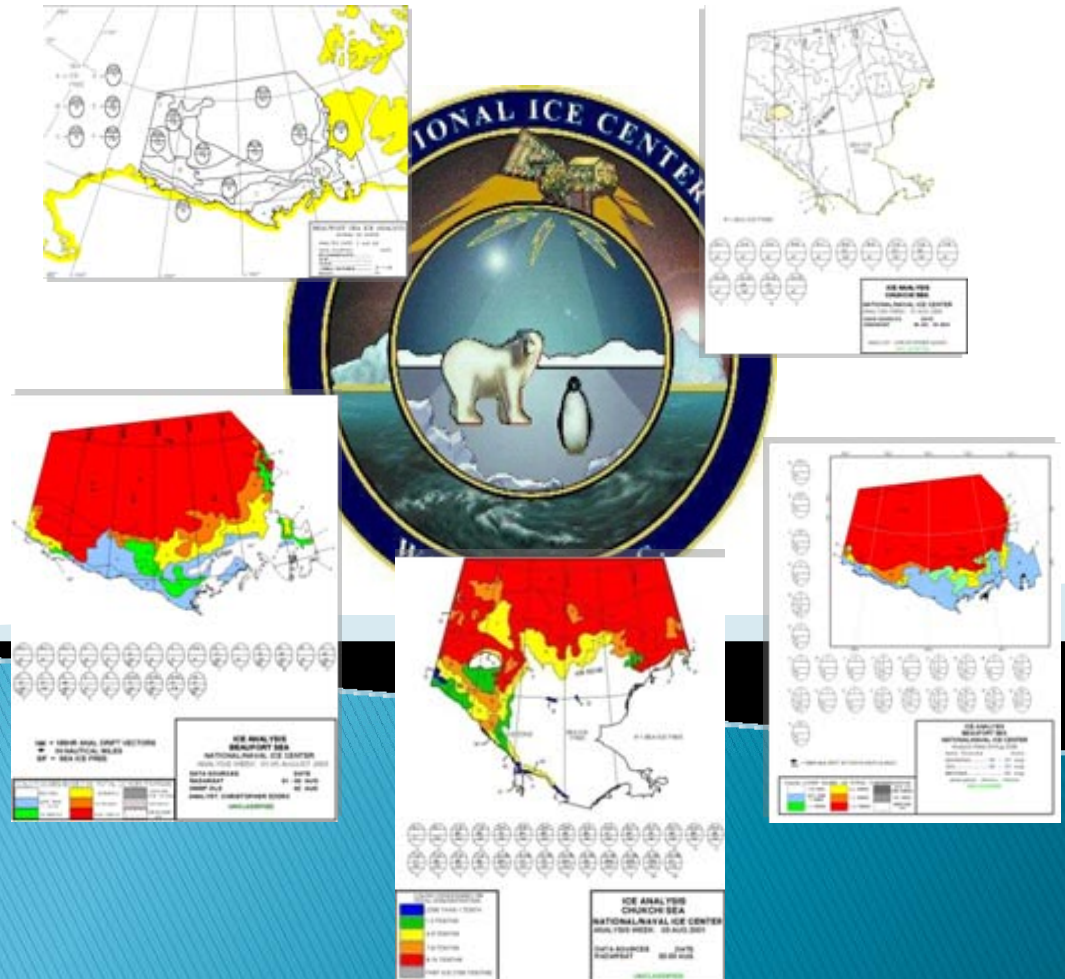
Using NIC Charts to Improve Seasonal Forecasting

Todd E Arbetter

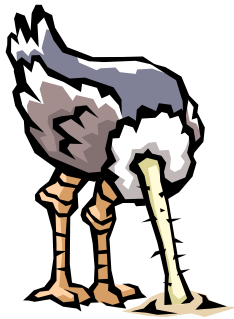
UCAR Visiting Scientist

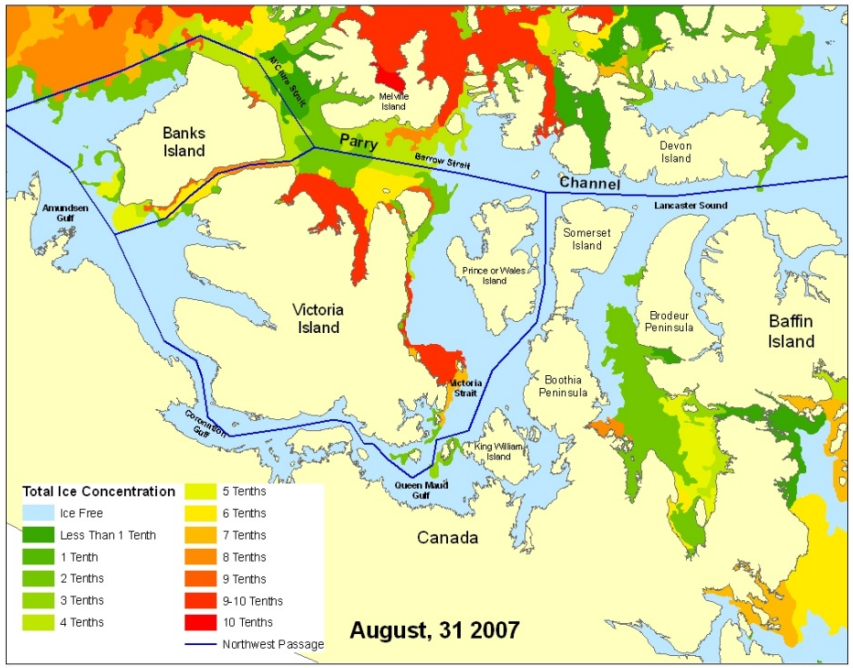
National Ice Center

Suitland, Maryland USA



Prologue: Northwest Passage 2007





National Ice Center

Statements from various agencies and entities that NWP was "open".

