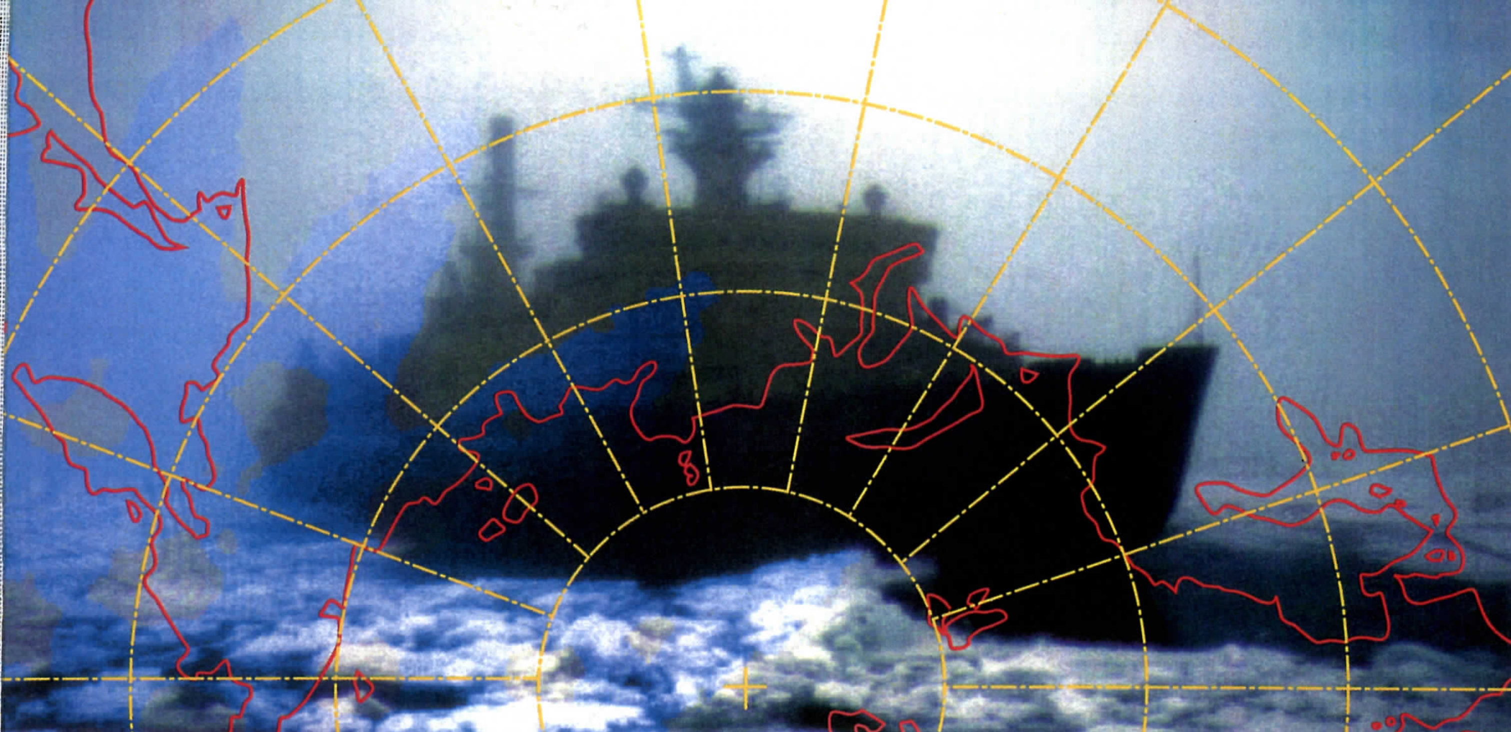
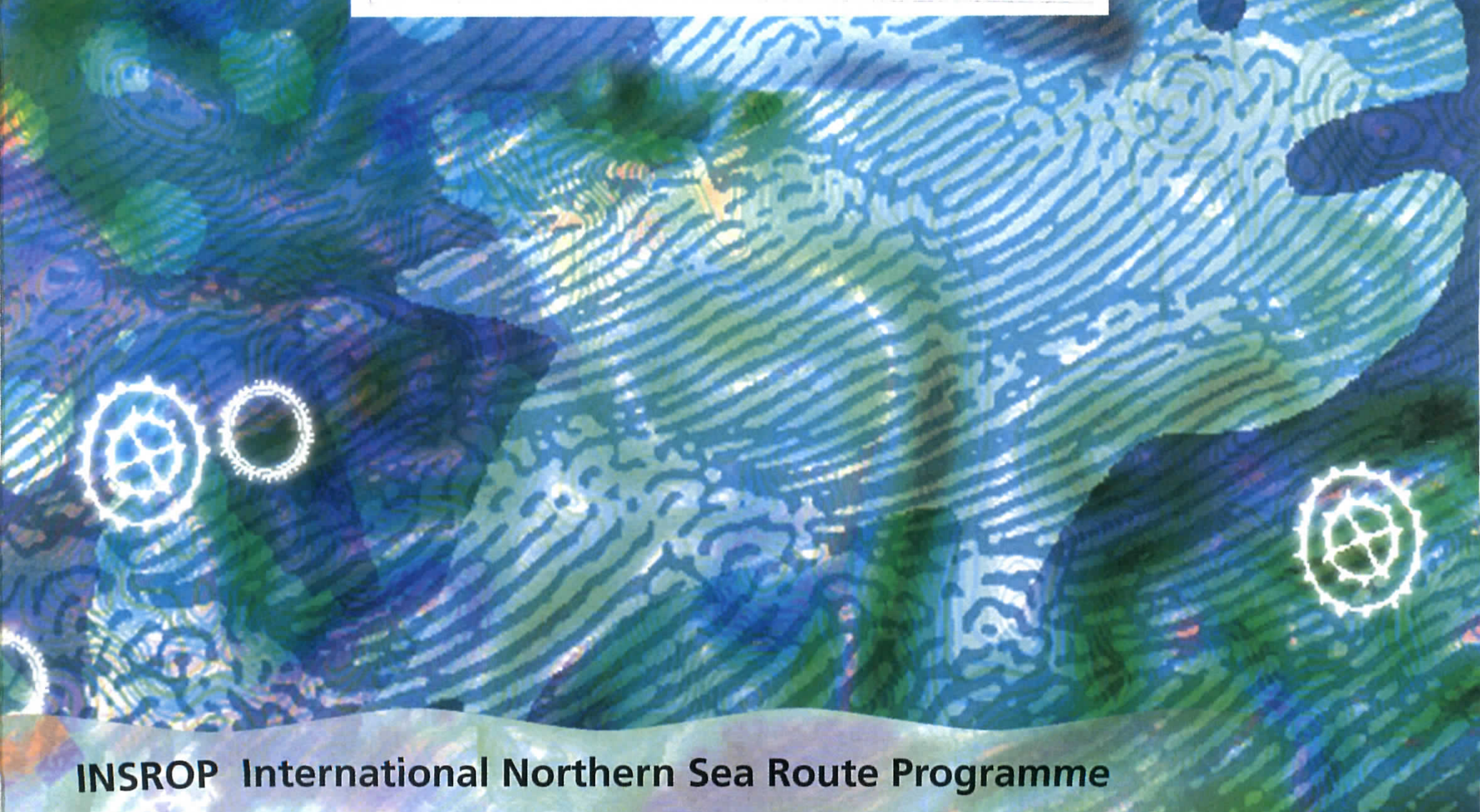


INSROP WORKING PAPER
NO. 127 - 1999, I.3.5

Hydrometeorological and Navigational Support for NSR Navigation

By V.D. Grishchenko, V.G. Smirnov, O.S. Deviatayev, Yu.A. Shcherbakov and S.V. Kovachev



INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship and Ocean Foundation, Japan

International Northern Sea Route Programme (INSROP)

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship & Ocean Foundation, Japan

INSROP WORKING PAPER NO. 127-1999

Box C RL

Sub-Programme I: Natural Conditions and Ice Navigation

Project I.3.5: Design of Information System

Supervisor: Vladimir D. Grishchenko, AARI

Title: **Hydrometeorological and navigational support for NSR navigation**

Authors: **V.D. Grishchenko, V.G. Smirnov, O.S. Deviatayev, Yu.A. Shcherbakov and S.V. Kovachev**

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Date: 15 January 1999

Reviewed by: Professor William M. Sackinger, Obelisk Hydrocarbons, Fairbanks, Alaska, USA.

What is an INSROP Working Paper and how to handle it:

FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the successor state to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

SPONSORS OF INSROP

- Nippon Foundation/Ship & Ocean Foundation, Japan
- The government of the Russian Federation
- The Norwegian Research Council
- The Norwegian Ministry of Foreign Affairs
- The Norwegian Ministry of Industry and Energy
- The Norwegian Ministry of the Environment
- The Central and Eastern Europe programme
- State Industry and Regional Development Fund, Norway
- Phillips Petroleum Company, Norway
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- Norwegian Federation of Shipowners
- Norsk Hydro
- Fridtjof Nansen Institute

PROFESSIONAL ORGANISATIONS PERMANENTLY ATTACHED TO INSROP

- Ship & Ocean Foundation, Japan
- Central Marine Research & Design Institute, Russia
- Fridtjof Nansen Institute, Norway
- National Institute of Polar Research, Japan
- Ship Research Institute, Japan
- Murmansk Shipping Company, Russia
- Northern Sea Route Administration, Russia
- Arctic & Antarctic Research Institute, Russia
- Norwegian Polar Research Institute
- SINTEF (Foundation for Scientific and Industrial Research - Civil and Environmental Engineering), Norway.

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ABSTRACT

The Report presents the main results under the framework of Project I.3.5. "Hydrometeorological and navigational support of research and operational goals of INSROP".

In 1997-98, the efforts were focused on the development of the hydrometeorological modulus of the INSROP information system using modern information technologies, especially GIS-technologies based on the results of the first stage of the development of INSROP information system. The Report contains information on the structural reorganization of the AARI information resources and plans for their further development in terms of the INSROP goals.

One of the major objectives was to create the conversion technology of data collected under the WP 2 (Box B), WP1 (Box B) and I.4.2 (Box C-R) Projects.

KEY WORDS: INSROP Information System, geo-information system, GIS, GIS-technology, databases, information communication lines.

ACRONYMS and GLOSSARY

A

AARI	-	Arctic and Antarctic Research Institute, State Research Center of the Russian Federation
Alta 20™	-	Pinnacle Micro® magnetic-optical Jukebox
ALISA	-	Russian abbreviation for the Automated Ice Information System for the Arctic
ANSI	-	American National Standards Institute
APPI	-	Russian abbreviation for the Autonomous Information Receiving Facility
ARC/INFO™	-	ESRI® Software Package for GIS
Arc/View™	-	ESRI® Software Package for GIS

B

C

IHMIC	-	Ice and Hydrometeorological Information Center
CONTOUR	-	Russian national format for exchanging operational and archived data on sea ice

D

DB	-	Database
dBase™	-	Borland® Software Package for DBMS
DBMS	-	Database Management System

E

EPR	-	Earth's polar regions
ERDAS™	-	ERDAS® Software Package for GIS and Remote Sensing
ERS	-	European Remote-Sensing Satellite
ESRI®	-	Environmental Systems Research Institute, USA

F

FTP	-	File Transfer Protocol

G

GIS	-	Geographical Information System

H

HMS	-	Hydrometeorological Support

I

IASNET	-	Russian Internet provider
IBM®	-	International Business Machine Inc., USA
ICN	-	Information-Communication Node
Imagine Production™	-	ERDAS® Software Package for GIS and Remote Sensing
INMARSAT®	-	International Mobile Satellite Organisation
IS	-	Information System
ISO	-	International Organization for Standardization

J

K

L

LAN	-	Local Area Network

M

METEOR	-	Russian Meteorological Operational Satellite
MS Office™	-	Microsoft® Software Package
MS Windows™	-	Microsoft® Graphic Shell

N

NetBEUI™	-	Microsoft® Network Protocol
NFS	-	Network File System
NOAA	-	National Oceanic and Atmospheric Administration, USA
NSR	-	Northern Sea Route

O

OKEAN	-	Russian Remote-Sensing Satellite
OS	-	Operating System, Operational System
ORACLE™	-	ORACLE® Software Package for DBMS
ORACLE-Glue™	-	ORACLE® Software

P

Pinnacle Micro®	-	Pinnacle Micro Inc., USA

Q

R

RADAR™	-	ERDAS® Additional Module for Imagine Production™
Radarsat®	-	Canadian Radar Satellite
Roshydromet	-	Federal Service of Russia for Hydrometeorology and Environmental Protection
ROSPAK	-	Russian Internet provider

S

SCANOR™	-	SCAN® satellite information receiving unit
SINTEF		Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
SINTEF NHL	-	SINTEF Norwegian Hydrotechnical Laboratory
Solaris™	-	SUN® Operating System (UNIX)
SPARC	-	Scaleable Processor ARChitecture
SPRINT	-	Internet provider
SQL*Net™	-	ORACLE® Software
SQL	-	Structured Query Language
SYBASE™	-	SYBASE® Software Package for DBMS

T

TCP/IP - Communication Protocol (Transmission Control Protocol/Internet Protocol)

TRANSINFORM - Internet provider

U

V

VideoBox™ - AARI Software Package for Remote Sensing

W

WWW - World Wide Web - Graphic Shell for Internet

X

X.25 - Communication Protocol

Y

Z

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INTRODUCTION

Project I.3.5 "Hydrometeorological and navigational support of research and *operational* goals of INSROP" is a logic continuation of Project I.3.4 "Information System Development", which was completed at the first stage of INSROP. The title of this project (Information System Development), coinciding with the title of Project I.3.1, caused some misunderstanding between the Russian and Norwegian project participants, which however did not prevent their constructive collaboration in GIS development. In the end, the results of the first stage of Project I.3.4 provided clear understanding of the place and importance of INSROP GIS for all program participants. The International INSROP Evaluation Committee highly commended on the INSROP GIS as an outstanding example of product, which meets the User's requirements.

