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New Project will Measure Secondary Organic Aerosols in the Tropics

Secondary organic aerosols (SOA) are key in the assessment of the role of the rainforest as the heat engine of the planet, driving the weather and climate globally. The aim of this new project is to provide, through direct measurements of SOA in the Amazonian basin, key information for climate modellers about the sources, transformation and fate of these aerosols.

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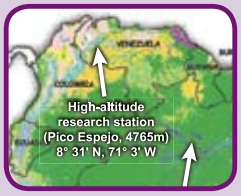
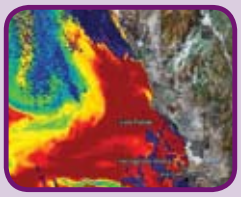
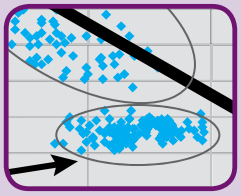


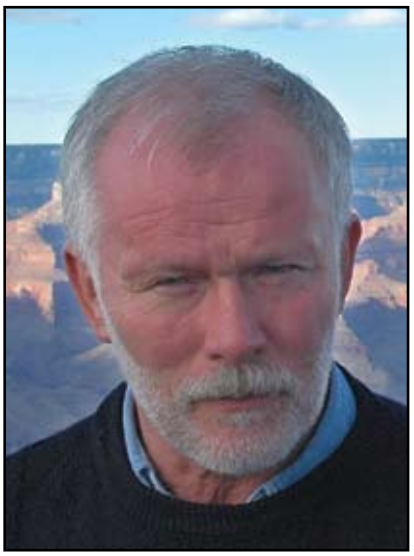
National Committee Science





Guest Editorial

Including Humans in (Earth System) Modelling



In these days of rapid global environmental change, we are indebted to the natural and life sciences to have clearly and persistently made the case since the 1990's that if we do not 'do something', our Earth system will soon change so dramatically that we may no longer recognise it. As a result, many individuals, but also (some) governments and a number of important corporations, are realising that something has to be done, and that it can be done without major threat to our way of life – if we do it *now*.

We also think we know how to combat some of the phenomena involved: for example, the greenhouse gas emissions that are transforming our climate, and future water shortages. But these solutions, even if we can implement them, do no more than deal with external manifestations of much more deeply rooted causes.

These causes may at first seem 'environmental', but upon reflection, we as humans define: (1) what our environment is, (2) what our environmental problems are, (3) what we think are the solutions to these problems. And then (4) we try and implement these solutions. We cannot escape the conclusion that the *apparently* environmental problems are in reality socio-environmental problems, born out of the interaction between our societies and their environments. The reason for including humans in Earth system modelling, therefore, is neither more nor less than that without understanding our societies we cannot even begin to solve our 'environmental' problems.

Until recently, that was where many efforts were stymied, there were not many social scientists interested in environmental matters, and when they were they saw them so differently, and spoke such a different language, that working with natural and life scientists was often doomed to failure. That situation, however, is changing rapidly. The increase in attendance at the IHDP Open Science Meetings, as well as changes in strategy among the funding agencies, many more 'environment' sessions at national and international social science meetings, etc., all testify to a growing readiness on the part of the social sciences to be involved.

Modelling is a very good starting point for trans-disciplinary activities. They focus the mind, are powerful

tools to help us understand complex dynamical relationships, are easily modified and poly–interpretable, but can be made sufficiently realistic to correct our thinking about the phenomena at hand. Yet they differ from reality in the sense that experimenting with them has no consequences in real life.

In recent years, modelling has spread widely beyond economics into the other social sciences. Models of human-environmental interaction abound at different spatial and temporal scales; other models explore decision making under uncertainty in the management of large-scale irrigation systems; yet others the role of institutions managing common pool resources.

Several such models were presented at the Earth Systems Science Partnership's first Open Science conference in Beijing, last November, in a very successful session. It seems therefore that the first steps are being taken in meeting the challenge of including humans in Earth systems modelling. But it is quite a challenge!

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Secondary Organic Aerosols: Thinking Outside the Smog Chamber

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Secondary Organic Aerosols (SOA), produced by the transformation of organic gases in the atmosphere, have received a considerable amount of attention over the last three decades because of their expected roles in urban pollution, global aerosol loadings, and cloud formation. While most investigations have been performed under controlled conditions such as smog chambers, atmospheric observations of SOA are sparse, mostly indirect, and critically limit the knowledge of these aerosols. In particular, techniques for the specific observation of the secondary organic fraction of aerosols in the atmosphere need to be developed, and seem today the most likely pathways to make significant progress in this topic.

One of the main difficulties in studying Secondary Organic Aerosols, both theoretically and in the atmosphere, lies in their definition. If "primary" aerosols are those emitted directly as condensed phase (liquid or solid), "secondary" organic ones would be those produced by the transformations of organic gases in the atmosphere. Depending on whether these transformations are microphysical (nucleation), physical-chemical (gas-liquid partitioning), or chemical (acid-catalysed and other types of oligomerisation*) this definition can include a wide range of processes and aerosols. For decades smog chamber studies implied that terpenes and aromatic compounds were the only precursors for SOA in the atmosphere, and that the formation of these aerosols was controlled by the partitioning of their oxidation products between the gas and particulate phase. Recent observations of real aerosols however indicated that isoprene might also be a precursor, and oligomerisation a possible formation process, two aspects previously overlooked by smog chamber studies. Refinements of the definition of SOA are thus to be expected to reflect a better understanding of these processes. This article does not intend to be exhaustive but, instead, to present a brief overview of the subject to highlight the directions of research that need most to be developed for moving from smog chamber approaches to a more realistic description of SOA.

From gas-to-particle equilibrium to oligomerisation: three decades of smog chamber studies

The formation of aerosols by the oxidation of organic gases in chamber experiments was already reported more than three decades ago [1,2,3]. Early on, smog chambers experiments appeared as the only practical way to study secondary aerosols in the absence of primary ones, and have been since then adopted as the main technique for studying SOA. The main

Figure 1. The Amazonian forest is expected to be the largest source of secondary organic aerosols of the planet [20]. Photo credit: Jose Alvarez Alonso, Research Institute of the Peruvian Amazon.

outcome of the first two decades of chamber studies was the *gas-to-particle conversion model*, predicting SOA yields from the equilibrium of the oxidation products of the precursors between the gas and the particulate phase [4]. This model accurately reproduced experimental SOA yields, even for complex mixtures of precursors [5,6] and was, for this reason, widely accepted by the atmospheric community. The success of this model excluded for a long time the idea that chemical transformations could take part in SOA formation. An entirely new direction of research was thus opened when later chamber studies showed that chemical reactions, in particular acid-catalysed ones, could indeed be involved [7]. Another milestone was reached again when chamber studies supported by atmospheric observations showed that isoprene could be a precursor for SOA [8,9,10,11,12]. Even if in this case the formation mechanisms are still unclear, this could be an important source of aerosols in the atmosphere because of the large global emissions of isoprene. The latest breakthrough in the study of SOA was the observation of oligomer compounds both in real atmospheric aerosols and in aerosols produced in smog chamber [13,14,15,16]. These later findings suggest formation mechanisms for SOA that are entirely different from gas-to-particle conversion.

Few of these chamber results, except for the latest ones, have been compared with atmospheric observations. Yet, the existence of actual atmospheric SOA and the nature of their formation mechanisms, which might be different from those in smog chambers, can only be established by atmospheric observations.

Modelling and indirect observations of SOA in the atmosphere

The integration of SOA to atmospheric models became possible largely because of the gas-to-particle theoretical framework. Model calculations using smog chamber data agree that SOA should be a significant fraction of the organic aerosols in urban [17,18,19] and forested areas [20] (Figure 1). And although SOA production at global scale seems modest compared to primary organic aerosols [20,21,22,23] they are more likely to participate in cloud formation and thereby have an indirect effect on climate because they should be more hygroscopic[+]. These processes are however still very uncertain.

But the validation of the gas-to-particle conversion theory by atmospheric observations is difficult because the definition of SOA is based on processes (the transformation of organic gases) rather than physical or chemical properties. A powerful solution to overcome this problem is the *source apportionment method*. This method determines the total concentration of SOA by difference between total organic aerosols and primary ones, the later being quantified from elemental carbon [24,25] or by adding up all possible primary sources using a *source receptor model* [26,27]. This method accounts for more than 85% of the organic fraction of aerosols and can therefore give fairly accurate SOA concentrations, even if the later combine uncertainties on the total and on the primary organic fraction of the aerosols. Another approach relies on the classical smog chamber result that SOA are made of the oxidation products of terpenes and aromatic compounds. Atmospheric concentrations of SOA are thus calculated by summing up the concentrations of all such oxidation products found in the aerosols [28,29]. Both methods give estimates of the total concentration of SOA but while the first one does not make any assumption on their origin or composition, the second one could be inaccurate if the oxygenated compounds taken into account were in reality primary, or if the actual building blocks for SOA were a different type of molecules altogether, such as oligomers. In addition these methods do not give much detail on the formation mechanisms or chemical composition that could help to verify SOA formation theories. With the development of techniques, powerful tools are now available to analyse the chemical composition of aerosols, including for single particles. The organic composition of aerosols has been extensively studied and has provided indirect evidences for the presence of secondary material, especially in regions where SOA are expected to be significant such as the Amazonian forest [30]. However, this information is of little use to understand SOA formation if the material analysed is not first identified as secondary.

The few comparisons made between modelled SOA and *in situ* observations suggest that the gas-to-particle theory, or at least the parameters obtained from smog chamber experiments, cannot be applied directly to atmospheric SOA. In particular, modelled SOA seem to systematically underestimate atmospheric ones. For instance, a comparison based on total organic aerosols in the Los Angeles Basin showed

that the model underestimated measured organic aerosols by at least 50% [17], and that this difference was due to SOA. Similar observations were made in a field campaign in the UK where actual organic aerosols contained much more secondary material than expected when using partitioning coefficients from smog chamber studies in a photochemical trajectory model [31]. The same trend seems also true with global models [23]. Even more compelling are measurements made during the ACE-Asia (Asian Pacific Regional Aerosol Characterisation Experiment) campaign showing that current models underestimate SOA sources in the free troposphere by a factor of 10 to 100 [32]. And real-time observations of SOA formation in urban environment by aerosol mass spectrometry indicated that both yields and time-scale for the formation of these aerosols are largely underestimated by the gas-to-particle theory [33]. While some of these discrepancies can be attributed to uncertainties in the measurements or in the models, the last two studies strongly point toward other formation processes for SOA than gas-to-particle conversion.

Toward the direct observation of SOA in the atmosphere?

While smog chamber studies are useful and have led to valuable information for the understanding of SOA, further progress seems at present more critically limited by information on actual atmospheric SOA. Field experiments focussing on aerosols often provide some information related to these aerosols, such as the ACE [34,35] or the Large-scale Biosphere-Atmosphere experiment (LBA) for instance. But, because of the complexity of the problem, information directly relevant to their formation mechanisms is usually obtained from investigations specifically focussed on SOA [36,37,38] or field campaigns dedicated on this topic, such as the project on Biogenic Aerosol Formation in the Boreal Forest (BIOFOR) [39]. In these concerted efforts, results that are specific to SOA were obtained thanks to simultaneous and time-resolved measurements of the aerosols and of their expected gas precursors. But while this constituted a progress, these results are still based on measurements of the sum of both primary and secondary fractions of organic aerosols, not on direct measurements of the secondary fraction alone. The many unknowns on the sources, composition, and behaviour of these two fractions bring large uncertainties on to what extent these results can indeed be attributed to SOA.

Developing direct techniques for the specific observation of the secondary organic fraction of aerosols in the atmosphere is thus very much needed. To fulfil the definition of SOA without making any assumption on their formation or composition such techniques have to monitor the formation of the aerosols while preventing primary ones from interfering with the observations. A recent technique meeting most of these criteria consists in measuring the SOA produced by living plants (of the scale of a tree branch) inside a Teflon enclosure [40]. A similar technique is currently being developed as part of the BOAAR project

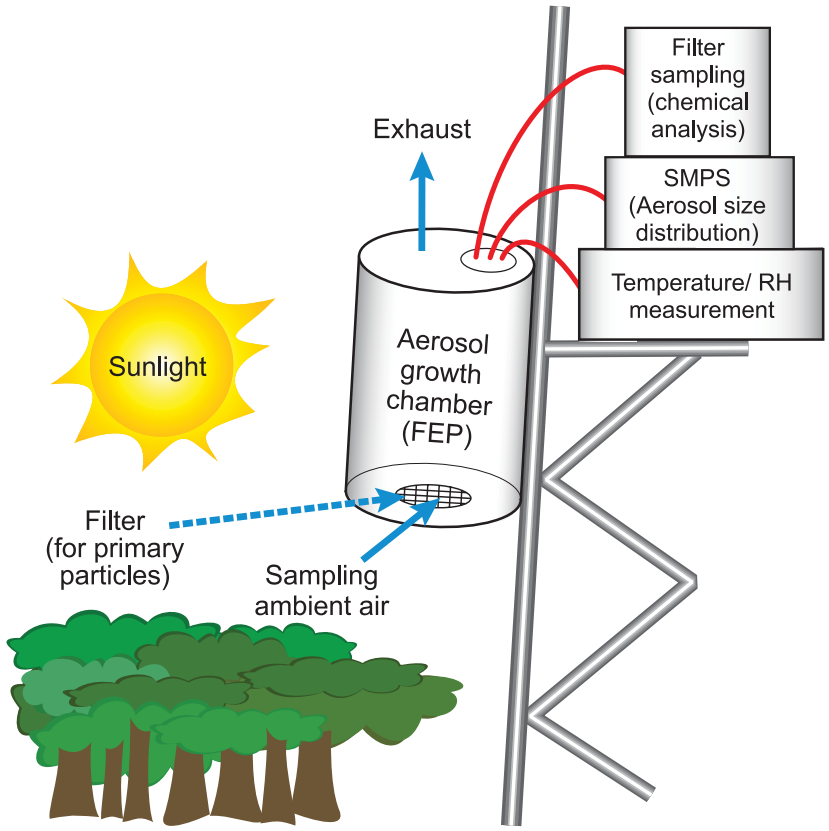

Figure 2. Schematic of the sampling method developed for the BOOAR project.

