SEAS5: The ECMWF seasonal forecast system

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S2S/S2D Boulder, Colorado

Sept. 18, 2018

See also Johnson et al. 2018 (submitted to GMD) and ECMWF's website.

ECMWF

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ECMWF SEAS5

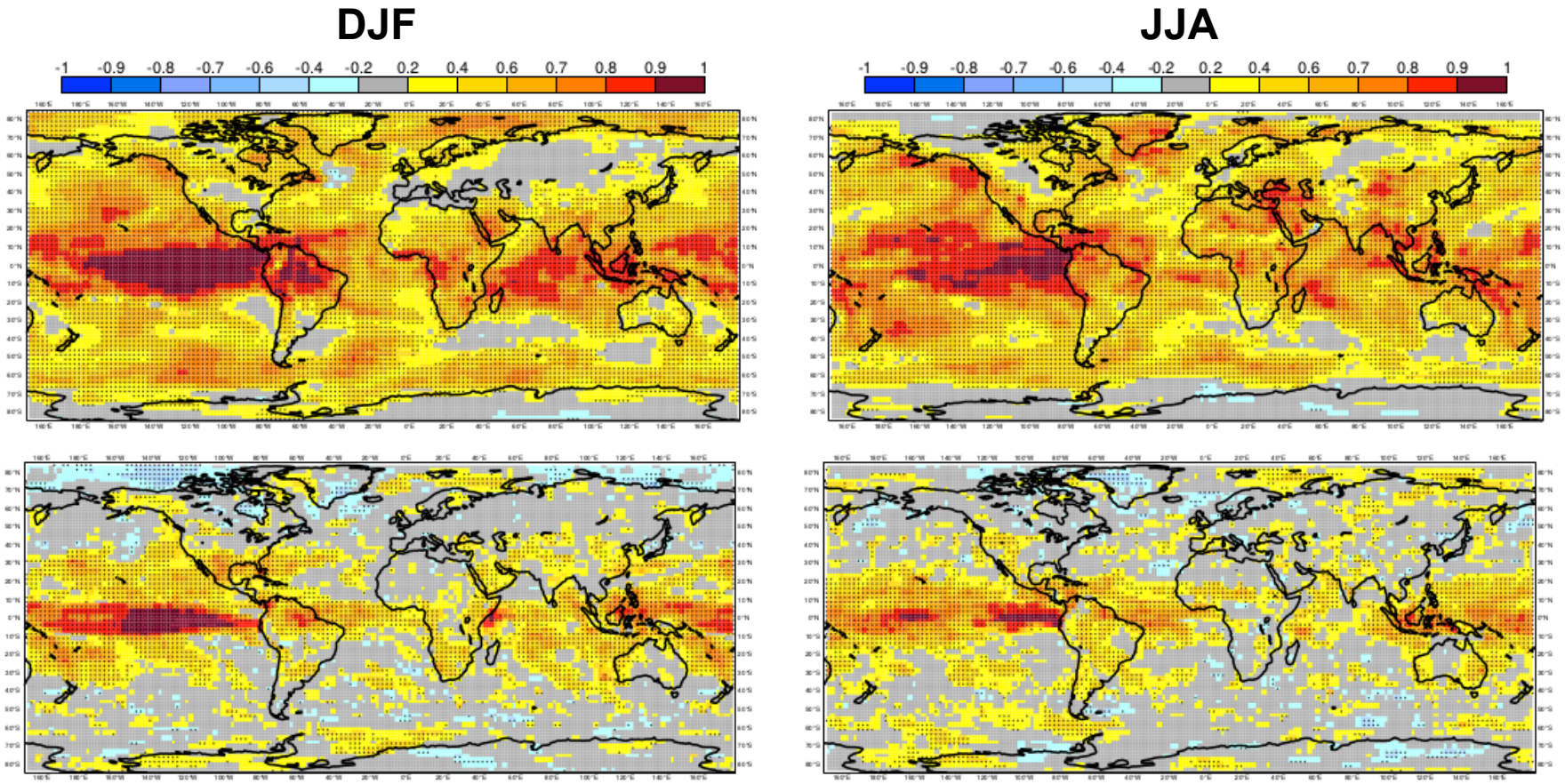
	System 4 (SEAS4) 2011	SEAS5 2017
Atmosphere	Cycle 36r4 T_L255 L91	Cycle 43r1 T_{Co}319 L91
Ocean	NEMO v3.0 ORCA 1.0-L42	NEMO v3.4 ORCA 0.25-L75
Sea ice model	Sampled climatology	LIM2
Atm. initial conditions	ERA-Interim/Ops	ERA-Interim/Ops
Ocean and sea ice initial conditions	OCEAN4	OCEAN5

