An assessment of regional sea ice predictability in the Arctic ocean

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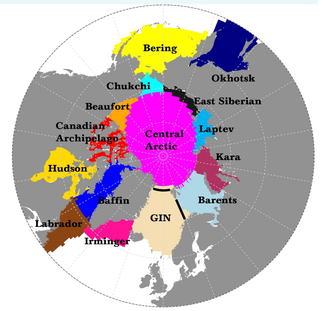
Motivation and goal of the study

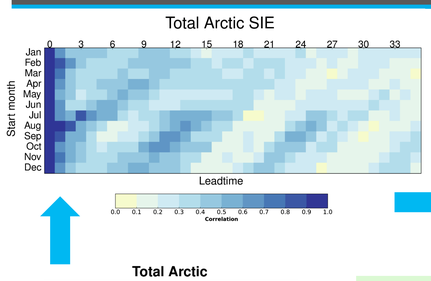
- Arctic sea ice evolution on **seasonal-to-interannual timescales** is of importance for ecosystems, populations and a growing number of stakeholders. A prerequisite for achieving better sea ice predictions is a better understanding of the underlying mechanisms of predictability. Research has shown that sea ice **predictability** varies depending on the **predictand** (area, extent, volume), **region**, and the **initial** and **target dates.**
- Here we explore the presence of pan-Arctic sea ice memory **re-emergence** and **persistence** mechanisms, and also the **sources and mechanisms of predictability at regional scales** for the Arctic sea ice using **EC-Earth 2.3** climate system in a **perfect-model approach**.

Methodology

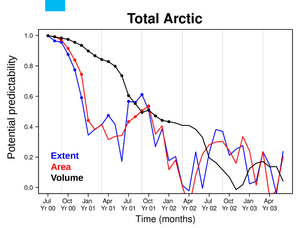
- We used a 300-year long present day control experiment, which provided the initial conditions to perform a set of idealized climate predictions initialized from July (3 years-long, 8 members).
- For evaluating the predictability: **1) P**rognostic **P**otential **P**redictability (**PPP**; If PPP = 1, perfectly predictable). **2)** lagged control experiment properties.
- **Breaking down into sectors**: different regional physical mechanisms.



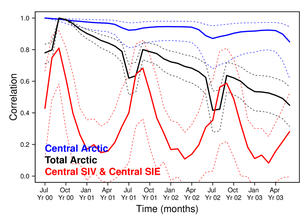
Results: **Pan-Arctic sea ice**



- Melt-to-freeze is present in the lagged correlation and the PPP (blue line).
- The long SIV persistence is consistent with the lagged correlations *(not shown)*.

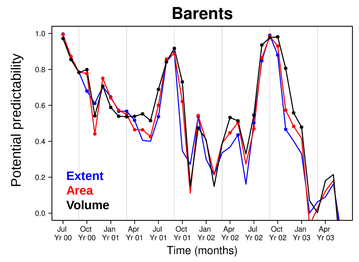


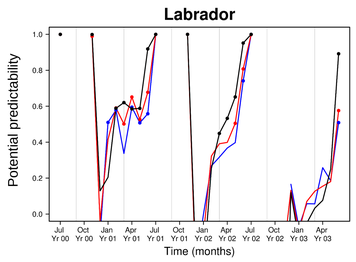
- **Pan-Arctic SIV persistence** arises almost entirely from the **central Arctic SIV persistence**, as suggested when the lagged correlation of the central and pan-Arctic SIV are compared (blue and **black** lines).

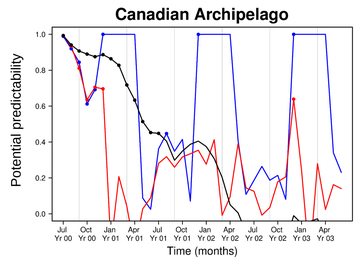


- **Summer-to-summer memory** re-emergence has its origin in the **summer SIT memory** (from the central Arctic). Over three continuous years, the central SIV and SIE are synchronously correlated in September (red line).

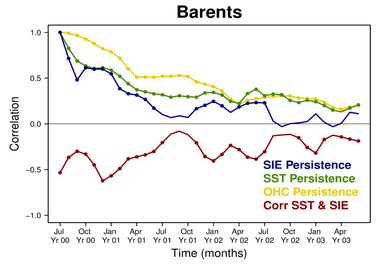
Results: **Regional Arctic sea ice**

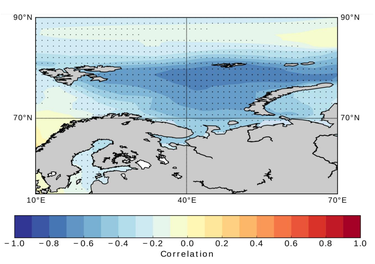




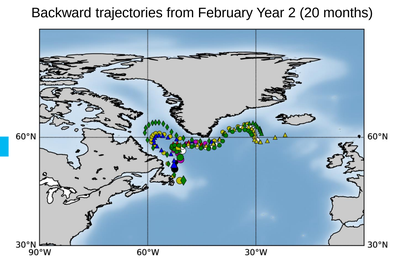


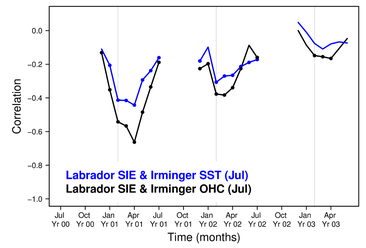
- **Significant re-emergence** the second and third summer in the **Barents Sea**, and in January-April in the **Labrador Sea**.
- **Fake melt-to-freeze** SIE re-emergence in the **Canadian Archipelago** caused by the extremely low sea ice variability in winter.





- Synchronous correlation between the SST and the SIE (red line) reveals that **SST** is a **source of SIE predictability** in December.
- Correlation between the **grid point SST in December** and **SIE** from December to February **confirms** the aforesaid **time series**.





- **Backward trajectories** from the **Labrador Sea** reveal that the **water masses origin is the Irminger Sea**, and the North Atlantic Ocean in a longer term.
- The **Irminger Sea SST and OHC** at the moment of the initialization and **the Labrador Sea SIE** are **significantly anti-correlated** from **February to July the two first years**, matching exactly the time when the PPP re-emergence in the Labrador Sea occurs.

Conclusions

- **Pan-Arctic SIE melt-to-freeze re-emergence** in the prognostic ensemble potential predictability and in the control run lagged correlations. Greater SIV predictability → Long persistence of the SIT in the central Arctic.
- **Pan-Arctic SIE summer-to-summer re-emergence** of the PPP → Persistence of SIT anomalies in the central Arctic.
- **Peripheral seas** (Atlantic Sector) **re-emergence** → Persistence of local oceanic thermal anomalies (SST and OHC).
- **Labrador Sea** predictability re-emergence between January and April → Advection of ocean temperature anomalies from the Irminger Sea and the North Atlantic Ocean.
- **Interior Arctic seas** in winter → Trivial SIE predictability (complete ice coverage). Long SIV predictability → Long SIT persistence.

Acronyms

SIE → **S**ea **I**ce **E**xtent
SIV → **S**ea **I**ce **V**olume
SIT → **S**ea **I**ce **T**hickness
SST → **S**ea **S**urface **T**emp.
OHC → **O**cean **H**eat **C**ontent

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