

INFLOW : ANNUAL REPORT 2009



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GTK = Geological Survey of Finland, Espoo, Finland

IOW = Leibniz Institute for Baltic Sea Research Warnemünde, Germany

GEUS = Geological Survey of Denmark and Greenland

Lund = Department of Earth and Ecosystem Sciences – Division of Geology, Lund University, Sweden

SMHI = Swedish Meteorological and Hydrological Institute

Szczecin = Faculty of Earth Sciences, Department of Paleooceanology, University of Szczecin

BCCR = Unifob AS, Bjerkes Centre for Climate Research, Norway

VSEGEI = A. P. Karpinsky Russian Geological Research Institute, St. Petersburg, Russia

Helsinki = Department of Geosciences and Geography, University of Helsinki, Finland

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Project acronym: INFLOW - Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios

Reporting period: 2009

Project Partners

INFLOW (2009-2011) (<http://projects.gtk.fi/inflow/index.html>) is one of the BONUS research programme (<http://www.bonusportal.org/>) projects and it is funded by national funding agencies, the EU Commission and participating institutes. Geologian tutkimuskeskus (GTK) coordinates the INFLOW project that has 9 partners in 7 countries of the Baltic Sea Region:

Germany: **Leibniz Institute for Baltic Sea Research Warnemünde - IOW,**

Denmark: **Geological Survey of Denmark and Greenland - GEUS,**

Sweden: **Department of Earth and Ecosystem Sciences – Division of Geology, Lund University,** and **Swedish Meteorological and Hydrological Institute – SMHI,**

Poland: **Faculty of Earth Sciences, Department of Paleoceanology, University of Szczecin,**

Norway: **Unifob AS, Bjerknes Centre for Climate Research - BCCR,**

Russia: **A.P Karpinsky Russian Geological Research Institute – VSEGEI,**

Finland: **GTK, and Department of Geosciences and Geography, University of Helsinki (2009: Department of Geology)**

Table 1. Institutes, persons and persons months of INFLOW Project 2009. PS = Principal Scientist.

Institute	Person	Acronym	Person months	
GTK			8.4	
	Aarno Kotilainen	ALE	2.8	Coordinator
	Jyrki Hämäläinen	JRH	0.3	Scientist
	Anu Kaskela	AMK	0.2	PhD student
	Joonas Virtasalo	JVI	5.1	Post-doc
IOW			27	
	Karoline Kabel	KKA	9	PhD student
	Thomas Leipe	TLE	2	Senior scientist
	Matthias Moros	MMO	5	Senior scientist
	Thomas Neumann	TNE	2	PS
	Christian Porsche	CPO	9	PhD student
GEUS			3	
	Antoon Kuijpers	AKU	1	PS
	Niels E. Poulsen	NEP	1	Senior scientist
	Jens Peter Rasmussen	JPR	1	Senior scientist
Lund			11	
	Bryan Lougheed	BLO	10	PhD student
	Ian Snowball	ISO	1	PS
SMHI			2	
	Markus Meier	MME		PS
	Kari Eilola	KEI		Senior scientist
	Anders Höglund	AHÖ		Senior scientist
	Robinson Hordoir	RHO		Senior scientist
	Gustav Strandberg	GST	2	Senior scientist
Szczecin			21	

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	Slawomir Dobosz	SDO	12	Phd student
	Andrzej Witkowski	AWI	9	PS
BCCR			1.5	
	Eystein Jansen	EJA	0.5	PS
	Björg Risebrobakken	BRI	1	Post-doc
VSEGEI			17	
	Timophej Bodryakov	TBO	3	PhD student
	Andrey Grigoriev	AGR	3	Senior scientist
	Darya Ryabchuk	DRY	2	Senior scientist
	Alexandr Sergeev	ASE	3	student
	Mikhail Spiridonov	MSP	3.5	PS
	Vladimir Zhamoida	VZH	2.5	Senior scientist
Helsinki			8.5	
	Laura Arppe	LAR	7	Post-doc
	Mia Kotilainen	MKO	1	Senior scientist
	Juha Karhu	JKA	0.5	PS
Total person months used			99.4	

General

During 2009 altogether 30 scientists and students were participating in INFLOW –project (Table 1), with total used resources of 99 person months.

Consortium Agreement between BONUS EEIG and Project Partners remains still unsigned (29th January 2010) due to prolonged negotiations between the German national funding agency and the BONUS EEIG. Despite this delay, the INFLOW Project has been started more or less as planned in the Full Research Plan. However, due to prolonged contractual negotiations between the Danish Natural Research Council (FNU) and the BONUS EEIG management, an official (financial) start of GEUS activities was delayed until September 1st 2009. Consequently, the originally scheduled work in scheme for 2009 underwent major revision which will have an impact on the 2010 work plan of GEUS as well. This implies, amongst others, a c. 8 months delay for the appointment of the (dinoflagellate) post-doc researcher, who originally should have started by January 1st 2010.

Introduction:

INFLOW uses sediment multi-proxy studies and modeling to identify the forcing mechanisms of palaeoenvironmental change of the Baltic Sea over the past 6000 years and to provide selected scenarios of the future Baltic Sea.

INFLOW studies ongoing and past changes in both surface and deep water conditions (e.g. saline water inflow, hypoxia and temperature) and their timing by means of multi-proxy studies combined with state-of-the-art modelling approaches. INFLOW uses sediment proxy data from key sites along a transect from the marine Skagerrak to the freshwater dominated northern Baltic Sea. The focus of the project will be the Late Holocene. The validated ecosystem models can provide simulated data for extreme natural climatic conditions over the past thousands of years (e.g. Medieval Warm Period, Little Ice Age). Proxy reconstructions will be compared to results from model simulations to investigate the relationship between natural variability and human impact. Validated models will be used to provide scenarios of the Baltic Sea ecosystem state at the end of the 21st century for selected IPCC climate change scenarios. That information produced by the INFLOW project can form the

scientific basis for political strategies adapting to future climate change. INFLOW will provide policy makers with valuable information on how humans have been affected in the past 6000 years. This may shed some light on the possible impacts of future climate change.

This report focuses on activities of INFLOW project during 2009. The timing of different work packages (WP) and tasks are shown in table 2. Deliverables due during the reporting period (2009) were:

Deliverable (D1.1) "*High-resolution sediment cores covering the past 6000 years*" that was due month 9.

Deliverable (D3.3) "*INFLOW web-page*" that was due to month 4.

Deliverable (D4.1) "*Floating University field course, covering the INFLOW topics*" that was due to month 6.

Table 2. The timing of different Work packages and Tasks of INFLOW Project.