- Forecasts initialized on the first of the month
  - 51 members integrated for 7 months
  - 15 of those members integrated for 13 months in Feb, May, Aug, Nov
- Reforecasts initialized from 1981 to 2016
  - 25 members integrated for 7 months
  - 15 of those members integrated for 13 months in Feb, May, Aug, Nov
  - For operational charts, 1993 to 2016 used for calculating anomalies (consistent with C3S)

An upgraded system, with more complexity
Seamlessness a key priority in development

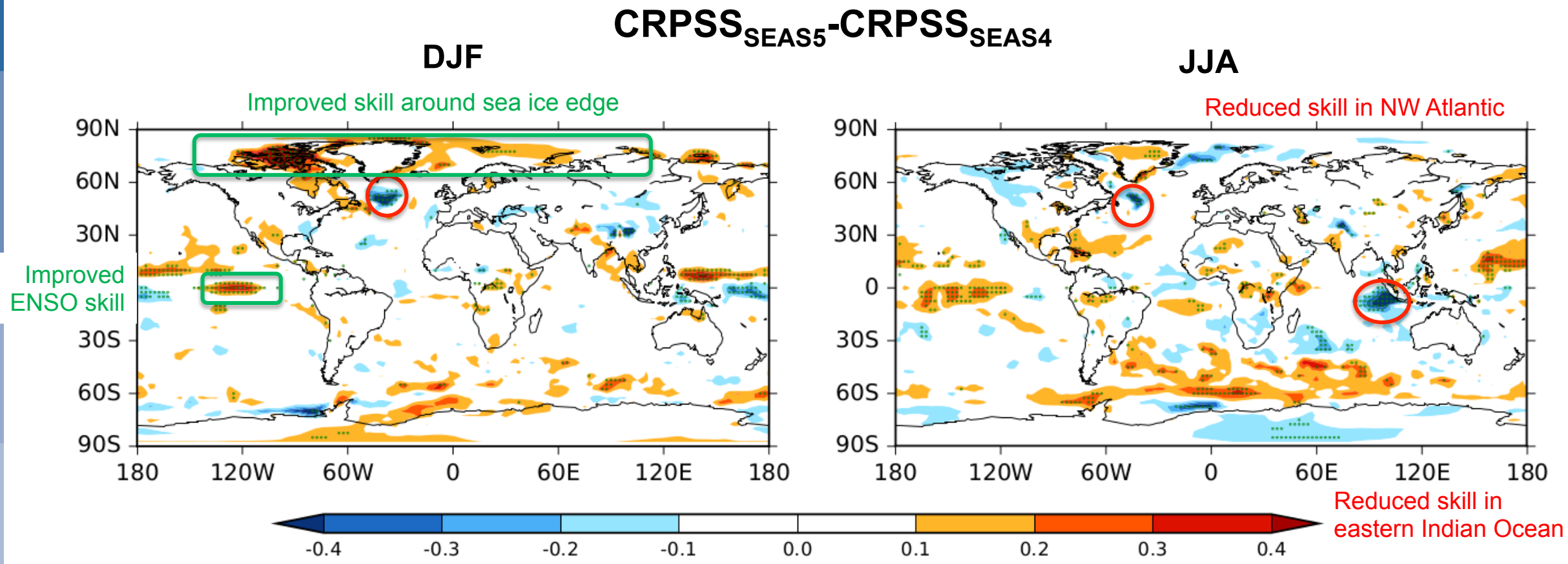
In this presentation, plots primarily show seasonal means at one month forecast lead (i.e. month 2 to 4 of the forecast) using 25 ensemble members

SEAS5 anomaly correlation maps



- Skill in 2m temperature and precipitation present over tropical oceans.
- Skill in 2m temperature extends to the extratropics. For example, over Europe in summer.

