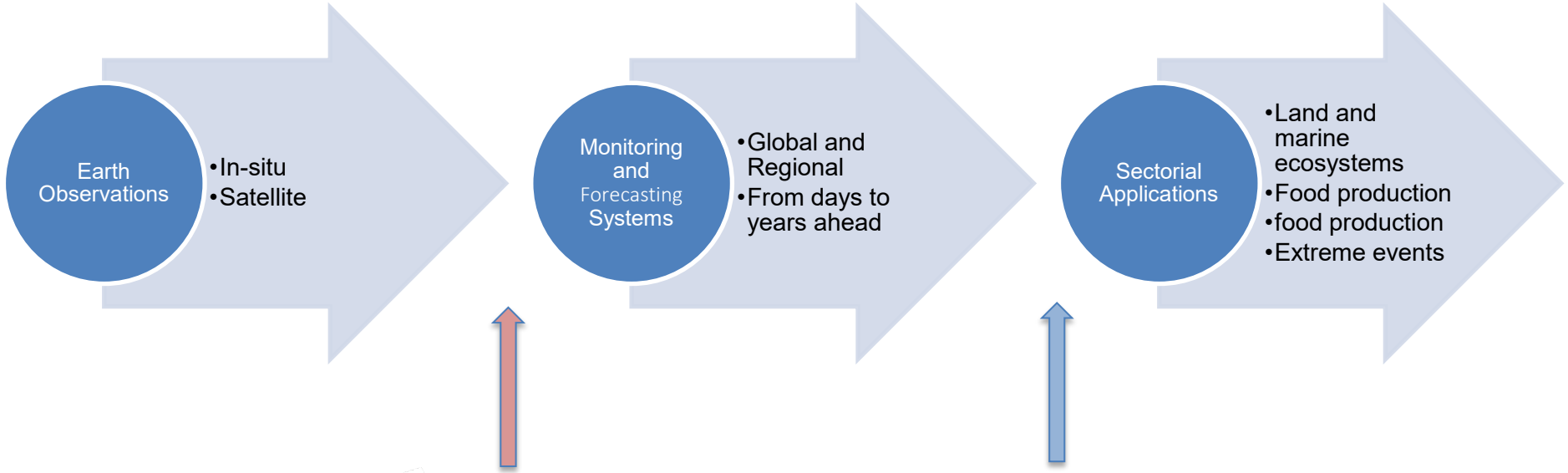
The importance of Ocean and Land ECVS for S2S/S2D forecasting systems

Magdalena A. Balmaseda,
Ronan McAdam, Simona Masina, Karina von Schuckmann, Silvio Gualdi, Retish Senan, Michael Mayer, Eric de Boisseson, Christopher Roberts, Frederic Vitart, Beena Balan Sarojini, Souhail Boussetta, Gianpaolo Balsamo, Anca Brookshaw.

Improving the value chain of Earth Observations for Societal Applications



System Development for reanalyses and reforecasts

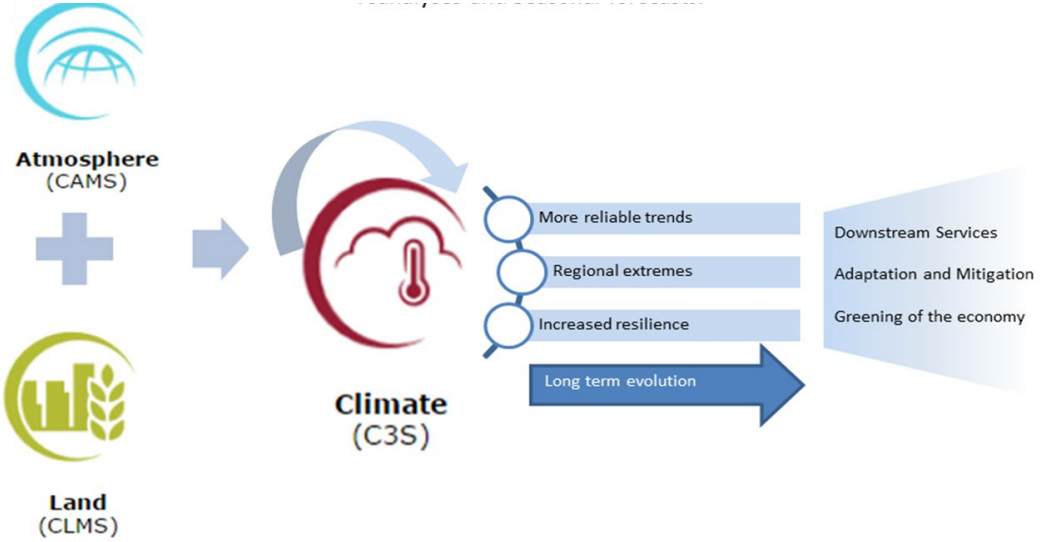
Verification of S2S ocean fields

https://confess-h2020.eu/

Co-ordinated by ECMWF

CONFESS

Consistent representation of temporal variations of boundary forcing in reanalyses and seasonal forecasts



CONFESS aims at **improving the representation of global trends and regional extremes in next generation of C3S earth system reanalyses and seasonal forecasts,** by taking stock of observational data sets and model developments across different Copernicus Services on vegetation, land cover, atmospheric composition and biomass burning.

