SAMCoT
sfi Centre for Research-based Innovation

SAMCoT News Letter 01/2016

(January - June 2016)

Administrative Reporting

Briefing on Selected Activities:

SAMCoT currently counts 23 different partners after adding the Swedish Polar Research Secretariat (SPRS) as a Public Partner in 2015. SPRS's contribution will be fundamental to SAMCoT`s field activities, starting with two research cruises in the second semester of 2016 where 5 SAMCoT researchers will participate.

The leaders of different SAMCoT Work Packages (WPs) made a great communication effort in the first semester of 2016 through a series of WP specific workshops, where Industry and Research partners presented their strategic needs and questions. Furthermore, SAMCoT PhDs presented the status and future plans of their research during the annual Scientific Seminar held in May before an audience of approximately 65 industry and research partners. VIDEOS of most presentations are currently available to all SAMCoT Partners at the e-room, including a presentation of the Ice-induced vibrations of offshore structures (IVOS) Associated Project by Gesa Ziemer.

Notifications:

WPs specific Workshops:

WP5 - 20 September;

WP4 - Either 19 or 21 September (TBA) , NTNU Trondheim

SAMCoT Technical Workshop: October 4 & 5, NTNU Trondheim

SAMCoT General Assembly: October 5, NTNU Trondheim

SAMCoT EIAC: Tentatives September & October (TBA), NTNU Trondheim

SAMCoT Board Meeting (2) 2016: 3 November, NTNU Trondheim

1 December 2016: Annual Reporting Research Council of Norway.

All IP participants to IVOS approved its extension until the end of September 2018 (cost-neutral). This decision facilitates the parallel existence of IVOS with a more recent project on Contact pressure and scaling in ice-structure interaction problems (CoPSIS) funded by the German Federal Ministry for Economic Affairs and Energy. Both projects aim at providing a high quality data set for the study of ice-induced vibrations. More information of the project is available at the IVOS area on the SAMCoT e-room, or by contacting Gesa Ziemer.

In addition to the associated project, SAMCoT has established extensive collaborative links with different research programs and organizations and these activities are resulting in important deliveries for the Centre.

Short list of current SAMCoT collaborations:

- SFI SAMCoT & Arctic Ocean 2016: a polar research expedition in collaboration with Canada with two icebreakers, the Swedish icebreaker Oden and the Canadian icebreaker Louis S. St-Laurent. SAMCoT PhDs Runa A. Skarbø (WP4) and Hans-Martin Heyn (WP5) will take part in this research cruise. Before this activity, the icebreaker ODEN will sail towards the ice following the west/north coast of Spitsbergen. The aim of the expedition is to make engine power and performance measurements when breaking ice. Stian Ruud (WP5) and Marnix vd Berg (WP4) will join the expedition to study ice breaking and icebreaker performance.
- SFI SAMCoT & the Norwegian Center of Excellence, Centre for Autonomous Marine Operations and Systems (AMOS): SAMCoT's collaboration with AMOS is well routed and provides advantages for both Centres. Currently four PhDs involved in research linked to ice management are benefiting from this collaboration.
- SFI SAMCoT & the Center for Research-based Innovation, Center for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA). This collaboration has resulted in the addition of a female researcher to SAMCoT's Floating Structures area of research.
- SFI SAMCoT & NTNU Oceans: NTNU Oceans is one of four strategic research areas at NTNU that aims to achieve "Knowledge for a sustainable ocean". Because of the collaboration among different SFIs, SFFs, NTNU Oceans and SINTEF, and over the next few years, hundreds of PhD candidates will take part of the Ocean School of Innovation.
- SFI SAMCoT & MOSIDEO `Microscale interaction of oil with sea ice for detection and environmental risk management in sustainable operations`. Norut Narvik leads the project under the PETROMAKS2 program of the Research Council of Norway 2015 – 2018. A PhD candidate and a Postdoc linked to this project are closely collaborating with NTNU/SAMCoT to gain knowledge of the interactions between oil & sea ice pore as well as risk assessment and contingency planning of oil spills in sea ice covered waters.
- SFI SAMCoT & Japan. Professor Akihisa Konno from the Kogakuin University (Tokyo UrbanTech) is currently a visiting researcher at NTNU/SAMCoT. His stay has greatly contributed to the definition of the 'Japan-Norway Collaboration for Sustainable Development of the Arctic (JNArc)' project, for which SAMCoT/NTNU has applied for funding to the INTPART programme (a collaboration programme between the RCN and SIU, the Norwegian Centre for International Cooperation in Education). In addition, SAMCoT Centre Director S.Løset participated at the Japan-Norway Arctic Science & Innovation in June'16.
- SFI SAMCoT & Hydralab+: The need of in-depth research in the field of wave/ice interaction and the availability of the unique facilities provided by HSVA (Large Ice Model Basin equipped with a wavemaker) moved three SAMCoT partners (HSVA, Kærner & NTNU) to apply for EU funding to investigate interaction processes between surface waves, ice and a structure. The grant was approved this June. All deliverables will be open.

The Research Council of Norway (RCN) had its annual Site Visit to SAMCoT on 9 June. The RCN was satisfied with how SAMCoT is incorporating the recommendations from the midterm evaluation to the initial plans and vision of the Centre. The RCN encourages NTNU, as the Centre's host institution, to preserve the expertise and value created through the center's work, as well as, to continue an open dialogue with all SAMCoT Partners regarding the way forward and the current search for future EU funding for all SAMCoT related activities.

Data Collection and Process Modelling (WP1)

Briefing on Selected Activities

Ice Strength:

WP 1 focused on the comparison of ice strength characteristics during in-situ tests on sea ice strength. The researchers performed small-scale tests with samples cored from sea ice in the land fast ice in the Van-Mijen Fjord (Spitsbergen). 11 tensile and 52 compressive strength test were implemented. In addition, the researchers measured the acoustic emissions for each meso-scale tests perfomed in the Van-Mijen Fjord.

Researchers performed as well meso-scale tests directly on drift ice in the Barents Sea (Olga strait). A total of 2 shear strength, 2 tensile strength, 3 compressive strength, 4 indentation, 17 flexural strength with floating cantilever beams, 4 torsion strength with L-shape beams and 2 shear strength of triangle block tests.

