

# APPLICATE

## Advanced Prediction in Polar Regions and Beyond

Thomas Jung (Coordinator)  
Alfred Wegener Institute (AWI)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727862.

- Develop enhanced predictive capacity for weather and climate in the Arctic and beyond
  - Determine the influence of Arctic climate change on Northern Hemisphere mid-latitudes
- for the benefit of policy makers, businesses and society!



# The Consortium

16 partners and 1 third-party from 9 countries



APPLICATE Kick-off, AWI, January 2017

... and many collaborators!

# Budget and duration

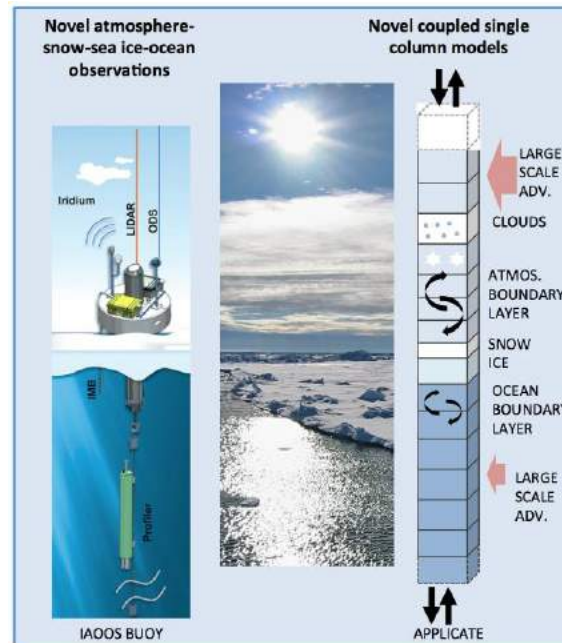
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- € 8 Mio + separate Russian contribution
- 1<sup>st</sup> November 2016–31<sup>st</sup> October 2020 (4-years)



# General approach

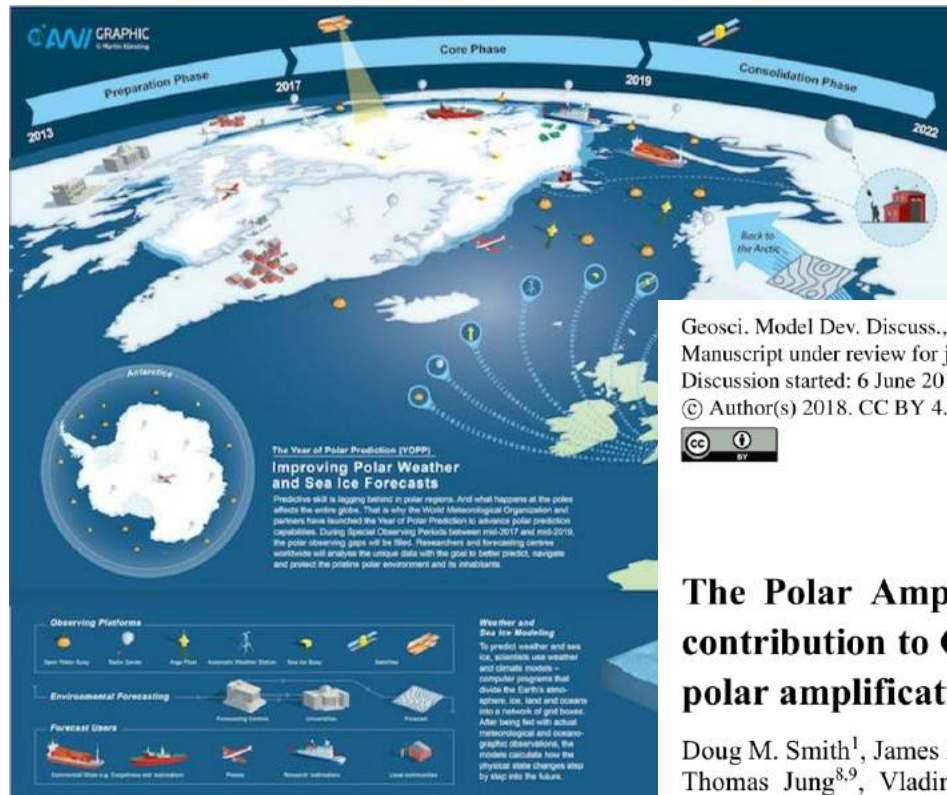
- Bringing together the NWP and climate communities
- Involving experts on the Arctic and midlatitudes
- Engaging operational centres for maximizing impact
- Effectively combining models and observations





# General approach

- Exploiting European and international collaboration (e.g. YOPP and PAMIP)



Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-82>  
Manuscript under review for journal Geosci. Model Dev.  
Discussion started: 6 June 2018  
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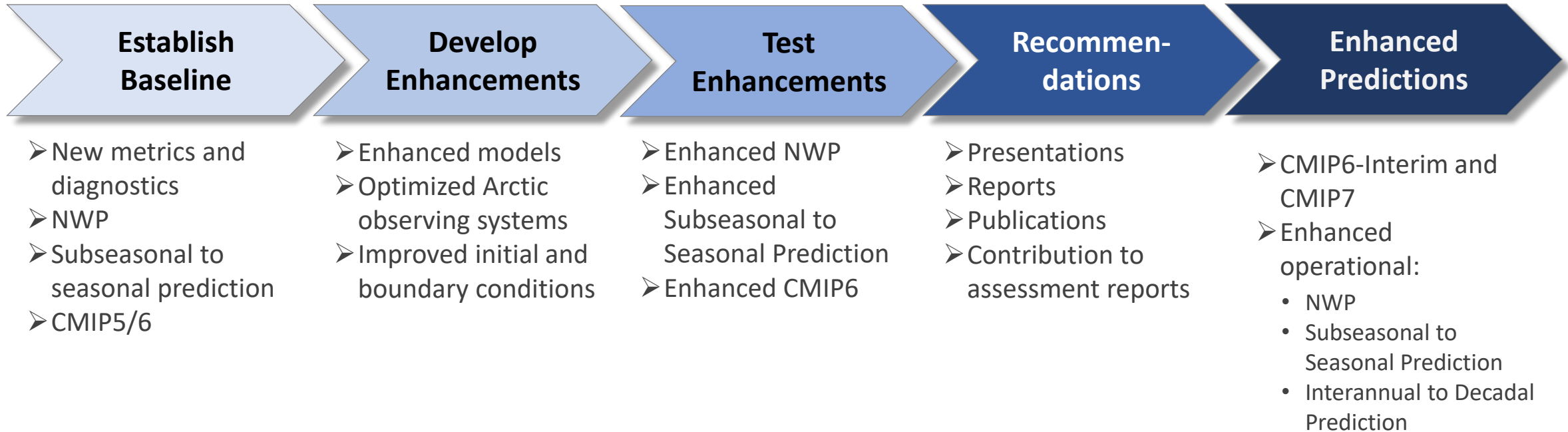
Geoscientific  
Model Development  
Discussions  
Open Access  
EGU

