

NorCPM's new seasonal prediction skill in regional Arctic sea ice

Yiqiao Wang^{1,2}, François Counillon^{1,2,3} and Nicholas Williams^{1,2}

1. Nansen Environmental and Remote Sensing Center, Norway
2. Bjerknes Centre for Climate Research, Norway
3. Geophysical Institute, University of Bergen, Norway
Mail: yiqiao.wang@nersc.no



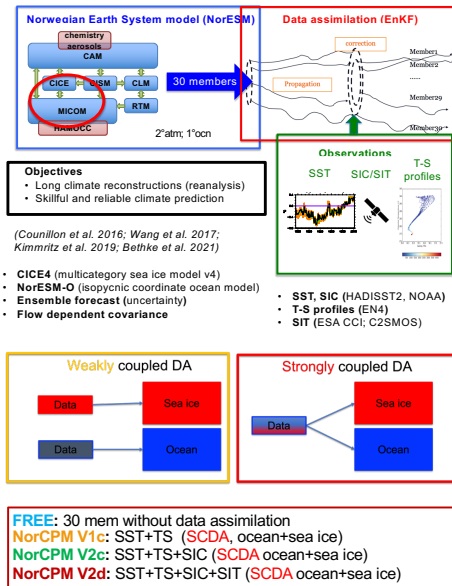
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Take-home messages

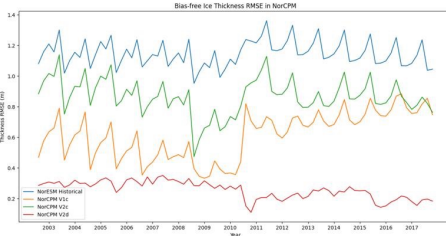
- NorCPM features anomaly strongly coupled data assimilation (SCDA) of ocean and sea ice data.
- Assimilation of ocean data updates the multicategory sea ice state and reduces sea ice thickness (SIT) error and achieves prediction skill (e.g., Barents Sea).
- Assimilation of sea ice concentration (SIC) enhances prediction skill of sea ice extent (SIE) compared to ocean data only.
- SIT assimilation only improves SIE prediction skills in some regions (degrades otherwise).
- Further investigations are needed:
 - Why ocean-only is so good?
 - Why does SIC assimilation degrade SIT?
 - Why SIT assimilation does not yield large improvement?
 - Can this relate to anomaly assimilation?

1. NorCPM introduction & Experiments

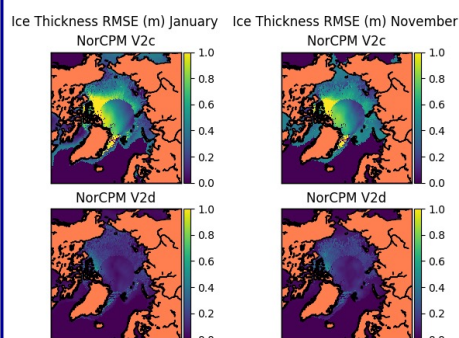


2. Added value of sea ice thickness for reanalysis

Intercomparison of SIT bias free RMSE from FREE, NorCPM V1c, NorCPM V2c and NorCPM V2d for 2003-2017.

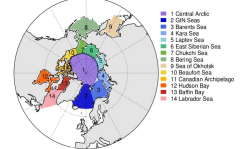
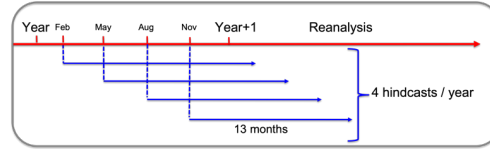


- Assimilation of ocean only reduces bias and bias-free RMSE
- Assimilation of SIC increases error compared to the ocean only
- Assimilation of SIT further reduces the RMSE for SIT to 0.2 m.

