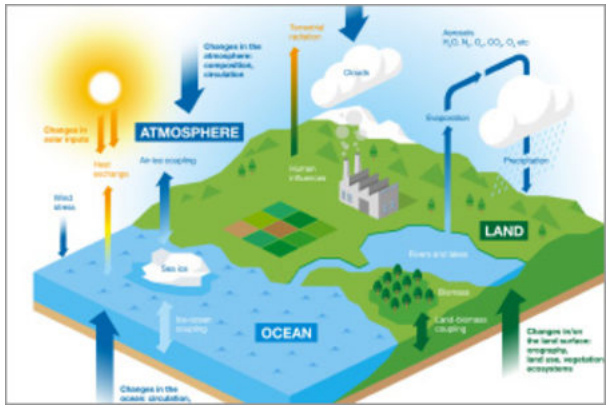
ECMWF updates

The ECMWF research activity is in several areas. The main focus is to improve the operational forecasts from the medium to seasonal ranges.

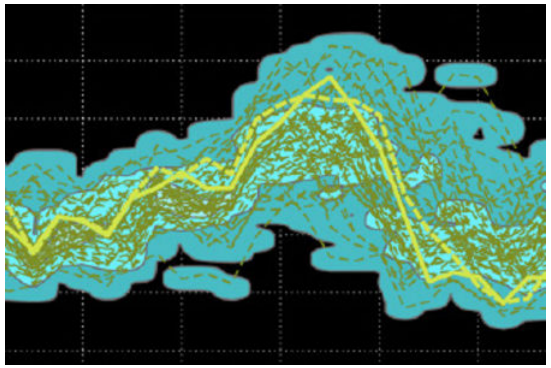
Earth System modelling



Reanalysis

Data assimilation

Predictability



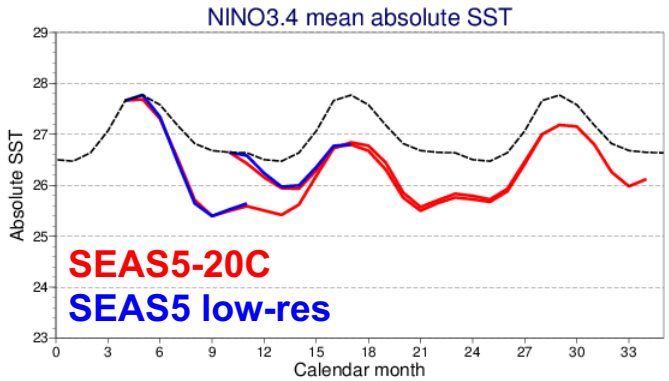
SEAS5-20C: Biennial (24-month long) hindcasts for the 20th Century

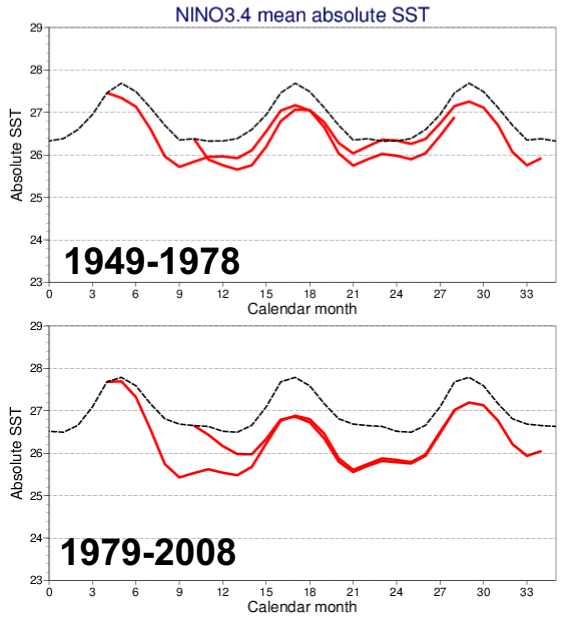
Motivation

- Can we predict ENSO beyond one year?
- Has the model climate converged after 2 years?
- Given the pronounced multi-decadal variability in seasonal forecast skill in the extratropics, how does the predictability of ENSO vary throughout the 20th Century?

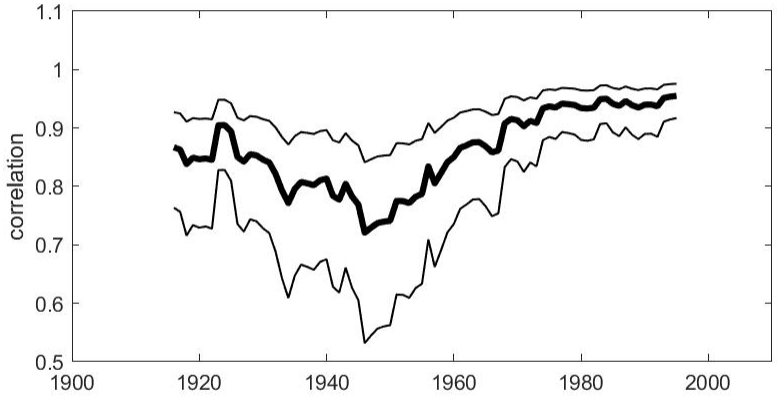
Experiments

- Coupled hindcasts initialised from coupled 20th Century reanalysis CERA-20C from 1901 to 2010
- SEAS5 low-res model resolution: T_{co}199L91 (ca. 50km) with ORCA1Z42 (1 degree)
- 24-month forecasts with 10 ensemble members
- additional experiments to test sensitivity to ocean initial conditions





Multi-decadal variability of seasonal forecast skill of the SOI
(30-year moving window)