Difference in 2 m temperature skill

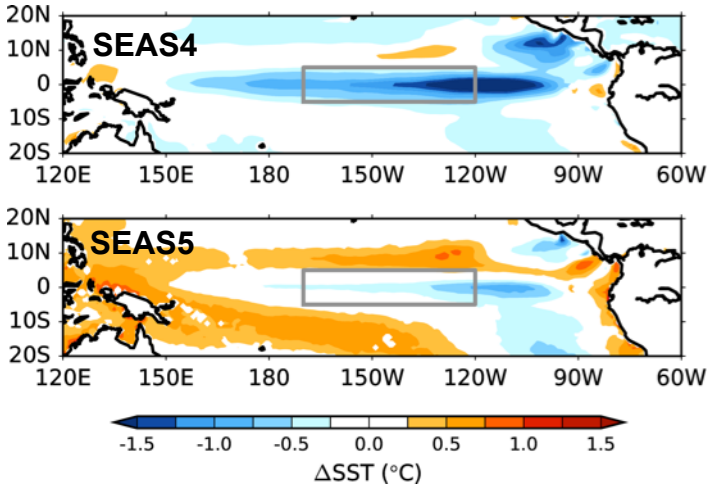


Will discuss each of these in the next slides…

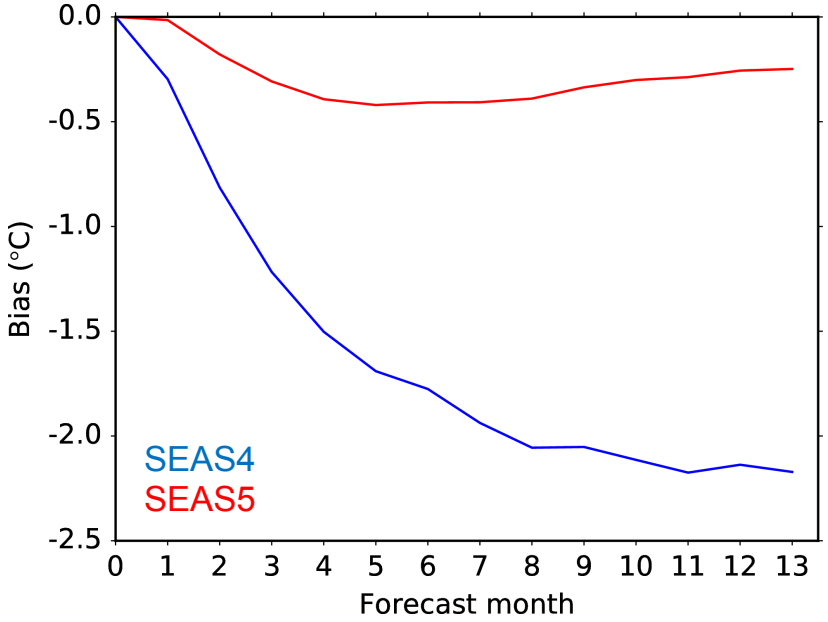
Niño 3.4

Niño 3.4 annual range reforecasts: 15 members with respect to OIv2

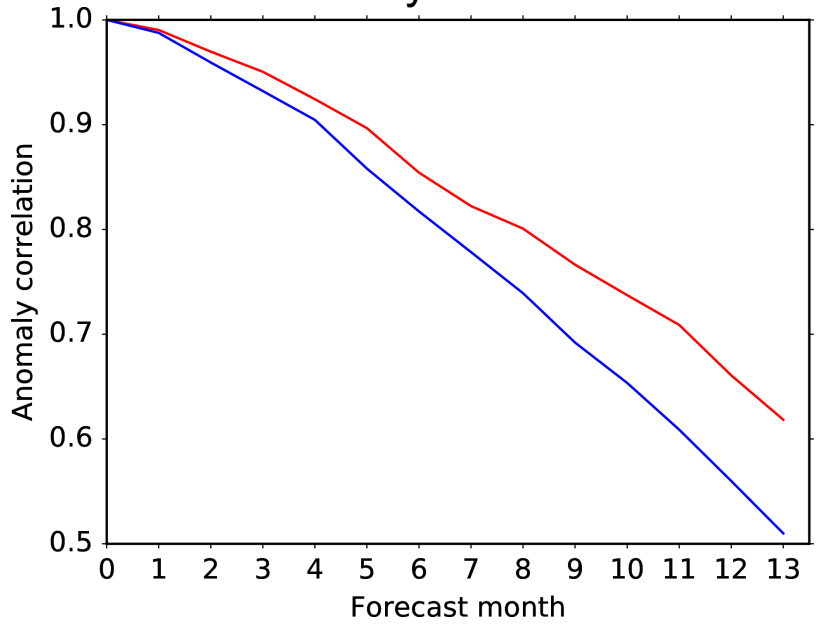
DJF SST bias compared to OCEAN4/5



