

CLIVAR/CliC/SCAR Southern Ocean Region Panel SORP-12: 29-30 June 2017

National activities report

Country: Belgium_____

Contributor(s) (writer(s)) :Fran ois Massonnet_____

Date: June 14th, 2017_____

Receipt of material prior to 15 June 2017 will ensure inclusion in meeting discussion. Receipt of material prior to 15 July 2017 will ensure inclusion in meeting report and contribute to future SORP discussions, as well as input to the SOOS and other CLIVAR/CliC/SCAR activities. All reports will be posted on the SORP website.

Purpose of material gathered for the SORP: To build an overview of
- observational, modeling, ocean reanalysis and state estimation initiatives relevant to the SORP

(This can include a list of activities, maps showing where work has been done, major international project involvement, etc.)

Please refer to SORP's terms of reference (also given at the end of this template) for guidance on scope: <http://www.clivar.org/clivar-panels/southern>

Note: Biological topics such as marine ecology and marine ecology research, for example, are not within the scope of SORP's terms of reference and are therefore not required in these reports. However, SOOS has an interest in such research, so National Representatives are welcome to include summaries of such research as separate sections.

Note: The Southern Ocean is not explicitly defined in SORP's terms of reference, so please note what the limit used for your national report is (e.g., research on regions only beyond an oceanographic boundary like "south of the Polar Front", or research contained within latitudinal limits like "south of 50°S").

A. Recent and ongoing activities

Does your country have a national committee tasked with oversight of Southern Ocean climate science?

YES. This is the Belgian National Committee for Antarctic Research (BNCAR, <http://dev.ulb.ac.be/glaciol/BNCAR/index.htm>). The BNCAR is made of about 45 effective, associate or honorary members and is the direct link with the Scientific Committee on Antarctic Research (SCAR). The BNCAR is the national forum to share and discuss scientific results but also identify strategies for better coordination of resources.

The following acronyms are used to refer to universities or research institutes:

RMI : Royal Meteorological Institute
UCL: Université catholique de Louvain
VUB : Vrije Universiteit Brussel
ULg : Université de Liège
KUL : Katholieke Universiteit Leuven
ULB : Université Libre de Bruxelles
RMCA : Royal Museum of Central Africa
UG : Universiteit Gent

What major activities have been carried out in the last several years or are in progress now? Contact information for the projects would be useful.

1. Observational?

a. RMI. Contact: mangold@meteo.be.

- i. Since February 2009 - continuous monitoring of total ozone, UV irradiation and ambient aerosol physical and optical properties at Princess Elisabeth Station, Dronning Maud Land, East Antarctic and weather balloon launches February 2014 and December 2014 to February 2015, as well as austral summer 2015-2016 Website: <http://ozone.meteo.be/meteo/view/en/1550481-AEROCLOUD.html>

b. VUB

- i. Participation to SIPEX-2 Sea Ice Physics and Ecosystem eXperiment (Sep-Oct 2012) was an Australian seven-week voyage into the sea-ice zone jointly coordinated by ACE-CRC and the Australian Antarctic Division. It was a continuation of the SIPEX 1 expedition that took place in 2007. The purpose of SIPEX2 was to investigate relationship between the physical & biogeochemical sea-ice system, and the structure of Southern Ocean ecosystems. Research was conducted at about 100-120°, east of Australia's Casey Station. BIGSOUTH participants are part of the Trace Metal & Biogeochemistry team. They especially worked on primary production and C, N, Si nutrient cycling via in-situ incubations experiments and natural nitrate isotopes signal study. Contact: Arnout.Roukaerts@vub.ac.be
- ii. REVOLTA (Resources Ecologique et Valorization par un Observatoire à Long Terme en terre Adélie ; Nov-Dec 2014). As part of the Belspo BRAIN-be funded vERSO project VUB participants performed in-situ incubations experiments to assess carbon and nitrogen uptake by bottom ice and under ice algae. They also studied the natural isotopic composition of nitrate.
- iii. During the Austral spring of 2015 (Oct. 27th – Dec. 11th) the VUB team participated in a one-month field campaign at the Australian Davis station, Prydz Bay, Antarctica. The field work was organized in close collaboration with colleagues from the Institute