## The Polar Amplification Model Intercomparison Project (PAMIP) contribution to CMIP6: investigating the causes and consequences of polar amplification

Doug M. Smith<sup>1</sup>, James A. Screen<sup>2</sup>, Clara Deser<sup>3</sup>, Judah Cohen<sup>4</sup>, John C. Fyfe<sup>5</sup>, Javier Garcia-Serrano<sup>6,7</sup>, Thomas Jung<sup>8,9</sup>, Vladimir Kattsov<sup>10</sup>, Daniela Matei<sup>11</sup>, Rym Msadek<sup>12</sup>, Yannick Peings<sup>13</sup>, Michael Sigmund<sup>5</sup>, Jinro Ukita<sup>14</sup>, Jin-Ho Yoon<sup>15</sup>, Xiangdong Zhang<sup>16</sup>

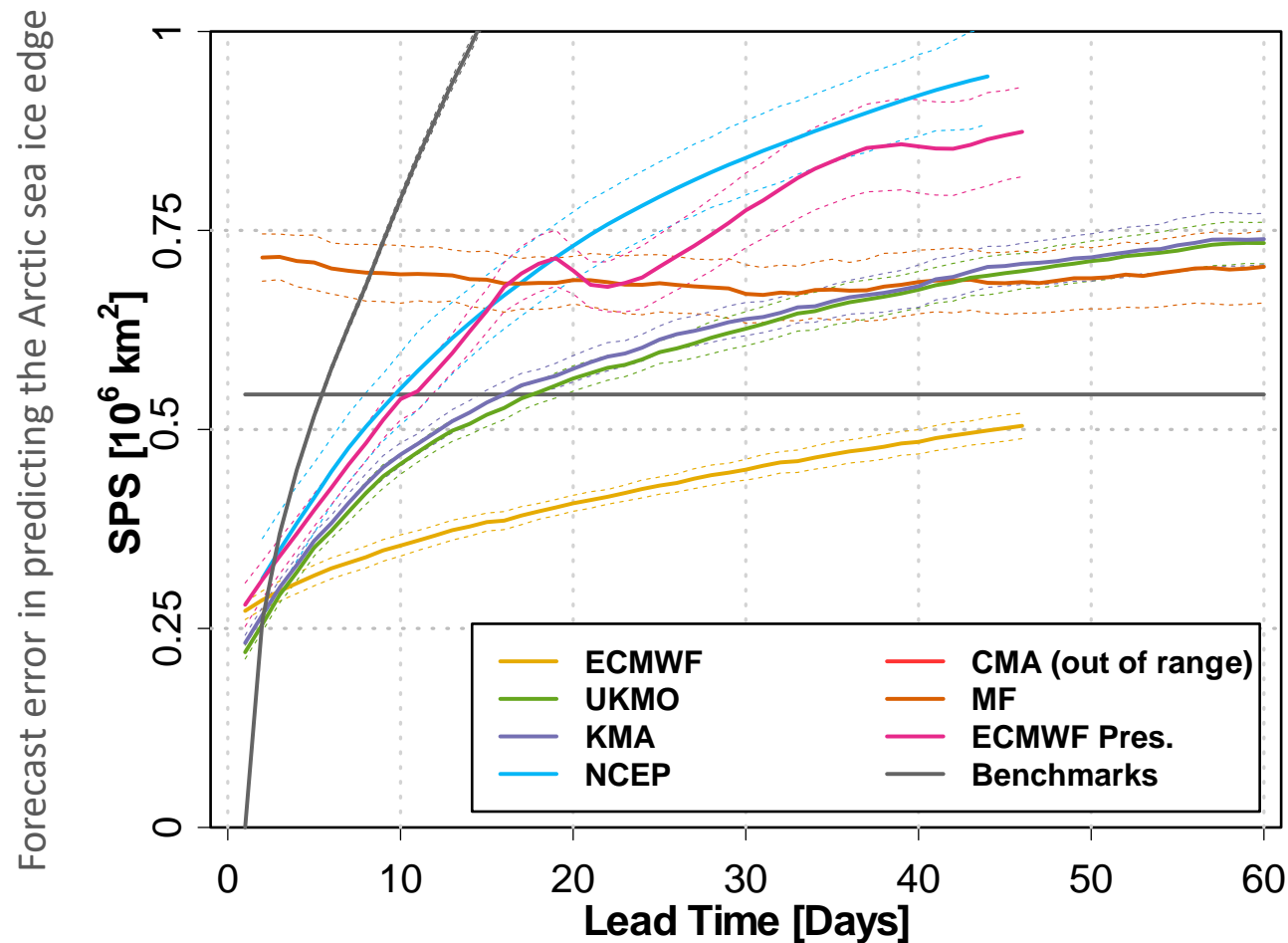


## Delivering enhanced predictions across time scales



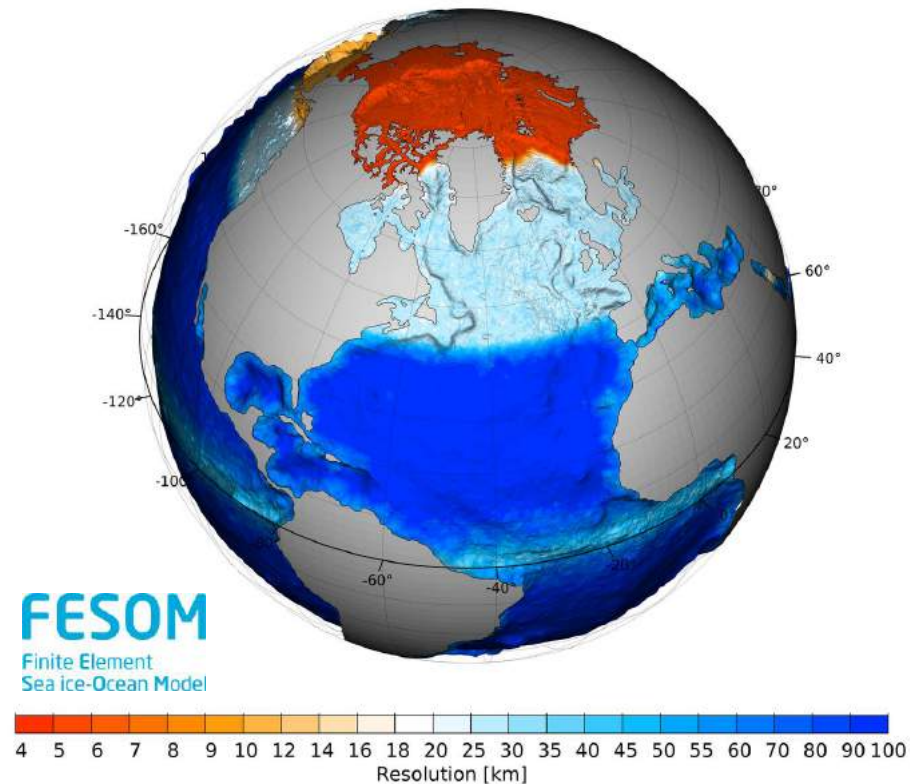
# Delivering enhanced predictions

## Establishing a baseline





## Enhancing models—The role of increased resolution



Geosci. Model Dev., 11, 1229–1255, 2018  
<https://doi.org/10.5194/gmd-11-1229-2018>  
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Geoscientific  
Model Development  
Open Access  
EGU