The second stage was aimed to test the real use of GIS-technologies in the operational practice of providing support for international shipping along the NSR. The previous stage formulated the major principles for creating the hydrometeorological module of a common INSROP GIS. The requirements for equipping this module and its information and technological content were worked out, including the order of its operation in one common INSROP GIS environment. It was planned that the development of the hydrometeorological GIS module would permit the INSROP participants to work with the operational and the regime hydrometeorological information in the on-line mode, supplement the available databases and run standard ice navigation scenarios. However, inadequate funding necessitated a reduced scope of work for the development of the module.

The main efforts under the Project were focused on continuing adaptation of the Russian Operational Information System (AARI) to the common INSROP GIS and its transfer to current information technologies, providing access of INSROP participants to two types of operational information – composite ice chart and medium-range ice forecasting as well as creating technology for input of data obtained from the aforementioned projects to INSROP GIS.

1 ADAPTATION OF THE AARI INFORMATION SYSTEM TO ONE COMMON INSROP GIS

Insufficient funding of work under Project I.3.5 (as compared with funding planned) delayed significantly the updating of the AARI information system and the ALISA system in general. However, it was possible to analyze the system of hydrometeorological support for shipping along the NSR under the current economic conditions, consider new aspects of Roshydromet policy for reducing the hydrometeorological network in the Arctic and envision the use of the most recent technological achievements in informatics and communication.

1.1 General Characterization of the AARI Information System at the beginning of the second stage of INSROP

1.1.1 AARI local area network

The architecture of the AARI local area network (LAN) was described in much detail at the first stage of [1]. The system layout is presented in Figure 1.

The information-communication block (ICB) serves as a system forming network components. It provides exit to the external networks and combines the AARI computation and information resources.

From 1996, the exit to the external networks (Internet) was organized via the scientific-education network of northwestern Russia "ROCSON NW". The fiber optical cable connecting the AARI and the St. Petersburg RAS Institute of Informatics, was used.

1.1.2 A system of operational hydrometeorological information Processing and analysis

A System of Operational Hydrometeorological Information Processing and Analysis is part of the ALISA system. It was implemented at the IHMIC (Ice Hydrometeorological Information Center) as an independent subsystem. In 1996 it included the ADTS (automated data transmission system) communication block with the "Tsiklon" and "Transmet" complexes,

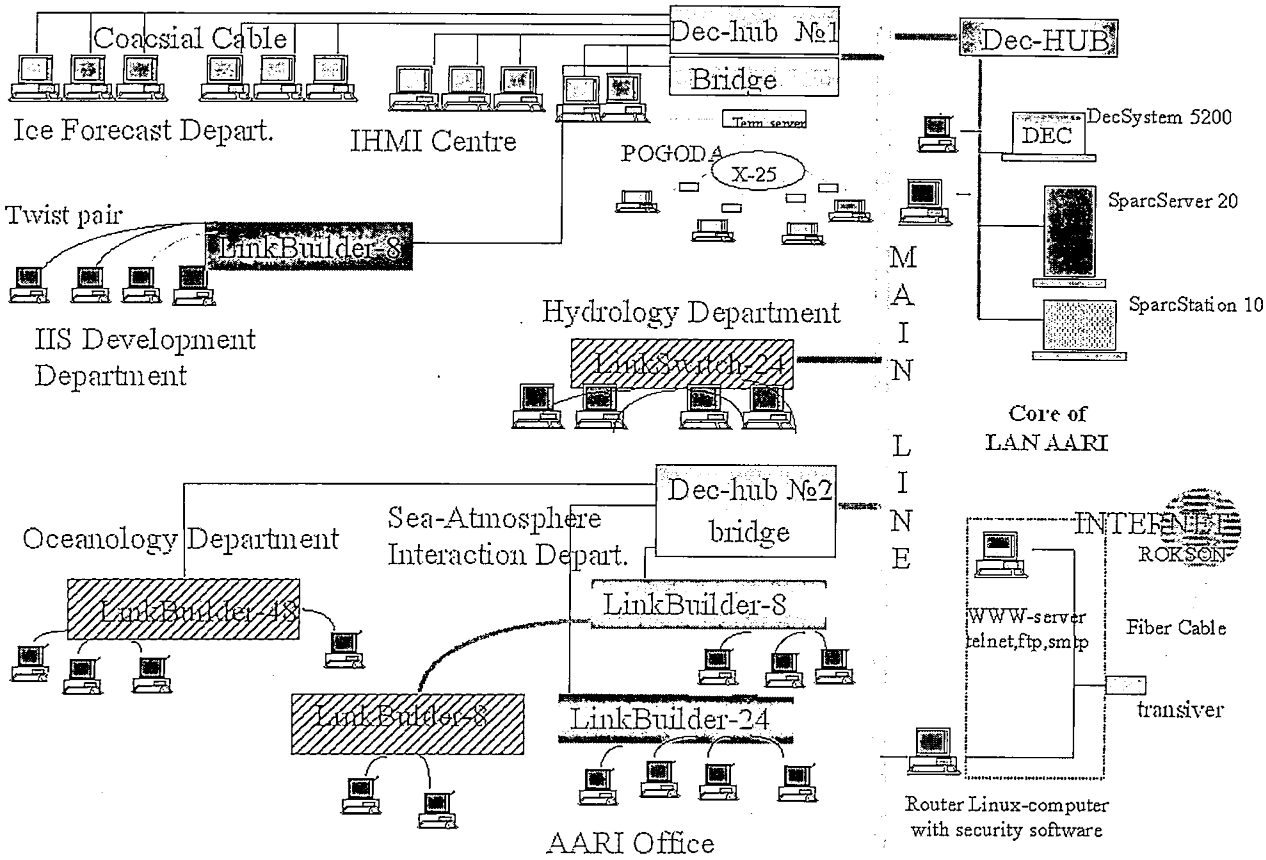


Fig.1. A block-diagram of the AARI network

autonomous information receiving facilities, operational database formation block and weather and ice information presentation (charts) block.

1.1.2.1ADTS (automated data transmission system) communication block POGODA

The ADT service used the "Tsiklon" complex based on the SM computer family, which was morally and physically outdated (with exploitation since 1987). However, in 1996 there was no money to replace it or new equipment corresponding to the AARI goals. That is why the main attention was paid to updating the individual blocks and using additional capabilities of the communication channels. For this purpose, the hard- software "Transmet" complex was used.

In 1996 using the "Transmet" complex the IHMIC Ice Computation Center (Ethernet) was connected with the Roshydromet network (IÀSNET) using the X.25 Protocol. The inter-machine data exchange based on the X.25 Protocol permitted the AARI to meet its requirements for the inter-machine exchange with the Arctic Hydrometeorological Centers (HMC).

1.1.2.2APPI (Autonomous Information Receiving Facility)

In 1996, the main satellite data receiving equipment included stations operating in the meter wavelength range permitting data receiving in the APT mode from NOAA, Meteor and Okean satellites. The quality of this information was satisfactory until there was a possibility to perform regular airborne ice reconnaissance along the NSR. However, in 1996, this possibility was absent and new requirements for the quality of satellite data received were formulated [1].

For image processing, a software complex "VIDEOBOX" devised at the AARI was used. Charts were prepared manually and then digitized in the "Contour" format. These ice charts were reported by facsimile or in the cable form in the "Contour" format to different users.

1.1.2.3 Operational database

The operational database includes data of hydrometeorological observations at synoptic times reported via the ADTS "Pogoda". Software for operating this database was devised by the AARI staff using special formats. This software allowed the AARI:

- to plot data of hydrometeorological stations using the A0 format plotters;
- calculate ice and hydrometeorological characteristics for issuing different types of forecasts and recommendations;
- store data on magnetic medium.

1.1.3 Results of work under Project I.3.4 at the first stage of INSROP

Gaining experience of international collaboration in developing the INSROP Information System was one of the major results for the AARI at the first stage. Before the AARI participated only in creating the Russian (Soviet) information systems.

Simultaneously, it was possible to achieve the following goals and namely:

1. To perform an analysis of the AARI information structure in respect of meeting the international cooperation requirements.
2. To define the place of the AARI Information System (ALISA) in the INSROP structure.
3. To determine the strategic directions in developing and updating the ALISA system taking into account hydrometeorological support for shipping along the NSR.
4. To create the basic information structures at the AARI for transforming the ALISA system to modern information technologies.

1.2 Development and improvement of the ALISA system as a hydrometeorological INSROP GIS module

Further development and improvement of the ALISA system taking into account hydrometeorological support for international transit navigation along the Northern Sea Route is carried out along the following lines:

I. Information collection subsystem:

- Use of satellite remote sensing medium- and high-resolution data in the visible, IR and radio regions,
- Introduction of self-contained buoys and coastal stations with an extended set of parameters measured;

II. Processing Sub-system:

- use of high-technology software, in particular GIS-technologies;
- development of methods for information complexing and supplementing direct observation data by calculations.

III. Information reporting and dissemination:

- updating the corporate ADTS “Pogoda” block;
- updating the network;
- information presentation in the formats that are used in the geo-information systems and especially, ECDIS;
- use of satellite communication channels;
- provision of inter-machine exchange;
- wide use of Internet capabilities.

1.2.1 Review of basic information technologies

It is necessary to consider an extremely rapid development of information technologies. According to recent data, presented by the reviewers of such popular publications as PC magazine, PC World, Computer Press, etc. the change of processor and operation system generations occurs every two years with sub-systems of operational and external memory (hard disks) changed every year. The concepts for information system structure change every 5-6 years.

The INSROP Project is being maintained for five years. During this time the Internet appeared and was rapidly developed. Two processor generations (from 486 to Pentium II with Merced planned to replace the latter) were changed in desktop systems. The operational memory volume in standard configuration was increased by one order (32 Mb instead of 4). A hard disk contains 10 Gb, rather than 200 Mb. We operate now in Windows 98 instead of Windows 3.1. Similar changes took place at the scale of enterprise systems.

The main factor is a sharp drop in computer prices and accessories. PCs are used now at every workstation. There is a change in computer perception by users. From an expensive tool of high-level science and space technologies it is as common now as a telephone At present it is impossible to imagine any production facility without information technologies.

1.2.2 Changes in the Information System Structure concepts

Data Warehouses and the Internet network have become lately the most popular topics in the computer industry. Integration of two leading technologies allows enterprises to significantly increase their efficiency. Using Web for communication with Data Warehouses yields several advantages:

Application of Web-browser as a common client interface will resolve the problem of platform incompatibility.

Since practically any user can get access to Internet, it is not necessary to expand the provider's own networks to cover all potential users.

The cost of the Online Analytical Processing (OLAP) System with one workstation is typically more than 500 - 1000 USD. However, many users require only part of the functional capabilities of the OLAP applications. Web-browsers at a price between 20 to 50 USD are easily downloaded from the Web-nodes of providers.

