

# Decadal-scale predictive skill of North Atlantic upper-ocean salt content and its attribution to the initialization of the North Atlantic Ocean circulation

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## Motivation

- **Predictive skill of North Atlantic upper-ocean salinity has, in contrast to upper-ocean temperature, so far not received much attention in the literature**
- **Upper-ocean salinity in the western subpolar North Atlantic and the Nordic Seas is crucial for the preconditioning of deep water formation**
- **Upper-ocean salinity variability in the North Atlantic correlates well with changes in the distribution and abundance of marine ecosystem species from various trophic levels**

# Data

**Initialized hindcast prediction experiments (initialized every year between 1960 and 2005) and 20C simulations (uninitialized prediction) from CMIP5**

	<b>Ensemble members</b>	<b>T, S Initialization</b>
<b>MPI-ESM-LR *</b>	<b>3 (10 every 5th year)</b>	<b>ORAS4 reanalysis</b>
<b>EC Earth</b>	<b>10</b>	<b>NEMOVAR ocean reanalysis</b>
<b>HadCM3</b>	<b>10</b>	<b>Ocean reanalysis</b>
<b>GFDL-CM2.1</b>	<b>10</b>	<b>Coupled assimilation run, assimilates T, S observations</b>
<b>CanCM4</b>	<b>10</b>	<b>SODA ocean reanalysis</b>
<b>MIROC5</b>	<b>6</b>	<b>Observation-based T, S dataset</b>

\* version baseline1 from the German MiKliP project

# Data

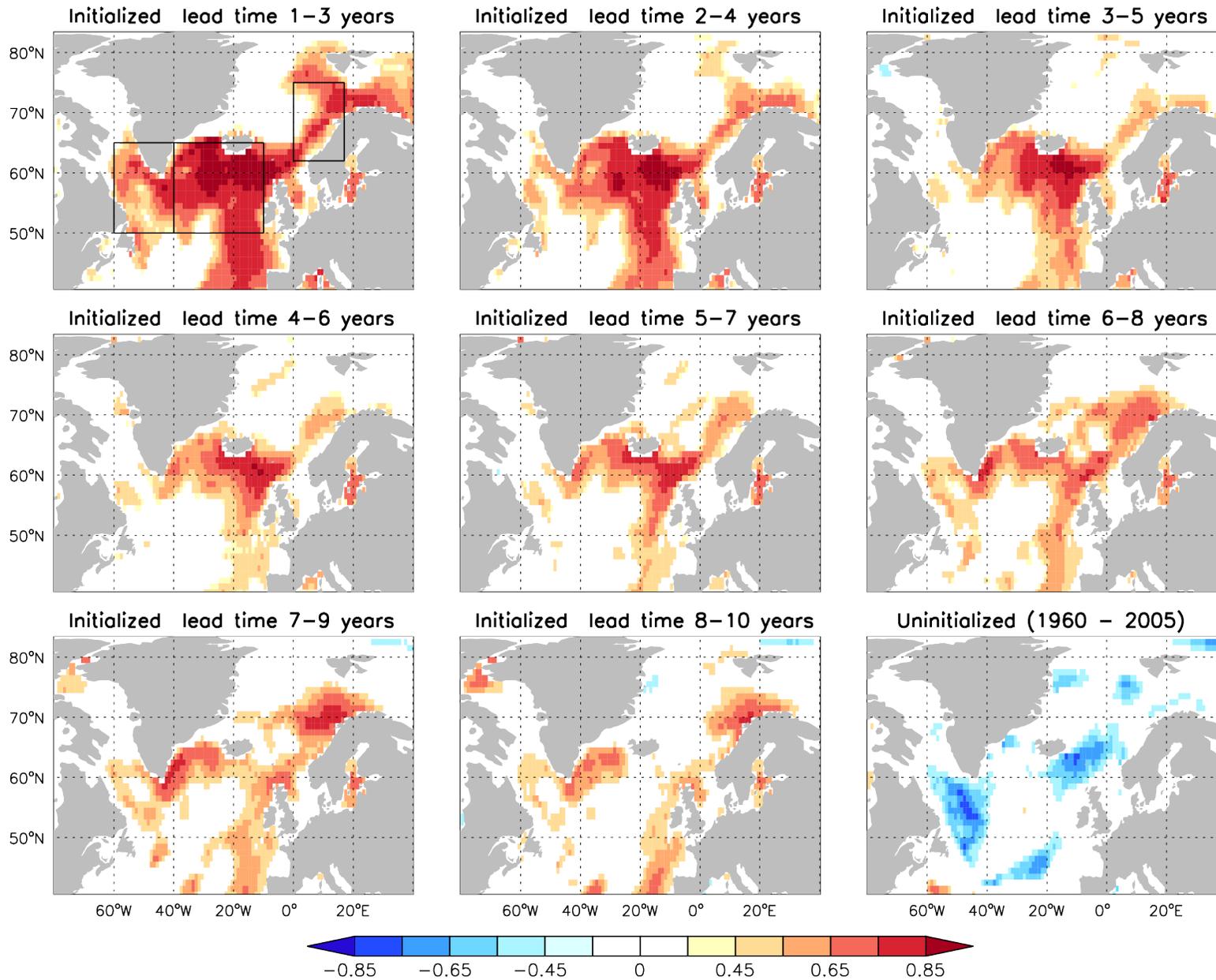
- **Resolution  $\sim 1^\circ$ , in subpolar North Atlantic/Nordic Seas 20 – 110 km**
- **Upper-ocean salt content (0 - 500m) with 3 year running mean applied**
- **Multi-model ensemble mean on  $1^\circ \times 1^\circ$  grid, based on normalized anomalies**
- **Observation based dataset against which skill is assessed:  
ISHII dataset \* (Japan Marine Science and Technology Center)**