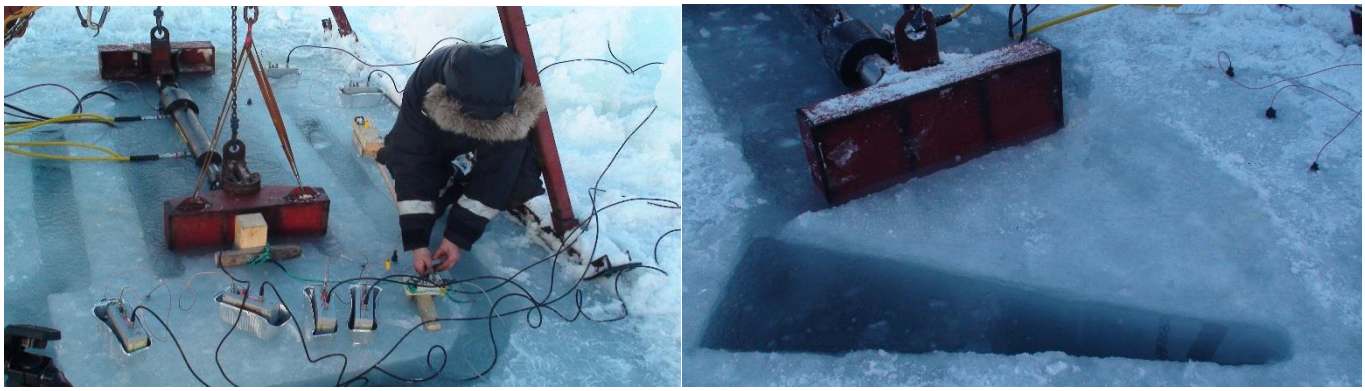


Fig.1. In-situ meso-scale tests on tensile strength (left) and shear strength of triangle block (right) of sea ice.

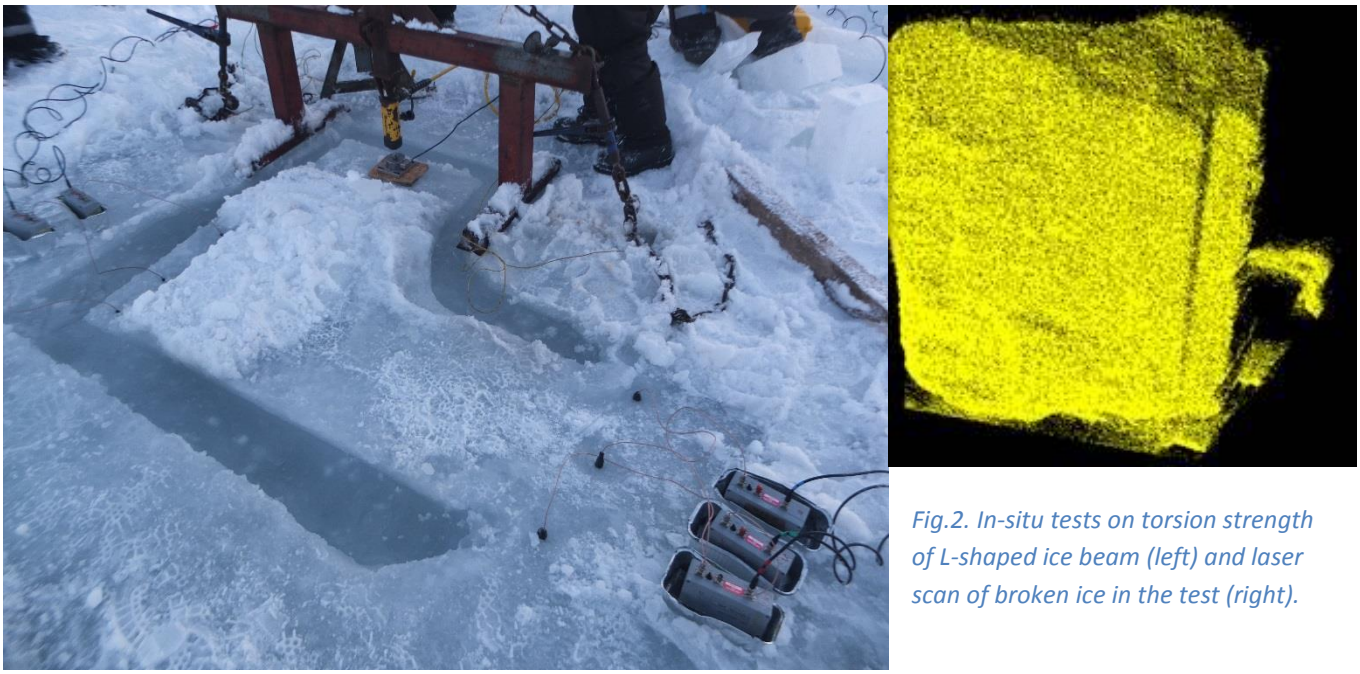


Fig.2. In-situ tests on torsion strength of L-shaped ice beam (left) and laser scan of broken ice in the test (right).

Ice Rubble:

Researchers from WP1 study the thermodynamic processes of ice ruble through different types of experiments, i.e. laboratory size, small scale, and full scale. The developing of the consolidated layer and studies of a transformation mechanism of the ridge keel are of the particular interest.
During March 2016, a small-scale field experiment was performed in the Van-Mijen Fjord (Spitsbergen). Lake Vallunden was the chosen location for the experiment due to the seasonal ice conditions, as it is connecting with the fiord through a strait. At the time of the experiment its water was covered by saline ice. A thermistor string was deployed through the rubble field and conductivity sensors were deployed inside and under the rubble.
Researchers monitored the consolidation of the layer over a period of two weeks from 3 March. After this period, the consolidated rubble field was lifted and samples were taken to investigate its physical properties. The properties in combination with the temperate profile taken will allow WP1 researchers to evaluate the thermal properties and the heat transfer balance.

