APPLICATE.eu
Advanced prediction in polar regions and beyond

Update on WGSIP related activities

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21st WGSIP session, Moscow, May 2019

Credits: Thomas Jung (AWI), Pablo Ortega (BSC), François Massonnet (UCL)

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Overview of APPLICATE

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Advanced prediction in polar regions and beyond

Mission statement: "Develop enhanced predictive capacity for weather and climate in the Arctic and beyond, and determine the influence of Arctic climate change on Northern Hemisphere mid-latitudes, for the benefit of policy makers, businesses and society."

AWI
CERFACS
cnrs
ARCTIC PORTAL
ECMWF
Met Office
Norwegian Meteorological Institute
METEO FRANCE
University of Reading
Stockholm University
University of Tromsø
uni Research
UCL Université catholique de Louvain
Universitas Bergensis
Institute of Oceanology of Russian Academy of Sciences
Voeikov Main Geophysical Observatory
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Overview of APPLICATE

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Understanding Arctic-midlatitude linkages

- Coordinated multi-model approach (CMIP6-PAMIP → see Doug's talk)
- Employ atmosphere-only *and* coupled models
- Study linkages also from a short-term prediction perspective
- Repeat some of the experiments with enhanced models

Delivering enhanced predictions

Establish Baseline

- New metrics and diagnostics
- NWP
- Subseasonal to seasonal prediction
- CMIP5/6

Develop Enhancements

- Enhanced models
- Optimized Arctic observing systems
- Improved initial and boundary conditions

Test Enhancements

- Enhanced NWP
- Enhanced Subseasonal to Seasonal Prediction
- Enhanced CMIP6

Recommen-dations

- Presentations
- Reports
- Publications
- Contribution to assessment reports

Enhanced Predictions

- CMIP6-Interim and CMIP7
- Enhanced operational:
  - NWP
  - Subseasonal to Seasonal Prediction
  - Interannual to Decadal Prediction

