Blended sea ice climatologies based on national ice charting products for the Arctic and Antarctic – content and possible applications

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Fourth International Workshop on the Advances in the Use of Historical Marine Climate Data (MARCDAT-IV)

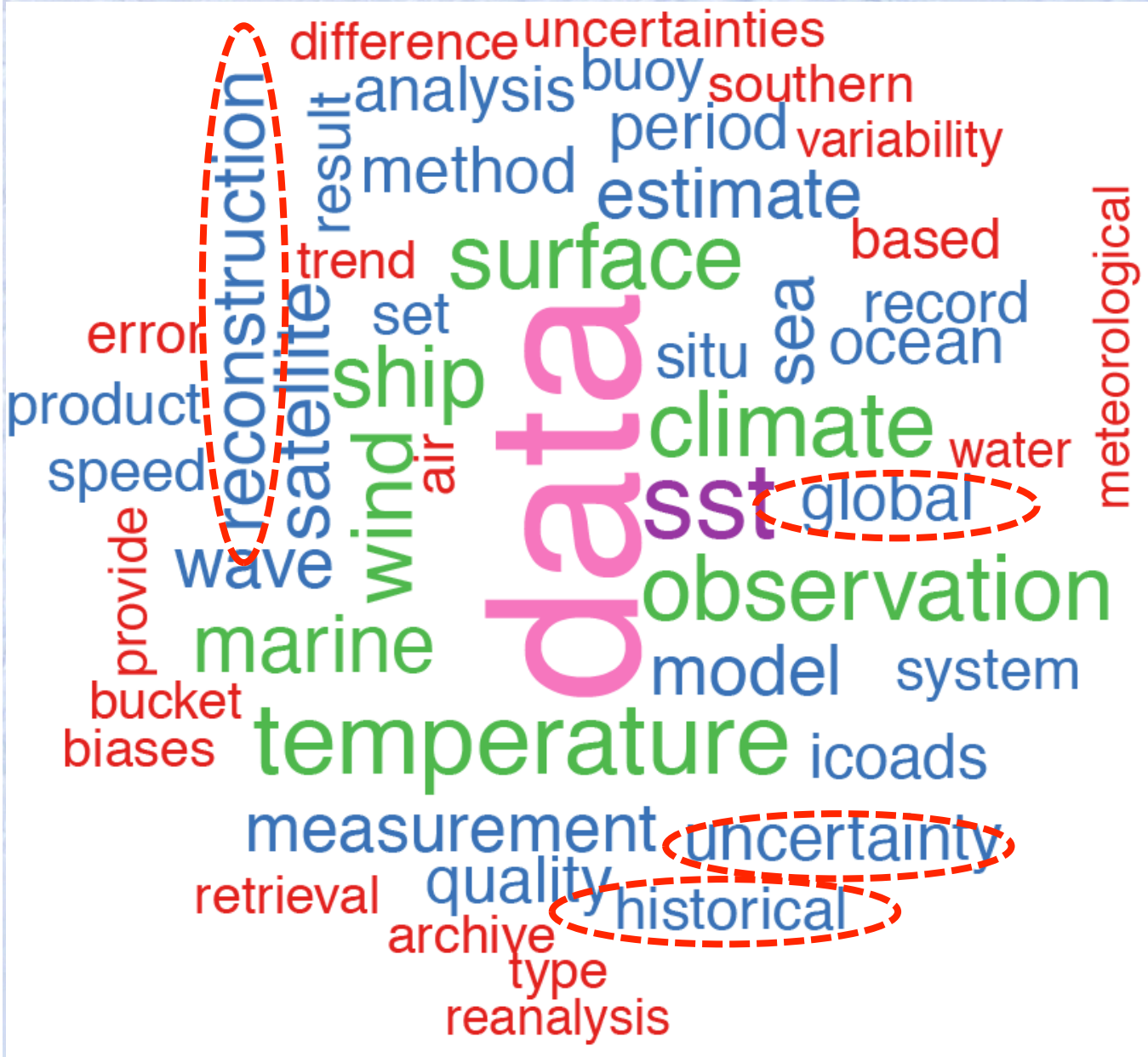**18 – 22 July 2016, National Oceanography Centre, Southampton, UK**

Marine climate data

Marine climate data should
- ✓ Be global – include polar regions
- ✓ Contain all marine meteorological parameters – include sea ice
- ✓ Based on processing all historical archives – including ice charting
- ✓ Contain uncertainties and scales – e.g. trends extremes for sea ice extent

Reasons and background

1) Ice charting or an expert ice analysis of comprehensive material – satellite imagery, ice air reconnaissance, coastal and ship-borne observations, presented as the ice charts are still source of the most adequate information on a number of sea ice parameters – concentration, stages of development, fast ice, forms of ice

2) Based on a single universal international standard – the WMO Sea Ice Nomenclature, the ice charting material contains a number of multidecadal or centennial long time series (North Atlantic, Baltic Sea)

3) First blending of ice analysis and satellite material was implemented by John Walsh and John Walsh and Chapman in 1980-1990 and further for a ~1° grid

4) Our approach is based on entirely ice charting material available through the WMO "Global Digital Sea Ice Data Bank" project, supervised by JCOMM ETSI

5) First blended versions were constructed in 2002 and 2007 within collaboration with UK Metoffice and repeated in 2011-2013 within IARC grant
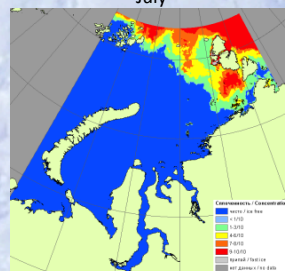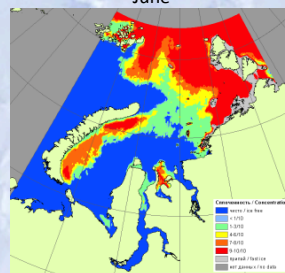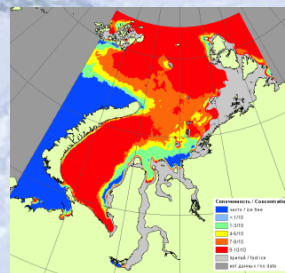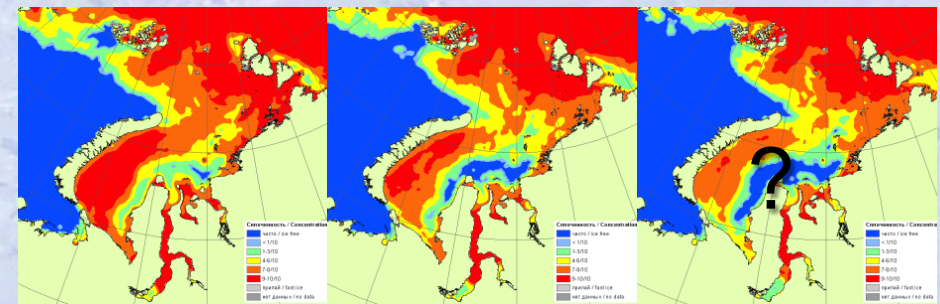

12/03/1915

Reason for using the ice charting material is clearly visible if we compare, for example statistics for total concentration, based on a ice charting and widely used passive microwave ASI-algorithm data (using the Kara Sea as a sample area)
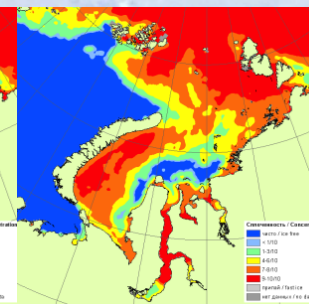
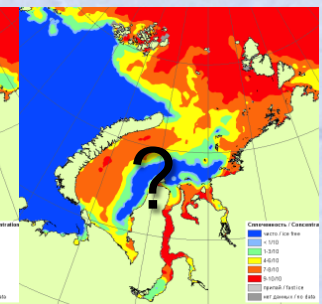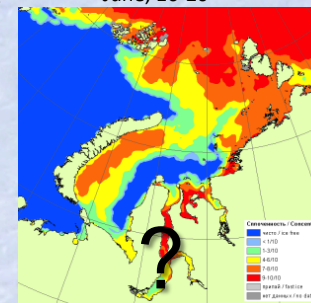Total concentration (CT) median monthly values based on ice charting material for 2000-2012
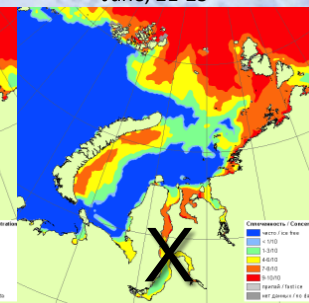
June

