Sea ice Data Sets Available within the WMO GDSIDB Project and Future Candidates

Vasily Smolyanitsky,
Arctic and Antarctic Research Institute &
JCOMM Expert Team on Sea Ice
• Started in 1989 according to recommendations and resolutions of CMM to provide data for WCP, WCRP etc.

Near North pole (82°N,172°W), 08 September 2000
WMO Global Digital Sea Ice Data Bank project, other facts from the history

- Started in 1989 according to recommendations and resolutions of CMM to provide data for WCP, WCRP etc.
- At its second session in August 1992 NSIDC, NIC and AARI were only contributors
- In May, 2000 the last 8th session was held there representatives from the main ice services are data centers were present, including AARI, Argentina, BSIM, China, CIS, DMI, Iceland, JMA, NIC, NSIDC
- During 1980s-90s supervised by the former CMM sub-group on sea ice and its own Steering Group with two co-chairmen – Dr R.G.Barry (NSIDC) and Dr I.Ye.Frolov (AARI), has two archiving centers at NSIDC and AARI
- Supported by JCOMM-I resolutions, now supervised by JCOMM PA Services Expert Team on Sea Ice
- In October 2002 next 9th session is planned in Buenos Aires
Prime data source - digitization of historical and operational sea ice charts
Main data unit - sea ice chart, describing linear elements of ice cover and uniform ice zones

Historical AARI ice chart

NIC ice chart in standard WMO Nomenclature
1. AARI data set, Arctic, summary for 1950-1992

Sea Ice parameters included:
- total concentration
- stages of ice development (up to 11 acc. to WMO Nomenclature, including NY, FY, MY etc.)
- indicator for drifting/fast ice
- estimate of mean-weighted thickness of level ice

Coverage (n/N), %

Robust mean

- 10-days periodicity with gaps in time and space
- in SIGRID-1, EASE-GRID ArcInfo compatible formats
1. (continued) AARI data set, Arctic, summary for 1950-1959

Coverage (n/N), %

Robust mean

Sample winter chart (April, 1954)

Sample summer chart (July, 1954)
1. (continued) AARI data set, Arctic, summary for 1960-1969

**Coverage (n/N), %**

**Robust mean**

<table>
<thead>
<tr>
<th>Total</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
<th>Fast ice</th>
<th>Land</th>
<th>No data</th>
</tr>
</thead>
</table>

*Sample winter chart (March, 1962)*

*Sample summer chart (July, 1962)*
1. (continued) AARI data set, Arctic, summary for 1970-1979

Coverage (n/N), %

Robust mean

Sample winter chart (Feb., 1972)

Sample summer chart (July, 1972)
1. (continued) AARI data set, Arctic, summary for 1980-1989

Coverage (n/N), %

Robust mean

Sample winter chart (Jan., 1986)

Sample summer chart (Aug., 1985)
2. NIC data set, Arctic region, summary for 1972-1994

Sea Ice parameters included:
- total concentration
- stages of ice development (up to 11 acc. to WMO Nomenclature, including NY, FY, MY etc.)
- indicator for drifting/fast ice
- estimate of mean-weighted thickness of level ice

Coverage (n/N) = 100 %

Robust mean

-7-days periodicity without gaps in time and space
- in SIGRID-1, EASE-GRID ArcInfo .e00 and other compatible formats

First chart (03.01.1972)  One of the last charts (10.08.1994)
3. NIC data set, Antarctic region, summary for 1973-1994

Coverage (n/N) = 100 %

Sea Ice parameters included:
- total concentration
- very few cases for stages of ice development for 70s, but situation much better for 80s and 90s - NY, FY, MY etc. present on last charts

- 7-days periodicity without gaps in time and space
- in SIGRID-1, EASE-GRID ArcInfo .e00 and other compatible formats

One of the first charts for winter period (Aug., 1973)

One of the last charts for winter period (Aug., 1994)

Coverage (n/N) = 100 % for ice season (~December - ~ May)

Sea Ice parameters included:

• total concentration

5-days periodicity without gaps in time and space

in SIGRID-2, EASE-GRID

Sea Ice chart for 03.02.1994
5. BSIM data set (FIMR and SMHI), Baltic Sea, summary for 1960-1979

Coverage (n/N) = 100 % for ice season (~November - ~ June)

Sea Ice parameters included:
- total concentration
- sea ice thickness / 9 stages of ice development acc.
- fast ice indicator

