Objective of the Project
The main objective of the project is to perform comparative analysis of three independent measurement methods of marine aerosol flux in two different environments: in the southern Baltic Sea region and in the Norwegian, Arctic and Greenland Sea. The analysis will be performed using parametric functions fitted to the results of aerosol emission. These functions will depend from chosen meteorological and physical parameters, such as: particles size distribution, wind speed, wind friction velocity, surface water and air temperature, Reynolds number or sea state parameters.

Description of the basic research
The project will consist of two parts: experimental and analytic. During the first part, measurements on board research vessel Oceania will be carried. The analytic part will focus on processing gathered data, marine aerosol flux determination and comparative analysis. Aerosol is a colloid of fine solid particles or liquid droplets, suspended in the air or another gas. The project will focus on marygenic aerosol which means that emitted directly from sea surface. Unlike marine aerosol – the aerosol transported from the land and gained the marine feature.

The measuring platform will be the r/v Oceania. This scientific vessel is a three-mast schooner. It differs from other common research vessels in that the body of the ship has low influence on air flow. 32 meters high masts allow for aerosol concentration measurements on different heights. This is invaluable advantage for measurements in air-sea interaction area.

Measurements will be carried in two different environments. In the southern Baltic Sea and in so called European Arctic. The Baltic Sea is an inland brackish sea. It means it is characterized by much lower salinity than oceanic waters, and different sea state parameters (the mean wave period or significant wave height). Polar regions, on the other hand, are characterized by extremely clear air. Thanks to that fact, we are sure that measurements carried in this region are not disturbed by any human activity. An aerosol flux comparison using three independent methods in two different environments, will allow to present a mass exchange between the sea and the atmosphere in a new light.

To apply aerosol measurements several instruments have to be used. The three aerosol particle counters: Classical Scattering Aerosol Spectrometer Probe (PMS CASP-100HV), Laser Aerosol Spectrometer (TSI 3340), Condensation Particle Counter (TSI model 3771). These instruments use the laser light scattering on particles, which allows to measure the concentration of aerosol particles in the air volume. The PMS CASP-100HV counts in range from 0.5 μm to 47 μm In 37 size channels. The TSI 3340 works in range 0.09 μm to 7.5 μm in 99 channels. The third instrument gives total aerosol concentration in range 0.01 μm – 3 μm. Furthermore a gas analyser LI-COR 7550A connected with ultrasonic anemometer will be used. Both put together will allow to measure fluxes of carbon dioxide, water vapour, heat (sensible and latent) and momentum in near water boundary layer. Such parameters are called micrometeorological. The novelty in such measurements on board r/v Oceania will be the recording of ship movements on the sea and implementing a correction in micrometeorological measurements. To achieve this, the special accelerometer will be bought. It is essential to apply such correction in two of the measurements method.

In the analytic part of the project the gathered data will be processed, and aerosol fluxes will be calculated. Three methods will be used. Gradiental method (fluxes are calculated from aerosol concentration gradient determined by measurements on five heights). Eddy correlation method (flux is calculated from covariance between aerosol concentration and vertical component of wind speed. Covariance is a measure of how much two variables change together). The last method is inertial dissipation method. This method is based on a turbulence spectral analysis.

After fluxes calculation using three independent methodology it will be possible to conduct a flux parameterization. The result of such parameterization is called sea spray source function. Such function shows the relation between aerosol flux and chosen meteorological or physical parameters such as mentioned in the first paragraph. The most popular parameter is wind speed, measured 10 meters above medium sea level and particles size. It is necessary to perform such procedure because it allows to make a comparison between two different regions of measurement and also with the results of other authors.

Motivation
Marine aerosol emission and transport research have a significant impact on many branches of geophysical sciences, such as cloud physics, atmospheric optics, environmental pollution processes analysis and air-sea interaction processes. Without good understanding of air-sea mass exchange, the properly modeling of weather phenomena will be limited. Hence it is important for properly working weather forecasts.

As sea salt emission from sea surface is well recognized, the biggest challenge is to give accurate parameterization of flux values in turbulent boundary layer over the sea surface. This is evident since in the recent publications on these subject estimations of flux values differ even by a few orders of magnitude. That is why making a new parameterization using the sea spray source function from environmental parameters is challenging.

New to this kind of research are simultaneous measurements of the micrometeorological parameters in the near water boundary layer, such as friction velocity and turbulent fluxes. All in situ measurements of marygenic aerosol emission were conducted in open ocean region. So far there is very little research devoted to measurements of aerosol emission in the inland seas. Comparing results of measurements in the Baltic Sea region and European Arctic is another novelty. Actions proposed in this Project will contribute to a better understanding of the phenomena responsible for the air-sea interactions.