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Teacher-Scientist Partnerships for Global Change Education 2005-2006 report



*CarboSchools is an initiative which promotes partnerships between global change scientists, secondary school teachers and their students in order to raise young people's awareness of the local and global consequences of climate change, to encourage them to discover the scientific research and to act locally to reduce emissions of greenhouse gases. CarboSchools is proposed by two large European research projects on climate change, **CarboEurope** and **CarboOcean**, in which more than 100 institutes from 17 countries are working together to investigate the carbon cycle on land and ocean respectively.*

NEWS FROM FIELD PROJECTS

This section gives a few examples of activities with schools in various places in Europe

- **From Ingunn Skjelvan, Bergen, Norway**

As the Norwegian branch of CarboSchools, we have just started a cooperation between teachers at Bergen Katedralskole, which is an upper secondary school in Bergen, and scientists at Bjerknes Centre for Climate Research (BCCR), which is a research institution connected to the University of Bergen.

What we have done until now:

- several meetings between teachers and scientists
- a class (27 students) and their teachers have visited BCCR. A lecture on greenhouse effect, carbon cycle and scientific challenges was given, and a sightseeing of some of the labs was performed. Some of the scientific instruments were introduced.

What we will do in the near future:

- September 1 and 15 we will spend the day with the students onboard a research vessel going out on the fjord. During these days the students shall get a grip on oceanographic measurements (e.g. do water sampling themselves, do hydrographical measurements etc.).
- The water samples will be brought back to the lab and the students will be involved in analyzing the samples (total inorganic carbon, alkalinity)
- We will use the results to calculate the oceanic carbon system, and further play around with changing parameters to see various effects (e.g. what happens in a future world with higher oceanic concentrations of carbon)

Ideas for the not-so-near future:

- Carbon data are provided for the students from one of the VOS lines (continuous carbon data from the surface water sampled using cargo ships, weather ship or research vessel) in use. These data can be used in statistics, mathematics, and to look at different processes (e.g. how do carbon (pCO₂) in seawater change with temperature, and how to develop the equations for this relationship?)
- Examining of seasonal variations in a marine carbon dataset; inorganic carbon content in seawater varies with plankton bloom etc.
- Participation in one of the field experiments close to Bergen, where we have the opportunity to manipulate the marine carbon cycle.

- ***From Annette Freibauer, Jena, Germany***

In the last school year, I worked with three groups of secondary school students (around 18 years old), who do a "Seminarfacharbeit". This is a one-year activity in which they determine a topic of interest, find a supervisor outside the school, read and do some practical work to write a report of about 30 pages in German. Themes were: 1) CO₂ and energy, 2) climate change and the responsibility of the USA, including the awareness of the public about climate change. The third group vanished. The quality one report was really bad, the second one is OK but not entirely convincing. I do not have an electronic copy but could try to get one.

I am working with the booklet for an event outside the school: The famous victory battle of Napoleon near Jena has its 200th anniversary in 2006. In the end of August, an international workshop is organised for students from France, Germany, Poland and Hungary, mainly about peace, communication between countries, history etc. Together with a geology professor of the university, I organise two workshop blocks about global change and the individual responsibility for energy saving. Although this activity is outside of schools it comes closest to the idea of CarboSchools.

I also prepare some small pot experiments for demonstration to schools and the broad public for an event in July in which our campus hosts the German initiative "land of ideas" in the frame of the football world championship. The plan is, of course, to keep this demonstration for future events.

- ***From Janusz Olejnik, Poznan, Poland***

I have got a lot of contacts with schools in Poznań. Together with directors of these schools we decided that the best time to give a lecture about global change problems and projects related to that (CarboEurope) is September. That is the time when pupils have to decide about their "university plans". So we arranged about 20 meetings in secondary schools here in Poznan in September this year.

- ***From Francesco Primo Vaccari, Firenze, Italy***

This summer and probably from 11 July to end of July a little scientific community will be on Pianosa island. Together with Prof. Roland Vogt (Institut für Meteorologie, Klimatologie und Fernerkundung Departement Umweltwissenschaften Universität Basel) and Prof Christian Bernhofer from University of Dresden 25 students will have the opportunity to participate in the scientific mission. The students from Basel are beginners, this is their first field course where they have to do something in their own, the students from Dresden are at second field course. All the students are at university level.