### A 4.5 km resolution Arctic Ocean simulation with the global multi-resolution model FESOM 1.4

Qiang Wang<sup>1</sup>, Claudia Wekerle<sup>1</sup>, Sergey Danilov<sup>1,2</sup>, Xuezhu Wang<sup>3,1</sup>, and Thomas Jung<sup>1,4</sup>

<sup>1</sup> Alfred Wegener Institute Helmholtz Center for Polar and Marine Research (AWI), Bremerhaven, Germany

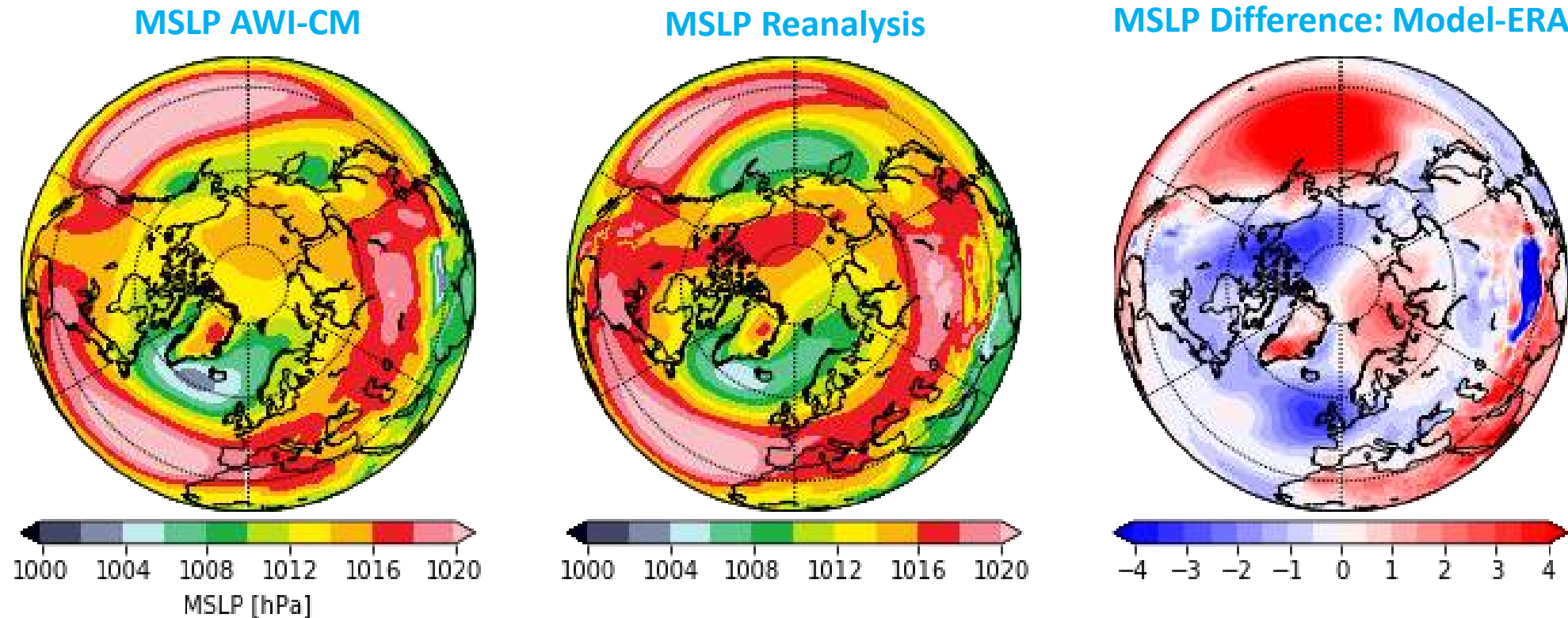
<sup>2</sup> Jacobs University Bremen, Department of Mathematics & Logistics, Bremen, Germany

<sup>3</sup> Hohai University, College of Oceanography, Nanjing, China

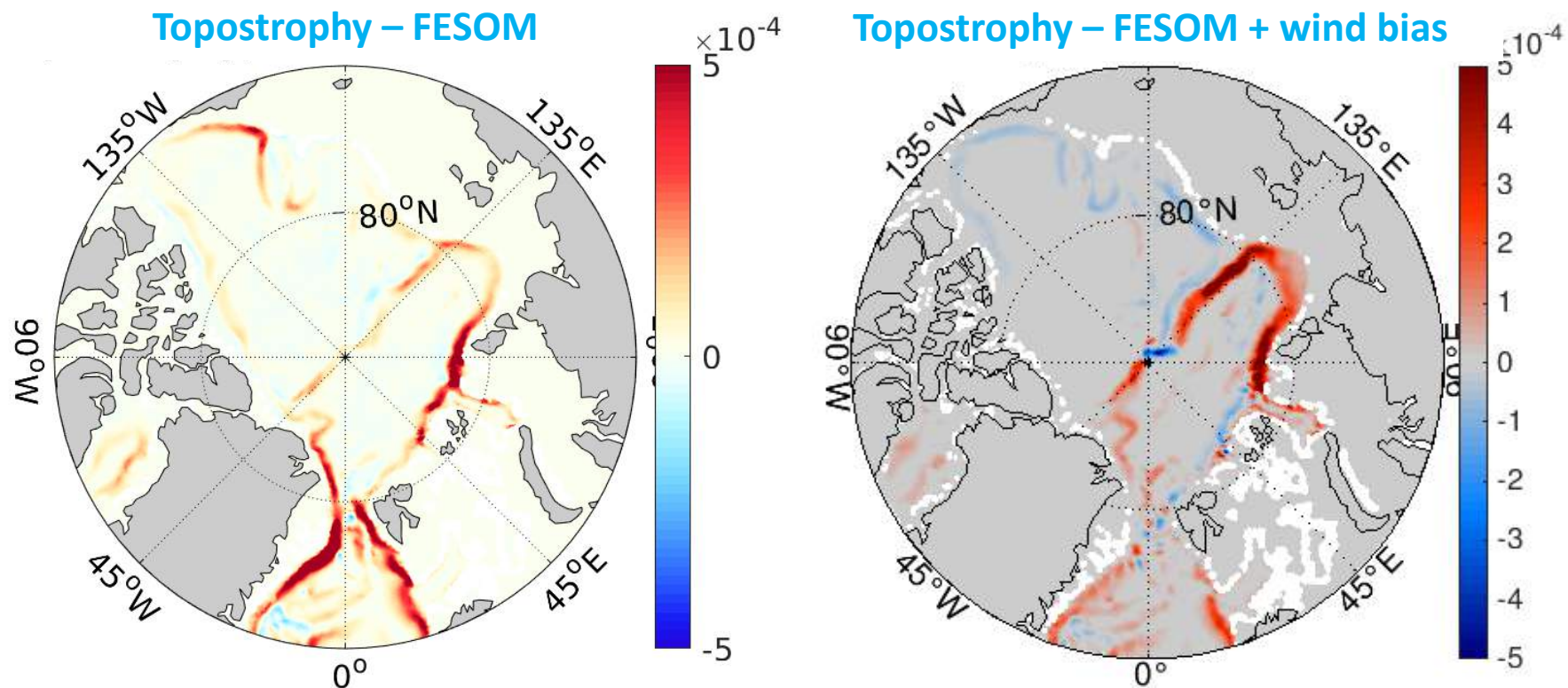
<sup>4</sup> University of Bremen, Department of Physics and Electrical Engineering, Bremen, Germany



