Advances in sea-ice data sets for XX century within the WMO Global Digital Sea Ice Data Bank (GDSIDB) project

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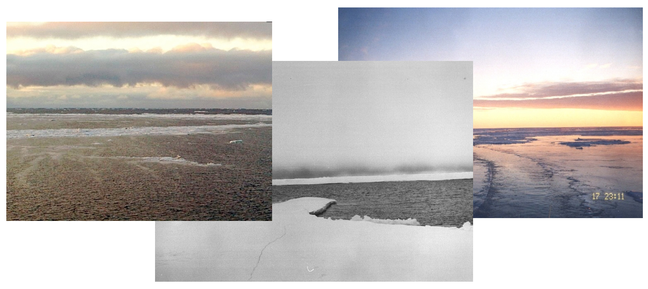
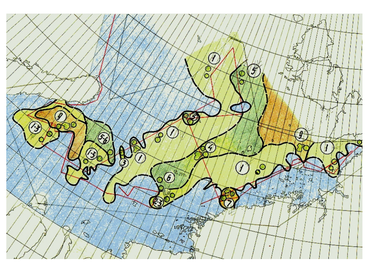
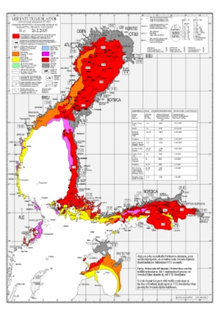
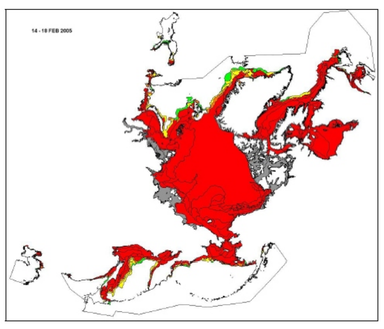
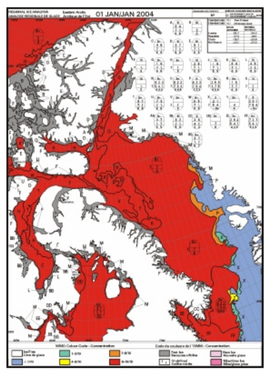


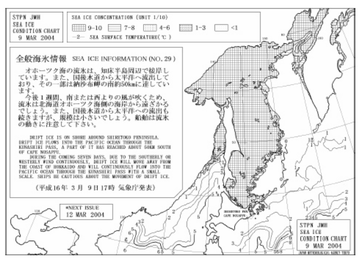
Ice charting now has more than 100 years practice, i.e. we may assess long-term trends. WMO Nomenclature firstly introduced in 1950s, incorporates experience from a number of national services, i.e. we may blend ice charts. Ice charts are still more harmonized product than remotely sensed data, using ice charting technique we can test how different Sea Ice Terms, e.g. ice edge and openings are described by remotely sensed means, i.e. validate them.



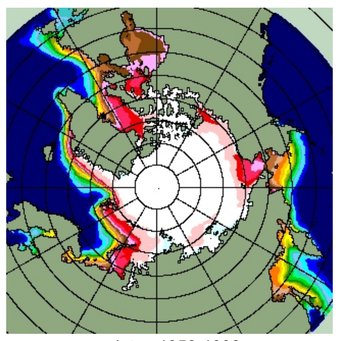




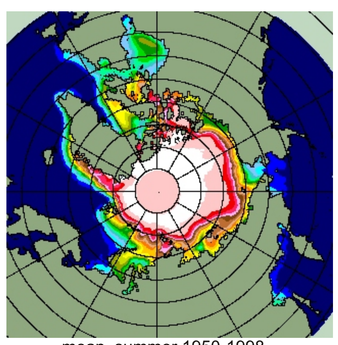




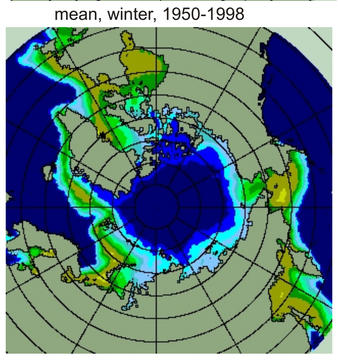
Sample historical ice charts from GDSIDB archive: AARI (Russian Federation), FIMR (Finland / Baltic Sea Ice Meeting), NIC (USA), CIS



