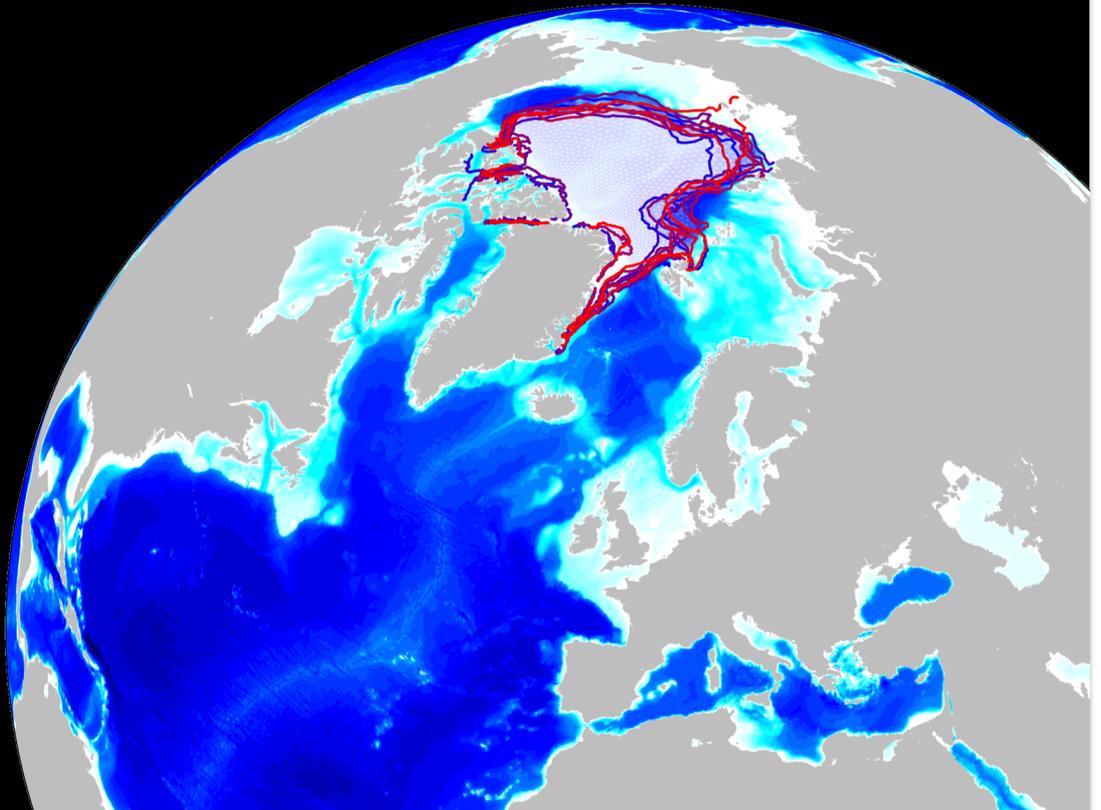


Seamless prediction systems prove potential for skillful Arctic sea-ice forecasts far beyond weather time scales

IUP Seminar
Bremen, May 4th, 2018

Lorenzo Zampieri
Alfred Wegener Institute



Predictability and ensemble forecasting

Research Motivation

The S2S Prediction Project

Verification metrics

Predictive skills

Dynamical models vs Climatology

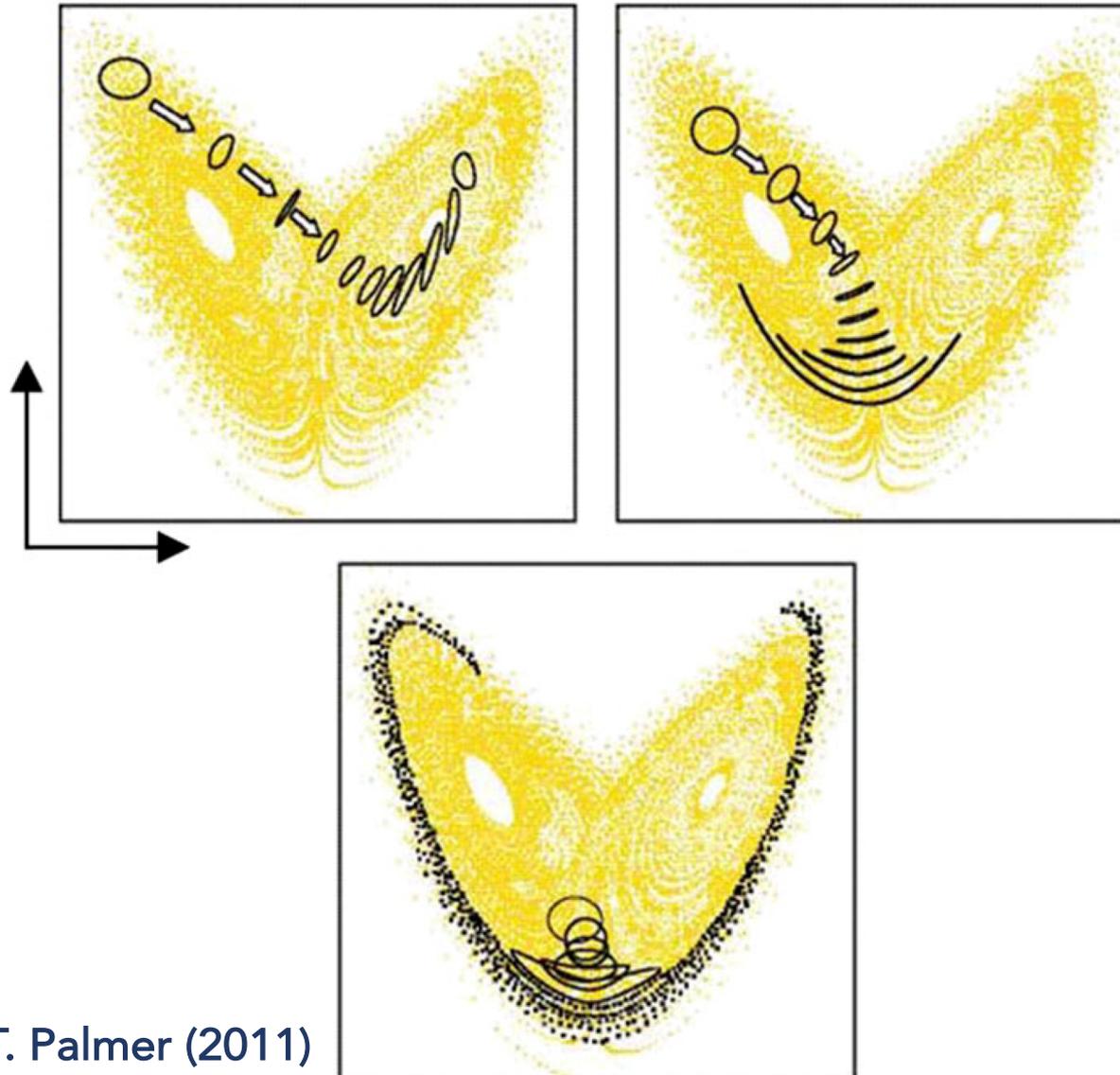
Predictability and Ensemble Forecasting

A simple set of equations...

$$\left\{ \begin{array}{l} \frac{dX}{dt} = -\sigma X + \sigma Y \\ \frac{dY}{dt} = -XZ + \rho X - Y \\ \frac{dZ}{dt} = XY - \beta Z \end{array} \right.$$

