Annual Report for the year 2013:

SOLAS Sweden

compiled by:__Katarina Abrahamsson_____

Notes:
Reporting Period is January 2013 – December 2013
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Influence of coastal upwelling on the air-sea gas exchange of CO_2 in a Baltic Sea Basin

During coastal upwelling cold water from the ocean interior with high CO_2 concentration is brought up to the surface, allowing this water to interact with the atmosphere. This sets the stage for events with potentially altered sea-air CO_2 fluxes. Upwelling events off the east coast of Gotland in the Baltic Sea were analyzed to assess the impact of upwelling on the air-sea exchange of CO_2. For each event, the observed pCO_2 were found to be a function of sea-surface temperature (SST) in the upwelling area, which allowed satellite observations of SST to form a proxy for surface water pCO_2. A bulk formula was then used to estimate the air-sea CO_2 flux during the upwelling events. The results show that the CO_2 fluxes in the study area are highly influenced by the upwelling. A rough estimate indicates that it may also be of significant importance for the average annual CO_2 flux from the Baltic Sea. Including upwelling possibly decreases the Baltic Sea annual average uptake by up to 25%.

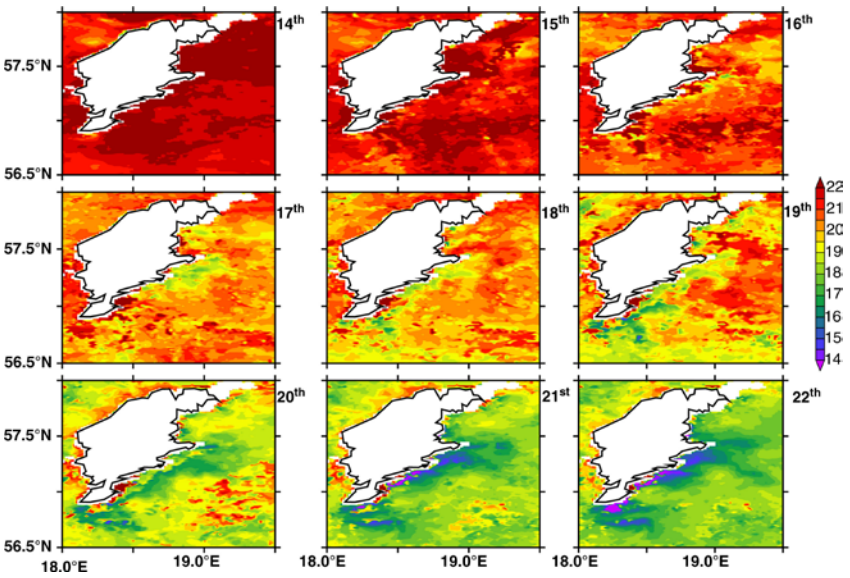

***Figure**: Daily averaged satellite images of sea-surface temperature (SST) (8C) around the island of Gotland in the Baltic Sea during 14-22 July 2005 (Period 1). The colours represent the SST value described by the colour bar (from Norman et al., 2013).*

Karl, M., Leck, C., Coz, E. and Heintzenberg, J. (2013) Marine nanogels as a source of atmospheric nanoparticles in the high Arctic, Geophys. Res. Lett., 40: 3738–3743, doi:10.1002/grl.50661.

Statistical analysis of the aerosol size distribution data recorded in the years 1991, 1996, 2001, and 2008 classified 75 nanoparticle events covering 17% of the observed time period as nanogel-type events, characterized by the spontaneous appearance of several distinct size bands below 200 nm diameter.

To explain the high Arctic nucleation events a novel route to atmospheric nano-particles that appears to be operative in the high Arctic is suggested. It involves the injection of marine granular nanogels into the air from evaporating fog and cloud droplets, and is supported by observations [*2*].