Instead of specialized application interfaces created using Microsoft Visual Basic or Powersoft PowerBuilder languages, one can use a Web-browser, which will access the Application performing a Web-gateway function, i.e. a translator between the HTML and API-interface of the database server. In addition, Web provides access to the electronic mail, Usenet news and to a number of other constantly developing Internet services without additional payment.

The access to the Data Warehouse through Web is an open solution allowing the use of any browser.

In short, application of Web-browsers for accessing data is an efficient and cost-effective method of information dissemination among a large number of users.

1.2.2.1 Tendencies in the development of GIS-technologies

A significant production decrease with a simultaneous cost decrease of desktop systems stimulated migration of GIS tools from UNIX-stations to MS Windows NT (and even to MS Windows 95). This migration affected all large GIS manufacturers including ESRI, Intergraph, ERDAS, etc., resulting in appearance of new manufacturers such as MapInfo, Atlas GIS (purchased later by ESRI) and other. The majority of most time-consuming operations for data preparation, editing and presentation can be now performed by the desktop systems.

Open system technologies have become another important achievement in GIS development. Bulky all-in-one systems of the ARC/INFO and ERDAS class with their difficult-for-access and very expensive shell-development toolkits and slow internal interpretation languages (APL, EPL) do not meet the increased requirements of GIS developers and users. The transfer to module systems began, and a team of developers can flexibly use its core and a functional block set for GIS creation. It becomes possible to gradually increase the system capacity (scaling) with the increase of user's demands. One of the examples is an ESRI product line where ARC/INFO, ArcView and Atlas GIS can use the Spatial Database Engine (SDE) as clients (and as independent systems), as well as the products of other SDE supporting companies. The toolkit of developers is supplemented by a possibility of incorporating their own modules (Avenue) or, vice versa, geo-information modules to their system (MapObjects) in the DLL form.

Finally, the modern instrumental GIS can widely use the Internet capabilities beginning from specialized servers providing GIS access from Web to full functional shared systems realized on Java.

1.2.3 Updating and development of the ALISA system in 1997-1998

1.2.3.1 Updating the AARI Network

Further development of the operation systems of mass use such as Windows 95 – Windows 98 and Windows NT 4.0 – Windows NT 5.0, envisages the increase of computer-shared functions based on the "client-server" solutions not only in a two-component variant, but rather with multiple clients, servers and combining links routing the service requests. It should be specially stressed that the network presence allows using obsolete computers as "thin clients" for visualization of tasks run on more powerful computers. In addition, the AARI

LAN should expand the capability of interaction with external clients (external network) – users of information produced by the divisions of the Institute. A standard variant is the use of powerful WWW-servers coupled with the SQL-servers. The operational database is stored on SQL-servers, whereas the WWW-servers maintain the interaction interface with the Internet-clients. At the same time, the SQL-server is necessary for the Institute to meet some of its internal needs – for location and quick access from workstations to operational hydrometeorological information.

Thus to meet the aforementioned demands and increase traffic capacity of the communication channels, the AARI LAN is being reconstructed on a comprehensive basis. This includes expansion of the network services connected with operational processing of hydrometeorological information, network protection and management. Modernization of LAN is a replacement of the backbone active and passive network equipment and expansion of server facilities.

As a strategic direction for updating the AARI building information infrastructure the Fast Ethernet technology will be used for creating the trunk line, and the switched and shared Ethernet for arranging the channels to the workstations of end users.

The LAN architecture presents a star-shaped topology with two switches that are connected with periphery (store) workgroup hubs. The main servers are connected with one of the central switchers and the exit to global networks (Internet) is created via one of them.

The links between the switches present high-speed communication channels with a maximum traffic capacity of 100 Mbit/s. They are created using a fiber-optical cable and the Fast Ethernet technology.

The switch ports are linked with the ports of workgroup hubs by a “twist pair” cable. Each such link forms *a leased* high-speed communication channel using the Fast Ethernet access method with the maximum 100 Mbit/s traffic. The hub ports are connected with the user workstations also by a “twist pair” cable forming *shared* communication channels with a maximum traffic of 100 Mbit/s or 10 Mbit/s depending on the conditions for the given workgroup. Figure 2 presents a sketch of updated infrastructure of the Institute building.

1.2.3.2 Upgrading the ADTS block

Refurbishing of the communication block envisages a refusal from using the outdated "Tsiklon" complex, its dismantling and transfer to using the "Transmet-K" complex. This work was performed in the summer of 1998.

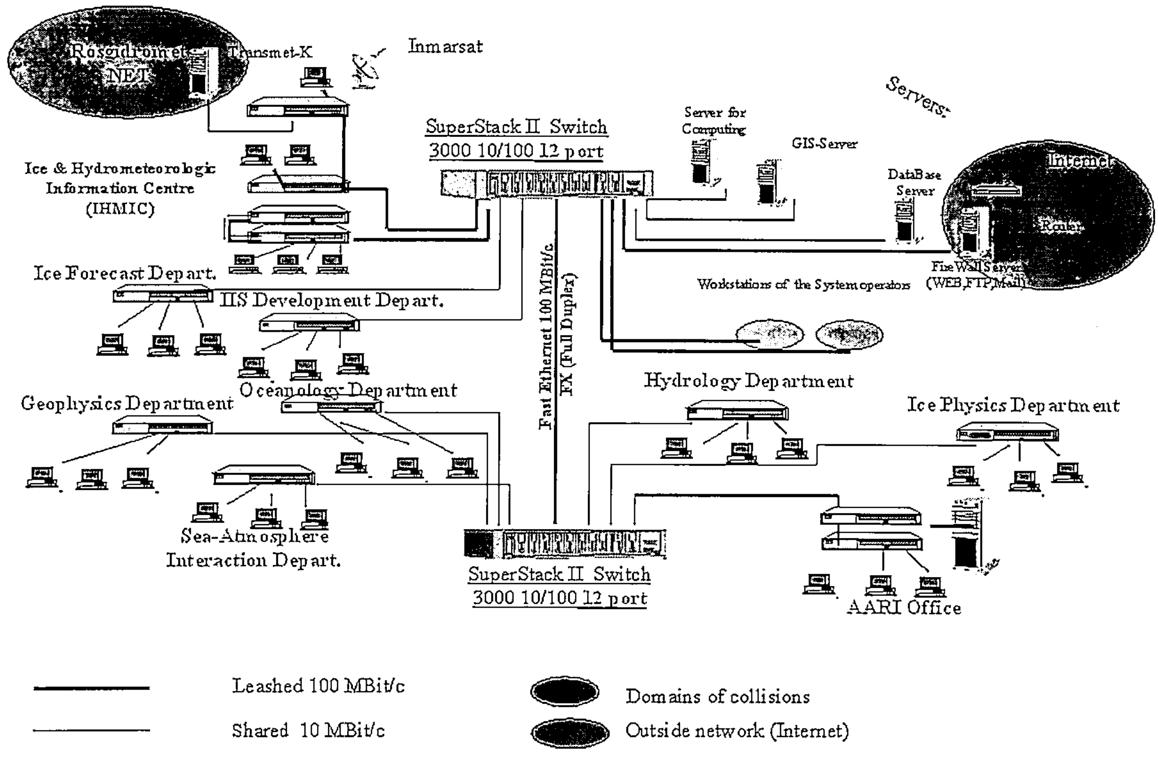
A number of measures were undertaken providing organization of digital communication channels with Dikson. Such line was introduced into practice with Amderma and Tiksi from 1997 and with Tiksi and Pevek from the spring of 1998. These channels enabled using e-mail for correspondence and the FTP protocol for exchanging operational information. The facsimile server set up in Obninsk allows a high quality exchange of ice and synoptic charts with the HMC.

There are regular consultations and coordination of work planned with the VNIIGMI-MCD (Obninsk) aiming at improving the data transfer system via the AARI-Obninsk channel, in particular, the transfer to the X.25 and TCP/IP protocols.

For communication with the Antarctic stations and ships, Inmarsat C standard equipment was installed. However, it is also possible to operate in the B-standard using the PIN-code.

1.2.3.3 Upgrading the autonomous satellite data receiving station

Refurbishing the autonomous satellite data receiving stations should provide data from the Russian (METEOR and OKEAN) and non-Russian (NOAA, ERS, RadarSat, etc.) satellites in the decimeter range (1.7 and 8.2 GHz). At the first stage, the SKANOR station ("Skaneks" Company) was purchased for receiving NOAA information in the 1.7 GHz range. In addition, the US colleagues provided the "Telonics" stations for NOAA data receiving under the international exchange framework. Both stations provide a guaranteed data receiving based on the "main-back-up" principle.



Scheme of AARI Network Upgrade

Figure 2 Scheme of AARI Network Upgrade

The Internet capabilities are widely used for obtaining additional information. In particular, medium- and high-resolution data from the "Resurs" satellite can be received on a highly operational basis from Moscow. The possibility of exchanging satellite images with Vladivostok, Khabarovsk and Yakutsk was repeatedly tested.

As one of the main methods for processing satellite data, it is proposed to use the ERDAS 8.3 software package for processing remote sensing data in a basic set Imagine Advantage and the RADAR expansion module. The variant of using ArcView 3.0 with the Image Analysis expansion module is also considered .

1.2.3.4 Current and predicted meteorological and ice data presentation block

The use of Internet capabilities is planned as the main method for information product presentation. At present, the work on providing access and testing map presentation formats is underway.

Now the INSROP participants have access to a weekly review Arctic ice chart, as well as to the forecasts of ice drift, edge motion, level surface oscillations up to 6 days in advance. The charts are presented in the picture format (gif, jpeg). It is planned in the future to use Internet MapServer ESRI for presenting the ice charts prepared in ArcView 3.0.

For chart reporting to icebreakers and vessels operating in the Arctic, the Inmarsat communication system will be used. The decision on the compulsory use of automated navigation systems (ECDIS) in high latitudes made it possible to use more fully the electronic ice charts for hydrometeorological support of marine operations. One of the problems in doing so is to incorporate the ice charts to the available systems. As a rule in ECDIS the data format in the S57 standard (former DX90) is applied. The ESRI products (adopted as basic for the INSROP GIS) do not support this standard thus creating additional problems in data conversion. However, the company management assured to provide support f or the S57 standard in the near future.

In 1997, the experiments for reporting the ice charts in the "Contour" format to vessels were carried out. The charts were to be used as an additional layer in the automated navigation systems. These experiments are still going on.

2 THE ARRI WEB-SERVER STRUCTURE

2.1 Main page outline

Address of the AARI Web-server is http://www.aari.nw.ru and the FTP-server is– ftp://ftp.aari.nw.ru. The main page of the AARI Web-server allows a user an option to select the communication language (Russian or English) as well as the amount of graphics and multimedia applications.

2.2 Description of the most important AARI web-server page for INSROP participants

By selecting the "English, frames" mode, the user enters the Web-server navigation page (Fig. 4). This page provides references to the Roshydromet Web-servers or to pages of other polar centers.

The section Main Information acquaints with a historical sketch (with illustrations), the AARI publications over 1990-1997 and allows access to the Institute department pages (Fig. 5) and the staff e-mail addresses.

The section "Operational data" contains pages with current and prognostic meteorological (Fig. 6), ice (Fig. 7) and hydrological information (Figs. 9-10). It is also possible to view Okean, NOAA and Resurs satellite images (Fig. 8). At present all charts and images are presented in the gif format. Soon the composite ice charts will also be presented in the ARC/INFO exchange format.

The section Historical Data presents archived ice cover data that can be received both from the World Sea Ice bank and from other sources. The section also describes the Sigrid and Sigrid-1 formats, as well as the draft Contour-2 format.