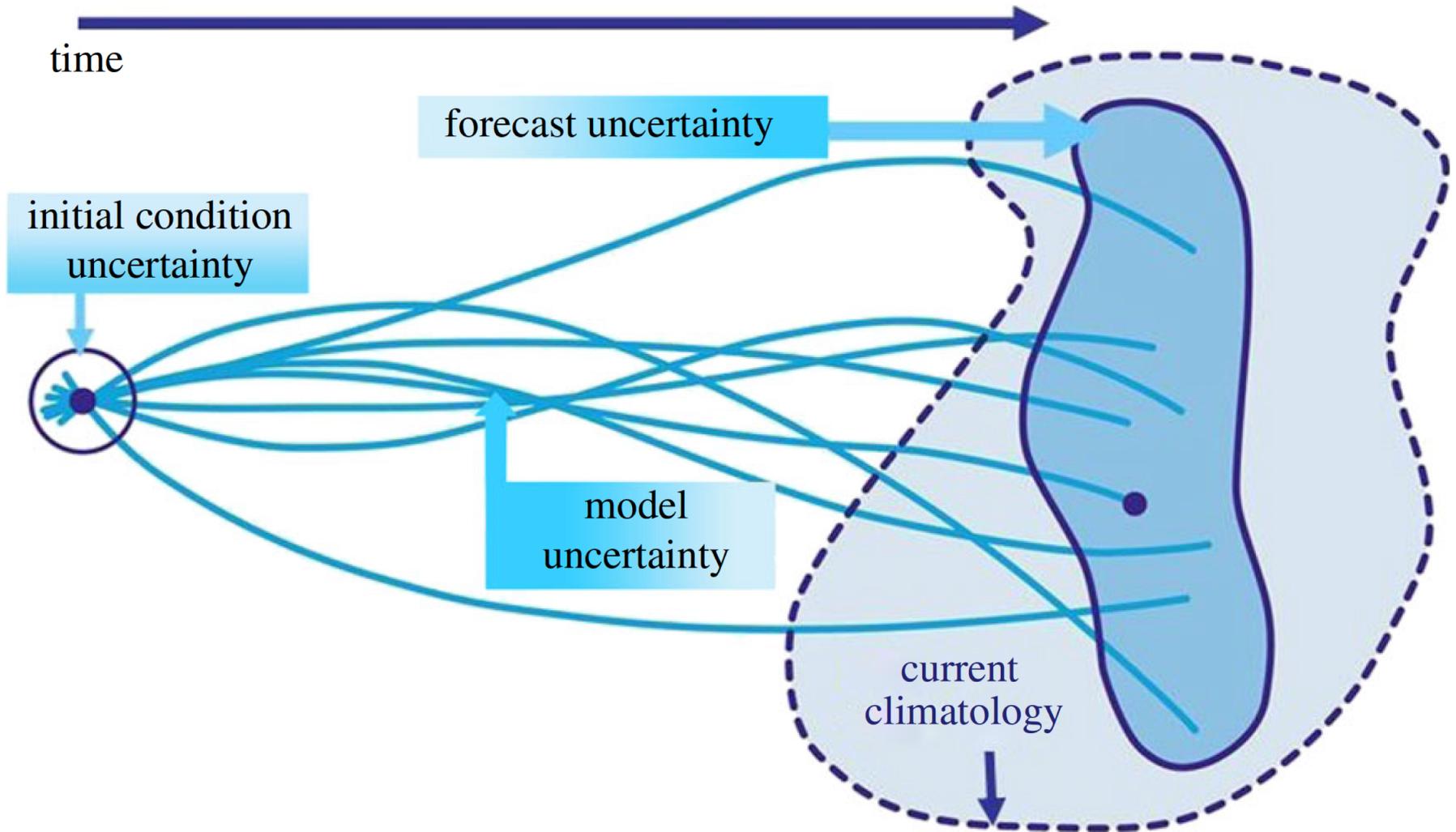
Lorenz, E. N. (1963) Deterministic nonperiodic flow.

...with an interesting solution



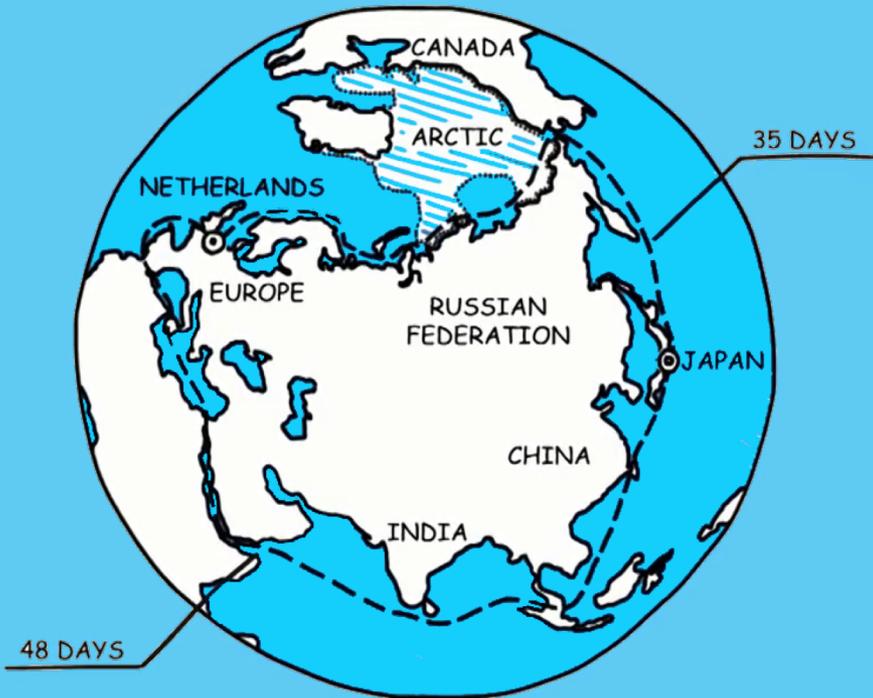
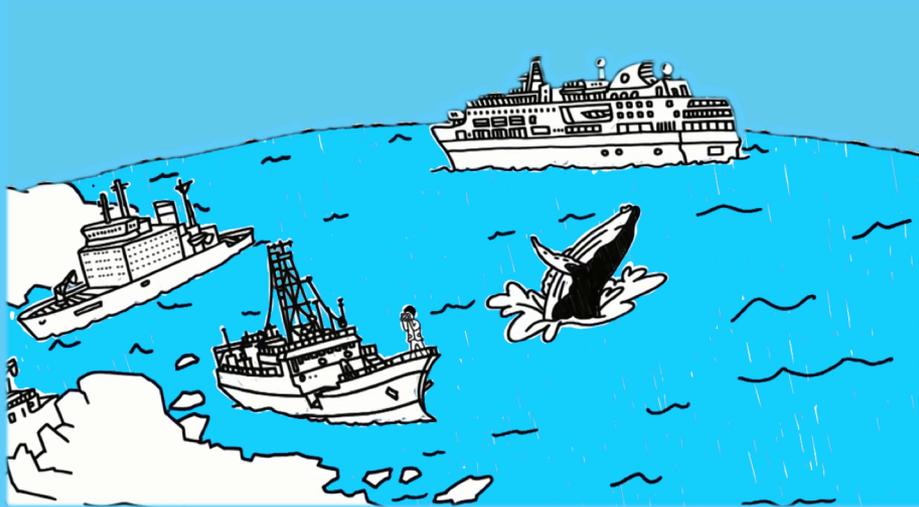
J. Slingo and T. Palmer (2011)

