Seasonal forecasting activities at ECMWF

An upgraded ECMWF seasonal forecast system:

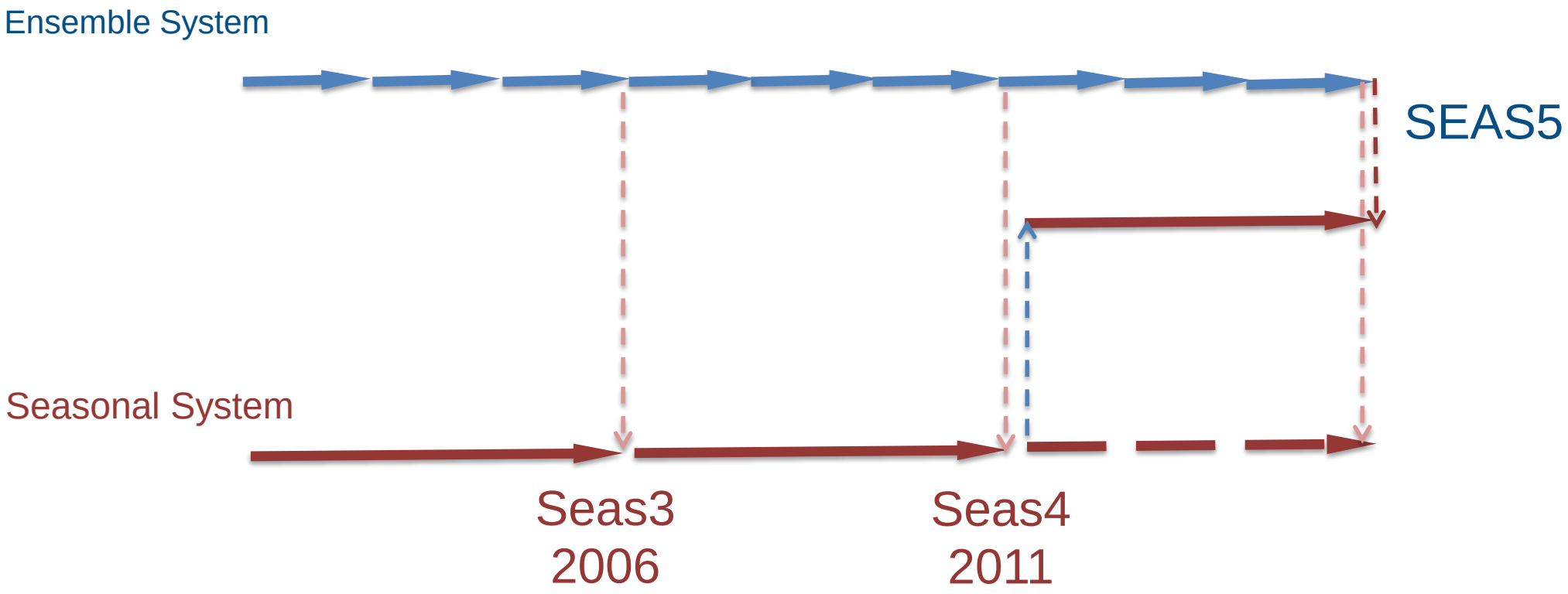
Tim Stockdale, Stephanie Johnson, Magdalena Balmaseda, and Laura Ferranti

Progress with C3S:

Anca Brookshaw

ECMWF

A change of tack: towards an unified ensemble prediction system



SEAS5 main characteristics:

	SEAS4 (2011)	SEAS5 (2017)
Atmosphere	Cycle 36r4 ~ 80Km, L91	Cycle 43r1 ~36 km, L91
Ocean	NEMO v3.0 ORCA 1.0-L42	NEMO v3.4 ORCA 0.25-L75
Sea ice model	Sampled climatology	LIM2
Non-orographic GWD	Altered	Altered
Ozone scheme	Cariolle	BMS
Ozone interactive	Yes	No