of Marine and Antarctic Studies (IMAS) in Hobart, Australia. Samples of sea ice (drilled ice cores), snow and the underlying water column were taken over time on fast ice (6 samplings over the duration of the field work) about 1.5 km from Davis station, to be analyzed for different parameters such as temperature, salinity, nutrient concentrations, isotopic signatures of nitrate and particulate organic matter. The focus of our team was on the nitrogen and carbon cycle using isotope enriched uptake experiments and analyzing natural isotopic abundances of organic matter and N-nutrients. Per sampling event some 5 to 7 ice cores were drilled. A time series of experiments was conducted to measure in-situ uptake rates for carbon and nitrogen by the sea-ice associated algae and to follow the changes in growth rate with progress of the season. Contacts: Florian.deman@vub.be ; Arnout.Roukaerts@vub.be

- c. UCL
 - i. Participation to the SIPEX-2 campaign (see below). Contact: Olivier.lecomte@uclouvain.be
- d. ULg
 - i. Impact of natural iron fertilization on the biogeochemical cycles in the Southern Ocean (KEOPS 2 project). Contact: Bruno.delille@ulg.ac.be
- e. KUL. Contact: henrik.christiansen@bio.kuleuven.be, Filip.Volckaert@bio.kuleuven.be, antonarctica@gmail.com
 - i. Collection of biological tissue samples of various Antarctic fish for molecular identification and population genetics.
 - ii. Development of genetic markers (microsatellites, and more recently SNPs using next generation sequencing)
 - iii. Fundamental research on connectivity, including reviews.
- f. ULB. Contact: jean-louis.tison@ulb.ac.be
 - i. YROSIAE (Year-Round Ocean-Sea-Ice-Atmosphere Exchanges) (add period Nov 2011- Dec 2012) is a Belgian project funded by the Fonds National de la Recherche Scientifique (FNRS) and the Belgian Science Policy (BELSPO). The work has been focused on the study of landfast sea ice physics and biogeochemistry in order to better understand and budget exchanges of energy and matter across the atmosphere-sea ice-ocean interfaces during ice growth and decay, and to quantify their potential impact on fluxes of climate gases (CO₂, DMS, CH₄, N₂O) to the atmosphere and carbon export to the deep ocean. Ice cores, sea water, brines and exported material had been collected in trace clean condition during field surveys at regular intervals to characterize the distribution of climate gases (CO₂, DMS, CH₄, N₂O), physical (salinity, temperature, texture, 18O) and CO₂-related (DIC, TA, CaCO₃) biogeochemical parameters, macro-nutrients and particulate material (including δ¹³C, δ³⁰Si and δ¹⁵N), micro-

nutrient (Fe), biological parameters (chlorophyll a, primary production within sea ice derived from O₂/Ar and O₂/N ratios, transparent exopolymer particles (TEP). Incubations had been also carried (¹³C, ¹⁵N, and ³⁰Si). Micro-meteorological tower for measurement of air-ice CO₂ flux by eddy-covariance and related parameters, sea ice mass balance buoy (ICE-T) and dust collectors were also deployed. A 1D halo-thermodynamic biogeochemical sea ice model will be used used to better constrain the interplay between GCOS Essential and Ocean Climate Variables and as temperature salinity, partial pressure of CO₂, ocean acidity, oxygen nutrients in the ice and the underlying layer.

- ii. The 2013 Antarctic Winter Ecosystem Climate Study is a German voyage into the sea-ice zone (R.V. Polarstern, ANTXXIX-6, Alfred Wegener Institute, Germany). This was an integrated multidisciplinary study of pack ice biogeochemistry in the Weddell Sea during the winter 2013 (June-August). A total of 12 stations were investigated by the sea ice biogeochemistry group, collecting a suite of variables in the fields of physics, inorganic chemistry, gas content and composition, microbiology, biogeochemistry, trace metals and the carbonate system in order to give the best possible description of the sea ice cover and its interactions at interfaces. Samples were therefore collected in the atmosphere above (gas fluxes), in the snow cover, in the bulk ice (ice cores), in the brines (sackholes) and in the sea water below (0m, 1m, 30 m).
- iii. Participation to the BIGSOUTH project (see above).
- iv. IceCON project: "Determining coastal uplift and ice mass change over the last 20,000 years using geodetic GPS, radar, GPS monitoring, ice coring, and ice sheet modelling". Contact: fpattyn@ulb.ac.be
- g. RMCA: participation to the BIGSOUTH project (see above).
- h. UG. Contact: elie.verleyen@ugent.be
 - i. Reconstruction of past climate and environmental changes in Lützow Holm Bay (East Antarctica) and South Georgia.
 - ii. Development of relative sea level curves for Lützow Holm Bay and Prydz Bay (East Antarctica)
 - iii. Contribution to reviews regarding past changes in ice sheet and glacier dynamics in East Antarctica and the Sub-Antarctic Islands.

