An introduction to SPARSE

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SPARSE project information

- Developing and Advancing Seasonal Predictability of Arctic Sea Ice
- RCN’s KLIMAFORSK project
- 01.10.2016 - 31.03.2020
- Progress report deadline: 1 October
- Final Report: 1 month after conclusion of project

Consortium of SPARSE

Agenda

Kickoff meeting

- ❑ Overview of the whole project
- ❑ Identify (and solve) challenges and risks of the project
- ❑ Supplement extra resources not well presented in the original proposal
- ❑ Enhence the collaboration of the consortium

- Practical information

Agenda

8 November, Tuesday, Room A0.007, VNN

11:00 Welcome/presentation of participants
11:10 Introduction to SPARSE, Keguang Wang
11:40 The coupled ROMS-CICE system - preliminary results and some challenges, Nils Kristensen
12:00 ECMWF forecasting systems, Sarah Keeley
12:15 Utilizing seasonal forecasts as forcing in a sea ice prediction model, Jens Debernard

12:30 Lunch, Room A2.007

13:30 Testing Arctic sea ice predictability in NorESM, Jens Debernard
13:50 Available sea ice satellite data suitable for Arctic sea ice seasonal forecasting, Thomas Lavergne
14:20 Ice observations in the 7th Chinese National Arctic Research Expeditions 2016, Peng Lu

14:50 Coffee break

15:10 Discussion of field work and improving sea ice physical representation
15:40 Discussion of data assimilation
16:00 Discussion of challenges and risks
16:20 Update agenda for day 2
16:30 End of day 1

18:00 Ice breaker, Room A0.007

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- SPARSE management
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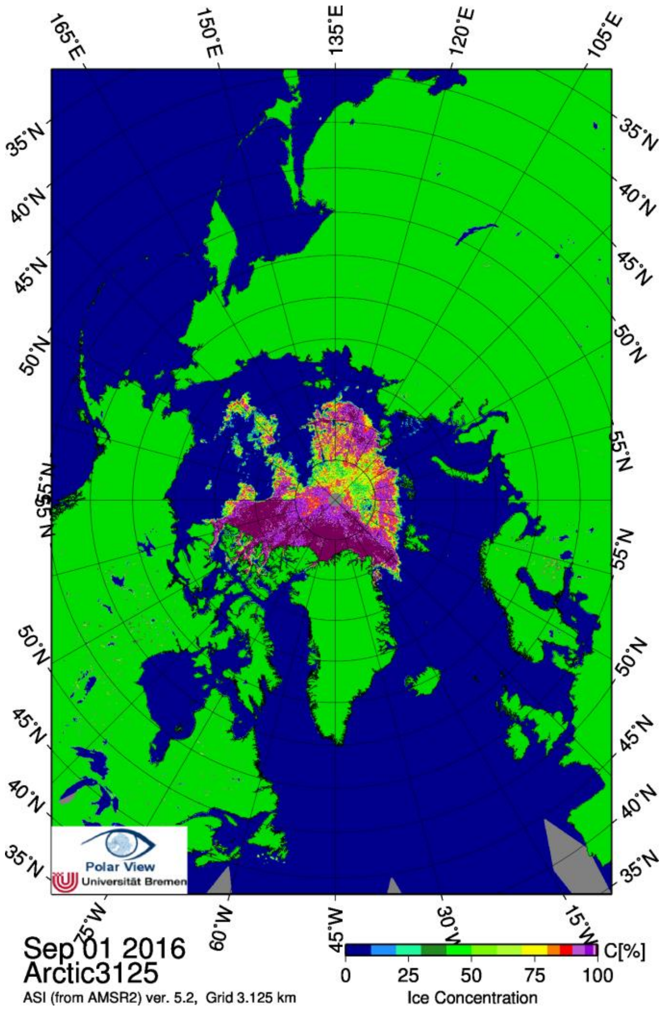
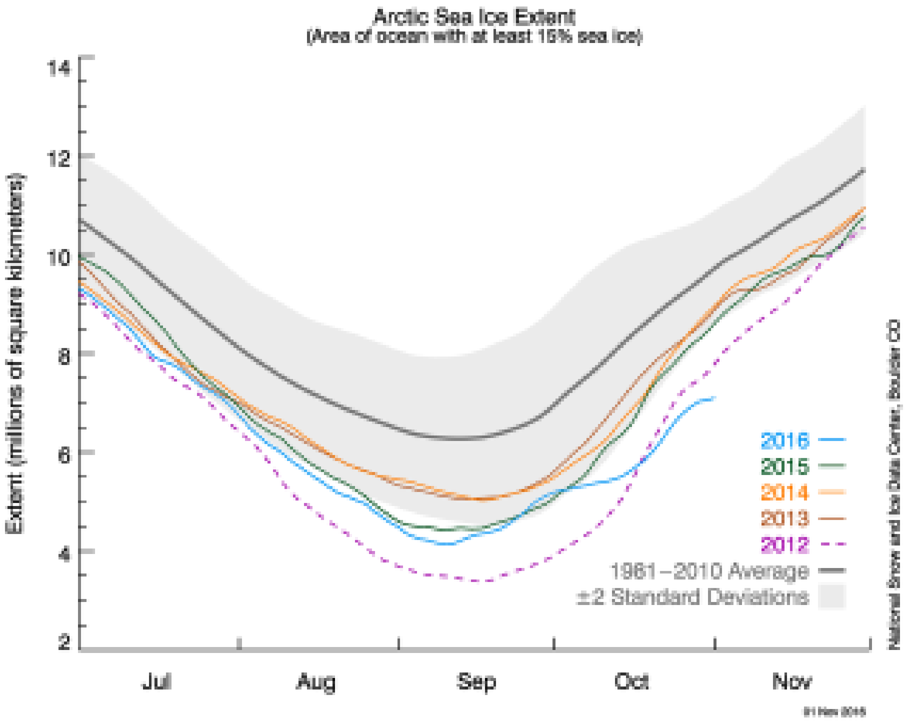
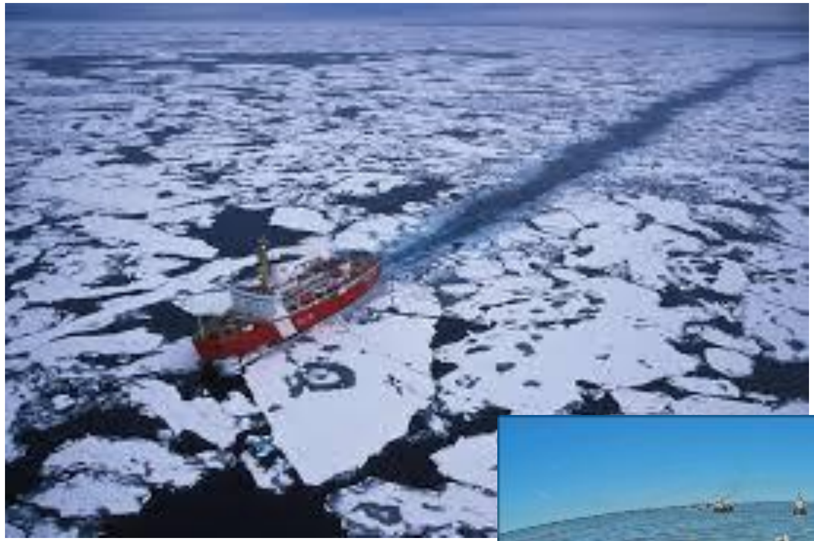
  - ❑ Budgeting

