# The Norwegian Climate Prediction Model (NorCPM)

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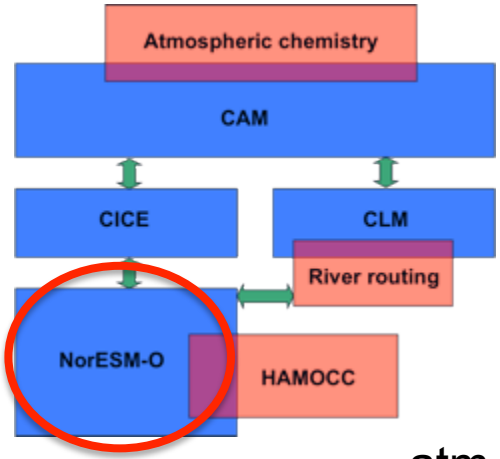
**Yvan Orsolini*, Fei Li**

NILU - Norwegian Institute for Air Research, *BCCR - Bjerknes Centre for Climate Research

# Norwegian Climate Prediction Model (NorCPM)

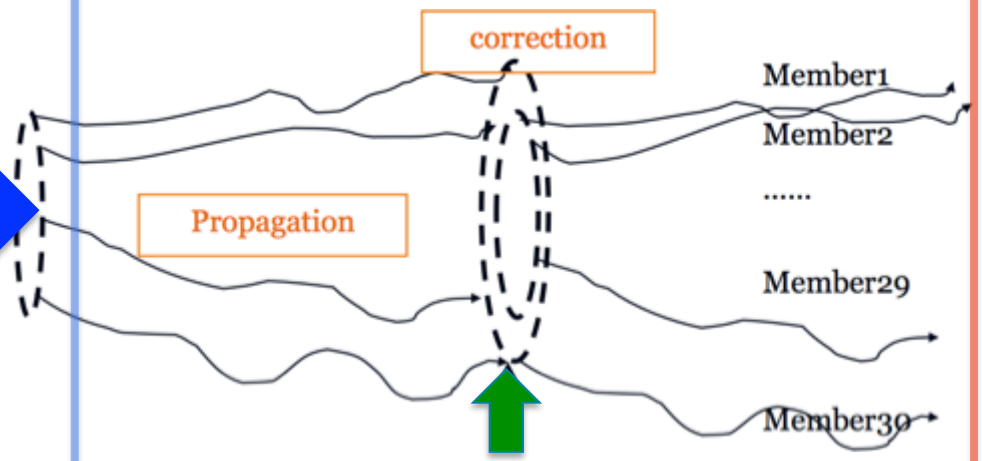
## Earth System model (NorESM1-M)




30 members

atm 2°; ocean+ice 1°

## Data assimilation (EnKF)



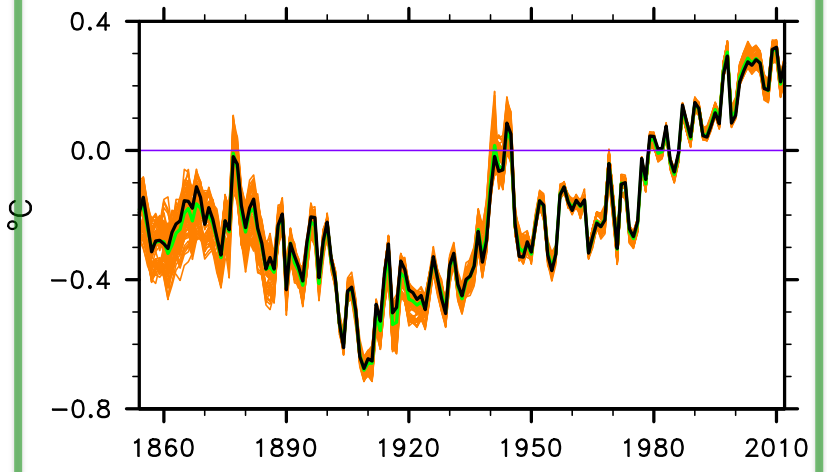

**Potential for long-term reanalysis (1850 – present), but so far from 1950-2010**

V0 system: **SST anom**
V1 system: **SST anom + ocean Temp-Salinity**
V2 system (in prep): **Ice-concentration**

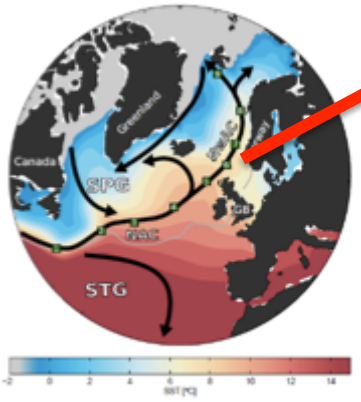
Counillon et al., Tellus 2014 & 2016

## observations

HadISST2 anom (monthly)