Media and public interest snowballed, leading to numerous (mis)interpretations of significance.

Much of route is navigated annually by Canadian icebreakers and convoys, but **clearing** of Victoria Strait and M'Clure Strait **unprecedented**. Analyses indicated less MY ice in region than typical.

Commercial viability remains limited in short-term, but event underscored the need to improve seasonal outlooks.

Outline:

1. NIC Overview
2. NIC/NAIS Seasonal (90-Day) Outlooks
3. Trends from 1953-2007 Observations
4. Forecasts and Trends since 1976
5. Progress and Future Work

1. NIC Overview

NIC Mission & Scope

“Tri-agency” organization

~70 military and civilian personnel

Suitland, Maryland

Pentagon Component

Excellence in sea ice analysis and forecasting

NIC’s mission is to provide timely, accurate and relevant METOC / ice products and services to meet the ***strategic***, ***operational*** and ***tactical*** requirements of U.S. national interests across a ***global*** area of responsibility.

Integrated Excellence through External Partnerships

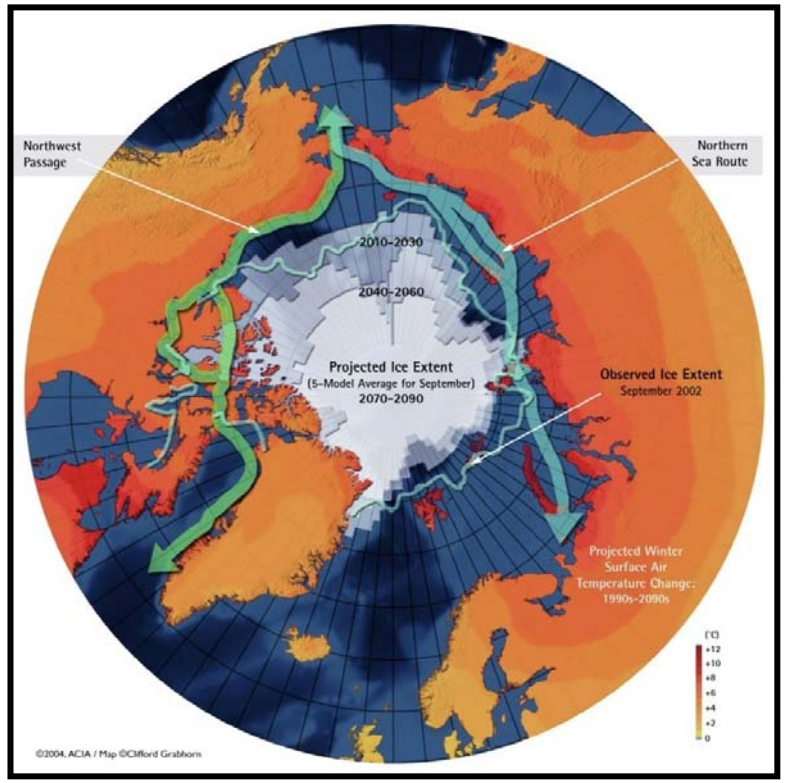
- International Partners
  - **North American Ice Service (NAIS)**
    - National/Naval Ice Center (NIC)
    - Canadian Ice Service (CIS)
    - International Ice Patrol (IIP)
  - **International Arctic Buoy Programme (IABP)**
  - **International Ice Charting Working Group (IICWG)**

Outreach

Over 140 known customers & agencies

A Changing Arctic…

- *Arctic facts:*
  - Persistent Cloud Cover (75%-90%) & 24hr darkness (in winter)
  - Over past 50 years:
    - Warmer (2-3 °C)
    - Summer ice extent ↓ 15%-20%
  - Winter ice is thinner
  - Later freeze-up, earlier break-up
  - 10% decline in albedo
- *Future Trends:*
  - Opening sea lanes
    - Increased maritime traffic
  - Energy exploration
- *Inter-Fleet transits via Arctic*
  - Fast, least expensive route, covert

