

Implementation of SEAS6

Tim Stockdale

(on behalf of the seasonal forecast team and other colleagues)

ECMWF

tim.stockdale@ecmwf.int



SEAS6 implementation is underway ...

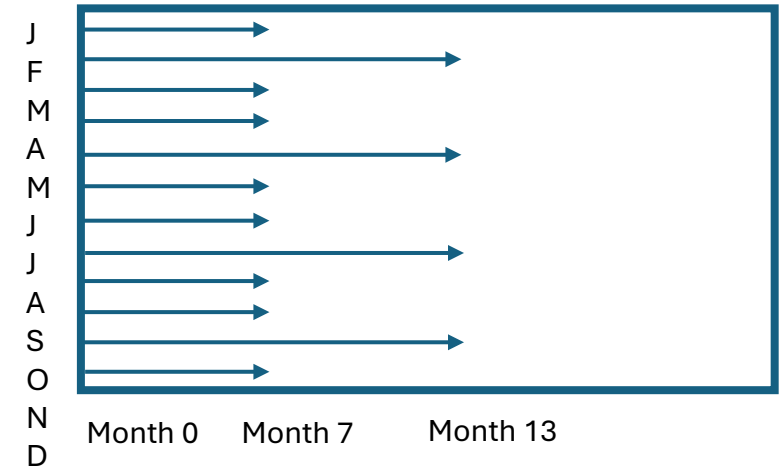
- Structure
- Science
- Output
- Products
- Timeline

SEAS6 structure: configuration summary

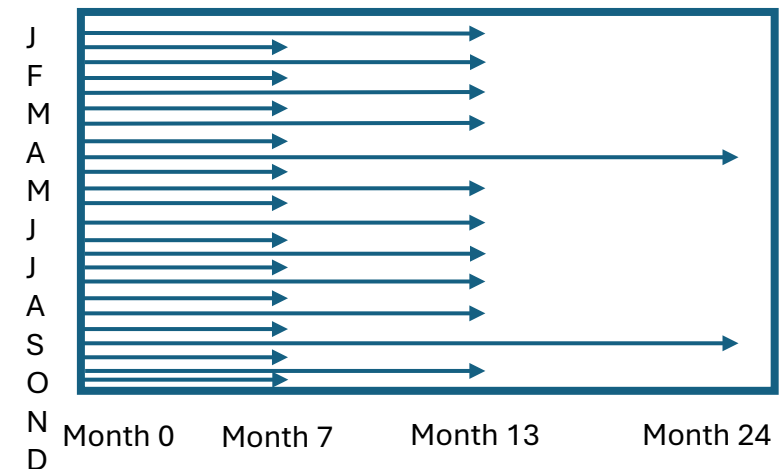
- Enhancement 1: Real-time 101-member ensemble
- Enhancement 2: Issue SEAS twice per month
 - Initial date 1st and 16th of each month
- Enhancement 3: Expand annual-range ENSO forecasts
 - Issue forecast monthly not quarterly
 - Twice per year, increase range to 24 months
- Enhancement 4: More comprehensive reforecasts
 - Larger ensemble sizes and larger set of years

IFS horizontal resolution unchanged: TCo319. Vertical > L137

SEAS5



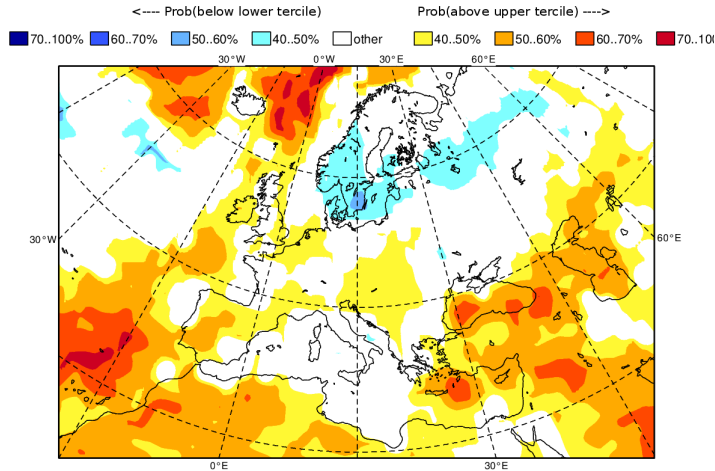
SEAS6



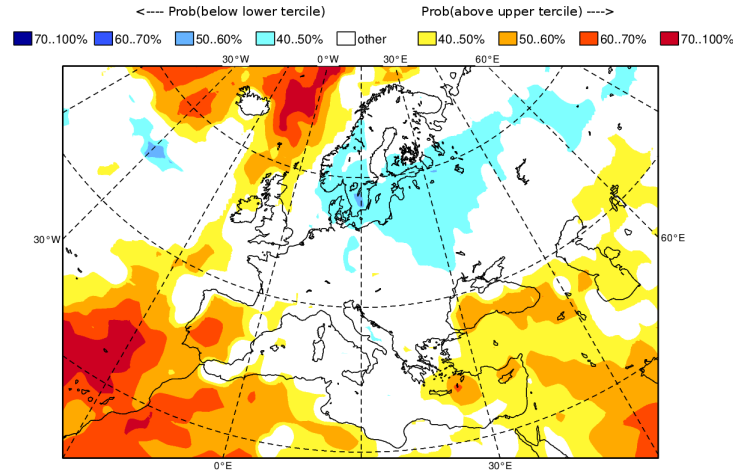
Structure: 101-member ensembles

- Reduced noise and improved accuracy in forecasts
- Consistent with recent increase in SUBS