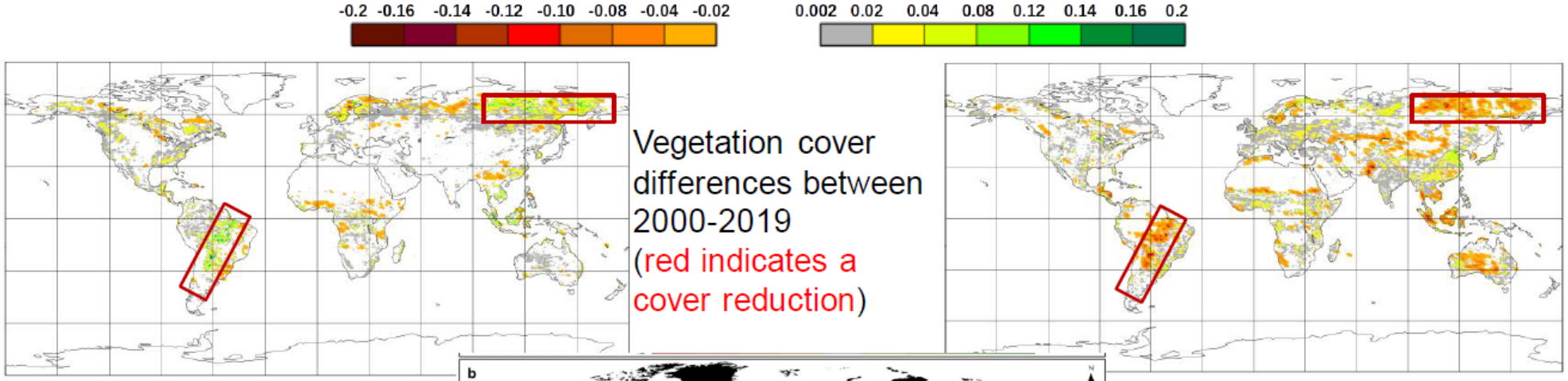
ECMWF METEO FRANCE CNRS BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación ISAC

Representing temporal variability in in Land Cover/Land Use and Vegetation

A primary objective of CONFESS.

C3S LC/LU based on ESACCI from 1993-2019 is processed and used with harmonized version of CGLS and THEIA GEOV2 LAI to drive ECLand and assess their impact on surface fluxes, soil moisture, and ultimately on seasonal reforecasts.

LULC Inter-annual variability



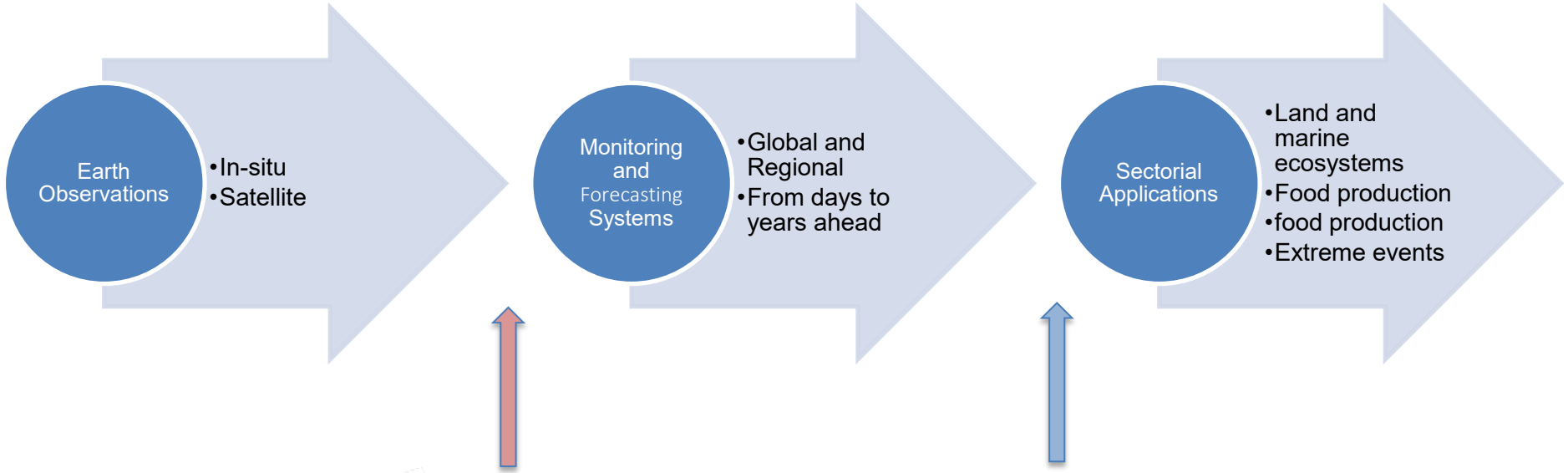
Low vegetation cover

Deforestation and burned areas signal detected over the Amazon and North-East Asia regions

High vegetation cover

Results are consistent with (Radwan et al,. Nature 2021) Spatial distribution of LC changes between 1992 and 2018 for forest cover