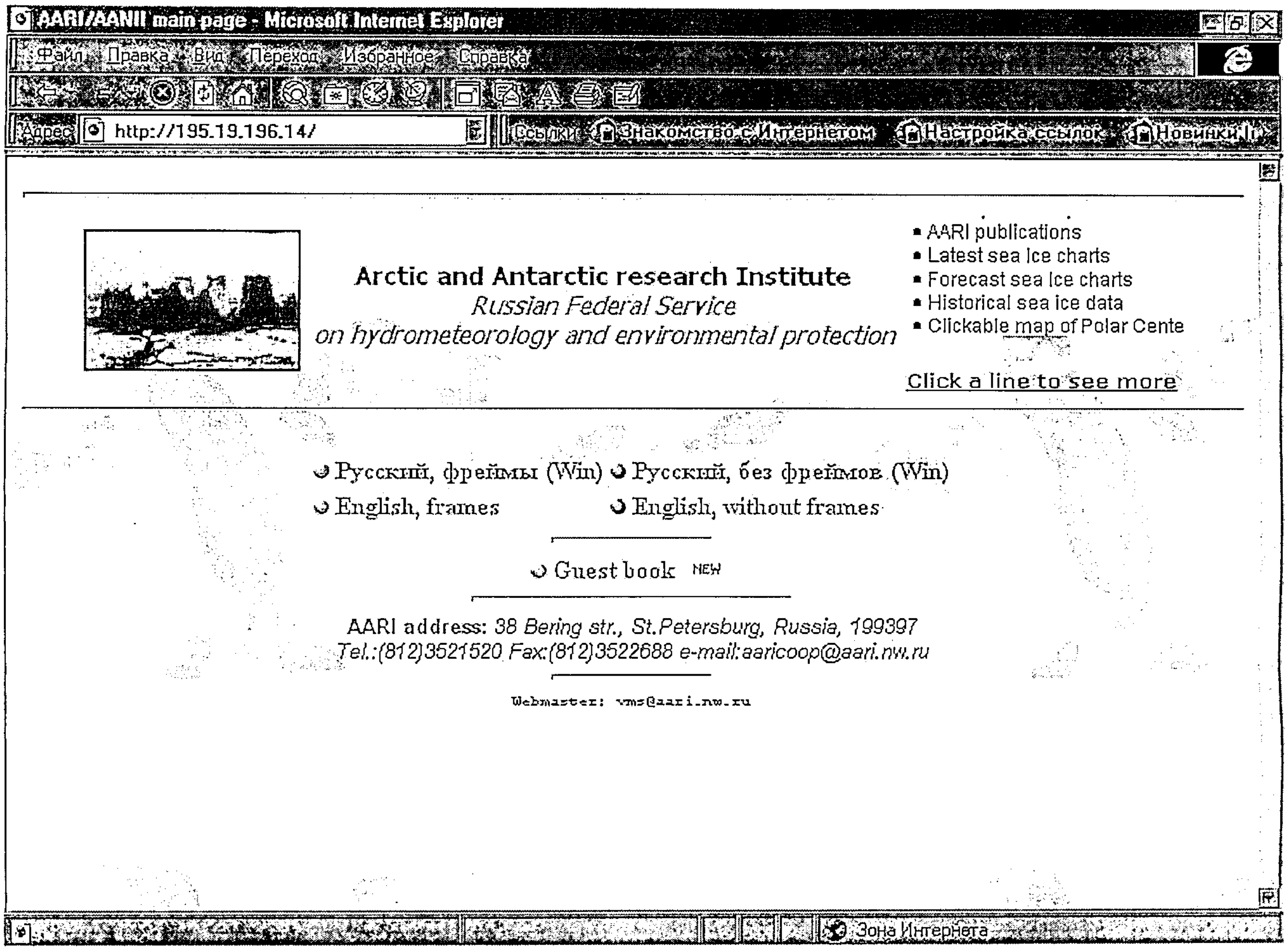


Figure 3 Main page of the AARI Web-server

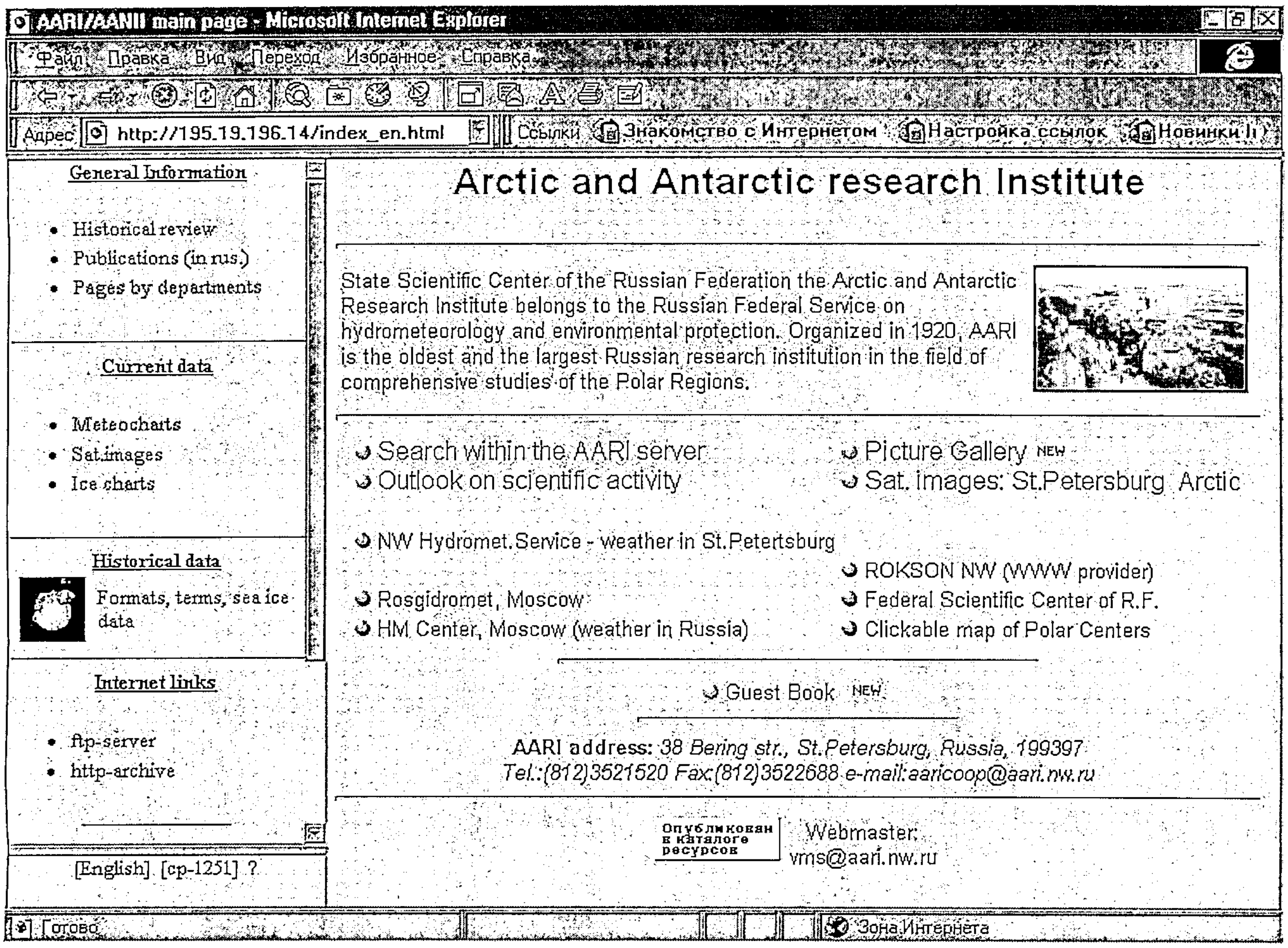


Figure 4 Web-server navigation page

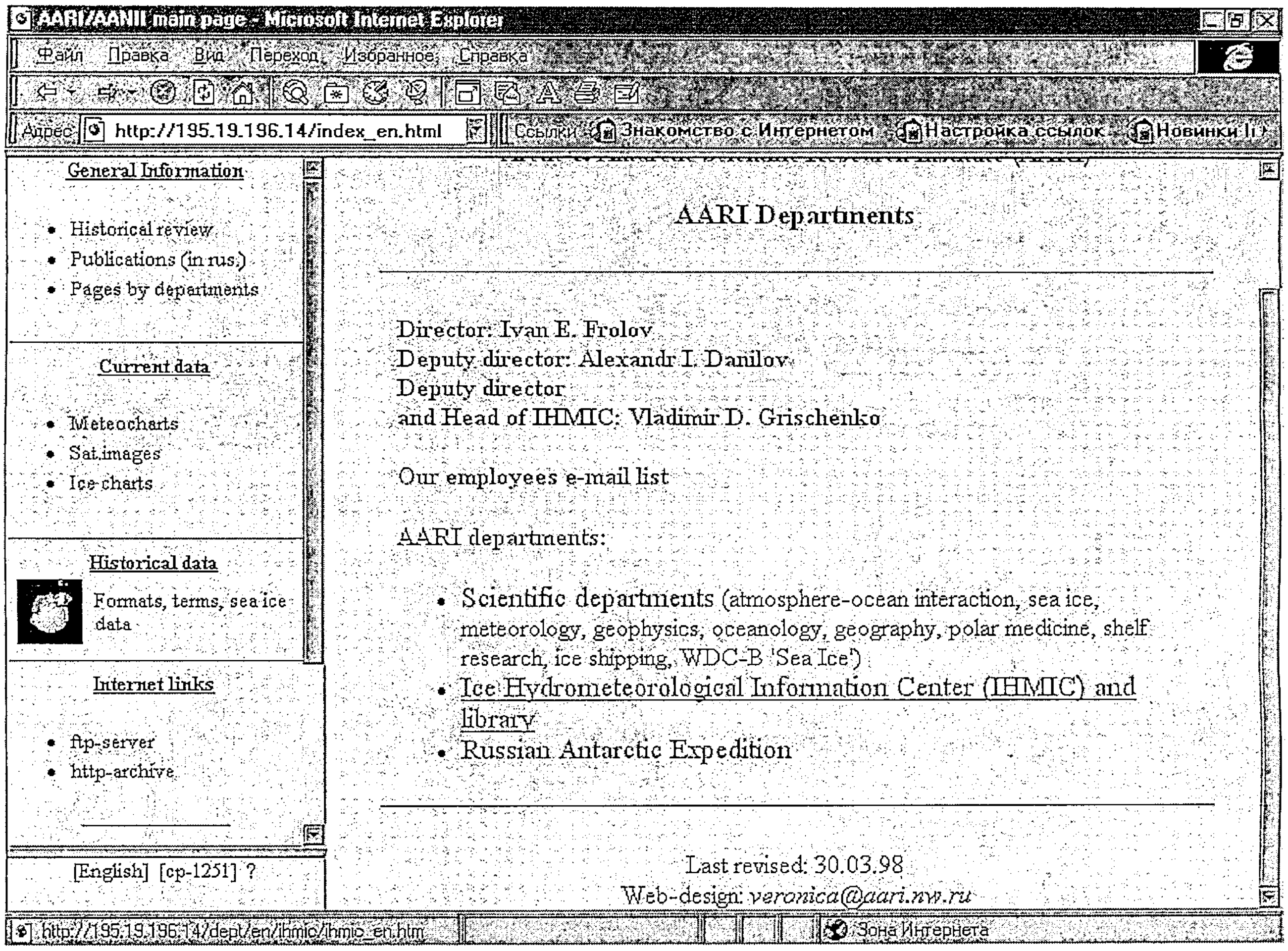


Figure 5 Institute department pages

