Plans for SEAS6

Outcomes of a User Consultation

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Introduction

- Three pillars of operational development
  - Science
    - How we can improve (calibrated) forecast skill and reliability
  - Affordability
    - HPC costs and human resources
    - Strategies: single model for all timescales, leverage resources by working with C3S
  - User priorities
    - Account for a diverse user base, scientific limits and relative costs of improvements.

=> USER SURVEY

- SEAS6
  - Will be operational in 2024, on new HPC
  - Horizontal resolution (TCo319, 36km) will be **unchanged**
  - HPC resources will be used to increase number of forecasts/reforecasts

SEAS configuration history

System	Grid resolution	Reforecast years	Reforecast nens	Real-time nens	Reforecast annual	Real-time annual
System 1	200 km	6	11	30	-	-
System 2	200 km	15	5	40	-	-
System 3	125 km	25	11	41	5	11
System 4	80 km	30	15	51	15	15
SEAS5	36 km	36	25	51	15	15

Basic enhancement: increased real-time ensemble size

SEAS6	36km	42	25	101	15	25

Re-forecasts for skill estimation from 1981-2022, not 1981-2016

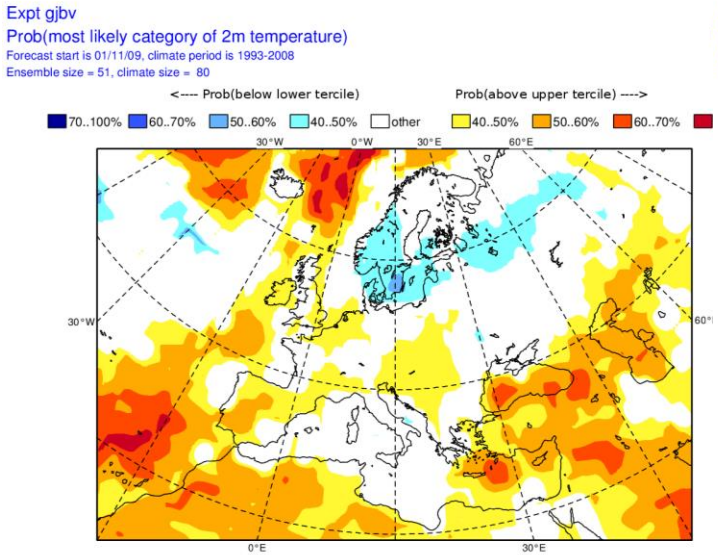
Increase in real-time ensemble size gives better sampling at minimal cost

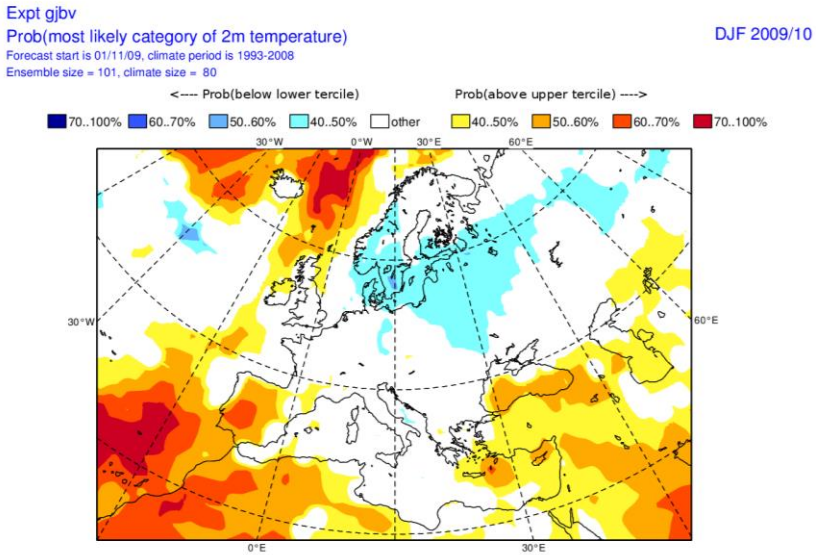
SEAS6 configuration options

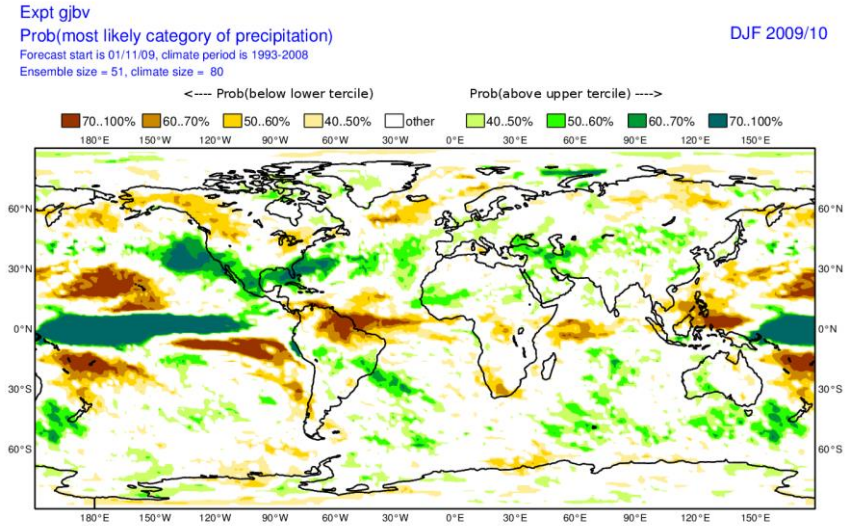
- **Enhancement 1: Real-time forecasts with 101 member ensembles**
- **Enhancement 2: Issue SEAS twice per month**
  - Initial date 1st and 16th of each month
- **Enhancement 3: More comprehensive reforecasts**
  - Larger ensemble size and/or larger set of years
- **Enhancement 4: Expand annual-range ENSO forecasts**
  - Option 1: Issue forecast monthly not quarterly
  - Option 2: Remain quarterly, but increase range to 18-24 months
- **(Enhancement 5: shorter lifetime of SEAS6, keep closer to operational cycle)**

