Sea Ice: Model Developments, Predictability and Prediction

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With contributions from:
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Why build a CICE Consortium?

to enhance sea ice model development for and by the community

- Acceleration of scientific development
- Acceleration of R&D transfer to operational use
- Vehicle for collaboration and sharing

https://github.com/CICE-Consortium

Environment and
Climate Change Canada

github.com/ESCOMP/CICE

Atmosphere-Ice-... | Universities / Insti... | Misc. Servers / In... | Online news | Sports | Kids | Software FAQ, FT... | NCAR Library Proxy | Using Intake-ESM...

ESCOMP / CICE

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Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights | Settings

CICE Public

forked from CICE-Consortium/CICE

EMC has their own fork.

Edit Pins | Unwatch 6 | Fork 119 | Star 2

main | 6 branches | 51 tags | Go to file | Add file | Code

This branch is up to date with CICE-Consortium/CICE:main. | Contribute | Sync fork

apcraig Update .readthedocs.yaml, add pdf (CICE-Consortium#837) ... 7eb4dd7 last week **893** commits

.github	Rename cicedynB to cicedyn, update test suites (CICE-Consortium#...	7 months ago
cicecore	Fix for mesh check in CESM driver (CICE-Consortium#830)	last week
configuration	Add functionality to change hist_avg for each stream (CICE-Consorti...	last month
doc	Add functionality to change hist_avg for each stream (CICE-Consorti...	last month
icepack @ 6703bc5	Update Icepack to #6703bc533c968 May 22, 2023 (CICE-Consortiu...	last month
.gitattributes	Add .gitattributes file (CICE-Consortium#332)	4 years ago
.gitignore	NOAA machine pass of base_suite CICE-Consortium#155 (CICE-Con...	3 years ago
.gitmodules	CICE: Floe size distribution (CICE-Consortium#382)	4 years ago
.readthedocs.yaml	Update .readthedocs.yaml, add pdf (CICE-Consortium#837)	last week
.travis.yml	Make JRA55 default forcing dataset (CICE-Consortium#533)	3 years ago

About

Development repository for the CICE sea-ice model

Readme
Activity
2 stars
6 watching
119 forks
Report repository

Releases

51 tags

Create a new release

Packages

No packages published

ESCOMP/CICE

ESCOMP/CICE

- cicecore/drivers/nuopc/cmeps (same as used in UFS)
- Keep ESCOMP “main” up to date with CICE Consortium main.
- Issue PRs from forks back to Consortium main.
- Test the caps within their own model systems.
- CICE standalone driver tested on several machines.
- Separate wrapper layer ESCOMP/CESM_CICE.

CESM-PCWG Plans for CESM3 and beyond

Plan for sea ice within CESM3:

- using new CICE6 model physics including: improved snow physics, landfast ice, floe-size distribution (improved wave-ice interactions)
- Adding better ice-ocean freshwater / salt coupling (done!)
- Possible C-grid capability
- Inclusion of sea ice biogeochemistry and coupling to ocean

Plans for CESM3+

- Parameterizations of subgridscale snow heterogeneity influence
- Improvements to albedo (optical properties of ponds, spectral resolution, etc.)
- Improvements to pond parameterization (water retention on ice, etc.)
- Motivated by MOSAiC.