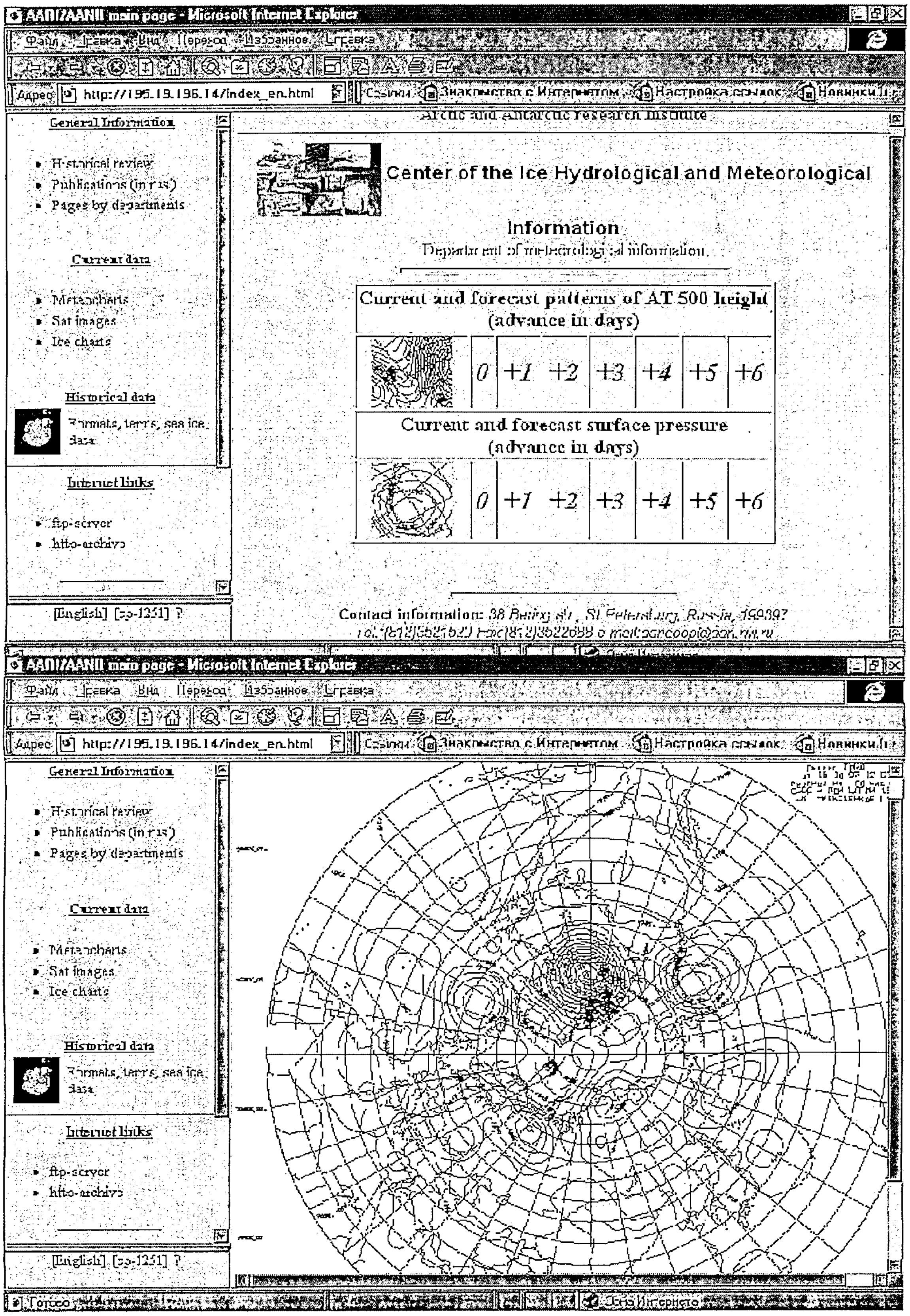


Figure 6 Meteorological information page

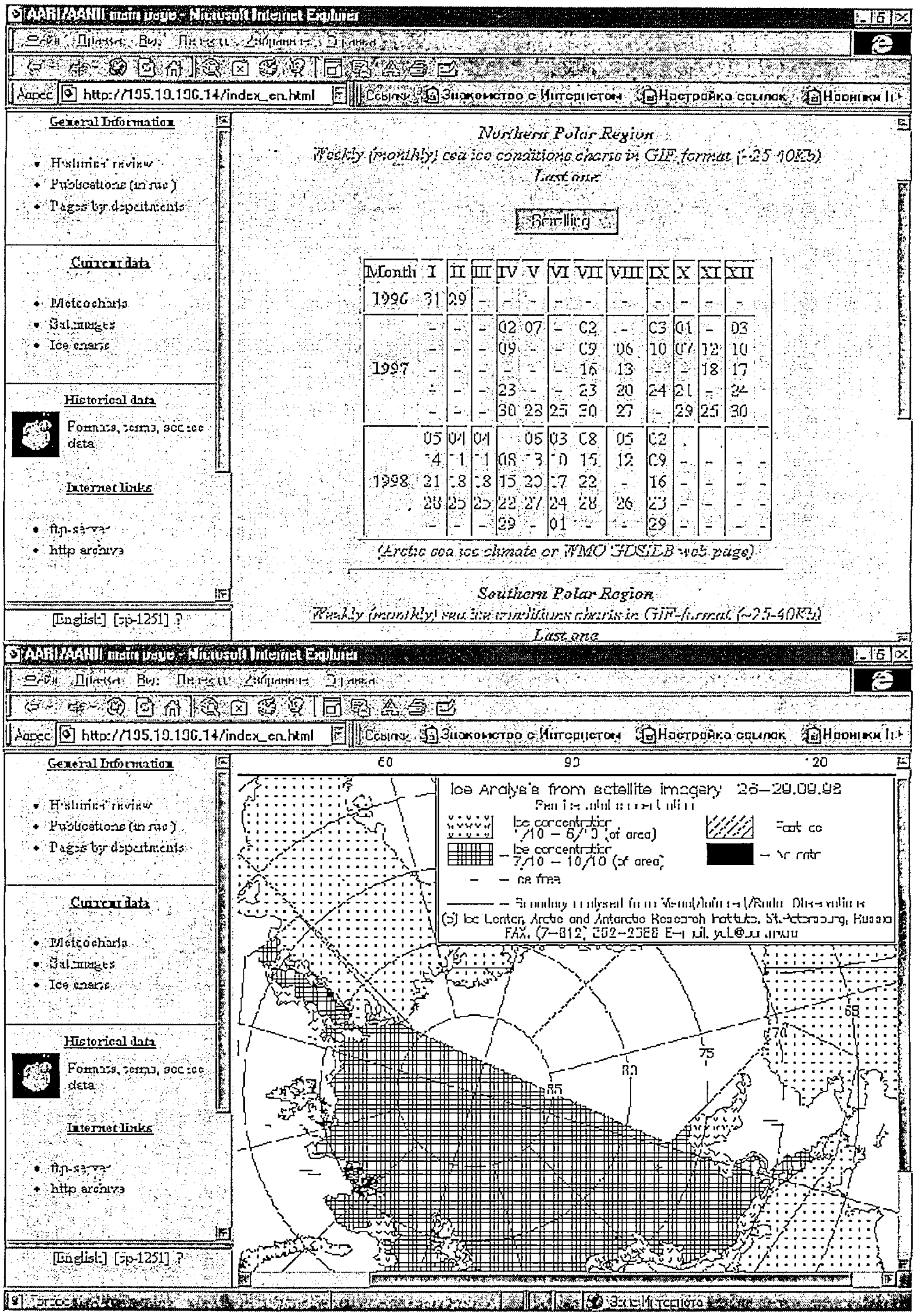


Figure 7 Ice information page

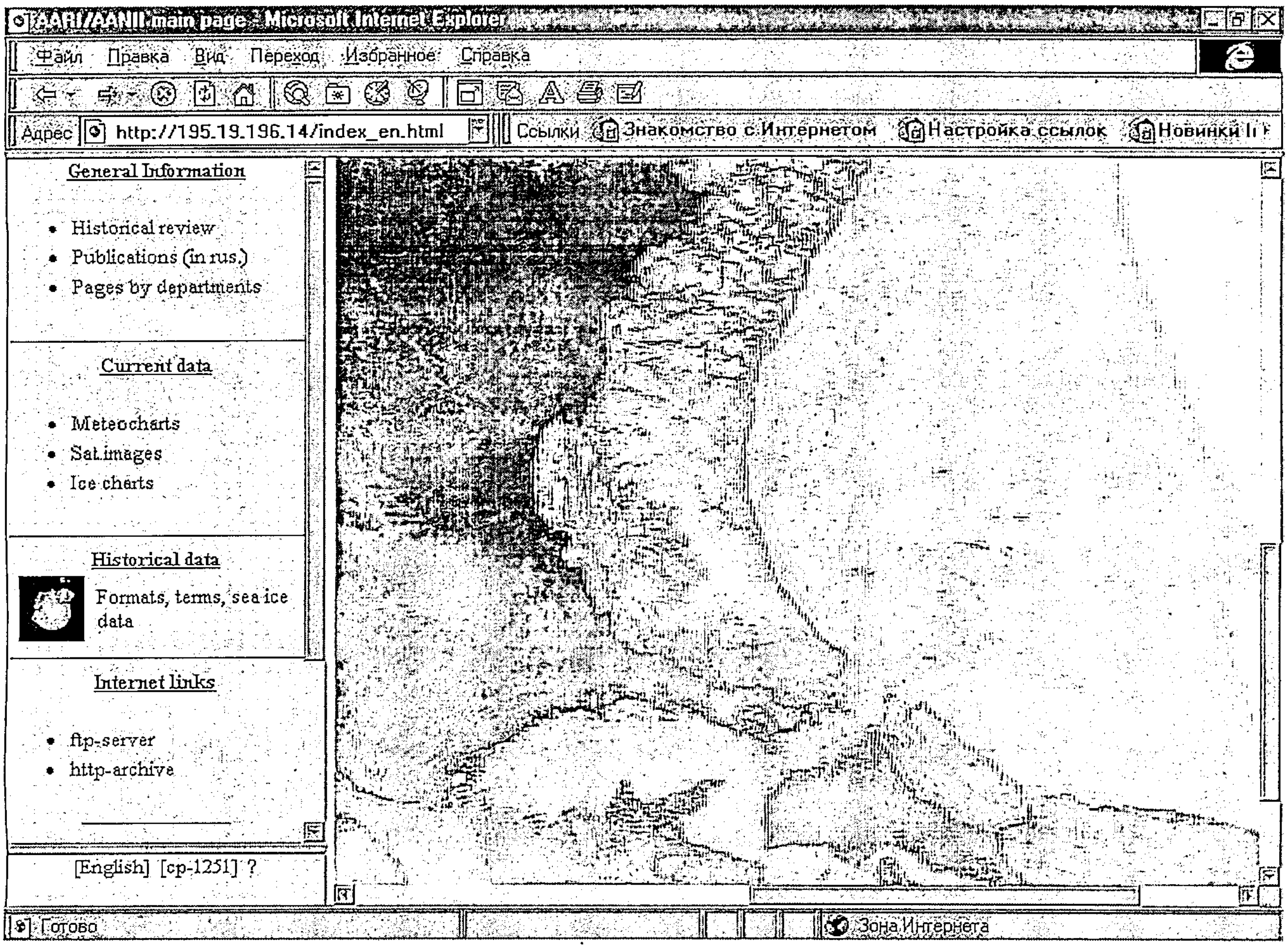


Figure 8 Example of satellite image (Kara Gate Strait region)