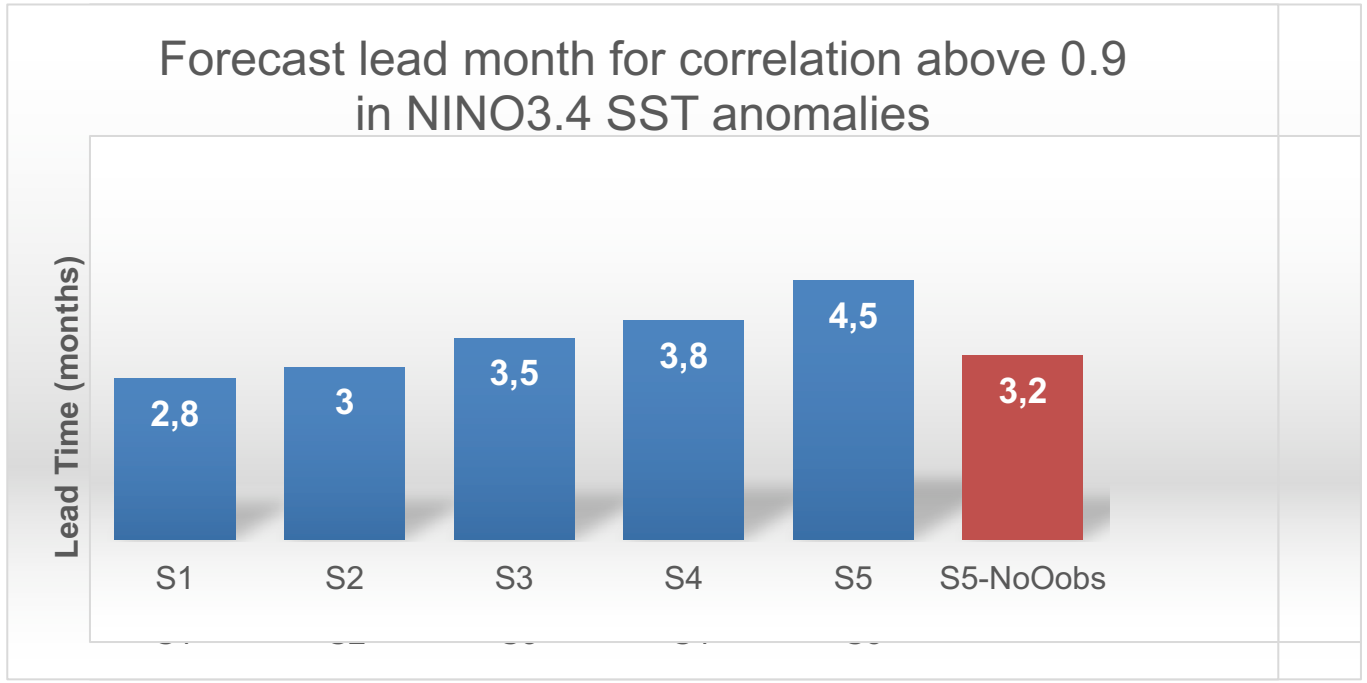


Antje Weisheimer, ECMW

20 years or progress in ENSO prediction at ECMWF

and contribution of ocean observations

- 1997 • System 1
- 2002 • System 2
- 2006 • System 3
- 2011 • System 4
- 2017 • SEAS5



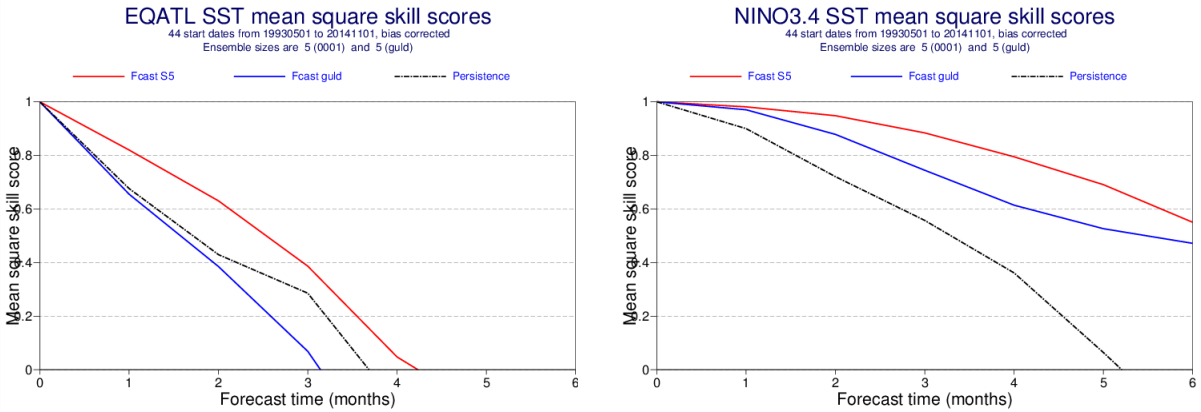
Gain about 2 months in ENSO prediction

What if we did not have ocean observations?

We would lose about 15 years of progress.

- S1 was the first ECMWF seasonal forecasting system. Implemented as a pilot in 1997
- SEAS5 is the latest ECMWF seasonal forecasting system. Implemented in November 2017. Contributes to Copernicus Climate Change Services C3S.

Impact of Assimilating Ocean Observations in Seasonal Forecast



SEAS5 is the new ECMWF seasonal forecasting systems (Johnson et al 2018, GMD)
SEAS5 initialized by Ocean Reanalyses ORAS5 (Zuo et al, 2018)
SEAS5-NoOObs is initialized by an “Ocean Simulation” where Ocean observations have are not assimilated (Only winds and SST)

Reanalysis OSEs:

Carried out with ORAS5 equivalent at low resolution (1degree). Period 1993-2015.

OSEs by removing global observing system components

- All : all observing system
- NoArgo: Removal of Argo float observations
- NoMooring: Removal of tropical moorning arrays
- NoXBT: Removal of XBT/MBT and CTD observations
- NoInsitu: Removal of all in-situ observation types (Argo, XBT/MBT, CTD, mooring, Seals)
- NoAlti: Removal of satellite altimeter sea-level observations

Extended and Seasonal Forecast From the Reanalysis OSES:

15 ensemble members. May-Nov starts. 1993-2015

The experiments are being finalized and analysis has started.

- Is there impact and mechanisms?
- Is the skill affected?

