Berichte zur Polar- und Meeresforschung

Reports on Polar and Marine Research

576
2008

The 6th Annual Arctic Coastal Dynamics (ACD) Workshop, Oct. 22-26, 2006, Groningen, Netherlands

Edited by
Pier Paul Overduin and Nicole Couture
with contributions of the participants

HELMHOLTZ GEMEINSCHAFT

ALFRED-WEGENER-INSTITUT FÜR
POLAR- UND MEERESFORSCHUNG
In der Helmholtz-Gemeinschaft
D-27570 BREMERHAVEN
Bundesrepublik Deutschland

ISSN 1866-3192

Hinweis

Die Berichte zur Polar- und Meeresforschung werden vom Alfred-Wegener-Institut für Polar-und Meeresforschung in Bremerhaven* in unregelmäßiger Abfolge herausgegeben.

Sie enthalten Beschreibungen und Ergebnisse der vom Institut (AWI) oder mit seiner Unterstützung durchgeführten Forschungsarbeiten in den Polargebieten und in den Meeren.

Es werden veröffentlicht:
— Expeditionsberichte (inkl. Stationslisten und Routenkarten)
— Expeditionsergebnisse (inkl. Dissertationen)
— wissenschaftliche Ergebnisse der Antarktis-Stationen und anderer Forschungs-Stationen des AWI
— Berichte wissenschaftlicher Tagungen

Die Beiträge geben nicht notwendigerweise die Auffassung des Instituts wieder.

Notice

The Reports on Polar and Marine Research are issued by the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven*, Federal Republic of Germany. They appear in irregular intervals.

They contain descriptions and results of investigations in polar regions and in the seas either conducted by the Institute (AWI) or with its support.

The following items are published:

— expedition reports (incl. station lists and route maps)

— expedition results (incl. Ph.D. theses)

— scientific results of the Antarctic stations and of other AWI research stations

— reports on scientific meetings

The papers contained in the Reports do not necessarily reflect the opinion of the Institute.

The „Berichte zur Polar- und Meeresforschung"
continue the former „Berichte zur Polarforschung"

* Anschrift / Address

Alfred-Wegener-Institut
Für Polar- und Meeresforschung
D-27570 Bremerhaven
Germany
www.awi.de

Editor in Charge:
Dr. Horst Bornemann

Die Berichte zur Polar- und Meeresforschung werden ab 2008 als Online-Publikation (Adresse: http://epic.awi.de) in Form von pdf-(Adobe)-basierten Dokumenten herausgegeben; von diesen Dateien können bei Bedarf Buchdrucke erzeugt werden: print-on-demand.
Es ist zu beachten, dass die Online-Ausgaben farbige Darstellungen enthalten können. Beim Buchdruck werden diese Vorlagen hiervon abweichend oft mit Graustufen-Darstellungen reproduziert.

The 6th Annual Arctic Coastal Dynamics (ACD) Workshop, October 22-26, 2006, Groningen, Netherlands

---

Edited by
Pier Paul Overduin and Nicole Couture
with contributions of the participants

Ber. Polarforsch. Meeresforsch. 576 (2008)
ISSN 1866-3192

Arctic Coastal Dynamics

Report of the 6th International Workshop
Arctic Centre, University of Groningen
Groningen (Netherlands)
22 - 26 October 2006

Edited by Paul Overduin and Nicole Couture

Alfred Wegener Institute for Polar and Marine Research
Telegrafenberg A43, 14473 Potsdam, Germany
Contact: Pier Paul Overduin
(Paul.Overduin@awi.de)
http://arctic-coastal-dynamics.org

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background and Focus of the Workshop

The coasts of the circumpolar Arctic region differ from their temperate and tropical counterparts, in particular due to the influence of ground ice, permafrost and sea ice. As is the case for southern coastlines, the Arctic coast is the site of human habitation, resource use, migration, and transportation. However, changes to the global climate system are felt most keenly in the Arctic, where they have their greatest effect in environments that form the margins between ecoregions. This holds true for the coastal zone, which is defined as the region along the coastline within which marine processes directly affect the terrestrial realm, and vice versa. Given the relevance of this zone to human endeavour and its sensitivity to anthropogenic and natural change, it is of critical importance to understand the processes shaping the Arctic coastal zone and their responses to change.

The Arctic Coastal Dynamics (ACD) project of the International Arctic Science Committee (IASC) and the International Permafrost Association (IPA) was created in 1999 to improve our understanding of circum-Arctic coastal dynamics under the influence of environmental changes and geologic controls. Members of the Arctic coastal research community developed a science and implementation plan to guide the first 5-year phase of the project (ACD I). During that time, progress towards achieving the plan's objectives was reviewed and furthered through annual workshops. The results of ACD I, which ran from 1999 until 2005, are presented in a series of workshop reports, numerous journal articles, a special issue of the journal *GeoMarine Letters*, a forthcoming volume on regional and process-based studies entitled *Arctic Coasts - Circum-Polar Processes and Dynamics*, and a GIS Internet Map Server which includes a detailed characterization of coastal morphology and processes for the entire circum-Arctic. Workshop reports are available as volumes in this journal:

- Volume 413/2002: *Arctic Coastal Dynamics. Report of an International Workshop. Potsdam (Germany) 26-30 November 2001*, edited by Volker Rachold, Jerry Brown and Steve Solomon.
- Volume 443/2003: *Arctic Coastal Dynamics. Report of the 3rd International Workshop. University of Oslo (Norway) 2-5 December 2002*, edited by Volker Rachold, Jerry Brown, Steven Solomon and Johan Ludvig Sollid.
- Volume 482/2004: *Arctic Coastal Dynamics. Report of the 4th International Workshop. VNIIOkeangeologia, St. Petersburg (Russia), 10-13 November 2003*, edited by Volker Rachold, and Georgy Cherkashov.
- Volume 506/2005: *Arctic Coastal Dynamics. Report of the 5th International Workshop. McGill University, Montreal (Canada), 13-16 October 2004*, edited by Volker Rachold, Hugues Lantuit, Nicole Couture and Wayne Pollard.

The second phase of the Arctic Coastal Dynamics project (ACD II) seeks to further develop knowledge about coastal processes and to extend the objectives of ACD I.

In order to focus the next phase of ACD activities, an international workshop was held at the Arctic Centre, University of Groningen, Netherlands, on October 22-26, 2006. The workshop's main objective was to outline the steps to be supported and undertaken by the Arctic Coastal Dynamics community over the next five years to further the science goals in the Arctic coastal zone. Twenty nine participants from Canada, France, Germany, the Netherlands, Russia, and the United States took part. Researchers provided a context for their current activities and presented results in oral and poster presentations. In several plenary sessions and working group meetings, workshop participants discussed the achievements of the first phase of ACD in terms of the original science plan, and within the context of the Arctic Coastal Processes Science Plan produced at the Second International Conference on Arctic Research Planning (ICARP II) in November 2005. In addition to these two framework documents, efforts at both the circum-Arctic and the national level to establish a network of arctic coastal observatories within the scope of the International Polar Year (IPY) were presented, in order to help in the creation of a coastal observatory monitoring template. Working groups were established for the following five areas of study:

1. human dimensions
2. subsea permafrost
3. nearshore zone processes
4. environmental forcing factors
5. remote sensing

Cross-cutting issues for all the working groups to consider included expanding activities at key ACD sites into a full coastal observatory network, the continued refinement and development of the GIS, as well as general data information management, preservation and availability. Biodiversity was recognized as an important element of coastal dynamics, but is the focus of Arctic Coastal Biodiversity (AC-Bio), a parallel project initiated by IASC and incorporated in the Coastal Working Group of the ICARP II initiative.

Each of the Groningen working groups reviewed what accomplishments had been achieved since the 5th ACD workshop in Montreal in 2004, discussed the major Arctic coastal zone science questions that remain unanswered, and outlined a series of science initiatives. Some of these initiatives serve to continue work begun during ACD I, while others are new. Taken together, these goals and the strategies for achieving them form the ACD II Science and Implementation Plan, which is published separately. Details and the main results from the working group discussions are presented in the following pages, as are the abstracts from the presentations made at the workshop.

1.2 Acknowledgements

Financial assistance for the workshop was provided by the International Arctic Science Committee, the Arctic Centre of the University of Groningen, the Netherlands Arctic Programme, and the Willem Barentsz Foundation, and is greatly appreciated. The Arctic Centre provided excellent organizational support and special thanks go to Louwrens Hacquebord, Nienke Boschman, and Frits Steenhuisen. Additional support was provided by the International Permafrost Association and by Mayday, the University of Groningen’s student sailing club. Steve Solomon of the Geological Survey of Canada (Atlantic) gave a public evening lecture at the Arctic Centre entitled “Frozen Coasts in a Changing Climate” and his contribution to informing the public about current issues in Arctic coastal research is very much appreciated. IASC provided financial aid allowing four young scientists to travel to and participate in the workshop. We are grateful to this year’s young scientists, Nataliya Belova, Alexander Makarov, Alexey Noskov, and Roy Shirocov, all of whom contributed abstracts and posters or presentations to the workshop.

Participants of the 6th International Workshop on Arctic Coastal Dynamics, Groningen, Netherlands, October 22-26, 2006 (Photo by Jerry Brown).

1.3 Arctic Circumpolar Coastal Observatory Network (ACCO-Net)

To detect and quantify trajectories in coastal/shelf systems, their components and transformations must first be monitored. A coordinated monitoring programme incorporating diverse regions and providing site-specific, fine-scale baseline and time-series data will yield maximum value, facilitating local and circum-Arctic studies, such as validation of multiscale biodiversity and coastal community models. To address these issues, it is proposed that an internationally coordinated circum-Arctic network of coastal and marginal seas observatories (~20 key sites including deltas and estuaries of major Siberian and North American rivers) be established within the IPY 2007-2008 framework based on ecoregion representation criteria. The sites will be loci for multi-disciplinary, multi-resolution studies set within a broader eco- and socio-regional frame of reference and will include sensitive areas with varying degrees of human impact. The network of coastal observatory sites will be established to provide a basis for better assessing the impact on Arctic coasts of large-scale climate changes, and to improve our capacity to more precisely quantify/identify feedbacks and parameterizations required for input into large-scale forecast models, to ultimately improve the reliability of their forecasts. The objectives of the Arctic Circumpolar Coastal Observatory Network are:

- to better understand coastal processes
- to establish baseline data
- to monitor changes over time
- to examine spatial differences
- to predict future impacts
- to catalogue and describe activities in terms of hazards, resources and utilization

Requirements for Implementation

Implementing a network of this scale requires international coordination. Required resources include personnel, co-ordination activities and observatory establishment and support. Data management and archiving must be addressed at the co-ordination level. Human resources include the creation of a Network secretariat and the hiring of personnel for monitoring, GIS and remotely sensed data processing and quality control. Data portals are emerging through IPY (e.g. ARMap), and facilitating data exchange.

The ACCO-Net Implementation strategy includes five steps:

1. Initial site characterisation and representation assessment: (a) acquisition of comprehensive, high-resolution imagery of the circum-Arctic coastline, (b) physical (atmospheric, terrestrial, inter-tidal and marine coastal conditions), (c) ecological (marine and terrestrial classification, habitat mapping, assessment of biodiversity indicators and components), (d) biogeochemical fluxes of major and minor elements and greenhouse gases (e) socio-economic (general situation, interaction of resource us-

ers, assessment of resources used, local knowledge of coastal processes, state of legal and administrative regulations);

2. Monitoring of changes: (a) physical (atmospheric and oceanographic forcing, permafrost parameters, coastal terrestrial and marine morphology, riverine fluxes), (b) ecological (habitats, biodiversity, living resource assessment) (c) biogeochemistry, (C, N, and gas fluxes, environmental quality, biological production and biogeochemical cycles), (d) socio-economic (industrial production, plans and potential constraints for development, quality of life, local economy, population and demography, social issues of native peoples);

3. Data analyses: (a) change detection, (b) identification of interdependencies amongst physical, biological, social, and ecological parameters;

4. Data/information management: (a) metadata standards, (b) Arctic spatial data infrastructure, (c) web accessible databases and products (e.g. maps), (d) data accessibility to local and scientific communities;

5. Synthesis: formulation of models at multiple levels (conceptual to numerical and regional to global) incorporating interdependent physical, biological and environmental changes in response to natural and anthropogenic forcing, development of response strategies.

Observatory Sites and Network Structure

A defined set of criteria guide observatory location:

- Permanent station with a long time series of data
- Location at the margin of eco-regions
- Nearby community for infrastructure support
- Year-round operation
- Responsible person/institution (station manager, science director, etc.)
- Data delivery and preservation
- Representation of the range of Arctic coastal morphologies

Site selection will be coordinated with local communities and with national level projects, some of which are IPY projects clustered together with ACCO-Net in the IPY Coastal Monitoring Cluster. Wherever possible, monitoring sites will build upon existing monitoring programmes and data availability. In particular, the circum-Arctic coastal key sites established within the IASC/IPA/IGBP-LOICZ project Artic Coastal Dynamics (ACD), the river monitoring stations installed at down-stream locations on the 6 largest rivers draining the pan-Arctic watershed (Yenisey, Lena, Ob, Kolyma, Yukon, Mackenzie) as part of the NSF-ARCSS Freshwater Initiative (FWI), and the pilot version of the Hudson Bay Complex Observatory (MERICA) will be considered. ACD II implements the human dimensions goals of ACD I by seeking to incorporate socioeconomics in monitoring efforts and by including communities in the observatory effort.

Standardizing Monitoring Activities

Monitoring is co-ordinated through the use of a standard template for primary and secondary monitoring parameters. In addition, remote sensing products are applied for at the international level so that standardized products are available for all observatory sites for common time periods. The primary data available from optical remote sensing products are detailed digital elevation models, coastline position, and land-cover classification. These data are a baseline for future work.

Interoperability of observatories requires an international standardized data format. Data standards are ensured via two efforts: 1. adoption of Standard Operating Procedures (SOPs) for monitoring and 2. adherence to ISO standards for data and metadata reporting. In addition, ACCO-Net co-ordinates the efforts of the coastal observatory network with other observatory networks (TSP, CAPP, CEON, NEON, AON, SAON).

2 WORKING GROUP REPORTS

2.1 Coasts and People Working Group

Chair: Kathleen Parewick

Introduction

Unlike the other returning ACD working groups, the Coasts and People team lacked the member continuity to simply "pick up" the conversation where the 5th ACD Workshop in Montreal had left off. That 2004 gathering was the first to have a dedicated work group addressing the "human dimension" so the documentation supplied on their discussions was reviewed by the new team. It was quickly concluded that although the preceding human dimensions group had offered workable suggestions to the ACD project at-large, an implementation plan and clear leadership had been lacking. The 2006 Coasts and People recommendations attempt to address this.

The new Coasts and People Working Group was also charged with answering the following:

- What are the key questions for people in the coastal environment?
- What motivation might people in the coastal zone have to become involved in monitoring the physical environment?
- Can coastal observatories be relevant to people in the coastal zone? If so, how?
- How do human activities affect coastal processes? How do coastal processes affect human activities?

The Human Dimension in ACD

Achieving a well-integrated "human dimension" in future science work depends on the ACD membership having a common understanding of what that term actually encompasses. To this end, the Coasts and People team examined how their social science perspectives related to the particular approaches described by the other ACD working groups.

In each instance, a geo-referenced schema was present. The *Submarine Permafrost* working group described the scope of its investigations in relation to dominant isostatic regimes: the study of submerging and eroding coasts commencing from relatively unchanged terrain inland and moving towards the offshore, while the studies of emerging coasts begin at the offshore extent of unchanged sea floor and head landwards. The *Environmental Forcing* work group had its own cut-away view of the coastal zone with key forcing factors and coastal processes generically attributed to terrestrial, nearshore and offshore environments. In neither instance though were elements of human use or occupation incorporated. Perhaps the closest the earlier ACD gatherings had come to envisioning physical and life system interactions was reflected by a coastal marine ecosystem diagram that illustrated the varied communities associated with the permanent and marginal ice cover zones.

Given that a picture says so much, it was recommended that a new conceptual graphic reflecting the scope of the Coasts and People theme and its relationship to other ACD themes be prepared for inclusion in forthcoming ACD materials.

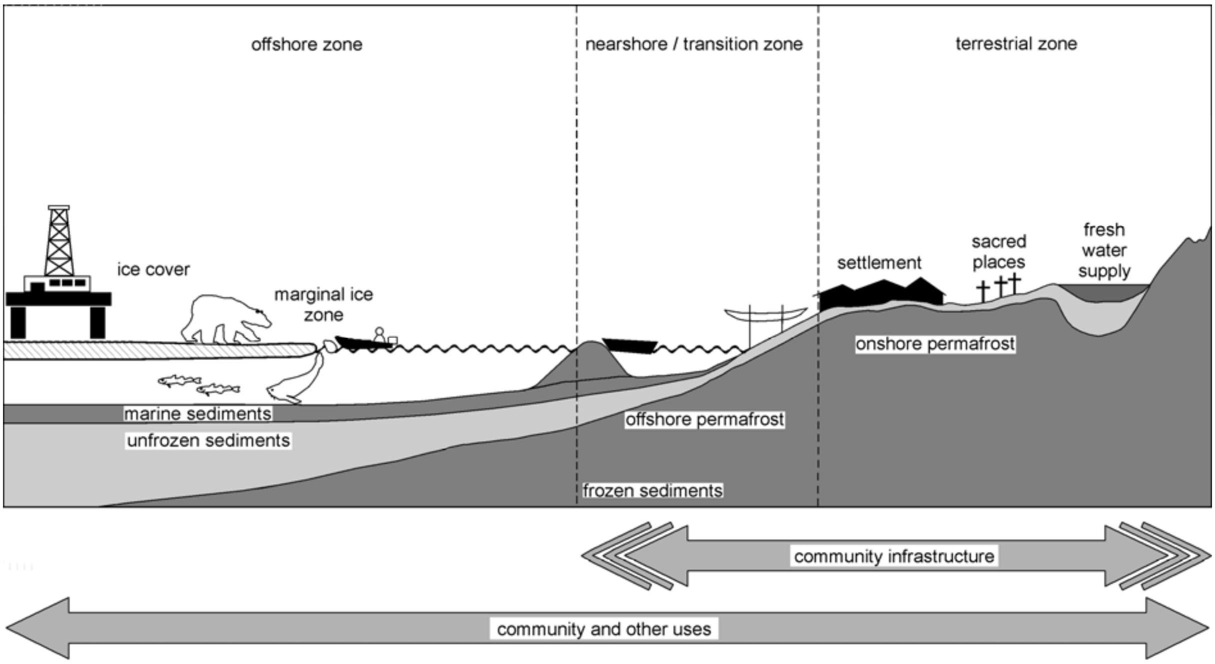


Figure 2.1.1 The Human Dimension of the Coastal Zone.

ACD II Science Plan

A key objective of the working groups' deliberations was the identification of items to include in the ACD II Science Plan. The Coasts and People team re-examined the suggestions made by their predecessors in 2004 (ACD 5th International Workshop Report, pp. 12-13). Having determined that each of these original suggestions was worth pursuing through ACD II, the following suggestions for implementation and further development were made:

<u>ACD I Suggestion # 1: GIS System Development</u>

The lack of "human dimension" content in the existing ACD GIS must be addressed by the new Science Plan. The information that should be displayed in the new layer(s) include community locations, jurisdictional/political boundaries, key infrastructure (transportation, dwellings, industry), cemeteries, archaeological sites, sacred places, and indigenous/local land use. Special considerations should be given to the ways in which geo-referenced data may be put to use by communities and social scientists (i.e. to support local site selection and research development control processes, inventorying and monitoring of local geo-hazards, and forecasting/analysis of likely future risk scenarios).

This task may be expected to be time-consuming but the Coasts and People team noted that it is primarily a compilation exercise: much of this data already exists (e.g. Nunavut Land Use Survey, Alaskan Coastal Zone Mapping Project, community-specific research on local and regional land use).

ACD I Suggestion # 2: Selection Input for Coastal Observatories

Together with the GIS, the proposed network of coastal observatories comprise the major infrastructure that will support ACD activities in coming years. The Coasts and People team offered the following 'human dimension' considerations to guide observatory site selection:

- Communities with established research collaborations (community-social science) will be easier to work in. Prior to community selection, liaise with ACD Coasts and People Working Group and consult GIS database to help identify ongoing social science community-based projects.
- Communities in close proximity to coastal industry (oil and gas, mining, shipping, fisheries infrastructure) as well as those currently experiencing coastal hazards associated with permafrost thaw, erosion, sea ice dynamics, or landslides, may be expected to have greater interest in monitoring and a greater motivation for hosting and participating in local science activities. In such instances, monitoring can support local development processes, community hazard planning and hazard reduction initiatives. Communities should be actively involved in the monitoring process from project design to research dissemination. Efforts should be made prior to site selection to identify potential hazard or development 'hot spots' where monitoring can be initiated. Liaise with ACD Coasts and People Working Group and consult the GIS database to evaluate potential locations where monitoring can have a direct benefit to communities.
- Efforts should be made to ensure a diverse and representative sampling of communities (i.e. variety of scales, economic bases, cultural diversity).

ACD I Suggestion # 3: Catalogue local and regional monitoring programs

The Coast and People team saw the cataloguing of local and regional monitoring programs very much as a companion piece to the proposed new GIS content (see Suggestion # 1). This documentation will serve to ensure that geo-referenced ACD data may be further cross-referenced with existing or ongoing social science research, and will give ACD researchers one more means of becoming aware of potential project linkages with other major scientific networks or local stakeholders (e.g., ArcticNet, Human Dimensions of the Arctic System).

ACD I Suggestion #4: Research Guide

A guide for coastal researchers is a worthwhile undertaking but the Coasts and People team believed that this initiative should be kept simple. In order to capitalize on the wealth of existing materials in this vein, it was recommended that the guide take the form of an on-line bibliography and list of web links respecting such matters as:

- how to work with communities (community liaison, facilitation techniques, plain language reporting, translation, video as a communications tool, etc.);
- obtaining research licenses;
- how to use traditional or local knowledge in scientific research;
- human research ethics.

The Coasts and People working group will compile and make available such resources.

ACD I Suggestion #5: Knowledge Gaps

Recognizing that there are enough outstanding knowledge gaps to keep the ACD community busy for many science plans to come, the Coasts and People team proposed that priorities be identified that will build on opportunities for collaborations in the coming IPY period. For instance, projects respecting nutrient/contaminant fluxes and their impacts on coastal regions and peoples could be pursued (Potential Partners: Land-Ocean Interactions in the Coastal Zone (LOICZ), ArcticNet). The theme of Vulnerability and Resilience of Human Systems was also identified as offering many timely opportunities for collaboration (see pilot project below).

Coastal Observatories

The second key objective of the 2006 workshop was to compile a list of parameters and methods to include in the coastal observatory monitoring template. Further to *Suggestion # 2* above, the Coasts and People team discussed the particular parameters that would address the human dimension. It was agreed that the ACD would, for each observatory, need to identify factors of concern to the associated community – data and indicators relating to day-to-day functions and governance. The following were offered as examples from previous research conducted by members of the working group:

Example 1: Local Wind Conditions
Hunters decide where to go based on where and how the wind may affect ice. It determines safety of travel and ice use, and ability to engage in harvesting activities.
Indicators: *wind speed, direction, variability, intensity*

Example 2: Changing Permafrost
Communities need to distinguish lands suitable for development from those at-risk or requiring extra work.
Indicators: *permafrost extent, character (especially ice content), erosion/aggradation rates*

Parameters that need to be measured will differ throughout the Arctic region depending on how people interact and utilize the environment, and according to local physiography. Where possible, project proponents should liaise with social scientists to identify—in collaboration with community members and stakeholders—local monitoring needs.

New Objective: A Pilot Project

Finally, the Coasts and People team identified a new objective for ACD II which provides an opportunity for interdisciplinary research. Noting that the earlier mentioned theme, *Vulnerability and Resilience of Human Systems* (see Suggestion # 5 above), is already a key cross-cutting theme for many other Arctic research undertakings (i.e. ACIA, LOICZ, IPY, IPCC, Arctic Human Development Report, ICARP), and has been identified as an urgent research need (ACIA, 2005; ICARP, 2005), the team recommends that ACD mount a pilot project under this banner in conjunction with the launch of several of the proposed observatory network sites. ACD, with its strong background in the physical sciences and emergence of a human dimensions focus, is ideally situated to undertake such research.

A primary focus of this initiative would be the active collaboration of physical scientists and social scientists within the ACD. Interdisciplinary collaboration is most productive when it is designed in at the front end of research rather than after-the-fact and this project aims to model the kind of mutually beneficial exchange that can arise when different ways of knowing are brought together in this manner.

2.2 Submarine Permafrost Working Group

Chair: Pier Paul Overduin

Introduction

Subsea permafrost is created by the inundation of coastal lowlands by sea level rise, isostatic or tectonic movement and coastal erosion. Subsea permafrost may also be created by shifts in sea water salinity and temperature, or by the introduction of freshwater into a cryotic submarine environment. An initial assessment of the state of our understanding of submarine permafrost revealed that the key science questions identified at the 5th ACD workshop in Montreal remain unresolved. The key science questions identified there are retained as the basis for the discussions in this working group in Groningen. The first phase of ACD categorized submarine environments into emergent/submergent and high latitude/low latitude, and identified priorities for each. These distinctions serve to focus efforts on key processes in each environment:

Higher latitude, submergent:

- the evolution of sub-sea permafrost in delta areas
- the diffusion of sea salts into freshwater bottom sediments
- near-bottom water temperatures, particularly in the near-shore zone affected by ice gouging and tides
- the existence or absence of permafrost on the deeper shelf
- the modelling of offshore permafrost development

Lower latitude, emergent:

- what happens with the salt in the saline pore solutions during freezing?
- how do soil heaving processes work during freezing?
- the formation of gas bubbles in the newly formed ice
- the influence of groundwater flux and composition on the thermal regime of permafrost
- to identify the complex processes of the formation of vegetation on the new and frozen land areas
- to understand the important role of the tidal zone in coastal dynamics

Higher latitude, emergent:

- polygonal structures formed in flood plains
- formerly emerging coasts which are now in subsidence and eroding

- the movement of salt and chemicals, and hydrodynamics in the freezing area of the bottom fast ice zone
- the interaction between permafrost and warm and saline waters
- complex sequences in emerging coasts of newly formed permafrost interlayered with unfrozen saline sediments (technological problem for constructions)

Common themes running through all environments are the processes governing porewater chemistry during the transition from or to permafrost and the distribution of permafrost. The current generally accepted definition of permafrost is based on temperature alone (earth material cryotic for at least 2 consecutive years). This definition requires refinement in the cryotic submarine environment in which the distribution of frozen, ice-bearing or ice-bonded sediments depends on sediment type and pore water chemistry, and thus on regional glacial and relative sea level history. Distinctions between the ice-bearing, ice-bonded and ice-free permafrost are important with respect to the function of the permafrost. The ice content of the sediment is, for example, critical for gas production and migration in the sediment, for slope stability, and for the amount of energy required to change the permafrost state. The dependence of ice content on porewater chemistry requires research in these contexts.

