Hydralab 2008

Proposals for access to facilities at HSVA

User selection panel October 30th 2008

Hull, UK
Proposals:

HyIII-HSVA-G7

Title: INTERICE 4
User group leader: Prof. David N. Thomas, School of Ocean Sciences – University of Bangor

HyIII-HSVA-G8

Title: Model tests of Iceberg Towing
User group leader: Kenneth Johannessen Eik, Norwegian University of Science and Technology (NTNU), Department of Civil and Transport Engineering, Trondheim, Norway

HyIII-HSVA-G9

Title: Investigation of local ice load dependency on flare and stem angles through model testing
User group leader: Vegard Aksnes, Norwegian University of Science and Technology (NTNU), Department of Civil and Transport Engineering, Trondheim Norway
Access to major experimental ice engineering facilities

Please send the completed form by e-mail to the facility provider:

- Hamburg Ship Model Basin (HSVA): Karl-Ulrich Evers, evers@hsva.de

1. Title of the proposal

INTERICE 4

1. Requested facility/facilities (Large Ice Tank or Environmental Test Basin):

Environmental Test Basin

2. Applicant's full name and title (User Group Leader)

Professor David N. Thomas

3. Affiliation

School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey. LL59 5AB. UK
Male/Female: Male
Tel.: .0044 1248382878
Fax.: as telephone
E-mail: d.thomas@bangor.ac.uk    Web-site: www.sos.bangor.ac.uk

4. Full name, titles, positions in institution and nationalities and gender of all other persons participating in the project:

PLEASE SEE ATTACHED DESCRIPTION OF PROPOSED WORK

<table>
<thead>
<tr>
<th>Name, titles and affiliation</th>
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5. Names and access period of those that made use of the access programme to this facility in previous EC framework programmes:
D. Thomas, G. Dieckmann, S. Papadimitriou, H. Kennedy, J.L. Tison, M. Granskog, H. Kuosa

6. Estimated number of access days requested; this includes the time needed for building the test setup, testing and calibration when necessary, main experiments, and removal of the test setup:

40

7. Estimated total number of the visiting person-days
(sum of the days of presence at the installation of all the members of the visiting team);

130

8. Most appropriate period for the experiments?
Are there any constraints for the period when you may or may not perform the experiments?

September 2009 maybe extending through to early October 2009

9. Tentative list of instrumentation requested (contact us for information)
   Ice tank
   Experimental tanks as discussed
   Storage facilities for frozen samples
   Space for setting up analytical labs (as previous Interice 3)

10. Description of the proposed work (maximum of four A4 pages in a separate file), at least specifying the installation needed and
    (i) the scientific objectives,
    (ii) the test setup and test programme,
    (iii) the work content and methodology,
    (iv) proposed analysis of the results,
    (v) the benefits expected from the use of the large installation.
Research Proposal

using the European ARCTECLAB,

Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA), Hamburg

Large Scale Facility

PROPOSAL

INTERICE 4

Participants:

Bangor University, UK (Bangor)
Essex University, UK (Essex)
Alfred Wegener Institute, Germany (AWI)
Université Libre de Bruxelles, Belgium (ULB)
University of Helsinki, Finland (UH)
Finnish Institute of Marine Research, Finland (FIMR)
National Environmental Research Institute, Denmark (DMU)
Norwegian Polar Institute, Norway (NPI)

Co-ordinator:
Prof. David N. Thomas,
School of Ocean Sciences, Bangor University,
Menai Bridge, Anglesey. LL59 5AB. UK.
(Tel: 0044 1248 382878, email: d.thomas@bangor.ac.uk)

August 2008
1. BACKGROUND
INTERICE 4 is designed to further three other successful INTERICE campaigns conducted at the Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA), Hamburg. By bringing together teams that have used the facility before, and who are therefore familiar with both the possibilities it offers as well as its limitations, a programme of research has been designed that will help to elucidate several fundamental questions in sea ice biogeochemistry.

The INTERICE 1, 2 & 3 teams identified various benefits from running the ice basin facility using containers suspended in the larger basin for conducting clean biological and chemical experimental work.

In the light of this previous work it is proposed that INTERICE 4 will be a two-phased programme of experiments to address two key, but very different aspects of sea ice biogeochemistry. The unique nature of the HSVA facility mean that it is ideally suited for such work, and we want to emphasize that the conception of these experiments has only been possible because the HSVA facility exists.

One of the most limiting factors in the study of sea ice biogeochemistry is the obvious logistic costs, as well as the very limited access for making temporal measurements on natural sea ice. An exciting new development in sea ice research has been the use of the EU supported large facility ice tank basin at the Hamburg Ship Model Basin (HSVA). We aim to determine the factors initiating and controlling the unique chemistry within sea ice. In particular we will measure factors controlling:

1) Calcium carbonate dynamics in sea ice
2) Fractionation of dissolved organic matter during sea ice formation, consolidation and ice melt.

Because of the two-phase nature of the work, in the following the rationale for the work will also be divided into two sections.

2. PHASE 1
Background
The interaction between the marine and atmospheric carbon cycle is a critical factor in understanding climate change. The polar oceans play an important role in mediating the Earth's climate, for example, by providing an appreciable part of the global carbon sink in their surface waters and up to 80% of reflection of solar radiation by polar ice. Although the interplay between biology and climate change is a major focus of current studies, less attention has been paid to abiotic drivers that may influence carbon cycling and sequestration. Carbonate minerals and their production in sea ice is an unquantified component of the polar carbon cycle, and key aspects of their dynamics need to be studied before a true appreciation of their role can be assessed.

Seawater begins to freeze at -1.85°C, leaving its salts in the water (brine) that remains. At -10°C the brine is four times saltier than seawater. Thermodynamic principles predict that under these conditions minerals, such as calcium carbonate, should precipitate, and there is some indirect evidence to support this from laboratory experiments. The consequences of carbonate formation and its subsequent dissolution are complex and may have a strong bearing on the carbon cycle in polar oceans. For example, it has been estimated that 720,000,000 t of carbon may be removed from surface to deep polar waters as a consequence of carbonate mineral formation in sea ice. Until recently, these estimates have remained subjective and speculative, because neither carbonate minerals nor their mineral form had been described, while the effects of physical-chemical properties on their precipitation and dissolution in sea ice was unknown. The recent discovery (Dieckmann et al.) of ikaite, a metastable phase of hydrated CaCO₃ (CaCO₃.6H₂O), has confirmed the presence and form of the carbonate mineral in sea ice but has left us unable to assess the significance of its role in
carbon cycling in polar oceans because controls on its production and dissolution in sea ice are unknown. Our aim is to perform laboratory experiments that will determine 1] whether previous thermodynamic modeling of ikaite formation correctly describes the onset and rate of precipitation and dissolution of this mineral from brine solutions typical of sea ice; 2] whether the confined conditions found in the brine channels of sea ice affect the manner and rate at which these processes occur. We will then use our findings to refine our understanding of the importance of ikaite in carbon cycling in the polar oceans. Our second aim is to use the stable isotopic composition of ikaite crystals to reconstruct some of the conditions under which the mineral precipitates in sea ice. This is currently impossible in the natural environment because we cannot probe individual brine pockets to derive the information that we need directly. A combination of oxygen and carbon isotopic measurements of CaCO$_3$.6H$_2$O will allow us to record the temperature and the properties of the brine at the scale of the brine pocket.

2.1 The Measurement Programme PHASE 1

The aim is to try and set up conditions during freezing that represent a low pCO$_2$ (autotrophic) and high pCO$_2$ (heterotrophic) setting, as well as a control. The hypothesis is that low pCO$_2$ would promote ikaite precipitation at all temperatures i.e. ikaite should precipitate throughout the ice and high pCO$_2$ would inhibit ikaite precipitation except at the coldest temperatures i.e. maybe less mass throughout the core or maybe only precipitation in the upper ice layers.

The experiment of phase 1 will use a series of 18 small enclosures as used in INTERICE 2 will be used within the basin to avoid contamination, and to ensure clean conditions for chemical sampling. In all enclosures the seawater should be filtered North Sea water collected and transported by AWI. It is proposed that there would be three treatments: 1] North Sea water 2]North Sea water + NaOH to raise the pH 3] North Sea water + HCl and addition of phosphate. Each treatment would be run in triplicate, but as we would need separate tanks for coring (3 per treatment) and sackhole (3 per treatment) sampling. Therefore there would have to be 6 replicate tanks for each treatment.

N.B. Once the waters have been put into the experimental tanks it will be necessary to let them equilibrate for 2 days before freezing commences.

Every two to three days following the initiation of ice growth, samples will be taken from the ice sheet and underlying water in each enclosure. The ice growth will be monitored by measuring ice thickness manually. Most of the sampling will include processing of samples for future analyses back in the home laboratories. However, some chemical analyses and filtration will have to be conducted at HSVA. Cold room facilities and storage freezer space at –30ºC will be required.

**From the ice cores we will collect data on:**
1] Mineralogy, ikaite distribution, number, volume and surface area and mass of ikaite crystals (AWI & BU)
2] Temperature, salinity, inorganic nutrients (BU)
3] Isotopic composition of the ikaite (BU)
For brine sampling and under ice water:
As for ice coring plus additional measurements of alkalinity, pH, DIC and $\delta^{13}$C-DIC, $\delta^{18}$O-H$_2$O (AWI, BU & ULB)

We will also:

a) take direct pCO2 measurements in the sackholes brines to compare to the pCO2 deduced from the chemical measurements (ULB)

b) install sediment traps to answer the question of "how much of the (eventually) newly formed CaCO3 in the skeletal layer remains trapped within it, as compared to what is eventually sedimenting or entrained with the descending brines at the ice-water interface". (AWI, BU & ULB)

Complementary measurements of total gas content will be made in ice/brine and water fractions (Toepler extraction line) and gas composition (O$_2$, N$_2$, CO$_2$ dry extraction and gas chromatography) (ULB).

3. Phase 2

Background

The pool of oceanic dissolved organic matter (DOM) is derived by biogenic sources such as algal and bacterial exudation, viral lysis, grazing and excretion by-products, and is removed by microbial heterotrophic activity and through uptake by algae capable of heterotrophic growth and metazoans. DOM, depending on its nature, may therefore be an available substrate to trophic flows in the food web, supporting the communities found within sea-ice (including bacteria, protozoa, microalgae and small metazoans). The supply of DOM has been argued as a more important factor in regulating rates of bacterial growth in the Barents Sea than temperature per se. It has also been suggested that DOM can affect the penetration of light and the exchange of gases at the sea surface). During sea-ice formation ice crystals aggregate in a matrix and the formed brine, containing the dissolved constituents of seawater, is expelled in a network of channels.

It has been determined that sea ice diatoms and bacteria produced large amounts of extracellular polymeric substances (EPS) or mucilages, that fill the brine channels. These mucilages are thought to help the diatoms to survive in the harsh conditions of the sea ice channels. The cells that remain metabolically active in this hypersaline brine at ultra low temperatures are living in an environment of such reduced free energy that the system is virtually locked up at the molecular level. It is suggested that the extracellular polymeric substances (EPS) may confer general benefits to ice diatoms, such as cryoprotection, salinity barriers and a localized microclimate.

The objective of our work is to determine whether DOM and EPS behaves conservatively during brine exclusion caused by sea-ice formation, and the degree to which fractionation of DOM constituents takes place. This will be achieved by determining the concentration and distribution of DOM derived from different sources under simulated conditions of sea-ice formation, both in the vertical profiles of the water column and in sea-ice (both in the brine and ice), relating it to physical and chemical parameters (salinity and nutrient concentrations).

In a related set of experiments the incorporation of particles of different sizes into sea ice will be investigated. Modern day technology enables significant room for increasing our understanding of the relationship between particle size and rates of incorporation into sea ice than some of the early experiments conducted in the 1970s and 80s.
3.1 The Measurement Programme PHASE 2
We will use the same 18 experimental containers as in Phase 1 (although it will be better to change the container walls). Again the baseline experimental media will be filtered North Sea water.