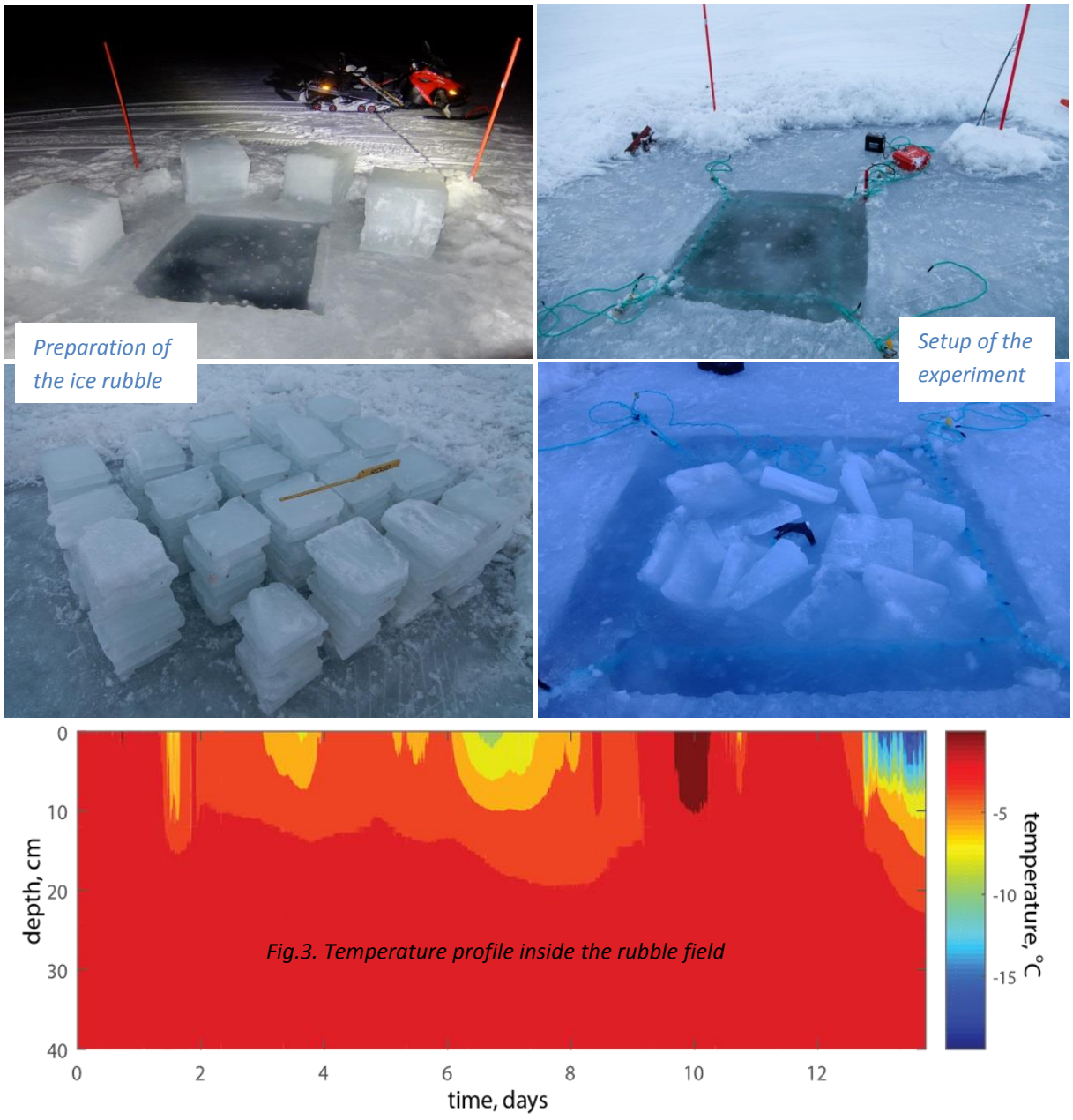


Fig.3. Temperature profile inside the rubble field

GIS:

Researcher Nataly Marchenko met DNV GL and Statoil at Fornebu in April. An initial `data work team` has been created (Nataly Marchenko – UNIS; Kenneth Johannessen Eik, Guy Maurice, Semund Høsøien Simensen – Statoil and Karl John Pedersen – DNV GL). WP1 efforts to identify and structure the available data is well on its way.
During the meeting, the following actions were defined:

- Guy Maurice (Statoil) and Karl John Pedersen (DNV-GL) are currently working on summarizing best alternatives to provide SAMCoT partners with access to the data on-line through GIS. The summary will be available to SAMcot partners to opt for the best solution in the near future.
- All WP leaders will soon present to the EIAC an inventory list of all data collected within their respective WPs. These reports will be studied to define which data and what formats to include in the database. All SAMCoT data should be stored in one unique location.
- Nataly Marchenko in collaboration with Stian Heid (key account manager for Petroleum at Geodata) have created a SAMCoT GIS data on line solution, ArcGIS. She is now working on the best way to make ArcGIS available to all SAMCoT partners. A report will soon available with option and the implications in terms of licensing/administration.

Summary of the scientific activities performed by WP1 - January-May 2016

Laboratory experiments on thermo-elastic waves in saline ice
Laboratory experiments on thermal expansion of frozen soil samples
Thermodynamic consolidation Model of drifting ice rubble, num. simulations & incorporation in ice dynamic model
Formulation of thermo-mechanical model of saline ice including closed brine pockets and permeable channels
Numerical modeling of indentation tests
Numerical modeling of tests with L-shape floating cantilever ice beams
Laboratory experiments on cyclic compression of ice samples
In-situ meso-scale tests on drifting and land fast sea on ice strength in compression, tension and shear
In-situ small scale tests on drifting and land fast sea on ice strength in compression and tension
In-situ tests with floating cantilever ice beams on flexural strength of sea ice
In-situ experiment on ice rubble consolidation
Filed investigations of ice-tide water interaction in very shallow region of Van-Mijen Fjord (Braganzavagen)
Deployment of ice trackers with wind measurement system on the drift ice in Olga Strait, Barents Sea
Laser scanning of ice rubble in the Barents Sea, Lance cruise
Laser scanning of ice failure patterns in meso-scale tests on ice strength
CTD and ADCP profiling in the Barents Sea, Lance cruise
Data analysis and storage in GI system

Achievements:

In 2016 (Q1&2) WP1 published 3 journal papers and 14 international conference papers.

Material Modelling (WP2)

Briefing on Selected Activities

Frozen soil and Ice rubblemariaa:

WP2 will close down by the end of 2016, so in the first half of 2016 the PhD candidates have been working hard on completing their PhD theses.