(Biogenic organic aerosols over the Amazon rainforest) to study SOA in natural environments such the Amazonian forest in Brazil and at a high altitude site in Venezuela (Figure 2,3). The main objective will be to isolate SOA from primary aerosols, quantify them, and, if possible, analyse their chemical composition. If successful, this approach should provide new and direct information on the formation and composition of the secondary organic fraction of aerosols. Because this type of information is currently limiting our understanding of SOA the development of similar approaches should be encouraged.

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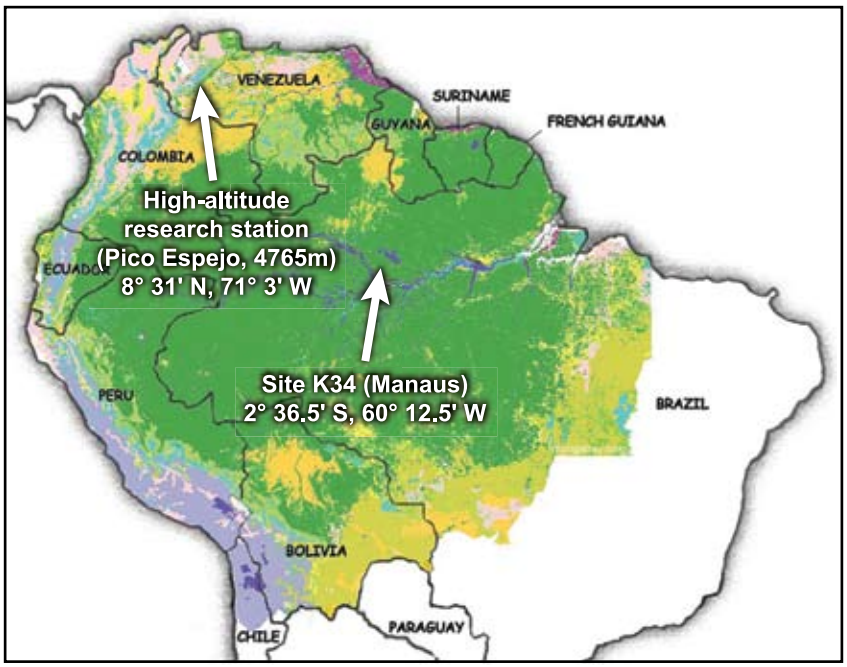

Figure 3. Map of the Amazon basin showing the two sampling sites for the BOOAR project: the forest site near Manaus, Brazil, and a new high altitude site overlooking the Amazonian forest in Venezuela.

Definitions

Oligomerisation: the chemical process of creating oligomers from larger or smaller molecules.

Hygroscopy: the ability of a substance to attract water molecules from the surrounding environment through either absorption or adsorption.

Acknowledgements
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Arctic Warming – a Perspective from Svalbard

V. Pohjola

During the International Polar Year many projects connected to IGBP science will be implemented, mostly within the Arctic and Antarctic areas. This glaciology project is connected to the IPY via the projects IPY-GLACIODYN and IPY-KINNVIKA, and has been carried out since 1997 on the Lomosovfonna ice field on central Spitsbergen in the Svalbard archipelago, and, in this respect, has a longer perspective than most IPY projects. The main interests are to estimate the mass balance, retrieve proxy palaeo temperature records and to identify anthropogenic emissions trapped in the glacier – through the drilling of ice cores spanning the last millennia.

With the IPCC report released during 2007 the scientific community is adding confidence to the relation between global warming and the boost of the greenhouse effect via anthropogenic emissions. Modelling work after the previous IPCC report have shown that the Arctic region is likely to warm up faster than the global average, and that the Arctic may be one of the regions to have the quickest response to global warming [1]. One of the "hotspots" in this Arctic warming may be Svalbard, due to the fact that this archipelago is positioned right where the Arctic front separates the polar and extra-tropical air and water masses. The North Atlantic drift is a powerful contributor of heat into the Nordic Seas and further into the Arctic Ocean, where the northern branch of the drift splits at Svalbard.

How well the Svalbard region senses global climatic variability is exemplified by the much larger warming the archipelago experienced in the 1920–30s event than what was recorded at other North Atlantic/Arctic sites (Figure 1). The reason for this Arctic warming is debated, but was likely an effect of enhanced atmospheric circulation triggered by heat excess in its source region [2].

Ice Coring Reveals Human Emissions

With these facts as a background glaciologists from the Dutch University of Utrecht, the Estonian Geological Institute, the Finnish University of Lapland, the Norwegian Polar Institute and Uppsala University started an ice coring and an ice mass balance monitoring programme

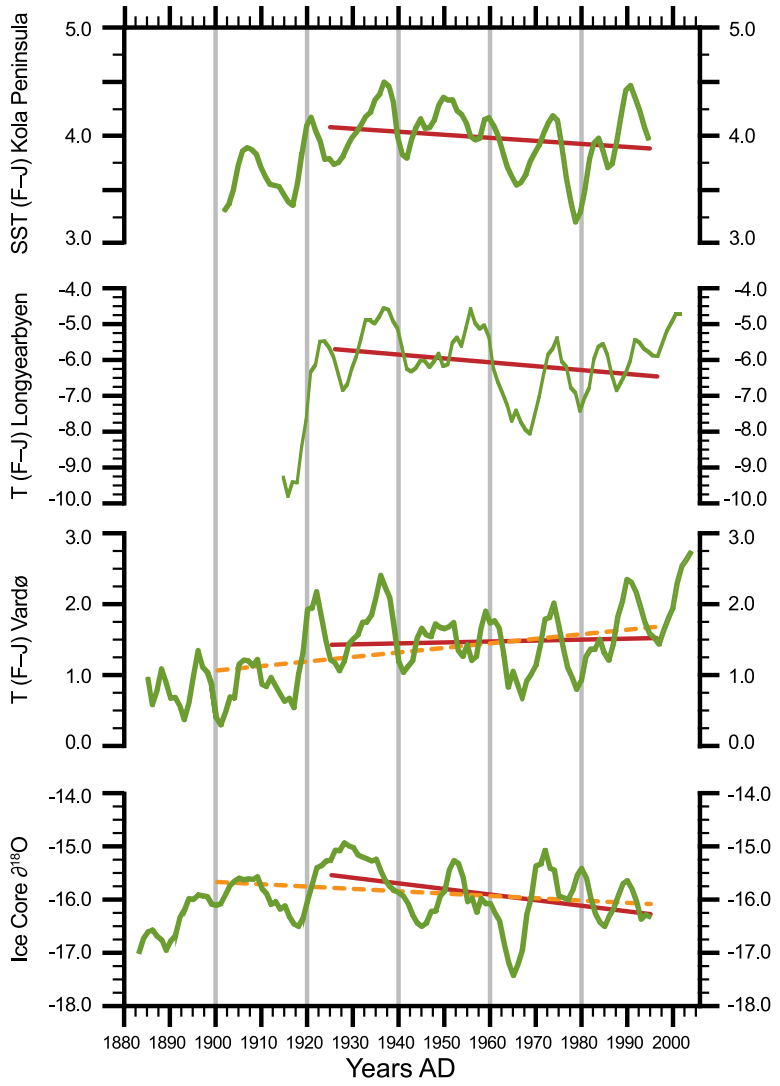

Figure 1. The 5-year running average time series of annual average (Feb–Jan) 1.5 m temperatures of Longyearbyen and Vardø (http://www.unaami.noaa.gov/analyses/sat/), and the sea surface temperatures off Kola Peninsula [15] compared to the annual average $\partial^{18}O$ from the Lomonosovfonna summit ice core.

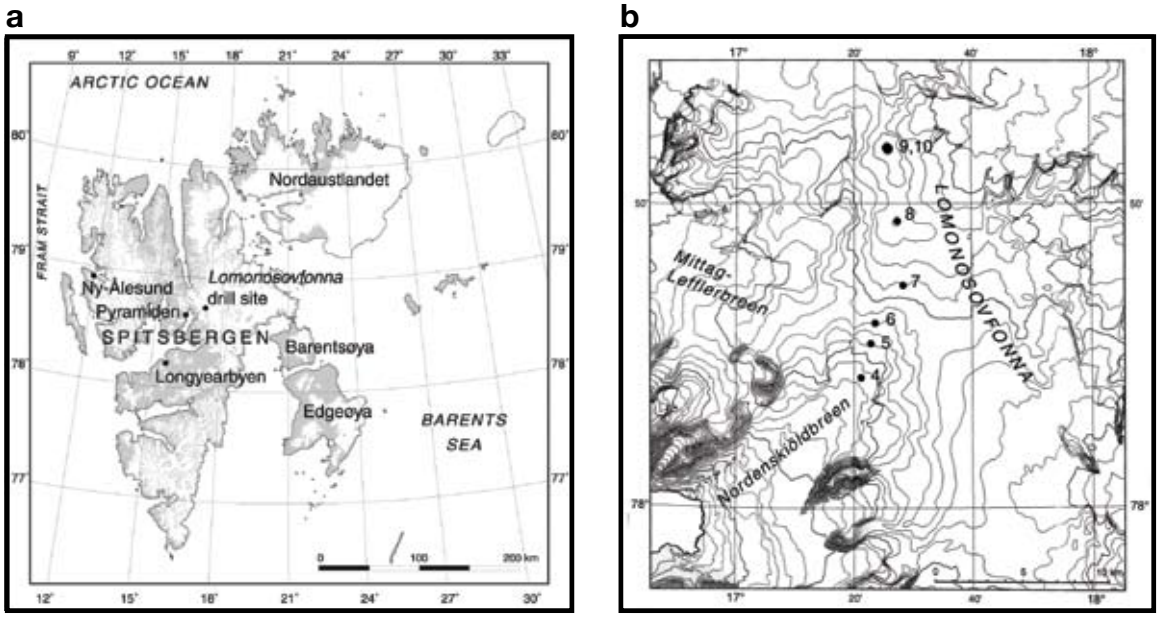

Figure 2.

a) Svalbard, the 800 km^2 large ice field Lomonosovfonna (1250 m.a.s.l.), and other localities.

b) Lomonosovfonna, Nordenskiöldbreen and the positions of ice cores drilled in 1997. Seven cores were drilled, where no. 10 marks the deep core shown in Figure 1. The other cores were shallow and used for the spatial cohesion of the ice core records.

on the 800 km^2 large ice field Lomonosovfonna and the 25 km long outlet glacier Nordenskiöldbreen (Figure 2). During the spring 1997 we retrieved a 122 m deep ice core from the summit of Lomonosovfonna (Figure 3) [3]. The ice core reached down to a few metres from the bedrock. Using dating models we found the ice core to contain more than 800 years of climatic and environmental records [4,5]. With the Laki (1783–85) volcanic horizon as stratigraphic indicator [6] and well-preserved annual cycles of stable water isotopes we have relatively good control of the time scale over the last 300 years of the ice core record [7], including the time period shown in Figure 1.

Chemical data from the ice core show that increased anthropogenic pollution have reached the Svalbard archipelago over the last 100 years, with an ongoing increase of ammonium, nitrates and sulfates [8]. Studies of organic substances on Svalbard ice fields indicate rather high concentrations of pesticides [9] that definitely change the romantic view of the Arctic being clean, pure and untouched by human hands.

The physical information from the ice core has been used to derive palaeo-climatic information over the ice field. Figure 1 shows about hundred years of $\partial^{18}O$ as proxy-temperature for the ice field. The ice core proxy-temperatures compare well to decadal features of the land and sea surface temperatures from the Barents Sea region over this period, as exemplified by the 1920–30s warming and the cooling of the 1940s and the 1960s.