## Enhancing models—The role of increased resolution



## Enhancing models—The role of increased resolution

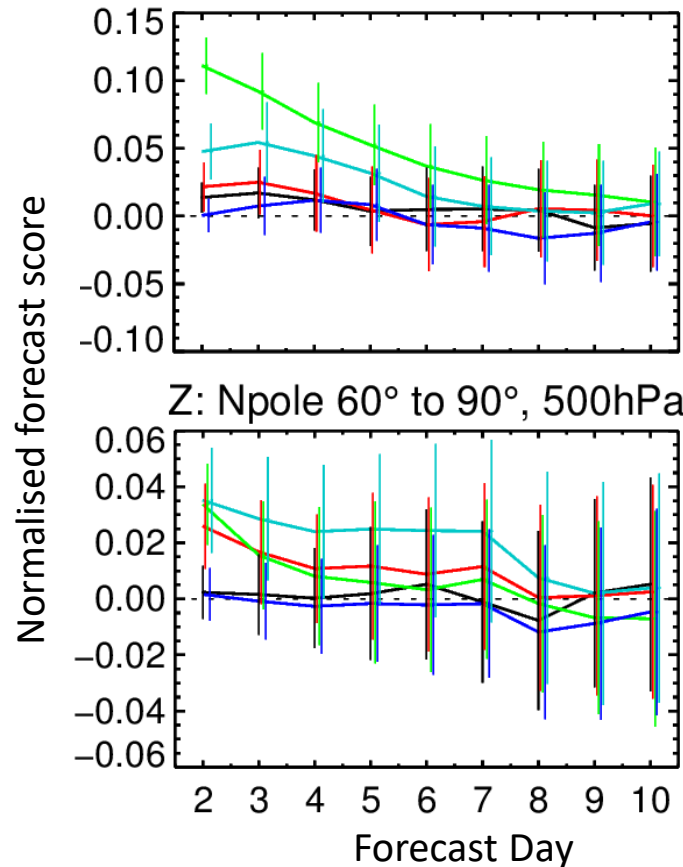


# Delivering enhanced predictions

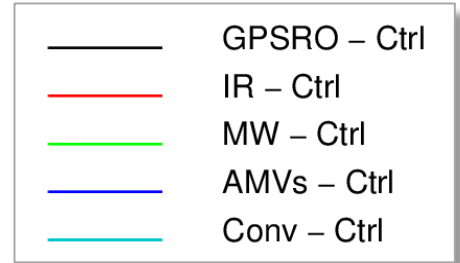
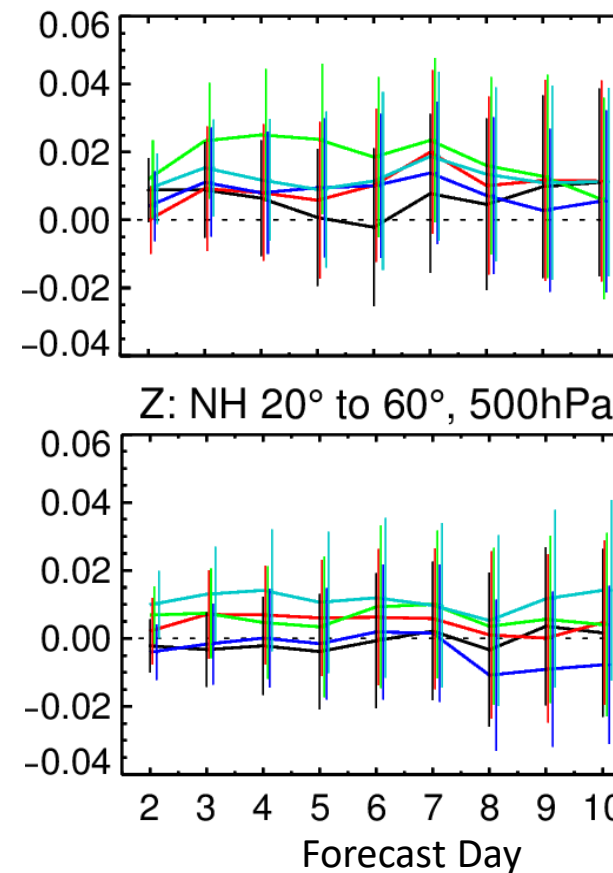
## Optimizing Arctic observing system