Ensemble Forecasting



J. Slingo and T. Palmer (2011)

Research Motivations



Images from the YOPP Promotional Video

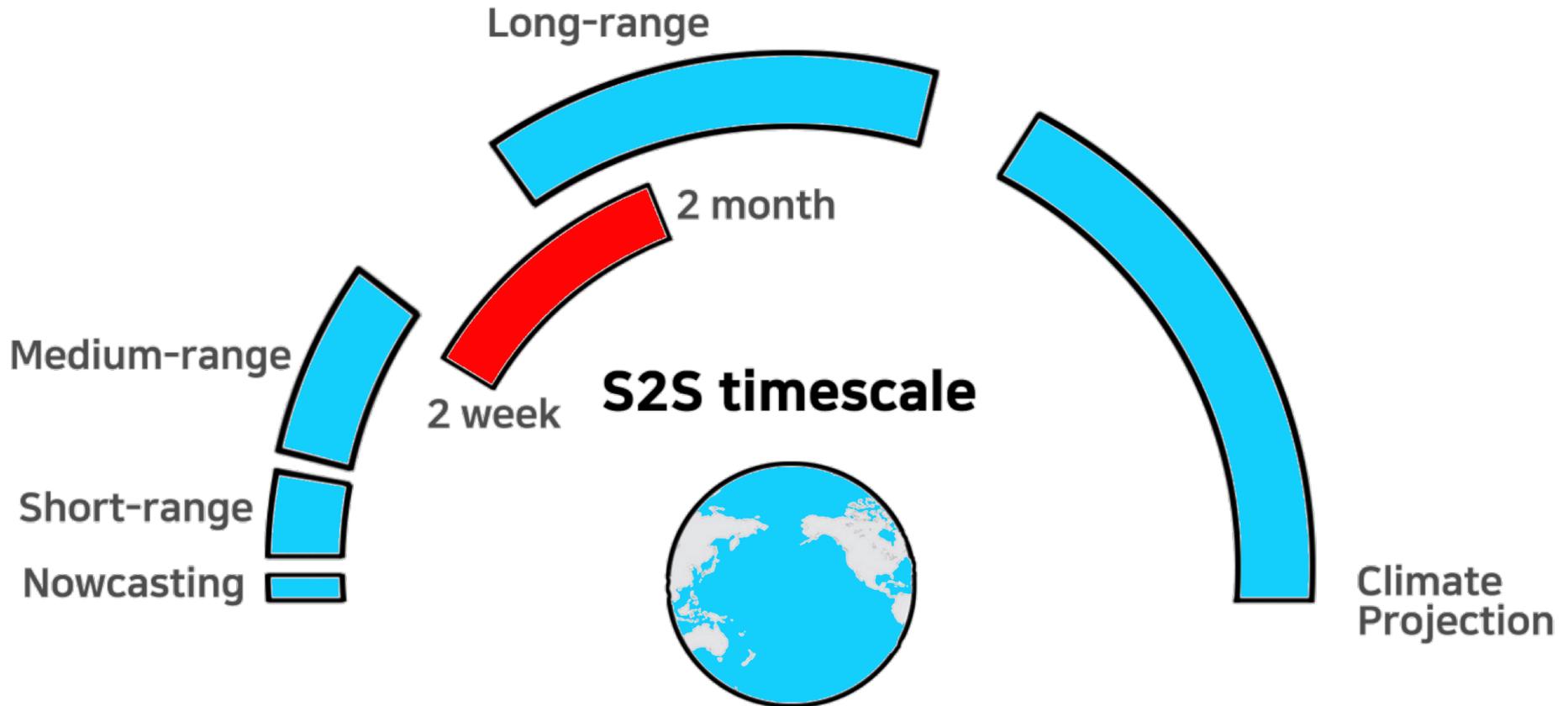


Images from the YOOP Promotional Video

S2S

Sub-seasonal to Seasonal Prediction Project

The S2S timescale



Prediction forecast timescale

Image from the S2S Promotional Video

The S2S Database



- Coupled models from operational weather forecast centers

UK Met Office
ECMWF

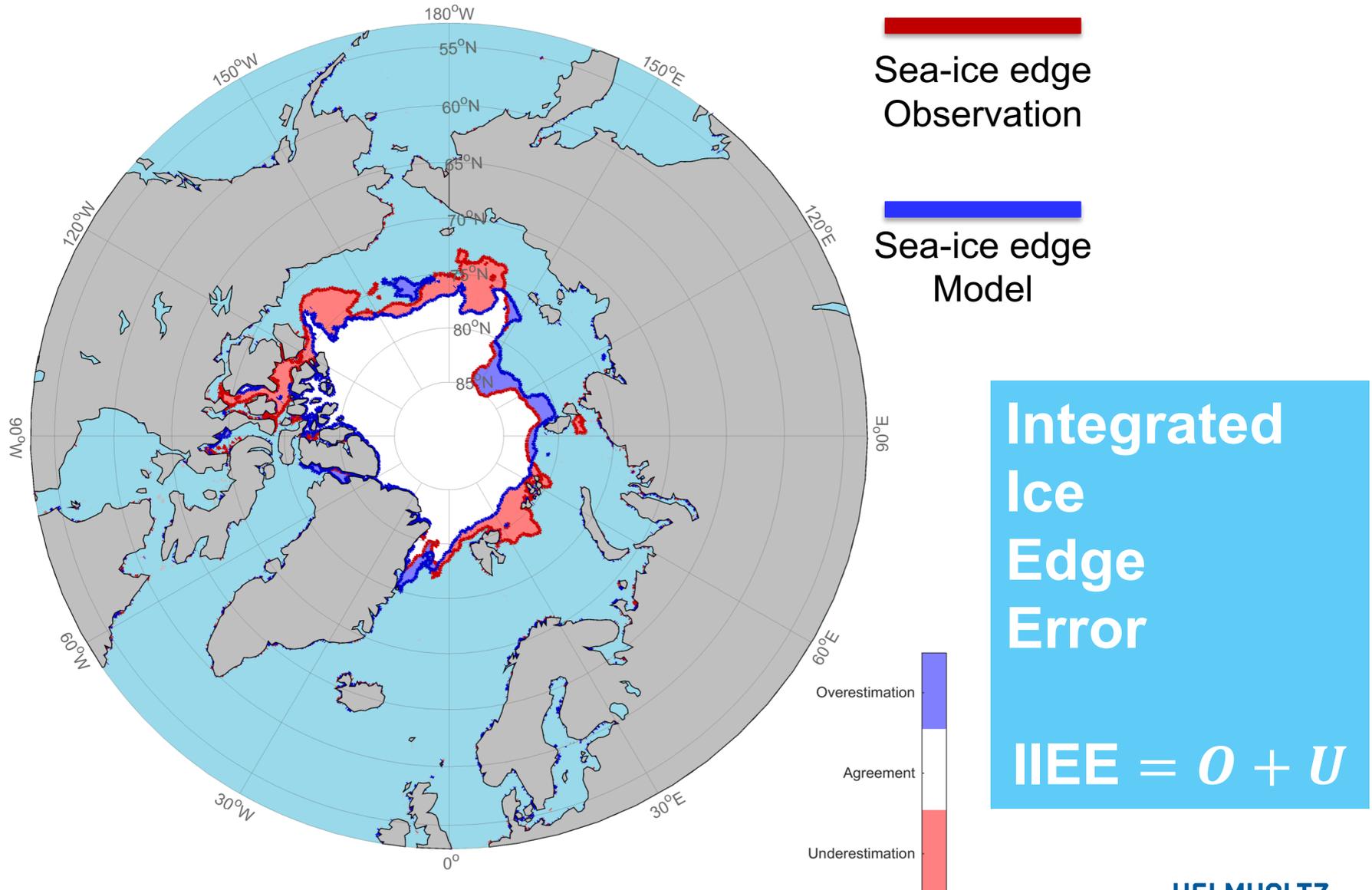
KMA
CMA

Météo France
NCEP

- Ensemble forecasts
- Dynamical sea ice components
- Assimilated sea surface temperature and sea-ice concentration
- Long temporal coverage (25 years)

