Ocean Predict

SYMPOSIUM OP'24

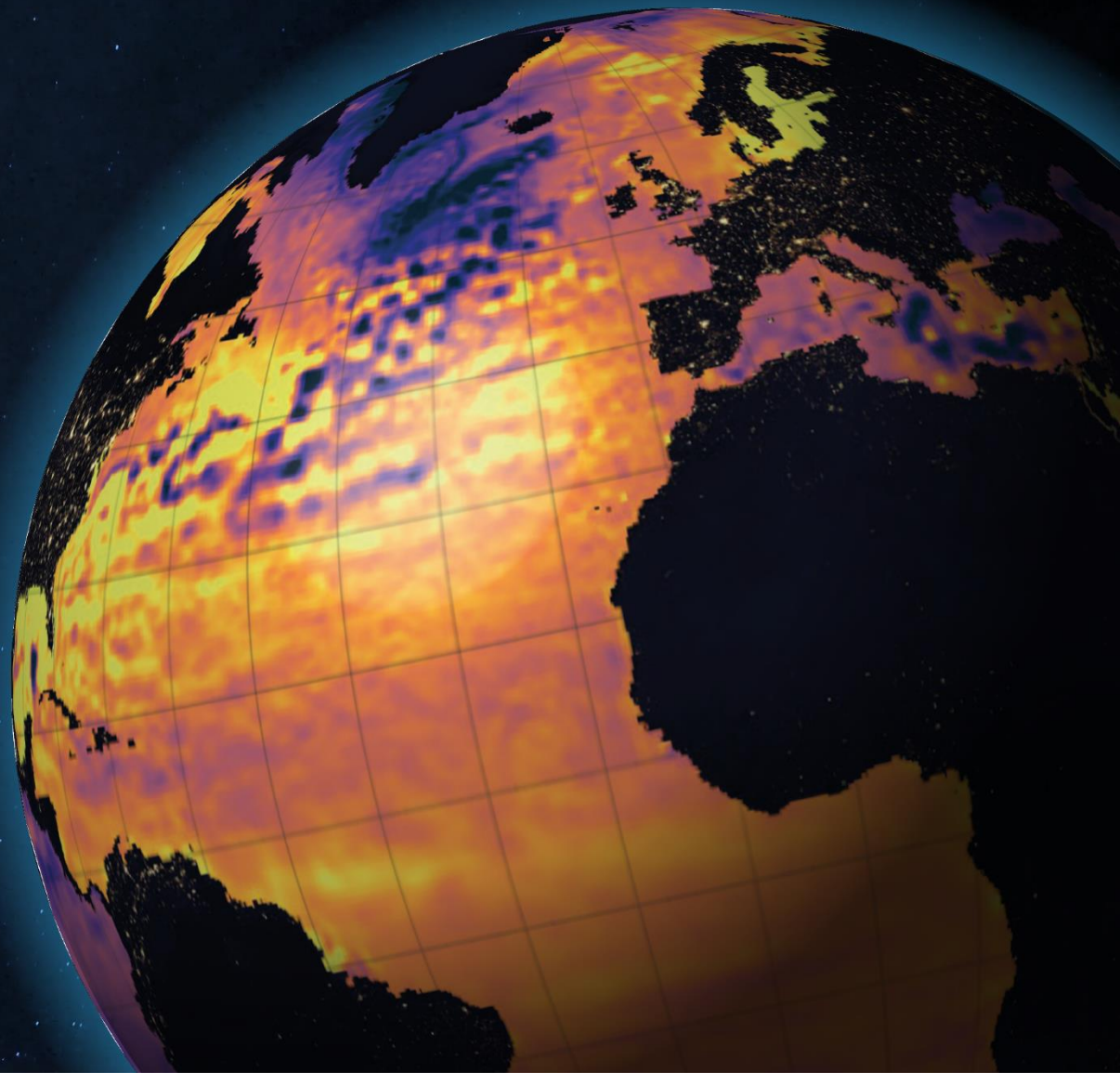
In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Assessments of quality of predictions for sea ice

Arne Melsom

Norwegian Meteorological Institute /
Arctic Monitoring and Forecasting Centre,
Copernicus Marine Service



Key questions

- How is the quality of sea ice prediction from model forecasts typically assessed?
- Do we properly address user needs regarding the level of quality of our products?
- Which aspects receive too little attention?