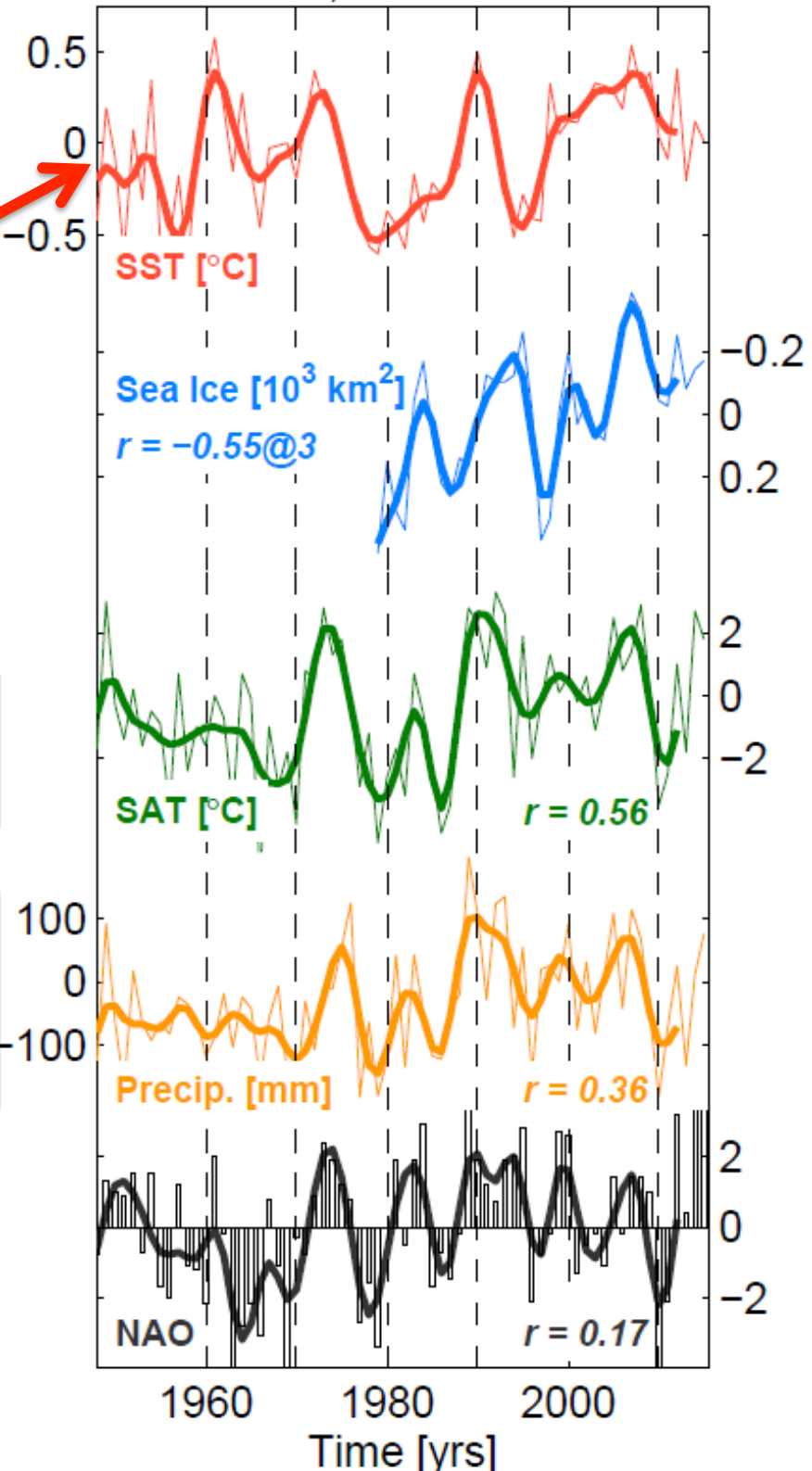
# Focus on Arctic - North Atlantic climate




## Oceanic influence

- Norwegian **SAT**, **precipitation**, and Arctic **sea ice** co-vary with Norwegian Sea **SST**.

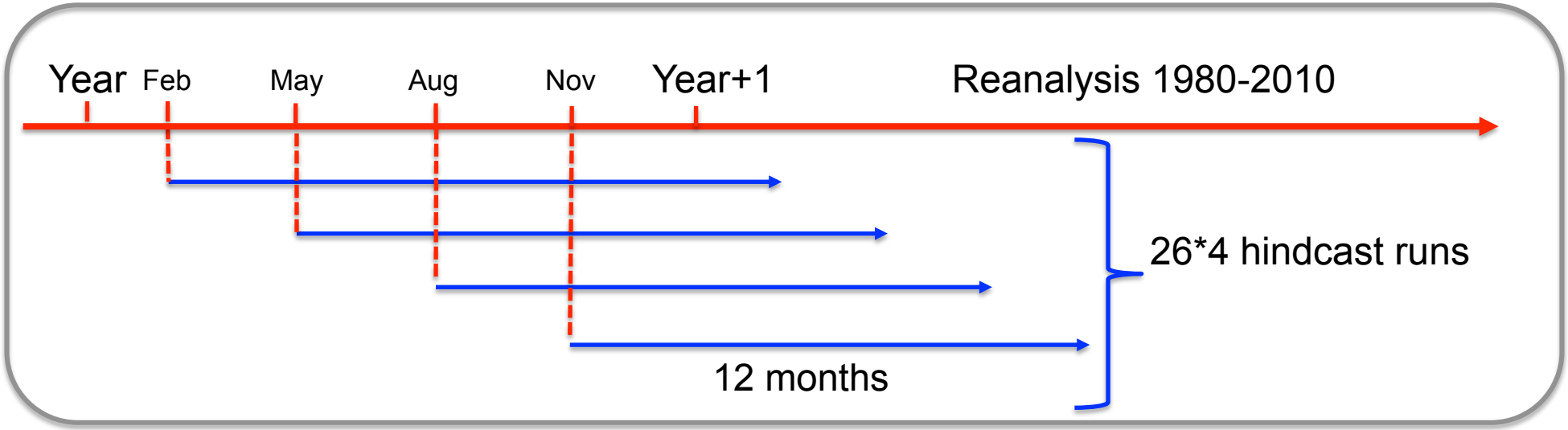
- Climate impacts associated with regional SST anomalies are complementary to those of the **NAO**.