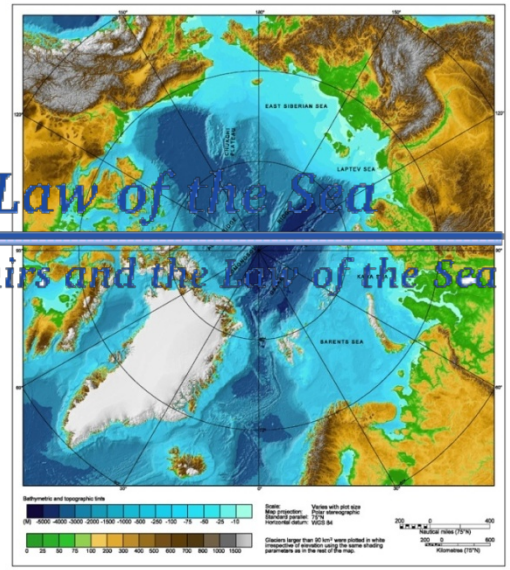


Potential shipping lanes in an ice-diminished Arctic

Sovereignty: Security and Economics

Changing Arctic conditions will bring new challenges and opportunities

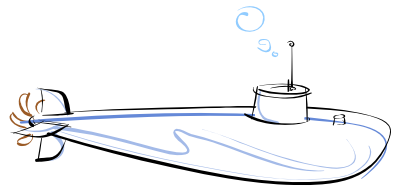
Map from British Broadcasting Corporation



IBCAO Chart

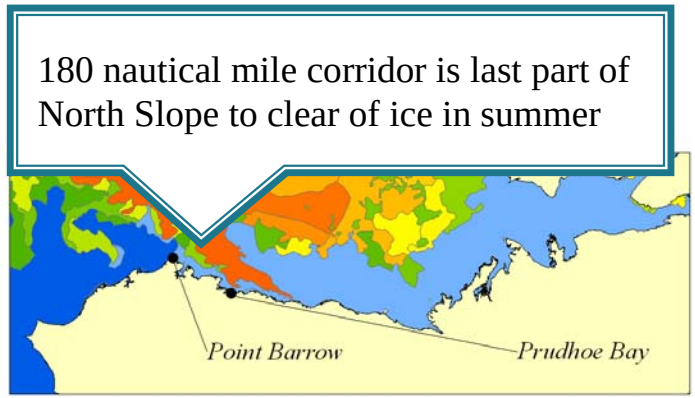
Ice forecasts, outlooks needed for long term planning and support:

- *military/coast guard defense and search/rescue*
- *commercial development, shipping, and ecotourism*
- *scientific research, planning and logistics*



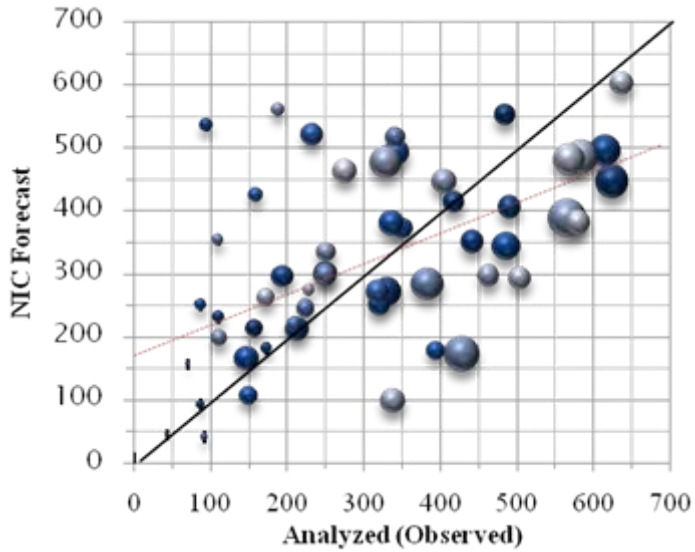
2. NIC/NAIS Seasonal (90-Day) Outlooks

Background



NIC West Arctic Seasonal Outlook:

- Prediction of shipping route between Pt Barrow and Prudhoe Bay along **Alaska's North Slope**
- **Statistical forecast method** initially developed by Barnett (1976) in response to heavy sea ice year in 1975 (North Slope route did not open)
- **Barnett Severity Index:** linear summation of opening dates, ice edge distance from shore, and navigable season length
- Opening, closing dates, severity determined by change in BSI from previous year, meteorological measurements from Jan-Apr of current year



Historically, NIC Forecasts underpredict severe years (low BSI) and overpredict light years (high BSI)…

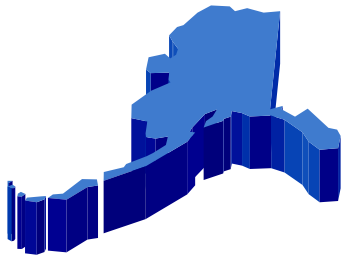
… but method has not evolved with changing Arctic.

North American Ice Service (NAIS)

Western Arctic Seasonal Outlook

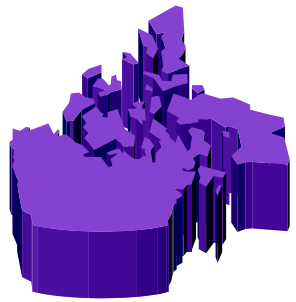
National Ice Center component

- statistical regression
- based on pressure, temperature readings at specified locations, times
- compared with previous years
- no meteorological model input
- only concerned with Point Barrow-Prudhoe Bay
- method not significantly updated since 1983 (ie same equations in use)



Canadian Ice Service component

- based on ice freezing and melting degree days
- RADARSAT analysis
- compared with previous years
- long term meteorological forecasts used
- more thorough coverage of Beaufort/Chukchi and in to NWP



In both cases, forecaster (human) experience plays a key role!

…but how good are the tools they use?