Overview of APPLICATE

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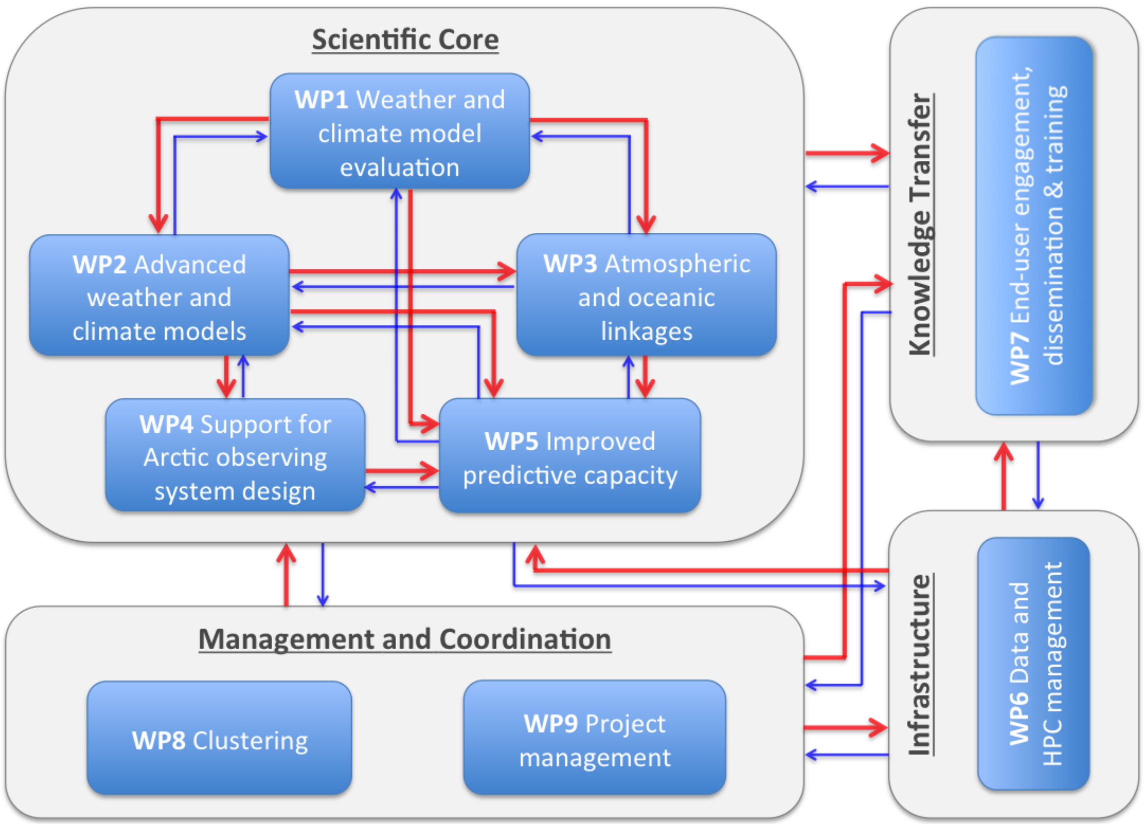
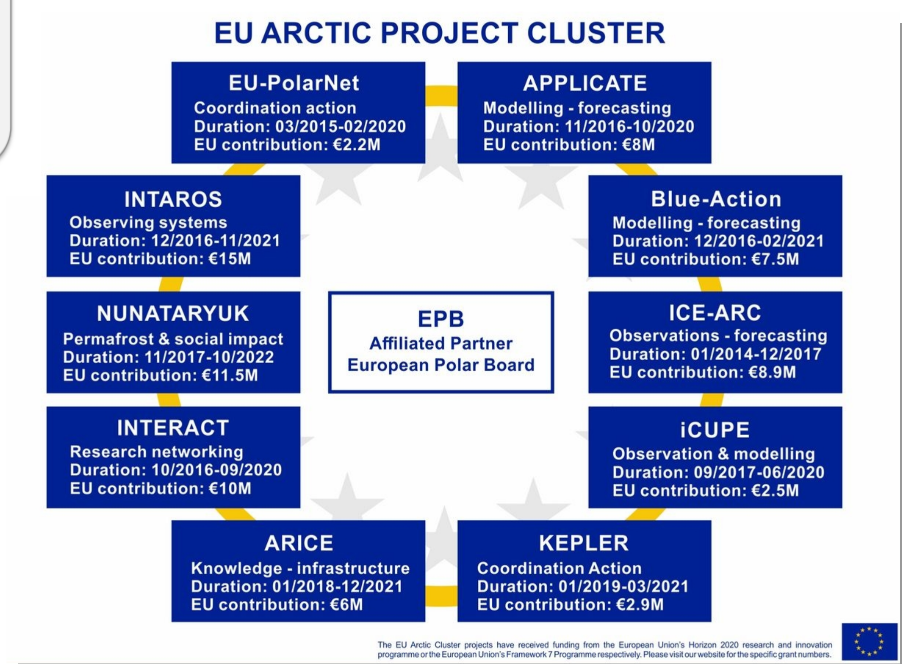


- ➢ Project structure reflecting over-arching goals

- ➢ European and international collaboration (e.g. Arctic Cluster, YOPP and PAMIP)