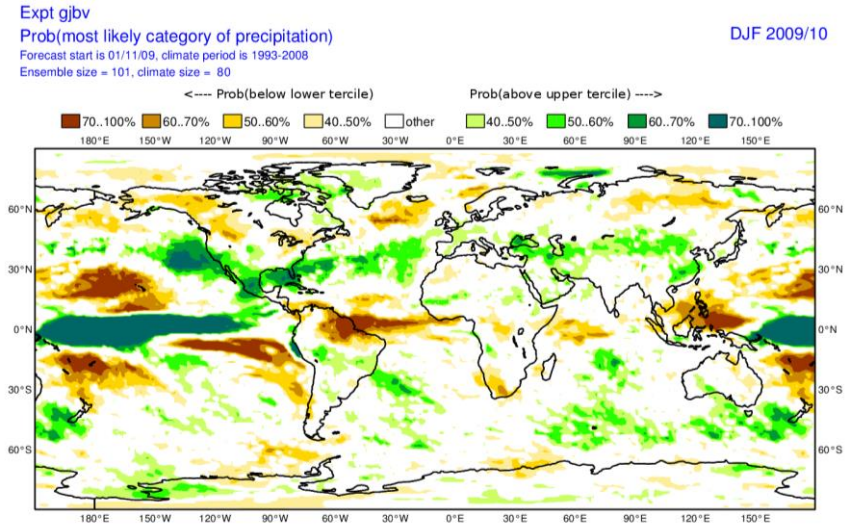
SEAS6 enhancement 1: 101 member ensembles

- Reduced noise and improved accuracy in forecasts









- Consistent with planned increase in EXT
- For SEAS5, real-time is only 5.4% of seasonal cost in first year, so doubling this is relatively cheap.

SEAS6 enhancement 2: Issue forecasts twice per month

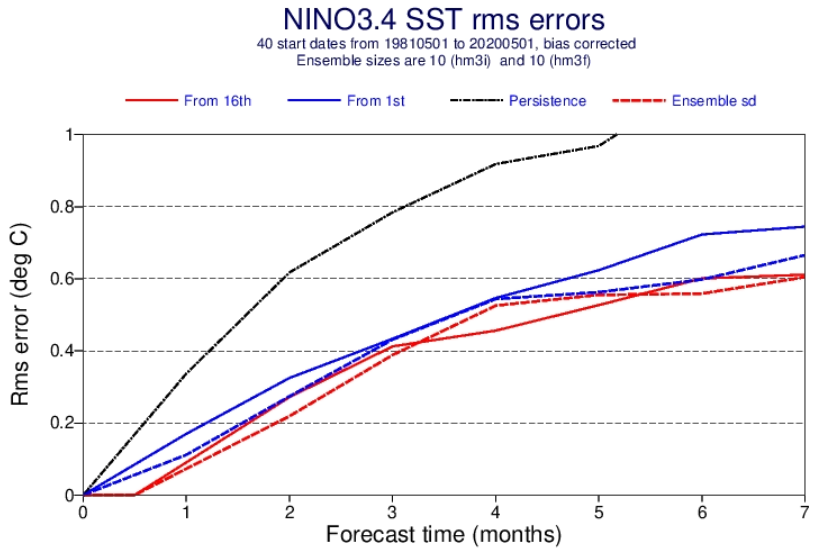
Rationale:

- Provide more timely updates to users, particularly for months 2-4
- Slightly improved effective skill levels due to reduced average lead time
- More credibility when things change, e.g. due to MJO activity or an SSW

Cost:

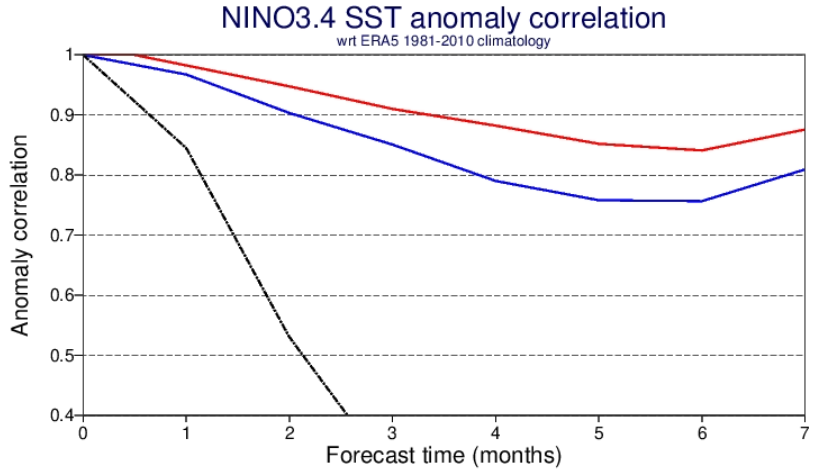
- Cost can be modest, if we restrict re-forecasts to provide ensemble calibration only
- Full skill estimates need bigger ensembles, and will only be provided on 1st of each month, as now.