One of our goals was to find out if the proxy-temperatures of the ice field $\partial^{18}O$ confirm a trend of warming during the last century, with an accelerated warming the recent decades as many climate models has predicted. We found a general warming from 1880 culminating with the warmth of the 1920–30s, but the trend from the 1930s to the mid 1990s shows a general cooling over the ice field, contrary to a warming over the whole century (Figure 1). The land and sea surface records of the region indicate similar trends as the ice core record (Figure 1), with the difference that the climate proxy record from the ice core shows a more pronounced cooling than the instrumental data. One reason for this could be that the ice field is the northernmost site of the four sites in Figure 1, and there is a steeper gradient of cooling within more northern latitudes. Another reason may be that the proxy record is sensitive not only to close-to-surface temperature, but also to other parameters that modulate the ice core $\partial^{18}O$. The lack of a coherent warming signal in the Arctic during the last century has been shown earlier by analysis of land surface temperature records [10] and by satellite derived tempera-

ture proxies [11]. One reason for the lack of coherence in Arctic warming is the large regional variability due to the circulation dynamics in the Arctic climate [10], which may veil a regional signal of greenhouse driven warming over the last century.

Is Svalbard warming – or cooling?

Do Svalbard records indicate any signs of recent Arctic warming at all? The Longyearbyen air temperature record for the last decades shows a clear warming. The increase of the annual temperatures is mostly pronounced during the winters. Førland and others [2] argues that the warming trend since the 1960s is driven by increase in circulation regimes. This is particularly evident in the warmer winters during the last decades, with an enhanced warming starting in the 1990s. The Lomonosovfonna ice core does not cover the last decade, but $\partial^{18}O$ records fro m the top of a 125 m deep ice core drilled in 2005 at the ice field Holtedahlfonna c 100 km west of Lomonosovfonna, show a clear signal of increased warming since 1997 [work in progress]. We visited Lomonosovfonna this spring (March 2007) to drill a shallow ice core aiming to add the last ten years of data to the 1997 ice core record. The data is not yet processed, but during drilling we found most of the ice column to have a higher melt index as compared to the uppermost 50 years of melt index in the 1997 core. The melt index is simply a ratio where solid ice layers indicate melting conditions in dry firn (or ice with many air bubbles) [12]. Our findings indicate an increase of melt over the ice field, reflecting the last ten year trend of a general warming of the region since the 1990s.

The Future?

Does this suggest that greenhouse driven Arctic warming has hit Svalbard only for the last ten years? We know that Svalbard glaciers have been losing mass since their maximum extent during the Little Ice Age, in the end of the 19th century. Nordenskiöldbreen, the outlet glacier of Lomonosovfonna, have retreated c 2.5 km from its front moraines from 1880, which equals 10% of its total length. The Svalbard glacier mass balance-monitoring program started in the 1960s, indicating a steady loss of mass of Svalbard glaciers since then [13]. The loss of mass, despite the general cooling trend since the 1950s is conflicting (Figure 1), but it may involve less precipitation during the colder periods, starving the glacier systems. Another reason may be that Lomonosovfonna have another mass balance history than the monitored glaciers. This is possible since most monitored glaciers are south and west of Lomonosovfonna. A third possibility is a bias to the mass balance record, since the mass balance records started in a relatively cool period, which gives a cooler state as a reference point. Laser altimetry flown over Lomonsovfonna and the ice caps Aust- and Vestfonna [14] indicates increased accumulation on high altitudes over the last decade. All together this points to warmer, and more precipitous winters over Svalbard, and to longer melt periods during the warm part of the year. Considering these facts, it seems like the high altitude and high latitude ice fields will get a larger mass turnover, and some may even increase their mass, while the more southern and lower altitude glaciers and ice fields will continue to diminish over the period to come. If the warming projections by the climate models are correct the northern Svalbard ice fields will likely begin to fade with an increasing rate within the decades to come.

Figure 3. Ice core drilling on the summit of Lomonosovfonna April 1997. Photo: V. Pohjola.

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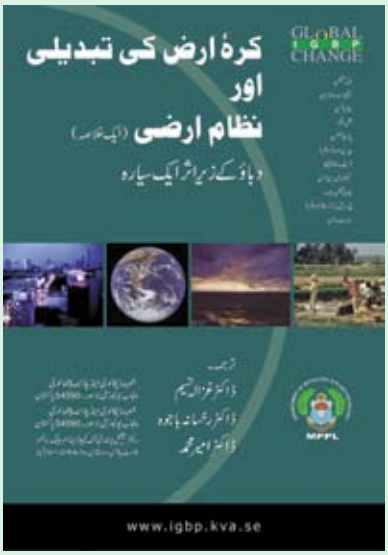
A new translation of the IGBP Executive Summary

The executive summary of the IGBP Synthesis book Global Change and the Earth System – A Planet Under Pressure by Steffen W et al. (Ed.s., 2004) has been translated into Urdu, the national language of Pakistan.



The main authors of the translated work are:
Dr. Ghazala Nasim and Dr. Rukhsana Bajwa (both at the Department of Mycology and Plant Pathology, University of the Punjab, Lahore, Pakistan), and Dr. Amir Muhammed (President, ASIANICS International, Islamabad; Rector, National University of Computer & Emerging Sciences, Pakistan; and Chair, IGBP National Committee, Pakistan).

The IGBP National Committee in Pakistan generously supported the translation and printing of the document.
A digital copy will soon be downloadable from the IGBP website, www.igbp.net

To receive paper copies of the Urdu translation, please contact Dr. Amir Muhammed at amir.muhammed@nu.edu.pk

National Committee Science

Articles in this section highlight global change science conducted by IGBP National Committees around the globe. The contributors to the following article are affiliated with the Risø National Laboratory in Roskilde and are members of the Danish National Committee.

Air-sea Fluxes of CO_2 from Galathea 3 Ship and Satellite Measurements

M. B. Christiansen, L. L. Sørensen,
C. B. Hasager, J. Nissen

Members of the Danish IGBP National Committee have participated in the Danish research expedition Galathea 3, which was launched from the harbour of Copenhagen in August 2006 as a follow-up on previous expeditions Galathea-1 (1845–47) and Galathea-2 (1950–52). Fitted with research equipment, the navy vessel 'Vaedderen' set off on a 9-month worldwide cruise with 100 scientists, journalists and crew members on board. More than 50 science teams are involved in the Galathea 3 expedition, and among the larger projects is "The marine carbon cycle from north to south along the Galathea 3 route".

The goal of this interdisciplinary project is to describe the role of the oceans in the global carbon cycle. The world's open oceans are considered to be net absorbers of CO_2 from the atmosphere. The oceanic absorption may, to a certain degree, counteract the increasing CO_2 emission from human activities. However, very large uncertainties remain for estimates of the marine carbon budget, especially in near-shore areas where coastal upwelling, river discharge, and wave breaking occur.

The Mission

In the atmospheric part of the carbon cycle project we focus on the exchange (or flux) of CO_2 between the oceans and the atmosphere and on how these fluxes can be estimated from a combination of ship and satellite measurements. The Galathea 3 expedition covers a wide range of climates, from Greenland to Antarctica and around the entire World. The data collected along the cruise track provide a unique opportunity to estimate CO_2 fluxes globally and to test different methods for the flux retrieval. The ship measurements may be extrapolated in time and space using satellite observations. In contrast to ship measurements, satellite imagery offers global, year-round coverage. Another major advantage is that satellite observations describe properties of the *sea surface*, where the air-sea gas exchange takes place. Ship measurements are usually obtained at some height above the sea surface or at some depth into the ocean.

CO_2 Measurements

The air-sea exchange of CO_2 is partly controlled by differences in the partial pressure of CO_2 in the ocean and the atmosphere (ΔpCO_2). The atmospheric CO_2 concentration is approximately 370 ppm all over the globe. A lower CO_2 gas concentration in the ocean would cause a downward flux, as the system seeks to obtain a state of equilibrium. Accordingly, a higher CO_2 concentration in the sea would lead to an upward flux. Partial pressures of CO_2, in seawater and in the atmosphere, were measured continuously along the Galathea 3 route using an equilibrator, which took in seawater and sprayed the water into an air-tight chamber. The CO_2 concentration of the chamber air was measured, once a state of equilibrium was established between the air and the water. The measurements were displayed in near-real-time at the website www.risoe.dk/galathea.

A bulk parameterisation method is used to estimate CO_2 fluxes from the equilibrator measurements of ΔpCO_2:

$$\mathbf{F = k\,\alpha\,\Delta pCO_2} \quad \textbf{(Eq. 1)}$$

where F is the daily flux of CO_2 (g m^{-2}), α is a coefficient that describes the CO_2 solubility in seawater, and k is the gas transfer velocity (m s^{-1}). The CO_2 solubility varies according to the temperature and salinity

of seawater. A ferrybox measured these and other properties of the surface water along the Galathea 3 route. The transfer velocity is closely related to wind speed and several equations exist that describe the k-to-wind relationship. The transfer velocity is often set proportional to the cube of the wind speed at 10 m, as this height is widely used for meteorological measurements. On the Galathea 3 expedition, wind speeds were measured with sonic anemometers mounted on the bridge. The wind measurements were then corrected for the speed of the vessel.

Using Satellites Eyes

Satellite images were collected along the entire expedition route of Galathea 3. Within the project "Satellite Eye for Galathea 3", the satellite images were ordered, collected, processed and presented in near-real-time through Google Earth and a Java system (see www.satelliteeye.dk). Educational material based on the satellite images was published online at http://galathea3.emu.dk/satelliteeye/index_uk.html. Several Galathea 3 projects use the satellite information in their research. The satellite images show snapshots of sea surface temperature, sea ice, global ozone, bathymetry, sea level height, ocean winds, ocean wave height, clouds, and land/sea surfaces from both optical and radar sensors. At locations of special interest, such as the harbours, very detailed images were collected. The high-resolution data also included chlorophyll maps from the satellite Envisat MERIS (Medium Resolution Imaging Spectrometer) and wind maps retrieved from Envisat ASAR (Advanced Synthetic Aperture Radar). Together with sea surface temperature observations, the Envisat MERIS and ASAR data are the most relevant satellite data available for CO_2 flux parameterisation.

How to Deal with Coastal Upwelling

In the following, we demonstrate how CO_2 fluxes can be parameterised for an upwelling zone off the coast of Peru. Strong southeasterly winds often prevail along the coast resulting in the rising of cold water to shallower depths. This is a well known phenomenon along the west coast of South America. Because of the Coriolis force, surface water is transported at a 90 degree angle to the left of the winds in the southern hemisphere. This is why southeasterly winds parallel to the coastline of Peru tend to "drag" surface waters westward and away from the shore.

a **b**

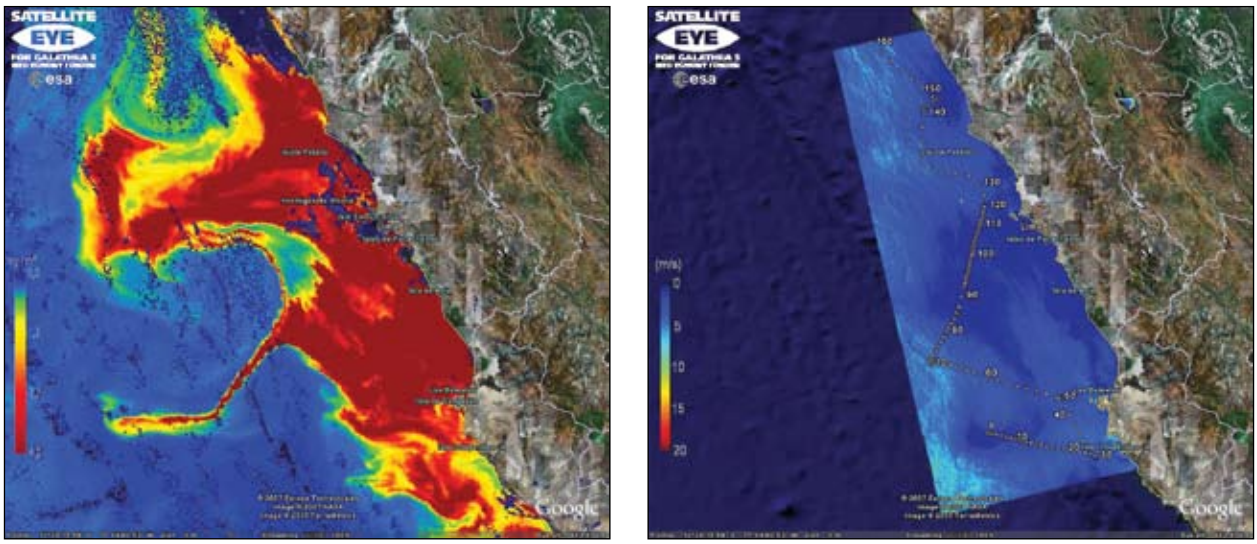


Figure 1.

a) Map showing chlorophyll-a concentrations from Envisat MERIS, 22 February 2007. High concentrations are found in the coastal upwelling zone off Peru where cold waters, rich in nutrients and CO_2, are forced to the sea surface. Image credit: ESA (EO-3917)

b) Map showing wind speeds at 10 m height retrieved from Envisat ASAR, 26 February 2007. Winds are from the southwest with relatively low wind speeds (<8 m s^{-1}). Galathea 3 measurement stations are indicated (25–28 February 2007). Image credit: ESA (EO-3917)

