# Insights into $CO_2$ simulations from the Irish Blackwater peatland using ECOSSE model

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## Introduction & Background

- Non-degraded peatlands are known to be important carbon (C) sink; however, if they are exposed to anthropogenic changes they can act as C source.

- This study forms a part of the larger AUGER project. It uses the ECOSSE process-based model to predict $CO_2$ emissions [heterotrophic respiration (Rh)] associated with different peatland management (Smith et al., 2010).

- The work aims to provide preliminary insights into $CO_2$ modelling procedures for drained and rewetted sites from Blackwater, the former Irish raised bog. After drainage in 1950's (due to peat-extraction) and cessation of draining in 1999, the landscape developed:
    - drained 'Bare Peat' (BP), and
    - rewetted 'Reeds' (R) and 'Sedges' (S) sites
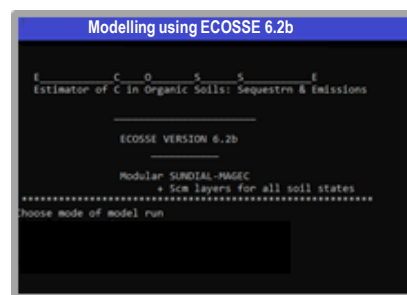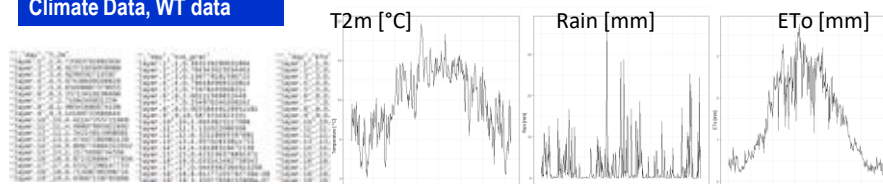    (Renou-Wilson et al., 2019).

Figure 1 Illustrative presentation of model inputs and outputs

Sources: Photos (adapted) from www.ucd.ie/auger,@augerpeatproject  Inputs adapted from Premrov et al. (2020); outputs & model-window examples from ECOSSE model run (ECOSSE by Smith et al. 2010)

## Methods

- Modelling of $CO_2$ from sites was done using ECOSSE-v.6.2b model ('site-specific' mode) with water-table (WT) module (Smith et al., 2010), and default peatland vegetation parameters.

- The other model-input parameters (including soil respiration, WT and other soil parameters) were obtained from measurements reported in Renou-Wilson et al. (2019).

- Simulations on drained  BP site were run starting from 1950 and on rewetted R and S sites starting  from 1999 (which is the year of cessation of drainage).

- The climate data inputs  (2010-2017) were obtained from ICHEC (EPA_Climate-WRF, 2019). The long-term average climate data for model spin-up were obtained from Met Éireann (2012) with potential evapotranspiration estimated by Thornthwaite (1948) method.

- Daily ecosystem respiration (Reco) data for May/June 2011 to Aug 2011 obtained from raw $CO_2$ flux measurements (Renou-Wilson et al., 2019) were used. For vegetated sites Rh was estimated from Reco using method explained in Abdalla et al. (2014).