Evaluation of current skill

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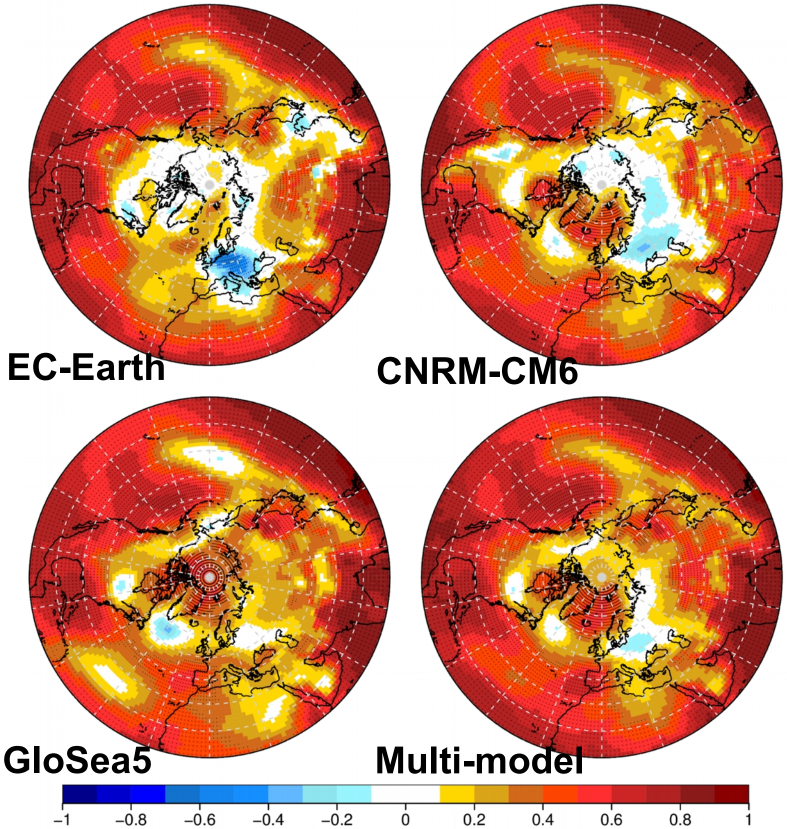
- First step of APPLICATE WP5 activities: evaluation of baseline skill in S2S and seasonal forecast systems
- Seasonal hindcasts: "stream 1" with current state-of-the-art GCMs in partner centers

Model/ System	**CNRM-CM6-1**	**EC-Earth 3.2.2**	**GloSea5**	**SEAS5**	**MF Sys6**
Atmosphere	ARPEGE 6.3	IFS Cy36r4	UM v6	IFS Cy43r1	ARPEGE 6.2
Ocean	NEMO 3.6	NEMO 3.6	NEMO 3.4	NEMO 3.4	NEMO 3.6
Sea ice	GELATO v6	LIM3	CICE 4.1	LIM2	GELATO v6
Atmospheric resolution	tl127l91r (~ 1.4°)	tl255l91r (~ 0.7°)	N216L85	TCo319L91	tl359l91r (~0.5°)
Ocean resolution	eORCA1 L75	ORCA1L75	ORCA 0.25 L75	ORCA 0.25 L75	eORCA 1 L75
Initial conditions	GLORYS (Mercator)	Forced NEMO run	NEMOVAR	ORA-S5	GLORYS (Mercator)
Ensemble size	30	10	28*	25	25*