2. Modeling?

- a. ULg. Contact: Bruno.delille@ulg.ac.be
 - i. Assessment of air-ice CO₂ fluxes over the Antarctic sea ice combining field observations and the NEMO-LIM3 large-scale sea ice-ocean. Participation to the BIGSOUTH project: BIGSOUTH is a research network funded through the SSD programme of Belspo (<http://bigsouth.be/>).

- b. UCL
 - i. Participation to the BIGSOUTH project (see above).
 - ii. Development of new processes in the sea ice model LIM, such as snow-on-sea ice representation, melt ponds, rheology, ice-ocean coupling. Development of the LIM is, among others, carried out in the framework of two H2020 projects (PRIMAVERA and APPLICATE). Contact: Thierry.fichet@uclouvain.be
 - iii. Simulations with different types of model (ice-ocean models driven by reanalyses, analysis of the results of coupled climate models of different complexity). A focus is the impact of internal variability and in particular of ice-ocean interactions on the recent trends in sea ice extent in the Southern Ocean. Project PREDANTAR: <http://www.climate.be/PREDANTAR> Contact: hugues.goosse@uclouvain.be
 - iv. Study of past interglacials over the southern high latitudes including Southern Ocean through modelling approach (<http://www.nature.com/nature/journal/v494/n7436/full/nature11790.html>). Contact: qiuzhen.yin@uclouvain.be
 - v. Simulation of biogeochemical cycles in the Southern Ocean sea ice. Contact: s.moreau@uclouvain.be, hugues.goosse@uclouvain.be, martin.vancoppenolle@locean-ipsl.upmc.fr
 - vi. New project: Mass2Ant, East Antarctic surface mass balance in the Anthropocene : observations and multiscale modelling, East Antarctica, 2017-2022. Contacts: Hugues Goosse, Jean-Louis Tison, Stéphane Vannitsem, Jan Lenaerts, Stef Lhermitte, hugues.goosse@uclouvain.be, jtison@ulb.ac.be, svn@meteo.be, stef.lhermitte@kuleuven.be, Jan.Lenaerts@Colorado.EDU
 - vii. Launch of SIPN South, a coordinated experiment to forecast the evolution of sea ice in the Southern Ocean at the seasonal time scale. Contact: francois.massonnet@uclouvain.be.

3. State estimation?

- a. UCL
 - i. Implementation of ensemble data assimilation for reanalyses of Arctic and Antarctic sea ice. Coupled data assimilation. Contact: francois.massonnet@uclouvain.be

B. Planned activities

What major activities are planned or likely to occur during the next several years?
Contact information for the projects would be useful.

1. Observational?

- a. RMI. Contact: mangold@meteo.be
 - i. Existing activities (see above) will continue for at least 4 years. Focus will shift from purely monitoring to investigation of cloud-precipitation-aerosol interactions (collaboration with KUL).