Again it is proposed that there are three treatments
1] North Sea water
2] North Sea water + terrestrial derived DOM addition
3] North Sea water + algal/bacterial (therefore EPS rich) derived DOM addition

Each treatment would be run in triplicate, but as we would need separate tanks for coring (3 per treatment) and sackhole (3 per treatment) sampling. Therefore there would have to be 6 replicate tanks for each treatment.

From the ice cores, brines and underlying water we will collect data on:
1] Chemical composition of DOM, size fractions of DOM, (BANGOR, UH, ESSEX)
2] Temperature, salinity, inorganic nutrients (BANGOR, FIMR)
3] CDOM and fluorescence characteristics of DOM (UH, NPI & DMU)

Because of the DOM measurements it will be important to enumerate bacteria in the ice/brine and underwater fractions (FIMR).

The particle size experiment will use an ADDITIONAL 6 experimental containers. It will be important to locate these at the other end of the basin from the DOM experiments so that no fluorescent contamination takes place. To these fluorescent-labelled particles of various sizes (sub µm through to mm) will be added to the starting water. Size distribution of particles in ice/brine and underlying water samples will be measured (FIMR & UH)

Every two to three days following the initiation of ice growth, samples from ALL of the Phase 2 experiments will be taken from the ice sheet and underlying water in each enclosure. The ice growth will be monitored by measuring ice thickness manually. Most of the sampling will include processing of samples for future analyses back in the home laboratories. However, some chemical analyses and filtration will have to be conducted at HSVA. Cold room facilities and storage freezer space at –30ºC will be required.

4. DELIVERABLES
The results from both phases will constitute unique data sets that could not be obtained by any other means. Therefore it is anticipated that there will be great interest to a wider scientific audience. This has certainly been the response following previous INTERICE campaigns.

The results of the testing will be given in a data report. Furthermore the results of the study will be disseminated via peer-reviewed articles in internationally acknowledged journals and by presentations at national and international scientific meetings. David Thomas has a strong track record in presenting the results of his work to the general public. We will endeavour to communicate the results of the proposed study in a similar fashion.

5. TIME SCHEDULE
The duration of the project at the large-scale facility is estimated to be 5 weeks.
Phase 1: 1 September to 11 September (NB participants to arrive on 31 August)
Transition phase (Clearing Phase 1 & preparation for phase 2) 14 September to 18 September
Phase 2: 22 September to 2 October (NB participants to arrive on 21 September).
6. PARTICIPANTS
The following will attend the laboratory work:

PHASE 1
BANGOR (School of Ocean Sciences, University of Bangor)
Prof  David Thomas, Male, UK
Dr Hilary Kennedy, Female, UK
Dr Stathis Papadimitriou, Male, Greece

AWI (Alfred Wegener Institute for Polar and Marine Research)
Dr Gerhard Dieckmann, Male, Germany
Dr Gernot Nehrke, Male, Germany
Not named yet

ULB (Université Libre de Bruxelles)
Prof Jean-Louis Tison, Male, Belgium
Dr Bruno DeLille, Male, Belgium

PHASE 2
BANGOR (School of Ocean Sciences, University of Bangor)
Prof David Thomas, Male UK

ESSEX (University of Essex)
Prof Graham Underwood, Male, UK
Dr Shazia Aslam, Female, UK

AWI (Alfred Wegener Institute for Polar and Marine Research)
Dr Gerhard Dieckmann, Male, Germany

FIMR (Finish Institute of Marine Research)
Dr Hermanni Kaartokallio, Male, Finland
Dr Riitta Autio, Female, Finland

UH (University of Helsinki)
Prof. Harri Kuosa, Male, Finland
Dr Anssi Vähätalo, Male, Finland
Ms Susann Haase, Female, Germany (working for PhD in Finland)

DMU (National Environmental Research Institute, University of Aarhus)
Dr Colin Stedmon, Male, Irish (working permanently in Denmark)

NPI (Norwegian Polar Institute)
Dr Mats Granskog, Male, Finland (working permanently in Norway)
David Neville Thomas – Mini CV

CAREER
01.10.08 - 30.12.13 Academy of Finland Distinguished Professor (FiDiPro), Finnish Institute for Marine Research, Finland.
15.12.06 - Present Professor of Marine Biology (Established Chair) at the School of Ocean Sciences, Bangor University
01.08.05 - 14.12.06 Professor of Biogeochemistry (Personal Chair) at the School of Ocean Sciences, Bangor University
01.07.03 - 31.07.05 Reader at the School of Ocean Sciences, Bangor University
01.10.99 - 30.06.03 Senior Lecturer at the School of Ocean Sciences, Bangor University
01.07.96 - 30.09.99 Lecturer at the School of Ocean Sciences, Bangor University
01.01.96 - 30.06.96 Researcher at the Centre for Tropical Marine Ecology, Bremen, Germany. (Based at the Interuniversity Marine Institute, Eilat, Israel).
01.05.94 - 31.12.95 Researcher at the Institute for Chemistry and Biology of the Sea, University of Oldenburg, Germany.
01.07.90 - 30.04.94 Researcher at Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany.
16.01.89 - 30.06.90 Royal Society Post Doctoral Research Fellow (European Exchange Programme) at Department of Marine Botany, University of Bremen, Germany.
01.10.84 - 18.03.88 NERC studentship at Department of Botany, University of Liverpool. Awarded PhD
01.10.81 - 04.07.84 University of Liverpool. Awarded BSc (2.1, Hons) Environmental Biology

David Thomas is internationally highly recognised for his work on sea ice and ocean biogeochemistry: In 2008 was awarded a 5 year distinguished professorship (FiDiPro) by the Academy of Finland for his work on catchment to coast processes. From 2000 to 2003 he held a Climate and Oceanography Fellowship at the Hanse Institute for Advanced Studies in Germany. He was awarded an Antarctic CRC Fellowship from the University of Tasmania from 2004 to 2007. His most recent research has focused on biogeochemical processes in polar oceans and sea ice, with an emphasis on the role of dissolved organic matter in these systems. He has been, and currently is, the PI on several national projects, including 8 NERC awards, as well as several international research projects, including 2 EU-funded projects, WOMP and DOMAIN. He has won over £4 million in research funding since 1996, and his research is published in over 70 peer-reviewed articles in leading journals, eight books, four book chapters, plus numerous reports, articles, and ‘popular press’ publications. He has presented invited, high profile lectures on sea ice at the Gordon Research Conference in Ventura (vice Chair for 2007 and Chair for 2009), California, the Royal Society, the Royal Institution, and the Royal Geographical Society.

5 Selected Publications for David Thomas
C Stedmon, DN Thomas, MA Granskog, H Kaartokallio, S Papadimitriou & H Kuosa. 2007. The characteristics of dissolved organic matter in Baltic coastal sea ice: Allochthonous or autochthonous origin? Environmental Science and Technology. 41, 7273-7279
Work Experience
Senior Research Officer: Jan 2008-todate, Department of Biological Sciences, University of Essex. Colchester, Essex, CO4 3SQ, UK
Title: Production, characterisation and novel roles of sea-ice diatom exopolymers (EPS)

Post doctoral Research Officer: Sep 2004-Dec 2007, Department of Biology and Biochemistry, University of Bath, Bath, UK.
Title: Bacterial extracellular polysaccharide and their role in pathogenicity


Education and qualifications
Ph.D. in Organic Chemistry: 2000-2004, Natural Resources Institute, University of Greenwich, UK.
M.Sc. in Organic Chemistry (Distinction): 1994-1997, Uni. of Agriculture, Faisalabad, Pakistan
B.Sc. in Biological Sciences (Distinction): 1992-1994, Queen Mary College, Lahore, Pakistan.

Research interests
Purification and chemical characterisation of microbial polysaccharides; learning new techniques for characterization of carbohydrate chemistry; Understanding the biological role of microbial polysaccharide and structural function activity of polysaccharides.

Society Memberships
British Society of Plant Pathology
Associate Member of Royal Society of Chemistry

Publications


Personal details

Autio, Riitta Maria, born on March 15, 1962 in Kotka

Current engagement

Leading Research Scientist, Finnish Institute of Marine Research, 1.7.2007-
Project leader (Nottbeck Foundation): "Baltic Sea ice biogeochemistry - the
role and importance of photochemistry and bacterial processes"

Education

Ph.D. (hydrobiology), University of Helsinki 2000
Adjunct Professor (marine biology), University of Helsinki, 2003

Previous affiliations

research assistant, University of Helsinki, 1985-87
scientist, The Ecological Plankton Research Programme (PELAG II),
subproject Biotic and abiotic regulation of plankton ecosystem: micro, nano-
and picoplankton, UH/Walter and Andrée de Nottbeck found., 1987-90
scientist, The Finnish Research Programme on Climate Change (SILMU),
subproject The effects of climate changes on pelagic ecosystem in the
northern Baltic Sea, (Academy of Finland), 1990-95
scientist, Walter and Andrée de Nottbeck foundation, 1996-02
senior scientist, Finnish Institute of Marine Research, 2002-07

Sea ice related research interests

Bacteria are in key position in sea-ice ecosystems, especially in carbon and
nutrient transformation and transfer. Changes in ice physical environment or
quality of DOM can alter bacterial community composition and successional
dynamics that in turn affect sea-ice biogeochemistry. In the studies of my
research group we try to assess the effects of substrate alteration on bacterial
community physiology and composition. Experimentally we also study the
effects of various substrates on bacterial growth and growth efficiency as well
as on nitrogen fluxes including DON. In addition the efficiency of carbon
transfer to upper trophic levels via functional microbial loop is in a central
position in my research interests.

Recent publications

and photosynthetic activity of Dinophysis acuminata populations in the

• Stoecker, D., Autio, R., Rintala, J.-M. & Kuosa, H. (2005): Ecto-
enzyme activity associated with filamentous cyanobacteria. Aquatic
Microbial Ecology 40: 151-161.

• Laanemets, J., Lilover, M.-J., Raudsepp, U. Autio, R., Vahtera, E.
(2006): A fuzzy logic model to describe the cyanobacteria Nodularia
spumigena bloom in the Gulf of Finland, Baltic Sea. Hydrobiologia
554:31-45.

Changes in phytoplankton biomass and nutrient quantities in sea ice as
responses to light/dark manipulations during different phases of the

• Kuparinen, J., Kuosa, H., Andersson, A., Autio, R., Granskog, M.A.,
Ikävalko, J., Kaartokallio, H., Karell, K., Leskinen, E., Piiparinen, J.,
and organic material cycles in the northern Baltic Sea. Ambio 36: 149-
154.
Research Interest

I am mainly interested in inorganic carbon dynamics in polar oceans and related air-ocean fluxes of CO₂. I am addressing various issues related to CO₂ dynamics in contrasting areas and environments, from the uptake of CO₂ by kelp forests in the subantarctic coastal area to the effect of the precipitation of calcium carbonate within arctic sea ice. I am also trying to better constrain air-ice-sea CO₂ fluxes and penetration of anthropogenic CO₂ into the ocean interior. I have a particular interest in sea-ice biogeochemistry and how CO₂ dynamics within sea ice processes support significant atmospheric CO₂ uptake.

Education

Jul. '06 | Ph. D. in Oceanology from the University of Liège, Belgium.

Main appointment

From Oct '97 | Research assistant at the University Research assistant at the University Research assistant at the University of Liège involved in the projects BELCANTO I to III. BELCANTO (BELgian research on Carbon uptake in the ANTarctic Ocean) projects aim to assess the impact and sensitivity of the Southern Ocean's biological pump in the context of climate change. Theses projects are supported by the Belgian Science Policy

Nov.'95 - Jun. '97 | Field Supervisor of MICROBIOKER Research Project (Subantarctic Marine Microbiology) supported by Institut Français pour la Recherche et Technologie Polaire/Elf Acquitaine

5 recent publications


Dr. Gerhard Dieckmann is senior research officer and leader of the sea ice biology working group at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. He obtained his Masters in marine ecology at the University of Cape Town in 1979 and a Ph.D. in natural sciences at the University of Kiel, Germany in 1982. Since then he has been employed at the AWI where his main field of research is sea ice ecology and biological oceanography. He spent a Post doc with Prof. Cornelius Sullivan at the University of Southern California, Los Angeles and Mc Murdo station, Antarctica in 1989. Most important research fields include geochemistry of sea ice, sea ice formation processes and the effect of physical and chemical properties on the sea ice ecosystem. He has participated in 15 expeditions to Antarctica and the Arctic to work on sea ice.

