



20th Century Russian sea ice variability: results from a new digital dataset

Andy Mahoney^{1*}, Roger Barry¹, Vasily Smolyanitsky², Florence Fetterer¹
¹National Snow and Ice Data Center, University of Colorado, Boulder, CO, USA
²Arctic and Antarctic Research Institute, St. Petersburg, Russian Federation
 *Corresponding author: Andrew.Mahoney@nsidc.org - (303) 492-2850

The AARI sea ice charts

- Ice chart record began in July 1933
- Charts cover mostly Russian Arctic
- Early coverage limited to coastal regions in summer
- Produced from a variety of observation techniques, but mostly aerial reconnaissance
- Total sea ice concentrations as well as partial concentrations of new and young, first year, multi-year and landfast sea ice
- Nominal resolution 12.5 km
- Data and documentation available at: <http://nsidc.org/data/g02176.html>

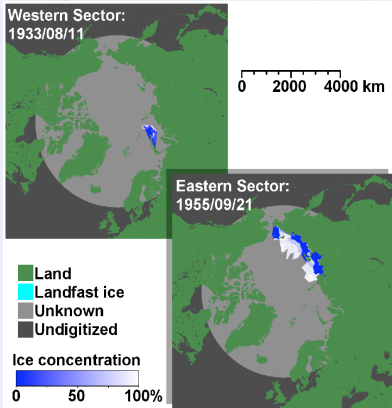


Figure 1: Examples of AARI ice chart coverage from different regions and different parts of the record

Calculating sea ice extent

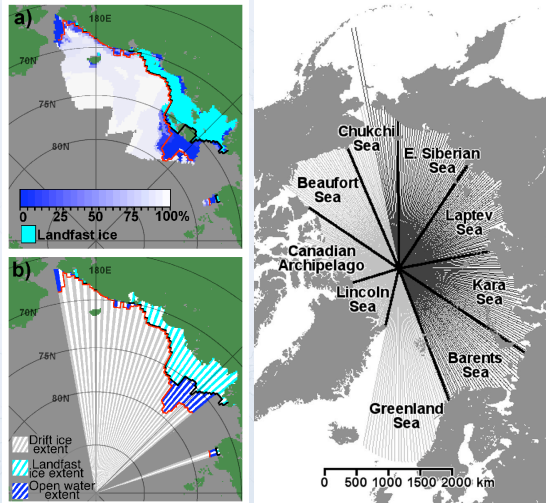


Figure 3: a) Pack ice edge (red) and landfast ice edge (black); b) Areas of pack ice, landfast ice and open water inferred from ice edges in a).

Figure 4: Marginal seas defined in this study and transects used to locate ice edges

Ice charts are used to define 3 ice edges according to the following criteria:

- **Landfast ice edge:** northmost pixel of landfast ice that is contiguous with land (excludes islands)
- **Pack ice edge:** transition from $\geq 15\%$ to $< 15\%$; or the landfast ice edge; or the coast
- **MY ice edge:** transition from $\geq 15\%$ to $< 15\%$; or the coast

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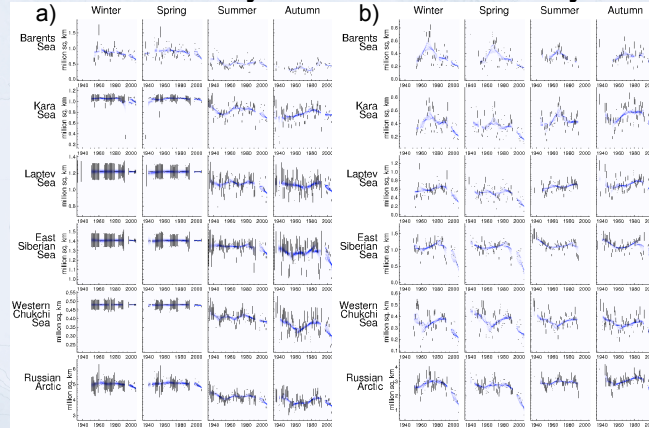


Figure 5: Variability in a) Total sea ice extent and b) MY ice extent around the Russian Arctic. Points show annual means with estimated errors. Blue regions show results of smoothing over intervals from 5-20 years with random error sampling.

Ice chart data indicates an overall decrease since in sea ice extent since the beginning of the record, but with 3 distinct periods of variability:

- Period A: (pre 1950s)** Sea ice retreat seen in overall Russian Arctic in summer and autumn
- Period B: (1950s-1980s)** Partial recovery
- Period C: (mid 1980s - now):** Retreat seen in all seas of Russian Arctic; winter time retreat in Barents and Kara seas

Arctic air temperature variability

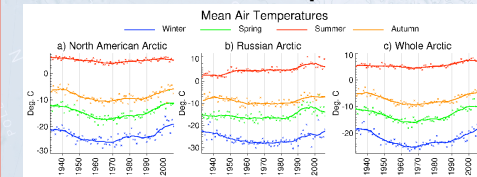
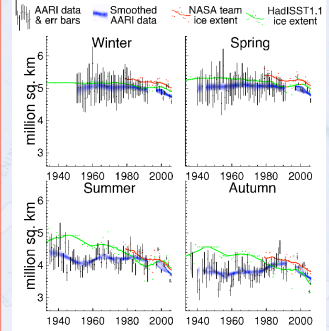


Figure 8: Mean seasonal temperatures from 231 stations around the Arctic. Solid lines show 10-year running means

All curves are U-shaped except Russian Arctic summer temperatures, which suggests that Russian Arctic variability may not have been synchronized with that of the rest of the Arctic in the early 20th century

Comparisons with other sea ice datasets



Generally good agreement during satellite era, but HadISST results miss significant variability and transitions in the 20th century

Conclusions

- Sea ice in Russian Arctic has been retreating since at least 1933
- Retreat during Period A and partial recovery during Period B may have been limited to Russian Arctic
- Retreat during Period C has become year-round and Arctic-wide
- AARI ice chart data should be incorporated into future global sea ice datasets

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