Our current understanding of subsea permafrost distribution is based largely on modelling efforts, many of which are listed in ACD's online publication database and indirect measurements of geophysical properties of the subsea sediments. The IPA permafrost map indicates regions of potential subsea permafrost in the subsea based on relative sea level histories and shelf bathymetry.

Data mining

First steps in improving our understanding of submarine permafrost state and distribution must therefore begin with data mining, collection and synthesis. Potential sources of data and secondary information relative to the distribution and state of subsea permafrost were discussed at length during the working group meetings. A global database of submarine permafrost-relevant information is required. It was agreed that a corroborative electronic mapping effort could provide a basis for uniting the distributed and diverse information and data sources. Mapping would have to occur on the variety of spatial scales relevant to the data sources. A number of potential data sources were identified:

- historical borehole records for which permafrost-relevant sediment characteristics were logged. Data sets in the public domain would need to be collected centrally.
- mapping of secondary indicators. For example, Russia's continental shelf geology digital mapping program, and an American catalogue (created for Mineral Management Services) of Alaskan borehole sites.

- offshore geophysical surveying data. This includes both bathymetric data, geo-electric and seismic surveys. Currently available global bathymetric data-sets (e.g. IBCAO) are weakest in the nearshore zone, and shallow shelf waters have limited the collection of ship-borne bathymetric data. The advent of airborne methods, and increased ship traffic in the north offer opportunities to improve our near-shore bathymetry. The 1960s and 1970s were a period of intense permafrost drilling, both in the Alaskan Beaufort and Chuckhi offshore zones, and in the USSR. These studies offer the unique chance of providing both a benchmark for geophysical surveys that extend 1D borehole data records or 2D borehole transects to a third dimension, as well as a reference for the decadal change detection. Both seismic and geoelectric surveys are relevant in this regard, and can provide complementary data sets.

New permafrost drilling campaigns are an integral part of pushing forward limits on our knowledge of permafrost evolution and degradation in the nearshore zone. The COAST permafrost drilling campaign in the Laptev Sea, and drilling in the Mackenzie Delta are important examples of the potential for new primary data on permafrost state and evolution in the submarine environment. The role of permafrost and ground ice in stabilizing or destabilizing coasts and studies of sediment transport pathways are an important complement to this research.

Recommendations

Recognizing the fact that investigations of past and ongoing subsea permafrost are numerous, widely dispersed geographically and through time, the Submarine Permafrost working group recommends:

1. Compilation and synthesis of existing data via the creation of maps at global, regional (1:1 000 000) and local, site-specific scales.

2. Modelling and validation on the basis of extensive drilling and geophysical data for key sites. Methods include seismic, geoelectric and bathymetric surveying coupled with offshore drilling. Surveys are often regarded as the prerequisite for drill site location. In the context of permafrost, however, these surveys take on significance independent of drilling, since they are the tool of choice in identifying the three dimensional structure of the sea-floor bed and of the upper surface of ice-bonded sediment.

3. Global mapping on the basis of modelling, regional (1:1 000 000) mapping based on geophysical methods, site-scale mapping, especially in the nearshore zone. Global mapping includes compilation, synthesis, digitization of available maps/data.

4. Extension of the GIS segmentation database seaward to include the slope of ice-bonded sediment, for correlation with coastal retreat rates and other environmental factors. The input data will depend mainly on historical data.

5. The investigation of near-shore zone (also termed *transition* or *grey zone*) processes relevant to permafrost evolution and degradation. These include but are not limited to shoreface geomorphological changes, thermokarsting, bottom-fast ice for-

mation, duration and extent, the creation of brines during sea water freezing, coastal advection, deltaic sediment fluxes, salinity distribution and seasonality.

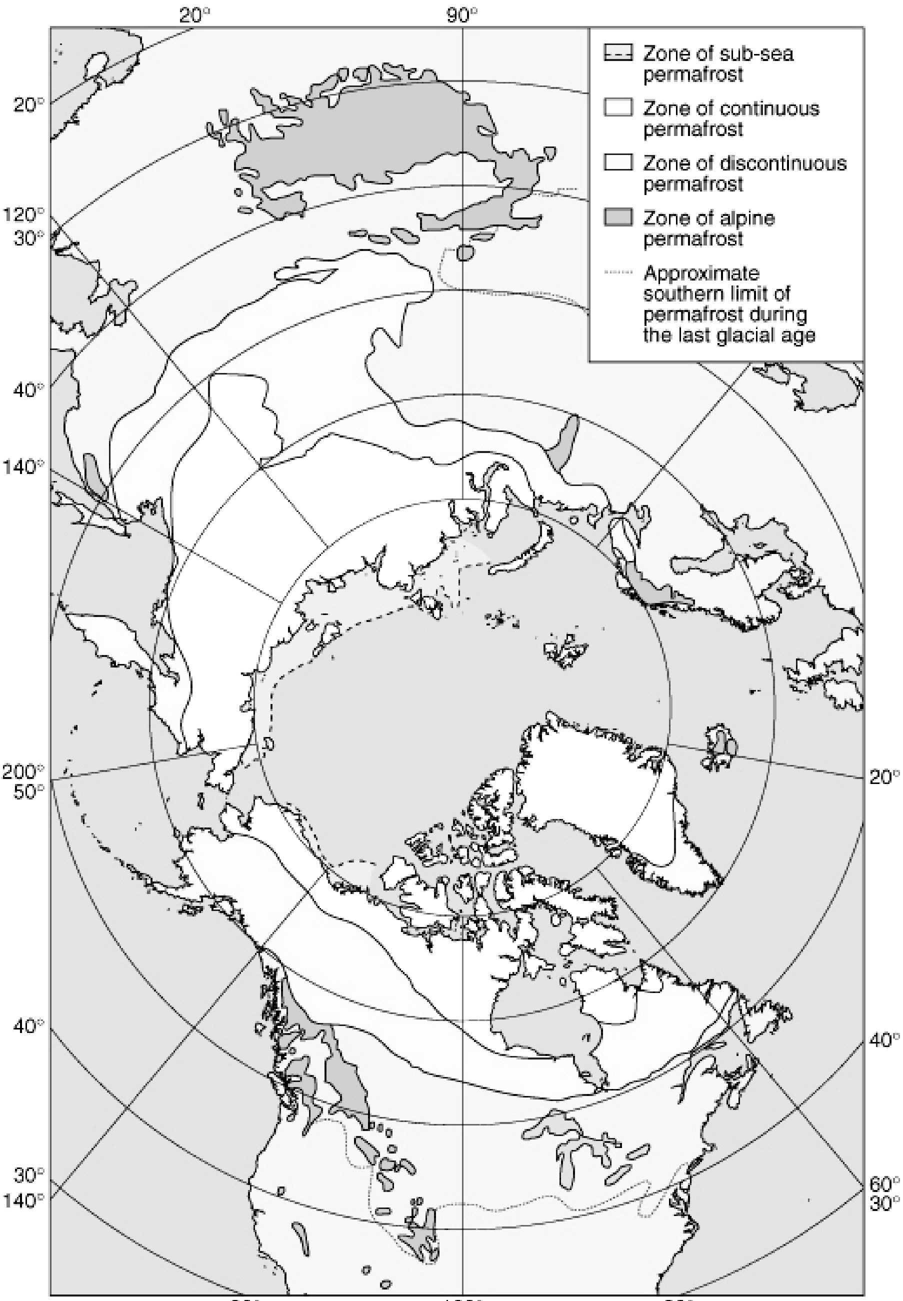


Figure 2.2.1 The International Permafrost Association map of permafrost distribution (Brown, J., O.J. Ferrians Jr., J.A. Heginbottom, and E.S. Melnikov. 1998. revised February 2001. Circum-Arctic map of permafrost and ground-ice conditions. Boulder, CO: National Snow and Ice Data Center/World Data Center for Glaciology).

2.3 Fluxes in the Coastal Zone Working Group

Chairs: Alexander Vasiliev and Nicole Couture

Introduction

From its inception, the primary objective of the Arctic Coastal Dynamics project has been to develop a better understanding of coastal processes, in large part in order to determine the flux of materials from the land to the ocean. An important goal of the first phase of ACD was to arrive at an overall estimate of circum-Arctic fluxes of sediment and organic carbon from coastal deposits. This was achieved by segmenting the entire coastline of the Arctic Ocean, establishing the material composition of each segment, and determining the rate of erosion of each segment. This data was used to calculate average annual fluxes of materials. This was the background for the working group on fluxes in the coastal zone which met at the Groningen workshop. Discussions examined how to further the initial achievements of ACD I, and what the primary goals of the next phase of the project should be.

In order to answer the main scientific questions, a combination of monitoring, project oriented science, and modelling should be used. Monitoring was seen as the best way to study natural processes (for example coastal erosion or thermal denudation) versus time. At the same time, investigation of shore deposits as a source of material or marine sediment as a final product of the fluxes requires an object-oriented approach. Finally, modelling will be required to predict future coastal zone fluxes. Several lines of investigation were identified for further study:

Recommendations for further study

1. Improve our understanding of the role of organic matter involved in the modern biogeochemical cycle. One important potential method is to extend our estimate of organic carbon assessed during ACD I through the development of a GIS database of actual organic carbon measurements in the coastal zone. Further parameters to include:

- Sample ID
- Method of sampling (borehole, natural exposure, etc.)
- Coordinates (lat/long in decimal degrees)
- Position relative to sea level
- Geomorphological unit (based on ACD classification)
- Type of deposits
- Genesis of deposits
- Age
- Bulk density
- Ground water content

- Total organic carbon
- Method of analysis
- Contact person
- Relevant publications
- Several free fields (categories to be determined)

In order to include the data into a land-ocean interaction model it should be uniform and consistent with the thematic databases. Protocols of sampling and measurement, adapted to the requirements of erosion and thermal denudation models need to be developed.

2. Determine the quality/lability of organic matter (not just carbon) in the coastal zone both onshore and offshore using macerals and biomarkers. This includes material stored in frozen and thawed deposits, thermal terraces, dissolved in the water, etc. The transformation of coastal material must be examined prior to denudation (grain size, quality/lability of organic matter, water content, bulk density) and following erosion (remineralization of carbon, oxidation of low-valency metals) to better understand the effects of the addition of this material to coastal waters. Distinguish between terrigenous and marine sources of organic carbon in nearshore sediments using organic geochemical bulk parameters such as stable isotopes (δ^{13}Corg), C/N ratios, and Rock-Eval pyrolysis.

The fact that both coastal erosion and thermal denudation play a significant role in the emission of greenhouse gases into the atmosphere was discussed, as was the importance of these emissions in terms of climatic feedbacks. The fluxes of contaminants such as mercury, other heavy metals, and oil also need to be considered. This is especially relevant when these trace elements are organically bound to carbon for instance, as is the case with mercury.

3. Continue periodic measurements of shoreline position to monitor coastal erosion and sediment accumulation in the nearshore zone since these processes can lead to changes in the shoreface profile; this can effect changes in wave energy as well as in the thermal regime in the nearshore. Measurement of the shape and size of accumulative forms and accumulation rates can be achieved through direct sampling, as well as analysis of remotely sensed imagery such as air photos and LIDAR imagery. Conduct bathymetric surveys to determine where critical zones are to capture major processes in terms of sediment transport.

4. Develop a sediment transport model to understand sediment and carbon balance in the shallow water zone and validate it using transect sampling and remote sensing. Possible methodology for validation: sampling transects of the coast from the backshore, through the foreshore, to the nearshore zone (Fig. 2.3.1). The question of boundary placement between the three subzones remains open.

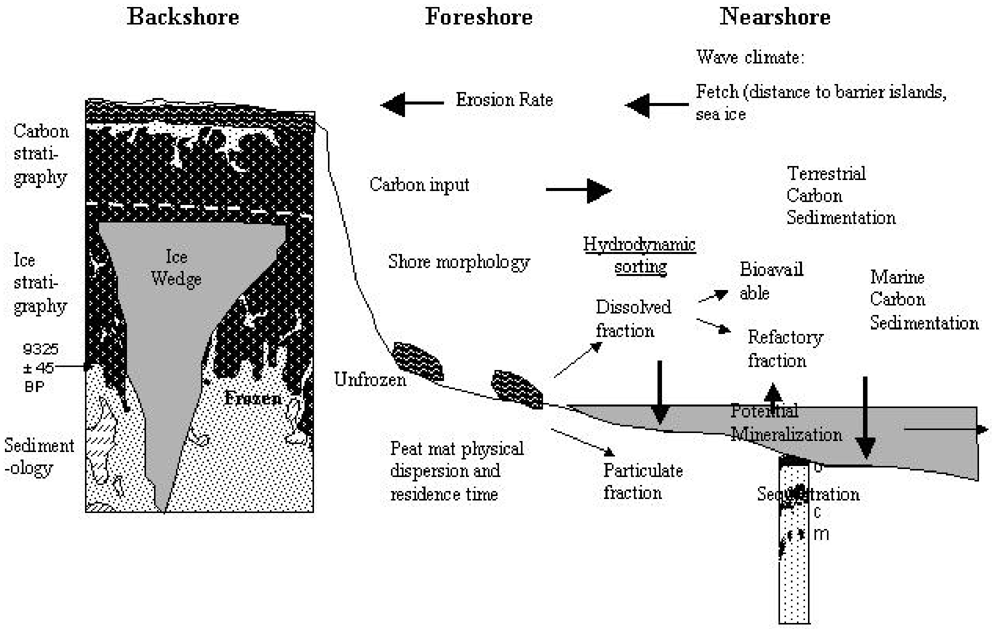


Figure 2.3.1 Schematic of the coastal zone sub-zones and the key elements to be modeled within each.

At this point in the discussions, the Coastal Fluxes Working Group and the Environmental Forcing Working Group recognized that their goals were converging as both sets of meetings were focusing on the development of an erosion model. It was decided to merge the two groups and the subsequent discussions are covered in the following section.

2.4 Environmental Forcing and Modelling Working Group

Chair: David Atkinson

Introduction

The working group meeting had four primary focal points:

1. Status and direction of Working Group objectives. A primary goal of this meeting was to establishing the objectives of this working group as ACD begins its next 5 years. Objectives fall into two broad categories: 1) continuing the original role of the Environmental Forcing Working Group to furnish the project with requisite forcing layers, and 2) identifying research questions in the context of model development and other forcing questions and marshalling requisite resources to address these emerging research needs. Some of this material will form the basis of research projects that will form part of the new ACD Science Plan.

2. Improve social relevancy. Without building some form of linkage to the social realm the physical science activities possess little broader relevancy. It was recognized that this topic has two main aspects that speak to what is a two-way flow of information: 1) determining where and how the observations of those living on the arctic coasts can be factored into analyses and understanding of environmental forcing, and 2) foster improved relationships between working group members and coastal inhabitants to address requirements associated with tailoring research results in an effective way. “Coastal inhabitants” are broadly defined in this context to include inhabitants as well as those who act on behalf of the coastal inhabitants, such as emergency managers and planning officials that might operate at the regional or state/provincial government levels.

3. Commence quantitative erosion model work. Initiating a specific development path for a quantitative coastal erosion model that can be applied to a broad range of coastal types. Development of such a model will enable full advantage to be taken of the ACD coastal information database to arrive at better quantitative estimates of erosion rates and sediment load depositions. Significantly, it will also enable site-specific forecast estimates to be made to facilitate planning decisions.

4. Introduction of other relevant questions. Details are given below.

These four focal points are expanded upon below.

Status and direction of Working Group objectives

There was recognition that the essential and original role of this group, that is, the provision of supporting data layers to the project, still has considerable work left to do. Specific layers that should be considered include:

- Improved wave energy data using the method applied by S. Ogorodov and an improvement upon an approach introduced by D. Atkinson. Specific improvements are listed below in Table 1. In general the ultimate goal is to better incorporate environmental forcing results into ACD efforts via a generic, broadly applicable “coastal erosion model”. That is, our interest in environmental forcing is really a means to an end – that is, determining the erosion response.

- Sea ice data should be provided. Digital layers are now available from various national sources, and historical data have been compiled by the Environmental Working Group in their publication, “Sea Ice Atlas of the Arctic”. This work will have to be coordinated with the GIS working group.
- Detailed statistical information for coastal sites around the Arctic should be provided. These include standard, aggregate summaries, such as wind roses, but should also move to extreme event return period calculations.
- Precipitation layers. This information is important for coastal process understanding because, for example, rain can melt snow and enhance failure, and snow can insulate and promote sea-ice formation. Precipitation is a more difficult layer to provide because it is a discontinuous phenomenon that is currently not well captured in large-scale atmospheric models. This can form a subject of ongoing work for the working group as well as a simple target data layer, e.g., how best to interpolate station data, for example, or investigating the suitability of the University of Delaware or British Climate Research Unit data sets.
- Station sea-ice observations. Obtain and digitize where necessary all available station-based sea-ice observation data, especially land-fast ice on/off dates. Russ-Hydromet stations regularly took these observations, for example. The Arctic and Antarctic Research Institute (AARI) have 10-day maps of this parameter. This would come in useful for verification of an empirical shore-fast ice on/off model.

Table 2.4. Specific improvements to wave modelling
Improve wave modelling – parallel route (with S. Ogorodov’s) to on-shore energy

> more sophisticated approach (cnoidial vs Airy)

> better link with ice edge for fetch limitation

> better link to bathymetry for depth limitation

> determine land fast ice condition and incorporate (affects resultant wave energy available to the coastal zone)

> higher resolution wind forcing

> (longer term) – ingest results from Tolman/Perrie’s wave modelling work

(this work is more applicable for modelling in detail the wave response to a given storm)

> run for “on demand” periods within the GIS system?

Improve social relevancy

It is being broadly recognized throughout the Arctic that research into the physical sciences should not be conducted in isolation from those who are not only the most directly impacted, but who are often in a position to offer strong partnerships via taking advantage of their own observations and involving them in the design, placement and monitoring of instrument networks. In addition to the requirements of inhabitants are planning and emergency management officials at the town or state/provincial/territorial level who also require access to the type of data being developed by the ACD project. In many cases research results do not make it to those who could most benefit and apply the information. Equally important, when it does, it is frequently presented in forms not suitable for the target user groups.

Part of the on-going mandate of this group will be the seeking of opportunities to draw from communities and officials and to link back to them results presented in relevant forms that directly address real-world needs.

Commence quantitative erosion model work

The concept of a "generic" coastal erosion model was discussed at length by the group. Given the detail and extent that the coastal information database developed by the ACD has now reached, a logical next step is development of a model to predict erosion based on parameters available in the database. This has been identified as one of the main objectives of both the Environmental Forcing and the Coastal Fluxes working groups.

This effort is not starting from scratch. Work to this end has been conducted at various locations. A starting-point conceptual schematic was developed by the group. M. Leibman also indicated that a PhD student of hers, A.I. Kizyakov, devoted his PhD dissertation to this subject and has recently developed a more thorough and formalized result that will be of great use help guide Working Group efforts along this line (Kizyakov 2005). Kizyakov's schematic diagram has been translated and is reproduced here (Fig. 2.4.1). Kizyakov's schematic will form a starting point for the effort and other, existing, results will be entrained as they are identified. An essential point identified during discussion was the idea that erosional processes exist on a continuum, with pure thermal denudation coasts at one end and pure thermal erosion coasts on the other. Most coasts are somewhere in between, as dictated by soil type, ice content, bluff height and form, exposure, and other factors.

Other relevant questions

Probabilistic modelling approaches

The idea of possibly adopting probabilistic, instead of deterministic, modelling methodologies for some parameters was raised. Parameters that do not exist as a continuous function in space are especially difficult to model in an explicit-predictive fashion. This is more of a science question rather than an effort towards building any particular GIS layer. An example of where probabilistic modelling would be applied would be to provide a "first-order" means to incorporate precipitation layers using, for example, climatology combined with empirical/statistical relationships derived between precipitation in a given area and major modes of atmospheric variability, such as for example, the Arctic Oscillation. This approach is currently employed by the Climate Prediction Center of the US National Oceanic and Atmospheric Administration to arrive at weekly and monthly/seasonal outlooks. An example may be found here: http://www.cpc.noaa.gov/products/predictions/30day/

Ice push events

Ice push is a sporadic yet locally important process that can significantly modify the dynamics of the coastal zone, by plowing up berms in the near-shore zone. In so doing it can also destroy any infrastructure that is in the way. The potential extent of the modification of the coastal situation means that determination of local values for long-term wave energy, e.g. at the level of the ACD coastal segmentation database, could be dependent on knowing if ice push occurs frequently. There does not exist systematic work identifying regions where ice push events commonly occur, nor have they been explicitly modeled. A modelling solution would almost certainly require a deterministic sea ice model, which is a significant requirement. A suggestion for work by the group could be development of an empirical/probabilistic model that attempts to better indicate where ice pushes could be more common. Some level of information concerning where and under what conditions these events occur would be of great use. Remote sensing data would be of use in this regard, but work on ice push would be greatly benefited by working with communities, because they will have more detailed knowledge of where the events commonly occur.

Marine thermokarst

The issue of wide-spread nearshore permafrost degradation leading to marine thermokarst was raised. This is of potential importance to the near-shore wave energy regime because the occurrence of thermokarst causes a lowering of the sea floor. Given that waves are depth limited, a lowered sea floor in turn can result in an increase in wave energy. This is especially true in shallow shelf zones. The three main questions that arose in this regard were, A) how extensive/important is this process, B) how would it be indicated in the ACD GIS in its current format, and C) following on A), is it important or widespread enough to warrant investigation at this time.

Thermal timeline

One question that arose when considering the mechanics of erosion was the utility of various predictor variables for the thermal state, such as melt-season length. It was pointed out that the simple air temperature above-freezing/below-freezing definition obscures many aspects of a complex evolution, and one that may not be providing the right information for modelling purposes (Fig. 2.4.2). Questions about how some of these parameters would be obtained, however, remain outstanding; which underscores why air temperature-derived parameters are heavily used.

Future climate scenarios

The Arctic Coastal Dynamics project should also be expanding its focus towards future climate scenarios and their impact on the coastal zones of the arctic regions. In a milieu of rapid coastal change, those vested in coastal living or development need answers to questions concerning potential erosion trends. The recently released Intergovernmental Panel on Climate Change "Assessment Report 4" has spawned a new generation of future climate scenario runs; specifically eighteen models were run at three 10-year time slices (2010-2019, 2050-2059, and 2090-2099). Data from these scenarios form the drivers that, when fed into process models that have/are being developed by the ACD project, can form the basis of predictions of coastal response. Results like this begin to feed into coastal planning considerations, both passive (e.g. setback ordinance) and active (coastal armouring) mitigation efforts.

An important note to make concerning this process is that the spatial resolution of the atmosphere-ocean general circulation models used to produce climate forecasts are on the order of hundreds of kilometers. In this format these data are not suitable for direct application into the more regional/local context that is the main focus of the ACD project. These data must go through a "downscaling" process using a finer resolution climate model before they are suitable for direct incorporation into derivative environmental forcing or application to ordinance work described above. Selection of which model to use for the projection data, which regional model to use for the downscaling process, and then how to go about tuning the regional model are significant questions. Work is currently underway to provide downscaling results for coastal zones in Alaska and Chukotka.

Observatory requirements

The Working Group should provide a list of coastal observatory requirements that would meet the data types and frequencies required for, e.g., better determination of the thermal timeline. A list of suggested parameters to monitor is presented below.

Suggested observational parameters:

Terrestrial observations:

- air temperature
- sunshine
- clouds
- precipitation
- wind (10 m) – to best represent offshore + multiple level for stress/roughness
- ground temperatures
- low atmosphere temperature, winds – tower mounted

Sea ice observations:

- landfast ice on/off

- wintertime break out events
- thickness and extent (percent cover)
- fetch (distance to pack ice edge)

Ocean parameters
- waves
- longshore currents (wave and permanent)
- sediment load/transport
- water level surges – duration, height (not just maximum height)

Surges

Surges, or temporary increases in sea level caused by the persistent, on-shore winds that often accompany storms, present two problems. 1) They are a major source of coastal flooding that result in significant infrastructure damage, and 2) where flooding is not an issue, the increase in water level they afford results in larger waves that are able to attack higher up on the coastal bluff. Generally, the presence of a beach forces waves to lose some of their energy as they run up the beach slope. If they are lifted above this run-up zone, they lose less of their energy and thus possess greater erosive potential. In many non-arctic areas the natural tidal range is sufficient to often mitigate the problem of most surges, unless they happen to occur during high tide. In the Arctic, however, the small tidal ranges mean that anytime a surge occurs it is likely to be problematic. A surge climatology layer should be added to the database. Andrei Proshutinsky developed a surge model several years ago; some of his preliminary results were contrasted with observational data to provide a very rough assessment of surge potential at various locations (Fig. 2.4.3). More work should be done to determine the appropriate course of action to better represent this phenomenon.