SPARSE project background

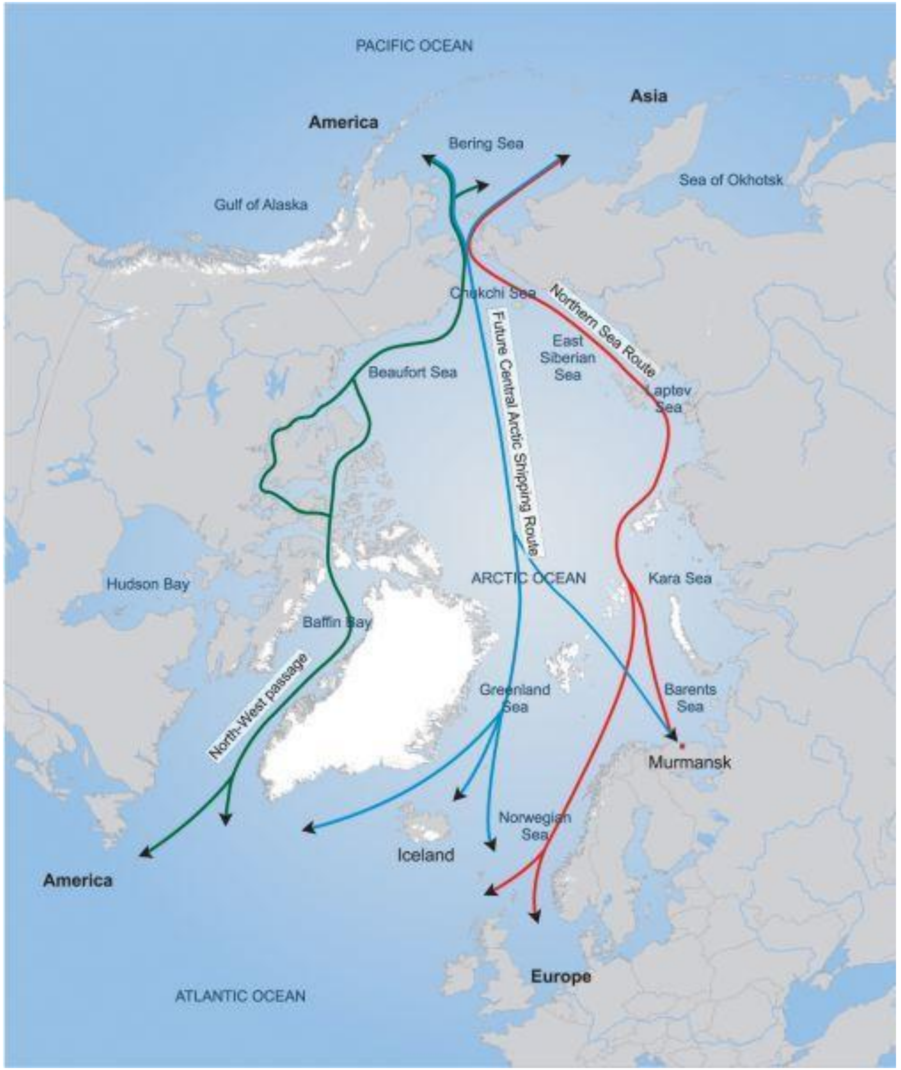




Importance of seasonal Arctic sea ice prediction



CIDS, Glomar Beaufort Sea II, Japan



Physical systems classification

- Deterministic: laws of motion are known and orderly, so future can be directly determined from past
- stochastic/random: no laws of motion, we can only use probability to predict the location of parcels, we cannot predict future states of the system without statistics, only give probabilities
- chaotic: we know the laws of motion, but these systems exhibit "random" behavior due to nonlinear mechanisms. The future can only be predicted skillfully in a limited period

CHAOS: a simple system--Double Pendulum