Improving the value chain of Earth Observations for Societal Applications



System Development for reanalyses and reforecasts

Verification of S2S ocean fields

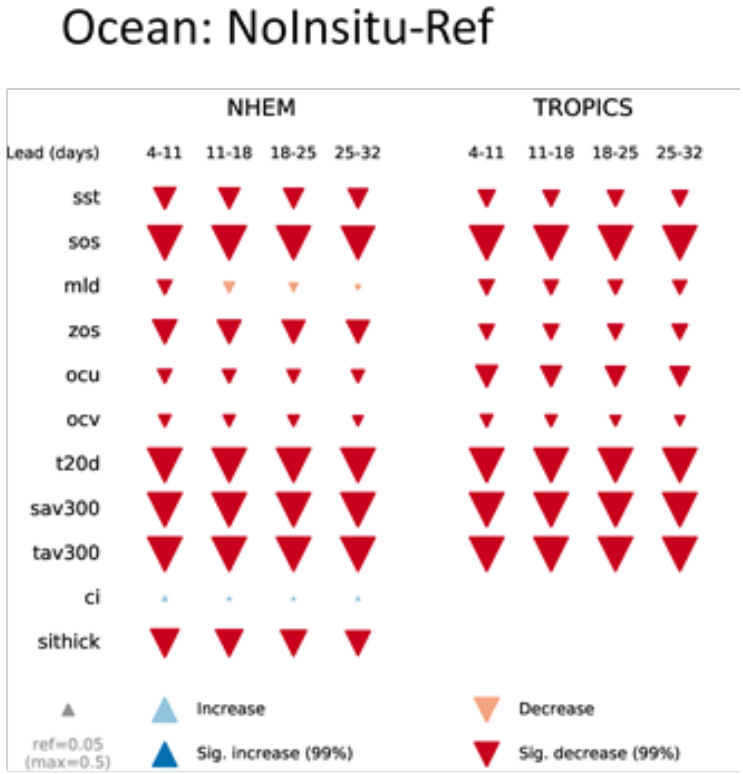
Let's start with the subseasonal time-scales

The S2S data base now includes ocean variables from operational models across the globe

Verification of ocean variables is fundamental step for **forecast applications** and for **model development.**

Long harmonized temporal records of **daily** values are proving very valuable for S2S verification

Currently we use SST-SIC and SSH because of its maturity level. Can we have more?



Red : Degraded mean state

Score card measuring impact of specific aspects of forecasting system development. In this case, the impact of removing ocean observations in the initialization of extended range forecasts

Frederic Vitart, Chistopher Roberts, Beena Balan Sarojini

We continue with the seasonal time scales

- **Background:**
- Current C3S seasonal forecast of ocean variables are under-utilized
- Yet, there is demand of information for planning marine – related activities
- C3S will shortly to provide information on seasonal forecasts of ocean variables.

- **Objectives of our work in EuroSea:**

1) Use improved climate records of ECV (SST, OHC and SLA) to validate seasonal forecast of ocean variables.
2) A set of user-relevant climate and ocean indicators will be derived from the ensemble of seasonal forecast

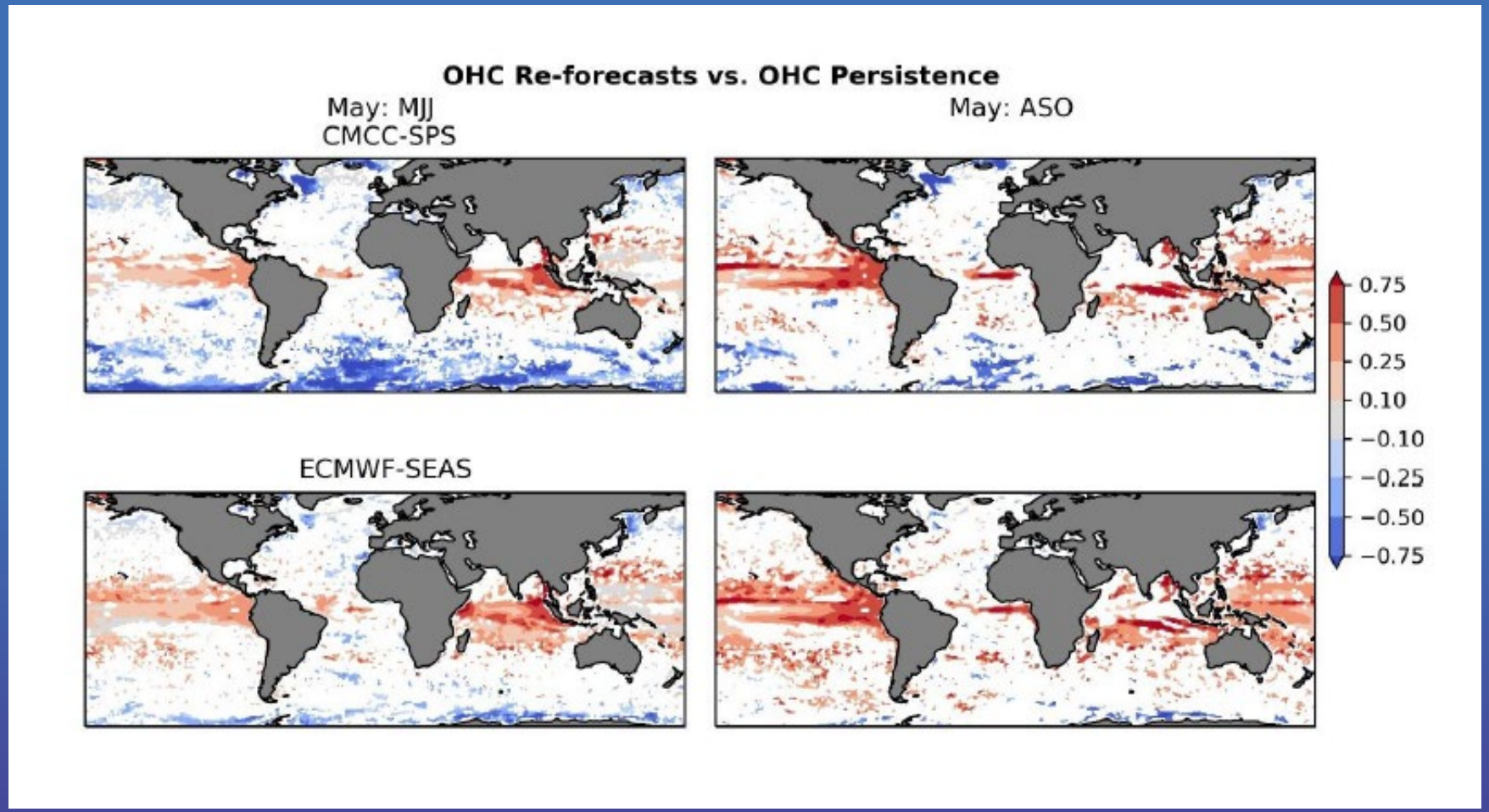
- **Verification data sets**: SST and SSH (ESA-CCI), OHC 300m (CMEMS GREP)
- **Seasonal reforecast:** ECMWF and CMCC contributing to C3S.
- **Temporal record**: 1993 – 2016 (y=24 years), monthly values. **Common grid**: 1x1 lat/lon