Årthun et al., Nat. Comm., 2017

# NorCPM : Annual Hindcasts

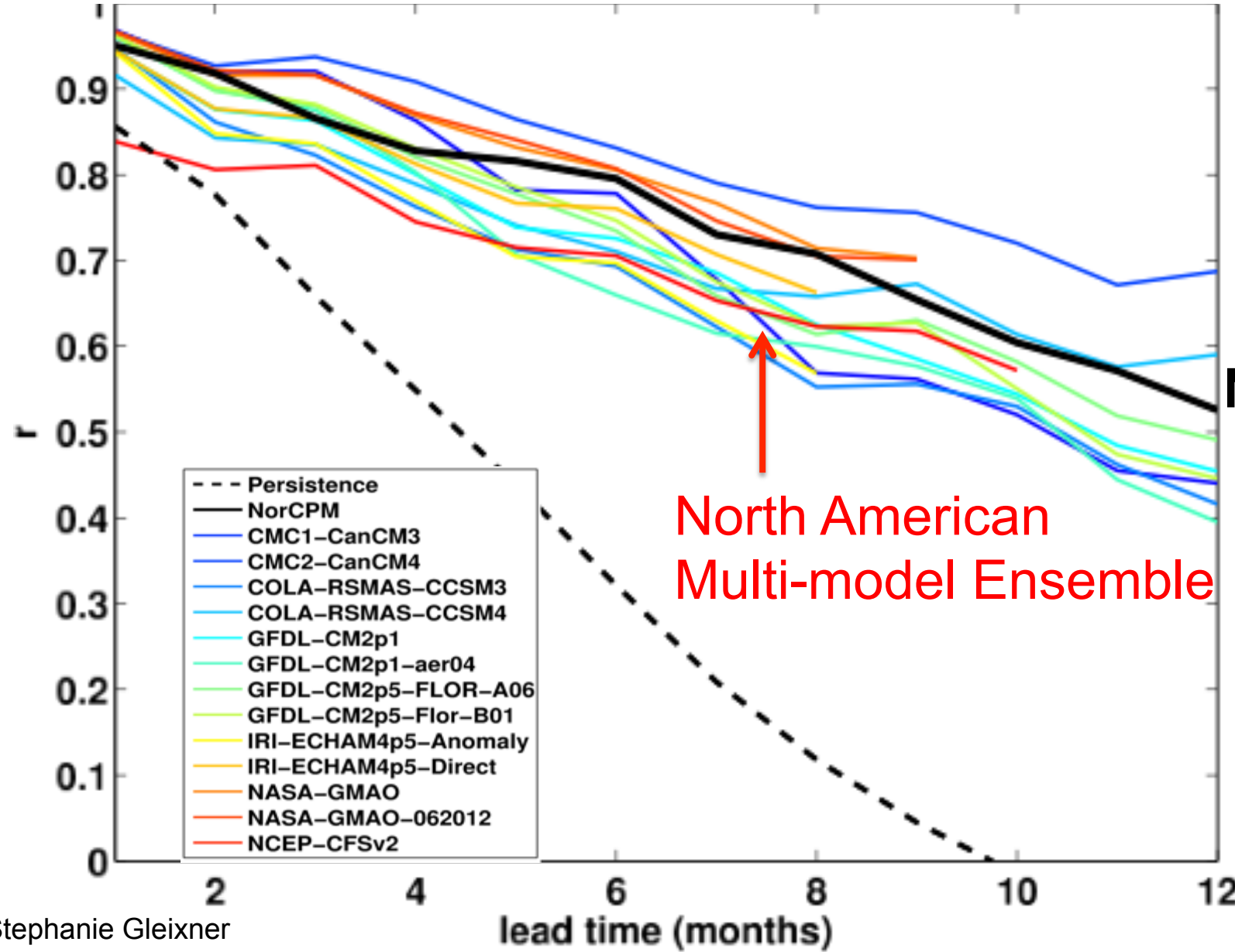
- **9** ensemble members
- Retrospective forecast period from **1985** to **2010**
- Forecast start from **Feb**, **May**, **Aug** and **Nov**
- Forecast length: **12 months**
- Historical external/RCP8.5 forcing
- Ocean/Atm/Land initialised with re-analyses with SST anom assimilation




Courtesy of Y. Wang

# ENSO seasonal prediction skill matching other systems, but initialised only with SST

Anomaly Correlation Sea Surface Temperature for Niño 3.4 index (NOAA OISST) 1985-2010