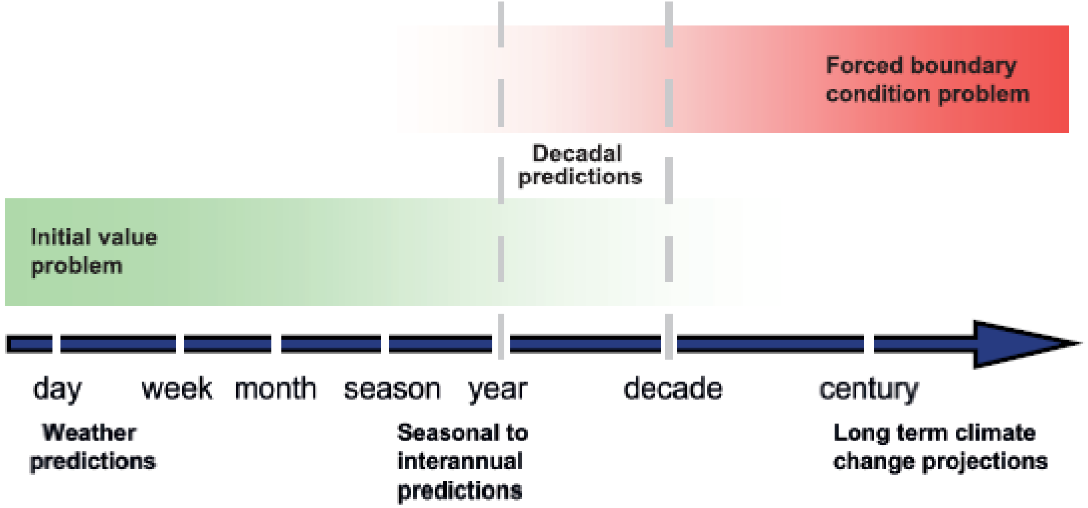
- No periodic behavior
- Difficult or impossible to forecast
- Motion looks random
- Nonlinear
- Sensitive to initial conditions
  - ❑ double pendulum is choatic
  - ❑ initial speeds:
    - ❑ main arm: 400 deg/sec (left), 400.1 deg/sec
    - ❑ secondary arm: 0.0

Climate system as a huge chaotic system

- Chaotic climate system:
  - ➢ sensitive to initial conditions
  - ➢ sensitive to imperfect representation of the system

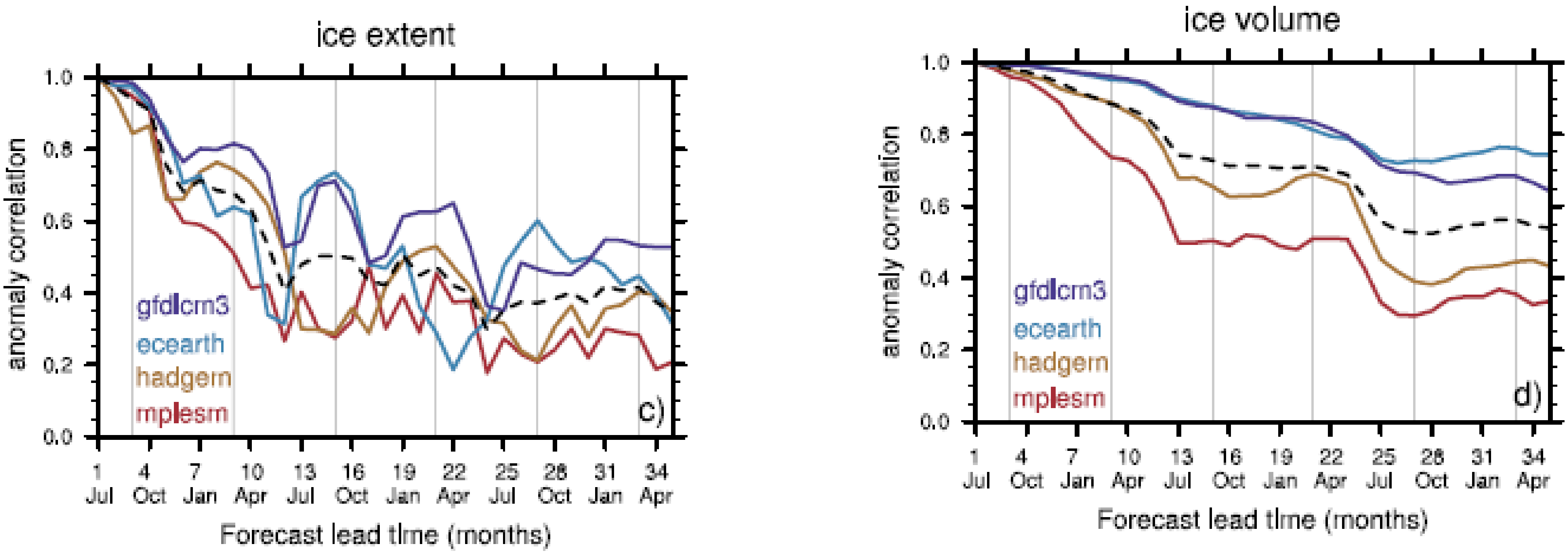
- Predictability:
  - ❑ the degree to which a correct prediction or forecast of a system's state can be made either qualitatively or quantitatively
  - ❑ different for different variables & models