ERA5 forcings adopted for SEAS5

- Decadally varying tropospheric sulphate aerosol from CMIP5
- Time varying stratospheric volcanic aerosol from GISS
- GHG forcings from CMIP5 as in 43r1

SEAS5 vs. SEAS4

- Updated IFS cycle with many improvements to model physics
- Increased horizontal resolution in atmosphere and ocean, increased vertical resolution in the ocean
- Introduction of the LIM2 interactive sea ice model
- Ozone scheme non-interactive

Initialization and forecast strategy

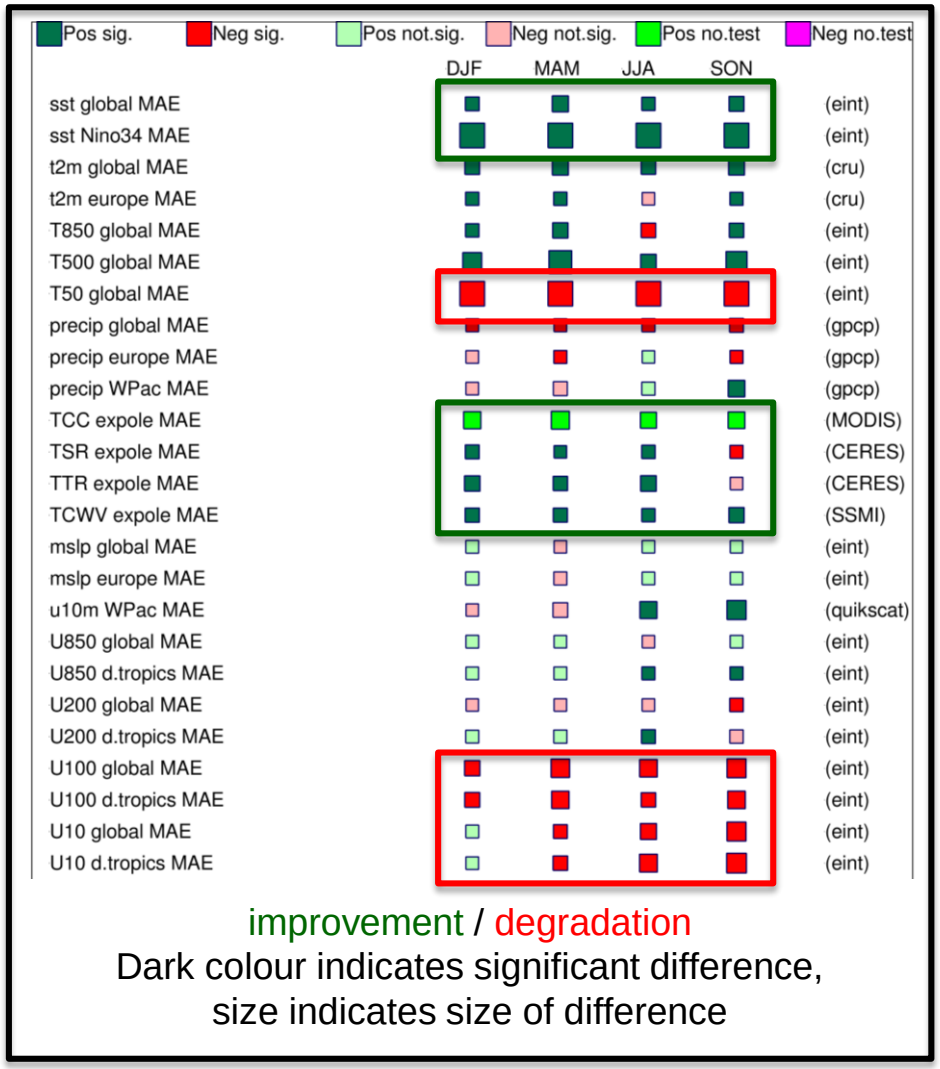
	SEAS4	SEAS5
Atm. Initialization	ERA-Interim	ERA-Interim
Land initialization	ERA-Interim Land 32r3	ERA-Interim Land 43r1
Ocean initialization	ORA-S4	ORA-S5
Ensemble spread	SPPT & SKEB	SPPT& SKEB
Forecast members	51	51
Reforecast members	15	25
Calibration period	1981-2010	1993-2016
Reforecasts period	1981-2010	1981-2016