	2009				2010				2011			
	1	2	3	4	1	2	3	4	1	2	3	4
WP1 – Sediment proxy studies												
Task: 1.1. Key-site selection & sampling												
Task: 1.2. Chronostratigraphy												
Task: 1.3. Reconstr. of deep water condit.												
Task: 1.4. Reconstr. of surface water condit.												
WP2 - Modelling approach												
Task: 2.1. Forcing function												
Task: 2.2. Time slice experimensts												
WP3 – Synthesis												
Task: 3.1. Model validation												
Task: 3.2. Link to North Atlantic												
Task: 3.3. Future Scenarios												
WP4 – Training and Education												
Task: 4.1. Floating University												
Task: 4.2. Workshops												
Task: 4.3. Outreach	Presentations in conferences											
	Raising public awareness											
Project meetings												
Publications												
Final reports												

Note: Due to the known (contract) delay in the GEUS time/work schedule, GEUS post doc contribution to Task 1.4 (surface water reconstruction) will consequently also be delayed. The duration of Task 1.4 might then extend to mid 2011 (2/2011).

Activities and results

Work package WP1. Sediment proxy studies

Participating Institutes: GTK, IOW, GEUS, GBSCL, Szczecin, BCCR, VSEGEI, Helsinki

Multi-proxy sediment studies will be used to understand the natural elasticity of the ecosystem. We will study ongoing and past changes in both surface (temperature, salinity, sea-ice) and deep water (oxygen, salinity) conditions and their timing. Sediment studies will provide needed data for modelling approaches (WP2). Sediment proxies will be studied from key-sites along a transect from the marine Skagerrak to the freshwater dominated northern Baltic Sea. Work in the WP1 was divided into following tasks:

Task 1.1.: Key-site selection and sediment sampling – Activities 2009:

The field investigations of the INFLOW project in 2009 concentrated on the whole INFLOW project study area: on a transect from the marine Skagerrak to the freshwater dominated northern Baltic Sea (Figure 1). The purpose of the field investigations were to take (all) sediment samples from the study area to sediment proxy studies.

Altogether five cruises onboard four research vessels (*RV Maria S. Merian*, *RV Professor Albrecht Penck*, *RV Ladoga*, *RV Aranda*) were carried out during year 2009 (Table 3). The INFLOW field expeditions were organized by the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany (*RV Maria S. Merian*, *RV Professor Albrecht Penck*), A.P Karpinsky Russian Geological Research Institute (VSEGEI), Russia (*RV Ladoga*) and The Finnish Environment Institute (SYKE) (*RV Aranda*). These cruises were funded mainly by the institutes that organized cruises. In addition INFLOW participated in *RV Penck* HYPER cruise (chief Scientist: Claudia Fellerhoff) and co-operated with BALTIC GAS *RV Poseidon* cruise December 2009 (chief scientist (Rudolf Endler).

Table 3. Cruises of the BONUS INFLOW project. * = Cruise Report available in the INFLOW website at <http://projects.gtk.fi/inflow/index.html>; # = cruise report available at IOW.

Research Vessel	Date	Chief Scientist	Cruise Report
Albrecht Penck	May–June 2007	Thomas Leipe (IOW)	#
Albrecht Penck	April 2008	Matthias Moros (IOW)	#
Aranda	April 2009	Harri Kankaanpää (SYKE)	*Available
Albrecht Penck	June 2009	Matthias Moros (IOW)	#
Ladoga	June 2009	Daria Ryabchuk (VSEGEI)	*Available
Maria S. Merian	September 2009	Falk Pollehne (IOW)	#
Aranda	August 2009	Harri Kankaanpää (SYKE)	*Available

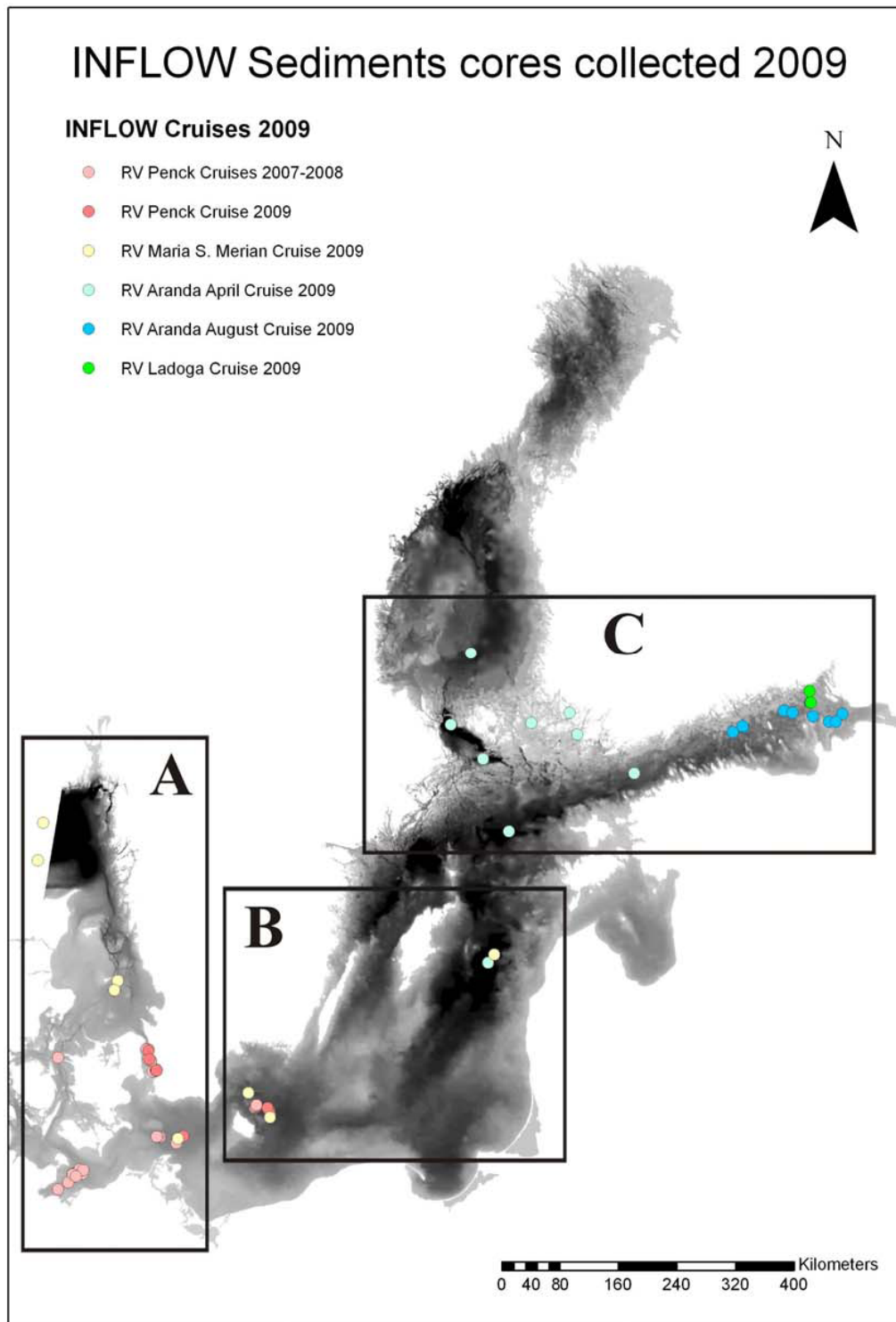


Figure 1. Bathymetric map of the Baltic Sea with the coring locations indicated. Bathymetric map is a product of BALANCE "Baltic Sea Management – Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning" Interreg IIIB EU-project. Working areas (A, B and C) are also shown in figure.