Happy to share this data for further analysis. TPOS2020; S2S Phase II

Artic sea-ice predictions

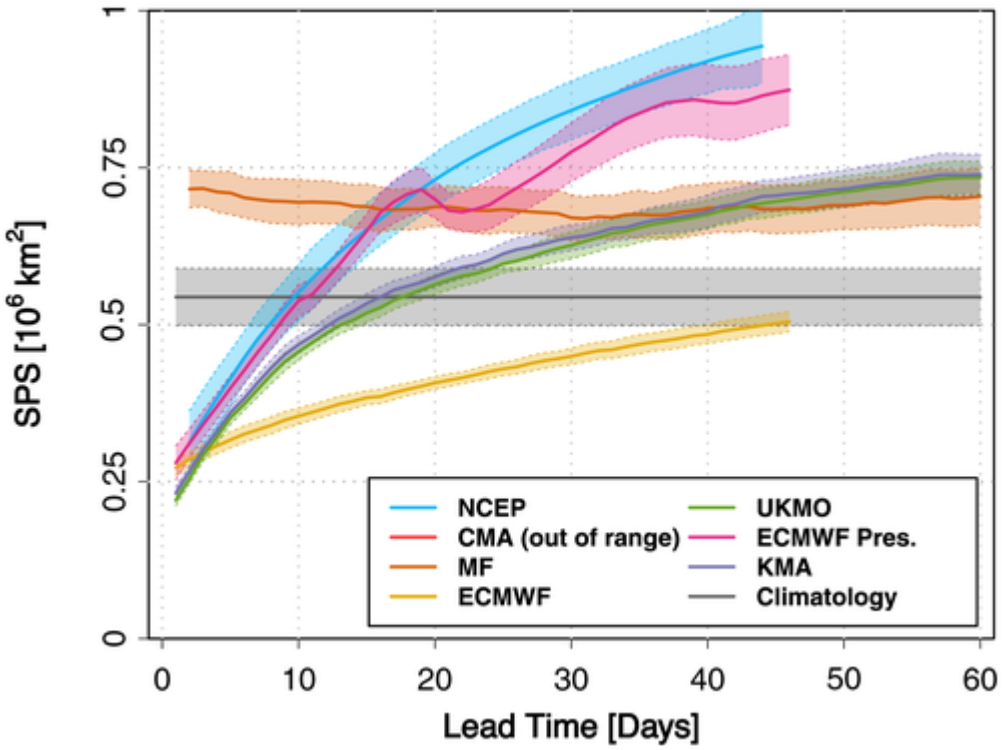


Fig. 1 Annual-mean skill in terms of the SPS of the different forecast systems (colored-solid lines) and the climatological benchmark forecast (gray-solid line) in predicting the Arctic sea ice edge as a function of lead time. Results have been averaged over the common reforecast period 1999–2010. Predictions with SPS values smaller than the climatological value (≈0.55·106 km2) can be considered skillful. The shading and dashed lines indicate ~95% confidence intervals, based on standard errors obtained from the twelve individual annual means. Note that the CMA forecast system is not depicted given that its large errors lie outside of the range shown. ECMWF Pres. is based on the predecessor ECMWF system, the main difference being that sea ice was not simulated dynamically but prescribed based on a combination of persistence and climatology.

Zampieri et al. (2018). G R L, 45, 9731– 9738. https://doi.org/10.1029/2018GL079394

Subseasonal-to-Seasonal S2S Prediction Project

TIGGE

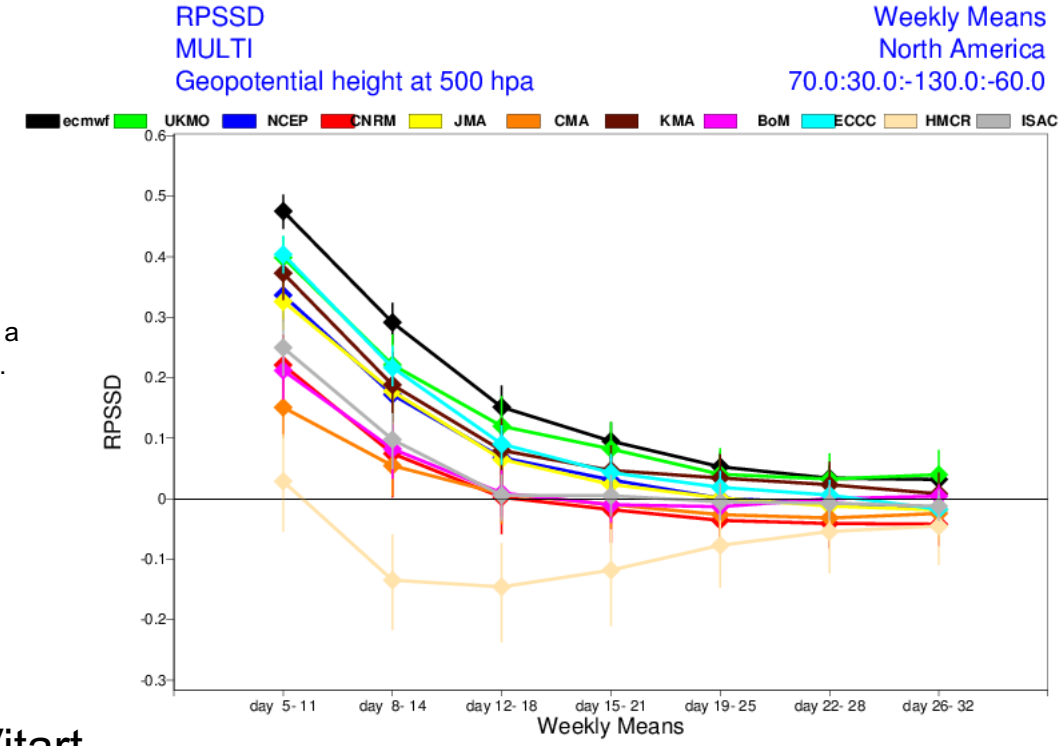
WCRP World Climate Research Programme

WWRP World Weather Research Programme

Workshop on Predictability, dynamics and applications research using the TIGGE and S2S ensembles 2-9 April 2019

