SAGES UPDATES. CARBON FOOTPRINTS

SAGES NEWS. HIGHLIGHTING SAGES AT STIRLING

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6C–News

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T2 EXAMINING THE ROLE OF SOIL-PLANT-ATMOSPHERE INTERACTIONS IN CLIMATE CHANGE

What are the BIG questions?

John Grace from Edinburgh ponders some big ideas….

Few subjects in environmental science have attracted as much attention as the carbon cycle. The reasons are clear- the carbon cycle and the feedbacks therein are a part of the climate system, and the rising CO_2 concentration is currently causing dangerous climate warming. As a consequence, the funding available for research in this topic is now large; moreover, the subject is attracting some of the brightest young minds and the output of published papers on the carbon cycle has been growing exponentially.

What has been achieved so far, does however, fall short of what is required if we are to understand properly the relationship between humans and the climate system. In this short article, I'll try to list the big science questions that still engage us. They fall into two categories: firstly, the basic processes; secondly, the human dimension of the problem.

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MARKET WATCH

Officially opened 1 year ago, the Cambridge Centre for Climate Change Mitigation Research (4 CMR) focuses on climate change mitigation. The objective of the Centre is to predict strategies, policies and processes to mitigate human-induced climate change. http://www.landecon.cam.ac.uk/research/eeprg/4cmr/index.htm

ACES in Aberdeen is still developing. It aims to tackle issues related to conflicting uses/demands placed on environmental resources. Two main research themes are proposed: Environmental Degradation and Ecosystem restorations, and Sustaining Biodiversity & Livelihood. http://www. aces.ac.uk

John Grace's big questions continued...

Basic processes

Where are the sources and sinks of carbon dioxide on the Earth's surface and how will they behave over the next 100 years? Humans inject about 7 Pg of carbon as CO_2 into the atmosphere from fossil fuel burning each year and an additional 1-2 Pg of carbon from tropical deforestation. If we look at any of the recent reports on the global carbon cycle, all we can reasonably conclude is that the emissions exceed the rate of appearance of CO_2 in the atmosphere. The balance (formerly called the 'missing sink') is accounted for by the dissolution of CO_2 in the ocean and the storage of carbon in the terrestrial biomass. Most attempts to put uncertainties on these sink terms, or to attribute sink strengths to particular parts of the terrestrial biosphere (the tropical rain forest, European forests, grasslands etc) serve to demonstrate how difficult the problem really is. As for the long term future of the sinks, estimates once more vary widely- but almost all authors agree that the carbon sinks will weaken or disappear over periods of a few decades.

"Do we really believe that UK soils are losing carbon ..?"

[1] *What are the main feedbacks in the carbon cycle?* Several important feedbacks are well known, but not well quantified. Perhaps even more important is the nature of feedbacks still to be discovered. We know for example that rising temperatures increase respiration of microbial organisms in the soil. If they have adequate substrates these organisms will break down soil organic matter, which will increase the atmospheric CO_2 even more, and cause even more warming.

"The more money you get the more travel emissions you have."

[2] How stable is soil carbon? There have been many experiments in which soil organic matter is shown to break down at high temperatures, but almost all of them are of the 'black box' variety. There have been few attempts to characterise the chemical nature of the soil carbon, and indeed the ultra-structural properties which may determine its susceptibility to decomposition. Is it true that climate warming will lead to loss of our blanket peat? I think the definitive experiments have not yet been done. Do we really believe that UK soils are losing carbon, and if so what has caused it, and what is the remedy?

[3] *Where are the sources of methane?* Recent work has suggested that methane can be emitted from plants under aerobic conditions, and (if this is shown to be correct) the global methane budget is in tatters. We also have rather poor knowledge of how the CH_4/CO_2 ratio of emissions from bogs may vary as the water table changes.

[4] What are the lateral transports of carbon associated with landscapes and regions? Flows through drainage systems are poorly quantified. Flows through commerce and trade (food, timber, other products) are reported, but not quantified in terms of carbon.

[5] *How can we monitor the carbon cycle using satellites?* This is a major question which will engage many of my colleagues, and it is also the core work of the newly formed (as I write, 'forming' is the appropriate word) National Centre for Earth Observation, NCEO.

The Human Dimension

I heard recently that a group of celebrities are forming 'the billion tonne club'. The idea is simple: if a billion people can be persuaded to reduce their carbon emissions by one tonne per year, then the planet will be saved. And my colleague Dave Reay has shown how people might do this in his book *Climate Change Begins at Home*. How many people are actually changing their lifestyles to minimise emissions?

Continued on page 3

Well, we heard last week that NERC grants may contain an element of funding for a carbon offset fee to cover conference travel. What about ordinary people? There are many web sites where personal carbon emissions can be estimated, and where carbon management services can be procured. But like organic food and ethical investment it may be a minority of people- those who can afford to pay extra.