Part of stream 1

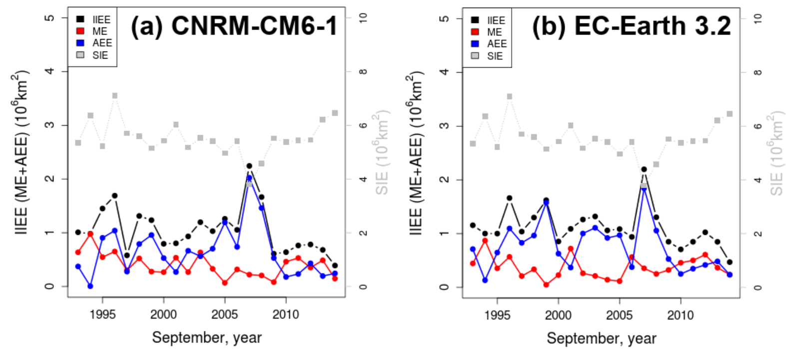
Other systems

Evaluation of current skill

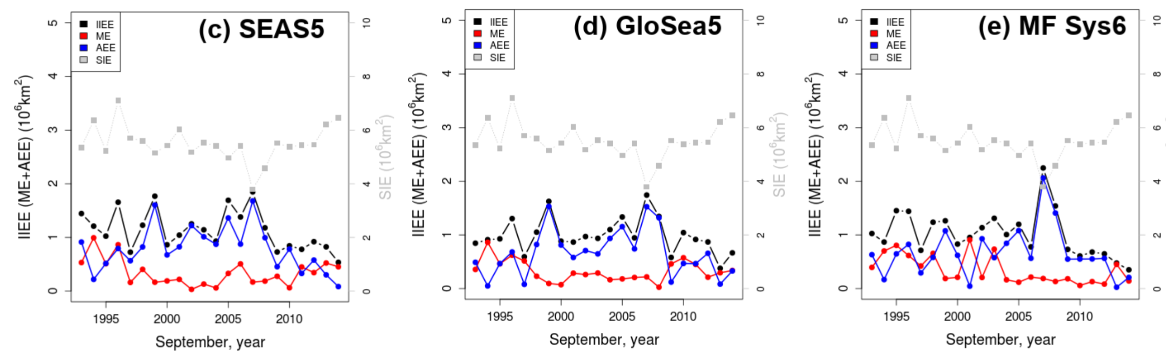


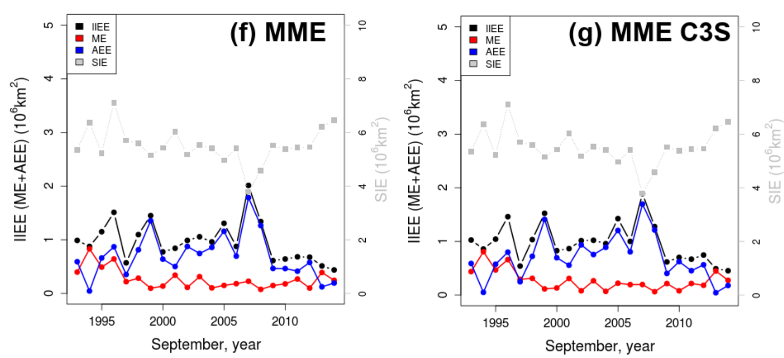
Mean DJF sea level pressure ACC in Nov forecasts 1993-2014 (vs. ERA-Int)

Acosta Navarro et al., in prep



Goessling et al. 2016





Batté et al., in prep

Integrated ice edge error vs. NSIDC for September 1993-2014 (May forecasts) in each model/system and two multi-models

Evaluation of current skill: S2S

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- Assessment of sub-seasonal hindcasts from the S2S database
- Use of IIEE / SPS metrics
- Case study for 2007
- Lower-performing systems are those that do not directly assimilate sea ice for initial conditions

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Geophysical Research Letters

RESEARCH LETTER
10.1029/2018GL079394

Bright Prospects for Arctic Sea Ice Prediction on Subseasonal Time Scales

Lorenzo Zampieri[1], Helge F. Goessling[1], and Thomas Jung[1,2]

[1]Alfred-Wegener-Institut Helmholtz-Zentrum fur Polar- und Meeresforschung, Bremerhaven, Germany, [2]University of Bremen, Bremen, Germany

Special Section:
Bridging Weather and Climate: Subseasonal-to-Seasonal (S2S) Prediction

Key Points:
- The skill in predicting the location of the Arctic sea ice edge differs substantially among subseasonal forecasting systems
- The most skillful system beats climatological forecasts more than 1.5 months ahead, with then highest skills in late summer
- Major improvements are possible by reducing errors in initial states and model formulation

Abstract With retreating sea ice and increasing human activities in the Arctic come a growing need for reliable sea ice forecasts up to months ahead. We exploit the subseasonal-to-seasonal prediction database and provide the first thorough assessment of the skill of operational forecast systems in predicting the location of the Arctic sea ice edge on these time scales. We find large differences in skill between the systems, with some showing a lack of predictive skill even at short weather time scales and the best producing skillful forecasts more than 1.5 months ahead. This highlights that the area of subseasonal prediction in the Arctic is in an early stage but also that the prospects are bright, especially for late summer forecasts. To fully exploit this potential, it is argued that it will be imperative to reduce systematic model errors and develop advanced data assimilation capacity.