**Publications:** 88 in peer reviewed Journals and books. Co-editor of the book *Sea ice: an introduction to its physics, chemistry, biology, and geology / ed. by David N. Thomas and Gerhard S. Dieckmann, Oxford [u.a.] : Blackwell Science, 402 pp*

**Invited Talks:** 40.

**Grants:** National Science Foundation, Deutsche Forschungsgemeinschaft, BMBF. EU

**Recent publications:**

Curriculum vitae

Dr. Mats Granskog

Personal Details

Citizenship: Finland
Affiliation: Norwegian Polar Institute, N-9296 Tromsø, Norway
Electronic mail: mats.granskog@npolar.no

Qualifications

Doctor of Philosophy April 2004 Geophysics (sea ice), Univ. of Helsinki, Finland

Recent career history

Research Scientist – Norwegian Polar Institute 10/2008-
Post doc – University of Lapland, Finland 8/2005-9/2008
Post doc – University of Manitoba, Canada 1/2005-12/2006

Research interests

Role of sea ice in modifying the marine physical environment and biogeochemical cycles. Impacts of climate change on sea ice and the physical/chemical environment in polar and sub-polar seas. Small-scale sea ice processes and feedbacks.

Recent publications


CURRICULUM VITAE

PERSONAL INFORMATION

Name: Susann Haase
Contact address: PL 65 (Viikinkaari 1)
00014 University of Helsinki, Finland
Mobile: +358-445155646
Email: susann.haase@helsinki.fi
Date of birth/place: 20.07.1981 in Freital, Germany
Nationality: german

EDUCATION

Since 01/2008 Ph.D. position at the University Helsinki: “The photochemical transformation of organic matter in sea ice and its impact on the functioning of the sea ice ecosystem.”
member of the Sea Ice Ecology consortium
10/2007 - 12/2007 Research Assistant at the Alfred-Wegener-Institut for Polar- and Marine Research (AWI), Bremerhaven
01/2007 - 09/2007 Diploma thesis at the Alfred-Wegener-Institut for Polar- and Marine Research (AWI), Bremerhaven „Eukaryotic Biodiversity in Sea Ice“ under the supervision of Andreas Krell, Gerhard Dieckmann, Klaus Valentin
01/2006 - 06/2006 Studies at the University Centre on Svalbard (UNIS), Spitzbergen
11/2003 - 02/2004 Internship at the högskolan in Halmstad (Schweden), wetlands group, Ph.D. Göran Salem
10/2001 - 09/2007 Studies of Biology, TU Braunschweig
(Main subjects: Plant biology, Genetics, Cell biology, Zoology)

RELEVANT EXPERTISE

05/2008 Participant at the course “Field techniques in interdisciplinary sea-ice research” in Barrow, Alaska
07/2007 Participant at the International Sea-Ice Summer School, UNIS, Svalbard
05/2006 - 06/2006 Graduate course „Light, climate and primary production in the Arctic“

RESEARCH INTERESTS

My research interests lie between biology, chemistry and physics of sea ice. The behavior of dissolved organic matter during ice formation and its photobleaching by UV radiation are part of my studies as well as the impact of biochemistry on the ecosystem sea ice. The observation of ongoing physical processes in the micro- and macrostructure of ice are of great importance for the understanding of biochemistry in sea ice and under-ice water which is characterized by the concentration and distribution of chemicals and organic matter and its interactions with surfaces within the ice.
CURRICULUM VITAE

PEKKA HERMANNI KAARTOKALLIO
Finnish Inst. of Marine research. PoB 2 00561 HELSINKI FINLAND
Email: hermanni.kaartokallio@fimr.fi

PERSONAL DETAILS
born: 11th July 1974, Hämeenlinna, Finland, Family status: married, three children,
Nationality: Finnish.

EDUCATION
MSc (Hydrobiology): 1998, University of Helsinki, PhD (Hydrobiology): 2006,
University of Helsinki

AFFILIATIONS
Current: Senior research scientist (1.4.2008-) FIMR, Senior research scientist
(substitute) 2006-2008 FIMR, Scientist, Academy of Finland BIREME-programme.
2003-2006 FIMR/University of Helsinki, Grantee/Walter & Andréé de Nottbeck

ICE-RELATED RESEARCH INTERESTS
Structure and function of sea-ice food webs, especially sea ice bacteria. Succession
and growth regulation of sea-ice organism communities. The role of sea-ice in Baltic
Sea wintertime biogeochemistry from the microbial perspective. Bacterial
communities in ice: composition, phylogeny, key microbial players in the sea-ice
biogeochemistry.

RECENT PUBLICATIONS
Kaartokallio H, Kuosa H, Thomas DN, Granskog MA, Kivi K (2007) Changes in
biomass, composition and activity of organism assemblages along a salinity
Kuparinen J, Kuosa H, Andersson A, Autio R, Granskog MA, Ikävalko J,
Kaartokallio H, Karell K, Leskinen E, Piiparinen J, Rintala J-M, Tuomainen J
(2007) Role of sea-ice biota in nutrient and organic material cycles in the
Feedbacks as Cause and Demise of Neoproterozoic Icehouse: Astrobiological
Prospects for Faster Evolution and Importance of Cold Conditions. PLoS ONE
2(2): e214. doi:10.1371/journal.pone.0000214
Stedmon CA, Thomas DN, Granskog M, Kaartokallio H, Papadimitriou S, Kuosa H
(2007) The characteristics of dissolved organic matter in Baltic coastal sea ice:
allochthonous or autochthonous origins? Env Sci & Technol 41:7273 – 7279.
doi:10.1021/es071210f
Kaartokallio H, Tuomainen J, Kuosa H, Kuparinen J, Martikainen PJ, Servomaa K.
fast ice. Polar Biol, published online first 02/02/08, DOI: 10.1007/s00300-
008-0416-1.
Curriculum Vitae of Hilary Kennedy

Hilary Kennedy trained as a geochemist gaining a PhD at the University of Leeds and undertaking a post-doctoral position at Cambridge University before joining Bangor University as a lecturer in 1985, where she was promoted to Reader in 2006. She has established a stable isotope research group and has participated in both national and international research projects. Her research has focused on using stable isotopes (C, N, O, and S) to indicate the source and reactivity of chemical elements during biogeochemical processing, with the overall aim of understanding biogeochemically important processes in the ocean and to provide past and present day tracers of climatic and ecological change. She has been a member of a national funding committees e.g. NERC College (1998–2001, 2007–2010), the NERC Isotope Geosciences Laboratory steering committee (1998–2001), and the NERC Life Sciences Mass Spectrometry steering committee (2007–2010). She was awarded a Sabbatical fellowship by the Ministerio de Education y Culture at the Institute of Mediterranean Advanced Studies in Spain (2000–2001). She has been a PI on 13 NERC and 4 EU awards, and has published over 55 peer-reviewed articles in international journals.

She has a wide ranging expertise in applications that use the stable isotopic composition of dissolved and particulate inorganic and organic carbon, especially as it relates to our understanding of primary production, biomineralisation and abiotic (inorganic) precipitation of calcium carbonate. She has studied the variations in stable isotopic composition of algae in both the open waters and in the sea ice of the Southern Ocean. The results have provided key information on the environmental controls on algal growth in these environments. She has also utilised stable isotope techniques to investigate the physical and chemical controls on carbon chemistry in sea ice during a previous large scale experimental freezing of seawater and in the Southern Ocean pack ice. She is currently PI on a nationally funded grant, “The role of sea ice dynamics in carbonate mineral production and its fate in the Polar Oceans”, which is a collaborative project with researchers at the School of Ocean Sciences, Bangor University and the Alfred Wegner Institute.

Kennedy, H & Robertson, J.E. 1995 Variations in the Isotopic Composition of particulate organic carbon in surface waters along a 88°W transect from 67°S to 54°S. Deep Sea Research II, 42, 1109 – 1122
Curriculum vitae Harri Kuosa

1. Full names
   • Harri Juhani Kuosa

2. Date and place of birth, nationality
   • 24.10.1959 Pertteli, Finnish

3. Earlier and current positions
   • Scientist at Tvärminne zoological station 1986-1991 (Nottbeck Foundation and Academy of Finland)
   • Scientist, Senior Scientist and Chief Scientist at the Finnish Institute of Marine Research 1991- (on leave 2002-)
   • Professor in Baltic Sea Research, University of Helsinki, Tvärminne Zoological Station, from 1.1.2002 to 31.12.2011

4. Activities concerning sea ice studies:
   • I have been working on sea ice from 1988, when I participated EPOS-programme in Weddell Sea. After that I have worked two more times in Antarctica (1992 NARE and 2004/5 ISPOL). The experiences gained from Antarctic have been used in the Baltic Sea sea ice studies from late 1990’s onwards. I have been the principal investigator for several Baltic Sea sea ice projects, and supervised several sea ice related PhD-students. Two of my recent Academy of Finland projects are: ‘The role of Baltic Sea ice biota in carbon cycling during winter, 2003-2006’ and ‘The response of pelagial food web to nutrient enrichment, 2007-2010’.
   • My sea ice work, both in Antarctica and in the Baltic Sea, has been concentrating on microbial processes, the microbial loop, algae and nutrient dynamics. Specifically in the Baltic Sea, I have conducted experimental work in field and laboratory.

5. Co-operation in sea ice research:
   • Bangor University (Wales), Alfred Wegener Institute (Germany), P. et M. Curie University (France), University of Umeå (Sweden), University of Oslo (Norway), University of Kiel (Germany)

6. Selected publications:


Curriculum vitae of
Gernot Nehrke

Dr. Gernot Nehrke is Postdoc in the marine biogeosciences working group at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. He obtained his Masters in mineralogy / environmental geochemistry at the University of Heidelberg in 1996 and a Ph.D. (title of thesis “Calcite precipitation from aqueous solution: transformation from vaterite and role of solution stoichiometry”) at the University of Utrecht, The Netherlands in 2007. Since 2003 he has been employed at the AWI where his main field of research is on the thermodynamic and kinetic effects on trace element / isotope fractionation during inorganic carbonate formation and biomineralization of marine calcifying organisms.

Publications: 10 in peer reviewed Journals and books.
InvitedTalks: 1

Recent publications:


Curriculum Vitae

Name: Stathys (Efstathios) Papadimitriou
DOB: 09/04/1963
Nationality: Greek
Work Address: School of Ocean Sciences, College of Natural Sciences, Bangor University, Menai Bridge, Anglesey LL59 5AB
tel: 0044 1248 388123
e-mail: s.papadimitriou@bangor.ac.uk

Career: Stathys Papadimitriou is a Geologist (BSc)–Marine Geochemist (PhD). He is a Research Lecturer at the School of Ocean Sciences, Bangor University, appointed in 2007 on a Welsh Assembly-funded Research Programme. With the biogeochemistry group at the School of Ocean Sciences, he has participated in a wide range of national, international, and European–wide research programmes over the past 10 years, including the INTERICE III mesocosm experiment at Hamburgische Schiffbau- und Versuchsanstalt, Hamburg, Germany, and two expeditions to the seasonal sea ice zone in the Weddell Sea, Antarctica, in 2004 and 2006 onboard the German icebreaker Polarstern. His research is driven by his interest in the cycles of carbon and nitrogen in the marine environment. In his research, he applies geochemical tools, such as the natural stable isotopic abundance of carbon and nitrogen, as well as the abundance of dissolved organic and inorganic nutrients, to profile the traces of biological and non-biological processes in the aquatic environment (deep-sea sediments, tropical and temperate coastal and estuarine ecosystems, and the polar seas). His current research activities on estuarine biogeochemistry include collaborative projects with Aberystwyth University and the Centre of Ecology and Hydrology at Bangor.

