

## Report for the year 2021 and future activities

### SOLAS 'Mexico'

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This report has two parts:

- **Part 1:** reporting of activities in the period of January 2021 - Jan/Feb 2022
- **Part 2:** reporting on planned activities for 2022 and 2023.

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 2021 to Jan/Feb 2022

#### 1. Scientific highlight

- The National Congress of Oceanography was held from September 21 to 24, 2021 in the city of Ensenada, Baja California, Mexico. This was a mixed congress with a virtual component and a face-to-face component, given the health situation of this year 2021. The event featured papers from the seven thematic areas that the congress has covered for more than 10 years:

Biological Oceanography, Oceanography Physics, Geological Oceanography, Chemical Oceanography, Fisheries and aquaculture, Management of coastal and marine resources and Climate change. In total, 124 works were presented, 99 in the oral modality and 25 posters. 10 master conferences were presented and two discussion forums and a workshop were held, in addition to live interviews through the 'Mares de México' program, available on social networks. Students and researchers from most marine science institutions in the country participated in the congress, as well as colleagues from Spain, Portugal, France, the United States of America, Chile, Colombia, Brazil and Venezuela. There was an EXPO-OCEANO exhibition center that showed products and services during the event ([https://www.researchgate.net/publication/355711792\\_Memorias\\_del\\_XXI\\_Congreso\\_Nacional\\_de\\_Oceanografia\\_y\\_III\\_Reunion\\_Internacional\\_de\\_Ciencias\\_Marinas](https://www.researchgate.net/publication/355711792_Memorias_del_XXI_Congreso_Nacional_de_Oceanografia_y_III_Reunion_Internacional_de_Ciencias_Marinas)).

- The Mexican Carbon Program is pleased to present the 2021 National Synthesis, a work that brings together the efforts of numerous scientists, both national and foreign, to promote research and advance knowledge of the Carbon Cycle and its Interactions in Mexico. During the XII International Carbon Symposium in Mexico, more than 90 contributions were presented in the various thematic areas that make up the Scientific Committee: Atmosphere, Bioenergy, Social Dimension, Aquatic Ecosystems, Coastal Ecosystems, Marine Ecosystems, Terrestrial Ecosystems and Agricultural Systems. The purpose of the Symposium was to encourage and promote the scientific contribution of the PMC towards Natural Climate Solutions, hand in hand with the initiative Mexico Clean Economy 2050 (MEL 2050) and the Tecnológico de Monterrey, including its expansion towards marine and coastal ecosystems, in such a way that opportunities can be generated to trigger carbon markets aimed at the use sustainability of the natural capital of Mexico. In addition to evaluating the common collaboration agenda of Mexico-United States-Canada, in the context of CarboNA, for the establishment of measures that allow continuing with international efforts (<http://pmcarbono.org/pmc/publicaciones/sintesisn.php>).

**2. Activities/main accomplishments in 2021 (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).**

- An international cruise was done in 2021. Mexican Institution as CICESE, Colegio de La Frontera and The University of Baja California endorse and support a proposal EAST AND GULF COAST OCEAN ACIDIFICATION OBSERVING SUPPORT: GOMECC-4 CRUISE, SHIP OF OPPORTUNITY (SOOP) AND MAPPING EFFORTS submitted to the NOAA/OAR Ocean Acidification Programmed this September to October 18<sup>th</sup> 2021. The proposal addresses a critical need to perform high quality measurements of the 4 inorganic carbon parameters in the Gulf of Mexico, necessary to provide a quality synoptic view of ocean acidification in the region.
- The Scientific Cooperation Service of the French Embassy in Mexico organized from June 28 to 30, the third edition of the "Oceans" Workshop, in connection with the reactivation of the CONACYT thematic network "Ocean Climate and Global Change". The objectives of this event were: 1) to take stock of Franco-Mexican and regional collaborations in marine sciences and 2) to carry out a prospective exercise for the construction of a roadmap (2021-2023). The workshop was developed in a blended format from the IUEM (Brest) in order to allow the widest possible participation of the scientific community involved in this field, both in Mexico and France.