Yared W. Bekele successfully defend his thesis «Isogeometric Analysis of Coupled Problems in Porous Media - Simulation of Ground Freezing» 19 May. The assessment committee was formed by Professor Stein Sture, University of Colorado at Boulder, USA; Assistant Professor Clemens Verhoosel, Eindhoven University of Technology, The Netherlands and Professor Bjørn H. Skallerud, Department of Structural Engineering, NTNU. Bekele will continue as researcher within WP6 for the second semester of 2016.

Candidates Anna Pustogvar and Sergey A. Kulyakhtin are getting closer to submitting their theses. Kulyakhtin published a paper at IAHR (Kulyakhtin and Polojärvi, 2016).

During 2016, NTNU/SAMCoT is hosting a guest PhD candidate from Dalian University of Technology (DUT) in China, Xiaodong Chen. The candidate conducts work on fundamental experimental work on ice consolidation, melting and heat transfer between ice and water at the ice laboratory of the Department for Civil engineering. Different publications (Chen and Høyland, 2016) will be the results of his work and will be presented next year.

Lindbjør-Nilsen completed her MSc and started to work in Multiconsult. In IAHR 2016 she presented a paper based on her master thesis (Lindbjør-Nilsen and Høyland).

Achievements:

In 2016 (Q1&2) WP2 published 1 PhD thesis and 4 international conference papers.

References:

Bekele, Y. (2016). Isogeometric analysis of Coupled Problems in Porous Media. PhD thesis from NTNU, ISBN 978-82-326-1618-3 (printed ver.), ISBN 978-82-326-1619-0 (electronic ver.) ISSN 1503-8181, 174 p.

Chen, X. and Høyland, K.V. (2016). Laboratory Work on Heat Transfer in Submerged Ice, Theory, Experimental Setup and Results. Proc the 23 Int Ice Symposium (IAHR), Ann Arbor, USA, Paper 4868615.

Heinonen, J. (2016). CEL-Analysis of Punch Shear Tests to Evaluate Mechanical Properties of Ice Rubble. Proc the 23 Int Ice Symposium (IAHR), Ann Arbor, USA, paper 484335.

Kulyakhtin, S. and Polojärvi, A. (2016). Ice Rubble Stress in Virtual Experiments for Assessing Continuum Approach. Proc the 23 Int Ice Symposium (IAHR), Ann Arbor, USA, paper 4853045.

Lindbjør-Nilsen, H. and Høyland, K.V. (2016). FEM-CEL simulations of full scale and model scale punch tests on ice rubble with the Modified Cam clay model, Proc the 23 Int Ice Symposium (IAHR), Ann Arbor, USA, paper 4877586.

Fixed Structures in Ice (WP3)

Briefing on Selected Activities

Ice-induce vibrations:

Torodd Nord is well into his Post-Doc on Ice-induced vibrations and has spent time on ice loads on Nordströmsgrund and other Swedish lighthouses. Together with Morten Bjerkås and Knut V. Høyland, he has provided input to the ISO committee on ice loads on fixed structures. He attended the International Ice Symposium (IAHR) in Ann Arbor, being chairman in a session on ice-structure interaction and presenting two papers on analysis of full-scale data from the Baltic (Bjerkås and Nord; Li et al.).

Hayo Hendrikse continues his work on finalizing his PhD thesis and plays a fundamental role in the scientific discussions related to the IVOS Associated Project, which last meeting in May he attended. In addition, Hendrikse was co-authoring a IAHR paper (Sinitsyn et al. WP5).

Ice ridge action:

Janne Ranta is progressing with his PhD with the presentation of yet another paper, this time at the 23 Ice Symposium (IAHR) in Ann Arbor, USA, where he won the Best Student paper award.

At the same event, Åse Ervik presented two papers about drifting first year ice ridges in Arctic Ocean in May-June 2015. Together with postdoc Aleksey Shestov (WP1), Åse studied drifting and melting ice ridges in Arctic Ocean in May-June 2015. She participated on the fifth of six legs on the expedition "Norwegian young sea ICE expedition 2015" (N-ICE-2015). The purpose of the experimental work carried out by Åse and Aleksey, was to investigate the changes in thermo-mechanical properties in melting first year ice ridges. Melting ice ridges are particularly important for structures located in temperature areas, such as the southwestern Barents Sea.

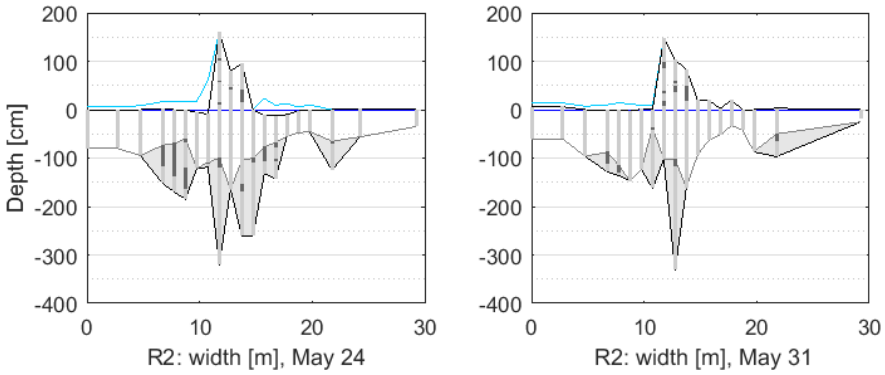


Fig. 1. The smallest ice ridge R2. The vertical lines are drill holes where dark grey is voids of non-ice, the shaded grey area is rubble.

The researchers observed that simultaneously with increases of temperature and decreases of the amount of ice and macro-porosity of the rubble, the consolidated layer continued to increase. This indicate that a first-year ice ridge occurring in the southwestern Barents Sea, is probably a large first-year ridge that is eroded and melting, with a thick consolidated layer compared to the amount of rubble and a low rubble macro-porosity. Ervik is currently working on a numerical model for simulating the failure of consolidated ice on Nordstrømsgrund lighthouse while in addition exploring the possibilities of using SPH method to simulate the consolidated layer.

Evgeny Salganik started his PhD within WP3 Scale-model ice ridges in January 2016 and spent the first half year at UNIS. He participated in field work, took a course and conducted laboratory experiments on ice ridge consolidation together with Post-Doc Aleksey Shestov. Their results were presented and discussed during the Ice rubble and ice ridge action SAMCoT workshop in May 2016. A new PhD candidate at UCL, Mark Shortt, will start his work in July 2016.