- Practical value of seasonal forecasts



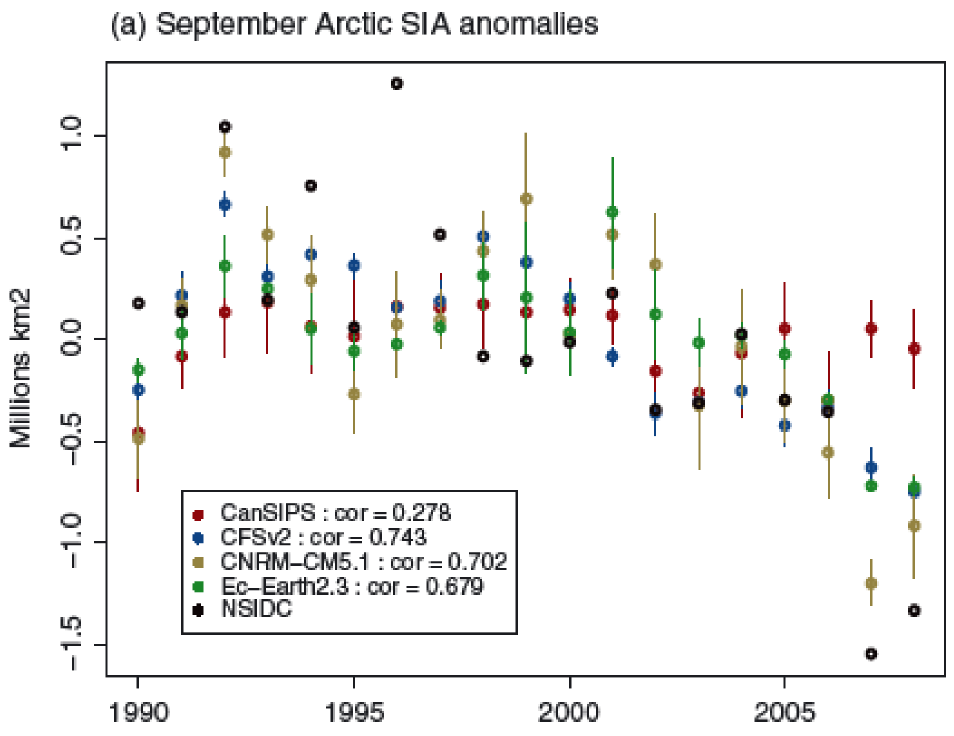
Meehl et al. (2009)