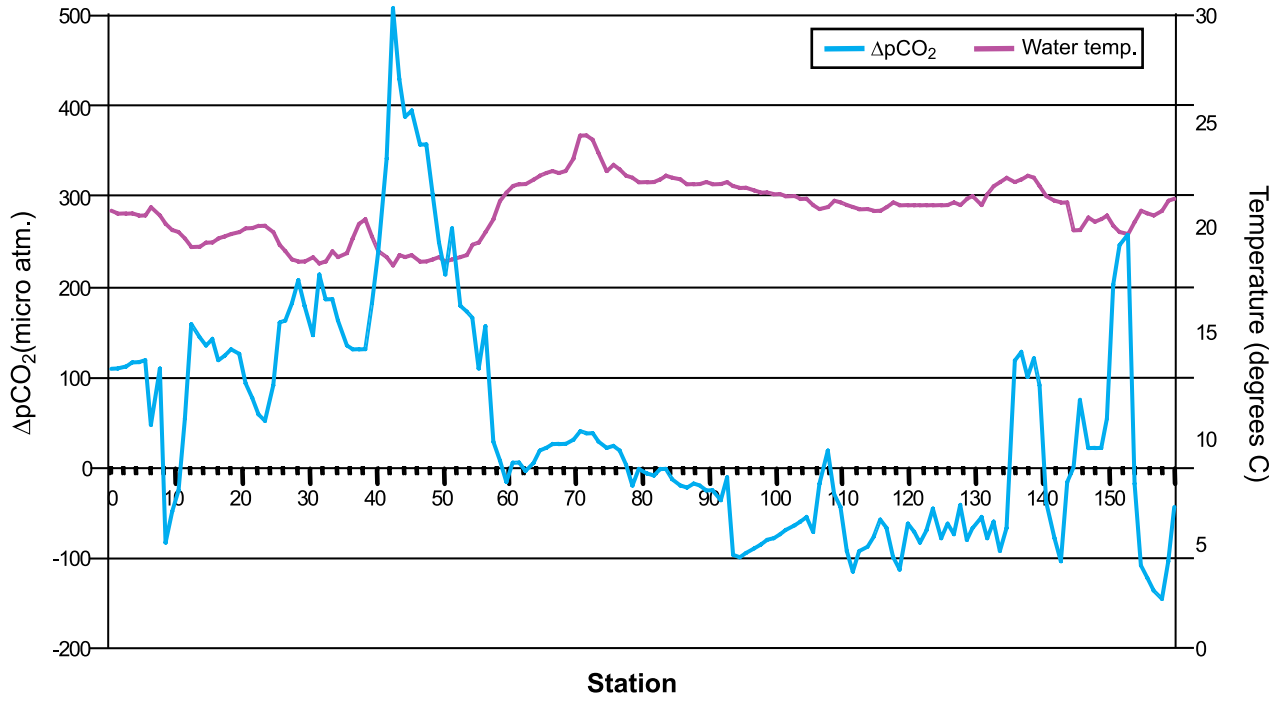


Figure 2. Ship measurements of the difference in CO_2 partial pressure between air and sea (negative values indicate a downward transport) and water temperatures near the sea surface. CO_2 outgassing occurs mainly at lower temperatures.

Deep waters are rich in nutrients and CO_2. Upwelling regions therefore result in very high emissions of CO_2 in comparison to other parts of the ocean, unless the primary production is able to consume the extra CO_2.

Figure 1a shows a map of chlorophyll-a over Peruvian waters based on Envisat MERIS observations from 22 February 2007. The highest chlorophyll concentrations are found near the coast and indicate an upwelling of cold waters, rich in CO_2 and nutrients. Figure 1b shows a wind map over the same area generated from Envisat ASAR data a few days later, on 26 February 2007. The wind retrieval relies on capillary- and short-gravity waves at the sea surface. The ASAR sensor measures this small-scale roughness and empirical model functions are used for a conversion to wind speeds at 10 m height. The presence of algae or other surfactants have a damping effect on small-scale surface waves. Wind maps over algae-rich waters may therefore show artificially low wind signatures. We believe this is why large areas of very low wind speeds are seen in Figure 1b. Laboratory studies have indicated that capillary waves are required for an air-sea gas transfer to take place. The flux is related to the wave steepness, which also determines the radar signature used in satellite wind mapping. Satellite wind maps may thus be a better indicator of surface fluxes than the wind speed at 10 m height measured from ships or masts.

The daily flux of CO_2 was estimated from Eq. 1 using ship measurements of wind speed, water temperature and salinity, for the period 25–28 February 2007. The measurement stations are indicated in Figure 1b. A second calculation is made where wind speeds are extracted from the satellite wind map, around each station, and used in combination with the ship measurements. This is possible because variations of the wind speed and direction are small for the 4-day period (recall that the satellite image is a snap-shot acquired over only a few seconds). Figure 2 shows the water temperature and the differences in CO_2 partial pressure that enter the parameterisation. The resulting CO_2 fluxes are seen in Figure 3. The two figures show how CO_2 fluxes depend largely on ΔpCO_2. Fluxes are numerically smaller when satellite winds are used in the parameterisation rather than wind speed measurements from the bridge of the research vessel. For the stations 0–10 and 80–130, the CO_2 flux found from satellite

Continued on page 18 ➲

The International Polar Year involves many IGBP projects

IGBP projects and its partner programmes are engaged in many ways in the International Polar Year through Earth system science in the polar areas. Some of these projects connected to IGBP are highlighted at these two pages.

1 Pan Arctic Ice Camp Expedition (PAICEX)

The major scope of PAICEX is to develop 8–10 manned sea-ice platforms to support basin-wide, continuous round-year, multi-disciplinary observations in the Arctic Ocean. Priorities are observations of snow-ice cover dynamic, hydrological samplings and biodiversity studies in the atmosphere-sea ice-upper ocean system.

IGBP projects involved: Individual scientists from the IGBP network.

Time frame: Mar 2007–Mar 2008.

Contact person: Artur Chilingarov, Association of Russian Polar Explorers, Russia.

Website: www.paice.ru

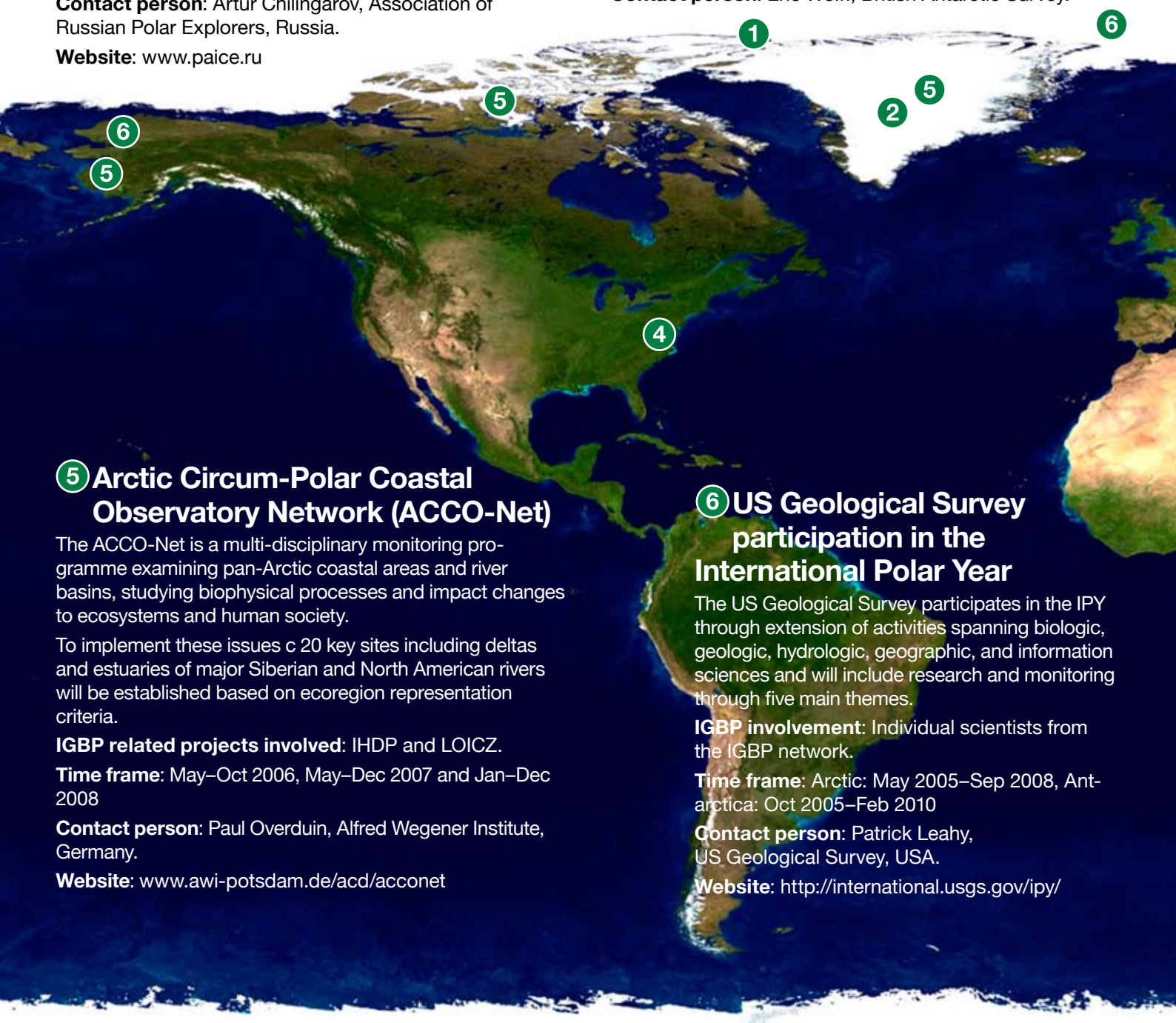
2 Air-Ice Chemical Interactions (AICI)

The AICI project aims to determine the importance of air-ice processes at both poles, and assess how these would alter with a warming climate and shrinking cryosphere. To provide an overall context for the intensive campaigns AICI will determine the year-round spatial distribution of at least that most important molecule, ozone, in the boundary layer.

IGBP projects involved: IGAC and SOLAS

Time frame: Arctic: Apr 2007–Aug 2008, Antarctica: Oct 2007–Feb 2009

Contact person: Eric Wolff, British Antarctic Survey.



5 Arctic Circum-Polar Coastal Observatory Network (ACCO-Net)

The ACCO-Net is a multi-disciplinary monitoring programme examining pan-Arctic coastal areas and river basins, studying biophysical processes and impact changes to ecosystems and human society.

To implement these issues c 20 key sites including deltas and estuaries of major Siberian and North American rivers will be established based on ecoregion representation criteria.

IGBP related projects involved: IHDP and LOICZ.

Time frame: May–Oct 2006, May–Dec 2007 and Jan–Dec 2008

Contact person: Paul Overduin, Alfred Wegener Institute, Germany.

Website: www.awi-potsdam.de/acd/acconet

6 US Geological Survey participation in the International Polar Year

The US Geological Survey participates in the IPY through extension of activities spanning biologic, geologic, hydrologic, geographic, and information sciences and will include research and monitoring through five main themes.

IGBP involvement: Individual scientists from the IGBP network.

Time frame: Arctic: May 2005–Sep 2008, Antarctica: Oct 2005–Feb 2010

Contact person: Patrick Leahy, US Geological Survey, USA.

Website: http://international.usgs.gov/ipy/

3 Trans-Antarctic Scientific Traverses Expeditions – Ice Divide of East Antarctica (TASTE–IDEA)

During a three-year period the TASTE-IDEA project will conduct scientific traverses across the Antarctic continent. Some of the objectives and main goals are to: obtain ice cores to extend the record of climate variability in the past; study surface mass balance and ice sheet elevation change; survey the ice dynamics and geologic settings of the East Antarctica; and to revisit areas and sites first explored during IGY traverses to observe possible changes.

IGBP projects involved: PAGES and individual scientists from the IGBP network.

Time frame: Sep 2007–Mar 2008, Sep 2008–Mar 2009 and Sep 2009–Mar 2010.

Contact person: Heinz Miller, Alfred Wegener Institute, Germany.

4 Antarctic Treaty Summit: The Roles of Science in International Policy

The goal of this international and interdisciplinary activity will be to develop a century-scale view of how science can contribute to the protection and the sustainable development of Antarctica for future generations.