**3. List SOLAS-related publications published in 2021 (only PUBLISHED articles).**

**If any, please also list weblinks to models, datasets, products, etc.**

Grant C. Pitcher, Arturo Aguirre-Velarde, Denise Breitburg, Jorge Cardich, Jacob Carstensen, Daniel J. Conley, Boris Dewitte, Anja Engel, Dante Espinoza-Morriberón, Georgina Flores, Véronique Garçon, Michelle Graco, Marilaure Grégoire, Dimitri Gutiérrez, José Martin Hernandez-Ayon, Huai-Hsuan May Huang, Kirsten Isensee, María Elena Jacinto, Lisa Levin, Alberto Lorenzo, Eric Machu, Lander Merma, Ivonne Montes, Naqvi SWA, Aurelien Paulmier, Michael Roman, Kenneth Rose, Raleigh Hood, Nancy N. Rabalais, Anne Gro V. Salvanes, Renato Salvatelli, Sonia Sánchez, Abdelfettah Sifeddine, Abdoul Wahab Tall, Anja K. van der Plas, Moriaki Yasuhara, Jing Zhang, ZY Zhu. (2021). System controls of coastal and open ocean oxygen depletion, *Progress in Oceanography*, (197). <https://doi.org/10.1016/j.pocean.2021.102613>.

Valdivieso-Ojeda, J. A., Huerta-Díaz, M. A., Delgadillo-Hinojosa, F., Otero, X. L., Arenas-Islas, D., & García-Orozco, J. (2021). Sediment trace metal levels in the Ojo de Liebre Lagoonal Complex (Baja California, Mexico), a marine wildlife protected area. *Marine Pollution Bulletin*, 165, 112097.

Santamaría-del-Ángel, E., Cañon-Páez, M. L., Sebastián-Frasquet, M. T., González-Silvera, A., Gutiérrez, A. L., Aguilar-Maldonado, J. A., ... & Castillo-Ramírez, A. (2021). Interannual climate variability in the West Antarctic Peninsula under austral summer conditions. *Remote Sensing*, 13(6), 1122.

Damien, Pierre, Julio Sheinbaum, Orens Pasqueron de Fommervault, Julien Jouanno, Lorena Linacre, and Olaf Duteil. "Do Loop Current eddies stimulate productivity in the Gulf of Mexico?." *Biogeosciences* 18, no. 14 (2021): 4281-4303.

**4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2021? If yes, who? How did you engage?**

We have a talk/Panel with the topic "Effects of climate change on marine ecosystems: ocean acidification" organized by the The Secretariat of Sustainable Economy and Tourism in Baja California Mexico.

**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.).**

***Project 2021-2023: Phytoplankton Blooms in a Loop Current Eddy (PhytBloomEddy)***

- This project were the conceptual framework is inconsistent with recent Bio-Argo floats observations scattered in the GoM reported by several authors that show constant vertically integrated content of Chla and phytoplankton production in the Gulf of Mexico (GoM) throughout the year. However, a regionalization of the open waters of the Gulf of Mexico based on the seasonal and interannual variability of chlorophyll concentration using a coupled physical-biogeochemical model shows that the central and northern Gulf of

Mexico appears to be affected by winter convection and phytoplankton bloom driven by the increase of nutrient concentration in the euphotic layer. While the importance of mesoscale eddies in physical and biological processes has been recognized, above cited literature shows that contrasting results exist regarding the role of the anticyclonic warm core eddies in the upper ocean ecosystem and their role in the annual cycle of phytoplankton biomass and community structure. A better understanding of the influence of the mixed-layer depth on biological activity in the GoM is clearly needed. The project target is to understand, from observational and numerical approaches, how physical transport mechanisms, (turbulent) winter convection and (advective) eddy-induced Ekman pumping, influence nutrient, dissolved organic carbon (DOC), glider-inferred particulate organic carbon (POC), and dissolved inorganic carbon (DIC) fluxes; phytoplankton biomass and community structure, and ultimately how are they linked in the context of the *biological carbon pump*. A new report based on 25-years (1993-2017) of daily satellite data (Delgado et al., 2019) shows three main aspects of physical-biogeochemical interactions in the Gulf of Mexico: 1) The intrusion of the subtropical underwater (SUW) by LC- LCEs extends further into the western GoM than was previously known; 2) Chl-a concentrations respond to the dynamics inside the GoM and are influenced by the LC anticyclonic and cyclonic eddies and 3) Since 2002, near surface Chl-a concentrations over bathymetry deeper than 250 m have decreased, and GoM surface waters may be turning more oligotrophic than in the previous decade. This work emphasizes the role of climatology in determining GoM circulation and its productivity and suggests that further climatologically- induced changes are probably imminent. It explores the ability of the LCEs to export carbon into the deep ocean, in response to increasingly frequent extreme wind events (tropical storms and cold-fronts) in the Gulf of Mexico. The project is led by Dr. Enrick Pallas with institution involved as Centro de Investigacion Cientifica de Educacion Superior de Ensenada (CICESE) and the University of Baja California.

