

## Report for the year 2020 and future activities

### **SOLAS Belgium**

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*This report has two parts:*

- **Part 1:** reporting of activities in the period of January 2020 - Jan/Feb 2021
- **Part 2:** reporting on planned activities for 2021 and 2022.

*The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity or specify an overlap between Themes or Cross-Cutting Themes.*

- 1 Greenhouse gases and the oceans;
  - 2 Air-sea interfaces and fluxes of mass and energy;
  - 3 Atmospheric deposition and ocean biogeochemistry;
  - 4 Interconnections between aerosols, clouds, and marine ecosystems;
  - 5 Ocean biogeochemical control on atmospheric chemistry;
- Integrated studies of high sensitivity systems;  
Environmental impacts of geoengineering;  
Science and society.

**IMPORTANT:** *This report should reflect the efforts of the SOLAS community in the entire country you are representing (all universities, institutes, lab, units, groups, cities).*

**First things first...Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?**

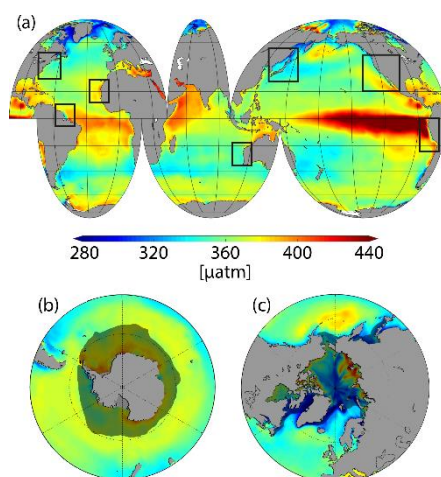
### **PART 1 - Activities from January 2020 to Jan/Feb 2021**

#### **1. Scientific highlight**

“A uniform pCO<sub>2</sub> climatology combining open and coastal oceans”

Landschützer, P., Laruelle, G. G., Roobaert, A., and Regnier, P.: A uniform pCO<sub>2</sub> climatology combining open and coastal oceans, Earth Syst. Sci. Data, 12, 2537–2553, <https://doi.org/10.5194/essd-12-2537-2020>, 2020.

In this study, we present the first combined open- and coastal-ocean  $p\text{CO}_2$  mapped monthly climatology constructed from observations collected between 1998 and 2015 extracted from the Surface Ocean  $\text{CO}_2$  Atlas (SOCAT) database. We combine two neural network-based  $p\text{CO}_2$  products, one from the open ocean and the other from the coastal ocean, and investigate their consistency along their common overlap areas. While the difference between open- and coastal-ocean estimates along the overlap area increases with latitude, it remains close to  $0 \mu\text{atm}$  globally. Stronger discrepancies, however, exist on the regional level resulting in differences that exceed 10% of the climatological mean  $p\text{CO}_2$ , or an order of magnitude larger than the uncertainty from state-of-the-art measurements. This also illustrates the potential of such an analysis to highlight where we lack a good representation of the aquatic continuum and future research should be dedicated. A regional analysis further shows that the seasonal carbon dynamics at the coast–open interface are well represented in our climatology. While our combined product is only a first step towards a true representation of both the open-ocean and the coastal-ocean air–sea  $\text{CO}_2$  flux in marine carbon budgets, we show it is a feasible task and the present data product already constitutes a valuable tool to investigate and quantify the dynamics of the air–sea  $\text{CO}_2$  exchange consistently for oceanic regions regardless of its distance to the coast.



**Figure.** (a) Climatological mean  $p\text{CO}_2$  of the merged product presented in this study. Panels (b) and (c) highlight the polar regions. Black boxes in (a) illustrate regions that are further investigated in the regional analysis. Shaded areas in (b) and (c) delineate the maximum sea ice extend.

**2. Activities/main accomplishments in 2020 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).**

- Contribution to the activities of Scientific Committee on Ocean Research (SCOR) Working Group #143 "Dissolved  $\text{N}_2\text{O}$  and  $\text{CH}_4$  measurements: Working towards a global network of ocean time series measurements of  $\text{N}_2\text{O}$  and  $\text{CH}_4$ " (<https://scor-int.org/group/143/>) in particular regarding the elaboration of a "Standard Operating Protocol" for the "A Best Practice Guide to Dissolved  $\text{CH}_4$  and  $\text{N}_2\text{O}$  Measurements" (publication in 2021 by Woods Hole Oceanographic Institution)
- Intercalibration experiment for measurement of carbonate system parameters and gases in sea ice at the Roland von Glasow air-sea-ice chamber of the University of East Anglia, Norwich, UK in the frame of ECV-ice SCOR working group with the support of the Eurochamp-2020 Infrastructure Activity. January 2020 & March 2020.
- Involved in the International Arctic Drift Expedition on the RV Polarstern led by AWI MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate) in the Biogeochemical group (responsible for  $\text{N}_2\text{O}$  dynamics, air-ice  $\text{CO}_2$  exchange, and reactive

N isotopes)

- Contribution to international assessments by the Global Carbon Project (GCP). ULB-BGEOSYS provided datasets and analyses on bottom-up natural emissions of CH<sub>4</sub> from estuarine systems that were incorporated in the Global Methane Budget 2000-2017 (Saunois et al., 2020). ULB-BGEOSYS led (P. Regnier) inland water and coastal modelling and synthesis for the first release of the N<sub>2</sub>O budget by GCP (Tian et al., 2020).