Status of CESM-CICE6 developments

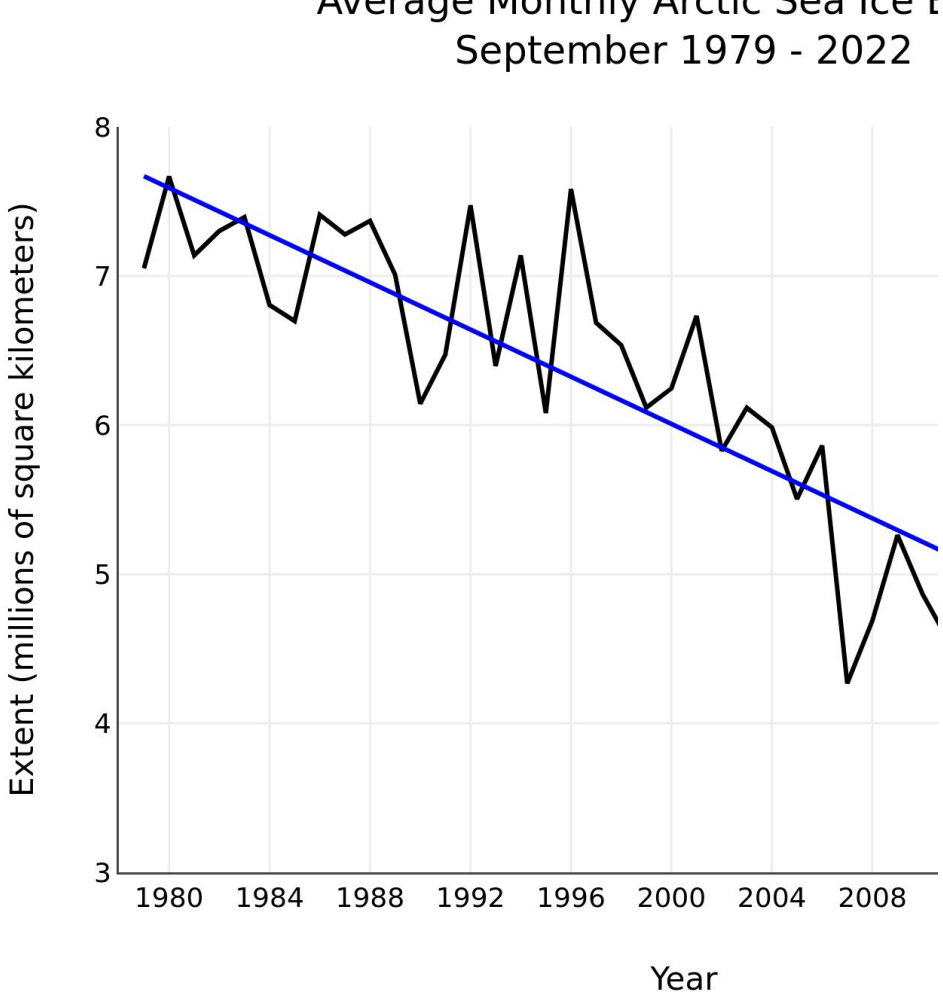
- Salt flux coupling to MOM6 is complete. Work in progress for enthalpy (heat from phase changes) coupling.
- Landfast sea ice: Need updated ocean bottom bathymetry.
- Snow physics: Mostly ready. Need to perform sensitivity studies to understand the coupled impacts. Wind blown snow into leads.
- Floe size distribution – wave interaction: On hold due to physics concerns and also some technical challenges.
- C-grid: Some instabilities in standalone CICE with incremental remapping advection.
- BGC: Need to draw up coupling necessary between CICE and MARBL.