What do we expect to learn from the verification?

- Does the skill of the dynamical seasonal forecasts of ocean variables beat the persistence forecast? Does it beat climatology?
- How does the forecast skill compares between different variables?
- What is the added value of new variables for process understanding processes and system development?

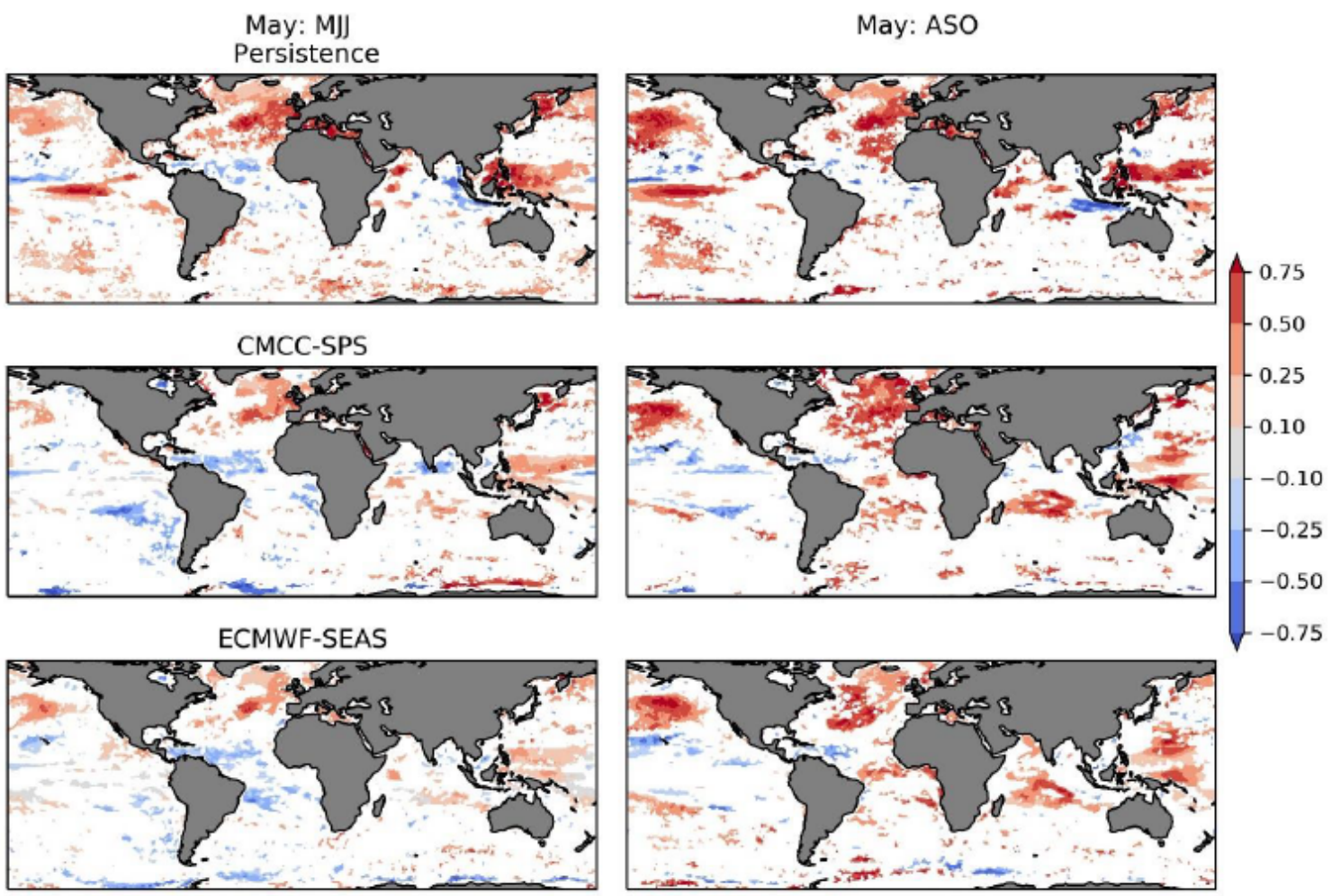
Dynamical SF of OHC better than persistence in dynamically active regions

Anomaly Correlation Skill in OHC: SF v Persistence



From McAdam et al 2022

Skill of OHC in extratropics better than SST



From McAdam et al 2022

Note that the OHC/SST skill ratio is different in persistence than in dynamical forecasts, especially in the tropics.