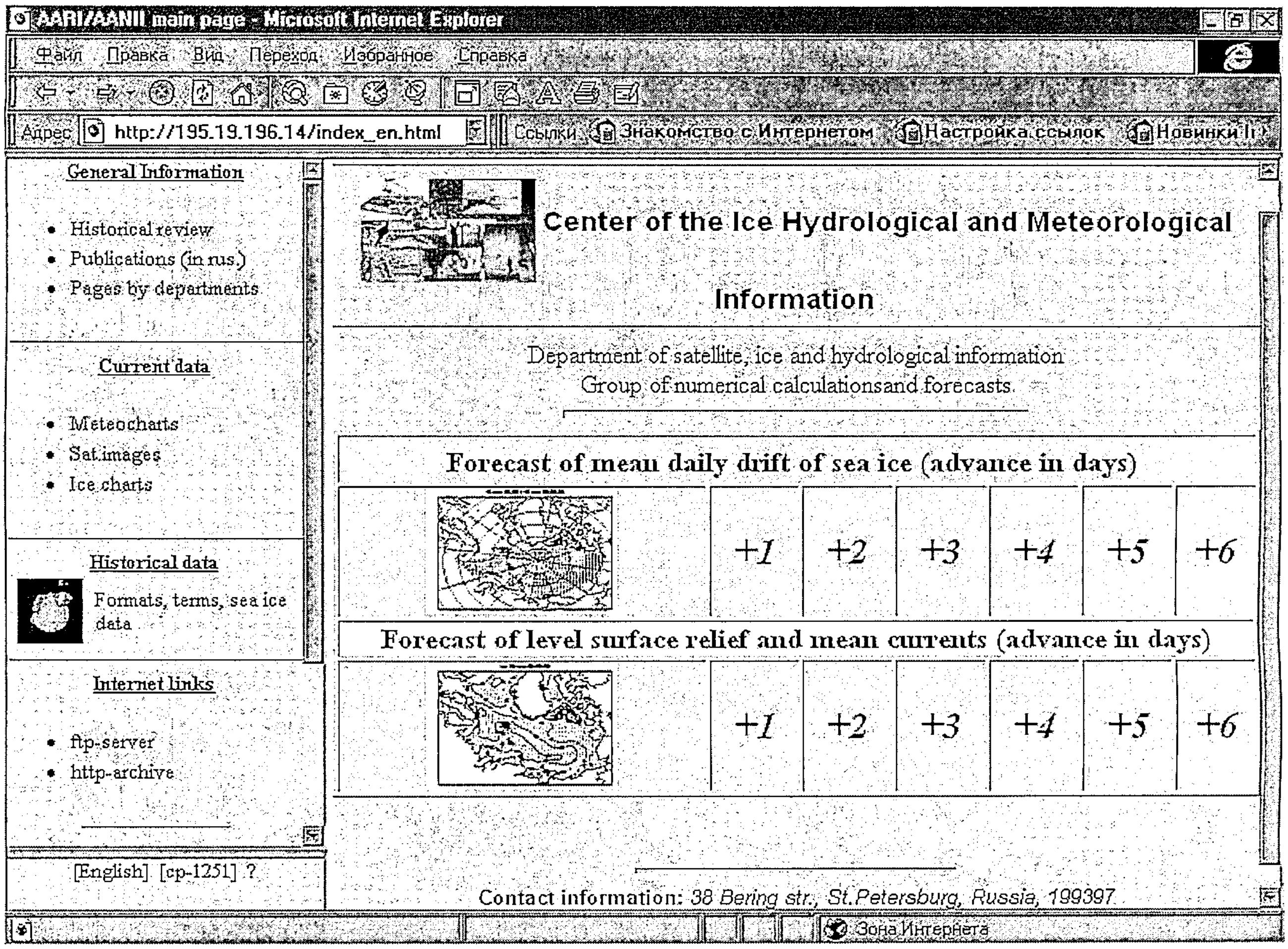


Figure 9 Forecast of ice and hydrological characteristics

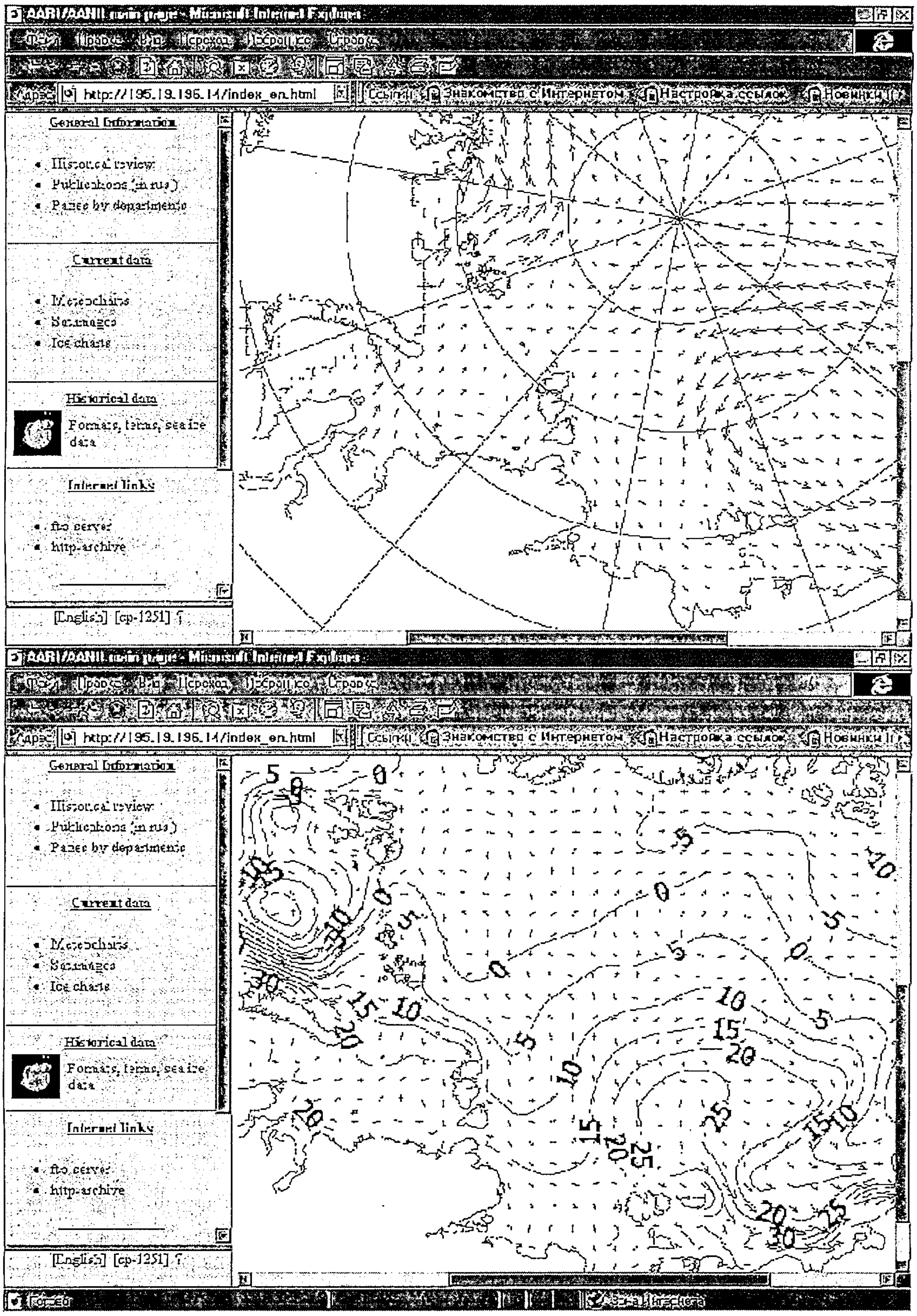


Figure 10 Example of forecasting ice drift, surface current and sea level oscillations

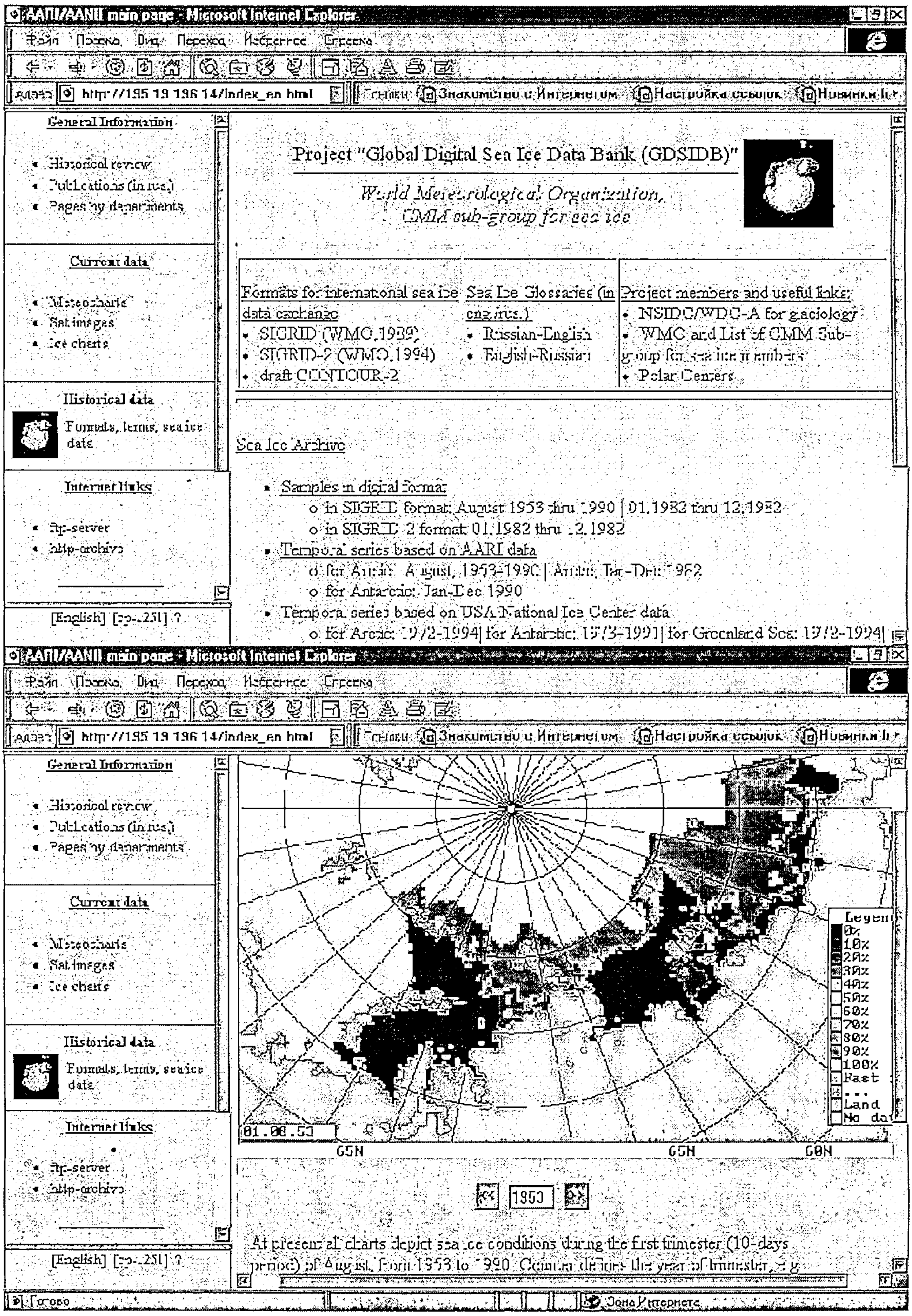


Figure 11 Archived sea ice cover data

3 DATA CONVERSION TECHNOLOGY

3.1 Data conversion in the "Contour" format

One of the objectives of Project 1.3.4 at the first stage of INSROP was to create a technology for converting operational ice charts issued by the Ice and Hydrometeorological Information Center to the Arc/Info (ArcView) GIS format.

In other words, a task was set to develop software providing conversion of data from the "Contour" format to the format suitable for using in the aforementioned GIS. Currently, the AARI has accumulated a significant data set in the "Contour" format. In addition, operational information on the actual ice distribution is also converted to this format. The converting software devised at the AARI written in the C-language provides the formation of three text data files containing all necessary information on the ice cover distribution and characteristics for constructing polygon-type coverage. The first file that is a standard ARC/INFO exchange file contains the coordinates of zones that are written in the form

```
ID
                X  Y
                END
```

Example of a file with the coordinates of zones:

```
1
    84.4667     83.8833
    70.5833     82.9667
    64.2333     81.6000
    60.0833     81.0000
    60.0167     79.8500
    60.1167     79.6833
    60.1333     79.2667
    60.0667     78.7333
    95.6333     82.9500
    84.4667     83.8833
END

2
```

60.0667	78.7333
60.7333	78.6833
61.3333	78.6500
61.6000	78.6833
61.5333	78.7667
61.7167	78.8167
61.4500	78.9333
60.8333	79.0167
60.3333	79.2000
60.1333	79.2667

END

END

The second file contains the coordinates of the central points of ice zones.

The record format provides automatic addition of polygon labels.

Example of a file with the central point coordinates:

8

2

1

1,60.8500,78.8667

1,60.6667,78.3667

1,64.1500,78.8667

1,66.7667,78.5000

1,67.0167,77.7500

1,70.0833,78.1667

1,62.9500,77.4833

1,61.1000,76.6500

1,63.4500,76.9500

9

The third file contains the characteristics of ice zones.

Record format: ID, characteristic, value.

Example of a file with the characteristics of ice zones:

1,IO,40

1,TZ,10

1,CT,99

1,CA,20

1,SA,24

1,CB,80

1,SB,20

2,IO,40

2,TZ,10

2,CT,99

2,CA,99

2,SA,22

3,IO,40

3,TZ,10

3,CT,99

3,CA,99

3,SA,22

Based on these data, a linear coverage in the ARC/INFO environment is formed presenting contours of ice zones. Then a coastline is added to this coverage and graphics is corrected in the interactive mode. When a final coverage is created the main portion of time is required for manual editing of input information. After correction, the polygonal topology is constructed and linking of zone characteristics with the table performed. The AML-software texts are contained in the Appendix.

The final coverage formation with topology construction is performed with the ARC/INFO tools using several software packages in the AML language. After that based on the coverage obtained and using Avenue in the ArcView environment an electronic map of ice distribution is plotted with WMO-code symbols (Fig. 12 and 13) that is available to User via the Internet.