Estimated accuracy in Copernicus Marine Service

Period: 2022-07 – 2023-06				
Variable	**Region**	**Supporting observations**	**Best estimate**	
			RMSD	**Bias (model-observation)**
Sea ice concentration (area fraction)	**Full domain**	**SSMIS**	**0.13**	**0.04**
	American s.		0.12	0.04
	European s.		0.13	0.04
	Asian s.		0.13	0.04
Sea ice edge length (Kkm)	**Full domain**			**0.11**
	American s.			-0.01
	European s.			0.13
	Asian s.			-0.01
Sea ice edge position (km)	**Full domain**		**78**	**1**
	American s.		88	-3
	European s.		56	2
	Asian s.		65	10
Sea ice thickness(*) (m)	**Full domain**	**SMOS**	**0.33**	0.11
		Cryosat-SIRAL	**0.78**	-0.31
Sea ice drift displacement (km)	**Full domain**	**SAR**	**5.4**	**-0.2**
	American s.		4.2	0.7
	European s.		6.7	-1.1
	Asian s.		5.7	-1.3

Quality information at a glance

- A very limited set of quality metrics
- Poor information of regional contrasts
- No information about temporal changes in quality (e.g. seasonal)
- Only one type of instrument used for each property
  (exception: sea ice thickness)
- No information about dependency on forecast day range

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COPERNICUS MARINE SERVICE ARCTIC OCEAN MFC

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- No information about temporal changes in quality (e.g. seasonal)
- Only one type of instrument used for each property (exception: sea ice thickness)
- No information about dependency on forecast day range
- Definitions not provided, not obvious, and essential for some results

