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Feedbacks in the Earth System

After the special edition on IGBP II we return this issue to our normal format. Preliminary results from the recent Newsletter Survey (see p 12) tell us that



the Science Features are extremely popular with the vast majority of readers, and the three

articles in this edition will not disappoint you. Andy Ridgwell first illustrates the concept of 'feedbacks' in the Earth System with an example involving iron in the ocean, CO₂ and climate (p 2). John Harte continues on p 5



with some interesting new experimental studies on climate feedbacks in mountain regions. In the last Science Feature (p 9),

Torben Christensen reveals the global importance of northern wetlands as sources of methane, a key greenhouse gas.



from page 2

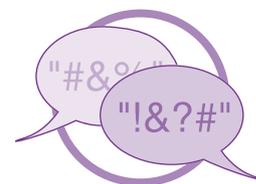
Integration

In the Integration section, we have an article about the 'Earth System Atlas' currently under development by GAIM (p 16).



Discussion Forum

And finally, IGBP Chair Guy Brasseur challenges us to think of ways to bring new talent into the IGBP network.



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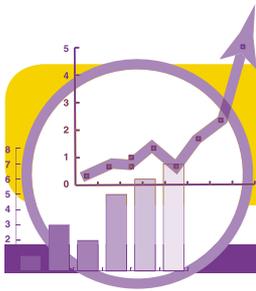
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Science Features

Feedbacks in the Earth System: Past changes in dust and iron fertilisation of the ocean

by A. Ridgwell

A climatic sub-system having the necessary properties for feedback has been found, with the marine iron cycle as its central component. This arises since CO_2 in the atmosphere, and therefore climate, may be responsive to dust due to iron 'fertilisation' and, in turn, dust supply depends on global climate. As the environmental sciences move towards a more holistic approach to understanding climate change on a range of time scales ("Earth System science"), it is becoming increasingly clear that 'feedbacks' are integral to the behaviour of the Earth System and its response to both natural and anthropogenic perturbations (see Box). Although the marine iron cycle feedback could be expected to play a role in the future climate response to anthropogenic change, it is more likely to have been important during past glacial periods when dust appears to be highly sensitive to small changes in climate.

A long-standing puzzle in oceanography has been why the primary producers of the open ocean (phytoplankton) do not always appear to fully utilise the major nutrients (such as phosphate and nitrate) that are supplied to them, since in certain regions of the world's oceans (most notably the eastern equatorial Pacific, North Pacific, and Southern Ocean), high concentrations of these nutrients remain in the surface waters in association with relatively low standing stocks of phytoplankton. Although physical (temperature, light levels, and the depth to which the surface ocean is mixed) and ecological (zooplankton grazing) regimes must all play a part in controlling phytoplankton standing stocks, open ocean iron 'fertilisation'

experiments carried out first in the equatorial Pacific, and more recently in the Southern Ocean (e.g., [1], see Figure 1) and North Pacific, have demonstrated that insufficient iron availability limits phytoplankton growth.

A key source of this iron to the biota of the open ocean is via the deposition of mineral aerosol (dust)(Figure 2). Records of past dust deposition contained in ice, marine, and terrestrial records from around the world all suggest that during the last ice age the aeolian flux of iron to the surface ocean must have been much higher than at present (globally, some 2-3 times on average). This was also a time of much lower mixing ratios of CO_2 (CO_2) in the atmosphere (around 190 ppm

[2]). This correspondence led John Martin to formulate the glacial 'iron hypothesis' [3], in which low atmospheric CO_2 is explained as a result of enhanced iron fertilisation of the biota. The results of numerical models of the ocean carbon cycle [e.g., 4] are consistent with the 'iron hypothesis' [5] although by itself dust cannot explain all of the observed ~ 90 ppm amplitude of glacial-interglacial CO_2 change, and different models of ocean biogeochemistry currently disagree as to what this fraction should be. Because of the radiative forcing on climate exerted by the presence of CO_2 in the atmosphere, climate will therefore also be sensitive to changes in the aeolian iron supply to the ocean.

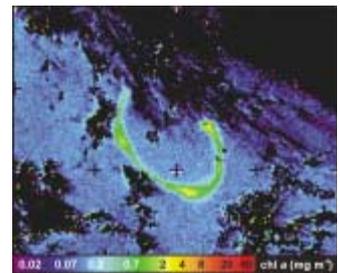


Figure 1. Ocean colour satellite (SeaWiFS) image of concentrations of surface ocean chlorophyll (a phytoplankton photosynthetic pigment, whose concentration can be taken as a rough indicator of cell density), taken some 6 weeks after the deliberate release of iron in the Southern Ocean [1]. The contrast between the 'fertilised' area (green/yellow colour) and the surrounding ('unfertilised') waters (blue) can be clearly made out (note: black pixels in the image represent cloud cover). (SeaWiFS data provided by the NASA DAAC/GSFC and copyright of Orbital Imaging Corps and the NASA SeaWiFS project, and processed at CCMS-PML.)

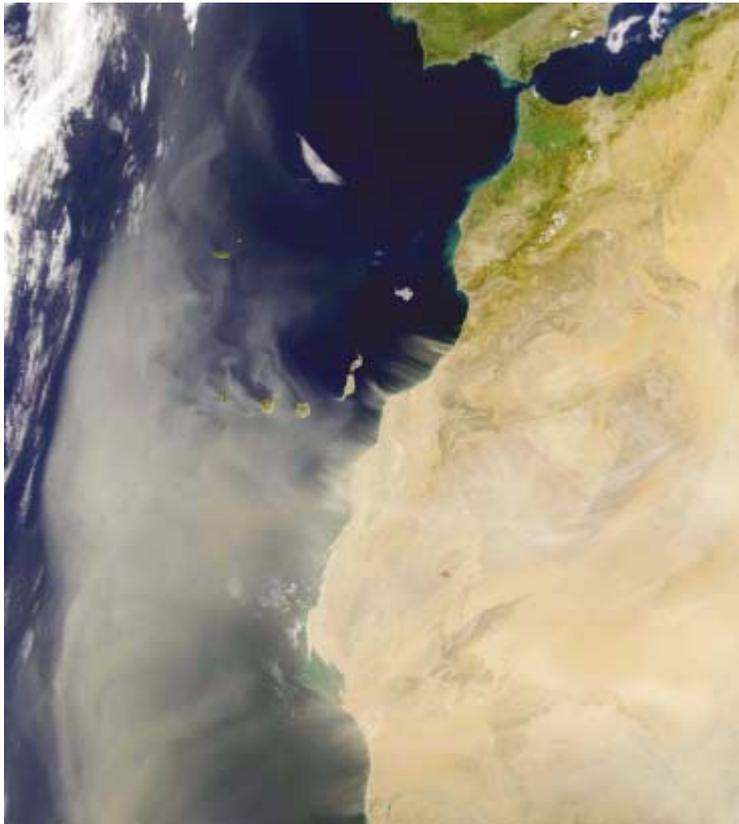


Figure 2. True colour satellite (SeaWiFS) image taken on February 11th 2001 of a massive sandstorm blowing off Northwest Africa and the Sahara Desert and out over the Canary Islands. Wind-blown dust is a key source of iron to biota in the open ocean, and is thought to be central to a climatic feedback system. (The SeaWiFS image was provided by NASA DAAC/GSFC and is copyright of Orbital Imaging Corps and the NASA SeaWiFS project).

What factors might influence aeolian iron supply? The entrainment of dust from the land surface is facilitated by low soil moisture levels (when the cohesive forces that exist between soil particles are minimal) and also by the absence of vegetation cover (which allows greater wind speeds to be reached at ground level). Dust transport out to the open ocean becomes more efficient under a less vigorous hydrological cycle (as a result of decreased dust removal by rainfall over land and coastal regions). CO_2 in the atmosphere can also have a direct ‘fertilising’ effect on vegetation growth. That climate (and

CO_2) should exert a strong control on dust is consistent with information contained within ice cores [e.g., 2] which demonstrate that enhanced dust concentrations are associated with cold dry glacial periods.

Taking these two different linkages in the Earth System together; if changes in dust flux affect atmospheric CO_2 , and therefore climate, and dust fluxes are in turn responsive to global climate (and CO_2), a positive ‘feedback’ loop is formed [5] (see Box). In this feedback system, any cooling of global climate (such as might arise due to orbitally-

driven changes in insolation at the Earth’s surface) will tend to produce an increase in dust availability and transport efficiency. This could, in turn, produce a decrease in atmospheric CO_2 (through iron fertilisation of the biota), causing additional climate cooling and thus further enhanced dust supply. Equally, the feedback loop could operate in the reverse direction to amplify a warming of climate. Preliminary calculations suggest that the operation of this feedback is not uniform in climate space, but exhibits a maximum effect during glacial conditions (when any perturbation of climate could be amplified by over 50%). This is because dust (as recorded at in the Vostok ice core [2]) appears to be relatively insensitive to small changes in climate during interglacials. In addition, CO_2 becomes insensitive to small changes in dust under times of extreme glacial conditions (and maximum dust supply rates) [4], when ocean productivity may no longer be responsive to further iron fertilisation (perhaps due to the onset of limitation by other nutrients [5]). It is possible that operation

“The dust - CO_2 - climate feedback could give rise to two distinct glacial states in the Earth System, one of ‘high- CO_2 low-dust’, and the other ‘low- CO_2 high-dust’.”