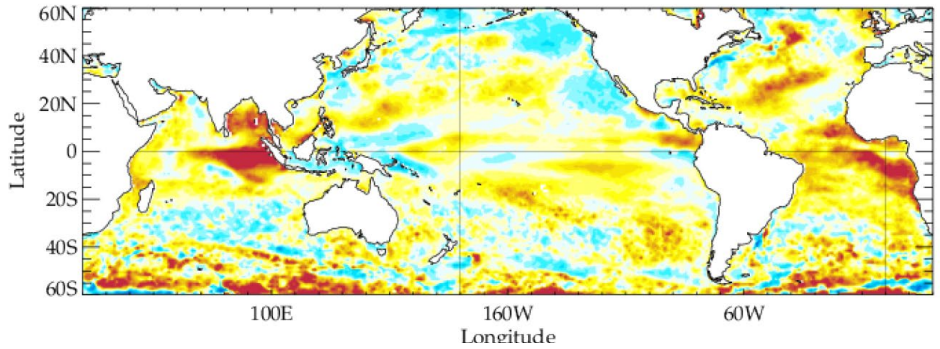
Interpretation 1: dynamical models exploit the memory of the subsurface.

Interpretation 2: OHC in initial conditions not good enough

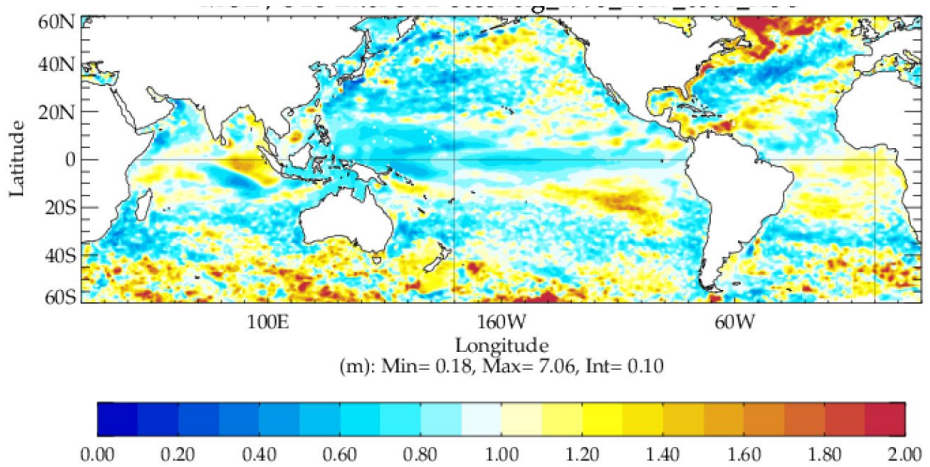
Comparing interannual variability in forecasts of SST v SSH

Variability ratio (Model – ECVobs) .
Forecasts Initialized in May. Verifying on ASO

SST



SSH



Diagnostics across different variables gives insight into factors influencing the forecast quality

In the tropical Pacific, the forecasts of SST are overactive (too large interannual variability), which the forecasts of SSH are underactive.

the balance between thermocline and surface feedback is not correct in the model. SST respond to strong to a given thermocline perturbation

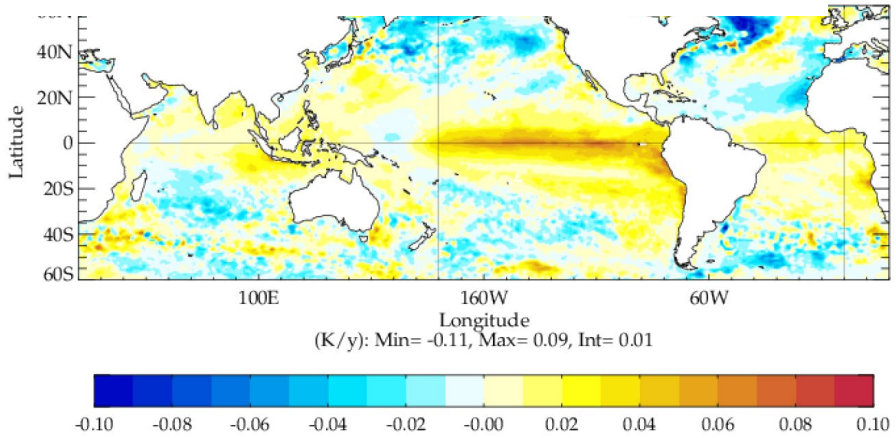
Does the overestimation of variability in SST/SSH over south eastern tropical basins points towards consistent errors in wind variability?

The consistency in the underestimantion of variability over the Pacific warm pool is quite seasonal dependent and needs to be better understood.