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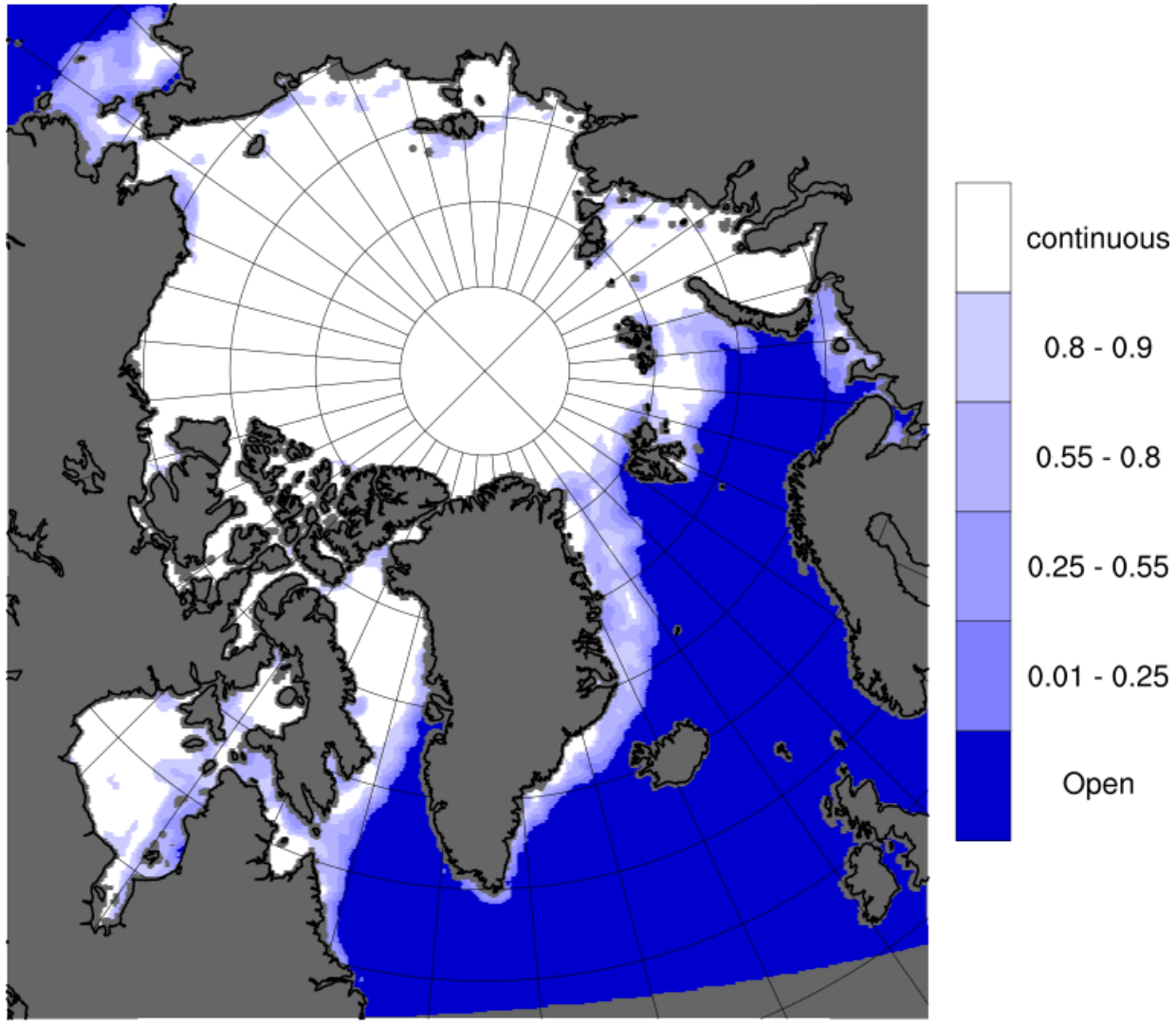
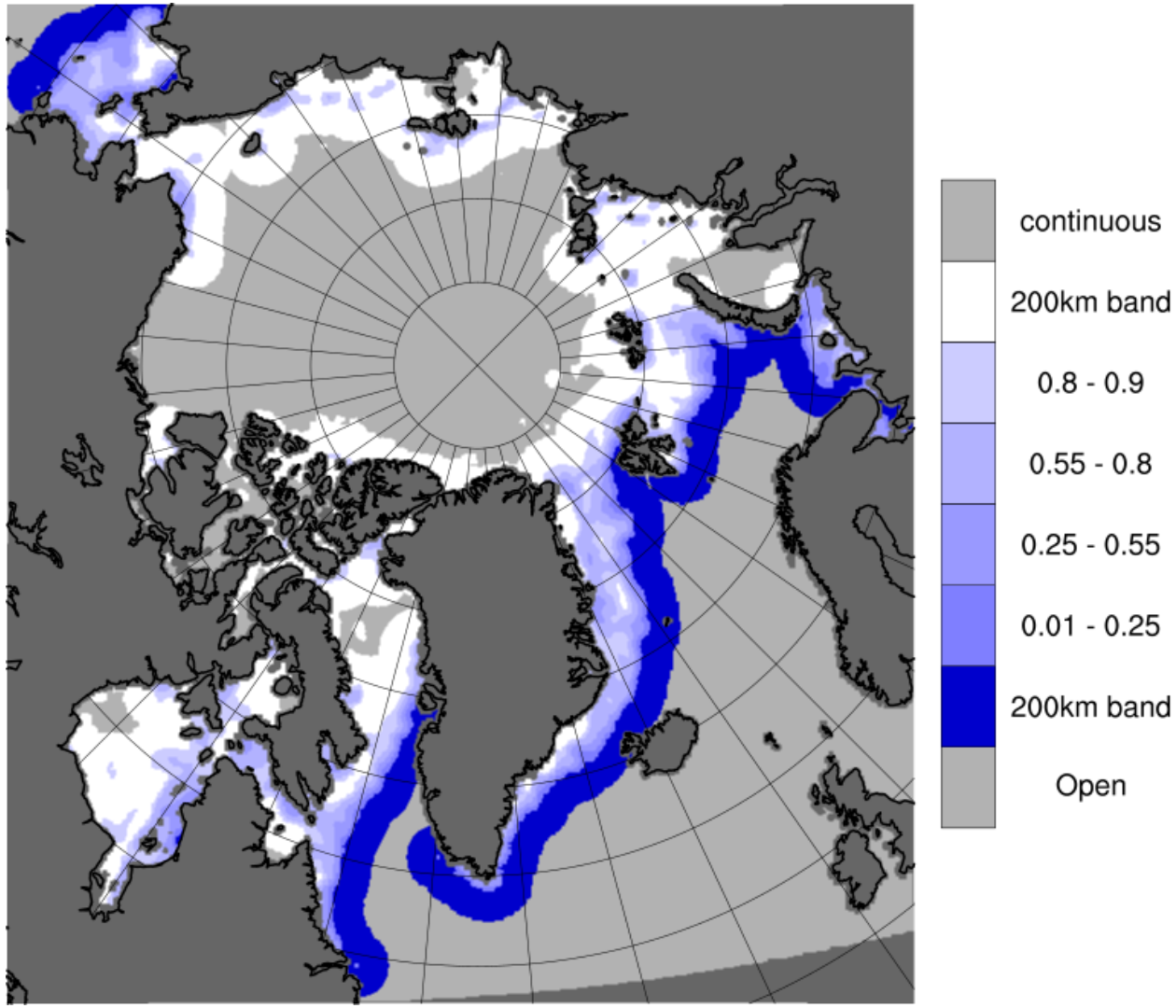
Sea ice concentration – restrictions on the domain