- 3-4-days periodicity without gaps in time and space
- in SIGRID-1, Baltic code, EASE-GRID

Sea Ice chart for 14.02.1967
6. CIS data set, Canadian Arctic, summary for 1968-1998

Coverage (n/N) = 100 % for ice season (~November - ~ June)

Sea Ice parameters included:
• total concentration
• stages of ice development (up to 11 acc. to WMO Nomenclature, including NY, FY, MY etc.), mean-weighted thickness.....
• indicator for drifting/fast ice

- 7-days periodicity without gaps in time and space
• in SIGRID-1, ArcInfo .e00
Total summary:

1. Sea Ice total concentration, ice extent and estimates of mean-weighted thickness of level ice are available on the basis of AARI data for Eurasian shelf seas
   • with least amount for summer period (June-early September) for 1950…1992 and for second half of winter (Feb-March-May) for the NSR area
   • for other months (October-December, April) efficient material starts in 1960s

2. Starting from late 1960s blended datasets based on AARI, CIS and NIC charts and containing sea ice total concentration, ice extent and estimates of mean-weighted thickness in principal can be constructed for the Arctic Ocean with 7-10 days periodicity on ~25x25 km grid.
Formats used to archive data from sea ice charts

1. WMO SIGRID (Sea Ice GRID) or SIGRID-1. The most used up to now format. Proposed by SMHI expert T. Thompson. Approved by WMO in 1989. Uses raster coding of charts. At each node of geographical grid with basic resolution of 15’ all coded acc. to WMO Sea Ice Nomenclature sea ice parameters are written as ASCII string like: $CT92CA609708CB309508CC108508$ Linear objects and dynamic processes can be also coded. All ice identifiers (~50), identifications are summarized in Code Tables.

2. WMO SIGRID-2. Proposed by AARI expert A.V. Bushuev. Approved by CMM in 1994. Similar to SIGRID but is more friendly for the user to understand codes and produce shortened ASCII strings. Presently used by JMA to code charts for the Sea of Okhotsk. Part of AARI material is also duplicated in SIGRID-2.
3. In order to facilitate user access, in 1996-1997 NSIDC and AARI converted sea ice charts from basic SIGGRID into EASE-GRID projection coinciding with 25 or 12.5 km SSM/I. One grid correspond to sea ice parameter, e.g. CT (total concentration) or MY (partial concentration of multi-year ice)

4. In 1997-2000 while preparing Joint Russian-USA Artic Ocean sea ice Atlas AARI and NIC archives in SIGRID-1 were converted or reproduced in GIS ArcInfo .e00 and other import format. However, SIGRID coding for ice parameters remained.

5. In 2000-2002 in cooperation with IICWG (International Ice Charting Working Group) a new draft SIGRID-3 is under preparation for both operational and historic data. Uses vector coding. Utilizes: a) WMO adopted SIGRID-1 Code Tables, b) ESRI .shp open format to code uniform zones of sea ice parameters, c) descriptive information (like agency, projection, region etc.) is put into supplementary .xml file.

SIGRID-3 is expected to be considered and possibly recommended for adoption by WMO Secretariat at ETSI-I in October 2002
Access to the GDSIDB data

1. At NSIDC (http://www.nsidc.org) use http- or ftp-links to copy data in SIGRID or EASE-GRID formats or contact User services
Access to the GDSIDB data (continued)

2. At AARI web-site (http://www.aari.nw.ru) go to GDSIDB page (http://www.aari.nw.ru/gdsidb/) to get graphical replica of SIGRID data, various climate statistics or e-mail to wdc@aari.nw.ru to get data in SIGRID format.

Interactive SIGRID Java-browser (version 2.0beta, 29 March 2001)

Decadal statistics for AARI data.

Java-browser for SIGRID data

Mixed AARI and NIC charts
## Anticipated data sets within GDSIDB archive

<table>
<thead>
<tr>
<th>#</th>
<th>Institute</th>
<th>Region</th>
<th>Time interval</th>
<th>Exchange date/notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AARI</td>
<td>Antarctic</td>
<td>1971-1990 (10-days period 1933-1949)</td>
<td>SIGRID-1,3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arctic ???</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Argentinean Navy Hydrographic Service</td>
<td>Weddell and Bellingshausen Seas</td>
<td>App. 1982 to 1990, point observations Current observations</td>
<td>2001-2002 Point observations in NIC-code in .db format, submitted with weekly interval to NSIDC and AARI ftp-servers</td>
</tr>
</tbody>
</table>
### Anticipated data sets within GDSIDB archive *(continued)*