CV - Dr. Colin A. Stedmon

Scientist at Dept. Marine Ecology, National Environmental Research Institute, University of Aarhus, Frederiksborgvej 399, DK4000 Roskilde, Denmark.
Email: cst@dmu.dk, Tel: +45 4630 1805, Fax: +45 4030 1114.
Website: http://colin.stedmon.googlepages.com/

Education:
Ph.D. Faculty of Science, University of Copenhagen, Denmark, 2004.
B.Sc. Marine Environmental Chemistry (1994). University of Southampton, UK.

Employment:
2000-2001: Research Assistant at Dept. Marine Ecology, NERI.
2004- Research Scientist at NERI, Dept. of Marine Ecology (now part of the University of Aarhus).

Research Interests:
I study the biogeochemistry of organic matter and nutrients in aquatic ecosystems. Including the bioavailability of carbon, nitrogen and phosphorous bound in dissolved organic matter (DOM). Additionally I am interested in aquatic optics and photo-chemistry and using UV-Vis spectroscopy (absorption and fluorescence) to characterise DOM. Since 2005 I have been principle investigator (PI) on four research projects and co-PI on two. Currently collaborating with David Thomas on the properties of DOM in Baltic Sea and Antarctic sea ice and working on a project together with Rainer Amon and Ron Benner on tracing terrestrial organic matter in the Arctic Ocean. At NERI I am also coordinator and cruise leader for the marine monitoring sampling program. I have published 17 peer reviewed papers to date (nine as first author).

Five recent publications (2006-):


BRIEF C.V. OF Tison, Jean-Louis

CURRENT POSITION
Professor, Université Libre de Bruxelles (ULB)

EDUCATION
Agrégé en Sciences, June 26th 2002, ULB
PhD in Sciences: June 23rd 1981, ULB
Agrégé de l’Enseignement Secondaire Supérieur, 1976, ULB
Licencié en Sciences, 1976, ULB

RESEARCH and ACADEMIC CAREER
From Oct. 2002 Professor at the Université Libre de Bruxelles
(Department of Earth and Environmental Sciences)
Jan. 1989 - Sep. 2002 Research Associate at the Fonds National de la Recherche
Scientifique
Scientifique
Sep. 1985 - Sep. 1988 Postdoctoral Researcher at the Université Libre de Bruxelles
(Federal Office for Scientific, Technical and Cultural Affairs - Belgium)
Sep. 1981 - Aug. 1985 Teacher at Decroly’s School (Brussels - Belgium)
Scientifique

PUBLICATIONS in PEER REVIEWED INTERNATIONAL JOURNALS
81

PRESENTATIONS AT INTERNATIONAL SYMPOSIA
92
Countries: New Zealand, Greenland, Alaska, United Kingdom, Italy, China,
Australia, Belgium, France, Germany, USA, Switzerland, Sweden, Canada
AWARDS

Wiley Award 1990
Descartes Award (EU), 2008

FIELD EXPERIENCE

Arctic Regions (4)

- 2001: North GRIP site, central Greenland - European program lead by Denmark (NBI)
- 1992: Kangerlussaq, western Greenland - *Basal ice of the western margin of the Greenland ice sheet* - team leader of a Belgian field party of 5 people
- 1979: Bylot Island, canadian Arctic - *Basal ice co-isotopic studies* - collaboration with University of Edimburgh

Antarctic Regions (12)

- 2007: SIMBA N.B. Palmer cruise 2007 (Antarctica, Bellingshausen Sea) – Biogeochemistry of spring first-year sea ice in the Bellingshausen Sea – leader of a 9 people Belgian team – collaboration with: NSF, UTSA (Texas, USA), DRI (Reno, USA)
- 2004-2005: ISPOL Polarstern cruise 2004-2005 (Antarctica) - *Biogeochemistry of summer first-year sea ice in the western Weddell Sea* - leader of a 4 people Belgian team - collaboration with: AWI (Germany), RUG (Holland), U. Bangor (UK) and ACE-CRC (Australia)
- 2003: Dumont Durville - Casey, Aurora Australis V1 cruise - *Biogeochemistry of Antarctic pack ice within the (114°E-119°E) sector* - leader of a 5 people Belgian team - collaboration with AAD (Australia)
- 2003: Scott Base - *Sea ice biogeochemical studies in McMurdo Sound (Part III)* - collaboration with ANZ/IRL (New Zealand)
- 2001: Scott Base - *Sea ice biogeochemical studies in McMurdo Sound (Part II)* - collaboration with ANZ/IRL (New Zealand)
- 1999: Scott Base - *Sea ice biogeochemical studies in McMurdo Sound (Part I)* - collaboration with ANZ/IRL (New Zealand)
1998-1999: Nathaniel B. Palmer - NBP 98/3 Summer sea ice cruise - Pack ice biogeochemical studies - collaboration with USARP (USA)

1998: Nathaniel B. Palmer - NBP 98/3 Winter sea ice cruise - Pack ice biogeochemical studies - collaboration with USARP (USA)

1995-1996: Hells Gate and Nansen Ice Shelves - Marine ice and Ice-Ocean interactions studies - collaboration with PNRA-XIth Antarctic Italian Expedition (Italy)

1993-1994: Hells Gate and Nansen Ice Shelves - Marine ice and Ice-Ocean interactions studies - collaboration with PNRA-IXth Antarctic Italian Expedition (Italy)

1989-1990: Base de Dumont d’Urville - Basal ice and moraine studies at Moraine Preudhomme - collaboration with EPF (France)

1987-1988: George VI Ice Shelf (Peninsula) - Sea ice and Marine ice studies - collaboration with BAS (UK)

**Alpine Regions (16)**

1999: Glacier de Tsanfleuron, Switzerland - Testing Antarctic sampling equipment

1997: Glacier de Tsanfleuron, Switzerland - Basal Clear Ice Layer study (Part II) - collaboration with University of Aberystwyth, Wales, UK

1996: Glacier de Tsanfleuron, Switzerland - Basal Clear Ice Layer study (Part I) - collaboration with University of Aberystwyth, Wales, UK

1993: Haut Glacier d’Arolla, Switzerland - Subglacial Hydrology and Basal ice studies (part II) - collaboration with University of Cambridge, UK

1993: Glacier de Tsanfleuron, Switzerland - Basal Clear Ice Layer and glacial hydrology study - collaboration with University of Aberystwyth, Wales, UK

1991: Titliiss Rock Glacier, Switzerland - Basal ice from rock glaciers - collaboration with ETH Zurich

1990: Haut Glacier d’Arolla, Switzerland - Subglacial Hydrology and Basal ice studies (part I) - collaboration with University of Cambridge, UK

1989: Glacier de Tsanfleuron, Switzerland - Subglacial Hydrology and carbonate precipitates - collaboration with University of Cambridge, UK

1987: Titliiss Rock Glacier, Tsijiore Nouve Glacier, Tsanfleuron Glacier, Switzerland - Basal ice from alpine glaciers

1986: Titliiss Rock Glacier, Tsijiore Nouve Glacier, Tsanfleuron Glacier, Switzerland - Basal ice from alpine glaciers

1981: Grüben Glacier, Switzerland - Basal ice from alpine rock glaciers
1980: Tsjiore Nouve Glacier, Grüben Glacier, Switzerland - *Basal Ice from alpine glaciers*

1979: Tsjiore Nouve Glacier, Switzerland - *Basal Ice from alpine glaciers*

1979: Tsjiore Nouve Glacier, Grüben Glacier, Switzerland - *Basal Ice from alpine glaciers*

1978: Tsjiore Nouve Glacier, Ferpècle et Mont-Miné Glacier, Switzerland - *Basal Ice from alpine glaciers*

1977: Tsjiore Nouve Glacier, Switzerland - *Basal Ice from alpine glaciers*

**OTHER INTERNATIONAL WORKING TRIPS**

81

**Countries:** New Zealand, United Kingdom, Italy, Belgium, France, Germany, Switzerland, Denmark, Canada, USA

**PEER REVIEWING IN JOURNALS and BOOKS**


**Books:** John Wiley and Sons, London Geological Society

**REFEREE FOR INTERNATIONAL POLAR RESEARCH FUNDING AGENCIES**

National Environmental Research Council (NERC - UK), National Science Foundation (NSF - USA), Expéditions Polaires Françaises (EPF - France)

**SCIENCE STEERING COMMITTEES**

BASICS in IPY (Biogeochemistry of Antarctic Sea Ice and the Climate System), ASPeCt (Antarctic Sea ice Processes and Climate - member of SCAR), GRIP (Greenland Ice Core Project), EPICA (European project for Ice Coring in Antarctica), EPB (European Polar Board)

**CONTRIBUTION TO NATIONAL AND INTERNATIONAL RESEARCH PROJECTS**

2008-2010 **BELISSIMA** (BELgian Ice Sheet-Shelf Ice Measurements in Antarctica) - Belgian State, Federal Office for Scientific, Technical and Cultural Affairs (OSTC)

2009-2010 **BASICS–IPY-FRFC (2)** (Suivi annuel des flux air-glace-mer de CO$_2$ au dessus de la banquise arctique: une contribution à l’Année Polaire Internationale) - Fonds de Recherche Fondamentale Collective - FNRS (convention n° 2.4584.09)
2007-2008 **BASICS-IPY-FRFC(1)** (Biogéochimie des glaces de mer dans les océans polaires: implications sur les échanges de gaz à effet climatique et les variations climatiques d'origine naturelle, ou anthropique – une contribution à l’année polaire internationale) - Fonds de Recherche Fondamentale Collective - FNRS (convention n° 2.4649.07)

2001-2005 **AMICS** (Antarctic ice sheet dynamics and climate change: Modelling and Ice Composition Studies) - Belgian State, Federal Office for Scientific, Technical and Cultural Affairs (OSTC) - (EV/11/8B)

2001 **Interice III Project** (HSVA, Hamburg): study of sea ice growth processes and properties in experimental ship basin: relationship with biological processes - funded by EU

1995-2002: **EPICA** (European Project for Ice Coring in Antarctica) – Phase I, II and III: workpackage #3: “isotopes measured on ice: access to climatic and environmental information” – funded by the EU (contracts: ENV4.CT95.0074, ENV4.CT98.0702 and EVK2.2000.00762)

1997-2002: **PNRA** (Progetto Nazionale di Ricerche in Antartide); study of marine ice and landfast sea ice in the Terra Nova Bay area, Antarctica (phase 2) – partly funded by OSTC (A4/DD/E02)

1999-2002: **ANTARCTICA NEW ZEALAND**: study of landfast sea ice in McMurdo Sound, Ross Sea, Antarctica – partly funded by OSTC (A4/DD/E02)

1995-2002: Joint research project. **University of Otago** (Geography). Université Libre de Bruxelles (Earth Sciences) funded by Marsden Fund (NZ), Antarctica New Zealand, Belgian Scientific Program on Antarctica: (Processes acting under cold basal glaciers in the Dry Valleys, Antarctica).


1996-2001: **North GRIP Ice Coring Project** (Denmark, Germany, France, Japan), partly funded by F.N.R.S.


1997-1999: **“Study of the basal ice facies of temperate glaciers”**: field program with the Center for Glaciology (Aberystwyth, Wales) – funded by NERC (contract GR9/2026)

1992-1997: **PNRA**: study of marine ice and landfast sea ice in the Terra Nova Bay area, Antarctica (phase 1) – partly funded by OSTC (A4/DD/E02 and previous)

1994-1996: **“Reactive carbonate in basal ice”**: project with the University of Birmingham. funded by the Belgo-British Academic Research Collaboration Program (British council, CGRI)

1989-1992: **GRIP** (Greenland Ice core Project) Study of the basal part of the ice core, especially in collaboration with University of Copenhagen, Alfred Wegener Institut für Polar Forschung, Bremerhaven and Laboratoire de Glaciologie du CNRS, Grenoble.
BROAD RESEARCH INTERESTS

I have developed my expertise in glaciological studies of high-altitude temperate and polar regions as a member of the Glaciology Laboratory of the Earth and Environmental Sciences Department of the Université Libre de Bruxelles since 1977. For more than 40 years now, this laboratory has focused his activities on the study of physico-chemical properties of «interface ice», be it the «ice-bedrock», «ice-ocean» or «ice-atmosphere» interface. My expertise is based on numerous “ice-oriented” field expeditions (16 in the Alps, 10 in Antarctica and 4 in the Arctic regions) and laboratory experiments, and on the development of equipments and analytical techniques dedicated to the multi-parametric study of ice rich in solid or liquid impurities: textures and fabrics, stable isotopes of oxygen and hydrogen, total gas content and gas composition, bulk salinity, major elements chemistry…The main objective of this research effort is a better understanding of initial and boundary conditions of large ice masses (continental or marine), together with a comprehensive approach of the processes governing their interactions with the climate, more specially in the framework of the potential impact of mankind on future climate at a global scale.
CURRICULUM VITAE: Graham James Charles Underwood.