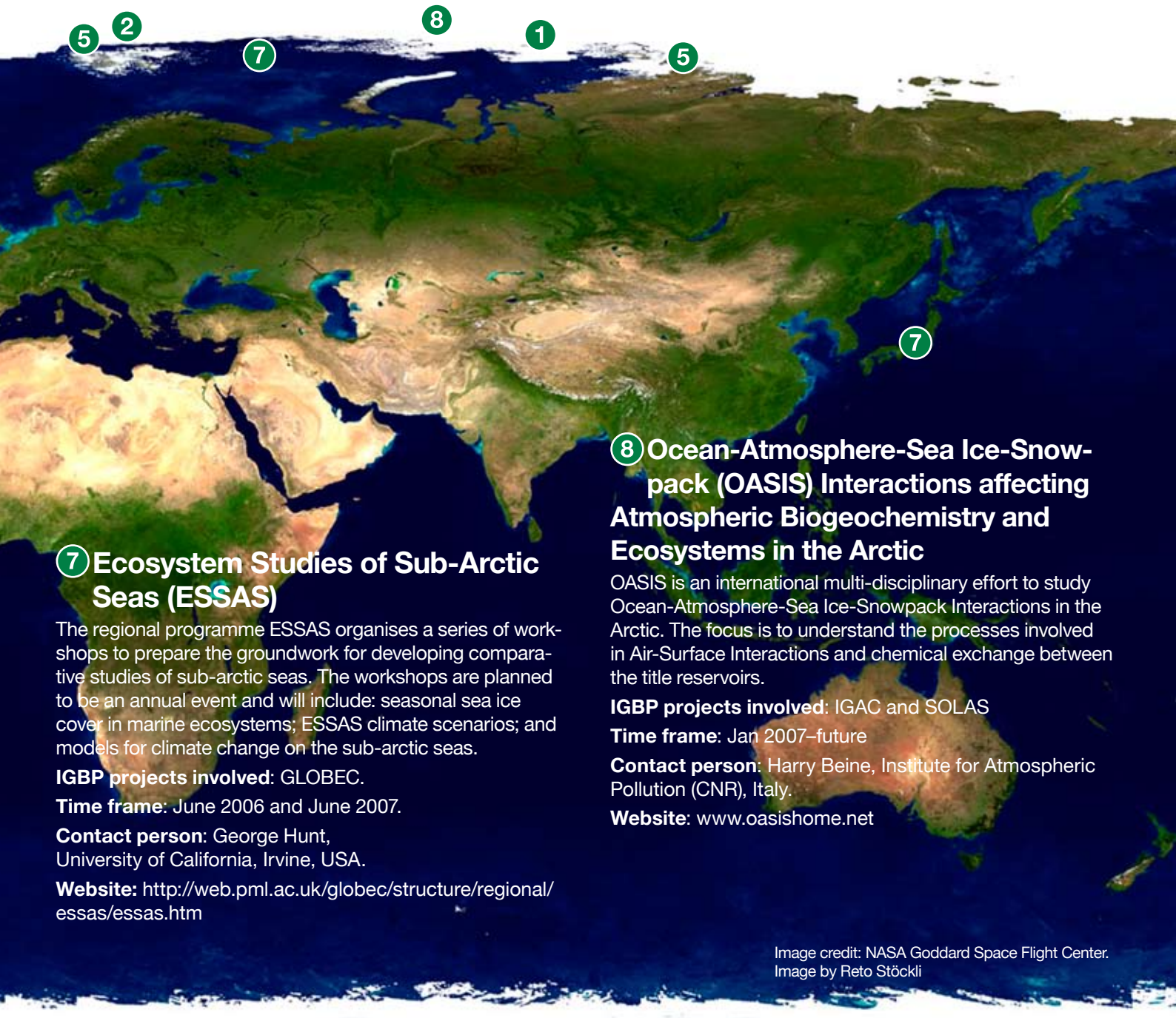
Summarised, the Antarctic Treaty Summit intends to promote ecosystem conservation, environmental protection and international cooperation, and identify international policy precedents that are enhanced by the "freedom of scientific investigation".

IGBP related projects involved: IGBP and IHDP.

Time frame: To be announced the first quarter of 2009.

Contact person: Paul Berkman, University of California Santa Barbara, USA.

Website (searchable database for the Antarctic Treaty): http://aspire.nvi.net/



7 Ecosystem Studies of Sub-Arctic Seas (ESSAS)

The regional programme ESSAS organises a series of workshops to prepare the groundwork for developing comparative studies of sub-arctic seas. The workshops are planned to be an annual event and will include: seasonal sea ice cover in marine ecosystems; ESSAS climate scenarios; and models for climate change on the sub-arctic seas.

IGBP projects involved: GLOBEC.

Time frame: June 2006 and June 2007.

Contact person: George Hunt,
University of California, Irvine, USA.

Website: http://web.pml.ac.uk/globec/structure/regional/essas/essas.htm

8 Ocean-Atmosphere-Sea Ice-Snowpack (OASIS) Interactions affecting Atmospheric Biogeochemistry and Ecosystems in the Arctic

OASIS is an international multi-disciplinary effort to study Ocean-Atmosphere-Sea Ice-Snowpack Interactions in the Arctic. The focus is to understand the processes involved in Air-Surface Interactions and chemical exchange between the title reservoirs.

IGBP projects involved: IGAC and SOLAS

Time frame: Jan 2007–future

Contact person: Harry Beine, Institute for Atmospheric Pollution (CNR), Italy.

Website: www.oasishome.net

Image credit: NASA Goddard Space Flight Center.
Image by Reto Stöckli

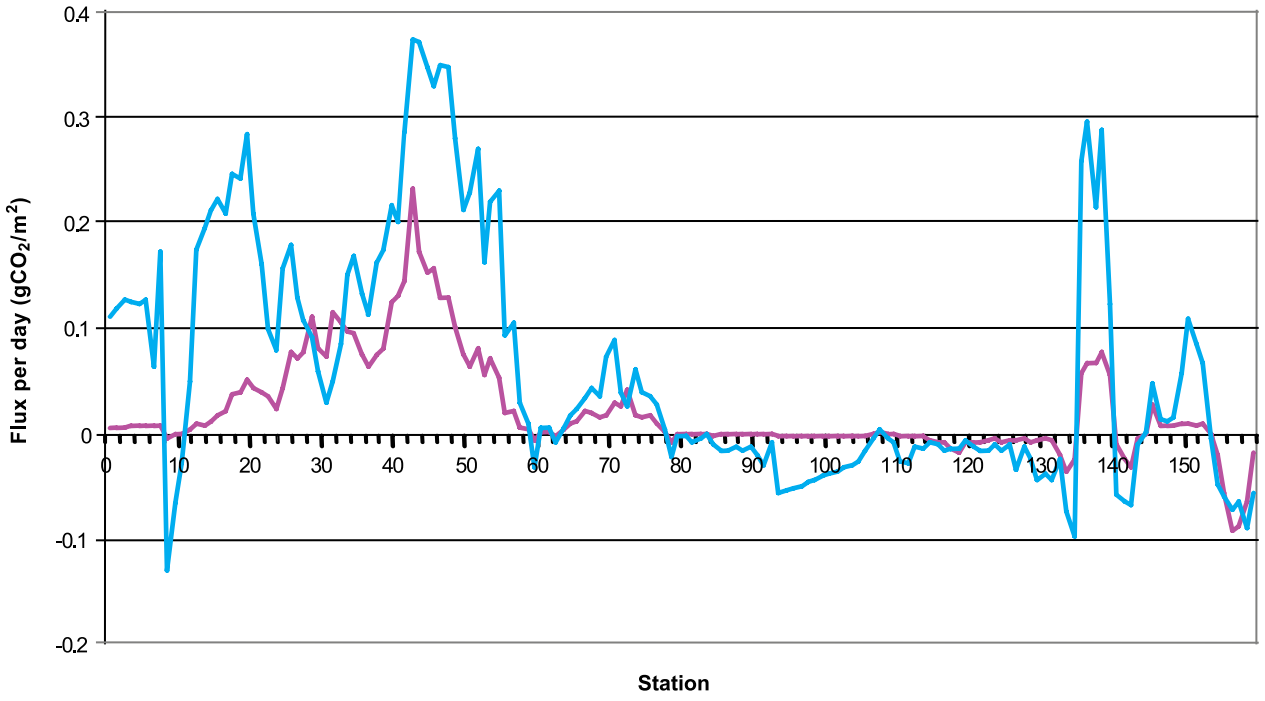


Figure 3. Estimated daily fluxes of CO_2 using ship and satellite measurements of the wind speed to determine the transfer velocity (k in Eq. 1). Fluxes are generally lower when satellite winds are used in the parameterisation. This may be a result of capillary wave damping by algae films.

winds is close to zero. This is possibly an effect of algae films at the sea surface, which impact the satellite wind measurements.

A further investigation of the CO_2 fluxes including direct micrometeorological flux measurements from the Galathea 3 expedition is planned. From this investigation we aim to refine existing parameterisation schemes for air-sea fluxes of CO_2 to obtain the highest possible accuracy on global flux estimates.

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FIRST ANNOUNCEMENT:

RESILIENCE 2008

RESILIENCE, ADAPTATION AND TRANSFORMATION IN TURBULENT TIMES.

INTERNATIONAL SCIENCE AND POLICY CONFERENCE, STOCKHOLM, SWEDEN, APRIL 14-16 2008.

Welcome to the first high-level science conference on the concept of resilience – the capacity to deal with change and continue to develop. Resilience 2008 will bring together scientists who work on the complex dynamics of interconnected social-ecological systems, representatives from governments, business and other major actors.

EXPECT THE UNEXPECTED!

Join us in Stockholm for scientific exploration, discussion, and discovery with social and natural scientists from all over the world. Hear cutting-edge lectures by leading political scientist Elinor Ostrom, the father of resilience theory Buzz Holling and renowned ecologist Steve Carpenter. Other key speakers include Brian Walker, Marten Scheffer, Frances Westley, Will Steffen and Carl Folke.
Resilience 2008 is much more than a regular science conference. On the agenda in Stockholm are plenary sessions, core and short paper sessions, poster sessions, panel and working group sessions, but also open space and futures sessions, a policy forum, a science-inspired art exhibition and musical performances.

DATES:

Resilience and Art: April 12-13 and throughout the conference and policy forum.
Resilience Science Conference: April 14-16
Resilience Policy Forum: April 17

VENUES:

The conference will be held at Stockholm University and at the Royal Swedish Academy of Sciences.

ORGANIZERS:

Resilience 2008 is organized by the Resilience Alliance in collaboration with the Royal Swedish Academy of Sciences and International Council for Science (ICSU). Local organizers: Stockholm Resilience Centre, Centre for Transdisciplinary Environmental Research (CTM) at Stockholm University, Stockholm Environment Institute (SEI) and Beijer International Institute of Ecological Economics.

FOR FURTHER INFORMATION GO TO: **www.resilience2008.org**

Second Symposium on the Ocean in a High-CO_2 World

The Scientific Committee on Oceanic Research,
the Intergovernmental Oceanographic Commission of UNESCO,
the International Atomic Energy Agency,
and the International Geosphere-Biosphere Programme
are planning a second Symposium
on the Ocean in a High-CO_2 World.

International Council for Science
Scientific Committee on Oceanic Research

IAEA

GLOBAL CHANGE
IGBP

The symposium will be held in Monaco on 6–8 October 2008

Registration and abstract submissions will be possible starting 31 March 2008

The symposium will feature invited and contributed oral and poster presentations on the following topics:

- scenarios of ocean acidification
- effects of changes in seawater chemistry on nutrient and metal speciation
- ocean carbon system from deep-time to the present to the distant future
- palaeo-chemistry
- mechanisms of biocalcification
- impacts on benthic and pelagic calcifiers
- physiological effects, from microbes to fish
- adaptation and (micro)evolution
- fisheries, food webs, and ecosystem impacts
- biogeochemical consequences and feedbacks to the Earth system
- economic consequences
- CO_2 disposal

Information about the meeting will be posted at www.ocean-acidification.net, as it becomes available.

For additional information, please contact James Orr (J.Orr@iaea.org) or one of the sponsors' representatives:
Ed Urban (Ed.Urban@scor-int.org)
Maria Hood (m.hood@unesco.org)
Wendy Broadgate (wendy@igbp.kva.se)

The Australian National Committee for Earth Systems Science held a workshop of experts dedicated to the question in this title. They found that available data do not yet support the frequently repeated assumption that global warming increases evaporative demand on the land, an assumption that continues to be common, for instance in the IPCC 4th Assessment Report, Summary for Policy Makers.

Evaporative demand: Does it increase with global warming?

It may seem counterintuitive, but the overwhelming body of data from pan evaporimeters and estimated lake evaporation rates averaged over large regions in numerous countries in both hemispheres show decadal trend-lines, fitted through the inter-annual variability, of declining rates of unconstrained free-water evaporation since the early 1970s (when measurements began). This is despite the warming of the lower atmosphere during that period. Although there is considerable spatial and temporal variation in annual pan evaporation, on average the evaporation rate from such 1.2 m diameter pans of water (Figure 1) has been declining by about 2–4 mm per year since the 1970s in many regions, e.g. USA, former Soviet Union, China, India, Thailand, Australia, New Zealand and Canada. The rate of decline for lakes since the 1950s has been similar. After reviewing the evidence for this phenomenon, the workshop addressed why this might be, what significance it has for evaporative demand on the vegetation in the area of the pan evaporimeters during global warming, and what implications the observation have for our understanding of the global hydrological cycle and its representation in global climate models (GCMs).

Why is it so? Is it an artifact of the pan evaporimeter methodology? It was concluded that only one of the known artifacts of pan evaporimeters (as a measure of lake or wet- vegetation evaporation) could cause a decline in readings over several decades. That was the Australian practice of retrofitting bird-guards at various dates for the different pans. However, applying the 7% correction for

Figure 1. A Class A Pan Evaporimeter run by the Australian Bureau of Meteorology at Canberra Airport.

the bird-guard effect from the dates of installation did not alter the conclusion much that Australian annual pan evaporation rates have been in long term decline by about 3 mm per year.