July

August

June, 16-20th

June, 21-25th
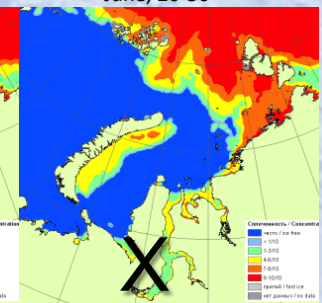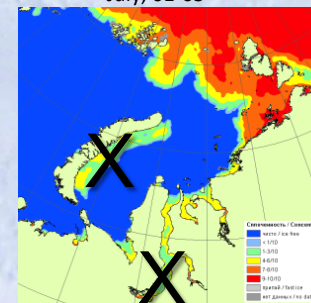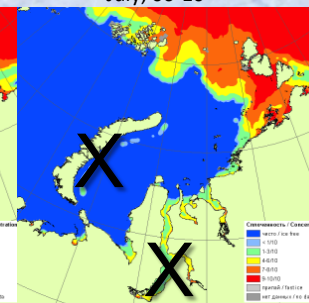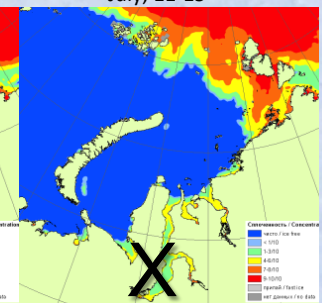
June, 26-30th

July, 01-05th

July, 06-10th

July, 11-15th
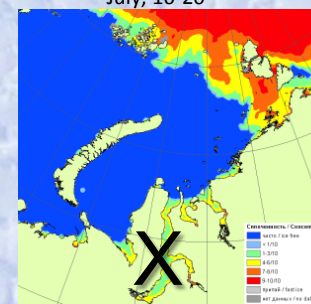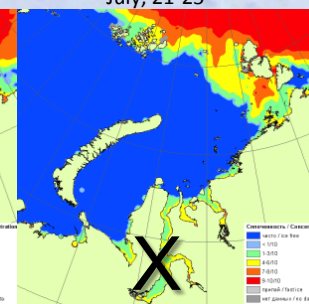
July, 16-20th

July, 21-25th
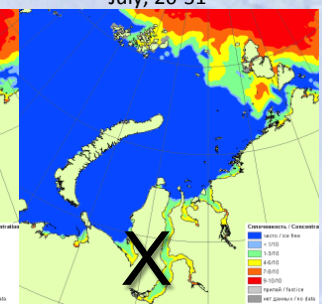
July, 26-31st

August, 01-05th

August, 06-10th

August, 11-15th

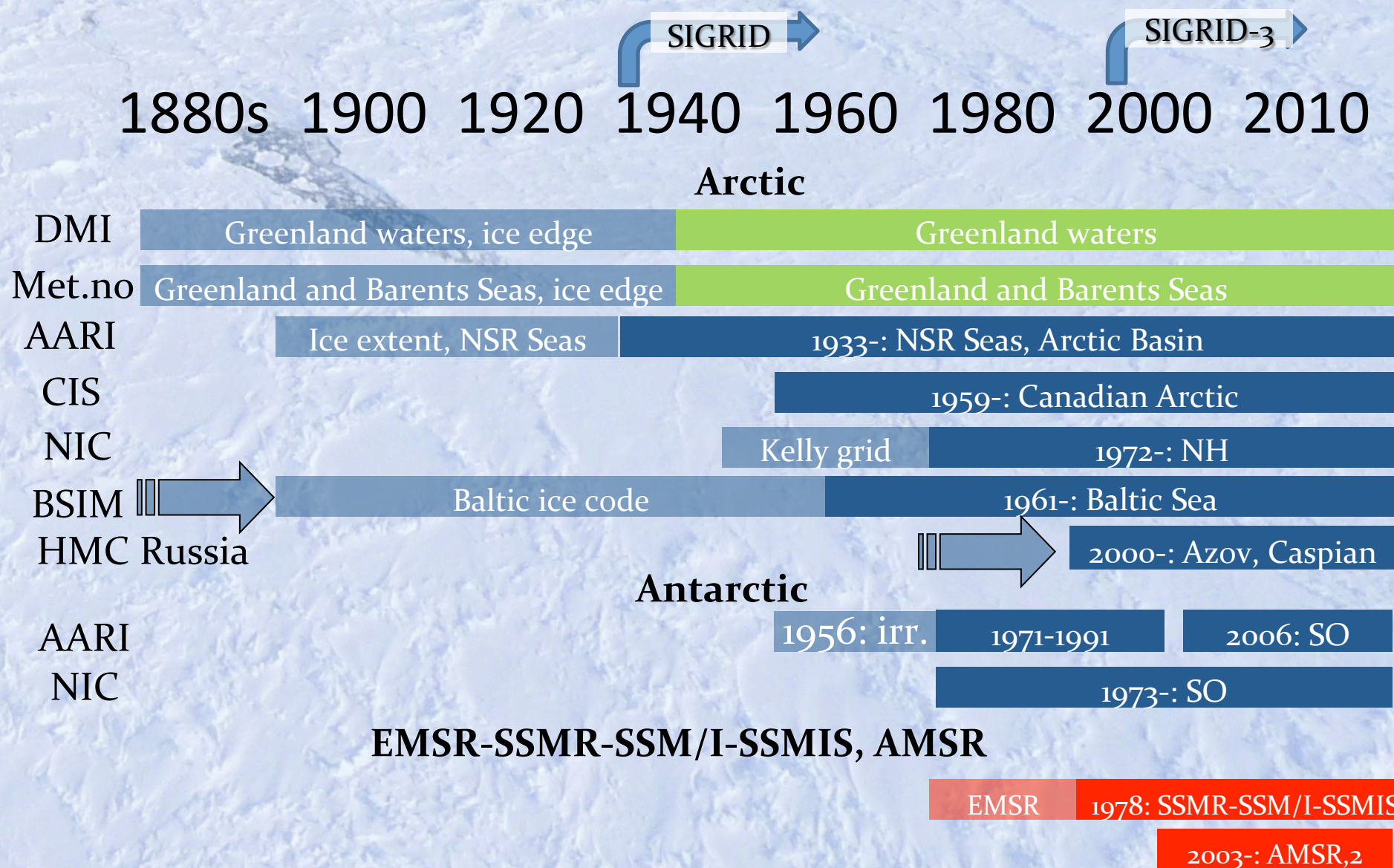CT median pentad values for 16 June – 15 August based on ASI-algorithm data, 2000 – 2012

Gaps in Walsh and Chapman NH Sea Ice

- Rather coarse ~1° resolution grid
- Single sea ice parameter – CT, no indicator for fast ice
- Single statistic, no information for observed extremes
- A number of regional multi-decadal datasets are still missing, e.g. most of the AARI data for Eurasian Arctic, mid-20th century met.no, DMI series for Barents Sea and Greenland waters
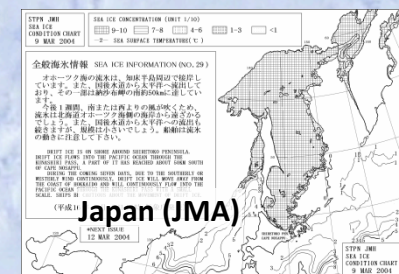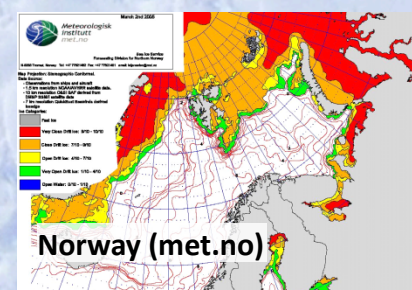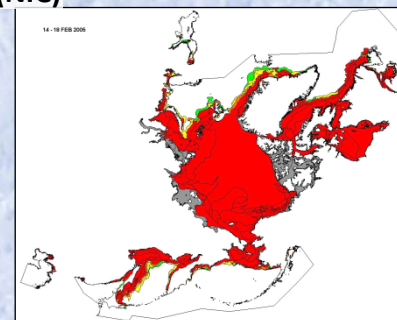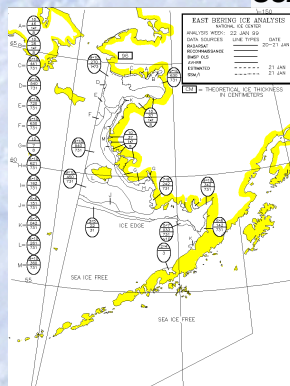
Chronology of <u>digital</u> sea ice charting within the GDSIDB archive

SIGRID →

SIGRID-3 →

1880s 1900 1920 1940 1960 1980 2000 2010

Arctic

DMI	Greenland waters, ice edge | Greenland waters
Met.no	Greenland and Barents Seas, ice edge | Greenland and Barents Seas
AARI	Ice extent, NSR Seas | 1933-: NSR Seas, Arctic Basin
CIS	1959-: Canadian Arctic
NIC	Kelly grid | 1972-: NH
BSIM	→ Baltic ice code | 1961-: Baltic Sea
HMC Russia	→ 2000-: Azov, Caspian

Antarctic

AARI	1956: irr. | 1971-1991 | 2006: SO
NIC	1973-: SO

EMSR-SSMR-SSM/I-SSMIS, AMSR

EMSR | 1978: SSMR-SSM/I-SSMIS

2003-: AMSR,2

Sample ice charts for the Northern Hemisphere

Russia (AARI)

Canada (CIS)

Denmark (DMI)

BSIM (FMI

USA(NIC)

Norway (met.no)

Japan (JMA)