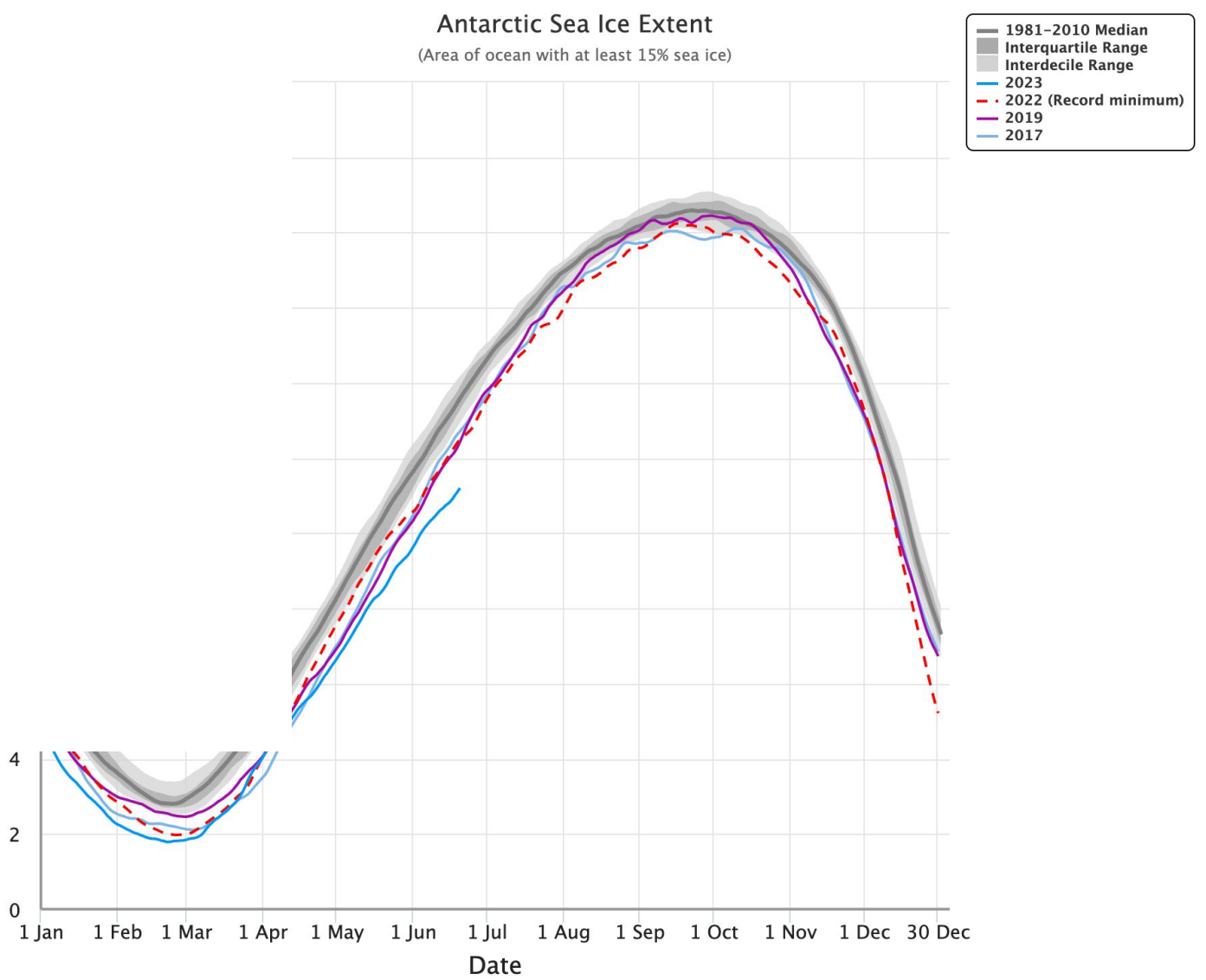
Predictability Work at NCAR

Holland et al. – Arctic and Antarctic sea ice predictability measures based on initial conditions for the sea ice and ocean.

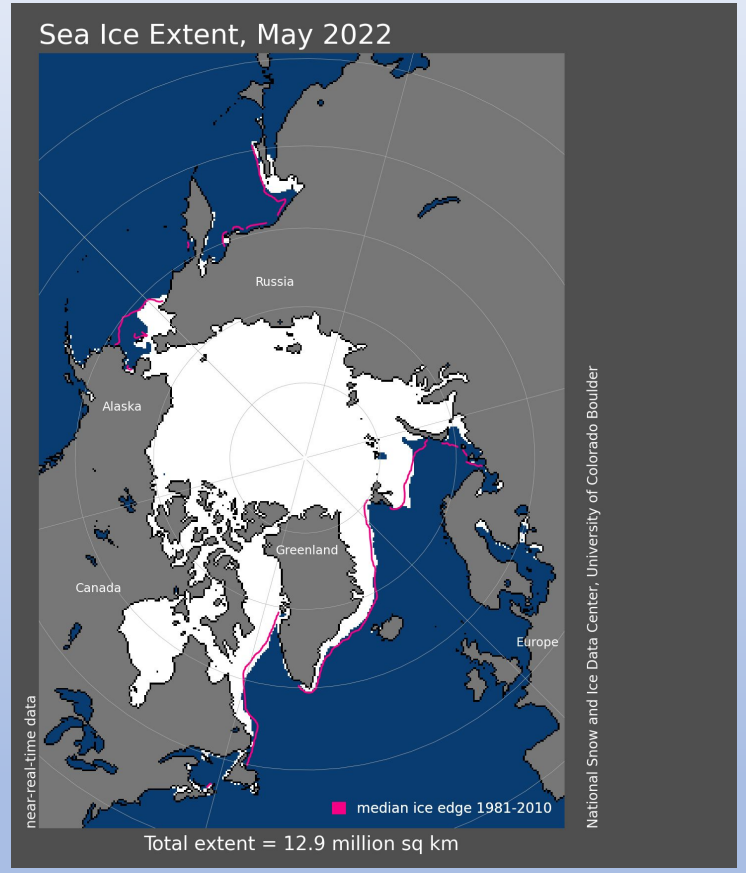
Yeager et al. – Seasonal-to-Multiyear Large Ensemble (SMYLE). An initialized ensemble looking at predictability in the whole Earth system including sea ice.