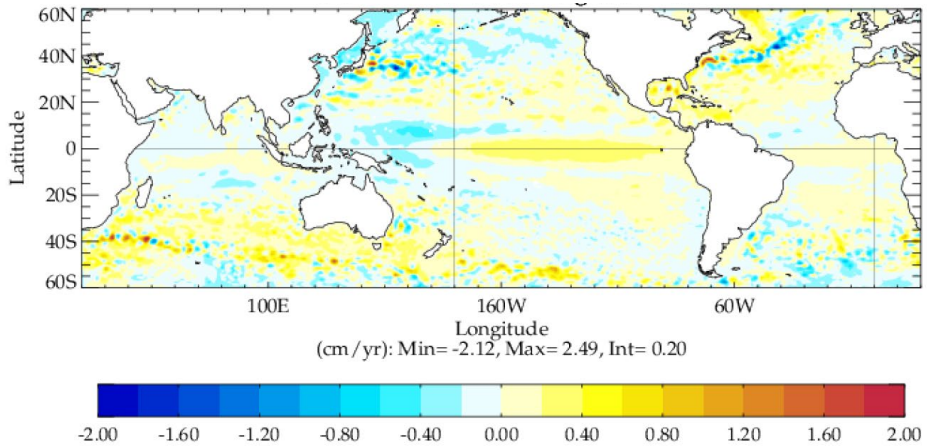
Comparing trends in forecasts of SST v SSH

Trend Differences (Model- ECVobs) .
Forecasts Initialized in May. Verifying on ASO

SST



SSH



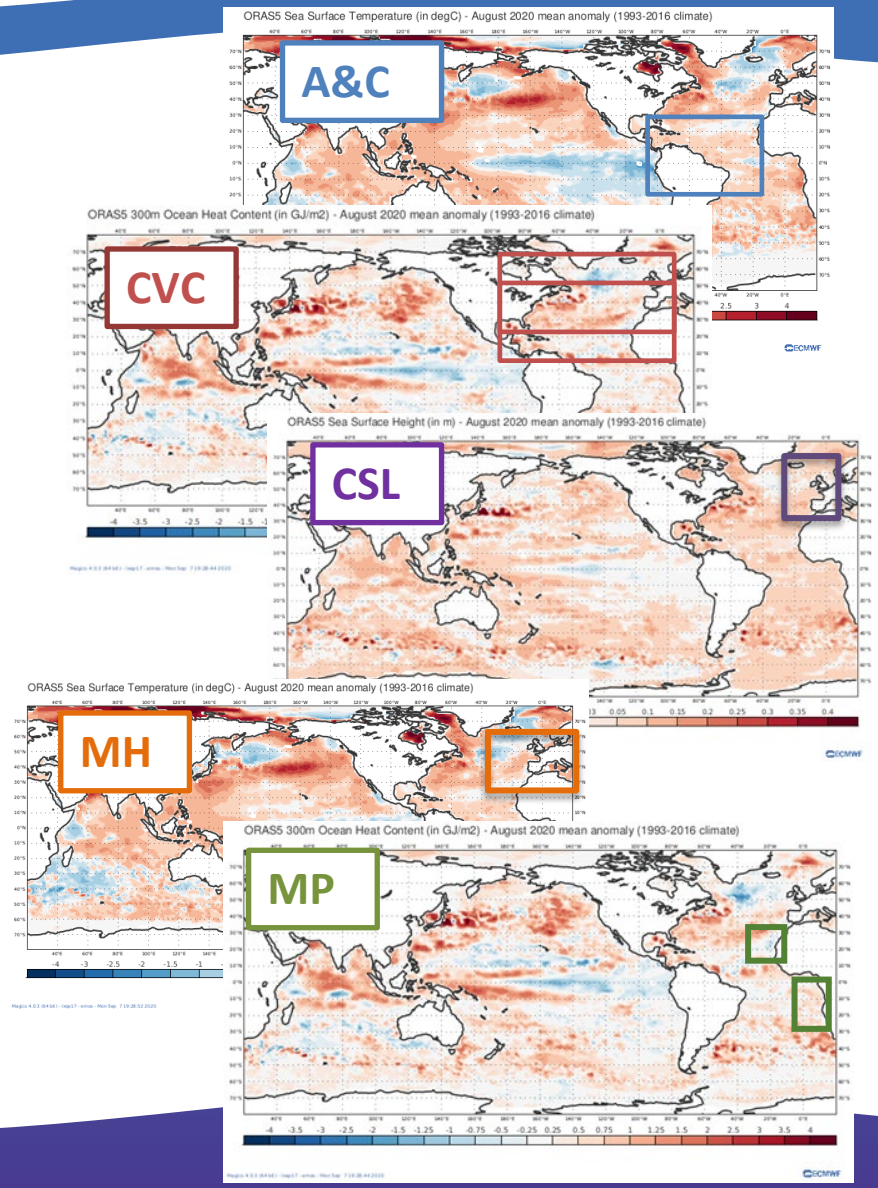
Errors in the FC trends on the Eq Pacific are consistent on SST/SSH, in contrast with the differences found in interannual variability.

- The model produces more El Nino-like conditions than observations.
- This error is the long term trends is seen in the first 3 months into the forecasts.
- Implication: seasonal reforecasts as a pragmatic test to develop climate models