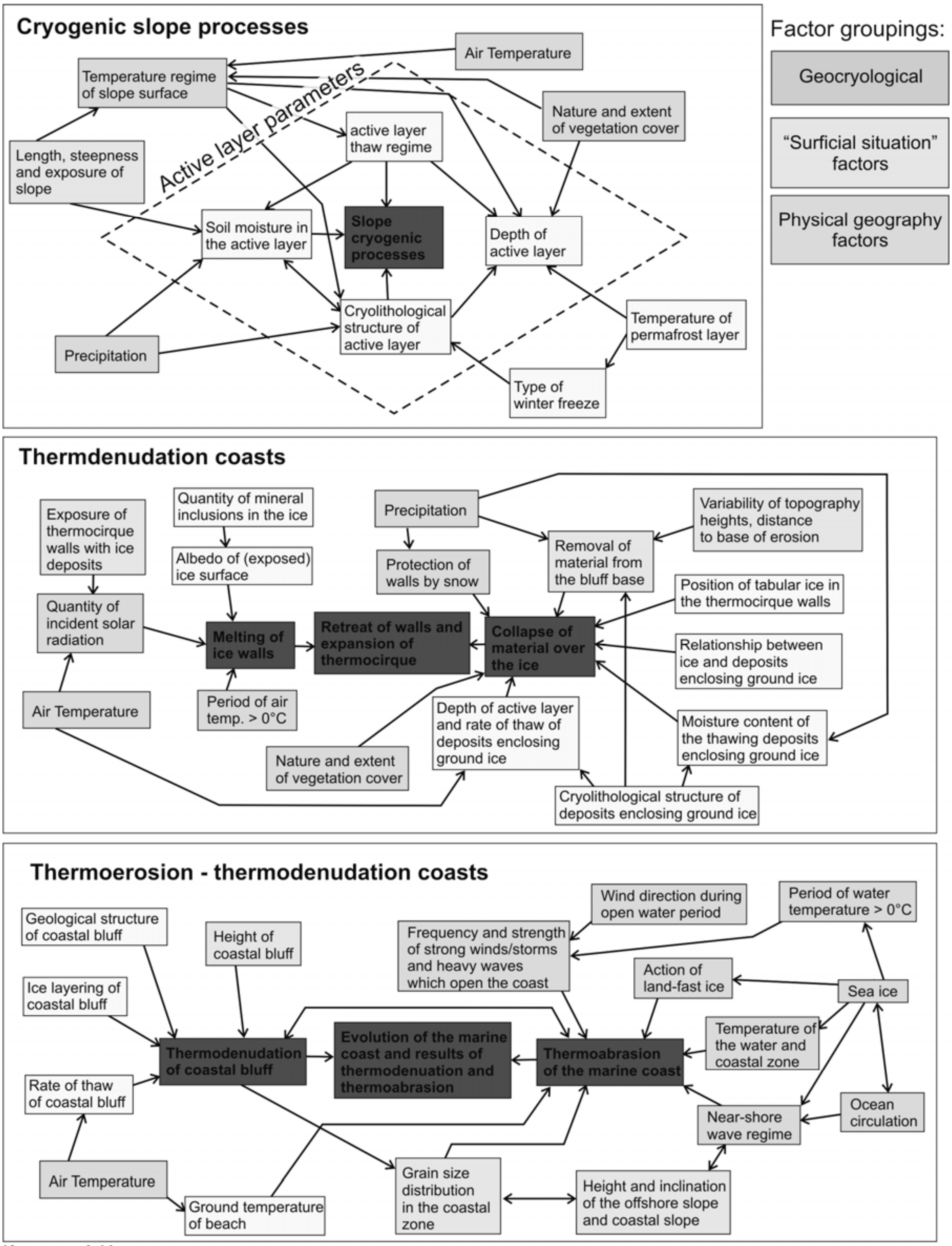
Land-fast ice on/off model

Develop an empirical/statistical prediction system such that hindcast climate data could be used to predict rough dates when land-fast ice forms/disappears. Knowing when the coastal zone is armored with ice is an important aspect governing the calculation of total wave energy directed into the coastal zone. Such a model could be verified using ice charts from AARI or other datasets of observed ice on/off times.

References

Кизяков А. И. Динамика термоденудационных процессов в районах распространения залежей пластвых льдов. Автореф. Канд. Дисс. М.: МГУ, 2005. 26 с.

Kizyakov, A. I., 2005. Dynamics of the thermodenudation processes in the areas with tabular ground ice occurrence. Summary of candidate-of-science dissertation. Moscow, Moscow University Press, 26 p. (in Russian).



Кизяков, А.И.
Перевод: Аткинсон, Д.Э.

Kizyakov, A.I.
Translation: Atkinson, D.E.

Figure 2.4.1 The detailed coastal erosion process schematic developed by A.I. Kizyakov, working under M. Leibman.

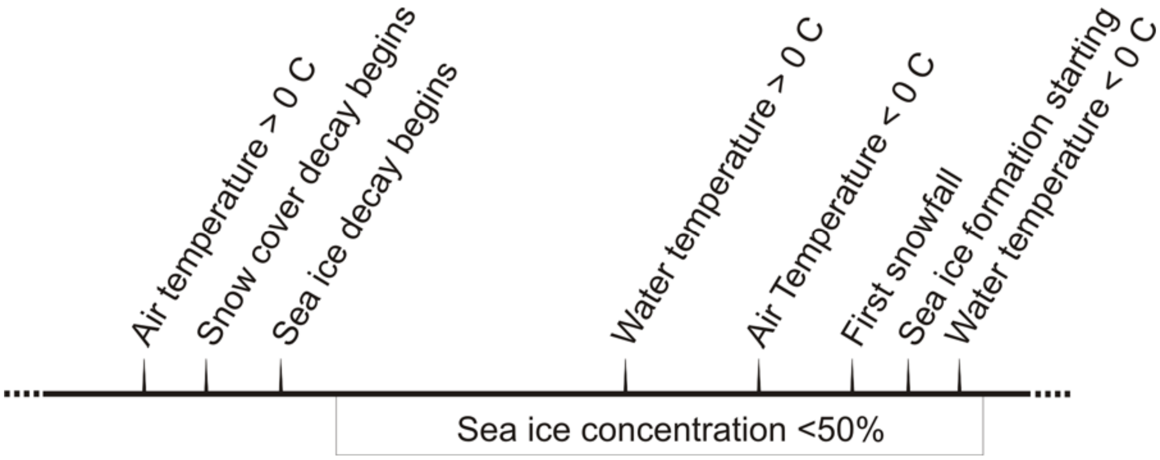


Figure 2.4.2 A more detailed representation of a coastal thermal timeline. Some of these parameters, however, would be difficult to consistently obtain on a continual basis.

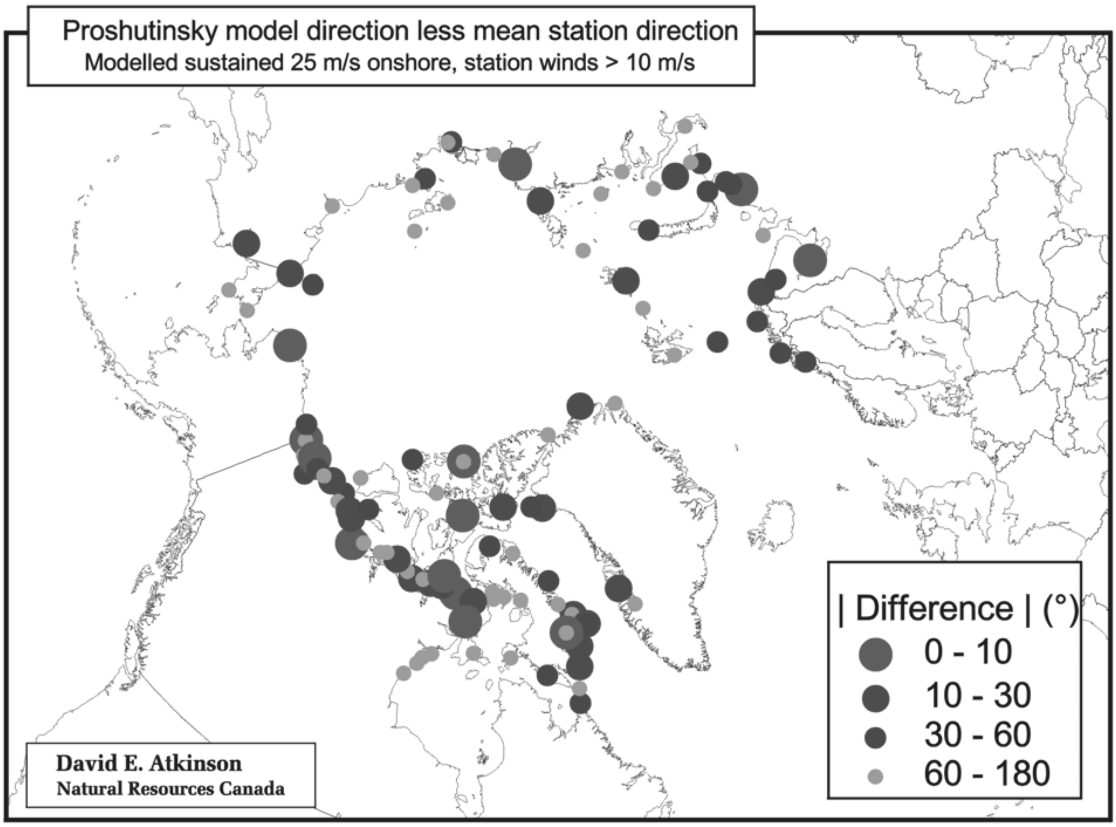


Figure 2.4.3 Coastal susceptibility to surging based on A. Proshutinsky model results. Proshutinsky's model provides the onshore wind direction that would result in the greatest potential surge. These results were compared with the direction of the strongest on-shore winds observed at coastal weather stations. The plotted differences indicate those sites where the strongest winds are blowing in the direction likely to favor water level surges, that is, the smallest difference in direction between the model results and the observations.

2.5 Remote Sensing Working Group

Chair: Torre Jorgenson

Introduction

The newly formed ACD Remote Sensing Working Group met at the 6th ACD workshop to answer three basic questions:

- How can we effectively expand the use of remotely sensed data for monitoring coastal change?
- Which products are key to establishing time series of remotely sensed data?
- How should remotely sensed data be used to characterize observatory sites?

The answers to these three questions were meant to provide the framework for the remote sensing component of the Groningen workshop.

The Remote Sensing Working Group differed from the other working groups in the sense that it was primarily attempting to define the extent to which remote sensing tools could help answer the science questions defined in other groups. Its goal was therefore to define tools and protocols accessible to the rest of the Arctic coastal science community, rather than developing new scientific challenges. To do so, and to answer the three questions raised at the beginning of the workshop, the Remote Sensing Working Group chose to organise its thoughts around three main axes:

- The definition of a set of basic geospatial datasets for each observatory
- Proposals for simple yet powerful data products for the ACD II project extracted using remotely sensed tools
- The discussion of issues related to the availability, storage and treatment of imagery for the ACD II project.

Basic geospatial datasets for coastal observatories

Each observatory listed and operated under the umbrella of both the ACD II and ACCO-Net projects will have to feature a certain number of basic datasets. The Remote Sensing Working Group listed these datasets in Table 1. This table lists both the data objectives, the type of sensor required to achieve these objectives, and its priority for the observatory. The priority is defined as “primary” or “secondary”. Primary requirements are defined as those that must be available or made available at each observatory for it to be part of the network. Secondary requirements are products that are acknowledged by the Remote Sensing Working Group as valuable additions to the set of geospatial data at each observatory, yet not a prerequisite. Secondary products are not necessarily less valuable to the network, but can be hard to provide at the circum-Arctic level at each observatory in a systematic manner, for logistical, cost, or legal reasons.

Table 2.5.1 Set of geospatial requirements for ACD II – ACCO-Net observatories.

Data Objective	Sensor	Products	Priority
1. Control Point Network	DGPS	Ground Control point network for high res imagery based on: facilities, ice wedge polygons	**Primary**
	DGPS	Ground control point network for low res imagery based on: waterbodies	**Primary**
	Permanent DGPS	Vertical motion	Secondary
2. Current Shoreline Delineation	Satellite Images, Mod. Res. (2-30 m) Landsat ETM, NASA Geocover	Current shoreline line dataset	Secondary, relevant at the circum-Arctic level
	Satellite Images High Res. (<2.5 m) IKONOS (1.0 m), Quickbird (0.6 m), ALOS (2.5 m)	Current shoreline line dataset	**Primary**
	Airphotos 0.3-1m resolution	Current shoreline line dataset.	**Primary** (if high res satellite imagery not available)
3. Planimetric Coastal Erosion (Time Series)	Satellite Images, High Res. IKONOS, Quickbird, ALOS CORONA (Strips back to 60s)	Shoreline line dataset	**Primary**
	Airphotos Archive Airphotos	Shoreline line dataset	**Primary** all shoreline datasets should be compiled all onto central server
	Time-Lapse Cameras	Temporal, webcam, fixed camera	**Primary**
	DGPS/Geodetic	Annual measurement of	**Primary**

		shoreline position	
4. Topography-DEM	Airphoto Photo-grammetry	10x10 km DEM	**Primary**, but method flexible
	Satellite Photo-grammetry IKONOS, Quick-bird	10x10 km DEM	**Primary**, but method flexible
	IFSAR	10x10 km DEM	**Primary**, but method flexible
	Topo map curves interpolation	10x10 km DEM	**Primary**, but method flexible
	Airborne LIDAR	10x10 km DEM	**Primary**, but method flexible
5. Microtopog-raphy, Thermo-karst	Airborne LIDAR	Detailed terrain model	Secondary
	Satellite LIDAR ICESat (poor horizontal resolu-tion)	DEM	Secondary
	Ground-based Lidar mm accuracy, 100 m radius	Localized DTM (e.g. ret-rogressive thaw slumps) terrain model	Secondary
	Traditional Sur-veying, Theodolite	Localized DTM (e.g. ret-rogressive thaw slumps) terrain model	Secondary
	DGPS, theodolites	Transects (100 m per-pendicular to the shore-line)	**Primary** (cm res.)
6. Sea Level	Absolute First class instru-mented	Sea level variations	Secondary
	Summer, Sub-mersible water-level recorder, 1 hr	Relative sea level	**Primary**
7. Storm-Surge	Satellite Images, Low Res.	Salt-killed tundra identifi-cation	Secondary

	Satellite Images, High Res.	Driftwood identification	Secondary
	Airphotos	Driftwood identification	
	Time-Lapse Cameras	Photo-documentation	**Primary** with scale
	Submersible water-level recorder	Relative sea level	**Primary**
	SAR	Flooding	Secondary, opportunistic
8. Coastal Currents	MODIS	Sediment plumes description, sediment distribution	Secondary
	SAR, scatterometers	Sediment distribution by knot velocity	Secondary
	Acoustic Doppler Current profilers. Ship or mooring.	Velocity profiles	Secondary
	Codar, Land-based Radar	Wind field	Secondary
9. Bathymetry	SAR	Time-series of bottom fast ice for deltas (freshwater only). Interferometry (experimental technique)	Secondary
	SAR	Channel mapping, modelling of surface roughness from capillary waves	Secondary
	Bathymetric LIDAR	Bathymetry for shallow waters	Secondary
	Multibeam Sidescan Sonar	Detailed bathymetric maps	Secondary
	Conventional Sidescan Sonar	Bathymetric maps	**Primary**
10. Sediment Load	Satellite Optical MODIS, SeaWifs, MERIS	Sediment load mapping	**Primary**
	Water sampling for calibration		Secondary

11. Sea Ice	Low Res. satellite imagery (e.g. MODIS)	Landfast ice mapping, nearshore ice complex product, duration of open water season, open water distance, safe travel	**Primary** (but metrics to be developed, EF)
	Synthetic Aperture Radar (e.g. RADARSAT)	Floe edge, ice-road routing, can be derived from existing products	Secondary
12. Ground Ice	Ground Penetrating Radar	Mapping ice wedges, needs validation data	Secondary
	DC Resistivity	Mapping ice wedges, needs validation data	Secondary
	Capacitive Coupled Resistivity	Mapping ice wedges, stratigraphy	Secondary
	Terrain unit maps using multispectral sensors (e.g. Landsat)	Terrain unit correlation	Secondary
13. Terrain Units	Satellite High-res, Photo-intepretation	Terrain unit maps	**Primary**
14. Marine Stratigraphy	Multibeam Sidescan Sonar	Nearshore and shoreface stratigraphy, ice-scours	Secondary
	Subbottom profiling Acoustic reflection systems at differing frequencies,	Stratigraphy, top of permafrost	Secondary
	Acoustic stratigraphy	Sedimentary history, taliks, lake fills	Secondary
15. Snow Depths	Snow products developed by other programs	Snow depth records	Secondary

Remote Sensing-derived data products for ACD II

The Remote Sensing Working Group proposed two new projects for ACD II based on the use of remotely sensed imagery.

A new shoreline for the Arctic

The aim of this project is to create a new shoreline for the Arctic, attempting to solve some of the precision and accuracy issues associated with the use of the World Vector Shoreline (WVS). The WVS (Soluri and Woodson, 1990) is currently the best available shoreline dataset at the global scale. It is based on 1:250,000 maps, which often date back to the 1950's. The aim of this project is therefore to provide a new single-source shoreline for the Arctic coasts, using remotely sensed data. The Remote Sensing Working Group proposes that the freely available Geocover dataset be used to compile this shoreline during the duration of the ACD II research program. Several techniques for shoreline extraction will be explored in order to provide a usable, precise and accurate replacement to the WVS.

Time-lapse cameras at coastal observatories

Based on successful experiments on the northern coast of Alaska, the Remote Sensing Working Group proposes to implement a network of ground-based time-lapse cameras at each observatory. Time-lapse cameras are off-the-shelf digital cameras pre-programmed to acquire pictures periodically. They are positioned in the vicinity of the shoreline and record the movement of the cliff top, and provide a good vision of wave and sea ice dynamics in the shore zone. Because of the relative low costs of these cameras, this network could easily be implemented at the circum-Arctic level, using the ACD II – ACCO-Net network of observatories. The Remote Sensing Working Group proposes therefore to explore the coordination of such an effort for the ACD II project

Availability, storage and treatment of imagery

Remotely sensed imagery use can be limited for several reasons, including weather perturbations, priority acquisitions or prohibitive costs. The Remote Sensing Working Group acknowledges these difficulties and therefore recommends planning a long-term commitment to imagery collection. The Remote Sensing Working Group will be responsible for maintaining awareness of international programs and status of imagery collection among other ACD II members. The Remote Sensing Working Group will, in particular, make sure that the acquisition of imagery will be coordinated, if not standardized. This effort should result in the increased availability of comparable datasets for the ACD II project.

The Remote Sensing Working Group recommends addressing as early as possible the issues of storage, retrieval and treatment of imagery. In particular, it recommends the designation of a central location for storage and archiving of data, as well as the elaboration of a simple workflow system for the dispersion and treatment of data.

These issues will be addressed by the ACD II project steering committee and the Remote Sensing Working Group so that a clear framework is proposed to the ACD II community by the beginning of the 7th workshop. Basic storage and archival capacities have already been secured, and will be consolidated during 2007.

References

Soluri, E. A., Woodson, V. A., 1990. World vector shoreline. *International Hydrographic Review* 67: 27-35.

2.6 ACD GIS Development

An important outcome of ACD I was the segmentation and characterization of the entire circum-Arctic coastline by regional experts. This detailed evaluation has been compiled into a geographic information system (GIS) which contains data on coastal morphology, composition, dominant processes, ground ice, and environmental forcing parameters such as wind speed, storm counts, melt season, and wave energy. This information is available for over 800 segments, covering the coastline of all eight regional seas of the Arctic Ocean. The length of individual segments is variable (median length is 38 km), and depends on classification parameters and data availability.

We list individual and organizational contributors to the GIS system here. The list is unlikely to be complete, and we apologize for any omissons. Data provider details are also associated within individual coastal segments in the GIS itself

.

Individual Contributors to ACD GIS

Jerry Brown
Chris Cogan
Nicole Couture
Allison Graves-Gaylord
Mikhail N. Grigoriev
James W. Jordan
Janet Jorgenson
Alexander N. Kotov
Hugues Lantuit
Bill Manley
Olga Medkova
Stanislav Ogorodov
Vladimir Ostroumov
Pier Paul Overduin
Volker Rachold
Morten Rasch
Charlotte Sigsgaard
Johan Ludvig Sollid
Steve.Solomon
Frits Steenhuisen
Alexander Vasiliev

Contributing Organisations

- Alaska Biological Research (ABR), Inc., Fairbanks, Alaska, USA
- Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany
- Arctic Centre, University of Groningen, Groningen, The Netherlands
- Canadian International Development Agency (CIDA)
- Canadian Department of Foreign Affairs and International Trade (DFAIT)
- Department of Geography, McGill University, Montréal, Quebec, Canada

- Earth Cryosphere Institute, Moscow, Russia
- Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada
- Gjøvik University College, Gjøvik, Norway
- Industrial and Research Institute for Engineering of Construction, Moscow, Russia
- International Arctic Research Center, University of Alaska Fairbanks, Alaska, USA
- International Arctic Science Committee (IASC)
- International Permafrost Association (IPA)
- International Geosphere-Biosphere Program / International Human Dimensions Program - Land-Ocean-Interactions in the Coastal Zone (IGBP/IHDP - LOICZ)
- International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union (INTAS, Project Numbers INTAS Open Call 2001-2329 & INTAS Open Call 2001-2332)
- International Arctic Research Center (IARC, Analysis of Coastal Meteorological and Oceanographic Forcing in the Arctic Basin Project Grant)
- German Ministry for Education and Research / Russian Ministry for Research and Technology (Permafrost Dynamics in the Laptev Sea Project Grant)
- Moscow State University, Moscow, Russia
- Nuna Technologies, Fairbanks, Alaska, USA
- Permafrost Institute, Yakutsk, Russia
- Shirshov Institute of Oceanology, Moscow, Russia
- United States of America National Science Foundation Office of Polar Programs (OPP, Study of the Northern Alaska Coastal System – SNACS)
- University of Oslo, Norway

Description

For each segment of the world vector shoreline (WVS), the following data layers are visible (the field name as it appears in the GIS tables is given in brackets).

Backshore elevation (bak_elev): This is given in metres. The backshore is the upper part of the active beach above the normal reach of the tides, but affected by large waves occurring during a high water event.

Backshore material 1 (bak_mat1): A code is provided that provides a primary classification of the backshore, either lithified (l) or unlithified (u).

Backshore material 2 (bak_mat2): This is a more detailed classification of the backshore: mud-dominated (m), sand-dominated (s), gravel-dominated (g), diamict (d), organic material (o), or a mixture of these types, for example mud and gravel (mg) or sand and gravel (sg).

Shore material 1 (sho_mat1): The shore is the strip of ground bordering the sea which is alternately exposed, or covered by tides and/or waves. This is the primary classification of the shore material, either lithified (l) or unlithified (u).

Shore material 2 (sho_mat2): This is a more detailed classification of the shore: mud-dominated (m), sand-dominated (s), gravel-dominated (g), diamict (d), organic material (o), or a mixture of these types, for example mud and gravel (mg) or sand and gravel (sg).

Distance from the shoreline to the 2m isobath (iso_2m): This is provided in metres. This distance is significant in that the sea ice is generally about 2 m thick, so it will be frozen to the bottom within this zone.

Distance to the 5m isobath (iso_5m): provided in metres.

Distance to the 10m isobath (iso_10m): provided in metres.

Distance to the 100m isobath (iso_100m): provided in metres.

Offshore material (off_mat): This is a classification of the material in the offshore: mud-dominated (m), sand-dominated (s), gravel-dominated (g), diamict (d), organic material (o), or a mixture of these types, for example mud and gravel (mg) or sand and gravel (sg).

Ground ice 1 (ice1): This provides an estimate of the amount of ground ice within the total shoreface along this segment of the coast. The amount is considered to the low (l) if it accounts for between 2 and 20% of the volume of the coast, medium (m) if it is between 20 and 50%, and high (h) if it is greater than 50%.

Ground ice 2 (ice2): This provides a value for the amount of ground ice, as a percentage of the total volume of the shoreface.

Change rate (rate): Negative values indicate the amount of erosion in metres per year, and positive value represent accumulation in metres per year.

Dry bulk density (bulk_den): This is the mass of soil per volume and is expressed in tonnes per cubic metre (t/m^3). It may be an estimate based on the type of soil, i.e. 1.3 for clay, 1.5 for silt, and 2 for sand.

Organic carbon (oc): This is the percentage of organic carbon by weight for the total shoreface volume.

Soil organic carbon (soc): This is the amount of soil organic carbon in the top 1 metre of soil, in kg/m^2.

Data quality issues

Discussions at the workshop led to a decision to perform data quality assessment for quantitative database variables (i.e. those neither qualitative nor classed). The proposed levels of data quality themselves are classed variables, with classes based on sampling density:

L – low. Best guess or interpolated from non-neighbouring segments (when justified, i.e. geomorphology, quality may be interpolated from non-neighbouring segments and the data quality can be medium)

M – medium. One measurement or interpolated from neighbouring segments

H – high. More than one measurement in the segment

For fields with no data, the data quality is not assessed. Data providers are to be contacted individually to provide data quality assessments.

Internet Map Server

An internet map server porting of the ACD GIS was demonstrated at the workshop (http://gisweb2.awi-bremerhaven.de/Website/ACD/viewer.htm). The goal of the internet map server is to allow individual users to prepare their own maps displaying the region and variables of interest and represents an option for release of the database.

3 EXTENDED ABSTRACTS

THE COASTAL RESEARCH ENVIRONMENT IN ALASKA: BRIDGING THE GAP BETWEEN SCIENCE AND THE PUBLIC

David E. Atkinson[1], Oceana Francis-Chythlook[1], John Marra[2], James Partain[3], David Levinson[4], John Jensen[4]

1 International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, Alaska, USA (datkinson@iarc.uaf.edu)
2 National Oceanic and Atmospheric Administration (NOAA) Ideas Center, Honolulu, Hawaii, USA
3 NOAA/National Weather Service, Anchorage, Alaska, USA
4 NOAA/National Climatic Data Center, Asheville, North Carolina, USA

A series of recent natural events in the world and in the United States (south-Asian tsunami, US severe hurricanes, coastal sea-ice reduction trends) have caused officials in the US government to ask hard questions about our level of understanding of coastal systems, the nature of risks they face, and the extent to which research results are being turned into effective planning and hazards-mitigation tools for the public. As a result of this, research opportunities focusing on arctic climate, sea ice, the coastal zone, their interactions with each other and with the social environment have grown considerably in the last two years. Much of this work is being led by the US federal agency, the National Oceanic and Atmospheric Administration (NOAA).

We describe several efforts recently initiated by NOAA, in partnership with University of Alaska Fairbanks and University of Hawaii, to perform science work leading to operational products better tailored to emergency planning and response for coastal zones Alaska and Hawaii. These projects bring together coastal experts from diverse US federal and Alaskan state agencies, academia, and research groups to enable NOAA to build operational capacity and assist emergency management decision-making. To reach this objective the project must first identify gaps and capacities in the following areas: data (climate/oceanic), wave modeling, geodesic information (high-resolution bathymetry, topography, coastal composition), infrastructure database/cataloging, and the topic of how information is presented to the public. These projects will utilize available results, build alliances where necessary, or develop necessary capacity where it does not already exist.

URAL COAST OF BAYDARATSKAYA BAY, KARA SEA: MASSIVE ICE BEDS AS A FACTOR OF COASTAL DYNAMICS

N.G. Belova, V.I. Solomatin, A.I. Noskov and S.A. Ogorodov

Faculty of Geography, Lomonosov Moscow State University, Russia.

The dynamics of typical thermo-abrasion coasts is generally determined by both thermal and wave energy factors. Correspondingly, in the case of open straight coasts with equal wave energy conditions, the differentiation of coastal bluff segments by the rate of their destruction would be a function of cryolithological structure, in particular of the presence of massive ice beds.