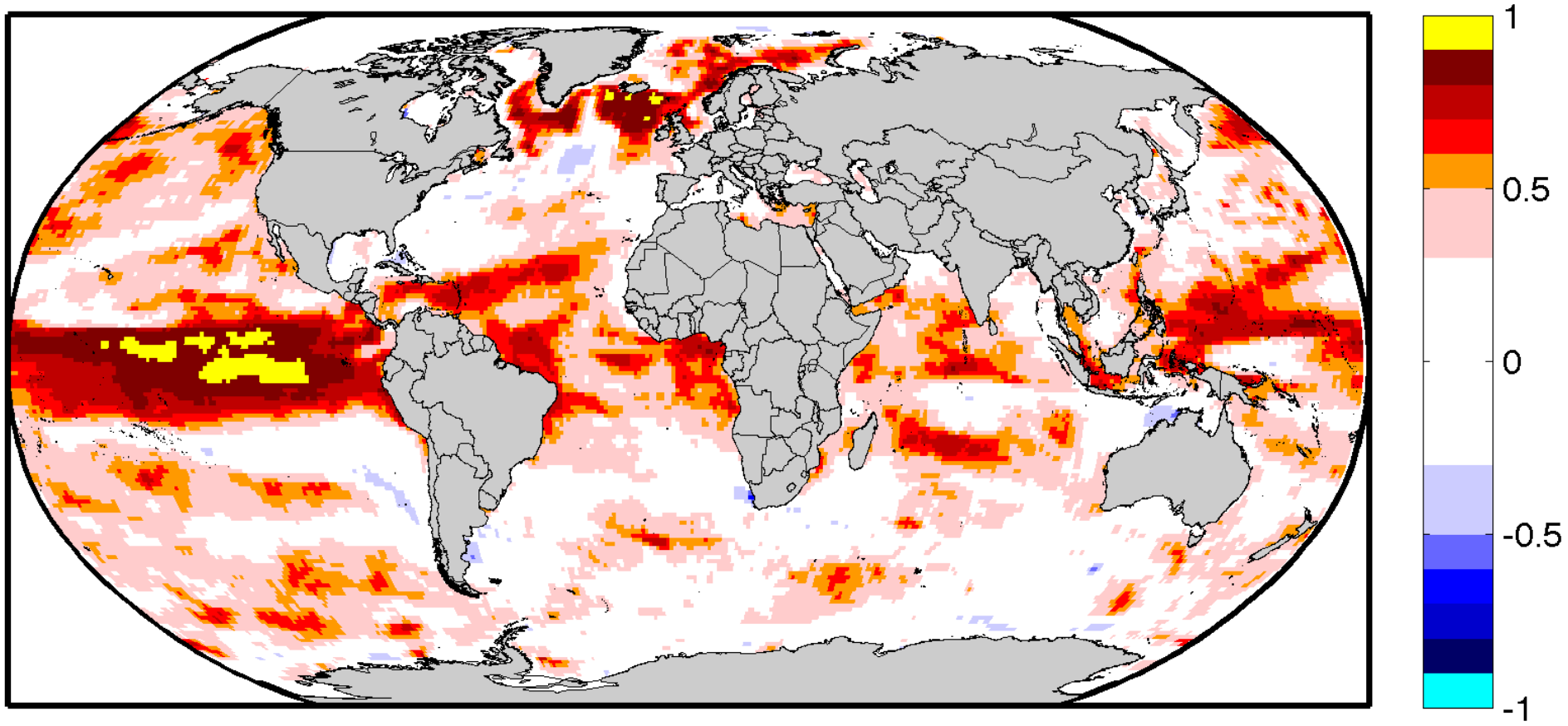

Courtesy of Stephanie Gleixner

# SST seasonal prediction skill high in Nordic Seas

Anomaly Correlation for Sea Surface Temperature with observations

Period 1985-2010, 9 ensemble members

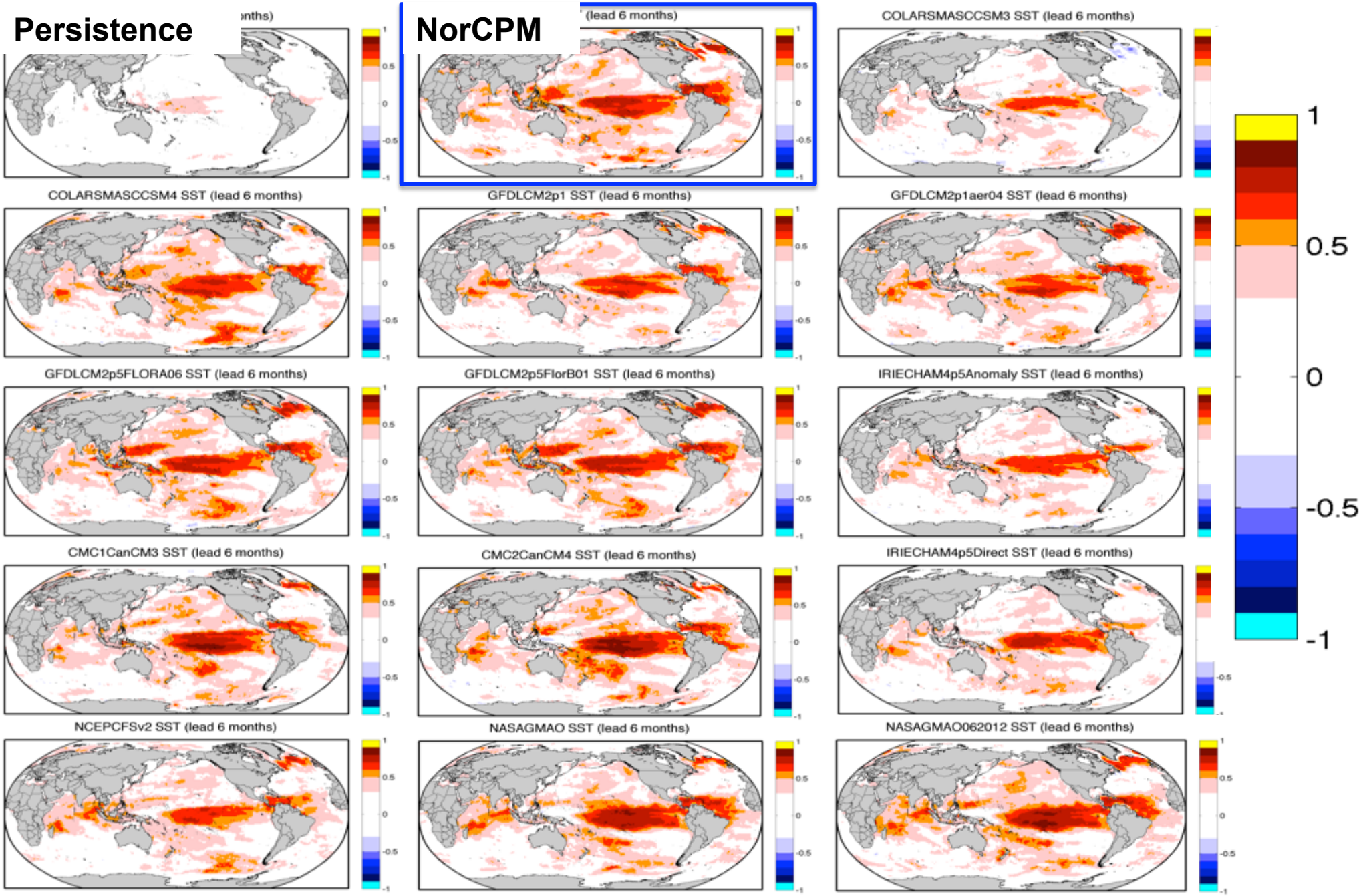
## 6-month lead from 1st of August



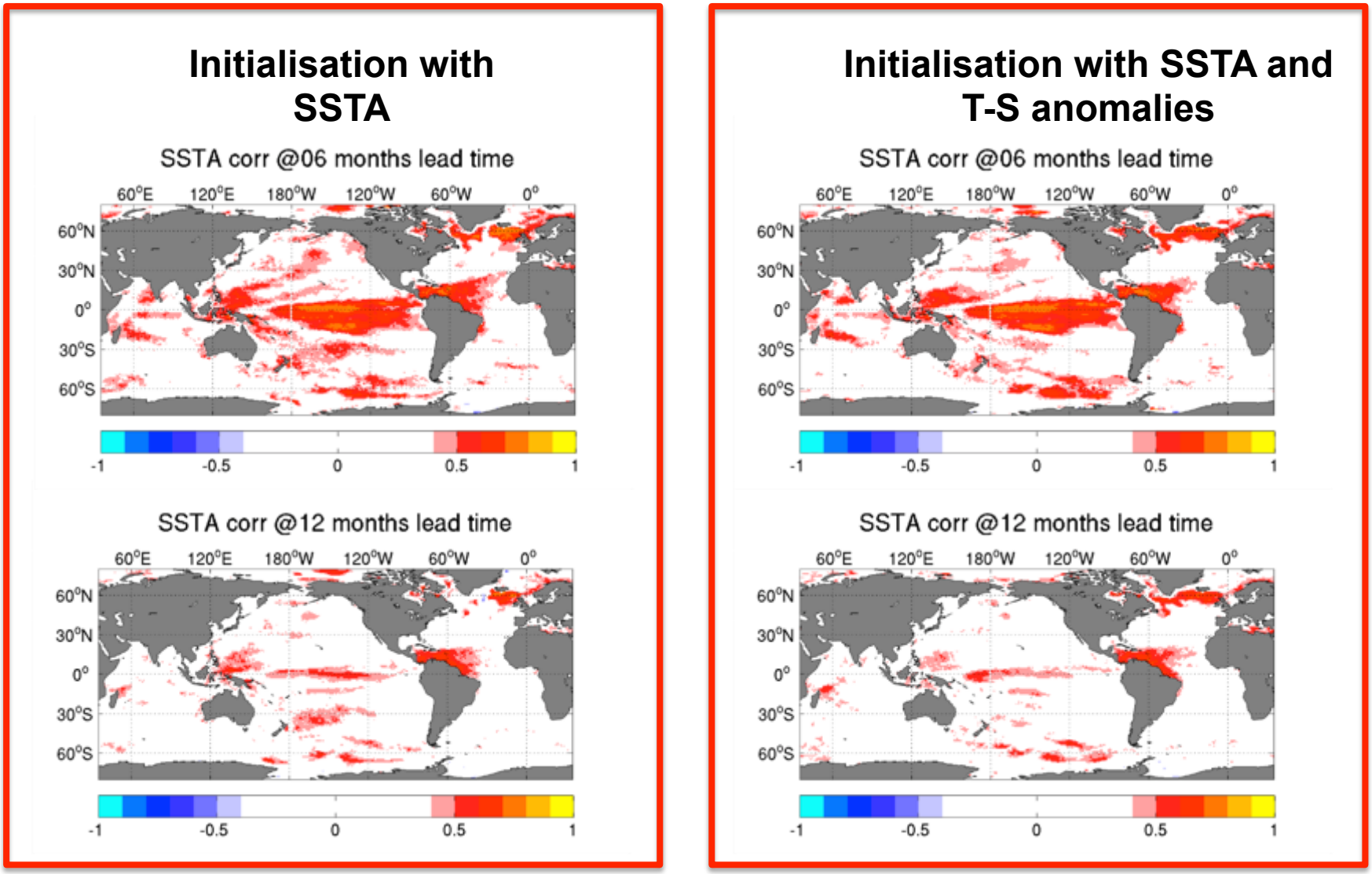