Expt gjbv
 Prob(most likely category of 2m temperature)
 Forecast start is 01/11/09, climate period is 1993-2008
 Ensemble size = 51, climate size = 80

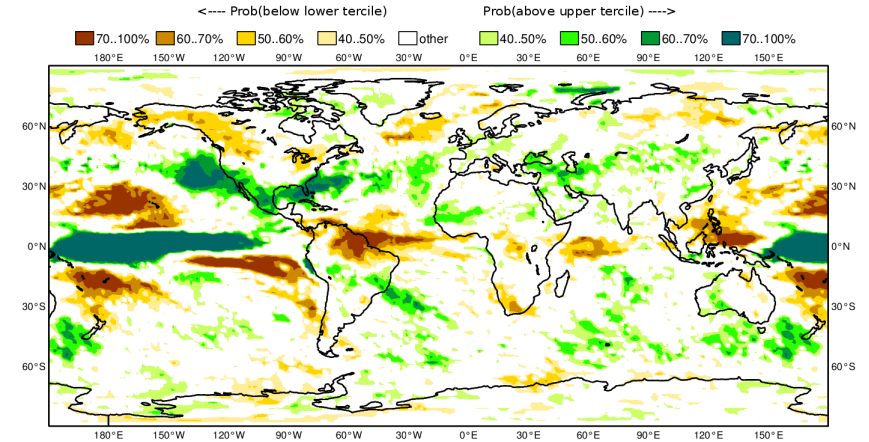


Expt gjbv
 DJF Prob(most likely category of 2m temperature)
 Forecast start is 01/11/09, climate period is 1993-2008
 Ensemble size = 101, climate size = 80



Expt gjbv
 Prob(most likely category of precipitation)
 Forecast start is 01/11/09, climate period is 1993-2008
 Ensemble size = 51, climate size = 80

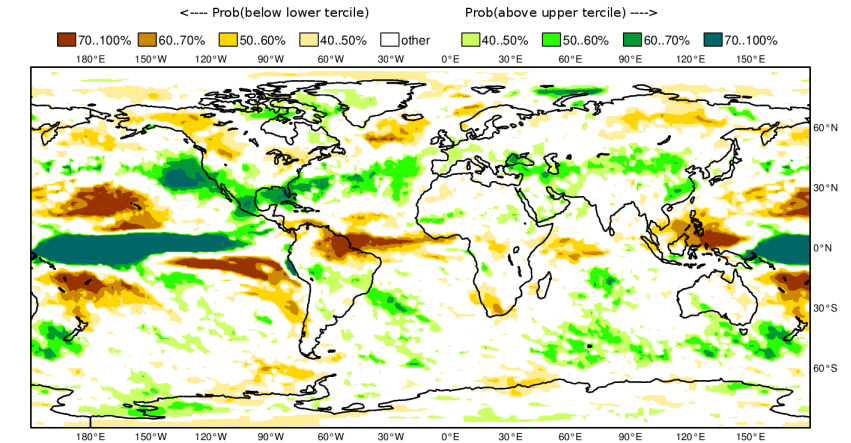
DJF 2009/10



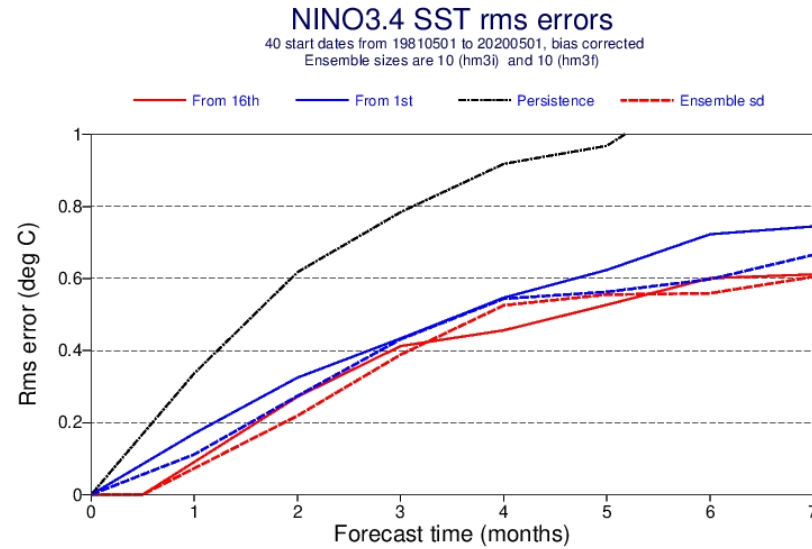
DJF 2

xpt gjbv
 Prob(most likely category of precipitation)
 Forecast start is 01/11/09, climate period is 1993-2008
 Ensemble size = 101, climate size = 80