Date of birth: 31.03.64. Nationality: British.
Address: Department of Biological Sciences, University of Essex, Colchester, Essex. CO4 3SQ.
Tel: (01206) 873337, FAX (01206) 873416, email gjcu@essex.ac.uk

Education and Employment

1983 - 1986 University of Reading, Whiteknights, Reading.
1986 B.Sc. (Hons.) First Class, Zoology with Microbiology as a subsidiary subject.
1986 University Prize, University of Reading.
1986 Alison Grisley Prize, University of Reading.
1989 Degree of Doctor of Philosophy, Univ. of Sussex.
1992 - 1998. Lecturer in Department of Biology, University of Essex.
1998 – 2002. Senior Lecturer, Department of Biological Sciences, University of Essex.
2002 – 2004. Reader, Department of Biological Sciences, University of Essex
2004-present. Professor, Department of Biological Sciences, University of Essex

Sea Ice related Research interests, activity and funding

My specialism is the microbial biogeochemistry, physiology and ecology of microphytobenthic diatoms and their associated bacterial assemblages and the production of extracellular polysaccharide mucilage’s (EPS). The focus of much of this work has been the interaction between microbial activity and the external environment (inorganic nutrients, light climate, spatial and temporal variability). Recent work has focussed on the behavioural and physiological adaptations of benthic diatoms to deal with stress which enables them to maintain high rates of activity across a whole spectrum of environmental conditions. My current interests include two recent NERC project grants determining the patterns of production and the importance of diatom–derived EPS in the sea ice environment. We have applied techniques used for characterising EPS in marine sediment biofilms to sea ice matrix, and have demonstrated that between 40-80% of the DOM consists of carbohydrates. The majority (>75%) of this carbohydrate is EPS, with high molecular weight polymers (30 and 50% alcohol precipitates) representing a significant proportion of the total EPS pool. There are also differences in the chemistry of the different EPS fractions, probably caused by the ability of diatoms to modulate their EPS production and chemistry in response to environmental cues, which will influence the physical interactions between EPS and the ice matrix.

Five selected publications since 2000 (66 publications since 1990)

CV of Anssi Vähätalo
Anssi Vesa Vähätalo, P.O. Box 65, FIN-00014 University of Helsinki, Finland
anssi.vahatalo@helsinki.fi.

Education: PhD 2000, Adjunct Prof. 2005, University of Helsinki.

Recent Professional career
• 2005-2010, Academy Research Fellow, University of Helsinki, Department of Bio- and Environmental Sciences.
• 2007 Sep-Dec; Professor, Limnology, Department of Bio- and Environmental Sciences, University of Helsinki.
• 2004-2005, University of Helsinki, Department of Bio- and Environmental Sciences, Research on the biogeochemistry of aquatic ecosystems and climatic change.

Activity as a supervisor of Ph.D. students
• started 2008, Susann Haase, The role and importance of photochemistry and bacterial processes in sea ice, University of Helsinki, supervisor, together with Dr. Mats Granskog.
• started 2006, Hanna Aarnos, Photolytic decomposition of natural organic matter in environment, University of Helsinki, supervisor.
• started 2005, Miika Kuivakko. Photochemical decomposition of brominated flame retardants in the environment, University of Helsinki (supervisor, together with Prof. Tapio Kotiaho)

Sea Ice Project:

Representative publications
Please send the completed form by e-mail to the facility provider:

- CNRS Coriolis/LEGI Grenoble: Joel Sommeria, sommeria@coriolis-legi.org
- DHI Water & Environment: Jens Kirkegaard, jkj@dhigroup.com
- Hamburg Ship Model Basin (HSVA): Karl-Ulrich Evers, evers@hsva.de
- Norwegian University of Science and Technology (NTNU): Alexandra Neyts, alexandra.neyts@bio.ntnu.no

1. **Title of the proposal**
   Model tests of iceberg towing

2. **Requested facility/facilities:**
   Hamburg Ship Model Basin (HSVA)

3. **Applicant's full name and title (User Group Leader)**
   Kenneth Johannessen Eik, PhD student

4. **Affiliation**
   (name and full postal address of the applicant's institution, including department or school):
   
   Norwegian University of Science and Technology (NTNU), Department of Civil and Transport Engineering, Høgskoleringen 7A, 7491 Trondheim

   Male/Female: Male

   Tel.: +47 48 04 72 68
   Fax.: +47 73 59 70 21
   E-mail: kenjo@statoilhydro.com Web-site: http://www.ntnu.no/

5. **Full name, titles, positions in institution, nationalities and gender of all other persons participating in the project (NB: only users who intend to access the facilities!)** (enlarge the table if necessary):

<table>
<thead>
<tr>
<th>Name, titles and affiliation</th>
<th>Position</th>
<th>Nationality</th>
<th>M/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenneth J. Eik, PhD student NTNU/ Researcher Statoilhydro</td>
<td>PhD student</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Christian Ulrich, MSC student TUHH</td>
<td>MSC student</td>
<td>German</td>
<td>M</td>
</tr>
<tr>
<td>Aleksey Shestov, PhD student UNIS</td>
<td>PhD student</td>
<td>Russian¹</td>
<td>M</td>
</tr>
<tr>
<td>Sveinung Løset, Professor, NTNU</td>
<td>Professor</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Aleksey Marchenko, Professor, UNIS</td>
<td>Professor</td>
<td>Russian¹</td>
<td>M</td>
</tr>
<tr>
<td>Ove Tobias Gudmestad, Professor, UIS</td>
<td>Professor</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Thomas Rung, Professor, TUHH</td>
<td>Professor</td>
<td>German</td>
<td>M</td>
</tr>
</tbody>
</table>

¹ Resident of Svalbard,
6. **Names and access period of those that made use of the access programme to this facility in previous EC framework programmes:**

7. **Estimated number of access days requested:** this includes the time needed for building the test setup, testing and calibration when necessary, experiments, and removal of the test setup:

   2 weeks (thereof 1 week for producing icebergs, team leader only)

8. **Estimated total number of the visiting person-days**
   *(sum of the days of presence at the installation of all the members of the visiting team);*

   45

9. **Most appropriate period for the experiments?**
   *Are there any constraints for the period when you may or may not perform the experiments?*

   As soon as possible!
   This experiment may also be performed in combination with other experiments as it does not require an unbroken ice sheet.

10. **Tentative list of instrumentation requested**
    *(contact us for information; if you also use your own instruments, please give the characteristics)*

    - 2 cylindrical buckets (diameter 2.8 m)
    - 2 rectangular buckets (length 2.8 m/width 1.5 m)
    - 4 accelerometers (2 installed at each iceberg)
    - 30 m floating tow line
    - 2.5 m steel hawser
    - Strain gauge (to measure tension in tow line)
    - Video camera

11. **Description of the proposed work (maximum of four A4 pages).**

    This must specify the installation needed and should contain a brief description of:
    - Scientific context of the study (incl. reference to the state-of-the-art)
    - Scientific aims
    - Theoretical framework and methodology
    - Proposed analysis of the results
    - Publication plan
    - Justification for access
    - The role of each team member

    Reference is made to the attached Research Proposal: “Iceberg tow-research proposal_080908.doc”

12. **Technical details and specifications of the planned experiments (maximum of one A4 page)**

    Reference is made to the attached Research Proposal: “Iceberg tow-research proposal_080908.doc”

**Appendix (please provide in a separate file)**

*CV of each group member (max 1 page per person)*

Attached in separate file: “CVs Iceberg tow.pdf”
Research Proposal

In the 6th European Framework Programme Hydralab III

Hamburg Ship Model Basin
(Hamburgerische Schiffbau Versuchsanstalt – HSVA)

PROPOSAL

Model Tests of Iceberg Towing

Proposed by
Norwegian University of Science and Technology (NTNU),
Trondheim

August 13, 2008
1.0 Introduction

Icebergs may cause a threat to installations, vessels and operations in a number of Arctic and Antarctic regions. If icebergs are detected and considered to be a threat, it has been documented that they can be deflected into a safe direction in approximately 75% of the events (Rudkin et al., 2005). The preferred method for iceberg deflection is single vessel tow rope (Figure 1).

The majority of the unsuccessful tows ended because the tow slipped over the iceberg while ruptures of tow line or iceberg rolling over are other common explanations (Rudkin et al., 2005). There are also examples of towing where towing in the planned direction was not possible. In order to increase the understanding of what happens when an iceberg tow is started, Marchenko (2005) and Marchenko and Ulrich (2008) developed a numerical model for iceberg towing.

While all successful iceberg towing operations so far has taken place in open water, future oil and gas developments are expected to take place in regions with occurrence of icebergs embedded in sea ice. The possibility to manage icebergs in such conditions will contribute to increased safety in future operations. The potential for handling icebergs in sea ice may also directly influence the design of offshore structures in Arctic waters.

This proposal includes a description of iceberg tow tank model tests which can be used to validate the existing numerical models and if necessary further improve the model skills. Such tests should be performed both in open water as well as in waters with sea ice.

2.0 Objectives

The objectives of this project are as follows:

- Validate and further develop existing mathematical models for iceberg movement and line tension during open water tow and tow in ice covered waters.
- Gain knowledge regarding possibilities and complications by iceberg towing in ice covered waters.
- Gain experience regarding physical model tests of iceberg towing
- Gain experience regarding the influence of towing rope stiffness on the stability of the towing.

3.0 Scope of Work

Two buckets of appropriate size are filled with fresh water which is frozen. One of the buckets has a cylindrical shape while the other is rectangular. When the ice is completely frozen, the iceberg models are moved into the ice tank. A tow rope which consists of a floating part and a steel hawser is attached to the icebergs as shown in Figure 1. The loose end is attached to the tank carriage which in this test will represent the tow vessel. The carriage will tow the icebergs with constant speed while iceberg movement and line tension are recorded during the tow.

This procedure is carried out with both iceberg shapes in the tank in ice concentrations at 80%, 60%, 40%, 20% and open water. In order to achieve maximum value of each ice sheet, this can be done by doing the tests in 80% concentration first. Thereafter 20% of the ice is removed and tests are done in 60% ice concentration and so on.

The experiments will be repeated with towing ropes of different thicknesses. Minimal thickness of the floating tow line is estimated from the condition that rope tension should be about its strength. Diagram of the floating tow line stiffness under the tension will be constructed before the tests.
4.0 Test programme

The experiments will be conducted in the large ice tank at HSVA.

4.1 Theory

The equation of momentum balance will describe the iceberg motion during towing:

\[ M_i \frac{dv_i}{dt} = F_{wa} + F_{wi} + F_I + T, \quad \frac{dx_i}{dt} = v_i \]

where \( M_i \) is iceberg mass (including added mass), \( v_i = \left(v_{ix}, v_{iy}\right) \) is the vector of iceberg velocity in the horizontal plane \((x,y)\), \( F_{wa} \) is the force applied to the iceberg by the water and \( F_{wi} \) correspondingly by the air. \( F_I \) is the force from surrounding sea ice. \( T \) is the force applied to the iceberg by the rope and vector \( x_i = \left(x_i, y_i\right) \) shows the location of iceberg centre mass at the plane \((x,y)\).

In order to ensure a safe tow, it is required that the tension in any part of the tow rope is less than the ultimate capacity of the rope. In accordance to Marchenko and Ulrich (2008) the vector of rope tension by iceberg towing with one rope branch can be calculated by:

\[ T = e_{IS} \sigma_0 (r, X) \]

where \( e_{IS} \) is a normalized vector giving the direction, \( \sigma_0 \) is the rope tension which is a function of the initial rope length and the distance between fastening points at ship and iceberg. The formulas by Marchenko and Ulrich (2008) will have to be slightly modified in order to take into account a different tow-line configuration (ref. Figure 1) and the influence of rope stiffness under the tension.