Summer

**Z500 Arctic**



**Z500 Mid-latitudes**



Winter

**Summer (larger):**

- Microwave
- Conventional
- Infrared
- GPSRO, AMVs

**Winter (smaller):**

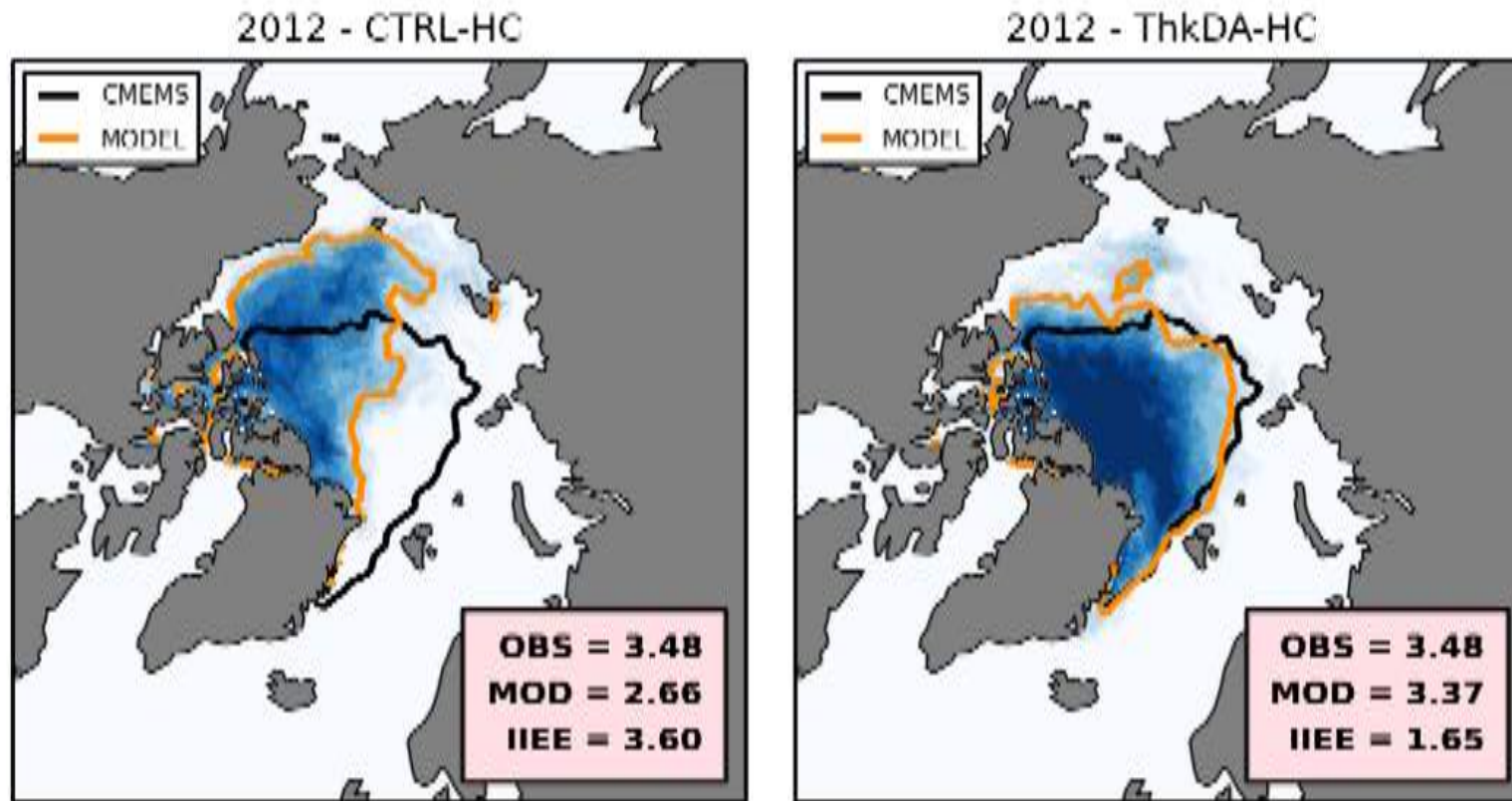
- Conventional
- Infrared/Microwave





# Delivering enhanced predictions

## Improved initial conditions



Impact of  
initializing sea ice  
thickness from  
CryoSat-2



## Understanding Arctic-midlatitude linkages

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



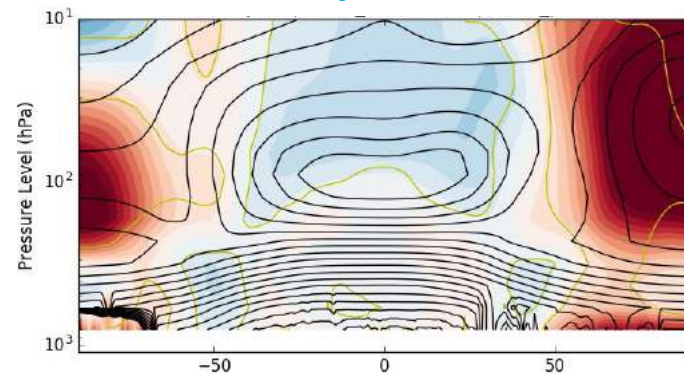


# Arctic-midlatitude linkages

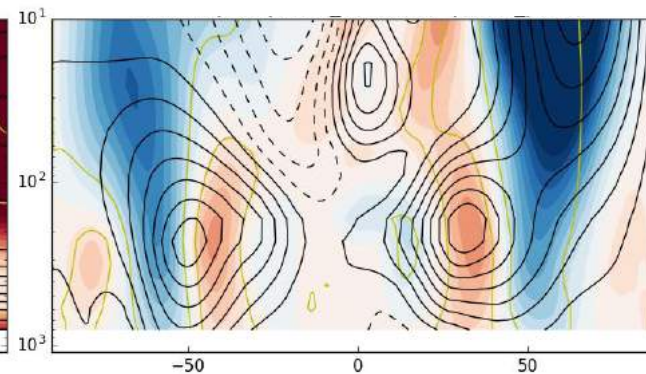
## A coordinated multi-model approach (CMIP6-PAMIP)

MetOffice

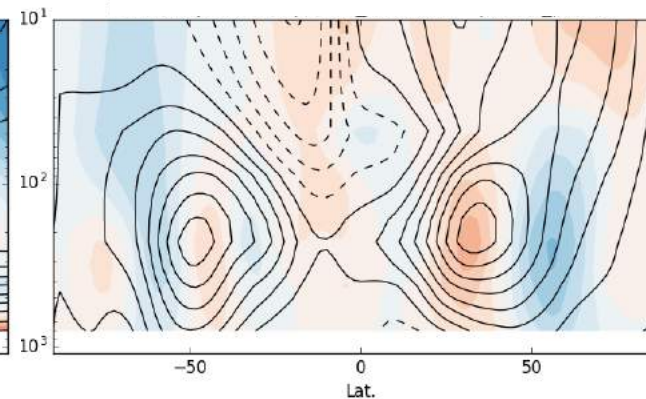
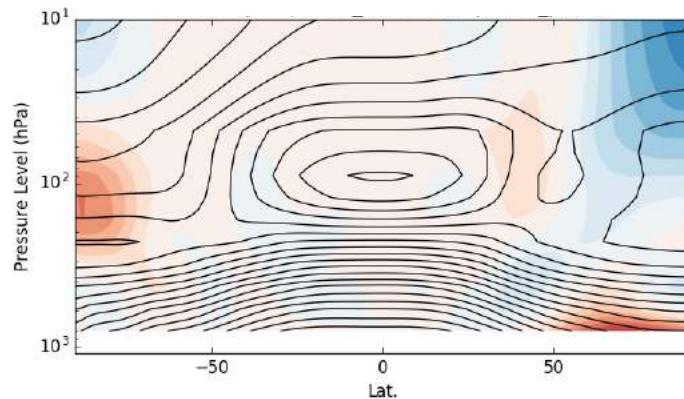
Temperature



