Good morning everyone, My nam is Iwona Wrobel and I am PhD student at the Institute of Oceanology Polish Academy of Science. Today I want to show u my results from using FluxEngine software for calculating whitecaping coverage, momentum and air-sea CO2 fluxes in the NA and the EU. I made this work as a part of my PhD and OceanFlux GHG Project with my tutor Jacek Piskozub.

Short outline: at first background, motivation, then I will show u results from calculating momentum and whitecapp fluxes. We just start working with this data and parameterization for them so I am open for some useful advices during coffe break. Next I show results from calculting air-sea CO2 fluxes, which is major toppic of my presenation today. Then conclusion and future work.

So, we used FluxEngine toolbox created within OceanFlux GHG Project funded by European Space Agency which is right now open-source software toolbox for calculating air-sea exchange and data from all of those year are no update, but when we started work within this project we tested it and check correctness of the data. In our work we used sattelite data, like wind-wave from GlobWave Project and in situ data.

Wind speed in the North Atlantic and the European Arctic is background for all our results. As we can see average of wind speed in this region is 9-10 m/s and almost all year is higher than that, only during summer the wind is weaker.

Seasonal covering….. High uncertainty in the size of the net Arctic Ocean sink of CO2, shows a lack of coordinating in situ measurements and difficulties of logistical support, so potential alternative solutions lies in exploitin satellite data

We want to use this parameterization to estimate aerosol source fluxes and air bubble on gas flux. All of them were created using various effect and variables, what was already said at this conference. We choose 4 new and first one parameterizations to calculate whitecapp coverage fluxes. Here is the most popular figures, which we can already see. Mean wind speed in the NA is around 9-10 m/s so we can expect that Monahan and Sugihata parameterization are unrelevant for this region.

At first we calculated monthly fluxes of whitecape coverage in global scale, in the North Atlantic, European Arctic and West Spitsbergen. At the North Atlantic wind speed is higher that at the other region, so we expect the difference between the parameterizations, there larger than around other parts. Even if we cross Monahan parameterizations. Result from Goddijn-Murphy, Hwang and Sletten, Stramska and Petelski and Schwendeman and Thompson parameterization are close to each other, in absolute value, especially in summer, in every region.

We choose 5 different parameterization to calculate drag coefficient of momentum fluxes which depend on wind speed. All parameterizations were created for various conditions. The differences are not so big as earlier but as we can see that increasing of Cd at higher wind speed show that it dependenc of the varying sea state and how waves influencing on this.

There is a lot of uncertainty to estimate air-sea CO2 fluxes. Mostly because of the uncertainty in the process which influenc on the gas transfer velocity, like in the surfactants or rain. Last year during SOCAT meeting, Wanninkhof, Daivd Ho and Phil Nightingale found that all three quadratic parameterizations are interchangable.

In my articles one of the most important results was calculating corelation between air-sea CO2 fluxes and gas transfer velocity, partial pressure of CO2 etc. Fluxes are strongly correlation with gas tranfsfer than with pCO2 in seawater. We also calculate fluxes for all the parameterizations. The resulats using cubic parameterizations are higher by up to 30% for WMcG and up to 50% for McG in global scale, and around 28% in Arctic and 45% in North Atlantic, compare to N2000. Quadratic parameterizations results in a net air-sea Co2 fluxes in 4-5% for Ho and 3-4% fo Wanninkhof, comapre to N2000. Annual net air-sea Co2 sink depending on formula used, varies from -0.3 PgC fo N2000 to -0.56 Pg C for McG.

During the processing of the data, we have noticed that the NA resulats for different k formulas are similar that global ones. This results was interesting vecause NA winds are stronger than the global averages ones. Was the flux result similarity caused by the fact that the parameterization were tuned to the NA area where many of the early measuring CO2 fugacities were performed. It is not quait true. We found two reason of that. The first one is fact that most of the k functions intersect close to 9 m/s, the typical NA wind speeds. The wind speed of the intersection has to be higher than global wond speed averages because discrepancies between different parameterizations increase with wind speed. The NA region seems to have by chance just the right average wind seed to make at the parameterizations resulting in simmilar annual fluxes.

However there is a second reason for smaller inter-parameterizations discrepancies in the NA than many other ocean basin. Thw NA CO2 fluxes are downward in every month. In many regions of the world, the direction of the flux changes beteen the winter and summer, with wind speed much stronger in the cold season. We show, using the actual formulas that in such a case the differencies between the parameterizations partly cancel out which is not the case when the flux never changes its direction.

We also compare air-sea CO2 fluxes climatologies from Takahashi with the re-analysed SOCAT version 1.5 and 2.0. In the case of NA study area, althoug the monthly values show large difference but in the Arctic they are opposite to each other, due to extrapolation.

With increasing of gas transfer velocity, air-sea CO2 fluxes became more negative, as a resulat of higher values of wind speed, especially in winter. In summer fluxes are weaker when values of wind speed is smaller, but most due to increase of pCO2 in seawater, than wind speed (sea-ice melting, temeprature of water rise, marine biological activity increas)

The fluxes are negative because of their relative with low pCO2. We can see now, that pCO2 in seawater increase an with this fluxes became positive, whats mean that more CO2 stay in atmosphere.

Spatial resolution of air-sea CO2 fluxes. The area, as a whoe, is a sink of CO2, but in some regions, close to North Atlantic Drivt and East Greenland Current is net source. At this maps we can see variability affects by physical process and biological activity. For example, the areas at the south became CO2 source in summer and autumn due to sea-water changes.

Difference in pCO2 between August and February indicate that inside Arcitc Fiords and near the lands, Arctic water are place where physicall process exceeds biological CO2 uptake due to run off from lands but in the open water of the Arcitc Ocean, the relataions is