Complementary relationship

An important effect in water-limited (arid) environments but not wet ones (Figure 2), is the so-called "complementary relationship" in which, during times of lower rainfall, pan evaporation rates tend to be higher than during wetter periods. This is because when rainfall is high, the atmosphere is moist and also cloudiness is often high, leading to lower insolation. Thus a primary cause of inter-annual variation in individual pan evaporation in the more arid areas is a sometimes complementary variation in local rainfall. On the other hand, after this correlation is stripped out of the data, there remains the downward long-term trend in the area-averaged record that is unrelated to long term change in precipitation, in for example, Australia, China and New Zealand. What this means is that in periods of drought, evaporative demand can be relatively high despite the long term trend of decline in potential evaporation. Thus, if for a particular area, global warming shifted spatial and temporal patterns of climate causing an increase in the frequency of droughts (offset by increased rainfall elsewhere), for that droughty area, potential evaporation could increase, not because of the directly enhanced greenhouse warming, but because of the changed local weather (less cloud, less rain, and higher air temperature than via just the enhanced greenhouse warming alone) that global warming engendered via atmospheric circulation changes. Unfortunately distinguishing whether a drought event at a specific location is part of normal long term variability or is attributable to greenhouse gas (GHG) induced global warming is not possible for any one event. That is why when discussing the impact of global warming on potential evaporation it is only meaningful to consider long term spatially averaged trends.

What increases the evaporation rates?

That it is typically hotter by day during a drought owing to less cloudiness, fosters the intuitive perception that hotter conditions cause high evaporation rates. However, it is not high temperature that increases evaporation rates, it is the low vapour pressure deficit that can go with high temperature that increases evaporative demand. Thus if *all else is equal,* warmer conditions do increase evaporative demand via increased atmospheric Vapour Pressure Deficit (VPD). But, with temperature increases attributable to increased atmospheric concentrations of GHG, all else is not equal. As Arrhenius, and all greenhouse effect modellers since have supported, the magnitude of GHG warming is associated with increased atmospheric humidity consistent with the principle behind the Clausius-Clapeyron relationship. This leads to approximately constant globally averaged relative humidity involving increases in absolute atmospheric humidity but only a small increase in the VPD. In fact, about half of the modelled greenhouse warming derives from the long-wave radiation absorption by the assumed increased water vapour content of the atmosphere. Thus with that central feedback in GHG forcing considered alone, we would not expect a large change in evaporative demand with greenhouse warming. So why are inter-decadal declines in potential evaporation rates being widely observed?

In fact, about half of the modelled greenhouse warming derives from the long-wave radiation absorption by the assumed increased water vapour content of the atmosphere.

The physics of evaporation from a free land-locked water, or fully hydrated vegetation, surface has been accurately expressed in the Penman Equation, which combines the net radiation-driven and aerodynamically-driven components of evaporation into a single relationship. In that highly successful formulation, evaporation from a free water surface, like an evaporation pan, mostly depends on three drivers: atmospheric vapour pressure deficit, wind speed, and net radiation load on the wet surface. The temperature of the evaporating surface is eliminated when the radiation and aerodynamic components are combined in the derivation of the Penman Equation. The workshop devoted much time to evaluating these three possibilities for the observed decline in pan evaporation. It was not resolved except that all three drivers have shown trends with different contributions in different places. Vapour pressure deficit sometimes shows a declining trend commensurate with the daily temperature range declining as night minimum temperatures have increased faster than daytime maxima.

Widespread dimming of incident solar radiation was discussed and seemed to be at least partly responsible for the decline in pan evaporation at many sites. But solar dimming may have ceased in the 1990s and may have started to re-brighten over large areas of the Earth since then, though the evidence for that is mixed. Average wind speeds have varied over the last decades as global warming proceeded too. No consistent cause of the declining pan evaporation rates, applicable everywhere, was identified at the workshop but work has continued since then.

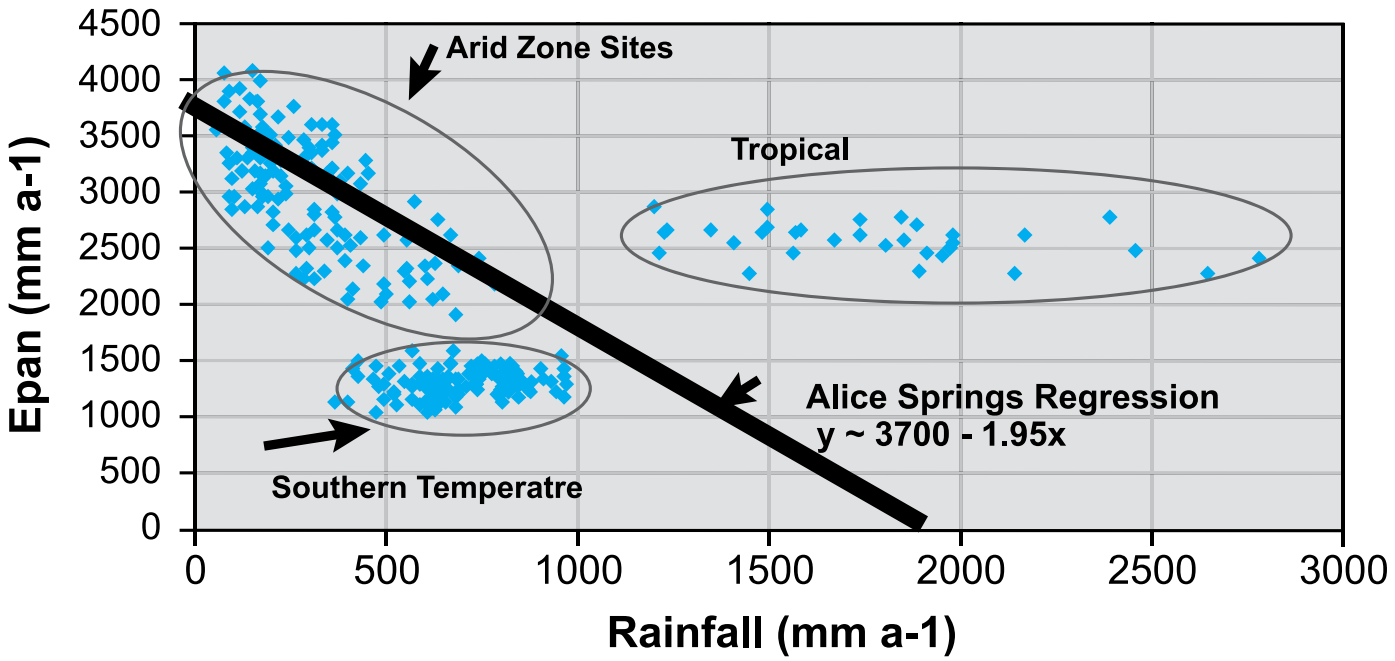

Figure 2. The strong "complementary relationship" between pan evaporation (potential evaporation) and precipitation in arid, high-evaporation environments does not apply in wet environments.

How to define potential evaporation

There are different ways that "potential evaporation" can be conceptualised and defined. The Penman equation implicitly permits the evaporating surface temperature to float with the evaporative cooling, which is the appropriate approach when the impact of evaporative demand on actual evaporation from vegetation is of interest. This is what is needed for studying the impact of climate change on primary productivity, e.g. agricultural production. Under that assumption the actual evaporation rate of a fully wetted vegetation surface is equal to the potential evaporation – adding more water causes no increase in actual evaporation. As the soil dries, actual evaporation declines towards the rate at which the vegetated non-saturated soil can supply water to the air and plant processes. In the intermediate moist zone of soil wetness, between wet and dry, actual evaporation is determined by both the evaporative demand and the soil moisture availability for evaporation. The latter depends on several things including soil type, litter-mulch, rooting depth, root extension rates into moist soil under plant water deficits, and plant stomatal response to evaporative demand and leaf surface temperature. A low evaporative demand, *sensu* Penman, can be equivalent to a wetter soil insofar as plant growth is concerned.

A second way to conceptualise potential evaporation is to adopt a fixed evaporating surface temperature equal to near-surface air temperature rather than allowing it to float with evaporation rate. While this is not the case in the real world where increased evaporation decreases the surface temperature by evaporative cooling, it is the way that GCMs have usually been programmed to predict "potential evaporation" using the Dalton Equation that does not take the changed energy balance into account but uses the saturated vapour pressure at surface temperature (assumed to be equal to near surface air temperature without any evaporative cooling effect) to drive calculated evaporation. This could perhaps be one reason for a GCM to predict that global warming will increase the "potential evaporation".

Proceedings of the workshop with extended abstracts of the 13 papers presented and a detailed review of the conclusions of the meeting, including primary literature references, can be found as a PDF at the Australian Academy of Sciences website: www.science.org.au/natcoms/pan-evap.pdf.

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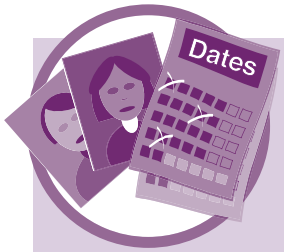


New Roles and Faces

New Science Officer at PAGES

The PAGES Office is very pleased to welcome **Louise Cromer**, who has taken over from Christoph Kull as Science Officer. Louise has a background in palaeoecology and Antarctic palaeolimnology and is about to finish her Ph.D. at the University of Tasmania, Australia. In detail her research focuses on reconstruction of past Antarctic environments and palaeolake communities through analysis of faunal microfossils in lake sediment cores. She is also interested in the origins of the Antarctic freshwater fauna and their responses to small and large-scale environmental change. Within the last four years, Louise has made several trips to Antarctica for a variety of research projects, including the collection of sediment cores for her own studies.

E-mail: cromer@pages.unibe.ch

New IMBER SSC members

Mary-Elena Carr and Michael Roman have been appointed to the SSC for the next three years.

Mary-Elena's expertise includes remote sensing and marine biogeochemistry. Mary-Elena graduated with a M.Sc. degree in Biology at the University of Barcelona (1986) and a Ph.D. in oceanography at Dalhousie University in 1991. After a postdoctoral experience at the Oregon State University, she joined the University of Rhode Island as a marine scientist. She has been a research scientist at the Jet Propulsion Laboratory (NASA) since 1996 in the Water and Carbon Cycles Group. Her research interests include interannual variability of ocean carbon fluxes, novel applications of remote sensing to study ocean biogeochemistry, physical-biological interactions, eastern boundary current systems, air-sea gas exchange, and biological productivity.

E-mail: Mary-Elena.Carr@jpl.nasa.gov

Michael's expertise is in zooplankton ecology, and the structure and dynamics of food webs, particularly in areas of hypoxia. Michael obtained a M.A. in biology at the City College and a Ph.D. in zoology from the University of New Hampshire (1976). He has worked as research assistant at Woods Hole Oceanographic Institution and in 1978 he became Assistant Professor at the School of Marine and Atmospheric Science, University of Miami. Michael joined the Center for Environmental and Estuarine Studies, University of Maryland in 1981 and held several positions until 2001 when he became Director of the Center for Environmental Science. Together with his team at the Horn Point Laboratory, he has developed several projects including BITMAX (Bio-physical Interactions in the Turbidity Maximum), and has worked collaboratively on projects involving toxic dinoflagellates, ecosystem structure, biogeochemical fluxes and vulnerability to climate change perturbations, and integration of traditional, optical and acoustic zooplankton and fish data in the Chesapeake Bay, the largest estuary in the United States.

E-mail: roman@hpl.umces.edu

New SOLAS SSC members

Isabel Cacho became an SSC member of SOLAS in 2006. With her background in past oceanography and climate change she brings in palaeo-aspects of SOLAS research and acts as a link between the SOLAS and PAGES projects. She is also actively working in INQUA, where she is leading a working group on "marine-terrestrial linkages during past global climatic changes". Isa's research focuses on applying a series of geochemical tools to reconstruct ocean properties during past rapid (decadal-to-millennial) climate variability. Her work has been mostly centred on the Mediterranean Sea and, more recently, on the Eastern Equatorial Pacific Ocean. During her career, Isa has moved between Kiel (Germany), Barcelona (Spain) and Cambridge (UK). Since 2003, she has been back at the University of Barcelona as a Scientific Researcher.

E-mail: icacho@ub.edu

New GLP SSC member

Since February 2007 Cheikh Mbow from Senegal has replaced Emma Archer as a new SSC member of GLP. With the applications of remote sensing and GIS as the basis of most of his research Mbow has mainly been working on bush fires and land cover/land use change in the savannah. Other areas of research spans fire risk assessment, fire detection and impacts, and vegetation dynamics (including carbon stocks dynamics) in savannah ecosystems. The human dimensions of the natural resource management are considered in his research (local perceptions, adaptation to environmental changes, local practices, etc.). Since 2007, Mbow is co-leader of the WP 3.2 of the EU African Monsoon Multidisciplinary Analyses (AMMA) project on vulnerability and adaptation to climate change in pastoral and agro-forest ecosystems in West Africa. He is promoting the set up of the West African Remote Sensing Network using satellite technology for environmental studies. Mr. Mbow is appointed for the period 2007–2010.

E-mail: cmbow@ucad.sn

IGBP and Related Global Change Meetings

A more extensive meetings list is available on the IGBP web site at www.igbp.net.