DJF 2009/10

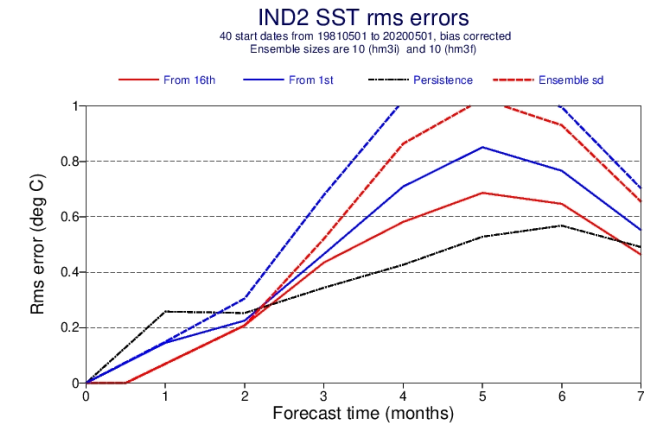
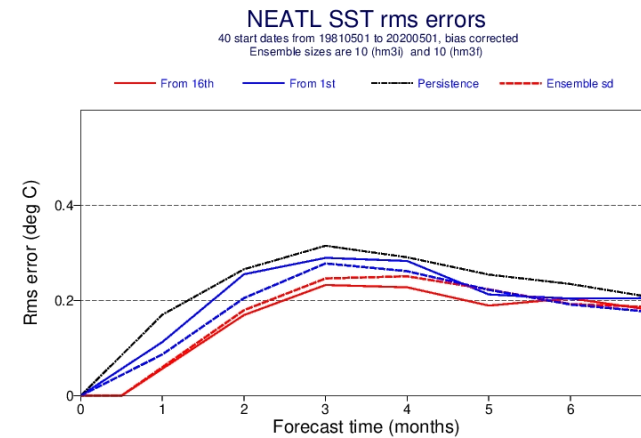
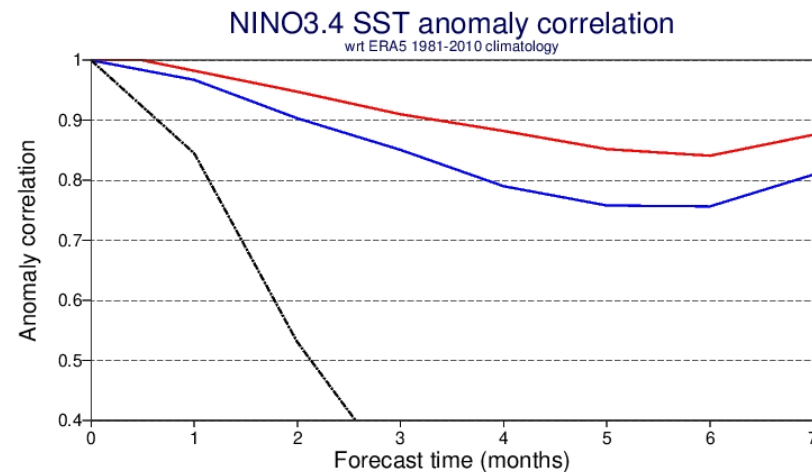


Structure: Issue forecasts twice per month

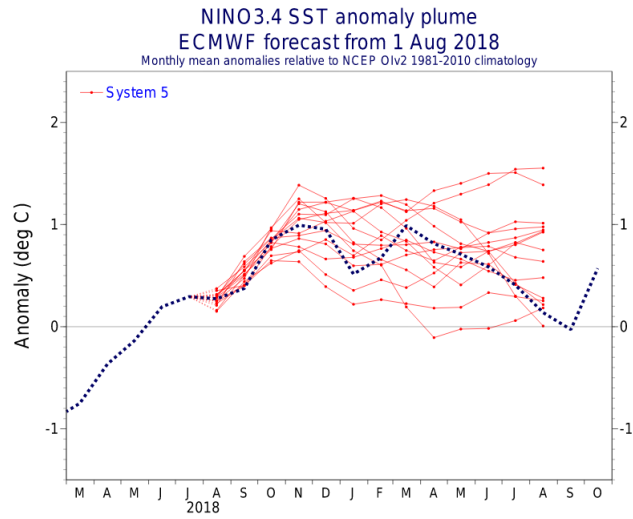


TCo199 Cy47r3 tests for May starts show strong benefit from starting on the 16th (red) rather than the 1st (blue).