The Project

Forecasting the Condition of Sea Ice On Weekly to Seasonal Timescales

NOAA Climate Transition Program

- Pablo Clemente-Colon (National Ice Center)
- Ignatius Rigor (University of Washington)
- Todd Arbetter (National Ice Center)

Objectives:

1) Analyze observations from ice mass balance buoys and other in situ sources to validate the NIC forecast method

2) Exploit the significant lag correlations between variations in atmospheric circulation and sea ice extent to produce long range forecasts of Arctic sea ice conditions

Rationale

How accurate are the NIC/NAIS outlooks?

What are reasons for inaccuracies?

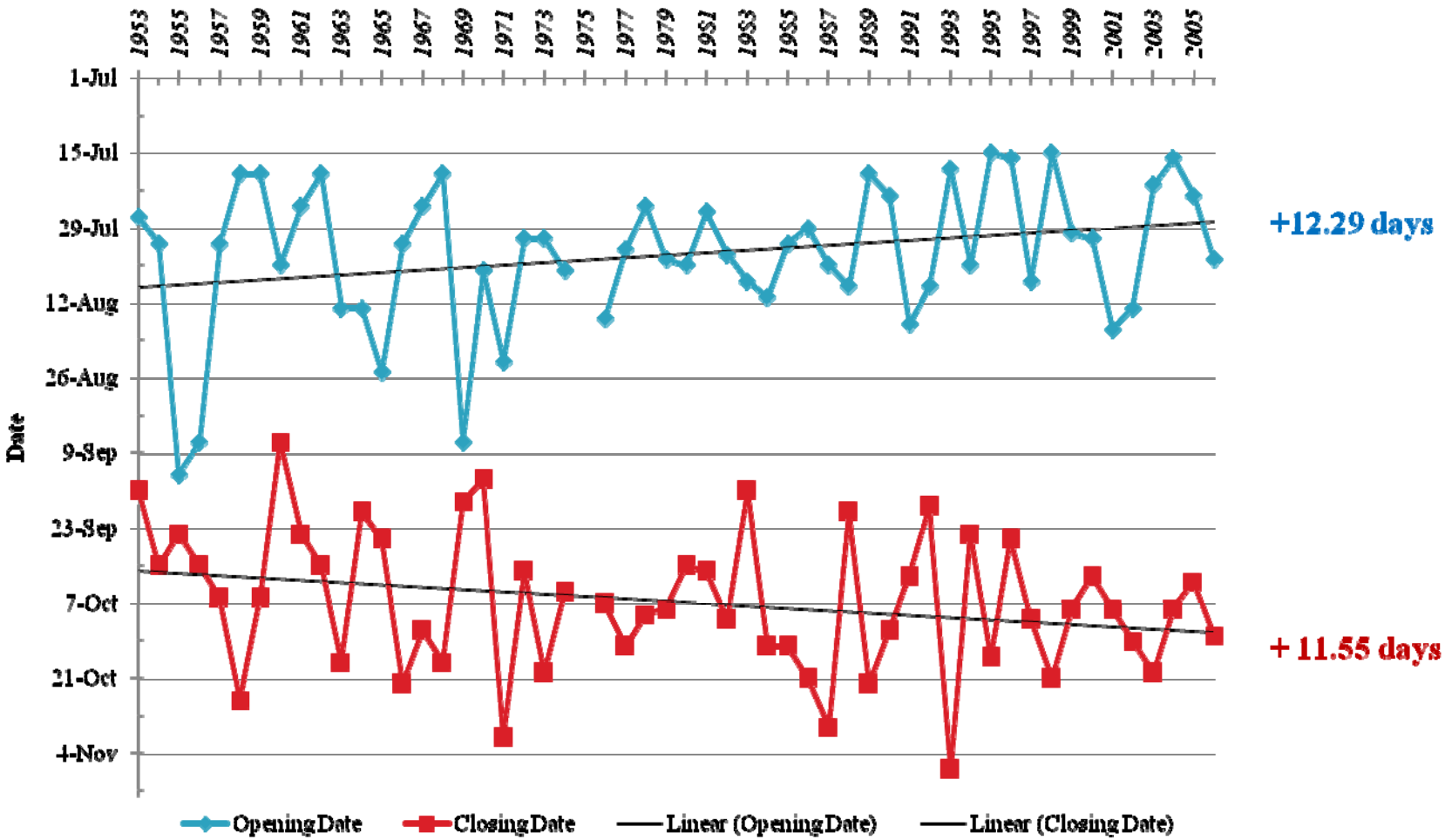
Can the methods be improved?