#### **A cruise to the heart of the ETNP oxygen minimum zone off Acapulco/Mexico**

- A cruise is scheduled for June 2022 to the center of the Eastern Tropical North Pacific Oxygen Minimum Zone (ETNP-OMZ) with a working transect of 400 km WSW from the coast of Acapulco, using the Mexican research vessel 'Alpha Helix' stationed in Ensenada Baja California. The cruise, including ship time is financed by an 'individual' grant from the Mexican CONACYT. We will work seven 24 hour stations with the aim to do 'everything' from primary production and detailed near surface profiling, to routine casts down to 2000 m. The latter will provide hydrographic data and samples for a range of data from particulate matter (C, N, P), organic chemistry to inorganic carbon and nutrients. There will be a limited number of samples for eDNA, prokaryote 16S, cell counts and the intent to measure respiration rates. We are not trying to focus on one of the current questions in oxygen deficit waters, e.g. the nitrogen cycle, but rather take a holistic view as far as that is possible with such a short cruise. Our cruise effort will be greatly helped by the participation and sample processing of Mexican, French, American, and German interested of oceanographic oxygen minimum zone. The region that we target has seen few oceanographic observations in the last decades even though it is at the heart of the ETNP-OMZ which by any measure is the most extensive of the global OMZs. This region has also been deprived of the benefit of ARGOs deployments. So, with good fortune they will manage to avoid hurricanes (June!) and find interesting information that will help to come closer to the understanding of the formation and maintenance of the ETNP\_OMZ. And with some luck the obtained data will provide the arguments for a more extensive cruise in the future. The project is led by Dr. Helmut Maske from Cicese, Mexico.

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

XIII International Carbon Symposium in Mexico Hosted virtually from Xalapa, Veracruz 26 - 28 October 2022 Main theme: Ecosystem Restoration and Conservation for Climate Change Mitigation.

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

**2021 Seatrec FIND Project Proposed Science Mission**

The proposed mission of a frequently profiling ( $\leq 1$  cycle per day) float over a prolonged period (years), sustained by energy harvesting technology, presents a unique opportunity to make scientific discoveries. Most floats profile on the 10-day Argo mission and those that profile more frequently generally carry only physical (and occasionally biooptical) sensors and expend their batteries more rapidly, limiting their science potential. To take advantage of the FIND Project opportunity, we propose to add chemical and bio-optical sensors (costs covered by NOAA) to the NavisSL1 float to study primary production, carbon export, air-sea fluxes of oxygen and carbon dioxide gas, as well as modulation of ocean heat content and physical and biogeochemical transformations driven by ubiquitous mesoscale structures in the Gulf of Mexico (GOM). While some of these processes have been evaluated individually on rapidly profiling floats in other regions, capturing these processes simultaneously and over multiple years will provide new information in a poorly observed region that is characterized by economically important fisheries, extensive physical and biogeochemical gradients, and extreme weather systems. The GOM exhibits a year-round  $>10$  °C temperature gradient within the upper 1000m and is home to one of NOAA's BGC Argo pilot arrays. We propose to deploy the Navis-SL1 float in the southwestern deep basin of the GOM during a fall 2022, Mexican-lead research cruise. This float would complement four NOAA BGC-Apex floats deployed in US GOM waters during 2021. The Navis-SL1 float deployment will be coordinated with Mexican seaglider fleet deployments and the resulting data will be assimilated into ongoing US and Mexico-led regional modelling efforts.

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

Mexico as a part of the NorthAmerica's HuB is also part of the Ocean Acidification Research for Sustainability (OARS) - Providing society with the observational and scientific evidence needed to sustainably identify, monitor, mitigate and adapt to ocean acidification; from local to global scales

OARS will foster the development of the science of ocean acidification including the impacts on marine life and sustainability of marine ecosystems in estuarine-coastal-open ocean environments. As part of the EC we will participate in the organization during this year direct with the Outcome "3" dedicated to codesign and implement observation and research to address the threat of ocean acidification, and 4) communication and delivery of the outputs to policy makers and communities.

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

See the above

**Comments**