Verification Metrics

The sea-ice edge position



The Spatial Probability Score

Ensemble sea-ice forecasts



Probabilistic verification metric required

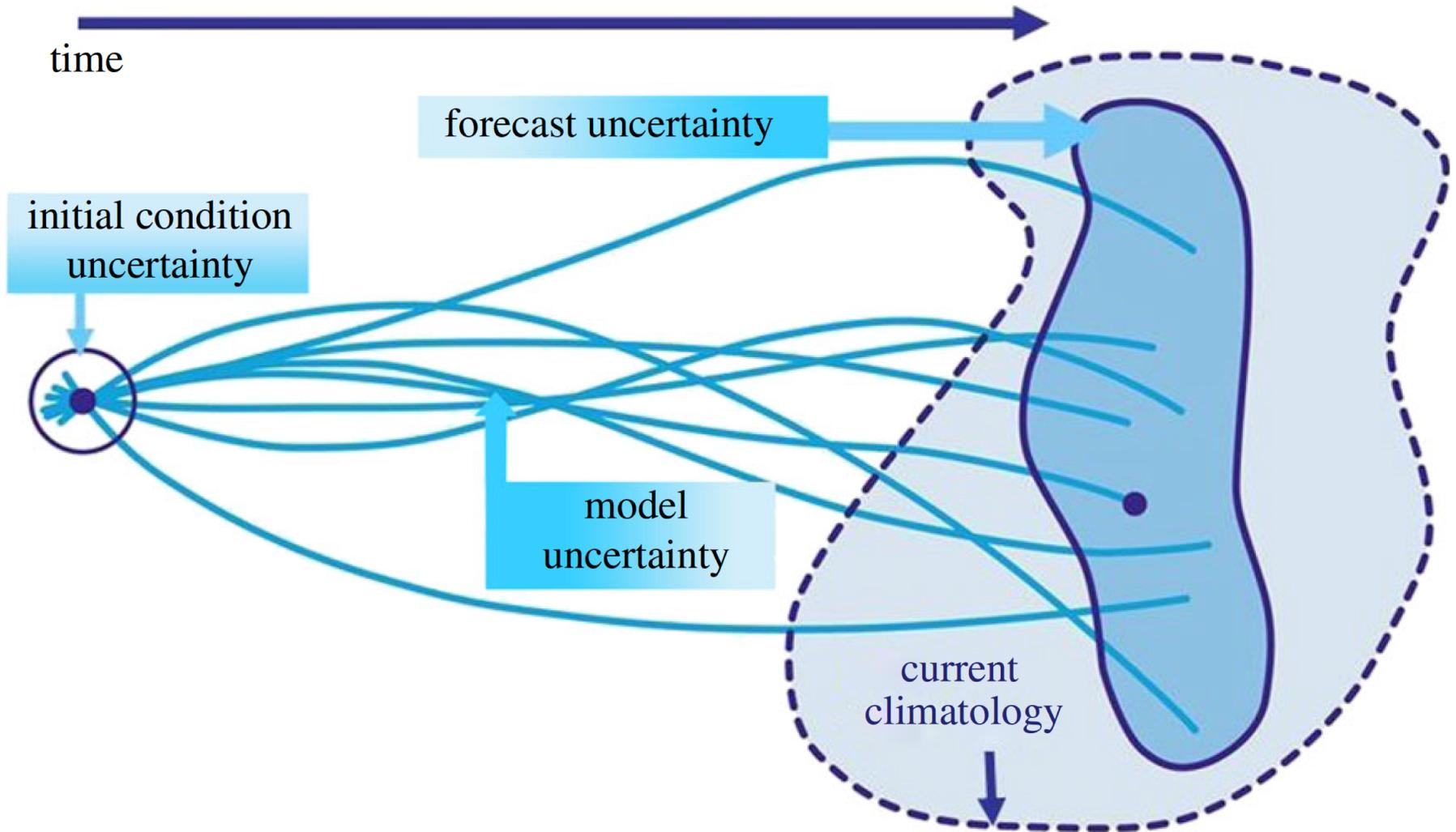
Spatial Probability Score