Zonal Wind



AWI

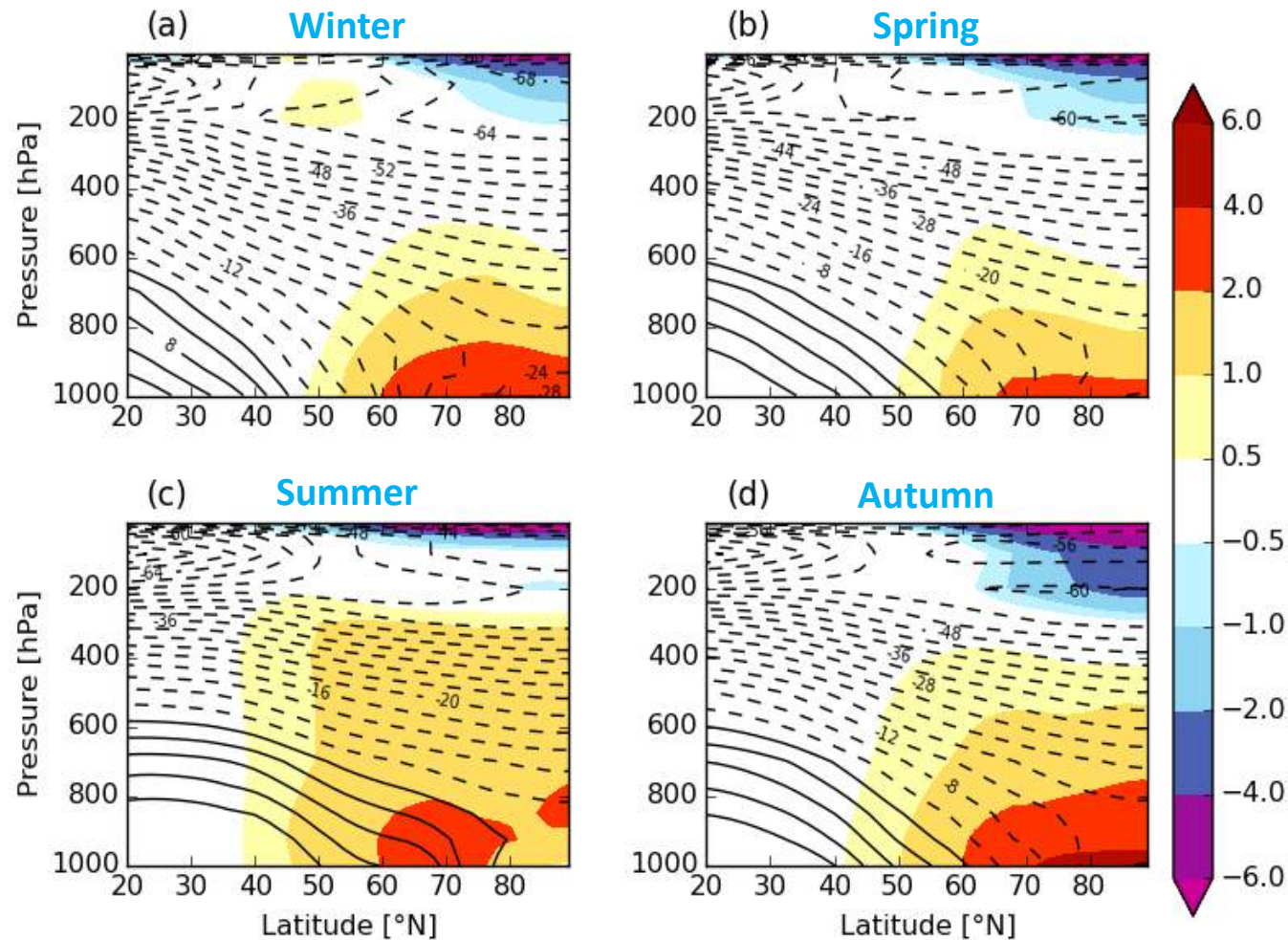


Winter Response:  
Future minus  
present-day Arctic  
sea ice



# Arctic-midlatitude linkages

## Coupled experimentation



4×CO<sub>2</sub> north of 60°N  
only (first 30-yr)

Semmler et al., *Clim. Dyn.* (subm.)

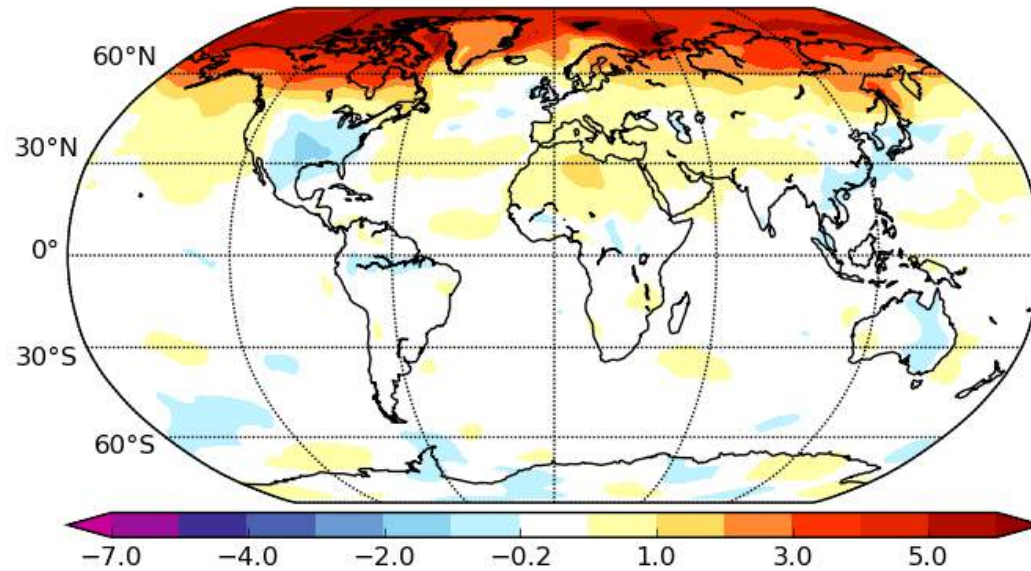




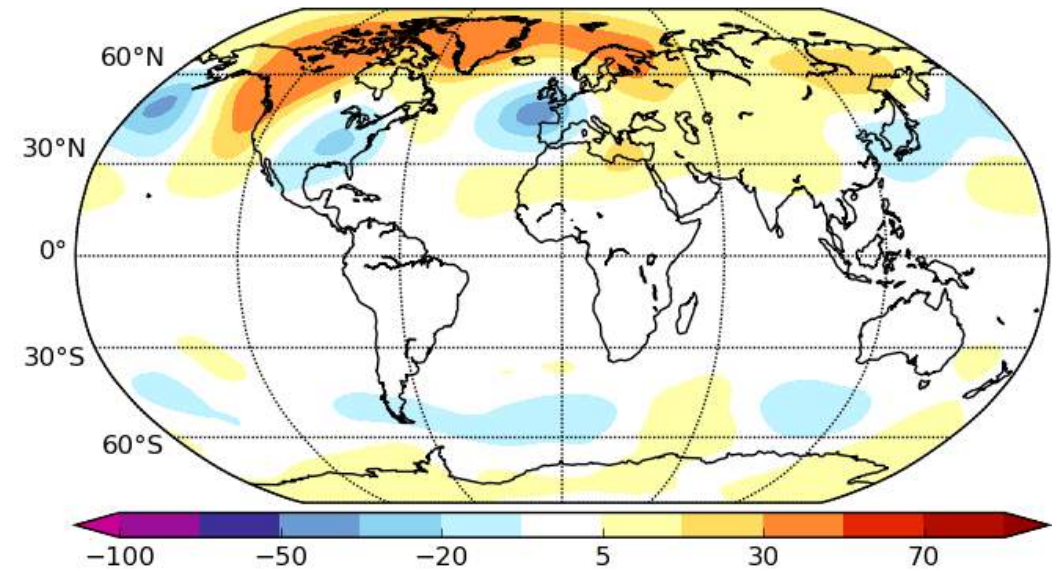
# Arctic-midlatitude linkages

## Coupled experimentation

2m Temperature response (DJF)