Verification of S2S real-time forecasts

8 June 2017 to 1st November 2018



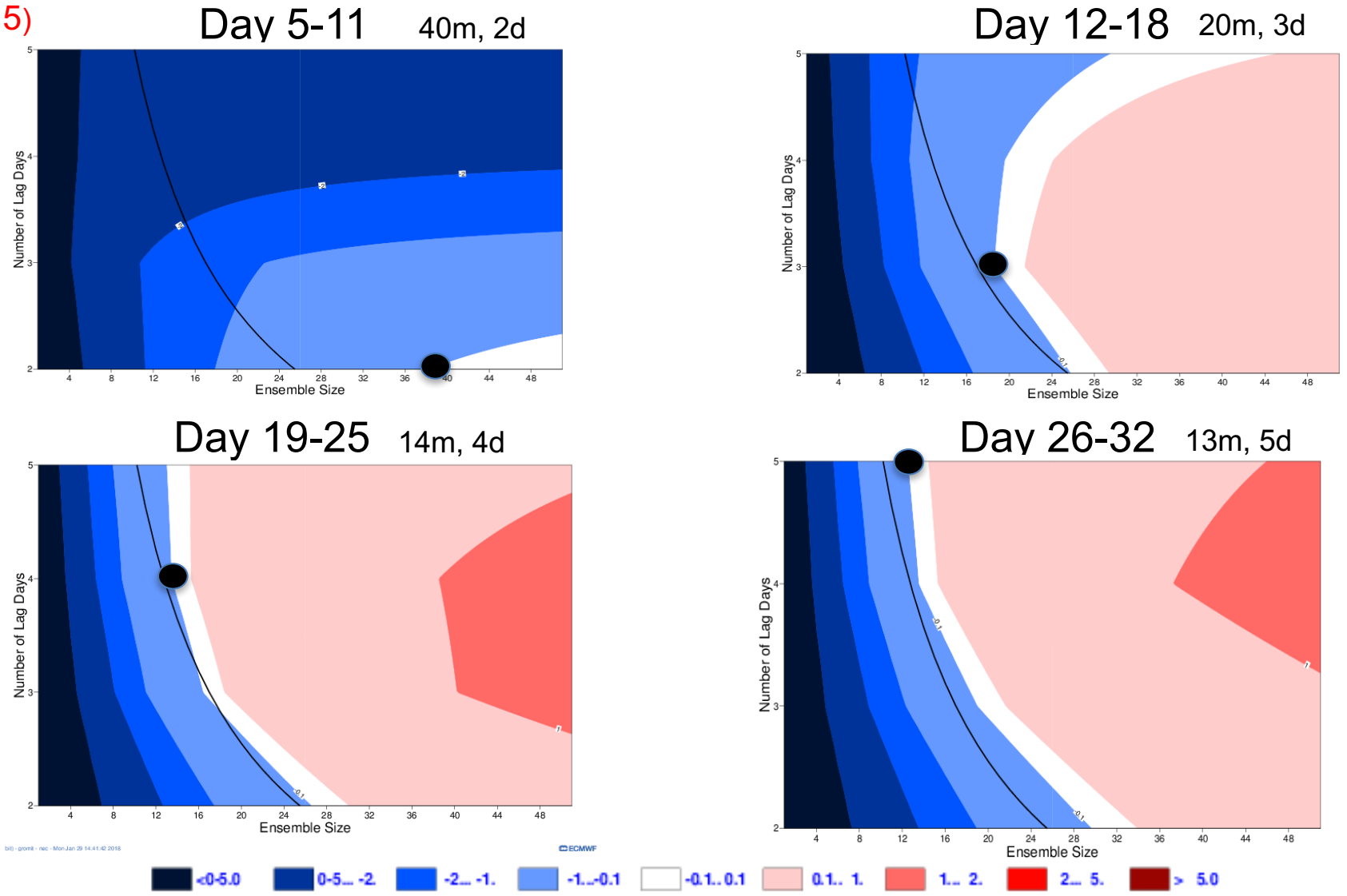
From F. Vitart

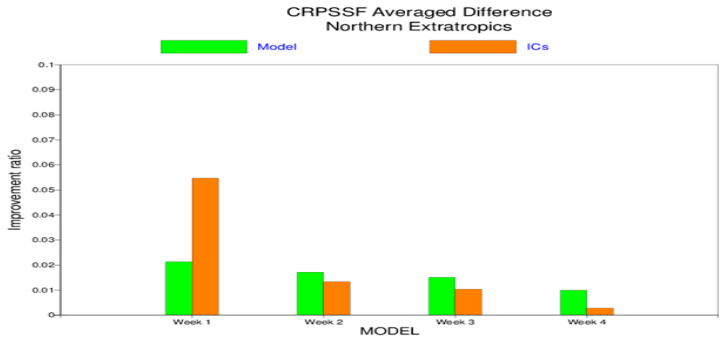
Impact of lag ensemble on CRPSS (averaged over 20 variables)
N. Extratropics

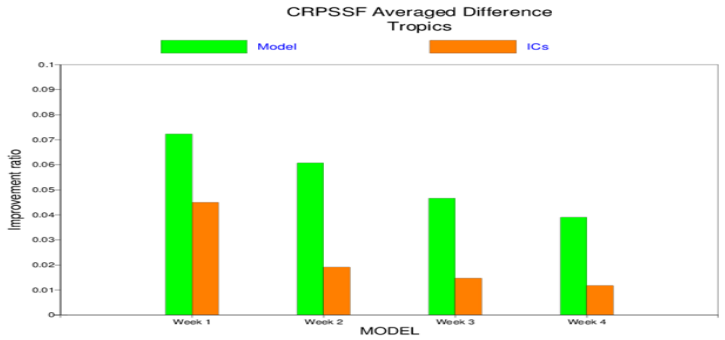
Lag ensemble defined by 2 attributes:
- i: Ensemble size per day (i=1 to 51)
- j: Number of lag days (j=2 to 5)

