

# Northern Climate ExChange

*Independent Information - Shared Understanding - Action on Climate Change*

NCE Update September 30, 2009

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## Announcements

### 1. Employment Opportunity: Communications/Outreach Intern, Northern Climate Exchange, Northern Research Institute, Yukon College.

Communications/Outreach Intern, Northern Climate Exchange,  
Northern Research Institute  
Ayamdigut Campus, Whitehorse  
Term position from 6 to 9 months  
Status: 35 hours per week  
Salary: \$14.00 per hour  
Initial Review Date: October 16, 2009  
Location: Whitehorse, Yukon Territory  
Please apply directly to **YWCA** (see below)

For eligibility criteria and to apply please refer to the following website:  
<http://www.yeip.ca/>

Note: Apply directly to the **YWCA**, not the YMCA for this internship and indicate your interest in this internship in your application.

For more information, please contact the [NCE](#).

[www.taiga.net](http://www.taiga.net)

### 2. YSI Lecture: International Polar Year and the Future of Polar Research - David Carlson, Director, International Programme Office, International Polar Year



**October 4, 2009**, 7:30 pm Yukon Beringia Interpretive Centre, Whitehorse  
**October 5, 2009**, 7:30 pm Kluane National Park VRC, Haines Junction

International Polar Year (IPY) just ended in March of 2009. What was accomplished... and where do we go from here?

Join David Carlson, as he examines what has been achieved through international collaboration among research agencies over the last two years, and what is required to sustain the momentum created by IPY. The IPY successes in outreach and education, particularly those initiated by and involving young researchers, are an important part of the legacy for future polar research. Ensuring that avenues are available to young researchers excited by IPY, particularly given the upcoming challenges facing polar residents and global citizens, is also critical.

<http://www.taiga.net/ysi/next.html>

### **3. UNEP Climate Change Science Compendium 2009**

The Climate Change Science Compendium is a review of some 400 major scientific contributions to our understanding of Earth Systems and climate that have been released through peer-reviewed literature or from research institutions over the last three years, since the close of research for consideration by the IPCC Fourth Assessment Report.

The Compendium is not a consensus document or an update of any other process. Instead, it is a presentation of some exciting scientific findings, interpretations, ideas, and conclusions that have emerged among scientists.

Focusing on work that brings new insights to aspects of Earth System Science at various scales, it discusses findings from the International Polar Year and from new technologies that enhance our abilities to see the Earth's Systems in new ways. Evidence of unexpected rates of change in Arctic sea ice extent, ocean acidification, and species loss emphasizes the urgency needed to develop management strategies for addressing climate change.

[Download full report](#) (4.6 MB)

[www.unep.org](http://www.unep.org)

### **4. Film Screening: 'The Age of Stupid'**

The **Northern Climate ExChange**, Yukon College, is pleased to invite you to a screening of the new feature-length cinema-documentary:

"**The Age of Stupid**" [www.ageofstupid.net](http://www.ageofstupid.net)

**Wednesday October 14, 2009**

The Old Firehall, Whitehorse, YT

Doors open at 6:30 p.m.

Show starts at 7 p.m.

(Seating is limited, so please arrive early).

'**The Age of Stupid**' is the new cinema documentary from the Director of 'McLibel' and the Producer of the Oscar-winning 'One Day In September'. This enormously ambitious drama-documentary-animation hybrid stars Oscar-nominated Pete Postlethwaite as an old man living in the devastated world of 2055, watching "archive" footage from 2008 and asking: why didn't we stop climate change while we had the chance?

[www.taiga.net/nce](http://www.taiga.net/nce)

## 5. Launch: Whitehorse Green Drinks!

Tuesday, October 20th, 4:30 pm  
Capital Hotel Bar, 103 Main Street, Whitehorse

**Green Drinks** is a free-from event, held monthly in cities around the world. Environmental like-minds, those working in the sector or those who would like to, those who are passionate about environmental issues or those who are just curious about 'greening' up their lives, come together to share a drink and chat in a relaxed informal setting.

Come out to the launch of Whitehorse Green Drinks Tuesday, October 20th at the Capitol from 4:30pm onward for a casual drink to discuss environmental topics.

When: The third Tuesday of every month from 4:30 pm onward.  
Our first Green Drinks will occur on Tuesday, October 20th!!