$$SPS = \iint_A (p_f - p_o)^2 dA$$

Spatial Probability Skill Score

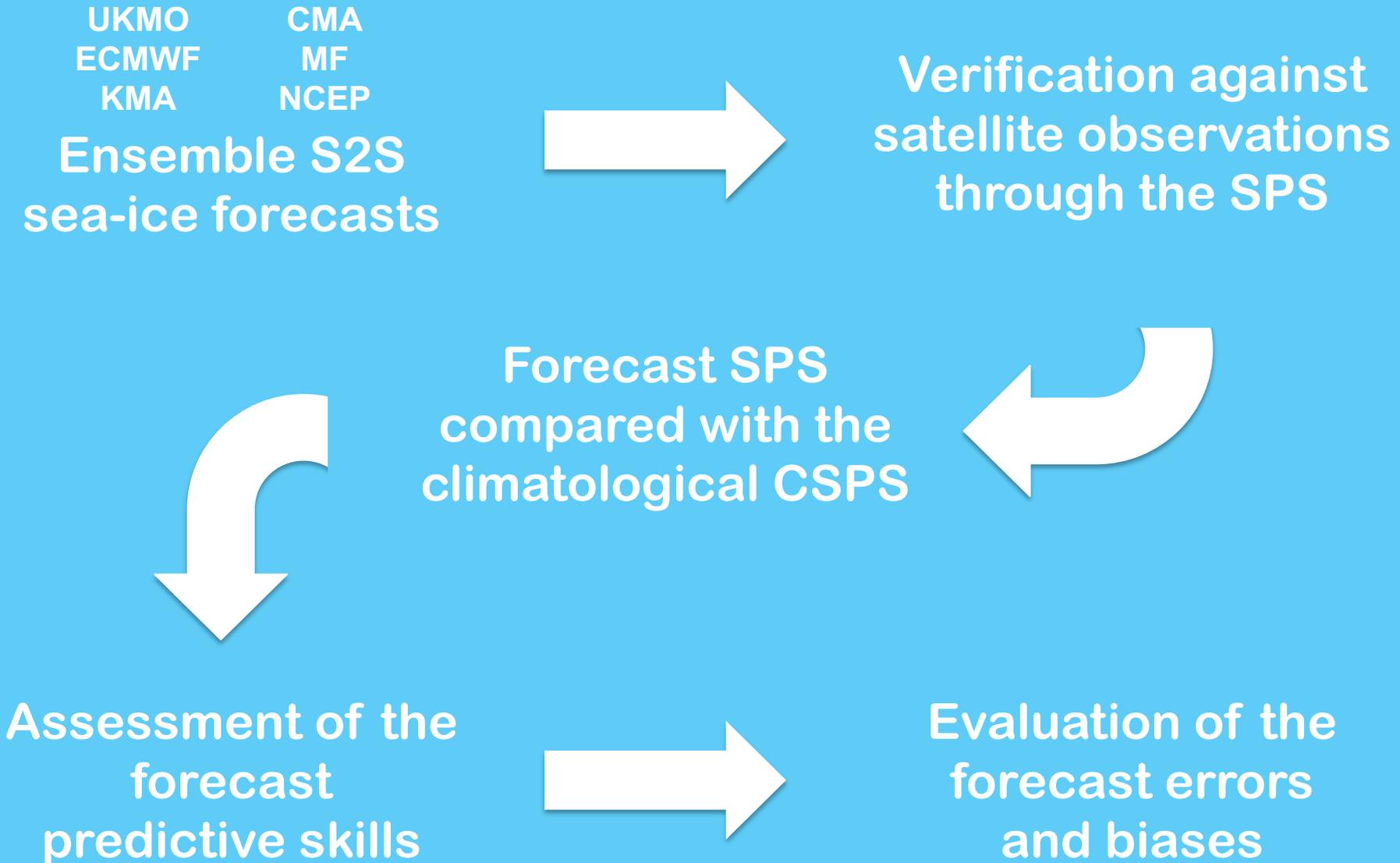
$$SPSS = 1 - \frac{SPS}{SPS_{CLIM}}$$

Ensemble Forecasting

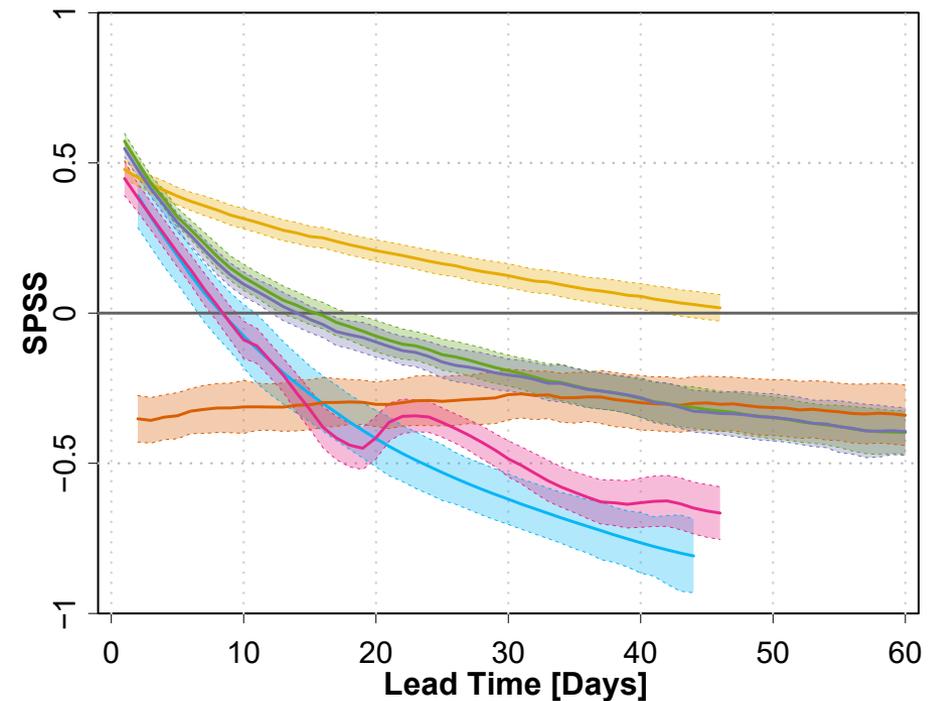
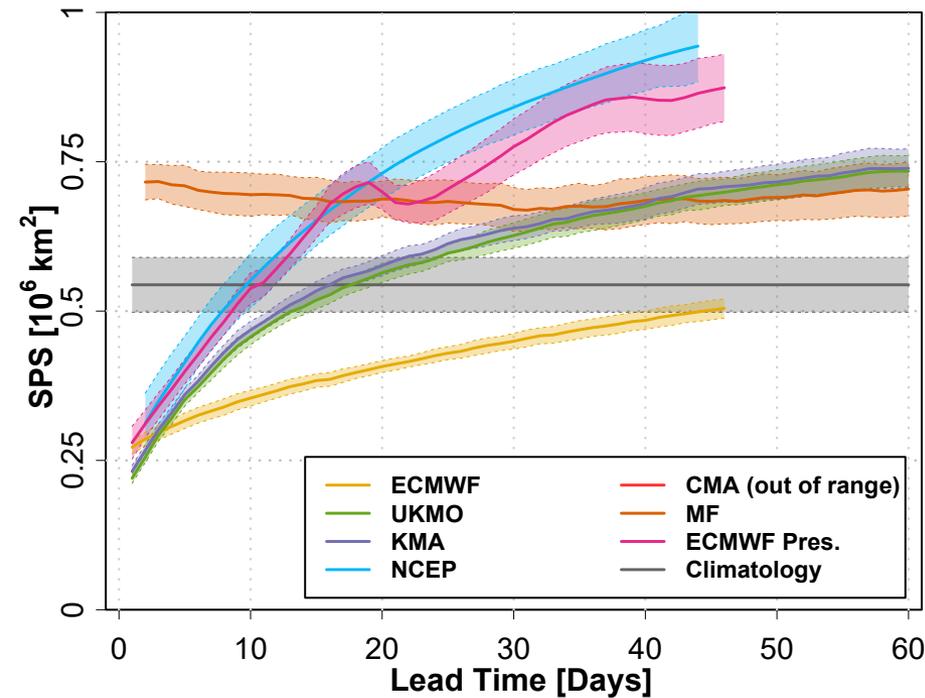