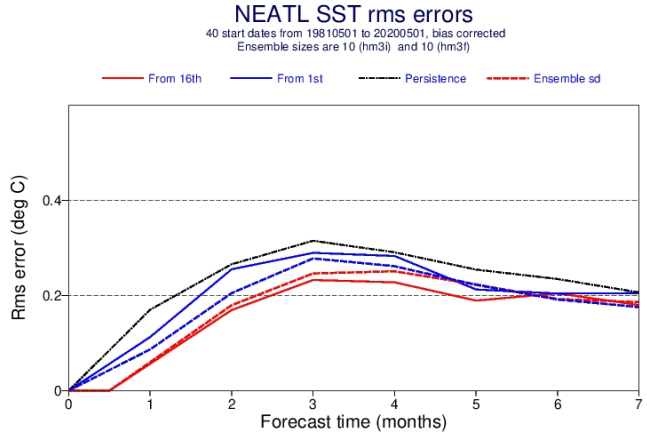
SEAS6 enhancement 2: Issue forecasts twice per month

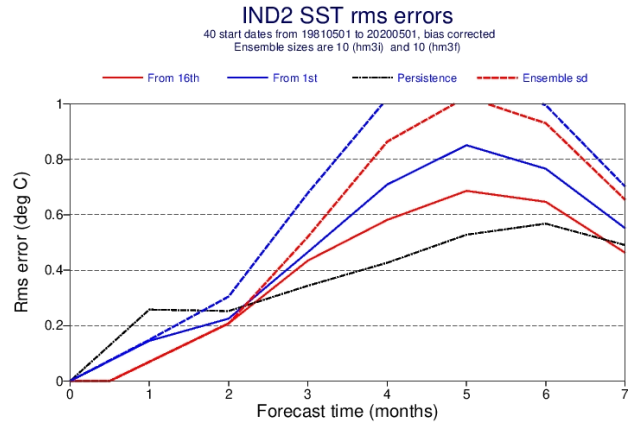


TCo199 Cy47r3 tests for May starts show strong benefit from starting on the 16th (red) rather than the 1st (blue).

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.







SEAS6 enhancement 3: more comprehensive reforecasts

Business as usual reforecasts:

- 1993-2022 for calibration (30 years, 25 members every month)
- 1981-1992 for additional years (25 members every month)
- Feb/May/Aug/Nov starts: extra ensemble members for skill estimation (25 > 51).

Possible enhancements:

- Extend additional years backwards in time (eg from 1961 to present)
- Extend ensemble size (eg 51 members every month)

These sort of enhancements range from expensive to very expensive.

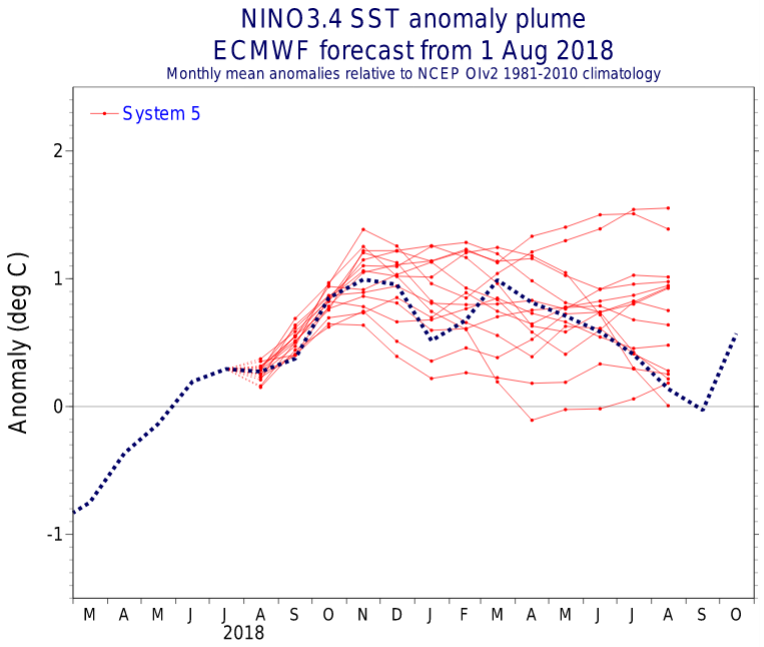
SEAS6 enhancement 4: Extend annual-range forecasts

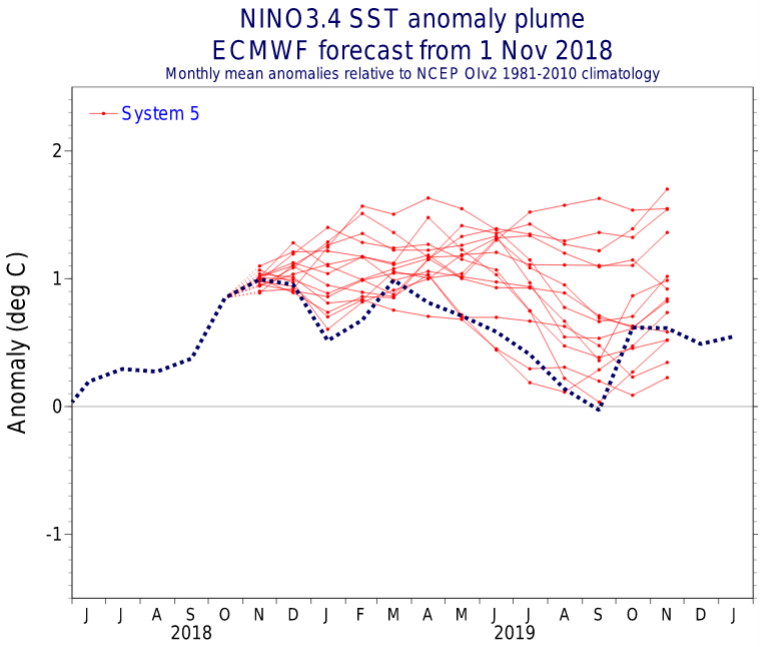
Rationale:

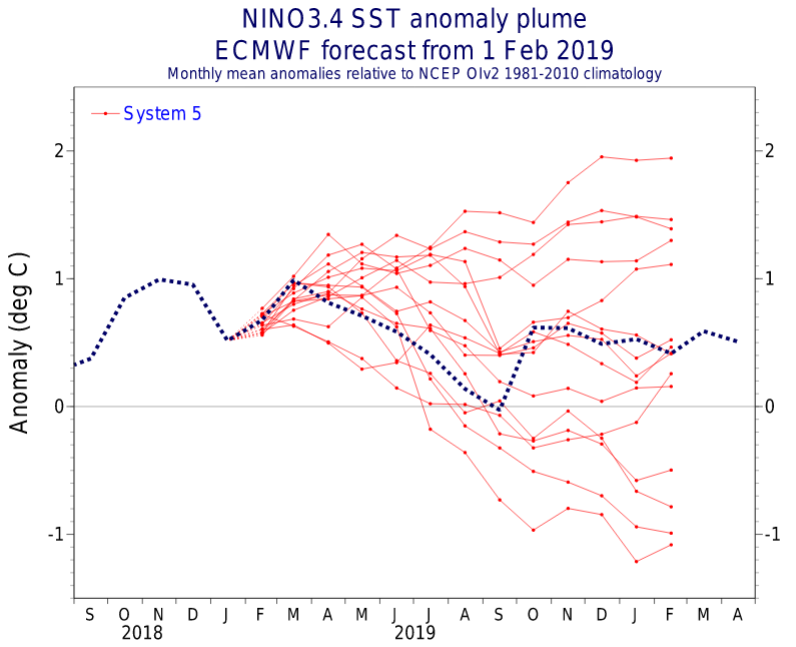
- Our ENSO forecast is world-class out to 13 months, yet we only update it 4 times per year compared to other forecasts which are updated monthly
- ENSO evolution is affected by noise, and the forecast outlook can change a lot during 3 months
- We have demonstrated forecast skill to 18 months and beyond
- WMO definition of long-range forecasting extends to 2 years

Cost:

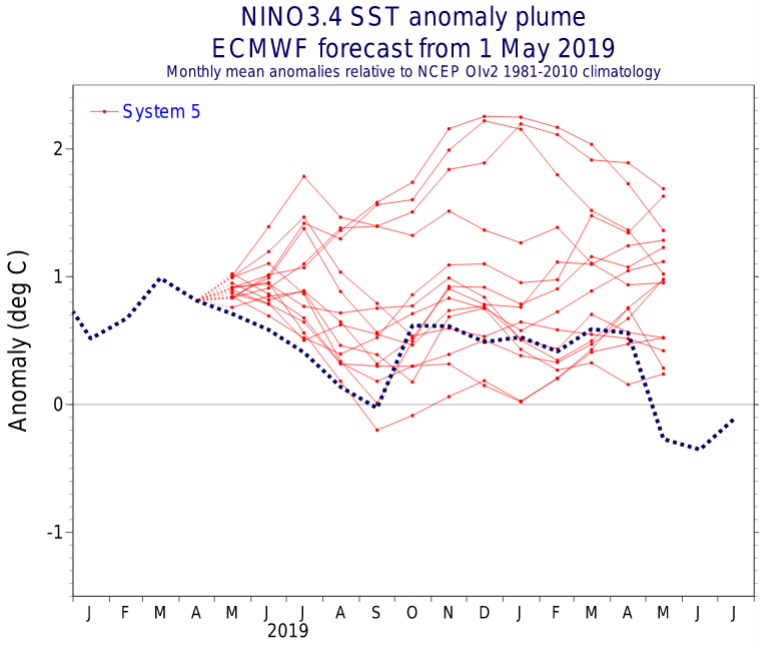
- Expensive: costs mount quickly, need to consider cost vs benefit
- ENSO forecast needs moderate ensemble sizes, but less than mid-latitude forecasts