Sensitivity to domain definition

- Use the full domain to get excellent results **but!**
- Large areas are irrelevant, such as the open ocean far away from the ice edge
- Bias, root mean square difference values will be misleading to operators in ice infested waters

Sea ice concentration – restrictions on the domain

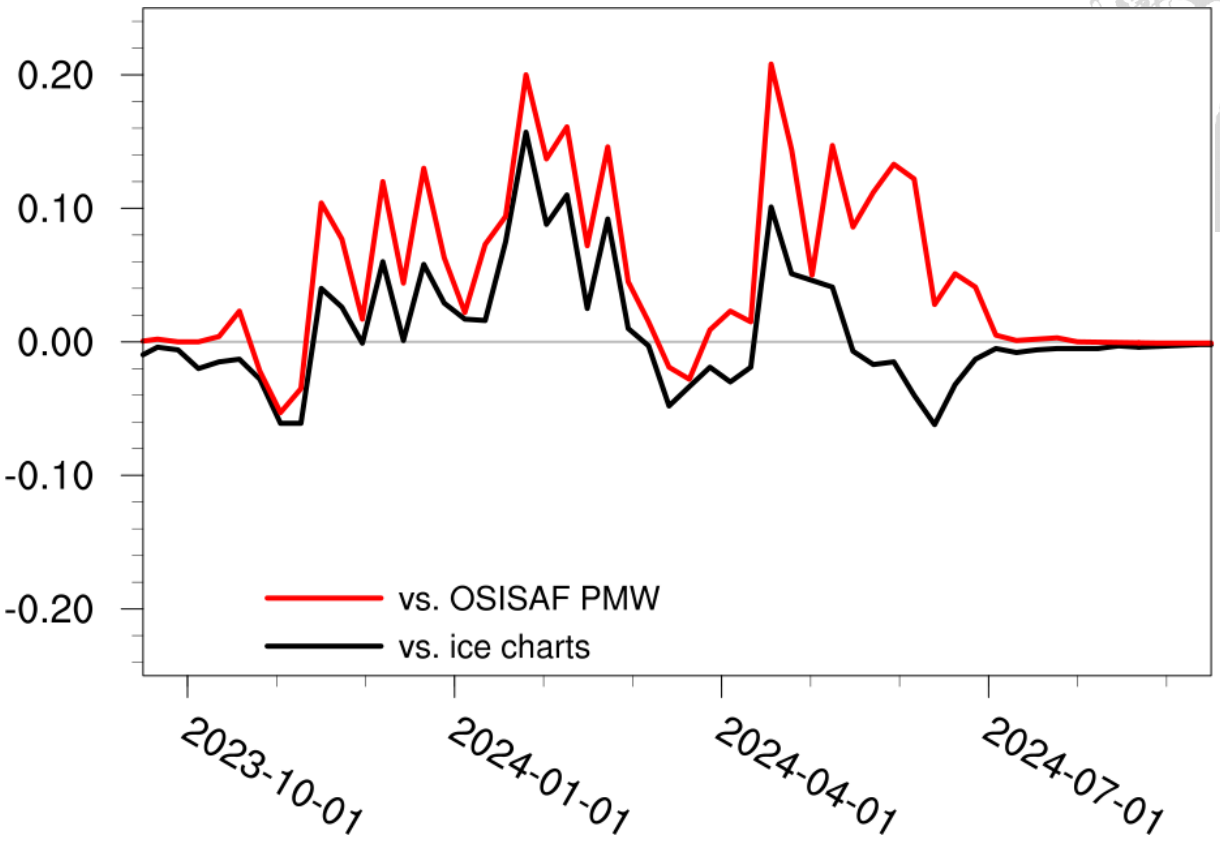


Sensitivity to domain definition

- Use the full domain to get excellent results **but!**
- Large areas are irrelevant, such as the open ocean far away from the ice edge
- Bias, root mean square difference values will be misleading to operators in ice infested waters
- ARC MFC approach:
  Restrict validation domain to
  - Area with observed concentration in the range [0.01, 0.9]
  - Plus «padded» 200km zones