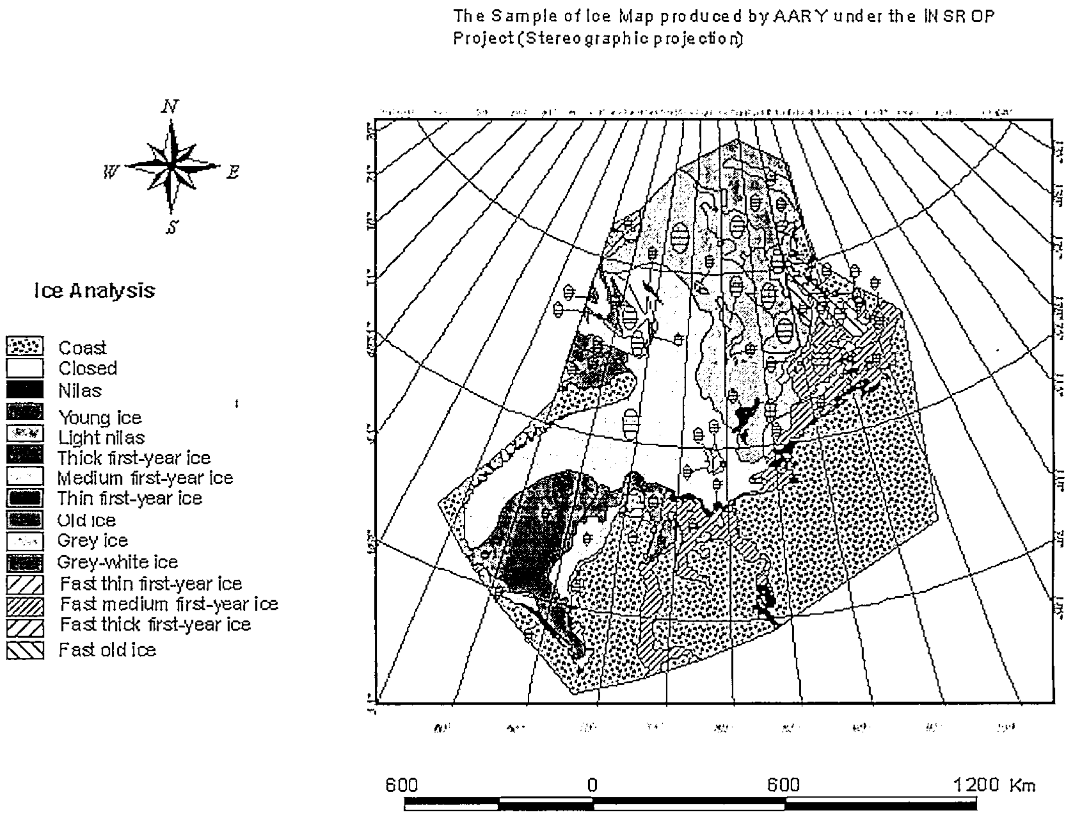


Figure 12 Example of an ice chart

3.2 Conversion of data from WP2 (Box B), WP1 (Box B) and I.4.2 (Box C-R) projects

The main aim of Project I.3.5 was to convert the aforementioned data to the format, which can be directly used in the ArcView or Arc/Info GIS.

Based on the analysis of Project 1.4.2 data, a conclusion was drawn that these data were impossible to use directly in the GIS environment. After that, it was decided to convert them to standard formats. With this aim, two software packages in the Avenue programming language were devised. They were fully tested and can be used in the project for data conversion. Moreover, the data presented in Project I.4.2 were converted using these software packages. Now all text files containing tabular information and having 131 to 142 fields are presented in the form of DBF files with 5 fields each (Segment_ID, Route_type, Year, Month, Value), whereas the coordinates of the navigation route segments present one linear shape with added fields (ROUTE_TYPE and SEGMENT_ID).

Linking between a linear shape and tabular files can be made by using the general field SEGMENT_ID.

The software texts are presented in Appendix 1.

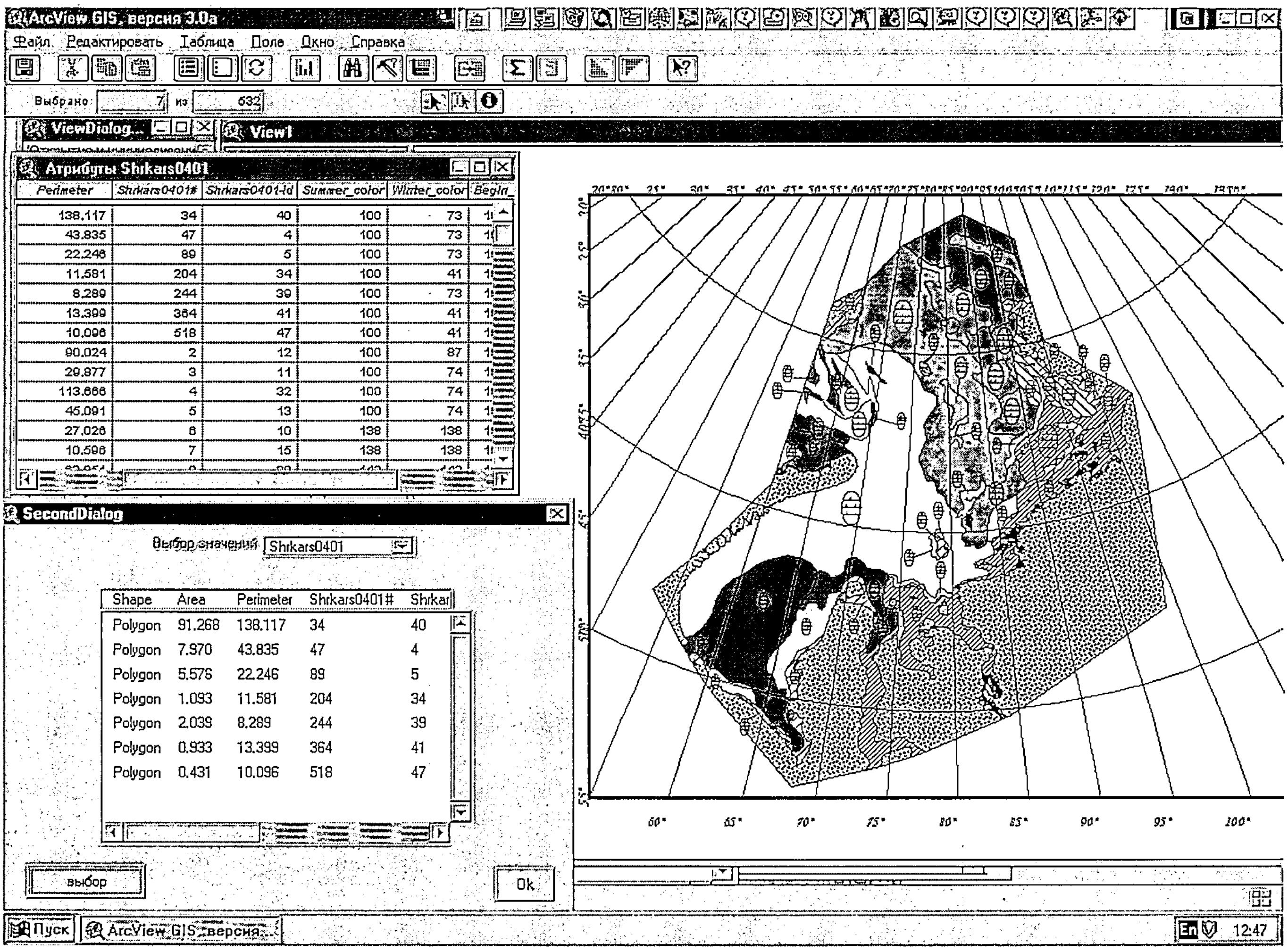


Figure 13 Example of ice chart plotting in ArcView 3.0

4 REFERENCES

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3. "Russian Module of the INSROP Information System", INSROP Symposium TOKYO'95, IST'95, October 1-6, 1995 Tokyo, Japan pp.101-104.
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5. Grischenko, V.D. et. al. "The Russian Ice-Information System for the Arctic", POAC-'95, August 15-18 1995, vol. 1, Russia, St.Petersburg, 1995, pp.194-199.
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5 APPENDIX 1 – SOFTWARE TEXTS

5.1 SOFTWARE PROVIDING LINEAR SHAPE FORMATION FOR CONSTRUCTING A LINER COVERAGE OF THE NAVIGATION ROUTES BASED ON THE ASCII-FILE FROM THE PROJECTS WP2 (Box B), WP1 (Box B) and I.4.2 (Box C-R)

```
' fields:
' ROUTE_TYPE  type char 1
' SEGMENT_ID type short 4
' SHAPE type line
_GlobalCheck=0
FiMin = 90
FiMax = 0
LaMin = 360
LaMax = 0
TmpFmin=0
TmpFmax=0
TmpLmin=0
TmpLmax=0
asciiName = FileDialog.Show("*.*","ASCII-ôàéë","Select ASCII File to Convert")
if (asciiName = nil) then
  exit
end
asciiFile  = LineFile.Make(asciiName, #FILE_PERM_READ)
totalRecs = asciiFile.GetSize
' create a shape-file
myshpName = asciiName.GetBaseName.AsString
defaultName                                                                  =
FileName.Make(asciiName.ReturnDir.AsString).MakeTmp(myshpName.AsString,"shp")
shpName  = FileDialog.Put( defaultName,"*.shp","Output Shape File" )
if (shpName = nil) then
  exit
end
shpName.SetExtension("shp")
```

```
shpFTab = FTab.MakeNew(shpName, Polyline)
fields = List.Make
fields.Add(Field.Make("ROUTE_TYPE", #FIELD_CHAR , 5, 0))
fields.Add(Field.Make("SEGMENT_ID", #FIELD_SHORT, 4, 0))
shpFTab.AddFields(fields) ' added fields to the table
shpField = shpFTab.FindField("Shape")
RouteField=shpFTab.FindField("ROUTE_TYPE")
SegField=shpFTab.FindField("SEGMENT_ID")
i = 0
while (i<totalRecs) ' a cycle of line reading from the ASCII - file
buf = asciiFile .ReadElt
bufTokens = buf.AsTokens(" ")'divided the line into components
RType=bufTokens.Get(0)
if (RType = "s") then
RType = "south"
else
RType = "north"
end
Seg=bufTokens.Get(1).AsNumber
FiBeg=bufTokens.Get(2).AsNumber
LaBeg=bufTokens.Get(3).AsNumber
FiEnd=bufTokens.Get(4).AsNumber
LaEnd=bufTokens.Get(5).AsNumber
if(FiBeg>FiEnd) then
TmpFmin=FiEnd
TmpFmax=FiBeg
else
TmpFmin=FiBeg
TmpFmax=FiEnd
end
if(LaBeg>LaEnd) then
TmpLmin=LaEnd
TmpLmax=LaBeg
```

```
else
TmpLmin=LaBeg
TmpLmax=LaEnd
end
if(FiMin>=TmpFmin) then
FiMin=TmpFmin
end
if(LaMin>=TmpLmin) then
LaMin=TmpLmin
end
if(FiMax<=TmpFmax) then
FiMax=TmpFmax
end
if(LaMax<=TmpLmax) then
LaMax=TmpLmax
end
LaBegTmp = LaBeg
LaEndTmp = LaEnd
if(LaBeg>180) then
LaBeg=LaBeg-360
end
if(LaEnd>180) then
LaEnd=LaEnd-360
end
pointList = List.Make
BegPoint= LaBeg@FiBeg
EndPoint= LaEnd@FiEnd
pointList.Add( BegPoint )
pointList.Add( EndPoint )
LaBeg = LaBegTmp
LaEnd = LaEndTmp
rec = shpFTab.AddRecord
shpFTab.SetValue(RouteField, rec,RType)
```

```
shpFTab.SetValueNumber(SegField, rec,Seg)
pl = Polyline.Make( {pointList} )
shpFTab.SetValue( shpField, rec,pl)
pointList.Empty ' cleansing of pointList
i=i+1
LaBeg = LaEnd
FiBeg = FiEnd
end ' end while
```

