Identifying non-linear dynamics in hydrological and biogeochemical responses to global environmental change at the Birmingham Institute of Forest Research

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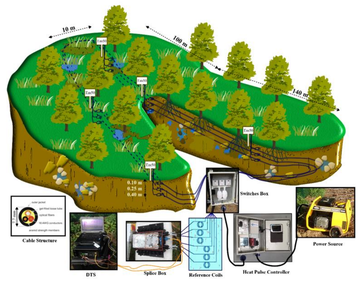
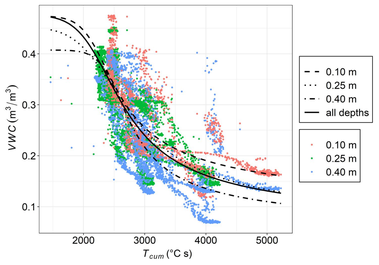
Catchment Hydrology

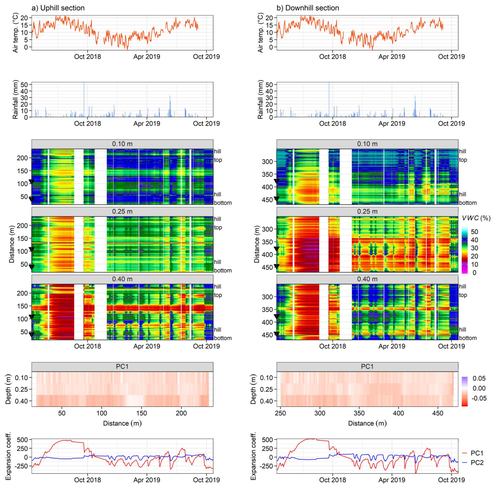
High-resolution monitoring of soil-moisture dynamics by Active (heated) Fibre-optic Distributed Temperature Sensing (A-DTS):



Experimental setup of A-DTS soil moisture monitoring, comprising three soil depths along two 250m hillslopes, 25 cm sampling resolution



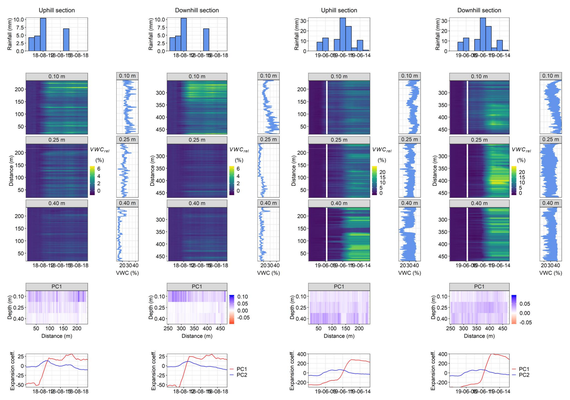
Soil depths and transect specific A-DTS soil moisture calibration - comparison to TDR/FDR point observations along both slopes



1.5 years of A-DTS soil moisture observations, including substantial summer drought in 2018 as indicated by precipitation and temperature observations (top)

A-DTS allows for unprecedented spatial resolution of soil moisture monitoring - identifying predominantly vegetation controlled patterns that vary significantly in space and time.

Seasonal patterns overlap with event dynamics - different locations show variable peak responses to storm events and recession (centre).



Pre-event conditions control soil moisture development across depths

Relative soil moisture change after dry spell starting from top (left)

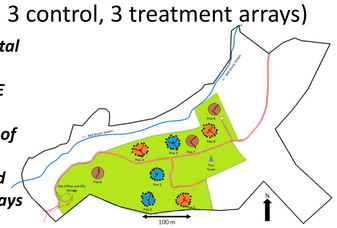
Relative soil moisture change after dry spell starting from top (right)

BIFoR - The Birmingham Institute for Forest Research:

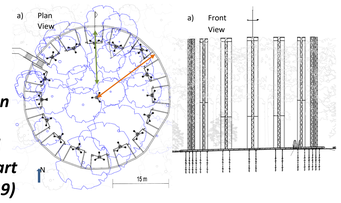
- Established 2014, with the ambition to beyond its initial phase of 10 years *(www.birmimngham.ac.uk/research/bifor/index.aspx)*
- Free Air Carbon Emission (FACE) experiment in mature mixed woodland
- Characterisation of water, energy, nutrient fluxes at soil-water-plant-atmosphere interface in response to raised CO_2 levels (3 'ghost', 3 control, 3 treatment arrays)