SEAS4 vs. SEAS5

- Updated ocean and land initial conditions
- Updated atmosphere and ocean initial condition perturbations
- Larger reforecast ensemble size
- Calibration period set by C3S

SEAS5 vs. SEAS4 mean state summary

1993-2015: May/Nov start dates



improvement / degradation

Dark colour indicates significant difference, size indicates size of difference

- Global SST biases improve, especially in the ENSO regions
- Changes in model physics lead to better tropical cloud cover and surface temperatures, but this doesn't always lead to better tropical precipitation
- Stratospheric temperature and winds biases increase

In general, the climate mean is improved in SEAS5 compared to SEAS4, except for the stratosphere.

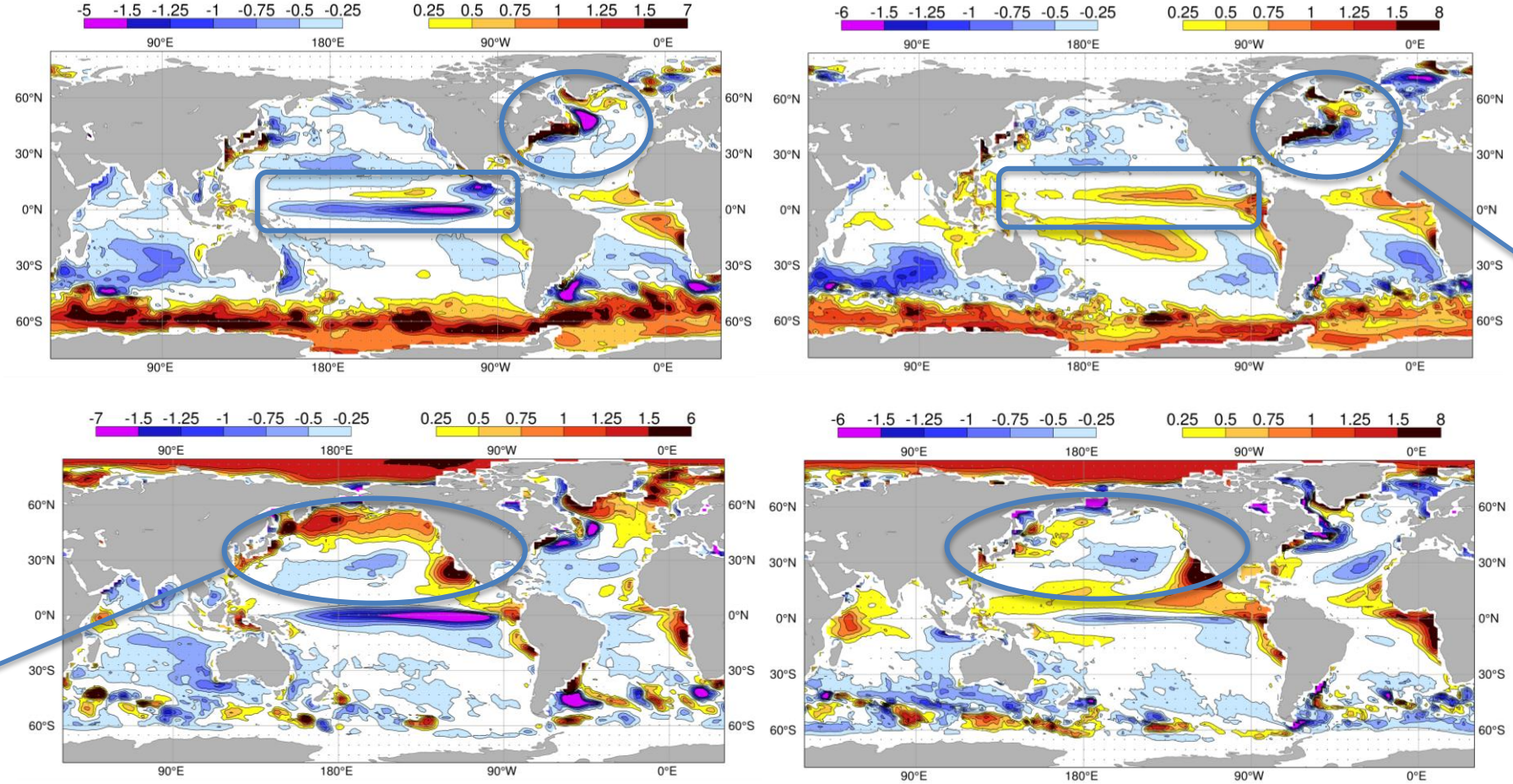
Global SST biases improve, especially in the ENSO regions