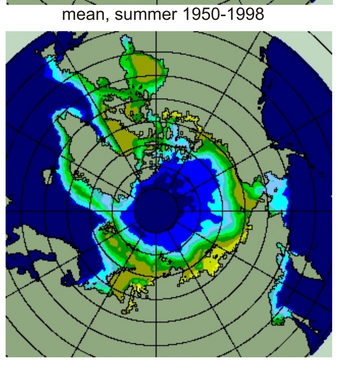
mean, winter, 1950-1998



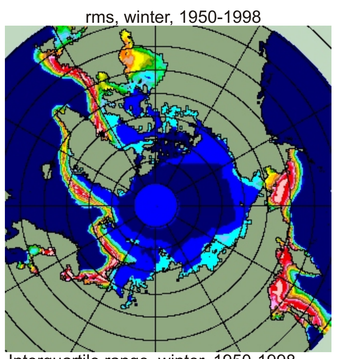
mean, summer 1950-1998



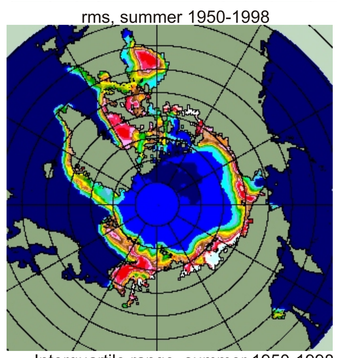
rms, winter, 1950-1998



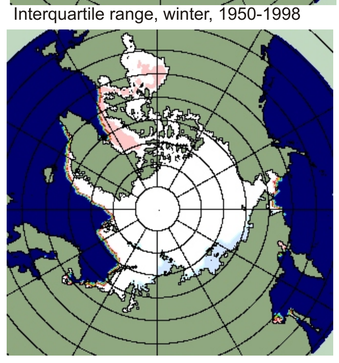
rms, summer 1950-1998



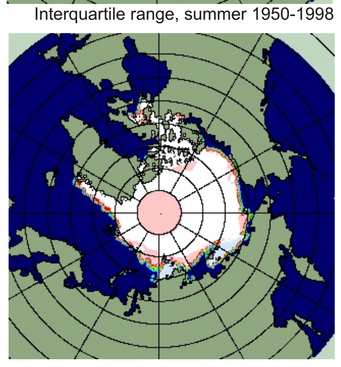
Interquartile range, winter, 1950-1998



Interquartile range, summer 1950-1998



mode, winter, 1950-1998



mode, summer 1950-1998

Extended set of seasonal statistics, based on GDSIDB blended monthly data for 1950-1998 (AARI+CIS+NIC+J.Walsh) // Proposal for WMO norms on sea ice

Summary

In the present report an attempt is undertaken to give a possibly fuller description of historical ice charts of the XX century submitted in a digital form by national ice services, and to show special features of applying various statistical parameters to assess long-term and large-scale variability of ice conditions of the Arctic region.

Types of ice information for climatic studies

The historical sea ice information used in climatic researches, may be differentiated:
- by the nature as direct and indirect or proxy,
- by dimensions as pointal, linear and fields of characteristics, and lastly,
- reception means as surface (visually and/or instrumentally) and remotely sensed.

Ice charts as an optimal informational product

We estimate ice charts as an information product, optimal and self-sufficient for an assessment of the variability of an ice cover of XX century from aspects of temporal duration, accuracy, harmony (i.e. presence of insignificant changes in compilation technique), as well as spatial coverage of Arctic regions. Other types of the ice information under condition of their individual use - satellite data (for example SSMR-SSM/I), coastal station, shipborne, proxy from fauna/flora, folklore, etc. concede on a number of parameters either in duration, or accuracy, or in spatial coverage.

Information archived within the WMO "Global Digital Sea Ice Data Bank" project

The largest archive of 5-10 days ice charts of XX century in standard digital WMO format SIGRID presently is available within the framework of WMO project "Global Digital Sea Ice Data Bank" - GDSIDB (http://www.aari.nw.ru/gdsidb and http://nsidc.org/noaa/gdsidb). The project includes charts from Canada (since 1962), Russia (since 1950), the USA (since 1972), the Baltic services (since 1961), Japan (since 1970), etc., giving the information on distribution of the sea ice total and partial concentrations and stages of development of the Arctic seas and Basin, total number of archived units being of 10,000 order. Extension of the project is scheduled before IPY 2007/2008 both back in time to 1930s (for Eurasian Arctic) and to last annual intervals 2004-2006s (for the whole Arctic).