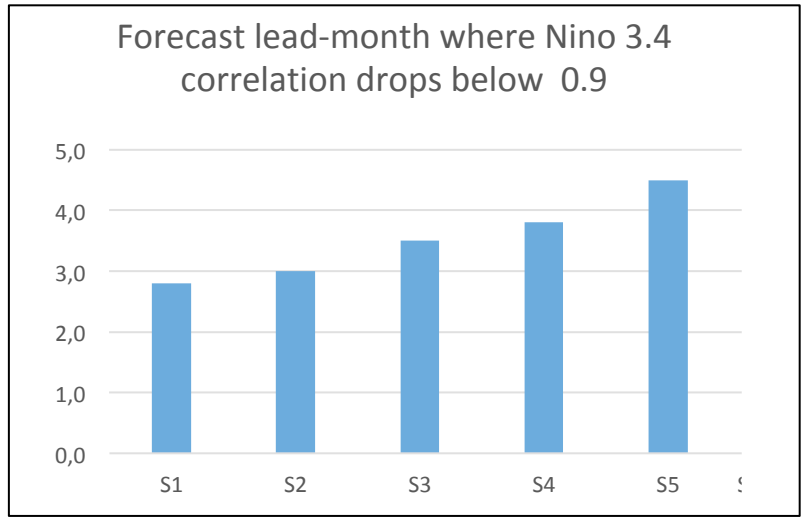
Bias



Anomaly correlation



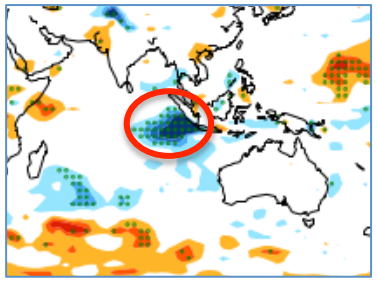
- Large improvement in equatorial cold tongue bias.
- Improvement in Niño 3.4 skill, particularly at longer lead times.
- Improvement in ENSO similar to progress when introducing previous forecast systems.