Supporting Information:

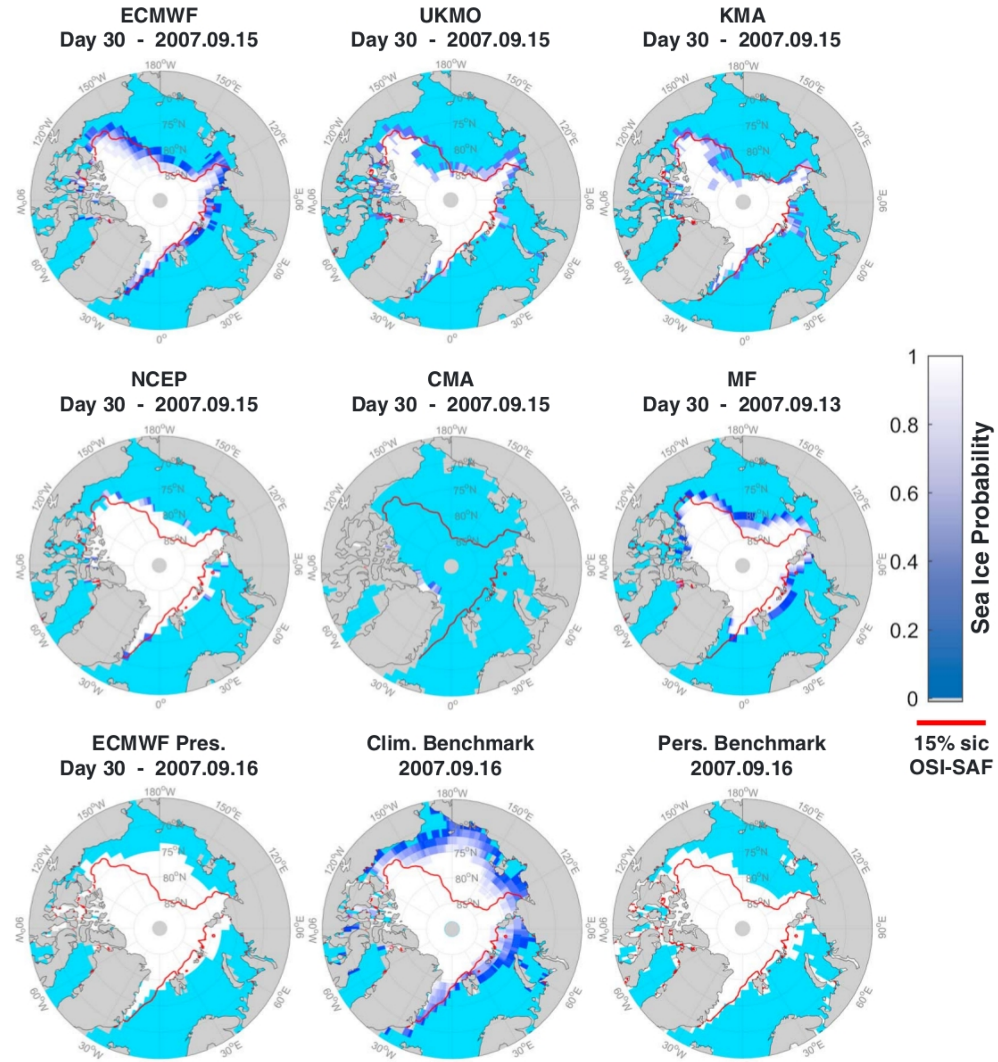

Figure 3. 30-day forecasts for 15 September 2007 of the sea ice probability (probability that sea ice concentration exceeds 15%) as obtained from different forecast systems and from climatological and persistence benchmarks. The observed sea ice edge (15% contour of OSI-SAF sea ice concentration) is also shown (red contour). ECMWF = European Centre for Medium-Range Weather Forecasts; UKMO = UK Met Office; KMA = Korea Meteorological Administration; NCEP = National Centers for Environmental Prediction; CMA = China Meteorological Administration; MF = Météo-France.

Fig. 3 from Zampieri et al. 2019 (GRL)