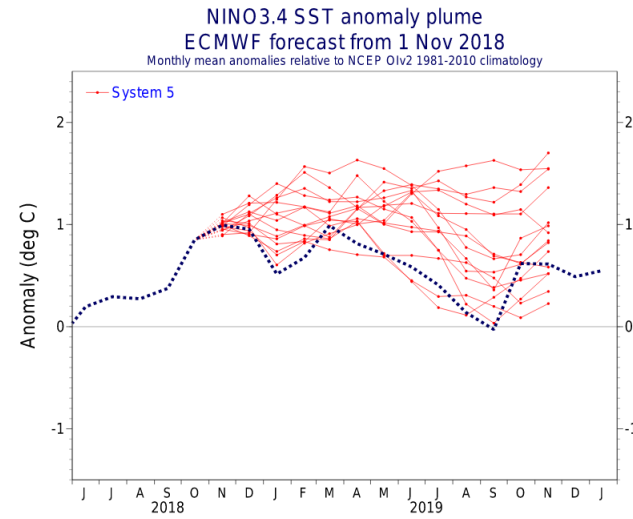
Benefit is not just a uniform shift in lead time, but in some situations a more up-to-date forecast gives access to a more accurate forecast regime.



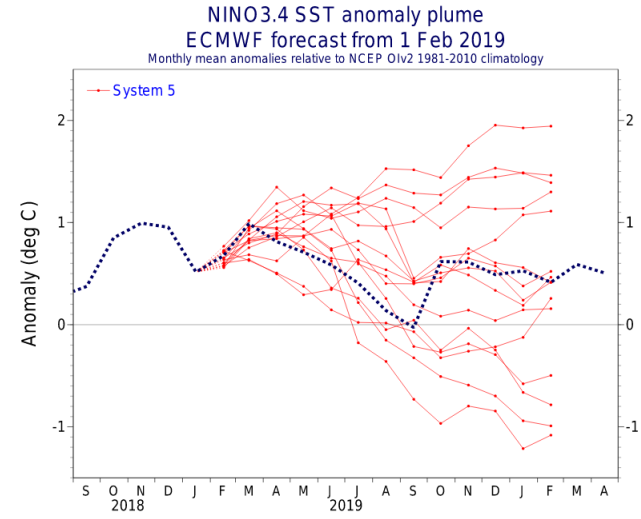
Structure: Expand annual-range forecasts