Åse Ervik and Annu Oikkonen during N-ICE-2015

The deliverables so far this year are two journal papers and eight conference papers.

References:

Bjerkås, M. and Nord, T. (2016). Ice action on Swedish lighthouses revisited, Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 9000010.

Ervik, Å. and Shestov, A. (2016). Studies of Drifting Ice Ridges in the Arctic Ocean during May-June 2015, Part I. An overview of measurements. Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4868656.

Ervik, Å. and Shestov, A. (2016). Studies of Drifting Ice Ridges in the Arctic Ocean during May-June 2015, Part III. Evolution in morphology. Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4873973.

Hansen, E., Borge J. and Høyland, K.V. (2016). Effects of the observational footprint on the ice thickness distribution. Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4850809.

Hendrikse, H. and Metrikine, A. (2016). Edge indentation of ice with a displacement-controlled oscillating cylindrical structure. CRS&T 101, 100-107.

Kolari, K. (2016). Strain-Rate Softening of Granular Ice in Brittle Regime: Fact or Artifact? Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4848548.

Li, H, Bjerkås, M., Høyland, K.V. and Nord, T. (2016). Panel loads and weather conditions at Norströmsgrund lighthouse 2000-2003, Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4879572.

Nord, T., Øiseth, O. and Lourens E. (2016) Ice force identification on the Nordströmsgrund lighthouse, Computers and Structures, 169 (2016) 24–39.

Polojärvi, A, Tuhkuri, J., Häsä, R. and Schneider, S. (2016). 2D FEM-DEM Study on Ice Loads on Shallow Water Structure. Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4853332.

Ranta, J., Polojärvi, A. and Tuhkuri, J. (2016) A simulation based statistical study on evolution of ice-structure interaction process. Proc the 23 Int Ice Symposium (IAHR)- Ann Arbor, USA, paper 4784293.

Floating Structures in Ice (WP4)

Briefing on Selected Activities

Ice in waves:

Several activities in 2016 are related to studying interaction processes between ice, waves and structures in the Marginal Ice Zone (MIZ). Among them a full-scale experiment on ice dynamics in waves performed as part of the research expedition on R/V Lance in the Barents Sea in April/May 2016. Postdoc Andrei Tsarau, in collaboration with Aleksey Shestor and Sveinung Løset deployed several 6-DOF Inertia Measurement Units (IMU) on ice floes to investigate, e.g., how gravity waves propagate into the ice cover.

A. Tsarau, A. Shestov and S. Løset deploying equipment on an ice floe in the Barents Sea

As the ice is noticeably thinning year after year, the wave spectrum measured in the ice cover far from the ice edge is no longer characterized by only long waves, but also shorter waves are present. The latter is due to the weak wave attenuation.

Another experiment planned this year includes testing ice dynamics in waves and also ice actions on a structure in the presence of waves.

This activity was proposed within the Hydralab+ programme by Kvaerner, NTNU, University of Gdansk, and Clarkson University.

The project will be executed at HSVA. The layout of the experiment is presented in the following figure.

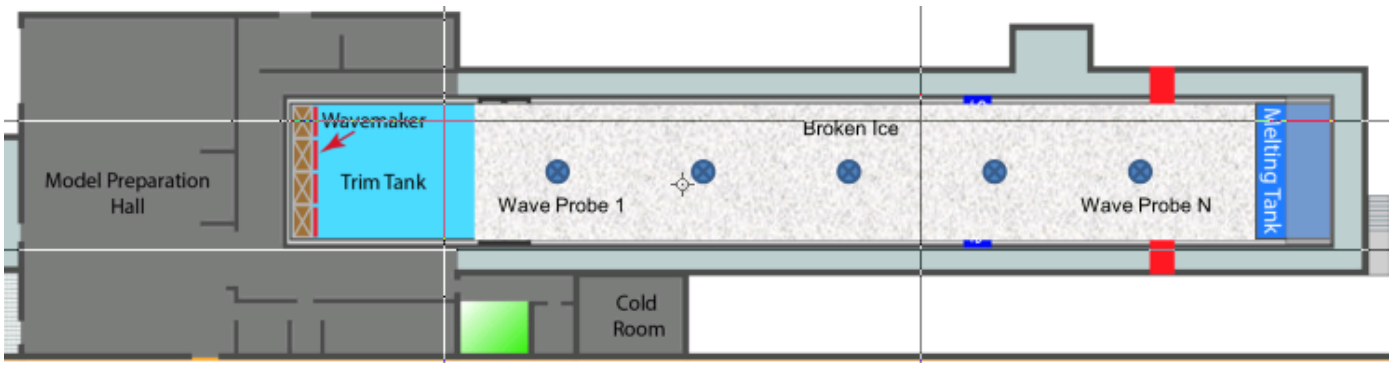
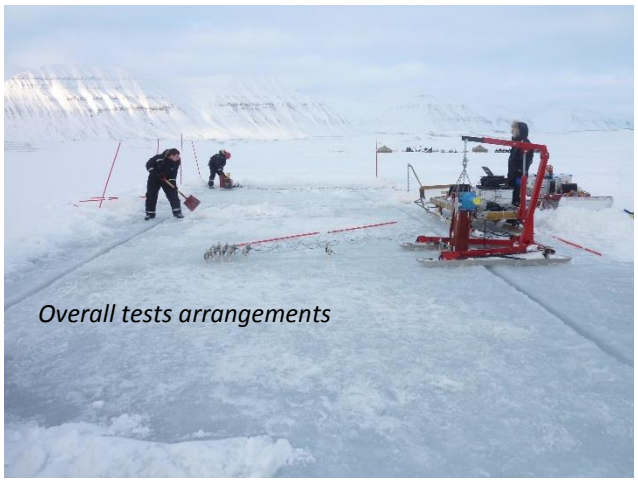


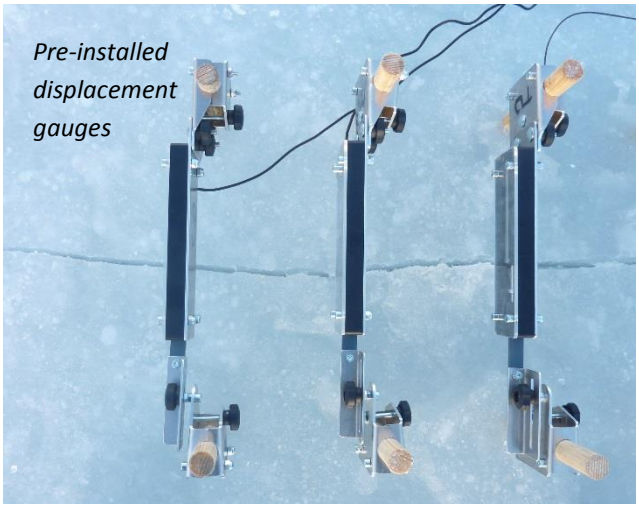
Fig. 1. Layout of the experiment for measurement of wave propagation in broken ice at HSVA`s Large Ice Model Basin.