Courtesy of Stephanie Gleixner

# Anomaly correlation skill, 6-month predictions, SST

## NorCPM, North American Multimodel Ensemble



# Assessing the benefit of ocean T-S data for seasonal prediction skill

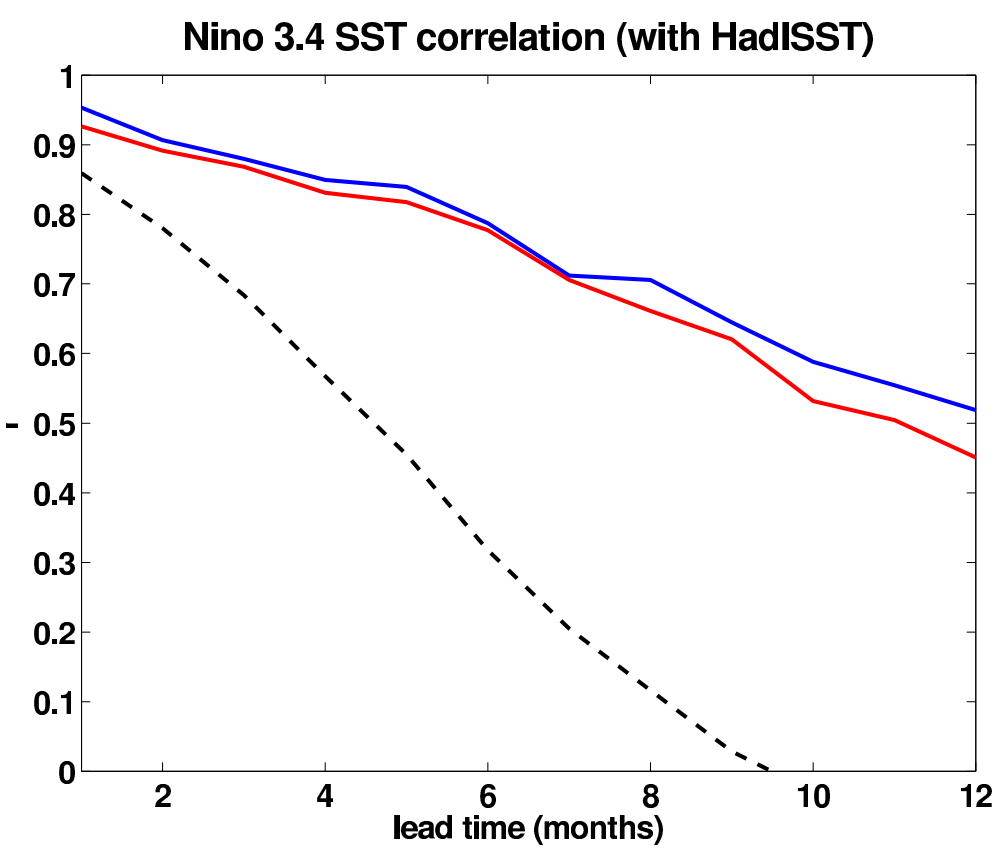



Seasonal forecast skill (currently) not improved by adding subsurface ocean temperature and salinity data