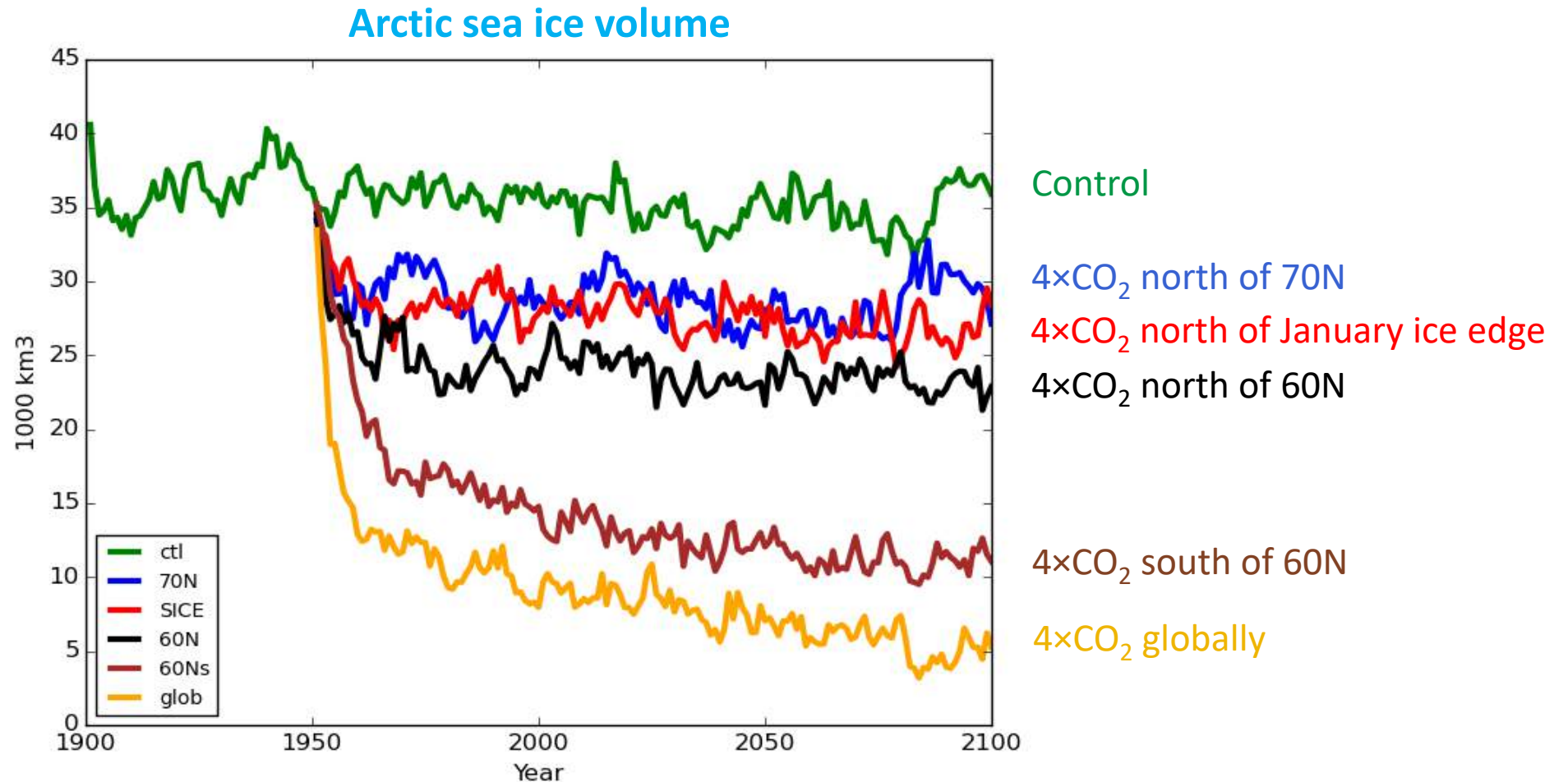
Z500 response (DJF)



4xCO<sub>2</sub> north of 60°N only  
(first 30-yrs)



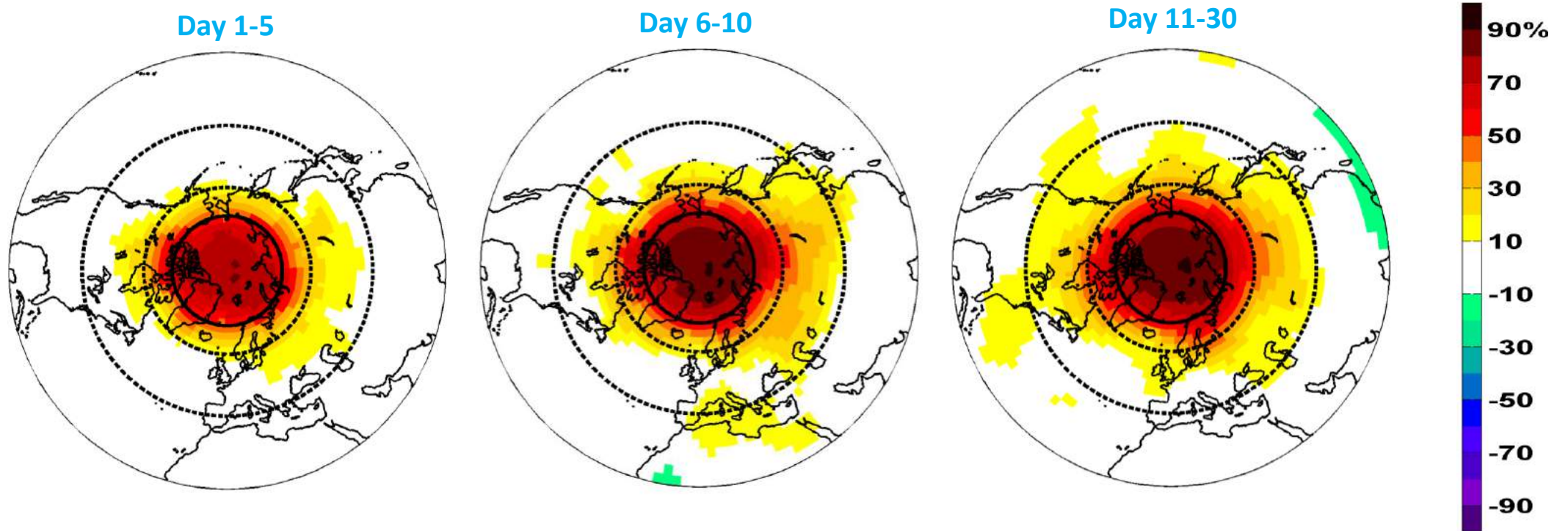
## Coupled experimentation



Semmler et al., *Clim. Dyn.* (subm.)



