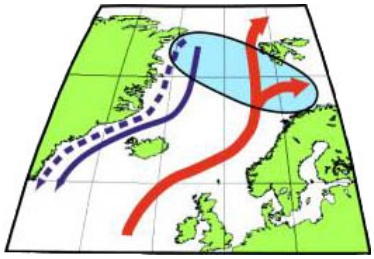
ASOF-N

Arctic-Subarctic Ocean Flux Array for European Climate: North

Contract No:
EVK2-CT-2002-00139

FINAL REPORT



Section 4

Technological Implementation Plan

Energy,
Environment
and Sustainable Development

Fifth
Framework
Programm

4. Technological Implementation Plan

Description of project	
EC PROGRAMME:	**EESD**
PROJECT TITLE:	Arctic-Subarctic Ocean flux array for european climate: North
ACRONYM:	ASOF-N
PROGRAMME TYPE:	5th FWP
CONTRACT NUMBER:	EVK2-CT-2002-00139
PROJECT WEB SITE (if any):	http://www.awi-bremerhaven.de/Research/IntCoop/Oce/ASOF/
START DATE:	01 Jan 2003
END DATE:	31 Mar 2006
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Commission Officer Name: Dr. Georgios T. Amanatidis

Executive summary

Original research objectives

The climate of Northwest Europe is anomalously warm for its latitude and this warmth is maintained by a variety of processes and factors in the Nordic Seas and the Arctic. Possible changes include cooling which may occur both rapid and radical. Arctic warming over the last 50 years was three times stronger than the global increase of surface temperatures. ASOF-N, one part of the ASOF cluster, aims at understanding the controlling processes of climate change in the high latitude North Atlantic. To improve and validate models with a predictive power needed for the assessment of the socio-economic consequences of the potential changes which are already obvious in the Arctic, time series of oceanic parameters are required over time scales of decades. ASOF-N aims to advance the installation of a suitable cost effective component of a global ocean observation system in choke points of the oceanic circulation.

Expected deliverables

- D 1.1 Status report of existing data
- D 1.2 Status report of float deployment
- D 1.3 Calibrated float data, current fields
- D 1.4 Preliminary data from hydrographic surveys
- D 1.5 Calibrated data, T/S and ADCP current fields
- D 1.6 Merged modeled and observed fields of currents and water mass properties
- D 2.1 Status report of existing data
- D 2.2 Preliminary data from CM
- D 2.3 Preliminary data from repeat sections with CTD and ADCP
- D 2.4 Calibrated data, Analysis of time series and historical data
- D 2.5 Estimates of fluxes of volume, heat and salt
- D 2.6 Comparison of modelled and measured fluxes
- D 3.1 Status report of existing data
- D 3.2 Preliminary data from moored array and repeated sections (CM, DCM, ADCP, CTD)
- D 3.3 Calibrated data, calculated fluxes, data reports
- D 3.4 Time series of models and observations, analysis and interpretation of flux variability
- D 3.5 Comparison between model and observed statistics of the heat flux
- D 4.1 Status report of existing data
- D 4.2 Preliminary data from moored array and repeated sections (CM, ULS, DCM, ADCP, CTD)
- D 4.3 Calibrated data, calculated fluxes, data reports
- D 4.4 Time series of models and observations, analysis and interpretation of flux variability
- D 4.5 Comparison of model and observations
- D 5.1 ASOF-N-www-homepage installed
- D 5.2 Reference material on data matters provided
- D 5.3 Data-inventories, project data, historical data
- D 5.4 Project CD-ROM

Project's actual outcome

All deliverables listed above were submitted.
One outstanding achievement of ASOF-N was the estimation of the exchange of water masses between the Arctic and Atlantic Ocean. This has never been done before and is an important contribution towards understanding the impact of climate change on the Arctic ocean. In addition the optimisation of the observing system necessary to monitor oceanic fluxes in the Fram Strait and the western Barents Sea contributes to more accurate measurements and a better understanding of oceanic fluxes in this area. The optimised observing system is an outcome of ASOF-N that will be used in all follow-up projects.

Broad dissemination and use intentions for the expected outputs

The scientific achievements made during ASOF-N are disseminated in peer reviewed scientific publications. A total of 22 papers have been published in high ranking scientific journals and a further 10 are estimated to be published within the next three years. Additionally, results were presented and discussed with fellow scientists at various

conferences. Final results of the ASOF-N project will be presented to a broad audience at the European Geosciences Union General Assembly 2006 in Vienna. The ASOF-N data will be also accessible on request via AWI's Internet database: www.awi-bremerhaven.de/OZE

ASOF-N is integrated in the ASOF cluster with ASOF-EC(E) and ASOF-EC (W) which measured exchanges of water further south. The results from ASOF-N will be merged with results from these projects and will be also incorporated into the Arctic-Subarctic Ocean study (ASOF international). The outcome of these projects will be presented in a joint publication.

This book is planned to comprise 31 chapters and will cover: i) the Subarctic seas as source of Arctic change, ii) the freshwater flux from the Northern seas as a moderator of the Atlantic Meridional Overturning Circulation, iii) the dense water overflows of the Northern seas as drivers of the Atlantic Meridional Overturning Circulation and iv) the receiving volume of the Labrador Sea as well as a concluding chapter. Integrated results of the projects as well as details about the book will be discussed at the ASOF conference in June 2006 in Faroe Islands.

Furthermore consortium members of all three EU projects will join the activities and integrate the results within IP DAMOCLES to increase the understanding of oceanic fluxes in the Arctic and Northern Seas and expand the results to studying interactions of oceanic fluxes with ice and air. ASOF-N results will be also used within various activities for the International Polar Year (IPY) and several nationally funded projects.

The ASOF-N consortium was also very active in disseminating the results to politicians and stake holders. Results from ASOF-N and the EU-funded preceding projects VEINS and MAIA gave background information to the scientific report from the Arctic Climate Impact Assessment (ACIA) published in 2005. ACIA is an international project of the Arctic Council and the International Arctic Science Committee (IASC), to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences. The Arctic Council is a high level intergovernmental forum of the following member states: Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America. The ASOF-N results are included into reports to ICES (the International Council for the Exploration of the Sea), which gives advice to the member countries and helps them manage the North Atlantic Ocean and adjacent seas. The results are included in reports presented at different ICES working groups like Working Group on Oceanic Hydrography (WGOH) and Arctic Fishery Working Group (AFWG), and during the last two years were also included in overall ICES assessment reports. In addition stake holders were informed about ASOF-N results e.g. by distributing a leaflet during an aquaculture exhibition in Norway. The dissemination activity was lead by the Institute of Marine Research in Bergen, Norway. Meetings with politicians were held by ASOF-N members from the IMR, NPI and IOPAN to assure the dissemination of results. Strategies for future research were developed in the frame of ICARP II (International Conference on Arctic Research Planning II) and AOSB (Arctic Ocean Sciences Board). In the frame of the Arctic Science Summit Week held in Potsdam early 2006, journalists were briefed about challenges and results of Arctic research.

TV documentaries shot during one of the ASOF-N cruises and a radio interview disseminated the ASOF-N project to the general public. In addition ASOF-N members had open institute or open ship days and gave lectures to pupils and students.

Overview of all your main project results

No.	Self-descriptive title of the result	Category A, B or C*	Partner(s) owning the result(s) (referring in particular to specific patents, copyrights, etc.) & involved in their further use
1	Heat Flux through Fram Strait calculated from high-resolution year-round measurements and from hindcasts with the NAOSIM model	A	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung Institute of Oceanology PAS
2	Freshwater Flux through Fram Strait during 2003-2005 as measured during ASOF-N	A	Norwegian Polar Institute Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung
3	Heat Flux in the Western Barents Slope measured from 2003-2005 during ASOF-N	A	Institute of Marine Research
4	Inflow of Atlantic water into the Nordic Seas measured during ASOF-N from 2003 to 2005	A	LOCEAN (Laboratoire d'Oceanographie et du Climat) Institute of Oceanology PAS
5	Dissemination of results from oceanographic measurements in the Ocean between northern Norway, Spitsbergen and Greenland to decision takers	A	Institute of Marine Research
6	Data and data management of CTD profiles and mooring	A	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung Norwegian Polar Institute Institute of Marine Research Institute of Oceanology PAS LOCEAN (Laboratoire d'Oceanographie et du Climat)
7	Exchanges of volume, heat and freshwater between the Atlantic and the Arctic Ocean	A	Finnish Institute of Marine Research Institute of Oceanology, Polish Academy of Sciences Norwegian Polar Institute Institute of Marine Research LOCEAN (LABORATOIRE D'OCEANOGRAPHIE ET DU CLIMAT) Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung
8	The optimised observing system for monitoring oceanic fluxes in Fram Strait and western Barents Sea	A	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung Finnish Institute of Marine Research LOCEAN (Laboratoire d'Oceanographie et du Climat) Institute of Marine Research Norwegian Polar Institute Institute of Oceanology PAS
9	Data of Lagrangian floats deployed in the Norwegian Sea during the years 2002-2005	A	LOCEAN (LABORATOIRE D'OCEANOGRAPHIE ET DU CLIMAT)

*A: results usable outside the consortium /B: results usable within the consortium /C: non usable results

Quantified Data on the dissemination and use of the project results

Items about the dissemination and use of the project results (consolidated numbers)	Currently achieved quantity	Estimated future* quantity
Product innovations	1	1
Process innovations	1	1
New services (commercial)	0	1
New services (public)	1	1
New methods	2	2
Scientific breakthrought	22	10
Technical standards to which this project has contributed	0	0
EU regulations/directives to which this project has contributed	0	0
International regulations to which this project has contributed	3	3
PhDs generated by the project	0	1
Grantees/trainees including transnational exchange of personnel	3	5

* "Future" means expectations within the next 3 years following the end of the project

Comment on European Interest

Community added value and contribution to EU policies

European dimension of the problem

ASOF-N contributed to understanding the processes that control the transports of warm and salty waters toward the Arctic Ocean and of cold, fresh water and sea ice to the Nordic Seas. This understanding is a prerequisite to predict possible effects of “global warming” on the climate in Northern Europe and to mitigate these effect. The EC decided to foster a European GOOS (Global Ocean Observing System) component, the necessity of which was agreed in the UN FCCC. A measurement array was developed during ASOF-N that is able to monitor cost effectively oceanic fluxes at sufficient resolution. It will permit to establish this well calibrated array as an Arctic component of the European contribution to GOOS. The region covered by the ASOF-N includes very productive fishing grounds, where environmental changes have direct effects on commercial fish stocks, and where a sustainable fishery is of central importance. The region is also of interest as a depository of fossil fuels.

Contribution to developing S&T co-operation at international level. European added value

ASOF-N was integrated in a project cluster of ASOF(EC)W and E and an international component with partners from the US and Canada. The close cooperation between the projects, (project meetings were usually attended by a representative of the cluster) eased the identification of appropriate partners for further studies and contributed to the development of expertise in this research area. The collaboration during joint ASOF-N cruises improved the transfer of methods and know-how. The valuable data sets created during ASOF-N add to the time series generated by previous projects in the region. These data series are the key to understanding the longer time scale variability of the fluxes and their implications. Such effort can only be carried out at the community level and will be continued with IP DAMOCLES which started in 12/2005. The international scientific cooperation will be intensified during the International Polar Year (IPY), an interdisciplinary study of the polar system.