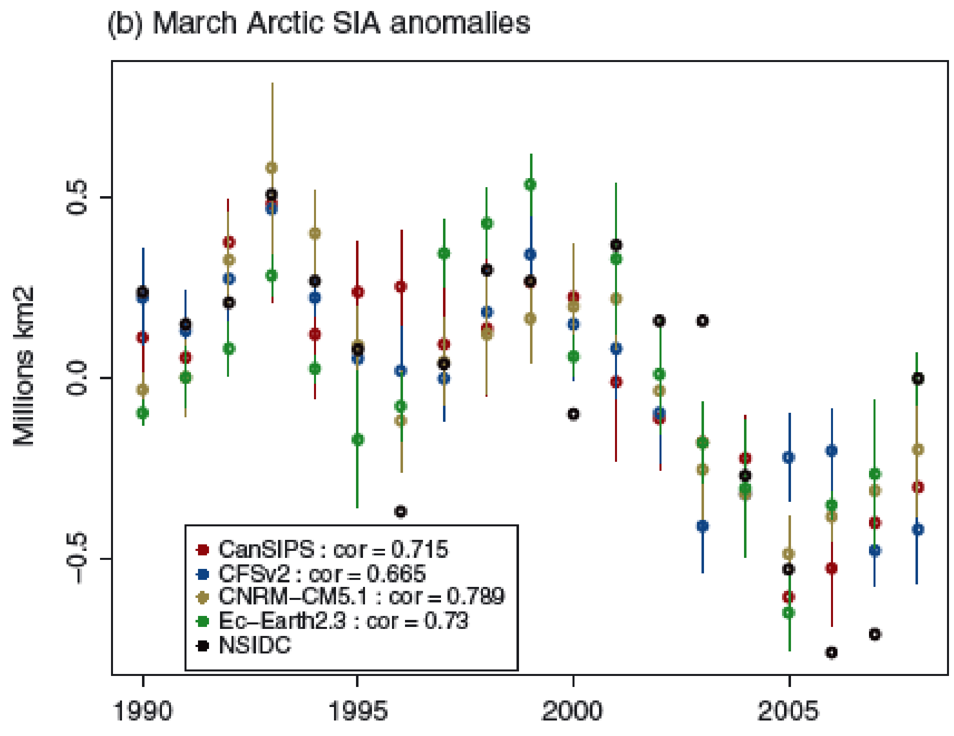
GCM “perfect-model” Arctic sea ice predictability



Tietsche et al.

Initialized GCM seasonal hindcast skill

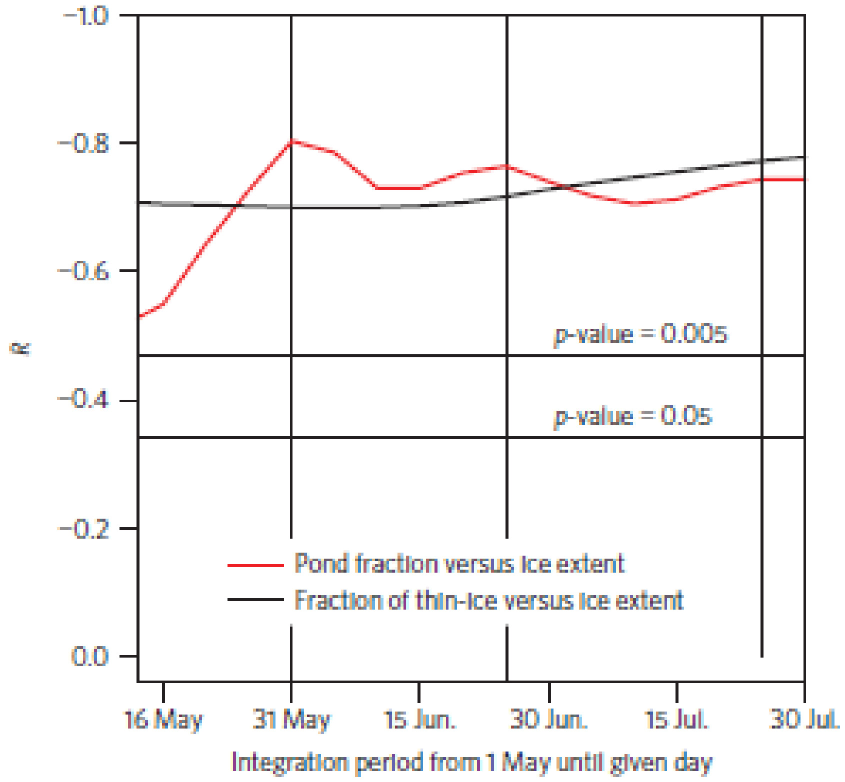




Guemas et al.

Statistical analysis results

- Earlier main findings (Lindsay et al., 2008):
  - ❑ ice concentration is the most important variable for first two months
  - ❑ ocean temprature about 250 m is most important for longer lead times
  - ❑ for detrended data there is no skill for lead times of 3 months or more



Schröder et al. (2014)

Inspirations from Schröder et al.'s work

- A coupled ice-ocean model with melt ponds predictions is perhaps able to provide better seasonal prediction than a GCM without melt ponds description