SEAS4 - ERAI

SEAS5 - ERAI

DJF

JJA

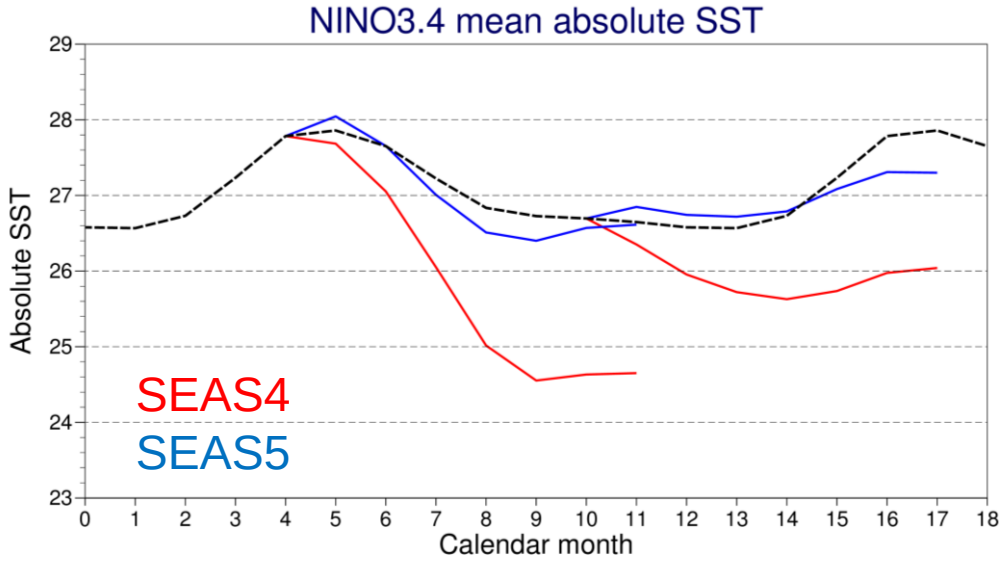


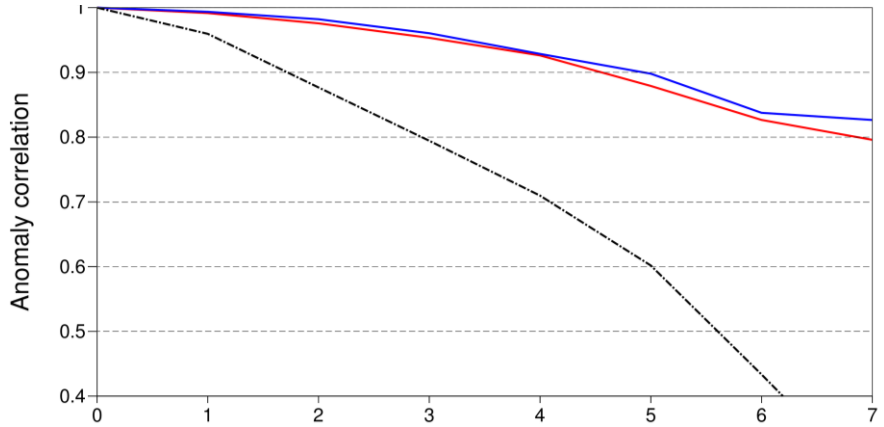
Ocean horizontal resolution

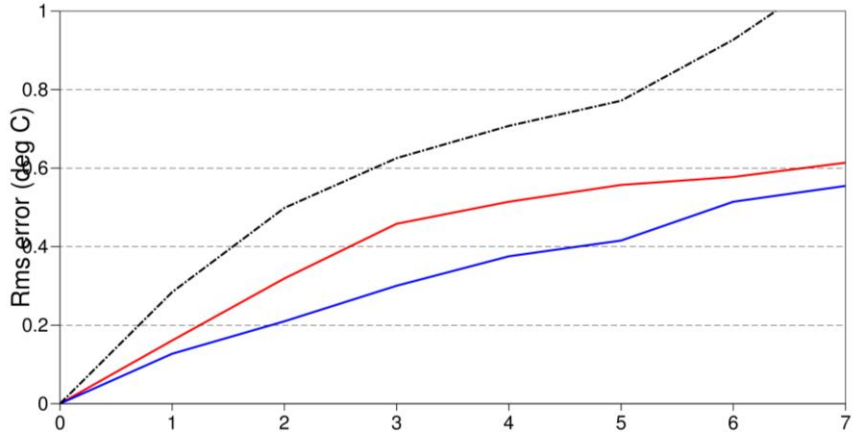
Ocean vertical mixing

Particular improvement in the ENSO regions, much better foundation for ENSO teleconnections