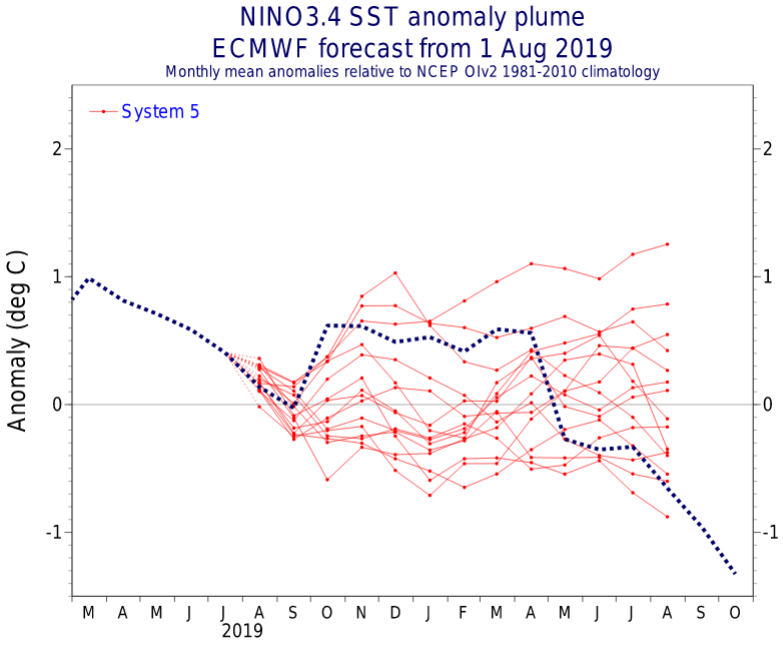






ECMWF



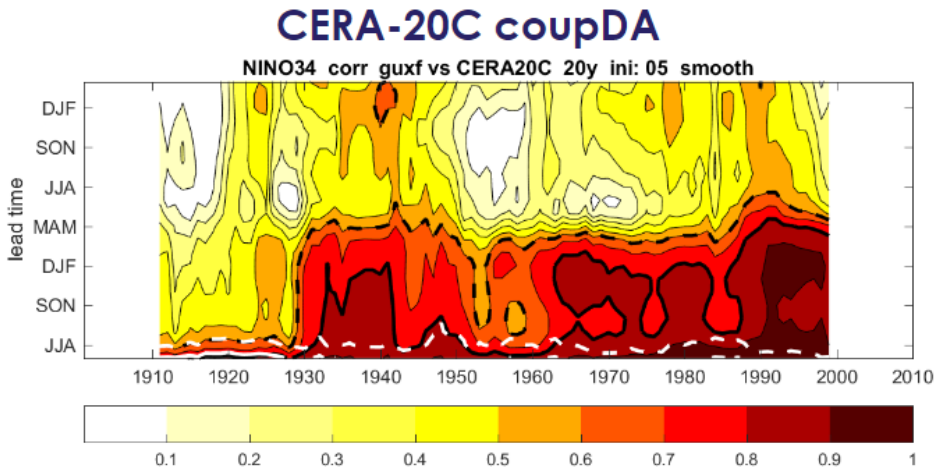


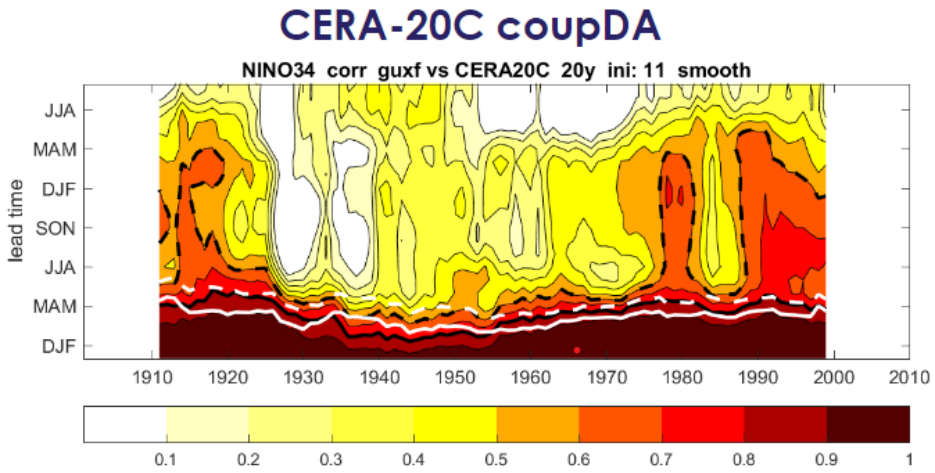
ECMWF

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

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

Long-lead ENSO skill – how far can we go?





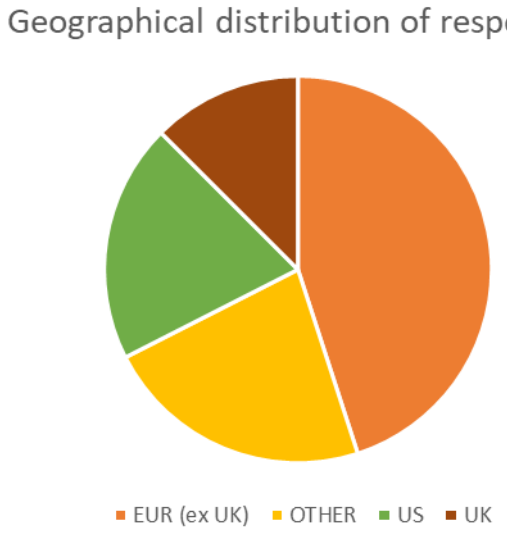
A study of ENSO prediction using CERA-20C / SEAS5 shows that skill limit is seasonally varying. From May (left) we have good skill for 12 months, and sometimes modest skill beyond. For November (right), we have fairly good skill for 18 months in recent decades.

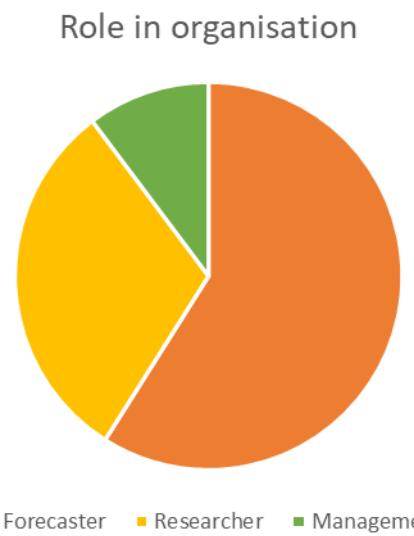
We don't know exactly how SEAS6 will perform, and how predictable the next few years will be. However, these results suggest that forecasts to 18 months and beyond would be well justified.