- ***From Philippe Carbonne, Lycee Jean Moulin de Pezenas, France, in collaboration with Richard Joffre CEFÉ-CNRS***

We (teachers from Lycee Jean Moulin) have collaborated with the CEFÉ-CNRS team in Montpellier through which we have :

- Visited their experimental forest
- Used their instruments on a tree of the school and analyzed the measurements to show the links between sap fluxes and the environment
- Invited the scientists for a conference on climate change research
- worked on their field measurements (using Excel) investigating whether the Mediterranean forest is a source or a sink of carbon and under which conditions.
- modeled (using the STELLA software) the future of water availability (limiting factor for growth and hence carbon storage) for trees in 2100 on this forest according to climate predictions (local model arpegge precipitations/temperature)
- not yet modeled the source/sink carbon balance (will be done next year)
- looked at the bombyx worms attacks on the Mediterranean forest through satellite pictures and modeled their cyclic pullulation (mathematical relation between food and worms)

Next year we intend to study of how carbon storage by plants is affected by environmental conditions (i.e. comparing the weight of plants grown under various temperature and humidity levels). Why not cooperating with another school in Europe and share our models, local predictions etc.

- ***From Timo Vesala and Sakari Kannisto, University of Helsinki, Department of Physical Sciences, Finland***
- 1. We had a planning meeting with Sakari Kannisto (SK) and a rector of the school in September. About 40 students together with SK visited Hyytiälä Forestry Field Station and SMEAR II flux site in 27 October. Timo Vesala (TV) gave 1 1/2h presentation on biosphere-atmosphere interaction processes and carbon cycle and then we had site visit. In November both TV and SK attended CarboSchool session in CarboEurope meeting in Levi, Finland. In 8 May TV gave 1 1/2h talk on climate change in the school.
- 2. Impression is that the participating school is very interested in this kind of activity and tries to give their full support. Many of students are interested in environmental issues as well. The activities are hindered by other duties, especially since no funding is not available which would push and force this kind of work. Also, there exists kind of inertia before the work is proceeding in full way.
- 3. Plan is
 - to continue seminars, for example half a day could be reserved for talks by several people dealing with climate change, carbon cycle, atmospheric physics, ecophysiology
 - to continue visits to the field site
 - to look ways to make students participate in the work, for example some exercises concerning simple data analysis of the real field data could be delivered

REGIONAL PROJECTS

This section shows how some institutions are organising educational projects at the regional level, aiming at involving several schools with the support of a local coordinator.

- **The carbon cycle and climate change, pedagogic project of the LSCE (IPSL, CEA-CNRS, France) with secondary schools in Ile-de-France**

Coordinator : Marc Jamous, marc.jamous@cea.fr

For the academic year 2006-2007, the LSCE will work with 5 secondary schools on the problematic: “the carbon cycle and climate changes”. By this collaboration, students will learn how research works. Indeed, the LSCE will propose some experimental material and the students will write hypotheses, imagine experiment protocols, realize experiments and drive conclusions. Students will be introduced to the basic use of models. Scientifics at LSCE will help by answering scientific questions, explaining unclear results of experiments and so on.

In schools, the work will be done in workshop (little group of 15-20 voluntary students, 2 hours per week, multidisciplinary teachers team) or during the regular school schedule. Students’ age ranges between 11 and 17. As the work begins in September, we will have first results at the date of the Carboschools presentation in Crete (Nov. 2006).

The main project contains four important steps: a meeting in the classroom with a scientific mediator to open the project, a laboratory visit, an experimental and modelisation phase and a second meeting in the classroom to end the project. Steps do not have to take place in this order, it depends on schools: some of them prefer to finish by the laboratory visit, others prefer to organize it on the middle of the project and others prefer to begin with. Schools will have the possibility to communicate via an Internet website especially produced for the project by LSCE.

The LSCE proposes three ways of experimentation: dendrochronology, study of carbon sources and sinks with little greenhouses, study of carbon exchanges between atmosphere and ocean. Schools can perform all experimentations or just some of them.

Dendrochronology

Dendrochronology is the study of tree ring growth. It is one of the ways to date past events (climatic changes). It can also bring knowledge about absorption of carbon by plants and is thus a good way to get onto the carbon cycle.

The LSCE will propose scans of recent tree sections. Students will analyse them by measuring rings. We propose to make them work by groups and give them as little instructions as possible. They will then ask themselves how to measure rings (where a ring begins and where it finishes). Groups will find different results, so students will discover experimental errors.

After measuring, students will plot the profile “ring width versus years”. With the help of meteorological data, they will then be able to elaborate a model “ring width and meteorological event”.

Finally, profiles “ring width versus years” for past centuries (Xth or XVIIIth century) realized by several laboratories will be analysed by students to hypothesize meteorological events when observations did not exist yet. Students will then be able to use their models. Their hypotheses will be confronted with historical texts about vintage or flowering dates.