Speaking of the relationship between wealth and emissions, I would like to end this article with a research result from one of our own students (Korbetis et al 2006. Atmospheric Environment, 40, 3219-3220). She interviewed a sample of Edinburgh's inhabitants to learn about the relationship between their Surprisingly, the relationship was linear- the more money you get the more travel emissions you have. The extra emissions were not the result of taking children to school in 4 x 4 vehicles (although that contributed). The extra came from professional and holiday travel. As the one billion people in China and in India increase their wealth and travel over the coming decades, let us hope we can find clean energy technologies for transport. If not, the future is bleak indeed.

John Grace
Edinburgh

Motivated by John's article, I have looked at my diary (January to June) and calculated what my business related travel will do for CO_2 in the environment [http://www.co2balance.com/]

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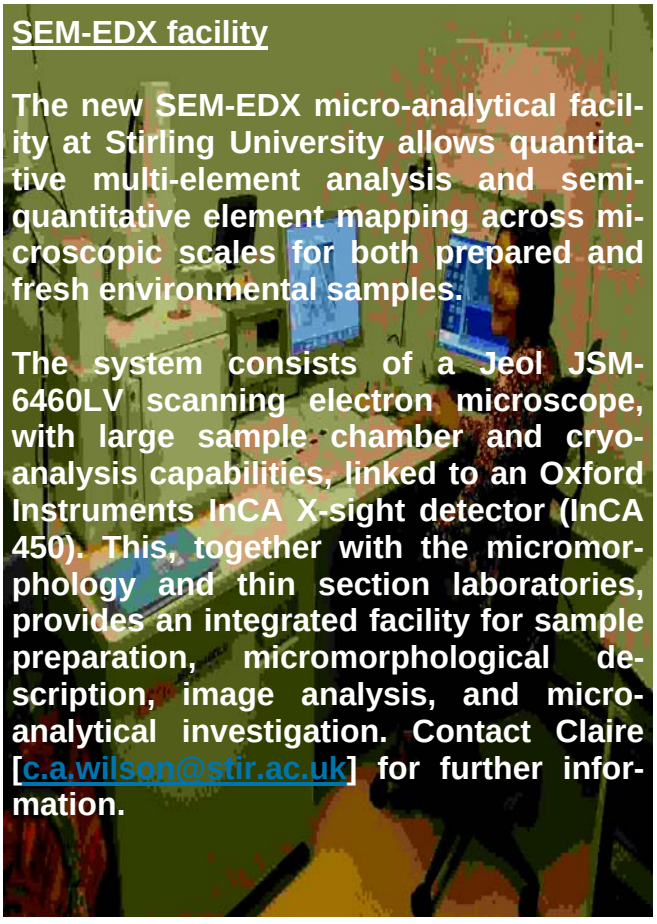
Transport	Origin	Destination	Journeys	Tonnes C	Offset cost (£) per visit	Total cost (£)
AIR	*Edinburgh*	*Nottingham*	x2	0.11	5	10
	Edinburgh	*Bristol*	x2	0.15	5	10
	Dundee	*London (City)*	x2	0.12	5	10
	Edinburgh	*Boston*	1	1.08	10	10
	Edinburgh	*Montpellier*	1	0.44	5	5
	Edinburgh	*Beijing*	1	0.87	16	16
TRAIN	*Dundee*	*Edinburgh*	3	0.02	5	15
	Dundee	*Glasgow*	3	0.02	5	15
Bus per yr	*8 miles per day*			0.06		5
TOTAL						**96**

The total is FAR less than what the cost the University accountants place on travel transactions! I am sure that there will be many other ways to do this calculation. So, send in your travel costs to the environment…..

Iain Young, Abertay

Focus on Stirling

Clare Wilson has been working for the past 5 years as a post-doctoral researcher at Stirling University on a series of NERC, DEFRA and Historic Scotland funded projects. Her research has concentrated on investigating the physical and chemical legacy of past human activity on soil properties. Before that she worked for a year and a half as a soil and geoarchaeology consultant in mid Wales. She received her honours degree in environmental science from Aberystwyth University, studied for a Masters in environmental archaeology from Sheffield University, and completed her PhD in soil micromorphology at Stirling University. Within SAGES Claire plans to use the micromorphological and micro-analytical facilities at Stirling University to investigate the spatial distribution of soil carbon and the role of soil aggregate formation in carbon stabilisation.