Sea ice concentration bias, Barents Sea

Results for the 7-day forecast range

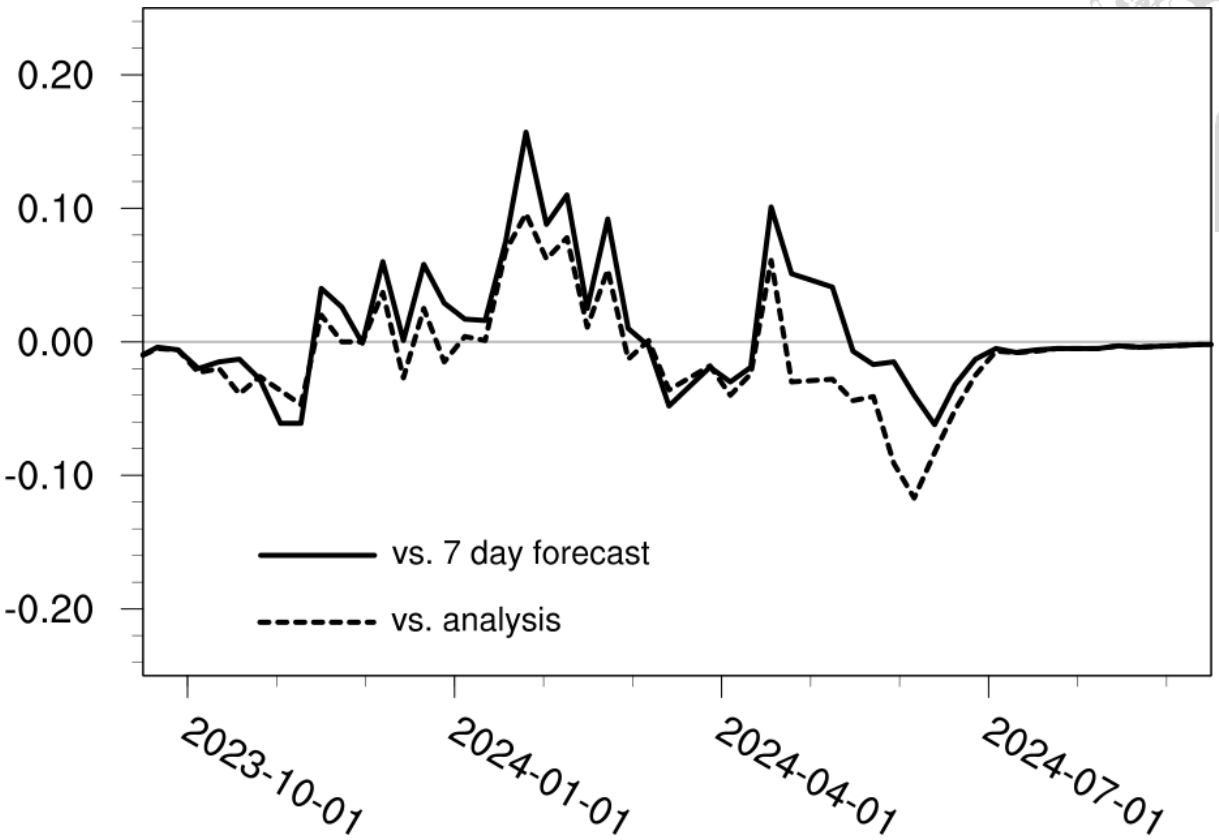


Quality aspects addressed

- Temporal changes in quality
- Regional results for quality
- Two independent observational datasets

Sea ice concentration bias, Barents Sea

Results, model vs ice chart data



Quality aspects addressed

- Temporal changes in quality
- Regional results for quality
- Quality changes for forecast range

Sea ice concentration, category contingency table

- Model *vs* SSMIS data, full domain
- Model results are with a 7 day forecast range
- Tabulated values are accumulated from weekly results during 2023-09-07 – 2024-09-12
- Off-band («remote») match-ups removed

Observations

Model	remote	<0.01	0.01-0.1	0.1-0.4	0.4-0.7	0.7-0.9	>0.9	remote
<0.01		***.413***	.006	.005	.000	0	0	0
0.01-0.1	.002	**.059**	.007	.014	.002	.000	0	0
0.1-0.4	.001	.032	.008	.026	.013	.001	.000	0
0.4-0.7	0	.013	.004	.021	.023	.008	.001	0
0.7-0.9	0	.008	.001	.023	**.044**	**.048**	.032	0
>0.9	0	.004	.001	.009	.023	**.064**	**.085**	