- WP2: Regional ice-ocean model for seasonal Arctic sea ice prediction

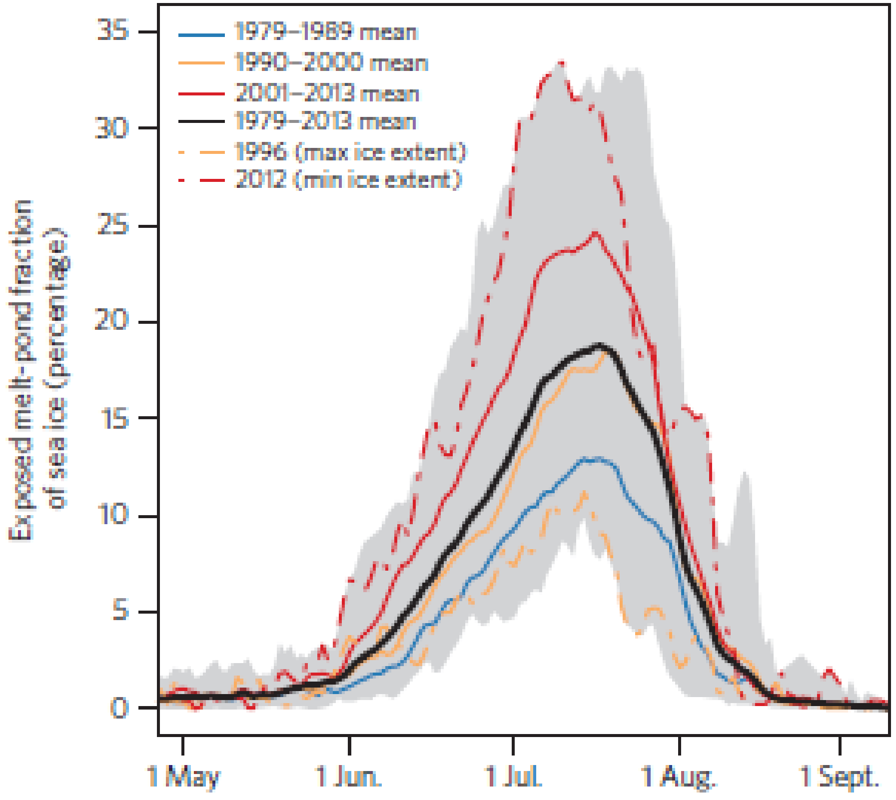
- Analyzed ice concentration, melt ponds fraction and ocean temperature may provide an even better prediction than Schröder et al. (2014) prediction

- WP3: stastistical model for seasonal Arctic sea ice prediction and predictability

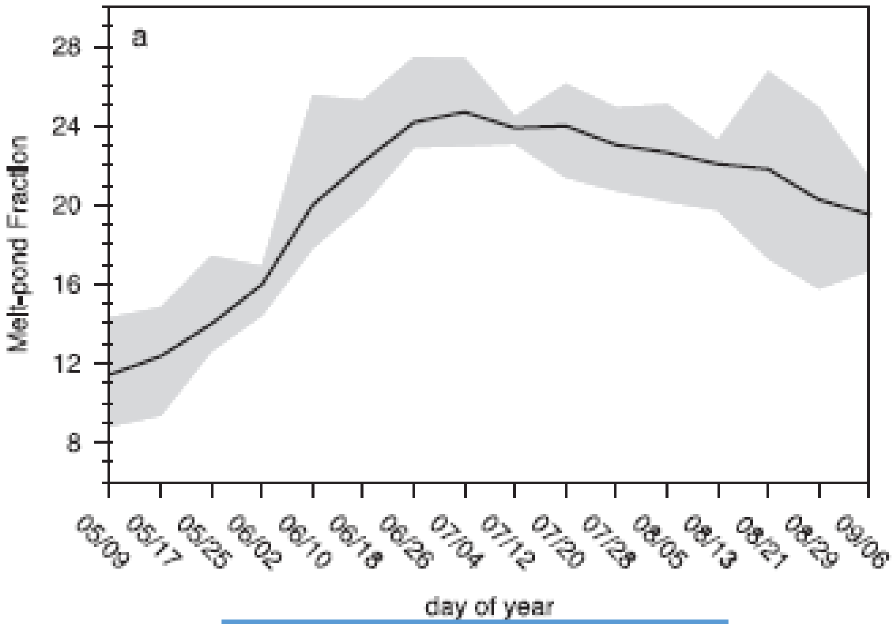
- A GCM with melt ponds fraction evolution such as NorESM may provide an even better prediction than those without

- WP4: NorESM Arctic sea ice prediction and predictability

Problem in Schröder et al. model results



Schröder et al. (2014)



Liu et al. (2015)

WP1 sea ice field observation and physics improvement

Goal and objectives

- The overall goal of SPARSE is
  - ❑ To investigate whether more accurate initial information and model physics can improve the seasonal predictability of Arctic sea ice
- The objectives of SPARSE are
  - ❑ To develop seasonal prediction systems for the Arctic sea ice
    - ➢ statistical model (WP3)
    - ➢ regional ROMS-CICE (WP2)
    - ➢ NorESM (WP4)
  - ❑ To assess the predictability of these three systems
  - ❑ To advancing seasonal predictability for Arctic sea ice through
    - ➢ data assimilation with more accurate and reliable information about the ocean and sea ice state (WP2, WP4)
    - ➢ physics refinement with particular emphasis on representation of snow melt and melt ponds, as well as radiation scheme improvement (WP1, WP2, WP3, WP4)

Work packages:

- WP1: Field observations and analysis
- WP2: ROMS-CICE seasonal forecast system development and predicability
- WP3: Statistical model development and predictability
- WP4: NorESM seasonal forecast and predicability
- WP5: Satellite data preparation

WP1 tasks and deliverables

- Tasks
  - ❑ Reanalysis of albedo and IMB data
  - ❑ Obervation of snow melt and melt ponds
  - ❑ Parameterization of sea ice processes and albedo
  - ❑ Implementation of improved sea ice parameterization into CICE
- Buy two IMBs

- Deliverables
  - ❑ Field work report 2017, due 30 June, 2017
  - ❑ Manuscript #1 submission: Early snow melting and melt pond formation on Arctic sea ice, 31 Dec. 2017
  - ❑ Sea ice new snow melt and melt ponds parameterization report for implementation in CICE, 31 March 2018
  - ❑ Field work report 2018, due 30 June 2018
  - ❑ Sea ice radiation parameterization report for implementation in CICE, 31 Dec 2018
  - ❑ Manuscript #2 Submission: Impact of new sea ice albedo parameterization on the simulation of melt pond fraction in a coupled ice-ocean model, 31 June 2019 (?)