J. Slingo and T. Palmer (2011)

Methods Summary

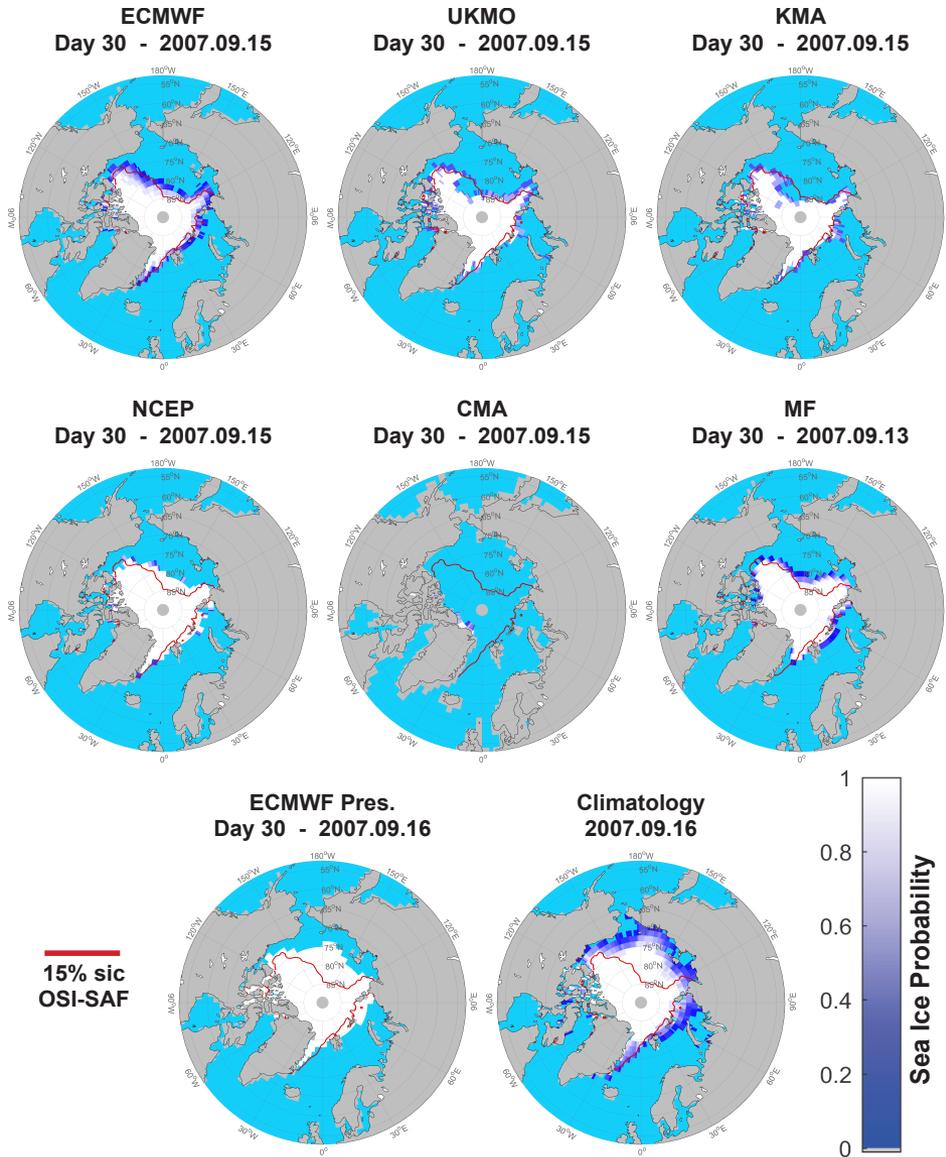


Skills of S2S forecast systems

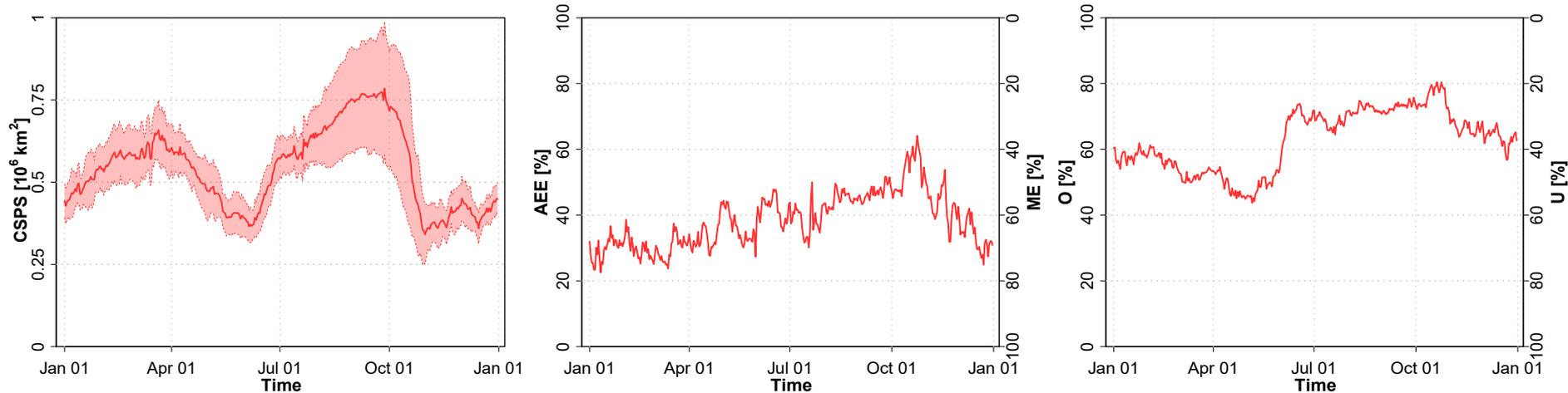


Results averaged over **12 years**
of hindcasts (**1999-2010**)

Forecasting the 2007 minimum



The CSPS seasonal cycle



Skills of the climatological forecasts based on the previous 10 years of observations

15/09/2007 forecast is based on:

15/09/1996, 15/09/1997, ... , 15/09/2006



ECMWF & UKMO

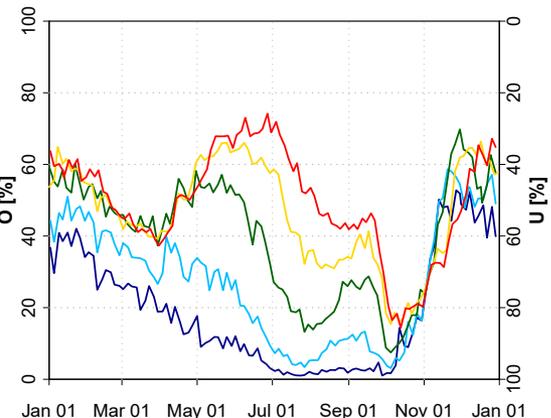
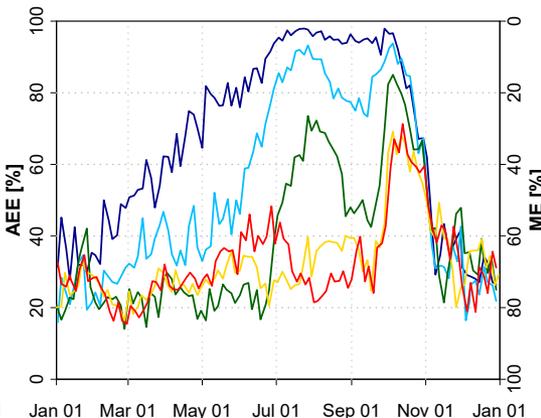
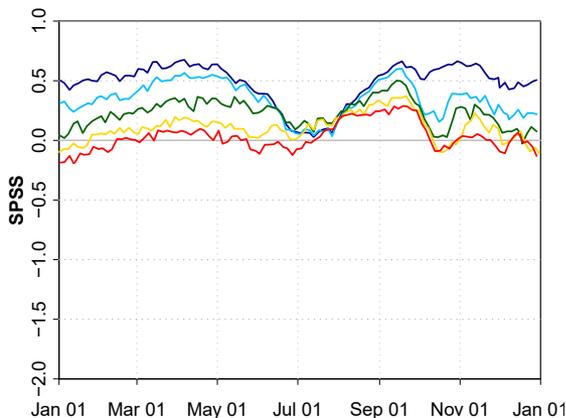


SPSS

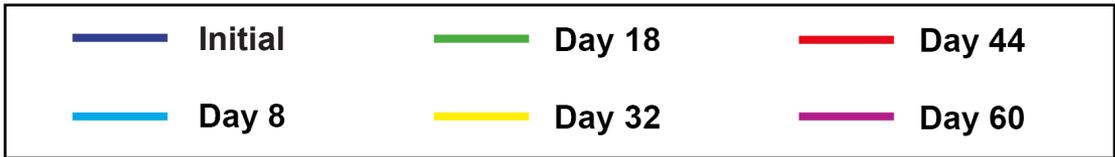
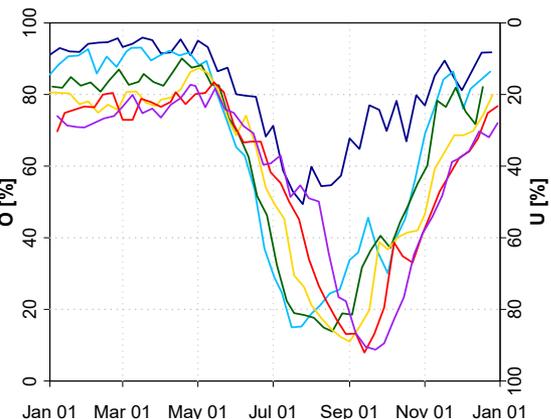
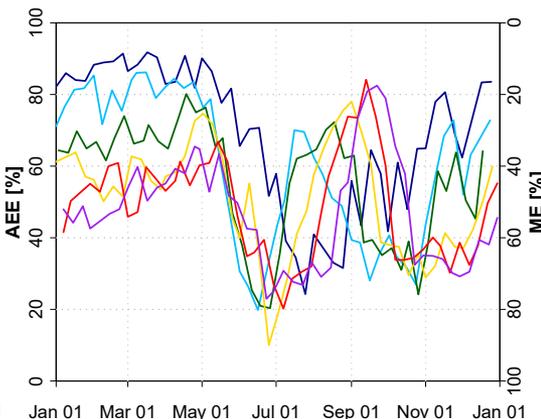
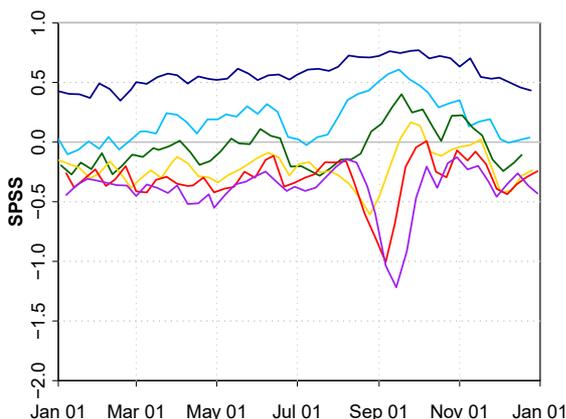
AEE and ME