Bushuk et al. – Sea Ice Prediction Network (SIPN)

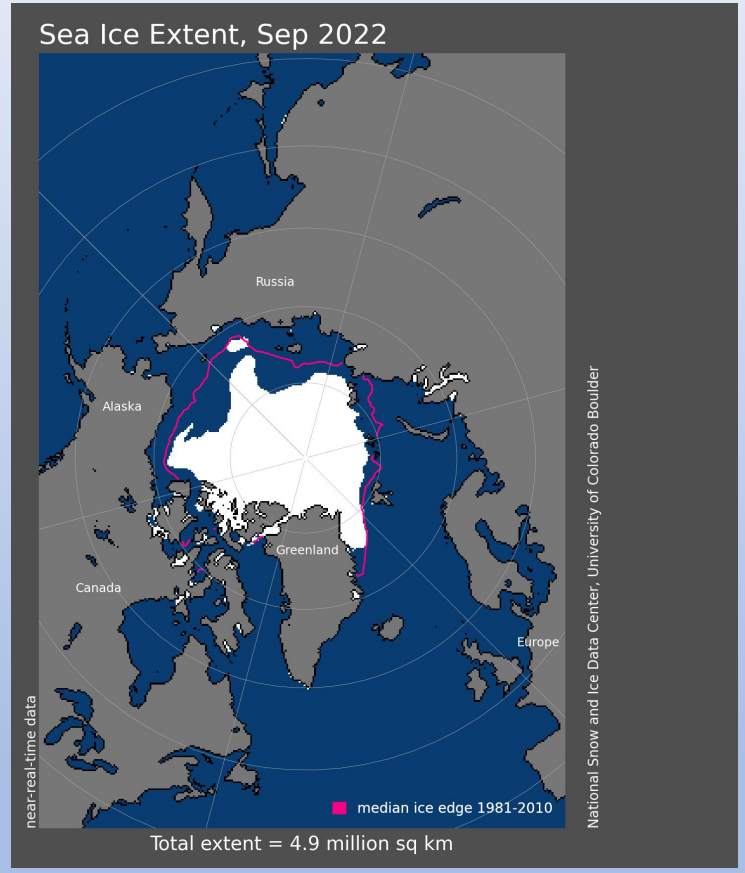

Average Monthly Arctic Sea Ice E
September 1979 - 2022
Extent (millions of square kilometers)
8
7
6
5
4
3
1980
1984
1988
1992
1996
2000
2004
2008
Year


Antarctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)
1981–2010 Median
Interquartile Range
Interdecile Range
2023
2022 (Record minimum)
2019
2017
4
2
0
1 Jan
1 Feb
1 Mar
1 Apr
1 May
1 Jun
1 Jul
1 Aug
1 Sep
1 Oct
1 Nov
1 Dec
30 Dec
Date
National Snow and Ice Data Center, Boulder, CO

Is May extent a good predictor for September?



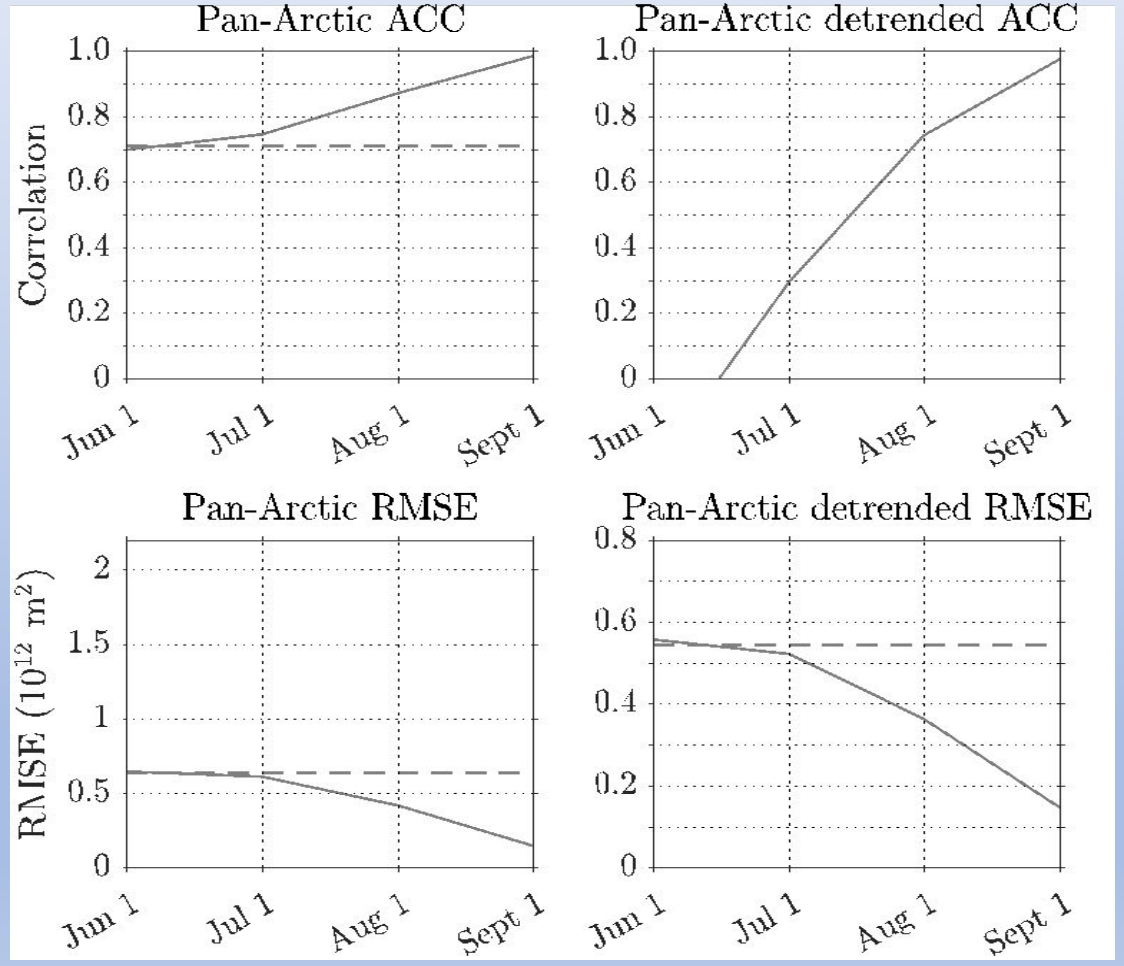
???