WP2 tasks and deliverables

- Tasks:
  - ❑ Setup of ROMS-CICE seasonal forecasting system
  - ❑ Development of data assimilation system for ROMS-CICE system
  - ❑ Improving ROMS-CICE interface to use challenging atmospheric forcing products
  - ❑ Reconstruction of Arctic climate with improved sea ice parameterization
  - ❑ Seasonal forecast and predictability assessment

- Deliverables:
  - ❑ Report ROMS-CICE coupling, 31 Mar 2017
  - ❑ Report on Arctic sea ice climate simulation with ROMS-CICE, 30 June 2017
  - ❑ Report on improving ROMS-CICE interface to use challenging atmospheric forcing, 30 June 2017
  - ❑ Report on data assimilation for ROMS-CICE system, 30 Sept. 2017
  - ❑ Manuscript #3 submssion: Effect of data assimilation on the seasonal predictability of Arctic sea ice, 30 Sept 2019

WP3 tasks and deliverables

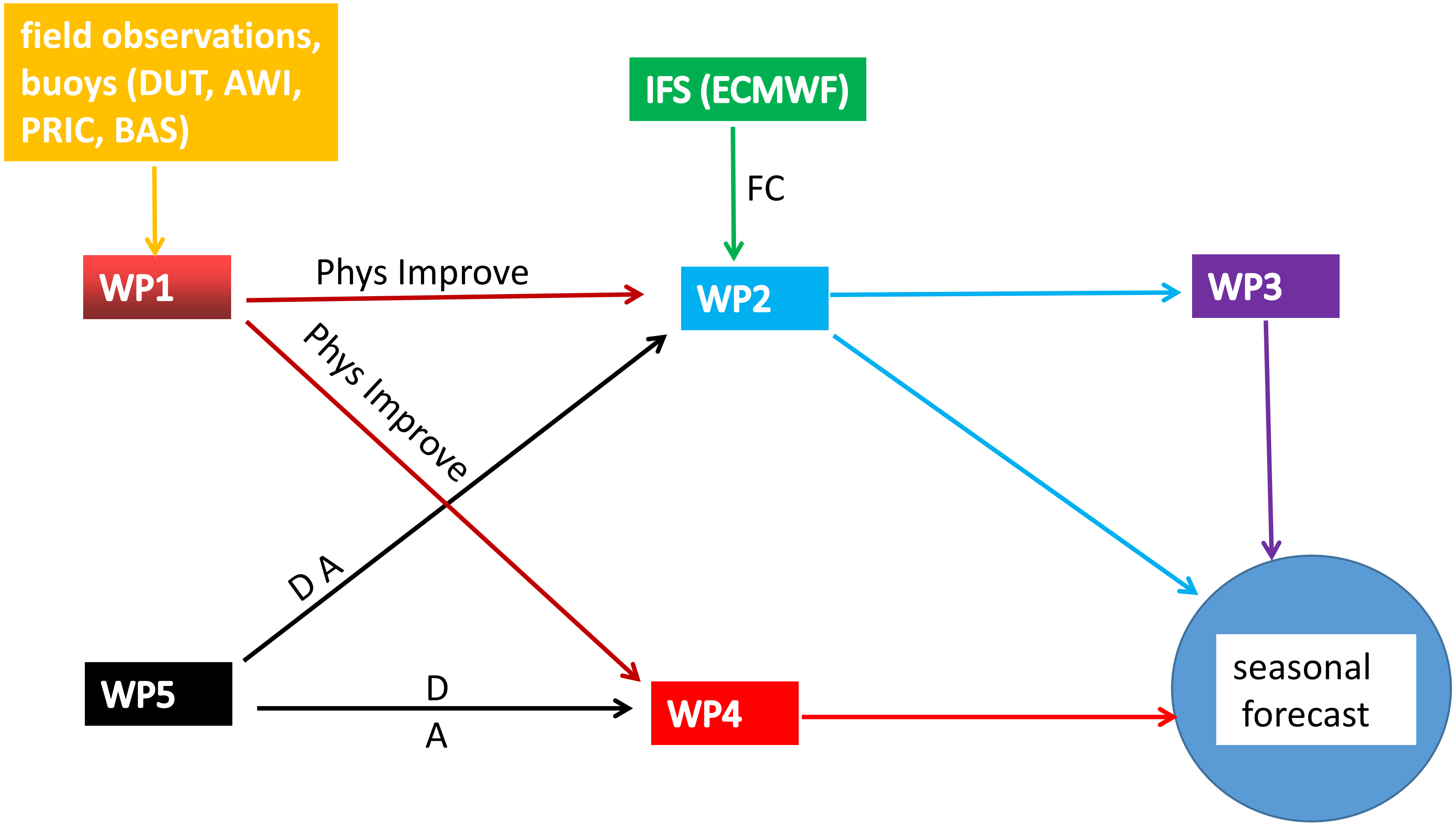
- Tasks:
  - ❑ Statistical analysis of the ROMS-CICE climate reconstruction
  - ❑ Statistical model development
  - ❑ Statistical seasonal forecast and assessment of predictability

