Research project objective

The aim of the project is determine, that the air-sea CO_2 fluxes depends to a large extent from difference in partial pressure of CO_2 (pCO_2) in seawater and that overlying air. Proving the objective requires estimate the distribution of partial pressure (pCO_2) depending on Sea Surface Temperature, Sea Surface Salinity (SSS) and biological activity from unevenly spread data, and analysis the net air-sea flux of CO_2 in the exchange layer. Monthly, seasonal and interannual analysis will be carry out for 5-year (2013-2017) with appointment of scenario of future changes by using two statistical method and one mathematical model od artificial neural networks.

Description of the basic research

The project will be implemented using data from available dataset, which will be analyzed by method of correlation and regression, and also until now almost unused in this type of research: mathematical model of artificial neural networks – e.g. self-organizing map (SOM).

The study area will be Arctic Ocean, mostly Norwegian Seas and Greenland Seas, which are characterized be the biggest sink for atmospheric CO_2.

Archives, from which data will be conducted are: SOCAT (Surface Ocean CO_2 Atlas) - fCO_2 data given from *in situ*, ESA/GlobWave Altimeter – wind speed, SOCOM (Surface Ocean pCO_2 Mapping intercomparison) – pCO_2, OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis) and ESA/ARC/(A)ATSR (Global Monthly Sea Surface) as well as NCEP/NCAR Reanalysis Project – Sea Surface Temperature, GlobColour GSM – biological activity, ESA/SMOS (Soil Moisture and Ocean Salinity) – Sea Surface Salinity. In analyses will be used LI-COR 7550 A connected with ultrasonic anemometer TSI 3340 to measure fluxes of carbon dioxide in near boundary layer. Data from there will be gathered from archives of Air-Sea Interaction Department of Institute of Oceanology Polish Academy of Sciences and during AREX cruise in 2017.

The aimed of the analysis will be finding the relation between parameters influencing directly and indirectly on air-sea CO_2 fluxes in the Arctic, and testing in this research new method, which is an artificial neural network.

Statistical models will be conducted in order to check integration of the pCO_2 distribution with temperature, salinity and biological activity as well as depicting strength of the association between $\Delta\, pCO_2$, wind speed and air-sea CO_2 fluxes.

Motivation

One of the main questions posed by scientists during the analyzes, are: how pCO_2 in water change due to changes pCO_2 in atmosphere. Research conducted by Schuster et al. (2009) have shown decrease CO_2 fluxes into the ocean, while Rödenbeck (2005) have shown an inverse relationship. While it is know that at low latitudes those changes are correlated, for changes in higher latitudes scientist are not sure that pCO_2 in water increase/decrease, slower growth, not at all increase with pCO_2 in atmosphere (Lèfèvre et al., 2005).

As a results of the growing concentrations of GHG emitted in relation to the human activity during industrial age, the average air temperature increase about 0.8^{o} C and the Sea Surface Temperature about 0.11^{o} C. Polar regions, including the Arctic, are the most exposed to fluctuations of the temperature (the temperature increase even 3-times faster than the average for the whole planet) which causes quicker melting of sea ice and thus increase the area of open water in the Arctic and so enhancing the potential for the oceanic uptake of CO_2 from atmosphere. Current researches show that the size of the absorbed carbon dioxide through oceans amounts to 1.5-2.0 Pg C $year^{-1}$ (Pg = 10^{15}=1 Giga ton).

Parameters affecting the size and volume of the air-sea CO_2 fluxes are well recognized by now, but the biggest challenge is to give accurate grade of the influence each of the single factors at the air-sea fluxes. Existing of the five different parameterizations of the gas transfer velocity parameter (k), dependent on the wind speed, generating the size of air-sea fluxes, can provide the importance of this study.

Implementing of the model of artificial neural networks and comparing with statistical methods for Arctic Oceans, in order to check the effectiveness these methods in oceanographic study for unevenly divided observation, will be innovative.