Sample ice charts for the Southern Hemisphere

Russia (AARI)

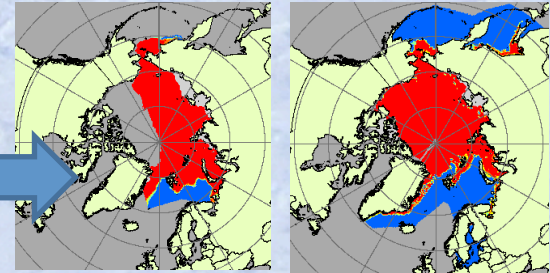USA(NIC)

Denmark (DMI)

Norway (met.no)
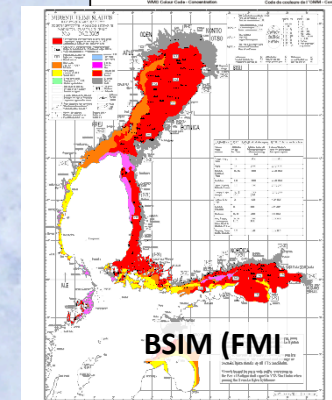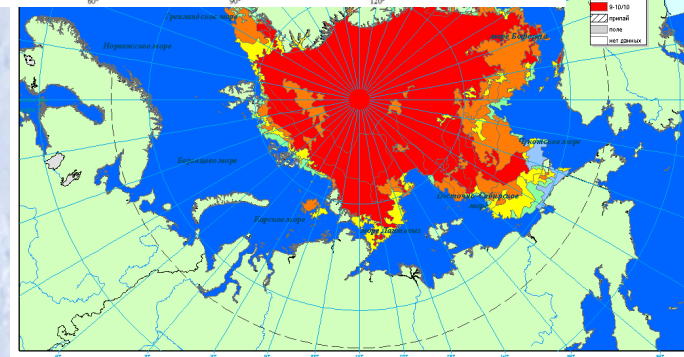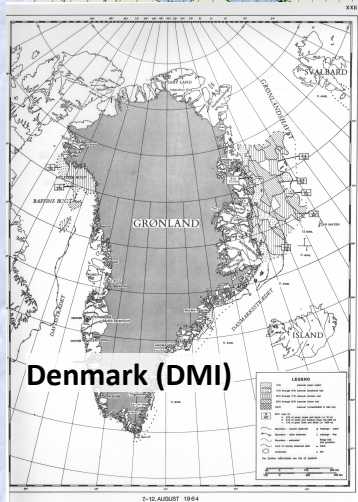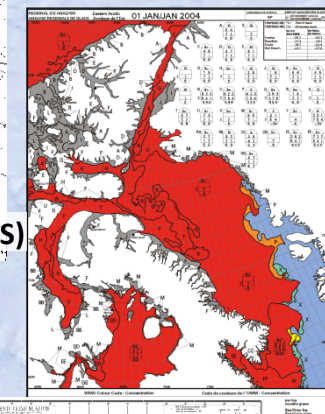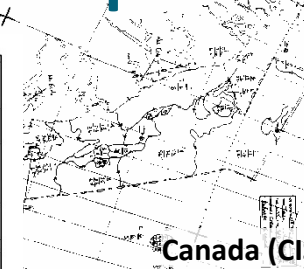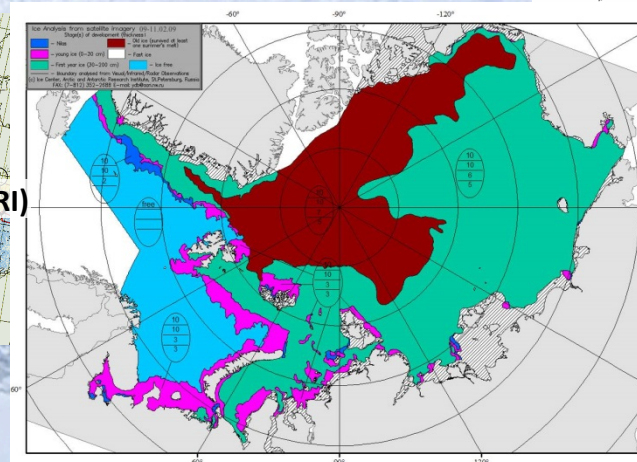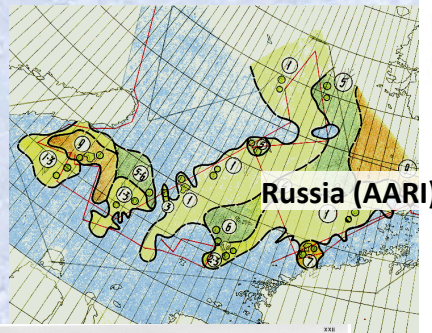
# GDSIDB data sources used for blending by ice services (1)

1. Russian Federation AARI (a) Eurasian Arctic (Greenland – Chukchi Seas, Arctic Basin and Bering Sea) ice charts with 10-days periodicity (with gaps) for 1933-1992 (~2400 charts) in SIGRID format and (b) 7-days period Eurasian Arctic (Greenland – Beaufort Seas, Arctic Basin, and Bering, Okhotsk, Baltic Seas) ice charts for 1999-2016 (~6000 charts) in SIGRID-3 format.

2. Canadian Ice Service (CIS) (a) 7-days period ice charts for Canadian Arctic (East Arctic, West Arctic, Hudson Bay and Eastern Coast) for 1958-1998 (~3500 charts) in SIGRID format and the same (b) for 2006-2016 (~1400 charts) in SIGRID-3 format.
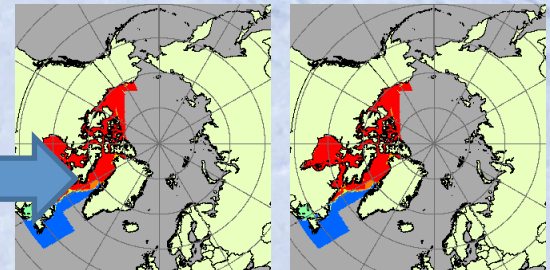
3. USA National Ice Center (NIC) (a) 7 days period (weekly) and 14 days period (bi-weekly) Northern hemisphere charts for 1972-2002 (~1600 charts) in Ease-Grid format and the same (b) bi-weekly charts for 2003 - 2016 (~400 charts) in SIGRID-3 format.
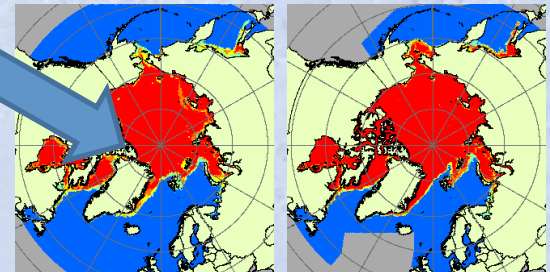
4. Baltic Sea Ice Meeting (BSIM), jointly compiled by Swedish Hydrological and Meteorological Institute (SHMI) and Finnish Institute for Marine Research (FIMR), 3-4 days period ice charts for the Baltic Sea for 1960-2014 (~2000 charts) in Baltic code translated to SIGRID format.

5. In addition to 1-4 the "Monthly Arctic Sea Ice Concentration Grids (January 1901 – Dec 2005)" (Walsh and Chapman dataset) was used to gain ice analysis prior to 1972 from Danish Meteorological Institute (DMI), Japan Meteorological Agency (JMA) and Naval Oceanographic Office (NAVOCEANO.