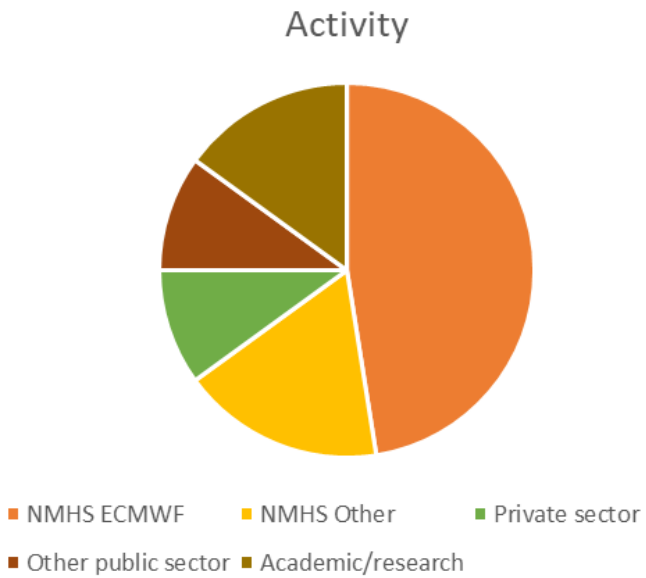
(See Weisheimer et al 2022, GRL for details)

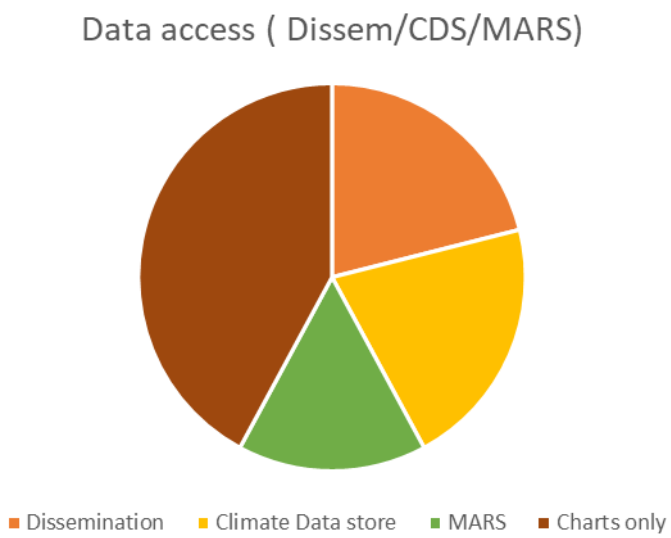
User Survey Results - demographics

40 responses by cut-off
Many thanks for all those who took part, and for the detailed comments many gave.



