CA/05

BIGSOUTH

BIo**G**eochemical cycles in the **SOUTH**ern Ocean: Role within the Earth System

DURATION OF THE PROJECT
01/12/2010 – 30/11/2014

BUDGET
1.199.685 €

KEYWORDS
Southern Ocean; carbon fluxes; climate gases; open ocean and sea ice; trace metals; stable Si, N, C isotopes; sea-ice biogeochemical modeling; NEMO-LIM-PISCES.

CONTEXT

Our perception of the Southern Ocean's (SO) role as source-sink of atmospheric CO2 and other climate gases has significantly changed in the past years because more observational data and model results have become available. Source-sink strengths are now perceived as more seasonally, inter-annually and spatially variable. Model studies and observations stress the significance of the biological C pump in contributing to CO2 uptake by the SO, and unraveling these intimate links between CO2 sink strength and fate of carbon is critical to assess the ocean's C sequestration capacity. In particular it is critical to understand the significance of natural Fe fertilization in margin systems and sea ice environments, as well as the role of sea ice biota and associated biogeochemical processes on climate gases production/uptake and carbon export to the underlying water column..

PROJECT DESCRIPTION

Objectives

Sound knowledge of the complex processes controlling the exchanges of carbon and other climate gases between functionally differing SO systems (margin impacted systems, open-ocean, sea ice covered systems) and the atmosphere is critically needed. It is crucial to understand and predict spatial and temporal variability of these processes in order to achieve a realistic integrated view of the SO's role as sink-source of climate gases and to evaluate the efficiency of carbon sequestration and its evolution in a changing climate.

Therefore, this project focuses on the following key questions: (1) What is the significance of sea ice physical and biogeochemical processes on atmosphere - ocean fluxes of climate gases (CO2, DMS, CH4, N2O) and fluxes of matter (carbon, macro- and micro-nutrients) to the water column? (2) Can we reconstruct paleo-sea ice extension based on sedimentary records and sound knowledge of sea ice biological and physico-chemical processes? (3) How are formation rate, composition, lability and sinking speed of marine biogenic particles related to planktonic community structure and trophic interactions and how do margin systems open ocean and sea ice covered systems, which differ in Fe availability, compare? (4) What are the physical and ecosystem conditions and pathways that lead either to shallow remineralisation or to deep export of organic matter produced in seaice and surface waters? (5) What is the impact of these processes on water column nutrient ratios and nutrient distribution in the Global Ocean?

Methodology

Practically, in order to assess fluxes of carbon and nutrients (N, Si), which are essential components of the biopump, the consortium has developed a unique integrated approach based on key stable isotopes and proxy techniques as well as modeling. This tool-box will be applied in contrasting but representative functional entities of the SO: the Fe-deficient high nutrient low chlorophyll open circumpolar ocean; the Fe-replete areas in vicinity of margins and plateaus (KEOPS 2, Kerguelen Plateau area; 2011) and the sea ice zone (ISPOL2, 2013; YROSIAE, 2011-2013; SIPEX2, Australian sector, 2012).

INTERACTION BETWEEN THE DIFFERENT PARTNERS

To achieve the above stated goals and challenges, this project integrates expertise of a triumvirate of modelers (H. Goosse, UCL; M. Vancoppenolle, UCL; B. Barnier, LEGI Grenoble); biogeochemists (F. Dehairs, VUB; L. André RMCA; B. Delille, ULg; F; Fripiat, ULB) and glaciologists (J.-L. Tison, ULB), that will be used for further interpretation of existing data gathered during previous projects and expeditions and also, importantly, for additional, focused, field studies..

LINK INTERNATIONAL PROGRAMMES

The BIGSOUTH project has close links with the following international programmes: GEOTRACES, IMBER, SOLAS, SCAR-ASPeCt, ICED

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EXPECTED RESULTS AND/OR PRODUCTS

Broad deliverables of the project will be: (i) an assessment of the physical and biogeochemical processes in sea ice and their impact on exchange of climate gases between ocean and atmosphere and on fluxes and isotopic signature of matter exchanged with the water column and the sediment; (ii) a comparative assessment of the functioning of the carbon biopump for different oceanic functional entities (sea-ice zones, open-ocean zones, margin areas); (iii) an integrated assessment of the deep ocean carbon sequestration magnitude and efficiency (relative to primary production); (iv) an assessment of the impact of biopump processes on nutrient distributions and nutrient ratios in the deep ocean waters, which affect future production once upwelling in the surface; (v) a robust, up to date, sea-ice biogeochemical model for integration in widely used ocean biogeochemistry general circulation models (OPA-LIM-PISCES).

PARTNERS

Activities

Frank Dehairs, Vrije Universiteit Brussel: Biopump processes and impact on C, N fluxes

Jean-louis Tison, Université Libre de Bruxelles: Physical-biological controls of sea-ice on climate gas fluxes

François Fripiat, Université Libre de Bruxelles: N and Si cycling within and below sea-ice and impact on δ30Si and δ15N proxies

Luc André, Royal Museum for Central Africa: Impact of sea-ice processes on δ30Si proxy

Hugues Goosse, & Martin Vancoppenolle; Université catholique de Louvain: 3D modeling of ocean and sea-ice biogeochemistry

Bruno Delille, Université de Liège: Sea ice physical-biogeochemical controls on climate gas fluxes; brine carbonate system

V.éronique Schoemann, Stichting Koninklijk Nederlands Instituut voor Zeeonderzoek (NIOZ): Trace metal bio-availibility

Bernard Barnier, Laboratoire des Ecoulements Géophysiques et Industriels (LEGI): 3D modeling of ocean and sea-ice biogeochemistry

CONTACT INFORMATION

Coordinator

Dehairs Frank,
Vrije Universiteit Brussel
Analytical & Environmental Chemistry dept &
Earth System Sciences research group
Tel : +32 2 629 1265;
Fax: +32 2 629 1811; e-mail:
fdehairs@vub.ac.be

Partners

Jean-Louis Tison and François Fripiat,
Université Libre de Bruxelles
Tel : +32 2 650 22 25
Fax: +32 2 650 22 26
jtison@ulb.ac.be

Luc André
Royal Museum for Central Africa
Tel : 02-7695459
Fax: 02-7695432
lucandre@africamuseum.be

Hugues Goosse and Martin Vancoppenolle
Université catholique de Louvain
Tel : 010 47 32 98
Fax: 010 47 47 22
hugues.goosse@uclouvain.be
Martin.Vancoppenolle@uclouvain.be

Bruno Delille, Université de Liège
Tel : 04 366 31 87
Fax: 04 366 33 67
Bruno.Delille@ulg.ac.be

Véronique Schoemann
Stichting Koninklijk Nederlands Instituut
voor Zeeonderzoek (NIOZ)
Veronique.Schoemann@nioz.nl

Bernard Barnier
Laboratoire des Ecoulements
Géophysiques et Industriels,
BP53, 38041
Grenoble cedex 9, France
LEGI, CNRS
bernard.barnier@legi.grenoble-inp.fr

Follow-up Committee
For the complete and most up-to-date composition of the Follow-up Committee, please consult our Federal Research Actions Database (FEDRA) by visiting http://www.belspo.be/fedra

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Belgian Science Policy
Louizalaan 231 Avenue Louise • B-1050 Brussels
Tél. +32 (0)2 238 34 11 • Fax +32 (0)2 230 59 12 • www.belspo.be/ssd
Contact : Maaike Vancauwenberghe

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