- b. KUL. Contact: henrik.christiansen@bio.kuleuven.be,
Filip.Volckaert@bio.kuleuven.be, antonarctica@gmail.com
 - i. Integrative approach of modeling and genetics ("seascape genetics")
 - ii. Trophic ecology studies
 - c. VUB:
 - i. As part of the Belspo BRAIN-be funded vERSO project, the VUB team will contribute to Project 4291 of the Australian Antarctic Science program: Impact of changes in sea ice extent on primary productivity in the Southern Ocean: links between the iron and carbon cycles in fast ice and the marginal ice zone. (Nov. – Dec. 2015). The VUB will study primary production and the N-cycle in sea ice using stable isotope techniques. Contact: fdehairs@vub.ac.be
 - ii. Ice cores were sampled during the R/V Aurora Australis, Voyage 2 expedition to Mertz Glacier (Dec. 2016 – Jan. 2017) by our Australian colleagues (IMAS, Hobart). Six sites were sampled with ice cores saved for investigating the nitrogen and carbon cycling, based on natural isotopic abundances of organic matter and N-nutrients. Furthermore, colleagues from ULg and ULB are presently (April-June 2017) sampling sea ice in the Ross Sea (PIPERS expedition; winter conditions), also saving ice cores for analysis at VUB. These different samples will be shipped to VUB later this year.
 - d. ULB and ULg are planning to participate to the PIPERS (Polynyas, ice production and seasonal evolution in the Ross Sea) cruise funded by the NSF and led by Steve Ackley (UTSA). The cruise will investigate the Ross Polynya in April-Jun 2017. PIPERS is a larger multi-platform project designed to carry out In situ observations of air-sea-ice interactions in order to improve estimates of sea ice production and water mass transformation in the Ross Sea.
 - e. UG. Contact: elie.verleyen@ugent.be
 - i. Planned field campaigns to Southern South America (2015-2016) and the Larsemann Hills (2016-2017).
2. Modeling?
- a. UCL:
 - i. Identification of sources of model biases and improvement of physical processes in climate models in the Southern Ocean. Contact: hugues.goose@uclouvain.be
 - ii. Analysis of CMIP6 simulations in the polar regions. Contact: thierry.fichefet@uclouvain.be
 - iii. Study of small-scale processes using high-resolution (2 km) a coupled atmosphere-ocean-sea ice regional climate model. Contact: Thierry.fichefet@uclouvain.be (partnership with ULg)
 - iv. Study of predictability of sea ice in the Southern Ocean. Contact: sylvain.marchi@uclouvain.be

- v. Contribution of Southern Ocean to the interglacial carbon cycle.
Contact: qiuzhen.yin@uclouvain.be
 - vi. Project PARAMOUR (submitted to EOS program) to study the interactions between ice sheets, oceans, sea ice and atmosphere in a climate prediction context.
- b. ULg:
- i. Study of small-scale processes using high-resolution (2 km) a coupled atmosphere-ocean-sea ice regional climate model.
Contact: Xavier.fettweis@ulg.ac.be
 - ii.
3. State estimation?
- a. UCL:
- i. Ensemble, coupled reanalyses in the Southern Ocean. Contact: francois.massonnet@uclouvain.be, hugues.goose@uclouvain.be

SORP terms of reference <http://www.clivar.org/clivar-panels/southern>

"To serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean. To advise CLIVAR, [CliC](#), and [SCAR](#) on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research."

Specific Activities:

1. Facilitate progress in the development of tools and methods required to assess climate variability, climate change and climate predictability of the ocean-atmosphere-ice system in the Southern Ocean.
2. Identify opportunities and coordinated strategies to implement these methods, spanning observations, models, experiments, and process studies.
3. Provide scientific and technical input into international research coordination, collaborating as required with other relevant programs, including the [Southern Ocean Observing System \(SOOS\)](#).
4. Monitor and evaluate progress in Southern Ocean research, and identify gaps.
5. Enhance interaction between the meteorology, oceanography, cryosphere, geology, biogeochemistry and paleoclimate communities with an interest in the climate of the Southern Ocean.
6. Work with relevant agencies on the standardization, distribution and archiving of Southern Ocean observations.

References (this list is not exhaustive)

Barthélemy A., T. Fichefet, H Goosse, G. Madec, 2015. Modelling the interplay between sea ice formation and the oceanic mixed layer: limitations of simple brine rejection parameterizations. *Ocean Modelling* 86, 141-152.

Carnat G, Zhou J, Papakyriakou T, Delille B, Goossens T, Haskell T, Schoemann V, Fripiat F, Rintala J-M, Tison J-L. 2014. Physical and biological controls on DMS,P dynamics in ice shelf-influenced fast ice during a winter-spring and a spring-summer transitions. *J. Geophys. Res. Ocean.* 119:2882–2905.
<http://doi.wiley.com/10.1002/2013JC009381>

Cavagna A.J., F. Fripiat, M. Elskens, P. Mangion, L. Chirurgien, I. Closset, M. Lasbleiz, L. Flores–Leiva, D. Cardinal, K. Leblanc, C. Fernandez, D. Lefèvre, L. Oriol, S. Blain, B. Quéguiner and F. Dehairs, 2015. Biological productivity regime and associated N cycling in the vicinity of Kerguelen Island area, Southern Ocean, *Biogeosciences*, 12, 6515-6528.