GDSIDB data sources used for blending by ice services and periods (2)
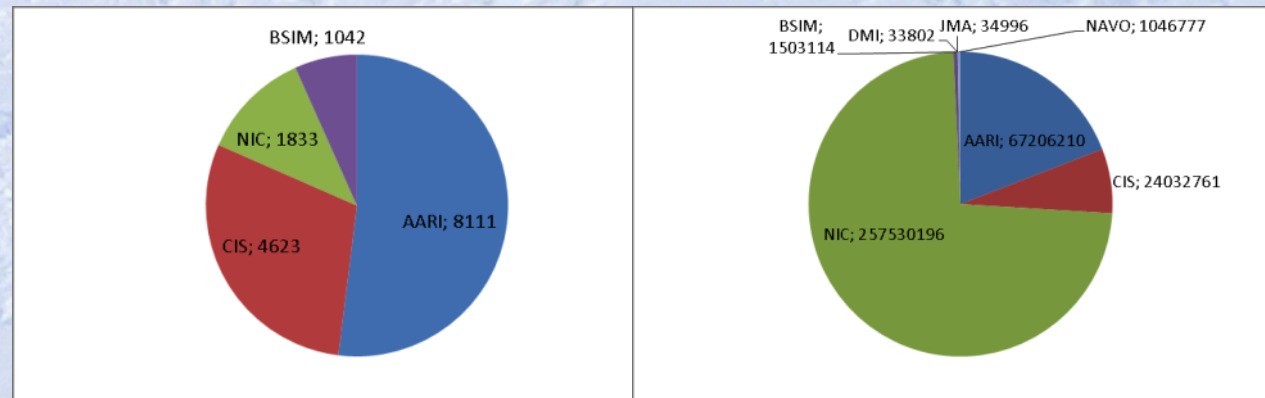
Summary number of charts (left) and summary number of points by originating centers for the period January, 1901 – Dec, 2015
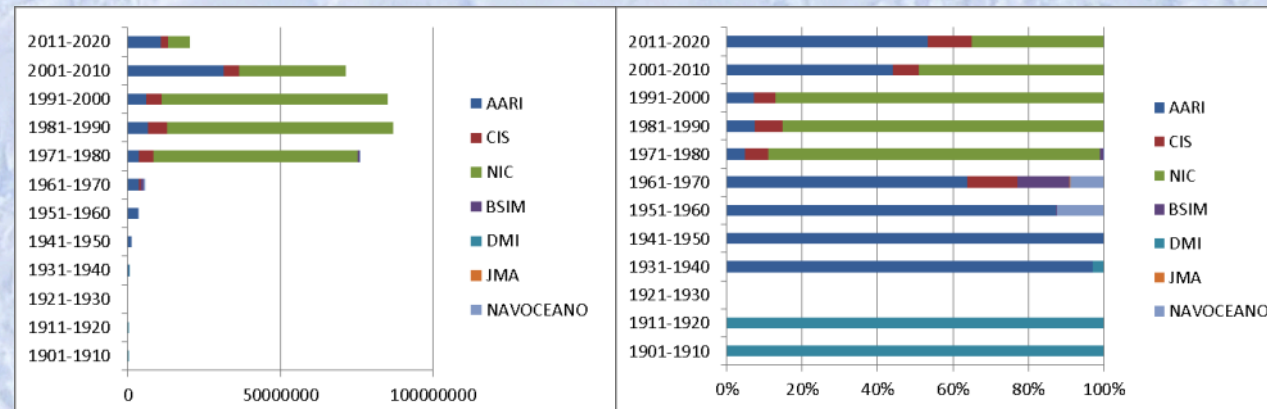
Summary absolute and % number of points by decades by originating centers for the period January, 1901 – Dec, 2015

Blending technique

1) Exporting layers of particular sea ice parameters (CT, SD) from the ice charts in SIGRID, SIGRID-3 formats to geo grid 0.25°x0.25°, including:
   - ❑ Exporting sea ice parameters from raster SIGRID format charts
   - ❑ Rasterization of vector SIGRID-3 ice charts
   - ❑ Co-location (nearest node) of CT data from Walsh and Chapman ~1° dataset with 0.25°x0.25°geo grid
   - ❑ Расчет статистических параметров (среднее, максимум, минимум) для контроля качества данных и географических преобразований
2) Statistical processing of 5-30 days period initial datasets
   - ❑ Monthly mean, median, extreme values, number of cases with monthly period for each node
3) Exporting monthly statistics to a binary BIL, netCDF and ASCII TSV formats
   - ❑ Header (YYYY.MM.DD) + matrix for BIL
   - ❑ Separate files for mean, median, extreme, number of cases, data origin
4) Quality control carried out manually checking decadal extreme statistics

Formal of resulting dataset (CT)
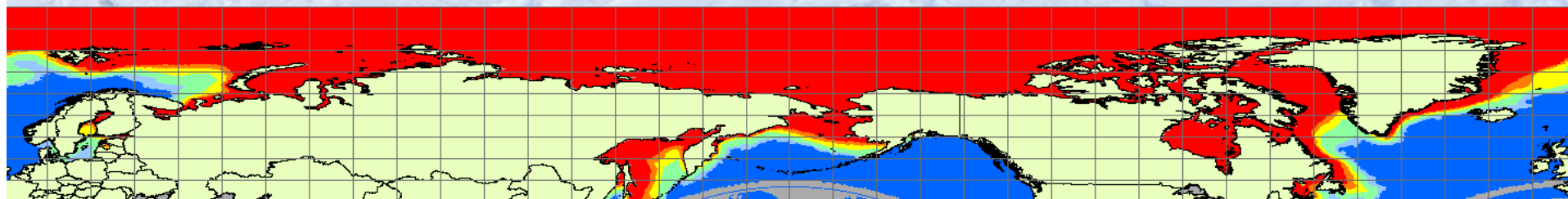
- Total concentration in % within interval '0'…'100', plus '101' & '122', where '101' is for fast ice, 122 – no data
- Stage of development in a form of mean weighted thickness of level ice in cm within interval '0'…'250', plus '251' for values > 250 and '252' – no data
- Grids cover area 90°N…45°N 0°….360° with 0.25°x0.25° resolution, , or 1440 cols by 180 rows, top leftmost 90N,0
- Currently period Jan 1901 – Dec 2015
- Separate files for 4 statistics (mean, min, max, median), number of cases and source of data
- Code of data source can be '5' for mixed data or '10'…'90' for individual sources (DMI, JMA, BSIM, AARI, CIS, NIC, NAVOCEANO, Kelly)

Access through WDC-SI at AARI (http://wdc.aari.ru)

Initial ice charting data (SIGRID)

– http://wdc.aari.ru/datasets/d0004

Initial ice charting data (SIGRID-3)

– http://wdc.aari.ru/datasets/d0004

– http://wdc.aari.ru/datasets/d0031

– http://wdc.aari.ru/datasets/d0032

– …
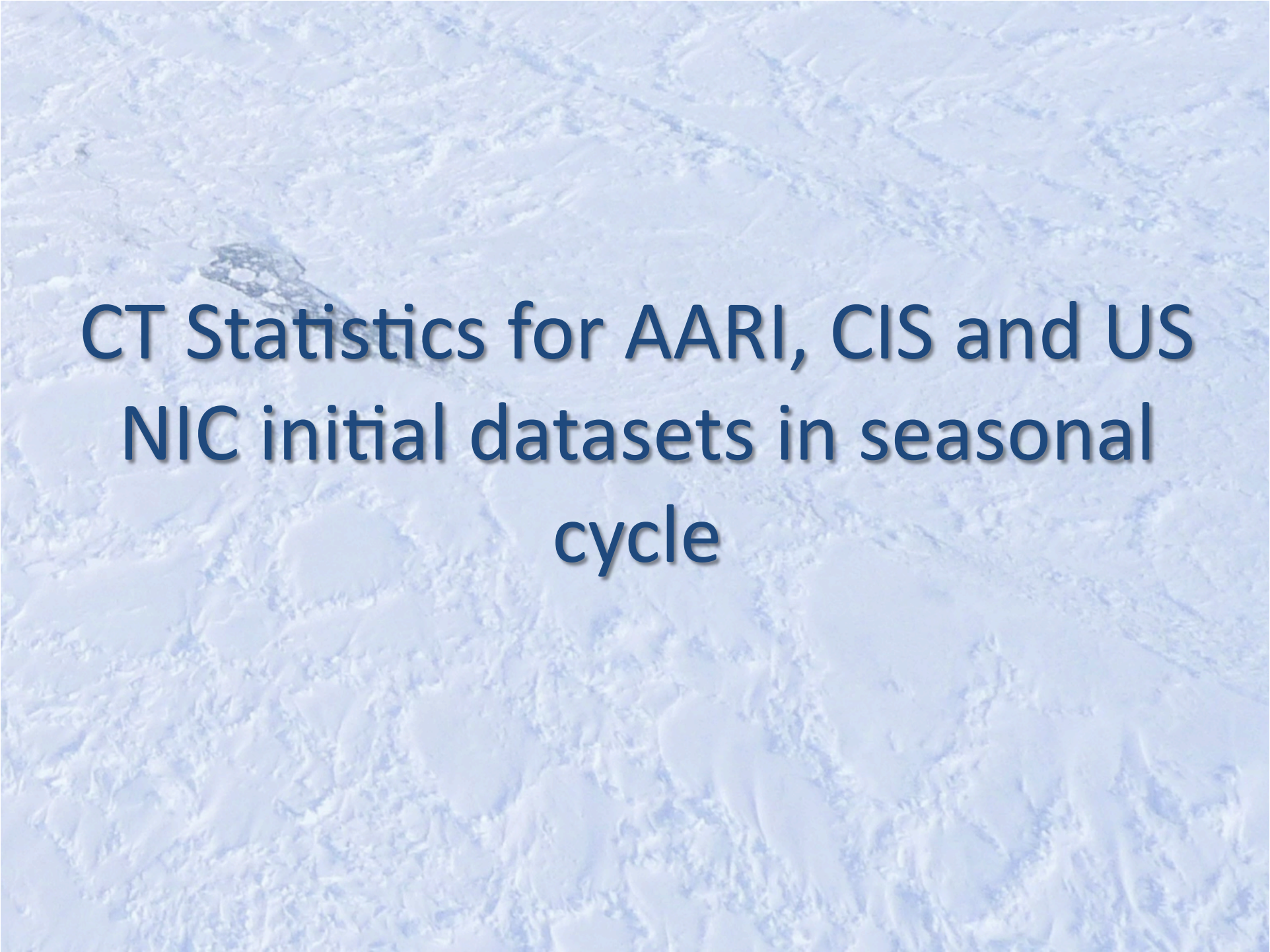
Blended datasets, documentation, sam[ple]
f90 codes