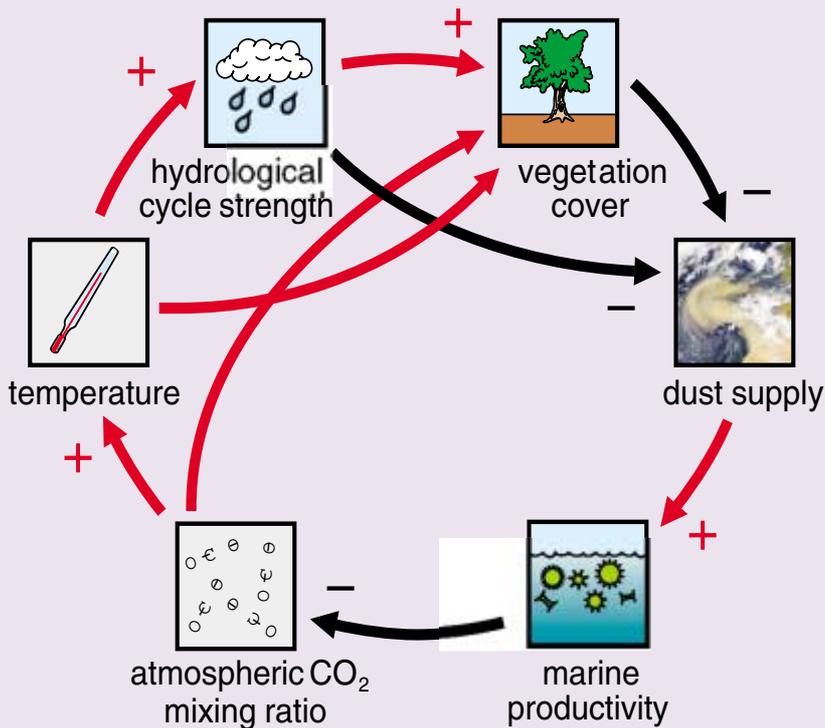
of this feedback could give rise to two distinct glacial states in the Earth System, one of ‘high- CO_2 low-dust’, and the other ‘low- CO_2 high-dust’. This is consistent with developing views of the Earth System as being characterised by the presence of different quasi-steady

Box: What are 'feedbacks'?

Different components of the Earth System can be connected in two different ways:

- with a positive correlation (i.e., an increase in the state of one component causes an increase in a second, or, a decrease in the state of one component causes a decrease in a second);
- with a negative correlation (i.e., an increase in the state of one component causes a decrease in a second, or *vice versa*);

If a path of successive connections can be traced from any given component back to itself, a closed or 'feedback' loop is formed (see Figure). An even number (including zero) of negatively correlated connections counted around the loop gives a positive feedback, which will act to amplify an initial perturbation in the state of any component within this loop. Conversely, an odd number of negative correlations gives a negative feedback, which will tend to dampen any perturbation, thus stabilising the system.



The feedback system is, of course, much more complicated than portrayed in this simplified schematic. For instance, as a result of the optical properties of dust aerosol, the presence of dust in the atmosphere can drive a strong direct radiative forcing of climate. There are also potentially important influences of climate on dust via the growth of ice sheets – both through their ability to produce suitably sized mineral fragments, and in altering sea level (exposing shelf sediments to wind erosion) [5].

Figure. Some of the potential feedbacks involving dust and iron fertilisation in the climate system. Positively correlated connections are shown in red, and negative ones in black. Four main (positive) feedback loops exist in this system, each having a total of two negatively correlated connections within the loop;

- (1) dust supply → productivity → CO₂ → temperature → hydrological cycle → vegetation → dust supply,
- (2) dust supply → productivity → CO₂ → temperature → hydrological cycle → dust supply,
- (3) dust supply → productivity → CO₂ → vegetation → dust supply, and
- (4) dust supply → productivity → CO₂ → temperature → vegetation → dust supply

Examples of feedbacks

The well-known 'ice-albedo' feedback involves the reciprocal interaction between temperature and snow/ice cover. An increase in ice and/or snow cover increases surface albedo, resulting in a reduction in absorbed solar energy and a surface cooling, thus driving a tendency for a further increase in ice/snow cover.

Recent coupled climate-vegetation models have identified the existence of potentially important positive feedbacks between climate and the release of CO₂ from the terrestrial biosphere (particularly in the Amazon), and between climate and vegetation cover in the Sahelian region of North Africa [6,7 respectively]. Misunderstandings can arise in tightly coupled systems such as these since a climatic component may appear to be simultaneously both 'cause' and 'effect' (consider in the 'ice-albedo' feedback; snow cover affects temperature, but yet it is also affected by temperature). However, this situation is simply the basic property of a feedback system.

states with comparatively abrupt transitions between them.

Identifying and quantifying the role of feedback systems such as described here, in amplifying (or suppressing) climatic change may help us to understand not only how the climate system operated in the past (such as during the glacial-interglacial cycles of the past few million years), but how it may respond in the future to continuing greenhouse gas emissions.

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For more information see:

<http://tracer.env.uea.ac.uk/e114/publications.html>

Climate-ecosystem interactions in montane meadows

by J. Harte

Climate change can alter ecosystems and thereby trigger feedback effects that can either enhance or retard the climate change. Such feedbacks are especially likely in montane and high-latitude ecosystems where soils are carbon-rich, sharp transitions in ecosystem community structure are prevalent as a result of topographic variability, vegetation is sensitive to climatic variables such as snowmelt date and length of growing season, and climate change is expected to be large due to snow-albedo feedback. Predicting the chronology and magnitude of such feedbacks is a major challenge in ecology today, as well as an important issue both for global climate change science and policy and, locally, for people whose livelihood is dependent upon montane climatic and ecological regimes.

To investigate montane climate-ecosystem interactions, we are conducting three types of field

studies in subalpine meadow habitat. Central to the research is a climate manipulation exper-

iment (Figure 1) that uses overhead electric heaters to continuously warm five 30m² Rocky Mountain meadow plots (matched with five control plots) by an amount anticipated from global warming models during the middle of this century. The site is at 2920 m, 38°53'N 107°02'W on the western slope of the Colorado Rockies in Gunnison Co. CO, USA. In 1988 we designed the experimental facility and in 1990 began collecting data. Since then we have been routinely monitoring effects of the manipulated climate change on soil microclimate, carbon and nitrogen fluxes and pool sizes, and plant growth, flowering success, physiological vigour, phenology, and species diversity.

The climate manipulation has lengthened the snow-free growing season (Figure 1b) by approximately two weeks at

each end and, during the growing season, increased soil temperatures at 12 cm depth by approximately 1.5°C and decreased soil moisture by about 0.15g(water)/g(soil) [1]. The ecological responses to these climatic changes have included a decrease in annual production, physiological vigour, and flowering success of various species of non-woody flowering plants [2, 3], and an increase in the annual production and physiological vigour of the dominant shrub in the plots, *Artemisia tridentata*, a sagebrush [4]. The plants that were most sensitive to heating were shallow-rooted species, such as *Erigeron speciosus*, the dominant plant species in the plots [5]. We also observed an increase in the rate of net nitrogen mineralisation in the heated plots and a 15% decrease in soil organic matter in the top 10cm of the heated plots. The loss of soil organic matter resulted not from an altered rate of decomposition but rather from the negative net effect of heating on vegetation productivity, which caused a decrease in litter input to the soil [6].

Feedbacks

Two ecologically-mediated feedbacks could potentially result from these responses to warming. The shift in vegetation community structure is altering the energy budget of the plots because the solar reflection coefficients (albedos) of forbs (non-grassy herbaceous species) and sagebrush differ significantly. Sagebrush has a lower albedo and thus the increasing dominance of this species under a warmer climate would lower regional albedo and augment the warming. Currently sagebrush is found on the western

slope of the Colorado Rockies at elevations up to 3100 m, but only in scattered patches as the high elevation limit is approached. We anticipate that future climate warming will result in the increasing dominance of sagebrush in montane meadows of the western U.S. as these scattered patches expand. Very approximate estimation of the magnitude of this

“Climate manipulation has lengthened the snow-free growing season by two weeks at each end..., increased soil temperatures at 12 cm depth by 1.5°C and decreased soil moisture”.

plant-albedo feedback effect suggests that local- to landscape-scale, annually-averaged surface warming could be increased by several watts per m².

A second feedback concerns the carbon cycle. The loss of soil organic matter was not balanced by an increase in living biomass and thus there was a net loss of total ecosystem carbon. If our results could be extrapolated to large spatial and temporal scales, the corresponding increase in atmospheric carbon dioxide would add significantly to the rate of increase of this greenhouse gas, thereby augmenting global warming. But while the warming manipulation has resulted in an initial loss of soil organic matter, we hypothesise that soil organic matter and total ecosystem carbon in the heated plots will recover back toward, or even above, control plot levels during the next decade. This hypothesis is motivated by the fact that shifts in plant community com-

position can alter both the quantity of litter input to soils and the quality of that litter and the soil organic matter that the litter produces. The observed decrease in soil organic matter resulted from the decline in the quantity of annual litter input, but at the same time the quality of that input is decreasing because sagebrush litter is more recalcitrant than is forb litter [6, 7].

Scaling up from experiments

Manipulation experiments provide information on the spatial scale of small plots and the temporal scale of at most a decade or two. How can we extend the knowledge obtained from experimental manipulations

to spatial scales on the order of landscapes and whole biomes and to temporal scales on the order of a century or more? One common approach to achieving this goal invokes the space-for-time assumption, which states that ecological changes observed along a climate gradient (in space) can be directly used to predict how ecosystems along the gradient will respond to a change in climate (over time). Clearly if this assumption were valid, then the enormous effort, use of personnel, and expense of conducting manipulation experiments would be unnecessary and simpler observational work along climate gradients would allow us to predict responses to climate change at large spatial scales.