O and U

ECMWF



UKMO





CMA & Météo France

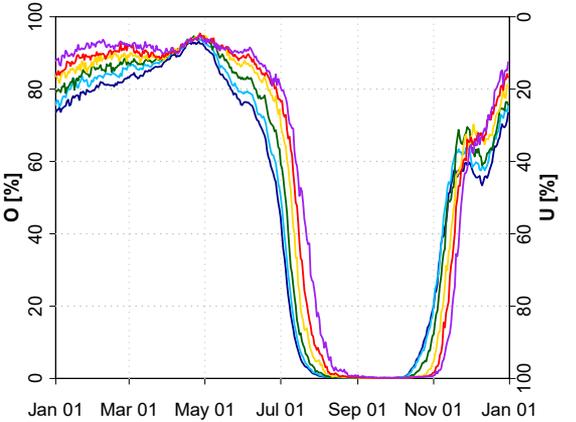
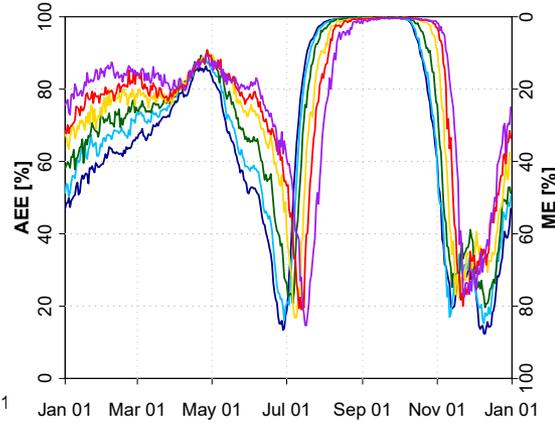
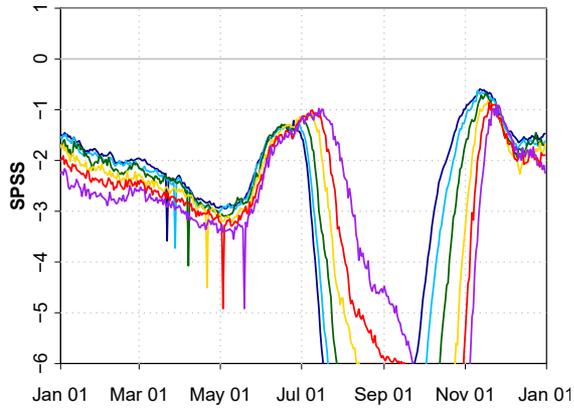


SPSS

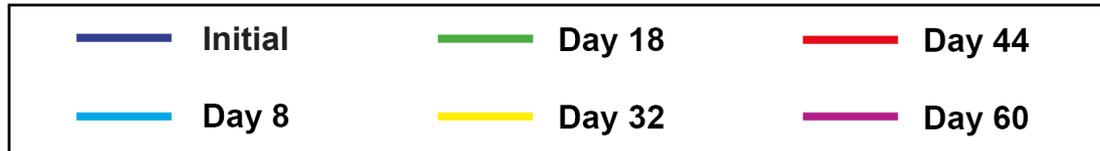
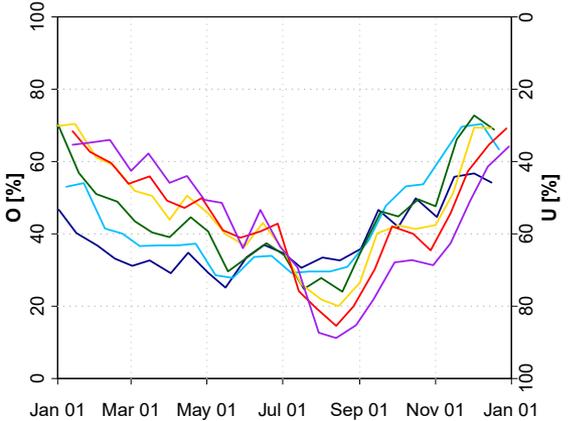
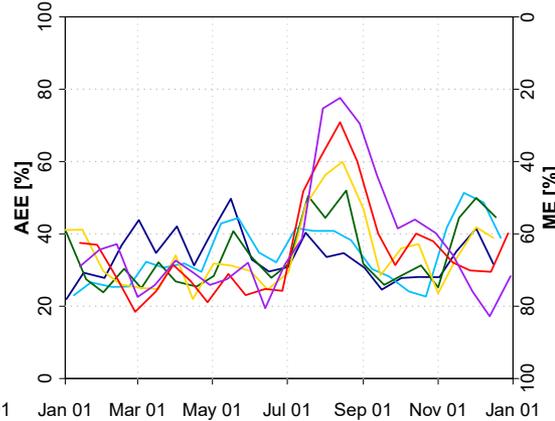
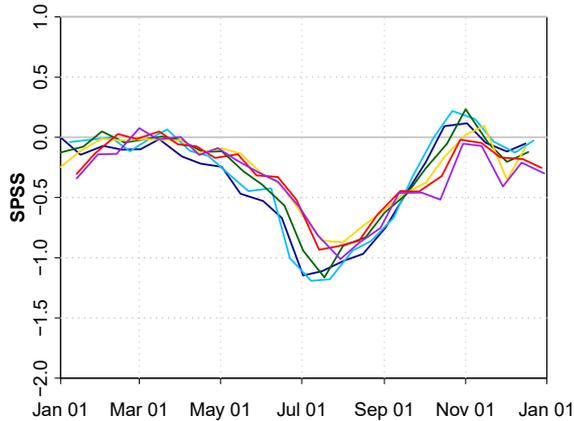
AEE and ME

O and U

CMA



MF



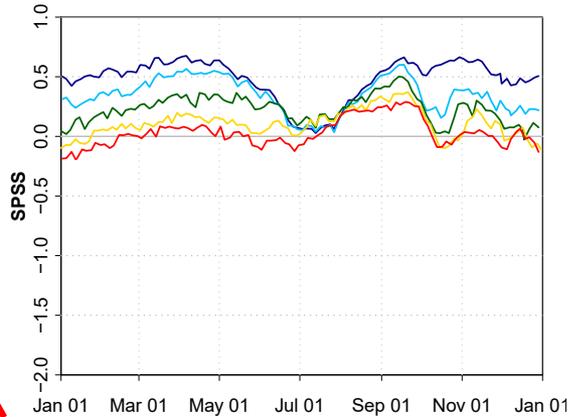
Improvements in ECMWF system



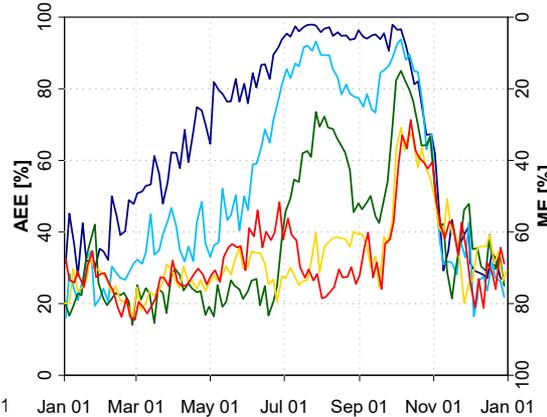
NEW!