– http://wdc.aari.ru/vms/blended/

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CT Statistics for AARI, CIS and US NIC initial datasets in seasonal cycle
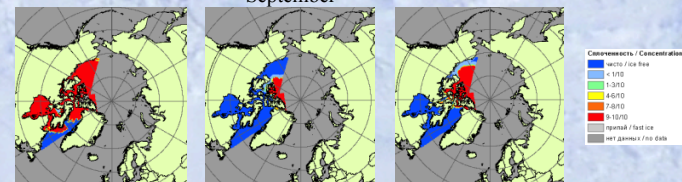
AARI, 1933-1992

January

February

March

April

May

June

June

July
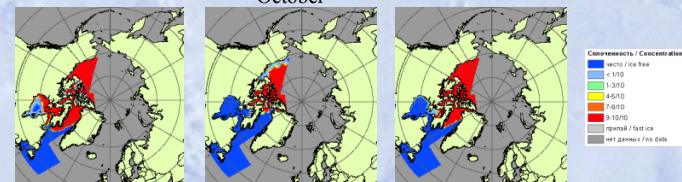
August

September

October

November

December

AARI, 1997-2015

January

February

March

April

May

June

June

July

August

September

October

November

December

CIS, 1958-1998

January

February

March

April

May

June

June

July
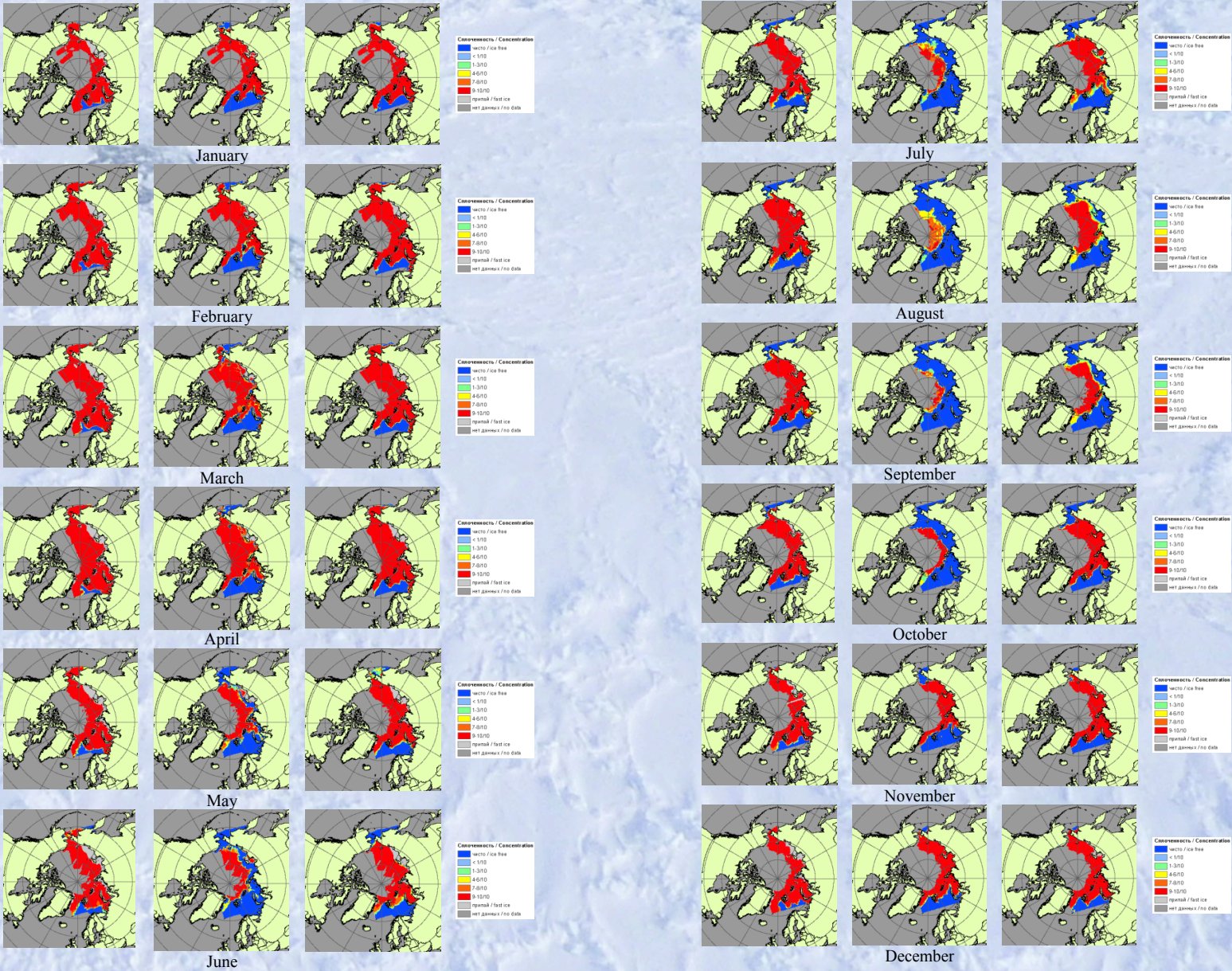
August

September
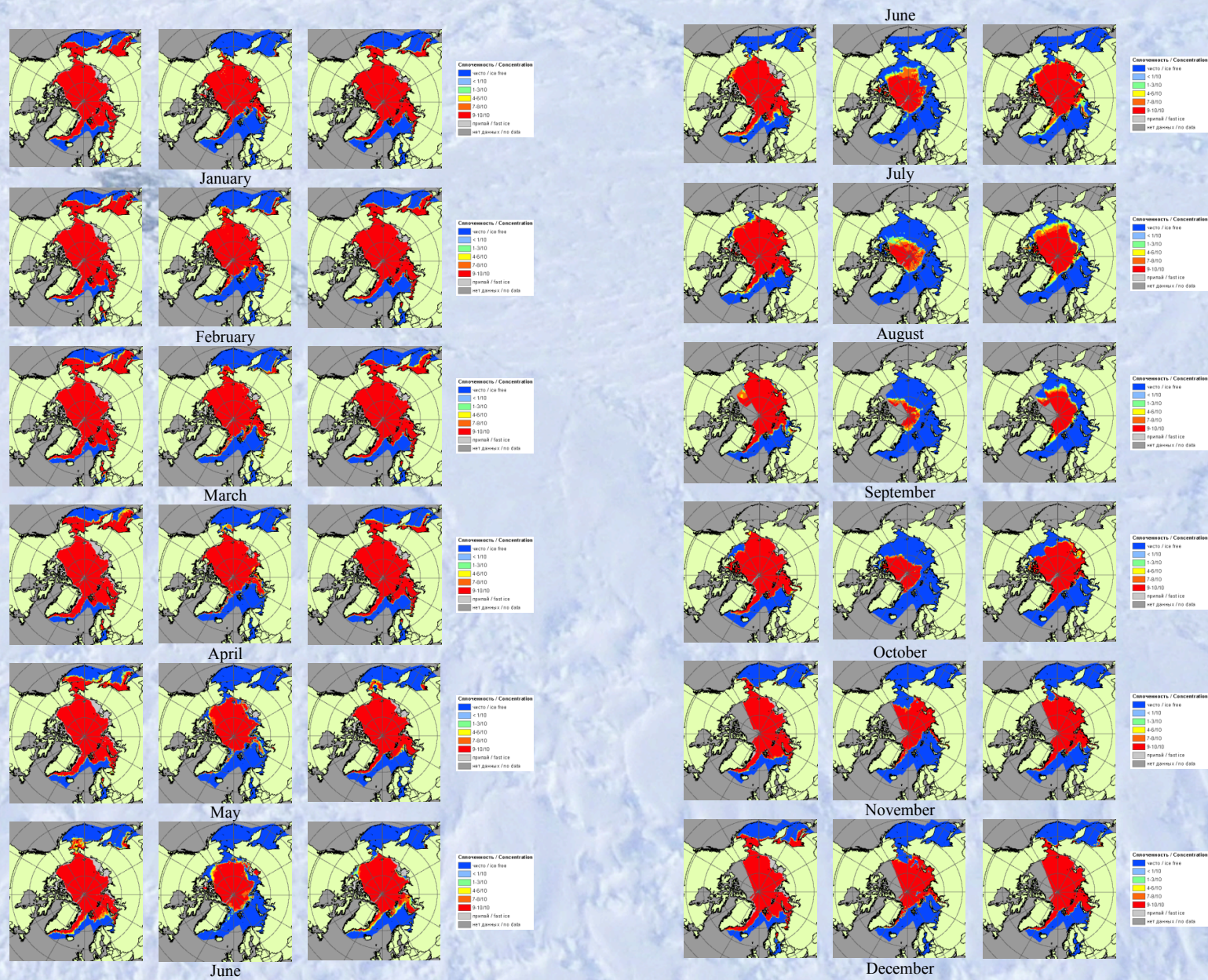
October

November

December