FACE fumigation arrays in the BIFoR Birmingham Institute for Forest Research, Staffordshire, UK

Experimental setup at BIFoR-FACE with alignment of treatment, control and 'ghost' arrays



FACE fumigation setup in individual arrays (Hart et al., 2019)



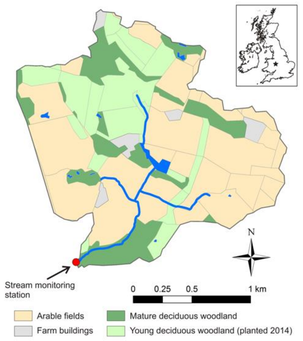
- In addition, monitoring of microbial, invertebrate communities, runoff generation processes and catchment nutrient spiralling

Observations:

- TDR-FDR soil moisture at 10 cm depth across arrays and vertical profile (six depths down to 1.5m)
- Soil lysimeters and rhizometers, pore water chemistry,
- Continuous sap flow at primary (Oak) and secondary (Sycamore) species
- Above and sub-canopy micro-meteorology
- Soil respiration and leaf litter decay
- Plant phenology (LAI, PAR, stomatal conductance, multispectral…)
- Stream metabolism and carbon, nitrogen, phosphorous speciation, dissolve oxygen, stream and sediment GHG emissions (*Blaen et al. 2017a; Comer-Warner et al., 2019*)
- Continuous in-situ monitoring of water quality (DO, T, EC, NO3, NH4, DOC, TLF, CDOM at multiple locations in rural catchment (*Blaen et al., 2016*)

Nutrient Cycling

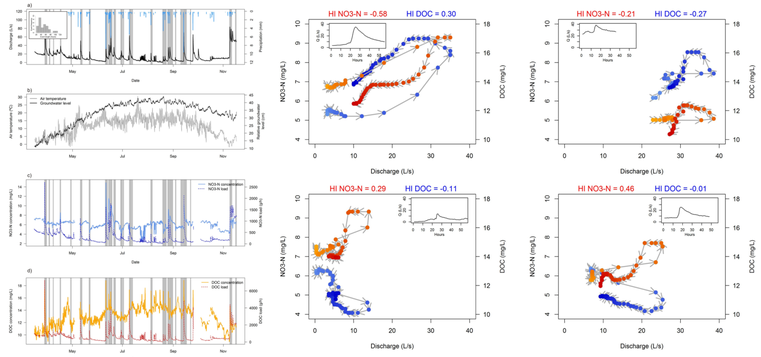
Continuous in-situ monitoring of water quality (DO, T, EC, NO3, NH4, DOC, TLF, CDOM at multiple locations in rural catchment



In-situ water quality monitoring station (optical, fluorescence, absorbance) (top)

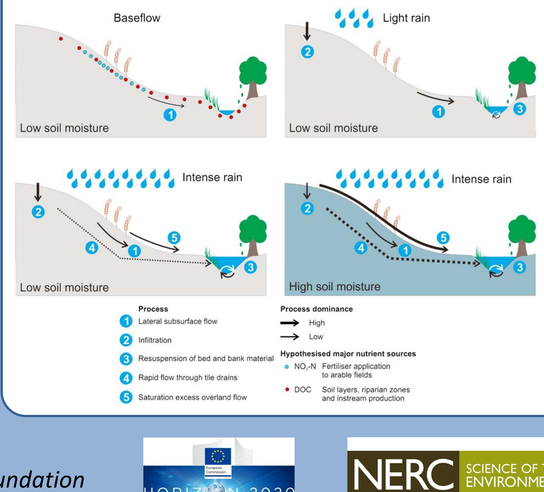
Mill Haft catchment with mixed landuse, currently undergoing shift to sustainable agriculture (left)

Analysis of Q-c relationships: Establishing dynamic source area activation behaviour in response to hydrometeorological forcing



Precipitation and discharge for 48 selected storm events with corres-ponding NO_3 and DOC concentrations

Q-c relationships for storm events reveal variability in hysteretic behaviour of NO_3 + DOC, indicating activation of different distal / proximal sources (Blaen et al., 2017b)



Mechanistic understanding of drivers and controls of dynamic solute source zone activations derived by analysis of Q-c hysteretic relationship improve conceptualisation of catchment runoff generation processes (left).

High-frequency monitoring data contribute to improve representativity of catchment solute transport models (Qiu et al., 2019

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