To test this assumption and extend our knowledge to larger spatial and temporal scales, we are also investigating ecological trends in thirty 16 m² meadow plots that lie along a natural 12 km long elevational and climate gradient within the same

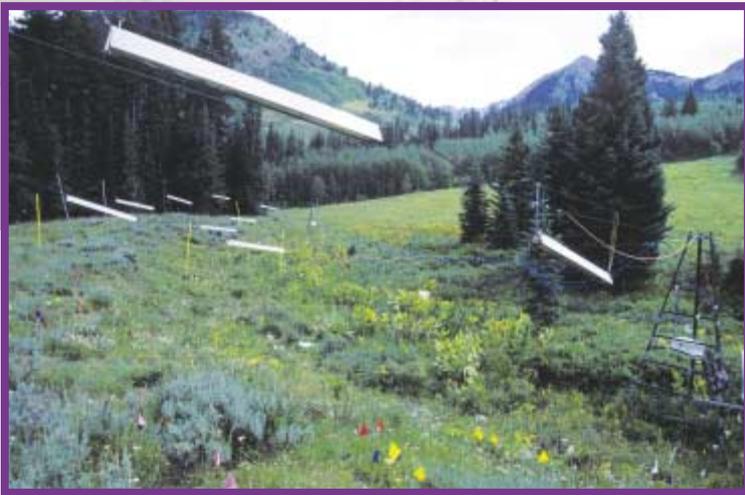


Figure 1.
 a. The warming experiment at the Rocky Mountain Biological Laboratory. The overhead electric heaters deliver approximately 22 watts m^{-2} over the 30 m^2 plots, and have been on day and night, year around, since January 1991.
 b. The experiment in spring. Snow melt in the heated plots is advanced by about 2 weeks, which has significant effects on the timing of flowering, shrub dominance, nutrient cycling and the carbon cycle.

drainage (The Upper East River Valley) as the manipulation experiment. Whereas the controlled climate manipulation provides insights into causal mechanisms governing short-term responses to climate change, gradient studies help elucidate longer-term phenomena; together they are contributing to the construction of an increasingly unified understanding of ecosystem-climate interactions across a range of space and time scales.

For certain ecological response variables we have found the space-for-time assumption to be surprisingly

valid. For example, comparing the response of plant phenology to a) climate manipulation, b) variation in climate along an elevational gradient, and c) inter-annual variation in climate, we have found that for each of these sources of climate variability, the timing of snowmelt explains nearly 100% of the variance in the date of plant flowering in montane meadows for a wide range of species, including both early and late blooming ones. Moreover, the dependence of flowering time on each of these sources of variability is identical, which means that observations along gradients pre-

dict response to manipulation [8].

In contrast, when the space-for-time assumption is naively applied to other response variables, such as soil organic matter, the assumption fails dramatically. However, a combination of laboratory soil incubations at a variety of moisture and temperature conditions, foliage and litter chemical analyses, litter bag experiments, and vegetation censusing along a gradient have permitted us to develop, calibrate, and validate a mathematical model (DWP, or "Decomposition Weighted Productivity") that predicts soil

organic matter both along gradients and in response to manipulations [6]. With the aid of this relatively simple and robust model, the ecological factors that will govern future short- and long-term changes in soil organic matter have been identified and tested.

Climate warming in montane regions will clearly have important ecological consequences, and will trigger climate-ecosystem feedbacks at least at local to landscape scale.

“Climate warming in montane regions will have important ecological consequences, and will trigger climate - ecosystem feedbacks at least at local to landscape scale”.

But could a large climate-induced alteration of carbon sources and sinks in montane ecosystems around the world lead to a significant effect on the global carbon cycle? On the global stage, montane soil carbon plays a secondary role: we estimate that subarctic alpine and subalpine soils contain no more than ~ 3% of global soil carbon. Rather, the global significance of our investigations of montane ecosystem responses to climate warming stems from the insights they provide into spatial and temporal scaling. In particular, our work elucidates the uses and misuses of the space-for-time assumption, and the opportunities for the application of an integrated combination of experimental manipulations, observations along climate gradients, and mathematical modelling to significantly enhance

our ability to predict both ecosystem responses to climate change and climate consequences of climate-induced ecological changes over a wide range of spatial and temporal scales. Although our insights have been obtained from investigations in mountain ecosystems, which are particularly

vulnerable to climate warming, we expect that the methodological lessons learned from this work will be widely applicable.

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An expanded version of this article will appear in a book entitled ‘Global Change and Mountain Regions - a State of Knowledge Overview’ that will be published by the Mountain Research Initiative (<http://www.mri.unibe.ch>) in early 2003. This compilation portrays the status of Global Change research in mountain regions for the ‘International Year of Mountains’ and consists of summaries of recent studies and anticipated future research directions from key researchers in mountain regions around the world. The book will synthesise research that spans both the physical and social sciences and will identify areas where synergies between workers from different fields may be initiated and developed.

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Biogenic controls on trace gas fluxes in northern wetlands

by T.R. Christensen, D. Lloyd, B. Svensson, P.J. Martikainen, R. Harding, H. Oskarsson, T. Friborg, H. Soegaard and N. Panikov

The composition of the atmosphere is critically dependent on microbial activities in soils and sediments as well as those of the terrestrial plant cover. Natural wetlands, an important component of the terrestrial ecosystem in the Northern Hemisphere, constitute only about 3% of the total land surface area but an enormous deposit of soil organic carbon, estimated at about 20% of the global total. The role of these northern wetlands as sources or sinks of CO₂ and CH₄ has been studied in a large-scale integrated study that has looked at the biological, physical and chemical controls on CH₄ and CO₂ emissions, from process level to landscape and large scales. It has found that seasonal soil temperature is the best predictor of CH₄ emissions at the large scale, that the influence of vascular plant productivity is highly species specific, and that the region is a net source of greenhouse gas emission throughout the year, despite the strong mid-summer uptake of CO₂.

In northern wetlands, gradual plant decomposition and microbial decay processes lead to slow deposition of precisely stratified peat, so that in a millennium its depth may increase by a metre. Anoxic sub-surface microbial fermentation and methanogenesis culminate in gaseous exchange of end products from land to atmosphere. Of the eight major quantified sources of methane (wetlands, rice, ruminant animals, termites, fossil fuel, biomass burning, landfill), northern peatlands are one of the league leaders with a global estimate of methane emission of about 40 Tg yr⁻¹. As a source and/or sink of atmospheric CO₂, the role of the northern wetlands is less well defined, but a highly significant contribution to global warming potential is to be expected. Furthermore, current global circulation models are predicting the strongest warming in northern continental areas where most

of the northern wetlands are located. The pronounced temperature sensitivity of methane emissions from peat at many different sites, often giving Q₁₀ values greater than 3 (i.e., the emissions will increase by a factor of 3 over a ten degree temperature change), indicates an alarming potential for positive feedback on climate change.

A number of reports have stressed the complexity of gas emission from wetlands; the major established factors include hydrology (levels of the water tables), nutritional sources, microbial activities, temperature and illumination. The density, type and distribution of the surface vegetation play a critical role in the temporal organisation of gas release, and circadian control of plant physiology is paramount [1]. At the outset of this study, we aimed to integrate this understanding of the mechanisms

and dynamics of land-atmosphere gas exchanges with a detailed series of field investigations along a transect from NE Greenland, over Iceland, N Sweden, N Finland to W Siberia [Table 1], during the period 1998-2001 [2-5]. Our findings have more than confirmed the interdependence and interplay of the separate biological, physical and chemical controls on the carbon budget of the plant-soil-microbe system. The fieldwork has highlighted the relevance of laboratory studies to understanding responses to environmental manipulation (shading) at a number of sites with different vegetation, soil chemistry and climatic conditions [Table 1, Figure 1]. We have also been able to validate the relevance of process studies to large-scale micrometeorological (and chamber) flux measurements. At one site (W Siberia) detailed measurements of hydrological and plant-related subsurface characteristics have been assessed.

Novel flux measurement techniques and ¹⁴C labelling indicate that, of the three path-

“The pronounced temperature sensitivity of methane emissions from peat at many different sites indicates an alarming potential for positive feedback on climate change”.

ways of gas emission (diffusion, plant-mediated transport and ebullition (bubbles)), the latter may account for up to 50% of the total; this route has been difficult to estimate in previous investigations [6]. So called aerenchymatous vascular plants (plants with gas filled pore space in their tissues), typically found



Figure 1. Shading experiments to reduce photosynthesis rates and study the subsequent effects on CH₄ emissions from a high arctic fen of the Zackenberg valley, NE Greenland. This type of experimental manipulation was conducted at all five study sites (Table 1). Photo: Anna Joabsson.

in situations where waterlogging sometimes occurs, are also enormously influential (transport through these account for up to 48% of total CH₄ emission). Plant-mediated facilitation of peat-atmosphere gas transport also includes CO₂ uptake or

production and oxygenation of root systems. The production of photosynthetically-derived root-mediated exudations is highly species-specific and this results in a differential relationship between net ecosystem CO₂ exchange and CH₄ emission

depending on the species of vascular plant present [2, 6]. Thus variations between, and even within, ecosystems are to be expected as a consequence of spatial heterogeneities on a scale of metres, rather than only one of kilometres, as well as at even larger scales.

Innovation and refinement of techniques that allow direct probing of peat cores has allowed measurement of sub-surface gradients of dissolved gases and hence the distribution of the micro-organisms responsible for aerobic respiration, methane oxidation and methanogenesis [7]. The variations in the molar CH₄/CO₂ ratios with depth indicate the shifting balances between competing processes (e.g., methanogenesis and CH₄ oxidation) and the presence of “hot-spots” of microbial activity. Emission rates into the atmosphere are closely linked to the micro-scale characteristics of the peat; methane emissions would be much enhanced (e.g., by as much as 60%) were it not for the extensive consumption of methane by microbial-mediated oxidation in the aerobic surface layer and around plant roots [8].