Contribution to policy design or implementation

Results from ASOF-N provided background information to the scientific report from ACIA published in 2005. (details about ACIA, ICES see dissemination and use intentions) and are included into reports to ICES working groups (WGOH, AFWG) and the overall ICES assessment reports. ASOF-N also contributed, by developing an optimised observing system, to the establishment of an European GOOS component, the necessity of which was agreed in the UN Framework Convention on Climate Change (FCCC)and further stressed in the Gleneagles Plan of Action 2005. ASOF-N results are also expected to be communicated to the IPCC (Intergovernmental Panel on Climate Change) through Prof. Lemke (AWI senior scientist and lead author of IPCC 4th Assessment Report). The importance of the IPCC was stressed in the Gleneagles Plan of Action and the analysis of research being undertaken to complete the 4th Assessment report was welcomed in order to manage the impact of climate change.

Contribution to Community social objectives

Improving the quality of life in the Community:

The ASOF-N region includes some of the world's most productive fishing grounds, where climate changes have direct effects on the growth, distribution and food consumption of commercial fish stocks, and where a sustainable fishery is of central importance for the socio-economic conditions of European nations. ASOF-N contributes to the development of a system to monitor environmental change, which could be used to develop a predictive capability to anticipate changes in fish stocks. ASOF-N took a first step towards understanding the regional effects of global change. Reliable predictions of climate change will help implementing adaptation and mitigation measures and ensure employment in sectors likely to be effected (e.g. fisheries, aquaculture, agriculture, oil drilling and transport). The quest to understand our environment is part of our culture and ASOF-N advanced the understanding of the poorly understood Arctic environment.

Provision of appropriate incentives for monitoring and creating jobs in the Community (including use and development of skills):

During ASOF-N all involved scientists continued to improve their expertise and skills, thereby improving chances for future employment. One key aspect in skill development was the involvement of the SME Optimare. The skills acquired during ASOF will improve the competitiveness of this company.

Supporting sustainable development, preserving and/or enhancing the environment (including use/conservation of resources):

ASOF-N contributed to developing predictive capabilities which will reliably anticipate changes in fish stocks. Such a system together with understanding the ocean fluxes are needed for a sustainable use of the productive fishing grounds in these regions. Such an understanding is also necessary to evaluate options and risks of oil drilling and transport activities. In order to conserve such a unique environment as the Arctic a sound understanding of the processes and driving forces of water transport, ice formation and their reaction to climate change is necessary.

Development of an Arctic Ocean Observing System: A measurement array was developed during ASOF-N that is able to monitor cost effectively oceanic fluxes at sufficient resolution. It will permit to establish this well calibrated array as an Arctic component of the European contribution to GOOS.

Expected project impact (to be filled in by the project coordinator)

EU Policy Goals	I SCALE OF EXPECTED IMPACT OVER THE NEXT 10 YEARS -1 0 1 2 3	II other	
		Not applicable to project	Project Impact too difficult to estimate
1. Improved sustainable economic development and growth, competitiveness	0	√	
2. Improved employment	1		
3. Improved quality of life and health and safety	1		
4. Improved education	1		
5. Improved preservation and enhancement of the environment	0		
6. Improved scientific and technological quality	3		
7. Regulatory and legislative environment	1		
8. Other	3		

1. Economic development and growth, competitiveness	Scale of Expected Impacts over the next 10 years (2)	
	By Project End -1 0 1 2 3	After Project End -1 0 1 2 3
a) Increased Turnover for project participants - national markets		
b) Increased Turnover for project participants - international markets		
c) Increased Productivity for project participants		
d) Reduced costs for project participants		
e) Improved output quality/high technology content		

2. Employment	Scale of Expected Impacts over the next 10 years (2)	
	By Project End -1 0 1 2 3	After Project End -1 0 1 2 3
a) Safeguarding of jobs	1	1
b) Net employment growth in projects participants staff	1	2
c) Net employment growth in customer and supply chains	1	1
d) Net employment growth in the European economy at large	0	0

3. Quality of Life and health and safety	Scale of Expected Impacts over the next 10 years (2)	
	By Project End -1 0 1 2 3	After Project End -1 0 1 2 3
a) Improved health care	0	0
b) Improved food, nutrition	1	1
c) Improved safety (incl. consumers and workers safety)	0	0
d) Improved quality of life for the elderly and disabled	0	0
e) Improved life expectancy	0	0
f) Improved working conditions	0	0
g) Improved child care	0	0
h) Improved mobility of persons	0	0

4. Improved education	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End -1 0 1 2 3**
a) Improved learning processes including lifelong learning	1	1
b) Development of new university curricula	0	0
5. Preservation and enhancement of the environment	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End -1 0 1 2 3**
a) Improved prevention of emissions	0	0
b) Improved treatment of emissions	0	0
c) Improved preservation of natural resources and cultural heritage	1	1
d) Reduced energy consumption	0	0
6. S&T quality	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End -1 0 1 2 3**
a) Production of new knowledge	3	3
b) Safeguarding or development of expertise in a research area	3	3
c) Acceleration of RTD, transfer or uptake	1	1
d) Enhance skills of RTD staff	3	2
e) Transfer expertise/know-how/technology	3	2
f) Improved access to knowledge-based networks	2	2
g) Identifying appropriate partners and expertise	2	2
h) Develop international S&T co-operation	3	3
i) Increased gender equality	1	1
7. Regulatory and legislative environment	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End -1 0 1 2 3**
a) Contribution to EU policy formulation	1	2
Contribution to EU policy implementation	0	0
8. Other (please specify)	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End -1 0 1 2 3**
	3	3

Description of Results

No.	Title:
1	**Heat Flux through Fram Strait calculated from high-resolution year-round measurements and from hindcasts with the NAOSIM model**

CONTACT PERSON FOR THIS RESULT

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URL	http://www.awi-bremerhaven.de/
Specific Result URL	http://www.awi-bremerhaven.de/Research/IntCoop/Oce/ASOF/

SUMMARY

Fram Strait is the only deep connection between the Arctic Ocean and Nordic Seas and represents the major gateway for the flux of warm water from mid latitudes to the Arctic Ocean. The oceanic heat imported from the North Atlantic has the potential to affect the ice cover in the Eurasian Arctic and to be released to the Arctic atmosphere. Thus, it is an important component for understanding Arctic climate, which is strongly linked with European climate, necessitating long-term measurements and simulations in a regional model. Since 1997 a continuous time series of volume and heat flux through Fram Strait was derived from measurements with moored instruments. The moorings cover the cross section over the entire deep part of Fram Strait. Temperature and velocity are monitored, allowing to integrate heat fluxes and to distinguish between northward, southward and net fluxes. ASOF-N allowed continuing the time series, which is now sufficiently long to determine the variability of the oceanic fluxes through Fram Strait on interannual time scales - and also to approach the declared objective of the ASOF cluster to capture variability on decadal time scales. The yearly averaged northward heat flow through Fram Strait increased dramatically, from about 38 to 60 Terrawatt (TW), during 1997-2000. In the following years the heat flow decreased slightly although summer temperatures of the inflow measured during ship surveys showed record high values in 2004 and 2005. While moorings record year round data and provide high temporal resolution, they still have a limited spatial resolution. Therefore, since 2001 they are complemented by ADCP (Acoustic Doppler Current Profiler) recordings during ship cruises that deliver high spatial resolution temperature and velocity data sets (typically two or three per year in the summer season). Yearly hydrographic measurements with high spatial resolution were also used to derive the flow field and heat flux with a third independent method.

Key innovative features:

1) The combination of these three observational methods, which to the best of our knowledge has never been published before, is one innovation made during the ASOF-N project in obtaining an as accurate estimate as possible of the heat transport.

2) The complicated topographic structure of Fram Strait leads to a splitting of the warm West Spitsbergen Current into various branches transporting water northward and eastward or recirculating immediately in Fram Strait. The size and strength of the different branches largely determine the input of oceanic heat to the inner Arctic Ocean and have to be distinguished. Therefore one key progress made during ASOF-N was recognizing the strong impact of areas of high recirculation on calculated heat and volume flow. By deploying additional moorings in the central part of Fram Strait the error of calculated heat and volume flow was considerably reduced.

3) A realistic model representation of these different branches was made possible by another innovation, the improved spatial resolution in the North Atlantic-Arctic Ocean-Sea Ice Model (NAOSIM) of AWI. The NAOSIM models use meteorological data and simulate their influence on sea ice, currents, temperature and salinity in the ocean north of approximately 50°N. The improved model has a horizontal resolution of approximately 9km and a vertical resolution of down to 10 m in upper ocean layers (with 50 depths layers in total). The modelling was done for the period from 1990 (using initial conditions in 1990 based on the coarser resolution version of the model) to 2005 using NCEP (National Centers for Environmental Predictions) reanalysis data for the integration. This model version resulted in a number of improvements, for instance the far better reproduction of the recirculation of Atlantic waters in Fram Strait. The averaged northward volume transport increased to around 10 Sverdrup (Sv) between 1995 and 2003. This fits observations much better than the around 3Sv of the previous model. The good agreement between the model and the observationally based estimates in Fram Strait makes it possible to use the model to relate changes in Fram Strait to large scale oceanic developments.

Potential users:

- The scientific community working in climate research (because the oceanic heat flux through Fram Strait is an important part in the North Atlantic and Arctic heat balance)
- Scientists working in Arctic Ocean research (influence of ocean temperature on sea ice, atmosphere, chemical & biological processes)
- Off-shore technology and shipping in the Arctic (since the oceanic heat is expected to affect the Arctic ice cover)
- Commercial fishery (because of the temperature effect on the distribution of marine organisms)
- Advisory panels for national and international policies

SUBJECT DESCRIPTORS CODES

172 EARTH OBSERVATION TECHNOLOGY AND INFORMATION EXTRACTION
174 EARTH SCIENCES FOR CLIMATE RESEARCH
272 GLOBAL CHANGE: CLIMATE CHANGE
369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)
400 MODELLING/MODELLING TOOLS, 3-D MODELLING

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Scientific article (peer reviewed)	Fahrbach, E., J. Meincke, S. Østerhus, G. Rohardt, U. Schauer, V. Tverberg, and J. Verduin (2001), Direct measurements of volume transports through Fram Strait, Polar Research, 20(2), 217-224.	Public
Scientific article	Gerdes, R., M. Karcher, F. Kauker, and U. Schauer (2003), Causes	Public