- **Bold**: > 4%
- ***Bold italics***: >10%
- Diagonal: 60%
- Tri-diagonal: 87%

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Sea ice concentration, category contingency table

- Model *vs* SSMIS data, full domain
- Model results are with a 7 day forecast range
- Tabulated values are accumulated from weekly results during 2023-09-07 – 2024-09-12
- All open ocean and «continous ice cover» match-ups removed

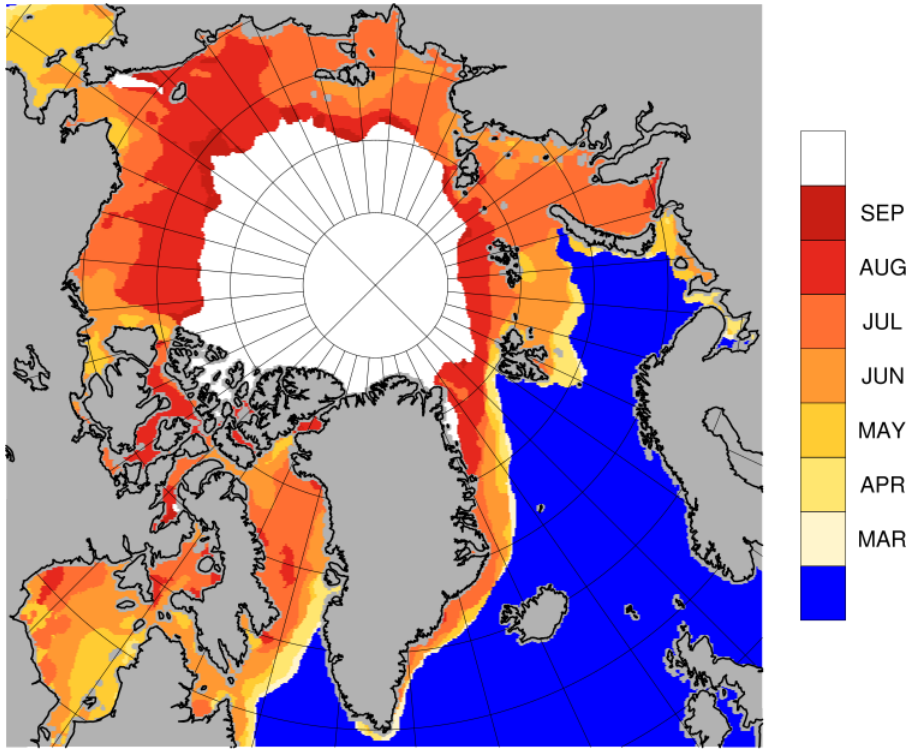
Observations

Model	remote	<0.01	0.01-0.1	0.1-0.4	0.4-0.7	0.7-0.9	>0.9	remote
<0.01			.011	.010	.001	0	0	0
0.01-0.1	.003	***.118***	.015	.028	.004	.000	0	0
0.1-0.4	.001	**.064**	.017	**.052**	.026	.002	.000	0
0.4-0.7	.000	.026	.009	**.042**	**.045**	.015	.001	0
0.7-0.9	0	.016	.007	**.041**	**.087**	**.095**	**.063**	0
>0.9	0	.007	.003	.017	**.046**	***.128***		

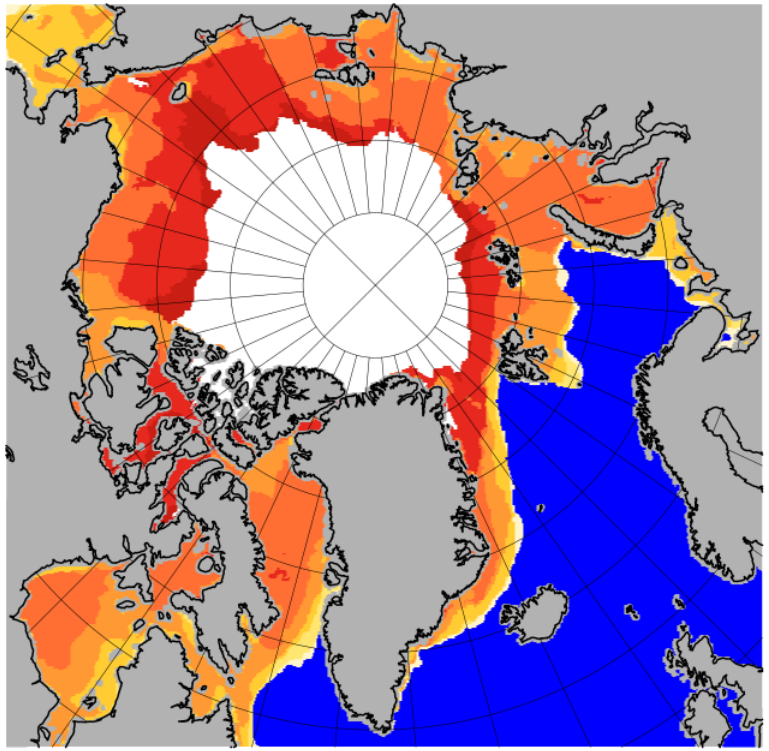
- **Bold**: > 4%
- ***Bold italics***: >10%
- Diagonal: 21%
- Tri-diagonal: 74%