In the Context of:

- Ice Chart Climatology
- Numerical Weather Prediction Models
- Remote Sensing and Station Data
- Statistical Methods

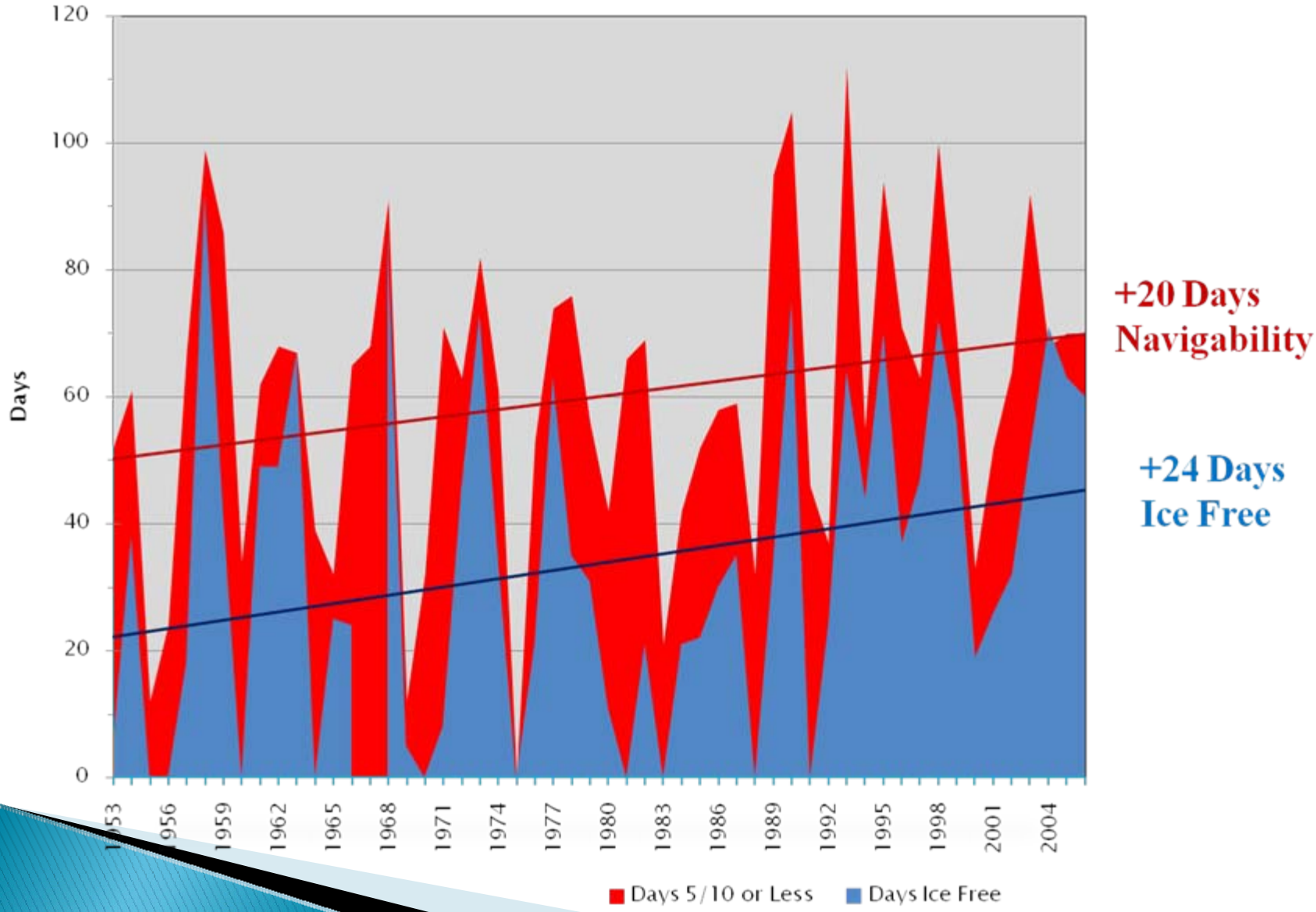
3. Trends from 1953-2006 Observations

Barrow-Prudhoe Bay Observed Trends 1953-2006



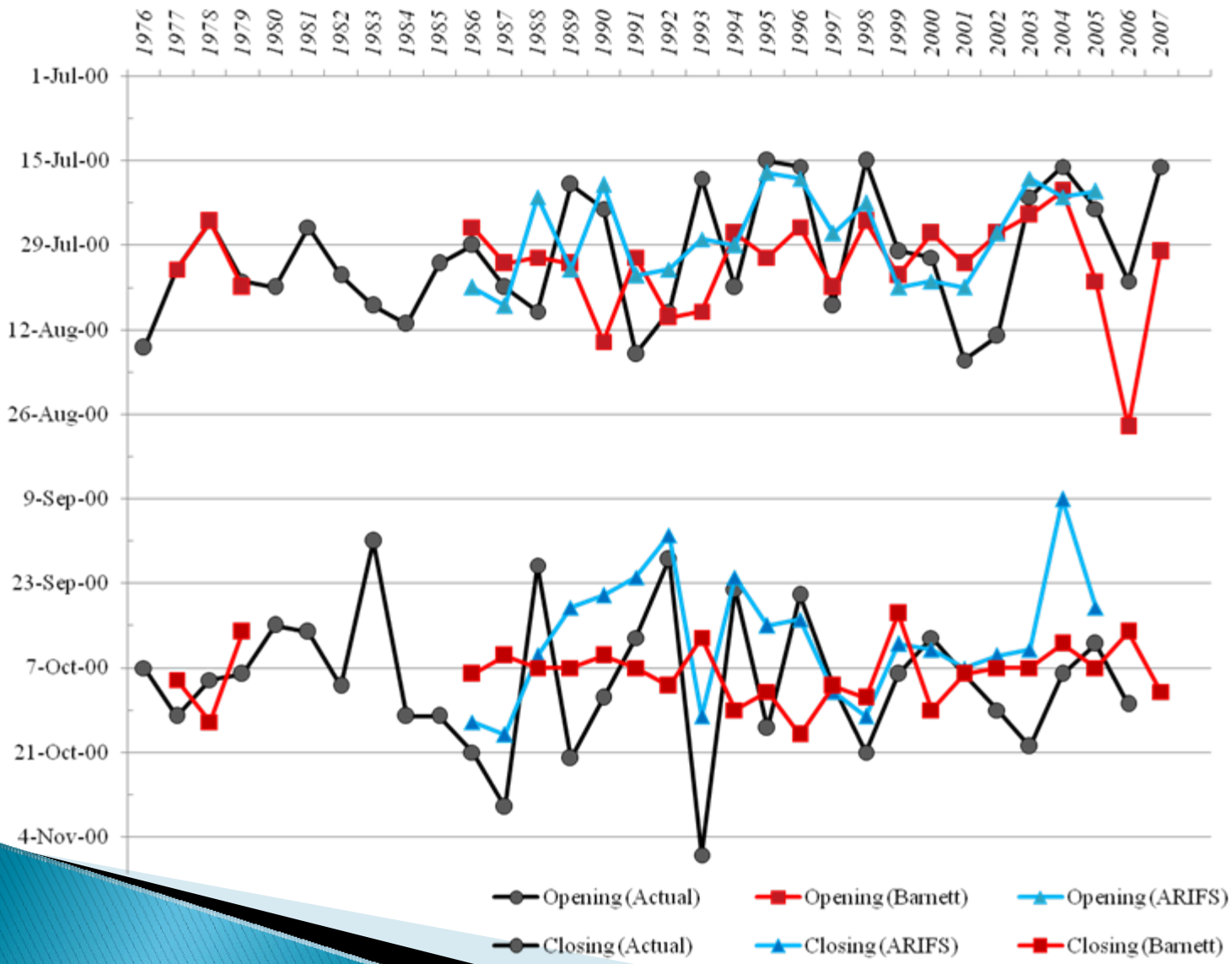