(peer reviewed)	and development of repeated Arctic Ocean warming events, Geophysical Research Letters, Vol.30, 1980.(No.19), DOI: 10.1029/2003GL018080.	
Scientific article (peer reviewed)	Polyakov, I.V., A. Beszczynska, E.C. Carmack, I.A. Dmitrenko, E. Fahrbach, I.E. Frolov, R. Gerdes, E. Hansen, J. Holfort, V.V. Ivanov, M.A. Johnson, M. Karcher, F. Kauker, J. Morison, K.A. Orvik, U. Schauer, H.L. Simmons, Ø. Skagseth, V.T. Sokolov, M. Steele, L.A. Timokhov, D. Walsh, and J.E. Walsh (2005), One more step toward a warmer Arctic, Geophysical Research Letters, in press.	Public
Scientific article (peer reviewed)	Rudels, B., Jones, E.P., Schauer, U., Eriksson, P. (2004) Atlantic sources of the Arctic Ocean surface and halocline waters Polar Research 232 (2) 181-208	Public
Scientific article (peer reviewed)	Waldemar Walczowski, Jan Piechura, Robert Robert Osiński, Piotr Wieczorek (2005), The West Spitsbergen Current volume and heat transport from synoptic observations in summer, Deep Sea Research I, 52 (2005) 1374-1391	Public
Scientific article (peer reviewed)	Schauer, U., Fahrbach, E., Osterhus, S., Rohardt, G. (2004) Arctic warming through the Fram Strait - oceanic heat transport from three years of measurements. Journal of Geophysical Research 109	Public
Scientific article (peer reviewed)	Karcher, M. J., Gerdes, R., Kauker, F., Koeberle, C.(2003). Arctic warming - Evolution and Spreading of the 1990s warm event in the Nordic Seas and the Arctic Ocean, Journal of Geophysical Research, Vol. 108(C2), 3034, 10.1029/2001JC001265	Public

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	**KNOWLEDGE: Tick a box and give the corresponding details(reference numbers, etc) if appropriate**					**Pre-existing know-how Tick a box and give the corresponding details(reference numbers, etc) if appropriate**	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:						√	NAOSIM Hierarchy of Ocean Sea Ice Models was provided by AWI

1) Number of **P**riority (national) applications/patents
2) Number of **I**nternationally extended applications/patents

MARKET APPLICATION SECTORS

Market application sectors
80 Education
73 Research and development
61.1 Sea and coastal water transport

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	2	46
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	0	11
Targeted user audience: of reachable people	250	500
& publications (referenced publications only)	5	7
publications addressing general public (e.g. CD-ROMs, WEB sites)	2	4
publications addressing decision takers / public authorities / etc.	0	3
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

Based on the results of ASOF-N, time series of heat flow through Fram Strait will be continued within the EU-funded IP "DAMOCLES" (Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies). The aim is to obtain longer time series to be able to tackle decadal variability of the fluxes and to improve and develop new instrumental technology based on experiences during ASOF-N to monitor the input of mass and heat to the Arctic Ocean.

The flux time series will be used in order to integrate the expected high resolution SPACE (Synoptic Pan-Arctic study of Climate and Environment) planned during the International Polar Year 2007/08 (IPY).

In a Polish/US cooperation the velocity measurements from lowered ADCPs will be combined with modelling activities in the SBI (Shelf-Basin Interaction) project.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

In the course of the three follow up projects and one proposal, there might be the demand for scientist or Ph.D. students fitting the requirements of the programme.

No.	Title:
2	**Freshwater Flux through Fram Strait during 2003-2005 as measured during ASOF-N**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

Background and result description: Fram Strait is the main source of freshwater for the Greenland and Iceland Seas. Along with Davis Strait it is also the main provider of freshwater for the Labrador Sea and North Atlantic. This freshwater export from the Arctic to subarctic seas have the potential to influence the northbound current systems by modifying the stratification of the receiving basins. This would alter the oceanic heat transport, which again would influence the climate of North Western Europe. The export of fresh water occurs in liquid (polar water) and solid (sea ice) phase. With the advent of ASOF-N we were able to continue and extend existing time series (solid phase freshwater flux since 1990 and liquid freshwater flux since 1997), and hence determine the seasonal and interannual variability of freshwater fluxes through Fram Strait. The annual cycle of the liquid freshwater transport in the East Greenland Current (EGC) has a minimum in spring (~600 km3/yr) and a maximum in late summer (~2000 km3/yr). The mean of the transport time series is 900 km3/yr. The anomalies with respect to the mean seasonal cycle have a magnitude of typically 500 km3/yr. There is no general trend in the freshwater transport over the period 1997 to 2005. From the first ASOF-N winter time CTD section and the first mooring on the shelf it is clear that additional moorings are needed, as there is a potential for considerable freshwater transport across the wide shelf. During the May 2005 cruise low salinity water was found also east of the EGC, meaning that an additional freshwater transport could occur east of the existing mooring array. The comparison between fresh water observations at 79 N, 74 N and 63 N so far shows no significant signal propagation of water mass characteristics along the EGC path, in contrast to what is observed along the Atlantic Water path in the east.
Key innovations: Time series have been maintained using more basic observational arrays since 1997 but ASOF-N allowed using a full scale version of the observational array facilitating.

Key innovations:

1) With the advent of ASOF-N we were able to tailor make the observational setup to study fresh water transport, as far as the physical conditions allow. This includes near surface salinity sensors and tube moorings with ADCPs (Acoustic Doppler Current Profiler).

2) The wide shelf at this latitude was an open issue as due to extensive ice cover and icebergs drifting through the region, access is difficult and moorings are not likely to survive. Few observations have therefore been made in this area. Introducing tube moorings has provided our first direct measurements of salinity on the shelf at 79 N.

3) The moorings provide year round point measurements in the vertical and horizontal. Annual cruises during summer provide high resolution hydrography which aids in the interpretation of the point measurements. However, for the observation of freshwater fluxes we also need high resolution spatial information on the seasonal cycle of the stratification. An extensive ice cover with heavy multiyear ice has prevented access to the region during winter. In 2005 a coastguard ice breaker was used to penetrate into the pack, serving as a base for helicopter CTD transects with portable equipment. This allowed ASOF-N to do the first high resolution wintertime hydrographic transect.

4) For some years freshwater observations have been performed also at the 74 and 63 North latitudes. With ASOF-N we were able to do the first comparisons of freshwater observed at these different latitudes. The aim of this ongoing work is to draw conclusions on the fate and pathways of freshwater exiting the Arctic at 79 N.

5) Model results from the high resolution version of AWI's NAOSIM have been used to fill spatial and temporal gaps in the observations and to link the freshwater fluxes in the East Greenland Current with the large scale oceanic circulation as well as with the meteorological forcing fields. The large liquid fresh water export event of the mid-1990s could thus be linked to changes in the Arctic Ocean freshwater distribution during previous years. These redistributions were forced by the strong positive NAO wind forcing during the early 1990s. Current status: The time series are now approaching a length which will enable us to quantify variability on decadal time scales, a stated objective of the ASOF cluster.

Potential users:

Climate scientists, since the freshwater output from the Arctic is thought to influence the net densification at high latitudes, and hence the current systems governing the oceanic heat transport to northern regions.

Oceanographers working in the Labrador and Nordic Seas, since the freshwater output will modify the stratification and hence the processes occurring here.

Advisory panels for national and international policies, particularly when the link between Arctic freshwater output and the climate system is better established.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT

174 EARTH SCIENCES FOR CLIMATE RESEARCH

269 GEOPHYSICS, PHYSICAL OCEANOGRAPHY, METEOROLOGY, GEOCHEMISTRY, TECTONICS

272 GLOBAL CHANGE: CLIMATE CHANGE

369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Scientific article (peer reviewed)	Holfort, Jürgen; Hansen, Edmond Timeseries of Polar Water properties in Fram Strait (2005) Geophys. Res. Lett., Vol. 32, No. 19, L19601	Public
Scientific article (peer reviewed)	Polyakov, Igor V.; Beszczynska, Agnieszka; Carmack, Eddy C.; Dmitrenko, Igor A.; Fahrbach, Eberhard; Frolov, Ivan E.; Gerdes, Rüdiger; Hansen, Edmond; Holfort, Jürgen; Ivanov, Vladimir V.; Johnson, Mark A.; Karcher, Michael; Kauker, Frank; Morison, James; Orvik, Kjell A.; Schauer, Ursula; Simmons, Harper L.; Skagseth, Øystein; Sokolov, Vladimir T.; Steele, Michael; Timokhov, Leonid A.; Walsh, David; Walsh, John E. One more step toward a warmer Arctic Geophys. Res. Lett. (2005) Vol. 32, No. 17, L17605 10.1029/2005GL023740	Public
Book chapter in preparation	Hansen et al Fresh water fluxes east of Greenland	Confidential

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	**KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate**					**Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate**	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

80 Education

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0

Number of (public or private) entities potentially involved in the implementation of the result:	2	53
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	1	18
Targeted user audience: of reachable people	150	500
& publications (referenced publications only)	1	5
publications addressing general public (e.g. CD-ROMs, WEB sites)	4	2
publications addressing decision takers / public authorities / etc.	5	5
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The observations will continue, partially funded under the EU funded Integrated Project DAMOCLES. The subtask dealing with the effect of the Arctic output of freshwater will directly build on the results achieved during ASOF-N. The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

Oceanographer and sea ice physicists can contribute within new projects. Field work expertise as well as experiences with EU funded projects are of advantage.

No.	Title:
3	**Heat Flux in the Western Barents Slope measured from 2003-2005 during ASOF-N**

CONTACT PERSON FOR THIS RESULT

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Specific Result URL	

SUMMARY

The Barents Sea influences the Arctic Ocean both by providing a pathway for Atlantic Water (AW), but also as a shallow shelf sea producing dense water through cooling and brine release. The Barents Sea provides intermediate water down to 1200 m depth in the Arctic Ocean, and, together with the Kara Sea, is the only source area for shelf waters ventilating the Nansen Basin below the halocline. Thus, knowledge of the variability of the Atlantic inflow to the Barents Sea is important for the understanding of the climatic state of the Arctic Ocean, and for evaluations of climate change. ASOF-N continued a time series started in 1997 of volume and heat flux through the Western Barents Slope (WBS) using moored instruments. These cover the cross section where the Atlantic inflow takes place -with the exception of heavily fished waters. Temperature and velocity are monitored, allowing to integrate heat fluxes and to distinguish between eastward, westward and net fluxes. The time series is now sufficiently long to determine the variability of the oceanic fluxes through the WBS on interannual time scales - and to approach the declared objective of the ASOF cluster to capture variability on decadal time scales. The long-term mean heat flux is 40 Terrawatt (TW) into the Barents Sea. Considering the interannual variability there was a relatively high heat flux into the Barents Sea in the winter of 2002/2003. Thereafter there was a pronounced decrease and 2003/2004 had the lowest heat flux observed during winter. In addition to the moorings, hydrographic measurements with high spatial resolution were used to derive flow field and heat flux six times a year.

Key innovative features and findings:

1) The combination of these two observational methods is one innovation made during the ASOF-N in obtaining an estimate of heat transport as accurate as possible.

2) The splitting of the flow of AW across the WBS was observed to take place in one wide branch but also to be split into several narrower branches, depending on the wind field. Between the branches there might be a weaker inflow or a return flow. At times the flow across the section is dominated by outflow (westward flow) and AW is flowing into the Barents Sea only in the southernmost part of the section.

3) There is no correlation between the fluxes and the temperature of the inflowing water. In fact, in certain periods temperature increases while the volume flux decreases. This shows that the WBS temperature is independent of the volume flux. The reason is that while the temperature of the inflowing water depends on the temperatures upstream in the Norwegian Sea, the volume flux depends mainly on the local wind field. This shows the importance of measuring both volume transport and temperature, since they not always are varying in the same manner. The short-time variations in the heat flux closely resembles the short-time variations in the volume flux, while the temperature variations influence the longer term variations in the heat flux.