ECMWF

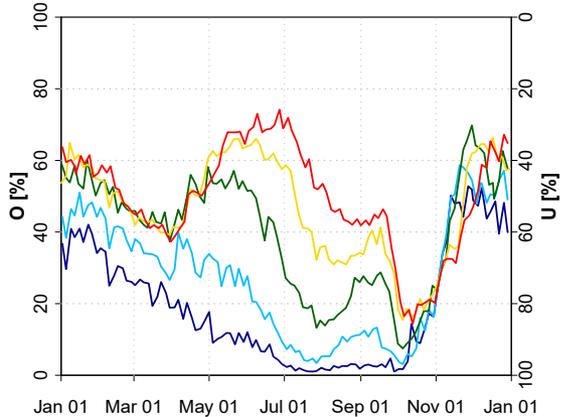
SPSS



AEE and ME

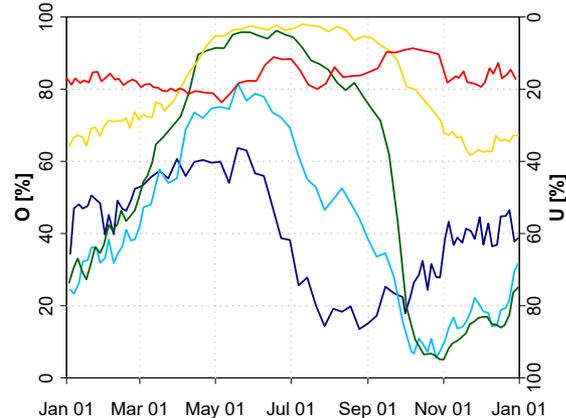
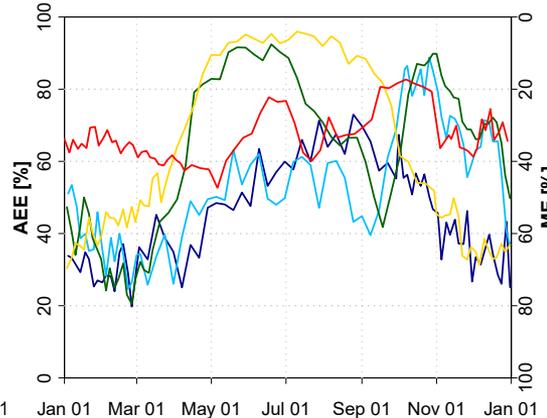
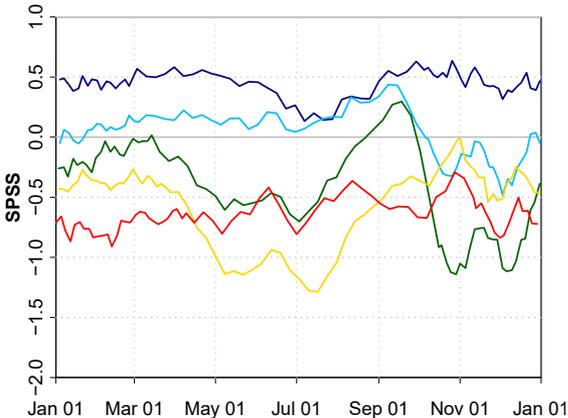


O and U

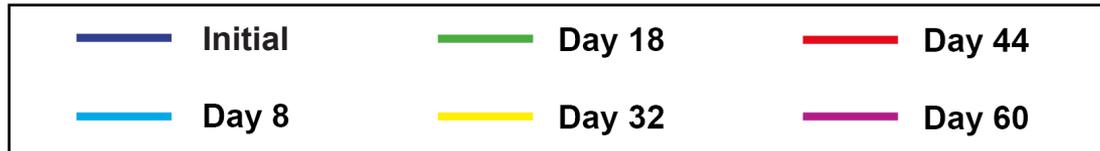


OLD!

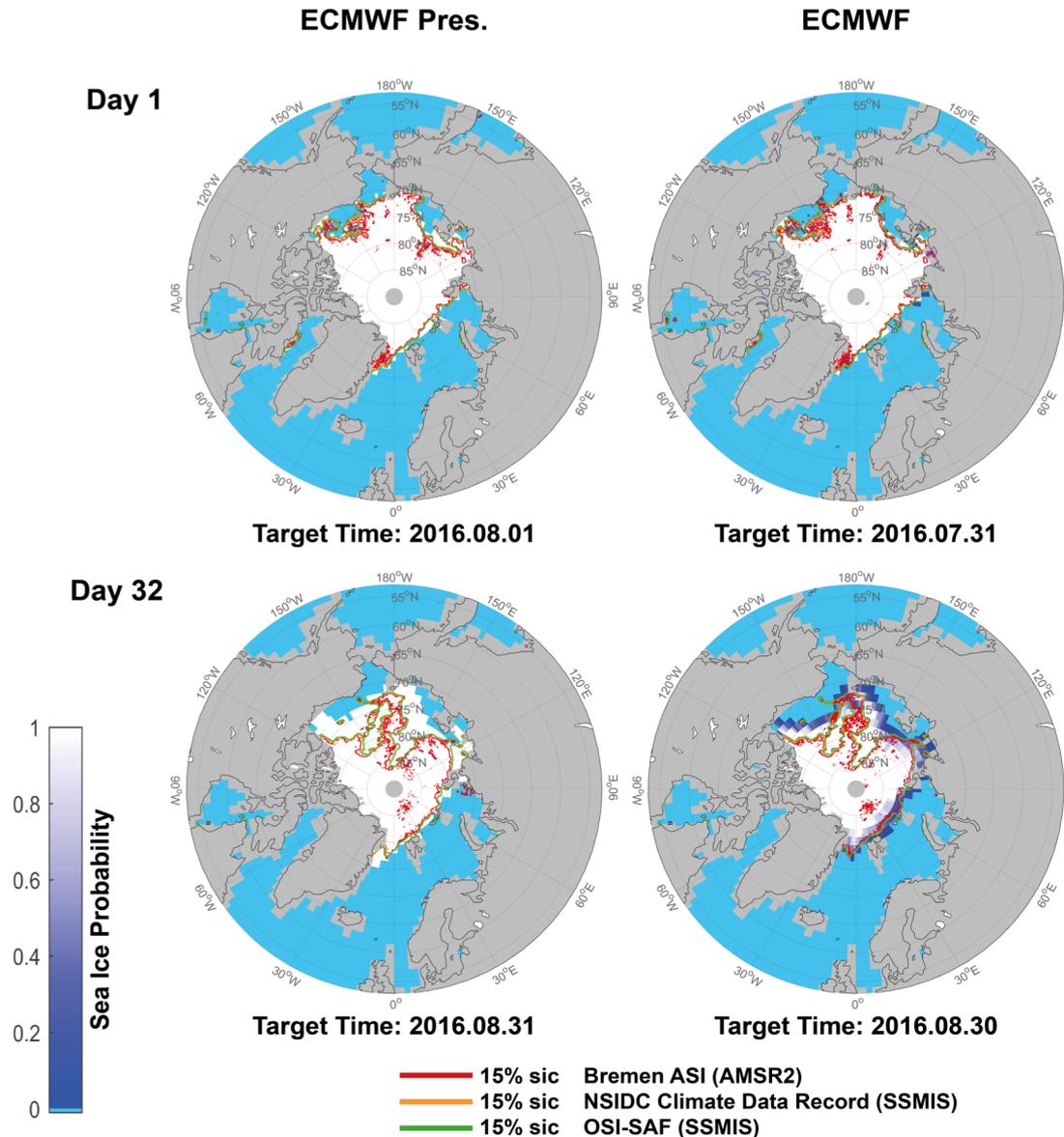
ECMWF Pres.



Target Time



Improvements in ECMWF system



- Spread of predictive skills between different forecast systems
- Errors during the data assimilation and relevant model biases affect the forecasts
- Lack of model tuning
- The ECMWF system shows encouraging results. Predictive skills after 46 days.
- Assimilation of new sea-ice thickness observations could be beneficial