Large scale sea ice fracture tests:

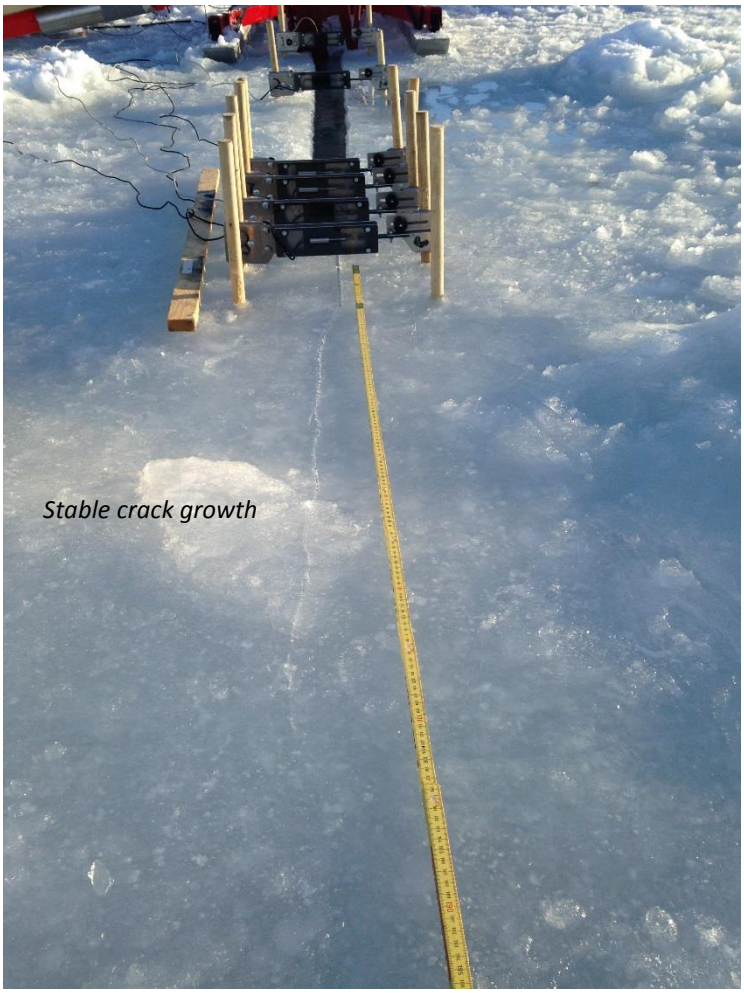
In order to extract the fracture properties of sea ice, large scale sea ice fracture tests were carried out in the period March 4th to 20th in a frozen lagoon near the bay of Braganzavågen in the Van Mijen Fjord of Spitsbergen. In total 17 splitting tests were carried out with floe sizes ranging from 3 × 3 metres to 10 × 20 metres. Rather consistent results of high quality were obtained for further data analysis. Notably, stable crack growth was produced during the tests.



Overall tests arrangements



Pre-installed displacement gauges



Stable crack growth

Achievements:

In 2016 (Q1&2) WP4 had one PhD defense, published 1 journal papers, 2 conference papers

PhD defense

On 19 January 2016 Martin Storheim successfully defended his PhD Thesis "Structural response in ship-platform and ship-ice collisions", Doctoral Thesis at NTNU, 2016:14.

Ice Management and Design Philosophy (WP5)

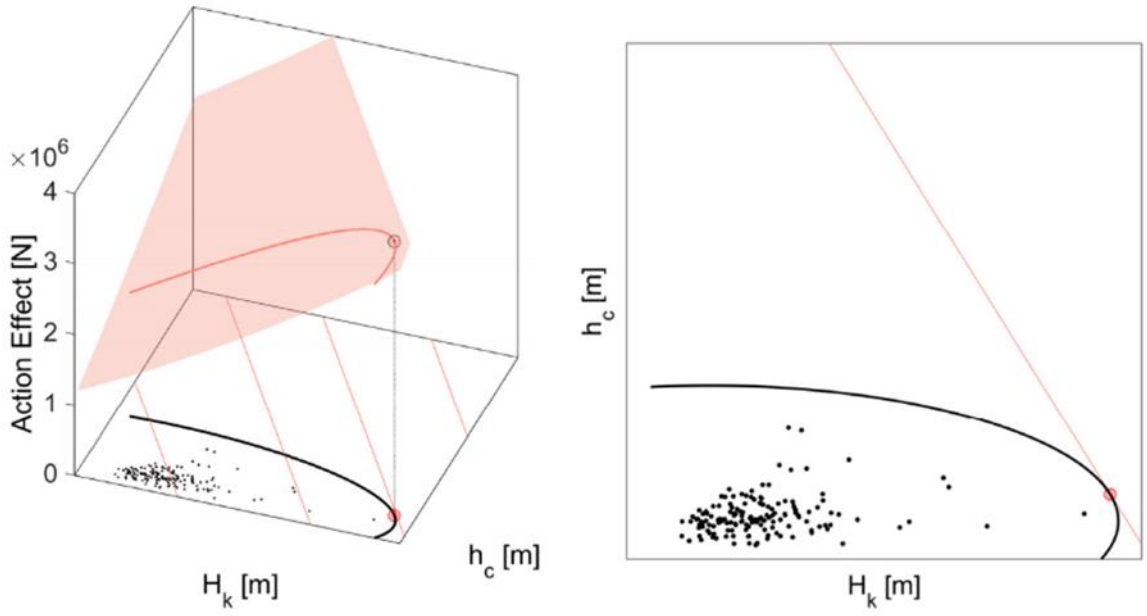
Briefing on Selected Activities

Alternative philosophies for design under different degrees of data availability

In order to design an offshore structure protected by ice management in the Arctic, one can take various approaches depending on the nature and amount of available information. In all of these approaches, the design philosophy can be qualitatively formulated as: Move sufficiently away from the frequent observations of uncertain parameters involved in the problem e.g. environmental parameters, but less than the situation where ice management is not part of the design concept. Then control the circumstances during the lifetime of the structure and in particular the ice management operation.