4) A realistic model representation of the Barents Sea region was made possible by another innovation, the coupling of a dynamic-thermodynamic sea ice model to a three-dimensional ocean general circulation model for the purpose of conducting climate dynamical downscaling experiments for the Barents Sea region. The Regional Ocean Model System (ROMS, http://marine.rutgers.edu/po/index.php?model=roms) was chosen as most appropriate since its model architecture is suitable for shelf seas as the Barents Sea. The improvement of the ROMS model is the sea-ice model extension, which performs well also on the high resolution grid used and is absolutely necessary for realistic Barents Sea simulations. The model will be used to conduct a hindcast for the period 1990-2005 including 3D fields of velocity and hydrography as well as water level and sea ice thickness and concentration. The horizontal grid resolution is ~10km. The vertical is resolved by 32 terrain

following levels. Previous model validation with results from a similar model implementation (i.e. using slightly different and less accurate forcing) against observations show that seasonal and interannual variability in the ocean are tracked successfully. Furthermore the model results are used to examine details in space not covered by observations (incl. estimates of the throughflow of AW in the Barents Sea to the Arctic Ocean).

Potential users:

Scientists in climate research - the oceanic heat flux through the Barents Sea is an important part in the North Atlantic and Arctic heat balance.

Scientists in Arctic Ocean research – influence of ocean temperature on sea ice, atmosphere, chemical & biological processes.

Off-shore technology and shipping in the Barents Sea and the Arctic - oceanic heat is expected to affect the Arctic ice cover.

Commercial fishery - the temperature effect on the distribution of marine organisms.

Advisory panels for national and international policies.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT

174 EARTH SCIENCES FOR CLIMATE RESEARCH

269 GEOPHYSICS, PHYSICAL OCEANOGRAPHY, METEOROLOGY, GEOCHEMISTRY, TECTONICS

271 GLOBAL CHANGE: BIOGEOCHEMICAL AND HYDROLOGICAL CYCLES

400 MODELLING/MODELLING TOOLS, 3-D MODELLING

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Scientific article (peer reviewed)	Ingvaldsen, Randi B. Width of the North Cape Current and location of the Polar Front in the western Barents Sea Geophys. Res. Lett., Vol. 32, No. 16, L16603 10.1029/2005GL023440	Public
Scientific article (peer reviewed)	Ingvaldsen R., Asplin L., Loeng H. 2004 The seasonal cycle in the Atlantic transport to the Barents Sea during the years 1997-2001 Continental Shelf Research 24 (2004) 1015–1032	Public
Scientific article (peer reviewed)	Ingvaldsen R., Asplin L., Loeng H. 2004 Velocity field of the western entrance to the Barents Sea. Journal of Geophysical Research vol. 109, C03021	Public
Scientific article (peer reviewed)	Budgell, W. 2005 Numerical simulation of ice-ocean variability in the Barents Sea region Ocean Dynamics, vol. 55, no. 3, pp. 370-387	Public
Report	The Deliverable D 2.6 describes the process of analysing the archive of model results. The analysis includes validation against the available observations of currents and hydrography at the WBS. Furthermore the model results are used to examine details in space not covered by the available observations (including estimates of the throughflow of AW in the Barents Sea to the Arctic Ocean).	Confidential

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate					Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

80 Education
73 Research and development
61.1 Sea and coastal water transport

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	1	61
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	1	15
Targeted user audience: of reachable people	500	800
& publications (referenced publications only)	4	8
publications addressing general public (e.g. CD-ROMs, WEB sites)	10	10
publications addressing decision takers / public authorities / etc.	4	4
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	

MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

The studies on the Heat flux western Barents Slope are of interest to a wide scientific community, especially to:

- Climate scientists, since the freshwater output from the Arctic is thought to influence the net densification at high latitudes, and hence the current systems governing the oceanic heat transport to northern regions.
- Oceanographers working in the Labrador and Nordic Seas, since the freshwater output will modify the stratification and hence the processes occurring here
- Advisory panels for national and international policies, particularly when the link between Arctic freshwater output and the climate system is better established.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

Within the new projects physical oceanographers and modellers will be involved. A partner that has experience in Air-Sea-Ice interactions will be of special use to the projects.

No.	Title:
4	**Inflow of Atlantic water into the Nordic Seas measured during ASOF-N from 2003 to 2005**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

The Atlantic water masses circulating across the Nordic Seas towards the Arctic Ocean, are of prime importance for the climate of the northern hemisphere. An excessive freshening of the Nordic Seas might be a prelude to a slow down of warm and salty Atlantic water masses advected from subtropical regions towards the Arctic Ocean. This reduced input of Atlantic water masses and their transformation in denser Arctic intermediate waters might eventually

lead to a shut down of the general thermohaline circulation and overturning in the northern North Atlantic. At the moment the observations taken at various strategic spots in the Nordic Seas and the Arctic Ocean, tend to indicate a temperature increase of Atlantic warm and salty waters all along the continental margin north of Eurasia intruding in large sectors of the central basin of the Arctic Ocean.

ASOF-N allowed studying Atlantic water pathways across the northern Norwegian Sea (Lofoten and Boreas basins) as well as the time and space variability of heat, salt and total transports associated with the Norwegian Atlantic current. The equipment and combined effort of three institutions (LOCEAN-formerly known as LODYC, Paris, France, IMR, Bergen, Norway and IOPAN, Sopot, Poland) was used to install the following main instruments (a) neutrally buoyant floats tracked acoustically underwater, (b) current meters installed on moorings and (c) CTD and LADCP operated from research vessels during field campaigns organised in 2003, 2004 and 2005.

The main objectives consisted in:

(1) studying the Norwegian Atlantic current and eventually confirm the nature of the general circulation of Atlantic water masses in the Lofoten and Boreas basins,

(2) measuring the variability in temperature and salinity of the Atlantic water masses circulating across the northern Norwegian sea,

(3) observing the main pathways of Atlantic water masses entering either in the Barents Sea or heading north towards Fram Strait,

(4) estimating the heat losses to the atmosphere versus the heat transferred to deep Arctic intermediate waters and the freshening via internal mixing of the Atlantic water masses in the Lofoten Boreas basins and the Greenland Sea.

The key scientific results:

(1) The real nature and structure of the so-called Norwegian Atlantic current which looks more like a broad and highly turbulent current extending 100 kms offshore from the shelf break of the Lofoten basin, rather than a narrow jet current constrained to the continental slope west of Norway, as often described in the literature.

(2)The two stream nature of the West Spitsbergen Current

(3) The intense and prominent mesoscale eddy variability characterizing the Norwegian Atlantic current, and the West Spitsbergen Current.

(4) A pronounced seasonal and interannual variability of temperature and salinity fields showing episodic freshening and cooling events.

(5) A remarkable interannual variability of the main transport of Atlantic water masses across the Lofoten basin.

(6) A long-term variability of temperature and salinity fields corresponding to an increase in temperature and salinity of the Atlantic water masses of more than 0.5°C and 0.1 psu over the past 25 years.

(7) The pulsating nature of the Atlantic Water transport within the West Spitsbergen Current.

(8) The close relation of the Atlantic Water volume transport with the local forcing in short-term variability.

The strategy used for better documenting the Atlantic water masses pathways in the northern Norwegian Sea was based on a combination of Eulerian techniques (moorings) and Lagrangian techniques (floats) as well as observations taken from research vessels (CTD, LADCP). This strategy provided an unprecedented level of information concerning the nature, structure, time and space variability of the Norwegian Atlantic current, the main carrier of Atlantic water masses to the Arctic Ocean.

Potential users:

Besides scientists interested in the role of the ocean circulation on climates, our result show important avenues to explore together with biologists concerned with the impacts of the physical environment on biomass accumulation, plankton distribution, over-wintering of fish larvae and all other major aspects characterizing one of the most productive ecosystems on Earth.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT
272 GLOBAL CHANGE: CLIMATE CHANGE
369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Scientific article (peer reviewed)	Polyakov, Igor V.; Beszczynska, Agnieszka; Carmack, Eddy C.; Dmitrenko, Igor A.; Fahrbach, Eberhard; Frolov, Ivan E.; Gerdes, Rüdiger; Hansen, Edmond; Holfort, Jürgen; Ivanov, Vladimir V.; Johnson, Mark A.; Karcher, Michael; Kauker, Frank; Morison, James; Orvik, Kjell A.; Schauer, Ursula; Simmons, Harper L.; Skagseth, Øystein; Sokolov, Vladimir T.; Steele, Michael; Timokhov, Leonid A.; Walsh, David; Walsh, John E. One more step toward a warmer Arctic Geophys. Res. Lett. (2005) Vol. 32, No. 17, L17605 10.1029/2005GL023740	Public
Scientific article (peer reviewed)	Orvik, K. A., and Ø. Skagseth (2005), Heat flux variations in the eastern Norwegian Atlantic Current toward the Arctic from moored instruments, 1995–2005, Geophys. Res. Lett., 32, L14610, doi:10.1029/2005GL023487.	Public

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate					Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	2	50
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	0	18
Targeted user audience: of reachable people	150	300
& publications (referenced publications only)	1	3
publications addressing general public (e.g. CD-ROMs, WEB sites)	1	10
publications addressing decision takers / public authorities / etc.	0	2
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html).

The combination of Eulerian (moorings) and Lagrangian (floats) techniques proved to be adequate and should be pursued in the future. Special emphasis should be taken on separating various scales of variability from general trends in the change of Atlantic water pathways. Furthermore emphasis should be given to the various mechanisms responsible for the variability observed on the shelves, the continental slope and the abyssal plain. New techniques such as sea gliders are very promising for dealing with these issues and in particular for studying internal mixing due to high frequency forcing such as tidal currents which are prominent all along the continental slope. Temperature and salinity fields should be retrieved in full coherency with currents and transports of water masses.

There are numbers of well structured programs such as PAN-AME (An EoI for IPY dealing with a Pan Arctic Cluster for Climate forcing of the Arctic Marine Ecosystem) the future EU Integrated Project DAMOCLES standing for Developing Arctic Modelling and Observing

Capabilities for Long-term Environmental Studies. ESSAS (EcoSystem Studies of SubArctic Seas) within GLOBEC (the International Geosphere-Biosphere Programme(IGBP) core project responsible for understanding how Global Change will affect the abundance, diversity and productivity of marine populations) which would strongly profit from developing active cooperation with ASOF-like programs.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

No.	Title:
5	**Dissemination of results from oceanographic measurements in the Ocean between northern Norway, Spitsbergen and Greenland to decision takers**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

The region covered by the ASOF-N includes some of the most productive fishing grounds of the world, where environmental changes have direct effects on the growth, recruitment, distribution, migration and food consumption of commercial fish stocks, and where a sustainable fishery is of central importance for the social and economic conditions of nations. The need is for a reliable system of environmental change monitoring to use in developing a predictive capability, which will reliably anticipate changes in fish-stocks. The Barents Sea for example is a high latitude ecosystem that is heavily depending on the inflow of Atlantic water from the south. Recent current measurements show a great variability of heat flux to the Barents Sea, which has consequences for the marine ecosystem. The heat flux has impact on species composition, distribution and migration of commercially important fish species. In addition the heat flux also determines the possibility of a Northern Sea route and the exploitation of natural resources (fossil fuel). It is therefore important to continue scientific activities to monitor this flow in order to investigate how it is related to climate variability and change. At the same time it is of prime importance to disseminate the scientific results and their implications to politicians and stake holders like fisheries organisations and the general public.