Where: The Capitol Hotel Bar, 103 Main St.

Contact us at [greendrinkswhitehorse@gmail.com](mailto:greendrinkswhitehorse@gmail.com) for more details.  
We look forward to meeting you!

## Articles

### 1. Conference Board creates Northern Research Centre

CBC News  
September 25, 2009

The Conference Board of Canada has launched a "virtual centre for the north" that will produce \$5 million worth of research on issues ranging from climate change to the northern economy.

The Conference Board's northern centre will back 50 major independent studies, to be produced over the next five years, on topics such as Canadian sovereignty, climate change, infrastructure, business opportunities and challenges, health and social development in the northern territories and the northern parts of the provinces.

The centre is "virtual" in that it doesn't include a physical presence in the North. The Conference's Board's offices are located in Ottawa.

"We feel that the issues and challenges facing the North right now are absolutely critical, not just for northern Canada, not just for the territories, but for all Canadians," Conference Board president Anne Golden told CBC News Thursday in Yellowknife, where the Centre for the North held its first meeting.

"It's important, though, to have an intelligent, fair-minded conversation about all of the many complicated issues."

At Thursday's meeting, Centre for the North investors reviewed the framework of the centre and determined the priority of research projects to be done in the year ahead.

Officials with the Conference Board, a non-profit research organization focusing on economic trends and public policy, say there often is not enough information that can be used to make decisions about the North.

'Key pressing issues'

"We're basically trying to get input from aboriginal communities, from business leaders, from government, to try and get a sense of what are the key pressing issues," said Pedro Antunes, the board's director of national and provincial forecast.

Antunes said the centre's main goal will be to encourage sustainable development in the North. Golden said the 50 studies will give northerners, as well as those south of 60, a better understanding of the challenges people face in Canada's North.

She added that the research data will be helpful in implementing policies "to look at it from a balanced perspective: not just simply from a viewpoint of what is the way to maximize economic growth, but root it ... in the whole theme of healthy communities."

The Conference Board will provide the Centre for the North with detailed economic forecasts for the North.

[www.cbc.ca](http://www.cbc.ca)

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## **2. Nunavut joins North American climate registry**

Nunatsiaq News On-line  
September 27, 2009

Nunavut will take the first step towards keeping track of its greenhouse gas emissions - by joining the Climate Registry.

The Government of Nunavut announced Sept. 24 that the territory will join the Climate Registry, a non-profit collaboration among North American states, provinces and territories.

Nunavut is the last provincial or territorial jurisdiction in Canada to join the registry, and one of the last in North America.

Nunavut Premier Eva Aariak said the decision to shows Nunavut recognizes the urgency of taking common action to curb greenhouse gas emissions, which are linked to global warming.

The registry sets standards, which are used calculate, verify and publicly report greenhouse gas emissions into a single registry.

And its members voluntarily measure, verify, and publicly report their greenhouse gas emissions. Members first establish their emissions baseline, that is, the amount of greenhouse gas emissions they produce. This is then used to document reductions under any regulatory programs.

Canada is expected to announce a mandatory reporting and reduction plan after the United Nations climate change conference in Copenhagen this December.

This conference should produce a new global plan to cut greenhouse gas emissions.

Scientific information from the International Panel on Climate Change suggests that to avoid the most catastrophic impacts of climate change, greenhouse gas emissions need to be reduced by 50 to 80 per cent below 1990 levels by 2050.

[www.nunatsiaqonline.ca](http://www.nunatsiaqonline.ca)

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## **3. Thinning glaciers driving polar ice loss, satellite survey finds**

*Satellite survey of Greenland and Antarctic ice sheets reveals extensive network of rapidly thinning glaciers that is driving ice loss in the regions*

By Ian Sample  
The Guardian

September 23, 2009

A comprehensive satellite survey of the Greenland and Antarctic ice sheets has revealed an extensive network of rapidly thinning glaciers that is driving ice loss in the regions.

The most profound loss of ice was seen along the continental coastlines, where glaciers speed up as they slip into the sea. In some regions, glaciers flowing into surrounding waters were thinning by nearly 10m a year.