CIS, 2006-2015

January

February

March

April

May
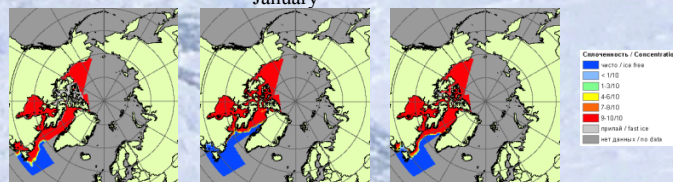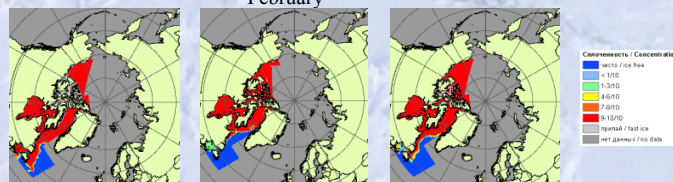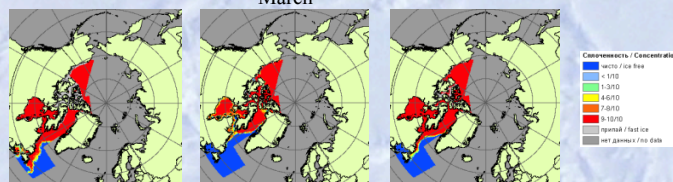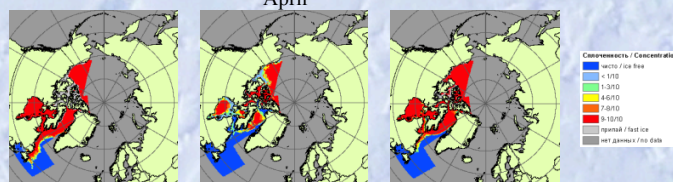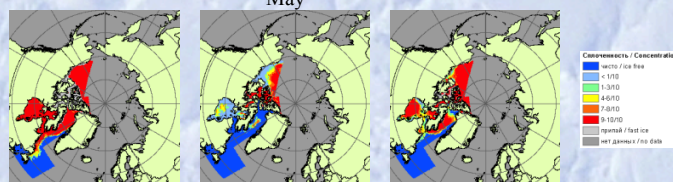
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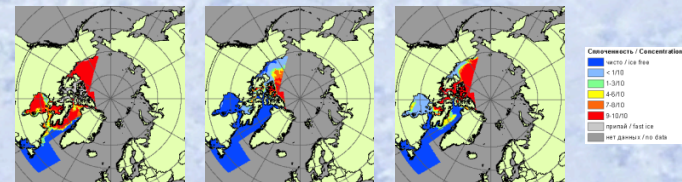
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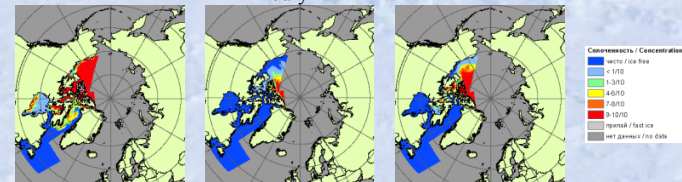
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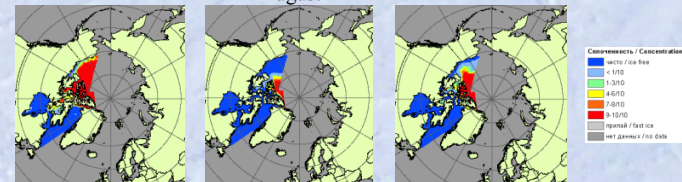
September

October

November

December

NIC, 1972-2007
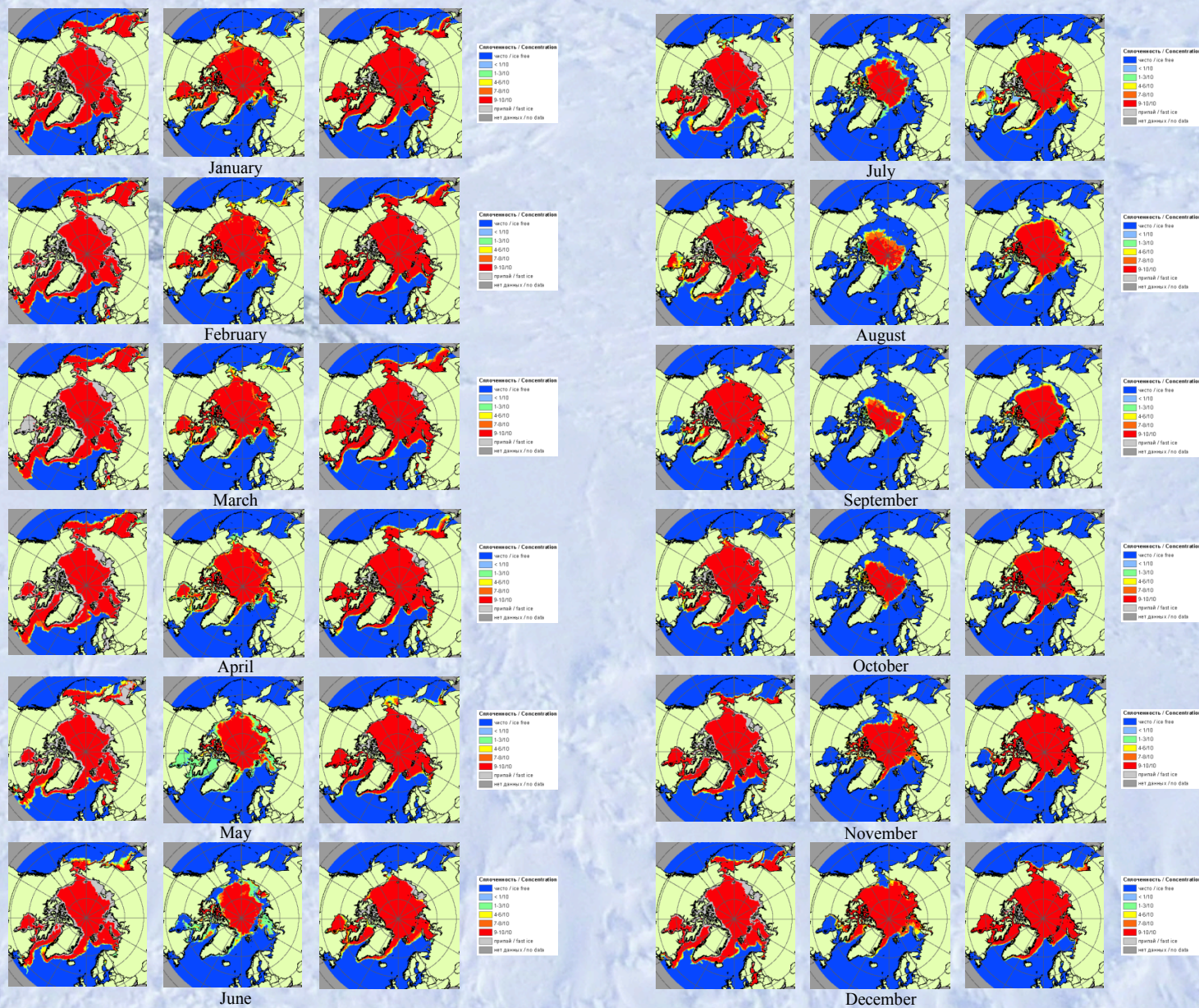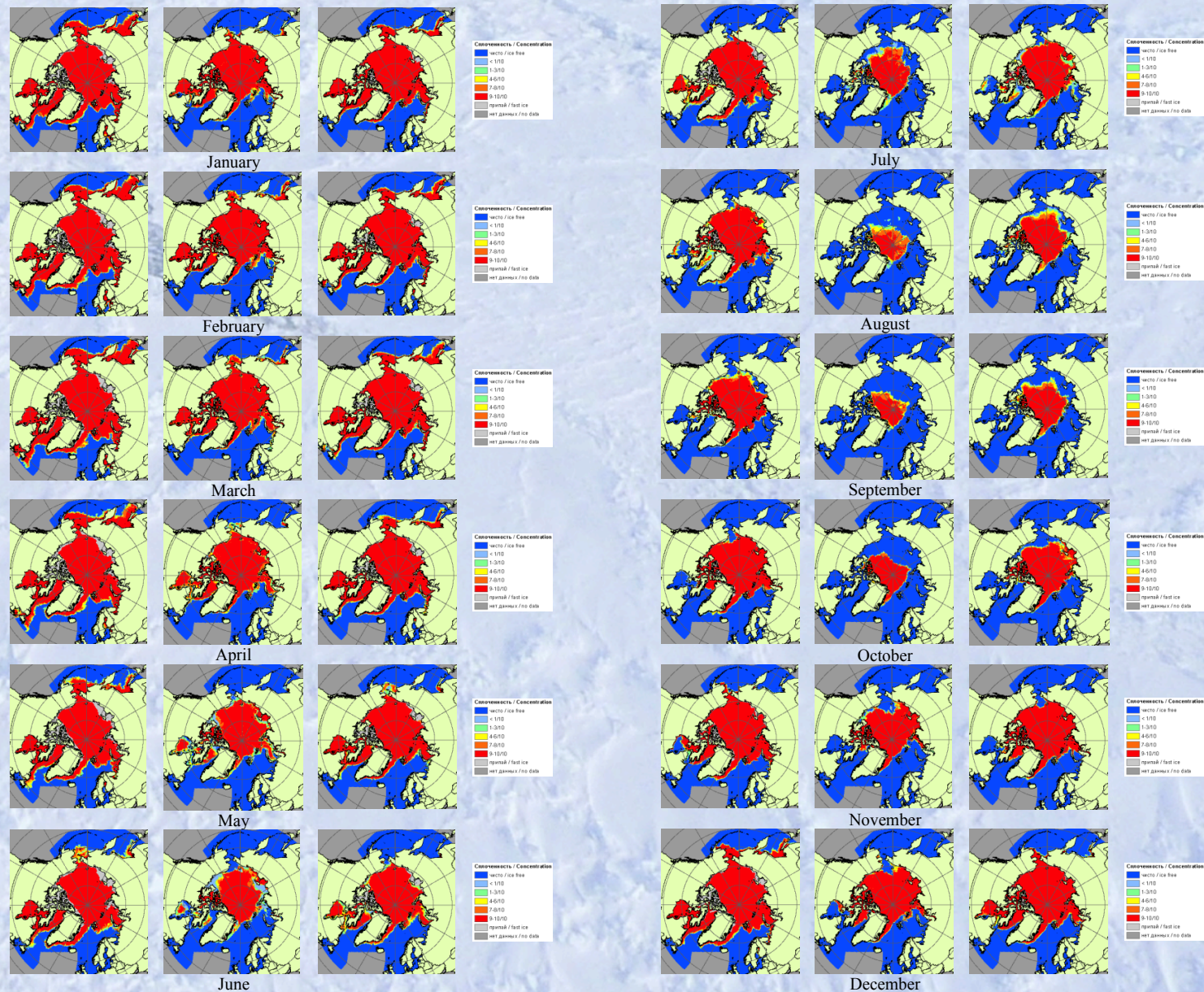
January