Current status:

ASOF-N data were compared with models and used for the preparation of information of ASOF-N results in a layman language. ASOF-N is an excellent example where observations and model results support each other in a very positive way: observations are used to validate model results and on the other hand, models are important tools for explaining variability in the observations. The results of ASOF-N therefore support the requirements for data derived both from mathematical models and observational data. In addition information on ASOF-N results were supplemented by results from related projects (ECOBE; ProClim and NESSAS)

with financial support from the Research Council of Norway. These results were presented in layman language to fisheries organisation as talks, newspaper articles and in form of a leaflet that was distributed during an Aquaculture exhibition through IMR, Norway. Scientific results on the effect of the changing climate on the marine ecosystem was also presented to the Norwegian Ministry of Fisheries during an oral presentation. In addition results on climate variability and its link to ecosystem development have been conveyed to the general public especially students and high school teachers during lectures given at universities and schools.

Results from ASOF-N and the EU-funded preceding projects VEINS and MAIA also gave background information to the scientific report from the Arctic Climate Impact Assessment (ACIA) published in 2005. ACIA is an international project of the Arctic Council and the International Arctic Science Committee (IASC), to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences. The Arctic Council is a high level intergovernmental forum of the following member states: Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America.

The ASOF-N results are included into reports to ICES (the International Council for the Exploration of the Sea), which gives advice to the member countries and helps them manage the North Atlantic Ocean and adjacent seas. The results are included in a few reports presented at different ICES working groups like Working Group on Oceanic Hydrography (WGOH) and Arctic Fishery Working Group (AFWG), and during the last two years also included in ICES assessment reports.

Benefits:

The communication of scientific results based on measurements in the Arctic as well as on predictive models to decision takers is a central requirement for anticipating and mitigating the regional effects of global warming.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT
272 GLOBAL CHANGE: CLIMATE CHANGE
366 MARINE ECOSYSTEMS
369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)
400 MODELLING/MODELLING TOOLS, 3-D MODELLING

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Report	ACIA report Impacts of a Warming Arctic - Arctic Climate Impact Assessment available at http://amap.no/acia/ or at Cambridge University Press ISBN-10: 0521617782	Public
Newsletter	Asplin, L., R. Ingvaldsen, H. Loeng and R. Sætre, 2005: General aspects of the southern Barents Sea circulation, Globec International Newsletter, Vol.11, no.1, p15	Public
Scientific article (peer reviewed)	Ottersen, G., Loeng, H., Ådlandsvik, B. and Ingvaldsen, R. 2003. Temperature variability in the northeast Atlantic. Ices Mar. sci. Symp.219 86-94	Public
Scientific article	Loeng, H. and Sætre, R. 2001. Features of the Barents Sea circulation. Fisken og Havet, 2001 (1): 1-40	Public
Scientific article (peer reviewed)	Tengberg, A., Andersen, T., Guillen, J., Hovdenes, J., Ingvaldsen, R. Józa, J. Loeng, H., Minken, H., Palanques, A., Pejrop, M. and	Public

	Sakkula, J. 2001. Use of current meters in aquatic research and engineering. Sea Technology, 42.2, 10-18.	

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate					Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

80 Education

05 Fishing, operation of fish hatcheries and fish farms; service…

73 Research and development

61 Water transport

CURRENT STAGE OF DEVELOPMENT

Other:

Dissemination activities

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	1	45
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	1	11
Targeted user audience: of reachable people	750	1500
& publications (referenced publications only)	0	0
publications addressing general public (e.g. CD-ROMs, WEB sites)	5	6
publications addressing decision takers / public authorities / etc.	6	6
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The current measurements started out in the EU-funded VEINS project in 1997 and continued under MAIA and finally under ASOF-N. In the future, the measurements will be a part of DAMOCLES and probably the International Polar Year (IPY). The array of moorings between Norway and Bear Island with support from EU, has recently been expanded with financial support from the Research Council of Norway and includes measurements in the inflowing Norwegian Coastal Current and the outflowing Arctic water south of Bear Island.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

The following partners could contribute to the advice of managers:
economists to assess the impact of climate change on the economy,
physical oceanographers to continue the mooring and CTD time series,
modellers to contribute to observationally supported model improvements.

No.	Title:
6	**Data and data management of CTD profiles and mooring**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

Result description CTD Data: CTD (Conductivity, Temperature, Depth) profiles were measured during 10 cruises in 2003 and during 10 cruises in 2004, 11 cruises in 2005 and 0ne cruise in 2006 by AWI, IFMH, IMR, IOPAS, and NPI across Fram Strait, in the East Greenland Current between 74° and 79° N and in the eastern part of the Greenland Sea. Detailed information on the CTD stations can be found at the ASOF-N website. The CTD

dataset contains 2514 profiles which can be retrieved via www.awi-bremerhaven.de/OZE. A summary of CTD datasets are presented in Tables provided in the documentation.

Instruments:

All institutions used a Sea Bird SBE911plus CTD profiler with a single CT-Sensor package (double CT-Sensor for AWI profilers). The CT sensors were frequently calibrated at Seabird Electronics. In addition salinity samples were taken to correct for sensor drift. The final data have been processed using Seabirds post-processing software which includes all necessary operations. The raw data have a vertical resolution of 0.04 dbar but still including noise e.g. due to ship motion. To reduce this noise, data were averaged to a vertical resolution of 1dbar. The number of data cycles averaged in each 1dbar record was stored together with the individual data points. ASOF-N continued a CTD time series started in 1997, which is now sufficiently long to determine the variability on interannual time scales - and also to approach the declared objective of the ASOF cluster to capture variability on decadal time scales.

Result description

Mooring Data:

Moorings were deployed and recovered during 15 cruises from 2003 to 2005 by AWI, IFMH, IMR, and NPI across Fram Strait and in the East Greenland Current at 74° N. A detailed map with mooring location is provided in the documentation. The current dataset contains 900 time series which can be retrieved via www.awi-bremerhaven.de/OZE. A summary of mooring records are presented in the documentation.

Instruments:

Most instruments being used in the mooring were current meters. Reliable current measurements were maintained by frequent services (usually before and after deployment). The common current meter type is a rotor current meter from Aanderaa Instruments. In addition to current speed and direction these instruments also measure temperature. CT recorders from Seabird (SBE16, SBE37) were used to measure precise temperature and salinity based on calibrations before deployment and after recovery. The sample rate depends on the different instrument types (and their power consumption and memory size) and ranges between 10 minutes and 2 hours. Data processing was done by the institution that provided the instrument. The standard procedures included converting binary data to engineering units, apply magnetic deviation correction, removing of spikes (small gaps were filled by interpolation and long gaps were filled with a dummy data value, e.g. NaN) and correcting for sensor drifts for example by applying post calibration.

Potential users:

Scientists working in Arctic Ocean research

Archiving and providing the data:

As important as collecting new data about the temporal variability of oceanographic parameters, is the availability of collected data. The ASOF-N partner send their processed and calibrated CTD and/or mooring datasets to the AWI where they are stored together with information about additional dataset available for this region. The data are transferred into a uniform format and archived in AWI's database with general cruise and instrument information. ASOF-N partners have password protected direct access via the internet or can order complete datasets on CD.

This process has the following key advantages:

Project partners can access all collected data from all over the world via the internet without delay. This is of great importance especially in the oceanographic community where scientists are often on cruises and answering requests for data are therefore delayed. Data are provided centrally in a uniform data format. The time consuming process of converting data is performed centrally using a fixed routine. The user accesses a uniform data format and can compare profiles directly without tedious and time consuming conversion of data formats. The data format supports importing of data using Matlab if desired by the user and can be visualised using the software ODV (Ocean Data View). ODV can be retrieved from http://odv.awi-bremerhaven.de. In contrast to archives, this working data base can be easily edited after the upload. This easy modification of the database allows for a fast correction if comparisons of data sets reveal faulty data points. Furthermore it enables the subsequent expansion of the data base. CTD data are processed fast and can made available immediately and data sets that need more time to process e.g. oxygen profiles can be easily added at a later stage without affecting the accessibility of CTD data.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT
150 DATABASES, DATABASE MANAGEMENT, DATA MINING
172 EARTH OBSERVATION TECHNOLOGY AND INFORMATION EXTRACTION
174 EARTH SCIENCES FOR CLIMATE RESEARCH
269 GEOPHYSICS, PHYSICAL OCEANOGRAPHY, METEOROLOGY, GEOCHEMISTRY, TECTONICS

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: PU=Public CO=Confidential**
Map of CTD stations and Moorings	The files show the location of moorings and CTD cruises. Additional information include number of profiles and time series, information on research vessels and cruise dates.	Public
Webpage	Detailed information on CTD stations and moorings can be found at: www.awi-bremerhaven.de/Research/IntCoop/Oce/ASOF/data-management/Map-CTD-Moor.htm. The CTD and mooring datasets can be retrieved via www.awi-bremerhaven.de/OZE.	Public
Data CD ROM	The complete ASOF-N dataset is available on CD ROM	Confidential

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	**KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate**					**Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate**	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							

Other - please specify:						

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	5	45
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	2	11
Targeted user audience: of reachable people	50	500
& publications (referenced publications only)	0	0
publications addressing general public (e.g. CD-ROMs, WEB sites)	2	1
publications addressing decision takers / public authorities / etc.	0	0
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

The data will be of interest for scientists working in Arctic ocean research. The strategy used during ASOF-N to improve the availability of collected data, is of interest for all scientist collecting large amount of data with different instruments or project partners. The data collected during ASOF-N were accessible for project partners via internet from all over the world in a uniform data format without delay. The working data base used during ASOF-N can be easily edited and expanded.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

No.	Title:
7	**Exchanges of volume, heat and freshwater between the Atlantic and the Arctic Ocean**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

Motivation:

One key question in Arctic climate research is, whether the sensible heat carried by the oceanic inflow can influence the formation of sea ice and whether e.g. a large increase in oceanic heat input could considerably diminish the ice cover. The inflow of water and heat from the Atlantic Ocean to the Arctic Ocean was studied during the ASOF-N programme. The Atlantic water (AW) reaches the Arctic Ocean through two passages, the deep (2600m) Fram Strait and across the broad shelf of the Barents Sea, where it enters through the Bear Island Channel and passes through the Barents Sea into the Kara Sea and most of the AW continues into the Arctic Ocean via the St. Anna Trough. The programme also attempted to quantify the outflow of sea ice and low salinity surface water (the export of liquid freshwater) from the Arctic Ocean to the Nordic Sea through Fram Strait and, since Fram Strait is the only deep passage connecting the Arctic Ocean to the world ocean, to estimate the exchanges of intermediate and deep waters between the Arctic Ocean and the Nordic Seas. The AW was followed on its way through the Norwegian Sea from the Greenland – Scotland Ridge to the two inflow passages and the strength of the transport and the changes in water mass characteristics were studied.