Model enhancements

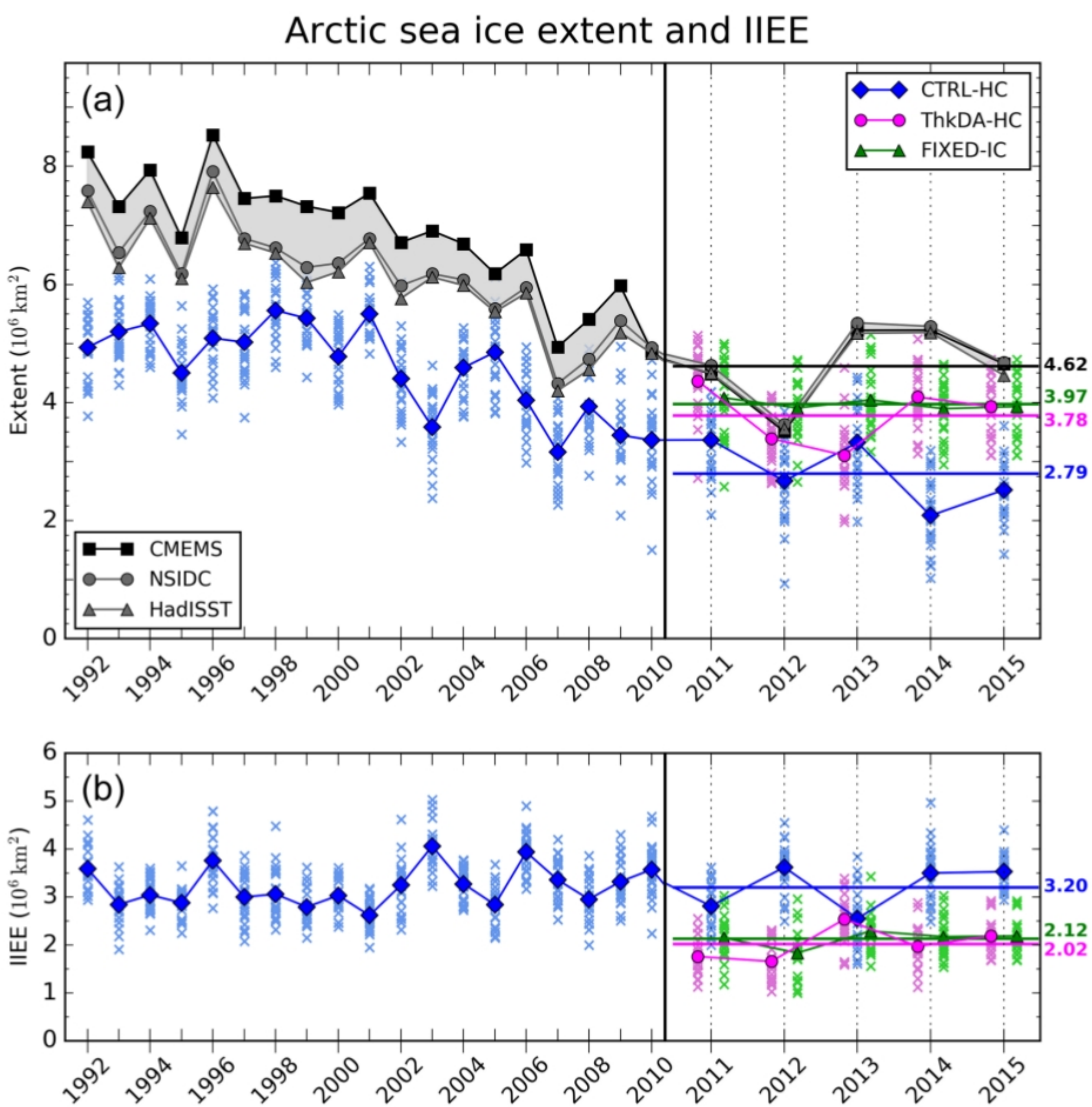

Fig. 4 from Blockley and Peterson 2018 (The Cryosphere)

- MetOffice: using nudging towards CryoSat-2 thickness data (Oct. 2010-2015) to initialize sea ice thickness in seasonal re-forecasts (May → September)
- Number of years restricted to CryoSat-2 data availability
- But promising improvements in terms of SIE and IIEE