*NIC Analyses indicate **+24 days** of North Slope navigation since 1953*

Barrow-Prudhoe Bay Navigability1953-2006



3. Forecasts and Trends since 1976

Barrow-Prudhoe Bay: Analysis since 1976



Analyses

Outlooks

ARIFS

-12.83 days

-10.33 days

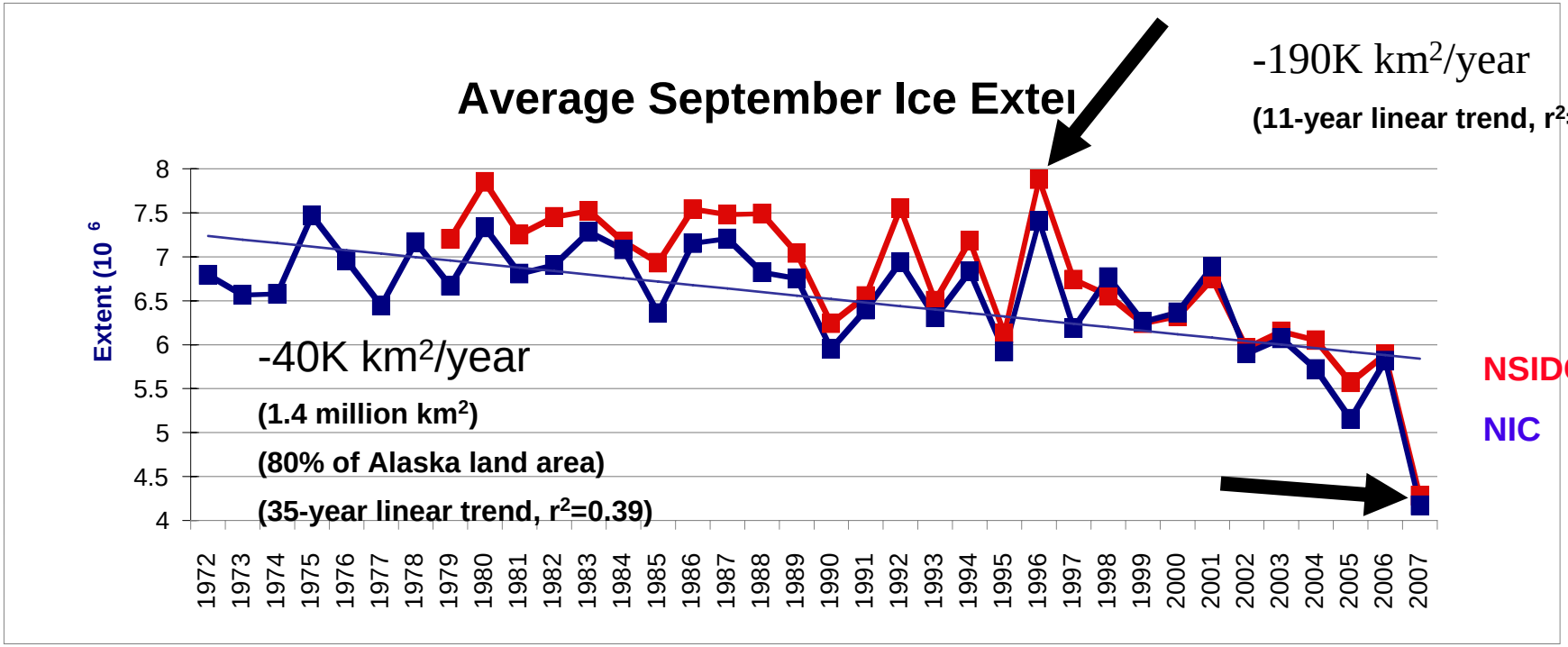
+1.06 days

-11.93 days

-1.43 days

+2.89 days

What happened?