Global SST biases improve, especially in the ENSO regions



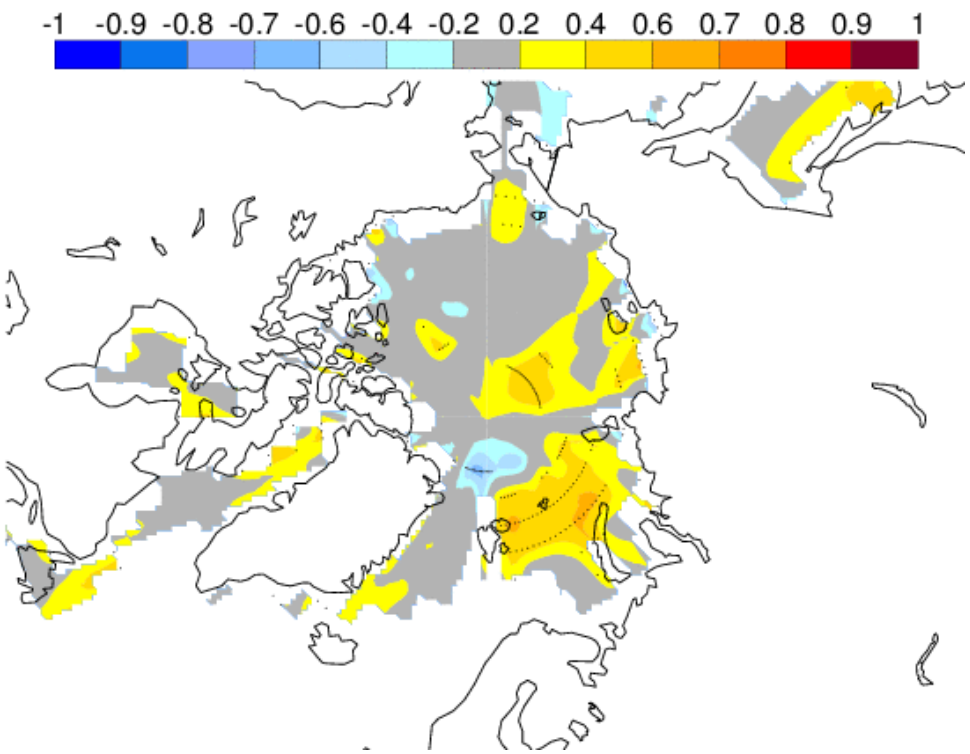




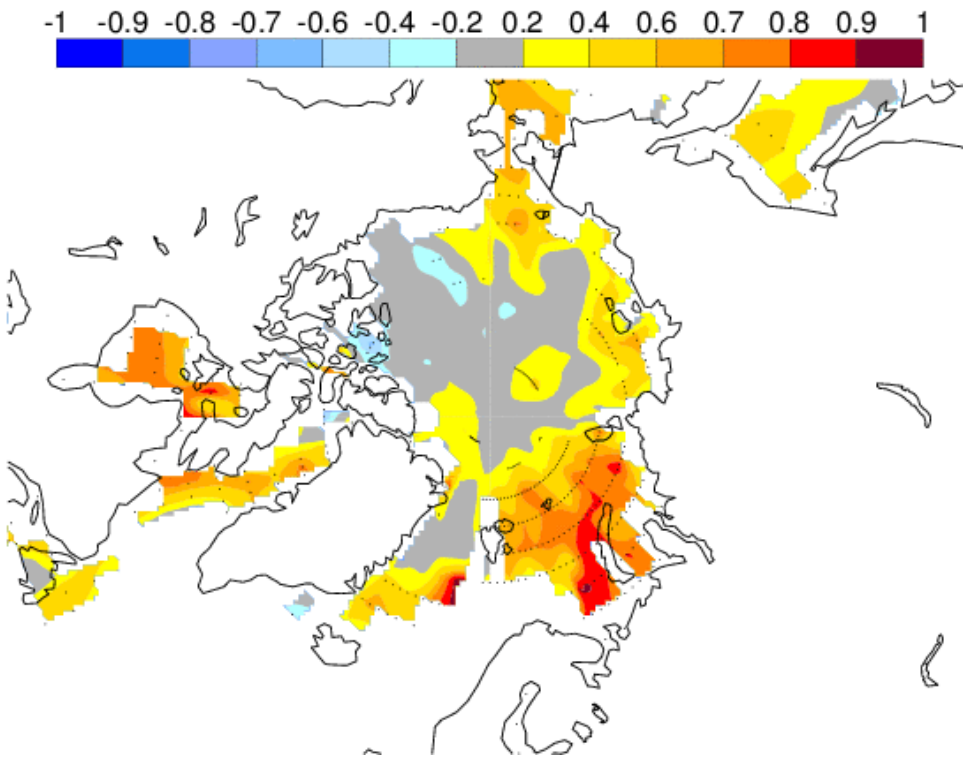
ENSO SST drift improves markedly. Also a small increase in ENSO correlation scores, an improvement in ENSO variance, and a decrease in RMS error (after bias correction).