Indicators for Sectorial Applications

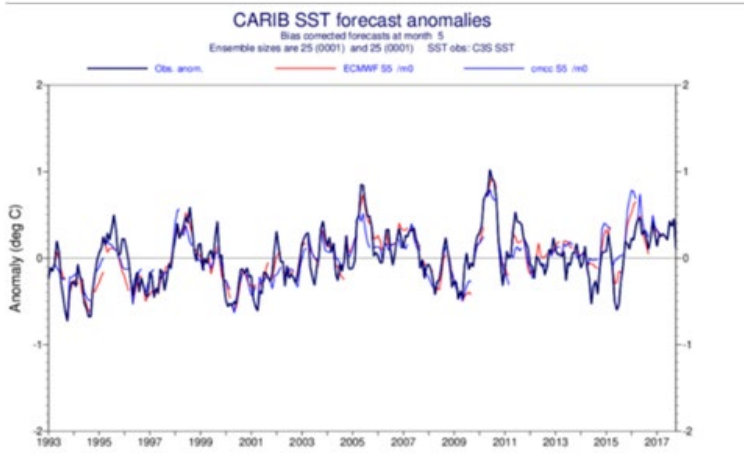
Proposed Sectorial Application

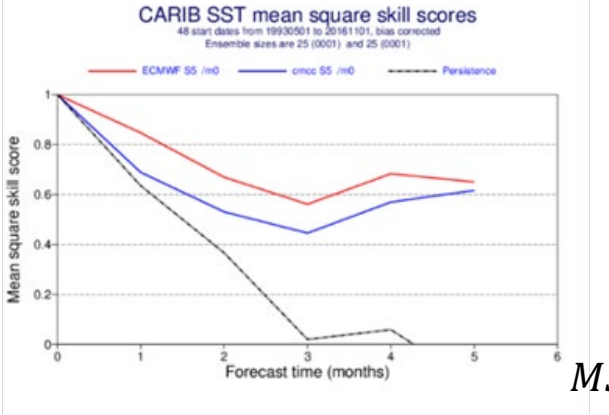
- **Atmosphere & Climate (A&C):**
  - Relevant for SF of hurricane season, Brazil and Sahel rainfall, West African Monsoon, European climate.
  - Example: Caribean, Gulf of Mexico, North Subtropical Atlantic, Tropical Atlantic Dipole.
- **Climate Variability and Change (CVC)**
  - Energy and water cycles, Ocean Circulation changes, Inter-basin connections.
  - Examples: North Atlantic Subpolar Gyre, North Atlantic (East and West). Latitudinal bands in Atlantic basin.
- **Coastal Sea Level Change: (CSL)**
  - **Example: North Eastern Atlantic**
- **Marine Health (MH)**
  - Focus on Marine Heat Waves
  - Mediterranean, North East Atlantic
- **Marine Productivity (MP)**
  - **Major upwelling regions (Canary, Benguela,)**



Verification and Skill Scores

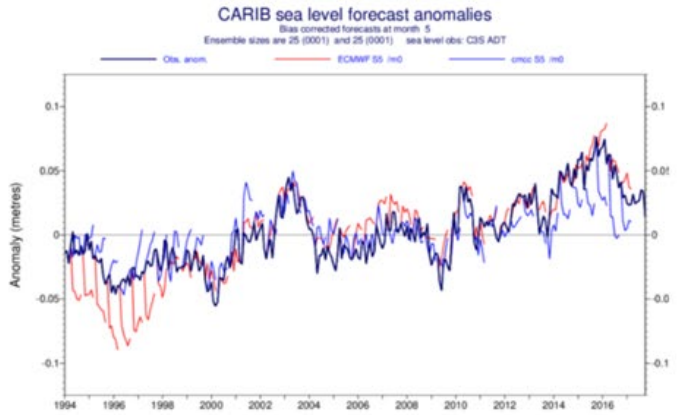
SF of SST better than persistence and climatology