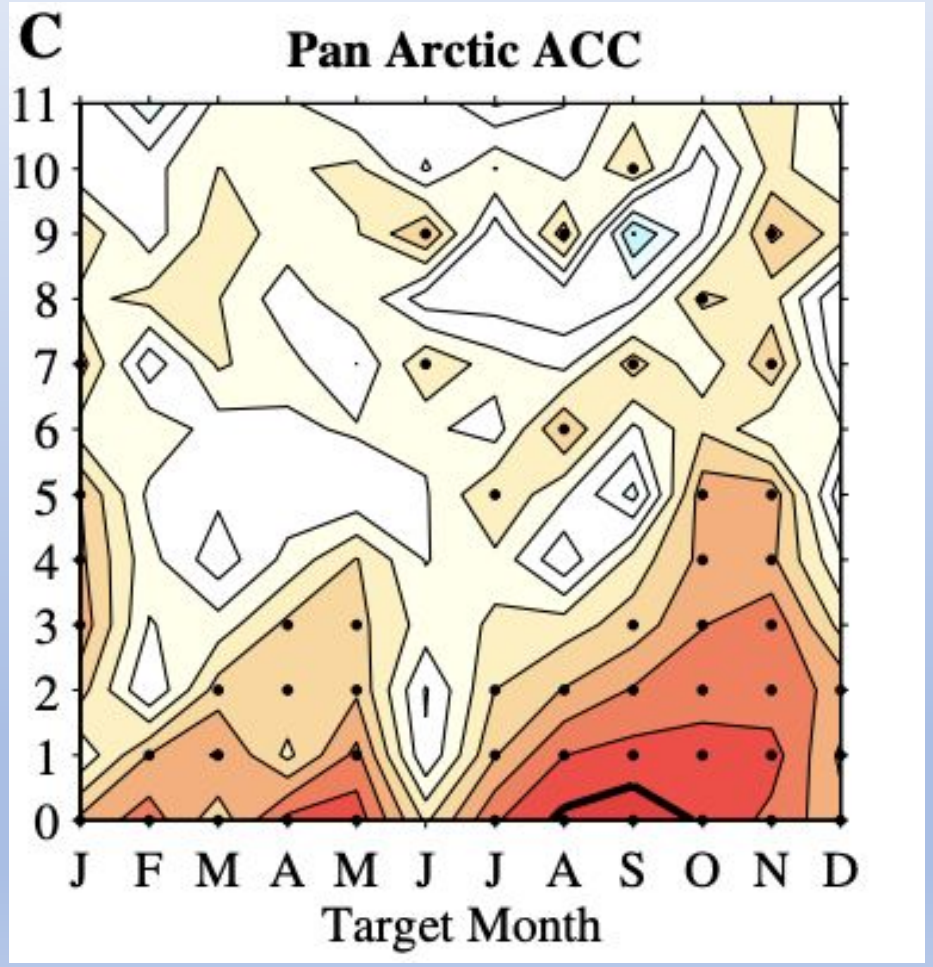
Short answer is no.