In conclusion, students will experiment several aspects of a scientific life by studying dendrochronology. They will make observations, derive models from their observations, use their models to make projections about the past and refine their models using historical references.

Study of carbon sources and sinks

By using little greenhouses and gas sensors (CO₂, O₂) it is possible to study carbon sources and sinks. The LSCE will ask students to realize prototype of little greenhouses where we can place plants, candles (to produce CO₂), container for sea water and so on. Gas and temperature captors will be added inside and connected to computers. Greenhouses will then undergo alternative lit and dark phases. Students will then be able to study photosynthesis and respiration.

Many scientific protocols can be then proposed by students and the main difficulty for teachers will be to select the more appropriate ones. For example, it would be better if the idea to realize a control greenhouse may come from a pupil and not from the teacher.

Study of carbon exchanges between atmosphere and ocean

As oceans are the most important carbon reservoir on Earth and as the absorption of atmospheric CO₂ by oceans could play a major role in climate change in the future, it is interesting for students to study carbon exchanges between air and sea water. The LSCE propose to use isolated container half full with sea water (for example, we can have a marmalade pot half full with sea water and closed with an impermeable cover). It is then possible to raise CO₂ concentration of the air and observe what happens with the help of CO₂ sensor. By reading introduction material on the subject, students can have the idea to test this experimentation at different temperatures.

Normally, elevated air CO₂ concentration will decrease due to the absorption of carbon by sea water. So students could think that oceans can be a solution to the overproduction of atmospheric CO₂, but they will see by experimentation and by reading articles that oceans can not absorb all CO₂. The LCSE propose also to make them think about the danger of this absorption: acidification of oceans.

By blowing into a drinking straw, pupils will raise CO₂ concentration of the sea water, which will produce an acidification of the water. By adding a shell of clam in the water, they will see that it starts dissolving.

If students add shells in the container of the first protocol about carbon exchanges (described three paragraphs above), it is not possible to see the dissolution. But if students think to weigh shells before and after experimentation they will observe a difference. Students should also come up with the idea for a control group and to weigh shells of this group before and after experimentations.

- **“School CO₂ net” : network of secondary schools observing CO₂ in the air, The Netherlands**

Coordinator: Harro A.J. Meijer, CIO, University of Groningen h.a.j.meijer@rug.nl

Website: <http://fwn-school-co2-net.hosting.rug.nl/>

The increase of the concentration of greenhouse gases in the atmosphere, most notoriously CO₂, is meanwhile commonly known. Still, general knowledge about the cycling of carbon, sources and sinks, and about the magnitude of emissions, is low. Let alone that people realise how easily measurable and "real" the effects on atmospheric CO₂ are. Therefore, the Centre for Isotope Research (CIO) and the Institute for Didactics and Educational Development (IDO), both from the University of Groningen, have initiated a project in which pupils from secondary schools get hand-on experience with real CO₂ measurements. For that, CO₂ on-line measurement equipment has been installed on three schools in the north of the Netherlands. Key words are: Day-night cycles, Sources and Sinks, Seasonal cycles, urban-rural differences, and regional gradients. Furthermore, educational material will be developed in close co-operation between the participating schools and the Institute for Didactics and Educational Development (IDO).

Initially, three of the participating schools have been provided with a suitable CO₂ sensor combined with basic meteorological instruments (temperature, wind speed, wind direction and eventually humidity). The instrument of choice is the Vaisala GMP 343 sensor, designed for ecological measurements in the field.

This sensor has been positioned on the roof of the school building, such that it is not influenced by the direct emissions of the school itself. The sensor is connected to a dedicated computer for read-out and storage of the measurements, using dedicated software developed by university informatics students. This computer is connected to the school's internal network. This makes the measurements available in every classroom of the school. Under normal conditions, a continuous record is being built up, in which day-night cycles (depending on the current weather), and wind-directional effects soon will be visible. Depending on the site of the school (large city, small city, rural) different aspects of the carbon cycle and the anthropogenic influences will become apparent.

From time to time, the sensor will also be used to monitor CO₂ in a number of environments, such as in the class room itself, close to a busy road (or in a parking garage), in woods, meadows or whatever is feasible around school. For these "measurement campaigns" the system is made hand-held using a portable data-logger and read-out system (also produced by Vaisala).

For optimal impact of the project a web site has been designed (again by university students as part of their curriculum): <http://fwn-school-co2-net.hosting.rug.nl/> (in Dutch) with a simple and straightforward interface for uploading of the CO₂ data for each school, such that they are made available to all participating schools, and in fact to other schools and anyone interested: downloading data is free. Furthermore, this web site contains other relevant information about the project.

