Measurements and determination of the marine coarse aerosol fluxes in near marine boundary layer.

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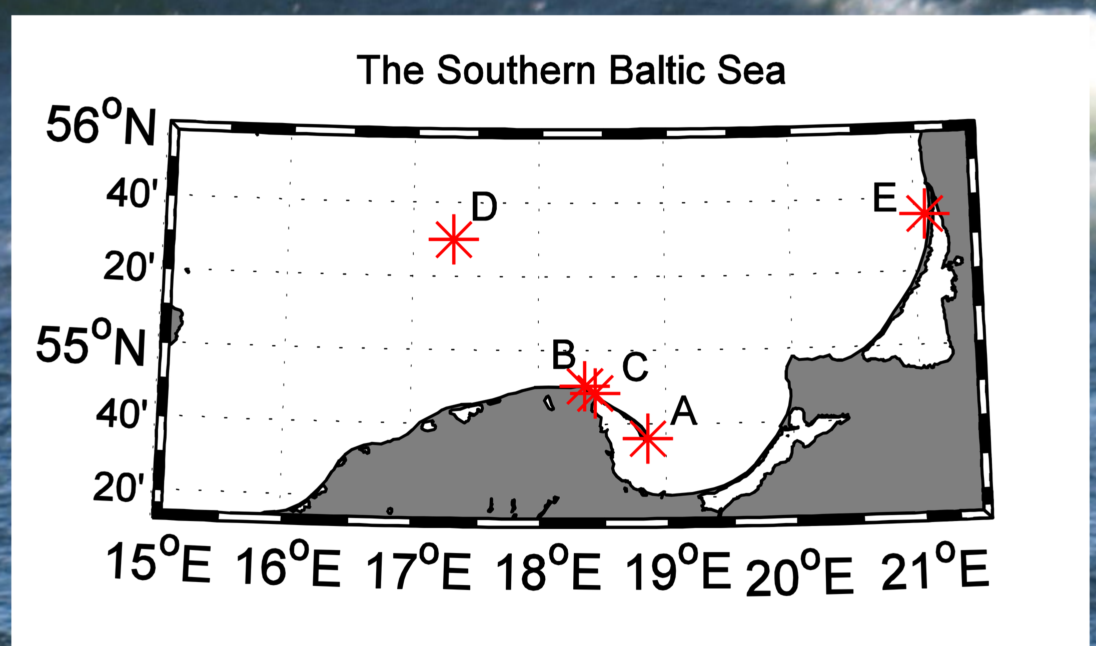
Abstract

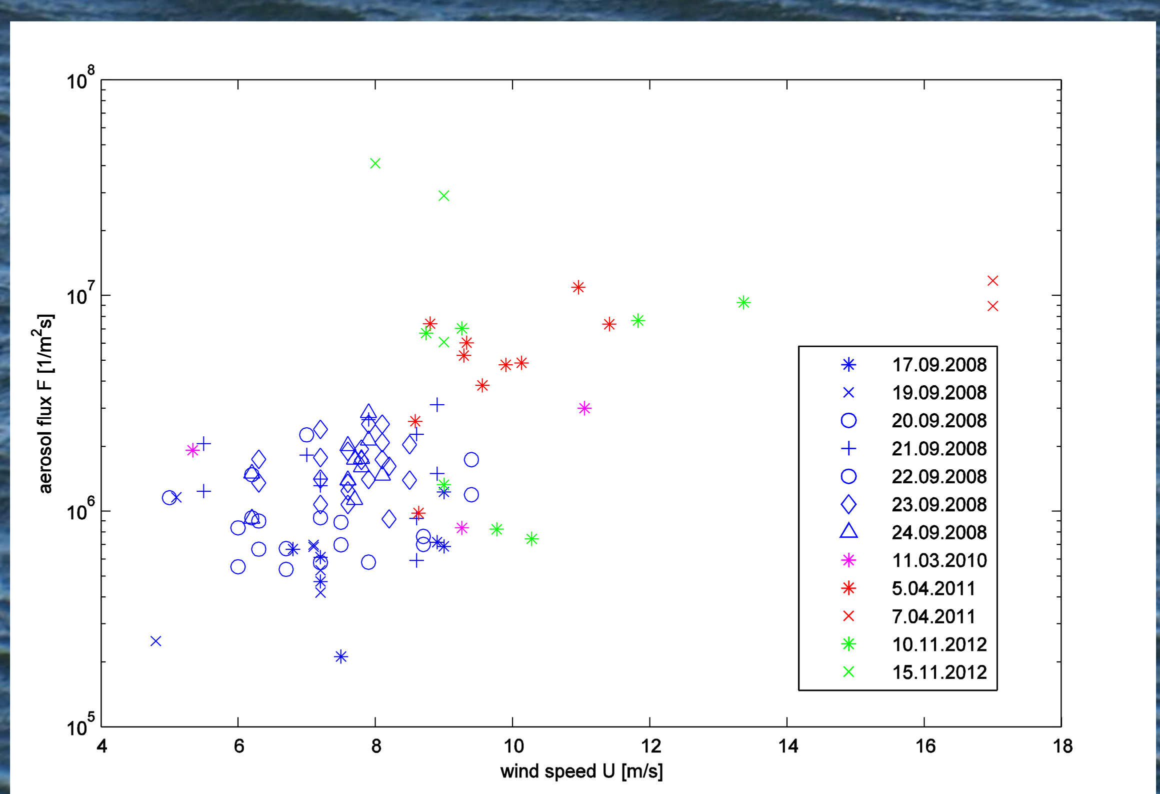
Studies of production and transport of aerosol over the sea are very important for many areas of knowledge. Marine aerosol emitted from the sea surface helps to clean the boundary layer from other aerosol particles. The emitted droplets do not dry out in the highly humid surface layer air and because of their sizes most of them are deposited quickly at the sea surface. Therefore, marine aerosol has many features of rain i.e. the deposition in the marine boundary layer in high wind events is controlled not only by the "dry" processes but also by the "wet" scavenging.