Close S., H. Goosse, 2013. Entrainment-driven modulation of Southern Ocean mixed layer and sea ice variability in CMIP5 models. *Journal of Geophysical Research Oceans* 118, 2811–2827, doi:10.1002/jgrc.20226

Dehairs F., F. Fripiat, A.-J. Cavagna, T.W. Trull, C. Fernandez, D. Davies, A. Roukaerts, D. Fonseca Batista, F. Planchon and M. Elskens, 2015. Nitrogen cycling in the Southern Ocean Kerguelen Plateau area: Evidence for significant surface nitrification from nitrate isotopic compositions, *Biogeosciences*, 12, 1459-148.

Delille B, Vancoppenolle M, Geilfus N-X, Tilbrook B, Lannuzel D, Schoemann V, Becquevort S, Carnat G, Delille D, Lancelot C, et al. 2014. Southern Ocean CO2 sink: The contribution of the sea ice. *J. Geophys. Res. Ocean.* 119:6340–6355.
<http://dx.doi.org/10.1002/2014JC009941>

Fripiat F., M. Elskens, T. Trull, S. Blain, A.-J. Cavagna, C. Fernandez, D. Fonseca-Batista, F. Planchon, P. Raimbault, A. Roukaerts, and F. Dehairs, 2015. Significant mixed layer nitrification in a natural iron-fertilized bloom of the Southern Ocean, *Global Biogeochemical Cycles*, 29, 1929-1943.

Goosse H., D.M. Roche, A. Mairesse, M. Berger, 2013. Modeling past sea ice changes. *Quaternary Science Reviews* 79, 191-206. doi: 10.1016/j.quascirev.2013.03.011

Goosse H., V. Zunz, 2014. Decadal trends in the Antarctic sea ice extent ultimately controlled by ice-ocean feedback. *The Cryosphere* 8, 453–470. Doi: 10.5194/tc-8-453-2014

Hodgson D.A., Graham A.G.C., Roberts S.J., Bentley M.J., Ó Cofaigh C., Verleyen E., Jomelli V., Favier V., Brunstein D., Colhoun E.A, Saunders K., Macintosh A., Hall K.,

- McGlone M., Van der Putten N. (2014). ACE Community Antarctic Ice Sheet reconstruction - sub-Antarctic Islands. *Quaternary Science reviews* 100: 137-158.
- Jacquet S. H. M., F. Dehairs, D. Lefèvre, A.-J. Cavagna, F. Planchon, U. Christaki, L. Monin, L. André, I. Closset, and D. Cardinal, 2015. Early season mesopelagic carbon remineralization and transfer efficiency in the naturally iron-fertilized Kerguelen area, *Biogeosciences*, 12, 1713-1731.
- Jardon F., Vivier F., M. Vancoppenolle, A. Lourenco, P. Bouruet-Aubertot, and Y. Cuypers. Full-depth desalination of warm sea ice. *Journal of Geophysical Research*, 118:435–447, 2013.
- Lancelot, C., A. de Montety, H. Goosse, S. Becquevort, V. Schoemann, B. Pasquer and M. Vancoppenolle, 2009. Spatial distribution of the iron supply to phytoplankton in the Southern Ocean: a model study. *Biogeosciences*, 6, 2861– 2878.
- Lannuzel, D., F. Chever, P.C. van der Merwe, J. Janssens, A. Roukaerts, A.-J. Cavagna, A.T. Townsend, A.R. Bowie, K.M. Meiners, 2016. Iron biogeochemistry in Antarctic pack ice during SIPEX-2, *Deep-Sea Research, II*, 131, 111-122.
- Laurenceau-Cornec E. C., T. W. Trull, D. M. Davies, S. G. Bray, J. Doran, F. Planchon, F. Carlotti, M.-P. Jouandet, A.-J. Cavagna, A. M. Waite and S. Blain, 2015. The relative importance of phytoplankton aggregates and zooplankton fecal pellets to carbon export: insights from free-drifting sediment trap deployments in naturally iron-fertilised waters near the Kerguelen Plateau. *Biogeosciences*, 12, 1007-1027.
- Lemaitre N., H. Planquette, F. Planchon, F. Dehairs, P. van der Merwe, A. Bowie, T.W. Trull, C. Bollinger, M. Le Goff, E. Grossteffan, 2016. Impact of the natural Fe-fertilization on the magnitude, stoichiometry and efficiency of PN, BSi and PFe export fluxes, *Deep-Sea Research, I*, 117, 11-27, <http://dx.doi.org/10.1016/j.dsr.2016.09.002>.
- Mackintosh A.N., Verleyen E., O'Brien P.E., White D., McKay R, Gore D.B., Dunbar R., Goodwin I., Fink D., Jones R., Post A., Miura H., Leventer A., Lilly K., Golledge N., van Ommen T., Wagner B., Zwartz D., Berg S., Hodgson D.A., Roberts S.J., Vyverman W., Masse G, Crosta X. (2014) Retreat history of the East Antarctic Ice Sheet since the Last Glacial Maximum. *Quaternary Science Reviews* 100: 10-30.
- Massonnet F., P. Mathiot, T. Fichefet, H. Goosse, C. König Beatty, M. Vancoppenolle, T. Lavergne, 2013. A model reconstruction of the Antarctic sea ice thickness and volume changes over 1980-2008 using data assimilation. *Ocean Modelling* 64, 67-75
- Massonnet F., T. Fichefet, H. Goosse, F. Counillon, 2014. Calibration of sea ice dynamic parameters in an ocean-sea ice model using an ensemble Kalman filter. *Journal of Geophysical Research Oceans* 119, 4168–4184, Doi: 10.1002/2013JC009705.