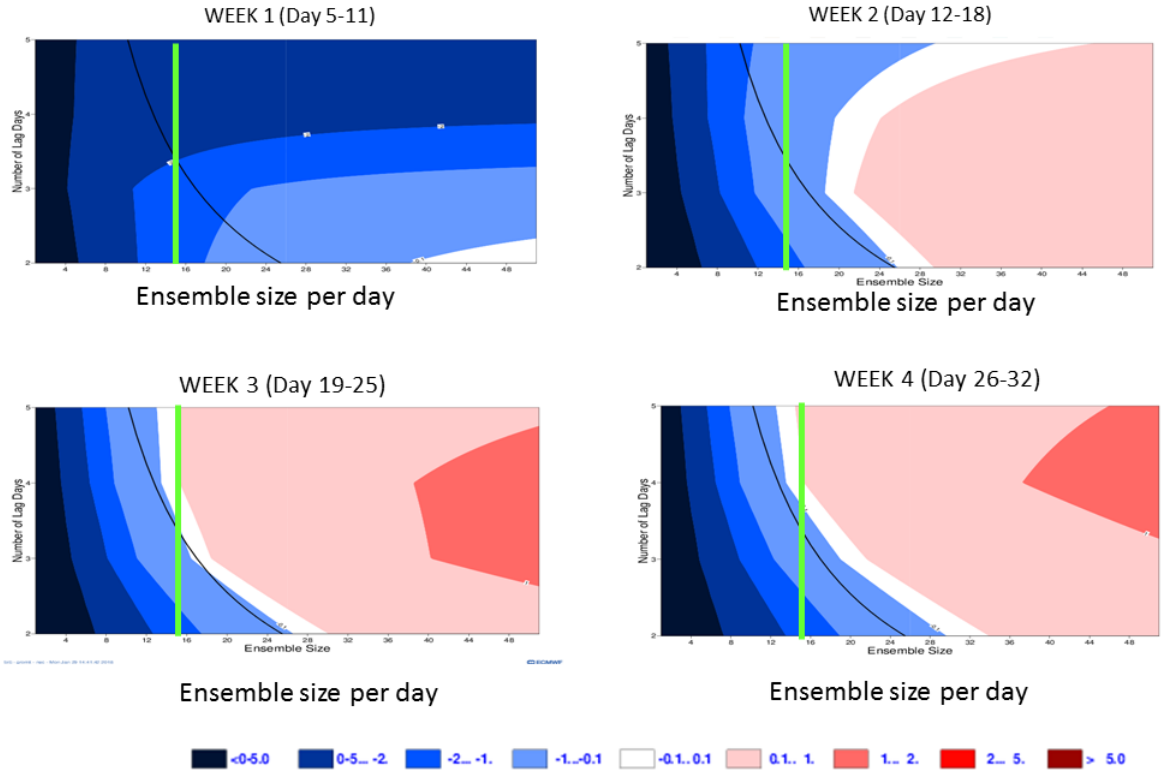
- Running legB daily could be an option if daily ensemble size > 20
- Using lag ensembles can help improve skill of weeks 2, 3 and 4
- Lag ensemble size should be larger than burst ensemble size
- Optimal number of lag days increases with lead time and in the Tropics

Diff Lag ensemble (i,j) – Burst (51m)









For week 2 to be at lest as skilful as the current system, the minimum number of ensemble members per day should be 20 and the optimal scores would be obtained by combining the forecast of day 0. -1 and -2 (3-day widow). For weeks 3 and 4, the minimum ensemble size diminishes (14 for week 3 and 13 for week 4) and the optimal window size of the lagged ensemble increases (4 day lag).