The selection of key sites for proxy studies is essential. Site selection of the INFLOW project key-coring sites (Fig. 1) was based on new high-resolution (multibeam) topographic information, shallow seismic, ecosystem modelling and other relevant data (from former projects) available at the participating institutes. The project utilized also the consortiums long-term experience in working with Baltic Sea sediments. Participating Institutes have used significant resources (and funding) to provide that information for the key site selection. Sites were selected from the spatially very different hydrographic conditions in the Baltic Sea. The high sedimentation rates (approximately 1-2 mm/year) at all selected sites provide an excellent opportunity to reconstruct ecosystem variability through time at decadal to centennial time scales. Records obtained in the western Baltic will contain clear signals of saline water inflow and the Baltic Sea outflow changes. Sites from the central and northern part of the Baltic Sea are to lesser degree directly influenced by saline water inflow changes and are influenced by feedback mechanisms (e.g. redox stage). However, these sites provide records of precipitation and terrestrial input changes, and of past variability in sea-ice cover. Sea-ice cover is a critical parameter for ecosystem modelling.

Altogether, more than 50 sediment cores (including gravity cores, piston cores and different types of surface sediment cores) were successfully recovered from the INFLOW project study areas of the Baltic Sea (Fig. 1). The recovered sites cover all the planned sites for the project (Fig.1). For detailed Site information see Virtasalo et al. 2009.

The sediment cores were digitally imaged, and first detailed lithologic descriptions were prepared onboard. In addition, bulk magnetic susceptibility measurements along with other mineral magnetic parameters, X-ray imaging, colour- and XRF scanning, extensive TOC/LOI/TC measurements and microfossil studies have been, and are, in part, still being carried out. Surface samples are currently being analyzed for microfossils. Based on extensive additional INFLOW surveys and the preliminary results of post-cruise studies (e.g. the various scanning data, first AMS¹⁴C results), most suitable and representative “key cores” from Gotland Basin and Northern Central Basin were selected for detailed high-resolution studies (workshop organized in December 2009 at IOW). “Key core” selection from Bornholm Basin and Skagerrak / Kattegat areas will be finished by end of January 2010.

Deliverable (D1.1) "*High-resolution sediment cores covering the past 6000 years*" was due month 9. Report was provided 30.10.2009. (Virtasalo et al. 2009).

Task 1.2.: Chronostratigraphy - Activities 2009:

Palaeomagnetic dating of sediment cores

The following sediment cores have been subsampled into discrete 2x2x2 cm plastic cubes at 3 cm resolution (Lund and other partners onboard).

<i>Core</i>	<i>Lat. (N)</i>	<i>Lon. (E)</i>	<i>Water depth (m)</i>	<i>Core length (cm)</i>	<i>Cruise</i>
370510-5	59.5818	23.6262	80	557	Aranda / April 2009
370520-6	58.8943	20.5737	182	474	Aranda / April 2009
370530-5	57.3854	20.2582	231	496	Aranda / April 2009
370540-6	57.2835	20.1208	243	743	Aranda / April 2009
370570-4	61.0853	19.5784	125	605	Aranda / April 2009
371080-5	55.3408	15.4480	93	375	Penck / June 2009
371090-5	55.3748	15.4029	92	365	Penck / June 2009
371120-3	55.8259	12.7530	24	384	Penck / June 2009
371120-3	55.8259	12.7530	24	384	Penck / June 2009
372610	57.6842	6.6833	320	547	Merian / Sep. 2009
372630	57.6758	7.1662	330	788	Merian / Sep. 2009
372650	58.4960	9.5985	550	524	Meriam / Sep. 2009
372680	56.6043	11.7757	38	499	Merian / Sep. 2009
367270	56.6880	11.7780		377	Penck / Nov. 2009
367280	56.6681	11.7650		373	Penck / Nov. 2009
367290	56.5951	11.7512		369	Penck / Nov. 2009

The following palaeomagnetic analyses have been carried out.

<i>Core</i>	<i>MS-SS</i>	<i>MS-DS</i>	<i>NRM</i>	<i>ARM</i>
370510-5	X	X	X	
370520-6	X	X	X	X
370530-5	X	X	X	

370540-6	X	X	X	X
370570-4	X	X		
371080-5		X		
371090-5		X	X	
371120-3		X		
371120-3		X		
372610				
372630				
372650				
372680				
367280				
367290				
367300				

MS-SS (Lund, GTK) = Magnetic susceptibility surface scans were made using a Bartington Instruments Ltd MS2E1 surface scanning sensor coupled to a TAMISCAN-TS1 automatic logging conveyor. Surface scans were carried out on board cruises shortly after retrieval of core. MS-DS (Lund) = Magnetic susceptibility analysis of discrete subsamples using Brno KLY-2 Kappabridge. NRM (Lund) = Natural remnant susceptibility analysis using SQUID magnetometer coupled to an automatic degausser system (2G Enterprises). ARM (Lund) = Anhysteretic remanent magnetisation analysis using SQUID magnetometer coupled to an automatic degausser system (2G Enterprises).

Radiocarbon dating (BCCR, GEUS, GTK, IOW, Lund)

Activities include picking and submission of 48 benthic foraminifera (BCCR, IOW) and sediment samples for AMS ¹⁴C dating to Poznan and Lund Radiocarbon dating laboratory. Also sections of a c. 25 m long sediment core from the Limfjord, Northern Jutland have been analysed (JPR/GEUS) for microfossils in order to obtain terrestrial plant material for AMS ¹⁴C dating of the record.

OSL dating (Helsinki)

Testing of the OSL-samples was done in Nordic Laboratory for Luminescence Dating, Department of Earth Sciences, University of Aarhus, Risø National Laboratory, Roskilde Denmark 3.-14.10.2009 (MK/Helsinki).