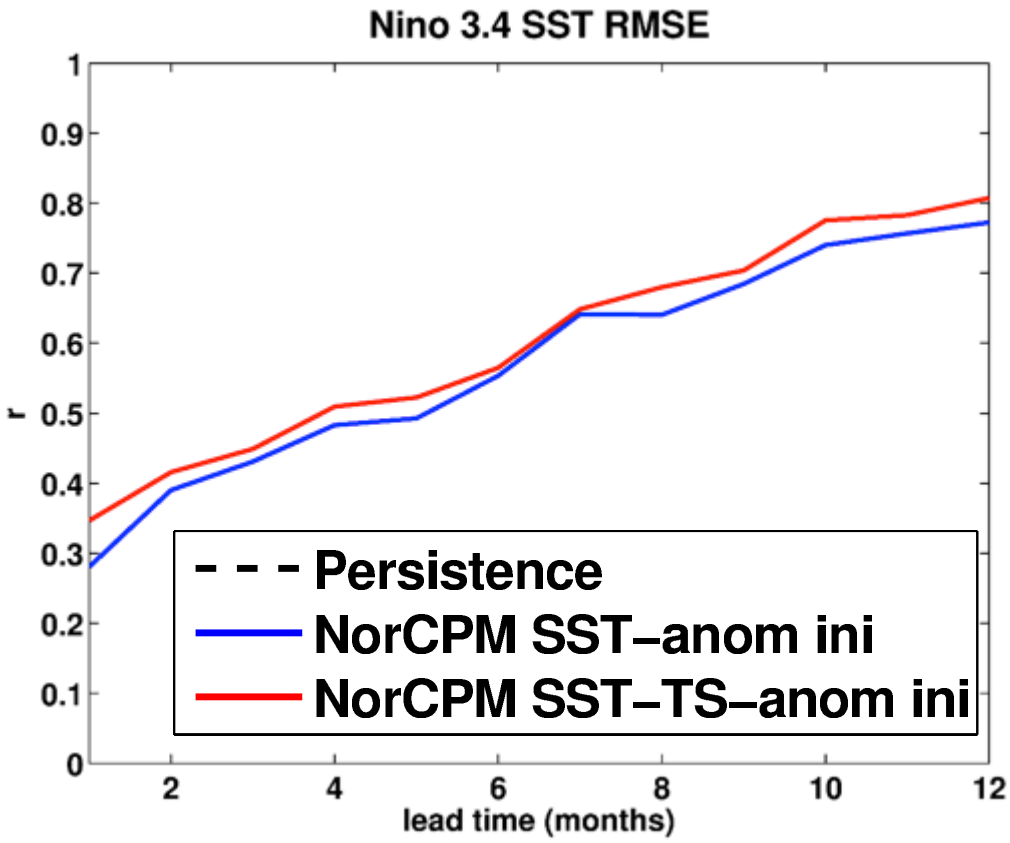
Courtesy of Yiguo Wang

# Nino 3.4 SST, 1985-2010, 4 start dates per year

## Anomaly Correlation




## Root mean square error

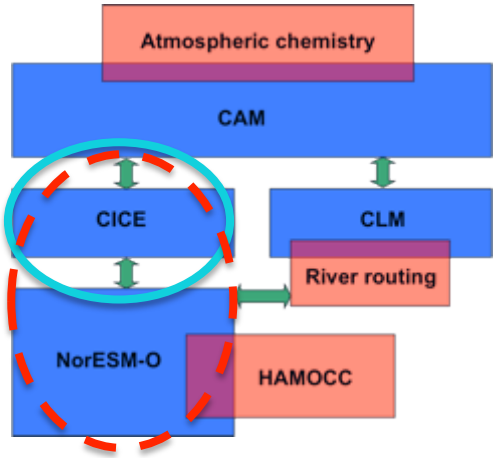



Seasonal forecast skill (currently) not improved by adding subsurface ocean temperature and salinity data

Courtesy of Yiguo Wang

# Testing assimilation of ice concentration

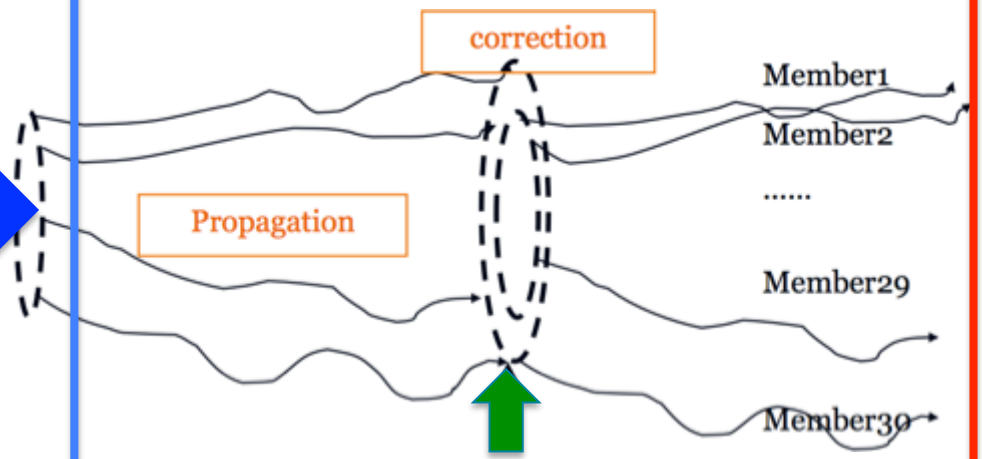
## Earth System model (NorESM)




Only ice / ice + ocean

30 members

## Data assimilation (EnKF)




V0 system :**SST**
V1 system: **SST+T-S**
V2 system: **Ice-concentration**

**Synthetic sea ice**

Monthly *aggregated ice conc. from model : NorESM at a different time (pre industr.)*

***→Future : satellite-derived SIC, thickness***

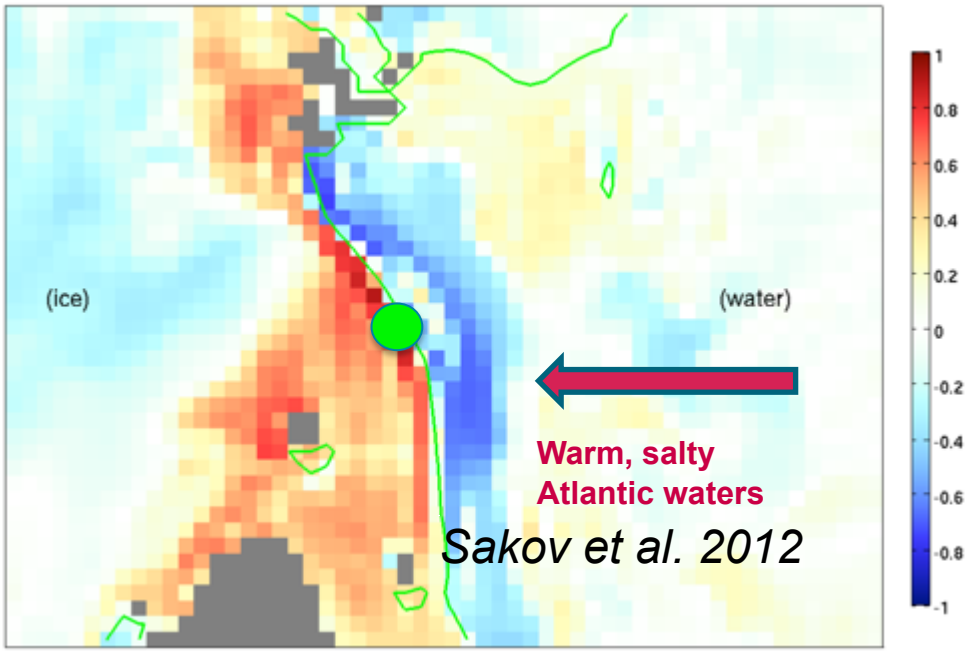
**What is the best way to assimilate this data:**