## Linkages from a prediction perspective



## Knowledge exchange

Focus on three key areas:

- User engagement
- Dissemination
- Training

Experienced partners taking the lead:

- Arctic Portal
- Barcelona Supercomputing Centre
- Association of Polar Early Career Scientists

Exploit existing “channels” from APPLICATE partners

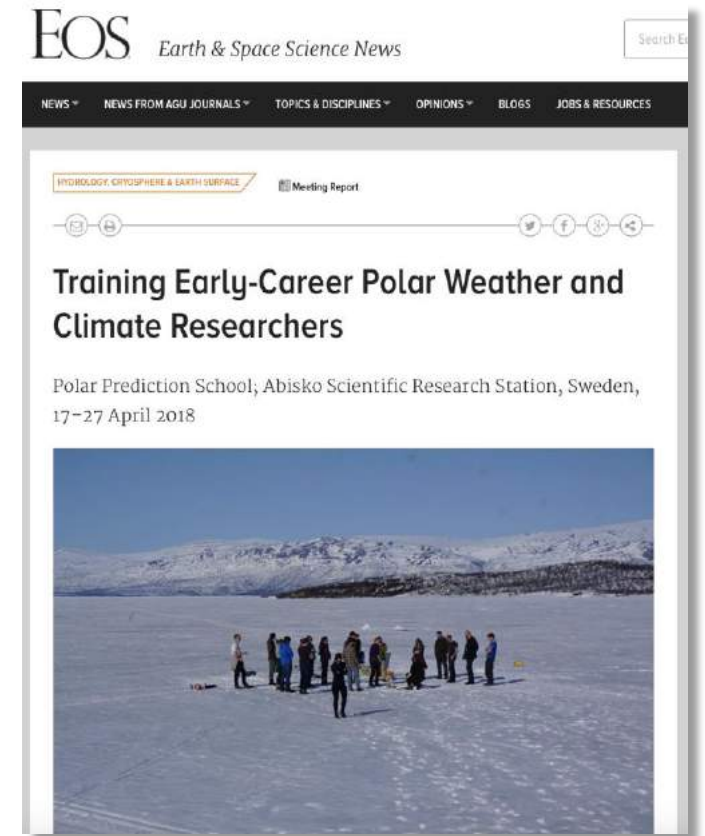




# Arctic-midlatitude linkages

## Knowledge exchange – Training

Polar Prediction School 2018, Abisko, Sweden



Tummon et al., *EOS* (2018)



# Link to Arctic ECRA



In this Briefing Document, it is argued that gaps in our scientific understanding and predictive capabilities are still hampering the evidence-based decision making processes by stakeholders. There is an urgent need to accelerate progress in building a reliable knowledge base, and **it is recommended that the EU fund collaborative research that aims to provide answers to the following three central questions:**

- **Why is Arctic sea ice disappearing so rapidly?**
- **What are the local and global impacts of Arctic climate change?**
- **How can environmental prediction capabilities be advanced?**

**Briefing Document**



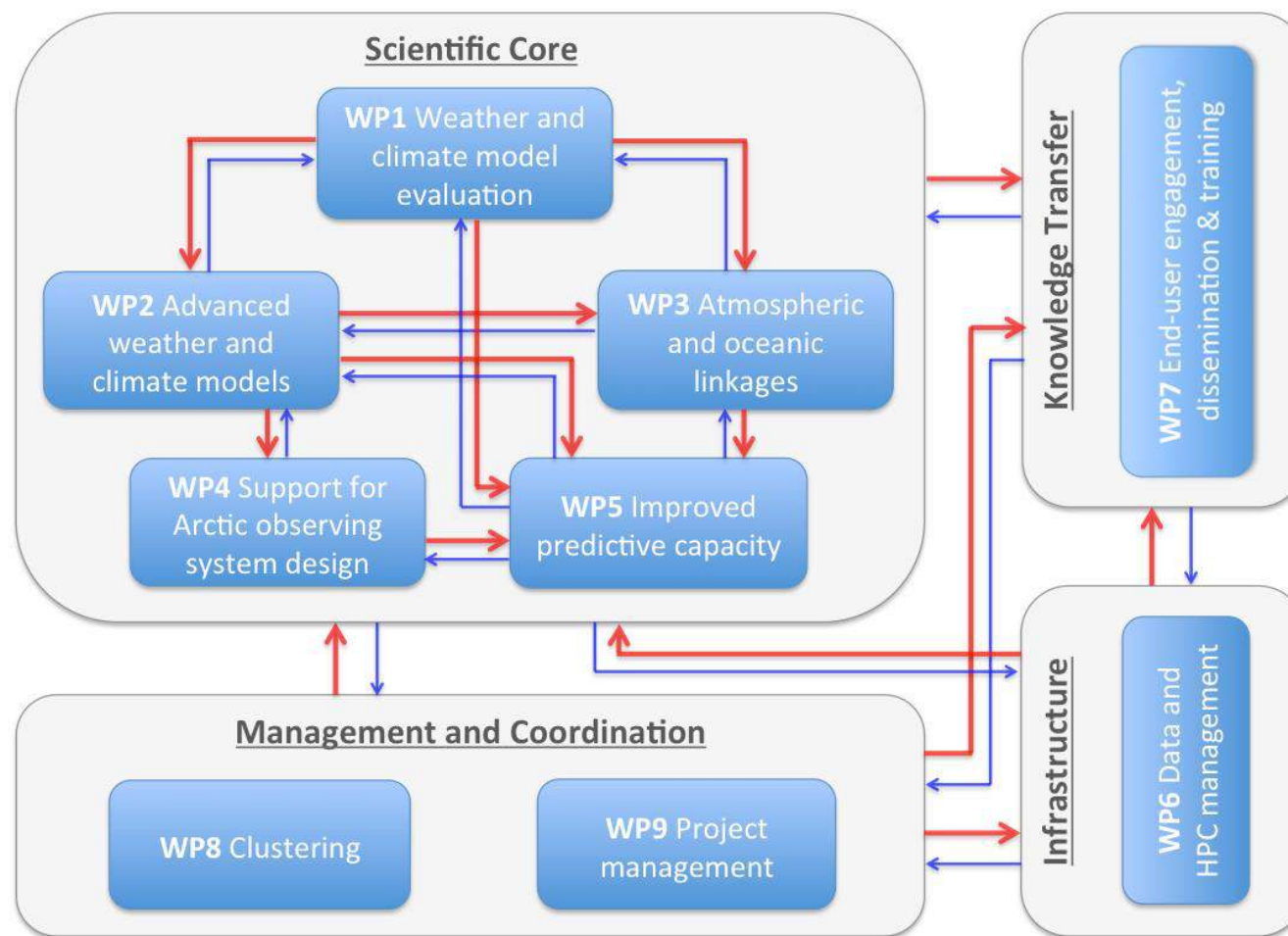
# In Summary, APPLICATE ...

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- Advances predictive capacity in polar regions and beyond:
  - Develop models with enhanced representation of Arctic processes
  - Contribute to improving the Arctic observing system
- Enhances our understanding of Arctic-midlatitude linkages (also from a prediction perspective)
- Brings different communities closer together
- Exploits and fosters international collaboration
- Works closely with key users and stakeholders
- Contributes to educating the next generation of scientists



# Project structure





## Understanding Arctic-midlatitude linkages