Task 1.3.: Reconstruction of deep water conditions – Activities 2009:

Various sediment proxies will be used to reconstruct deep water conditions. Post-cruise work in 2009 included:

- benthic foraminifera counting of surface samples from Kattegat/Skagerrak, selection of species for stable isotope and Mg/Ca measurements (BCCR, IOW)
- benthic foraminifera studies on central Gotland basin core (IOW)
- integrated sedimentological and ichnological (trace fossils) analysis of sediment cores (GTK)
- grain size analysis (VSEGEI)
- collecting relevant background information/data from the north Atlantic Ocean (BCCR)
 - stable isotope measurements
 - Mg/Ca analyses

Task 1.4.: Reconstruction of surface water conditions - Activities 2009:

To reconstruct surface water conditions during the past we will utilize extensive studies of surface sediments and long sediment cores. Post-cruise work in 2009 included:

- subsampling around 500 samples for diatoms analysis. Laboratory work: 150 surface samples are ready to microscopic work, and 50 samples have been analyzed. 140 samples from different long cores sites has been prepared and examined for quality of diatoms preservation (Szczecin).

- Dinoflagellate studies (Bornholm Basin) during the former GEUS ‘Bathy-Sed’ project have been studied as no dinoflagellate samples from joint INFLOW target cores are microscope-ready yet. These initial investigations of subrecent–recent seabottom surface samples from the Bornholm Basin east of Bornholm revealed small amounts of dinoflagellate cysts and a large number of diatoms and *Pediastrum* spp. (NEP/GEUS).
- TEX86 SST measurements on two multi-corers (NIOZ Texel, Diploma thesis) (IOW).
- XRF scanning (NIOZ Texel, Cologne) of 10 multi- and long cores (IOW).

For Tasks 1.3. and 1.4.: Geochemical analysis such as XRF–scanning, TOC/TIC/TC/S/N (IOW, GTK, VSEGEI), biogenic opal (IOW), P, Ca/Mn, Sr-isotope measurements (Helsinki, GTK). These geochemical studies cannot be solely linked to surface or deep water processes, but which are essential to characterize the status of the ecosystem (such as redox stage). Activities 2009 included:

- loss on ignition (LOI) data of 30 cores, TOC/TC/N measurements (IOW).
- XRF scanning (NIOZ Texel, Cologne) of 10 multi- and long cores (IOW).
- collecting background information on Baltic Sea foraminifera, and Sr-isotope technique practices and planning sampling for $^{87}\text{Sr}/^{86}\text{Sr}$ analyses (LA/Helsinki).
- Geochemical and palynological analysis - preparation of the samples collected in the cruises for analysis planning to fulfill in 2010 (VSEGEI).
- In addition to INFLOW sediment core studies some existing older sediment cores were studied, too. Together with Helmar Kunzendorf, Institute of Geography and Geology (Copenhagen University) AKU (GEUS) has spent time at a geochemical study of a 5.5 m long gravity core (211630-9) taken in the Bornholm Basin (RV ‘Kottsov’, 1997). Samples from this core have been analysed using a modified energy-dispersive X-ray fluorescence (EDX) techniques using radio-isotopes for characteristic X-ray excitation. The concentration of a larger number of major and trace elements was measured, including continent-derived K and Ti as well as the trace element Br being a marker element for salinity. The record of the past 7000 years for above gravity core shows major variability for the element Br, and to a less extent variations in K.

WP1 Results:

Altogether, five cruises onboard four research vessels (RV Maria S. Merian, RV Professor Albrecht Penck, RV Ladoga, RV Aranda) were carried out during year 2009. All study locations planned were recovered during field cruises. In total over 50 sediment cores (surface and long core) were collected during Cruises. Subsampling of sediment cores and laboratory analyses are in progress and partly finalized. ´

Magnetic susceptibility scans and discrete sample data show that the concentration of magnetic minerals in Baltic Sea sediments is highly variable. One result is that distinctly laminated sediments have higher magnetic concentrations than homogenous sediments. The cause of this difference is unknown and will be investigated. A second result is that satisfactory palaeomagnetic curves have been obtained for gravity cores taken at sites 370340 and 370530. Preliminary high resolution age-depth models based on palaeomagnetic secular variations have been produced for these two sites. These models will be validated by independent dating methods.

Integrated sedimentological and ichnological analysis of two sediment cores previously collected from the Gotland Basin show that these muds are characterized by four lithofacies: 1) laminated mud, 2) biodeformed mud, 3) burrow-mottled mud and 4) sedimentation-event bed. The laminated and burrow-mottled facies dominate the cores as alternating long intervals, while the biodeformed and sedimentation-event facies occur as thin interbeds within the laminated intervals. Lamination-discontinuity horizons within the laminites, where the regular lamination is sharply overlain by gently inclined downlapping lamination, challenge the traditional view of mud accumulation by settling from suspension, but indicate the lateral accretion of mud from bedload transport (moving water). The *biodeformed interbeds* record brief (few years to few decades) oxic–dysoxic conditions that punctuated the anoxic background conditions and permitted sediment-surface grazing and feeding by a very immature benthic community. The *sedimentation-event interbeds* are distal mud turbidites deposited from turbidity currents triggered probably by severe “century/millennium storms” in the adjacent coastal areas. The long *burrow-mottled intervals* are characterized by intensely bioturbated fabrics with discrete *Planolites*, rare *Arenicolites/Polykladichnus* and very rare *Lockeia* trace fossils, as well as bivalve biodeformational structures which represent shallowly penetrating endobenthic feeding and grazing strategies and permanent dwellings. These burrowed intervals represent longer periods (several years to few centuries) of oxic–dysoxic conditions that permitted maturation in the benthos by means of larval settling of opportunistic worm-like

macrofauna and bivalves. These observations imply more dynamic and oxic depositional conditions in Gotland Deep than previously thought. The observations on the sediment bioturbation intensity and quality were integrated to produce a conceptual model that can be used for reconstructing past levels of seafloor oxygen availability (Virtasalo et al., submitted). This new tool was applied to the sediment cores 370510-5 (western Gulf of Finland) and 349140 (North Central Basin) to reconstruct the seafloor oxygen conditions at those localities over the past several millennia. During 2010 the model will be used for several other cores of the INFLOW project with an emphasis on the key sites.

Deliverable (D1.1) *High-resolution sediment cores covering the past 6000 years* (Virtasalo et al.2009) was produced as planned in FRP.

Work package WP2. Modelling approach

Participating Institutes: IOW, SMHI

In this work package hydrographical and biogeochemical condition for historical time slices, a contemporary time slice, and future scenarios will be simulated. The ecosystem models will be forced with climate of extreme conditions from the past 6000 years. These model experiments will give insight into what extent the ecosystem responds to past natural climate variability and environmental change. Comparison with the simulated contemporary and future status allows relating the expected changes to conditions in historical times.