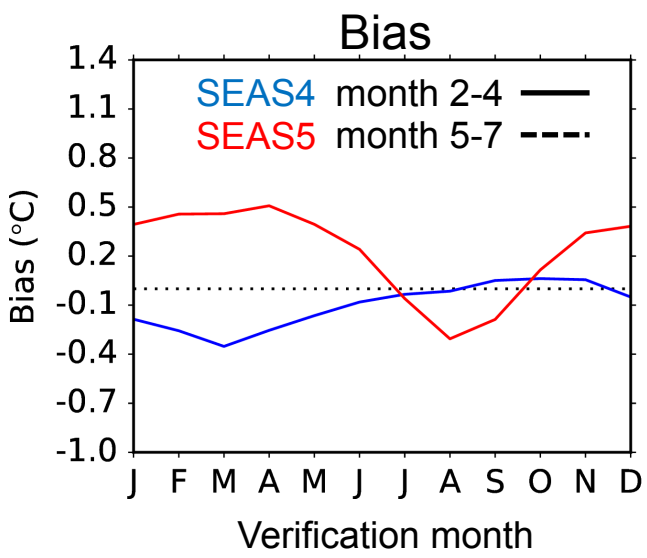


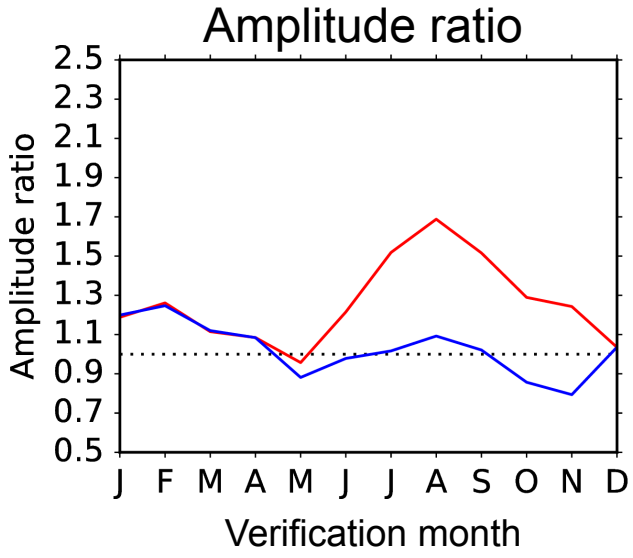
Eastern Indian Ocean

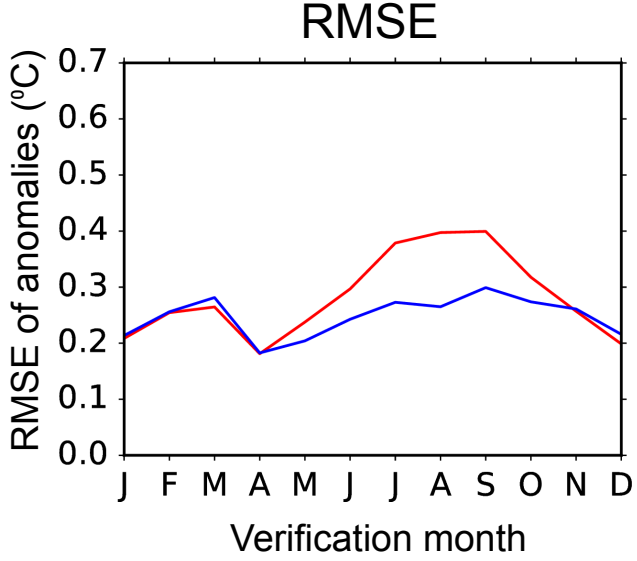
Eastern Indian Ocean reforecasts: with respect to OIv2