While many cruises conducted on board S/Y Oceania, we collected many data which were used to calculate sea salt source function over the Baltic Sea. Our cruises held betwen 2008 and 2012. Measurements were carried out using gradient method. For this method we used Laser Particle Counter (PMS model CSASP-100_HV) placed on one oft the mast of S/Y Oceania. Measurements were performed on five different levels around sea level: 8, 11, 14, 17 and 20 meters.

Based on the averaged vertical concentration, profiles were calculated, using Monin - Obuchow theory, vertical sea spray fluxes in the near water layer. Based on fluxes calculated from vertical concentration profiles was calculated sea spray generation function (SSGF) over the Baltic Sea. This function gives emission for different particle size, depending on environmental parameters. Emission of sea spray depends of the size of energy lost by the wind waves in process of collapse.



Measurements were leading in five different points on the Baltic Sea. A: In Hel Peninsula region, B: near Rozewie Cape, C: near Wladyslawowo City, D: in the Southern Middle Bank region, E: near Kláipeda Coast.



Overall results of upward fluxes measurements. Each symbol presents different day of measurement.

Results

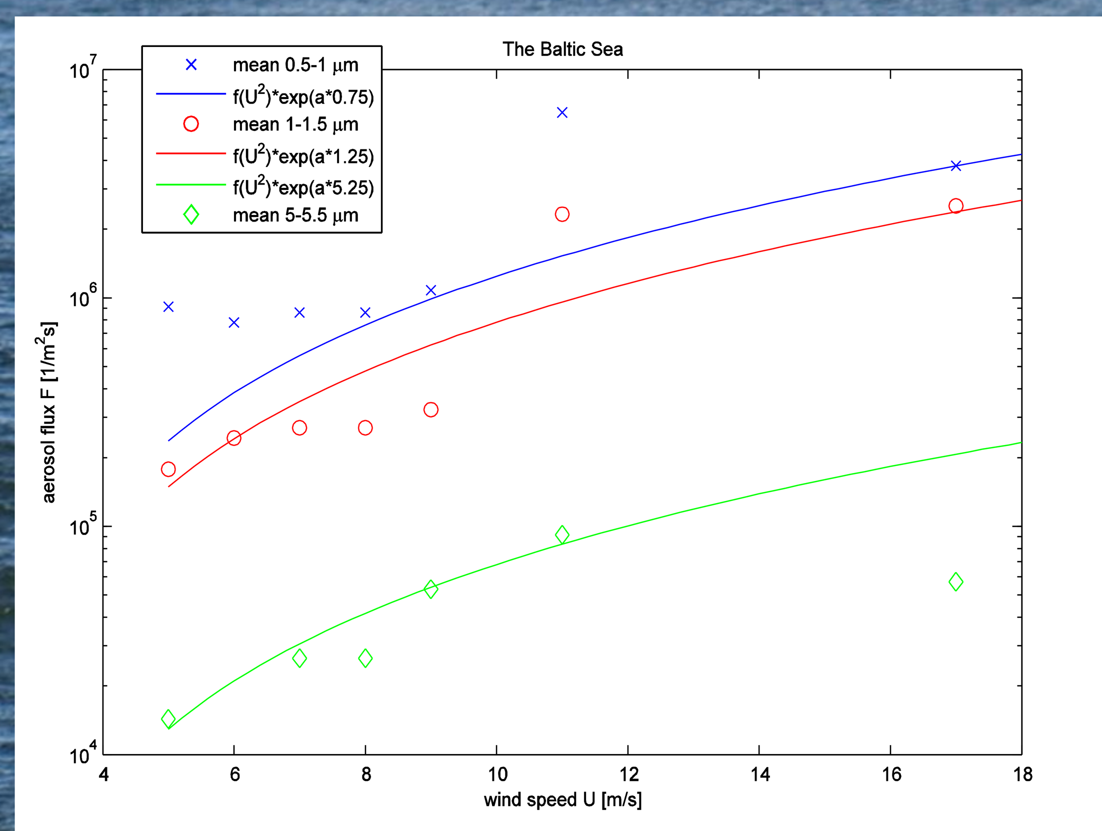
Factor a does not depend on the wind speed. In further calculations the average value of this factor was used, so $a=0.62$. It is possible to notice increasing value of factor b with wind speed. It is possible to approximate this by linear function but scatter of results is high. Data with total fluxes of aerosol particles are statistically more reliable than each flux for one diameter range separately. Instead of appointing a function $b(U)$ the function fitted in first fitting (AU^2+B) was used:

$$AU^2+B=\int_{r_{min}}^{\infty}\exp(-a2r)\,dr$$

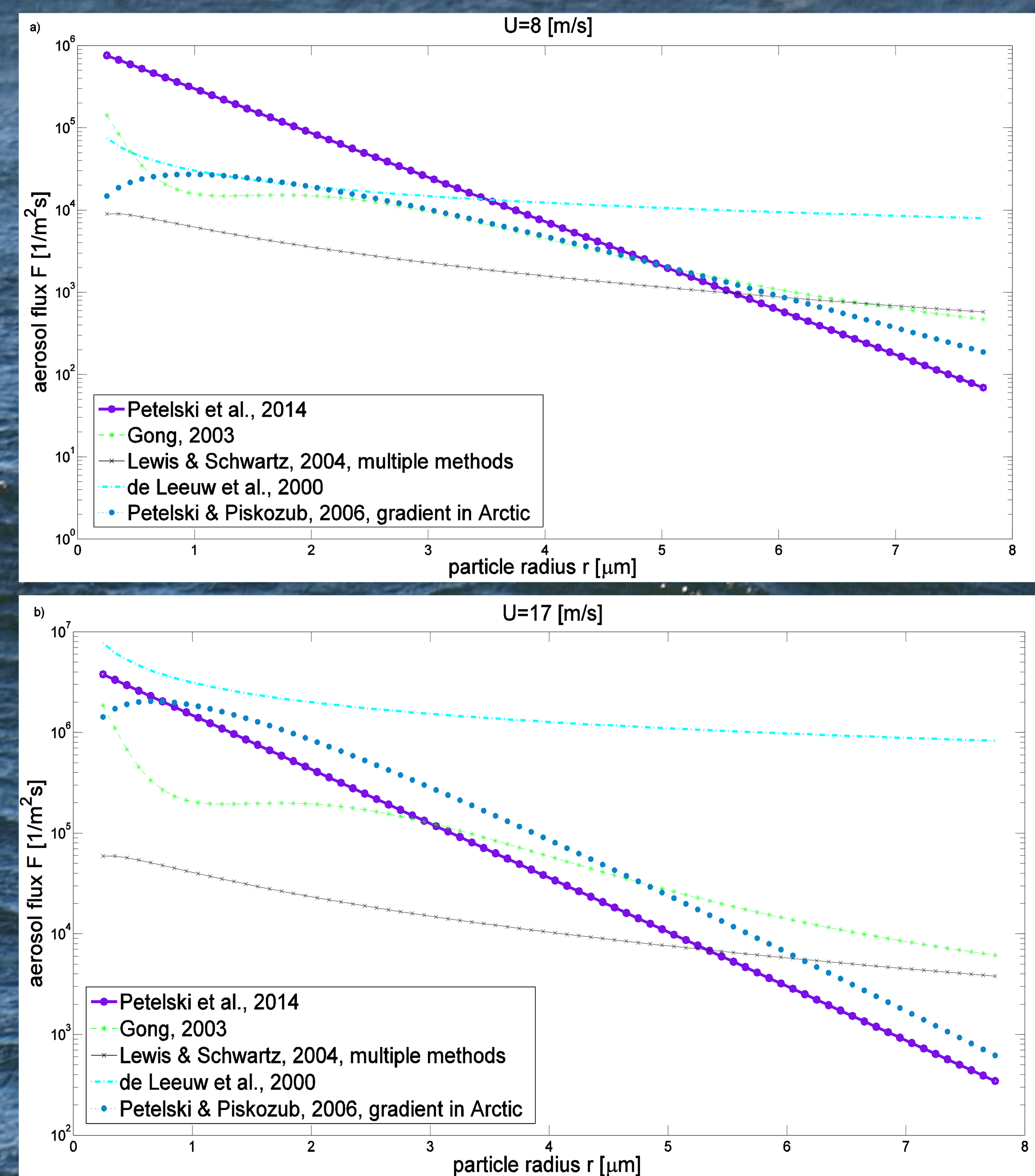
$$F(u,r)=F_1(u)F_2(r)=\frac{-0.4}{2a\exp(a2r_{min})}(Au^2+B)\exp(a2r)$$