Spatio-temporal variability in forecasts: Ice edge retreat

Observations



Model

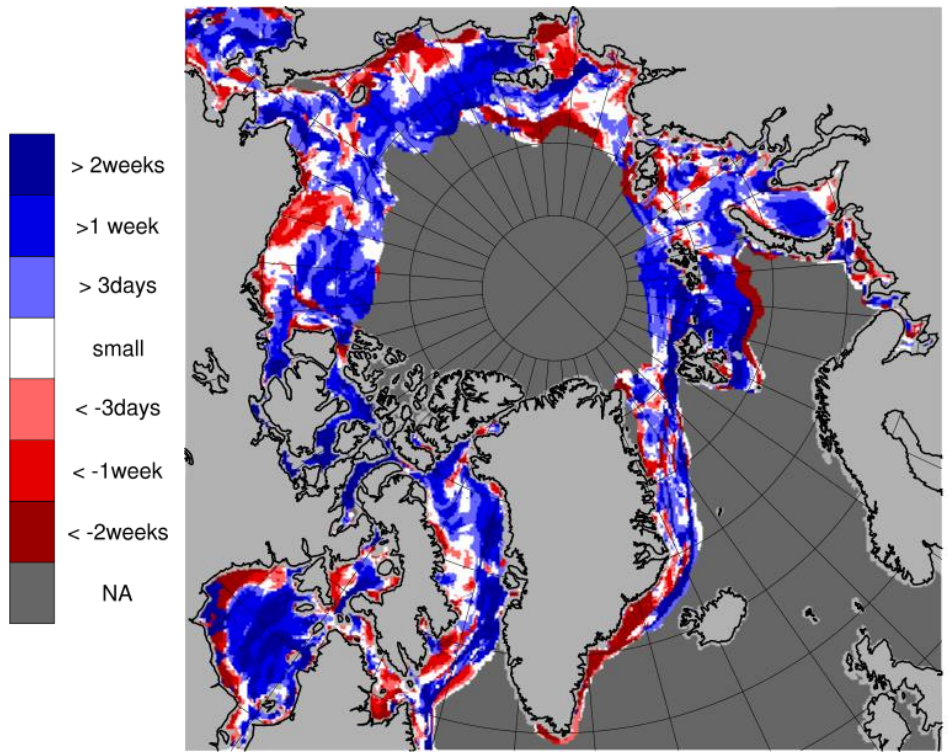


Date of retreating ice edge

- 10-day forecast *vs* SSMIS data
- Displayed season: 2024-03-20 - 2024-09-10
- Low (monthly) resolution in presentation
  ⇒ not user-friendly