How will possible changes in the CH₄ emissions from wetlands affect the greenhouse effect in the future?

Over two to three growing seasons at all field sites it was shown that soil temperature is the most influential of all factors, so much so that in fact it eclipses all others (e.g., soil moisture or plant productivity). This is so across large temporal and spatial scales (Figure 2). Water table

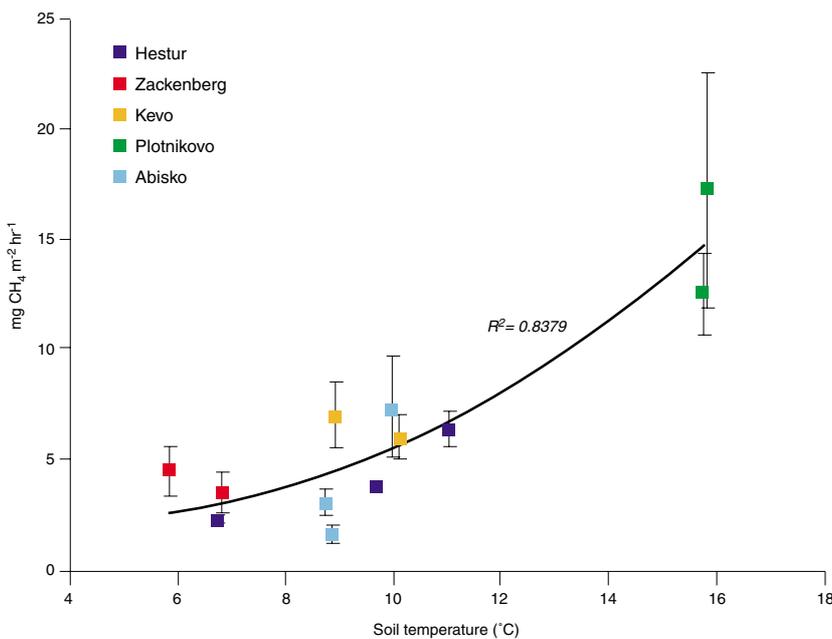


Figure 2. Across all temporal and spatial scales, soil temperature was found to be the most influential of all factors in controlling CH₄ fluxes. Here the relationship between mean seasonal soil temperatures and the overall mean of CH₄ fluxes from the different study sites and years are shown.

level, which usually is an important control on seasonal variations in CH₄ flux at individual sites, is no good as a predictor of fluxes at the large scale. At this scale the water table may act more like an on-off switch. At the relatively wet sites in this study these ‘switches’ are all “on” and variations in the position of the water table matters very little compared to the effect of temperature. As a predictor of future trends we found that even a modest average increase of summer temperature (say 2°C) would, other effects being equal, have the effect of increasing emission from wetlands by as much as 45%. Use of the standard global warming potential (GWP) of 56 (for methane relative to CO₂) suggests that the estimated present global total of 110 Tg CH₄ yr⁻¹ release from wetlands to the atmosphere would thereby be inflated by an annual equivalent of 0.8 Gt. This is equivalent to an extra 80% of the total anthropogenic greenhouse gas emission from

the European Union.

The influence of plant productivity on the CH₄ emissions was studied at the Zackenberg site in NE Greenland where it was shown that the major vascular species *Dupontia psilosantha* showed no correlation with the CH₄ fluxes, whereas the less abundant *Eriophorum scheuchzeri* and *Carex subspathacea* both showed strong correlations [2, Figure 3]. At the Kevo (N Finland) site, effects of shading on photosynthetic rates and methane emissions showed a clear relationship where both were diminished [unpublished and 4]. At other sites this relationship was less clearly shown. In general it was found that the effects of vascular plants on CH₄ fluxes are highly dependent on the species composition and much of the “noise” around the relative straightforward temperature relationship shown in Figure 2 is likely due to site-



Figure 3. Plant productivity and species composition strongly influences CH₄ emissions from northern wetlands. *Eriophorum scheuchzeri*, a wetland species here at Zackenberg, NE Greenland, seems to stimulate net methane emissions. Photo: Anna Joabsson

Continued on page 14...

Name	Position	Dominating vegetation	Climate	Climate annual (July)		Soil characteristics (total mean of top 15 cm)			Aboveground biomass (g dw m ⁻²)
				Temp. (°C)	Precipitation. (mm)	C/N	Bulk density (g dw cm ⁻³)	pH	
Plotnikovo, West Siberia	57°01'N, 82°35'E	<i>Pinus silvestris</i> , <i>Ledum polustre</i> , <i>Sphagnum fuscum</i> , <i>Eriophorum vaginatum</i> , <i>S. angustifolium</i> , and <i>S. magellanicum</i> , <i>Carex rostrata</i> , <i>C. limosa</i> over mosses <i>S. majus</i> , and <i>S. sp.</i> , <i>Equisetum fluviatile</i>	Cool temperate, strongly continental	- 0.5 (18)	513	54.9	0.057	3.8	1693
Kevo, Finland	69°45'N, 27°18'E S	<i>S. linbergii</i> , <i>S. riparium</i> , <i>E. angustifolium</i> , <i>E. russeolum</i>	Subarctic, semi-continental	- 2 (13)	395	51.7	0.033	4.0	530
Abisko, Sweden	68° 22'N, 19° 03'E	<i>C. rotundata</i> , <i>E. vaginatum</i> , <i>S. spp.</i> , <i>E. angustifolium</i>	Subarctic continental/ oceanic	- 0.8 (11)	300	45.1	0.097	4.4	114
Hestur, Iceland	64° 35'N, 21° 36'W	<i>C. rostrata</i> , <i>C. nigra</i> , <i>C. chordorrhiza</i> , <i>E. angustifolium</i>	Subarctic, oceanic	3.2 (10)	643	19.9	0.21	6.4	139
Zackenberg, NE Greenland	74°30'N, 21°00'W	<i>E. scheuchzeri</i> , <i>C. subspathacea</i> , <i>Dupontia psilosantha</i>	Arctic continental	- 10 (4)	214	38.6	0.13	6.2	39

Table 1. Characteristics and climate of the five study sites along a transect from NE Greenland to Western Siberia. The study integrated biological, physical and chemical controls on methane (CH₄) and carbon dioxide (CO₂) emissions in northern wetlands.

The Global Change Newsletter

In March we sent out a survey to find out what you really thought about the Global Change Newsletter. We have been amazed by the flood of replies – a response of more than 10% of the readership is more than we ever hoped for! Even more pleasing was the fact that the overall response was also extremely positive. Only 6% of those that responded wanted to be removed from the mailing list.



The most popular section by far was the 'Science Features' (93% rated it as 'good'), and several people asked for this section to be expanded! Common comments included 'very informative', 'well-balanced topics', 'up-to-date' and many of you said that you used the articles in teaching. Several people thought that the articles could go into more detail.



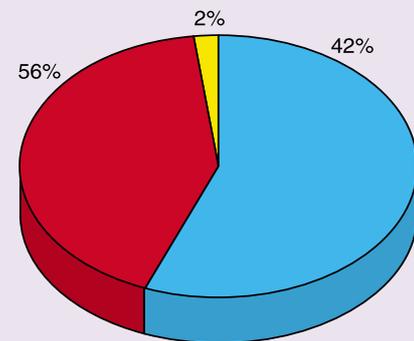
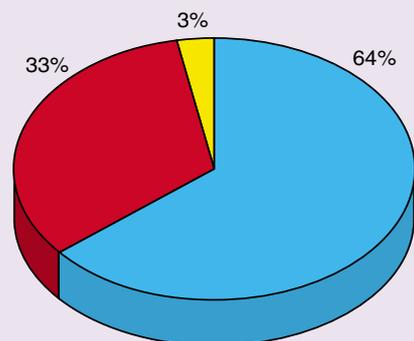
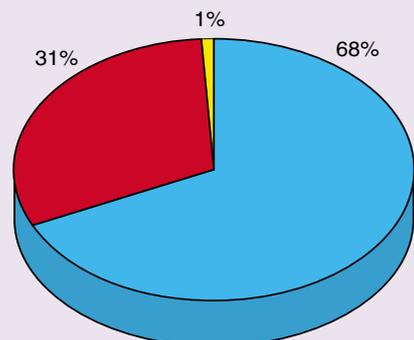
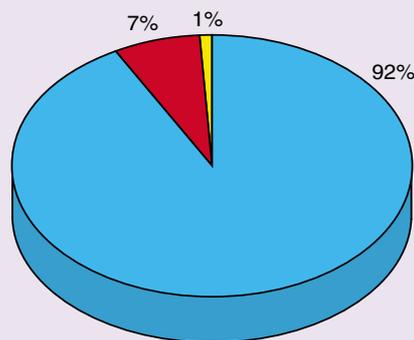
The Discussion Forum is still in its early days, so it was interesting to get your feedback to help us develop this section further. There was a lot of interest in having a section like this, but many felt that for it to be effective, a real dialogue needed to be developed on a focussed subject.



The majority thought that the People and Events section was necessary, but many thought it could be shorter. These comments were probably influenced by this section being unusually large in Newsletter 49, due to the big changes happening during the transition to IGBP II.