Model enhancements

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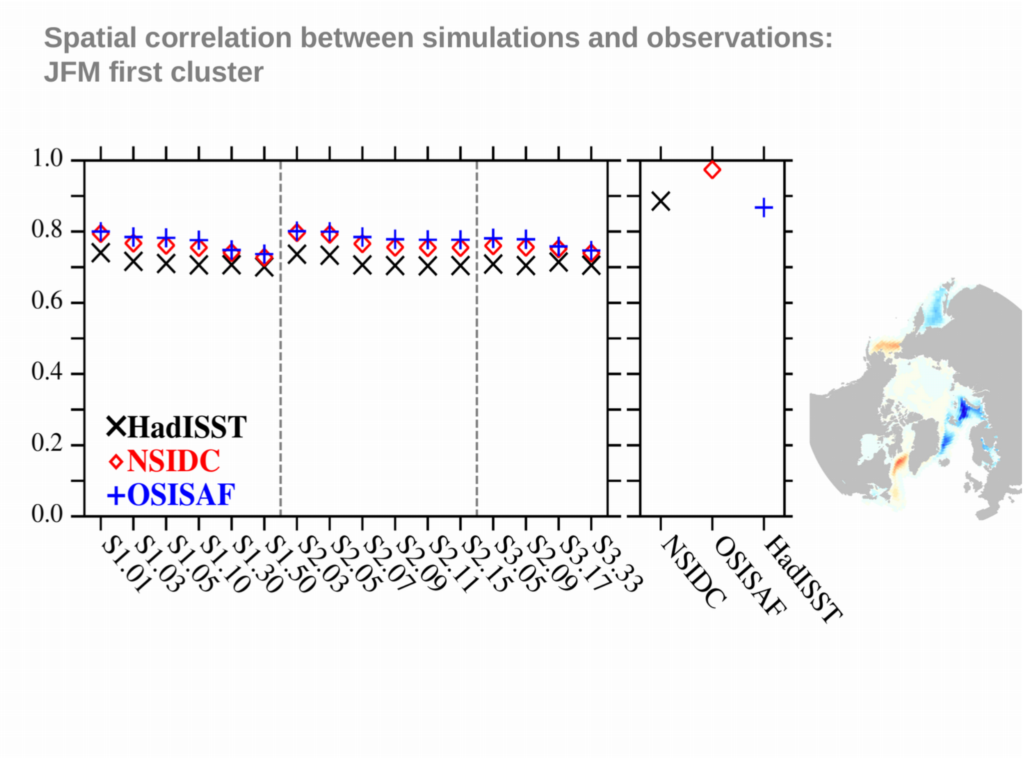
- Number of sea-ice categories in LIM3 (E. Moreno-Chamarro)



- Impact of higher resolution (e.g. NEMO 1° → NEMO 0.25°)

- Impact of melt ponds and land-fast ice parameterization

- Impact of snow and soil moisture initialization (GloSea)

⇒ **Definition of stream 2 experiments**

SIPN-South

YOPP YEAR OF POLAR PREDICTION

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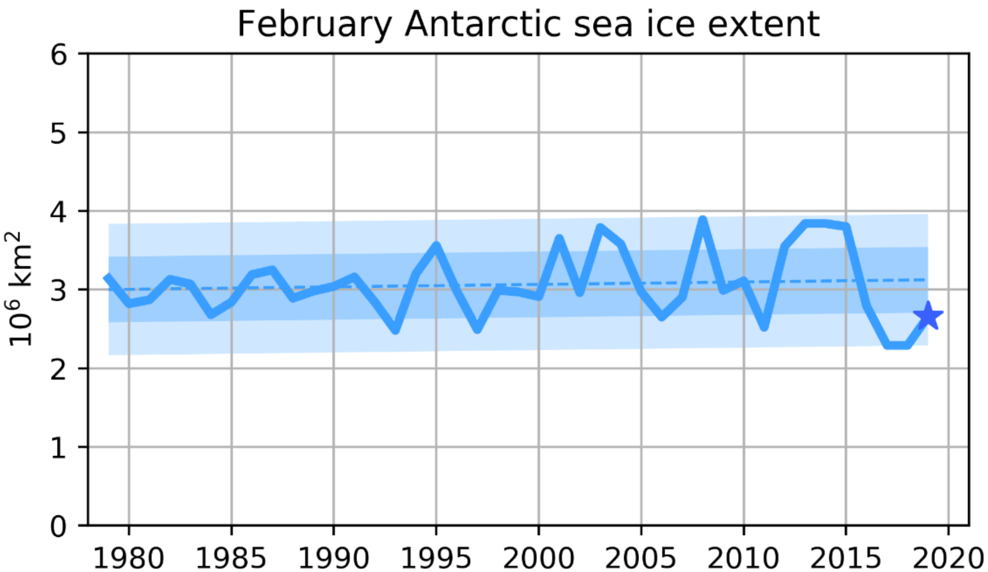