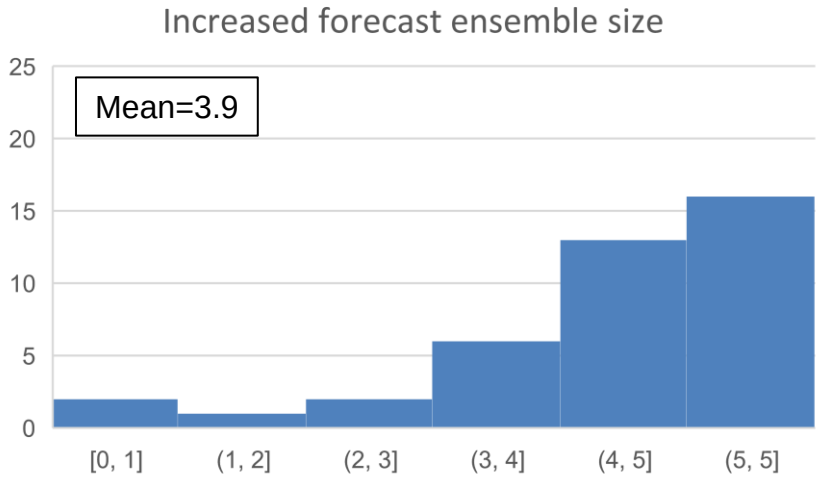


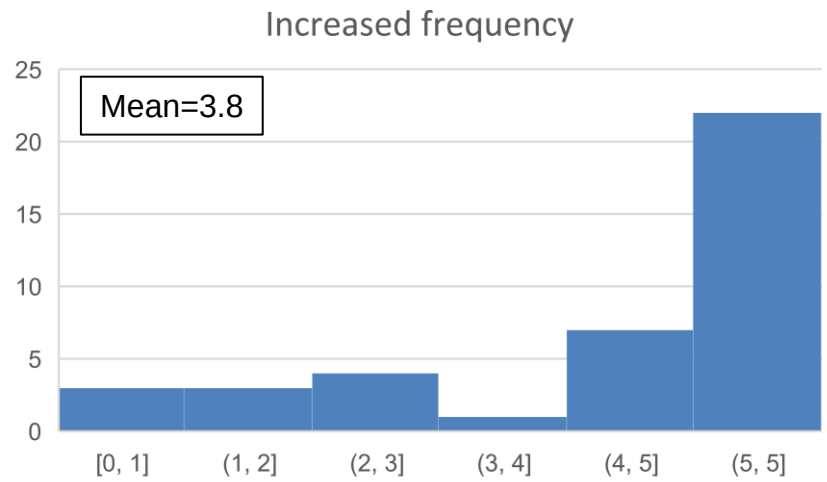


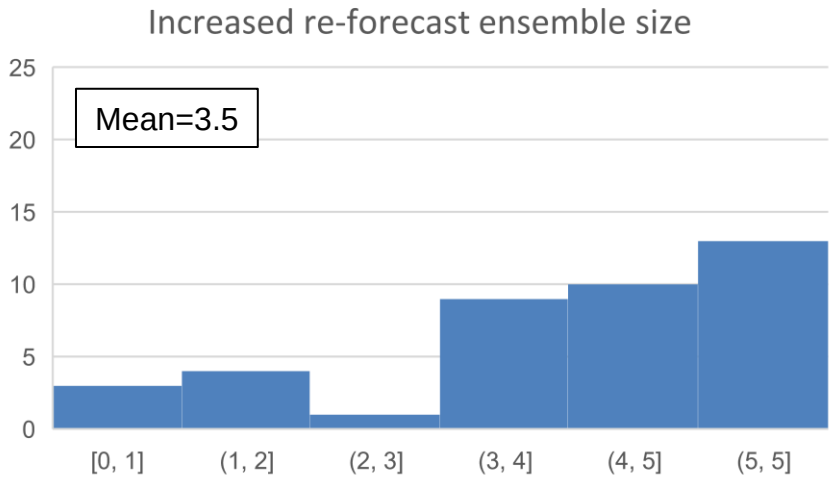


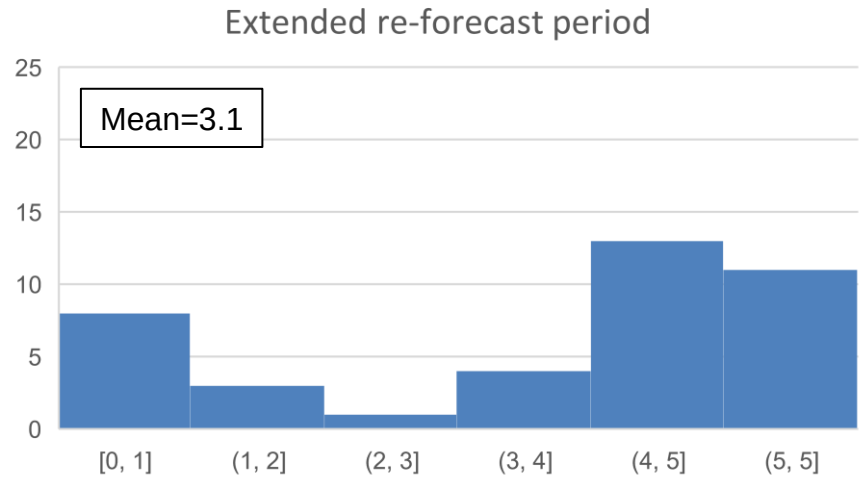
User survey results – seasonal range

- **Importance** of enhancements to seasonal range forecasts (scale 0-5)







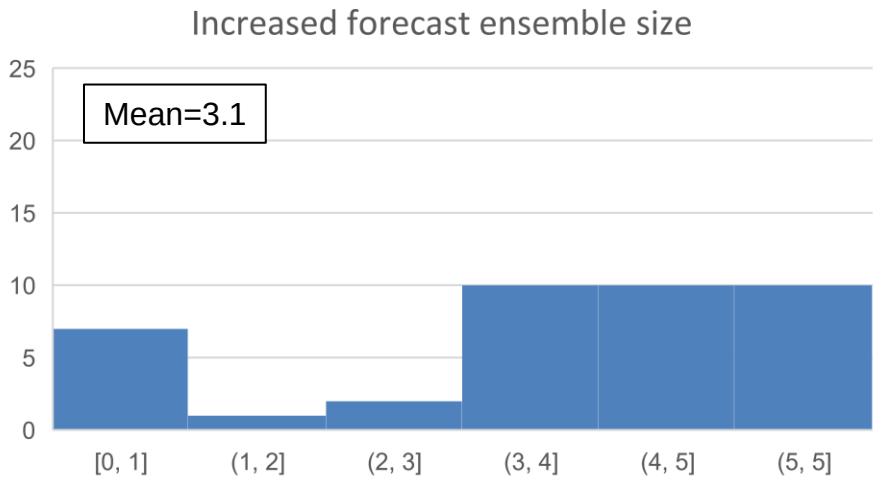


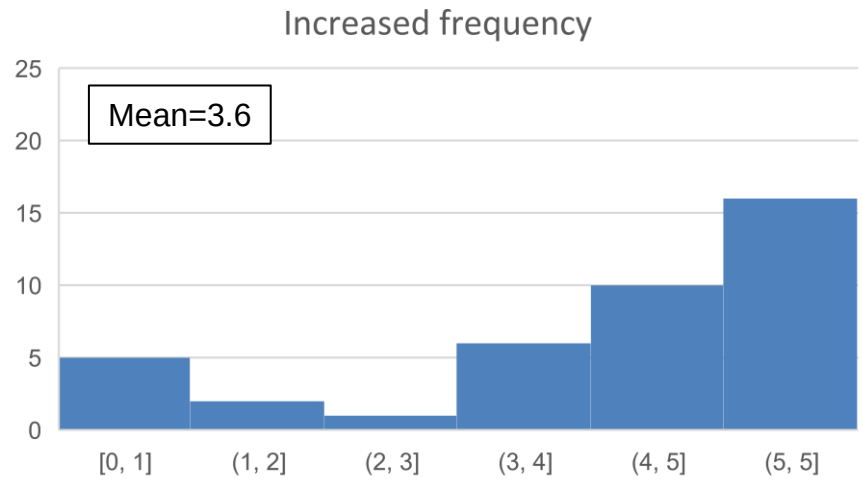
Preference **ranking**

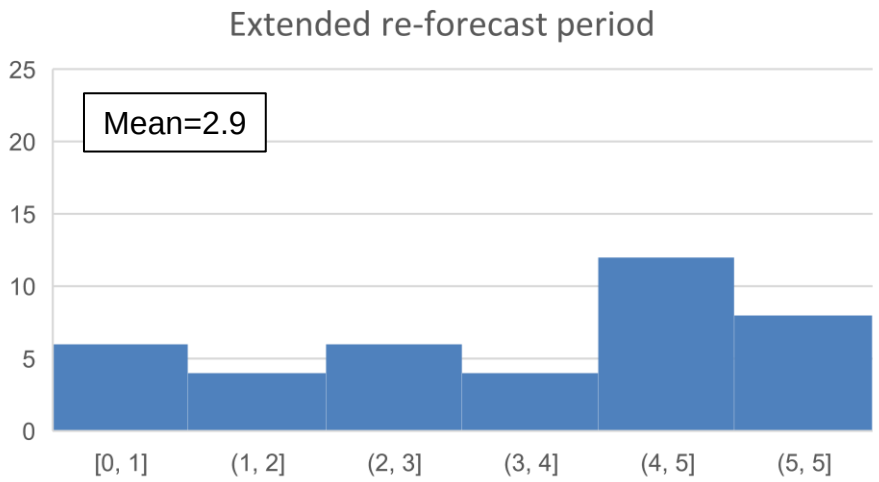
Enhancement	Mean preference
RT frequency	3.0
RT ens. size	2.9
Re-forecast ens. size	2.2
Re-forecast period	2.0

