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Is remote sensing of the surfactant effect on gas transfer velocity possible?

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The air-sea gas flux is proportional to the difference of partial pressure between the sea-water and the overlying atmosphere multiplied by gas transfer velocity *k*, a measure of the effectiveness of the gas exchange. Because wind is the source of turbulence making the gas exchange more effective, *k* is usually parameterized by wind speed. Unfortunately, measured values of gas transfer velocity at a given wind speed have a large spread in values. Surfactants have been long suspected as the main reason of this variability but few measurements of gas exchange and surfactants have been performed at open sea simultaneously and therefore their results were inconclusive. Only recently, it has been shown that surfactants may decrease the CO_2 air-sea exchange by up to 50%. However the labour intensive methods used for surfactant study make it impossible to collect enough data to map the surfactant coverage or even create a gas transfer velocity parameterization involving a measure of surfactant activity. This is why we propose to use optical fluorescence as a proxy of surfactant activity.

Previous research done by our group showed that fluorescence parameters allow estimation the surfactant enrichment of the surface microlayer, as well as types and origin of fluorescent organic matter involved. We plan to measure, from a research ship, all the variables needed for calculation of gas transfer velocity *k* (namely CO_2 partial pressure both in water and in air as well as vertical flux of this trace gas) and to use mathematical optimization methods to look for a parameterization involving wind speed and one of the fluorescence parameters which will minimize the residual *k* variability. Although our research will still involve water sampling and laboratory fluorescence measurements, the knowledge of which absorption and fluorescence emission bands are the best proxy for surfactant activity may allow to create remote sensing products (fluorescence lidars) allowing continuous measurements of surfactant activity at least from the ship board, if not from aircraft and satellites. The improved parameterization of the CO_2 gas transfer velocity will allow better constraining of basin-wide and global air-sea fluxes, an important component of global carbon budget.

If an improved gas transfer velocity parametrization based on surfactant fluorescence spectrum in concert with a turbulence proxy (wind) were to be found, a tantalizing possibility arises of a remote sensing estimation of k. Namely a UV lidar can both excite and measure the fluorescence band identified as proxy of the surfactant effect on the gas transfer velocity. Depending on the wavelength bands needed to be utilized, the effect could be measured from a moving ship (already an improvements on methods needing sampling), an aircraft or possibly even a satellite. We intend to pursue this idea in cruises to both the Baltic and the North Atlantic, possibly in cooperation with other air-sea interaction groups (this presentation is in part an invitation to cooperation).