Spatio-temporal variability in forecasts: Ice edge retreat

10 day forecast

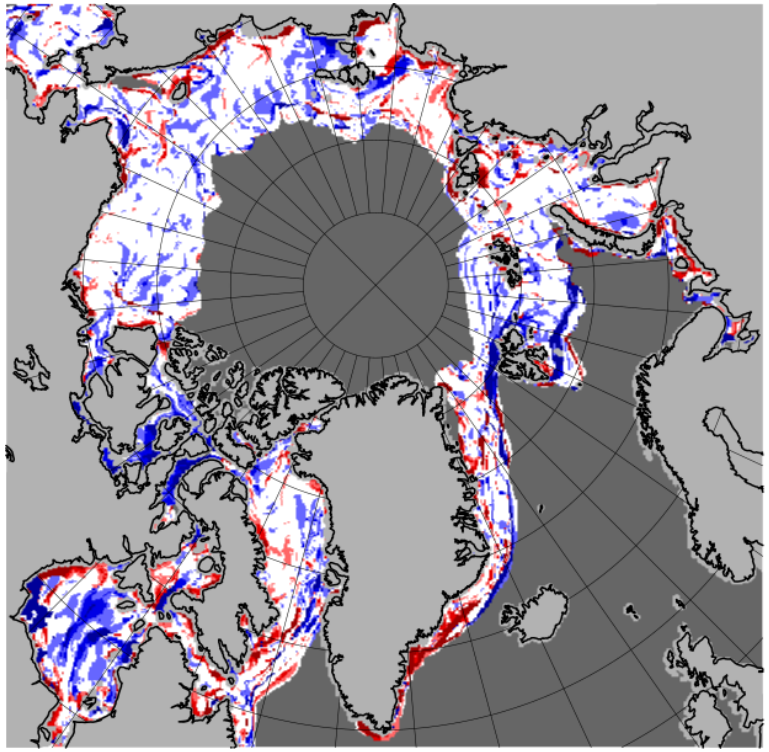


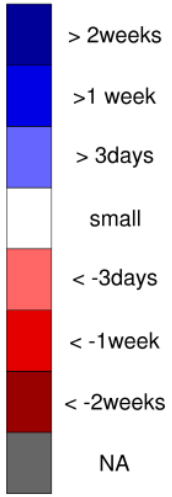
Date separation of retreating ice edge

- 10-day forecast *vs* SSMIS data
- Displayed season: 2024-03-20 - 2024-09-10
- Positive differences
  ⇒ faster retreat in observations
- Generally, model retreat is slower away from coast, faster near the coast

Spatio-temporal variability in forecasts: Ice edge retreat

Model analysis





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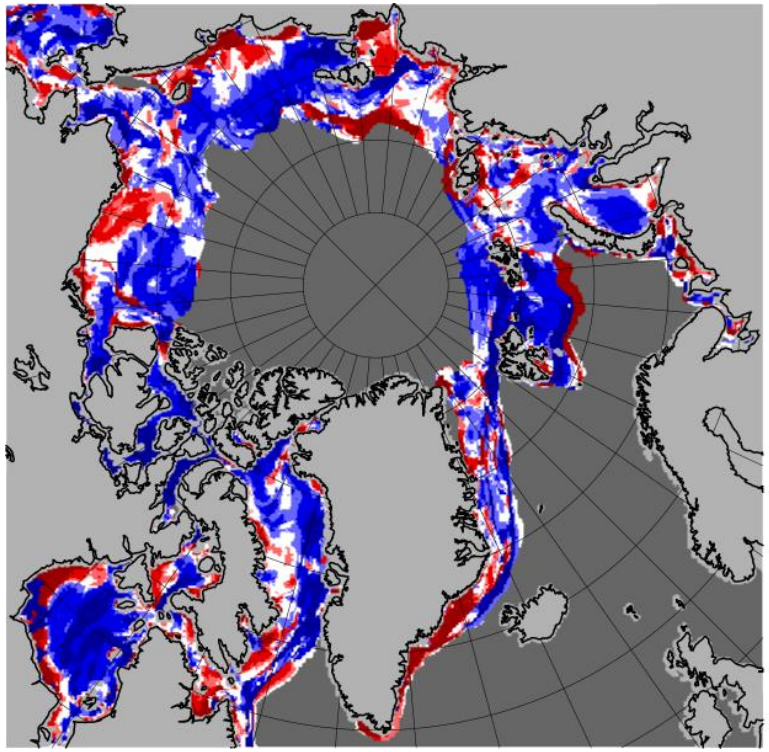

Date separation of retreating ice edge

- 10-day forecast *vs* SSMIS data
- Displayed season: 2024-03-20 - 2024-09-10
- Positive differences ⇒ faster retreat in observations
- Generally, model retreat is slower away from coast, faster near the coast
- Analysis much closer to observations

Recommendations

- For assessment of quality of sea ice concentration results, impose a restriction on the analysis domain.
- Go beyond single value quantities.
  In most contexts they are not very relevant.
- The quality of results for sea ice can vary between seasons.
  Span at least one full annual cycle in all evaluations.
- Include contingency tables.
  They are useful condensates for validation.
- Add results for spatio-temporal variability.
  User needs may be best served by this type of approach.

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European Commission

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