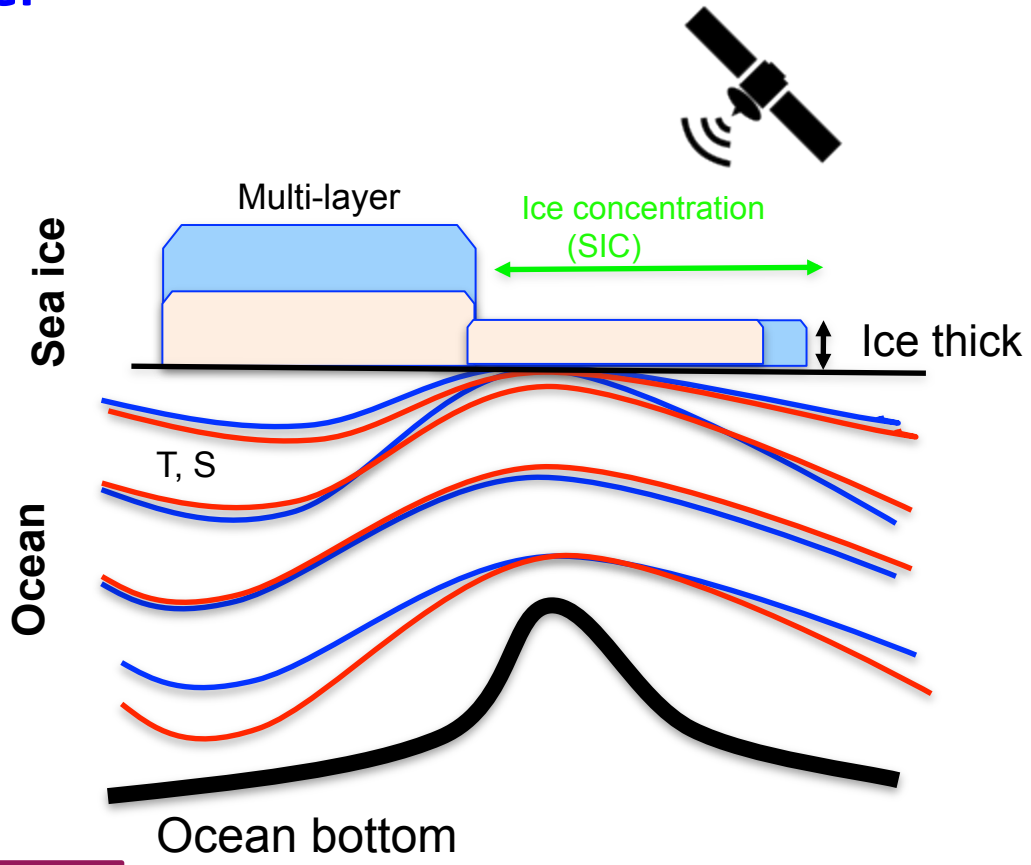
- Weakly coupled DA / Strongly coupled DA ?

(i.e assimilation with/w.o. ocean)

# Test assimilation of SIC with a fully coupled system (ocean-sea ice) (i.e. strongly coupled data assimilation) and with a multi-category sea ice model

Correlation between ice concentration at green dot and sub-surface Salinity




**Strong coupled DA** :

- ✓ SIC, thick, and thermos in every category
- ✓ T and S in the mixed layer depth

Ensemble KF : handle the flow-dependent and strongly anisotropic cross-covariance between ocean and sea ice

*Lisæter et al. 03*

Courtesy of F. Counillon, M. Kimmritz, Y Gao

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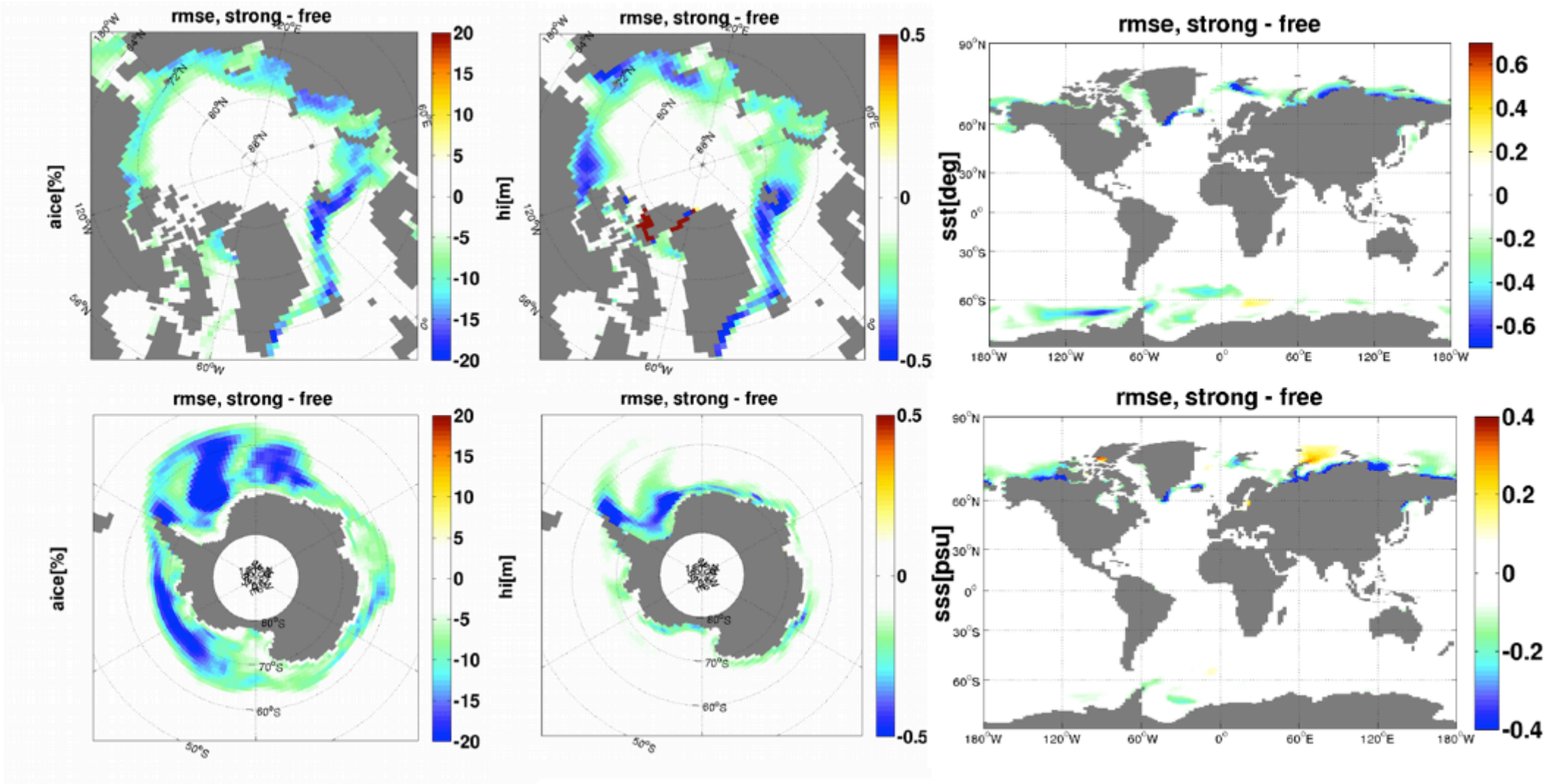
# What do we gain by assimilating ice concentration compared to a free ensemble run

Mean RMSE reduction compared to FREE over 10-year reanalysis

SIC

thickness




Blue means improvement !