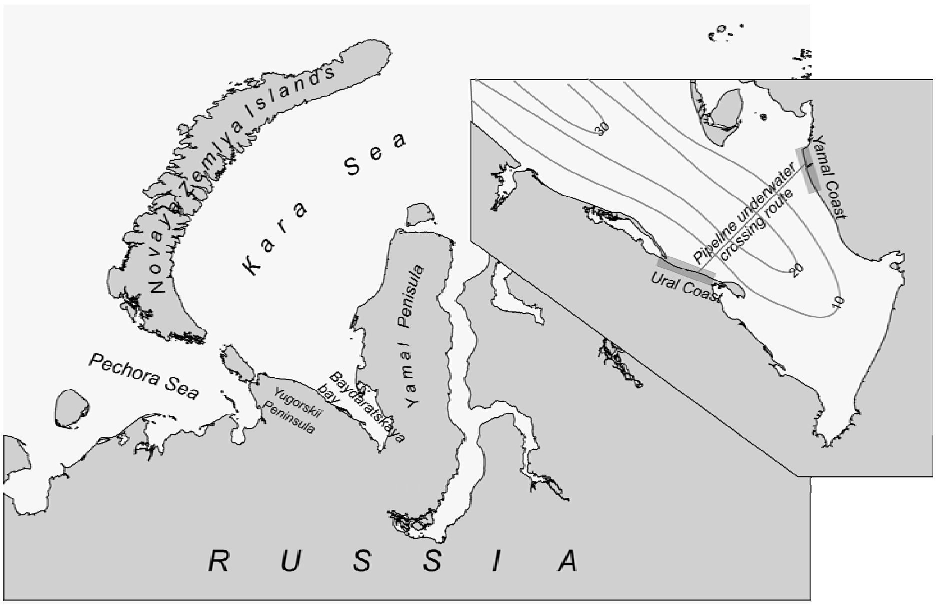


Figure 1. The research area.

Thick massive ice beds are exposed on the Ural Coast of Baydaratskaya Bay, Kara Sea (Fig. 1) to the west of a projected gas pipeline crossing (Fig. 2). They were first found here in 1991. We had an opportunity to investigate them in 2005 and 2006. The massive ice beds are exposed in several places. There the surface with altitudes from 10 to 15 m (in the east part of the research area) and from 20 to 25 m (in the west) comes to the coastline. The extent of massive ice bed exposures reaches up to 80 м along the coast.

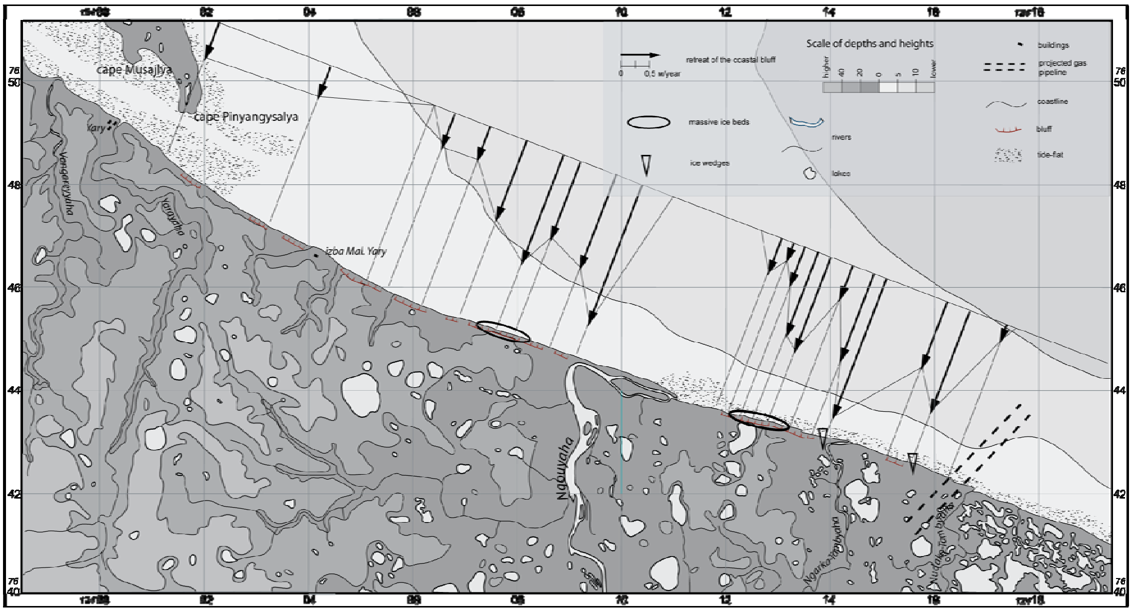


Figure 2. Massive ice bed location and retreat rate of the coastal bluff.

The thickness of the ice beds varies from 1 to 4-7 m (Fig. 3, a). Sediments which contain them are represented mostly by grey sands with minor lenses of gravel, sometimes pebble or loamy sands. Massive ice beds occur mostly as big lenses in different parts of the coastal bluff – in the upper, middle or lower. After storms, ice beds can even form a bench. The ice is laminated, layers are mostly sub-horizontal. Ice includes many sandy and loamy particles, sometimes even gravel and pebble, as dissipated, as in layers. In one place layers with different content of inclusions formed recumbent folds in the massive ice bed. The distribution of inclusions, the same overlaying and underlaying sediments and other factors point to the united origin of massive ice in the surfaces with different altitudes (10-15 and 20-25 m). However, this origin is not exactly determined. There are a few possible explanations. Among them a version of buried permanent snowbank, small glacier or even a submarine origin. To determine what version is correct samples of ice were taken for isotopic and chemical analysis, ground samples – to determine the type of salinity. Ice structure were described in the field. Most of analyses are being processing now, so we are waiting for the results to talk about massive ice beds origin more confidently.

Massive ice can occupy up to 1/3 of the coastal bluff (Fig. 3, a). Especially under such ice thickness due to massive ice beds thawing and destruction of overlaying sediments form large thermocirques. This process of thermo-abrasion and thermo-denudation destruction affects substantial areas, occupies up to tens metres towards the land. Here, landforms that are almost round in plan with vertical back walls made by massive ice beds and frozen sediments are formed. They thaw intensively in warm periods. Thawed sediments from thermocirques form strong flows to the beach. Then they are removing by waves and alongshore currents. During the short northern summer, the back frozen side of the thermocirque can retreat over several meters. The process goes on until the massive ice is completely thawed. After that the back side becomes stable. In this time the stage of predominantly abrasion of the balks between adjacent thermocirques is continued. The cycle of thermo-abrasion activation repeats after a new massive ice bed is exposed.

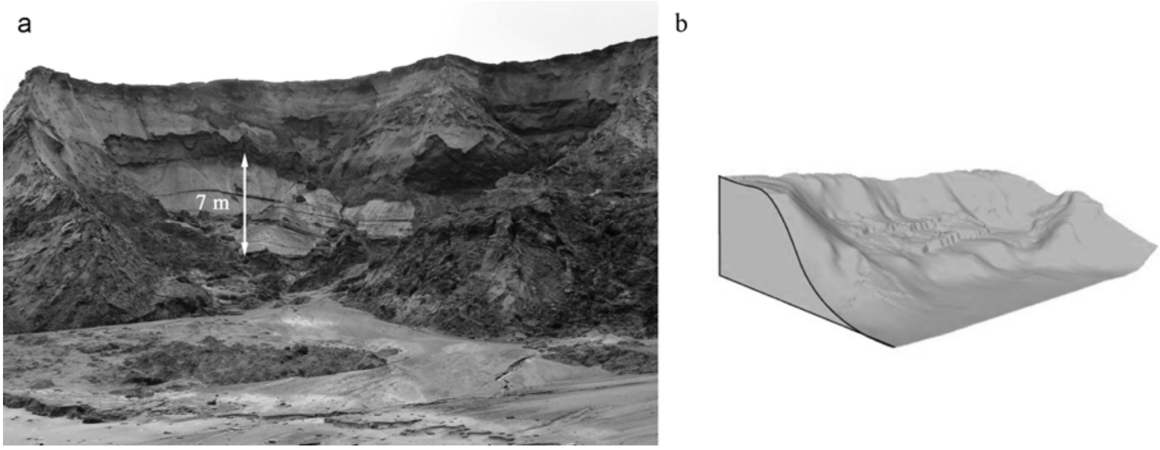


Figure 3. The thermocirque in 25-m surface: (a) – eastern part of the thermocirque (photo by A. Iosimov); (b) three-dimensional model.

This year taheometric shooting of thermocirques was carried out. The three-dimensional model of them has been made (Fig. 3, b). In the next year it is planned to make a repeated shooting, and also phototheodolite shooting to get a stereo mate. Than it would be possible to determine the volume of removed matter and correspondingly a rate of coastal destruction.

Data about massive ice bed location had been compared with annual rate of coastal destruction. Information about destruction rates is the result of monitoring observations on coastal dynamics, held since 1988. It had been found out that on the segments without massive ice the rate of coastal bluff retreat was on the average about 0,5m/year. But on the segments with massive ice beds the rate of retreat was three times or more higher than on the same heights of coastal bluff – even up to 3,5 m/year and more (Fig. 2).

Thus, this investigation confirmed that the rate of coastal bluff retreat is directly dependent on the presence of massive ice beds in the coastal bluff.

If we would take a segment with coastal bluff composed by sediments which include massive ice, than ice beds would expose only on at about 15% of its coastline. But massive ice beds were exposed in different parts of this coastal segment in different years. Taking this fact into account, we can conclude that in general all the length of this destructing surface is dynamically unstable. Our research permitted us to make recommendations about the location of the pipeline and the depth of its deepening taking into account the cryolithological composition of the coast.

THE IPA CONTRIBUTION TO THE INTERNATIONAL POLAR YEAR AND THE ARCTIC COASTAL DYNAMICS

Jerry Brown, President

International Permafrost Association, Woods Hole, Massachusetts, USA
(jerrybrown@igc.org)

The IPA has assisted in the development of four coordinated, IPY projects or clusters. These coordinated projects include over 60 individual projects and 150 individuals from many of the 26 IPA-member countries. Three of the four Clusters have direct applications to this ACD workshop and future activities of ACD and ACCO-Net.

Project 50 Permafrost Observatory Project: A Contribution to the Thermal State of Permafrost (TSP) will obtain a "snapshot" of permafrost temperatures throughout Planet Earth and develop a spatially distributed set of observations on the past and present status of permafrost temperatures. Emphasis is on permafrost temperatures since there is currently no global database that defines the thermal state of permafrost for a specific time period. The Circumpolar Active Layer Monitoring (CALM) network is an integral part of TSP. Other observatory measurements include periglacial and related slope processes. TSP is a field component of the WMO/GCOS Global Terrestrial Network for Permafrost (GTN-P) <www.gtnp.org>

Project 90 Arctic Circum-Polar Coastal Observatory Network (ACCO-Net) is linked to the Arctic Coastal Dynamics project and proposes to develop a coordinated monitoring programme incorporating diverse regions and providing site-specific, fine-scale baseline and time-series data from coastal sites, deltas and estuaries of major Siberian and North American rivers and including sites with varying degrees of human development and impacts. Additional details will be developed during the 6th ACD Workshop <www.awi-potsdam.de/acd/acconet>

Project 373 Carbon Pools in Permafrost Regions (CAPP) project is aimed at quantifying soil organic matter quantity and quality in high-latitude and high-altitude regions that are characterized by the presence of isolated to continuous permafrost terrain. CAPP includes the Northern Circumpolar Soil Carbon Database (NCSCD) that provides an improved estimate of soil organic carbon stocks for the permafrost regions of North America and Eurasia. Special attention will be given to the widespread peatlands. <www.geowiss.uni-hamburg.de/i-boden.capp>

The fourth cluster, **Project 30 Antarctic and sub-Antarctic Permafrost, Periglacial and Soil Environments Project (ANTPAS**), contributes to the bipolar objectives of the IPY-IPA programme. ANTPAS is aimed at integrating existing and new data on the distribution, thickness, age, history and physical and geochemical properties of permafrost, soils and the active-layer on the Antarctic continent and sub-Antarctic islands. A monitoring network, a regional subset of GTN-P and TSP and consisting of borehole temperatures, active-layer thickness, and periglacial and soil observations, will be established along selected environmental gradients. <http://erth.waikato.ac.nz/antpas/>

Both educational outreach and data management activities are key elements for all IPY activities. Data sharing and accessibility is an important element and the IPA will encourage all participants to adhere to these IPY policies. To date, the **Catalogue of International University Courses on Permafrost (IUCP)** is a compilation of 129 permafrost and periglacial field courses in 17 countries and was compiled by the IPA Secretariat at UNIS (see IPA web site). The **Permafrost Young Researchers Network (PYRN),** currently with approximately 200 members**,** was developed to facilitate and strengthen contacts and communications among young scientists in the permafrost community and to provide information on availability of fellowships, conference travel opportunities, job opportunities, and current developments. < www.pyrn.org>

Funding requests for many of the individual projects has been approved or are pending. An IPA Implementation Plan will be completed by early 2007 and will include details of observational programmes and data procedures; details will be found on <http://www.geo.uio.no/IPA/>. ACD can set an example by designing an integrated measurements programme at each of its sites and that includes permafrost temperature, active layer, and erosion and sedimentation rates, and assessments of carbon and ice volume contents. ACD has an excellent opportunity to contribute to the International Year of Planet Earth and its hazards theme <www.esfs.org>.

During summer 2008, initial results of IPY-IPA activities will be presented at the Ninth International Conference on Permafrost (NICOP) in Fairbanks, Alaska (www.nicop.org) and at the 33rd International Geological Congress (IGC) in Oslo, Norway. The 2008 ACD workshop should be held in conjunction with NICOP, the Coastal field trip and visits to Barrow, and post conferences courses in Russia. A joint NICOP-IGC “floating university” course in the Barents and Kara seas is under discussion.

CANADIAN ARCTIC NETWORK OF COASTAL OBSERVATORIES - CANCO

Nicole Couture[1], Michel Allard[2], Don Forbes[3], Steve Solomon[3], Wayne Pollard[1]

1 Department of Geography, McGill University, Montreal, Quebec, Canada (nicole.couture@mail.mcgill.ca)
2 Centre d'études nordiques, Université Laval, Québec, Québec, Canada
3 Geological Survey of Canada (Atlantic), Dartmouth, Nova Scotia, Canada

The Canadian contribution to ACCO-Net, the coastal observatory IPY initiative, is CANCO (Canadian Arctic Network of Coastal Observatories). Four core monitoring sites are planned: Beaufort Sea coast, east Hudson Bay, northern Baffin Island, and Ellesmere Island. Monitoring at the core sites will include compilation of existing geological, geotechnical, bathymetric and ecological data to synthesize current knowledge and assess what new information is required. Detailed surveys and mapping of topography, bathymetry, ice dynamics and shoreline change will be conducted using conventional and emerging technologies (including Quickbird, Ikonos, RADARSAT, multibeam, interferometric sidescan and LiDAR). Maps of traditional use and resource exploitation by the Inuit and Inuvialuit will be compiled. Shorezone processes will be monitored using meteorological stations, remote-controlled cameras, tide gauges, GPS stations, and current profilers. Offshore and onshore permafrost will be characterized with geophysics, boreholes, thermal instrumentation and laboratory analyses. Each network node will include central (core) sites and satellite sites. Selection of core sites will account for community research needs, location of sensitive ecosystems and harvesting areas, recent environmental changes, and logistical requirements. A full program of monitoring activities will take place at each core site. Satellite sites will also be identified where monitoring will provide subsets of information to characterize regional variations in coastal processes. The CANCO sites are part of the international IPY project ACCO-Net (Arctic Circum-Polar Coastal Observatory Network). The CANCO data will be compiled with data from similar observatories in other countries to provide a circum-Arctic assessment of coastal processes.

LAND-OCEAN INTERACTIONS IN THE COASTAL ZONE

Götz Flöser

Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany (goetz.floeser@gkss.de)

LOICZ is an international research project involving scientists from across the globe whose research investigates changes in the biology, chemistry and physics in the coastal zone. LOICZ has, since its launch in 1992, expanded its areas of research to include social, political and economic sciences to incorporate the human dimensions influencing the coastal zone. LOICZ is a core project of the International Geosphere Biosphere Programme and the International Human Dimensions Programme on Global Environmental Change and thus part of the Earth System Science Partnership ESSP.

A global, interdisciplinary network of scientists contributes to LOICZ core and affiliated projects. These projects build the backbone for up- and down-scaling of LOICZ results and synthesis.

The major results of the first decade of LOICZ research have been published in the Springer book "Coastal Fluxes in the Anthropocene". Examples are erosion and sedimentation along the coast, nutrient input, coastal typology, and the analysis of over 200 river catchments and their influence on the coast.

LOICZ research has been defined in the new Science Plan for the second phase. It follows the three Topics:

1. **Linking Social and Ecological Systems in the Coastal Zone**
2. **Assessing and predicting Impact of Environmental Change on Coastal Ecosystems**
3. **Linking Governance and Science in Coastal Regions**

The LOICZ Scientific Steering Committee (SSC) is a group of scientists who provide scientific guidance that oversees the development, planning and implementation of LOICZ activities. The SSC members are appointed by IGBP/IHDP and globally located.

The International Project Office (IPO) is responsible for the project administration on a day-to-day basis. The IPO role includes: co-ordination, planning, communication, advocacy and provision of a technical secretariat. It is, since January 2006, based at the GKSS Research Centre in Geesthacht, Germany. Regional Nodes promote and secure the future of LOICZ research and ensure that the research carried out by LOICZ is relevant to regional needs. Current nodes are established in Sri Lanka and Singapore.

LINKING THE SOCIAL AND PHYSICAL SCIENCES IN COASTAL CHANGE RESEARCH

James Ford

Department of Geography, McGill University, Montreal, Quebec, Canada (jamesdavidford@hotmail.com)

This presentation will illustrate a framework for linking the social and physical sciences in coastal change research. The framework has been developed to assess climate change vulnerability, and is currently being utilized in two coastal zone projects funded through the Canadian Climate Change Impacts and Adaptation Program (CCIAP). It offers a guide for how research conducted within the ACD program can examine interactions between humans and the coastal environment in the new science plan.

The framework for climate change vulnerability analysis involves two stages. Analysis starts by examining community experience and response to climate variability, change and extremes, to characterize **current vulnerability**. This involves: 1) identification of climatic conditions that represent risks to community members, 2) characterization of the biophysical nature of these risks, 3) characterization of how communities manage and experience these risks, and 4) identification of those processes and conditions that influence exposure to climatic risks and determine the efficacy, availability, and success of past and present adaptations. The second stage links analysis of current vulnerability into an assessment of vulnerability to future climate change. **Future vulnerability** is assessed by estimating directional changes in climatic conditions identified by the community as important. This involves collaboration with the biophysical sciences, using modeling and trend analysis to characterize how climate change will affect biophysical processes. Future adaptive capacity to manage predicted changes is assessed on the basis of past behavior and community identification of future adaptation options, constraints, and opportunities.

DYNAMICS OF SUB-SEA PERMAFROST TABLE IN THE NEAR-SHORE ZONE OF THE LAPTEV AND EAST-SIBERIAN SEAS

Mikhail N. Grigoriev[1], Volker Rachold[2]

1 Permafrost Institute, Russian Academy of Sciences, Yakutsk, Russia (grigoriev@mpi.ysn.ru)
2 Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany and International Arctic Science Committee Secretariat, Stockholm, Sweden

The development of sub-sea permafrost in the Arctic basin is insufficiently known natural process. In the geological past, during periods of lower sea-level, the shallow Arctic shelf seas (mainly the Siberian shelf seas) have been dry and permafrost could be formed, which today, after flooding of the shelves, may still exist as sub-sea relict permafrost. The occurrence of sub-sea permafrost in the near-shore zone has been observed in some relatively shallow drilling transects in different parts of the Laptev and East Siberian shelf.

- The sub-sea relict permafrost is distributed in most parts of the Laptev and East Siberian Seas shoreface where coastal erosion is active.
- New formation of submarine permafrost is active in the shallows surrounding the delta areas and the shallow accumulative bays, on condition that water depth is less than 2.5 m.
- The average sub-sea permafrost table inclination in the near-shore zone at the key sites of the Laptev Sea is about 0.011 (0.002-0.038).
- The trend of sub-sea permafrost table degradation at the near-shore zone (for the different types of the shoreface) is about 1-20 cm/year, depending on sea water depth and the period of flooding.
- One of the main indices of sub-sea permafrost table inclination for the eroded coast is the coastal retreat rate.

ARCTIC COASTAL PROCESSES: THE HUMAN DIMENSION

Louwrens Hacquebord

University of Groningen, Arctic Centre, Groningen, the Netherlands (l.hacquebord@rug.nl)

With less than 4 million inhabitants, the Arctic region is one of the most sparsely populated areas on Earth. According to figures dating from 2000, on average 9.4 % of the total population in the Arctic is indigenous. This percentage of indigenous people differs significantly from nation to nation: in Alaska it is 18.6 %, in Canada 56.8 %, in Greenland 88.1 %, in Scandinavia 9.1 % and in Russia 4.3 %. These figures show that indigenous people are a majority in Greenland and Canada and a minority in the Arctic area of all the other nations.

Many arctic indigenous peoples live along the coasts because the coast plays an important role in their economic system. In parts of the Arctic, more than 50% of the subsistence is based on fishing and hunting of marine mammals. The native people live on the coast, use it as a base for their hunting and fishing activities and store their equipment there. In terms of the "liminality of places" (their "between-ness") the coast forms a link between dwelling, hunting and fishing. It connects the settlement with the hunting and fishing grounds, gives access to the living marine resources and is important in the indigenous economic system. In many localities, holy places and cemeteries indicate the importance of the coast as the twilight zone between life and death; the transfer zone to the spiritual world. The coast also gives entry to the rest of the world, which is essential for the market economy the indigenous economic system is steadily moving towards.

Companies from outside the Arctic have exploited the natural resources in the Arctic for centuries. After exhaustion of the resources, these southerners would very often move to another place in the region and start again. These people consider the Arctic as a Resource Frontier Region used to produce raw materials for the world market. For them, the proximity of the coast is practical but not strictly necessary.

Transformations in the Arctic are the result of climate change, contamination of water and air, globalization of the economy and changes in geo-political situations. The changing climate causes modifications in sea-ice, snow-cover and permafrost, with coastal retreat very often being a consequence. This coastal retreat has serious implications for ecosystems and northern communities causing loss of housing, and damage to infrastructure, hunting and fishing grounds, holy places, cemeteries and other cultural heritage sites. The study of the human dimension of arctic coastal processes needs to include an assessment of all the indigenous settlements along the coast threatened by erosion, an assessment of the means of subsistence in the settlements, an assessment of the liminar places along the coast which, together with the experience of the indigenous people, may lead to a system for studying and predicting the impact of climate change on coastal communities.

ARCTIC COASTAL PATHWAYS OF ORGANIC MATTER: A PROPOSAL

Birgit Heim[1], Lutz Schirrmeister[2]

1 Berlin Program for Equal Opportunities for Women in Research, Berlin, Germany (birgit.heim@email.de)
2 Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany

Reports of enhanced coastal erosion, permafrost thawing, and higher river discharges in the Arctic regions have heightened concern about the potential impact of increased supply of terrigenous organic matter to arctic aquatic ecosystems. This study proposes to develop and apply remote sensing tools to measure the spatial and temporal dynamics of organic matter input by rivers and coastal erosion. Ocean Colour satellite data (SeaWiFS (NASA), MODIS (NASA), MERIS (ESA)) will allow us to use the chromophoric dissolved organic matter (cDOM) fraction of the dissolved organic carbon (DOC) pool to trace the pathways of the terrigenous input.

A circum-Arctic Ocean Color satellite data-base will be collected from 1998 up to the present. An adapted atmospheric correction will be developed according to the optical conditions of the coastal Arctic atmosphere. Optical remote sensing analyses will be combined with biogeochemical field data and spectroradiometrical field measurements to investigate Arctic-specific optical correlations of water color and biogeochemistry. The output will be spectral remote sensing algorithms for near-coast Arctic cDOM. These algorithms will be applied in the spectral processing of the atmospherically corrected satellite data to produce circum-Arctic remote sensing information on the organic matter pathways in the coastal zone.

FIELD-BASED MEASUREMENT OF COASTAL EROSION IN THE SOUTHEAST CHUKCHI SEA, ALASKA

James W. Jordan[1], William F. Manley[2], Diane M. Sanzone[3], Owen K. Mason[2]

1 Antioch University New England, Dept. of Environmental Studies, Keene New Hampshire, USA
(james_jordan@antiochne.edu)
2 INSTAAR, University of Colorado, Boulder, Colorado, USA
3 Arctic I&M Program, National Park Service, Fairbanks, Alaska, USA

Twenty-seven monitoring stations established between 1987 and 1993 in Bering Land Bridge National Preserve (BELA) and Cape Krusenstern National Monument (CAKR), Alaska, were reoccupied during August 2006 to investigate shoreline change in the southeast Chukchi Sea. The irregularly spaced stations span 200km of coastline in BELA and 70km in CAKR, and provide point estimates of shoreline retreat along undeveloped reaches. Retreat rates are highly variable in both areas (0.06m/yr to 2.02m/yr in BELA; 0.09m/yr to 1.29m/yr in CAKR, with net progradation occurring at two sites and no net change at one site in CAKR).

The highest rates of erosion occur along the Shishmaref barrier island chain in BELA and along ice-rich bluffs and the pronounced east-west to north-south shoreline reorientation in CAKR. The spatial variability in erosion rates reflects differences in the geomorphology, dominant processes, and exposure of reaches. This variability suggests that storm climatology and thermokarst degradation play greater roles in retreat than long-term regional sea-level rise. Preliminary analyses indicate decadal-scale cyclicity in storm intensity in the northern Bering – southeast Chukchi seas and a temperature rise of about 1.5^{o}C since 1950 at Kotzebue, which is located between the two parks. Results from monitoring stations alone are insufficient to determine regional coastal sediment flux, but they are important for 1) placing rates of erosion observed on developed shorelines in the context of rates occurring along non-modified reaches, 2) for documenting the inherent along-shore variability in retreat rates, and 3) for providing field-based data for calibrating GIS analyses of long-term change.