ΔCRPSS





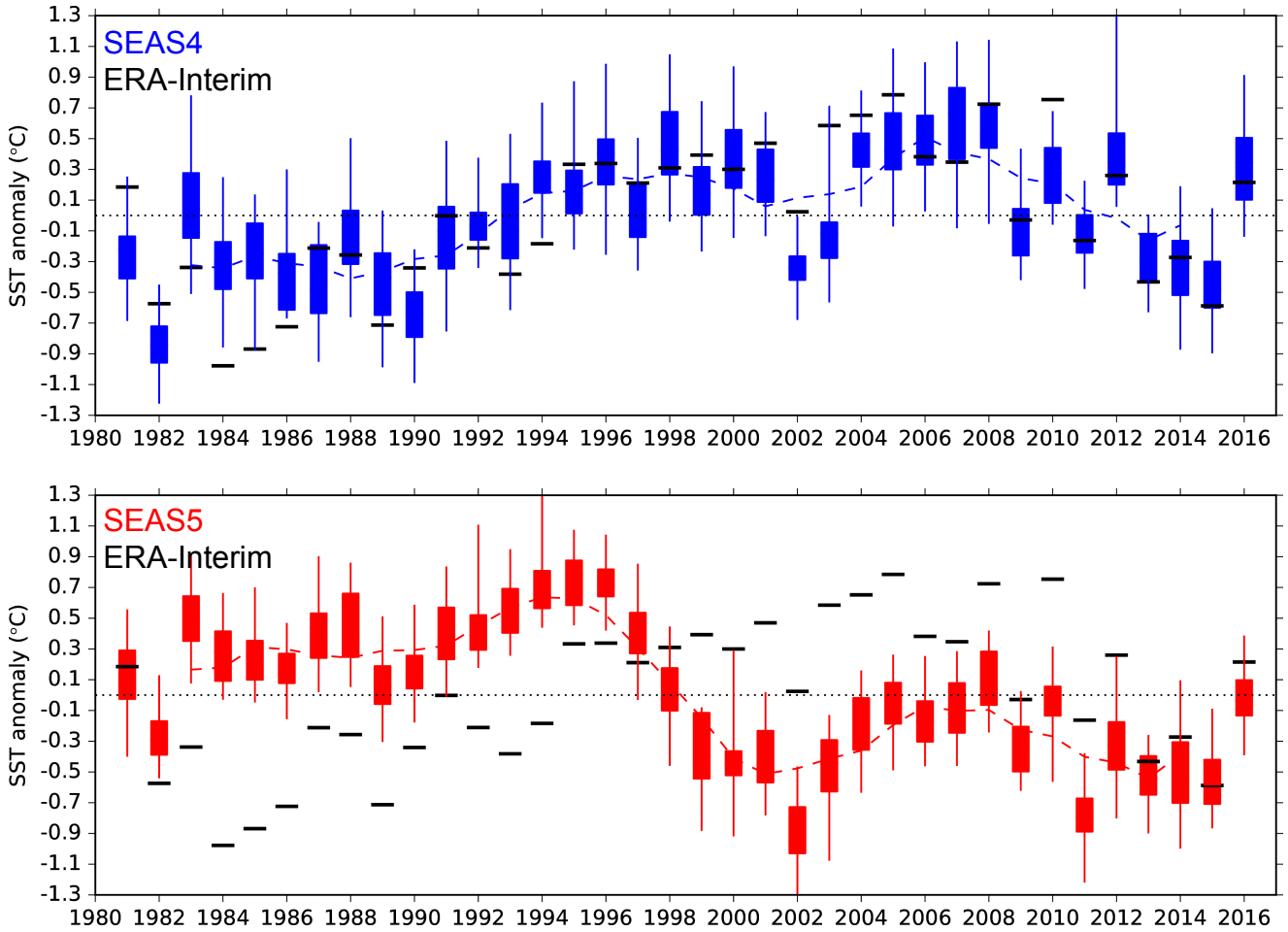




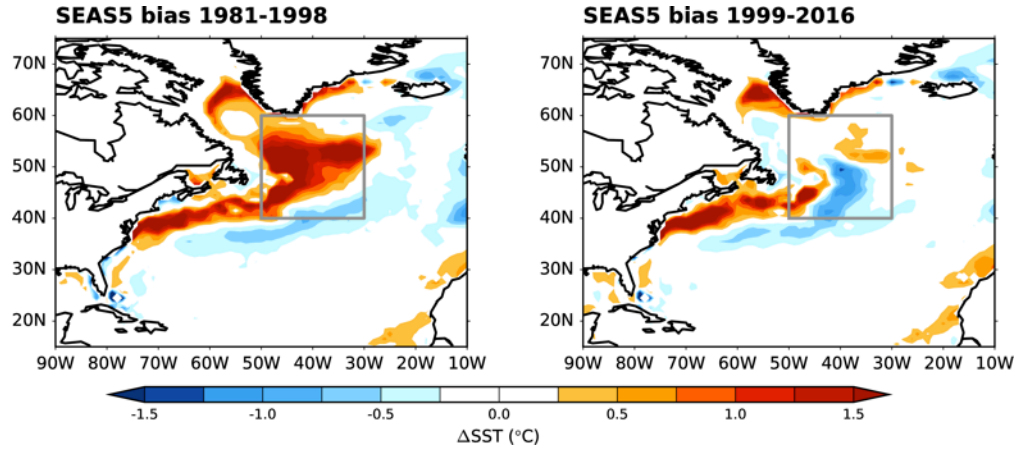
- Cold SST anomalies in the eastern Indian Ocean are too large, too variable and too frequent.
- Results in large errors in skill in the eastern box of Indian Ocean Dipole index.

New Northwest Atlantic problem

DJF SST anomalies in Northwest Atlantic



SEAS5 DJF SST bias with respect to OCEAN5



- Poor representation of the decadal variability in the Northwest Atlantic.
- Related to increased resolution of new ocean analysis system, investigations under way.
- Also investigating whether/how this loss in skill affects skill downstream.