Meiners K. M., M. Vancoppenolle, S. Thanassekos, G. S. Dieckmann, D. Thomas, J.-L. Tison, K. R. Arrigo, D. Garrison, A. McMinn, D. Lannuzel, P. van der Merwe, K. Swadling, W.O. Smith, I. Melnikov, and B. Raymond. Chlorophyll a in Antarctic sea ice from historical ice core data. *Geophysical Research Letters*, 39, 2012.

Moreau S., M. Vancoppenolle, B. Delille, J.-L. Tison, J. Zhou, M. Kotovitch, D.N. Thomas, N.-X Geilfus, H. Goosse, 2015. Drivers of inorganic carbon dynamics in first-year sea ice: a 1D modeling study. *Journal of Geophysical Research-Oceans* 120(1) 471-495. DOI: 10.1002/2014JC010388

Moreau S., M. Vancoppenolle, J. Zhou, J.-L. Tison, B. Delille, H. Goosse, 2014. Modeling argon dynamics in first-year sea ice. *Ocean Modelling* 73, 1-18. DOI 10.1016/j.ocemod.2013.10.004

Moreau S., Mostajir B., Bélanger S., Schloss I. R., Vancoppenolle M., Demers S. and Ferreyra G. A. 2015. Climate change enhances primary production in the western Antarctic Peninsula. *Global Change Biology* 21(6):2191-205

Moreau S., Vancoppenolle M., Delille B., Tison J.-L., Zhou J., Kotovitch M., Thomas D., Geilfus N.-X. and Goosse H. 2015. Drivers of inorganic carbon dynamics in first-year sea ice: A model study. *Journal of Geophysical Research: Oceans*, 120 (1) : 471-495

Moreau S., Vancoppenolle M., Zhou J., Tison J.-L., Delille B. and Goosse H. 2014. Modeling argon dynamics in first-year sea ice. *Ocean Modelling*, 73: 1-18

Pasquer B., N. Metzl; H. Goosse; C. Lancelot, 2015. What drives the seasonality of air-sea CO₂ fluxes in the ice-free zone of the Southern Ocean: a 1D coupled physical-biogeochemical model approach. *Marine Chemistry* (in press, available online <http://www.sciencedirect.com/science/article/pii/S0304420315300347>).

Planchon F., D. Ballas, A.-J. Cavagna, A.R. Bowie, D. Davies, T.W. Trull, E. Laurenceau, P. van der Merwe, and F. Dehairs, 2015. Carbon export in the naturally iron-fertilized Kerguelen area of the Southern Ocean based on the ²³⁴Th approach, *Biogeosciences*, 12, 3831-3848.

