International Geosphere-Biosphere Programme

Introduction

The International Geosphere-Biosphere Programme (IGBP) is a research programme that studies the phenomenon of Global Change (www.IGBP.net). IGBP research addresses the interactive physical, chemical and biological processes that define Earth System dynamics, changes that are occurring in these processes and the role of human activities in these changes. IGBP contributes to new knowledge on climate change, as well as many other global environmental change issues, by coordinating research activities through the IGBP Core Projects and by organising workshops and synthesis activities that bring together scientists from a wide range of disciplines. The nine Core Projects of IGBP address processes on land, in the atmosphere and oceans, and the interfaces between these. The projects include two integrative crosscutting projects that address future and past global change. Many IGBP activities have considerable collaboration with other partner programmes.

Research highlights

An eye on the Arctic coast

A recent report entitled "State of the Arctic Coast 2010: Scientific Review and Outlook" provides a comprehensive picture of the status and current and anticipated changes in the most sensitive Arctic coastal areas. The assessment takes a social-ecological approach that explores the implications of change for the interaction of humans with nature. The report is aimed to be a first step towards a continuously updated coastal assessment and to identify key issues seeking future scientific concern in an international Earth system research agenda. The report is organized in three parts: the first provides an assessment of the state of Arctic coastal systems under three broad disciplinary themes – physical systems, ecological systems, and human dimensions; the second examines progress in integrative approaches to monitoring, understanding, and managing change in Arctic coastal systems; the third identifies data gaps and research priorities over the coming decade.

> *Forbes D L (2011) State of the Arctic Coast 2010 – Scientific Review and Outlook. http://arcticcoasts.org*

Ocean fertilisation summary for policymakers published

Geoengineering schemes involving ocean fertilisation to tackle climate change have a low chance of success, according to a new summary for policymakers on the issue. Ocean fertilisation involves adding iron or other nutrients to the surface of the ocean to trigger growth of microscopic marine plants – these plants use dissolved carbon dioxide to grow, which led to the idea that deliberate fertilisation of the ocean on a large scale would remove carbon dioxide from the atmosphere. The summary notes that there are still major knowledge gaps. For example, it is unclear whether findings from small-scale experiments apply fully to larger scales. And a major concern is the possibility of large-scale fertilisation having unintended consequences for ecosystems. The latter was the theme of an IGBP synthesis workshop held in La Jolla, California, at the end of January. A diverse group participated in this assessment, and a report will be published shortly.

> *Wallace D W R et al. (2011). Ocean Fertilization. A Scientific Summary for Policy Makers. IOC/UNESCO, Paris 2010. IOC Brochure 2010-2.*
> *http://unesdoc.unesco.org/images/0019/001906/190674e.pdf*

Bounding the role of black carbon

A major assessment report on the role of black carbon in climate is due to be published in 2011. The report will: 1) summarize the state of the science of black carbon as a climate forcing agent and, specifically, the implications for mitigation decisions. The information will contribute to decisions that allow co-benefits for both climate and air quality/human health. 2) explain widely-varying forcing estimates, especially in the context of IPCC values, thus providing updates to AR4, and input to AR5. 3) present bounded uncertainties, especially for co-emitted species and cloud changes. 4) hand over usable numbers for mitigation decisions, which will be assured by engaging policymakers from the start.

Nitrogen and climate

Humans have perturbed the nitrogen cycle greatly, leading to substantial environmental effects as well as economic ones. Nitrogen also has direct and indirect contributions to climate change. The direct contributions are increased emissions of N_2O (nitrous oxide) to the atmosphere. The indirect contributions include, for example, increased concentrations of O_3 (ozone). Both N_2O and O_3 are greenhouse gases and contribute to atmospheric warming. Another indirect contribution is the increased loading of nitrogen-containing aerosols, which have the potential to scatter solar radiation and will act as a cooling agent. And nitrogen compounds enhance the productivity of ecosystems, thereby sequestering carbon. The net effect of the human perturbations of the nitrogen cycle is cooling of the climate, according to a report that emerged in October 2010. This will be discussed further at a joint workshop of the IPCC and the Task Force on Reactive Nitrogen proposed for later this year.

Terrestrial carbon budget refined

Researchers have announced that global vegetation draws down 123 billion tonnes of carbon from the atmosphere each year. The most accurate measurement to date of the carbon exchange between amosphere and land was made possible by a global network of over 250 measuring stations. The result will help improve climate models because the terrestrial carbon balance is a major area of uncertainty.

The highest gross carbon uptake in terrestrial ecosystems is found in tropical forests – over a third (34 percent) of the carbon dioxide (CO_2) uptake from the atmosphere. Savannahs cover twice the area but account for about one quarter (26 percent) of the global CO_2 uptake. The research team, from 18 institutes, also discovered that rainfall plays a more significant role than previously thought in determining the amount of carbon captured by plants during photosynthesis. Precipitation rates were found to have considerable influence in more than 40 percent of vegetated regions, and in half of all croplands. This has important implications for global food production.

Beer C et al. (2010) Science 329: 834-838.

Forest and Grassland Response to European Heat Waves

Europe experienced major heat waves in 2003 and 2006, and such waves are expected to become more frequent in the future. Depletion of soil moisture played a part, but how did the type and distribution of vegetation influence the temperature extremes? A team of researchers reports that forests and grasslands responded in fundamentally different ways during the course of these prolonged heat waves.

The team's analyses show that the surface over grasslands is cooler than that over forests during the early stages of a heat wave. This is because of higher evaporation over grass. But eventually this causes soil-moisture depletion in the grasslands, and there is a shift in behaviour as the heat wave advances: the surface over grasslands begins heating up and might cause a shift in the regional climate to even higher temperatures. Prolonged dry and warm conditions during the summer of 2003 in Europe meant that grassland became the main source of heating during the later stages of the heat wave. This likely explains the extreme temperatures measured in this region in August 2003. The researchers contend that forests could serve to ameliorate the effects of prolonged and severe heat waves, and also contribute to preserving water by virtue of generally lower evapotranspiration.

Teuling AJ et al. (2010) Nature Geoscience 3: 722-727.

Researchers call for systematic analysis of Southern Ocean food webs

The Southern Ocean region is experiencing rapid changes in ocean temperature and seasonal ice cover, and showing significant changes at all trophic levels. Complex interactions within food webs modify responses of individual species and influence the response of entire ecosystems to change. Yet ecological research in the Southern Ocean is often centred on key species or localised systems, a tendency that is reflected in much of the modelling effort to date. To build on this, the researchers say, a systematic analysis of regional food web structure and function is required.

Murphy E J et al. (submitted). Special issue of Progress in Oceanography on Comparative Analysis of Marine Food Webs.

Contact:

Sybil P. Seitzinger, Executive Director IGBP: sybil.seitzinger@igbp.kva.se

Webmail: http://www.igbp.net/