With respect to environmental forces, it can be assumed that forces from wind and waves are negligible while forces from water are found by the Morisson equation. Forces from surrounding sea ice may be accounted for as a drag-form contribution.

4.2 Test scale

It is suggested to model the icebergs with a geometrical scaling of 1:40 (scale factor \( \lambda = 40 \)). An iceberg with length in waterline 112 m will then be 2.8 m in the model basin. For the rectangular iceberg, the width will be 1.5 m in model scale corresponding to 60 m in full scale. A sail height of 5 m and corresponding draught of 35 m is considered as appropriate. In model scale, the draught will be 0.875 m. For remaining parameters such as velocity, acceleration etc., Froude scaling will be applied.

4.3 Model tests

We suggest an access to the ice tank for one week of actual testing. Since the testing will be done in broken ice, only one ice sheet will be required. It is desired to model the ice regime in the North Eastern Barents Sea which is represented by a mean level ice thickness of 0.8 m. This corresponds to 2 cm in the model tank. In accordance to McClintock et al. (2007) a tow rope consisting of 1200 m floating synthetic tow line and at least 100 m tow hawser is in general adequate for an iceberg tow. This corresponds to 30 m and 2.5 m respectively. For the icebergs in this proposal, this corresponds to a distance of approximately 12.5 m from the centre line of the iceberg to the carriage.
With respect to speed during the tow, it is of interest to investigate what happens after an acceleration or if the tow heading is changed. Due to this, it is proposed that two types of tow tests are performed:

1. Tests where the iceberg is subjected to a change in tow speed
2. Tests where the iceberg is subjected to a change in tow direction
3. Tests with different thicknesses of floating tow line

Type 1 tests:
Initially, the iceberg is floating in the centre line in one end of the tank. The iceberg is then accelerated from 0 m/s to 0.7 m/s within a period of 10 minutes. Thereafter, the iceberg is towed with a constant speed of 0.7 m/s for the next 10 minutes. After this, the iceberg is accelerated from 0.7 m/s to 0.8 m/s over a period of 30 s. This speed is then kept constant until the carriage reaches the end of the tank.

Type 2 tests:
In this test, the iceberg is located on the side of the tank while the tow line initially is attached straight ahead of the iceberg in the tow direction. During the tow, the end of the towline is moved to the opposite side of the carriage (Figure 2).

4.3 Equipment
The following equipment is required for the proposed test:

- 2 cylindrical buckets (diameter 2.8 m)
- 2 rectangular buckets (length 2.8 m)
- 4 accelerometers (2 installed at each iceberg)
- 30 m floating tow line
- 2.5 m steel hawser
- Strain gauge (to measure tension in tow line)
- Video camera

---

Figure 1 Synthetic line tow (McClintock et al., 2007)
Figure 2 Illustration of iceberg towing type 2 test. The tow heading is changed by moving the end of the tow line laterally on the carriage during the tow as indicated.

---

1 The approximate distance from tow start to end of acceleration is 16 m. Velocities correspond to full scale values.
5.0 Deliverables

The results of the testing will be given in a data report that includes an executive summary for submission to HSVA. In addition, test results will be applied in a validation study of existing numerical model for iceberg towing. Potentially, the numerical software will be modified and improved. Further, the plan is to disseminate the major results through two conference papers and one journal article, all subjected to peer review.

6.0 Time schedule and organisation

The model testing is anticipated to last 1 week (5 working days per week). It is suggested that the research team additionally has one week for disposal of the tank in advance of the actual model test week to freeze the icebergs, prepare the equipment and get used to the instrumentation. Hence, the large-scale facility programme should allocate the lab for two weeks.

Conditional access to the tank facilities, the test period is planned to take place during the first quarter in 2009. A status report will be given in summer 2009 and the final report of the project will be handed in by the end of the year 2009.

PhD student Kenneth Eik (NTNU\textsuperscript{1}) will be the project leader while professors from three different European universities as well as another PhD student from TUHH will participate in the project. Table 1 lists the participants, affiliation and nationality.

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenneth Eik</td>
<td>PhD student NTNU\textsuperscript{1}</td>
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</tr>
<tr>
<td>Christian Ulrich</td>
<td>PhD student TUHH\textsuperscript{2}</td>
<td>German</td>
</tr>
<tr>
<td>Aleksey Shestov</td>
<td>PhD student UNIS\textsuperscript{3}</td>
<td>Russian</td>
</tr>
<tr>
<td>Sveinung Loset</td>
<td>Professor NTNU</td>
<td>Norwegian</td>
</tr>
<tr>
<td>Aleksey Marchenko</td>
<td>Professor UNIS</td>
<td>Russian</td>
</tr>
<tr>
<td>Ove Tobias Gudnestad</td>
<td>Professor UIS\textsuperscript{4}</td>
<td>Norwegian</td>
</tr>
<tr>
<td>Thomas Rung</td>
<td>Professor TUHH</td>
<td>German</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Norwegian University of Science and Technology \textsuperscript{2} Hamburg University of Technology \textsuperscript{3} The University Centre in Svalbard \textsuperscript{4} University of Stavanger

7.0 References


CURRICULUM VITAE

PERSONAL:
Name: Eik, Kenneth Johannessen
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Nationality: Norwegian
Present position: PhD student,
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Engineering, Norwegian University of Science
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Researcher, StatoilHydro
Civil Status: Married with Nina Elise Thorshaug Eik;
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EDUCATION:
2006-present: PhD study in ice management,
The Norwegian Institute of Technology,
Trondheim.
1994-98: "Sivilingeniør", The Norwegian Institute of
Technology.
1992-94: Officer Candidate School, Royal Norwegian
Navy
1989-92: Jessheim Videregående Skole

WORK:
1998-06: Statoil (now StatoilHydro)
-Responsible for metocean data collection and
analyses

PUBLICATIONS:
Review of Experiences within Ice and
Iceberg Management
2004 8th International Workshop on Wave
Hindcasting and Forecasting, Hawaii
Application of STWAVE in Norwegian
Coastal Waters
2002 International Journal of Offshore and Polar
Engineers (IJOPE)
Joint Distribution for Wind and Waves in
the Northern North Sea
2001 International Society of Offshore and Polar
Engineers (ISOPE), Stavanger
Joint Distribution for Wind and Waves in
the Northern North Sea
2001 The Journal of Navigation, Vol. 54, no. 1,
pp. 81-96
Drift of Sea Ice Ridges in the Pechora Sea
2000 6th International Workshop on Wave
Hindcasting and Forecasting, Monterey
Joint Distribution for Waves and Current in
the Northern North Sea
1999 Port and Ocean Engineering under Arctic
Conditions, Helsinki.
Simulation of Iceberg Drift
CURRICULUM VITAE

PERSONAL:
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E-mail: christian.ulrich@tu-harburg.de

EDUCATION:
2003-present: Diploma study in Naval Architecture,
focus on fluid dynamics and offshore engineering,
Hamburg University of Technology, Germany
2002-2003 Officer training, German Airforce

PUBLICATIONS:
2008 19th IAHR International Symposium on Ice,
Vancouver

    Iceberg Towing: Analysis of Field
    Experiments and Numerical Simulations
CURRICULUM VITAE

PERSONAL:
Name: Aleksey Shestov
Born: 1985
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EDUCATION:
2008-present: PhD student, The University Centre in Svalbard (UNIS), Department of Arctic Technology.
2002-08: Moscow Institute of Physics and Technology (State University) (MIPT SU)
1991-02: High school, Ryazan, Russia

WORK:
2006-present: State Oceanographic Institute - numerical models in the GIS systems

PUBLICATIONS:
2008 Proceedings of the State Oceanographic Institute No. 211. Ocean and Sea Research

2008 Influence of Ice Formations on the Baydaratskaya Bay Bottom of the Kara Sea: Field Studies and Numerical Simulation

2008 Coastal Technology-Coast 2008

2008 Hydrological Characteristics of the Straight Separating Braganzavågen from Sveabukta in Van Mijen Fjord

2007 19th International Internet Conference of Young Scientists and Students, Moscow

2007 Thermodynamics of Ice Ridge Consolidation

2007 Proceedings of the 50th scientific conference of the Moscow Institute of Physics and Technology, Moscow

2007 Ice gouges in Baydaratskaya Bay of the Kara Sea

2007 “Physics and Progress”. Yong Scientific Conference, St. Petersburg

2007 Numerical Modelling of Ice Scouring Process in Baydaratskaya Bay of the Kara Sea

2007 RAO/CIS Offshore 2007

2007 Ice gouging in Baydaratskaya Bay of the Kara Sea: field studies and numerical simulations

2007 POAC-07, Dalian

2007 Ice Gouging in Baydaratskaya Bay of the Kara Sea: Field Studies and Numerical Simulations

2006 18th International Internet Conference of Young Scientists and Students, Moscow

2006 Ice gouging in Baydaratskaya Bay of the Kara Sea. Field studies and Numerical Simulation
CURRICULUM VITAE

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Present position: Professor in Arctic Marine Engineering, Department of Civil and Transport Engineering, Norwegian University of Science and Technology (NTNU); Professor II at the University Centre in Svalbard (UNIS)
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EDUCATION:
1990-93: Dr.ing. in marine technology, The Norwegian Institute of Technology, Trondheim.
1978-79: Pedagogic Training for Civil Engineers (PUFS), The Norwegian Institute of Technology.
1973-76: Volda gymnas.

KEY QUALIFICATIONS:
Scientific: Knowledge and direct experience of ice engineering from more than 15 years (1986-03) of field/laboratory investigations and numerical modelling:
- Ice physics and mechanics
- Ice loads on offshore and coastal structures (field/laboratory investigations, computations)
- Sea ice dynamics and rheology (field/laboratory investigations, computations)
- Statistics on sea ice and icebergs, Barents Sea
- Planning of oil/gas terminals in icy waters
- Thermodynamics of icebergs and sea ice ridges
- Cold climate engineering
- Oil in broken ice; behaviour, spreading and response
- Friction of solid materials on snow and ice
These items involve erudition on ice mechanics, ice physics and dynamics, structural engineering, statistical analysis as well as application of remote sensing techniques. Applied physics (with emphasis on dynamics, thermodynamics and numerical modelling) has been the key discipline in most of my practice.

Substantial collaboration with St. Petersburg State Technical University, Russia (1995-).
Extended contact with Helsinki University of Technology and VTT, Finland (1995-).
Extended contact with Hamburgische Schiffbau-Versuchanstalt, Germany (1988-).
Chairman of 12th International IAHR Ice Symposium, Trondheim, 1994.

PUBLICATIONS:
- 14 books and compendia
- 25 international refereed journal papers
- 96 refereed international conference papers
- 26 conference papers (selected)
- 54 technical reports (selected)
- 4 approved patents
CURRICULUM VITAE

PERSONAL:
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EDUCATION:
1997: Doctor of Sciences (Mechanics of liquid, gas and plasmas), Moscow State University and higher Attestation Board under the Government of Russia, Thesis: “Models of sea ice cover and flexural-gravity waves”.
1987: PhD. (Mechanics of liquid, gas and plasmas), Moscow State University and Higher Attestation Board under the Council of Ministers of the USSR. Thesis: “Some problems of the theory of internal and surface waves in the fluid beneath an ice cover”.
1982-1985: Post-Graduate Course, Moscow State University, Department of Hydromechanics, BS/MS (Mechanics), Moscow State University, Faculty of Mechanics and Mathematics.
1977-1982: BS/BM (Mechanics), Moscow State University, Faculty of Mechanics and Mathematics

EMPLOYMENT HISTORY
Scientific: Senior Researcher (1/2 staff) Laboratory “Arctic Shelf”, Arctic and Antarctic Research Institute, St. Petersburg, Russia, 2002-2008.
Leading Researcher, Theoretical Department, General Physics Institute, Russian Academy of Sciences, Moscow, 1991-pr.
Teaching: Associate professor of the University Centre in Svalbard, 2006-pr.
Visiting professor of the Seoul National University, Department of Naval Architecture and Ocean Engineering, teaching of Ice Mechanics and Ice Technology courses, 2003-.
 Supervising of course and diploma student works, Department of Hydromechanics, Moscow State University, 1998-2001.
Lecturer on theoretical mechanics and physics, Far East University, Vladivostok, Russia, 1980-1990.