5.1.1 Software for conversion the ASCII-files in projects WP2 (Box B), WP1 (Box B) and I.4.2 (Box C-R) to the tabular DBF files

```
' software of file reforming to a  dbf-file
'file selection for converting to  dbf
asciiName = FileDialog.Show("*.*","ASCII-","File selection for conversion")
if (asciiName = nil) then
  exit
end
asciiFile  = LineFile.Make(asciiName, #FILE_PERM_READ)
totalRecs = asciiFile.GetSize
ID  =  Field.Make( "Segment_ID",#FIELD_SHORT, 5, 0 )
Rt  =  Field.Make( "Route_type",#FIELD_SHORT, 2, 0 )
Ye  =  Field.Make( "Year",#FIELD_SHORT, 5, 0 )
Mn =  Field.Make( "Month",#FIELD_SHORT, 2, 0 )
Vl =  Field.Make( "Value",#FIELD_SHORT, 7, 0 )
' define the new file name
MyFileName =  asciiName.GetBaseName
MyFileDir = asciiName.ReturnDir
mydict = Dictionary.Make(36)
mydict.add("P01_n.txt","Ncoldsum.dbf")
mydict.add("P01_s.txt","Scoldsum.dbf")
mydict.add("P02_n.txt","NAvFyic.dbf")
mydict.add("P02_s.txt","SAvFyic.dbf")
mydict.add("P03_n.txt","NAvMyic.dbf")
```

```
mydict.add("P03_s.txt","SAvMyic.dbf")
mydict.add("P04_n.txt","NMinIc.dbf")
mydict.add("P04_s.txt","SMinIc.dbf")
mydict.add("P05_n.txt","NMaxIc.dbf")
mydict.add("P05_s.txt","SMaxIc.dbf")
mydict.add("P06_n.txt","NLevel.dbf")
mydict.add("P06_s.txt","SLevel.dbf")
mydict.add("P07_n.txt","NAvIth.dbf")
mydict.add("P07_s.txt","SAvIth.dbf")
mydict.add("P08_n.txt","NMinIth.dbf")
mydict.add("P08_s.txt","SMinIth.dbf")
mydict.add("P09_n.txt","NMaxIth.dbf")
mydict.add("P09_n.txt","SMaxIth.dbf")
mydict.add("P10_n.txt","NWindDir.dbf")
mydict.add("P10_s.txt","SWindDir.dbf")
mydict.add("P11_n.txt","NCurDir.dbf")
mydict.add("P11_s.txt","SCurDir.dbf")
mydict.add("P12_n.txt","NFloe.dbf")
mydict.add("P12_s.txt","SFloe.dbf")
mydict.add("P13_n.txt","NRidge.dbf")
mydict.add("P13_s.txt","SRidge.dbf")
mydict.add("P14_n.txt","NMaxRidg.dbf")
mydict.add("P14_s.txt","SMaxRidg.dbf")
mydict.add("P15_n.txt","NMaxRidm.dbf")
mydict.add("P15_s.txt","SMaxRidm.dbf")
mydict.add("P16_n.txt","NAvRDens.dbf")
mydict.add("P16_s.txt","SAvRDens.dbf")
mydict.add("P17_n.txt","NMnRDens.dbf")
mydict.add("P17_s.txt","SMnRDens.dbf")
mydict.add("P18_n.txt","NMxRDens.dbf")
mydict.add("P18_s.txt","SMxRDens.dbf")

NewFileName = mydict.Get(MyFileName.AsString)
```

```
 tmpChar=NewFileName.Left(1)
 if (tmpChar= "S") then
routeNumb = 1 'route labbel: south = 1 north = 2
else
routeNumb = 2
end
'string
tmpfilename = MyFileDir.AsString+"\"+NewFileName.AsString
'create a new table
'myFile = FileDialog.Put(tmpfilename.asfilename, "*.dbf", "Resulting file")
'if (myFile = nil) then
'  exit
'end
theVTab = VTab.MakeNew(tmpfilename.AsFilename,dbase)
myTable = Table.Make(theVtab)
 myList = {ID,Rt,Ye,Mn,Vl}
theVTab.AddFields(myList)

 ' here in the cycle fill the field with data read out from the file
i = 0
rec = 0
while (i < totalRecs)
buf = asciiFile.ReadElt
if (buf = Nil) then
   i = i + 1
   continue
 end
buf1 = buf.AsTokens(" ")'divided the line into components
tmpCount = buf1.count
' tmpValue =buf1.Get(13)
'fill the fields
' AsString
' it is necessary in the cycle to divide the line into components
```

```
tmpYear = buf1.Get(0)
tmpMonth = buf1.Get(1)
k = 1
tmpCount = tmpCount-1
for each i in 2..tmpCount

rec = theVTab.AddRecord
theVTab.SetValue(ID,rec,k)
theVTab.SetValue(Rt,rec,routeNumb)
theVTab.SetValue(Ye,rec,tmpYear)
theVTab.SetValue(Mn,rec,tmpMonth )
theVTab.SetValue(Vl,rec,buf1.Get(i))
 'add a record to the table
 k = k+1
end ' for each
end ' while

theVTab.Flush
```

9 December 1998

"Design of Information System"

By V. D. Grishchenko, V. G. Smirnov, O. S. Deviatayev, Yu. A. Shcherbakov, and S. V. Kovachev

Reviewed by
W. M. Sackinger

This is a description of the construction of the Web Pages of the Arctic and Antarctic Research Institute (AARI), including an Operational Information System for assistance in navigation on the Northern Sea Route. The Operational Information System is easily reached from the links on the introductory Web Pages. The charts to be available include ice charts, meteorological charts, satellite imagery, ice movement vector charts, both current and prospective.

The design of the information system, and the plan for its implementation, seem to be quite well conceived. The hardware and software internal to the AARI appears to be of contemporary speed and capacity, and is sufficient for the scientists there to compose the charts and load them on the server for access by customers on the Internet.

A trial of the system, however, has revealed several features of it which render it only marginally useful for real-time ice navigation. The most recent ice chart is 18 days behind real time. The satellite imagery is delivered at a very slow data rate of 160-180 bytes/sec, and is typically a 275K file, implying that many minutes are required to download the image on the terminal of a user. The most recent satellite image is 29 June 1998, some 5 months behind real time. The +3-day ice forecast yields a 40K file size being delivered at a painfully-slow 380 bytes/sec. The +3-day forecast does not show the date for which the forecast is valid, leaving it to the viewer to guess whether it is three days from today, or three days from the most recent ice chart which may be quite obsolete. Movement vectors are rather qualitative in the ice forecast charts, with direction and rough magnitude, but the new, predicted, ice distribution is not shown. This would be helpful. All charts should possess a date of their preparation, and the date for which a predictive chart is valid. The AT-500 mb atmospheric pressure chart for +1-day forecast was delivered at about 156 bytes/sec and was a 75K file, again a delivery time too long to be economic or to even take place without random interruption. These difficulties may be associated with the use of the .gif format, and other formats should be tried which deliver imagery faster. The obvious bottleneck in system delivery needs to be found and eliminated, for this to be useful. As it is now, the Inmarsat link to a ship transiting the NSR would charge many hundreds of US dollars to deliver each image, with low probability of a successful full transmission.

The archival ice imagery only holds samples of ice charts, from typically 15 years ago, and the full availability of all ice charts in the archival files, by means of the Internet link, seems to be very far in the future. Nevertheless, this should be a continuing objective of future scientific work.

When the difficulties with slow data flow and infrequent updates are solved, this system promises to be workable and usable. We look forward to that day.

Author's answer to comments of Dr. Sackinger

We sincerely appreciate your comments to our report.

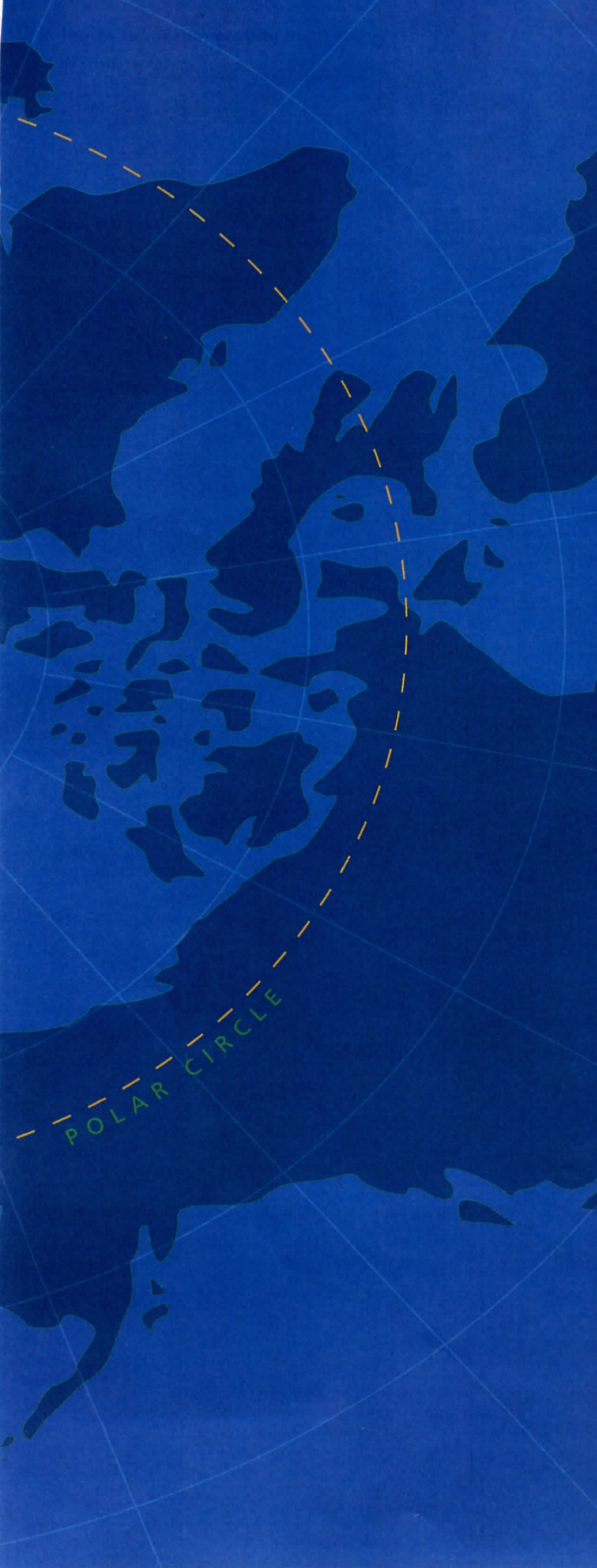
Information presented at present on the AARI Web Pages has mainly an illustrative character. One of the objectives of our project was the organization of access for INSROP *participants* to this information. Real operational information according to all requirements of the hydrometeorological supporting ice navigation will be provided when the international navigation along the NSR is started.

With the development of the AARI information system and application of GIS-technologies to prepare information products the content of Web Pages will increase.

Certainly, we are not satisfied ourselves with a very slow access rate to the AARI operational information. We have access to the global networks using a fibre -optical cable with the potential data rate of 10 Mb/s. But in addition to the financial and technical difficulties connected with the necessity of replacement of obsolete net hardware we have also organizational problems.

Unfortunately, the ROKSON net we use has no own channels to Europe and leases only one channel with the data rate of 512 Kb/s. This is not the justification but the ascertaining of the fact that the lack of INSROP investments to the development of infrastructure of the Russian information system core caused problems for all INSROP participants.

Best Regards
V.D. Grishchenko,
V.G. Smirnov,
O.S. Deviatayev



The three main cooperating institutions of INSROP

Ship & Ocean Foundation (SOF), Tokyo, Japan.
SOF was established in 1975 as a non-profit organization to advance modernization and rationalization of Japan's shipbuilding and related industries, and to give assistance to non-profit organizations associated with these industries. SOF is provided with operation funds by the Sasakawa Foundation, the world's largest foundation operated with revenue from motorboat racing. An integral part of SOF, the Tsukuba Institute, carries out experimental research into ocean environment protection and ocean development.

Central Marine Research & Design Institute (CNIIMF), St. Petersburg, Russia.
CNIIMF was founded in 1929. The institute's research focus is applied and technological with four main goals: the improvment of merchant fleet efficiency; shipping safety; technical development of the merchant fleet; and design support for future fleet development. CNIIMF was a Russian state institution up to 1993, when it was converted into a stockholding company.

The Fridtjof Nansen Institute (FNI), Lysaker, Norway.
FNI was founded in 1958 and is based at Polhøgda, the home of Fridtjof Nansen, famous Norwegian polar explorer, scientist, humanist and statesman. The institute spesializes in applied social science research, with special focus on international resource and environmental management. In addition to INSROP, the research is organized in six integrated programmes. Typical of FNI research is a multidisciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.