Presented are only preliminary results; more detailed work including improved water-table simulation for drained peatlands is currently in preparation for a journal publication (link will be provided in future)
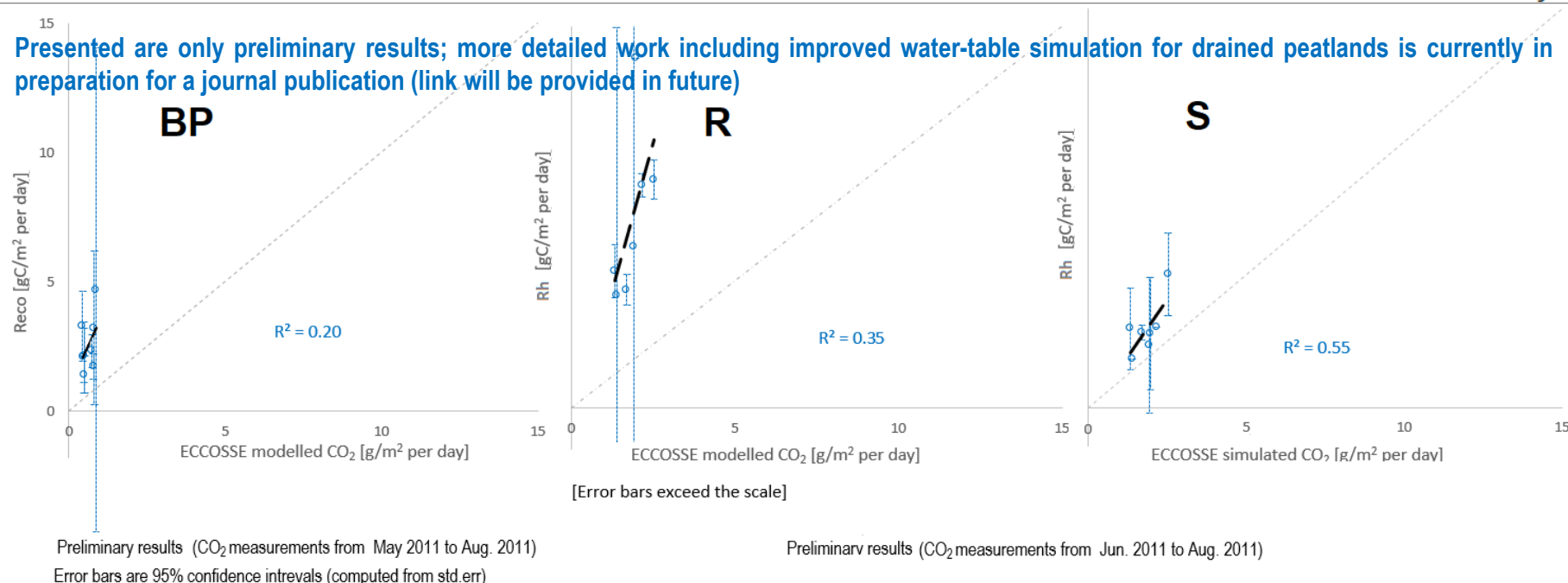
**BP** — Reco [gC/m² per day] vs. ECCOSSE modelled $CO_2$ [g/m² per day], $R^2 = 0.20$

**R** — Rh [gC/m² per day] vs. ECCOSSE modelled $CO_2$ [g/m² per day], $R^2 = 0.35$

**S** — Rh [gC/m² per day] vs. ECCOSSE simulated $CO_2$ [g/m² per day], $R^2 = 0.55$

[Error bars exceed the scale]

Preliminary results ($CO_2$ measurements from May 2011 to Aug. 2011)
Error bars are 95% confidence intrevals (computed from std.err)

Preliminary results ($CO_2$ measurements from Jun. 2011 to Aug. 2011)

Figure 2 Preliminary results for Blackwater peatland - measured Rh (Reco for bare-peat) vs. ECOSSE modelled $CO_2$

## Results & Findings

- Daily $CO_2$ simulations were compared to Reco for　　　　　BP site ($r^2 = 0.20$)

  and to Rh for　　　　　R site ($r^2 = 0.35$) and S site ($r^2 = 0.55$).

- The preliminary results showed some underestimation of simulated $CO_2$ indicating the need for further modelling refinements for satisfactory results.

- The preliminary results, especially from BP site, further indicated on the importance of including long-term drainage period (i.e. from 1950 on) because avoiding this step resulted in a large overestimation of predicted $CO_2$.

**Literature:** • Abdalla, M., et al. 2014. Simulation of $CO_2$ and attribution analysis at six European peatland sites using the ECOSSE Model. Water Air Soil Pollut 225:2182; • EPA_Climate-WRF (2019). ERDDAPv.1.82. ICHEC. https://erddap.ichec.ie/erddap/files/EPA_Climate/WRF/ ; •Met Éireann. 2012. 30 year averages. Met Éireann - The Irish Meteorological Service, Ireland.; • Premrov, A. et al. 2020. Biogeochemical modelling of Irish peatland sites - Insights into the processing procedures of daily climate input data obtained from ICHEC WRF climate datasets. IGRM2020, Athlone,, Ireland; • Renou-Wilson, F., et. al. 2019. Rewetting degraded peatlands for climate and biodiversity benefits: Results from two raised bogs. Ecol. Eng. 127:547-560. Smith, J., et al. 2010. ECOSSE. User Manual.; • Thornthwaite, C.W. 1948. An approach toward a rational classification of climate. Geog. Review 38, 55-94.