\* Ishii, M., A. Shouji, S. Sugimoto, and T. Matsumoto, 2005: Objective analyses of SST and marine meteorological variables for the 20th century using COADS and the Kobe Collection. *Int. J. Climatol.*, 25, 865-879

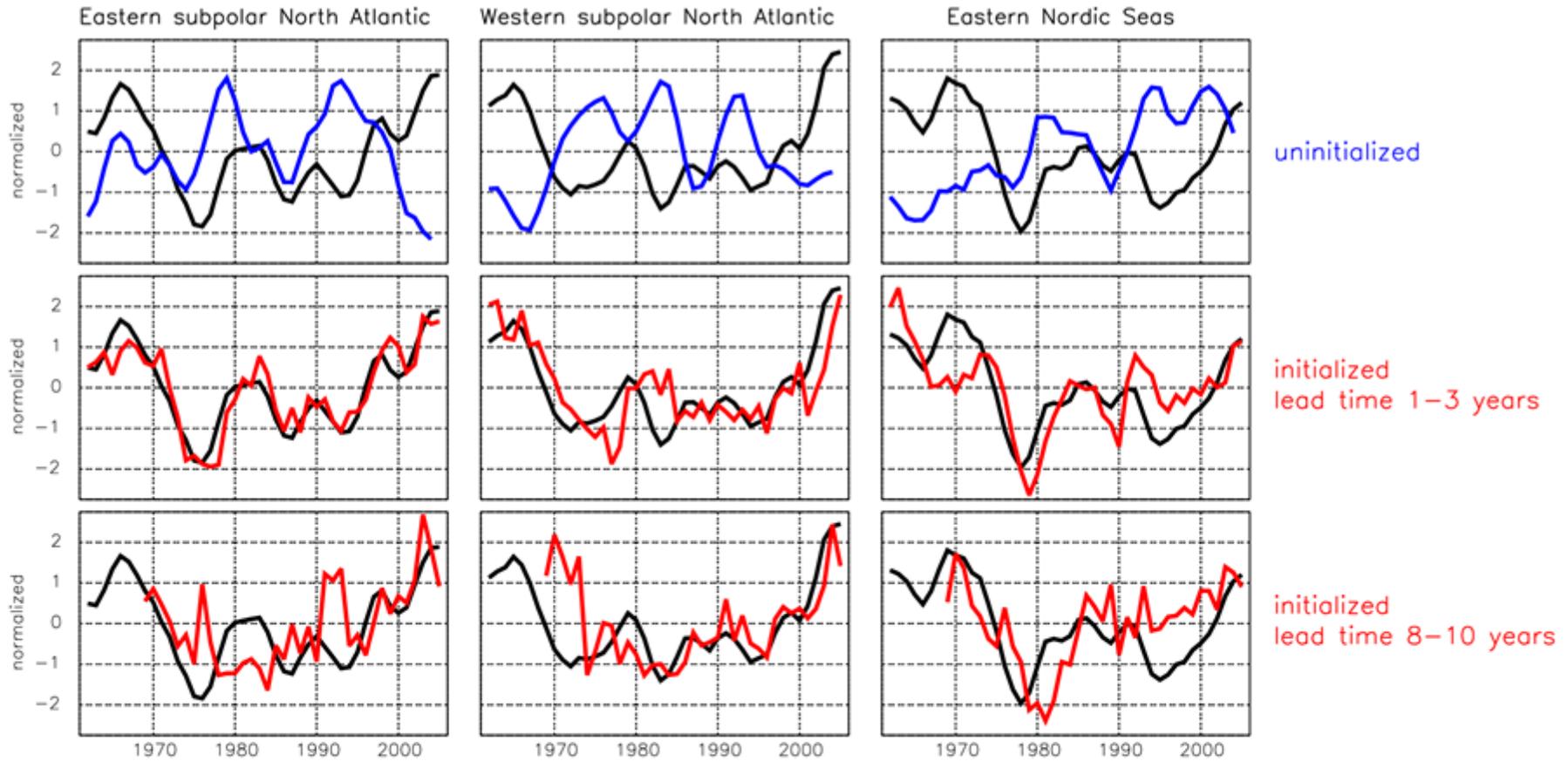
Ishii, M., M. Kimoto, K. Sakamoto, and S. I. Iwasaki, 2006: Steric sea level changes estimated from historical ocean subsurface temperature and salinity analyses. *J. Oceanography*, 62, 155-170