Sea ice cover - DJF anomaly correlations

SEAS4

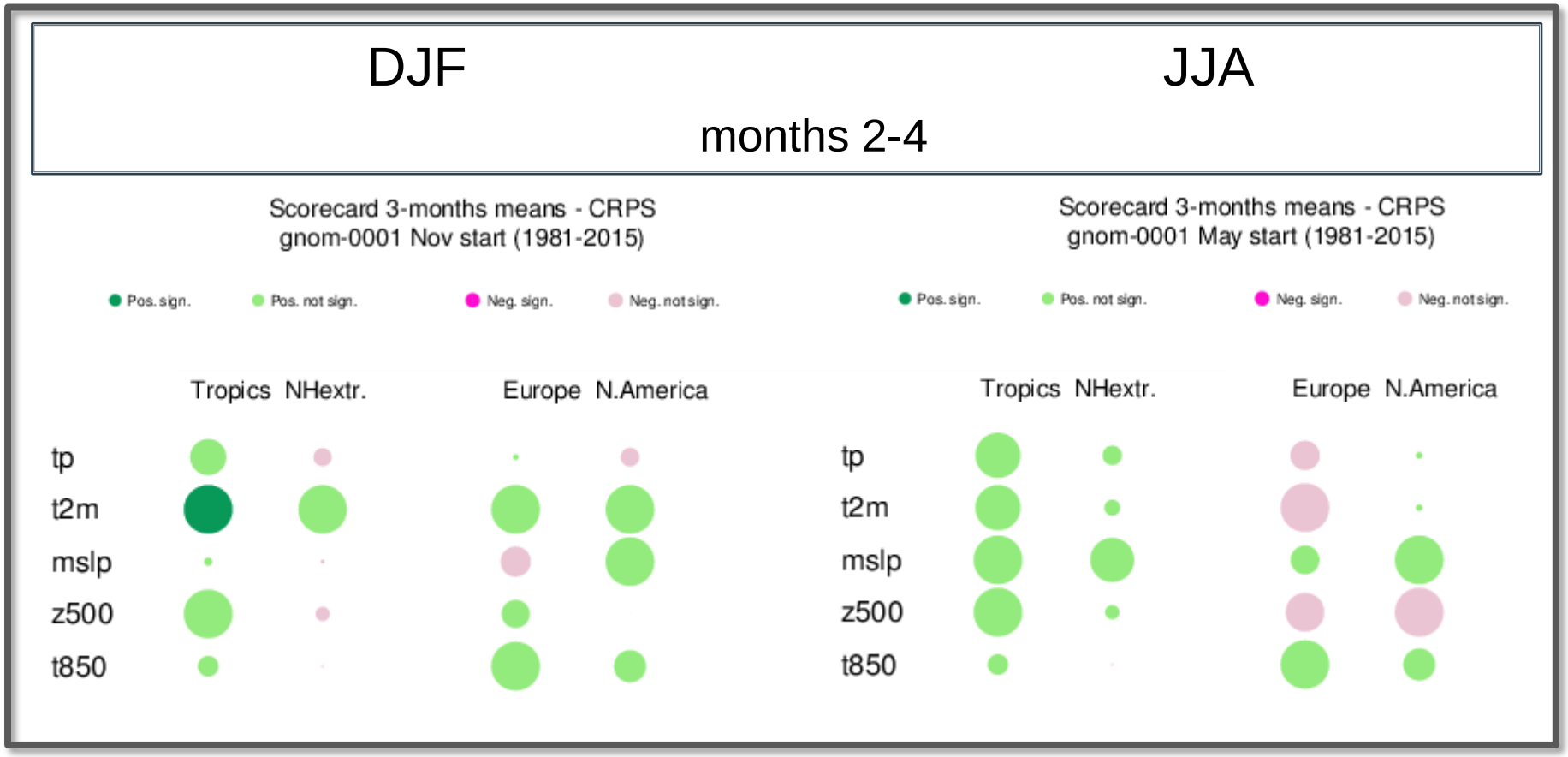


SEAS5



Sea ice cover predictability improves when we include the interactive sea ice model….

SEAS5 vs SEAS4 score cards:



Green System 5 is better

Pink System 5 is worse

ECMWF

Products:

Digital Data:

Surface data: several fields are upgraded to 6 hourly output, (SST, precipitation, snowfall, downward solar and downward thermal radiation). New addition:

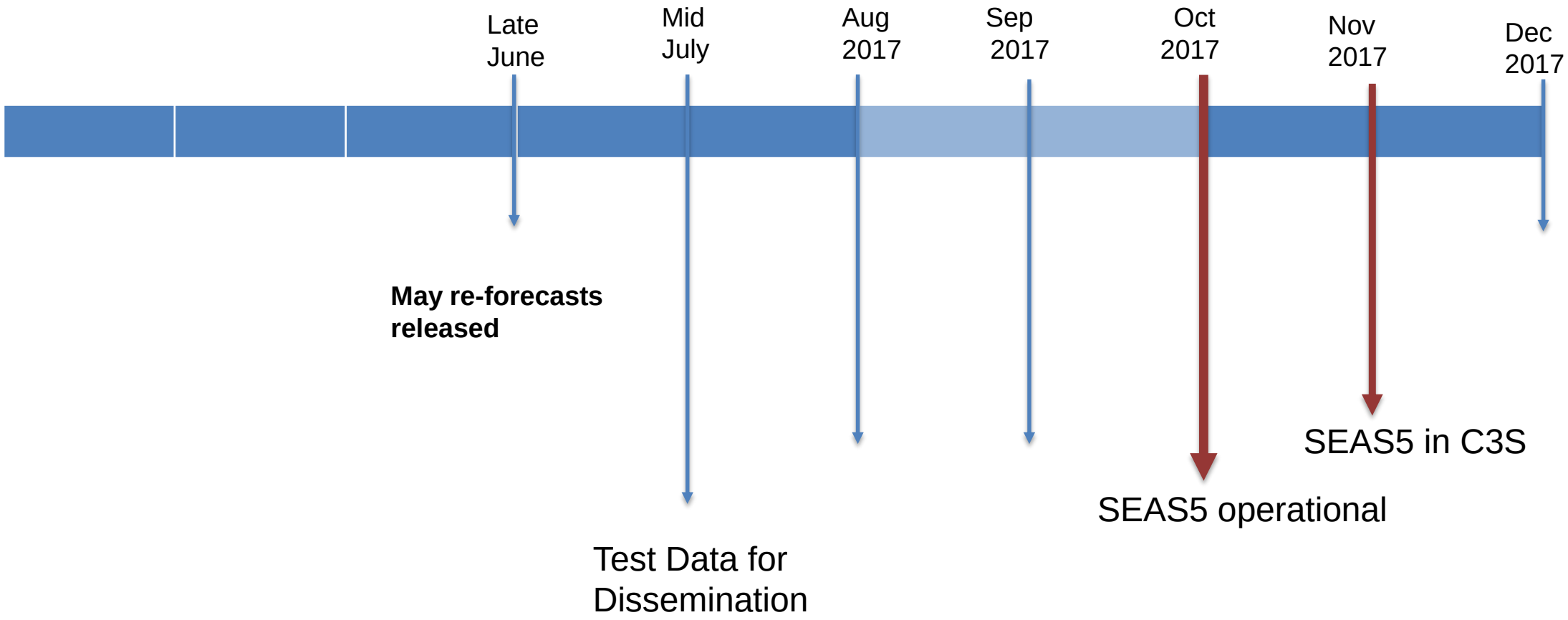
- 6 hourly instantaneous surface stresses (2 new fields, x and y).
- 24h incoming TOA solar radiation, lake mixed layer temperature, lake ice thickness
- Lake cover and Lake depth at step 0.

Model level data: the forecast length for which this is available is extended from 5 months to 6 months; the number of ensemble members with ml data remains unchanged.

Graphical products:

Same as the current but **the anomalies will be with respect to a 1993-2016 climate.**

SEAS5 proposed implementation schedule



Summary

System 5:	More recent model cycle. High resolution (ocean and atmosphere) Sea-Ice New ocean reanalysis ORAS5

- Broadly, **model climate improves, except in the stratosphere**.
- Global SST biases improve, especially in the ENSO regions. **Cold-tongue bias almost disappears. Improved ENSO variability.**
- Introduction of **interactive sea-ice** improves predictability of the sea ice cover, but introduces sea ice cover biases, especially in summer.
- **In the tropics the SEAS5 skill is significantly higher than SEAS4**.
- **Over the Northern extra-tropics and Europe the skill difference is not highly significant**.
- We have carried out a comprehensive evaluation of system 5 and the results will be published in a technical memo.