Roukaerts, A, Anne-Julie Cavagna, François Fripiat, Delphine Lannuzel, Klaus M. Meiners, Frank Dehairs, Sea-ice algal primary production and nitrogen uptake rates off East Antarctica, <http://www.sciencedirect.com/science/article/pii/S0967064515003008>

Roukaerts A., A.-J. Cavagna, F. Fripiat, D. Lannuzel, K. Meiners and F. Dehairs, 2016. Sea-ice algal primary production and nitrogen uptake rates off East Antarctica, *Deep-Sea Research II*, 131, 140-149, <http://dx.doi.org/10.1016/j.dsr2.2015.08.007>

Special issue KEOPS2: Kerguelen Ocean and Plateau Study 2, Editor(s): S. Blain, I. Obernosterer, B. Queguiner, T. Trull, and G. Herndl. BIGSOUTH members contributed to 9 papers of this special issue.

Strother S.L., Salzmann U., Roberts S.J., Hodgson D.A., Woodward J., Van Nieuwenhuyze W., Verleyen E., Vyverman W., Moreton S.G. (2015). Holocene vegetation and change of westerly winds reconstructed from a high resolution sub-Antarctic pollen record at Fan Lake, South Georgia. *The Holocene* 25: 263-279.

Tavernier I., Verleyen E., Hodgson D.A., Heirman K., Imura S., Kudoh S., Sabbe K., De Batist M., Debeer A.-E. & Vyverman W. (2014) Absence of a Medieval Climate Anomaly and Little Ice Age in the Lützow Holm Bay region, East Antarctica. *Antarctic Science* 26: 585-598.

The RAISED Consortium (Reconstruction of Antarctic Ice Sheet Deglaciation)*. A community-based reconstruction of Antarctic Ice Sheet deglaciation since the Last Glacial Maximum. *Bentley M.J., Ó Cofaigh C., Anderson J.B., Conway H., Davies B., Graham A.C., Hillenbrand C-D., Hodgson D.A., Larter R.D., Mackintosh A., Verleyen E. and others (2014). *Quaternary Science reviews* 100: 1-9.

Trull T.W., D. Davies, F. Dehairs, A.-J. Cavagna, M. Lasbleiz, E.C. Laurenceau-Cornec, F. D'Ovidio, F. Planchon, B. Quéguiner and S. Blain, 2015. Chemometric perspectives on plankton community responses to natural iron fertilisation over and downstream of the Kerguelen Plateau in the Southern Ocean, *Biogeosciences*, 12, 1029-1056, doi:10.5194/bg-12-1029-2015.

Van de Putte, A. P, J.K.J. Van Houdt, b, G.E. Maes, B. Hellemans, M.A. Collins, F.A.M. Volckaert, High genetic diversity and connectivity in a common mesopelagic fish of the Southern Ocean: The myctophid *Electrona antarctica*, <http://www.sciencedirect.com/science/article/pii/S0967064511001378>

Van de Putte, A. P, Karel Janko, Eva Kasparova, Gregory E. Maes, Jennifer Rock, Philippe Koubbi, Filip A.M. Volckaert, Lukáš Choleva, Keiron P.P. Fraser, Jerzy Smykla, Jeroen K.J. Van Houdt, Craig Marshall, Comparative phylogeography of three trematomid fishes reveals contrasting genetic structure patterns in benthic and pelagic species, <http://www.sciencedirect.com/science/article/pii/S1874778712000463>

Van de Putte, A.P., J. K. J. Van Houdt, G. E. Maes, K. Janko, P. Koubbi, J. Rock, F. A. M. Volckaert, Species identification in the trematomid family using nuclear genetic markers, <http://link.springer.com/article/10.1007/s00300-009-0672-8>

van der Merwe P., A. Bowie, F. Quéroué, L. Armand, S. Blain, F. Chever, D. Davies, F. Dehairs, F. Planchon, G. Sarthou, A.T. Townsend, and T.W. Trull, 2015. Sourcing the iron in the naturally-fertilised bloom around the Kerguelen Plateau: particulate trace metal dynamics, *Biogeosciences*, 12, 739–755.

Van Houdt, J., B. Hellemans, A. Van de Putte, P. Koubbi, F. Volckaert, Isolation and multiplex analysis of six polymorphic microsatellites in the Antarctic notothenioid fish,

Trematomus newnesi., <http://onlinelibrary.wiley.com/doi/10.1111/j.1471-8286.2005.01174.x/full>

Vancoppenolle M., Fichefet T., Goosse H., Bouillon S., Madec G. and Morales Maqueda M.A. 2009a. Simulating the mass balance and salinity of Arctic and Antarctic sea ice. 1. Model description and validation. *Ocean Modelling*, 27, 33-53, doi:10.1016/j.ocemod.2008.10.005.