Task 2.1.: Forcing function – Activities 2009:

Deliverable (D2.1.) *"Forcing data for time slice experiments"* will be due month 24 (December 2010).

Past climate simulations using RCA (the past 1000 years):

Retrieval of boundary data was delayed with 6 months until October 2009 due to technical problems at DKRZ Hamburg. Since then downloading of ECHO_G data from DKRZ started.

Almost 100 years of data from 6000 years BP period has been received (some years are still missing due to corrupted files) and the first 100 years from the period 1000-0 years BP.

The regional climate model at SMHI (RCA3) was set up and configured to read ECHO_G data, and forcing conditions for 6000 years BP was defined. The raw ECHO_G data was interpolated to be read by RCA3.

A preliminary test run was performed to see that RCA3 reads the boundary data correctly, that the output is correct and that the right variables are written as output. Some analyses are still to be made.

Present climate (1960-2007):

Hindcast simulations with the regional climate models RCA-ERA40 (25 km) and RCO-ERA40 (50 km) have been performed for the period 1960-2007. These data have been delivered to the partner (IOW).

Future climate (1960-2099):

The first transient simulation using RCO/ECHAM5-A1B for 1960-2099 is in progress. In collaboration with the ECOSUPPORT project the analysis of first results has been started.

Task 2.2.: Time slice experiments

Deliverable (D2.2.) "*Simulated hydrographic and biogeochemical variables from time slice experiments*" will be due month 30 (June 2011).

Both involved ecosystem models for the Baltic Sea, RCO-SCOB1 and ERGOM have been set up for the simulations and first simulations for present and future climate have been performed to test the quality of the forcing data and to calibrate the ecosystem models. A comprehensive validation of the model results of RCO-SCOB1 and ERGOM for the reference period is ongoing. For model calibration a comprehensive data set was compiled. For future climate the hydrological forcing from hydrological modelling including the loads is still missing.

Using a delta change approach, sensitivity studies have been started to explore the response of the ecosystem models to extreme changes in climate forcing conditions.

Work package WP3. Synthesis

Work will start 2010/2011 (see table 1)

22nd April 2009, INFLOW –project website was opened (<http://projects.gtk.fi/inflow/index.html>). Deliverable (D3.3) "*INFLOW web-page*" that was due to month 4.

In addition BLO/Lund has constructed an online Baltic Sea Radiocarbon Database, information accessible via: <http://www.geol.lu.se/inflow/>

Work package WP4. Training and education.

Participating Institutes: all Partners.

WP4 aims to educate students/researchers scientific knowledge, understanding, and multidisciplinary international cooperation in the Baltic Sea environmental issues for tomorrow's needs.

Task 4.1.: Floating University

Altogether 11 students (including 2 post-docs) (6 female and 5 male students) participated in “Floating University” organized during the RV Aranda SEDU 2009 Cruise 22.-29.4.2009. The Floating University experiment turned out to be very good and educative for the supervisors and senior scientists as well. The daily turnout of the coring was the main component to be taken into account while planning the teaching programme. On this cruise the outcome of the site coring was beyond the most optimistic plans, hence there were more opportunities for hands-on exercises than ever before. This modified our plans of the programme a great deal. Luckily, hands-on experience on marine sediments was exactly what the students needed most urgently – and from the pedagogical point of view, there hardly is more educative way to learn than by doing yourself. This cruise offered an excellent opportunity for educational achievements – and according to the

feedback we are pleased to have met the purpose of the Floating University (Ryabchuk, D., Kotilainen, M., 2009).

Deliverable (D4.1) "*Floating University field course, covering the INFLOW topics*" was due month 6. Report was provided 29.06.2009 (Ryabchuk,D., Kotilainen, M., 2009).

Task 4.2.: Workshops

Altogether five workshops were organized in 2009:

- INFLOW kick-off workshop, Helsinki, Finland, 15th January 2009 (GTK)
- small INLOW workshop during RV Aranda cruise (April 2009) (GTK, IOW, Lund, Szczecin, VSEGEI, Helsinki)
- ``The marine ecosystem in changing climate - on the added value of coupled climate-environmental modeling for the Baltic Sea", Norrköping, Sweden, 16 October 2009 (SMHI, IOW)
- INFLOW national workshop for Finnish Partners, Helsinki University, Department of Geology, 2.10.2009 (Helsinki, GTK).
- INFLOW workshop and subsampling party, Warnemünde, December 2009 (IOW)

Task 4.3.: Outreach

INFLOW Partners disseminated project actively during 2009. Altogether 22 conference and seminar presentations as well as invited lectures were given in 9 countries (Figure 2).