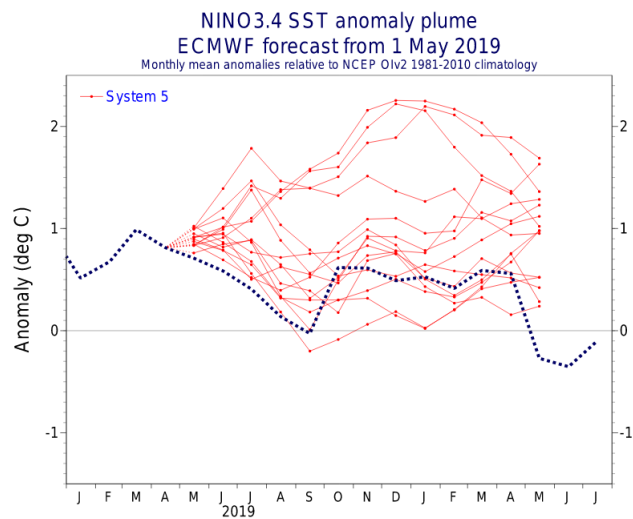
ECMWF



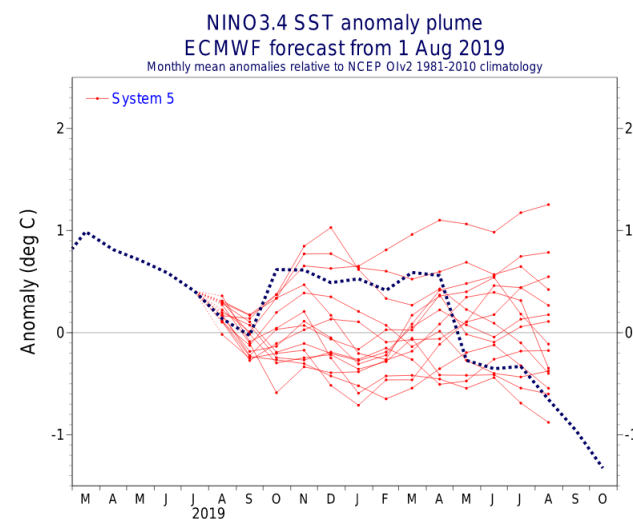
ECMWF



ECMWF



ECMWF



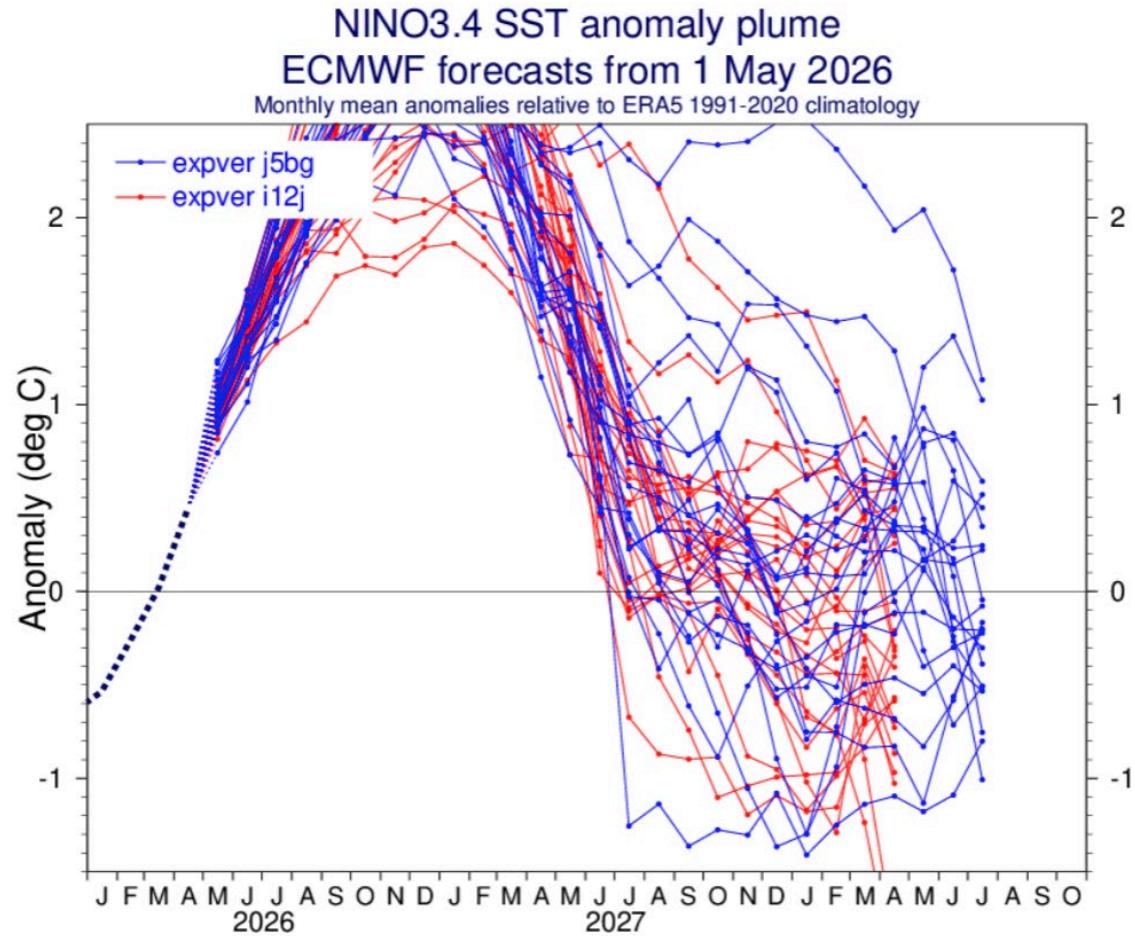
ECMWF

With 3-month intervals between forecasts, a lot can change and the latest forecast can be very out of date.

A monthly update will give users more consistent, accurate and up-to-date forecast information.

Structure: 2-year ENSO outlook

- In May and November, we will run forecasts out to 2 years



(Plot from M. Balmaseda)

Structure: Changes in seasonal-range re-forecasts

SEAS5 real-time	SEAS6 real-time	SEAS5 re-forecasts	SEAS6 re-forecasts
51 members, monthly	101 members, twice monthly	25 members monthly, 1981-2016	33 members twice monthly, 1993-2025
		51 members quarterly, 1981-2016	51 members quarterly, 1961-2025 (101 for November starts)

- SEAS5 calibration used 1993-2016, SEAS6 calibration will use 1993-2025, see later for details.
- Better resolved and more extensive skill information (up to 65 years, and up to 101 members)

Structure: Changes in annual-range re-forecasts

SEAS5 real-time	SEAS6 real-time	SEAS5 re-forecasts	SEAS6 re-forecasts
15 members quarterly	33 members monthly	15 members quarterly, 1981-2016	11 members monthly, 1993-2025
			22 members quarterly, 1961-2025
	33 members, May and Nov, to 24 months		22 members, May and Nov, to 24 months, 1961-2025