VILLAGE-BASED MONITORING AND REMOTE SENSING OF COASTAL DYNAMICS ALONG THE ALASKAN BEAUFORT COAST

M. Torre Jorgenson[1], Jerry Brown[2], Tim Buckley[3], Susan Fredrickson[3], Harry Brower[4], Dave Payer[5], Joeb Woods[6]

1 ABR, Inc., Fairbanks, Alaska, USA
(tjorgenson@abrinc.com)
2 International Permafrost Association, Woods Hole, Massachusetts, USA
3 North Slope School District, Barrow and Kaktovik, Alaska, USA
4 North Slope Borough Department of Wildlife Management, Barrow, Alaska, USA
5 U.S Fish and Wildlife Service, Fairbanks, Alaska, USA
6 Nuiqsut, Alaska, USA

A village-based network for monitoring coastal dynamics along the Beaufort Sea Coast of northern Alaska was initiated in 2004 to provide local residents, the science community, industry, and policymakers information on changes along the coast. Along with the field monitoring, a time-series of aerial photography has been compiled to quantify coastal erosion and assess the risks of erosion to village infrastructure. The network of three key sites at Barrow, Nuiqsut, and Kaktovik is designed to monitor sea level and storm surges, coastal erosion along monitoring transects, thaw depths, and permafrost temperatures. Equipment includes submersible water-level recorders, time-lapse cameras, temperature dataloggers, and topographic surveying equipment. Local teachers, students, village representatives, and scientists collaborate to collect the data, which are then available to students for use in classroom exercises and science fair projects. The historical aerial photography has been used in a popular classroom exercise that allows students to prediction when their school and house will be affected by coastal erosion at current erosion rates. The project has had substantial interest from the local communities, but maintaining the human capabilities of the network on a low budget remains a challenge. Data collection has been mostly successful, but loss and failure of cameras and water-level recorders in a harsh environment have prevented collection of a complete dataset across all sites. Information from the local network is contributing to the pilot-scale development of a web-based data portal called Exchange for Local Observations and Knowledge of the Arctic (ELOKA). The village-based monitoring is supported by the National Science Foundation's Study of Northern Alaska Coastal Systems, Barrow Arctic Science Consortium, and EPSCOR programs, and the North Slope Borough's School District and Department of Wildlife Management, U.S. Fish and Wildlife Service, ConocoPhillips Alaska Inc., International Permafrost Association, and ABR, Inc.

DRIFTWOOD IN THE ARCTIC – PROGRESS AND PERSPECTIVES

M. Kazmer

Tree-ring Laboratory, Department of Palaeontology, Eotvos University, Budapest, Hungary (mkazmer@gmail.com)

Rivers draining into the Arctic Ocean supply thousands to millions of driftwood logs annually. A significant portion of them carry a clear signal of the growth region and the year and season when it was felled or died. These logs are like natural buoys: when frozen in ice, they will travel thousands of kilometres, finally released by the melting ice floe. Ultimately most of the logs (buoys) will sink when released from ice, but a significant percentage of them is washed ashore by storms.

Tree-ring analysis is capable to tell which river introduced the log in the ocean. It also tells when the tree died (naturally or by lumbering).

Annual distribution of driftwood by originating river will supply crucial information on historical shifts of the Transpolar Current and the dimensions of the Beaufort Gyre, and routing of minor currents within and between Barents, Kara, Laptev, and Chukchi seas.

Driftwood embedded in coastal sediments around the Arctic has particular significance for calibration of the radiocarbon scale. Currently the Holocene oak chronology and the Preboreal pine chronology established at Hohenheim University, Germany forms a 12,482 year tree-ring chronology, starting at 12,430 calendar years BP (AD 1950). A further 1673 years of floating chronology from southern Germany covers most of the Bølling-Allerød interstadial (ca. 14,400 to 12,800 cal BP, based on ^{14}C dating). The gap in the early Younger Dryas to the absolutely dated Hohenheim chronology is estimated to be less than 250 years.

We seek partners for driftwood studies around the Arctic.

PECULIARITIES OF THE ORGANIC MATTER IN THE MAIN TYPES OF QUATERNARY DEPOSITS ON THE LAPTEV SEA COAST.

A. L. Kholodov[1], B. N. Zolotareva[1], L. T. Shirshova[1], L. Schirrmeister[2]

1 Institute of Physical, Chemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Moscow region, Russia
(akholodov@issp.psn.ru)
2 Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany

In accordance with different estimations, the yearly input of organic carbon into the Arctic basin due to coastal erosion of the Laptev and East Siberian seas can be up to 1.8 million tons/year or more. But it is more important to know not only the total quantity but the quality (stage of transformation or degree of lability) of organic matter (OM) stored in eroded deposits. These characteristics vary in the different types of deposits.

Humus parameters and elementary composition of OM in the following types of quaternary deposits were investigated:

- Middle Pleistocene deposits characterised by the ratios of C/N 5-7,5 (syncryogenic) and 10-12 (epycryogenic).
- Late Pleistocene syncryogenic deposits composed by true syncryogenic deposits and buried soils. The former characterized by the C/N ratio 9-11 the later 12-16.
- Late Pleistocene-Holocene taberal deposits - 10-12.
- Holocene alas deposits - 10-12.

On the basis of these data, the following conclusion can be drawn. More transformed OM is in the buried soils and alas deposits. OM of syncryogenic deposits is most labile.

Analysis of humus content shows the following:

TOC and stage of organic matter transformation in the syncryogenic deposits depends on ratio of sedimentation and freezing rate. Decreasing of freezing rate leads to more deposition and to deeper transformation of OM.

Most transformed OM is in alas deposits and buried soils. About 20% of organic carbon presented by humus. Syncryogenic and taberal deposits are not so deep lytransformed (Humus content 15%). All types of investigated deposits characterized by the high content of unhumidized rest (80-85%).

Research was supported by RFBR (05-05-64062), INTAS (YS 04-83-2950) and a grant of President of Russia (MK-1136.2005.5).

TOWARDS A RECALCULATION OF CARBON RELEASE IN THE ARCTIC OCEAN BY COASTAL EROSION: THE INFLUENCE OF COASTLINE FRACTALITY

H. Lantuit[1], V. Rachold[2], H.-W. Hubberten[1], W. H. Pollard[3], F. Steenhuisen[4], N. Couture[3]

1 Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany (hlantuit@awi-potsdam.de)
2 International Arctic Science Committee Secretariat, Stockholm, Sweden
3 Department of Geography, McGill University, Montreal, Canada
4 Arctic Centre, University of Groningen, Groningen, Netherlands

Arctic coasts are subject to intense erosion during the few months of the open-water season. Coastal erosion is expected to strongly increase with changing environmental conditions in the Arctic. The ACD (Arctic Coastal Dynamics) project aims at quantifying the current and future release of terrigenous carbon by coastal erosion in the circum-arctic. It relies on global geospatial coastline datasets to compute accurate carbon output numbers. However, the inconstant quality of these datasets is a great challenge to the expected accuracy.

It has long been known that the length of a given section of coastline increases with increasing resolution of measurement. This is termed the fractal property of a shoreline. Similarly, there exist multiple spatial and temporal scales of geomorphic activity on coasts. The given spatial scale at which a vectorized line delineates the coastline is therefore inherently attached to the geomorphic processes which operate within this spatial scale. Choosing a specific coastline dataset to investigate rates of erosion and erosion outputs means that a geomorphic process is preferentially emphasized which can prove problematic in systems operating at multiple scales such as the coastal one. It also means that erosion outputs (i.e. volumes), which are generally computed using the length of the coastline, are also tacitly associated with a specific spatial scale, that is, with the geomorphic processes taking place at these scales. Any volume loss estimation from the coasts will thus always be relative. It seems nevertheless necessary to provide the scientific community with numbers, especially at the global scale to compare sources/sinks of sediments from different types of environments. We therefore ask the question: Which scale is relevant to the calculation of volumes eroded form the coasts? Is it dependent on their lithological nature? On their morphology? Or is it intrinsically bound to the nature of the dynamics affecting the surfzone and/or the shoreface?

We provide an example taken from the Arctic Coastal Dynamics online Geographical Information System, a circum-arctic inventory of coastal environments with specific emphasis on the geomorphological description of the coastal tract and the carbon contents of the subaerial coastal units.

ADVANTAGES OF VARIOUS LAND-BASED METHODS TO STUDY DYNAMICS OF THE ICE-BEARING COASTS

M.O.Leibman[1], A.V.Khomutov[1], G.A.Cherkashev[2], B.G.Vanshtein[2]

1 Earth Cryosphere Institute SB RAS, Tyumen-Moscow, Russia, mleibman@online.ru

2 FGUP VNIIOceangeology, St-Petersburg, Russia

Studies at the Kara sea coast of Yugorsky peninsula (Fig. 1) were carried out since 1998. In 2001, accurate tacheometric survey was undertaken along the bluff edge and shoreline as well as measurements along transects. Repeated tacheometry allowed better evaluation of coastal retreat related to yearly climate fluctuations.

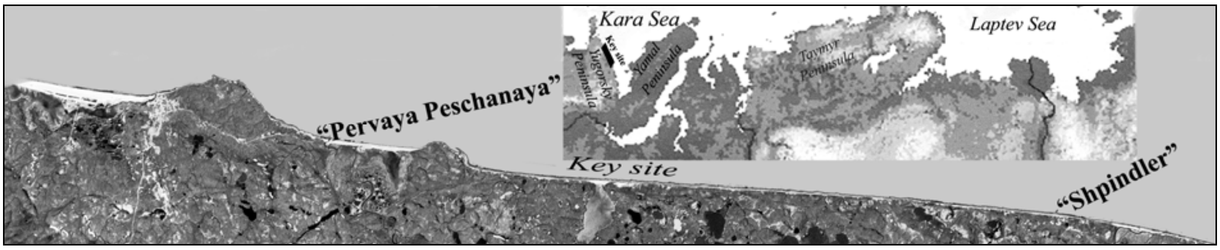


Figure 1. Study area.

Study area is noted for wide distribution of massive (tabular) ground ice (Leibman et al., 2003). Thus substantial portion of the coast is represented by thermocirques and thermoterraces (coasts of thermodenudation type). Thermodenudation coasts have two retreating planes and respective edges: thermocirque/thermoterrace back wall (retreating "upper" edge), and drop wall to the beach (retreating "lower" edge).

Our observations during 1998-2005 had shown that lower edge retreat was minimal. Boat trip along the coastal line didn't show any niches or failures, except several thermodenudation cirques. A trip of summer 2003 indicated increase of a number and size of thermodenudation cirques and thermoterraces (Kizyakov et al., 2003). But climatic events of spring-summer 2006 changed the rate of the process, especially in the drop wall along entire 43 km of the shoreline observed.

Main results are shown in tables 1 and 2. Table 1 (Kizyakov, 2005 with additions) shows relation of retreat rate on air temperature fluctuations. Calculations indicate that maximum retreat rate depends directly on degree-days. Each period of measurements is characterized by about 0,8-0,9 cm of retreat per one degree-day of summer temperature.

When comparing tables 1 and 2 one can see that at "Shpindler" Central thermocirque retreat rate is practically the same for the period 2005-2006. But this key site is characterized by less retreat rate compared to "Pervaya Peschanaya" key site. While transects cover several hundred meters and are fixed to the specific portion of the coast, survey is more flexible and efficient to cover more than a kilometer in few days. Due to tacheometry we measured coastal retreat at the peripheral portions of the key site where retreat the last few years had exceeded those measured along the transects.

Table 1. Shpindler monitoring site, Yugorsky peninsula, Russia. Thermocirque backwall retreat in relation to thaw index.

Period between measurements	Thermocirque backwall retreat, m		Days between measurements	Days with positive air temperature	Thaw index (TI), degree-days/TI per day
	Max	Average			
16.09.2001 – 10.08.2002	3,4	1,6	328	77	398,4/5,2
10.08.2002 – 22.08.2003	5,8	4,2	377	122	755,2/6,2
22.08.2003 – 05.08.2005	13,3 (6,35 m/yr)	7,65 (3,83 m/yr)	714	252	1401,9/5,6
05.08.2005 – 28.07.2006	7,55	3,74	358	120	839,3/7

Table 2. Retreat rate of the bluff edge at key sites “Shpindler” and “Pervaya Peschanaya”, Yugorsky Peninsula in 2001-2006.

Key thermocirques	Area of retreat, m^2			Average linear retreat, m area/2001 bluff edge length			Maximum retreat, m measured between edges		
	2001-2005/ annual	2005-2006	2001-2006/ annual	2001-2005/ annual	2005-2006	2001-2006/ annual	2001-2005/ annual	2005-2006	2001-2006*/ annual
Shpindler, Central	3723/ 931	1203	4924/ 985	14/3,5	4	18/3,6	19/3,8	8	24/4,8
Shpindler, Eastern	713/ 178	212	957/ 191	4/1	1	6/1,1	18/4,5	6	20/4
Pervaya Peschanaya, Eastern	5938/ 1485	2822	8757/ 1751	14/3,5	5	21/4,1	30/7,4	12	32/6,4
Pervaya Peschanaya, Western	7060/ 1765	6337	13340/ 2668	18/4,5	10	35/6,9	36/9	53	57/ 11,4

* Total retreat is not equal to the sum of annual retreats because year to year maxima are found at various locations of the bluff edge.

Analysis of table 2 indicates that maximum annual retreat rate for the period 2001-2006 is observed at Pervaya Peschanaya and ranges at 10 m average up to 53 m annual maximum. In 2005-2006, average retreat rate at all sites was very close to the average in 2001-2006, but maximum rates in 2005-2006 were much higher than average maximum in 2001-2006. Extremes of 2005-2006 were not only due to the high summer temperature (see table 1, thaw index per day), but also because of strong wave uprush, which was observed for several weeks while in field. The lower edge started retreating fast, niches were formed, rock falls occurred, and ice exposures appeared at formerly stable slopes (Fig. 2).

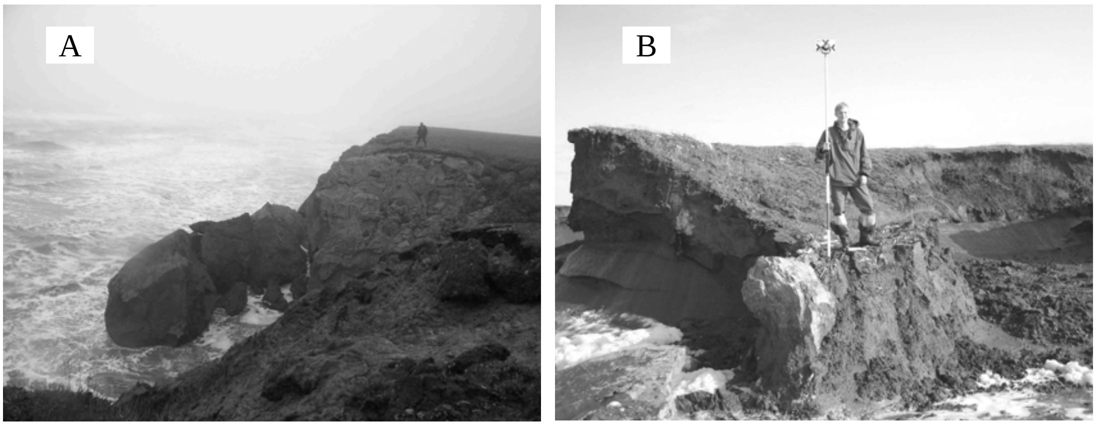


Figure 2. Kara sea coast, Yugorsky peninsula, the wave uprush. The key site “Shpindler”, frozen blocks failure (A), and the key site “Pervaya Peschanaya”, tabular ice at the base of the coastal bluff (B).

The wave uprush can be explained by two interrelating factors. Sea ice coverage reduces in spring-summer since 2001 as follows from (Fetterer & Knowles. 2002), and maximum wind speed and frequency in summer 2006 (Fig. 3) that was observed for the winds of northern rhumbs, almost perpendicular to the shoreline (see Fig. 1).

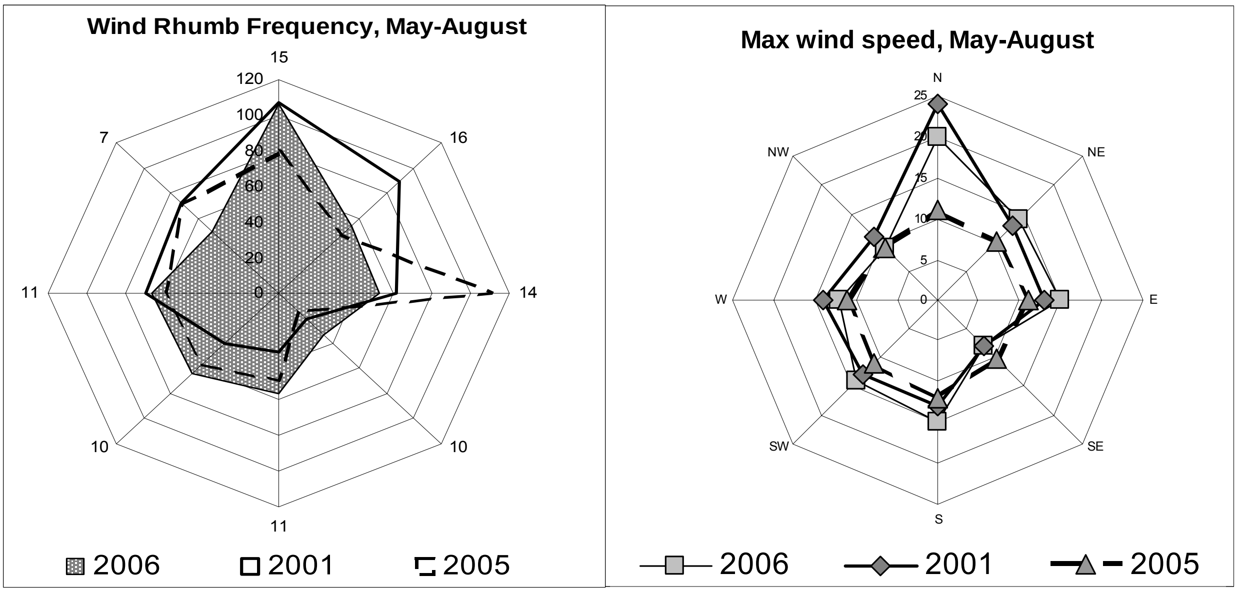


Figure 3. Wind direction and speed in summer 2005 and 2006 (data from Russia's Weather Server “Weather Archive” (www.infospace.ru, weather station Amderma)

Overview of the coastal bluffs, thermocirques/thermoterraces and thermoerosion coasts, during 6 years of key-site and long-shore observations showed the following. There were 2 periods of the active coastal destruction. Summers of 2000 and 2001 were noted for exposing tabular ground ice at Eastern (2000) and Western (2001) thermocirques of “Pervaya Peschanaya” key site. Note also strong northern winds in 2001. Summer of 2006 changed the whole coastal type structure. Most of the stable dry gentle slopes as well as lower portions of thermodenudation slopes turned into thermoerosional types with niches, block falls, cracks at the bluff edges which prepared continuous failures till the remaining summer months of 2006, and, probably, summer 2007.

Thus, rarely occurring summer wind events remodelled the coastal types and provoked thermoerosion at thermodenudation coasts of the Kara Sea. In the areas with tabular ground ice distribution, two commonly subdivided types of coasts: thermoerosional and thermodenudational, can not be applied. Any portion of the coastal line in a short-term dynamics under the climate fluctuations can not only be transformed into actively retreating from stable, but also into the different type, or even into combined type existing within one time slice. The last is observed when the “upper” edge is retreating according to thermodenudation pattern, while the “lower” edge is thermoerosional. Studying the effect of such short-term events as wave uprush was made possible by land-based observations and recurring tacheometric survey.

References

Fetterer, F., Knowles, K., 2002, updated 2006. *Sea ice index*. Boulder, CO: National Snow and Ice Data Center. Digital media, www.nsidc.org.

Kizyakov, A. I., 2005. The dynamics of the thermodenudation processes at the Yugorsky peninsula coast. *Earth Cryosphere* (Kriosfera Zemli) IX (1): 63-67 (In Russian).

Kizyakov, A. I., Perednya, D. D., Firsov, Yu.G., Leibman, M. O., Cherkashov, G. A., 2003. Character of the coastal destruction and dynamics of the Yugorsky peninsula coast. *Reports on Polar and Marine Research.* 443: 47-49.

Leibman, M. O., Hubberten, H.-W., Lein, A.Yu., Sterletskaya, I. D., Vanshtein, B. G., 2003. Tabular ground ice origin in the Arctic coastal zone: cryolythological and isotope-geochemical reconstruction of conditions for its formation. In: *Permafrost* (M. Phillips, S.M. Springman, L.U. Arenson, eds.)/Proceedings of the 8th International Conference, Zürich 21-25 July 2003. - Lisse, Netherlands: A.A. Balkema Publishers, 2003 V.1, -P.645-650.

FIFTY-FOUR YEARS OF SHORELINE CHANGE ALONG THE CHUKCHI SEA NEAR BARROW, ALASKA

Leanne R. Lestak[1], William F. Manley[1], Cove M. Sturtevant[2], James A. Maslanik[3]

1 INSTAAR, University of Colorado, Boulder, Colorado, USA
(Leanne.Lestak@colorado.edu)
2 GCRG, San Diego State University, San Diego, California, USA
3 Aerospace Engineering, University of Colorado, Boulder, Colorado, USA

There has been increasing interest in processes affecting Arctic coastlines, including shoreline change, flooding and sediment loading. Isolated coastal communities are more vulnerable as populations expand and climate changes. Documenting and understanding spatial and temporal variability in change rates are increasingly attainable as high-resolution imagery becomes available, and as GIS and remote-sensing tools are more widely accepted. This study presents such an analysis for 32 kilometers of the Chukchi coastline near Barrow, Alaska. Barrow is a key site with the Arctic Coastal Dynamics program. Coastal areas at this latitude are protected by sea ice approximately 9 months of the year. GIS and surveyed shoreline data were utilized for a quantitative analysis of coastline and bluff change. The geospatial data include: a high-resolution (0.7 m) QuickBird satellite image, a corresponding elevation model, and radar image (5 m) for 2002; rectified aerial photography from 7 time slices (1948, 1955, 1962, 1964, 1979, 1984 and 1997); and GPS shorelines for 5 days in 2001. Environmental forcing and human impact drive coastal change in the Barrow area. The long-term mean shoreline erosion rate is -0.05 m/yr. Inter-year mean change rates vary from -1.0 m/yr (erosion) to 1.41 m/yr (accretion). Bluff top long-term average erosion rates are –0.21 m/yr. Direct impacts include decrease of beach width, flooding, and loss of buildings and critical infrastructure in eroded areas. The coastal system appears to be sensitive to the frequency and intensity of storm events, increasing temperatures, permafrost melting, sea-level rise, and increasing length of the summer ice-free season.

HIGH-RESOLUTION RECTIFIED AERIAL PHOTOGRAPHY FOR COLLABORATIVE RESEARCH OF ENVIRONMENTAL CHANGE AT BARROW, ALASKA

Leanne R. Lestak[1], William F. Manley[1], Cove M. Sturtevant[2], James A. Maslanik[3], Craig E. Tweedie[4], Jerry Brown[5]

1 INSTAAR, University of Colorado, Boulder, Colorado, Colorado, USA (Leanne.Lestak@colorado.edu)
2 GCRG, San Diego State University, San Diego, California, California, USA
3 Aerospace Engineering, University of Colorado, Boulder, Colorado, USA
4 Department of Biology, The University of Texas at El Paso (UTEP), El Paso, Texas, USA
5 International Permafrost Association, Woods Hole, Massachusetts, USA

This dataset contains 74 geocorrected frames of aerial photography acquired for the Barrow area, an Arctic Coastal Dynamics (ACD) program key site, on 4 August 1948, 29 July 1949, 12-14 August 1955, 12-14 August 1962, 14 July 1964, 15 July 1979, 31 August 1984 and 16 July 1997 (Table 1). The original 9" x 9" black and white, true color and color infrared aerial photograph negatives and prints were scanned. Each frame was then georectified using a polynomial transformation with image-to-image control points taken from 2002 QuickBird satellite imagery (Manley *et al*., 2006). The frames are projected to UTM zone 4 using the NAD83 datum, with a horizontal resolution of at least 0.5 m, and are distributed in GeoTIFF format. The 1979 photo frames were orthocorrected using control points from the 2002 QuickBird imagery and the corresponding Interferometric Synthetic Aperature Radar digital surface model (5 m horizontal resolution) (Manley *et al*., 2005). Photograph index maps are shown in Figure 1. Digital geocorrected photographs serve a variety of purposes, from interim maps to the basis of observation and analysis for earth science investigations. These digital geocorrected images are useful as layers within a geographic information system. The National Snow and Ice Data Center, http://www.nsidc.org, located in Boulder Colorado, will distribute the 2 DVD dataset.

Table 1. Details of geocorrected aerial photographs.