Vancoppenolle M., Goosse H., de Montety A., Fichefet T., Tremblay B. and Tison J.-L., 2010. Modelling brine and nutrient dynamics in Antarctic sea ice: the case of dissolved silica. *Journal of Geophysical Research – Oceans*, 115, doi:10.1029/2009JC005369.

Vancoppenolle M., K. Meiners, C. Michel, L. Bopp, F. Brabant, G. Carnat, B. Delille, D. Lannuzel, G. Madec, S. Moreau, J.-L. Tison, P. van der Merwe. 2013. Role of sea ice in global biogeochemical cycles: emerging views and challenges. *Quaternary Science Review*, 79: 207-230

Vancoppenolle M., T. Fichefet and H. Goosse, 2009b. Simulating the mass balance and salinity of Arctic and Antarctic sea ice. 2. Sensitivity to the ice salinity processes. *Ocean Modelling*, 27, 54-69.

Vancoppenolle, M., C.-M. Bitz and T. Fichefet, 2007. Summer landfast sea ice desalination at Point Barrow, Alaska: modeling and observations. *Journal of Geophysical Research*, 112, C04022, doi:10.1029/2006JC003493.

Vancoppenolle, M., L. Bopp, G. Madec, J. Dunne, T. Ilyina, P. R. Halloran and N. Steiner. 2013. Future Arctic Ocean primary productivity from CMIP5 simulations: Uncertain outcome, but consistent mechanisms. *Global Biogeochemical Cycles* 27(3): 605-619.

Vancoppenolle, M., R. Timmerman, S.F. Ackley, T. Fichefet, H. Goosse, P. Heil, J. Lieser, K.C. Leonard, M. Nicolaus, T. Papakyriakou and J.-L. Tison (2011). Assessment of model forcing data sets for large-scale sea ice models in the Southern Ocean. *Deep-Sea Research II*, 58, 1237-1249, doi:10.1016/j.dsr2.2010.10.039.

Vancoppenolle, M., T. Fichefet and C.M. Bitz, 2005. On the sensitivity of undeformed Arctic sea ice to its vertical salinity profile. *Geophysical Research Letters*, 32, L16502, doi:10.1029/2005GL023427.

Vancoppenolle, M., T. Fichefet and C.-M. Bitz, 2006. Modeling the salinity profile of undeformed Arctic sea ice. *Geophysical Research Letters*, 33, L21501, doi:10.1029/2006GL028342.

Volckaert, F., Jennifer Rock, Anton P. Van de Putte, *Connectivity and Molecular Ecology of Antarctic Fishes*, http://link.springer.com/chapter/10.1007/978-3-642-27352-0_5

Yin, Q., Insolation-induced mid-Brunhes transition in Southern Ocean ventilation and deep-ocean temperature. *Nature* 494, 222–225 (14 February 2013)
doi:10.1038/nature11790

Zunz V. and H. Goosse, 2015. Influence of meltwater input on the skill of decadal forecast of sea ice extent in the Southern Ocean. *The Cryosphere* 9, 541-546, www.the-cryosphere.net/9/541/2015/, doi:10.5194/tc-9-541-2015.

Zunz V., H. Goosse, F. Massonnet, 2013. How does internal variability influence the ability of CMIP5 models to reproduce the recent trend in Southern Ocean sea ice extent? *The Cryosphere* 7, 451–468

SORP terms of reference <http://www.clivar.org/clivar-panels/southern>

"To serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean. To advise CLIVAR, [CliC](#), and [SCAR](#) on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research."

Specific Activities:

1. Facilitate progress in the development of tools and methods required to assess climate variability, climate change and climate predictability of the ocean-atmosphere-ice system in the Southern Ocean.
2. Identify opportunities and coordinated strategies to implement these methods, spanning observations, models, experiments, and process studies.
3. Provide scientific and technical input into international research coordination, collaborating as required with other relevant programs, including the [Southern Ocean Observing System \(SOOS\)](#).
4. Monitor and evaluate progress in Southern Ocean research, and identify gaps.
5. Enhance interaction between the meteorology, oceanography, cryosphere, geology, biogeochemistry and paleoclimate communities with an interest in the climate of the Southern Ocean.
6. Work with relevant agencies on the standardization, distribution and archiving of Southern Ocean observations.