Predictability from Ice Area (Bushuk et al.)

Satellite Observations

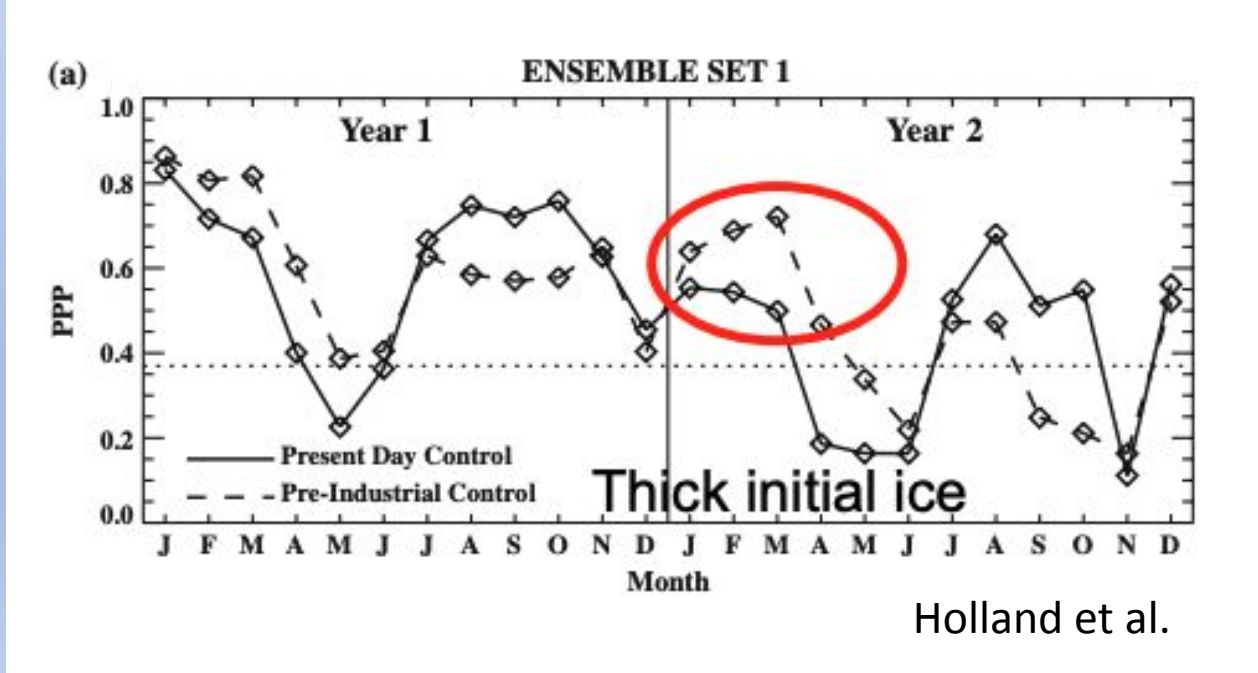


"Perfect" Model

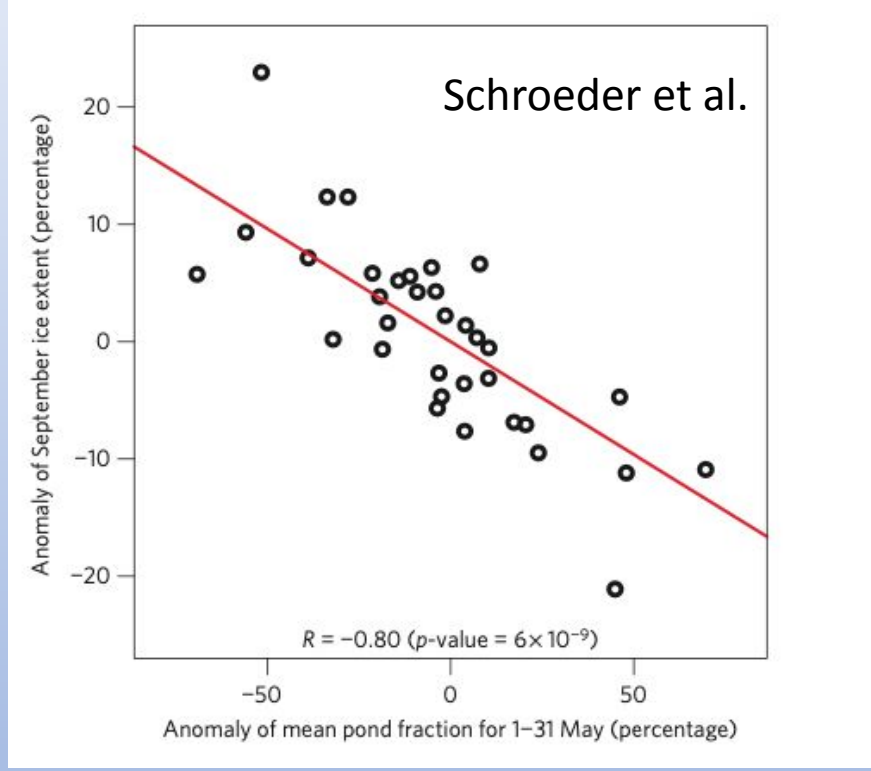