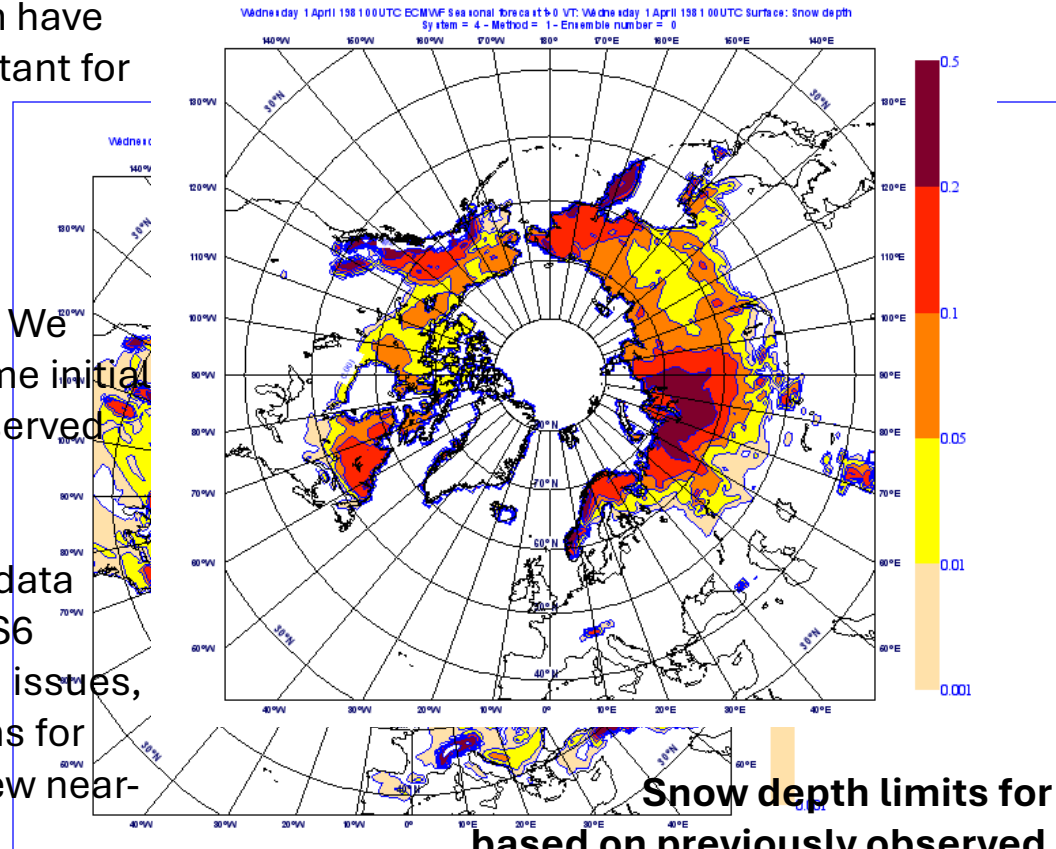
- More frequently updated forecast (monthly vs quarterly)
- Longer range ENSO outlook twice per year
- Better resolved forecast pdf (33 vs 15), but still ENSO focused (QBO should also be good)
- Additional skill information (up to 65 years, and up to 22 members)

SEAS6: land surface initial conditions from new LDAS suite

Soil moisture and **snow depth** both have long enough timescales to be important for seasonal prediction.

Previous SEAS configurations have **inconsistent** land initial conditions between re-forecasts and real-time. We limit the damage by insisting real-time initial conditions are within previously observed bounds (see figure, right).

SEAS6 will have a stand-alone land data assimilation system, run at the SEAS6 resolution to avoid any interpolation issues, and used to prepare initial conditions for **both** the re-forecasts and (from a new near-real-time operational suite) and the forecasts.



Snow depth limits for SEAS5, 1st April based on previously observed min (left) and max (right)

Used as a safeguard to limit inconsistency between real-time and re-forecast initial conditions. Limits are applied to soil moisture, snow, lakes, soil temperatures.

SEAS6 performance

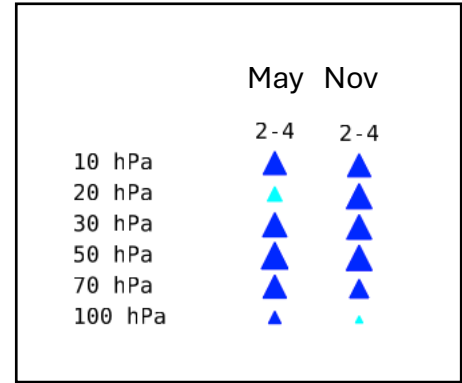
Some highlights relevant for seasonal forecast skill:

- Improved stratosphere
- Improved climate (mostly)
- Improved SST/precipitation forecast skill in far west Pacific

QBO variability

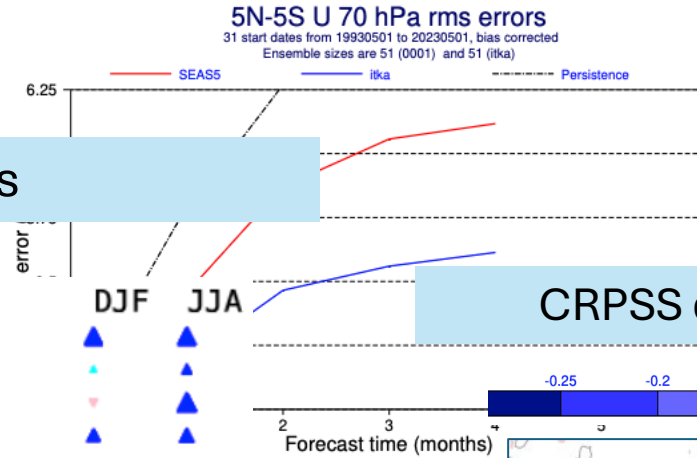
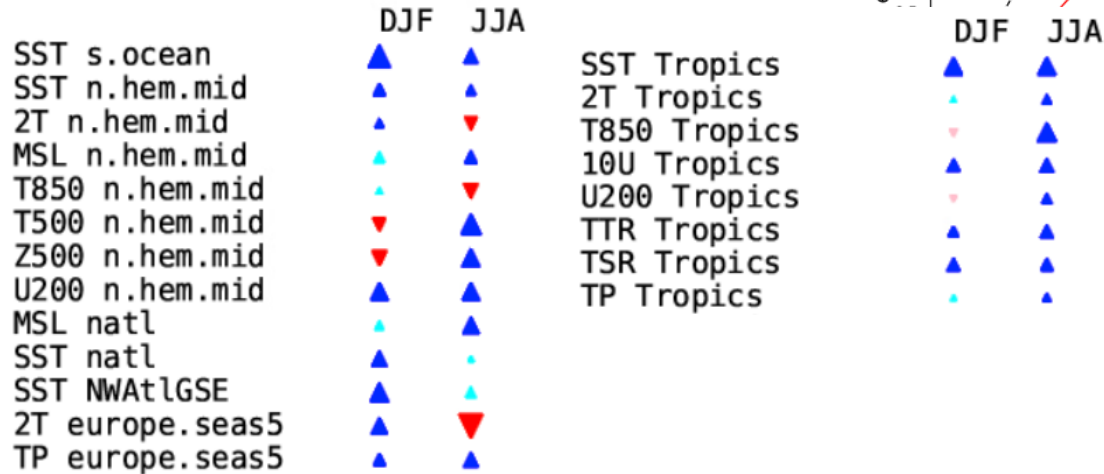
5N-5S U 70 hPa RMS errors