Date of Imagery	Scale	Source	Type	DPI	Horizontal Resolution (meters)	# of frames in Dataset
4 Aug 1948	19,200	Navy	B/W	1000	0.5	5
29 Jul 1949	10,000	Unknown	B/W	615	0.5	1
12 Aug 1955	51,000	USGS	B/W	1000	1.4	20
12-24 Aug 1962	5,000 10,000 21,600	CRREL	B/W	1000 1000 1200	0.1 0.3 0.5	17
14 Jul 1964	10,000	CRREL	B/W	600	0.35	11
15 Jul 1979	65,000	NASA	CIR	1800	2	6
31 Aug 1984	12,000	Aeromap	Color	635	0.5	8
16 Jul 1997	12,000	Aeromap	Color	635	0.5	6

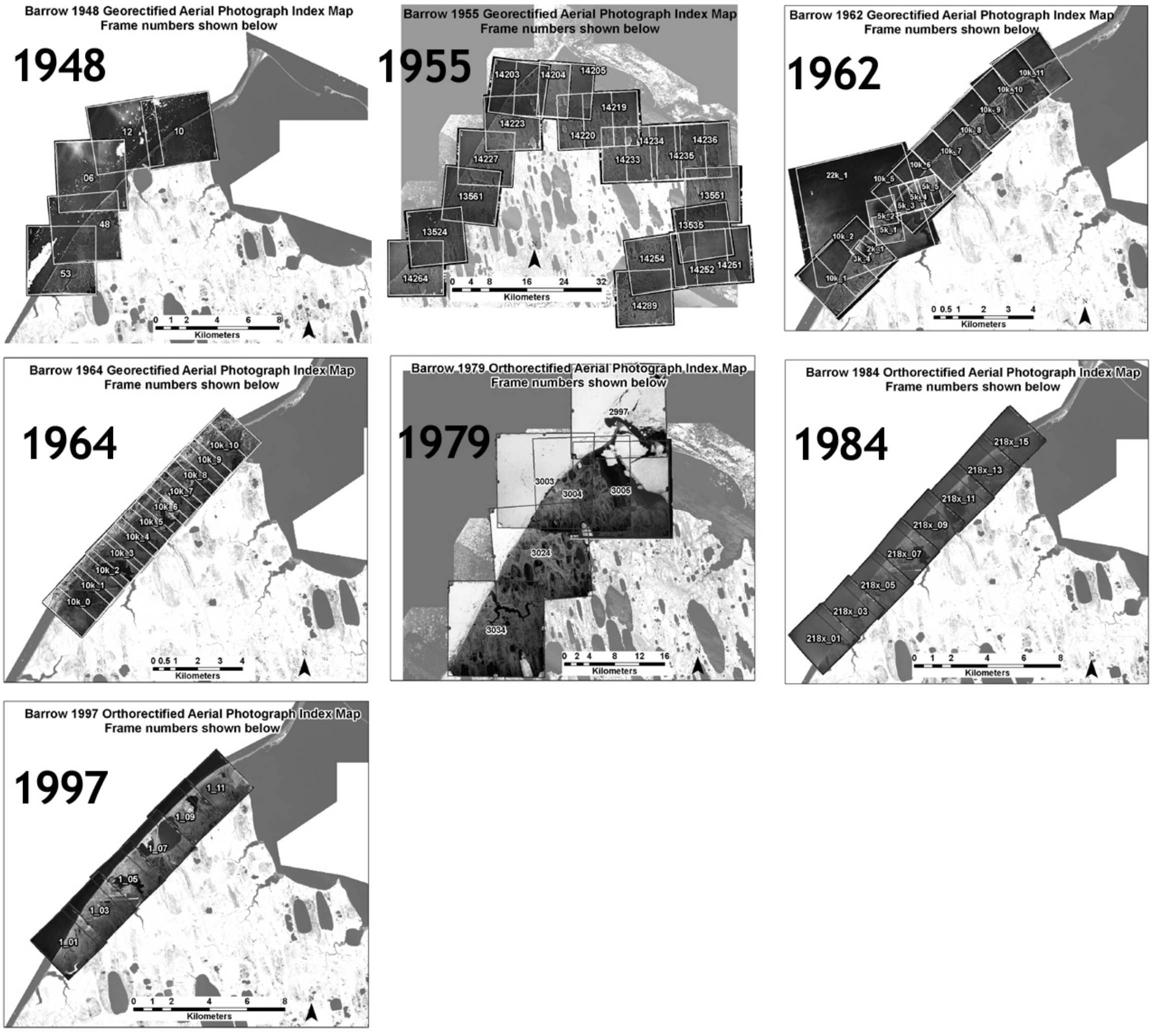


Figure 1. Geocorrected aerial photograph index maps.

References

Manley, W. F., Lestak, L. R., Tweedie, C. E., Maslanik, J. A., 2006. High-Resolution Quickbird Imagery and Value-Added Geospatial Layers for Collaborative Research of Environmental Change at Barrow, Alaska. Boulder, CO: National Snow and Ice Data Center. Digital media.

Manley, W. F., Lestak, L. R., Tweedie, C. E., Maslanik, J. A., 2005. High-Resolution Radar Imagery, Digital Elevation Models, and Related GIS Layers for Barrow, Alaska. Boulder, CO: National Snow and Ice Data Center. Digital media.

THE HYDRO-METEOROLOGICAL FACTORS OF ARCTIC COASTAL DYNAMICS

Alexander Makarov

Arctic and Antarctic Research Institute, St. Petersburg, Russia
(makarov@aari.nw.ru)

In this study the current questions of Russian Arctic coastal dynamics are taken up with respect to hydro-meteorological factors. We introduce a hydro-meteorological index which describes the duration of coastal destruction. Maps of the spatial distribution of this factor in the Russian Arctic coastal zone were created. This index gives the duration of the ice-free period or the period during which the ice cover occupied less than 50% of ocean surface. The map of the duration of the period when fast ice has disappeared and the role of fast ice in coastal dynamics is described. A map of the coastal dynamics of the Russian Arctic Seas shows coastal types, recession rates and rates of modern changing sea level and reveals the influence of modern sea level fluctuations on the coastal dynamics of the Russian Arctic. The classical model of coastal formation during sea level fluctuations according to Leont'ev has been supplemented with new and summarized observations from the Russian Arctic coast. In areas with decreasing modern sea levels, the abrasion rates are 2-3 times slower than in regions with modern increasing sea level.

GIS-BASED MEASUREMENT OF COASTAL CHANGE IN THE SOUTHEAST CHUKCHI SEA, ALASKA

William F. Manley[1], Diane M. Sanzone[2], James W. Jordan[3], Owen K. Mason[4], Eric G. Parrish[1]

1 INSTAAR, University of Colorado, Boulder, Colorado, USA
(William.Manley@colorado.edu)
2 Arctic I&M Program, National Park Service, Fairbanks, Alaska, USA
3 Antioch University New England, Environmental Studies, Keene, New Hampshire, USA
4 GeoArch Alaska, Anchorage Alaska, USA

Coastal environments at high latitudes are experiencing rapid change. Coastal erosion threatens a variety of nearshore marine, terrestrial, and freshwater habitats, and may be accelerating with Arctic warming. To better understand impacts for national parks in northwestern Alaska, a collaborative study has begun to document coastal change in the southeast Chukchi Sea. The comprehensive geospatial study includes: creation of a high-resolution (0.6 m) orthophoto mosaic for 2003; rectification of historic aerial photography from ca. 1950 and ca. 1980; and quantitative analysis of coastline and bluff erosion. For Bering Land Bridge NP and Cape Krusenstern NM, the GIS analyses quantify complex spatial and temporal variability tied to environmental forcing, as well as a dynamic range of coastal morphologies and processes. The geospatial analysis documents that most of the ca. 400-km-long coast from Wales to Kivalina has experienced erosion in the past five decades, with long-term average rates of 0-3 m/yr. Direct impacts include beach and bluff retreat, overwash deposition, migration or closure of inlets and lagoons, capture of thaw-lake basins, and release of sediment and organic carbon to nearshore waters (see Figs. 1-3). Observations of shrub expansion and thermokarst degradation are also consistent with rapid change. Coastal ecosystems in the region appear to be sensitive to the frequency and intensity of storm events, increasing temperatures, permafrost melting, sea-level rise, and increasing length of the summer ice-free season.

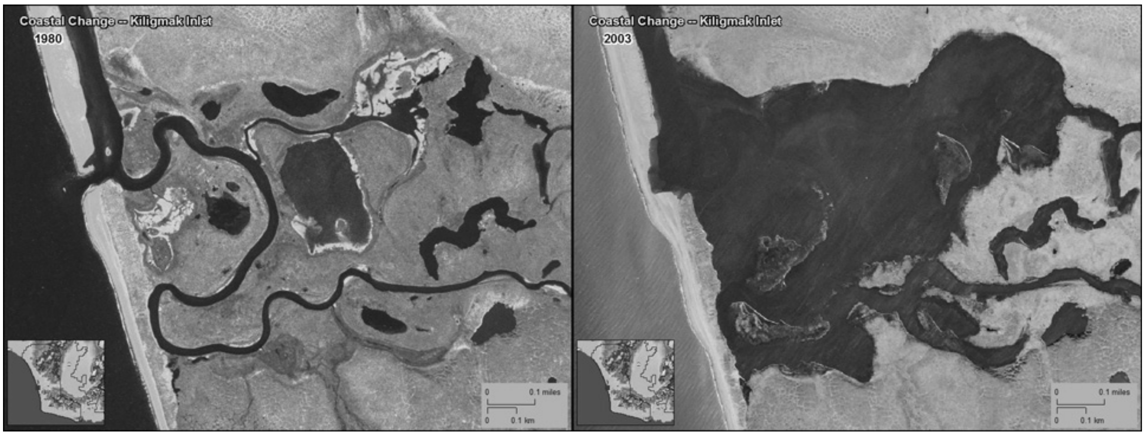


Figure 1. Flooding of Kiligmak Inlet, in Cape Krusenstern National Monument. The infra-red aerial photograph at left shows the creek, inlet, and surrounding tundra as they existed in 1980. The same area in 2003 is shown at right, after a storm moved sand and gravel across the inlet, forming a new lagoon, and flooding the tundra. The new lagoon is about 0.5 km wide.

Figure 2. An eroding bluff in Cape Krusenstern National Monument. This high bluff – made of unconsolidated silt, peat, and ground ice – is rapidly slumping and eroding into the Chukchi Sea. Orthorectified aerial photography shows that the bluff eroded about 33 m from 1980 to 2003.

Figure 3. An eroding bluff near Bering Land Bridge National Preserve that threatens archeological sites. The prehistoric remains of pit houses – with centuries-old artifacts – lie at the edge of the bluff in the background. Coastal erosion is causing the loss of cultural resources throughout the region.

APPLYING GIS TECHNOLOGIES FOR AN INVESTIGATING OF BAYDARATSKAYA BAY COASTAL DYNAMICS

Noskov A.I., Ogorodov S.A., Kamalov A.M.

Faculty of Geography, Lomonosov Moscow State University

Modern geoinformation technologies are used at studying dynamics of coast of the Baydaratskaya Bay, Kara Sea (Fig. 1). It has allowed to systematize the data received during 18 years, and to deduce researches on essentially new level.

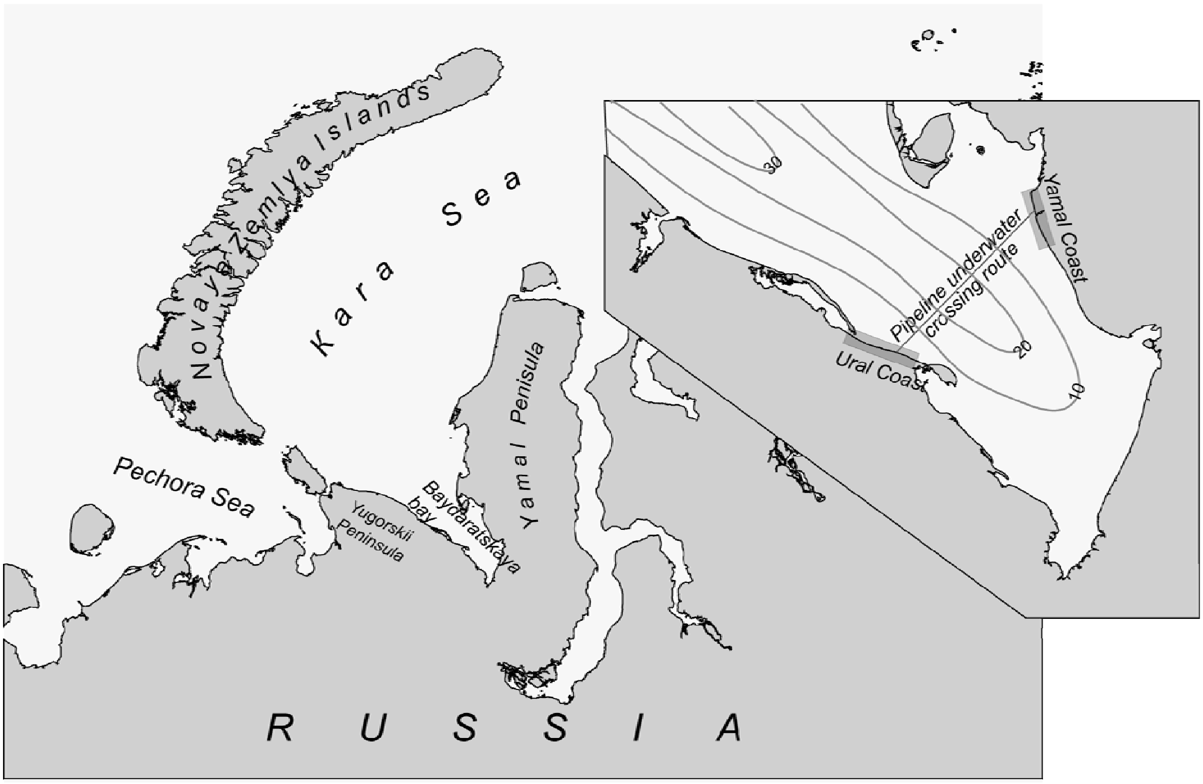


Figure 1. Location of research area.

Monitoring of dynamics of the coast is conducted in transition area of a prospective gas pipelines since 1988. Observations on coastal dynamics are based on the permanent monitoring network which consists from a number of benchmarks. There are 30 profiles on the Ural Coast and 20 profiles on the Yamal Coast.

The significant part of coastal investigations is carried out using reflectorless total station. At first scheduled coordinates and heights of reference points of a network are defined. The received values are compared with last year's ones to control the changes in position of the profiles. The following stage of the work is construction of profiles by a method of trigonometric leveling. In 2006 the network has been incorporated and the thermocirques dynamics monitoring which will be carried out on the basis of repeated construction of 3D models (see Belova et al.) began.

On the basis of long-term research the GIS of dynamics of the coast is developed. GIS is submitted by two levels: actual and synthetic. The first level (actual) is the big data file, collected during 18 years. It includes the data about the site of reference points, the results of leveling on the profiles, the granulometric data for profiles deposits. The second level is based on the allocated homogeneous coastal segments. On the basis of this GIS the maps of coastal retreat rate monitoring have been created. There are maps of dynamics of the coast and maps of litho-dynamic characteristics of coasts (Fig. 2).

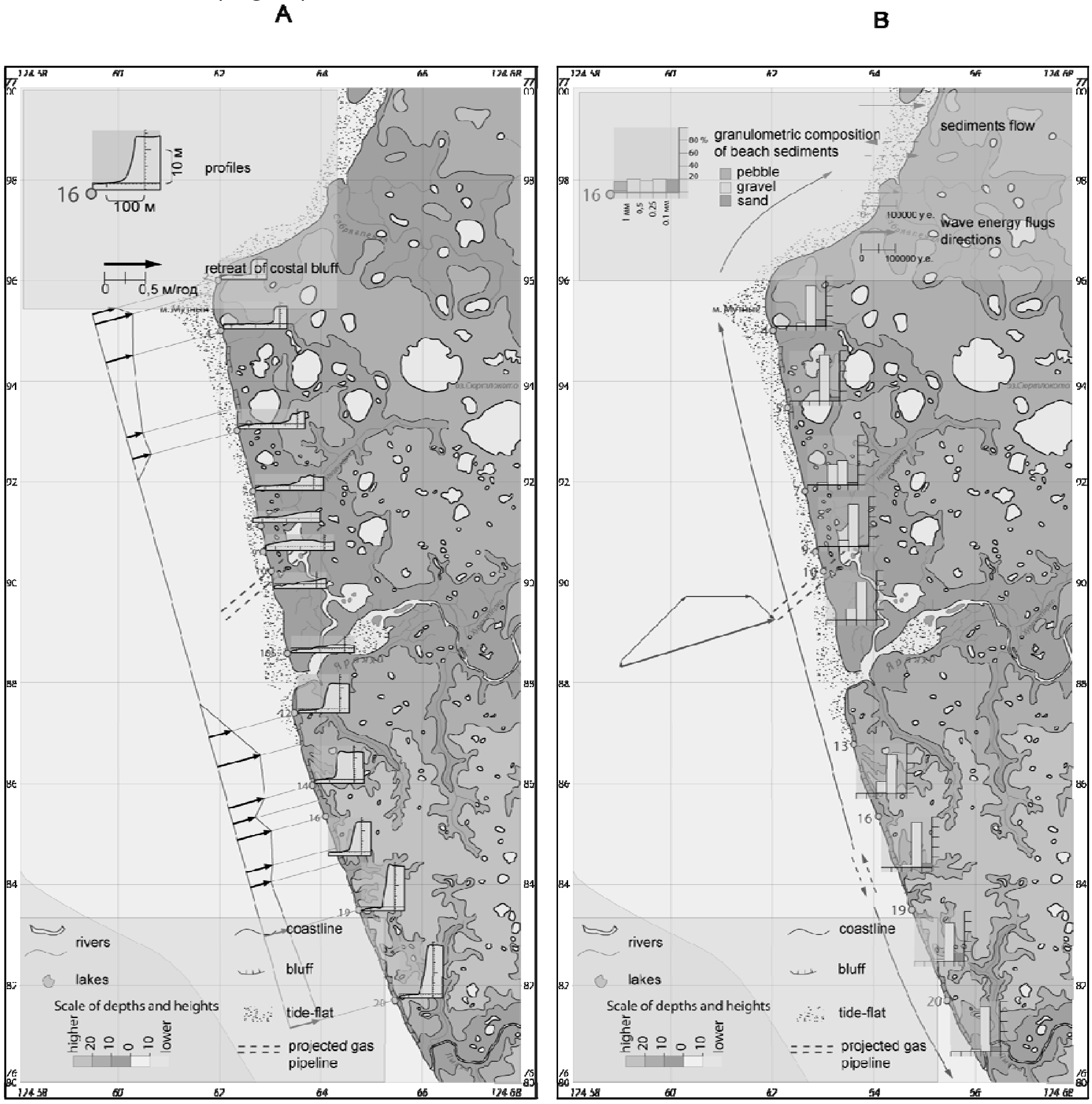


Figure 2. Examples of the maps (Yamal Coast): (1) The map of coastal dynamics, (2) The map of litho-dynamics characteristics.

Thus, on the basis of long-term researches of dynamics of the coast it has been created GIS in which the data were systematized, a series of maps of coastal retreat rate monitoring are created, three-dimensional models of thermocirques are constructed.

THE ARCTIC CIRCUM-POLAR COASTAL OBSERVATORY NETWORK

P. P. Overduin

Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany

As part of the International Polar Year (IPY), a circum-polar network of standardized monitoring sites is being planned to measure and track coastal processes in order to monitor the Arctic coastal zone and better understand responses to environmental changes. It represents the only coastal network of observatories in the list of 50 currently operating and 44 planned Arctic networks. The IPY-approved coordination project *Arctic Circum-Polar Coastal Observatory Network* (ACCO-Net; IPY full proposal ID 90) proposes an internationally coordinated circum-Arctic network of coastal and marginal seas observatories (~40 key sites including deltas and estuaries of major Siberian and North American rivers) based on historical records, community proximity and eco-region representation criteria.

The circum-Arctic coastal key sites established within the Arctic Coastal Dynamics (ACD I) project formed the initial set of ACCO-Net sites and thus include representatives from Canada, Denmark, Germany, the Netherlands, Norway, Russia, and the United States. National-level observatory IPY proposals for coastal sites are currently pending in Canada, the US and Russia. High spatial resolution optical imagery has been applied for through the European Space Agency's IPY program for forty-one locations and for both IPY years.

Thirteen additional projects in the ACCO-Net cluster of IPY proposals include student outreach projects, riverine transport and inputs to the Arctic seas, health issues surrounding methyl mercury, Greenland sea levels, Russian cryolithozone studies and ocean modeling. River monitoring stations installed at down-stream locations on the six largest rivers draining the pan-Arctic watershed (Yenissey, Lena, Ob, Kolyma, Yukon, Mackenzie) as part of the NSF-ARCSS Freshwater Initiative (FWI), and the pilot version of the Hudson Bay Complex Observatory (MERICA) are being considered as additional observatory locations. Co-ordination with other International Permafrost Association projects increases the reach of the observatory network.

Great challenges lie ahead to create an operating network that will persist beyond IPY to form the sort of legacy identified as a goal of the ICARP II Coastal Working Group science plan. These include the identification of currently operating site resources and the definition of a coastal monitoring template with a roster of necessary and sufficient observation parameters. This template is a focus and product of the current workshop. Further discussion needs to centre on identifying ways of creating observatories relevant to people in coastal regions. Our goal is to coordinate with local communities and build upon existing monitoring programs and data availability.

COMPLEX RESEARCH OF COASTAL AND BOTTOM DYNAMICS AT PIPELINE UNDERWATER CROSSING ROUTE IN BAYDARATSKAYA BAY OF KARA SEA

S.A. Ogorodov[1], A.S. Tsvetsinskiy[2]

1 Faculty of Geography, Lomonosov Moscow State University, Leninskie Gory, Moscow 119992, Russia
2 State Oceanographic Institute, Kropotkinskii pereulok 6, Moscow 119034, Russia

The Northern-Europe Gas Pipeline must directly connect Russia and Germany through the bottom of Baltic Sea by 2010. To provide gas for this pipeline, the Yamal-Europe pipeline design project, whose lines would cross the Baydaratskaya Bay of Kara Sea (Fig. 1), was renewed.

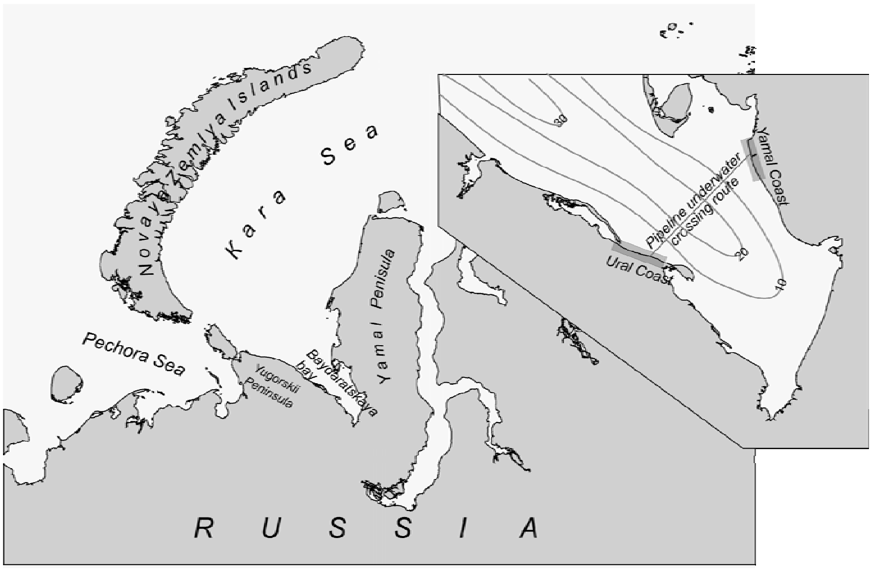


Figure 1. Location of research area.

Coastal and seabed dynamics is one of the most important factors that determine selection of the site of pipelines crossing from the offshore slope to the land, method and a value of pipeline deepening.

Laboratory of geoecology of the North, Faculty of Geography, MSU was carrying out permanent stationary observations on coastal and seabed dynamics of Baydaratskaya Bay during 1988-1997. Since 2005 in connection with renewing of the project the investigations on coastal zone dynamics was continued. In August-September 2006 the joint expedition of State Oceanographic Institute and Faculty of Geography, MSU had been carried out. Investigations were held on Yamal and Ural coasts and research vessel “Ivan Petrov” (Fig. 2) concurrently and included the following:

- repeated observations on coastal bluff retreat rate,
- geodesic and DGPS measurements,

- lithological-geomorphological researches,
- estimation of cryolithological composition and presence of massive ice beds influence on coastal dynamics,
- determining of granulometric composition of bottom and beach sediments,
- survey of depths on underwater slope (up to 7 m depth),
- characterization of ice gouging forms (Fig. 3) in the bottom relief (sonar survey, echolocation, photography and video filming),
- hydrological researches on water area (drift and direction of currents, temperature, salinity, turbidity, suspended sediments content, clarity),
- observations on water level and waves,
- meteorological observations (air temperature and humidity, atmosphere pressure, direction and force of wind).

Figure 2. Research vessel “Ivan Petrov”.

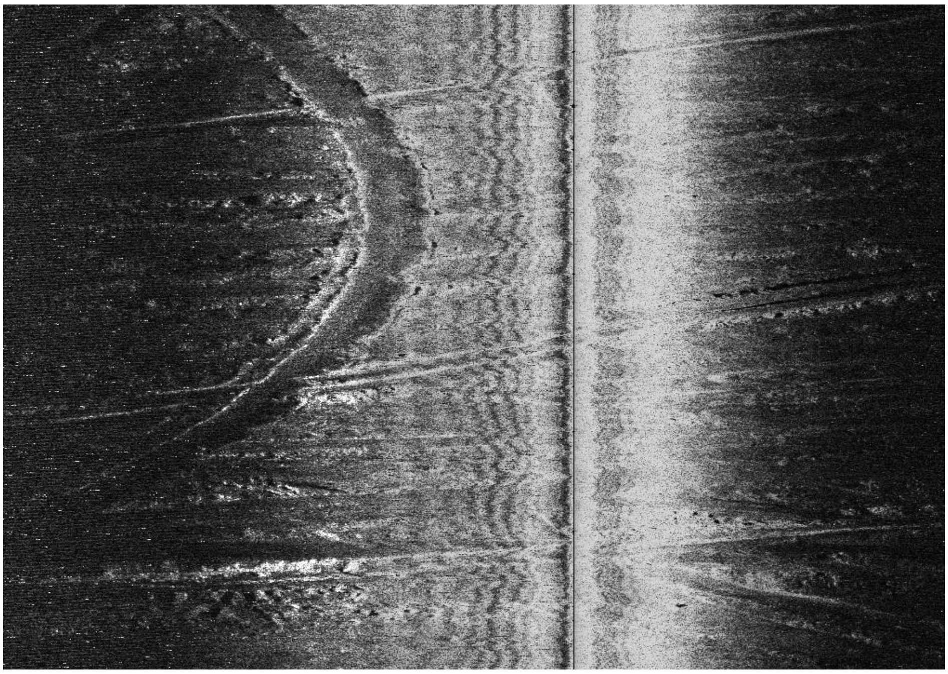


Figure 3. Ice gouges on the bottom of Baydaratskaya Bay.

Performed investigations permitted to get an accurate understanding of coastal and bottom dynamics of Baydaratskaya Bay, which is necessary for making designed decisions about pipeline laying and ensuring of environment protection.

THE COASTAL MONITORING AT THE SITE CAPE MALII CHUKOCII, EAST SIBERIAN SEA

V. Ostroumov[1], D. Fyedorov-Davydov[1], V. Sorokovikov[1], A. Kholodov[1], S. Gubin[1], D. Gilichinsky[1]

1 Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Moscow region, Russia
(v.ostroumov@rambler.ru)

The coastal monitoring site Cape Malii Chukocii is located in a Western part of the Kolyma Gulf shore, East Siberian Sea. The continuous permafrost takes place in a region. The Cape is a part of the neo-tectonically elated segment which stretches from dry land into the continental shelf. Two following type of deposits are presented in the cliffs here: the upper pleistocene syngenetic permafrost sediments of the ice complex (i), and secondary frozen taberal deposits (ii). The typical thermal abrasion cliffs are characteristic for the Cape Malii Chukocii. Also the coasts with the circus of the thermal erosion take place at the coasts with both ice complex and taberal deposits. The thaw slumping also permafrost massif falling (up to 300 – 450 m^3 of ground volume) destroys the ground at the sites with the cliff forming coast. The wave niches are typical for such sites too. The main ground destroying processes are thermal erosion and active layer failure at the sites with the circuses. A wide sallow strip takes place onshore around the cape. Very small sea bottom inclination hampers the sub sea run off of the material into the sea basin. The coastal dynamic monitoring was carried out at the Cape Malii Chukocii at three observing profiles during 1980 – 1998. The extended net of monitoring profiles is used after 1998. Twelve profiles of the extended net make in possible to obtain information about the peculiarities of the coastal dynamics under the different condition of the coastal erosion. New measurements were carried out in the 2006 field season at the Cape Malii Chukocii coastal monitoring site according to the ACD monitoring program. The data analysis shows that relation between input and run off of the sediment controls the dynamics of the coastal line at each profile.