Overall trend of sea ice declining since 1972

Accelerated decrease since 1996.

Record minimum in 2007

Ice in transition to new equilibrium? Seasonal pack?

Sea Ice Outlook linear regression based on 1953-1975 (ancient) statistics, need to update with more recent data, methods

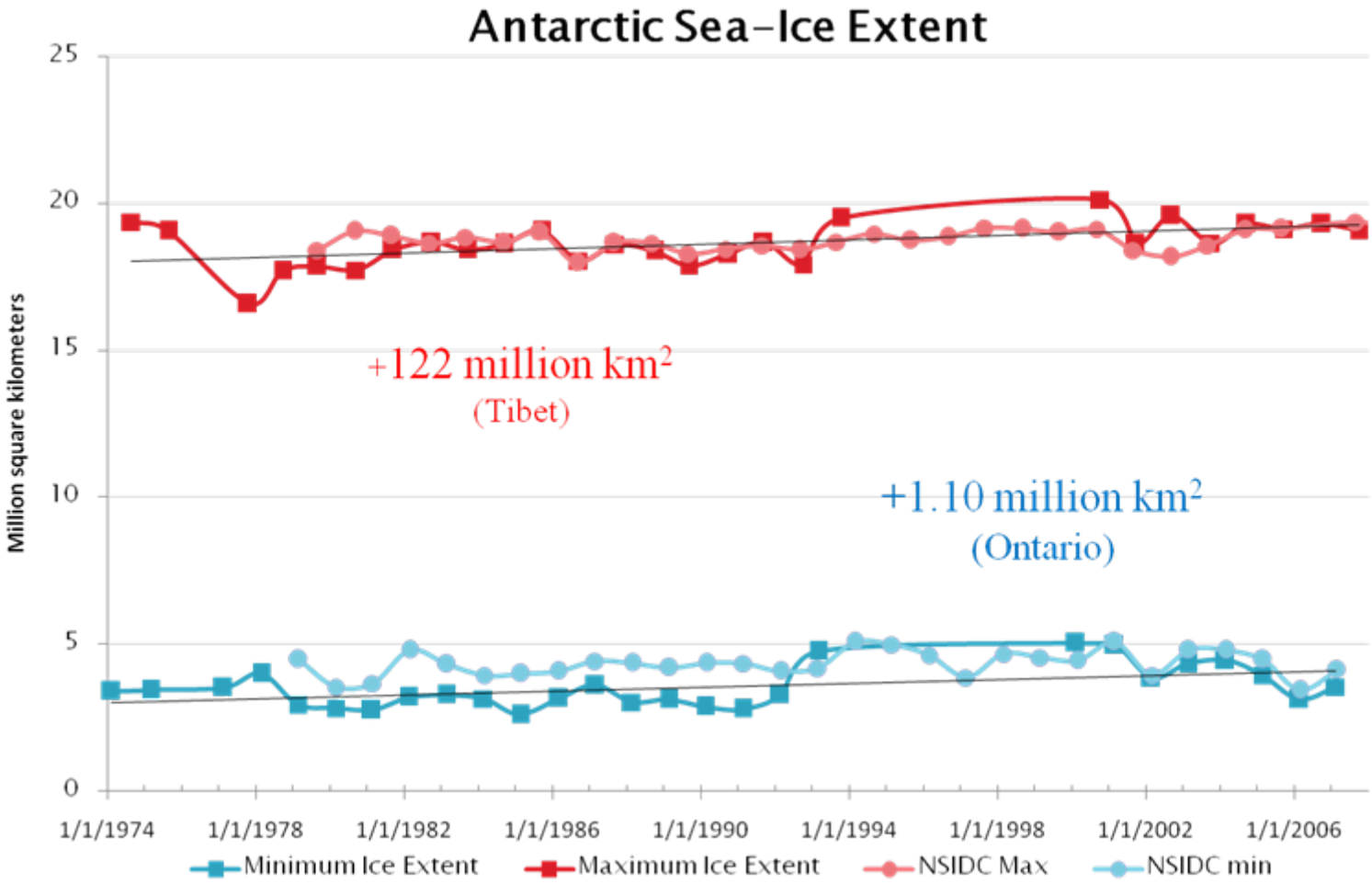
Summary

- NIC records and charts indicate a trend toward **longer periods of navigability** along the Barrow-Prudhoe Bay shipping route since 1953 (+20-24 days)
- NIC records indicate a trend toward **earlier openings, later closings**
- Since 1977, NIC observations have shown the route opens 10 days earlier and closes 3 days later.
- NIC seasonal outlooks have trended opposite, opening 1 day later and closing 1.5 days earlier.
- ARIFS (Drobot, University of Colorado) applied to 1986-2004, incorporating satellite observations from 1979-1985, better matches the opening trend but does not improve the closing trend.