The development of adequate educational material is crucial to the project. This development is taking place in the framework of the existing co-operation between the IDO and the network of secondary schools, with scientific assistance by the CIO. Visit(s) of scientists working in the field of the carbon cycle to the schools are envisaged as well.

As the project is multi-disciplinary, teachers in Physics, Chemistry and Biology are involved. A more general, but not less important goal of the project is to increase the general knowledge and awareness of the next generations of pupils and - thus - the general public.

INTERNATIONAL DEVELOPMENTS

Two international initiatives inspired by the CarboSchools launching workshop held in Die (France) in March 2005 have been initiated successfully over the past months.

- **CarboNordic launched : a pilot project for CarboSchools students exchange between nordic countries**

CarboNordic is an initiative that explores the feasibility of an international student exchange, in which students from secondary schools do project work in collaboration with scientific institutions both at home and abroad.

Originated within the framework of CarboSchools these scientific projects generally fall into the category of "Geosciences" or "Environmental Sciences" and are oriented mainly (but not exclusively) towards topics from the global change /CO₂ context. As such, they tend to be interdisciplinary, involving biology, chemistry, physics, mathematics and geography, as well as political and ethical aspects. Ideally, the student exchange is intended to be bilateral to foster scientific, language and social skills. To document this, at the end of an exchange a Europass Mobility will be awarded to participants.

To initiate CarboNordic student exchange program between northern European countries, a 2-day startup workshop was held in Kiel, Germany on May 18 and 19, 2006. 7 guests, both teachers and scientists, from Denmark, Finland, Norway and Sweden were met by German colleagues and students.

During the workshop, projects and activities already in place in the different locations were presented, and possible modes of cooperation discussed. The workshop program included a brief tour of the research institution IFM-GEOMAR, as well as a visit at the local partner school, Gymnasium Wellingdorf. Here, students at pre-university level, who had been working on science projects in cooperation with IFM-GEOMAR during the past months, presented their work in talks and posters.

On the second day of the program, a framework for a pilot phase of the CarboNordic cooperation was discussed that will serve as a basis for work in the first year of the project. Local contact teachers at every participating school were named, through which student application and the organization of individual exchanges will be managed.

The CarboSchools and BALTEX programs were identified as partner projects, in the framework of which scientific student exchanges should be possible.

After the workshop, a project outline was written which will be made available to all participants. This outline will continually be updated.

The startup workshop in Kiel was made possible by a grant from the Schleswig-Holstein Ministry for European Affairs.

Coordinator: Joachim Dengg, jdengg@ifm-geomar.de

Read the complete CarboNordic project outline on www.carboschools.org (go to "read project results & resources for schools")

- **CarboSchools Comenius proposal selected for funding : new resources for teacher training**

Under the title “(TSP) teacher – scientist – partnerships: a tool for professional development”, a funding proposal coordinated by the Heidelberg University of Education has been selected for funding by the EU Comenius programme with the aim to develop **teacher training modules and resources** in the frame of carboschools.

This project was felt as an important need to deepen methodological approaches and support teachers involved in partnership projects on the field, in a context where the initial funding allocated to carboschools from research budgets was limited to development of materials and training of climate change scientists. The project will be run by a small group of core institutions from Germany, Italy, Sweden and Holland with the aim of benefiting to the broader carboschools community.

Project summary:

Presently, traditional science teaching is ineffective to prepare students adequately for life’s complexity in a science and technology based society. Teachers’ professional knowledge and empowering contextual learning environments for students seem to be key factors for improvement.

We propose a systemic approach. We will start by building a partnership between teachers and scientists, and integrating both teachers and students in authentic research environments. For this purpose we have activated a well established network of research institutes all over Europe, working on carbon dioxide and climate change. Institutions of higher education in teacher development and local schools have agreed to establish local projects with research institutes. Target groups are science teachers and their students in secondary schools. Teaching and learning activities are agreed upon in a bottom-up approach, focused on improving teachers’ abilities to use external learning as a tool for development, student learning and scientist abilities to communicate with the public.

Outputs will be modules for in-service and pre-service teacher training that could be integrated into the various national education systems, based on best practice. Work is organised as an iterative ongoing process for 3 years. Learning processes and outcomes are analyzed by qualitative and quantitative means.

Coordinator: Michael Schallies schallies@ph-heidelberg.de

NB - due to unexpected technical difficulties, the printing of the hardcopies of the carboschools booklet in English has been postponed to September. We do our best to send it as soon as possible and apologize for the excessive delay. For similar reasons the publication of new language versions, expected in Norwegian, German and Dutch are also postponed for the moment.