SIMULATION OF THE COASTAL LINE DYNAMICS USING THE SEDIMENT TRANSFER MODEL

V. Ostroumov

Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Moscow region, Russia
(v.ostroumov@rambler.ru)

The coastal monitoring data show that the dynamics of coastal line is controlled by the relation between the intensity of the sediment input and sediment run off at the coastal line in permafrost regions. The sediment input flux to the coastal line is formed by the permafrost erosion at the subaerial part of slope. The sub sea run off flux is directed from the coastal line into the sea basin. The sea bottom slope inclination is an important factor of the intensity of the sub sea sediment run off flux. The sea bottom slope inclination is determined by the thaw settlement during the sub sea permafrost degradation in the Arctic shore. The sediment transfer model is purposed to simulate the dynamics of both input and run off sediment fluxes. The interaction between the fluxes is described using the system of two sediment transfer differential equations. The coefficients in the equations reflect the natural and technogenic factors of the coastal line dynamics in the permafrost regions. The solution of the equation system is the dynamic functions of both input and run off fluxes. The velocity of the coastal line retreat is calculated as a function of the mentioned intensities. The numerical solution is found for the differential equation system. The values of the coefficients were computed using the coastal monitoring data at the site Cape Malii Chukocii, East Siberian Sea as an example. A comparison between the results of simulation and the data of coastal monitoring was carried out. The found good concurrence shows that the modeling approach based at the sediment transfer, can be used for simulation of the coastal dynamics in permafrost regions.

THINGS CHANGE, WE CHANGE: PLANNING FOR RESILIENCE IN THE CANADIAN ARCTIC

Kathleen Parewick

Department of Geography, Memorial University, St. John's, Newfoundland, Canada (paerewyck@hotmail.com)

How do human communities cope with change and uncertainty? What distinguishes the community that bounces back from hard knocks and the one that comes apart at the seams? Is there a formula for community resilience?

These questions are being addressed today by practitioners in a number of disciplines. Ecology, economic development, community health, disaster management – each field offers its own perspective on the theme of resilience. Coastal Arctic communities have another. People there are pursuing practical local solutions to current problems occasioned by rising sea levels, decreasing sea ice extent and duration, increased wave action, permafrost melting, unpredictable weather and other climate change-related impacts.

This project uses community land use planning process as a vehicle for examining climate change adaptation in four case study communities across the Canadian Arctic. Findings from related research are introduced as part of these exercises in order to integrate ongoing climate change science with local knowledge. Engaging community members in timely information-sharing, discussion, analysis and planning is the immediate objective of this research, with the longer-term goal being the fostering of social learning, institutional 'memory' and a more effective exercise of 'adaptive' planning to support and enhance community sustainability.

STRUCTURE OF LATE QUARTERNARY SEDIMENTS AND SUBMARINE PERMAFROST IN THE LAPTEV SEA: RESULTS FROM MULTICHANNEL SEISMIC SURVEY DURING EXPEDITION TRANSDRIFT X

T. Schwenk[1], V. Spieß[1], P. Rekant[2, 3], E. Gusev[2, 3], H. Kassens[4]

1 Dept. of Geosciences, University of Bremen, Bremen, Germany (tschwenk@uni-bremen.de)
2 Otto Schmidt Laboratory for Polar and Marine Sciences at the State Research Center for Antarctic and Arctic Research, St. Petersburg, Russia
3 VNIIOkeangeologia, St. Petersburg, Russia
4 Leibniz Institut fuer Meereswissenschaften (IfM-GEOMAR), Kiel, Germany

Beneath the Laptev Sea, a thick permafrost layer has developed during the last glacials since the now flooded shelf was exposed and not glaciated. The permafrost still exists today in a submarine environment after the last transgression. Even if the existence of the submarine permafrost is confirmed by drilling, the distribution of the permafrost and its possible degradation is only partially known. Therefore, high-resolution multi-channel seismic data were collected during Expedition Transdrift X carried out in September 2004 in a Russian-German cooperation between the GEOMAR (Kiel, Germany), the VNIIO (St. Petersburg, Russia) and the University of Bremen (Germany). As equipment, a Mini GI Gun and a new 48-channel streamer especially designed for shallow water operation were used. The main focus of the cruise was a seismically strong interface, which shape and scale seems to be similar to today's thermokarst landscapes of the Siberian coastlands. The strong reflection of the interface indicates the presence of frozen sediments and is therefore thought to represent the top of the submarine permafrost. The presence of gas in small patches is also suggested by the seismic data. West of the main study area, the permafrost reflector becomes prolonged, which may indicate the degradation of the permafrost and/or the presence of gas. East of the main study area we crossed a shallow bank characterized by parallel layered reflectors beneath a seafloor reflector of high amplitude. It is believed that this facies represents a sandbank which may have been the base of a former ice-complex island.

GIS-ORIENTED BATHYMETRIC AND BOTTOM TEMPERATURE MAPS OF BARENTS AND KARA SEAS

R. Shirokov

Earth Cryosphere Institute SB RAS, Moscow, Russia
(shirocov@gmail.com)

Mapping of the offshore and coastal permafrost is probably the main problem in the ACD Project. To solve part of this problem, we tried to make bathymetric and temperature GIS of costal and offshore permafrost in Barents and Kara Seas. These data were combined within a database (or GIS-system). Oceanographic sources are the main for these maps. Bottom temperature data presented in this GIS-system were collected by ocean research organisations in Russia, the USA, the United Kingdom, Germany, Norway, and Poland for the Barents, Kara and White Seas region. Recently declassified naval data from Norway, the USA, and the UK are also included. More than 1 000 000 oceanographic stations containing temperature and/or seawater salinity data were originally selected. After correcting errors and eliminating duplicates, data from 206 300 checked stations were placed in the map database. In addition, temperature and salinity measurements were interpolated to the following standard horizons: 0, 25, 50, 100, 150, 200, 250, 300 m, and bottom. This atlas covers the 100-year period from 1898 to 1998 and is, to date, the most complete oceanographic data collection for these Arctic shelf seas. This data set is complemented by more than 9 000 measurements of sea surface temperature, which were recently digitized from ship logbooks. They cover the same geographical area within the time period 1867–2004. This data helped in the creation of maps of depth and bottom temperature of the Barents and Kara seas. These maps form only a part of the GIS project.

ONE YEAR OF GROUND TEMPERATURE MEASUREMENTS FROM BENEATH BOTTOMFAST ICE, BEAUFORT SEA, CANADA

Steven Solomon[1], Dustin Whalen[1], Christopher Stevens[2]

1 Geological Survey of Canada (Atlantic), Dartmouth, Nova Scotia, Canada (solomon@nrcan.gc.ca)
2 Department of Geography, University of Calgary, Calgary, Alberta, Canada

Measurements of temperature variations beneath bottomfast ice (BFI) are important for improving our understanding of the viability of permafrost and associated sediment properties in the nearshore. Thermistor cables were installed beneath BFI in 4 boreholes in a transect extending from a distributary channel in the Mackenzie Delta across a nearshore shoal. Each thermistor cable included 8 thermistors with a dedicated logger. The cables and loggers were installed in PVC casing to a total depth of approximately 10 m below the seabed. Temperature at each thermistor was logged every 3 hours from April 2005 to March 2006. BFI thickness above the top of the casing varied from 5 cm to 105 cm. Where BFI was thinnest temperatures varied from -25ºC at the seabed surface to -6ºC at the base of the borehole in winter (summer temperatures varied from +10ºC to -4ºC). Temperatures at the base warmed slightly and, at the surface a 1.2 m thick active layer developed between June and September. Where BFI was thickest, sub-zero temperatures were confined to a depth of 3 m below the seabed during the winter months with complete thawing of the frozen surface layer by August. Temperature variations in the boreholes where BFI thickness was 30-70 cm were transitional between these two cases. These results demonstrate that ice-bonded permafrost can be maintained or aggraded where BFI thickness is 70 cm or less, but at BFI thicknesses greater than 100 cm permafrost is likely to degrade if present.

DETECTING SUBSURFACE ARCTIC COASTAL HAZARDS USING GROUND PENETRATING RADAR

Christopher Stevens[1], Brian Moorman[1], Steven Solomon[2]

1 Department of Geography, University of Calgary, Calgary, Canada (cwsteven@ucalgary.ca)
2 Geological Survey of Canada (Atlantic), Dartmouth, Nova Scotia, Canada

Numerous subsurface hazards along the coastal margin of the Mackenzie Delta have become problematic in conducting safe petroleum exploration. The ability to detect potential hazards is crucial to decision making processes that guide winter projects in this area. Four aspects of the coastal environment; ice morphology, ice movement, bathymetry and the thermal properties of sub-bottom sediments, can create hazardous conditions. Two Ground Penetrating Radar systems run simultaneously with 100 MHz and 250 MHz antenna frequencies were towed in tandem covering over 250 line kilometres. This acquisition technique proved useful to rapid data collection and acted to enhance subsurface interpretation. Profile interpretation relied on the recognition of recurring radar signatures defined by primary and secondary reflection patterns. Hazards relating to ice morphology are described as zones of floating and bottom-fast ice that are indicated by secondary radar reflections. Spatially, ice morphology in this region was shown to be highly variable. Potential ice collapse features relate to the occurrence of water lenses trapped within the ice mass that are formed from major ice movement, over ice flooding and subsequent downward freezing. Indications of minor ice movement (i.e. ice fractures and pressure ridges) were also detectable. Bathymetric hazards in regions of floating ice were found to result from the presence of a subaqueous channel ~50 m in width. Subsurface thermal structures pose a particularly serious hazard to the stability of developmental infrastructure and were delineated by a strong laterally continuous reflection. Mapping of these features provides for better understanding of arctic coastal hazards.

ORGANIC CARBON SPATIAL DISTRIBUTION IN QUATERNARY SEDIMENTS OF RUSSIAN WEST ARCTIC (FRESH DATA)

I. D. Streletskaya[1], A. A. Vasiliev[2], B. G. Vanstein[3]

1 Moscow State University, Department of Geography, Moscow, Russia (strelets@gol.ru)
2 Earth Cryosphere Institute SB RAS, Tyumen, Russia
3 All-Russian Research Institute for Geology and Mineral Resources of the World Ocean, St-Petersburg, Russia

Organic carbon accumulation in the marine environment is caused by the supply of sediments due to coastal erosion. The study of sections of the Quaternary sediments and sampling on organic carbon content have been carried out at eastern and western sectors of Kara Sea coast (table).

Organic carbon in clayey marine Middle and Late Pleistocene deposits presents mostly in adsorbed form. Its content corresponds in direct ratio with the content of clayey particles.

Adsorbed form of organic carbon in clayey marine sediments is very resistant to the environmental changes: organic carbon content does not change in the process of cryogenesis during the freezing-thawing cycles. Organic carbon content in thawed and consequently refrozen sediments shows no changes in comparison with original permafrost.

In Late Pleistocene the condition of organic carbon accumulation in the western sector of Kara Sea were more favorable than in the eastern sector. Besides the adsorbed form, the organic carbon in the clayey sections of this sector accumulated also in the form of plant detritus and even peaty layers.

The organic carbon accumulation in the contemporary littoral sediments is going in a different way. Organic carbon occurs here in the form of plant remains and pedogenesis products. The mean values of the organic carbon content were calculated for the various types of sediments wide-spread at the coasts of Kara Sea.

Table 1. Organic carbon content (Corg, %) in Quaternary sediments of Kara Sea coast.

Location	Age and genesis	Composition of the soil	Corg, %	Number of samples
Cape Shpindler (West)	m,gm II^{2-4}	Clay	0.7	12
Pshenichny stream, Krasny Yar, Cape Shaitanskii (East)	m,gm II^{2-4}	Clay	0.6	23
Marre-Sale Cape (West)	m III^{1-3}	Loam. Clay	1.0	62
Sopochnaya Karga Cape (East)	m III^{1-3}	Loam. Clay	0.8	14
Sopochnaya Karga Cape (East)	l III^{3-4}	Varved clay	0.7-1.5	3
Sopochnaya Karga Cape (East)	ds, a III^{4}-IV (ice complex)	Loamy sand	1.6-2.1	4
Marre-Sale Cape (West)	a III^{4}- IV	Sand	<0.1	6
Marre-Sale Cape (West)	am IV	Loamy sand Loam	0.5-2.5	4
Marre-Sale Cape (West)	m IV	Sand	<0.1	2

CHANGES IN SHORELINE MORPHOLOGY AND THAW DEPTHS ALONG BARROW STRAIT, NUNAVUT, CANADA (1974 TO 2005)

R.B. Taylor and D. Frobel

Geological Survey of Canada (Atlantic), PO. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2, Canada botaylor@nrcan.gc.ca

Abstract

In August 2005, changes in shoreline morphology and thaw depths were investigated at 14 monitoring sites along Barrow Strait, Nunavut, Canada. The changes observed at these sites since our last survey in 1992 are illustrated and compared with changes observed in the 1970s and 1980s.

Between 1992 and 2005, the largest morphological changes were recorded along north-facing shores and all sites had a net gain of sediment. During the 31 years (1974-2005) thirteen sites were interpreted as building or stable (minor net change) and only one foreland had a net loss of sediment. Preliminary analysis of changes at the 14 sites suggests the maximum landward penetration of sea ice onshore has not significantly changed, nor has the magnitude of net beach change.

In mid-August 2005, beach thaw depths averaged 0.43 to 0.55 m beneath pebble-cobble beaches and 0.69 m beneath sand-dominated shores. Beach thaw depths in 2005 were similar to 0.26 m deeper than those collected from the same locations on roughly the same date in 1974. Changes in beach morphology and seasonal thaw were greater between 1970s and 2005 along the western parts of Barrow Strait, ie Lowther Island, than farther east, ie. Somerset and Devon Islands.

Introduction

In the 1970s line markers were established at fourteen shore sites to facilitate the monitoring of cross-shore morphological changes along Barrow Strait, Nunavut (Fig. 1). In the 1970s information about shoreline stability and thaw depths was required to assess the impacts on the construction of proposed gas pipelines. Subsequent resurveying of these sites were completed in the 1980s and early 1990s (Taylor 1987, Taylor and Hodgson, 1991). In 2005, the intent of resurveying the monitoring sites (Taylor and Frobel, 2006) was to assess whether rates of shoreline change and thaw depths significantly differed from the 1970s as a consequence of longer open water seasons (Canadian Ice Service, 2002). In contrast to the eastern and western edges of the Arctic Archipelago, where relative sea level is rising, the relative sea level in Barrow Strait is falling (Forbes et al. 2004). Storm driven wave overwash and localized shore erosion can be found, e.g. sites 5602, & 5581, but generally the shores of Barrow Strait do not exhibit erosional characteristics.

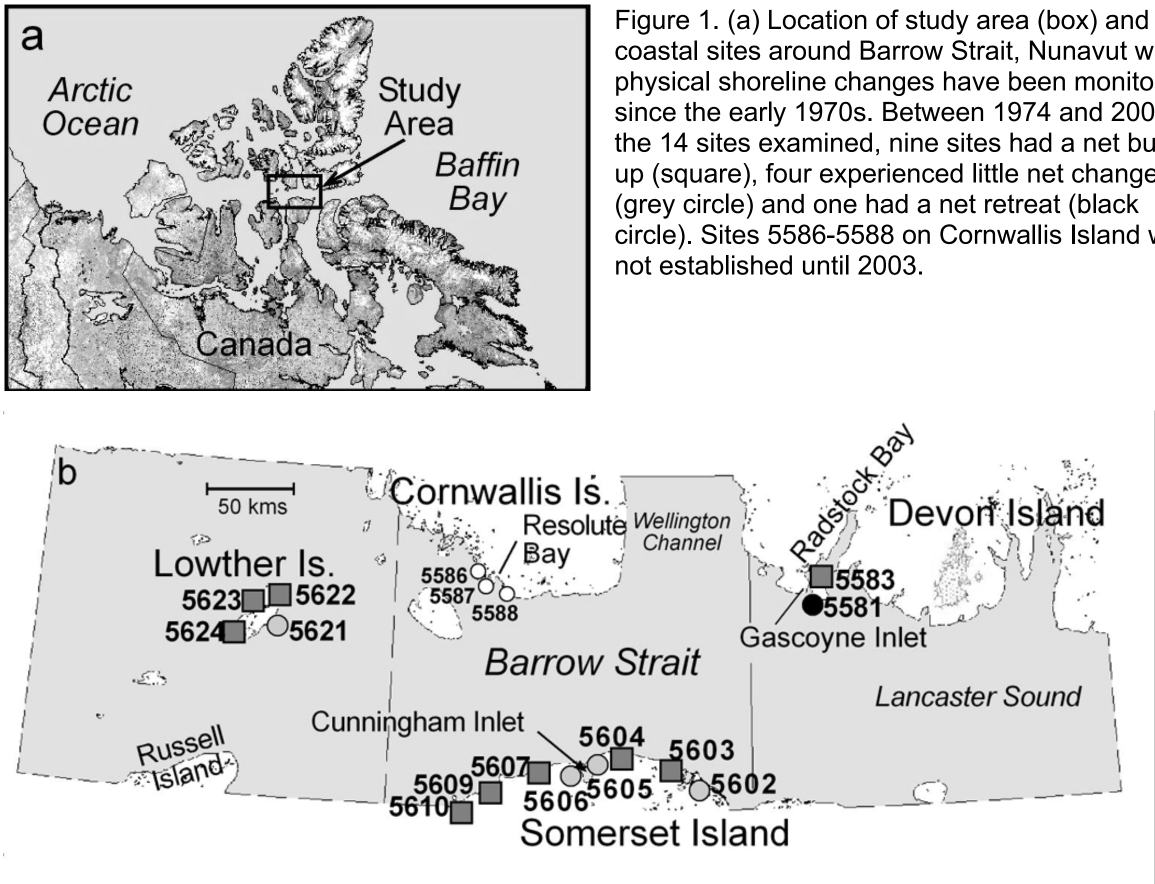


Figure 1. (a) Location of study area (box) and (b) coastal sites around Barrow Strait, Nunavut where physical shoreline changes have been monitored since the early 1970s. Between 1974 and 2005 of the 14 sites examined, nine sites had a net build-up (square), four experienced little net change (grey circle) and one had a net retreat (black circle). Sites 5586-5588 on Cornwallis Island were not established until 2003.

Methods

Beach surveys along Barrow Strait begun in 1968 (McCann and Owens, 1970) were expanded between 1972 and 1976 (Taylor, 1973, 1980, 1987) and many sites were resurveyed in 1981, 1986 and 1992. The number of shore-normal survey lines at any one site varied from one at the sites on Lowther Island to seventeen at site 5581 on SW Devon Island (Fig. 1). Surveys in the 1970s and 1980s used a level, theodolite or range poles and abney level. Visual observations and photos augmented the shore-normal surveys.

In 2005, 36 of 67 shore normal lines were re-surveyed. Twenty lines were completed using Real Time Kinematic (RTK) GPS technology and the rest using range poles and an abney level. Real Time Kinematic GPS surveys were conducted using Thales Navigation Z-Max receivers for base station and rover. Vertical and horizontal accuracy of the GPS surveys was ± 5 cm compared to decimeter accuracy with the other methods.

The depth of beach thaw was measured at a selection of shore-normal points representing both the raised and active beach at each site. Thaw depth refers to the depth from the beach surface to the upper limit of ice-bonded sediment (Owens and Harper, 1977). Maximum seasonal thaw depth, usually attained in late August or early September represents the active layer thickness. A soil auger (0.92m long) was used to determine the depth to the resistant frozen surface. Pits were also dug to confirm the presence of ice-bonded layers.

Results and Discussion

Beach Morphological Changes: The magnitude of net beach changes can vary considerably along Barrow Strait for any given time period depending upon wave and sea ice conditions. Between 1974 and 1976 and 1976 to 1992 five of fourteen beach sites (not always same ones) recorded a net loss of sediment. Between 1992 and 2005 the largest morphological changes were recorded along north-facing shores and all sites had a net gain of sediment. During the 31 years (1974-2005) nine sites had a net build-up (square), four had little net change (grey circle) and only one had a net retreat (black circle) (Fig. 1). Only Cape Ricketts, a large coastal foreland, experienced net erosion because the buildup of material from 1992 to 2005 was insufficient to offset the erosion recorded between the 1970s and 1980s. Preliminary analysis suggests the maximum landward extent of wave reworking at the 14 sites has not significantly changed, nor has the magnitude of net beach change (Fig. 2). An exception was along west Lowther Island where recent net beach changes were greater than in the 1970s when this shore was more ice-bound.

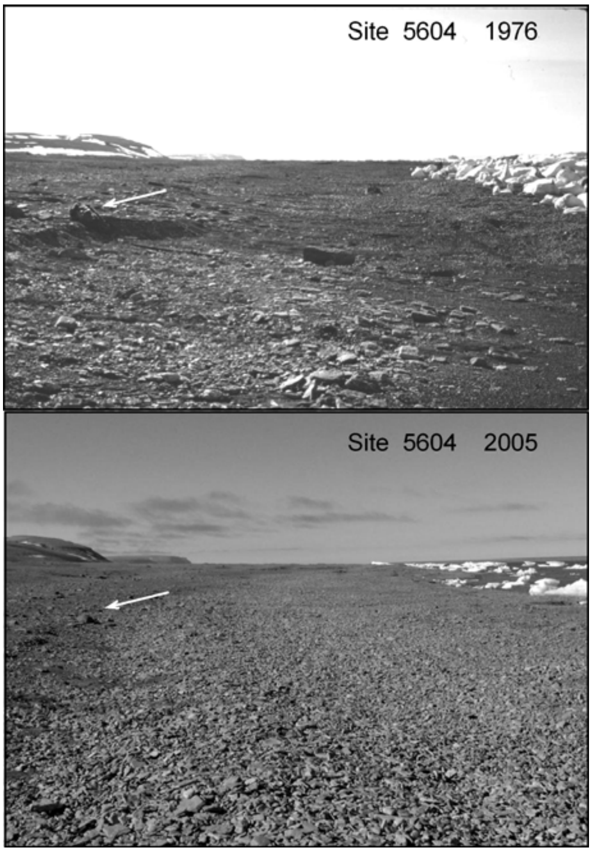


Figure 2. Views of site 5604 (Fig. 1) in 1976 and 2005. The beach was eroded down by waves between 1974 and 1976 and rebuilt by 2005 to roughly the same landward limit as 1974. Arrows mark the same location and landward limit of wave reworking. Repetitive shore-normal surveys at this location are shown in Figure 7.

For shores of Barrow Strait sediment supply for beach building is locally derived pebble-cobble which is low in abundance. Yet most of the sites were builtup between 1992 and 2005. A closer examination of individual beach sites suggested that headlands and beach promentories were eroded and the more embayed shores were builtup or experienced little net change. Where cross-shore survey lines were closely spaced, a longshore cut and fill sequence of change was observed. The best example was observed at Staples Beach where small beach promontories were trimmed and adjacent shores were infilled with the eroded sediment (Fig. 3). A longshore cut and fill process also helps to explain the variable build-up and erosion observed alongshore in Radstock Bay (Site 5583) and other shores following storms. More information is provided in the report by Taylor and Frobel (2006).

At Cape Ricketts, site 5581 (Fig. 1) three beach ridges were cut back and a fourth was scarped (Fig. 4. arrow 3) between

1970 and 1986 (Fig. 4 Line iii b-a.). Between 1986 and 2005 a major beach ridge was built and removed several times but the cape did not recover to its pre-1981 position by 2005. An examination of the raised beach also revealed scarped beach ridges (Fig. 4, arrows) however they were roughly twice the elevation of the most recent scarped ridges. It is suggested that the foreland is only extended seaward after short term transgressions.

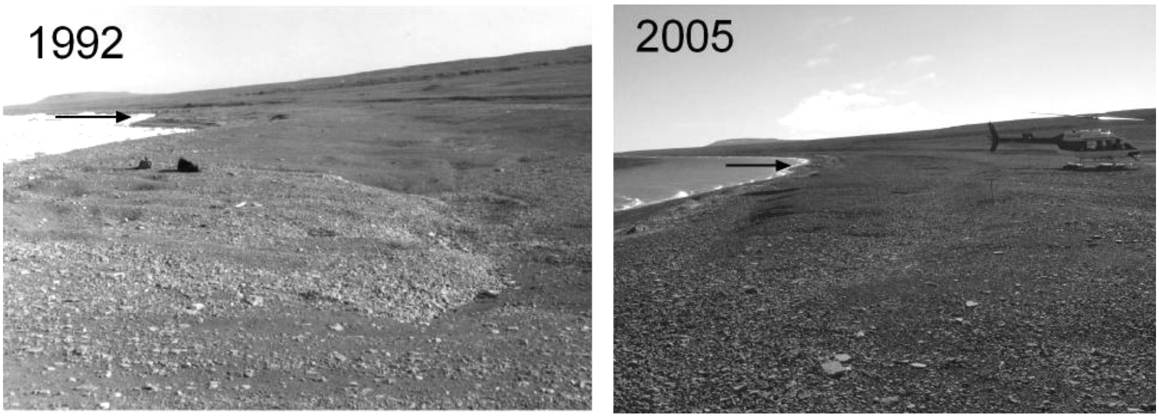
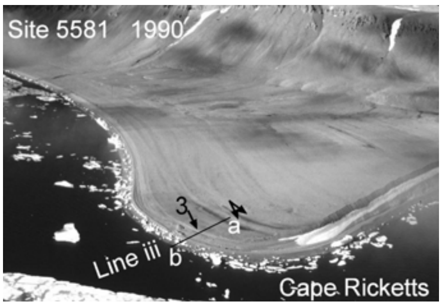


Figure 3. Views of site 5603 (Fig. 1) in 1992 and 2005 showing the loss of a small beach promontory (arrows) and the transfer of sediment longshore where the adjacent shore was prograded.