KEY QUALIFICATIONS:
International Collaboration:
Member of the International Committee of the International Conference on Port and Ocean Engineering Under Arctic Conditions (POAC).
Member of Gesellschaft fur Angewandte Mathematik und Mechanic (GAMM).

PUBLICATIONS:
• 16 papers in International refereed journals
• 35 papers in Russian refereed journals translated in English
• 36 papers in the Proceedings of International conferences
• 15 papers in books
CURRICULUM VITAE

PERSONAL:
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Present position: - Professor of Marin Technology at the University of Stavanger from 1st September 2008
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1971-1973: Cand real (Master program, scientific direction) in applied mathematics, non-linear mechanics, University of Tromso, Norway.
1971: Pedagogic Training (0.5 year course), University of Bergen, Norway.
1966-1971: Cand Mag, (Bachelor program) Mathematics and Physics, University of Bergen, Norway

EMPLOYMENT HISTORY
Industry: Employee of Statoil, Stavanger 1975 to 2008. Different positions, e.g. as advisor since 1995 on Concrete structures, Platform removal, Marine Technology and Arctic Technology
Scientific: Research assistant, University of Tromso, Applied Mathematics, 1973-1975
Adjunct professor Marine Technology, University of Stavanger, 1994-2008
Adjunct professor Arctic Offshore Civil Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, 2005-date
Teaching: Special advisor to Petrad Foundation, Stavanger, Teaching Courses on “Management of Field Development and Operations” for industry managers from 3rd world countries, 1991- date
Statoil in-house course on “Field Development”, Course developer, 1995 to 2005
University studies at Svalbard, UNIS, course developer and teacher: “Arctic Offshore Engineering”, 1995 to date

KEY QUALIFICATIONS:
Scientific: Prepared papers on the following subjects
- Nonlinear mechanics
- Wave loading and water wave kinematics
- Offshore structural design, in particular concrete platform design
- Environmental loading
- Marine offshore operational risk analysis
- Arctic Offshore Field development and concepts
International Collaboration: Norway’s representative to International Standardization Organization standard development, e.g. to ISO 19906, Arctic Offshore Structures
Project leader for projects on behalf of Statoil in Vietnam, China, Venezuela, USA, Denmark and Nigeria
Substantial collaboration with Russian Universities, that is: St. Petersburg State Technical University, Russia (collaboration from 1997-date), Gubkin University, Moscow (Honorary Doctor, 2002) and Murmansk State Technical University (Honorary Doctor 2008).

PUBLICATIONS:
- 8 books
- 47 international refereed journal papers
- 180 refereed international conference papers
- 27 approved patents
CURRICULUM VITAE

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http://www.tuhh.de/fds/

EDUCATION:
1994-2000: Dr.-Ing. in Mechanical Engineering, Technical University Berlin.
1976-85: Hardberg-Gymnasium, Bonn

KEY QUALIFICATIONS:
Scientific: Knowledge and direct experience of fluid mechanics from more than 15 years (1990-08) of field/laboratory investigations and computational modelling:

- Computational and theoretical fluid mechanics
- Fluid dynamic loads structures (field/laboratory investigations, computations)
- Flow physics modelling (field/laboratory investigations, computations)

Applied physics (with emphasis on thermofluid dynamics and numerical modelling) has been the key discipline in most of my practice at the university and as the lead engineer of the global centre-of-competence aerodynamics/thermodynamics and acoustics for Bombardier Transportation.

International collaboration: Substantial collaboration with Tsinghua University, China (2000-).
Extended contact with Chalmers University of Technology, Sweden (2005-).
Extended contact with MARIN, Netherlands (2005-).

PUBLICATIONS:
- 4 books and compendia
- 10 international refereed journal papers
- 15 refereed international conference papers
- 35 conference papers (selected)
Please send the completed form by e-mail to the facility provider:

- CNRS Coriolis/LEGI Grenoble: Joel Sommeria, sommeria@coriolis-legi.org
- DHI Water & Environment: Jens Kirkegaard, jkj@dhigroup.com
- Hamburg Ship Model Basin (HSVA): Karl-Ulrich Evers, evers@hsva.de
- Norwegian University of Science and Technology (NTNU): Alexandra Neyts, alexandra.neyts@bio.ntnu.no

1. Title of the proposal
   Investigation of local ice load dependency on flare and stem angles through model testing

2. Requested facility/facilities:
   Hamburg Ship Model Basin (HSVA)

3. Applicant's full name and title (User Group Leader)
   Vegard Aksnes, M.Sc.

4. Affiliation
   Norwegian University of Science and Technology (NTNU), Department of Civil and
   Transport Engineering, Høgskoleringen 7A, 7491 Trondheim. Male/Female: Male
   Tel.: ..... +47 735 94727 .........................
   Fax.: ..... +47 735 97021 .........................
   E-mail: vegard.aksnes@ntnu.no .......................... Web-site: www.ntnu.no/petroarctic

5. Full name, titles, positions in institution, nationalities and gender of all other persons participating in the project (NB: only users who intend to access the facilities!) (enlarge the table if necessary):

<table>
<thead>
<tr>
<th>Name, titles and affiliation</th>
<th>Position</th>
<th>Nationality</th>
<th>M/F</th>
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<tr>
<td>Vegard Aksnes, M.Sc., NTNU</td>
<td>PhD Student</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Basile Bonnemaire, Dr., NTNU &amp; Barlindhaug Consult</td>
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<td>M</td>
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<tr>
<td>Oddgeir Dalane, M.Sc., NTNU</td>
<td>PhD Student</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Trine Lundamo, M.Sc., Barlindhaug Consult</td>
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<td>Norwegian</td>
<td>F</td>
</tr>
<tr>
<td>Christian Lønøy, NTNU</td>
<td>M.Sc. Student</td>
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</tr>
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<td>Hanne Hagen, NTNU</td>
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<td>Norwegian</td>
<td>F</td>
</tr>
<tr>
<td>Sveinung Løset, Dr., NTNU</td>
<td>Professor</td>
<td>Norwegian</td>
<td>M</td>
</tr>
<tr>
<td>Ove Tobias Gudmestad, Dr., University of Stavanger</td>
<td>Professor</td>
<td>Norwegian</td>
<td>M</td>
</tr>
</tbody>
</table>
6. Names and access period of those that made use of the access programme to this facility in previous EC framework programmes:

Aksnes, Bonnemaire, Lundamo, Lønøy and Løset; June – July 2007

7. Estimated number of access days requested; this includes the time needed for building the test setup, testing and calibration when necessary, experiments, and removal of the test setup:

4 weeks (thereof 2 weeks for building the model, team leader only)

8. Estimated total number of the visiting person-days (sum of the days of presence at the installation of all the members of the visiting team):

125

9. Most appropriate period for the experiments?

Preferably as soon as possible.

10. Tentative list of instrumentation requested (contact us for information; if you also use your own instruments, please give the characteristics)

See project description.

11. Description of the proposed work (maximum of four A4 pages).

This must specify the installation needed and should contain a brief description of:
- Scientific context of the study (incl. reference to the state-of-the-art)
- Scientific aims
- Theoretical framework and methodology
- Proposed analysis of the results
- Publication plan
- Justification for access
- The role of each team member

12. Technical details and specifications of the planned experiments (maximum of one A4 page)

Appendix (please provide in a separate file)

CV of each group member is attached
Investigation of local ice load dependency on flare and stem angles through model testing

A research and test program proposed by

Written by: Vegard Aksnes
vegard.aksnes@ntnu.no

Summary
When a moored vessel is exposed to drifting ice, all parts of the waterline area of the hull may potentially interact with ice. Ice failure and hence ice load depend on the flare angle at the location of interaction and local ice loads will therefore vary along the waterline of the vessel. In these model tests we will study local ice load dependence on flare and stem angles with a simple model. Three flat sloping plates will be assembled as indicated in Figure 1. The angle of each of the sloping plates with the water plane will be possible to adjust individually. The angles between the three plates in the waterline will be adjustable as well. Each of the three plates will be divided into four smaller plates, all equipped with triaxial load cells.

The model will be mounted to a frame, which is connected to a driving carriage. The model will be towed through level ice, broken ice, rubble fields and first-year ridges with different configurations of angles. From these tests we will be able to study dynamic ice loads, dependence on flare and stem angles, normal and tangential loads on the panels, correlation between panels and splitting of ice load into breaking and friction parts. The results will be used by two PhD students and two master students in their theses.

1 Background
Moored ship-shaped vessels are thought to be feasible for hydrocarbon production in cold waters, see Hansen (1998); Jensen (2002); Bonnemaire (2005). Most concepts have so far been studied through extensive model tests. Model tests are expensive and time consuming and thus there is a need for numerical tools to simulate moored vessels in various ice conditions. Such a numerical tool is under development at the Norwegian University of Science and Technology (NTNU). The numerical tool will have to estimate dynamic ice loads acting on the vessel. Model tests in an ice tank are necessary for calibration of the input to the numerical tool.
In model tests it has been seen that yaw stability of moored vessels in ice with varying drift direction is important, Spencer et al. (1997); Jensen et al. (2008). Lack of horizontal stability may lead to events with extreme mooring loads and risk of capsizing. To be able to avoid such events it will be helpful to have a numerical simulation tool, such that different mooring configurations can be tested numerically before doing expensive model tests.

When a vessel is exposed to ice with varying drift direction, most parts of the waterline area of the vessel may be exposed to ice actions. The flare angle of a ship-shaped vessel varies along its waterline. Ice failure and hence ice load depend on the flare angle at the location of interaction and local ice loads will therefore vary along the waterline of the vessel as indicated in Figure 2a. The numerical tool will have to evaluate the angle dependence of the ice load analytically. However, today’s knowledge about flare angle dependence on ice loads is limited and it is necessary to do model tests. In these model tests, we will study the flare angle dependence on local ice loads with a simplified sloping structure. Moreover, we will study how the local ice load varies with the drift direction.

Figure 2: (a) Illustrative sketch of ice load distribution on a turret moored vessel exposed to sideways ice drift. (b) Bird view of the model without the mounting frame and instrumentation.

2 Test programme
The tests are planned to take place in the Large Ice Model Basin at HSVA in Hamburg, Germany. The Large Ice Model Basin is 78 m long, 10 m wide and 2.5 m deep.

2.1 Test setup and model
The model will have a relatively simple geometry. Basic sketches are shown in Figures 1, 2b and 3. The main details are the following:
- The main parts of the model are three individual sloping plates, indicated with dark grey in the figures.
- The angle of each of the sloping plates with the water plane should be possible to adjust individually.
• The angles ($\gamma_1$ and $\gamma_2$ in Figure 2b) between the three plates in the waterline should be adjustable as well.
• Each of the sloping plates will be divided into four separate elements. Each of the elements will be mounted on triaxial load cells as can be seen in Figure 3. Forces on the four triangular elements (in light grey) will not be necessary to measure.
• The four triangular plates will have to be adjusted for all combinations of waterline angles, $\gamma_1$ and $\gamma_2$.
• Plate 3 will be hinged to a bottom plate, see Figure 3. The bottom plate will be instrumented with load cells as well.
• The system of plates and load cells will be mounted on a frame system as suggested in Figure 3. The frame will be connected to the driving carriage.
• A vertical plate will be placed next to the main model to measure forces from ice crushing.
• A sketch of the tank setup in a level ice test is shown in Figure 4.

![Figure 3: Cross-sectional view of the model with mounting frame and instrumentation.](image1)

![Figure 4: Simple sketch of the tank and the model setup for a test in level ice.](image2)

### 2.2 Test matrix
We plan to have 3 ice sheets, all with the same ice properties. The model scale will be $\lambda = 20$. Froude scaling will be used since gravitational and inertial effects dominate.