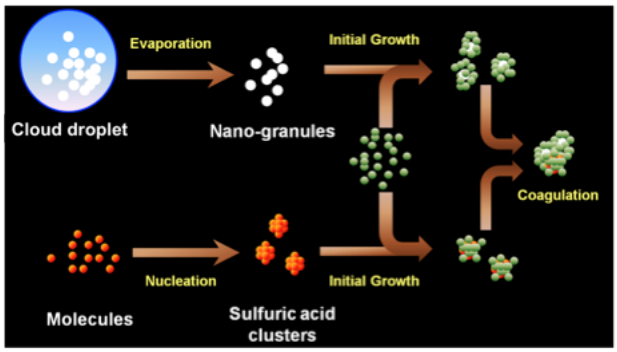

***Figure**: Schematic outline of the suggested route to new atmospheric nano-particles, involving sulfuric acid (orange), organic vapor (green), and marine nano-granules (white): 1) release of nano-granules from evaporating fog/cloud droplets, 2) nucleation of H_2SO_4 molecules to form stable clusters, 3) condensation of low-volatile vapors onto both nano-granules and H_2SO_4 clusters, 4) coagulation of nano-granules and H_2SO_4 clusters to form >3 nm diameter sized particles.*

2. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities, links with policy makers or socio-economics circles, etc.)

* Baltic Earth (Earth System Science in the Baltic Sea region), ongoing development of the successor program of BALTEX (Baltic Sea Experiment). International scientific network focusing Earth System Science in the Baltic Sea region (http://www.baltex-research.eu/balticearth/).
* DAMOCLES: Several Annual Meetings ending with the “The Arctic Climate system; its present status, future evolution and potential impacts” symposium November 2009 in Brussels, Belgium, and the final DAMOCLES Science Symposium May 2010 in Tromsö, Norway.
* WCRP/WGNE & WWRP: Invited presentation at the Joint Workshop on Physics in Weather and Climate Models, at California Institute of Technology in March 2012 in Pasadena, California, USA.
* IASC: International Arctic Science Committee’s Atmospheric Working Group Workshop on Arctic Observing September 2011, in Postdam, Germany.
* WCRP/GEWEX & WWRP: Invited lectures at both the European centre for Medium Range Weather Forecast (ECMWF) and GEWEX Atmospheric Boundary Layer Study (GABLS) Joint workshop on Stable Boundary Layers and Surface Interaction, November 2011, and in WWRP Polar Prediction Workshop in June 2013, both in Reading, UK.
* IASC: Several workshops and planning meetings for the MOSAiC multidisciplinary experiment involving an icebreaker borene icedrift at least one year across the Arctic.

3. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

SSEESS-SOLAS Workshop The Royal Swedish Academy of Sciences Stockholm, Sweden, November, 2013
Research expedition AWECS (ANT 29/6 and 7) to the Weddell Sea in Austral winter with R/V Polarstern

4. Human dimensions (outreach, capacity building, public engagement etc)

Book: Ocean-Atmosphere Interactions of Gases and Particles, **Eds Liss, Johnsson**

5. Top 10 publications in 2013 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Claremar, B., Wällstedt, T., Rutgersson, A.,Omstedt, A. (2013) Deposition of acidifying and neutralising compounds over the Baltic Sea drainage basin between 1960 and 2006. Bor. Env. Res. 18 (6) , pp. 425-445

Granfors A., Karlsson A., Mattsson E. Smith W. and Abrahamsson K., Contribution of sea ice to the flux of volatile halogenated organic compounds to the atmosphere of the Southern Ocean. Geophysical Research Letters. VOL. 40, 1–6, doi:10.1002/grl.50777, 2013

*Gålfalk, M., D. Bastviken, S. Fredriksson and L. Arneborg (2013). "Determination of the piston velocity for water-air interfaces using flux chambers, acoustic Doppler velocimetry, and IR imaging of the water surface." Journal of Geophysical Research: Biogeosciences **118**(2): 770-782.*

Hassellöv, I.-M., D. R. Turner, A. Lauer, and J. J. Corbett (2013), Shipping contributes to ocean acidification, Geophys. Res. Lett., 40, 2731-2736. doi:10.1002/grl.50521.

