Poster Presentation
Theme 3.1: Biogeochemical Processes - Processes Understanding and Human Impacts
Keywords: ocean, carbonate system, climatologies, neural network

Annual and monthly climatologies of seawater CO2 chemistry variables: A neural network approach.

Broullón Durán, Daniel* (1); Fernández Pérez, Fiz (1); Velo Lanchas, Antón (1); Olsen, Are (2); Key, Robert M (3); van Heuven, Steven (4); Lauvset, Siv K (2,5); Lin, Xiaohua (3); Schirnick, Carsten (6); Kozyr, Alex (7); Tanhua, Toste (6); Hoppema, Mario (8); Jutterström, Sara (9); Steinfeldt, Reiner (10); Jeansson, Emil (5); Ishii, Masao (11); Suzuki, Toru (12)
1: Instituto de Investigaciones Marinas (CSIC), Vigo, Spain; 2: Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Bergen, Norway; 3: Atmospheric and Oceanic Sciences, Princeton University, USA; 4: Royal Netherlands Institute for Sea Research (NIOZ) and Utrecht University, The Netherlands; 5: Uni Research Climate and Bjerknes Centre for Climate Research, Bergen, Norway; 6: GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany; 7: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, U.S.A.; 8: Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany; 9: IVL Swedish Environmental Research Institute, Göteborg, Sweden; 10: University of Bremen, Institute of Environmental Physics, Bremen, Germany; 11: Oceanography and Geochemistry Research Department, Meteorological Research Institute, Japan Meteorological Agency, Tsukuba, Japan; 12: Marine Information Research Center, Japan Hydrographic Association, Tokyo, Japan

For decades, the anthropogenic modification of the carbon cycle has been widely studied. More recently, ocean acidification studies have increased significantly. Establishing robust climatologies of seawater CO_2 chemistry variables and building models are a key point for a better understanding of the associated processes. The availability and quality of data is crucial for the evaluation of climate models and, consequently, to improve their predictions.
Version 2 of the Global Ocean Data Analysis Project (GLODAPv2) is an internally consistent data product composed of data from 724 scientific cruises covering the entire global ocean. Among others, it contains seawater CO_2 chemistry variables such as total alkalinity (AT), total dissolved inorganic carbon (TCO_2) and pH. This sparse dataset has been subjected to extensive quality control and different interpolation techniques have been applied to extend the data coverage on a homogeneous grid (Lauvset et al. 2016). We propose a novel neural network approach to generate annual and monthly climatologies of AT, TCO_2, pH and both calcite and aragonite saturation state from the GLODAPv2 dataset for the preindustrial and current periods. These climatologies are fitted to the World Ocean Atlas 2013 version 2 (WOA13v2) grid. WOA13v2 is a set of objectively analyzed (1° grid) climatological fields of different oceanographic variables (but not CO_2 system) at standard depth levels for annual, seasonal, and monthly compositing periods for the World Ocean.
A feed-forward neural network was chosen in a multi-layer architecture, which allows linear and non-linear variability to be assimilated by the network. The proposed configuration is able to approximate most functions arbitrarily well (Hagan et al., 2014). We have tested different neural network designs and sizes to obtain the minimum error. For that, the number of neurons in the network was varied and different training techniques were used. The input variables introduced in the network, which must be related to AT and TCO2 variability, were latitude, longitude, depth, potential temperature, phosphate, nitrate, silicate, year, month and atmospheric pCO_2. First, the network was trained with GLODAPv2 data and then AT and TCO_2 fields were derived from WOA13v2 data. Saturation states and pH were computed from these two variables.
The monthly pre-industrial climatology will be generated by eliminating anthropogenic carbon from the ocean.

Poster Session (see poster session schedule)