*Neither method **consistently** predicts accurate openings/closings (within 1 week of observed)…*

… but ARIFS shows potential (more later).

Meanwhile, in Antarctica…



NIC Climatology in progress, but little trend since 1974

5. Progress and Future Work

Next Steps

Collect other Seasonal Outlooks

ARIFS (Sheldon Drobot)

almost

NWS Alaska Ice Desk (Kathleen Cole)

Complete

CIS (Maria McLeod)

Vexcel UK (Kim Partington)

Evaluate Accuracy

Prudhoe Bay Sea Route

Now

Amundsen Gulf

Chukchi Sea

Bering Strait

Incorporate More Data

Arctic Buoys

Met Forecasts

Later

"Smart" Algorithms

ARIFS

Arctic Regional Ice Forecasting System (Sheldon Drobot, University of Colorado)

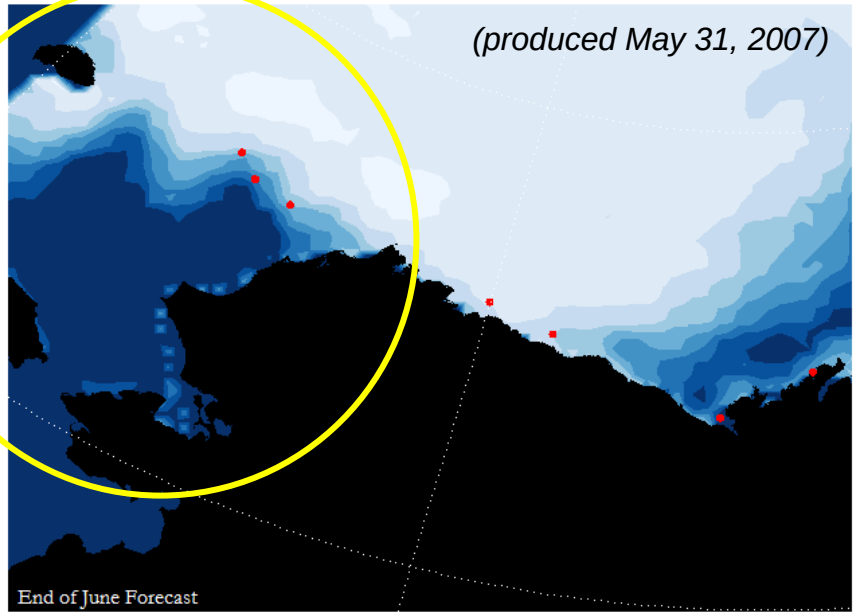
Uses up-to-date satellite observations and met observations

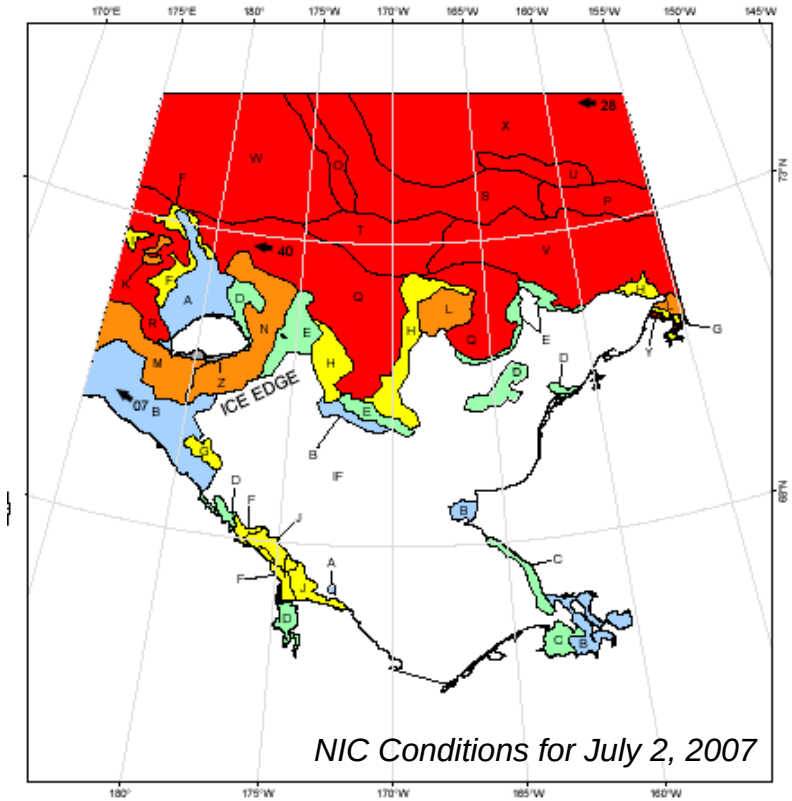
30 to 90-day point forecasts including probability of ice occurrence

Graphical forecasts:

ARIFS 30-day forecast for June 30, 2007

(produced May 31, 2007)





Alaska coast west of Barrow, October 1994