Högström, U., Rutgersson, A., Sahlée, E., Smedman, A., Hristov, T. S. , Drennan, W. M., and Kahma, K. K. (2013) Air-sea interaction features in the Baltic Sea and at a Pacific trade-wind site-an inter-comparison study. Bound. Layer Met., 147:139–163, DOI 10.1007/s10546-012-9776-8

Kapsch M-L, Graversen R G, and Tjernström M, 2013, Springtime atmospheric transport controls Arctic summer sea ice. Nature Climate Change, DOI: 10.1038/NCLIMATE1884

Karl, M, Leck, C, Coz, E and Heintzenberg, J, 2013, Marine nanogels as a source of atmospheric nanoparticles in the high Arctic, Geophysical Research. Letters, 40, 3738–3743, doi:10.1002/grl.50661.

*Karlsson, A., Theorin, M., Abrahamsson, K. Distribution, transport and production of volatile halocarbons ($CHBr_3$, CH_2Br_2, $CHBr_2Cl$ and CH_2ClI) in the upper waters of the ice covered high Arctic Ocean. Global Biogeochemical Cycles 27 **4** (2013) 1246-1261. DOI: 10.1002.2012.GB004519*

*Kupiszewski P, **Leck C**, Tjernström M, Sjogren S, Sedlar J, Graus M, Müller M, Brooks B, Swietlicki E, Norris S, and Hansel A, 2013, Vertical profiling of aerosol particles and tracer gases over the central Arctic Ocean during summer, Atmospheric Chemistry and Physics Discussions, 13, 10395-10461, DOI 10.5194/acpd-13-10395-2013.*

Leck, C., Gao, Q., Mashayekhy Rad, F., and Nilsson, U.: Size resolved airborne particulate

polysaccharides in summer high Arctic, Atmospheric Chemistry and Physics, 13, 12573–12588, 2013 www.atmos-chem-phys.net/13/12573/2013/doi:10.5194/acp-13-12573-2013.

Mattsson E., Karlsson A. and Abrahamsson K.Southern Ocean – a sink for Bromoform. Geophysical Research Letters. VOL. 40, 1–6, doi:10.1002/grl.50783, 2013

Meskhidze, N., Petters, M.D., Tsigaridis, K., Bates, T., O'Dowd, C., Reid, J., Lewis, E.R., Gantt, B. Anguelova, M.D., Bhave, P.V., Bird, J., Callaghan, A.H., Ceburnis, D., Chang, R., Clarke, A., de Leeuw, G., Deane, G., DeMott, P.J., Elliot, S., Facchini, M.C., Fairall, C.W., Hawkins, L. Hu, Y.X., Hudson, J.G., Johnson, M.S., Kaku, K.C., Keene, W.C., Kieber, D.J., Long, M.S., ***Mårtensson, E.M****., Modini, R.L., Osburn, C.L., Prather, K.A.,Pszenny, A., Rinaldi, M., Russell, L.M., Salter, M., Sayer, A.M., Smirnov, A., Suda, S.R., Toth, T.D., Worsnop, D.R., Wozniak, A., Zorn, S.R., 2013, Production mechanisms, number concentration, size distribution, chemical composition, and optical properties of sea spray aerosols., ATMOSPHERIC SCIENCE LETTERS, 14, Issue: 4, 207-213, DOI: 10.1002/asl2.441.*

Norman, M., Raj Parampil, S., Rutgersson, A., Sahlee, E.. Influence of coastal upwelling on the air-sea gas exchange of CO_2 in a Baltic Sea Basin. ***Tellus B****, 2013. Available at: <http://www.tellusb.net/index.php/tellusb/article/view/21831>*

*Norman, M., Rutgersson A. and Sahlee, E. Impact of improved air–sea gas transfer velocity on fluxes and water chemistry in a Baltic Sea model, J. Mar. Syst. (2013), 11:****175-188,*** *http://dx.doi.org/10.1016/j.jmarsys.2012.10.013*

Omstedt, A., Edman, M., Claremar, B., Frodin, P., Gustafsson, E., Humborg, C., Mörth, M., Rutgersson, A., Schurgers, G., Smith, B., Wällstedt, T., and Yurova, A.(2013). Future changes of the Baltic Sea acid-base (pH) and oxygen balances. Tellus B 2012, 64, 19586, http://dx.doi.org/10.3402/tellusb.v64i0.19586.