Climatic processing of sea ice charts

Climatic processing may be carried out on separate charts collection to obtain sea ice characteristics for a single area. However, for large-scale phenomena those data are more optimal, where natural information from all possible sources is fused. The first version of such blended GDSIDB dataset, developed in December 2002, integrated on a monthly basis and on a 15x15 geographical minutes grid the data of sea ice total concentration from various ice services since 1950 up to 1998. Elimination of gaps equal to ~1/2 in the first version was provided by means of monthly climatology by inserting median values. Certain extension of the blended dataset was undertaken in October 2005 by including data from existing ice charts for Eurasian Arctic for 1933-1949. It is planned to further blended dataset up to 2005-2006, so that it will be used as a source of WMO climatic normals for the planned International Polar Year IPY 2007/2008.

Types of climatic characteristics

Climatic characteristics can be assessed integrally for the whole Arctic Ocean or its regions (ice index) or on definite grid (fields of statistics). Further, from statistical point of view characteristics may be either unstable or robust, the first one sometimes corresponding to artificial cases, the least probable in the nature (e.g. average concentration 4-6/10 in the vicinity of the ice edge with binary 0 or 10/10 state). Analysis of relationship between statistics, assessed on a basis of GDSIDB data, and special features of ice conditions provides possibility to choose optimal statistical parameters for describing ice variability within certain areas of the Arctic Ocean in seasonal cycle, e.g. choose between r.m.s., range and entropy.

Temporal variability of Arctic sea ice parameters

For temporal variability, estimations of such classical parameters as ice index on a basis of GDSIDB historical charts give a typical picture of a negative trend from 1950 to ~2000; however transition to either sub-period (1900-1945, 1946-2003), or single seas of, e.g., Eurasian Arctic, or to wavelet-transform gives a more sophisticated picture varying in time, season and space. Typical features are alternation of -/+ signs of linear trend and heterogeneity for the fields of amplitudes and phases of 10-60-year fluctuations of ice concentration for different Arctic regions.

Validity (95%) of sea ice total concentration linear trend coefficients by regions and periods

#	Area	Month	*a* Mean	*a* $Min_{95\%}$	*a* $Max_{95\%}$
Period of observations 1900 – 2003 ??.					
1	Greenland	VIII	-0.954	-1.463	-0.446
2	Barents	VIII	-2.638	-3.324	-1.952
3	Kara	VIII	-1.533	-2.488	-0.578
4	Greenland – Barents – Kara		-2.863	-4.389	-1.337
5	Laptevs	VIII	-0.381	-1.023	+0.261
6	Eastern - Siberian	VIII	-0.368	-1.068	+0.332
7	Chukcha	VIII	-0.453	-0.743	-0.163
8	Laptevs – Eastern-Siberian – Chukcha		-1.202	-2.488	+0.084
9	Eurasian Arctic	VIII	-2.737	-4.381	-1.093
Period of observations 1968 – 2004 ??.					
10	Eastern Canadian Arctic	VIII	-2.599	-6.377	+1.179
11	Western Canadian Arctic	VIII	-1.260	-4.053	+1.532
12	Hudson Bay	VIII	-2.537	-5.240	+0.166
13	Canadian Arctic	VIII	-7.079	-13.580	-0.578