February

March

April

May

June

July

August

September

October

November

December

NIC, 2003-2015

January

February

March

April

May

June

July

August

September

October

November

December

CT blended statistics, (max/min/ trimean)

1901 – 2015

January - December

January

February

March

April

May

June

July

August

September

October

November

December
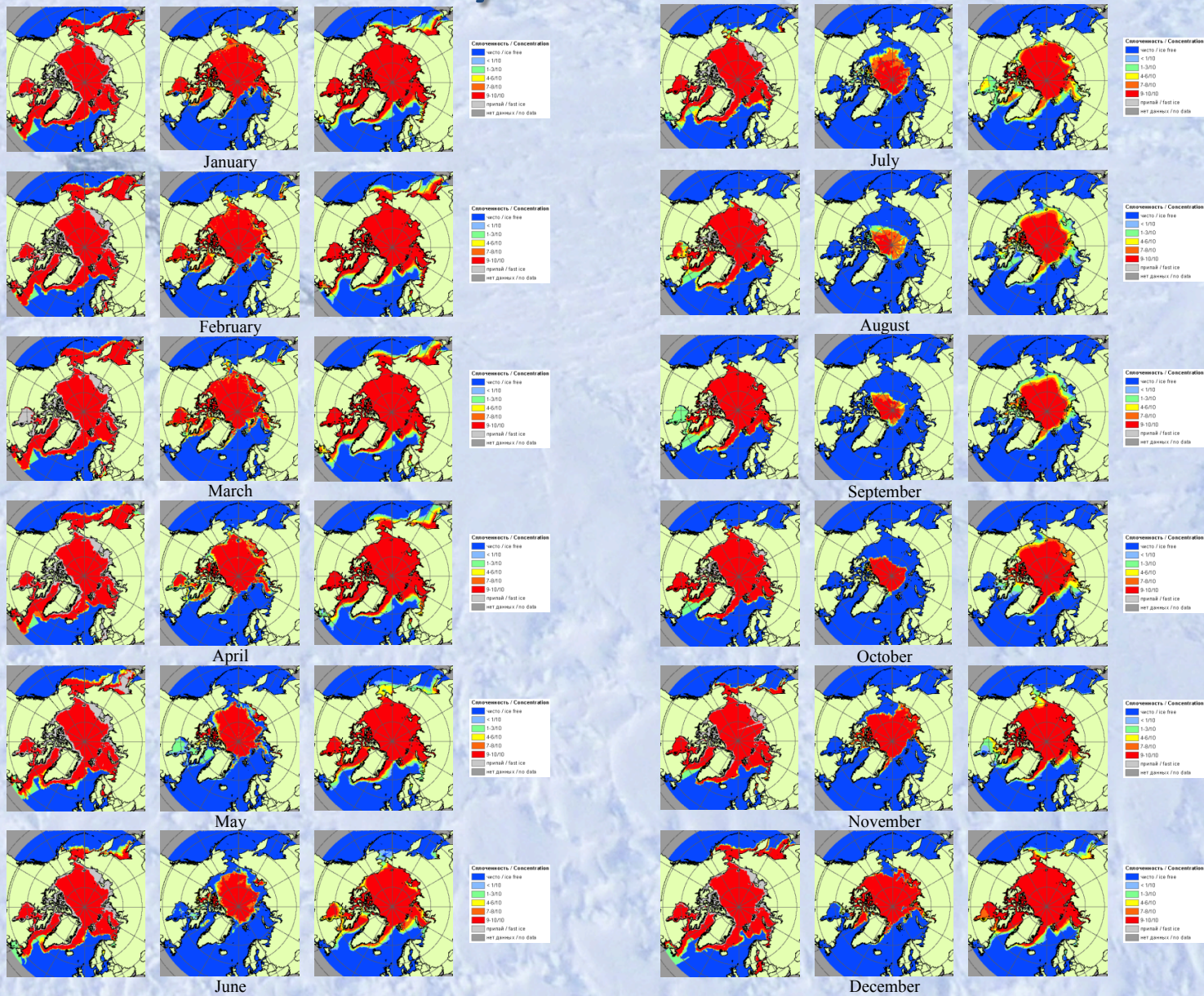
August, by decades
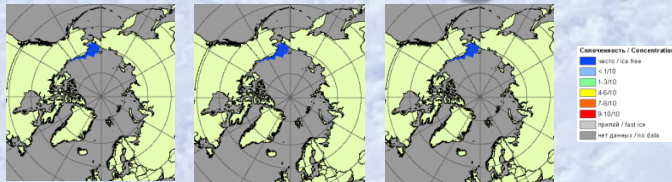
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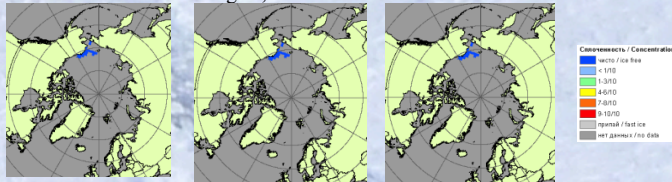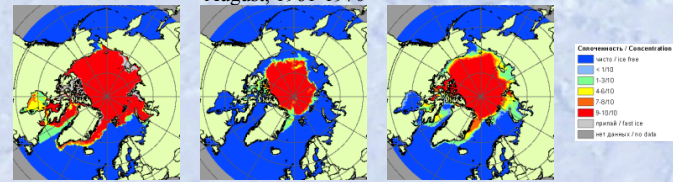
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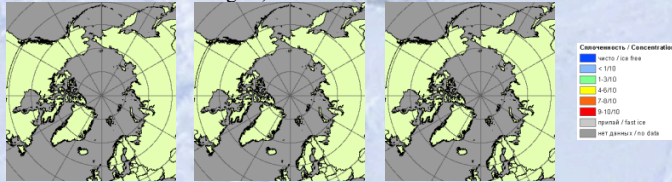
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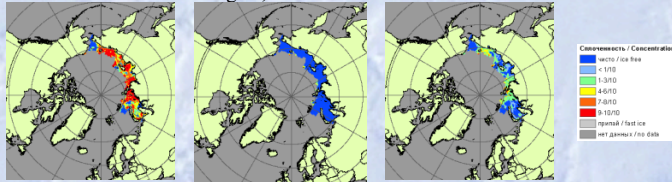
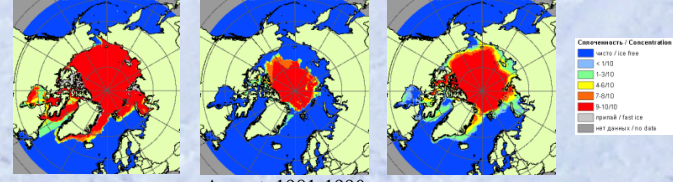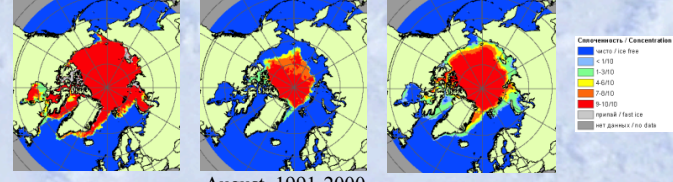August, 1931-1940
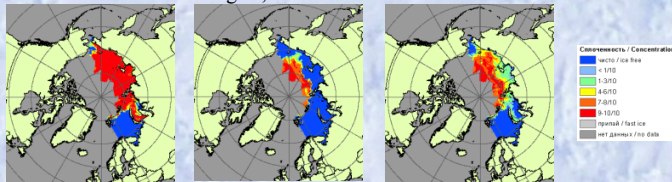
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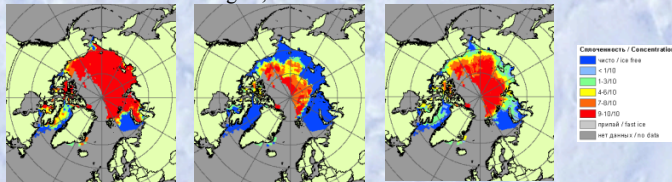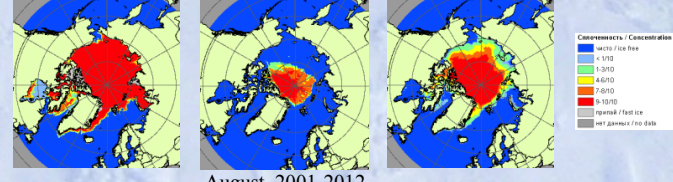
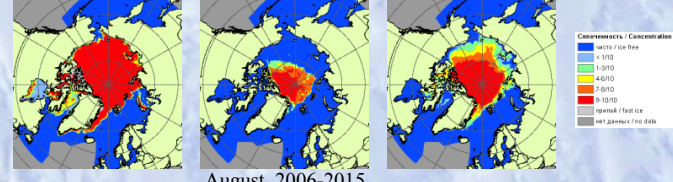August, 1951-1960
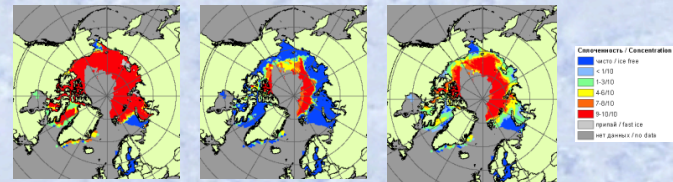
August, 1961-1970