Background information:

The AW loses a considerable amount of heat in the open area north of Svalbard, the Whalers' Bay, to the atmosphere and to the melting of ice. As the AW then passes eastward along the continental slope, it is covered by a less saline surface layer comprising AW diluted by ice melt, and its still large heat content is isolated from the sea ice and the atmosphere. The transformations of the Barents Sea inflow are much larger. Denser water masses are created that enter the deeper layers of the Arctic Ocean, as well as less dense waters that eventually enter the central Arctic Ocean and supply the low salinity surface water, the polar mixed layer, of the Arctic Ocean. The strongest transformation affecting the AW after it has entered the Arctic Ocean occurs north of the Kara Sea, where it meets and mixes with the colder, less saline Barents Sea branch entering the Arctic Ocean via the St. Anna Trough. The mixing between the two branches leads to a cooling of the AW in the Fram Strait branch. The heat still remains in the Atlantic layer, but it is now distributed over a larger volume. The largest changes in AW characteristics occur, when it penetrates from one basin into another basin and mixes with the water column present there. Another process changing the water mass

properties in the deep Arctic Ocean basins is the injection of cold, dense water, formed by ice formation and brine rejection on the shelves, which sinks down the slope as dense, entraining boundary plumes. Some plumes enter and cool the Atlantic layer, some sink deeper, entrain AW and bring it into the deep, warming the deeper layers.

Key findings:

Time series from the ASOF-N moorings in Fram Strait showed that several pulses of warmer AW combined with a stronger inflow, passed through the strait, adding heat to the interior of the Arctic Ocean. The net flow through Fram Strait is generally southward, ranging between 1 and 2 Sv. However, over long periods, extending over more than a year a monthly mean net transport into the Arctic Ocean was measured. The strength of this transport was close to 1 Sv. The AW supplies the main inflow of volume, salt and heat to the Arctic Ocean. The inflow through Fram Strait is, according to the recent ASOF-N results, an order of the magnitude larger than the inflow of Pacific water through Bering Strait, 10Sv as compared to 1Sv from the Pacific. In addition the inflow over the Barents Sea contributes about 1.5 Sv of AW. However, not all 10 Sv entering through Fram Strait are AW but also include intermediate and deep waters and a large part may be involved in a recirculation in, or just north of, the strait. The circulation loops (described in more detail in "potential offered for further dissemination and use") in the different basins have different residence times, and the heat that enters the Arctic Ocean as a warmer, and perhaps stronger, pulse becomes spread out spatially and temporally. Its return to Fram Strait extends over a period from perhaps less than 1 year for the re-circulation in (or just north of) the strait to 20–30 years for the farthest loops passing through the remote Canada Basin. This redistribution of the heat added to the Atlantic layer in the Arctic Ocean makes it difficult to determine how much of the oceanic sensible heat is lost to ice melt and released to the atmosphere, and how much is stored in the layer to eventually return to Fram Strait and the Nordic Seas.

Potential users:

Oceanographers working in the Arctic.

Scientists studying climate and climate change.

Fisheries, shipping, oil drilling companies (open water is a condition, which benefits these activities)

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT

272 GLOBAL CHANGE: CLIMATE CHANGE

369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)

400 MODELLING/MODELLING TOOLS, 3-D MODELLING

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Report	The Deliverable D 6.2 identifies active processes and estimates of their strength and time (forcing) dependence	Confidential
Scientific article (submitted for peer review)	Rudels, B., Anderson, L.G., Eriksson, P., Fahrbach, E., Jakobsson, M., Jones, E.P., Melling, H., Prinsenberg, S., Schauer, U. and Yao, Y. 2006: ACSYS chapter 4: Observations in the Ocean. In "Arctic Climate Change – The ACSYS Decade and Beyond" P. Lemke, T. Fichefet, C. Dick (Eds), (Submitted Feb. 2005)	Confidential
Book chapter	Rudels, B. 2001: Ocean Current: Arctic Basin Circulation. In "Encyclopedia of Ocean Sciences" Eds J. Steele, S. Thorpe and	Public

	K. Turekian. Academic Press, 177-187.	
Scientific article (peer reviewed)	Rudels, B., Björk, G., Nilsson, J., Winsor, P., Lake, I. and Nohr, C. 2005: The interaction between waters from the Arctic Ocean and the Nordic Seas north of Fram Strait and along the East Greenland Current: results from the Arctic Ocean-02 Oden expedition. Journal of Marine Systems 55, 1-30.	Public
Scientific article (peer reviewed)	Rudels, B., Jones, E.P., Schauer, U. and Eriksson, P. 2004: Atlantic Sources of the Arctic Ocean surface and halocline waters. Polar Research, 23, 181-208.	Public

INTELLECTUAL PROPERTY RIGHTS INTELLECTUAL PROPERTY RIGHTS

Type of IPR	**KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate**					**Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate**	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

80 Education

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	**Actual current quantity**	**Estimated (or future) quantity**
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	6	45
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	2	11

Targeted user audience: of reachable people	50	500
& publications (referenced publications only)	3	5
publications addressing general public (e.g. CD-ROMs, WEB sites)	1	1
publications addressing decision takers / public authorities / etc.	0	0
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

IP DAMOCLES will continue the investigations.

An interesting feature for further investigation are the recirculation patterns: The AW entering the Arctic Ocean returns towards Fram Strait in several loops confined to the different sub-basins of the Arctic Ocean to be re-exported to the Nordic Seas and eventually to the North Atlantic. The separation into several loops with different residence times and different mixing histories begins already in Fram Strait. This first recirculation loop is arguably the largest one and the one returning most heat to the Nordic Seas. A recirculation towards Fram Strait takes place in the northern Nansen basin, the water returning along the Gakkel Ridge. This return flow mainly comprises Fram Strait branch water. The Barents Sea branch water becomes gradually more prominent at the continental slope and in the basins and ridges farther from Fram Strait; in the Amundsen Basin, along the Lomonosov Ridge, in the Makarov Basin, along the Mendeleyev Ridge, at the Chukchi Cap, and in the loops in the Canada basin.

Another issue to be investigated in the future is how much the heat loss to ice and atmosphere in the Arctic Ocean depends upon the temperature of the entering Atlantic water and upon the strength of the inflow and how much is determined by the mixing processes driven by the local atmospheric conditions, atmospheric circulation, wind strength and cooling in the Arctic Ocean. It is conceivable that a larger inflow of heat is mainly manifested in a warmer Atlantic layer. Since the Atlantic waters in the different loops can, at least rudimentary, be distinguished by their salinities and by other tracers, it should be possible to estimate the storage in the different loops and determine the heat loss variations. This will require long time series of the hydrography in the strait and also in the interior of the basins. It is an important question though, since it addresses the vulnerability of the ice cover to changes of oceanic heat transports.

Another intriguing question arises from the fact that Fram Strait is the only passage that sustains transports in both directions and that the observations indicate periods longer than a year with a net inflow to the Arctic Ocean through Fram Strait. Part of the outflow from the Arctic Ocean is low salinity surface water and ice, part is intermediate and deep waters. Since

Fram Strait is also the only deep passage, it is the one passage, which allows Arctic Ocean intermediate and deep waters to exit. A net inflow through Fram Strait, together with the inflow of Atlantic water over the Barents Sea and the inflow of Pacific water through Bering Strait, then requires a balancing export of low salinity surface water, which must occur through the shallow Canadian Arctic Archipelago. The upper waters in the Arctic Ocean have a residence time of the order of 10 years with the present outflow rate of 2 – 3 Sv, divided about equal between Fram Strait and the Canadian Arctic Archipelago. A net inflow in Fram Strait implies that the outflow of upper water will at least double and most of this increased outflow must take place through the Canadian Arctic Archipelago. This would in a few years lead to a thinning of the upper layers, because the exported low salinity water can only be replaced by mixing and diluting Atlantic water with freshwater, and there is not enough freshwater supplied to the Arctic Ocean to accomplish this. The Atlantic water will be brought closer to the sea surface and could start to influence the ice formation and the thickness of the ice cover. These transport results must therefore be examined and tested in a Pan-Arctic context, where all passages are considered and where volume and salt balances are used as constraints on the obtained results. Such study will require long-term observations in order to obtain consistent results.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

No.	Title:
8	**The optimised observing system for monitoring oceanic fluxes in Fram Strait and western Barents Sea**

CONTACT PERSON FOR THIS RESULT

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URL	
Specific Result URL	

SUMMARY

The long term consolidated data sets necessary to determine the variability of the freshwater and heat fluxes between the Arctic Ocean and the North Atlantic require an innovative design of the cost effective and well calibrated measurement arrays. The northward flow of the Atlantic water carrying heat into the Arctic Ocean has to be monitored in two main gateways, the eastern Fram Strait and Barents Sea Opening. The southward freshwater flux which enters the Nordic Seas both as liquid water and sea ice needs to be measured across the western Fram Strait, including the wide shelf east of Greenland. The latter requires current measurements and salinity stratification in shallow depths as well as ice thickness and velocity. To monitor fluxes not only the large cross-sections of the gateways have to be covered by measurements but also intensive variations on a wide range of scales, revealed by earlier observations have to be resolved. Thus a larger number of moorings and instruments is

needed or integral methods, measuring the whole water column have to be used. During ASOF-N observational arrays in Fram Strait and Barents Sea Opening were augmented and optimised in accordance with the observed time-space variability of measured parameters. Newly developed instruments were installed in the moorings, the observational arrays were redesigned for optimal combination of various properties, transport estimates were proposed based on empirical relations to especially selected instruments. To secure data collected under harsh environmental conditions the possibilities of the near real-time data transfer via satellite link with pop-up buoys was tested. To complement the observing system of mooring arrays a grid of hydrographic stations was designed and repeated every summer to get the spatial variability of the Atlantic water pathways.

Key innovations:

The Fram Strait mooring array was optimized to achieve better performance in measurements of temperature, salinity, currents and ice thickness – a prerequisite to derive heat and freshwater fluxes. In the eastern and deep part of the strait additional instruments were added at the depth of ca 700 m to resolve the lower boundary of the Atlantic water layer. Two new moorings placed in the deep part of the strait to resolve the recirculation patterns of the Atlantic water and thus to reduce the error in volume transport estimates. In addition to the moorings, integral measurements were performed with the use of bottom pressure recorders (BPRs) and inverted echo sounders with pressure sensors (PIESs) to estimate the barotropic currents and heat content of the water column. The performance of different current meters and TS sensors during the long-term deployments was evaluated and unreliable instruments were replaced to achieve the highest data recovery rate and the best data quality. The freshwater part of the mooring array in the western Fram Strait was equipped with near surface salinity sensors. Tube moorings in combination with Acoustic Doppler Current Profilers (ADCPs) were successfully deployed on the shelf, surviving the extensive ice cover and drifting icebergs. The moorings in the Barents Sea Opening were combined with a high resolution hydrographic section repeated 6times per year. Additionally this moored array was augmented with two bottom-mounted ADCPs in shallow parts. A new strategy was used for tracking the Atlantic water pathways based on combination of moorings, floats and hydrographic sections. The hydrographic sections included not only standard CTD casts but also currents profiles which were measured by the lowered ADCP and quasi-continuously by the vessel-mounted ADCP. The grid of stations was adjusted to optimise the coverage of spatial structures.