JULY

Climate Change: Towards a decarbonised society (Spanish and English talks)

2–3 July, International Menéndez Pelayo University, Barcelona, Spain

Contact: http://www.cuimpb.cat/frameset.html?lang=cat&accio=webCurso&p1=id&v1=1

International Sea-Ice Summer School

2–13 July, University Centre in Svalbard, Norway

Contact: http://www.seaice.info/

IUGG 24th General Assembly: iLEAPS symposium on "Interactions of Land Cover and Climate"

2–13 July, Perugia, Italy

Contact: http://www.atm.helsinki.fi/ILEAPS/index.php?page=ileaps_meetings

IUGG 24th General Assembly: iLEAPS co-sponsoring CCS/IAMAS workshop on "Interactions between snow, vegetation and the atmosphere" (session JHW001)

2–13 July, Perugia, Italy

Contact: http://www.atm.helsinki.fi/ILEAPS/index.php?page=ileaps_meetings

IUGG 24th General Assembly: Impact of CO_2 Changes on Biogeochemical Processes and Ecosystem Functioning (IMBER session PS009)

2–13 July, Perugia, Italy

Contact: http://www.imber.info/special_sessions.html

World Congress: International Association for Landscape Ecology

8–12 July, Wageningen, Netherlands

Contact: http://www.iale2007.com

Radiocarbon in Ecology and Earth System Science

9–14 July, Irvine, CA, United States

Contact: http://ecology.botany.ufl.edu/radiocarbon07/

Workshop on A Global Change Research Network in African Mountains

23–25 July, Kampala, Uganda

Contact: http://mri.scnatweb.ch/content/view/170/80/

Ocean Carbon and Biogeochemistry (OCB) Summer 2007 Science Workshop

23–26 July, Woods Hole, MA, United States

Contact: Mary Zawoysky, mzawoysky@whoi.edu

2nd ACCENT Symposium, the European Network of Excellence in Atmospheric Composition Change

23–27 July, Urbino, Italy

Contact: http://www.accent-network.org/2nd%2Dsymposium/

17th INQUA Congress

28 July–3 August, Cairns, Australia

Contact: Inqua secretariat, INQUA2007@aqua.org.au

AUGUST

International Workshop on Land-Surface-Atmosphere Interaction

9–13 August, Lanzhou, China

Contact, MAIRS IPO, mairs@mairs-essp.org

2007 World Water Week in Stockholm

12–18 August, Stockholm, Sweden

Contact: http://www.worldwaterweek.org/

17th International Conference on Nucleation and Atmospheric Aerosols

13–17 August, Galway, Ireland

Contact: http://macehead.nuigalway.ie/icnaa2007

Vegetation Dynamics and Climate Change Workshop: Research Needs

14–15 August, Canberra, Australia

Contact: http://www.globalcarbonproject.org/meetings%5CVeg%5CVegetation_Dynamics_Workshop.htm

GCP-CarboAfrica Symposium "Carbon-Climate-Human Interactions in Africa"

23–25 August, Kruger NP, South Africa

Contact: http://www.globalcarbonproject.org/meetings/Africa.html

6th International NCCR Climate Summer School: Land Surface-Atmosphere Interactions in a Changing Climate

26–31 August, Grindelwald, Switzerland

Contact: http://www.nccr-climate.unibe.ch/summer_school/2007/

2nd International Conference on Earth System Modelling

27–31 August, Hamburg, Germany

Contact: http://www.mpimet.mpg.de/fileadmin/static/icesm/

3rd Alexander von Humboldt International Conference: East Asian Summer Monsoon, past, present and future

27–31 August, Beijing, China

Contact: https://www.copernicus.org/site/redsys/classicform.php?form=form_avh07_china_circular&site=egu

Carbon-Climate-Human Interactions in Tropical Peatland: Carbon Pools, Fire, Mitigation, Restoration and Wise Use

27–31 August, Yogyakarta, Indonesia

Contact: http://www.soil.faperta.ugm.ac.id/CT/

CLIVAR/WCRP 2nd International Conference on Earth System Modelling

27–31 August, Hamburg, Germany

Contact: http://www.mpimet.mpg.de/fileadmin/static/icesm/

Inter-Research Symposium # 2 – Effects of Climate Change on Marine Ecosystems

27–31 August, Kiel, Germany

Contact: http://www.ir-symposia.com/Conf_home.asp?Conference Code=EMBS%202007

UNFCCC Dialogue and Kyoto Protocol AWG 4

27–31 August, Vienna, Austria

Contact: http://www.unfccc.int

SEPTEMBER

2nd ALTER-Net Summer School "Trends in Biodiversity: European Ecosystems and Policy"

1–13 September, Peyresq, Alpes de Haute-Provence, France

Contact: http://www.pik-potsdam.de/alter-net/

International Conference: Monitoring the Effectiveness of Nature Conservation Programmes

3–6 September, Swiss Federal Research Institute WSL, Switzerland

Contact: http://www.wsl.ch/event_07/monitoring/

3rd International Conference on Climate and Water

3–6 September, Helsinki, Finland

Contact: http://www.ymparisto.fi/default.asp?contentid=169172&lan=en

Atlantic GEOTRACES workshop

10–13 September, University of Oxford, UK

Contact: Caroline Hutchings, Caroline.Hutchings@earth.ox.ac.uk

Interdisciplinary Opportunity for Recent PhD Graduates: Dissertations Initiative for the Advancement of Climate Change Research Symposium

10–17 September, Kilauea, HI, United States

Contact: http://aslo.org/phd.html or http://disccrs.org

International Workshop on Environmental Changes and Sustainable Development in Arid and Semi-arid Regions

10–17 September, Inner Mongolia, China

Contact: http://www.iggcas.ac.cn/iw07/index.htm

2nd Global Conference on Large Marine Ecosystems

11–13 September, Qingdao, China

Contact: http://www.imber.info/jobs-announcements/LMEs_second_announcement.pdf

12th International Workshop on Transport Phenomena in Two-Phase Flows

12–17 September, Sunny Beach Resort, Bulgaria

Contact: chboyadj@bas.bg or jordan.hristov@mail.bg or hristov-meister@gmail.com

IGBP 20th Anniversary

17–18 September, Stockholm, Sweden

Contact: Sri Sahlin, sri.sahlin@igbp.kva.se

Joint IMBER/LOICZ Continental Margins Open Science Conference: Impacts of Global, Local and Human Forcings on Biogeochemical Cycles and Ecosystems

17–21 September, Shanghai, China

Contact: http://www.confmanager.com/main.cfm?cid=792

ICES Annual Science Conference

17–21 September, Helsinki, Finland

Contact: http://www.ices2007helsinki.fi/index.php

Conference on the Science and Education of Land Use: A Transatlantic, Multidisciplinary and Comparative Approach

24–26 September, Washington, DC, United States

Contact: http://www.nercrd.psu.edu/TALUC/

Chapman Conference on The Role of the Stratosphere in Climate and Climate Change

24–28 September, Santorini, Greece

Contact: http://www.agu.org/meetings/chapman/2007/ccall/

2nd International Workshop on Uncertainty in Greenhouse Gas Inventories

27–28 September, Laxenburg, Austria

Contact: http://www.ibspan.waw.pl/ghg2007/

OCTOBER

Arctic Coastal Zones at Risk (jointly organized by LOICZ, IASC and AMAP)

1–3 October, Tromsø, Norway

Contact: http://w3k.gkss.de/events/arctic07/

4th Nitrogen Conference (N-2007), The International Nitrogen Initiative (INI)

1–5 October, Costa do Sauípe, Bahia, Brazil

Contact: http://www.nitrogen2007.com

7th European Meteorological Society Annual Meeting and 8th European Conference on Applications of Meteorology

1–5 October, Madrid/San Lorenzo de El Escorial, Spain.

Contact: http://meetings.copernicus.org/ems2007

Greenhouse 2007

2–5 October, Sydney, Australia

Contact: http://www.greenhouse2007.com/

CoastGIS Conference

8–10 October, Santander, Spain

Contact: http://www.coastgis07.com/

Long Time-Series Observations in Coastal Ecosystems: Comparative Analyses of Phytoplankton Dynamics on Regional to Global Scales

8–12 October, Rovinj, Croatia

Contact: http://www.agu.org/meetings/chapman/2007/bcall/

iLEAPS-ACCENT-QUEST Expert Workshop on the Relevance of Surface and Boundary Layer Processes for the Exchanges of Reactive- and Greenhouse Gases

9–12 October, Wageningen, Netherlands

Contact: Laurens Ganzeveld, laurens.ganzeveld@wur.nl or Ganzevl@mpch-mainz.mpg.de

Workshop Marie Curie-iLEAPS-MODELS: Towards a Process-based Description of Trace Gas Emissions in Land Surface Models

16–19 October, University of Lund, Sweden

Contact: Almut Arneth, almut.arneth@nateko.lu.se

3rd Global Change Research Network in European Mountains (GCRN_EM) Networking Meeting: From Strategy to Project

18–19 October, Innsbruck, Austria

Contact: http://www.mri.scnatweb.ch/dmdocuments/GCRN_EM_Innsbruck07.v1.pdf

SOLAS Summer School 2007

22 October–3 November, Corsica, France

Contact: http://www.uea.ac.uk/env/solas/summerschool/

Danish Network for Land System

25–26 October, Copenhagen, Denmark

Contact: http://www.lasys.dk/index.shtml

Geological Society of America Annual Meeting and Exposition Earth Sciences for Society: Beginning of the International Year of Planet Earth

28–31 October, Colorado Convention Center, Denver, CO, United States

Contact: http://www.geosociety.org/meetings/2007

NOVEMBER

1st International Conference on Adaptive & Integrated Water Management: Coping with Complexity and Uncertainty (CAIWA 2007)

12–15 November, Basel, Switzerland

Contact: http://www.usf.uos.de/projects/caiwa/index.htm

Asia-Pacific EcoHealth Conference: Sustaining People and Places in a Changing World

26–29 November, Basel, Switzerland

Contact: Marika Thomson, marika.thomson@deakin.edu.au or http://www.deakin.edu.au/events/ecohealth2007/

ECEM'07, the 6th European Conference on Ecological Modelling: Challenges for Ecological Modelling in a Changing World: Global Changes, Sustainability and Ecosystem Based Management

27–30 November, Trieste, Italy

Contact: http://www2.ogs.trieste.it/ecem07/

1st CLIOTOP Symposium: Climate Impacts on Oceanic Top Predators

3–7 December, La Paz, Mexico

Contact: https://www.confmanager.com/main.cfm?cid=722

AGU 2007 Fall Meeting

10–14 December, San Francisco, CA, United States

Contact: http://www.agu.org/meetings/fm07/

2008

JANUARY

Institute on The Monsoon System: Prediction of Change and Variability

2–12 January, Honolulu, HI, United States

Contact: http://www.start.org/curfinopp.html

European Research Course on Atmospheres

8 January–10 February, Grenoble, France

Contact: http://www-lgge.obs.ujf-grenoble.fr/enseignement/erca/

FEBRUARY

3rd WCRP International Conference on Reanalysis

1 February, Tokyo, Japan

Contact: http://jra.kishou.go.jp/3rac_en.html

International Workshop: Aerosols in the Amazon – Changes and their Consequences from Past and Future Human Activities

18–22 February, Manaus, Amazônia, Brazil

Contact: http://www.seas.harvard.edu/environmental-chemistry/AmazonWorkshop.htm

MARCH

2008 Ocean Sciences Meeting – From the Watershed to the Global Ocean

2–7 March, Orlando, Florida, FL, United States

Contact: http://www.aslo.org/forms/orlando2008.html

International Conference on Global Environmental Change and Food Systems

31 March–2 April, Oxford, UK

Contact: http://www.gecafs.org/

APRIL

Resilience 2008: Resilience, Adaptation and Transformation in Turbulent Times

14–16 April, Stockholm, Sweden

Contact: http://resilience2008.org/

2nd Workshop on Lysimeters for Global Change Research: Biological Processes and the Environmental Fate of Pollutants

23–25 April, Neuherberg near Munich, Germany

Contact: http://www.gsf.de/lysimeter-workshop

MAY

4th IGBP Congress 2008

4–9 May, Cape Town, South Africa

Contact: http://www.igbp.net

ICES/PICES/IOC Symposium: Effects of Climate Change on the World's Oceans

19–23 May, Gijón, Spain

Contact: PICES Secretariat, secretariat@PICES.int

JUNE

5th International Conference on Climate Change: The Karst Records Conference

2–5 June, Chongqing, China

Contact: http://www.climatechangekr5.org

Eastern Boundary Upwelling Ecosystems: Integrative and Comparative Approaches

2–6 June, Canary Islands, Spain

Contact: http://www.upwelling-symposium.org

JULY

SCAR/IASC Open Science Conference 2008

8–11 July, St. Petersburg, Russia

Contact: http://www.scar.org/events/#2008

4th International Limnogeology Congress

11–14 July, Barcelona, Spain

Contact: http://www.ilic2007.com/

37th Scientific Assembly of the Committee on Space Research and Associated Events – COSPAR 2008: 50th Anniversary Assembly

13–20 July, Montreal, Canada

Contact: COSPAR, cospar@cosparhq.cnes.fr or http://www.cospar2008.org/ or http://www.cospar-assembly.org

XVII INQUA Congress

28 July–3 August, Cairns, Australia

Contact: http://www.inqua2007.net.au/

AUGUST

33rd International Geological Congress: Earth System Science: Foundation for Sustainable Development

5–14 August, Oslo, Norway

Contact: http://www.pages.unibe.ch/calendar/calendar08.html

SEPTEMBER

13th World Water Congress

1–4 September, Montpellier, France

Contact: http://www.worldwatercongress2008.org

SPARC 4th General Assembly

1–5 September, Bologna, Italy

Contact: http://www.atmosp.physics.utoronto.ca/SPARC/GA2008/GA2008index.html

The 10th Scientific Conference of the IGAC Project: Bridging the Scales in Atmospheric Chemistry: Local to Global

7–12 September, Annecy, France

Contact: http://www.igacfrance2008.fr/

OCTOBER

SCOR/IOC/IGBP Symposium: The Oceans in a High CO2 World

6–8 October, IAEA, Monaco

Contact: http://ioc.unesco.org/ioccp/HighCO2/2008symposium/index.htm

NOVEMBER

IHDP Open Meeting

9 November–12 November, New Delhi, India

Contact: http://www.ihdp.org

Pin Board

The Pin Board is a place for short announcements and letters to the editor. Announcements may range from major field campaigns, new websites, research centres, collaborative programmes, policy initiatives or political decisions of relevance to global change. Letters to the editor should not exceed 200 words and should be accompanied by name and contact details.