August, 1971-1980

August, 1981-1990

August, 1991-2000

August, 2001-2012

August, 2006-2015

Perspectives and applications

- Regular annual update
- Calculation of additional statistics, assessment of uncertainties, errors
- Finalization of blended ice thickness dataset using stages of development as proxy
- Finalization of Antarctic blended dataset
- Inclusion of additional sources, e.g. linear ice edge from met.no for the first part of the 20th century, old Baltic Sea data, Caspian Sea…
- Restoration of gaps (principal components, wavelet-analysis)
- Availability of data through GCW portal, polar GDAC/CMOC
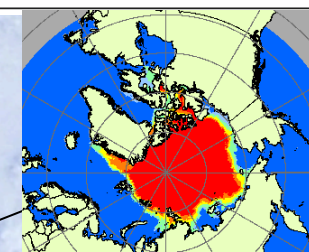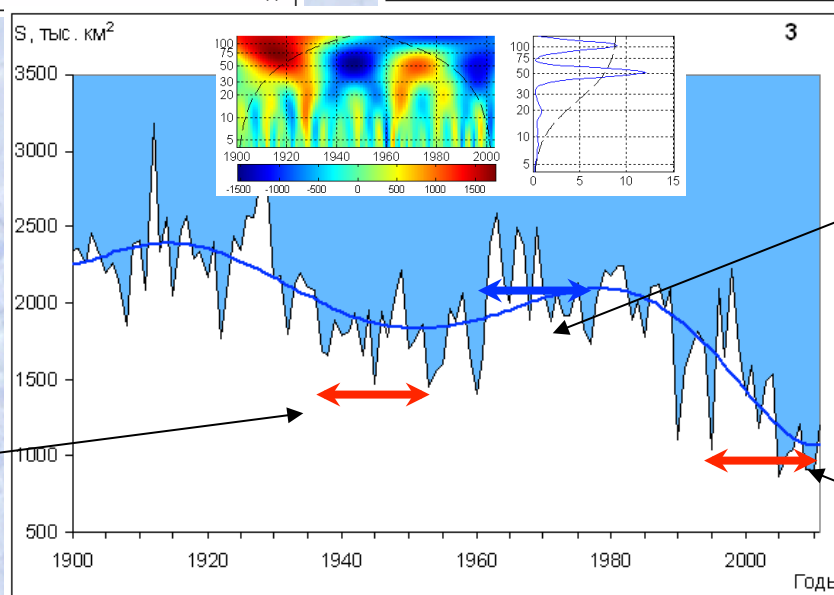
Some hints for applications:

- Regional atlases
- JCOMM quasi-centennial hemispheric ice edge in seasonal cycle, e.g. for GEBCO project
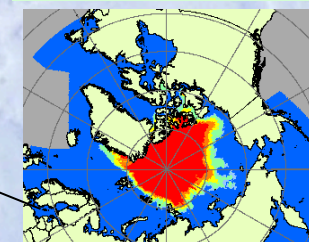- Validating / feeding climatic models

Changes in ice extent at the end of August for 1) western Eurasian Arctic (Greenland – Kara Seas), 2) Eastern Eurasian Arctic (Laptev – Chukchi) and 3) Eurasian Arctic
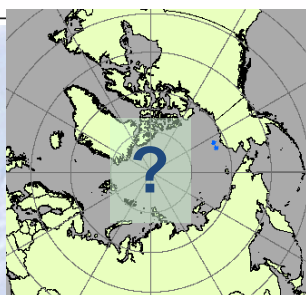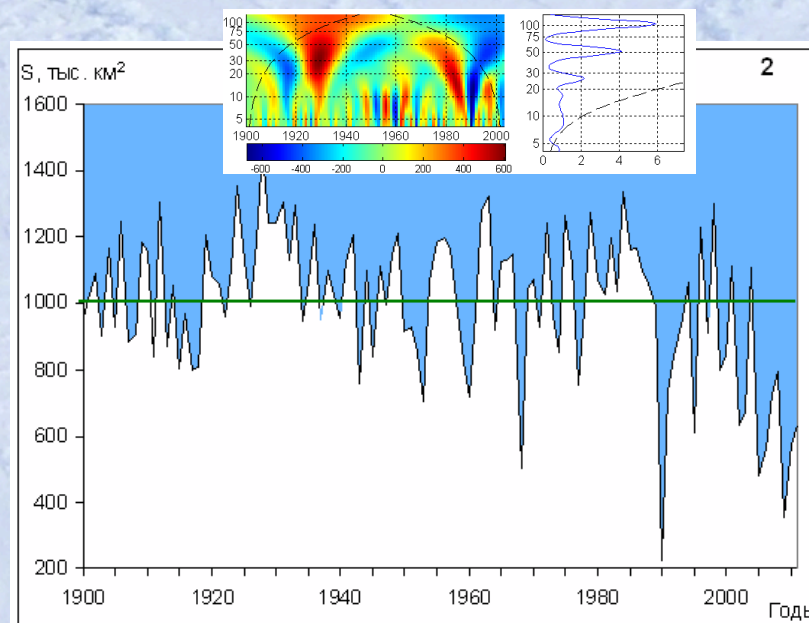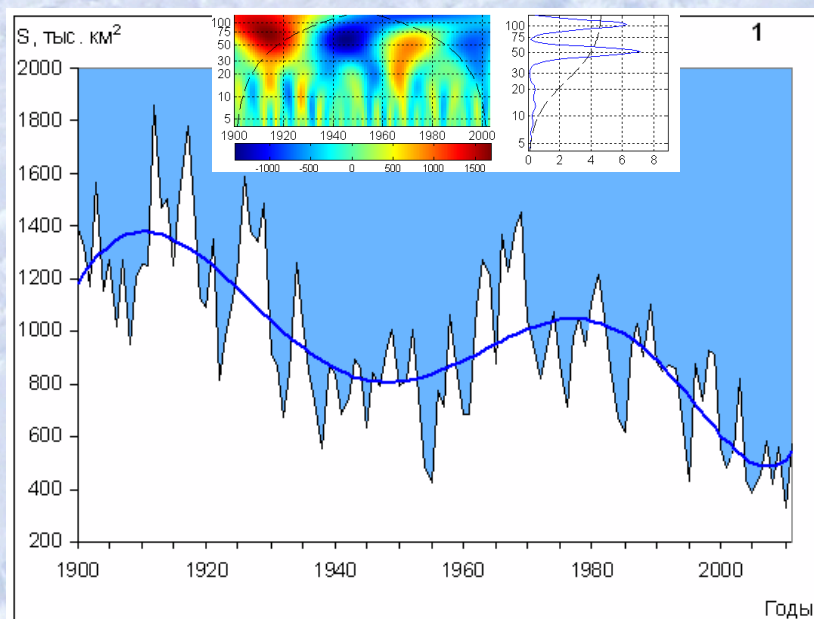
September, 1936 – 1943

September, 1971-1980

September, 2006 – 2012

- Thanks for attention
- Questions ?