<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th>Description</th>
<th>Period</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Australia (within the ASPeCT project)</td>
<td>Antarctic, en-route and pointal observations</td>
<td>1980-1997</td>
<td>In WMO code</td>
</tr>
<tr>
<td>5.</td>
<td>CIS</td>
<td>Canadian Arctic</td>
<td>1999-ongoing data forward in time</td>
<td>SIGRID-3</td>
</tr>
</tbody>
</table>
### Anticipated data sets within GDSIDB archive (continued)

<table>
<thead>
<tr>
<th></th>
<th>Data Provider</th>
<th>Location</th>
<th>Time Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>China, State Oceanic Administration</td>
<td>Bohai Sea</td>
<td>1968 – up to present, 1952/53 – up to present</td>
<td>0.1° by 0.1° grid, total and partial concentrations and stages of development maximum annual extent to be submitted before the next meeting</td>
</tr>
<tr>
<td>7.</td>
<td>DMI</td>
<td>Greenland waters</td>
<td>March 1999 – up to present</td>
<td>SIGRID-3</td>
</tr>
<tr>
<td></td>
<td>Organization</td>
<td>Area/Location</td>
<td>Time Period</td>
<td>Status</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------</td>
<td>------------------------------------</td>
<td>------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>8.</td>
<td>Germany, Federal Maritime and Hydrographic service (BSH)</td>
<td>Baltic Sea (south of 56°N and to the west of 14 20’)</td>
<td>1960-1982 and updates</td>
<td>to be determined</td>
</tr>
<tr>
<td>9.</td>
<td>Icelandic Meteorological Office</td>
<td>Icelandic waters</td>
<td>to be determined</td>
<td>to be determined</td>
</tr>
<tr>
<td>10.</td>
<td>JMA</td>
<td>Sea of Okhotsk</td>
<td>ongoing data forward in time</td>
<td>Once a year in SIGRID-2 format</td>
</tr>
</tbody>
</table>
## Anticipated data sets within GDSIDB archive (continued)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Arctic Antarctic</th>
<th>1995 – 1996</th>
<th>1995 – 1997</th>
<th>need to be converted to standard format and undergo QC before submission</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>NIC</td>
<td>Arctic</td>
<td>1996 - till present</td>
<td>1998 – till present</td>
<td>ArcInfo e00-format, available on-line via NIC web-site, SIGRID-3</td>
</tr>
</tbody>
</table>
Assessment of Sea Ice variability for 1950-1994 on the basis of GDSIDB data: trends or oscillations?
Weekly values and linear multi-annual trend of the normalized (by total concentration) sea ice cover area for Northern Polar Region for 1972-1991 period, 7-days NIC sea ice charts
Linear trend and robust mean (total concentration) for 1972-1994 (NIC data)

Two-dimensional trend: 1972-1994

Linear trend and robust mean (total concentration) for 1950-1992 (AARI data)

Two-dimensional trend: 1950-1992
August, 1972-1994

Linear trend and robust mean (total concentration) for August, 1972-1994 (CIS&NIC data)

August, 1950-1992

Linear trend and robust mean (total concentration) for August, 1950-1992 (AARI data)
Sub-periods?

1954-1963 (19 Solar cycle)
1964-1975 (20 Solar cycle)
1976-1985 (21 Solar cycle)
1986-1995 (22 Solar cycle)

To simplify analysis, solar cycles are chosen, however, cosmic influence is definitely indirect, while decadal variability of patterns of atmospheric circulation over Arctic is obvious.
Robust mean, Aug 1950-59 (AARI&J.Walsh data)

August, 1950-1959

August, 1960-1969

Robust mean, Aug 1960-69 (AARI&J.Walsh data)

August, 1986-1995

Robust mean, Aug 1986-95 (NIC&CIS data)
Further in past ....

Annual variations of ice extent in the last 10-days period of August within the area of Eurasian shelf seas (Kara, Laptevs, East-Siberian and Chukcha) based on AARI data. Black line – 4th order smoothing polynomial. Vertical scale – r.m.s of ice extent. Courtesy: A.G.Egorov, AARI
You are welcome to GDSIDB web-page for complete set of statistics, in graphic and digital form:
http://www.aari.nw.ru/gdsidb/