In recent years, summer Antarctic sea ice has experienced **high year-to-year variability**. While several mechanisms for seasonal predictability have been established, **the actual skill of prediction systems has yet to be established.**

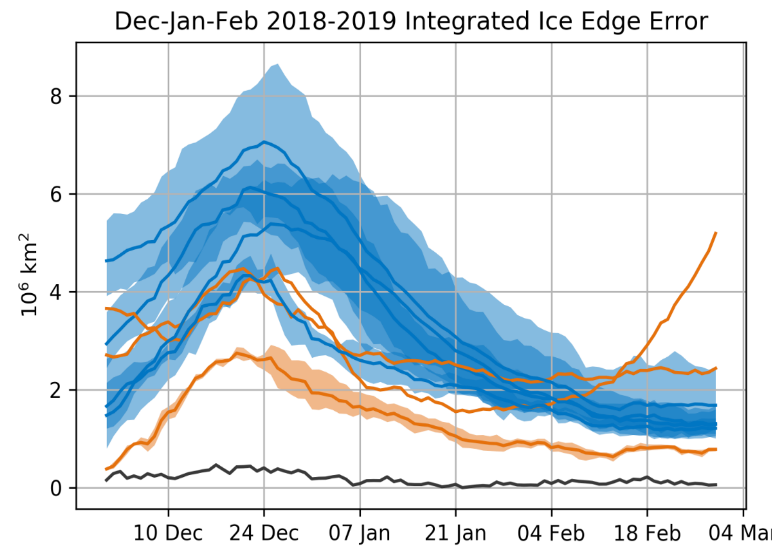
⇒ Activity led by F. Massonnet (UCL)

Want to contribute? More information? Feedback?

http://acecrc.org.au/sipn-south/

Table 1. Information about contributors to the summer 2018-2019 coordinated sea ice forecast experiment.

	Contributor name	*Short name (in figures)*	*Forecasting method*	*Nb. of forecasts*	*Initialization date*	*Diagnostics provided*
1	Naval Research Lab	nrl	Coupled dynamical model	9	Oct. 31st, 2018	SIA + rSIA + SIC
2	Nico Sun	Nico-Sun	Statistical model	3	Nov. 30th, 2018	SIA + SIC
3	NASA-GMAO	nasa-gmao	Coupled dynamical model	10	Nov. 27th, 2018	SIA + SIC
4	FIO-ESM	FIO-ESM	Coupled dynamical model	1	Nov. 1st, 2018	SIA
5	ECMWF	ecmwf	Coupled dynamical model	50	Dec. 1st, 2018	SIA + rSIA
6	Lamont Sea Ice Group	Lamont	Statistical model	1	Oct. 31st, 2018	SIA + rSIA + SIC (monthly, interp. daily)
7	Alek Petty	Petty-NASA	Statistical model	1	Nov. 30th, 2018	SIA (monthly, interp. daily)
8	Modified CanSIPS	Modified-CanSIPS	Coupled Dynamical Model	20	Nov. 30th, 2018	SIA + rSIA
9	Met Office	MetOffice	Coupled Dynamical Model	42	Nov. 25th, 2018	SIA + rSIA + SIC
10	CMCC	CMCC	Coupled Dynamical Model	50	Nov. 1st, 2018	SIA
11	UCL	ucl	Ocean—sea ice Dynamical Model	10	July 1st, 2018	SIA + rSIA + SIC
12	Sandra Barreira	Barreira	Statistical model	1	Dec. 1st, 2018	SIA + rSIA + SIC (monthly, interp. daily)



Forecasts based on **dynamical modeling approaches** appeared to have **larger errors than** those based on **statistical modeling approaches**. However, the **robustness of this finding has to be confirmed** at the occasion of future coordinated forecasts.

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Thanks for your attention!