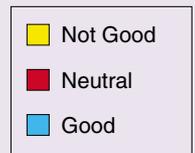
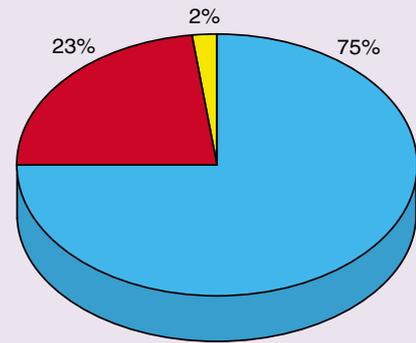


As we have not had much in the 'Correspondence' section recently, responses were very varied, and there was some confusion about what this section was. There is a demand for the opportunity to give feedback, but we may need to reconsider how this is done.



NewsLetter: feedback

The Meetings List was considered a useful resource by 75% of respondents, but at the same time was felt to be getting a little too long. We agree, and have started to include only meetings that are directly relevant to IGBP, or that are scientific meetings with a broad 'global change' appeal. The full list is still available on the web. Many of you also find some the meetings out of date by the time you receive the NewsLetter. It takes some people nearly 3 months to receive the NewsLetter. The problem is very country specific, suggesting that the problem lies with particular countries' postal systems rather than our distribution company in Sweden. We shall take this delay into account and try to look further into the future with our Meetings List.



We also asked if you would prefer to receive the newsletter electronically, by being sent an email alerting you to when the electronic version was available on the website for downloading. (The pdf files are uploaded at the same time that the newsletter is sent out by post, so receiving it electronically cuts out the postage delay). This was partly to try and cut costs by

reducing the number of newsletters that need to be printed, and also to reduce postage costs. More than 300 people (28%) preferred this option, and we have started this procedure with this edition. If you have not replied to the survey but would like to receive the newsletter electronically, please contact Charlotte Wilson (charlottew@igbp.kva.se).

Individual articles from Special Edition (issue 50) now online



"This is by far the best issue of the IGBP NewsLetter

I have yet seen on pretty much all

counts: content, graphics,

editing... I guess you should

abandon the NewsLetter

altogether now,

as this issue will

be very hard to

improve on."

K. Alverson,

PAGES.

www.igbp.kva.se

Available online as a single pdf file, or as individual articles if you wish to download only those articles that interest you.

...continued from page 11.

specific vascular species compositions, with some stimulating net emissions and others diminishing them.

Global warming effects of wetlands, traditionally regarded as sinks for CO₂ (as evidenced by the slow accumulation of peat) and as sources of CH₄ as a consequence of anaerobic processes of decay and decomposition, are evidently complex. The overall greenhouse gas budget for the largest wetlands on Earth, the West Siberian lowlands, was assessed using eddy correlation measurements including the application of a tunable diode laser (TDL) for high frequency measurements of CH₄ (Figure 4). Figure 5 illustrates how landscape-scale measurements of CO₂ and CH₄ fluxes reveal that CH₄ has a greater radiative forcing effect on the atmosphere than does CO₂. This is even the case during the short annual growing season (beginning- to

mid-summer), when CO₂ consumption is at its highest, resulting in this ecosystem type being a source of greenhouse warming throughout the year [9] despite being a strong carbon sink. (Results depend on the timescale applied in the calculation; here we used the standard GWP of 56 for CH₄).

Recent years have seen an upsurge of field studies measuring CO₂ and CH₄ in northern wetland ecosystems and these provide data for better-validated models. Simulations made by two models, MOSES and BIOME4, using data collected in 1999 at the five wetland study sites, have been compared. BIOME4 is a process-based biogeochemistry-biogeographical model, while MOSES is the British Meteorological Office Surface Exchange Scheme used in the Hadley Centre climate models to calculate land-atmosphere fluxes of heat, water and CO₂. Both models were found to give reasonable esti-



Figure 4. An eddy correlation tower, used for CO₂ and CH₄ flux measurements, near the settlement of Plotnikovo in the world's largest wetlands of West Siberia. Photo: Thomas Friborg.

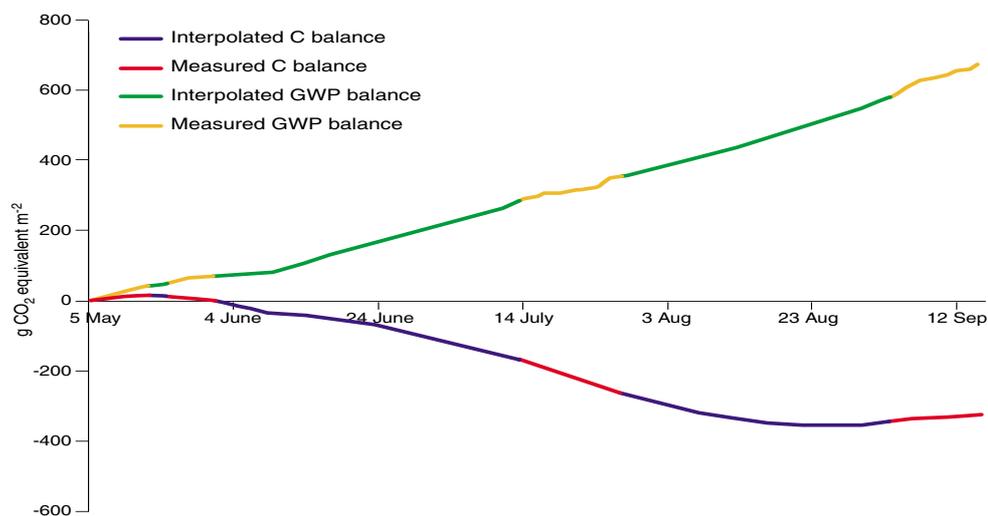


Figure 5. Accumulated carbon and GWP (global warming potential) budget for the Plotnikovo (West Siberia) site in 1999. Landscape-scale eddy correlation measurements of CO₂ and CH₄ fluxes reveal that CH₄ has a greater radiative forcing effect on the atmosphere than does CO₂, even during the summer growing season when the ecosystem is a strong carbon sink. The GWP for methane used in this calculation is the standard value of 56. Negative values represent an uptake of CO₂ equivalents from the atmosphere to the biosphere and positive values represent a release.

mates of gas exchanges and seasonal patterns (e.g., the switches to carbon sinks in spring) at the five sites, although the predictions made using MOSES were generally in closer agreement with the empirical data [10]. Deficiencies in predictive abilities of both models can be corrected by further refinements in future.

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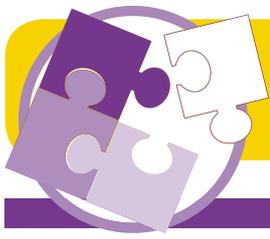
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Acknowledgements

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Integration

New Earth System Atlas

GAIM is initiating the production of an “Earth System Atlas” in order to provide a one-stop address for quantitative and spatially comprehensive information about the Earth System. The intended content is drawn from results of the IGBP and sister programs, as well as from other sources. The goal of the Atlas is to establish a medium for publication of scientific data that will constitute a “high profile publication” ensured by a review procedure comparable to that of a scientific journal, while making the results of Earth System research available to the scientific, lay, and educational communities world-wide.

The Earth’s climate, ecosystems and human activities are highly variable in both space and time. Past changes in climate, atmospheric composition and land use have affected the surface of the planet differently at each location, and all indications of future changes suggest that the pattern in every sphere will continue to be modified. Reconstructions of past environments and monitoring/mapping of the present provide a new quality of understanding of the processes that drive the Earth System. If data from reconstructions, observations and models can be made available easily, while maintaining unified and reproducible quality standards, then model simulations of future change can be made with unprecedented reliability.

Despite some noticeable exceptions, such as the International Satellite Land Surface Climatology Project (ISLSCP), research results describing multiple facets of the Earth System have to date been disseminated in a piecemeal fashion, with no standardised format that would allow comparison and assessment of the relations between the various factors that define and control the planet. To close this information dissemination gap, an Earth System Atlas is under development that will present and link together the myriad global change research results that have emerged in the last decade or so.

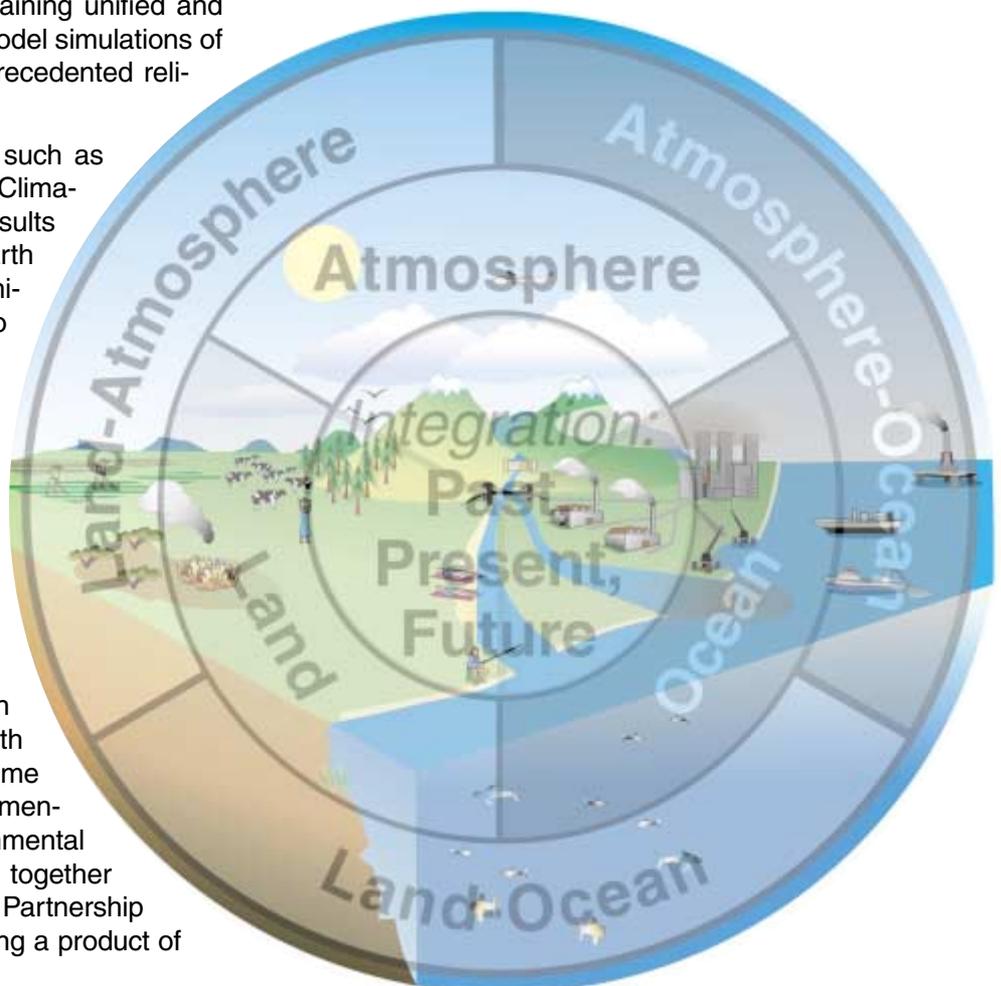
The Earth System Atlas represents an initiative of the IGBP in conjunction with the World Climate Research Programme (WCRP), the International Human Dimensions Programme of Global Environmental Change (IHDP), and DIVERSITAS, together comprising the Earth System Science Partnership (ESSP [1]). As such, it is aimed at being a product of