QBO scorecard

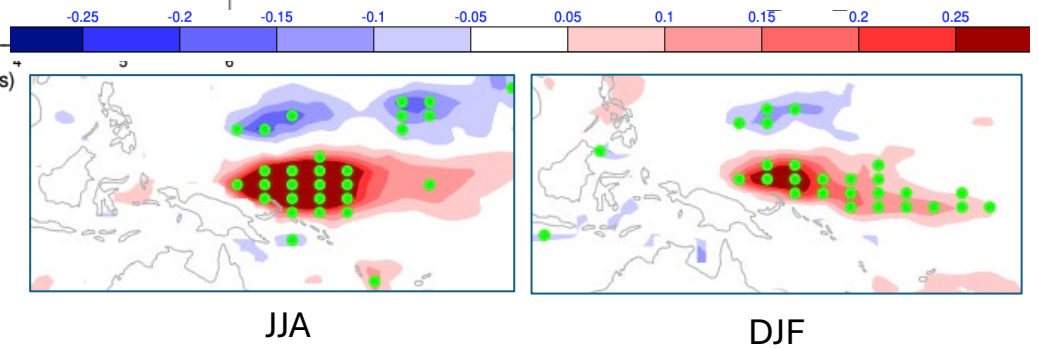


SEAS5
SEAS6_proto

Mean climate scorecards



CRPSS difference (SEAS6_proto – SEAS5), SST



1993-2024, 51 ensemble members, initialized on May 1 and Nov 1

SEAS6: output

- Major change: all output will be in GRIB2
- Major change: New MARS streams, structures and concepts
 - paramId: ECMWF concept, identifies field.
 - paramId for monthly mean is **different** from that for instantaneous value
 - For monthly streams, new keyword statype = MOAV/MOMX/MOMN/MOSD

1260	Seasonal forecast daily and sub-daily data	sfdd
1261	Seasonal forecast monthly data	sfmd
1262	Seasonal hindcast daily and sub-daily data	shdd
1263	Seasonal hindcast monthly data	shmd

- Major enhancement: Ocean output will be available in MARS, in GRIB2.
 - Ocean data is at full resolution on ORCA025 grid
 - MARS retrievals can provide data interpolated to regular lat-long grids