Potential users:

Scientists needing information on the physical conditions in the Arctic ocean. Companies working on development of the novel oceanographic instrumentation. Environmental Protection Agencies and fishery management (recommendation for sustainable observing systems). Climate or ocean observing programmes such as GOOS/GCOS could be interested in recommendations for the Arctic Ocean Observing System regarding methods of measurements, instrumentation, efficiency of the observing system, data transfer, etc.

Expected benefits:

Improvement of the existing observing system to assess Arctic change including additional observed properties, better coverage of the key areas, higher data recovery rate. Improved estimates of the oceanic fluxes due to more reliable and accurate time series, measured in representative locations with higher resolution. This allows for a better model validation and improvements in the potential of the models to predict environmental conditions. The experience gained in the design of a sustainable and cost effective observational system under harsh Arctic conditions.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT
172 EARTH OBSERVATION TECHNOLOGY AND INFORMATION EXTRACTION
174 EARTH SCIENCES FOR CLIMATE RESEARCH
269 GEOPHYSICS, PHYSICAL OCEANOGRAPHY, METEOROLOGY, GEOCHEMISTRY, TECTONICS
369 MARINE: OCEANOGRAPHY (PHYSICAL AND OPERATIONAL)

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Newsletter	Fahrbach E., U.Schauer, G. Rohardt, 2003. How to measure oceanic fluxes from the North Atlantic through Fram Strait. ASOF Newsletter, no. 1, 3-7.	Public
Scientific article (peer reviewed)	Schauer U., E. Fahrbach, S. Osterhus, G. Rohard, 2004. Arctic warming through the Fram Strait: Oceanic heat transport from 3 years of measurements, JGR, vol. 109, C06026, doi:10.1029/2003JC001823,	Public
Scientific article (peer reviewed)	Holfort J, E. Hansen, 2005. Time series of Polar water properties in Fram Strait, GRL, vol. 32, L19601, doi:10.1029/2005GL022957.	Public
Scientific article (peer reviewed)	Walczowski W., J. Piechura, R. Osinski, P. Wieczorek, 2005. The West Spitsbergen Current volume and heat transport from synoptic observations in summer, DSR I, vol. 52, 1374□1391.	Public

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate					Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	6	45
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	2	11
Targeted user audience: of reachable people	150	750
& publications (referenced publications only)	3	3
publications addressing general public (e.g. CD-ROMs, WEB sites)	1	0
publications addressing decision takers / public authorities / etc.	0	0
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

An augmented and optimised system (described in more detail in the TIP summary) which includes two gateway arrays of moorings and the hydrographic grid repeated on the annual basis is in operation at the moment and will be continued in the frame of the EU DAMOCLES integrated project. On the basis of knowledge achieved during ASOF-N the further optimisation of the observing system will take place, employing new techniques which became available during the project. The ASOF-N results showed that while the optimised mooring array in the eastern Fram Strait covers efficiently the main core of Atlantic water flow, the complex and variable recirculation in the deep part requires measurements with a high spatial resolution. Instead of increasing the number of moorings, it is planned to complement the deep part of the existing array by measurements with Seagliders, autonomous profiling devices capable to survey the repeated sections and to transfer data via satellite. A combination of this novel technique with the integral measurements tested in ASOF-N (BPRs, PIESs) should allow to decrease the number of moored instruments and to make the observing system more cost effective. For the near real-time data transfer the experience with pop-up buoys suggests that other solutions like a moored yo-yo data transmitter are more reliable and feasible for the Fram Strait array. The freshwater part of the moored array will be also continued with an effort put into the improvement of the tube moorings resistance under heavy ice conditions. The grid of hydrographic measurements will be repeated to trace the propagation of anomalies between the moored arrays and to establish a secondary observing system, allowing to cover gaps in the observations by moorings.

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

In the future the following partners could contribute to further optimisation of the observing system: Scientists e.g. oceanographers studying the physical conditions in the Arctic ocean. Engineering companies to develop novel oceanographic instrumentation.

No.	Title:
9	**Data of Lagrangian floats deployed in the Norwegian Sea during the years 2002-2005**

CONTACT PERSON FOR THIS RESULT

Name	Jean-Claude Gascard
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Specific Result URL	

SUMMARY

Neutrally buoyant floats are devices that drift with the currents and thereby track the water pathways. During ASOF-N standard RAFOS floats were used. They were equipped with acoustic receivers tuned to the same frequency as the SOFAR sound sources installed on 13 moorings. The floats' acoustic receivers are detecting the time of arrivals (TOA) of signals transmitted regularly by the SOFAR sources. With these TOAs the position of the floats is tracked underwater acoustically. Thirty-eight floats were ballasted to drift at depths of about 300 m and an additional four floats were ballasted to drift at 1000m. The floats were deployed west of the Lofoten Islands, across the Norwegian Atlantic Current and close to the continental slope. After drifting for approximately 6 months, the floats were released to pop up at the surface, where they transmitted via satellite the data recorded during the previous 6 months. During this transmission the floats also recorded in situ temperature and pressure. Of the 38 floats ballasted for 300m, 25 transmitted data. While in general the data transmission rate was very good (of 24 floats deployed between spring 2003 and 2004 only 3 were lost) all ten floats deployed in November 2004 were lost. The best explanation to account for this strange loss is that they got transported northward by a current surge and got stuck under the ice cover. This would then indicate that in winter 2004 none of floats got transported into the Barents Sea, where they would have been safe but all ten floats got transported into Fram Strait.

Innovations:

During ASOF-N the balance depth was increased to 300m as previous experience from the MAIA project showed that this is the depth were the core of Atlantic water is found. The 5 float deployments made during ASOF-N means that for the first time variability between the years can be traced. During the predecessor project MAIA only 1 deployment of 5 floats took

place. The measurements with floats made during ASOF-N showed that the Atlantic current is not restricted to a swift boundary current (like a jet) but more like a broad current dominated by mesoscale eddies.

Potential users:

Oceanographer, especially scientists interested in Arctic ocean research.
Scientists investigating ocean circulation.
Scientist studying the interactions of water circulation and climate.

SUBJECT DESCRIPTORS CODES

46 ARCTIC ENVIRONMENT
172 EARTH OBSERVATION TECHNOLOGY AND INFORMATION EXTRACTION
272 GLOBAL CHANGE: CLIMATE CHANGE
366 MARINE ECOSYSTEMS
367 MARINE SCIENCES/MARITIME STUDIES

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	Details (Title, ref. number, general description, language)	Status: PU=Public CO=Confidential
Report on float deployment	The report contains geographical locations (longitude and latitude) for each floats deployment and release. It also shows the position of the SOFAR moorings and selected float trajectories.	Confidential

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	KNOWLEDGE: Tick a box and give the corresponding details (reference numbers, etc) if appropriate					Pre-existing know-how Tick a box and give the corresponding details (reference numbers, etc) if appropriate	
	Current				Foreseen	Tick	Details
	Tick	NoP[1)]	NoI[2)]	Details	Tick		
Patent applied for							
Patent granted							
Patent search carried out							
Registered design							
Trademark applications							
Copyrights							
Secret know-how							
Other - please specify:							

1) Number of Priority (national) applications/patents
2) Number of Internationally extended applications/patents

MARKET APPLICATION SECTORS

73 Research and development

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)

Other:

QUANTIFIED DATA ABOUT THE RESULT

Items (about the results)	Actual current quantity	Estimated (or future) quantity
Time to application / market *(in months from the end of the research project)*	0	0
Number of (public or private) entities potentially involved in the implementation of the result:	1	45
of which: number of SMEs:	0	8
of which: number of entities in third countries (outside EU):	0	11
Targeted user audience: of reachable people	150	300
& publications (referenced publications only)	0	3
publications addressing general public (e.g. CD-ROMs, WEB sites)	0	5
publications addressing decision takers / public authorities / etc.	0	2
Visibility for the general public	YES	

FURTHER COLLABORATION, DISSEMINATION AND USE OF THE RESULT

COLLABORATIONS SOUGHT

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement		**INFO**	Information exchange/training	√
JV	Establish a joint enterprise or partnership		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

POTENTIAL OFFERED FOR FURTHER DISSEMINATION AND USE

The result will be merged with the data from the ASOF-EC(E) and ASOF-EC(W) cluster components and contribute directly to the the circum-Arctic International Arctic/Subarctic Ocean Flux Array (http://asof.npolar.no/about.html)

PROFILE OF ADDITIONAL PARTNER(S) FOR FURTHER DISSEMINATION AND USE

Exploitation plans

CONFIDENTIAL

Description of the use and the dissemination of result(s), partner per partner

Contract number:	EVK2-CT-2002-00139
Result number:	32062
Partner's name:	Eberhard Fahrbach

CONTACT PERSON(S):

Name	Eberhard Fahrbach
Position/Title	Senior Scientist/Mr
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TITLE AND BRIEF DESCRIPTION OF MAIN RESULT(S)

HEAT FLUX THROUGH FRAM STRAIT CALCULATED FROM HIGH-RESOLUTION YEAR-ROUND MEASUREMENTS AND HINDCASTS WITH THE NAOSIM MODEL

A continuous time series of volume and heat flux through Fram Strait was derived from measurements with moored instruments. The moorings cover the cross section over the entire deep part of Fram Strait. Temperature and velocity are monitored, allowing to integrate heat fluxes and to distinguish between northward, southward and net fluxes. ASOF-N allowed continuing the time series, which is now sufficiently long to determine the variability of the oceanic fluxes through Fram Strait on interannual time scales - and also to approach the declared objective of the ASOF cluster to capture variability on decadal time scales.

TIMETABLE OF THE USE AND DISSEMINATION ACTIVITIES WITHIN THE NEXT 3 YEARS AFTER THE END OF THE PROJECT

Activity:	Proposal: CLIVAR
Timescale(month):	3
Brief description:	A proposal in the framework of the international program CLIVAR (CLImate VARiability and Predictability) has been submitted to the BMBF. The project plans to monitor and model the circulation of fresh water in the Arctic and its release to the North Atlantic. In addition it is planed to submit a proposal to use ASOF-N data to advance understanding of the coupling between circulation and physical properties of Atlantic Water and zooplankton distribution in the Arctic Ocean.
Activity:	International Polar Year: SPACE

Timescale(month):	9
Brief description:	The flux time series will be used in order to integrate the expected high resolution synoptic Pan-Arctic study of Climate and Environment (SPACE) planned during the International Polar Year 2007/08 (IPY).
Activity:	Follow up project: IP DAMOCLES
Timescale(month):	0
Brief description:	Based on the results of ASOF-N, time series of heat flow through Fram Strait will be continued within the EU-funded IP "DAMOCLES" (Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies). The aim is to obtain longer time series to be able to tackle decadal variability of the fluxes and to improve and develop new instrumental technology based on experiences during ASOF-N to monitor the input of mass and heat to the Arctic Ocean.
Activity:	International Project: AOMIP
Timescale(month):	1
Brief description:	Optimisation of the NAOSIM model will continue within the Arctic Ocean Model Intercomparison Project (AOMIP). The project is an official activity of the Arctic Climate System Study / Climate and Cryosphere Numerical Experimentation Group (ACSYS/CliC NEG).