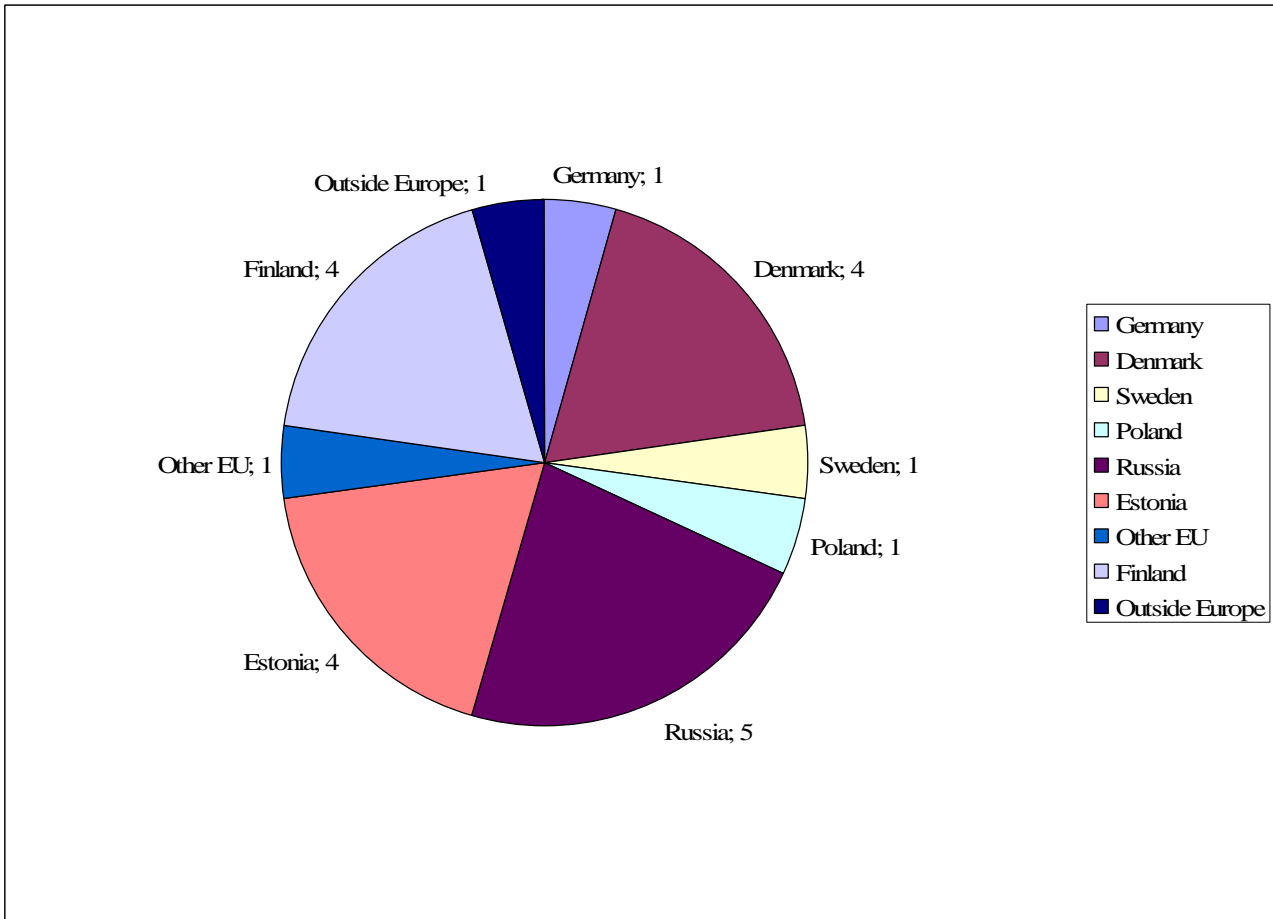


Figure 2. INFLOW related presentations in different countries 2009.

Presentations in national and international conferences

- BONUS –Programme Conference, Espoo, Finland, 13.-14.1.2009.
 - Author(s): Kotilainen, A.

Title: "INFLOW – Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios".
- 6th National Colloquium 4.-6.3.2009, Helsinki, Finland.
 - Authors: Kotilainen, A., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M. Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A.

Title: INFLOW – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios.
- Magellan WS “Baltic IODP” Workshop 14.-15.3.2009, Copenhagen, Denmark

- Authors Kotilainen, A., Arppe, L., Eystein, J., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, H.E.M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A.,

Title: INFLOW project - Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios
- Xth Baltic Sea Day, St. Petersburg, Russia, March 17-19, 2009.
 - Authors: Kotilainen, A.T., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M.M., Kuijpers, A., Meier, H.E.M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A.,

Title: INFLOW project – towards understanding on forcing mechanisms of environmental changes of the Baltic Sea and future scenarios.
- International Conference on Climate Change – The environmental and socio-economic response in the southern Baltic region. University of Szczecin, Poland, 25-28 May 2009.
 - Authors: Kotilainen, A., Arppe, L., Dobosz, S., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A.

Title: INFLOW project – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios
- Joint Assembly of IAMAS (International Association of Meteorology and Atmospheric Science), IAPSO (International Association for the Physical Sciences of the Oceans) and IACS (International Association of the Cryospheric Sciences), Montreal, Canada, July 20-24, 2009.
 - Author(s): H.E.M. Meier.

Title: Regional coupled climate and environmental modeling for the Baltic Sea Region.
- 7th Baltic Sea Science Congress, Tallinn, Estonia, 17-21 August, 2009.
 - Author(s): H.E.M. Meier, K. Eilola, and E. Almroth

Title: Climate-related changes in marine ecosystems simulated with a three-dimensional coupled biogeochemical-physical model of the Baltic Sea.
 - Author(s): Thomas Neumann

Title: Scenarios of climate induced regional changes in the Baltic Sea hydrography and biogeochemistry

- Author(s): Kotilainen, A., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A.

Title: Towards understanding the forcing mechanisms of environmental changes of the Baltic Sea and future scenarios – INFLOW project
- Author(s): Virtasalo, J., Leipe, T., Moros, M., Kotilainen, A.

Title: Depositional processes and macrobenthic dynamics in the Gotland Deep interpreted from the fabric of long sediment cores – how anoxic is the basin?
- International conference on “Linking Science and Management in the Baltic Sea Ecoregion”, Copenhagen, Denmark, 9-10 September, 2009.
 - Author(s): H.E.M. Meier

Title: New modeling tools for scenarios of the Baltic Sea ecosystem to support decision making.
- International Workshop on “The marine ecosystem in changing climate - on the added value of coupled climate-environmental modeling for the Baltic Sea”, Norrköping, Sweden, 16 October, 2009
 - Author(s): H.E.M. Meier.

Title: Impact of changing climate on biogeochemical cycles in the Baltic Sea - an introduction.
- International conference Colloquium Universite de la Mediterranee, Marseille, France, 2nd December 2009.
 - Author(s): T. Neumann

Climate change signals in the Baltic Sea hydrography and biogeochemistry
- XVIII International Conference on Marine Geology, Moscow, Russia, 16 – 20 November 2009.
 - Authors: Kotilainen A., Jansen E., Karhu J., Kotilainen M., Kuijpers A., Meier M., Moros M., Neumann T., Ryabchuk D., Snowball I., Spiridonov M., Witkowski A.

Title: INFLOW – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios.
- The International Conference “Integrating Geological Information in the City Management to Prevent Environmental Risks (GeoInform)”, St.Petersburg, Russia, November 24-25, 2009.

- Authors: D.V.Ryabchuk, M.A.Spiridonov, V.A.Zhamoida, E.N.Nesterova, A.Kotilainen, H.Vallius.

Title: Rossijsko-Finlândskie ekologo-geologiceskie issledovaniâ v Nevskoj gube.
(Russian-Finland ecological-geological investigations in the Neva Bay)

Other presentations (e.g. seminars)

- Seminar at the Baltic Sea Research Institute Warnemünde, Germany, 12th November 2009.
 - Author(s): C. Porsche
 - Title: The influence of climate change on the Baltic Sea ecosystem - comparison of variability from the last 2k years with the expected changes in the next 100 years
- Seminar "Työelämäorientaatio" for geology students of Helsinki University, GTK, Espoo, Finland, 27 November 2009.
 - Author: A. Kaskela
 - Title: INFLOW-, EMOGE-, ja FINMARINET – hankkeiden esittely.
- Internal Seminar of Research Programmes, GTK, Espoo, Finland, 9.6.2009.
 - Author: Kotilainen
 - Title: INFLOW and other marine geological research projects in GTK.