Arctic sea ice

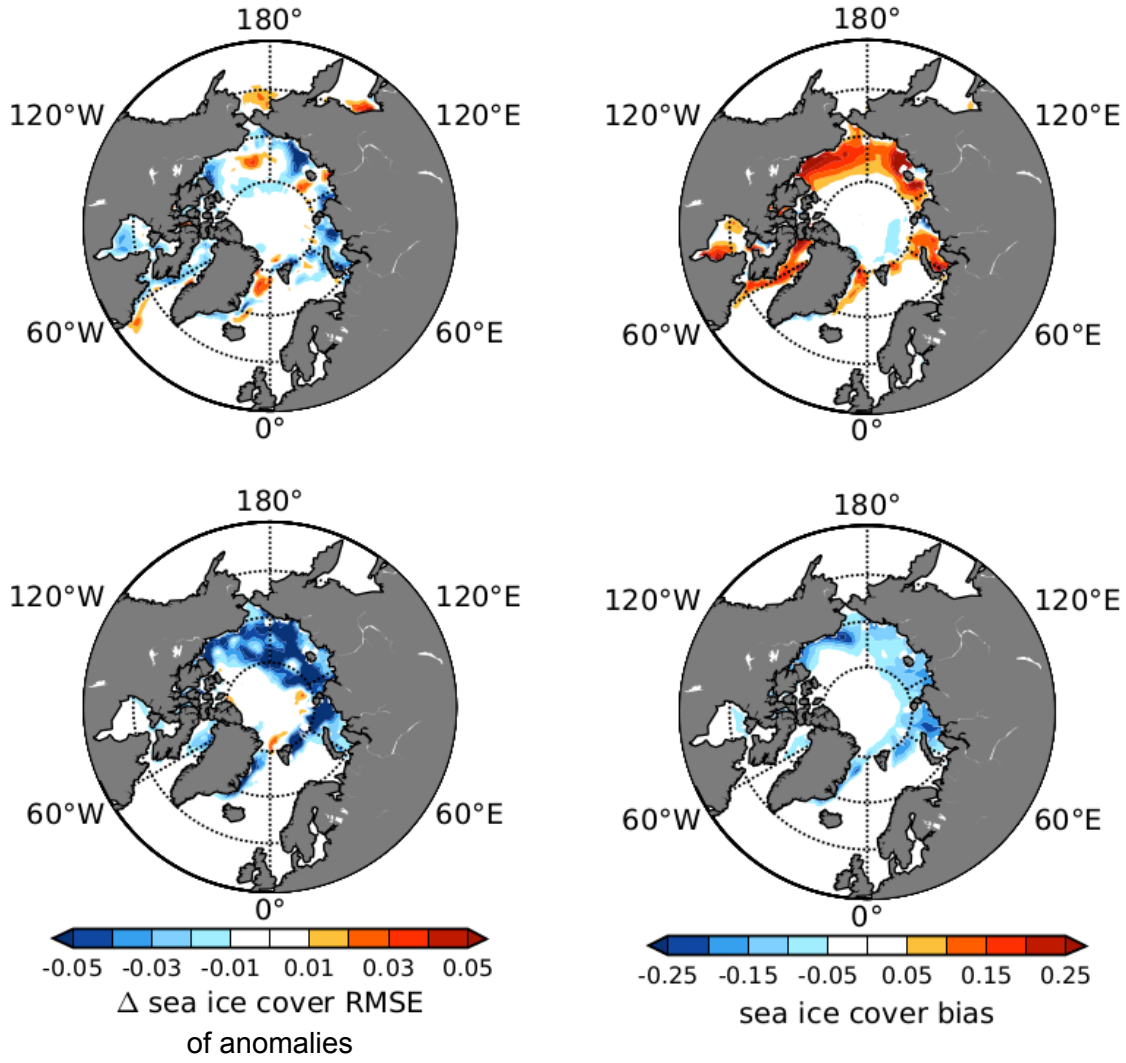
- SEAS4 used a simple empirical scheme that only captured the trend, not interannual variability.
- Adding LIM2 improves skill in predicting sea ice, but introduces sea ice biases.
- Skill improves most in autumn, and biases are worst in summer.