Scientists used data from Nasa's ICESat (Ice, Cloud and and land Elevation Satellite) to piece together a picture of the changing fortunes of glaciers on the ice sheets. The satellite bounces laser light off the ground, allowing researchers to measure the terrain with extraordinary precision.

The survey, compiled from 50m satellite measurements taken between February 2003 and November 2007, shows glaciers thinning at all latitudes in Greenland and along key Antarctic coastlines. Thinning penetrated deep into the interior of the ice sheets and continues to spread as ice shelves melt into the sea.

"We were surprised to see such a strong pattern of thinning glaciers across such large areas of coastline. It's widespread and in some cases, thinning extends hundreds of kilometres inland," said Hamish Pritchard who led the study at the British Antarctic Survey.

In Greenland, glaciers in the south-east were found to be flowing at speeds of more than 100m per year, during which they thinned by 84cm. More slow-going glaciers lost around 12cm a year.

In a vast region of western Antarctica that drains into the Amundsen Sea, the Pine Island glacier and neighbouring Smith and Thwaites glaciers are thinning by 9m a year, the satellite measurements show. The study is published in the journal Nature.

Previous satellite surveys of polar regions have relied upon radar measurements that cannot map the Earth's surface with the same precision as the ICESat laser rangefinder. The satellite allows scientists to take 65m-wide snapshots of the ground, giving an unprecedented view of glaciers on the steep terrain where ice meets ocean.

This satellite survey helps scientists explore how different aspects of climate change are driving ice loss in polar regions. Higher air temperatures can increase surface melting, but warm ocean currents accelerate ice loss more when glaciers flow into the sea.

"The majority of the thinning we see is not due to increased melting from higher atmospheric temperatures, but because the glaciers are flowing faster thanks to their interaction with the oceans," said Prof David Vaughan, a co-author on the study.

[www.guardian.co.uk](http://www.guardian.co.uk)

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#### **4. Federal agency agrees to deadline on listing ice seals**

By Dan Joling  
The Associated Press  
*Daily NewsMiner*  
September 28, 2009

ANCHORAGE, Alaska - A federal agency must decide within three weeks whether spotted seals, which depend on sea ice off Alaska's coast, should be listed as a threatened or endangered species.

In addition, the National Oceanic and Atmospheric Administration agreed to decide by Nov. 1, 2010, whether two other ice-dependent seals, ringed seals and bearded seals, should be listed.

A federal judge Friday approved the settlement between NOAA and the Center for Biological Diversity, which had sued to force a decision.

Center spokeswoman Rebecca Noblin said Monday the group was happy the agency had set the dates, since the summer sea ice minimum this year was the third-lowest since satellite measurements began in 1979.

"The quicker we can get protection for these seals, the better," she said.

NOAA officials in December denied listing ribbon seals as threatened or endangered. They said climate models project annual ice for the seals will continue to form each winter during the critical birthing and molting period. The Center for Biological Diversity has sued to reverse the decision.

John Kurland, acting deputy regional administrator of NOAA, said the agency has been studying spotted, ringed and bearded seals. Spotted seals had a similar distribution and an information overlap with ribbon seals, he said.

Information on the other two types of seals is more complicated, and the extra time will let the agency incorporate information compiled by the state of Alaska, Kurland said.

Ringed, bearded and spotted seals use sea ice in different ways for giving birth, rearing pups and resting. All three live in the Bering, Chukchi or Beaufort seas off Alaska's western and northern coasts.

The Center for Biological Diversity petitioned to list the seals in May 2008, the same month former Interior Secretary Dirk Kempthorne declared polar bears threatened because of sea ice loss.

The agency missed the one-year deadline for a decision, and the environmental group sued.

Spotted seals use the edge of sea ice far from predators to give birth and nurse pups. Loss of sea ice and early ice breakup threaten their ability to rear young, according to the listing petition.

Ringed seals are the primary prey of polar bears. They are the only seals that can live in completely ice-covered waters, using stout claws to dig and maintain breathing holes. They excavate snow caves on sea ice to provide insulated shelters for themselves and their pups.

Early breakup of sea ice threatens lairs during critical rearing periods when pups are too young to survive in water, according to the group. Warming also can expose lairs and make pups vulnerable to polar bears and Arctic foxes.

Bearded seals give birth and rear pups on drifting pack ice over shallow waters where prey is abundant. The retreat of sea ice away from shallow shelves decreases food availability, the environmental group said.