Predictability from Other Physical Quantities

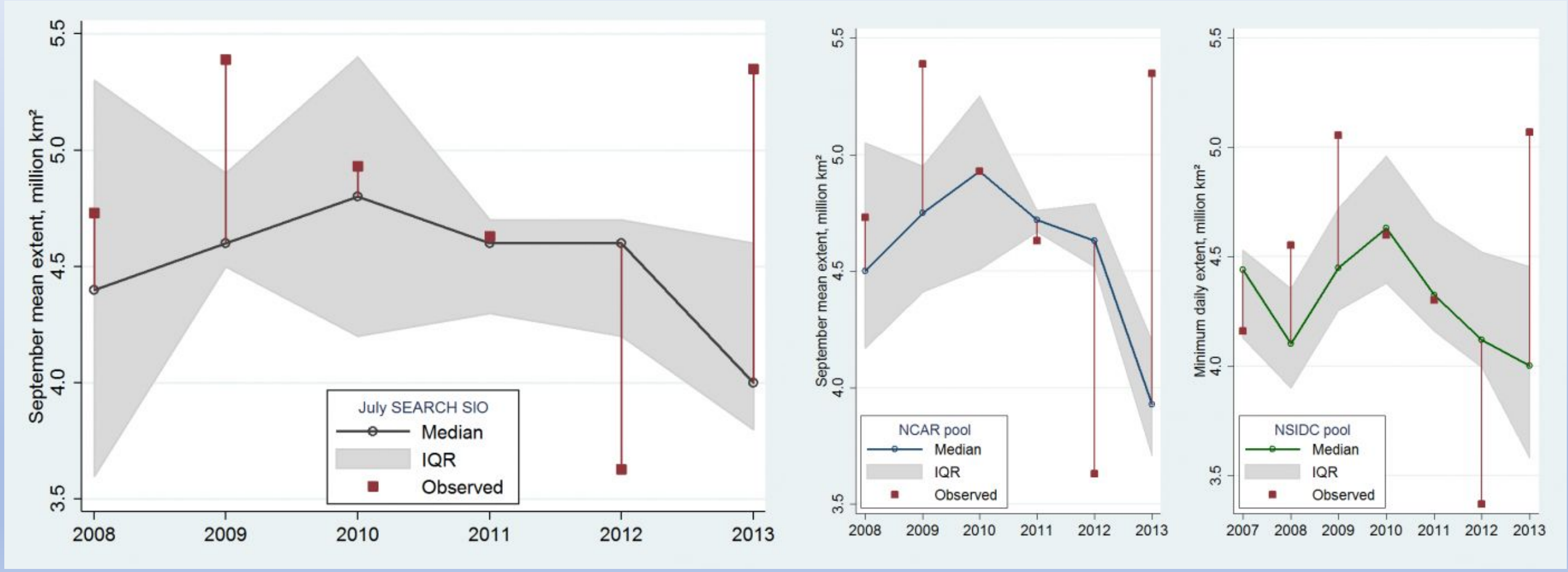
- More predictability from sea ice thickness, melt ponds, ...
- We just need these in real time!



Holland et al.