FORESEEN COLLABORATIONS WITH OTHER ENTITIES

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement/Franchising		**INFO**	Information exchange	√
JV	Joint venture		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

QUANTIFIED DATA

Items	Currently achieved quantity	Estimated future quantity
Economic impacts (in EURO)	0	0
number of licenses issued (within EU)	0	0
numberof licenses issued (outside EU)	0	0
Total value of licenses (in EURO)	0	0
number of entrepreneurial actions (start-up company, joint ventures...)	0	0
number of direct jobs created[c]	0	0
number of direct jobs safeguarded[c]	1	1
number of direct jobs lost	0	0

Description of the use and the dissemination of result(s), partner per partner

Contract number:	EVK2-CT-2002-00139
Result number:	34678
Partner's name:	Eberhard Fahrbach

CONTACT PERSON(S):

Name	Eberhard Fahrbach
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TITLE AND BRIEF DESCRIPTION OF MAIN RESULT(S)

DATA AND DATA MANAGEMENT OF CTD PROFILES AND MOORING

CTD Data
CTD (Conductivity, Temperature, and Depth) profiles were measured during cruises in 2003 - 2005 across Fram Strait, in the East Greenland Current between 74° and 79° N and in the eastern part of the Greenland Sea. For detailed information on the CTD stations see www.awi-bremerhaven.de/Research/IntCoop/Oce/ASOF/data-m anagement/Map-CTD-Moor.htm. The current CTD dataset can be retrieved via www.awi-bremerhaven.de/OZE.

Mooring Data
Moorings were deployed across Fram Strait and in the East Greenland Current at 74° N. A detailed map with mooring location is presented in the web. The current dataset can be retrieved via www.awi-bremerhaven.de/OZE.

TIMETABLE OF THE USE AND DISSEMINATION ACTIVITIES WITHIN THE NEXT 3 YEARS AFTER THE END OF THE PROJECT

Activity:	Improvements of database
Timescale(month):	4
Brief description:	In addition to the information about cruise details and data an additional service is planned for the summer 2006. In addition to the data set already provided, the data will be plotted and shown as profiles directly on the internet.
Activity:	IP DAMOCLES
Timescale(month):	0
Brief description:	During IP DAMOCLES mooring and CTD measurements will continue.

FORESEEN COLLABORATIONS WITH OTHER ENTITIES

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement/Franchising		**INFO**	Information exchange	√
JV	Joint venture		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

QUANTIFIED DATA

Items	Currently achieved quantity	Estimated future quantity
Economic impacts (in EURO)	0	0
number of licenses issued (within EU)	0	0
numberof licenses issued (outside EU)	0	0
Total value of licenses (in EURO)	0	0
number of entrepreneurial actions (start-up company, joint ventures...)	0	0
number of direct jobs created[c]	0	0
number of direct jobs safeguarded[c]	4	4
number of direct jobs lost	0	0

Description of the use and the dissemination of result(s), partner per partner

Contract number: EVK2-CT-2002-00139
Result number: 35048
Partner's name: Eberhard Fahrbach

CONTACT PERSON(S):

Name	Eberhard Fahrbach
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Fax	+49(471)4831-1797
E-mail	efahrbach@awi-bremerhaven.de

TITLE AND BRIEF DESCRIPTION OF MAIN RESULT(S)

THE OPTIMISED OBSERVING SYSTEM FOR MONITORING OCEANIC FLUXES IN FRAM STRAIT AND WESTERN BARENTS SEA

During ASOF-N observational arrays in Fram Strait and Barents Sea Opening were augmented and optimised in accordance with the observed time-space variability of measured parameters. Newly developed instruments were installed in the moorings, the observational arrays were redesigned for optimal combination of various properties, transport estimates were proposed based on empirical relations to especially selected instruments. To secure data collected under harsh environmental conditions the possibilities of the near real-time data

transfer via satellite link with pop-up buoys was tested. To complement the observing system of mooring arrays a grid of hydrographic stations was designed and repeated every summer to get the spatial variability of the Atlantic water pathways.

TIMETABLE OF THE USE AND DISSEMINATION ACTIVITIES WITHIN THE NEXT 3 YEARS AFTER THE END OF THE PROJECT

Activity:	IP DAMOCLES
Timescale(month):	0
Brief description:	An augmented and optimised system (described in more detail in the TIP summary) which includes two gateway arrays of moorings and the hydrographic grid repeated on the annual basis is in operation at the moment and will be continued in the frame of the EU DAMOCLES integrated project. On the basis of knowledge achieved during ASOF-N the further optimisation of the observing system will take place, employing new techniques which became available during the project.

FORESEEN COLLABORATIONS WITH OTHER ENTITIES

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement/Franchising		**INFO**	Information exchange	√
JV	Joint venture		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

QUANTIFIED DATA

Items	Currently achieved quantity	Estimated future quantity
Economic impacts (in EURO)	0	0
number of licenses issued (within EU)	0	0
numberof licenses issued (outside EU)	0	0
Total value of licenses (in EURO)	0	0
number of entrepreneurial actions (start-up company, joint ventures...)	0	0
number of direct jobs created[c]	1	1
number of direct jobs safeguarded[c]	0	1
number of direct jobs lost	0	0

Description of the use and the dissemination of result(s), partner per partner

Contract number:	EVK2-CT-2002-00139
Result number:	33135
Partner's name:	Eberhard Fahrbach

CONTACT PERSON(S):

Name	Eberhard Fahrbach
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TITLE AND BRIEF DESCRIPTION OF MAIN RESULT(S)

FRESHWATER FLUX THROUGH FRAM STRAIT DURING 2003-2005 AS MEASURED DURING ASOF-N

Freshwater export from the Arctic to subarctic seas have the potential to influence the northbound current systems by modifying the stratification of the receiving basins. This would alter the oceanic heat transport, which again would influence the climate of North Western Europe. The export of fresh water occurs in liquid (polar water) and solid (sea ice) phase. With the advent of ASOF-N we were able to continue and extend existing time series (solid phase freshwater flux since 1990 and liquid freshwater flux since 1997), and hence determine the seasonal and interannual variability of freshwater fluxes through Fram Strait.

TIMETABLE OF THE USE AND DISSEMINATION ACTIVITIES WITHIN THE NEXT 3 YEARS AFTER THE END OF THE PROJECT

Activity:	International Project: AOMIP
Timescale(month):	1
Brief description:	Optimisation of the NAOSIM model will continue within the Arctic Ocean Model Intercomparison Project (AOMIP). The project is an official activity of the Arctic Climate System Study / Climate and Cryosphere Numerical Experimentation Group (ACSYS/CliC NEG).
Activity:	IP DAMOCLES
Timescale(month):	0
Brief description:	During IP DAMOCLES the high resolution version of AWI's model NAOSIM will be used to support the observations and data interpretation.

FORESEEN COLLABORATIONS WITH OTHER ENTITIES

R&D	Further research or development	√	**FIN**	Financial support
LIC	Licence agreement		**VC**	Venture capital/spin-off funding

MAN	Manufacturing agreement	**PPP**	Private-public partnership
MKT	Marketing agreement/Franchising	**INFO**	Information exchange
JV	Joint venture	**CONS**	Available for consultancy
Other	(please specify)		
Details:			

QUANTIFIED DATA

Items	Currently achieved quantity	Estimated future quantity
Economic impacts (in EURO)	0	0
number of licenses issued (within EU)	0	0
numberof licenses issued (outside EU)	0	0
Total value of licenses (in EURO)	0	0
number of entrepreneurial actions (start-up company, joint ventures...)	0	0
number of direct jobs created[c]	0	0
number of direct jobs safeguarded[c]	0	0
number of direct jobs lost	0	0

Description of the use and the dissemination of result(s), partner per partner

Contract number:	EVK2-CT-2002-00139
Result number:	34692
Partner's name:	Eberhard Fahrbach

CONTACT PERSON(S):

Name	Eberhard Fahrbach
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TITLE AND BRIEF DESCRIPTION OF MAIN RESULT(S)

EXCHANGES OF VOLUME, HEAT AND FRESHWATER BETWEEN THE ATLANTIC AND ARCTIC OCEAN

The inflow of water and heat from the Atlantic Ocean to the Arctic Ocean was studied during the ASOF-N programme. The Atlantic water (AW) reaches the Arctic Ocean through two passages, the deep (2600m) Fram Strait and across the broad shelf of the Barents Sea, where it enters through the Bear Island Channel and passes through the Barents Sea into the Kara Sea and most of the AW continues into the Arctic Ocean via the St. Anna Trough. The programme also attempted to quantify the outflow of sea ice and low salinity surface water (the export of liquid freshwater) from the Arctic Ocean to the Nordic Sea through Fram Strait and, since Fram Strait is the only deep passage connecting the Arctic Ocean to the world ocean, to estimate the exchanges of intermediate and deep waters between the Arctic Ocean

and the Nordic Seas. The AW was followed on its way through the Norwegian Sea from the Greenland – Scotland Ridge to the two inflow passages and the strength of the transport and the changes in water mass characteristics were studied.

TIMETABLE OF THE USE AND DISSEMINATION ACTIVITIES WITHIN THE NEXT 3 YEARS AFTER THE END OF THE PROJECT

Activity: IP DAMOCLES

Timescale(month): 0

Brief description: During DAMOCLES an extensive, multifaceted observation programme (ice, atmosphere, ocean) will be launched and the measurements will be coupled with intense modelling activity.

FORESEEN COLLABORATIONS WITH OTHER ENTITIES

R&D	Further research or development	√	**FIN**	Financial support	
LIC	Licence agreement		**VC**	Venture capital/spin-off funding	
MAN	Manufacturing agreement		**PPP**	Private-public partnership	
MKT	Marketing agreement/Franchising		**INFO**	Information exchange	
JV	Joint venture		**CONS**	Available for consultancy	√
Other	(please specify)				
Details:					

QUANTIFIED DATA

Items	Currently achieved quantity	Estimated future quantity
Economic impacts (in EURO)	0	0
number of licenses issued (within EU)	0	0
numberof licenses issued (outside EU)	0	0
Total value of licenses (in EURO)	0	0
number of entrepreneurial actions (start-up company, joint ventures...)	0	0
number of direct jobs created[c]	0	0
number of direct jobs safeguarded[c]	0	0
number of direct jobs lost	0	0

Overview of Exploitations Plans

RESULT TITLE / OWNER	COMMENT
Heat Flux through Fram Strait calculated from high-resolution year-round measurements and from hindcasts with the NAOSIM model / Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	Exploitation plan included in eTIP
Data and data management of CTD profiles and mooring / Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	Exploitation plan included in eTIP
The optimised observing system for monitoring oceanic fluxes in Fram Strait and western Barents Sea / Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	Exploitation plan included in eTIP
Freshwater Flux through Fram Strait during 2003-2005 as measured during ASOF-N / Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	Exploitation plan included in eTIP
Exchanges of volume, heat and freshwater between the Atlantic and the Arctic Ocean / Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	Exploitation plan included in eTIP

I am the Co-ordinator of the above project, and confirm on behalf of the contracted Partners the information contained in this Technological Implementation Plan, and I authorise its public dissemination.

Signature:	**Name:**
Date:	**Organisation:**