Lectures:

Invited lecture for graduate students at the International BALTEX summer school on "Threats and challenges for the Baltic Sea environment under climate change", Nexö, Bornholm, Denmark, 27 July - 5 August, 2009: Regional climate simulations and uncertainties of scenario simulation (8 lecture hours) (M. Meier)

Invited lecture for graduate students at the International BALTEX summer school on "Threats and challenges for the Baltic Sea environment under climate change", Nexö, Bornholm, Denmark, 27 July - 5 August, 2009: Regional climate simulations and uncertainties of scenario simulation (8 lecture hours) Modelling the Baltic Sea Ecosystem (6 lecture hours) (T. Neumann).

Invited lecture in Russian Academy of Sciences "Towards understanding the causes of the Baltic Sea environmental changes over the past 6000 years and future scenarios -INFLOW project". 20th October 2009 (A. Kotilainen).

Invited lecture for graduate students at the St. Petersburg University, Department of Geology, Russia, 21st October 2009 (2 lecture hours) (A. Kotilainen).

INFLOW in Media:

- 13.1.2009, INFLOW –project presentation (in Finnish) (ALE/GTK) in BONUS Programme Press conference, Espoo, Finland.
- 13.1.2009, press Release of INFLOW – project (in Finnish, Swedish, English) (Academy of Finland, GTK).
- 2.2.2009, Article of INFLOW – project in Helsingin Sanomat magazine (in Finnish).
- March 2009, Article "Itämeren ympäristömuutosten salat ja tulevaisuuden kuvia. BONUS – ohjelman INFLOW –projekti." in Geologi – magazine (Kotilainen 2009)
- May 2009, Article of INFLOW – project in Saaristo –magazine (in Finnish).
- June 2009, Article "Look back - and learn" in Baltic Rim Economies –magazine (Kotilainen 2009).
- June 2009, Article ”Pohjasedimenteistä näkyy Itämeren tulevaisuus” in Geofoorumi – magazine (in Finnish) (Harriet Öster).
- August 2009, Article "Itämerta ei hymyilytä" in Kotilaisten suku –magazine.
- 10.8.2009 12:30pm, INFLOW –project in Russian Television Channel 5 News, "Marine mud and climate change", during INFLOW project RV Aranda Cruise visit in St.Petersbug (<http://www.5-tv.ru/>).
- Manuscript "Physicochemical and biological influences on sedimentary-fabric formation in a salinity and oxygen-restricted semi-enclosed sea: Gotland Deep, Baltic Sea" by Virtasalo et al. was submitted to *Sedimentology* journal. (Virtasalo et al.).

Other activities:

- Planning and organization of, and attending the Young Scientists Club meeting of the BONUS- programme (held 14.1.2009 at the Department of Geology, University of Helsinki) (LA/Helsinki).
- 10.2.2009 BONUS –projects (INFLOW, BALTIC GAS, HYPER) meeting on cruise sampling site selection, Department of Geology, Helsinki University, Finland, hosted by ALE/GTK.

- AKU/GESU has established contact for future collaboration with Kiel University (Prof. R. Schneider) where a recent initiative ‘Mid-Holocene climate variability in Northern Germany and surrounding oceanic regions’ will involve study of high-resolution sediment cores from the Skagerrak and Kattegat focusing on the period 7000-4000 yrs BP.
- 15.6.2009 participating in ”The 1st meeting of the Forum of Project Coordinators”, Academy of Finland, Helsinki, Finland (ALE/GTK).
- 16.6.2009 participating in “Joint meeting with the BONUS EEIG Steering Committee and Advisory Board”, Academy of Finland, Helsinki, Finland (ALE/GTK).

Co-operation with other BONUS projects

- Cruises (and co-operation with other BONUS Projects) along inflow transect
 - RV Aranda INFLOW Cruise in April 2009 with BALTIC GAS (floating university)
 - RV Penck HYPER Cruise in June 2009
 - RV Poseidon BALTIC GAS Cruise in December 2009 (sediment cores provided to INFLOW)
- ECOSUPPORT close co-operation in modelling
- Providing expertise for Site selection (BALTIC GAS, HYPER)
- Preparation of seabed substrate data to IBAM –project for modelling (ALE/GTK).

Publications:

Peer reviewed articles:

Virtasalo, J.J., Leipe, T., Moros, M., Kotilainen, A.T., in Revision. Physicochemical and biological influences on sedimentary-fabric formation in a salinity and oxygen-restricted semi-enclosed sea: Gotland Deep, Baltic Sea. *Sedimentology* .

Conference abstracts:

Kotilainen, A., Arppe, L., Dobosz, S., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A., 2009a. BONUS programme: INFLOW project – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios In: Witkowski, A., Harff, J., Isemer, H.-J. (Eds.) International Conference on Climate Change – The environmental and socio-economic response in the southern Baltic region. University of Szczecin, Poland, 25-28 May 2009. International BALTEX Secretariat, Publication No 42, May 2009, 11.

Kotilainen, A., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A., 2009. INFLOW – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios. In: Kubischta, F., Kultti, S., Salonen, V.-P. (Eds.) 6th National Colloquium 4.-6.3.2009, Helsinki : Program and Abstracts. Publications of the Department of Geology. Series A 3. Helsinki: University of Helsinki, 30.

Kotilainen, A., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, H.E.M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A., 2009. INFLOW project - Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios. In: Workshop Program. Magellan WS “Baltic IODP” Workshop 14.-15.3.2009, Copenhagen, Denmark. GEUS.

Kotilainen, A.T., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M.M., Kuijpers, A., Meier, H.E.M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A., 2009. INFLOW project – towards understanding on forcing mechanisms of environmental changes of the Baltic Sea and future scenarios. In: Abstract Volume. Xth Baltic Sea Day, St. Petersburg, Russia, March 17-19, 2009.

Kotilainen, A., Arppe, L., Jansen, E., Karhu, J., Kotilainen, M., Kuijpers, A., Meier, M., Moros, M., Neumann, T., Ryabchuk, D., Snowball, I., Spiridonov, M., Witkowski, A., 2009. Towards understanding the forcing mechanisms of environmental changes of the Baltic Sea and future scenarios – INFLOW project. In : Abstract Book. Baltic Sea Science Congress 2009, Tallinn, Estonia, August 17-21, 2009, 201.

Kotilainen A., Jansen E., Karhu J., Kotilainen M., Kuijpers A., Meier M., Moros M., Neumann T., Ryabchuk D., Snowball I., Spiridonov M., Witkowski A. INFLOW – providing information on forcing mechanisms of environmental changes of the Baltic Sea during the past 6000 years and future scenarios. Materials of XVIII International Conference on Marine Geology. Vol.I, Moscow, 2009. Pp.188-192.

