



New Figure: Schematic illustrating the two sources of organic material at the same depth within the peat column: older bulk peat and younger dissolved organic carbon (DOC) from surface litter decomposition. A) Surface vegetation acts as the primary source of new organic material entering the peat system. Key contributors include dead plant matter and root exudates, indicating that the species present at the surface significantly influence the composition of these organic inputs. B) Organic material can either accumulate gradually or move rapidly down the peat column as DOC in pore water. The peatland water table (WT) is dynamic yet situated close to the surface, enabling vertical transport of DOC. This diagram illustrates the two sources of organic matter available for decomposition and microbial production: slow accumulation of decomposing bulk peat (in greens) and more rapidly mobilized DOC (in blues). C) As bulk peat accumulates over time, decomposition alters the biochemical characteristics of the peat available for microbial gas production. The ¹³C NMR data from the study peatland indicate preferential preservation of lignin, a loss of lipids, and stable carbohydrate content from surface to deeper peat layers. This suggests that the bulk peat found in deeper layers remains relatively bioavailable, serving as a viable potential source for microbial decomposition. D) The gases produced within the peat soil exhibit isotopic signatures that reflect the dominant source material, or a combination of both sources. Both organic inputs can contribute to gas production—either from a single source (top orange box and bottom orange box) or a mix of both (middle orange box). E) The results of this study demonstrate overlapping radiocarbon signatures of respired gases with DOC, strongly indicating that younger DOC is fueling below-ground respiration, despite the bioavailability of the bulk peat, as illustrated in the red box.