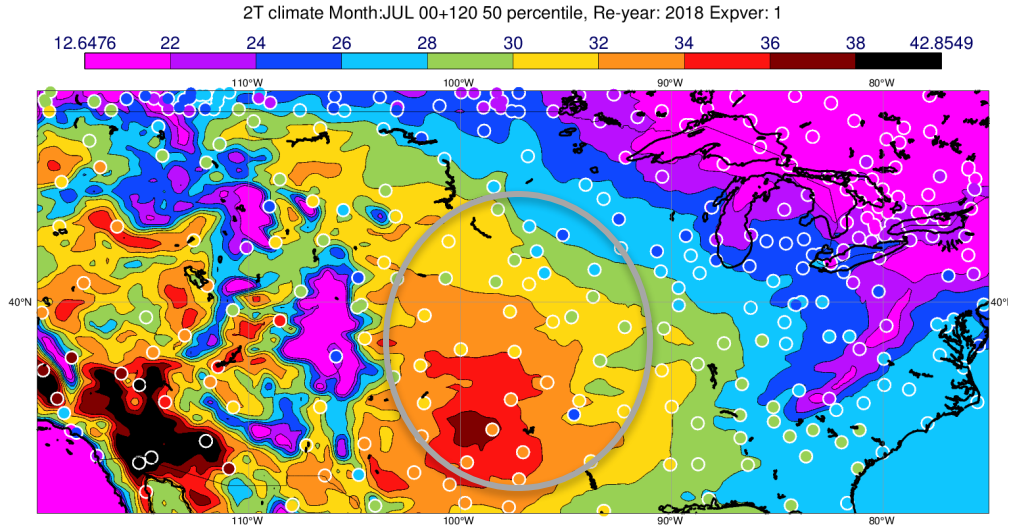
From Frederic Vitart

Consistency with real-time forecast initialization

IFS cycle 46r1

Daily report 20180717

Re-forecast climatology too warm over Central US

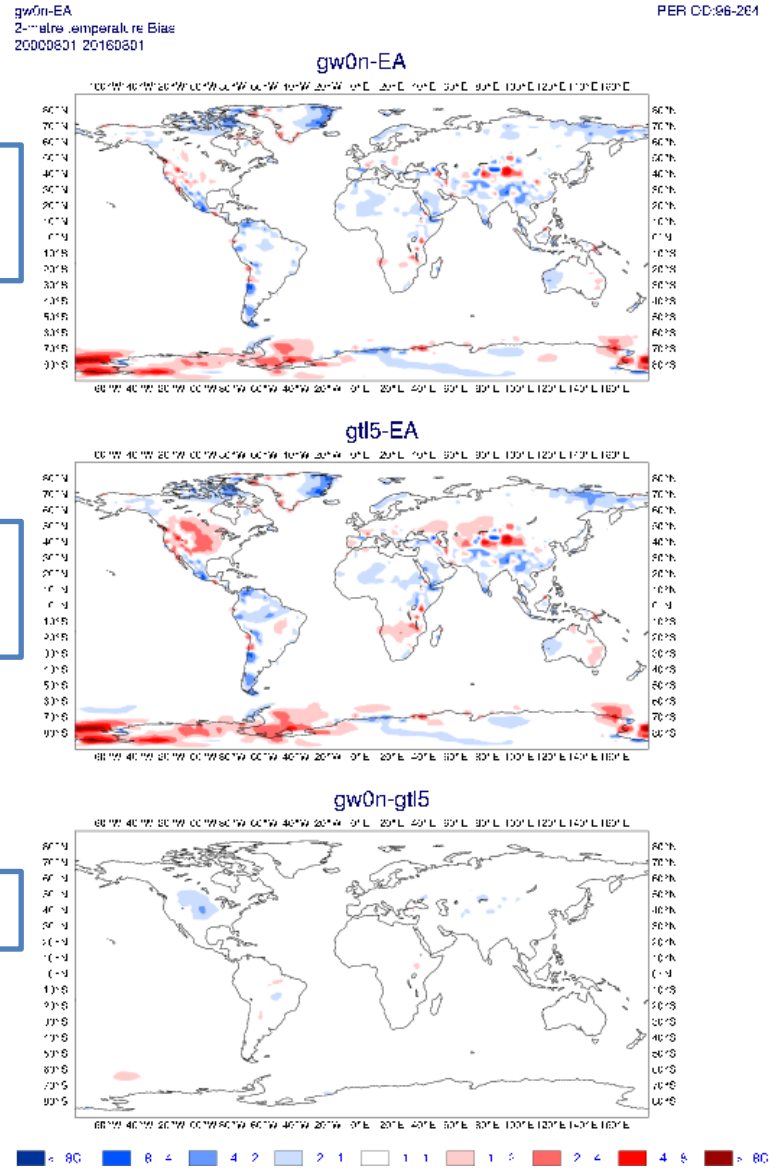


2t biases relative to ERA5
Day 5-11

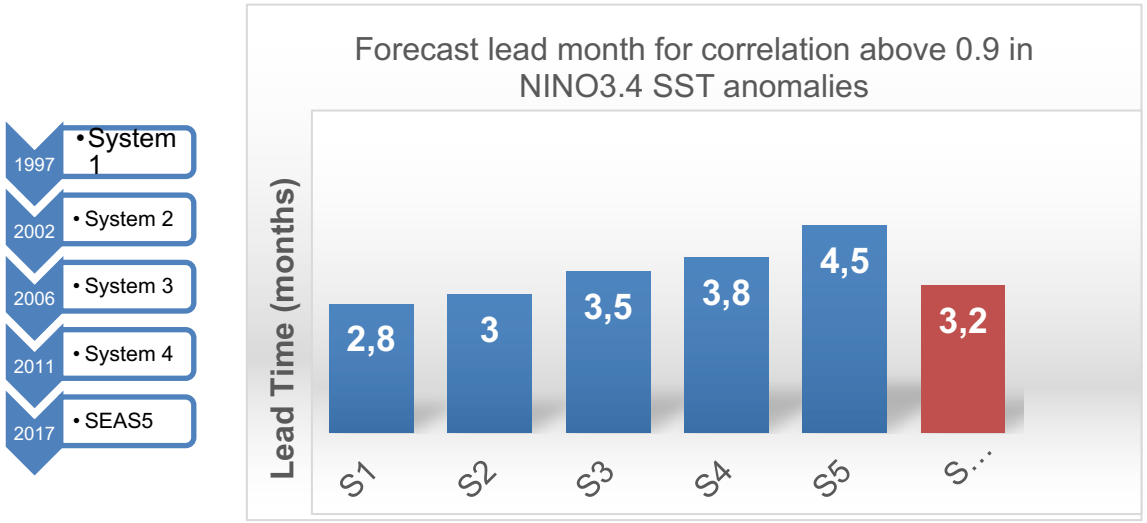
ERA5 initial conditions

ERA-I initial conditions

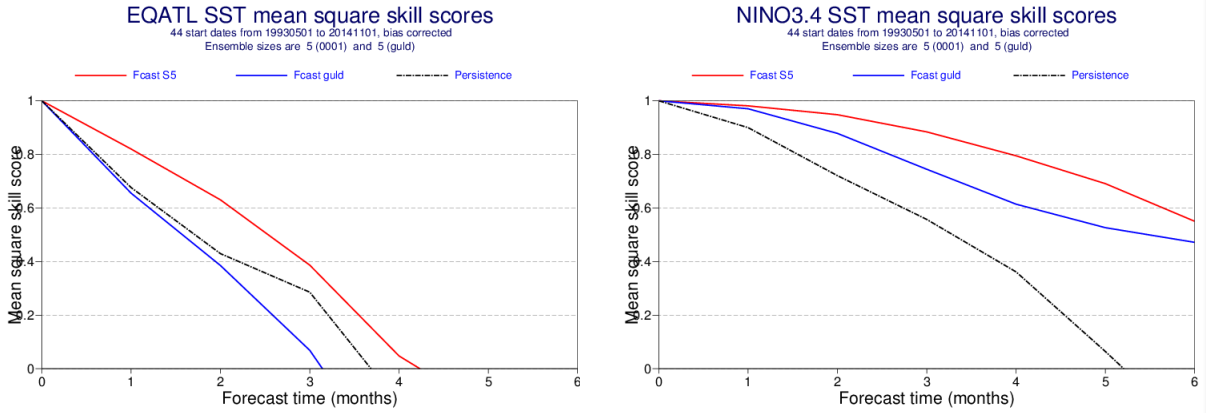
Difference



20 years or progress in ENSO prediction at ECMWF and contribution of ocean observations



Impact of Assimilating Ocean Observations in Seasonal Forecast



SEAS5 is the new ECMWF seasonal forecasting systems (Johnson et al 2018, GMD)
SEAS5 initialized by Ocean Reanalyses ORAS5 (Zuo et al, 2018)
SEAS5-NoOObs is initialized by an “Ocean Simulation” where Ocean observations have are not assimilated (Only winds and SST)

Reanalysis OSEs:

Carried out with ORAS5 equivalent at low resolution (1degree). Period 1993-2015.