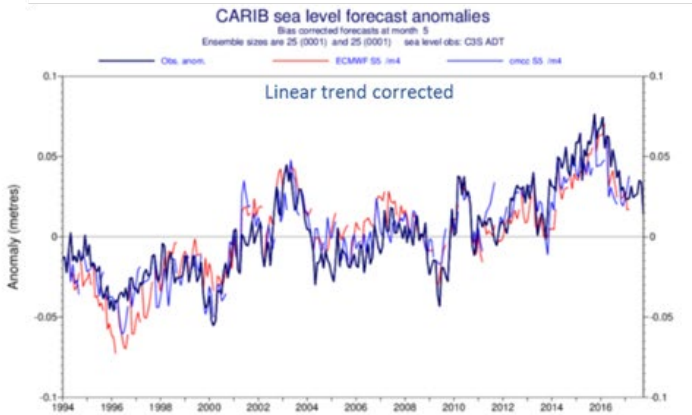


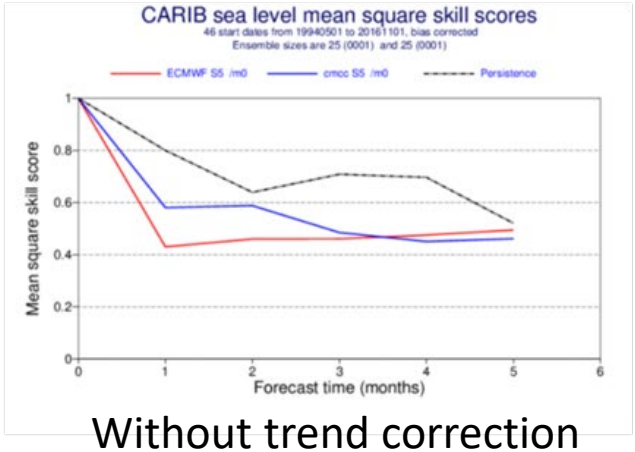


$$MSSS = 1 - \frac{RMSE_{fc}}{RMSE_{clim}}$$

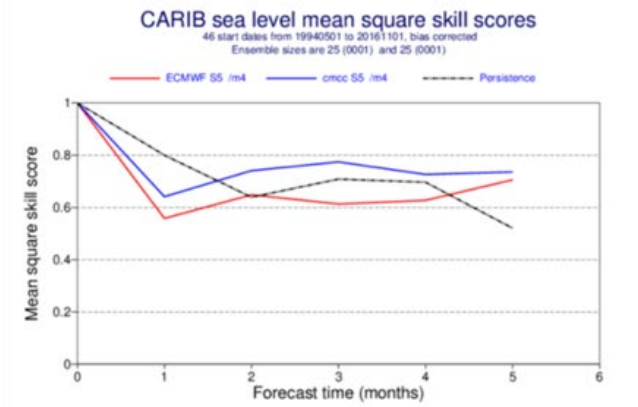
SF of SSH affected by errors in trends







Without trend correction



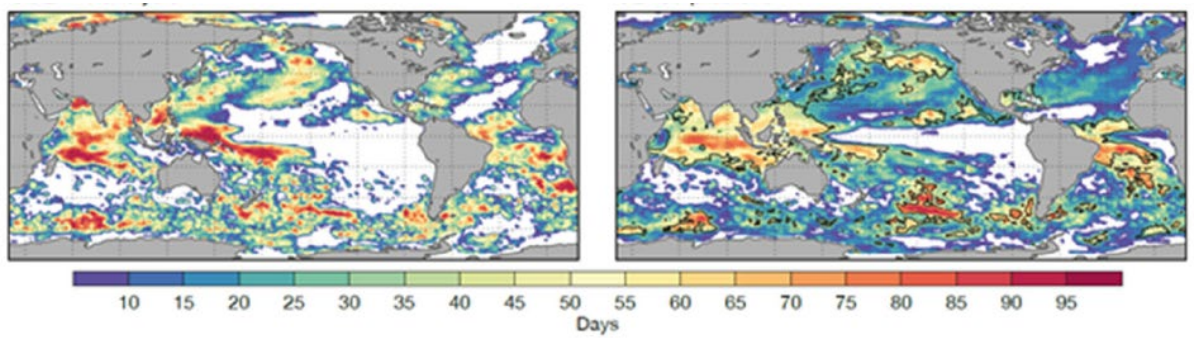
Trend corrected scores

Marine Heat Waves

Marine Heat Waves Days in JJA 2020

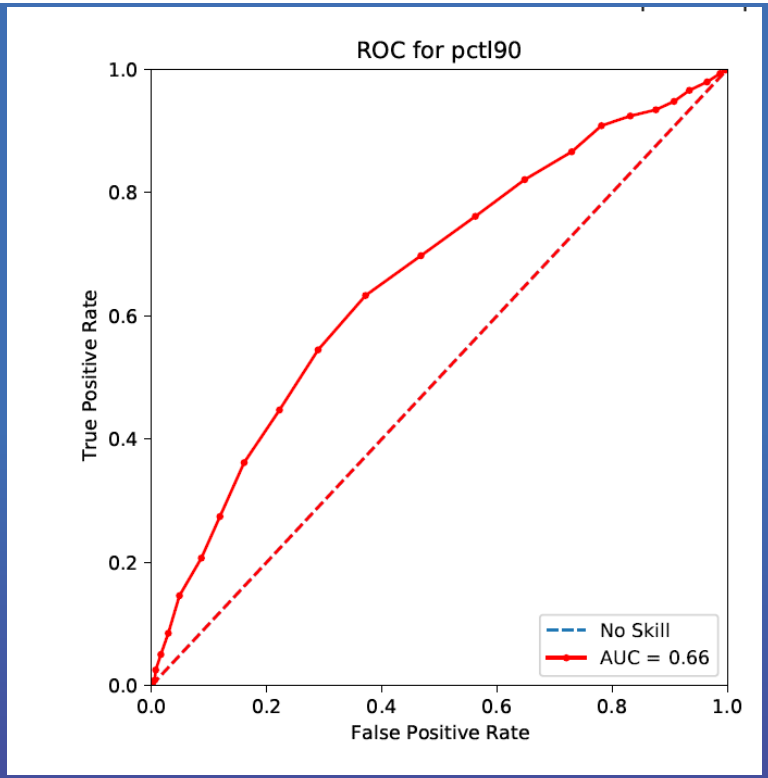
Ocean Reanalyses

Seasonal Forecasts (May start)



Number of days in June–July–August 2020 when SST anomalies exceeded the 90% threshold of the climatological value. Areas where such anomalies persisted for less than five consecutive days have been left blank. The black contour in the right-hand panel indicates areas where the probability of SEAS5 predicting a MHW is over 90%. *De Boisseson et al 2022*

ROC for MHW prediction in Western Mediterranean May Start. Verifying in JJA



Summary

- **Consistent temporal records of Land and Ocean variables are proving very valuable for improving the skill and usability of seasonal forecast.**
- **CONFESS will attempt for the first time to include land temporal variations in reanalyses and S2S reforecasts**
- **S2S data base includes ocean variables. C3S will include ocean variables. Sufficiently long and consistent records of SST/SSH are proving very useful for verification. Can we have more?**

- **Within EuroSea:**
  - Seasonal forecasts of of SST, OHC300m and SSH have been verified with a variety of metrics.
  - A set of indicators have been defined targeting different sectorial applications
  - Different skill structure between SST and OHC or SL yield information about the physical processes responsible for signals and errors
  - Dynamical forecasts are overall more skilful than persistence and climatology
  - SF of SSH need trend correction to be skilful
  - Promising results regarding seasonal forecasts MHW

Thanks for your attention

Any questions?