the entire research community rather than that of a single centre or institute. It specifically aims at including both human, biological and physical dimensions of the Earth System. As an effort by the entire community, the goal is also to provide much stronger quality controls than would be possible within a single research entity.

The purpose of the Atlas is to provide a wide range of users with a series of global change related digital maps and time series, along with access to the underlying data from which they were constructed, and text explanation of data collection, analysis, and other pertinent information.

The target audiences are:

- the global change science community (both within and outside the ESSP),
- the education community,
- government organisations and policy makers, and
- the general public.



The overarching goal of the Atlas will be to provide the results of recent global change research efforts to a broad range of audiences, enhancing the effectiveness of scientific research, enabling informed policy decisions, and providing an educational resource.

Specific objectives include:

- Establish a single source of global change information that has undergone scientific peer review;
- Present research results in an easily understandable format;
- Provide updates as new results and refinements emerge;
- Enable superposition of different aspects of global change for comparison, assessment, and interpretation;
- Link maps and time series with original data;
- Identify conceptual and data gaps that will help direct subsequent work within the research community.

Maps will be created from ground-based and satellite-derived data, conceptual and numerical models, census and additional relevant databases. The Atlas may also include, in addition to maps at global scale, some products at a broad regional scale of particular interest (e.g., the Amazon or the Arctic Basin). An important feature of the Earth System Atlas will be that maps will be developed in such a way that past conditions may be compared visually with the present, and also with future environmental conditions predicted on the basis of current models and forcing scenarios.

One of the primary unique features about the proposed Earth System Atlas is the fact that all data sets will be peer reviewed for quality and with respect to the scientific state-of-the-art. This will involve two phases. The first will be evaluation of any data set for appropriateness and relevance. Once a data set is selected for consideration for the Atlas, the editorial committee will initiate a peer review to scrutinise each data set for completeness, functionality, isolated errors, mismatches, etc. In addition, all accompanying text will be reviewed for accuracy, writing style (for each intended audience), appropriate context and references.

The Earth System Atlas will be produced in electronic form with on-line access in order to provide the broadest possible availability to the general public. Underlying data will be made available in electronic format. The free and open data exchange policy of the International Council of Scientific Unions (ICSU) will apply to all aspects of the Atlas.

The scientific scope of the Atlas will contain categories such as the following (the current list is tentative and reflects an IGBP bias – additions will be made to cover the full spectrum of participating ESSP programmes):

- Physiography
- Climate, Atmospheric Constituents

- Physical/Chemical Data from Ocean and Land
- Hydrology, Biogeochemical Cycles, Ecosystems
- Human Dimensions (population, resource use etc.)
- Future Scenarios (for all variables)

Each data set included in the Atlas will be accompanied by explanatory text describing the data as well as the meaning of the selected display within the Earth System. The text would have the form of extended “figure captions” and would be written specifically for each of four target audiences for the atlas - Earth System scientists; the education community; the policy community; the general public. The text will be fully referenced including data source(s), published literature, and links to data-specific websites, as appropriate.

There are a number of excellent global change-related data compilations and directories already in existence. We will aim to link and incorporate these data archives where possible to create on-line maps and time series. The Atlas will differ from existing data visualisation efforts in that it will have a broad Earth System focus, global coverage, and perhaps most importantly, its review mechanism. The current state of developments was achieved by discussions at several IGBP-SC and GAIM meetings, and various brainstorming workshops. A web-based prototype with several maps is nearing completion and will be presented to GAIM in October, as well as to several potential sponsors.

Following earlier presentations, we have already received many expressions for interest from the scientific community to contribute to, and help shape the Atlas. We currently expect to request formal approval for the initial planning documents from the IGBP Scientific Committee, while also approaching sponsors. As soon as implementation progresses beyond these milestones, we are hoping for a very broad involvement from individuals and organisations through participation in the steering committee, contribution of data sets or review of material. Interests for such participation are welcomed at any time by the authors.

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Discussion Forum

Over the last decades, IGBP and its projects have accomplished an outstanding job and have produced new and innovative scientific results. They have played a key role in defining the concept of Earth System science. The success of this enterprise is due primarily to a very active international research community, and specifically to many individuals who have served in different capacities on various IGBP committees and scientific groups.

A New Generation for the New IGBP

On behalf of IGBP, I would like to thank all our colleagues who have contributed to the success of the first phase of the programme. We all hope very much that these colleagues will continue to play a leadership role during the second phase of IGBP.

As we are entering the new phase of our programme and are developing stronger relations with other global change organisations, including WCRP, IHDP and DIVERSITAS, it is important to open IGBP more widely towards a broader group of scientists everywhere in the world. The transition that is underway is an opportunity to attract a new generation of researchers, the generation that will address the new challenges highlighted by the renewed IGBP projects.

In spite of constant efforts, IGBP remains too distant from individual scientists, and actions must be taken to discover future leaders and associate them with our projects. Every visit made by Will Steffen and myself in different parts of the world has revealed the presence of young talents from which international research could benefit.

In late January, the IGBP Science Committee will be asked to consider how to open more widely the IGBP structure and how to better involve high quality projects under development in key research institutions. Several ideas will be discussed:

- The appointment in IGBP project Science Steering Committees of 'Corresponding Members' may help 'rising stars' to contribute more easily to IGBP activities.
- The definition of a new role for the IGBP (or Global Change) National Committees should facilitate the links that exist between national initiatives and IGBP projects.

- The translation of some of our science documents into different languages, with the help of National Committees, should enhance our ability to communicate with the international research community. (A Chinese translation of Science 4 is already in progress).
- The organisation of an international network associating institutions focussing on interdisciplinary Earth System research would produce strength and continuity in research projects, and provide mechanisms for the exchange of scientist and students between different parts of the world.

We would very much welcome your feedback on these ideas, and any additional suggestions of how we can find and involve new blood from around the world.

While we are maintaining the highest scientific standards within the IGBP activities, it is important that the programme be more widely open to fresh talents, be more innovative and integrative of several disciplines. IGBP is not a 'club for a few recognised leaders'; it is the home of a large international community, the home of innovative scientists who will address in the next decade exciting questions from different perspectives and with different methodologies. This is the challenge for Earth System science and for IGBP.

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People and events



Meinrat (Andi) Andreae is a new co-Chair of the transition team of the Land-Atmosphere project of IGBP II (tentatively called iLEAPS). He joins fellow co-Chair Pavel Kabat, and Almut Arneth who is assisting in the planning process (as well as helping IGBP Chair Guy Brasseur – see NL49).

Dr Andreae's involvement with IGBP began in 1985, when he co-authored a background paper that provided the initial outline for research on atmospheric chemistry within IGBP (Crutzen PJ & Andreae MO. Atmospheric chemistry. In 'Global Change' Eds TF Malone & JG Roederer. pp



Louis Pitelka is the new Chair of GCTE. He first became associated with GCTE in 1995 when he served as a reviewer of the GCTE project, as part of the five-year review of IGBP. He has served

on the GCTE SSC since 1996 as an Activity leader.

Dr. Pitelka began his research career working in the areas of plant physiological ecology and population biology, but his interests have shifted increasingly to the functioning of terrestrial ecosystems, particularly carbon cycling and the effects of climate and other global changes. He also is very interested in issues related to the science-policy inter-

75-113, ISCU Press/CUP). Since then he has been a participant and organiser of workshops that defined research on biosphere/atmosphere interactions and biomass burning in IGAC, and was convenor of the IGAC Biomass Burning Experiment (BIBEX) from 1990-1998. He also participated in the design of the first Integrated Regional Study, the Large-Scale Biosphere/Atmosphere Experiment in Amazonia (LBA), and has been a member of its scientific steering committee since 1998. His expertise has led to his membership of the European Commission Science Panel on Atmospheric Composition Change.