OSEs by removing global observing system components

- All : all observing system
- NoArgo: Removal of Argo float observations
- NoMooring: Removal of tropical moorning arrays
- NoXBT: Removal of XBT/MBT and CTD observations
- NoInsitu: Removal of all in-situ observation types (Argo, XBT/MBT, CTD, mooring, Seals)
- NoAlti: Removal of satellite altimeter sea-level observations

Extended and Seasonal Forecast From the Reanalysis OSES:

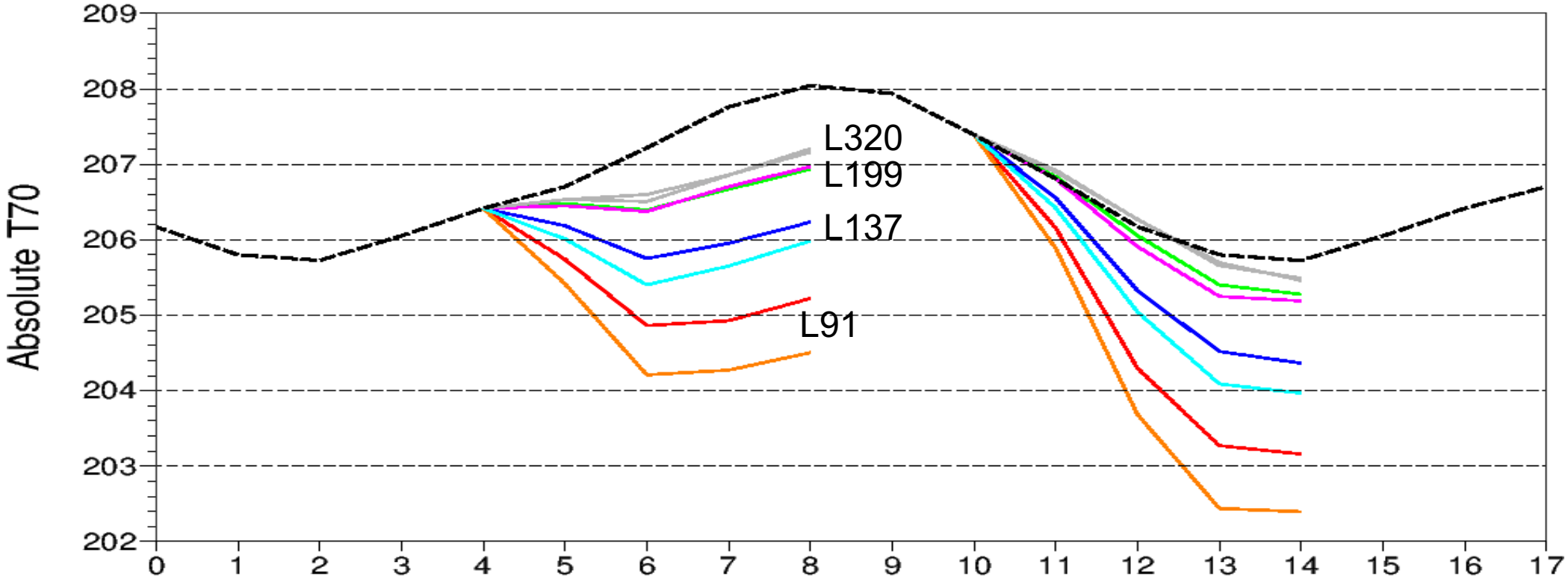
15 ensemble members. May-Nov starts. 1993-2015

The experiments are being finalized and analysis has started.

- Is there impact and mechanisms?
- Is the skill affected?