D.V.Ryabchuk, M.A.Spiridonov, V.A.Zhamoida, E.N.Nesterova, A.Kotilainen, H.Vallius. Russian-Finland ecological-geological investigations in the Neva Bay. Proceedings of the International Conference “Integrating Geological Information in the City Management to Prevent Environmental Risks (GeoInform). St.Petersburg, November 24-25, 2009. pp.67-69. (In Russian).

Ryabchuk, D. V.; Spiridonov, M. A.; Zhamoida, V. A.; Nesterova, E. N.; Vallius, H.; Kotilainen, A. 2009. Rossijsko-Finlândskie ekologo-geologiceskie issledovaniâ v Nevskoj gube. In: Geologiâ krupnyh gorodov: materialy mezhdunarodnoj konferencii, posvjasennoj zaverseniû mezhdunarodnogo proekta "Ispol'zovanie geologiceskoj informacii v upravlenii gorodskoj sredoï dlâ predotvraseniâ ekologiceskih riskov" (GeoInforM) programmy EC "Lajf-Tret'i strany", Sankt-Peterburg, 24-25 noâbrâ 2009 goda. Sankt-Peterburg: [Pravitel'stva Sankt-Peterburga], 67-69.

Virtasalo, J., Leipe, T., Moros, M., Kotilainen, A., 2009. Depositional processes and macrobenthic dynamics in the Gotland Deep interpreted from the fabric of long sediment cores – how anoxic is the basin? In : Abstract Book. Baltic Sea Science Congress 2009, Tallinn, Estonia, August 17-21, 2009, 33.

Other publications:

Kotilainen, A.T., 2009. Itämeren ympäristömuutosten salat ja tulevaisuuden kuvia. BONUS - ohjelman INFLOW -projekti. Geologi, 3, 86-91. (Summary in English).
<http://www.geologinenseura.fi/geologi-lehti/3-2009/bonus.pdf>

Kotilainen, A., 2009. Look back - and learn. Expert article 358, Baltic Rim Economies, Issue No. 3, 17 June 2009.

Kotilainen, A., 2009. Itämerta ei hymyilytä. Kotilaisten suku, Kotilaisten sukuseura ry:n jäsenlehti. Kolmastoista vuosikerta, 1/2009, 10-11. (in Finnish). http://koti.mbnet.fi/kotilais/2009-lehti/Kotilaisten_suku_2009_web.pdf

A.G.Grigoriev, V.A.Zhamoida, M.A.Spiridonov, A.Y.Sharapova, V.V.Sivkov. New data concerning development of the Southern-Eastern Baltic Sea in the period from Late Glacial time to the present. Regional Geology and Metallogeny. 2010. v.40, (In Russian)

Reports :

Kotilainen, A., Ryabchuk, D., Kotilainen, M., Arppe, L., Dobosz, S., Hämäläinen, J., Karhu, J., Kabel, K., Kaskela, A., Lougheed, B., Moros, M., Neumann, T., Porsche, C., Pötzsch, M., Sergeev, A., Snowball, I., Virtasalo, J. 2009. INFLOW Cruise Report, SEDU 2009, the RV Aranda 22.-

29.4.2009. INFLOW Interim Report No 1. Espoo: GTK. 19p.

http://projects.gtk.fi/inflow/Reports/INFLOW_Interim_Report_No_1_2009.pdf

Ryabchuk, D., Kotilainen, M. 2009. Floating University Report, the RV Aranda 22.-29.4.2009. INFLOW Interim Report No. 2. Espoo: GTK. 7 p.

http://projects.gtk.fi/inflow/Reports/INFLOW_Interim_Report_No_2_2009.pdf

Kotilainen, A., Hämäläinen, J., Ryabchuk, D., Spiridonov, M., Tuhkanen, M., Vallius, H., Zhamoida, V. 2009. INFLOW Cruise Report, FYTO 2009, the RV Aranda 3.-10.8.2009. INFLOW Interim Report No. 3. Espoo: GTK. 13 p.

http://projects.gtk.fi/inflow/Reports/INFLOW_Interim_Report_No_3_2009.pdf

Virtasalo, J., Moros, M., Ryabchuk, D., Kotilainen, A. 2009. High-resolution sediment cores covering the past 6000 years. INFLOW Interim Report No. 4. Espoo: GTK. 18 p.

http://projects.gtk.fi/inflow/Reports/INFLOW_Interim_Report_No_4.pdf

This report is a product of the "INFLOW" project.

INFLOW (Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios) –project studies ongoing and past changes in both surface and deep water conditions and their timing by means of multi - proxy studies combined with state-of-the-art modelling approaches. INFLOW uses sediment proxy data on a transect from the marine Skagerrak to the freshwater dominated northern Baltic Sea. The validated ecosystem models can provide simulated data for extreme natural climatic conditions over the past thousands of years (e.g. Medieval Warm Period, Little Ice Age). Proxy reconstructions will be compared to results from model simulations. These evaluated models will be used to provide predictions of the Baltic Sea ecosystem state at the end of the 21st century for selected IPCC climate change scenarios. Those scenarios of the future development of the Baltic Sea can form the scientific basis for political strategies adapting to future climate change.

INFLOW (2009-2011) is one of the BONUS research programme (<http://www.bonusportal.org/>) projects and it is funded by national funding agencies (e.g. Academy of Finland) and the EU Commission. Geologian tutkimuskeskus (GTK) coordinates the INFLOW project that has 9 partners in 7 countries of the Baltic Sea Region: Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany; Geological Survey of Denmark and Greenland (GEUS), Denmark; Lund University, Sweden; Swedish Meteorological and Hydrological Institute, Sweden; University of Szczecin, Poland; Unifob AS, Bjerknes Centre for Climate Research, Norway; A.P Karpinsky Russian Geological Research Institute (VSEGEI), Russia; Department of Geology, University of Helsinki, Finland.

The INFLOW Report Series included following reports on 30th of January 2010:

INFLOW Interim Report No. 1 "INFLOW Cruise Report, SEDU 2009, the RV Aranda 22.-29.4.2009".

INFLOW Interim Report No. 2 "Floating University Report, the RV Aranda 22.-29.4.2009".

INFLOW Interim Report No. 3 "INFLOW Cruise Report, FYTO 2009, the RV Aranda 3.-10.8.2009".

INFLOW Interim Report No. 4 "High-resolution sediment cores covering the past 6000 years".

INFLOW Interim Report No. 5 "INFLOW Annual Report 2009".

For more information on INFLOW –project see (<http://projects.gtk.fi/inflow/index.html>).