LTLS Long-Term Large-Scale Project

Riverine organic carbon

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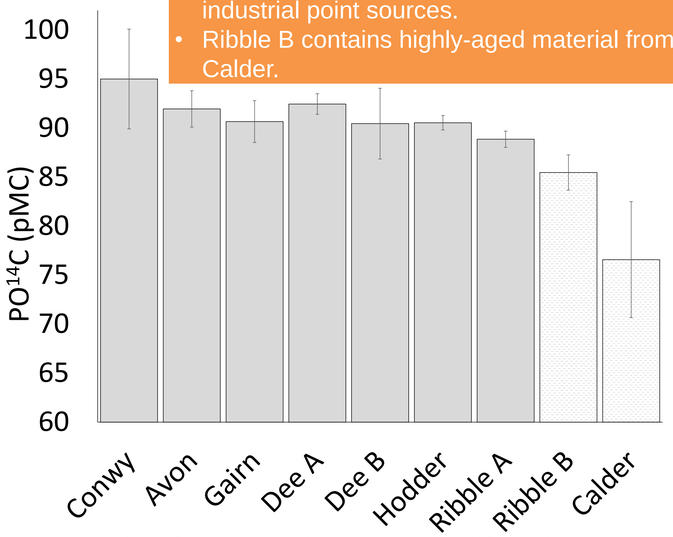
Aged riverine POC in four UK catchments

Suspended particulate matter (SPM) represents a mixture of surface and sub-surface materials. Particulate organic matter present in SPM plays an important role in the transport of macronutrients.

Key Questions

- What is the time elapsed between carbon fixation and release into rivers?
- What are the dominant sources of POC in the catchments?
- How do these compare to global catchments?

- All sites contain some depleted ^{14}C.
- Calder POC is significantly aged, due to industrial point sources.
- Ribble B contains highly-aged material from the Calder.



Average $PO^{14}C$ (pMC) for suspended sediment collected at high flow at the 9 sampling sites. Error bars represent standard deviations. Patterned bars show the two sites for which the $PO^{14}C$ values differ significantly from the others.

Conclusions

- Depleted ^{14}C: average enrichment of 91.2pMC (681 years).
- Calder catchment significantly depleted ^{14}C from industry.
- UK catchments fit within the general pattern of global data.
- Topsoil most likely source, mixed with highly aged material from sub-surface erosion.

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Lakes research and model

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Lakes & macronutrient fluxes: why?

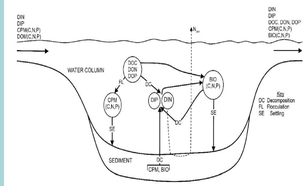
Lakes efficiently trap fluvially-transported particles and nutrients, retaining these in lake-bed sediment.

Therefore:-

- **The presence of a lake reduces nutrient transport through a landscape**
- **The lake sediment sequence contains information on past nutrient loadings**

For the LTLS project we:-

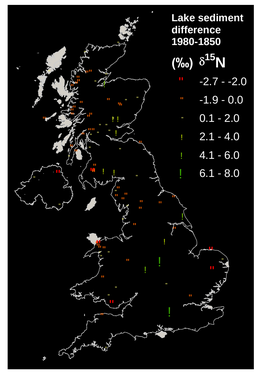
- **Developed a MODEL to calculate the impact of lakes on landscape CNP flux**
- **Used a lake sediment archive of "100 lakes" to observe spatial variation of post-1850 changes in nutrient loadings**
- **Assessed long-term (10,000 year) change using new data from "4 lakes"**



Capture of particles and adsorbed nutrients by lakes

"100 Lakes": post-1850 change

N-isotope measurements on ^{210}Pb dated lake sediments

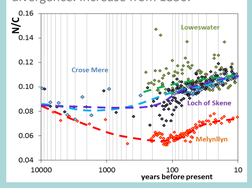


- **$d^{15}N$ significantly changed since 1850**
- **Consistent $d^{15}N$ depletion in uplands (>300m) from fossil fuel emissions**
- **$d^{15}N$ depletion in some lowland lakes recovering from 19th century waste inputs**
- **$d^{15}N$ enrichment in lowland lakes due to 20th century eutrophication**

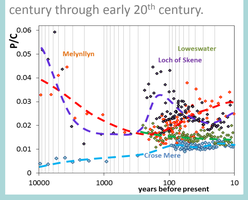
- The sediment records of most lakes show change since 1850
- Upland and lowland lakes show very different signals

"4 lakes": the long record

Initial state similar; early Holocene divergence. Increase from 1850.

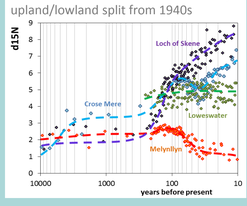


Variable initial state. Increase from 19th century through early 20th century.



Site locations

Initial state similar. Increase from 1800; upland/lowland split from 1940s

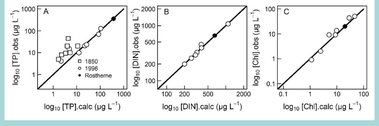


- Sites have similar N:C and $d^{15}N$ until recent centuries, then deviate strongly after AD 1800
- P:C varies in time and space, and shows little recent change in last 100 years
- Excepting early P enrichment, the last 200 years show the greatest variation

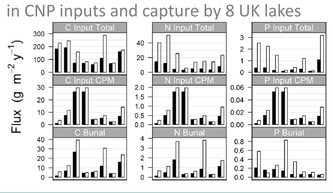
How?

Lake model

Water quality simulation at 8 training lakes



Contrast between 1900 (black) and 2000 (white) in CNP inputs and capture by 8 UK lakes



Macronutrient processing by temperate lakes: A dynamic model for long-term, large-scale application

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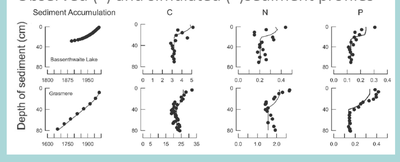
Observed (•) and simulated (/)sediment profiles



- Between 1990 and 2000 C fixation by lakes increased 6-fold
- Burial of C, N and P increased by 70%, 131% and 185% respectively

Conclusions

- The lake model successfully captures temporal trends in UK lakes
- It shows substantial increases in C, N and P burial over last 100 yrs
- The 100 lake data set shows spatial and temporal variation in nutrient pollution intensity and pathways
- The "4 lakes" data set shows stability through most of the Holocene, with intensifying change since 1800

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