Where $r_{min}=0.25$ µm is the smallest aerosol radius which is possible to measure with the instrument.
Function is true for $u \geq 3$ m/s.
Finally we propose SGF formula:

$$F(U,r)=(1.83\times10^4\times U^2-1.35\times10^4)\exp(-1.24\times r)$$



Final result of SSGF fitting. Lines presents predicted value of SSF for each aerosol diameter. Symbols presents average flux value from measurements.



Comparison with functions of other authors.

Methodology

Generation function $F(U,r)$ was presented as a product of two functions $F_1(U)$ and $F_2(r)$.

$$F(U,r)=F_1(U)F_2(r)$$

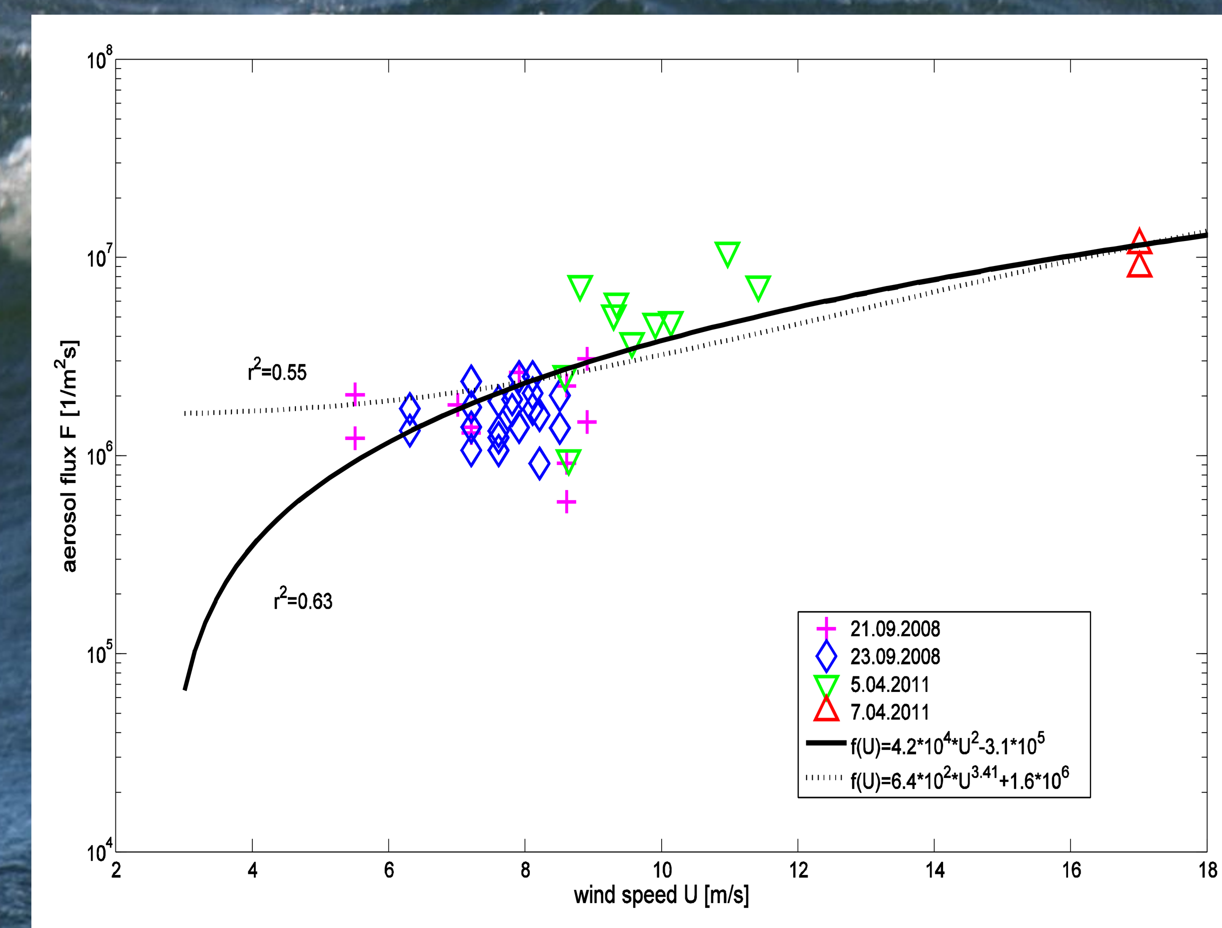
$F_1(U)$ was found by fitting least square method with function form AU^2+B to total upward fluxes data.

