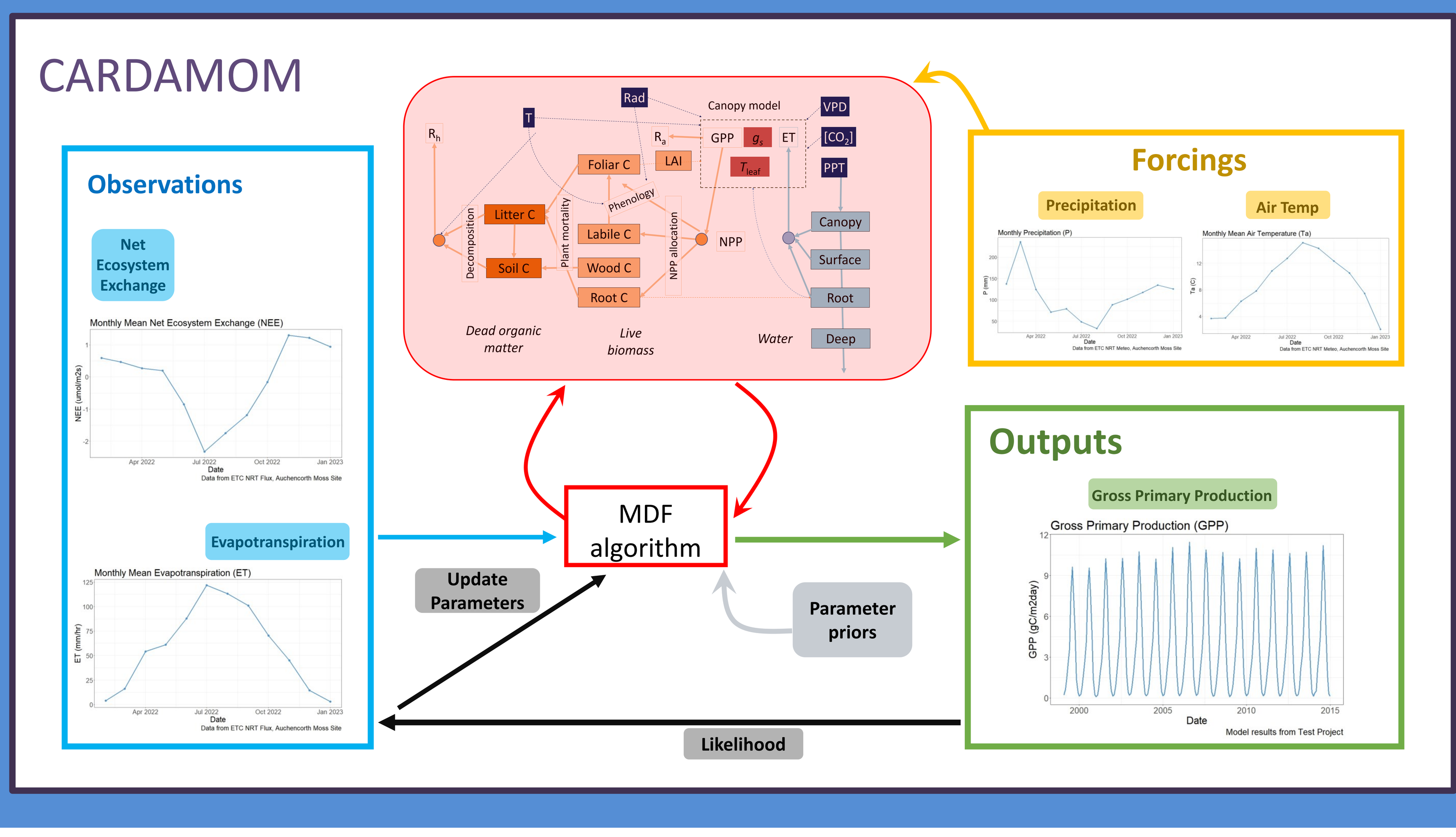
DALEC helps to improve our understanding of Eddy Covariance data. It also helps predict and deepen our comprehension of how ecosystems respond to factors such as climate changes, disturbances, management approaches, and shifts in land use.



DALEC schematic.

V. CARDAMOM

The CARbon DAta MOdel fraMework (CARDAMOM) calibrates model results and estimates parameter uncertainty by comparing model results from Drivers (meteorological data, land use/disturbance) and Parameter Priors with observations (NEE, ET, Leaf Area Index, among others).



VI. Next Steps

1. EC Data processing of Drivers and Observations.
2. Calibration and validation of the model at site level using time series data.
3. Model evaluation and development for peatlands.
4. Calibration and validation of the model at national scale using earth observation data and soil maps.
5. Exploration and development of different future scenarios for land use and climate forecast.

VII. References

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[3] Bloom, A. A., & Williams, M. (2015). Constraining ecosystem carbon dynamics in a data-limited world: Integrating ecological "common sense" in a model-data fusion framework. Biogeosciences, 12(5), 1299–1315. https://doi.org/10.5194/bg-12-1299-2015

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