#### 2.2.1 Open water tests
All configurations of the model will be towed through the tank in open water to identify water resistance and noise.
2.2.2 Ice tests
Tests in level ice are planned to be divided into four parts; towing through the first quarter of the tank at low speed \( (v_{fs} = 0.2 \text{m/s}) \) and towing through the second quarter of the tank at high speed \( (v_{fs} = 0.5 \text{m/s}) \) with one model configuration. Halfway in the tank, the model configuration is changed and the test is repeated in the second half of the tank.

We plan to make rubble fields, 25 m long and 7 m wide, constrained with wooden beams. The model will be towed through the ridge field, first at low speed, then at high speed. The model configuration will be then be changed and the test repeated.

The ridge test will be performed at high speed.

Details are shown in Table 1.

All three panels will have the same waterline angle within the same test series, thus only one panel angle is specified in Table 1.

Table 1: Preliminary test matrix for all ice sheets.

<table>
<thead>
<tr>
<th>Run #</th>
<th>Description</th>
<th>Panel angle</th>
<th>( \gamma_1 )</th>
<th>( \gamma_2 )</th>
<th>Model scale ( v ) [m/s]</th>
<th>Full scale ( v ) [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1110</td>
<td>Towing through tank – level ice</td>
<td>25°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>1120</td>
<td>Towing through tank – level ice</td>
<td>25°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>1130</td>
<td>Towing through tank – level ice</td>
<td>50°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>1140</td>
<td>Towing through tank – level ice</td>
<td>50°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>1210</td>
<td>Towing through tank – rubble field</td>
<td>50°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>1310</td>
<td>Towing through tank – rubble field</td>
<td>50°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>1410</td>
<td>Towing through tank – rubble field</td>
<td>25°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>1510</td>
<td>Towing through tank – rubble field</td>
<td>25°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>2110</td>
<td>Towing through tank – level ice</td>
<td>60°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>2120</td>
<td>Towing through tank – level ice</td>
<td>60°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>2130</td>
<td>Towing through tank – level ice</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>2140</td>
<td>Towing through tank – level ice</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>2210</td>
<td>Towing through tank – rubble field</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>2310</td>
<td>Towing through tank – rubble field</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>2410</td>
<td>Towing through tank – rubble field</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>2510</td>
<td>Towing through tank – rubble field</td>
<td>75°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>3110</td>
<td>Towing through tank – level ice</td>
<td>40°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>3120</td>
<td>Towing through tank – level ice</td>
<td>40°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>3130</td>
<td>Towing through tank – level ice and ridge</td>
<td>40°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
<tr>
<td>3210</td>
<td>Towing through tank – rubble field</td>
<td>40°</td>
<td>140°</td>
<td>160°</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>3310</td>
<td>Towing through tank – rubble field</td>
<td>40°</td>
<td>140°</td>
<td>160°</td>
<td>0.112</td>
<td>0.5</td>
</tr>
</tbody>
</table>

2.3 Ice preparation
The ice sheets will be prepared according to HSVA procedures, Evers and Jochmann (1993). Target ice thickness and flexural strength is 1 m and 600 kPa (full scale values), respectively. A first-year pressure ridge will be produced from the fifth ice sheet as described by Høyland et al. (2001) and embedded in level ice. Target ridge keel depth is 9m and target ridge width is 60m.

2.4 Measurements
We suggest the following instrumentation:
- Triaxial load cells on all panel elements, 12 in total.
- Triaxial load cells on bottom plate, 3 in total.
- Triaxial load cell on mounting frame for global loads.
• Triaxial load cell on the crushing plate.
The signals from all sensors should be synchronized and sampled at a high frequency.

2.5 Visual observations
The following equipment will be used for visual observations:
• Two video cameras on tripods.
• Two underwater video cameras.
• One bird view video camera.
• Two photo cameras.

3 Participants
The following persons will be involved in the tests (see Table 2):

Table 2: Participants and their affiliation.

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Nationality</th>
<th>M/F</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegard Aksnes</td>
<td>PhD Student, NTNU</td>
<td>Norwegian</td>
<td>M</td>
<td>Project leader</td>
</tr>
<tr>
<td>Sveinung Løset</td>
<td>Professor, NTNU</td>
<td>Norwegian</td>
<td>M</td>
<td>Advisor</td>
</tr>
<tr>
<td>Basile Bonnemaire</td>
<td>Post.doc, NTNU &amp; Barlindhaug Consult</td>
<td>French</td>
<td>M</td>
<td>Advisor</td>
</tr>
<tr>
<td>Oddgeir Dalane</td>
<td>PhD Student, NTNU</td>
<td>Norwegian</td>
<td>M</td>
<td>Data analysis</td>
</tr>
<tr>
<td>Ove Tobias</td>
<td>Professor, University of Stavanger</td>
<td>Norwegian</td>
<td>M</td>
<td>Advisor</td>
</tr>
<tr>
<td>Gudmestad</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trine Lundamo</td>
<td>Barlindhaug Consult</td>
<td>Norwegian</td>
<td>F</td>
<td>Preprocessing of data</td>
</tr>
<tr>
<td>Christian Lønøy</td>
<td>Master student, NTNU</td>
<td>Norwegian</td>
<td>M</td>
<td>Monitoring of ice properties</td>
</tr>
<tr>
<td>Hanne Hagen</td>
<td>Master student, NTNU</td>
<td>Norwegian</td>
<td>F</td>
<td>On-site documentation</td>
</tr>
</tbody>
</table>

4 Expected results
The following aspects are planned to be analyzed:
• Analysis of normal and tangential loads on the panels.
• Dependency on flare and stem angles.
• Dynamic analysis of the ice load.
• Correlation analysis between the panels.
• Separation of loads into breaking and friction parts.

The data will be analyzed by two PhD students and one master student for use in their theses. The results from the tests will be published in two conference papers and one journal paper. In addition, the results will be incorporated in a numerical model. Details about the numerical model will be published at a later stage.

5 References


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2007-present: PhD study in Arctic Marine Technology,
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2005-07: Master of Science - Mathematics,
The Norwegian University of Science and Technology
2002-05: Bachelor of Natural Sciences – Mathematics,
University of Bergen
1998-2001: St. Svithun videregående skole, Stavanger

PUBLICATIONS:
2008 Aksnes, V., Bonnemaire, B., Løset, S. and Lønøy, C.:
Model testing of the Arctic Tandem Offloading Terminal - Tandem Mooring Forces and Relative Motions between Vessels.
IAHR International Symposium on Ice, Vancouver, BC, Canada.

2008 Jensen, A., Bonnemaire, B., Løset, S., Breivik, K. G., Evers, K. U., Ravndal, O., Aksnes, V.,
Lundamo, T. and Lønøy, C.:
First Ice Model testing of the Arctic Tandem Offloading Terminal.
IAHR International Symposium on Ice, Vancouver, BC, Canada.

2007 Aksnes, V.:
On Fourier Series in Convex Domains.
Master Thesis in Mathematics, NTNU.

2002 Aksnes, V. and Gjessing, A.:
Klatring i Rogaland.
ISBN: 82-7955-041-0, 256p
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EDUCATION:
1990-93: Dr.ing. in marine technology, The Norwegian Institute of Technology, Trondheim.
1978-79: Pedagogic Training for Civil Engineers (PUFS), The Norwegian Institute of Technology.
1973-76: Volda gymnas.

KEY QUALIFICATIONS:
Scientific: Knowledge and direct experience of ice engineering from more than 15 years (1986-03) of field/laboratory investigations and numerical modelling:
- Ice physics and mechanics
- Ice loads on offshore and coastal structures (field/laboratory investigations, computations)
- Sea ice dynamics and rheology (field/laboratory investigations, computations)
- Statistics on sea ice and icebergs, Barents Sea
- Planning of oil/gas terminals in icy waters
- Thermodynamics of icebergs and sea ice ridges
- Cold climate engineering
- Oil in broken ice; behaviour, spreading and response
- Friction of solid materials on snow and ice
These items involve erudition on ice mechanics, ice physics and dynamics, structural engineering, statistical analysis as well as application of remote sensing techniques.
Applied physics (with emphasis on dynamics, thermodynamics and numerical modelling) has been the key discipline in most of my practice.

International collaboration:
Substantial collaboration with St. Petersbourg State Technical University, Russia (1995-).
Extended contact with Helsinki University of Technology and VTT, Finland (1995-).
Extended contact with Hamburgische Schiffbau-Versuchsanstalt, Germany (1988-).
Chairman of 12th International IAHR Ice Symposium, Trondheim, 1994.

PUBLICATIONS:
- 14 books and compendia
- 25 international refereed journal papers
- 96 refereed international conference papers
- 26 conference papers (selected)
- 54 technical reports (selected)
- 4 approved patents
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2008: Exchange student at Universidad de Buenos Aires
2006 - 2007: Exchange student at Technische Universität München
1999 - 2002: Ski Videregående skole

WORKING EXPERIENCE
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2005 – 2007: Veidekke ASA
Name: Ove T. Gudmestad

Born: 10th March 1947

Nationality: Norwegian

Present position: Professor of Marine Technology at the University of Stavanger, Adjunct professor of Arctic Marine Civil Engineering at NTNU


Experience with emphasis on work related to environment friendly energy and related areas:
Engineer and Adviser Statoil, Stavanger, 1975-2008 (to September 1th). Of particular relevance: Design and analysis of offshore structures, Marine risk analysis of offshore operations, Arctic offshore field developments, Nonlinear dynamics.

Present research activities and fields of interest: Marine Operations in waves and ice, Structures and vessels to resist ice loading, Design conditions versus operating conditions, Offshore field developments

Membership in academic and professional committees: SNAME (member), RINA (Fellow), NTVA, Norway’s representative to ISO standard work on Arctic Offshore Structures (ISO 19906).

Present doctoral students supervised: (Names and subject for thesis)
Erlend Hovland; Vessels for marine operations, defended December 2007
Arne Gürtner; Ice loading on shallow water structures
Kenneth Eik; Ice management
Raed Lubbad; Ice dynamics

Selected academic and professional publications 2006-2008:

Peer reviewed journals:

International conference proceedings:

Other professional publications, books:
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1999-2002: St. Olav videregående skole, Stavanger

PUBLICATIONS:
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EDUCATION:
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1999 - 2001 MSc in marine construction and hydrodynamics, Norwegian University of Science and Technology, Trondheim, Norway
2001 - 2005 PhD in Arctic marine technology, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

WORK EXPERIENCE:
Winter 2002-2004 Participating into the preparation and realisation of field measurements of ice forces, UNIS, Svalbard, Norway.
April 2005 - Barlindhaug Consult AS, Marine technology and cold climate engineer.
January 2006 - NTNU, Post-Doctorate, Station-keeping in ice infested waters.

SELECTED EXPERIENCE:
2008: WhitePearl Structure – Responsible for the ice design.
Design aspects related to sea ice and iceberg actions on a moored platform.
06 – 08: Development of the Arctic Tandem Offloading Terminal (ATOT) concept
Conceptual design, ice tank model testing and numerical simulations of the moored vessels
05 - 08: Development of numerical tools for the design of fish farms and other moored structures
Development of numerical tools for the simulations of waves propagation in coastal areas
Research topics:
Marine operations performance and response of moored vessels in ice infected waters,
Simulation of wave state in coastal areas;
Loads and effects of irregular waves on fixed and floating structures

SELECTED PUBLICATIONS:
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2003 – 2005 BSc in applied mathematics, University of New Mexico, New Mexico, USA
2000 – 2003 BSc studies in applied mathematics, University of Tromsø, Tromsø, Norway.

WORK EXPERIENCE:

2008 – Barlindhaug Consult AS, MSc, Numerical modelling and Marine technology
2006 – 2007 Barlindhaug Consult AS, part-time work Engineer - numerical modelling and ice loads

PROJECT EXPERIENCE:

Project team member:
2007: Arctic Tandem Offloading Terminal (ATOT).
Ice tank model tests at HSVA, Hamburg, Germany (participation in tests, responsible for data analysis).
Client: Statoil ASA.
Numerical modelling of a moored vessel in ice.
Client: Statoil ASA
Research projects:
2006: Ice actions on moored ships in ice.
Back-calculation of ice load applying on the vessel

PUBLICATIONS:


