**21st meeting of the Standing Committee for Life, Earth and Environmental Sciences (LESC)**

*Warsaw, Poland, 19 October 2007*

**TABLED DOCUMENT**

***AGENDA ITEM 9***

# Outline for a Strategic Workshop on Ocean Acidification (OA)

Jelle Bijma (Chair of EuroCLIMATE Scientific Committee)
Submitted to the ESF-LESC Standing Committee (October 2007)

## Introduction

Although "global change" and "global warming" have been topics of intensive research for more that a decade, "ocean acidification" has only recently put on the research agenda. However, impacts of "ocean acidification" are probably just as dramatic as that of "Global Warming" and the combination of the two even more so. Recently, several workshops and meetings addressed the issue and pointed to the fact that research is urgently required (e.g. workshop on the "Impacts of Increasing Atmospheric $CO_2$ on Coral Reefs and Other Marine Calcifiers" (www.isse.ucar.edu/florida), First IGBP-SCOR FTI workshop "Ocean Acidification – modern observations and past experiences" (http://www.igbp.net/page.php?pid=134). With generous support from the ESF EuroCLIMATE Programme and PAGES, and with participation from SOLAS and IMBER, we have also hosted a workshop on "Atmospheric $CO_2$, ocean acidification and ecological changes in planktonic calcifying organisms" in Barcelona (September 2007) (http://www.esf.org/acidification-workshop.html). In addition to that, several policy documents have been produced to draw attention to the impact of ongoing and future ocean acidification, such as "Die Zukunft der Meere – zu warm, zu hoch , zu sauer" (www.wbgu.de) and the Royal Society report "Ocean acidification due to increasing atmospheric carbon dioxide (www.royalsoc.ac.uk).

On this background the European Commission has launched one call (FP7-ENV-2007-1) to address the impact and consequences of ocean acidification. However, only one, so called "collaborative project" (EPOCA) will probably be funded with a maximum of 7 million € for the duration of 4 years. This European "research investment" seems low in comparison to the recently introduced bill on ocean acidification in the US senate (http://www.govtrack.us/congress/bill.xpd?bill=s110-1581). This bill seeks to launch a major research initiative in the field of ocean acidification, with a requested budget of 30 millions US$ per year for 2008-2012 and possibly beyond.

There is a broad scientific consensus that the topic of Ocean Acidification needs serious and immediate attention, and should be addressed at the European level. However, the current level of funding by the EC seems clearly insufficient, specifically with regard to the potential socio-economic impact of OA. This presents a unique opportunity for ESF to work with National Funding agencies on a current hot topic in climate science and take a leadership role in the International efforts as well as receive the well-deserved place in

the European sponsorship. The peace Nobel prize awarded to the IPCC and Al Gore signal that the timing is right and provides momentum that we should use!

Here we propose to hold a **LESC - EuroCLIMATE Strategic Workshop focusing on "Impact of Ocean Acidification"**, with main objectives to:

1) Produce a position statement in form of **ESF-LESC Science Policy Briefing** to be presented to ESF member organizations and possibly to the recently established European Parliament Climate Change Committee and
2) Establish a consortium for submitting a **Theme proposal for a new EUROCORES** programme on ocean acidification (EurOpA: European Project on Ocean Acidification).
3) Discuss the **Strategy on communication** of climatic issues and ocean acidification to the public, policymakers, and funding agencies

We propose to invite world class experts on Ocean Acidification, including policy makers, programs representatives (WCRP, IGBP, SCOR, ..) and key scientists.

**ESF-LESC Policy briefing**: We should learn from the big mistake made with regard to the research addressing the potential impacts of "global warming". It was the "Stern report" that made the difference to policy makers. This report does NOT address the impact of OA nor the potential costs of loosing or changing ecosystem functioning. Therefore it is of highest priority to provide an estimate on the possible economical damage through OA. We anticipate that this policy briefing, when distributed via the right channels, may have a similar impact.

It should be noted that, contrary to "global (regional) warming", the change in ocean carbonate chemistry due to $CO_2$ emissions, can be predicted with very high confidence but that the impact of OA on biota and ecosystems is largely unknown. Please refer to **Appendix 1** for extracts of the report on the Barcelona workshop on "**Atmospheric CO2, ocean acidification, and ecological changes in planktonic calcifying organisms**".

**Outline for a EUROCORES Theme proposal on Ocean Acidification ("EurOpA")**
At the moment the impact of OA on marine biota and ecosystems can only be guessed. In order to establish a firm basis for decision making, a strong and broad European programme is required to study the consequences of OA. Hereto, the geological archive, present day systems ("tipping points" and monitoring) and socio-economic impacts should be studied in addition to possible $CO_2$ mitigation techniques. An outline for a Eurocore programme on OA has been drafted by Gert-Jan Reichart (University of Utrecht, The Netherlands) en Jelle Bijma (Alfred-Wegener Institute for Polar and Marine Research, Bremerhaven, Germany) and can be found in **Appendix 2**.

## Workshop Topics

1) Socioeconomic and political components.
2) OA Monitoring.
3) Response of natural ecosystems to OA
4) $CO_2$ mitigation
5) Outreach

## Questions to be addressed:

**Socioeconomic and political components**:

- Can we estimate the economic costs of OA?
- What are the socio-economic consequences of ecosystem change?
- Which data required (topics 2-5 and beyond) to estimate the above?

**Monitoring**: The EC does not fund "monitoring" and points to national science foundations to address this issue. Hence the ESF seems to be in a perfect position to coordinate this.

- Which are the key areas to be monitored?
- Can we develop/participate in a "Global climate change observing system"
- Which instrumentation/equipment/autonomous buoys (automated alky or dic titration etc) need to be developed to do the job?
- formulate standard procedures and clear up the existing mess with regard to the carbonate system.

**Study of the responses of natural ecosystems to ocean acidification:** Only one coordinated project ("EPOCA") is currently under consideration for EC funding on OA issues. Even though "EPOCA" is an ambitious project, it is clearly not enough to study the potential dramaticstic impact of OA on a European scale.

- What are the tipping points at organism level?
- What are the tipping points at ecosystem level?
- Define standard experimental protocols for carbonate chemistry
- What can we learn from the past?
- Can we define a threshold atmospheric $CO_2$ level?
- How do weWhich data are required to translate the results in policy?

**$CO_2$ mitigation:**

- Which options do we have to capture $CO_2$?
- What are the timescales?

**Outreach:**

- How do we awake public awareness and reach policy makers?

## Suggested Location

Las Palmas, Gran Canaria, Spain
There are two good reasons to organize the workshop in Las Palmas: It will help to demonstrate the importance of the ESTOC time-series station (based in Las Palmas), as it is the only European time-series station collecting carbonate chemistry data since over a decade and it is important to keep this station going! In addition, in January it is attractive for potential participants to go to the Canaries and it may help convincing some of the top experts and high-level policy makers on such short notice.
local organiser: Melchor Gonzalez-Davila, from the University of Las Palmas, Gran Canaria.

## Participants

To address these topics and reach the strategic workshop goals, the smallest possible critical mass should be invited (target 30-35 people). Preliminary suggestions include:

**For the socioeconomic/political component:**

- Sir Nicholas Stern (see www.efactconference.nl/)

- Representatives from the Intergovernmental Panel on Climate Change (IPCC) Working Groups (e.g, Jean Jouzel or Filippo Giorgi for WG1 “Science of Climate Change”; : Martin Parry or J-P. van Ypersele for WG2 “Impacts, adaptation and vulnerability”; Bert Metz or Olaf Hohmeyer for WG3 “Mitigation of climate change”
- Representative from the IOC (Intergovernmental Oceanographic Commission, UNESCO)
- Maria Hood (International Ocean Carbon Coordination Project, UNESCO)
- Representative from the ICES (International Council for the Exploration of the Sea)
- Representative from the OECD (Organisation for Economic Co-operation and Development, Global Forum On Sustainable Development)
- Representaitve from the ESF Marine Board (e.g., Lars Horn)
- ~~Carol Turley (expert, member of IPCC WGs)~~
- Phil Taylor (NSF, Director of the Biological Oceanography Program)

**For monitoring:**

- Keith Alverson, GOOS (Global Ocean Observing System, UNESCO)
- Representative from POGO (Partnership for Observation of the Global Oceans)
- Representative from the ESTOC time-series station (Melchor Gonzalez-Davila)
- Representatives from other oceanographic time-series stations in the world
- Alex Kozyr (expert, CDIAC (Carbon Dioxide Information Analysis Center)

**For $CO_2$ mitigation:**

- Peter Haugan (expert, University of Bergen).
- Peter Brewer (expert, USF, US)
- Paul Crutzen (expert, Nobel Prize in Chemistry, for aspects on geoengineering)

**For “tipping points”, etc, to study the response of ocean acidification on the background of global warming:**

- Representative from IMBER (Integrated Marine Biogeochemistry and Ecosystem Research)
- Representative from GLOBEC (Global Ocean Ecosystem Dynamics)
- Representative from LOICZ (Land-Ocean Interactions in the Coastal Zone)
- Coordinator from the EPOCA Project (Jean-Pierre Gattuso)
- Coordinator of the DYNAMO Project (Dynamics of marine ecosystems in a changing environment)
- Scott Doney (WHOI, US)
- Dick Feely (NOAA, US)
- Joanie Kleypas (NCAR, US)
- Hans Otto Pörtner (Initiator of the German (BMBF) programme “GOVER” (Gefahren der Ozeanversauerung in Zeiten der Ozeanerwärmung)
- Representative from GLOBEC (Global Ocean Ecosystem Dynamics~~) person~~)

**For Outreach**

- Carol Turley (expert, member of IPCC WGs)
- Representative from EuroScience
- Representative from the European Geosciences Union (EGU), Committee on Education, Outreach, News & Sponsorship

Some additional name suggestions have already been provided by Françoise Gaill (LESC):

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Nadine Le Bris (biogeochemistry and science policy), Ifremer, Brest
P. Compere (arthropods specialist), University of Liège Belgium
N. Meziane (echinoderms specialist), MNHN Paris
P. Boucher (gasteropods specialist), MNHN Paris
O. Gros (Bivalves specialist), University Antilles Guyane
Marina Cunha (Crustacean biology), University of Algarve Portugal
Anders Waren (Specialist of bivalves), Sweden
Sylvie Gaudron (Ecophysiologist marine organism), University Pierre and Marie Curie

Those names and any other names to be provided by members of the LESC Standing Committee will be greatly appreciated and carefully considered for invitation.

➔ **The LESC Standing Committee members are invited to provide names of expert scientists in the field and of science policy-oriented "experts", influential programme directors and high-level "policy-makers" for possible invitation.**

## Workshop Format

**2 full days for most, 3 days for some:**

**Day 1:**
Introductory overview talks (for each topic one overview talk to bring everybody up to speed). After each talk a plenary discussion on what is going on what is needed in terms of research. One hour per topic boils down to ~~six~~ five hours
**Day 2:**
Morning: break-out in 5 topical groups with discussion leader and rapporteur.
Afternoon: plenary reports on.
**Day 3:**
Task team (DL's and/or R's) stay to prepare the policy briefing and "EurOpA" draft to be circulated among the participants for comments.

## Potential connections with other ESF activities:

EuroDEEP (benthic ecology);
EuroMARC (coral reef studies);
EuroMinScI (biomineralisation / biocrystallization);
MedCLIVAR (acidification impact in the Mediterranean).

## Budget

For 35 participants: Average cost per person for 2 full-day meals and accommodation and for travel: 850 Euros. Plus one extra day for the task team (8 persons maximum) preparing the policy briefing: 2000 Euros
Additional costs (logistics and administrative costs): 5000 Euros

**Total cost: about 36000 Euros**

Co-sponsored by EuroCLIMATE up to 25000 Euros

**Request from LESC: 10000-15000 Euros**

➔ **The LESC Standing Committee members are invited to support this Strategic Workshop.**

## Other issues to be considered:

**Other co-sponsoring to be considered**
UNESCO (Maria Hood)
IGBP-PAGES (Torsten Kiefer)
NSF (Phil Taylor)
SCOR (Ed Urban)

**Travel**
Participants should offset their carbon emissions from flights involving e.g GLOBEC's business through Climate Care.

**Gender balance:**
Wherever possible, the gender balance will be considered when inviting participants.

# Appendix 1

## Extracts from the Report on the ESF- EuroCLIMATE Workshop on "Atmospheric $CO_2$, ocean acidification, and ecological changes in planktonic calcifying organisms"

Cosmo Caixa Science Museum and Hotel Eden Roc Conference Center,
Barcelona, Spain, 26-28/09/2007

The European Science Fondation (EuroCLIMATE Programme) sponsored a workshop on ***Atmospheric $CO_2$, ocean acidification, and ecological changes in planktonic calcifying organisms*** (http://www.esf.org/acidification-workshop.html) with 45 international participants both from the EuroCLIMATE programme and external invited expertises,. The event was co-sponsored by PAGES (Past Global Changes). The workshop was hosted in Barcelona, Spain at the Cosmo Caixa Science Museum and Hotel Eden Roc Conference Center (Sant Feliu).

In the afternoon of September 26th a public symposium on ocean acidification was organized and co-sponsored at and by the Science Museum of Barcelona. Lectures were by four participants of the workshop: Richard Feely (NOAA Seattle) *Global Warming and Ocean Acidification: Double Trouble for Marine Ecosystems*, Victoria Fabry (California State University San Marcos) *A global geochemical experiment with unknown ecological consequences*, Jim Zachos (University of California at Santa Cruz) *Long-term Consequences of Ocean Acidification: A Paleoperspective* and Carol Turley (Plymouth Marine Laboratory) *Taking the Science of Ocean Acidification to Policy Makers, Stakeholders and Society.* The lectures will be available and open to the web at the ESF website of the workshop.

### Background

Changes in ocean chemistry due to anthropogenic $CO_2$ emissions affect marine life, nutrient cycles and biocalcification. Increasing atmospheric $CO_2$ levels will in part be buffered by increased seawater $CO_2$ concentrations; this will cause lowering of the pH and so result in a decrease in marine calcification, and an increase in carbonate dissolution. The gross chemistry of this process can be modelled reasonably well but it is more difficult to predict ocean acidification (OA) effects on the biosphere and the degree to which the biosphere will change the process. The main purpose of this workshop was to understand the consequences of future $CO_2$ emissions for the marine environment and to set up research priorities. The new formula of this workshop was to focus on the planktonic calcifying organism that have been identified as a vulnerable component since the abrupt anthropogenic increase in atmospheric $CO_2$ is predicted to cause a significant pH drop in oceanic waters, combined with changes in the biogeography of key organisms.

Marine carbonate precipitation today is predominantly a biologically controlled process occurring in living organisms, particularly corals, benthic mollusca, and pelagic organisms such as coccolithophores, foraminifera, and pteropods. Planktonic calcifiers are particularly significant since they live in the uppermost part of the ocean, and so are very sensitive to changes in atmospheric $CO_2$, and because a high proportion of the shells they produce are exported to the seafloor to form carbonate sediments. They also thus have a continuous fossil record and provide the opportunity to observe past chemical (calcification) and ecological responses in a range of scenarios including both rapidly rising and persistently high atmospheric $CO_2$ levels.

## Workshop structure

The structure of the workshop included 5 main core topic sessions:
1) Biocalcification mechanisms and their vulnerability to OA,
2) Genetics and Physiology - investigating organismal responses to OA,
3) Ecology and Biogeography - predicting the effects of population responses to OA,
4) Lessons from the fossil record - past responses to OA, and 5) Case study: the likely impact of OA in the Mediterranean.

Some of the key questions addressed included: How will rising $CO_2$ levels affect the calcifying taxa - will they simply produce lighter skeletons or will there be significant reductions in their gross productivity and selective extinctions? What will be the secondary ecological and biogeochemical consequences of a reduction in biocalcifiying plankton? Will a decrease in calcification significantly reduce the export flux of organic carbon by a reduction in the ballasting role, and will this significantly reduce the buffering of atmospheric $CO_2$ by pH rise? How will changes in the biogeography of key planktonic calcifiers affect overall marine carbonate export production? How will functional gene-diversity respond to changes in ocean chemistry such as OA and nutrient distribution? What is known about the evolution of these genes, such as potential adaptability? What have we learned from past and rapid OA events in relation to the above questions and points? What is known about the impact of anthropogenic $CO_2$ in the Mediterranean on biocalcification and ecology?

Excellent overview talks on each theme, plenty of time for discussion during the specific workshop sessions, and a very wide range of expertise contributed to a powerful format for the open exchange of concepts and knowledge.

## Conclusions

The stimulating cross-disciplinary thinking of this workshop provided a unique opportunity to trace the state of knowledge and priority research lines of future impacts of fossil-fuel CO2 on planktonic calcifying organisms and ecosystems.

We now are able to mechanistically start to understand why the physiology and the biocalcification of these organisms are affected by high CO2. This understanding makes the issue of OA and the rate and magnitude projected for the coming decades a even larger risk. There are already first field observations on ecological changes and effects on calcification.