Sea Ice Prediction Network (SIPN)



Stroeve et al. 2014

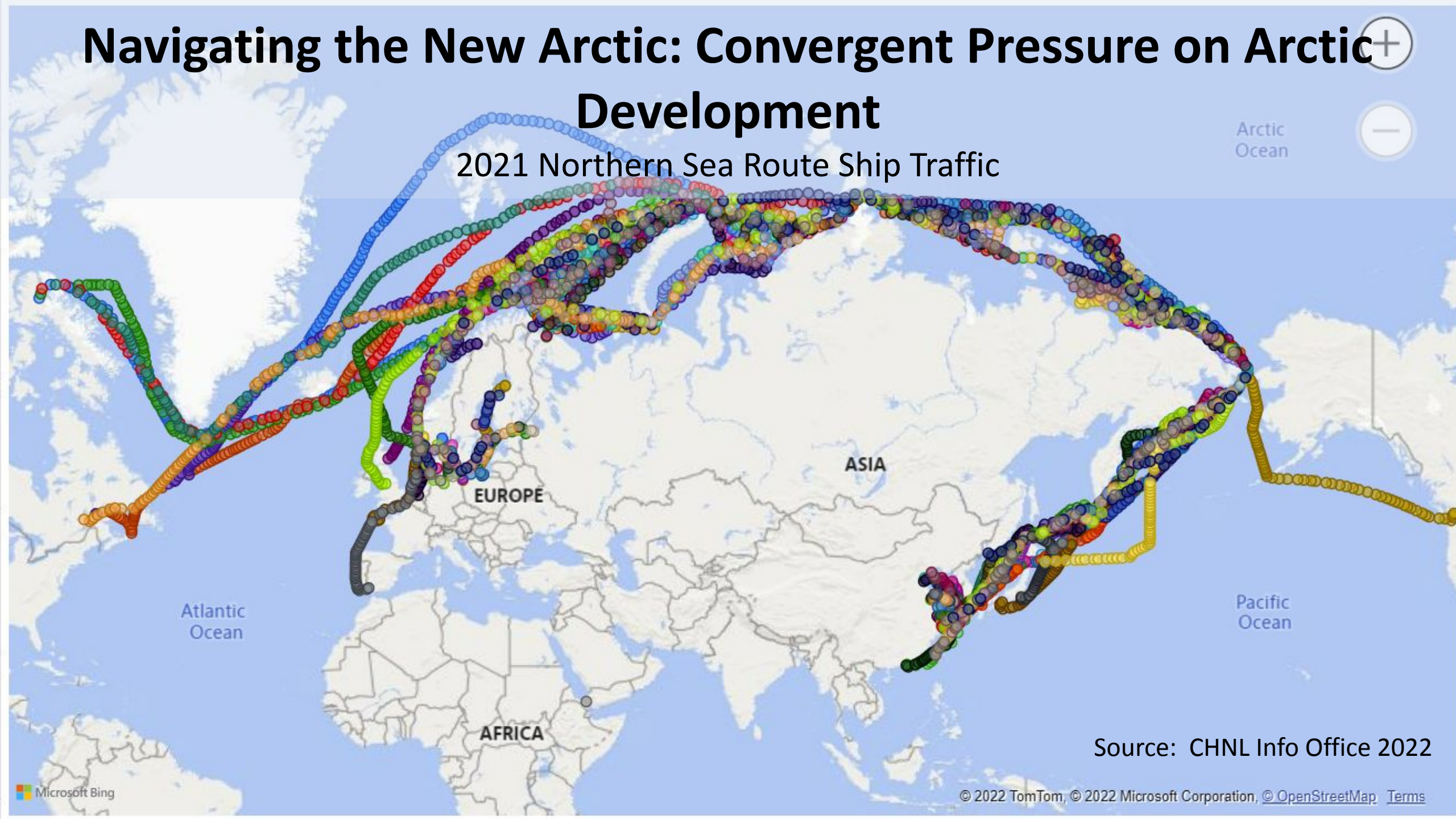
NCAR / CU Sea Ice Pool Results

2008	Masha Tsukernik (15)
2009	Keith Oleson (19)
2010	Jen Kay (19)
2011	James Screen (20)
2012	Kevin Raeder (23)
2013	Dave Bailey (26)
2014	Gokhan Danabasoglu (27)
2015	Marika Holland (30)
2016	Ed Blanchard-Wrigglesworth (27)
2017	Fred Castruccio (30)
2018	Dave Bailey (33)
2019	Peter Gent* (29)
2020	Sally Zhang (33)
2021	Sean Leister (38)
2022	Gina Jozef (27)

*Peter Gent in the top 3 five times!

Navigating the New Arctic: Convergent Pressure on Arctic Development

2021 Northern Sea Route Ship Traffic



Source: CHNL Info Office 2022

Summary

- CICE Consortium.
- CESM3 to be ready later in 2024.
- Snow physics and landfast ice likely to make it in. FSD-waves less certain.
- Arctic sea ice prediction is hard.
- Earth System Predictability and Actionable Science are key focus areas for NCAR.