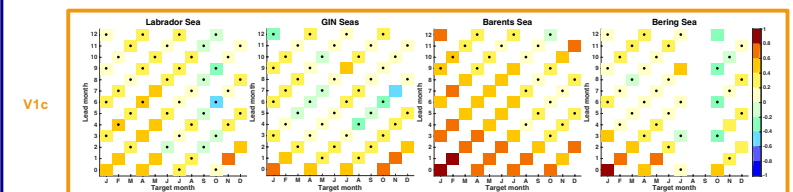
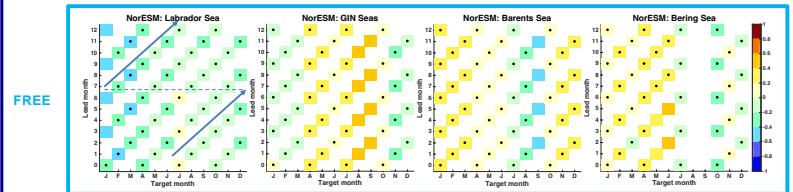


4. Seasonal predictions skill

Prediction skill is tested by retrospective forecasts (i.e., hindcasts) with 9 ensemble members and 4 starts per year (see figure below as an example)

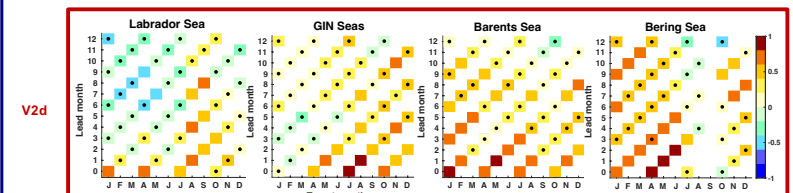
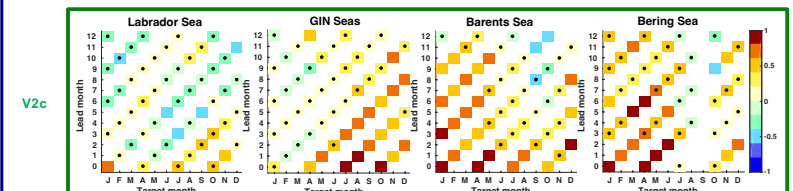


1. Detrended correlation of prediction of sea ice extent (SIE=sum(area | SIC > 15%)) vs that calculated from HadISST2 (1985-2010) for each lead-month (y-axis) and calendar month (x-axis) and organised by start date. A black dot indicates that the correlation is not significant.



- Labrador Sea:**
 - Ocean initialisation achieves good skill in SIE variability (ocean heat content).
- GIN Seas:**
 - FREE has skill in Aug and Sep.
 - Ocean initialisation improved sea ice export from the Arctic.
- Barents Sea:**
 - Ocean initialisation achieves good skill in boreal winter (ocean heat content).
- Bering Sea:**
 - Ocean initialisation achieves good skill to 2-3 lead months.

2. Same calculated from OISSTV2 over 2003-2019



- Labrador Sea:**
 - Winter skill is lost; can it relates to the different period?
 - SIT initialisation achieves good skill in Aug and Sep.
- GIN Seas:**
 - SIC initialisation achieves good skill in summer.
 - SIT initialisation degraded skill of April.
- Barents Sea:**
 - SIT initialisation degrades skill in boreal winter.
 - Improvement in spring.
- Bering Sea:**
 - SIT initialisation improves Jan and April predictions, but degrades Oct prediction.

Further investigations:

- Why can the assimilation of oceanic data constrain SIT so well?
- Why does the assimilation of SIT do not yields large improvement?
 - Degrades ocean heat content variability?
 - leads to strong prediction drift?
 - needs to fine-tune model parameter?

Reference:

- Counillon et al. "Flow-dependent assimilation of SST in isopycnal coordinates with NorCPM. Tellus A (2016)
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- Kimmritz et al. "Impact of Ocean and Sea Ice Initialisation On Seasonal Prediction Skill in the Arctic", JAMES (2019)
- Bethke et al. "NorCPM1 and its contribution to CMIP6 DCCP", GMD (2021)

Acknowledgments

This study was co-funded by the Bjerknes Center, the Norwegian Research Council project INES (270061) and ASICE (328886), the Trond Mohn Foundation under project number BFS2018TMT01. CPU and storage has been provided by UNINETT Sigma2 (nn9039k and NS9039K).