Tian, H. ... **Regnier, P.**, ... **Laruelle G.G.** et al. A comprehensive quantification of global nitrous oxide sources and sinks. *Nature*, vol : 286, pp 248-256, 2020, <https://doi.org/10.1038/s41586-020-2780-0>

Saunois, M. ... **Laruelle G.G.**, ... **Regnier P.** et al. The Global Methane Budget 2000–2017. *Earth Syst. Sci. Data*, 12, 1561–1623, 2020, <https://doi.org/10.5194/essd-12-1561-2020>

### 3. Top 5 publications in 2020 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

- Ai, X.E., A.S. Studer, D.M. Sigman, A.M. Martinez-Garcia, **F. Fripiat**, E. Michel, J. Gottschalk, L. Thöle, S. Moretti, S.L. Jaccard and G.H. Haug (2020). The role of obliquity in Southern Ocean upwelling and atmospheric CO<sub>2</sub>. *Science* 370, 1348-1352.
- Lannuzel D., L. Tedesco, M. van Leeuwe, K. Campbell, H. Flores, **B. Delille**, L. Miller, J. Stefels, P. Assmy, J. Bowman, K. Brown, G. Castellani, M. Chierici, O. Crabeck, E. Damm, B. Else, A. Fransson, F. Fripiat, N.X. Geilfus, C. Jacques, E. Jones, H. Kaartokallio, M. Kotovitch, K. Meiners, S. Moreau, D. Nomura, I. Peeken, J.M. Rintala, N. Steiner, **J.L. Tison**, M. Vancoppenolle, F. Van der Linden, M. Vichi, P. Wongpan, 2020. The future of Arctic sea-ice biogeochemistry and ice-associated ecosystems, *Nature Climate Change* 10 (2020) 983–992. doi:10.1038/s41558-020-00940-4
- Van der Linden F., **J. Tison**, **W. Champenois**, S. Moreau, **G. Carnat**, M. Kotovitch, **F. Fripiat**, F. Deman, A. Roukaerts, **F. Dehairs**, S. Wauthy, A. Lourenço, F. Vivier, T. Haskell, **B. Delille**, 2020. CO<sub>2</sub> transfer across the Antarctic landfast sea ice interface from ice growth to decay *Journal of Geophysical Research* doi: 10.1029/2019JC015807
- Wilson ST, AN Al-Haj, A Bourbonnais, C Frey, RW Fulweiler, JD Kessler, HK Marchant, J Milucka, NE Ray, P Suntharalingham, BF Thornton, RC Upstill-Goddard, TS Weber, DL Arévalo-Martínez, HW Bange, HM Benway, D Bianchi, **AV Borges**, BX Chang, PM Crill, DA del Valle, L Fariás, SB Joye, A Kock, J Labidi, CC Manning, JW Pohlman, G Rehder, KJ Sparrow, PD Tortell, T Treude, DL Valentine, BB Ward, S Yang, LN Yurganov (2020) Ideas and perspectives: A strategic assessment of methane and nitrous oxide measurements in the marine environment, *Biogeosciences*, 17, 5809-5828, <https://doi.org/10.5194/bg-17-5809-2020>
- **Wittek, B.**, **G. Carnat**, **B. Delille**, **J.-L. Tison**, **N. Gypens**, 2020. Dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO) cell quotas variations due to sea ice shifts of salinity and temperature in the Prymnesiophyceae *Phaeocystis antarctica*. *Environmental Chemistry* 17:7 509-523, doi: 10.1071/EN19302

### 4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2020? If yes, who? How did you engage?

## **PART 2 - Planned activities for 2021 and 2022**

### **1. Planned major national and international field studies and collaborative laboratory and modelling studies (incl. all information possible, dates, locations, teams, work, etc.).**

- ECV-ice intercalibration of air-ice CO<sub>2</sub> fluxes and primary production to be carried out in May 2022 in Cambridge Bay – Canada

### **2. Events like conferences, workshops, meetings, summer schools, capacity building etc. (incl. all information possible).**

- Because of the pandemic situation, BEPSII field school has been postponed to 2022.

### **3. Funded national and international projects/activities underway.**

- Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC, CDR J.0051.20, 2020-2021) Research Project funded by the F.R.S.-FNRS
- Estimating Tipping points in habitability of ANtartic benthic ecosystems under GIObal future climate change scenarios (TANGO, Brain, 2021-2024) funded by the Belgian Science Policy

### **4. Plans / ideas for future national or international projects, programmes, proposals, etc. (please indicate the funding agencies and potential submission dates).**

- BEPSII and CATCH working groups (both co-sponsored by SOLAS) are aiming to apply for a joint SCOR working group on research topics at the margin of BEPSII and CATCH expertise. Both communities are looking for a common forum where some common key question could be tackled by merging the expertise and workforce of both communities.
- BEPSII and CATCH communities are aiming to coordinate one (possibly several) survey in the Southern Ocean. There is a consensus that synergies between both communities are critical to unlock current key questions on air-sea exchange in ice-covered areas

### **5. Engagements with other international projects, organisations, programmes, etc.**

- BEPSII (Biogeochemical Exchange Processes at the Sea ice Interfaces) joint SOLAS-CLIC-IASC-SCAR working group
- ECVice (Essential Climate Variable for sea ice) SCOR working group
- SOOS task group on Air-Sea Fluxes
- CATCH (The Cryosphere and Atmospheric Chemistry) sponsored by SOLAS and IGAC
- ULB-BGEOSYS currently coordinates an international effort aiming at synthesizing greenhouse gas (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) fluxes from the coastal ocean at the regional scale. This assessment will be integrated in the REgional Carbon Cycle Assessment and Processes-2 (RECCAP2) 2019-2021 of the Global Carbon Project.

## **Comments**