The workshop was entitled "Atmospheric $CO_2$, Ocean Acidification, and Ecological Changes in Planktonic Calcifying Organisms", but it is noteworthy that most marine plankters are not calcifiers and several of the participants pointed out that we should place greater emphasis on the effects of elevated oceanic $CO_2$ and acidification on planktonic communities since we may assume that these changes will affect many other cellular processes and organismal interactions, in addition to calcification.

There is the need of an international network of observations and process studies investigating potential OA impacts. For this it is fundamental to agree on standardized protocols (e.g. calcification rate measurements, CO2 system parameters). The organizers of the Scoping Workshop on Ocean Acidification Research (Scripps, San Diego, 9-11 October 2007) Victoria Fabry and Richard Feely were also actively involved in this ESF workshop and felt very strongly about this.

There is the need to improve our communication to policy makers, of the specific risks associated with OA such the ones discussed in this workshop. This can provide a powerful action on the reduction of CO2 emission.

## Appendix 2

**Draft outline for a EUROCORES Theme on Ocean Acidification ("EurOpA"):**
(by Gert-Jan Reichart (University of Utrecht, The Netherlands) en Jelle Bijma (Alfred-Wegener Institute for Polar and Marine Research, Bremerhaven, Germany):

Rapid uptake of excess anthropogenic $CO_2$ by the oceans results in a major decrease in ocean pH. In view of the ongoing, increasing, input of $CO_2$ to the atmosphere it is anticipated that within this century ocean pH will reach its lowest most values since the last 50 million years. The increased acidity is corrosive to tests of calcifying marine organisms. Similarly, increased ocean acidification can be expected to affect both biodiversity and even change whole ecosystems. This in turn, can have severe socio-economic implications. Therefore, a process based understanding of the impact of ocean acidification on on marine biota is crucial for assessing the risks associated.

Themes that could be addressed in the call:

- Reconstructing impact of past ocean acidification (e.g. PETM, KT, ELMO)
- Proxies for past ocean acidification
- Development of a process based understanding of calcification
- Studying the impact of OA on oceanic ecosystems
- Coordination of a plan to monitor the consequences of ocean acidification on marine organisms and ecosystems
- Assessment of the socio-economic impact of ocean acidification
- Studying options for $CO_2$ mitigation

Deliverables:

- Assessment of the impact of increased acidity and changes in ocean chemistry on marine calcifying organisms
- Impact on marine biodiversity

*Reconstructing impact of past ocean acidification*
Earths history is punctuated by multiple events characterized by rapid increases in ocean pH. During the Paleocene-Eocene Thermal Maximum (PETM) a sudden release of methane similar in quantity and rate to today's anthropogenic $CO_2$ input resulted in the ocean becoming corrosive to pH up to very shallow depths. Studying this and similar episodes will help us understand not only impact, but also the timescales involved.

*Proxies for past ocean acidification*
Accurate reconstruction of the impact of past changes in greenhouse conditions on climate and the ocean critically relies on proxies that are calibrated outside the present day natural variability.

*Development of a process based understanding of calcification*
The response of calcifying organisms to higher $pCO_2$ and lower pH conditions is largely unknown. This response can be quantified using for instance laboratory cultures in which $pCO_2$ is artificially modified to simulate the future atmospheric composition.

*Studying the impact of OA on oceanic ecosystems*
The impact of OA on the response of marine biota and ecosystems is largely unknown and should be investigated to assess possible consequences.

*Coordination of a plan to monitor the consequences of ocean acidification on marine organisms and ecosystems*
The effect of ocean acidification on whole ecosystems should be monitored to improve our understanding and strengthen the ability of policy makers to assess impact and consequences.

*Assessment of the socio-economic impact of ocean acidification*
Marine biodiversity is an important asset of the European economy and changes in ocean chemistry threatens fisheries and the quality of the marine environment in general. Ocean acidification could, therefore, result in important social and economic costs.

*Studying options for $CO_2$ mitigation*
It seems reasonable to assume that it $CO_2$ emissions will continue according to the "business as usual scenario". Because OA will continue even if $CO_2$ emissions come to a halt, it can be expected that ecosystem thresholds or "tipping points" may be reached if $CO_2$ mitigation technologies are not studied and effectively adapted.