SEAS5 – SEAS4 RMSE
with respect to OSI-450

SEAS5 bias
with respect to OSI-450

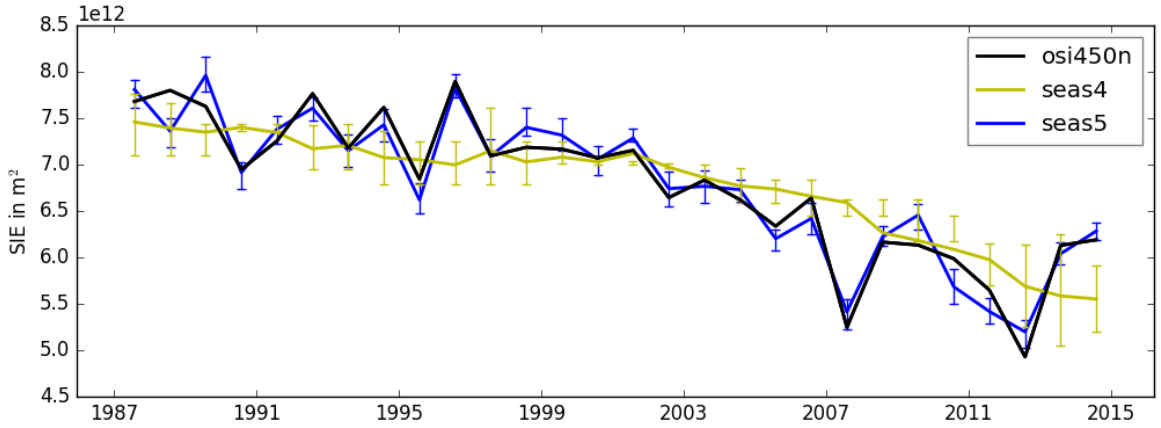
JJA

SON



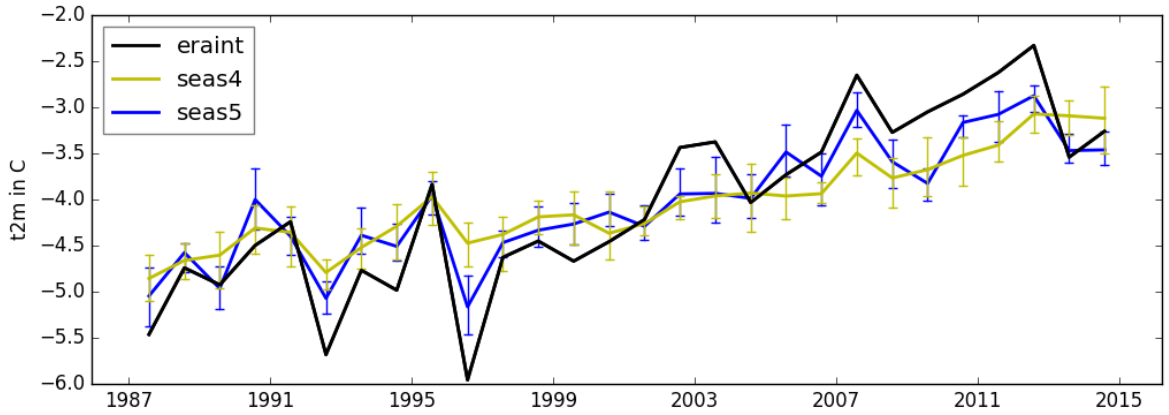
Arctic sea ice impacts

ASO mean sea ice extent north of 70⁰ N
July start - one month lead



Prognostic sea ice model introduces interannual variability in arctic sea ice extent.

ASO mean 2 m temperature north of 70⁰ N
July start - one month lead



Increased skill in 2 m T north of 70⁰ N associated with improved sea ice prediction.

Summary

- SEAS5 is a **state of the art seasonal forecasting system**: increased ocean and atmosphere resolution, prognostic sea-ice, new ocean reanalysis.
- **Seamlessness a priority** in SEAS5 development.
- Equatorial Pacific **cold-tongue bias almost disappears. Improved ENSO variability and skill.**
- Introduction of **interactive sea-ice** improves prediction skill of the sea ice cover and associated surface temperature at high latitudes, but introduces sea ice cover biases.
- Broadly, model climate improves, except in the stratosphere (see journal article).
- **Poor decadal variability over NW Atlantic** in SEAS5.
- SST variability over **eastern tropical Indian Ocean degraded.**
- SEAS5 tropical-extratropical teleconnections not improved, in some cases, degraded (see Franco Molteni's presentation).
- Stratosphere and tropospheric jets biases degrade in SEAS5 (see journal article).

SEAS5 data publicly available through C3S (see B4-08, Anca Brookshaw's presentation)

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