Courtesy of F. Counillon, M. Kimmritz, Y Gao

# Norwegian Climate Prediction Model (NorCPM) : used in SNOWGLACE

**Seasonal hindcasts (3 months)**

Land: **land model (CLM) off-line run**
Atmosphere: **nudging period with ERAINT**
Ocean & sea ice: **NorCPM re-analyses**

Also : High top (WACCM) : 140 km (full stratos chemistry)

## YOPP Proposal submitted

**SUBSEASONAL-TO-SEASONAL PREDICTION FOR THE ARCTIC**

**(S2S-ARCTIC)**

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**Jun Inoue, National Institute of Polar Research, Japan**

**Francisco Doblas-Reyes, Barcelona Supercomputing Centre, Barcelona, Spain**

**Cecilia Bitz, Univ. of Washington, Seattle, USA**

**Daniela Domeisen, ETH Zurich, Switzerland**

# Conclusions

- Weakly coupled data assimilation of SST anomalies using EnKF has potential for skilful long-term reanalysis (1850 to present) in the North Atlantic, North Pacific, and Tropical Pacific.
- NorCPM with only SST achieves competitive skill in seasonal predictions compared to NMME systems.
- (decadal prediction) good skills up to 3-4 years for S2D, with degradation beyond due to model limitation in east subpolar gyre

- Ongoing development for assimilation of ice concentration tested in idealised experiment: it is best to update the multicategory sea ice & ocean (Strongly coupled DA) with flow dependent covariance (EnKF)
  - Assimilation of ice concentration reduces substantially error in thickness, and ocean T & S without introducing a drift

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# RESERVE SLIDES

# SLP in winter

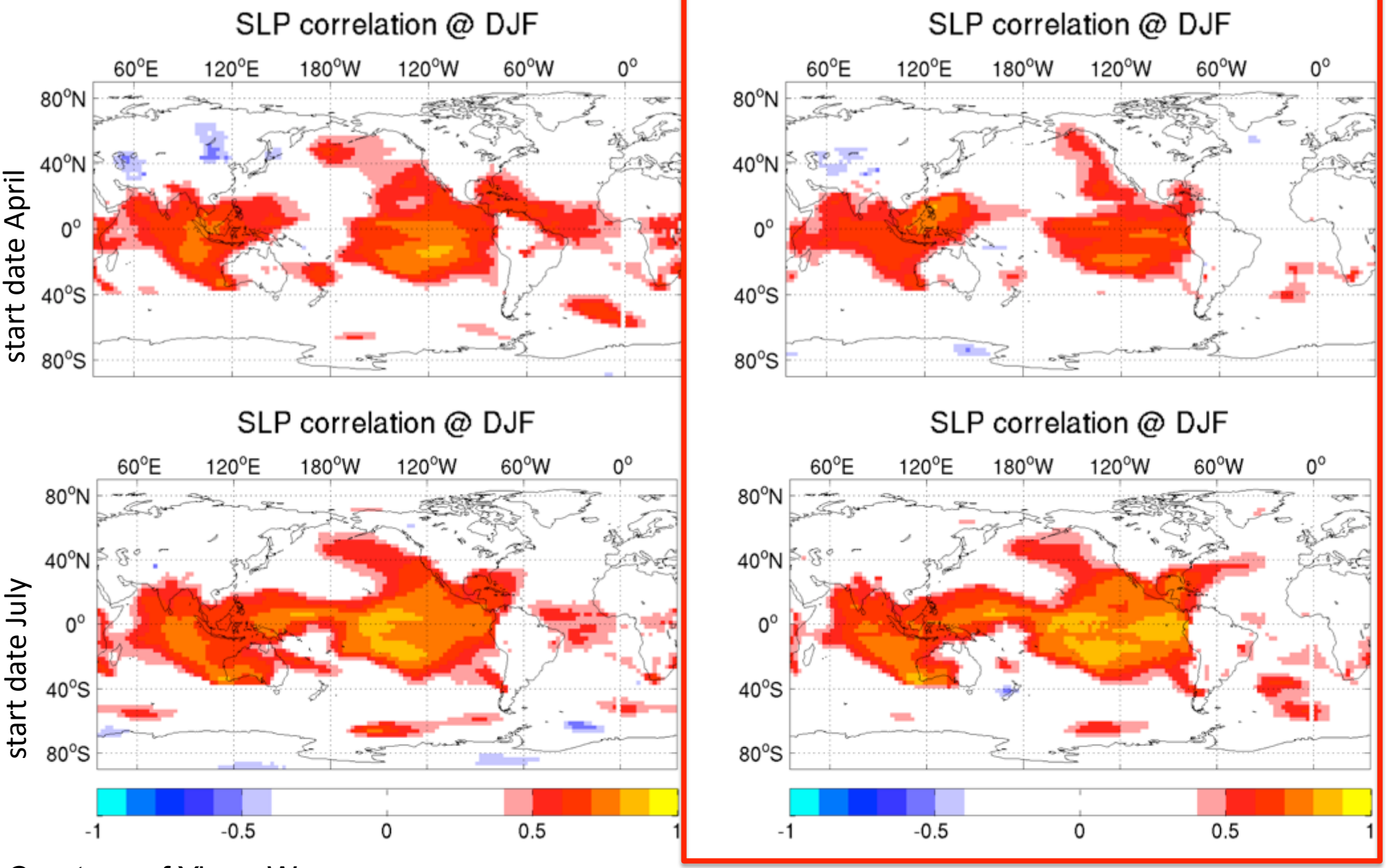
Anomaly Correlation (NCEP) 1985-2010

**Initialisation with SSTA**

**Initialisation with SSTA, T-S A**

start date April

start date July




Courtesy of Yiguo Wang

# Anomaly correlation skill, 6-month predictions, SST

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