Paul Falkowski (AIMES SSC) elected to National Academy of Sciences

Paul Falkowski, a faculty member at Rutgers, has just been elected to the National Academy of Sciences. Paul is a professor with a joint appointment in the Institute of Marine and Coastal Sciences and Geological Sciences at Rutgers, The State University of New Jersey, New Brunswick. He is well known for many important contributions to evolutionary biology, ecology, and the study of photosynthesis. This is a very nice honour for Paul, for Rutgers, and for the IGBP community.

World Environment Day

IGBP participated in the World Environment Day 2007 conference, 4–5 June in Tromsø, Norway. "Melting ice – a hot topic" was the theme of this year's annual commemoration, sponsored by the United Nations Environment Programme (UNEP). An additional attraction to the conference was the fact that 2007 is the 20th anniversary of the Brundtland report "Our Common Future". Speakers at the conference included Archbishop Desmond Tutu, Norwegian prime minister Jens Stoltemberg, UNEP executive director Achim Steiner, IPCC chair Rajendra Pachauri, Masoumeh Ebtekar, Sheila Watt Cloutier, and Chris Rapley, director of the British Antarctic Survey and former IGBP executive director.

Read more on: www.unep.org/wed/2007

Image: © UCAR, photo by James Hannigan)

New Research Centre Opened in Stockholm

Stockholm Resilience Centre was successfully inaugurated on Tuesday 29 May, and aims at advance transdisciplinary research for governance of social-ecological systems with a special emphasis on resilience – the ability to deal with change and continue to develop. The centre is a joint initiative between Stockholm University, the Stockholm Environment Institute and the Beijer International Institute of Ecological Economics at The Royal Swedish Academy of Sciences. The main funding to the centre comes from the Foundation for Strategic Environmental Research, Mistra. The conference "Resilience 2008", to be held in April 2008, is co-organised by the Stockholm Resilience Centre (see ad in this Newsletter).

Website: www.stockholmresilience.su.se

IGBP's 20th Anniversary Symposium

Planning for the IGBP´s 20th anniversary symposium is proceeding well. The programme for the symposium is divided into past, present and future challenges for IGBP. Sessions will include topics as global climate change, the ozone hole and the Montreal protocol, land use change in the tropics, iron fertilisation of the oceans, air quality and climate, ocean acidification, renewable energy, and adaptation and sustainable development. Participants are arriving from both the scientific sector and the political and private sectors. The symposium is co-organised with the Royal Swedish Academy of Sciences, IGBP's host institution for the last two decades.

New co-Chair at IGAC

Kathy Law has taken over from Sandro Fuzzi as the European co-Chair of IGAC from January 2007. Kathy obtained her PhD in Atmospheric Chemistry at the University of Cambridge, UK, where she worked as a research scientist up to 2002 before taking up a position at CNRS as Director of Research at the Service d'Aéronomie/IPSL (Institut Pierre Simon Laplace), UPMC (Université Pierre et Marie Curie), Paris, France. Her current research interests include long-range transport of pollutants (co-lead of the IGAC POLARCAT task) and the West African monsoon (as part of the IGAC AMMA task).

Kathy will be presented more thoroughly in the coming Global Change Newsletter.

Website: www.igac.noaa.gov

New PAGES Working Group: Global Monsoon

If you are interested in contributing to a new Working Group on Global Monson, please contact PAGES Focus 3 leader Pinxian Wang (pxwang@online.sh.cn). The Working Group will be launched with a Townhouse Meeting at the Humboldt Conference *East Asian Summer Monsoon, past, present and future*, which will be held 27–31 August 2007 in Beijing, China. The conference aims at discussing and integrating past records and present-day observations of monsoon climate, with a focus on the East Asian summer monsoon.

More information:
http://www.conferencenet.org/conference/avh.htm

Broecker Awarded 2006 Crafoord Prize

The Crafoord Prize in Geosciences 2006 was awarded to Wallace Broecker. With his innovative research on the interaction between atmosphere, oceans, ice and living organisms, he has contributed greatly to our knowledge of climate change and its mechanisms.

Wally's earliest contributions to palaeoceanography involved his work with accurate radiometric dating techniques applied to marine sediments and coral reef terraces. He was the first to document Milankovitch forcing of sea level in the uplifted coral reef terraces at Barbados. His work using with marine sediments provided the earliest, accurate chronologies of the last glacial cycle and along the way he defined the glacial terminations and the "saw-tooth cycle" of Pleistocene climate change. Wally's leadership role in the GEOSECS program and his early research on the distribution of ^{14}C in the oceans led to the conceptual model of the ocean conveyor circulation system. His contributions linking changes in coupled ocean-atmospheric circulation to abrupt changes in climate have set a research agenda that has dominated palaeoceanography and palaeoclimatology for the last 20 years.

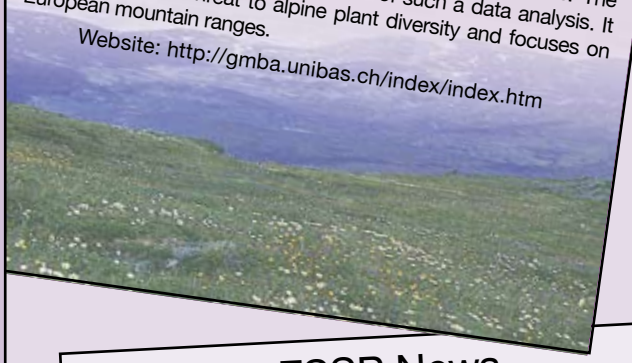
The Crafoord Prize is awarded annually and comes with a cash prize of US$500,000, truly a "Nobel Prize" for Earth scientists. The award was presented in Lund, Sweden on April 26, 2007 in a ceremony in the presence of Her Majesty Queen Silvia of Sweden. IGBP congratulates Wally for his many accomplishments and for this great and well-deserved honour.

Photo © Royal Swedish Academy of Sciences

Global Mountain Biodiversity Assessment (GMBA)

GMBA is a project on geo-referenced biological databases as a tool for understanding mountain biodiversity. There is a strong potential in biological databases linked to geophysical data (e.g. altitude, temperature) for the analysis of mountain biodiversity patterns. In cooperation with the Global Biodiversity Information Facility (GBIF), the GMBA encourages a global effort to mine georeferenced archive databases on mountain organisms. The EUROMONT initiative is one example of such a data analysis. It assesses climate threat to alpine plant diversity and focuses on European mountain ranges.

Website: http://gmba.unibas.ch/index/index.htm



ESSP News

The international programme of biodiversity science, DIVERSITAS, has moved to its new headquarters in Paris:

Muséum National d'Histoire Naturelle
57 Rue Cuvier – CP 41
75231 Paris Cedex 05, France
Phone: + 33 1 40 79 80 40
Fax. + 33 1 40 79 80 45

DIVERSITAS
an international programme of biodiversity science

Website: www.diversitas-international.org

Progress of the IHOPE initiative

The goal of the Integrated History and future Of People on Earth (IHOPE) project is to understand the interactions of the environmental and human processes over the past several ten to hundred millennia to determine how human and biophysical changes have contributed to Earth system dynamics.

The overall conclusion from IHOPE-Dahlem conference in 2005 was that human societies respond to environmental signals (e.g. climate) through multiple pathways including coping, adaptation, collapse or failure, migration, and creative invention through discovery

In January 2006, an IHOPE workshop was held in Stockholm to draft a research plan. This research plan has been reviewed by PAGES and approved for co-sponsorship by the International Human Dimensions Programme (IHDP).

The IHOPE activity is led by Robert Costanza, Lisa Graumlich, Sander van der Leeuw, Will Steffen, John Dearing, Carole Crumley and Kathy Hibbard.

Read more about IHOPE at the AIMES website: www.aimes.ucar.edu/activities/ihope.shtml

Announcement of Opportunity: Asia Monsoon Institute

The global change SysTem for Analysis, Research and Training (START) and the Asia Pacific Network for Global Change Research (APN) invite applications to the Institute on The Asian Monsoon System: Prediction of Changes and Variability. Early-career researchers are particularly encouraged to apply until 1 August 2007.

The institute will be held at The East-West Center and the University of Hawaii at Manoa in Honolulu, Hawaii, 2–12 January 2008.

The scientific agenda will include satellite observations and computing technology that have helped to increase our understanding of the Asian Monsoon system and modelling of the Monsoon, and to markedly enhance predictive capabilities. The institute will bring these advances to the attention of young researchers and scientists from the Asia Pacific region and promote their involvement in regional collaborative research and in international science programmes.

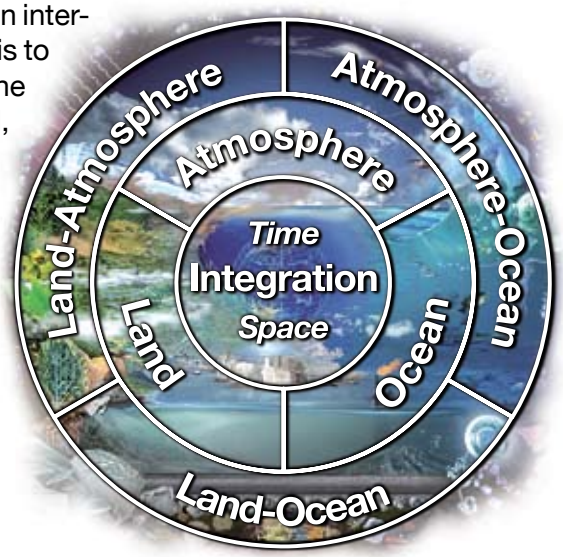
Read more at: www.start.org

START

IHDP • IGBP • WCRP

The International Geosphere-Biosphere Programme

IGBP is an international scientific research programme built on interdisciplinarity, networking and integration. The vision of IGBP is to provide scientific knowledge to improve the sustainability of the living Earth. IGBP studies the interactions between biological, chemical and physical processes and human systems, and collaborates with other programmes to develop and impart the understanding necessary to respond to global change. IGBP research is organised around the compartments of the Earth System, the interfaces between these compartments, and integration across these compartments and through time.



IGBP helps to

- develop common international frameworks for collaborative research based on agreed agendas
- form research networks to tackle focused scientific questions and promote standard methods
- guide and facilitate construction of global databases
- undertake model inter-comparisons
- facilitate efficient resource allocation
- undertake analysis, synthesis and integration of broad Earth System themes

IGBP produces

- data, models, research tools
- refereed scientific literature, often as special journal editions, books, or overview and synthesis papers
- syntheses of new understanding on Earth System Science and global sustainability
- policy-relevant information in easily accessible formats

Earth System Science

IGBP works in close collaboration with the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP), and DIVERSITAS, an international programme of biodiversity science. These four international programmes have formed the Earth System Science Partnership (ESSP). The International Council for Science (ICSU) is the common scientific sponsor of the four international global change programmes.

Participate

IGBP welcomes participation in its activities – especially programme or project open meetings (see meetings list on website). To find out more about IGBP and its research networks and integration activities, or to become involved, visit our website (www.igbp.net) or those of our projects, or contact an International Project Office or one of our 74 National Committees.

Contributions

The Global Change NewsLetter primarily publishes articles reporting science undertaken within the extensive IGBP network. However, articles reporting interesting and relevant science undertaken outside the network may also be published. **Science Features** should balance solid scientific content with appeal to a broad global change research and policy readership. **Discussion Forum** articles should stimulate debate and so may be more provocative. Articles should be between 800 and 1500 words in length, and be accompanied by two or three figures or photographs. Articles submitted for publication are reviewed before acceptance for publication. Items for the **Pin Board** may include letters to the editor, short announcements such as new relevant web sites or collaborative ventures, and meeting or field campaign reports. Pin Board items should not exceed 250 words.

Photographs should be provided as TIFF or high resolution JPG files; minimum of 300 dpi. Other images (graphs, diagrams, maps and logos) should be provided as vector-based EPS files to allow editorial improvements at the IGBP Secretariat. All figures should be original and unpublished, or be accompanied by written permission for re-use from the original publishers.

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