LOCATE
Land Ocean Carbon Transfer

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- Soil C pool is large
- Regulates climate
- 4 x ocean DOC
- 6 x combusted fossil fuel
• Org C key element of soil
• Supports crop growth
• "The Nation that destroys its soil destroys itself" FDR
- Flux to rivers is large
- Similar to ocean and land $C_{\text{anth}}$ uptake
System not in steady state

65% increase in DOC in upland catchments in recent decades

Increased terrestrial productivity due to increasing CO$_2$?  
(Freeman et al., 2004 Nature)

Increased DOC mobility due to reduction in acid rain?  
(Monteith et al., 2007 Nature)
• Multiple fates
  • Burial
  • Flux to ocean via estuaries
  • Loss to atmosphere
• Fluxes increasing (Regnier et al., 2013)
• What controls them?
• How do they affect climate?
• Ecological impacts?
“many of the key processes relevant to decomposition of [terrigenous] C are missing in models, particularly for C stored in boreal and tropical peatlands, despite their vulnerability to warming and land use change”.

Intergovernmental Panel on Climate Change, 2013
UK ESM

JULES
No Soil
DOC in rivers

MEDUSA
No DOC

Litterfall
Litter pools
Decomposition
Humus
Biomass

DOC
Leaching to rivers followed by loss

CO₂

MesoZoo
MicroZoo

Si
Fe
N

Slow detritus

flux
Work Packages

• To trace fate of terrigeneous organic matter (ToM) from soils to ocean with particular focus on estuaries and coastal waters (WP1)
• To quantify and understand loss processes in estuarine environment (WP2)
• To build new model of ToM cycling valid in Marine + Fresh waters, and use it to predict the future evolution of Land Ocean ToM flux (WP3)
1. Land Ocean C fluxes – Focus on GB

- N Scotland highest $C_{org}$ in Europe
- Large peat areas in Wales & S.W. England
- Do UK river fluxes reflect this?
- What happens to them in estuaries?
Resolve current uncertainties in flux distribution

N Scotland vs. SW England/Wales?

Hope et al., 1997

Tonnes C km² yr⁻¹

Worral & Burt, 2007
Whole GB Sampling (2017)

- BGS
  - Keyworth
  - Wallingford
  - Cardiff
- NOC
  - Southampton
  - Liverpool
- CEH
  - Edinburgh
  - Bangor
  - Lancaster
- PML
  - Plymouth
LOCATE Rivers drain 46% of GB.
LOCATE Estuaries drain 32% of GB.
N. Sea. with CEFAS
Core in estuarine mouth to look at burial and change
Common analytical techniques across whole system
- Bulk DOC+POC
- Fluorescence
- Isotopes
- Detailed organic chemistry
## Scale up to G.B. level

<table>
<thead>
<tr>
<th></th>
<th>Woodland (%)</th>
<th>Arable (%)</th>
<th>Grassland (%)</th>
<th>Mountain/Heath/Bog(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G.B.</strong></td>
<td>13</td>
<td>20</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td><strong>LOCATE River Catchments</strong></td>
<td>14 (5-50)</td>
<td>21 (0-75)</td>
<td>42 (5-75)</td>
<td>15 (0-75)</td>
</tr>
<tr>
<td><strong>LOCATE Estuary Catchments</strong></td>
<td>14 (5-30)</td>
<td>23 (0-65)</td>
<td>40 (5-75)</td>
<td>13 (0-75)</td>
</tr>
</tbody>
</table>

- Selected catchments similar to G.B.
  - Simple to upscale
- Wide range of catchments
  - Examine behaviour in different systems
Are GB samples representative?

• Targeted sampling:
  • Alaska
  • Eastern Canada
  • Scandinavia
  • Siberia
  • Indonesia
  • South Africa
  • Amazonia
  • Patagonia/Falkland Islands
  • South Georgia

• New simple OM analysis
  • Photolysis/Respiration
  • Low cost
  • High replication
  • Portable
Models need process detail
- ESMs computationally intensive
- Process detail expensive
  - Cannot model everything

Which processes really matter?

What controls them?
- OM Type?
- Season?
- Flow?
- T?
- Nutrients?
Three estuaries with different (sub) catchment types
- Halladale – Heath and Mountain Dominated
- Conwy and Dart – Grassland dominated
- Two Seasons; summer and winter
Process understanding for models (2018+19)

- Measure loss processes
  - Respiration
  - Flocculation/ Burial
  - Photolysis
- Provenance organic carbon
- Experiments to examine key processes – scenarios from literature
- Autonomous systems to examine extreme events
3. New models to understand and predict ToM cycling

- Develop new model
- Deploy it in series of nested models
- Estuarine scale
  - Which processes really need to be modelled?
- Shelf Scale
  - What controls flux to open ocean, how will it change
- N Atlantic Scale
  - How will ocean storage of ToM change?
New ToM Model - cross system, realistic, computationally cheap (2016-)

- How do pools map into each other?
- How many Bacterial pools are needed?
- Parameterised via experiments from WP2
- Present to international audience
More Analytes (Pollutants, metals)
More areas (Sealochs, NI)

LOCATE
Webinar, SPAG Note, Roadshow, Annual Science Meetings

Current programmes
Arctic Biogeochem + ESM

Extra Science
DEFRA Brown Carbon - JSR

Field Opportunities
Broad Scale Survey
Rivers and Estuaries
Process Studies
Labs and Boats

Extra Science
NERC
Fe Limitation of ToM respiration
Macrofauna
Possible links to others – SPAG opportunities

Field Opportunities
Broad Scale Survey Rivers and Estuaries
Process Studies Labs and Boats

Extra Science
Fe Limitation of ToM respiration
Ad biological studies to biogeochemical programme (molecular, macrfauna etc)
Brown Carbon - Joint Strategic Response?
More Analytes (Pollutants, metals)

More areas
Sealochs, NI, UK Territories
Summary

- Estimate Fate of GB soil OC in estuaries and coastal waters
- Resolve major spatial uncertainties in GB ToM fluxes
- Measure key processes in contrasting environments
  - photolysis, respiration, flocculation, burial
- New model of DOM cycling valid across land ocean boundary constrained and parameterised by process studies
- Ultimate aim is to improve ability of UK ESM to model future evolution of land ocean C fluxes and fate of soil organic C pool.
LOCATE Vision and Legacy

“The key processes relevant to decomposition of terrigenous C are well represented in models, particularly for C stored in boreal peatlands”.