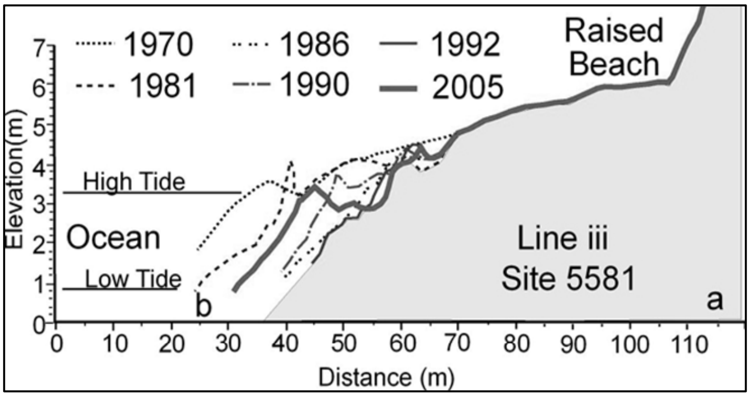


Figure 4. Aerial view of site 5581 (Fig.1), Cape Ricketts and sequence of shoreline changes at line iii from 1970 to 2005. Between 1970 and 1986 three beach ridges were eroded and a fourth was scarped (arrow 3) before new beach ridges were intermittently rebuilt and eroded between 1986 and 2005. Other beach scarps (arrows) observed on the emerged shore suggest a similar sequence of foreland growth.

In 2005 observations were made of the character and position of ice-built feature s onshore, as a way of detecting temporal changes in the mobility of sea ice. Since the mid-1970s sea ice ride-up and piling has occurred a number of times at the same shores along Barrow Strait. Where repetitive photos or surveys were available, they showed that the same sites were impacted by sea ice and the maximum landward extent of sea ice penetration was similar (Fig. 5 circled) in the 1970s and 2005.

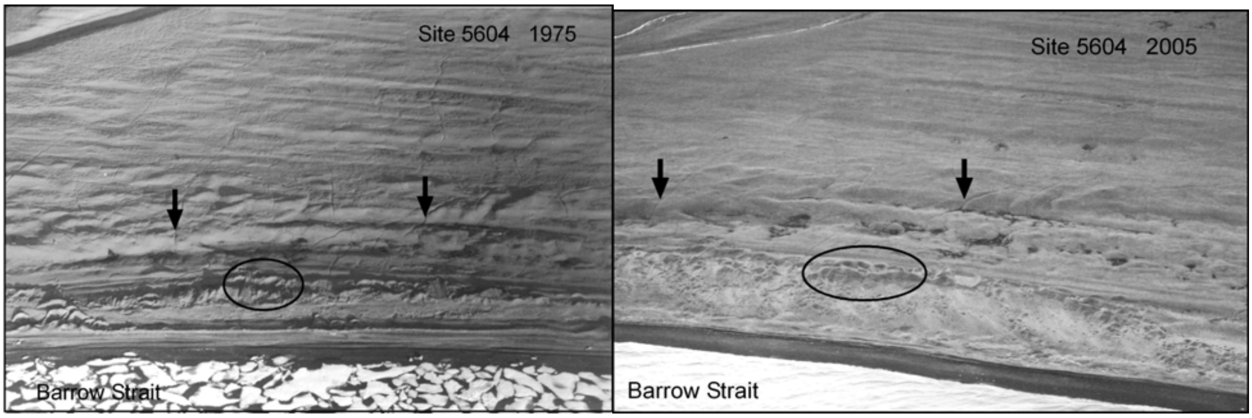


Figure 5. Views of the same location at beach site 5604, Somerset Island (Fig. 1) in 1975 and 2005 showing the maximum landward extent of sea ice rideup (circled) was similar. For reference the same frost cracks are marked by arrows.

Beach Thaw Depths: In August 2005 thaw depths averaged 0.43 to 0.55 m beneath pebble-cobble beaches and 0.69 m beneath sand shores of Barrow Strait. Thaw depths measured in 2005 at the same locations, on roughly the same date as in 1974, were similar to a maximum of 0.19 m deeper along Somerset and Devon Islands and were as much as 0.26 m deeper on Lowther Island (Fig. 6).

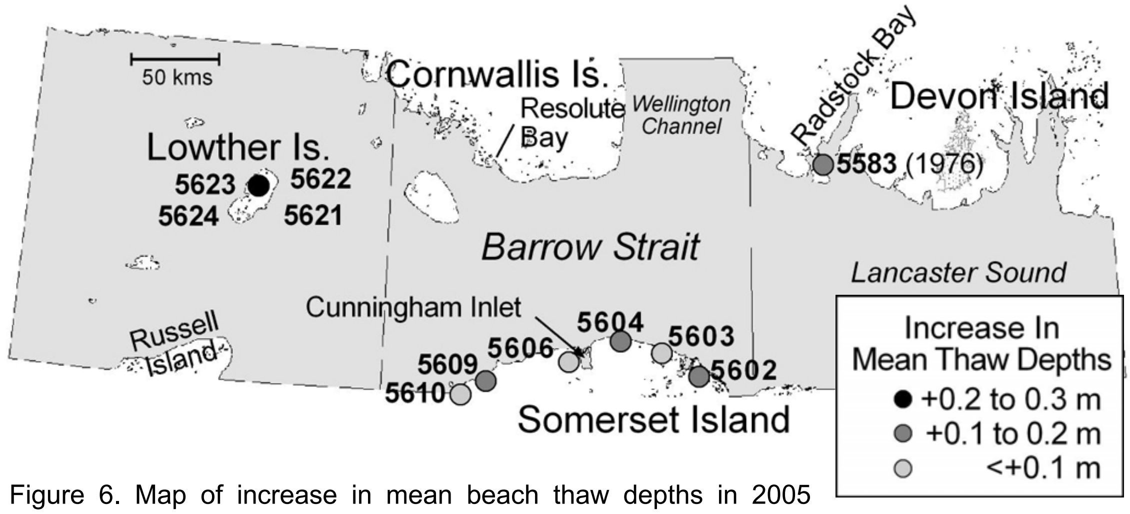


Figure 6. Map of increase in mean beach thaw depths in 2005 compared with 1974 and 1976 recorded at sites along Barrow Strait.

A further comparison of minimum and maximum recorded depths at any one site indicated thaw had progressed deeper at all sites in 2005 but maximum depths were only greater at five of eight sites in 2005. For site 5583, on southwest Devon Island, beach thaw was deeper than in 1976 and slightly less compared to 1981. A statistical analysis of the significance of the changes in beach thaw has yet to be completed but for Lowther Island the increase represents half the total active layer thickness. The deeper beach thaw recorded on Lowther Island in early August is attributed to the absence of shorefast ice in 2005. Although less difference in mean thaw (between 1974 and 2005) was observed on the other two islands, more examples of talik were observed in 2005, as the auger broke through layers of bonded sediment.

Beneath the portion of beach actively reworked by waves, bonded sediment aggrades upward with beach accretion or lowers with beach erosion as illustrated by repetitive surveys from site 5604 (Fig. 7).

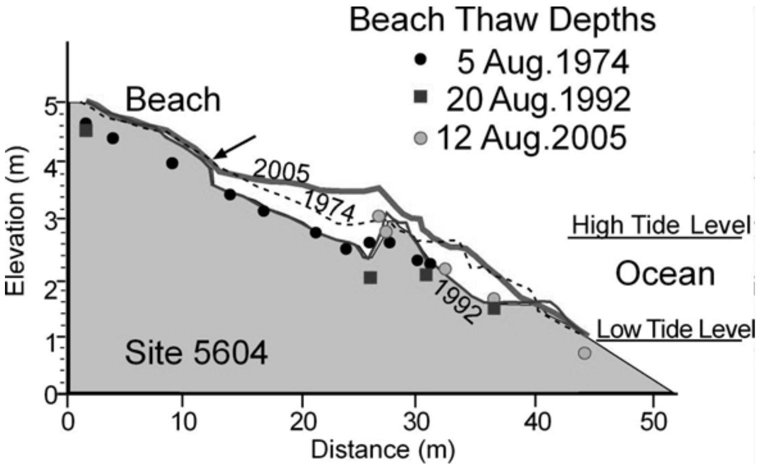


Figure 7. The surface of bonded sediment measured in 1974 coincided with the resultant scoured beach surface in 1975 which changed little by 1992. In 2005 the position of bonded sediment shifted upward as the beach aggraded.

Conclusions

1. The magnitude of net beach changes varies considerably along Barrow Strait as a function of wave and sea ice exposure. Yet, at any given site, the magnitude of beach change did not appreciably increase since the 1970s. Sediment accretion across the upper beach was greatest between 1992 and 2005.

2. Beach cut and fill and longshore transport provides a mechanism for supplying sediment for these shores as sea level falls. It takes a long time and sometimes the loss of several older beach ridges to generate sufficient sediment to build one of the ridges observed across the emerged shoreline.

3. Where sea ice impacts were observed at the same locations in the mid-1970s and 2005 the maximum landward extent of sea ice penetration across the backshore was similar.

4 Beach thaw was greater in 2005 than in 1974 at five of eight sites measured; little difference in thaw was observed at the other three sites. The greatest increase in thaw was observed beneath the shores of Lowther Island because of the absence of shorefast ice in 2005.

5. Repetitive monitoring of the shores of Barrow Strait since the mid-1970s suggest the impact of climate warming has not yet significantly changed shoreline stability along these emergent shores but there was a tendency for increased changes in thaw and morphology along the western parts of Barrow Strait.

Acknowledgements

Field logistics support in 2005 was provided by Polar Continental Shelf Project (PCSP), Natural Resources Canada, Contribution Number PCSP/ÉPCP # 029-06. The field program was financed under an earlier Climate Change Program of Natural

Resources Canada. We also appreciate the critical review and comments on this manuscript by Steve Solomon (GSCA).

References

Canadian Ice Service, 2002. Sea ice Climatic Atlas Northern Canadian Waters 1971-2000. *Environment Canada*, Ottawa, 200 p.

Forbes , D. L., Craymer, M., Manson, G. K., Solomon, S. M., 2004. Defining Limits of Submergence and Potential for Rapid Coastal Change in the Canadian Arctic. Arctic Coastal Dynamics Report of the 4th International workshop, St Petersburg (Russia) (V. Rachold and G. Cherkashov, eds) 10-13 Nov. 2003; *Berichte zur polar-und Meeresforschung* 482, 196-202.

McCann, S. B., Owens, E. H., 1970. Plan and Profile Characteristics of Beaches in the Canadian Arctic Archipelago. *Shore and Beach* 38 (N.2): 26-30.

Owens, E. H., Harper, J. R., 1977. Frost-table and thaw depths in the littoral zone near Peard Bay, Alaska. *Arctic* 30 (N3): 155-168.

Taylor, R. B., 1973. Coastal environments and processes in the Canadian Arctic Archipelago. Unpub. M. Sc. thesis, Geography Department, McMaster University, Hamilton Ontario, 210 p.

Taylor, R. B., 1980. Coastal environments along the northern shore of Somerset Island, District of Franklin, in The Coastline of Canada. S.B. McCann (ed.), *Geol. Surv. Can. Paper* 80-10: 239-250.

Taylor, R. B., 1987. Cruise Report 86303, Coastal Surveys in the Central Queen Elizabeth Islands (Dundas, Devon, Somerset, Cameron and Lowther Islands, NWT). *Geological Survey of Canada Open File Report* 1595, 45 p.

Taylor, R. B., Hodgson, D., 1991. Coastal studies in the Canadian Arctic Archipelago Brock, Devon, Prince Patrick and the Polynia Islands. *Geological Survey of Canada Open File Report* 2380, 54p.

Taylor, R. B.,Frobel, D., 2006. Cruise Report 2005-305: 2005 Field Survey of Coastal Changes Along Barrow Strait, Bylot and Northern Baffin Islands, Nunavut. *Geological Survey of Canada Open File* 5395, 1 CD-ROM.

GIS - ORIENTED COASTAL AND OFFSHORE PERMAFROST MAPS OF WESTERN RUSSIAN ARCTIC: RESEARCH AND DEVELOPMENT

A. Vasiliev[1], G. Cherkashov[2]

1 Earth Cryosphere Institute SB RAS, Moscow, Russia
(z_v_a_a@dio.ru)
2 VNIIOkeangeologia, St-Petersburg, Russia

Compilation of GIS-oriented coastal and submarine permafrost maps is one of the prime tasks of ACD and Russian IPY projects. Actually, offshore permafrost distribution is represented in a number of Russian maps. The well known one is “The geocryological map of USSR” (scale 1: 2 500 000, edited by E.D.Ershov) was published in 1991 but has no digital format. The main problem of this and other similar maps is the small amount of available data for the moment of their publication. Only relict permafrost is represented on the map for the western part of Russian Arctic. Recent submarine permafrost formation is not represented at all.

The new GIS-oriented coastal and offshore Permafrost Maps of western Russian Arctic are supposed to be compiled based on the reprocessed old data and using of newly obtained data.

As the fist step all available published and archive geomorphological, geological and permafrost maps of western Russian Arctic (more than 50 maps and schemes) were collected. Submarine permafrost distribution and properties data base (including drilling data) is being created. Persistent air temperature, sea water salinity and temperature, ice sheet dynamic information data is collected also.

GIS-oriented geological and geomorphological maps and Quaternary geology map are worked out. GIS-oriented bathymetric map and sea floor temperature map that will be the main GIS layer of «The coastal and offshore Permafrost Maps of western Russian Arctic» are also elaborated now. Modern version of these maps will have the scale 1: 1 000 000.

To study the interaction between coastal and offshore permafrost zones the monitoring site was established in the Marre-Sale (western Yamal). Preliminary short-range shallow zone sea floor temperature changing observations are being made. The modeling of the degradation processes of permafrost both in the continental and submarine environments will be done based on this data. The results of this study will be represented as the detailed map of Yamal region.

PUBLIC LECTURE

TUESDAY, OCTOBER 24, 2006

19:30 at the ARCTIC CENTRE

FROZEN COASTS IN A CHANGING CLIMATE

Steve Solomon

Geological Survey of Canada (Atlantic)

Arctic coasts lie between land, dominated by permafrost, and the sea, covered during the long winters by ice and subject to waves and storms in the summer and fall. In the Arctic, decreasing sea ice extent increasing air temperatures, unpredictable storm activity, and rising sea levels will likely lead to faster coastal erosion and permafrost degradation. Ice in its various forms defines the characteristics and responses of many of these arctic coasts.

Ground ice within permafrost can range from small crystals within soil pore spaces, to large bodies of massive ice that can extend for hundreds of square meters. It also exists beneath the sea floor in some coastal regions. Not only does ground ice govern where, when and how rapidly erosion will occur, but its thaw can lead to distinct and dramatic changes in the coastal landscape. Sea ice changes frozen coasts too. During the long winter season, a solid sea ice cover protects the coastline from attack by waves. Yet it can also have the opposite effect, scouring and scraping up bottom sediments or plowing them on to shore, especially during the freeze up or break up period. Sea ice can change ground temperatures at the sea bed when it freezes to the bottom in shallower waters.

Steve Solomon of the Geological Survey of Canada (Atlantic) is a senior coastal scientist who has spent many years working in the Arctic. He will discuss how ice shapes Arctic coasts, provide examples from different polar regions, and explain how a changing climate can affect these landscapes.

4 APPENDICES

4.1 Appendix 1: Participant List

Name	Affiliation	Email
David Atkinson	International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, Alaska, USA	datkinson@iarc.uaf.edu
Nataliya Belova	Faculty of Geography, Lomonosov Moscow State University, Russia	nataliya-belova@yandex.ru
Jerry Brown	International Permafrost Association	jerrybrown@igc.org
Georgy Cherkashov	VNIIOkeangeologia, St. Petersburg, Russia	cherkashov@mail.ru
Nicole Couture	Department of Geography, McGill University, Montreal, Quebec, Canada	nicole.couture@mail.mcgill.ca
Götz Flöser	Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany	goetz.floeser@gkss.de
James Ford	Department of Geography, McGill University, Montreal, Quebec, Canada	jamesdavidford@hotmail.com
Mikhail Grigoriev	Permafrost Institute, Russian Academy of Sciences, Yakutsk, Russia	grigoriev@mpi.ysn.ru
Louwrens Hacquebord	Arctic Centre, University of Groningen, Groningen, Netherlands	l.hacquebord@rug.nl
Birgit Heim	Berlin Program for Equal Opportunities for Women in Research, Berlin, Germany	birgit.heim@email.de
Hans-Wolfgang Hubberten	Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany	hubbert@awi-potsdam.de
Torre Jorgenson	ABR, Inc., Fairbanks, Alaska, USA	tjorgenson@abrinc.com
Alexander Kholodov	Institute of Physical, Chemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Moscow, Russia	akholodov@issp.psn.ru
Hugues Lantuit	Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany	hlantuit@awi-potsdam.de
Marina Leibman	Earth Cryosphere Institute SB RAS, Tyumen-Moscow, Russia	mleibman@online.ru
Alexander Makarov	Arctic and Antarctic Research Institute, St. Petersburg, Russia	makarov@aari.nw.ru

Alexey Noskov	Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia	alexkarta@mail.ru
Stanislav Ogorodov	Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia	ogodorov@aha.ru
Paul Overduin	Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany	poverduin@awi-potsdam.de
Kathleen Parewick	Department of Geography, Memorial University, St. John's, Newfoundland, Canada	paerewyck@hotmail.com
Pavel Rekant	VNIIOkeangeologia, St. Petersburg, Russia	rekant@mail.ru
Tillman Schwenk	Dept. of Geosciences, University of Bremen, Bremen, Germany	tschwenk@uni-bremen.de
Roy Shirokov	Earth Cryosphere Institute SB RAS, Moscow, Russia	shirocov@gmail.com
Yuri Shur	Engineering Department, University of Alaska Fairbanks, Fairbanks, USA	ffys@uaf.edu
Steven Solomon	Geological Survey of Canada (Atlantic), Dartmouth, Nova Scotia, Canada	solomon@nrcan.gc.ca
Frits Steenhuisen	Arctic Centre, University of Groningen, Groningen, Netherlands	f.steenhuisen@rug.nl
Irina Streletskaya	Moscow State University, Department of Geography, Moscow, Russia	strelets@gol.ru
Yuriy Strochkov	Department of Geology, Moscow State University	idw83@mail.ru
Alexander Vasiliev	Earth Cryosphere Institute SB RAS, Moscow, Russia	z_v_a_a@dio.ru

4.2 Appendix 2: Workshop Program

Sunday, 22 October 2006

16:00-18:00 Steering committee meeting (Arctic Centre)

18:00-21:00 Icebreaker and registration (Arctic Centre)

Monday, 23 October 2006
Status of ACD - Plenary session
Venue: Arctic Centre

8:30-9:00 Registration

9:00-9:15 **Welcome**
Louwrens Hacquebord
Prof. Of Polar Studies, University of Groningen
Director, Arctic Centre

9:15-9:30 **Introduction to workshop**
Nicole Couture and Paul Overduin

9:30-9:45 **Working group report: Transition from onshore to offshore permafrost**
Hans Hubberten

9:45-10:00 **Working group report: Environmental forcing**
David Atkinson

10:00-10:15 **Working group report: GIS development**
Frits Steenhuisen

10:15-10:30 **Working group report: Human dimensions of Arctic coastal dynamics**
Update on ACD book
Nicole Couture

10:30-11:00 Coffee break

11:00-11:20 **Dynamics of sub-sea permafrost table in the near-shore zone of the Laptev and East-Siberian Seas**
Mikhail Grigoriev

11:20-11:40 **Ural Coast of Baydaratskaya Bay, Kara Sea: massive ice beds as a factor of coastal dynamics**
Nataliya Belova

11:40-12:00 **One year of ground temperature measurements from beneath bottomfast ice, Beaufort Sea, Canada**
Steve Solomon

12:00-13:30 Lunch (Academy Building, University of Groningen)

13:30-13:50 **Arctic coastal processes: The human dimension**
Louwrens Hacquebord

13:50-14:10 **Linking the social and physical sciences in coastal change research**
James Ford

14:10-14:30 **Village-based monitoring and remote sensing of coastal dynamics along the Alaskan Beaufort Coast**
Torre Jorgenson

14:30-14:50 **The coastal research environment in Alaska: Bridging the gap between science and the public**
David Atkinson

14:50-15:20 Coffee break

15:20-15:30 **ICARP II**
Jerry Brown

15:30-16:20 **IPY plans and updates**
David Atkinson (US Coastal Observatories)
Nicole Couture (CANCO)
Misha Grigoriev (Russian IPY activites)
Paul Overduin (ACCO-Net)
Jerry Brown (IPA)

16:20-16:35 **IASC strategies for project development**
Louwrens Hacquebord

16:35-17:00 Daily summary and charge to working groups for coming days
Nicole Couture, Paul Overduin

Tuesday, 24 October 2006
Venue: Arctic Centre

9: 00-9:20 **Peculiarities of the organic matter in the main types of Quaternary deposits on the Laptev sea coast**
Alexander Kholodov

9: 20-9:30 Setup for the day
Nicole Couture, Paul Overduin

9:30-10:30 Working group meetings

10:30- 10:50 Coffee break

10:50-12:00 Working group meetings (cont'd)

12:00-13:30 Lunch (Academy Building, University of Groningen)

13:30-15:00 Working group meetings (cont'd)

15:00-15:30 Coffee

15:30-16:45 Working group meetings (cont'd)

16:45-17:00 Daily summary
Nicole Couture, Paul Overduin

19:30 **Frozen Coasts in a Changing Climate** - Public lecture (with reception following)
Steve Solomon

<u>Wednesday, 25 October 2006</u>
Venue: Arctic Centre

9: 00- 9:15 Setup for the day
Nicole Couture, Paul Overduin

9:15-10:30 Final working group meetings

10:30-10:50 Coffee break

10:50-12:00 Reports from the working groups

12:00-13:30 Lunch (Wool Restaurant)
Steering committee meeting (Wool Restaurant)

13:30- 22:00 Excursion and dinner (bus between Arctic Centre and hotel)

<u>Thursday, 26 October 2006</u>
Venue: Arctic Centre

9:00-10:30 Plenary session – Recommendations for coastal observatories

10:30-10:50 Coffee

10:50-12:00	Plenary session – Recommendations for science and implementation plan
12:00-12:30	Summary and plans for the future *Nicole Couture, Paul Overduin*
Afternoon	IPA-IPY meeting

4.3 Appendix 3: Abbreviations

AARI	Arctic and Antarctic Research Institute
ACCO-Net	Arctic Circumpolar Coastal Observatory Network
ACD	Arctic Coastal Dynamics
ACIA	Arctic Climate Impact Assessment
AON	Arctic Observing Network
AWI	Alfred Wegener Institute for Polar and Marine Research
CAPP	Carbon Pools in Permafrost
CEON	Circumarctic Environmental Observatories Network
GIS	Geographic information system
IASC	International Arctic Science Committee
IBCAO	International Bathymetric Chart of the Arctic Ocean
ICARP II	Second International Conference on Arctic Research Planning
IGBP	International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
IPA	International Permafrost Association
IPY	International Polar Year
LOICZ	Land-Ocean Interactions in the Coastal Zone
NEON	National Ecological Observatory Network
SAON	Sustained Arctic Observatory Network
TSP	Thermal State of Permafrost
WVS	World Vector Shoreline

Die "Berichte zur Polar- und Meeresforschung"
(ISSN 1866-3192) werden beginnend mit dem Heft Nr. 377 (2000) in Fortsetzung der früheren **"Berichte zur Polarforschung** (Heft 1-376, von 1982 bis 2000; ISSN 0176 - 5027) herausgegeben. Ein Verzeichnis aller Hefte beider Reihen befindet sich im Internet in der Ablage des electronic Information Center des AWI (**ePIC**) unter der Adresse http://epic.awi.de. Man wähle auf der rechten Seite des Fensters "Reports on Polar- and Marine Research". Dann kommt eine Liste der Publikationen und ihrer online-Verfügbarkeit in alphabetischer Reihenfolge (nach Autoren) innerhalb der absteigenden chronologischen Reihenfolge der Jahrgänge.

To generate a list of all 'Reports' past issues, use the following URL: http://epic.awi.de and select the right frame: Browse. Click on "Reports on Polar and Marine Research". A chronological list in declining order, author names alphabetical, will be produced. If available, pdf files will be shown for open access download.

Verzeichnis der zuletzt erschienenen Hefte:

Heft-Nr. 565/2007 — "Geochemistry of the Ob and Yenisey Estuaries: A Comparative Study", by Viacheslav V. Gordeev, Bettina Beeskow, and Volker Rachold.

Heft-Nr. 566/2007 — "Russian-German Cooperation SYSTEM LAPTEV SEA: The Expedition LENA 2006", edited by Julia Boike, Dmitry Yu. Bolshiyanov, and Mikhail N. Grigoriev.

Heft-Nr. 567/2007 — "Effects of UV Radiation on Antarctic Benthic Algae - With Emphasis on Early Successional Stages and Communities", by Katharina Zacher.

Heft-Nr. 568/2007 — "The Expedition ANTARKTIS-XXIII/2 of the Research Vessel 'Polarstern' in 2005/2006", edited by Volker Strass.

Heft-Nr. 569/2008 — "The Expedition ANTARKTIS-XXIII/8 of the Research Vessel 'Polarstern' in 2006/20067", edited by Julian Gutt.

Heft-Nr. 570/2008 — "The Expedition ARKTIS-XXI/1 a and b of the Research Vessel 'Polarstern' in 2005", edited by Gereon Budéus, Eberhard Fahrbach and Peter Lemke.

Heft-Nr. 570/2008 — "The Expedition ARKTIS-XXI/1 a and b of the Research Vessel 'Polarstern' in 2005", edited by Gereon Budéus, Eberhard Fahrbach and Peter Lemke.

Heft-Nr. 571/2008 — "The Antarctic ecosystem of Potter Cove, King-George Island (Isla 25 de Mayo). Synopsis of research performed 1999-2006 at the Dallmann Laboratory and Jubany Station", edited by Christian Wiencke, Gustavo A. Ferreyra, Doris Abele and Sergio Marenssi.

Heft-Nr. 572/2008 — "Climatic and hydrographic variability in the late Holocene Skagerrak as deduced from benthic foraminiferal proxies", by Sylvia Brückner.

Heft-Nr. 573/2008 — "Reactions on surfaces of frozen water: Importance of surface reactions for the distribution of reactive compounds in the atmosphere", by Hans-Werner Jacobi.

Heft-Nr. 574/2008 — "The South Atlantic Expedition ANT-XXIII/5 of the Research Vessel 'Polarstern' in 2006", edited by Wilfried Jokat.

Heft-Nr. 575/2008 — "The Expedition ANTARKTIS-XXIII/10 of the Research Vessel 'Polarstern' in 2007", edited by Andreas Macke.

Heft-Nr. 576/2008 — "The 6th Annual Arctic Coastal Dynamics (ACD) Workshop, October 22-26, 2006, Groningen, Netherlands", edited by Pier Paul Overduin and Nicole Couture.