Happy to share this data for further analysis. TPOS2020; S2S Phase II

Impact of horizontal and vertical resolution changes



Red and orange = TCo199L91 and TCo319L91

Dark blue and light blue = TCo199L137 and TCo319L137

Green and pink = TCo199L198 and TCo319L198

Grey and grey = TCo199L320 and TCo319L320

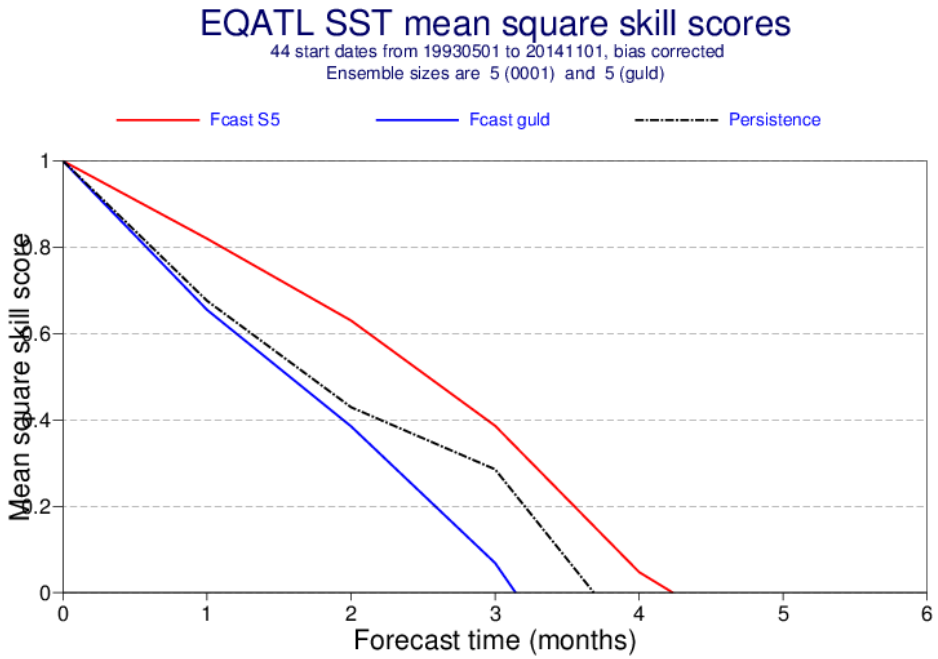
ECMWF

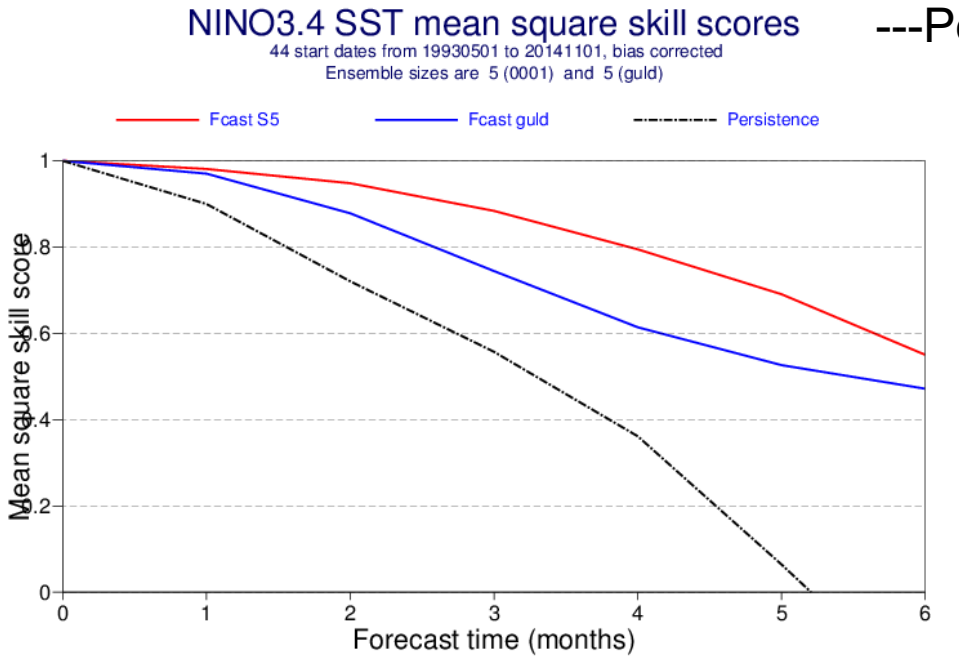
Impact of Assimilating Ocean Observations in Seasonal Forecast

SEAS5

SEAS5-NoOObs

---Persistence





SEAS5 is the new ECMWF seasonal forecasting systems (Johnson et al 2018, GMD)
SEAS5 initialized by Ocean Reanalyses ORAS5 (Zuo et al, 2018)

SEAS5-NoOObs is initialized by an “Ocean Simulation” where Ocean observations have are not assimilated (Only winds and SST)

OSEs with ORAS5-SEAS5 Low Resolution

A) Reanalysis OSEs:

Carried out with ORAS5 equivalent at low resolution (1degree). Period 1993-2015.

OSEs by removing global observing system components

- All : all observing system
- NoArgo: Removal of Argo float observations
- NoMooring: Removal of tropical moorning arrays
- NoXBT: Removal of XBT/MBT and CTD observations
- NoInsitu: Removal of all in-situ observation types (Argo, XBT/MBT, CTD, mooring, Seals)
- NoAlti: Removal of satellite altimeter sea-level observations

B) Extended and Seasonal Forecast From the Reanalysis OSES:

15 ensemble members. May-Nov starts. 1993-2015

The experiments are being finalized and analysis has started.

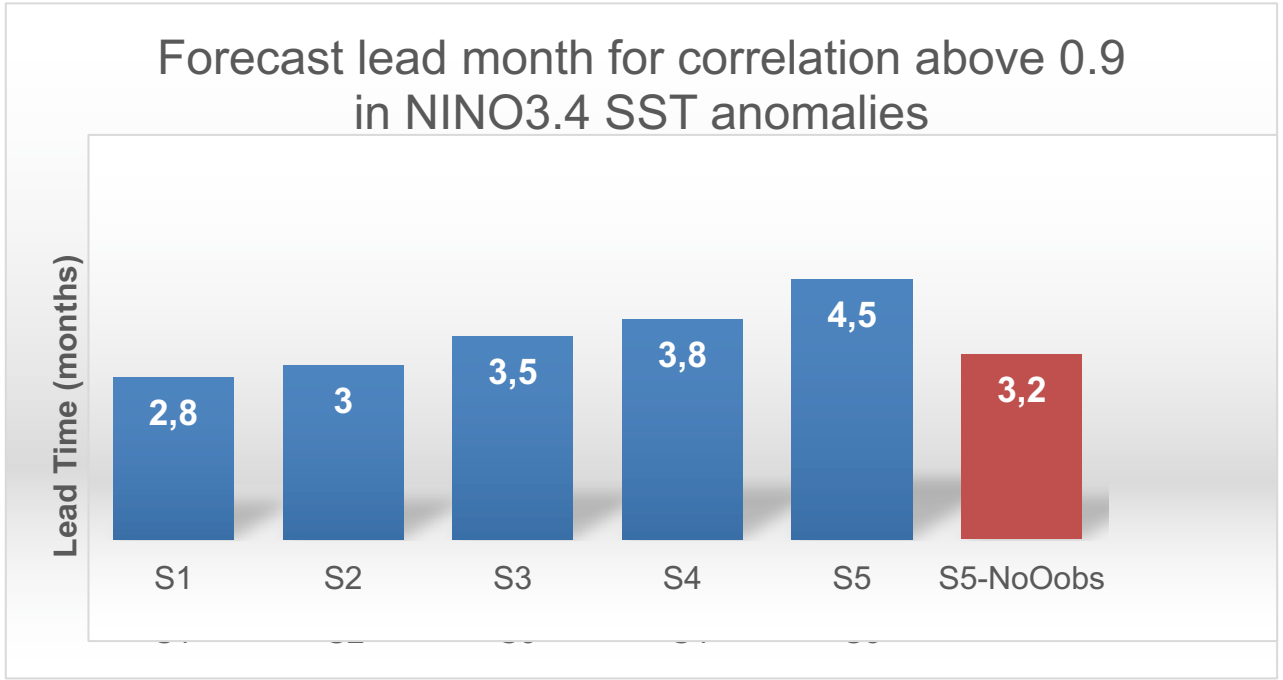
- Is there impact and mechanisms?
- Is the skill affected?

Happy to share this data for further analysis. TPOS2020; S2S Phase II

20 years or progress in ENSO prediction at ECMWF

and contribution of ocean observations

- 1997 • System 1
- 2002 • System 2
- 2006 • System 3
- 2011 • System 4
- 2017 • SEAS5



Gain about 2 months in ENSO prediction

Without ocean data assimilation, we would lose about 15 years of progress.

But comparatively slower progress in mid-latitude seasonal skill

Improving teleconnections is challenging

ECMWF