Shupe M D, Persson P O G , Brooks I M, Tjernström M, Sedlar J, Mauritsen T, Sjogren S, Leck C, 2013, Cloud and boundary layer interactions over the Arctic sea ice in late summer, Atmospheric Chemistry and Physics, 13, 9379-9399, doi:10.5194/acp-13-9379-2013

Struthers, H., Ekman, A. M. L., Glantz, P., Iversen, T., Kirkevag, A., Seland, O., ***Mårtensson, E. M.,*** *Noone, K., Nilsson, E. D., Climate-induced changes in sea salt aerosol number emissions: 1870 to 2100, 2013, J. Geophys. Res., 670-682, DOI: 10.1002/jgrd.50129*

Tjernström M & 42 coauthors, 2013, The Arctic Summer Cloud-Ocean Study (ASCOS): overview and experimental design, Atmospheric Chemistry and Physics Discussions, 13, 13541-13652, DOI 10.5194/acpd-13-13541-2013

Zábori, J., Krejci, R., Ström, J., Vaattovaara, P., Ekman, A. M. L., Salter, M. E., ***Mårtensson, E. M.,*** *Nilsson, E. D., Comparison between summertime and wintertime Arctic Ocean primary marine aerosol properties . 2012, Atmos. Chem. Phys., 13, Pages: 4783-4799 DOI: 10.5194/acp-13-4783-2013.*

Zhang, Q., R. A. Handler and S. T. Fredriksson (2013). "Direct numerical simulation of turbulent free convection in the presence of a surfactant." International Journal of Heat and Mass Transfer ***61****: 82-93.*

6. Goals, priorities and plans for future activities/events

Further development of the fields station Östergarnsholm.

The Arctic Clouds in Summer Experiment (ACSE) is part of the SWERUS-C$_3$ expedition that will deploy three months on the icebreaker Oden in the East Siberian Sea in July – October of 2014. During the expedition we will focus on surface/boundary-layer/cloud interactions during late spring-to-summer and summer-to-autumn conditions in sea ice, the marginal ice zone and in open ocean.

A multi-month Arctic field experiment deployed on the Swedish icebreaker *Oden* planned for the summer of 2017 or 2018 with an integrated study, from ocean mixed layer through the ice and the troposphere. To study this necessitates a strong interdisciplinary approach including the biogeochemical sources that were thought to lead to aerosol formation, possible growth processes and characterization of the aerosol that actually influences the properties of clouds. To allow for this approach the program comprises four subprograms: marine ecology, gas/aerosol chemistry/aerosol physics, meteorology, and oceanography.

Commercial shipping as a source of acidification in the Baltic Sea

David Turner et al.

Sulphur and nitrogen oxides (SOX and NOX) from ship exhausts are a potentially significant contributor to Ocean Acidification in heavily trafficked areas. The maximum sulphur content of marine fuel oil in Emission Control Areas (including the Baltic Sea) will be reduced from 1% to 0.1% in 2015. Two possibilities are available for commercial shipping: to use expensive low-sulphur fuel, or to use seawater scrubbing systems to absorb acidic gases from the engine exhaust. This second option generates large volumes of seawater at pH 3, which acidify the water if not neutralised before release. In either case, the consequences of the release for marine organisms are unknown. This project will examine the consequences for the Baltic Sea of SOX and NOX emissions from shipping. A range of scenarios will be developed by combining current projections from IPCC and EMEP, downscaled to the Baltic, with different options for the use of low-sulphur fuel, or high-sulphur fuel with scrubbing. In addition, the biological consequences of releasing scrubber output will be assessed on natural pelagic communities in different target areas. The scenarios will be developed in dialogue with a reference group representing the shipping industry and government authorities. A monitoring programme for shipping-derived acidification in the Baltic will be designed. The results of this research will support future policy development for regulation and monitoring of SOX and NOX emissions from shipping.

7. Other comments