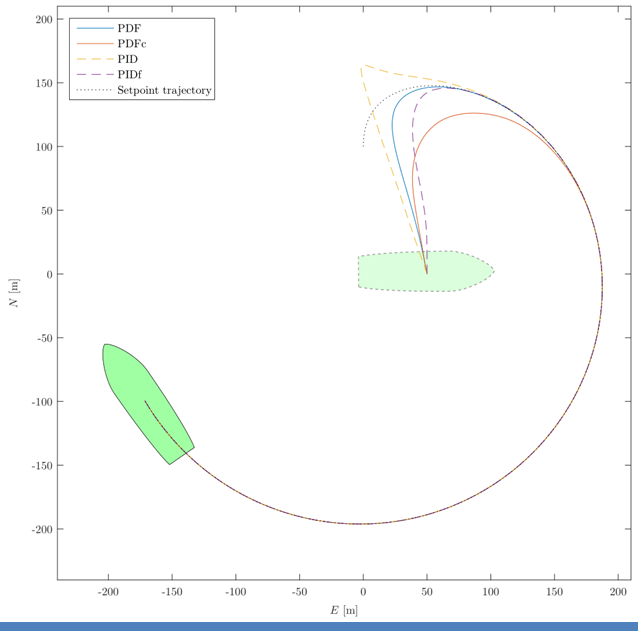
How to move sufficiently away from the frequent observations of uncertain parameters involved (e.g. ice parameters) is a function of target level of safety or reliability, but is also related to the efficiency and predictability of the ice management system. One can either do this probabilistically with classical structural reliability methods (philosophy 1) or by using the concept of probability classes which do not work with a single joint probability density function but rather an entire class (philosophy 2), or non-probabilistically by getting to the physical bounds of the data (philosophy 3). Which philosophy/methodology to use is directly related to how much data and information is available in each situation/project. Farzad has detailed the various aspects of each of these methodologies in his soon-to-be published thesis, as well as the relationship between them.

The Figure below illustrates the action effect (mooring load of a floating unit in this case) as a function of two uncertain environmental parameters related to ridge characteristics. Here, the maximum action effect is sought for along an ellipsoidal contour. This contour is associated with a prescribed level of target reliability and is created using the notion of probability classes. This is a distribution-free contour, meaning that any distribution satisfying a number of prior information constraints extracted from a limited dataset, are covered.



Stationkeeping: A new dynamic positioning control algorithm in ice

Postdoc Øivind K. Kjerstad proposes a new tracking control law for dynamic positioning of floating marine structures subject to heavy disturbances such as ice loads. A key station-keeping control algorithm responsible for computing the thruster forces and moments needed for control of the vessel motion. The work's contribution is mitigating some of the challenges often encountered in conventional control design while reducing the parametric dependency of the system. A small change in the conventional mathematical formulation enables the control law to act as its own reference generator, such that the explicit reference filter may be removed. The stability properties of the design has been analyzed and found to be excellent. Closed-loop simulations have been used to verify the theoretical findings, while further experimental testing is planned.



The figure presents a set point convergence trajectory simulation of the proposed solution (PDF and PDFc) compared to conventional solutions (PID and PIDf). The new and less complex design gives feasible trajectories that are at least equal, or even better, when compared to conventional solutions depending on the experimental setup.

Ref. Kjerstad, Ø. K., S. A. T. Værnø, & R. Skjetne`A Robust Dynamic Positioning Tracking Control Law Mitigating Integral Windup`10th IFAC Int. conf. Control Applications in Marine Systems, Trondheim, Sept. 13-16, 2016

Observations WP5 Workshop:

The scope of Ice Management (IM) activities is wide and cover very many aspects (technologies, equipment, systems, processes, operational procedures…) . Ice Management industry experiences originate from different fields in several geographical areas and refer to many different types of challenges. Different companies and disciplines have different roles, responsibilities, priorities, technologies, terminologies, cultures and have different views on how to approach the ice management issues. Industry needs a top-down 'method for supporting ice management decisions' based on aggregated quantified information.

The definition of barriers was initially proposed to be based on PSA Management regulation section 4 and section 5. International standards should also be referred to in order to start with an already agreed framework for ice management terminology.

A catalogue of relevant ice management barriers could be established (Ian Reed provided valuable input to start such catalogue). The ISO/CD 35104 describes a comprehensive set of measures to be considered for Ice Management operations. Reference also to ISO 19906.

It was proposed to establish 'business cases' with given set of assumptions to base the development, demonstration and testing of the proposed approach

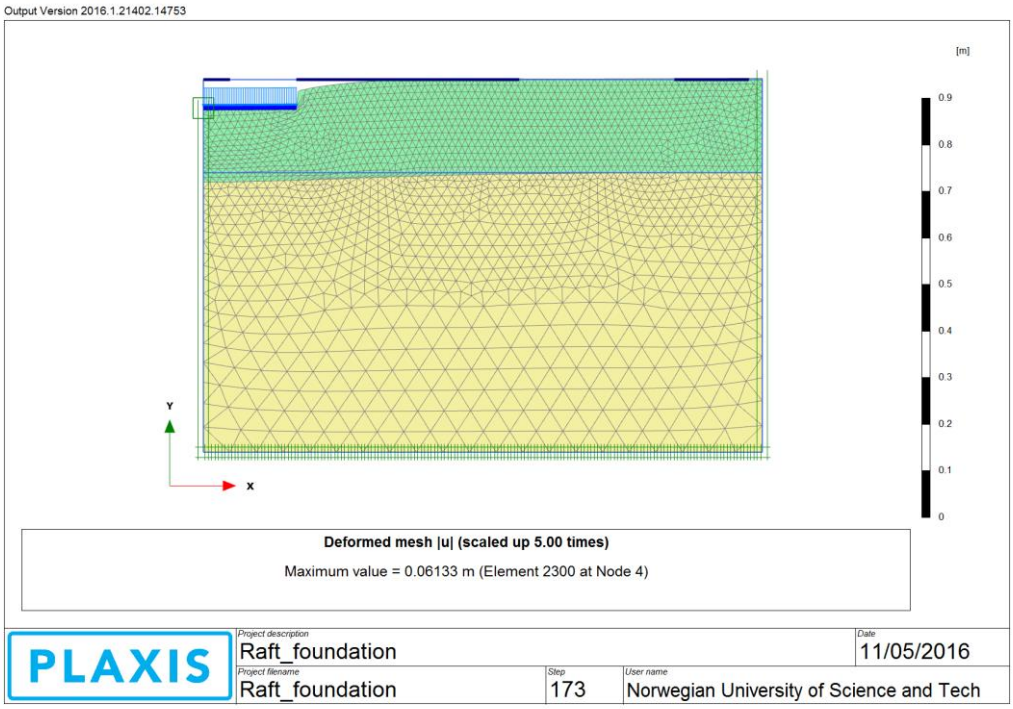
WP5 will continue the work on proposing a detailed approach for a method for Ice risk management. Industry partners are encouraged to come with additional input during the detailing of the approach.