Ishii, M., and M. Kimoto, 2009: Reevaluation of historical ocean heat content variations with time-varying XBT and MBT depth bias corrections. *J. Oceanography*, 65, 287-299

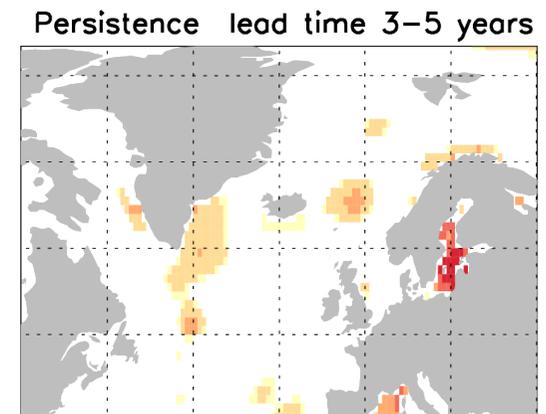
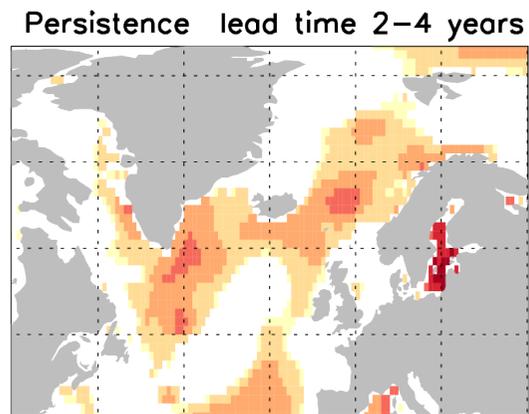
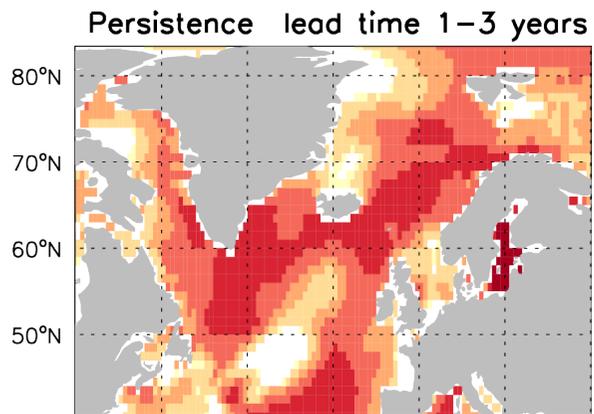
# Correlation skill of multi-model ensemble mean



