Studies of vertical coarse aerosol fluxes in the boundary layer over the Baltic Sea*

doi:10.5697/oc.56-4.697
OCEANOLOGIA, 56 (4), 2014.
pp. 697–710.

KEYWORDS
Sea spray aerosol
Coarse aerosol fluxes
Air-sea interaction
Marine boundary layer
Aerosol concentration gradient

Tomasz Petelski[1]
Piotr Markuszewski[1,⋆]
Przemysław Makuch[1]
Andrzej Jankowski[1]
Anna Rozwadowska[2]

[1] Physical Oceanography Department,
Institute of Oceanology,
Polish Academy of Sciences,
Powstańców Warszawy 55, 81–712 Sopot, Poland;

e-mail: pmarkusz@iopan.gda.pl

⋆corresponding author

e-mail: petelski@iopan.gda.pl

e-mail: makuch@iopan.gda.pl

e-mail: jankowsk@iopan.gda.pl

[2] Marine Physics Department,
Institute of Oceanology,
Polish Academy of Sciences,
Powstańców Warszawy 55, 81–712 Sopot, Poland;

e-mail: ania@iopan.gda.pl

Received 5 March 2014, revised 7 May 2014, accepted 14 May 2014.

* This work was supported through the National Science Centre grant NN 306315536; support for this study was also provided by the project 'Satellite Monitoring of the Baltic Sea Environment – SatBałtyk' funded by European Union through European Regional Development Fund contract No. POIG 01.01.02-22-011/09.

Abstract

The results of studies of the vertical gradient of aerosol concentration measurements made during cruises of r/v 'Oceania' between 2008 and 2012 are presented. Using the results from those experiments, sea spray emission fluxes were calculated for all particles of sizes in the range from 0.5 μm to 8 μm, as well as for particles of sizes from fifteen channels of 0.5 μm width. The information obtained was further used to calculate the Sea Salt Generation Function (SSGF) for the Baltic Sea depending on the wind speed and the aerosol size distribution.

1. Introduction

The latest reports on Sea Spray Aerosols (SSA) indicate that the level of knowledge in this field is still insufficient (Vignati et al. 2010, de Leeuw et al. 2011, Tsigaridis et al. 2013). New findings have been reported practically every year: e.g. the influence of the organic fraction on SSA has been suggested in recent years (Modini et al. 2010, Westervelt et al. 2012). The development of computer models of the global climate requires more detailed information about the importance of SSA in these models. One of the parameters that describes the generation of SSA in the atmosphere is the Sea Salt Generation Function (SSGF).

The dependence of SSA on parameters such as wind speed or particle radius has been studied by many authors (Monahan 1988, Smith et al. 1993, Andreas 1998, Zieliński & Zieliński 2002, Gong 2003, Zieliński 2004, Petelski & Piskozub 2006, Keene et al. 2007, Kudryavtsev & Makin 2009, Long et al. 2011, Norris et al. 2012). One of the methods for investigating aerosol fluxes involves the Gradient Method (GM) (Petelski 2003, Petelski 2005, Petelski et al. 2005, Petelski & Piskozub 2006). Very little research has been done on the topic of SSGF from the surface of the Baltic Sea (Chomka & Petelski 1996, Chomka & Petelski 1997, Massel 2007) and thus any new insights based on aerosol studies in this region are of great importance to global studies.

A new approach to the SSGF was suggested by Andreas et al. (2010). On the basis of a reliable estimate of the SSGF, they calculated the effective production rate for droplets with initial radii from 5 to 300 μm. Most publications associated SSA flux with wind speed or friction velocity. Later, Veron et al. (2012) described a sea spray concentration function for spume droplets under high wind speed conditions. This work suggests that supra-millimetre droplets are more important than had been earlier predicted. What is more, this work describes the observation of liquid sheets forming at the crests of breaking waves, which is an earlier unreported SSA generation mechanism. Another interesting parameterisation was proposed