- Deliverables:
  - ❑ Report on statistical analysis of the September sea ice minimun extent with ROMS-CICE climate, 31 Dec. 2017
  - ❑ Report on statiscal model, 31 March 2018
  - ❑ Manuscript #5 submission: Seasonal prediction of September Arctic sea ice extent by melt pond fraction and deep water temperature, 30 Sept. 2019

WP4 tasks and deliverables

- Tasks:
  - ❑ Setup of NorESM for seasonal “perfect-model” experiments
  - ❑ Assessment of seasonal predictability for a “perfect-model’ perspective
  - ❑ Assessment of seasonal predictability of NorESM with data assimilation
  - ❑ Assessment of seasonal predictability of NorESM with sea ice physics improvement
- Deliverables:
  - ❑ Report on NorESM perfect-model experiment, 31 Dec 2017
  - ❑ Manuscript #4 submission: Seasonal Arctic sea ice predictability in the NorESM, 30 June 2018
  - ❑ Report of the Effect of data assimilation on NorESM seasonal predictability, 31 March 2019
  - ❑ Manuscript #6 submission: The impact of improved sea ice initialization on the seasonal prediction of Arctic sea ice, 31 Dec. 2019

package collaboration



SPARSE management

- SPARSE management
  - ❑ Intranet and documentation
  - ❑ Issues list
  - ❑ Monthly status reporting
  - ❑ Budgeting

Budget (in NOK 1000):

- Source:
  - RCN: 9,852
  - MET: 2,919
  - NPI: 1,258
  - BAS: 100
- Total: 14,129

- Cost:
  - MET: 9,141
  - NPI: 4,888
  - BAS: 100
- Total: 14,129

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Questions and comments?

Task/funding distribution

Task no.	Task and deliverable	time	KW	JD	NK	TL	MET	NPI
1.1	Reanalysis of observational data	04.16						0+2
2.1	Setup ROMS-CICE & climate reconstruction	04.16 – 01.17	1+2		3	1	5+2	
2.3	ROMS-CICE forcing improvement	04.16 – 01.17		5			5	
2.2	ROMS-CICE assimilation & climate reconstruction	01.17 – 02.17	1+3		2	2	5+3	
1.2	Field work	02.17 – 03.17	1				1	1+2
1.1	Reanalysis of observational data	03.17						2
	Manuscript #1 preparation and submission	03.17 – 04.17						2
3.1	Statistical analysis of ROMS-CICE climate reconstruction	03.17 – 04.17	0+3				0+3	
4.1	Setup NorESM perfect model experiment	04.17		2			2	
1.1	Reanalysis of observational data	01.18						2
3.2	Statistical model development	01.18 – 02.18	1+3				1+3	2
4.2	Assess of perfect model NorESM predictability	01.18 – 02.18	0+1	2		1	3+1	
	Manuscript #4 preparation & submission	01.18 – 03.18						
1.3	Sea ice parameterization	02.18 – 03.18						4
1.2	Field work	02.18 – 03.18	1				1	2+2
	Manuscript #2 preparation and submission	03.18 – 04.18						
4.3	NorESM predictability with data assimilation	03.18 – 04.18	0+2	3		1	4+2	
	Manuscript #6 preparation & submission							
1.4	Implement new ice parameterization in CICE	03.18 – 01.19	0+1	2	1		3+1	4+2
2.4	Reconstruction Arctic climate with new ice parameterization	01.19 – 02.19	0+2		1		0+2	2
3.3	Assess statistical forecast & predictability	01.19 – 03.19	1+3				1+3	3
	Manuscript #5 preparation & submission							
2.5	Assess ROMS-CICE forecast & predictability	01.19 – 03.19	1+3		1	1	3+3	3
	Manuscript #3 preparation & submission	02.19 – 03.19						
4.4	NorESM predictability with new ice parameterization	02.19 – 04.19		5			5	2
	Manuscript #7 preparation & submission	04.19 – 01.20						3+2
	Final report	01.20	0+2				0+2	
2016			1+2	2	2	1	6+2	0+2
2017			2+6	5	3	2	12+6	5+2
2018			2+7	5	1	2	10+7	12+2
2019			2+8	7	2	1	12+8	12+2

- Project teams and collabrations
  - Field observation and analysis
  - ROMS-CICE modeling
  - Statistical analysis and modeling
  - NorESM modeling
  - inter-team collaborations