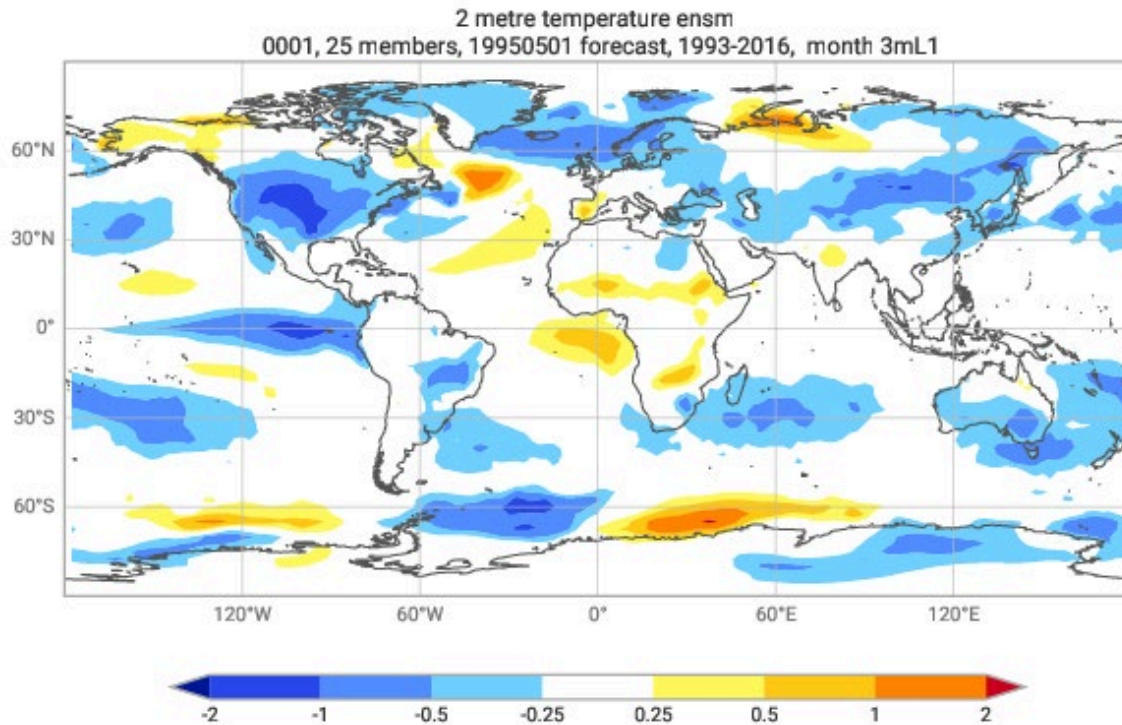
SEAS6: output

- Change: Monthly mean output will be based on **hourly** sampling of data
 - Consistent with ERA5 and ERA6 monthly means
- Change: Additional variables
 - Selected pressure level fields at 6h intervals
 - 6-h surface fields include 100m and 200m winds
 - Various additional surface fields
 - Revision of wave model output – wave model now at same resolution as atmosphere

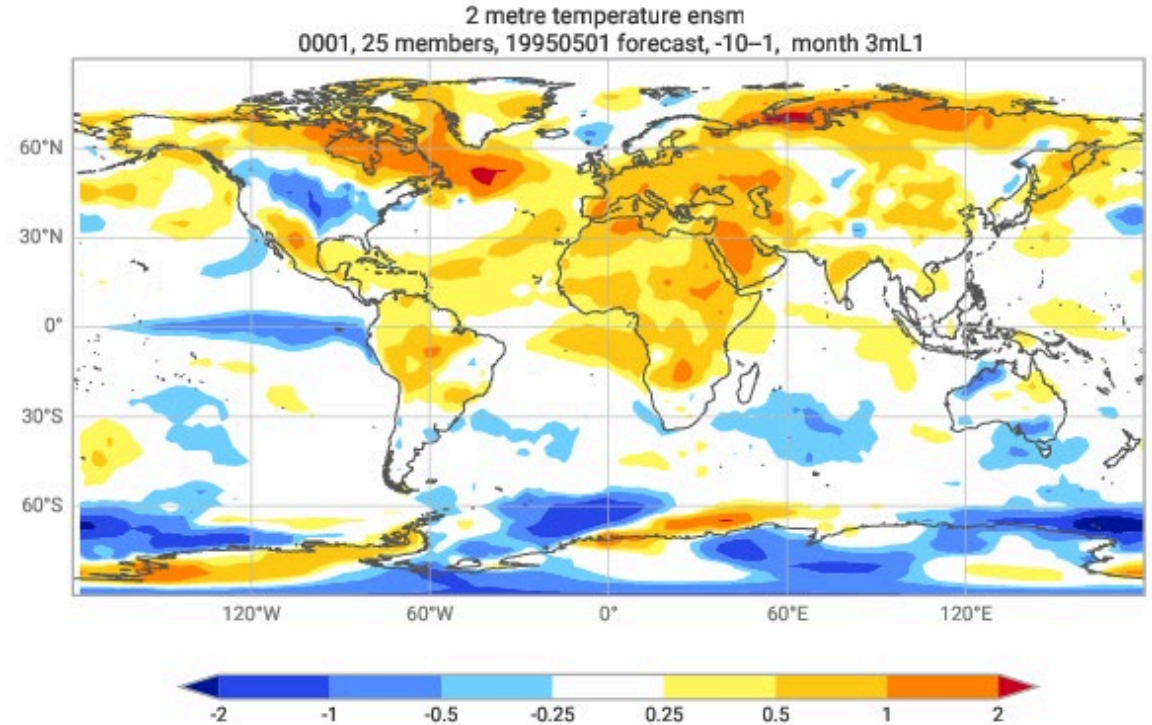
Calibration: impact of “previous 10 year” reference

SEAS5 T2M JJA anomalies, forecast for 1995

Reference period: 1993-2016



1985-1994 (previous 10 years)



(From Dan Befort)

SEAS6 products and calibration

- SEAS6 visualization uses echarts software
 - Plots produced on demand, and buffered
 - Wider choice of regions and products
- SEAS6 climagrams being revised – anticipate reduction in number of regions plotted
- SEAS6 tropical storm products will remain largely as is
 - **BUT** with the addition of full-season statistics from the annual range forecasts
- Re-written SEAS6 verification software, revised verification products
- Improved availability of derived products in MARS, in new derived products streams (sfdp,shdp)
- Products not yet finalised

SEAS6 timeline - TBC

- Re-forecasts start production in Q3 2026
- Real-time production and parallel run start in Q4 2026
- Declaration of operational status TBC
- Switch off SEAS5 TBC



www.ecmwf.int