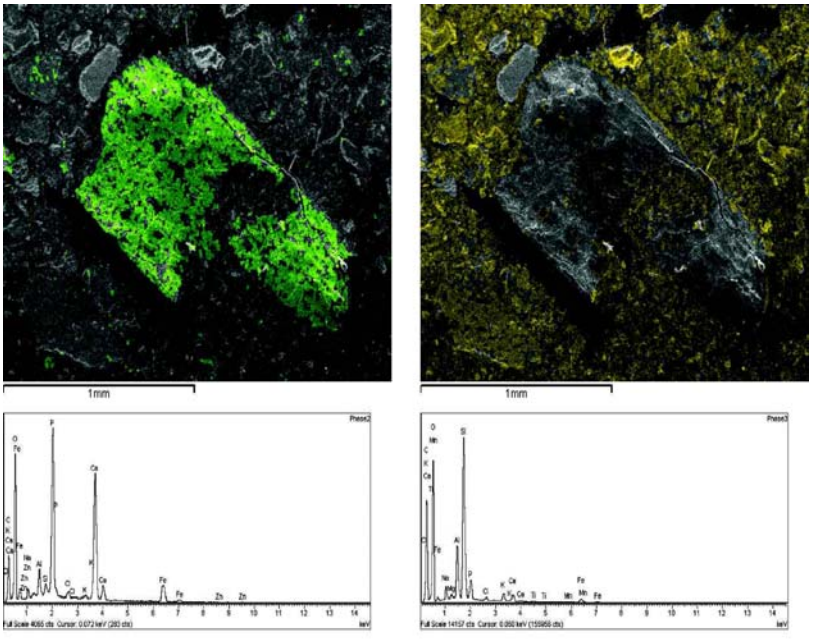


SEM-EDX facility

The new SEM-EDX micro-analytical facility at Stirling University allows quantitative multi-element analysis and semi-quantitative element mapping across microscopic scales for both prepared and fresh environmental samples.

The system consists of a Jeol JSM-6460LV scanning electron microscope, with large sample chamber and cryo-analysis capabilities, linked to an Oxford Instruments InCA X-sight detector (InCA 450). This, together with the micromorphology and thin section laboratories, provides an integrated facility for sample preparation, micromorphological description, image analysis, and micro-analytical investigation. Contact Claire [c.a.wilson@stir.ac.uk] for further information.

Quantification of Elemental analysis in heterogeneous soil



Phase mapping of old agricultural soils

Grants, News & Views

In Issue 1 we highlighted recent grants won by SAGES staff. We continue to do so in this Issue. When you win some grant money related to SAGES activities, please send details directly to SAGES@abertay.ac.uk, along with relevant images.

TROBIT (Tropical Biomes in Transition) is a new NERC consortium project, value £1.6 M. (Patrick Meir, John Grace & Michael Bird) The consortium is led by *Leeds University*, with PIs from the universities of *Edinburgh, St. Andrews, Sheffield, Exeter, and Oxford, together with the UK Centre for Ecology and Hydrology and the UK Met office*. The project has international collaborators in West Africa (Burkina Faso, Ghana, Mali and Cameroon), Bolivia, Brazil, Venezuela and Australia.

TROBIT is an integrated data assimilation and modelling project with an extensive fieldwork component investigating

"Zones of Tension" – areas where savannah and rainforest exist in a mosaic. The basic science question at issue is whether a conversion of tropical forest to savannah associated with climatic drying and warming is likely to amplify the rate of climatic change. This response is considered to be possible the because of the effects of feedbacks associated with changes in the global surface energy balance and the likely a substantial release of CO_2 to the atmosphere associated with such biome transitions in the tropics. already promises significant new insights.

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The Andes Biodiversity Consortium (ABC) was set up with National Science Foundation Funding in 2003 and has now received significant new funding (~£1.2 m) from new, equal sized, grants from NERC and the Gordon and Betty Moore Foundation (Patrick Meir & Michael Bird). The ABC comprises researchers from the UK (the universities of Edinburgh, Oxford and St Andrews), Peru and the USA.

The focal research area is an altitudinal forest transect down the eastern flank of the Andes, to the Amazon Basin.

ABC is multi-disciplinary consortium, reflecting the aims of understanding the threats to the forests in this region from both land use and climatic change. The research will include palaeoecological and botanical studies, together with a detailed study of the carbon cycle of montane-to-lowland rain forest. The latter study is the principal focus of the NERC grant and Edinburgh's & St Andrews's component will be to test hypotheses underlying the response by soil organic matter decomposition to temperature, and the gas exchange response by the forest canopy to nutrient and atmospheric drivers.

Publications

Abertay Library

Korbetis M, Reay DS & Grace J (2006). New directions: Rich in CO_2. Atmospheric Environment 40, 2319-1229.

Check the SAGES website for diary dates and regular updates.

Send Newsletter items to SAGES@abertay.ac.uk