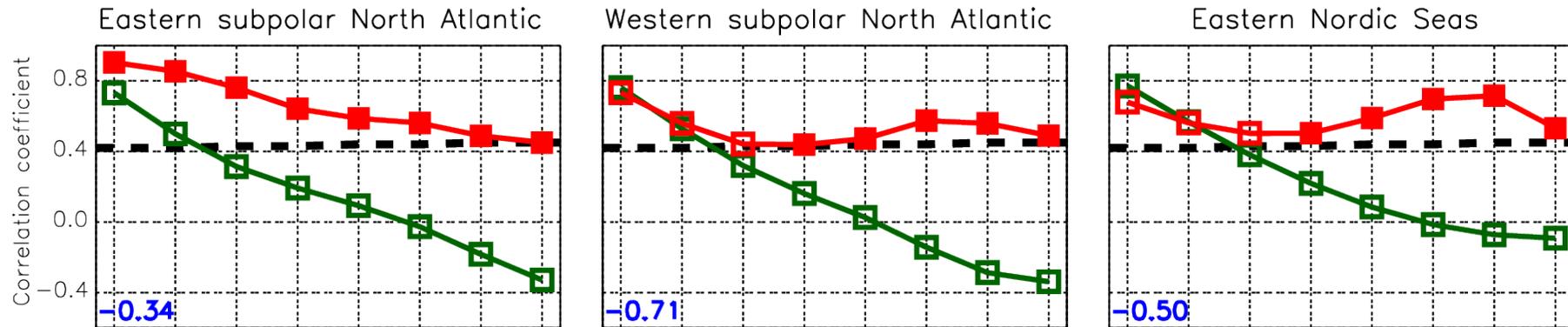
# Upper-ocean salt content evolution



# Correlation skill of persistence based on ISHII dataset

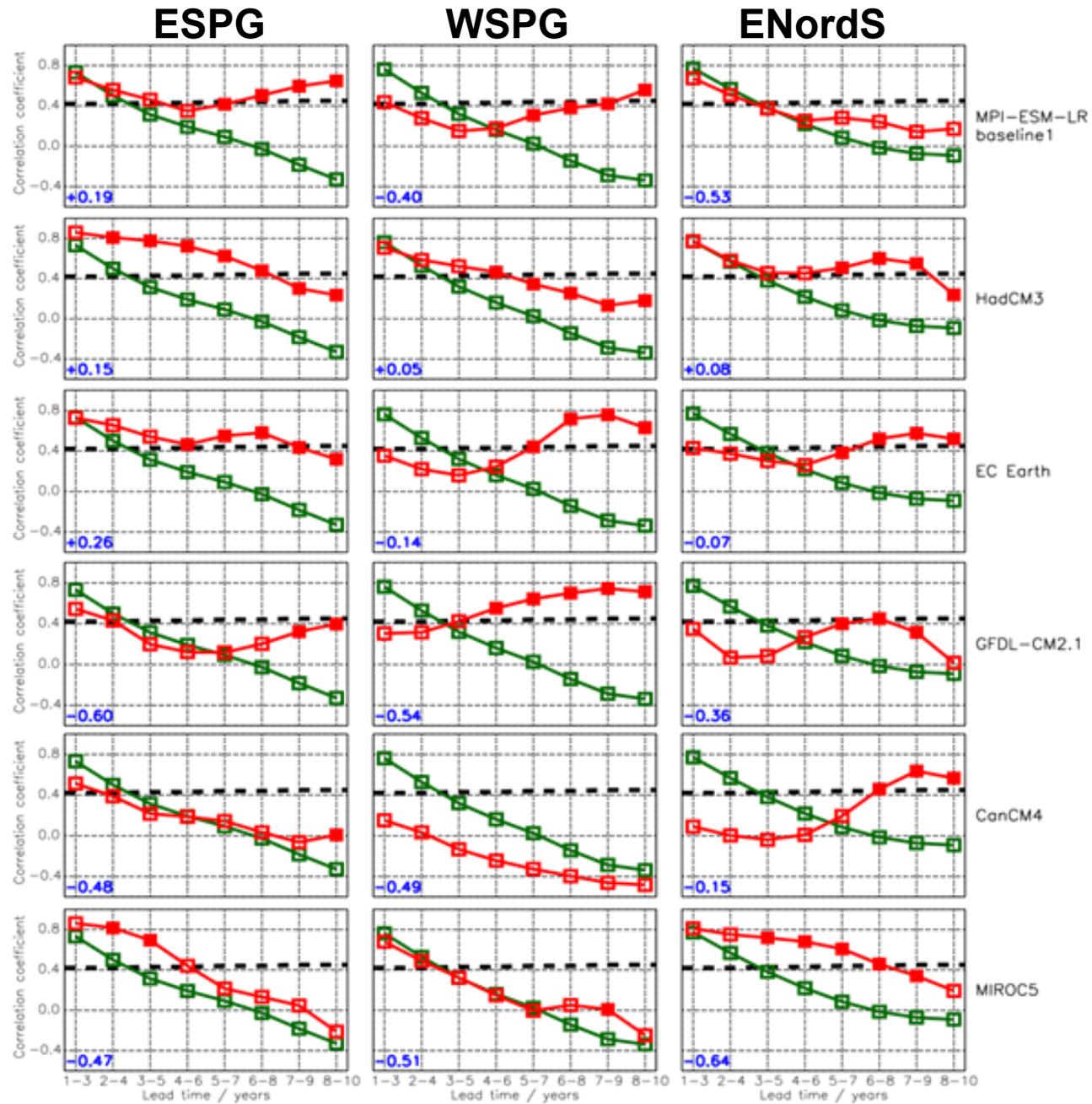


# Correlation skill of multi-model ensemble mean

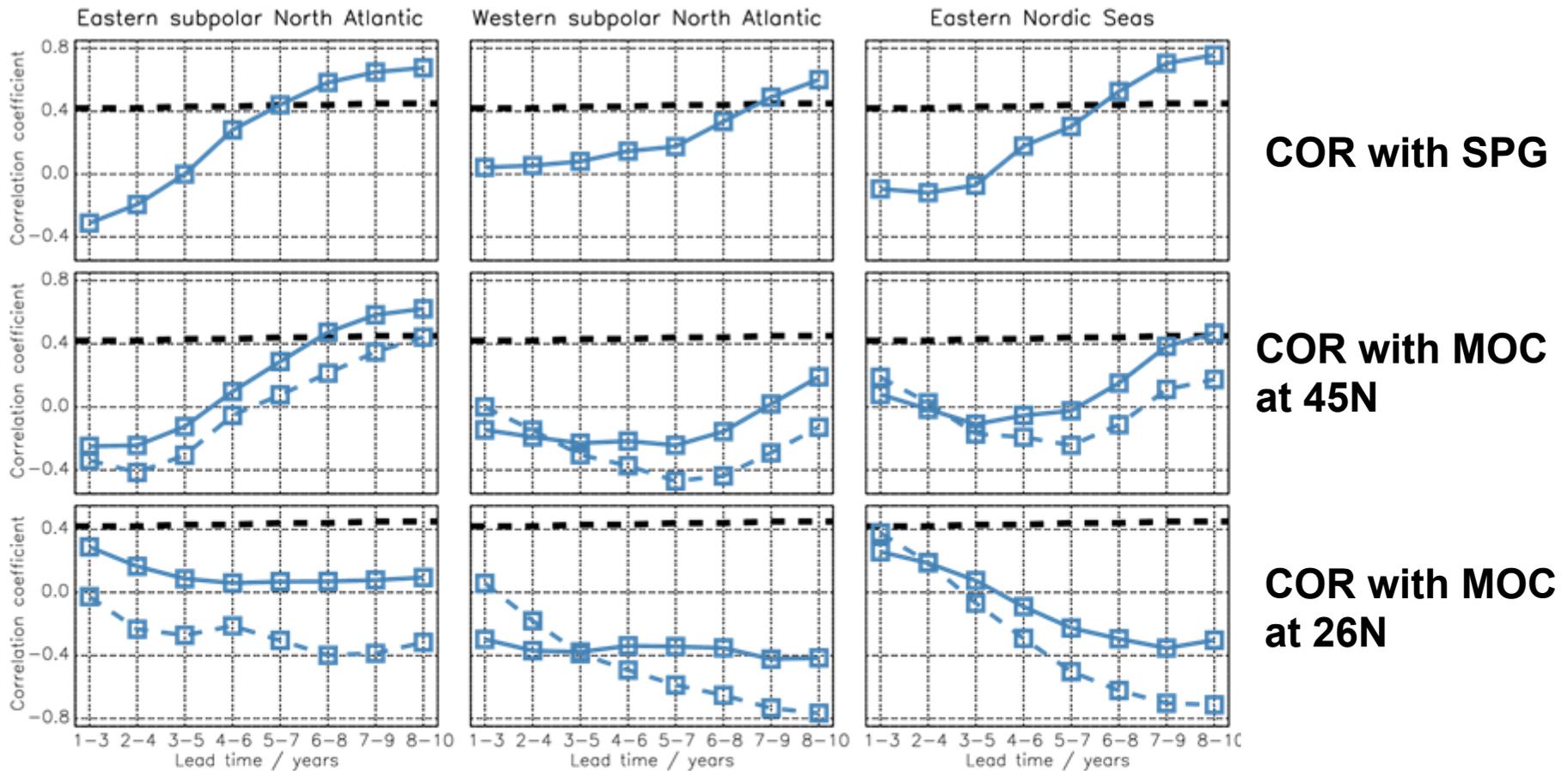
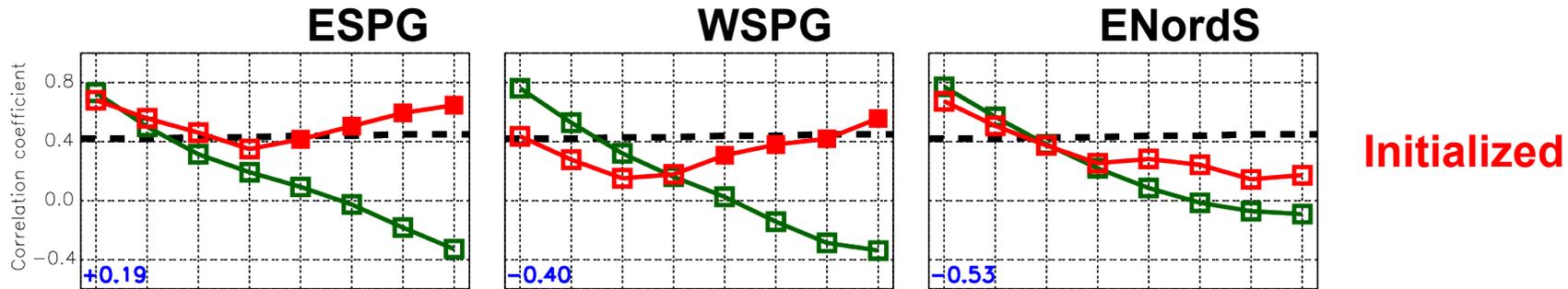


Initialized, Persistence, 20C

# Correlation skill of individual models



# Skill attribution based on MPI-ESM-LR



# Conclusions

- **Based on the multi-model ensemble mean hindcasts, decadal-scale predictive skill of upper-ocean salt content is found in the entire subpolar North Atlantic and the eastern part of the Nordic Seas**
- **Based on MPI-ESM-LR, we attribute the skill beyond the persistence forecast to a delayed response to the initialization of the North Atlantic gyre and overturning circulation**
- **The skill based on the individual models is partly much lower than the skill based on the multi-model ensemble mean, underlining the importance of a multi-model approach for predictability studies**

**Outlook: Extend skill attribution to all models**

**Challenge: Very limited availability of streamfunctions through ESGF nodes**





Photo credit:  
Kathryn  
Hansen/NASA

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