His present research interests are focused on the tropics, where he is investigating the interactions between the biosphere and atmosphere. In particular, he is interested in the fluxes of nitrogen oxides and hydrocarbons in the soil/canopy/atmosphere system, the production of aerosols by biological processes and vegetation fires, and the impact of these aerosols on atmospheric chemistry and climate.

face and the effective transfer of research results to decision-makers. He is currently Director of the Appalachian Laboratory, one of three research laboratories in the University of Maryland Center for Environmental Science, where he is a Professor.

Dr. Pitelka recently completed a term as Editor-in-Chief of Ecological Applications and currently serves on the editorial boards of Oecologia and Frontiers in Ecology and the Environment (a new journal of the Ecological Society of America). He has served on numerous planning, coordinating, and review committees for both national and international organisations.

Here at the Secretariat, Anna Bastås will be helping John Bellamy, until the end of December, with IGBP graphic design duties and the IGBP synthesis book.

IGBP and Related Global Change Meetings

For a more extensive meetings list please see our web site at www.igbp.kva.se

IGBP: OCEANS Open Science Conference Organising Committee Meeting

13-15 November, Washington DC, USA

Contact: Ed Urban, scor@jhu.edu

LUCC: Workshop entitled "Trajectories of Land Change in the Tropics";

16-19 November, Arizona State University, USA

Contact: LUCC Focus 1 office, focus1@indiana.edu

IGBP, IHDP, WCRP: Global Carbon Project Scientific Steering Committee

18-21 November, Tsukuba, Japan

Contact: Pep Canadell, pep.canadell@csiro.au

SOLAS: 2nd SOLAS SSC Meeting

24-27 November, Gif-sur-Yvette, Paris, France

Contact: Elsa Cortijo, Elsa.Cortijo@lsce.cnrs-gif.fr

Our ESSP partner programme, IHDP, has a new Scientific Committee. In addition to three new members (Dr. Tatiana Kluvankova-Oravska, Prof. Roberto Sanchez-Rodriguez, and Dr. Paul L.G. Vlek), IHDP has a new Chair and Vice Chair. A full up-to-date list of the IHDP SC is available on their website (<http://www.ihdp.org>). In addition, from Nov 1st they have a new Executive Director, Barbara Goebel.

Prof. Coleen Heather Vogel: IHDP Chair

Coleen Vogel is an Associate Professor in the School of Geography, Archeology and Environmental Studies of the University of the Witwatersrand, Johannesburg, South Africa.

Her research interests are focussed in the interface between the biophysical and human dimensions of environmental change in the southern African region. She is also active in networks and research that investigates ways in reducing environmental risks that may arise from environmental and other changes (e.g., drought). This work includes ways

to improve the usefulness and uptake of seasonal forecasts in reducing risk to environmental change, vulnerability research that identifies who and what is most at risk to environmental change, disaster mitigation and disaster-risk reduction research and policy. Other research areas include climatology and the reconstruction of climate over the past 100-200 years.

Her IGBP-related positions have included being Co-Vice Chair of LUCC (IHDP related issues) and also include being Committee Member of the South African Scientific Committee for Global Change (formerly an IGBP National Committee) and a Board Committee Member of SA ICSU National Board.



Prof. M.A. Mohamed Salih: IHDP Vice-Chair.

Mohamed Salih is Professor of Politics of Development at the Institute of Social Studies in The Hague, and the Department of Political Science,

University of Leiden, The Netherlands. His research focuses on politics and sustainable development issues in Africa, with particular reference to environmental policies and institutions, resource conflicts and the politics of national environmental action plans and conservation strategies.

LUCC: One-day workshop on LUCC Contribution to Asian Environmental Problems

2 December, Hyderabad, India

Contact: LUCC Focus Office 2, lucc2002@skl.iis.u-tokyo.ac.jp

JGOFS: Continental Margin Task Team Workshop for the Global Synthesis of the 5 Regional Syntheses

4-6 December, Washington DC, USA

Contacts: Larry Atkinson, atkinson@ccpo.odu.edu or Renat Quiñones, rquinone@udec.cl

AGU 2002 Fall Meeting

6-10 December, San Francisco, CA, USA

Contact: AGU Meetings Department, meetinginfo@agu.org or <http://agu.org/meetings/fm02/>

Advanced Training Workshop on Land Use and Land Cover Change Study

8-20 December, Taipei, Taiwan

Contact: Wen-Je lin, morp4@gcc.ntu.edu.tw

START, LOICZ: APN/START/LOICZ Regional Workshop on Assessment of Material Fluxes to Coastal Zone in South Asia and their Impacts

9-10 December, Colombo, Sri Lanka

Contact: Janaka Ratnasiri, janakar@itmin.com

GLOBEC: IOC/SPACC Study Group Workshop on Use of Environmental Information on the management of pelagic fish populations

9-11 December, Paris, France

Contact: Manuel Barange, m.barange@pml.ac.uk

Training Program on DSAAT Version 4: Assessing Crop Production, Nutrient Management, Climatic Risk and Environmental Sustainability with Simulation Models.

9-18 December, Griffin, Georgia, USA

Contact: Gerrit Hoogenboom, gerrit@griffin.peachnet.edu or <http://www.ICASAnet.org>



in cooperation with GAIM – IGBP and WGCM – WCRP

Announcement and Call for Papers

International Conference on Earth System Modelling

(formerly “International Conference on Modelling of Global Climate Change and Variability”)

15 –19 September 2003

Four years after the Fourth International Conference on Modelling of Global Climate Change and Variability, we are pleased to invite the scientific community involved in Earth System research to meet in Hamburg. The conference addresses global, regional and reduced complexity modelling. It will provide an opportunity to present new results in this field and to discuss recent developments and plans for the future.

The Program Committee invites contributions on any of the following subjects:

A. Development and Evaluation of Comprehensive Earth System Models

- 1) Atmosphere, Oceans and Sea-Ice
- 2) Atmospheric Chemistry (Aerosols, Sulphur Cycle, Ozone, etc.)
- 3) Biosphere in the Climate System
- 4) Modeling Paleo-Environments
- 5) Data Assimilation and new Earth System Data Sets
- 6) The Human Dimensions in the Earth System

B. Variability of the Coupled Earth System at Different Time Scales

- 1) Seasonal to Interannual Time Scales
- 2) Decadal to Centennial Time Scales
- 3) Changes in Variability Modes as seen in Records and Modelling Studies of Past

Climates

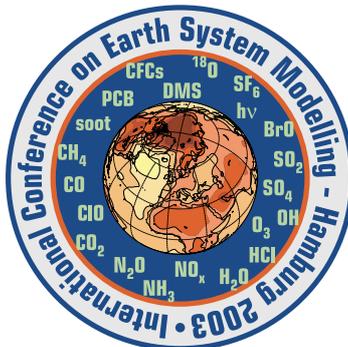
C. Anthropogenic Climate Change

- 1) Detection and Attribution
- 2) Climate Change Prediction
- 3) Simulation of Historical Climates
- 4) Greenhouse Gases, Aerosols, Land Use Change in the Present, Past and Future
- 5) Assessing the Risk of Extreme Events and Singularities
- 6) Integrated Assessments

Each subject covers global as well as regional aspects and will be introduced by an invited lecture.

Abstracts for reviewing should be sent via web by the Internet address listed below.

In order to receive further circulars for this conference, please express your interest by 15 December 2002.



Contact:

Max Planck Institute for Meteorology Conference Office “International Conference on Earth System Modelling”

Bundesstr. 55, D-20146 Hamburg, Germany

Tel: +49-40-41173-311 Fax: +49-40-41173-366

2003

IGBP: OCEANS Transition Team Meeting

6 January, Paris, France - (also 12-13 January)

Contact: Wendy Broadgate, wendy@igbp.kva.se

IGBP, SCOR: Open Science Meeting for the Developing Ocean Biogeochemistry and Ecosystems Project

7-10 January, Paris, France

Contacts: Wendy Broadgate, wendy@igbp.kva.se
Ed Urban, scor@ihu.edu or <http://www.igbp.kva.se/ocean/>

IGBP: IGBP Ocean Vision Workshop

11 January, Paris, France

Contact: Karin Lochte, klochte@ifm.uni-kiel.de

IGBP, SCOR: IOC-SCOR-GCP International Ocean Carbon Coordination Workshop

13-15 January, Paris, France

Contact: Maria Hood, m.hood@unesco.org

GLOBEC: GLOBEC-NEP/CGOA Symposium on Marine Sciences in the Northeast Pacific: Science for Resource Dependent Communities

13-17 January, Anchorage, Alaska

Contact: Hal Batchelder, hbatchelder@coas.oregonstate.edu

IGBP: 18th SC-IGBP Meeting

20-23 January, Punta Arenas, Chile

Contact: Clemencia Widlund, clemencia@igbp.kva.se

IGBP: Symposium & Global Change: Toward a Systemic View

23-25 January, Punta Arenas, Chile

Contacts: María Soledad Astorga, mastorga@aoniken.fc.umag.cl
or Laura Gallardo, lgallard@dim.uchile.cl or <http://www.cmm.uchile.cl/scc2003/>

IAI, IGBP: 3rd Collaborative Research Network Meeting

27-28 January, Mendoza, Argentina

Contact: Gerhard Breulmannerhard@dir.iai.int

IHDP: SC-IHDP Meeting

5-7 March, Bonn, Germany

Contact: Lisa Jibikilayi, jibikilayi.ihdp@uni-bonn.de

APN Science Planning Group Meeting

10-11 March, Hanoi, Vietnam

Contact: APN Secretariat, info@apn.gr.jp

APN Inter-Governmental Meeting

13-14 March, Hanoi, Vietnam

Contact: APN Secretariat, info@apn.gr.jp

This conference offers a prestigious platform for young scientists to present their research findings to leading scientists in the field. The idea was conceived at the Open Science Conference in Amsterdam, 2001, to provide a forum for young global change scientists, particularly those from developing countries. It is intended to stimulate competition, encourage excellence, reward outstanding performance, and encourage the development of personal and institutional networks. Furthermore, distinguished invited keynote speakers will give plenary presentations. The language of the conference is English.