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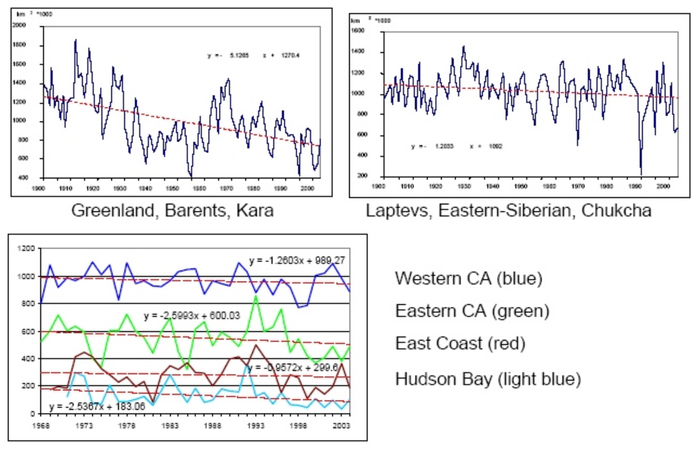
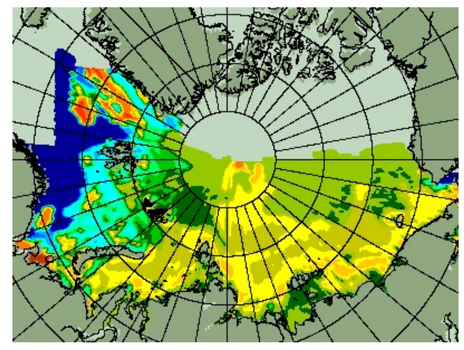
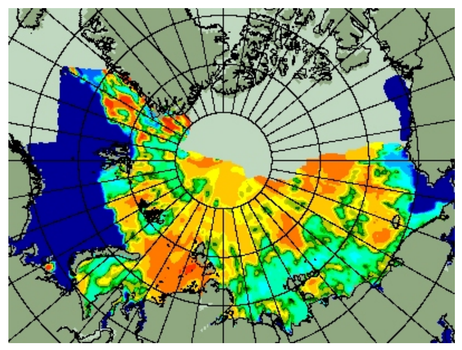


Greenland, Barents, Kara

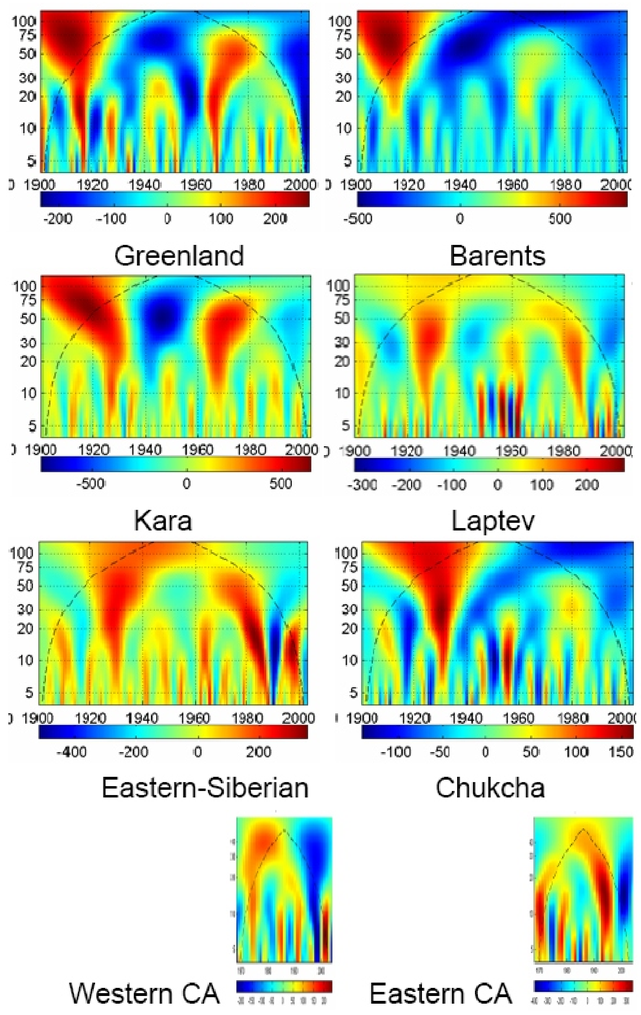
Laptevs, Eastern-Siberian, Chukcha

Linear trends in August sea ice extent for Eurasian Arctic, western and eastern (1900-2003) and Canadian Arctic (western, eastern, Hudson Bay, East Coast (April)) for 1968-2004





Spatial distribution of sea ice total concentration linear trend coefficient (upper - April, lower - August) for the period 1946-1992, based on AARI 10-days period sea ice charts.



Wavelet analysis of sea ice extent variations for Eurasian Arctic Seas (based on 1900-2003 period) and Canadian Arctic Seas (based on 1968-2004 period) in August (red more ice, blue less ice)