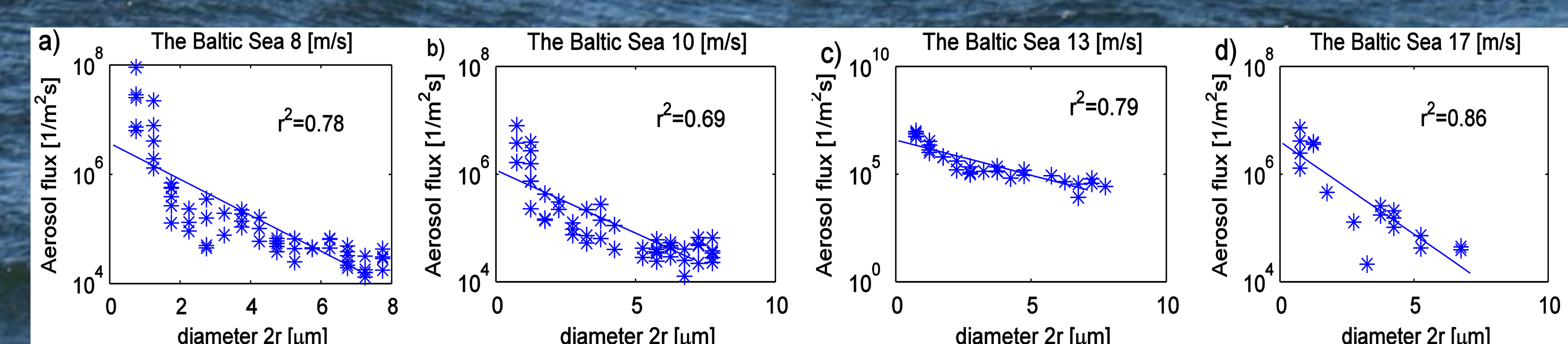
To designate $F_2(r)$ function, method from Petelski and Piskozub [2006] was used.

Namely fluxes data separated on series depend on wind speed. Each series from range U-0.5 m/s, U+0.5 m/s was assigned to integer wind speed U class. For each class, to find $F(r)$ equation, the linear approximation in the $ln(r)$, r area was used. For every wind speed was obtained function:

$$\ln(F)=a2r+b$$

where $F(r)=\exp(a2r+b)$.
Factors a and b were used in further calculations.





Exemplar wind classes of fluxes from diameter with linear approximation.

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