If you wish to attend, please contact Kristy Ross by the end of November 2002.

She may also be contacted for further information or to submit abstracts and CVs.

E-mail: kristy@crg.bpb.wits.ac.za Fax: +27 11 717-6535

Postal address: Climatology Research Group
University of the Witwatersrand
Private Bag 3
WITS 2050
South Africa

Y^{1ST} INTERNATIONAL YOUNG SCIENTISTS

GLOBAL CHANGE CONFERENCE
16-19 November 2003 Trieste, Italy

Call for Papers

Submissions of papers and posters are invited from young scientists (age 35 years or less) on the physical, biological and human aspects of global change. Selection of papers and posters shall be on the basis of scientific excellence, taking into account the need to achieve a thematic and regional balance. Authors will be expected to publish their papers in international journals.

Abstracts are due on Friday 14 March 2003. Submissions should not exceed 300 words, must include a title and authors' names and affiliations, and be accompanied by a brief curriculum vitae, including institution, contact details, age, qualifications, research, and publications of the presenting young scientist.

Costs

Wherever possible, those having papers/posters accepted will have their full costs covered. In the event of insufficient funds, participants from developed countries may be required to cover their own travel expenses.

Hosted by the Third World Academy of Sciences and the Abdus Salam International Centre for Theoretical Physics

Funded by START and the Norwegian Agency for Development Cooperation.

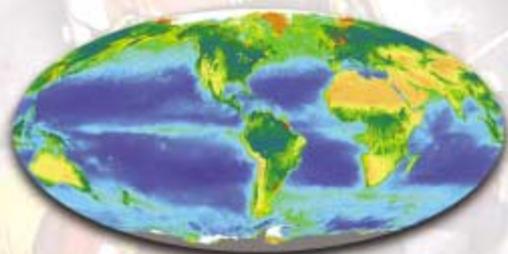


Final Open Science Conference

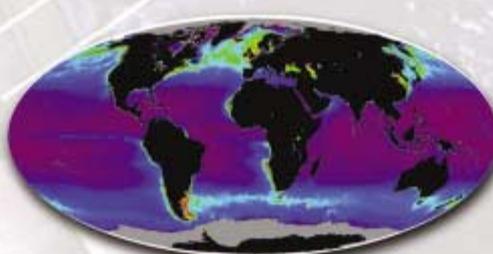
"A Sea of Change: JGOFS Accomplishments and the Future of Ocean Biogeochemistry"

U.S. National Academy of Sciences,
Washington, D.C., USA

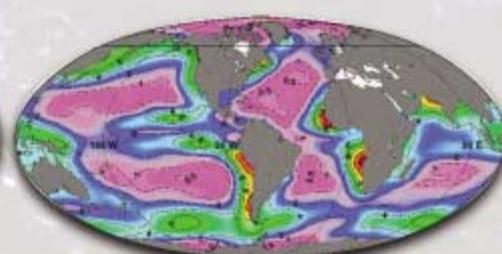
5-8 May 2003



Ocean Colour



Primary Production



Export

3rd World Water Forum

16-23 March, Kyoto, Shiga and Osaka, Japan

Contact: <http://www.worldwaterforum.org>

START: Integrated Regional Study of Global Change in Asia Session in conjunction with the XX Pacific Science Congress

17-21 March, Bangkok, Thailand (tentative)

Contact: Congbin Fu, sec@tea.ac.cn

International Symposium on Climate Change (ISCC)

31 March-3 April, Beijing, China

Contacts: Mr.Wang Bangzhong, Ms.Zhang Yan or Ms.Chao Qin-gchen, ISCC@cma.gov.cn

GLOBEC: BENEFIT-GLOBEC Forum 2003

TBA, April, Swakopmund, Namibia

Contact: BENEFIT Secretariat, skapepu@mfmr.gov.na

European Geophysical Society/AGU/EUG Joint Assembly 2003

7-11 April, Nice, France

Contact: EGS Office, egs@copernicus.org or <http://www.copernicus.org/egsagueug/index.html>

Framing Land Use Dynamics: Integrating knowledge on spatial dynamics in socio-economic and environmental systems for spatial planning in western urbanized countries

16-18 April, Utrecht University, The Netherlands

Contact: Organising Congress Bureau, framingland@fbu.uu.nl or <http://networks.geog.uu.nl/conference>

JGOFS: 18th JGOFS Scientific Steering Committee Meeting

TBA, May, Washington, DC, USA

Contact: Roger Hanson, Roger.Hanson@jgofs.uib.no

JGOFS: Final JGOFS Open Science Conference

5-8 May, Washington, DC, USA

Contacts: Roger Hanson, Roger.Hanson@jgofs.uib.no
Ken Buesseler, kbuesseler@whoi.edu

GLOBEC: GLOBEC-PICES-ICES Zooplankton Production Symposium

21-23 May, Gijon, Spain

Contact: Luis Valdes, luis.valdes@gi.ieo.es

AGU Chapman Conference on Ecosystem Interactions with Land Use Change

14-18 June, Santa Fe, New Mexico, USA

Contacts: Ruth DeFries, rd63@umail.umd.edu or Greg Asner, greg@globalecology.stanford.edu or <http://www.agu.org/meetings/chapman.html>

IGBP: 3rd IGBP Congress and associated SSC meetings

19-24 June, Banff, Canada

Contacts: Clemencia Widlund, clemencia@igbp.kva.se
Charlotte Wilson-Boss, charlottew@igbp.kva.se
Contact project IPOS for SSC information

SOLAS: SOLAS Summer School

30 June-11 July, Corsica, France

Contact: Corinne Le Quéré, lequere@bgc-jena.mpg.de or <http://www.bgc.mpg.de/~corinne.lequere/solas/>

The Impact of Global Environmental Problems on Continental & Coastal Marine Waters

16-18 July, Geneva, Austria

Contact: <http://www.unige.ch/sciences/near>

PAGES: 9th International Paleolimnology Symposium

24-28 August, Otaniemi Espoo, Finland

Contacts: Atte Korhola, Atte.Korhola@helsinki.fi or Veli-Pekka Salonen, Veli-Pekka.Salonen@helsinki.fi or Antti Ojala, antti.ojala@gsf.fi

WCRP, GAIM: GAIM and WGCM - International Conference on Earth System Modelling

15-19 September, Hamburg, Germany

Contact: Annette Kirk, annette.kirk@dkrz.de

PAGES: World System History and Global Environmental Change

19-22 September, Lund, Sweden

Contact: <http://www.pages.unibe.ch/calendar/2003/lund.html>

START: Young Scientists 1st International Global Change Conference

16-19 November, Trieste, Italy

Contact: Kristy Ross, kristy@crg.bpb.wits.ac.za

2004

GLOBEC: IOC-SCOR-GLOBEC Symposium on 'Quantitative Ecosystem Indicators for Fisheries Management'

31 March-3 April, Paris, France

Contacts: Philippe Cury, curypm@uctvms.uct.ac.za or Villy Christensen, v.christensen@fisheries.ubc.ca

GLOBEC: 4th World Fisheries Congress, Reconciling Fisheries with Conservation: The Challenges of Managing Aquatic Ecosystems

2-6 May, Vancouver, Canada

Contact: <http://www.worldfisheries2004.org/>

GLOBEC: ICES-GLOBEC Symposium on 'The Influence of Climate Change on North Atlantic Fish Stocks'

11-14 May, Bergen, Norway

Contact: Harald Loeng, harald.loeng@imr.no

Note to contributors

Articles for "Science Features" should achieve a balance of (i) solid scientific content, and (ii) appeal for the broad global change research and policy communities rather than to a narrow discipline. Articles should be between 800 and 1500 words in length, and be accompanied by one to three key graphics or figures (colour or black and white).

Contributions for "Discussion Forum" should be between 500 and 1000 words in length and address a broad issue in global change science. A "Discussion Forum" article can include up to 2 figures.

Contributions for 'Integration' should be between 800-1200 words in length and highlight how IGBP or its core projects are integrating with other areas of Earth System Science. The article can include up to two figures.

"Correspondence" should be no more than 200 words and be in the form of a Letter to the Editor in response to an article in a previous edition of the Newsletter or relating to a specific global change issue. Please include author and contact details.

Required Image Quality for IGBP Publications

Photographic images should be saved in TIFF format. All other images including charts, graphs, illustrations, maps and logos should be saved in EPS format. All pixel images need to be high resolution (at least 300 pixels per inch).

Some charts graphs and illustrations can be reconstructed at the IGBP Secretariat, however, poor quality photographic images, maps and logos cannot be improved. Material "borrowed" from the Internet cannot be used for publication, as it does not fit the requirements listed above.

If you have queries regarding image quality for the Global Change NewsLetter please contact John Bellamy
E-mail: john@igbp.kva.se

Please note: figures of any kind must either be original and unpublished, or (if previously published) the author(s) must have obtained permission to re-use the figure from the original publishers. In the latter case, an appropriate credit must be included in the figure caption when the article is submitted.

Deadlines for 2002 - 2003:

December issue	Deadline for material: November 1
March issue	Deadline for material: Feb 3, 2003
June issue	Deadline for material: May 5, 2003
September issue	Deadline for material: Aug 4, 2003

Send contributions by email to the Editor, Clare Bradshaw
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