Coastal Technology (WP6)

Briefing on Selected Activities

Thermo-Hydro-Mechanical (THM) constitutive models:

Postdoc Seyed Ali Ghoreishian Amiri and PhD candidate Mehdi Kadivar are working to develop Thermo-Hydro-Mechanical (THM) constitutive models for simulating the behaviour of frozen soils. They developed elastoplastic and elasto-viscoplastic models to describe the mechanical behaviour as well as the behaviour due to variation of temperature. The proposed models are able to represent many of the fundamental features of the behaviour of frozen soils such as ice segregation phenomenon, strength weakening due to pressure melting and long-term creep deformation. Nowadays, these models are being implemented in the commercial software package PLAXIS and will soon be ready to use in geotechnical engineering practice.



In May, a group form MSU led by Prof. Anatoli Brouchkov visited NTNU to discuss the NTNU's THM model and to collaborate with NTNU on the experimental validation of the model. TOTAL participated in the meetings and encouraged the collaboration between the two universities.

Climate Change & the Arctic Coast:

Climate change is predicted to strongly affect the evolution of the Arctic coast over the coming decades. The continuous warming trend observed in Svalbard and northwest Russia since the 1980s are creating concerns related to the stability and durability of existing infrastructure on permafrost and uncertainties related to the design of new structures and infrastructure in the region. An increase in ground temperatures may reduce the bearing capacity and increase settlement rates and subsidence of foundations, and stability of natural and engineered slopes. The effect of climate warming in permafrost regions may cause unacceptable risks according to existing engineering design criteria.

Dr. Arne Instanes suggested a methodology to assess the aforementioned effects. He uses the output from climate models as input to engineering models to assess changes in the ground thermal regime at site specific locations in permafrost regions. The main objective is to determine the computed warmest ground temperature occurring during the service lifetime of the structure. This type of information can be used in coupled thermo-dynamic and mechanical models of the local geotechnical site conditions including structural elements such as foundations, port structures, transportation systems and pipelines. Instanes used site specific data from statistical downscaling of General Circulation Models (GCMs). Soil and permafrost data from research sites in Svalbard and northwest Russia has been used in a geothermal model to compute possible future ground temperatures in the areas. The results from this study is submitted to the journal of CRST.

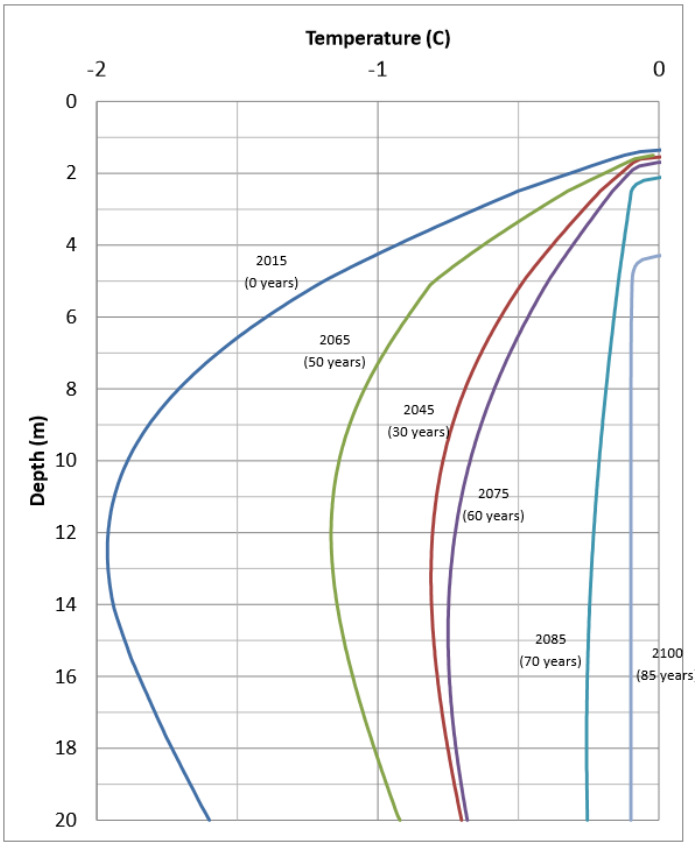


Figure 10 Maximum ground temperature vs. depth – Vestpynten, Longyearbyen 2015-2100

Dr. Ivan Depina together with Postdoc Emilie Guegan and Dr. Anatoly Sinitsyn published a state-of-the-art review of erosion protection measures for Arctic coasts. There, the erosion protection measures are compared with respect to several important design considerations with focus on Arctic-specific conditions. The results of this review were presented during WP6 workshop in May.

Dr. Anatoly Sinitsyn from SINTEF continues to lead the activity on guidelines development. The guidelines cover the different stages of E&P studies, i.e. the prospect stage, the design stage and the monitoring stage. The existing standards from geotechnical and marine civil engineering are being exploited during the development of these guidelines. Sinitsyn presented the status of his work during the workshops of WP6 in February and May; and he received valuable feedback from SAMCoT partners. By the end of 2016, an updated guidelines document will be published.

Achievements:

In 2016 (Q1&2) WP3 published 3 journal papers, 3 conference papers and offered several workshops to SAMCoT partners

PhD defense

Aleksyutina D.: Characteristics of coastal permafrost soil, departmental pre-defence on 12 April, final defence expected October 2016