Federal agencies are required to consider how their regulatory decisions affect listed and threatened species.

[www.newsminer.com](http://www.newsminer.com)

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## **5. Unusual Arctic Warmth, Tropical Wetness Likely Cause for Methane Increase**

NOAA  
September 25, 2009

Unusually high temperatures in the Arctic and heavy rains in the tropics likely drove a global increase in atmospheric methane in 2007 and 2008 after a decade of near-zero growth, according to a new study. Methane is the second most abundant greenhouse gas after carbon dioxide, albeit a distant second.

NOAA scientists and their colleagues analyzed measurements from 1983 to 2008 from air samples collected weekly at 46 surface locations around the world. Their findings will appear in the September 28 print edition of the American Geophysical Union's Geophysical Research Letters and are available online now.

"At least three factors likely contributed to the methane increase," said Ed Dlugokencky, a methane expert

at NOAA's Earth System Research Laboratory in Boulder, Colo. "It was very warm in the Arctic, there was some tropical forest burning, and there was increased rain in Indonesia and the Amazon."

In the tropics, the scientists note, the increased rainfall resulted in longer periods of rainfall and larger wetland areas, allowing microbes to produce more methane. Starting in mid-2007, scientists noticed La Niña conditions beginning, waning and then intensifying in early 2008. This kind of climate condition typically brings wetter-than-normal conditions in some tropical regions and cooler sea surface temperatures in the central and eastern tropical Pacific Ocean. It can persist for as long as two years. In the United States, La Niña often signals drier-than-normal conditions in the Southwest and Central Plains regions, and wetter fall and winter seasons in the Pacific Northwest.

Observations from satellites and ground sites suggest that biomass burning - the burning of plant and other organic material that releases carbon dioxide and methane - contributed about 20 percent, of the total methane released into the atmosphere in 2007.

However, during the scientists' 2007 measurement of methane for northern wetland regions, including the Arctic, temperatures for the year were the warmest on record. This temperature increase coincided with the large jump in the amount of methane measured in that area.

Dlugokencky and his colleagues from the United States and Brazil note that while climate change can trigger a process which converts trapped carbon in permafrost to methane, as well as release methane embedded in Arctic hydrates - a compound formed with water - their observations "are not consistent with sustained changes there yet."

Methane is typically created in oxygen-deprived environments, such as flooded wetlands, peat bogs, rice paddies, landfills, termite colonies, and the digestive tracts of cows and other ruminant animals. The gas also escapes during fossil fuel extraction and distribution and is emitted during fires.

Authors of the study are Dlugokencky, L. Bruhwiler, P.C. Novelli, S. A. Montzka, K. A. Masarie, P. M. Lang, A.M. Crowell, and J.B. Miller of NOAA's Earth System Research Laboratory, Boulder, Colo.; J.W.C. White of the Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colo.; L. K. Emmons of the National Center for Atmospheric Research, Boulder, Colo.; and L.V. Gatti of the Laboratorio de Quimica Atmosferica, Instituto de Pesquisas Energéticas e Nucleares, São Paulo, Brazil. Crowell and Miller are also at the Cooperative Institute for Research in Environmental Sciences in Boulder, Colo. The paper is available online.

NOAA understands and predicts changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and conserves and manages our coastal and marine resources.

[www.noaanews.noaa.gov](http://www.noaanews.noaa.gov)

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## **6. Met Office warns of catastrophic global warming in our lifetimes**

- *Study says 4C rise in temperature could happen by 2060*
- *Increase could threaten water supply of half world population*

By David Adam  
The Guardian,  
September 28, 2009

Unchecked global warming could bring a severe temperature rise of 4C within many people's lifetimes, according to a new report for the British government that significantly raises the stakes over climate change.

The study, prepared for the Department of Energy and Climate Change by scientists at the Met Office, challenges the assumption that severe warming will be a threat only for future generations, and warns that a catastrophic 4C rise in temperature could happen by 2060 without strong action on emissions.

Officials from 190 countries gather today in Bangkok to continue negotiations on a new deal to tackle global warming, which they aim to secure at United Nations talks in December in Copenhagen.

"We've always talked about these very severe impacts only affecting future generations, but people alive today could live to see a 4C rise," said Richard Betts, the head of climate impacts at the Met Office Hadley Centre, who will announce the findings today at a conference at Oxford University. "People will say it's an extreme scenario, and it is an extreme scenario, but it's also a plausible scenario."

According to scientists, a 4C rise over pre-industrial levels could threaten the water supply of half the world's population, wipe out up to half of animal and plant species, and swamp low coasts.

A 4C average would mask more severe local impacts: the Arctic and western and southern Africa could experience warming up to 10C, the Met Office report warns.

The study updates the findings of the 2007 report of the Intergovernmental Panel on Climate Change (IPCC), which said the world would probably warm by 4C by 2100 if greenhouse gas emissions continue to rise. The IPCC also listed a more severe scenario, with emissions and temperatures rising further because of more intensive fossil fuel burning, but this was not considered realistic. "That scenario was downplayed because we were more conservative a few years ago. But the way we are going, the most severe scenario is looking more plausible," Betts said.

A report last week from the UN Environment Programme said emissions since 2000 have risen faster than even this IPCC worst-case scenario. "In the 1990s, these scenarios all assumed political will or other phenomena would have brought about the reduction in greenhouse gas emissions by this point. In fact, CO2 emissions from fossil-fuel burning and industrial processes have been accelerating."

The Met Office scientists used new versions of the computer models used to set the IPCC predictions, updated to include so-called carbon feedbacks or tipping points, which occur when warmer temperatures release more carbon, such as from soils.

When they ran the models for the most extreme IPCC scenario, they found that a 4C rise could come by 2060 or 2070, depending on the feedbacks. Betts said: "It's important to stress it's not a doomsday scenario, we do have time to stop it happening if we cut greenhouse gas emissions soon." Soaring emissions must peak and start to fall sharply within the next decade to head off a 2C rise, he said. To avoid the 4C scenario, that peak must come by the 2030s.

A poll of 200 climate experts for the Guardian earlier this year found that most of them expected a temperature rise of 3C-4C by the end of the century.

The implications of a 4C rise on agriculture, water supplies and wildlife will be discussed at the Oxford conference, which organisers have billed as the first to properly consider such a dramatic scenario.

Mark New, a climate expert at Oxford who has organised the conference, said: "If we get a weak agreement at Copenhagen then there is not just a slight chance of a 4C rise, there is a really big chance. It's only in the last five years that scientists have started to realise that 4C is becoming increasingly likely and something we need to look at seriously." Limiting global warming to 2C could only be achieved with new technology to suck greenhouse gases from the atmosphere. "I think the policy makers know that. I think there is an implicit understanding that they are negotiating not about 2C but 3C or 5C."

[www.guardian.co.uk](http://www.guardian.co.uk)

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## **7. Impacts of Climate Change Coming Faster and Sooner: New Science Report Underlines Urgency for Governments to Seal the Deal in Copenhagen**

UNEP  
September 24, 2009

The pace and scale of climate change may now be outstripping even the most sobering predictions of the

last report of the Intergovernmental Panel of Climate Change (IPCC).

An analysis of the very latest, peer-reviewed science indicates that many predictions at the upper end of the IPCC's forecasts are becoming ever more likely.

Meanwhile, the newly emerging science points to some events thought likely to occur in longer-term time horizons, as already happening or set to happen far sooner than had previously been thought.

Researchers have become increasingly concerned about ocean acidification linked with the absorption of carbon dioxide in seawater and the impact on shellfish and coral reefs.

Water that can corrode a shell-making substance called aragonite is already welling up along the California coast decades earlier than existing models predict.

Losses from glaciers, ice-sheets and the Polar Regions appear to be happening faster than anticipated, with the Greenland ice sheet, for example, recently seeing melting some 60 percent higher than the previous record of 1998.

Some scientists are now warning that sea levels could rise by up to two metres by 2100 and five to ten times that over following centuries.

There is also growing concern among some scientists that thresholds or tipping points may now be reached in a matter of years or a few decades including dramatic changes to the Indian sub-continent's monsoon, the Sahara and West Africa monsoons, and climate systems affecting a critical ecosystem like the Amazon rainforest.

The report also underlines concern by scientists that the planet is now committed to some damaging and irreversible impacts as a result of the greenhouse gases already in the atmosphere.

Losses of tropical and temperate mountain glaciers affecting perhaps 20 percent to 25 percent of the human population in terms of drinking water, irrigation and hydro-power.

Shifts in the hydrological cycle resulting in the disappearance of regional climates with related losses of ecosystems, species and the spread of drylands northwards and southwards away from the equator.

Recent science suggests that it may still be possible to avoid the most catastrophic impacts of climate change. However, this will only happen if there is immediate, cohesive and decisive action to both cut emissions and assist vulnerable countries adapt.

These are among the findings of a report released today by the United Nations Environment Programme (UNEP) entitled Climate Change Science Compendium 2009.

The report, compiled in association with scientists around the world, comes with less than 80 days to go to the crucial UN climate convention meeting in Copenhagen, Denmark.

In a foreword to the document, the United Nations Secretary-General, Ban Ki-moon, who this week hosted heads of state in New York, writes, "This Climate Change Science Compendium is a wake-up call. The time for hesitation is over".

"We need the world to realize, once and for all, that the time to act is now and we must work together to address this monumental challenge. This is the moral challenge of our generation."

The Compendium reviews some 400 major scientific contributions to our understanding of Earth Systems and climate change that have been released through peer-reviewed literature, or from research institutions, over the last three years.

Achim Steiner, UN Under-Secretary General and UNEP Executive Director, said, "The Compendium can never replace the painstaking rigour of an IPCC process—a shining example of how the United Nations can provide a path to consensus among the sometimes differing views of more than 190 nations".

"However, scientific knowledge on climate change and forecasting of the likely impacts has been advancing

rapidly since the landmark 2007 IPCC report," he added.

"Many governments have asked to be kept abreast of the latest findings. I am sure that this report fulfils that request and will inform ministers' decisions when they meet in the Danish capital in only a few weeks time," said Mr. Steiner.

The research findings and observations in the Compendium are divided into five categories: Earth Systems, Ice, Oceans, Ecosystems and Management. Key developments documented since the IPCC Fourth Assessment Report include:

### **Earth Systems**

A new climate modeling system, forecasting average temperatures over a decade by combining natural variation with the impacts of human-induced climate change, projects that at least half of the 10 years following 2009 will exceed the warmest year currently on record. This is despite the fact that natural variation will partially offset the warming "signal" from greenhouse gas emissions.

The growth in carbon dioxide emissions from energy and industry has exceeded even the most fossil-fuel intensive scenario developed by the IPCC at the end of the 1990s. Global emissions were growing by 1.1 percent each year from 1990-1999 and this accelerated to 3.5 percent per year from 2000-2007.

The developing and least-developed economies, 80 percent of the world's population, accounted for 73 percent of the global growth of emissions in 2004. However, they contributed only 41 percent of total emissions, and just 23 percent of cumulative emissions since 1750.

Growth of the global economy in the early 2000s and an increase in its carbon intensity (emissions per unit of growth), combined with a decrease in the capacity of ecosystems on land and the oceans to act as carbon "sinks", have led to a rapid increase in the concentrations of carbon dioxide in the atmosphere. This has contributed to sooner-than-expected impacts including faster sea-level rise, ocean acidification, melting Arctic sea ice, warming of polar land masses, freshening of ocean currents and shifts in the circulation patterns of the oceans and atmosphere.

The observed increase in greenhouse gas concentrations are raising concern among some scientists that warming of between 1.4 and 4.3 degrees Centigrade above pre-industrial surface temperatures could occur. This exceeds the range of between 1 and 3 degrees perceived as the threshold for many "tipping points", including the end of summer Arctic sea ice, and the eventual melting of Himalayan glaciers and the Greenland ice sheet.

### **Ice**

The melting of mountain glaciers appears to be accelerating, threatening the livelihoods of one fifth or more of the population who depend on glacier ice and seasonal snow for their water supply. For 30 reference glaciers in nine mountain ranges tracked by the World Glacier Monitoring Service, the mean rate of loss since 2000 has roughly doubled since the rate during the previous two decades. Current trends suggest that most glaciers will disappear from the Pyrenees by 2050 and from the mountains of tropical Africa by 2030.

In 2007, summer sea ice in the Arctic Ocean shrank to its smallest extent ever, 24 percent less than the previous record in 2005, and 34 percent less than the average minimum extent in the period 1970-2000. In 2008, the minimum ice extent was 9 percent greater than in 2007, but still the second lowest on record.

Until the summer of 2007, most models projected an ice-free September for the Arctic Ocean towards the end of the current century. Reconsideration based on current trends has led to speculation that this could occur as soon as 2030.

Melting of the Greenland Ice Sheet surface also seems to be accelerating. In the summer of 2007, the rate of melting was some 60 percent higher than the previous record in 1998.

The loss of ice from West Antarctica is estimated to have increased by 60 per cent in the decade to 2006, and by 140 percent from the Antarctic Peninsula in the same period.

Recent findings show that warming extends well to the south of the Antarctic Peninsula, to cover most of

West Antarctica, an area of warming much larger than previously reported.

The hole in the ozone layer has had a cooling effect on Antarctica, and is partly responsible for masking expected warming on the continent. Recovery of stratospheric ozone, thanks to the phasing out of ozone-depleting substances, is projected to increase Antarctic temperatures in coming decades.

## **Oceans**

Recent estimates of the combined impact of melting land-ice and thermal expansion of the oceans suggest a plausible average sea level rise of between 0.8 and 2.0 metres above the 1990 level by 2100. This compares with a projected rise of between 18 and 59 centimetres in the last IPCC report, which did not include an estimate of large-scale changes in ice-melt rates, due to lack of consensus.

Oceans are becoming more acidic more quickly than expected, jeopardizing the ability of shellfish and corals to form their external skeletons. Water that can corrode a shell-making carbonate substance called aragonite is already welling up during the summer along the California coast, decades earlier than models predict.

## **Ecosystems**

Since the 2007 IPCC report, wide-ranging surveys have shown changes to the seasonal behaviour and distribution of all well-studied marine, freshwater and terrestrial groups of plants and animals. Polar and mountaintop species have seen severe contractions of their ranges.

A recent study projecting the impacts of climate change on the pattern of marine biodiversity suggests dramatic changes to come. Ecosystems in sub-polar waters, the tropics and semi-enclosed seas are predicted to suffer numerous extinctions by 2050, while the Arctic and Southern Oceans will experience severe species invasions. Marine ecosystems as a whole may see a species turnover of up to 60 percent.

Under the IPCC scenario that most closely matches current trends i.e. with the highest projected emissions between 12 and 39 percent of the Earth's land surface could experience previously unknown climate conditions by 2100. A similar proportion, between 10 and 48 percent, will see existing climates disappear. Many of these "disappearing climates" coincide with biodiversity hotspots, and with the added problem of fragmented habitats and physical obstructions to migration, it is feared many species will struggle to adapt to the new conditions.

Perennial drought conditions have already been observed in South-eastern Australia and South-western North America. Projections suggest that persistent water scarcity will increase in a number of regions in coming years, including southern and northern Africa, the Mediterranean, much of the Middle East, a broad band in Central Asia and the Indian subcontinent.

## **Management**

The reality of a rapidly-changing climate may make conventional approaches to conservation and restoration of habitats ineffective. Drastic measures such as large-scale translocation or assisted colonization of species may need to be considered.

Eco-agriculture, in which landscapes are managed to sustain a range of ecosystem services, including food production, may need to replace the current segregation of land use between conservation and production. This could help create resilient agricultural ecosystems better able to adapt to the changing climate conditions.

Experts increasingly agree that active protection of tropical forests is a cost-effective means of cutting global emissions. An international mechanism of reducing emissions from deforestation and forest degradation (REDD) is likely to emerge as a central component of a new agreement in Copenhagen. However, many issues need to be resolved, such as how to verify the reductions and ensuring fair treatment of local and indigenous forest communities.

A number of innovative approaches are emerging to keep carbon out of the atmosphere, including the use of "biochar", biologically-derived charcoal. It is mixed in soils, increasing fertility and potentially locking up carbon for centuries. This is a 21st century application of a technology known as Terra Preta, or Black

Earth, used by Amazon peoples before the arrival of Europeans in South America.

To download the full report, visit <http://www.unep.org/compendium2009/>

[www.unep.org](http://www.unep.org)

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## **8. Planetary Boundaries: A Safe Operating Space for Humanity**

The Stockholm Resilience Centre

September 23, 2009

New approaches are needed to help humanity deal with climate change and other global environmental threats that lie ahead in the 21st century. A group of 28 internationally renowned scientists propose that global biophysical boundaries, identified on the basis of the scientific understanding of the Earth System, can define a 'safe planetary operating space' that will allow humanity to continue to develop and thrive for generations to come. This new approach to sustainable development is conveyed in the coming issue of the scientific journal *Nature* where the scientists have made a first attempt to identify and quantify a set of nine planetary boundaries.

"Human pressure on the Earth System has reached a scale where abrupt global environmental change can no longer be excluded. To continue to live and operate safely, humanity has to stay away from critical 'hard-wired' thresholds in Earth's environment, and respect the nature of planet's climatic, geophysical, atmospheric and ecological processes," says lead author Professor Johan Rockström, Director of the Stockholm Resilience Centre at Stockholm University. "Transgressing planetary boundaries may be devastating for humanity, but if we respect them we have a bright future for centuries ahead," he continues.

The group of scientists including Hans Joachim Schellnhuber, Will Steffen, Katherine Richardson, Jonathan Foley and Nobel Laureate Paul Crutzen, have attempted to quantify the safe biophysical boundaries outside which, they believe, the Earth System cannot function in a stable state, the state in which human civilizations have thrived.

The scientists first identified the Earth System processes and potential biophysical thresholds, which, if crossed, could generate unacceptable environmental change for humanity. They then proposed the boundaries that should be respected in order to reduce the risk of crossing these thresholds.

Nine boundaries were identified including climate change, stratospheric ozone, land use change, freshwater use, biological diversity, ocean acidification, nitrogen and phosphorus inputs to the biosphere and oceans, aerosol loading and chemical pollution. The study suggests that three of these boundaries (climate change, biological diversity and nitrogen input to the biosphere) may already have been transgressed. In addition, it emphasizes that the boundaries are strongly connected - crossing one boundary may seriously threaten the ability to stay within safe levels of the others.

"What we now present is a novel framework through which our scientific understanding of the Earth System can potentially be used more directly in the societal decision making process," says co-author Katherine Richardson, Professor at the Earth System Science Center at the University of Copenhagen.

The scientists emphasize that the rapid expansion of human activities since the industrial revolution has now generated a global geophysical force equivalent to some of the great forces of nature.

"We are entering the Anthropocene, a new geological era in which our activities are threatening the Earth's capacity to regulate itself. We are beginning to push the planet out of its current stable Holocene state, the warm period that began about 10,000 years ago and during which agriculture and complex societies, including our own, have developed and flourished," says co-author Professor Will Steffen, Director of the ANU Climate Change Institute at The Australian National University. "The expanding human enterprise could undermine the resilience of the Holocene state, which would otherwise continue for thousands of years into the future."

Co-author Professor Hans Joachim Schellnhuber points out that the climate system has clearly started to drift away from the familiar domain where historic experiences apply. The risk of highly nonlinear changes in our environmental conditions is sharply increasing outside that domain.

"Observations of an incipient climate transition include the rapid retreat of summer sea ice in the Arctic Ocean, melting of almost all mountain glaciers around the world, and an increased rate of sea-level rise in the last 10-15 years," Professor Schellnhuber says. He is Director of the Potsdam Institute for Climate Impact Research.

The researchers stress that their approach does not offer a complete roadmap for sustainable development, but does provide an important element by identifying critical planetary boundaries.

"Within these boundaries, humanity has the flexibility to choose pathways for our future development and well-being. In essence, we are drawing the first - albeit very preliminary - map of our planet's safe operating zones. And beyond the edges of the map, we don't want to go. Our future research will consider ways in which society can develop within these boundaries - safely, sanely and sustainably," says co-author Professor Jonathan Foley, Director of the Institute on the Environment at the University of Minnesota.

Feature article in Nature, September 24 issue: "A safe operating space for humanity", as well as individual commentaries and reader responses:

<http://www.nature.com/news/specials/planetaryboundaries/index.html>

Full scientific article: "Planetary Boundaries: Exploring the safe operating space for humanity", and video interviews, graphics and further background material: <http://www.stockholmresilience.org/planetary-boundaries>

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