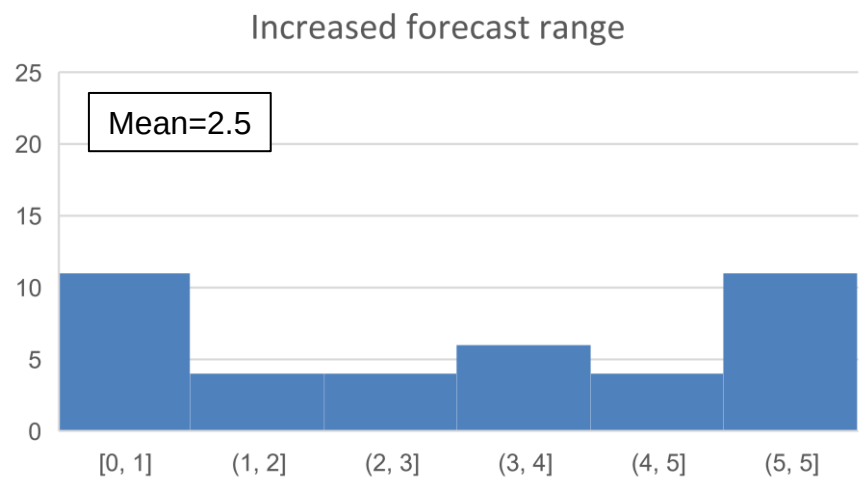
User survey results – annual range

- Importance of enhancements to annual range forecasts (scale 0-5)



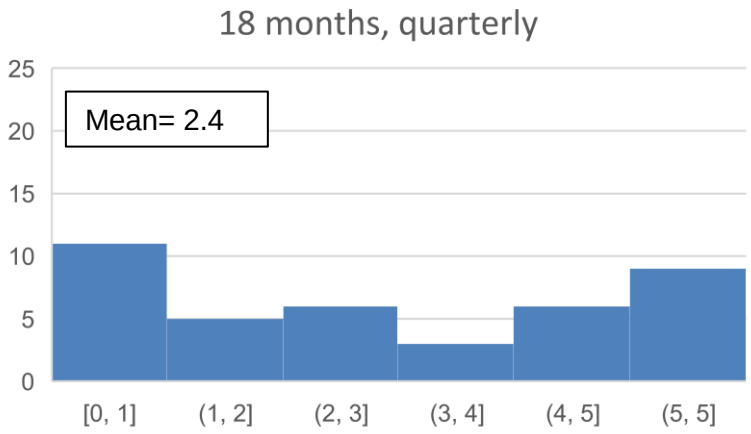


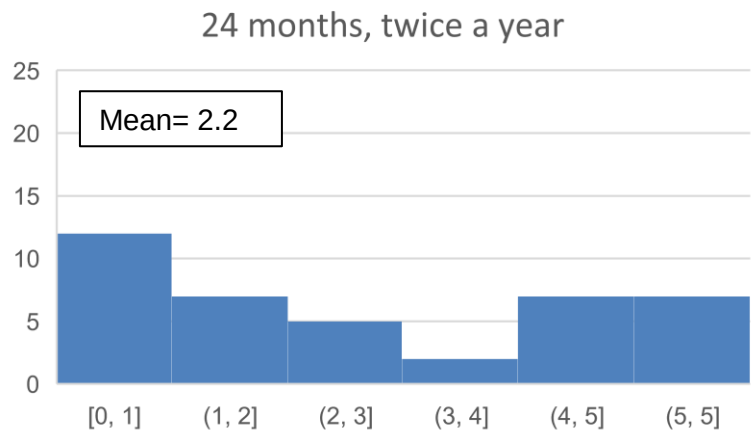


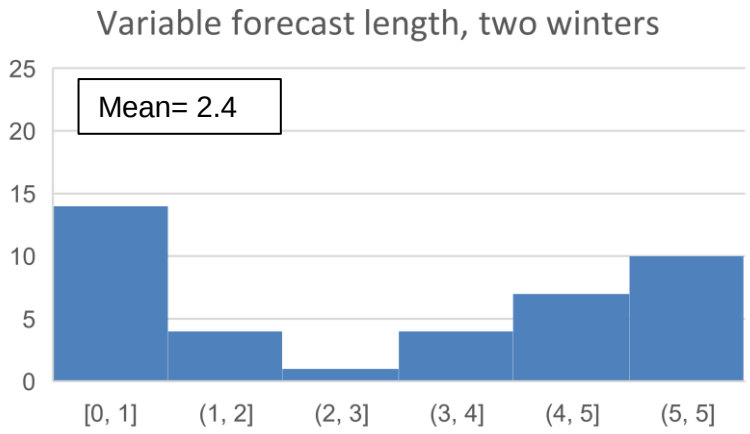


User survey results – annual range

- Different strategies for extending the annual-range forecast range







- A few selected comments:
  - Increased forecast range to 18 months quarterly is useful to appreciate the trend of model.
  - Running to varying lead times to have similar end month skill would make sense to us.
  - Covering second winter and spring may provide interesting info regarding winter and spring crop planting
  - … the information would need to be accompanied with some indication on skill
  - Not convinced there is a lot of useful skill there yet, when recent forecasts have shown a pretty notable warm bias even in the few month time frame.
  - … this would be of research, rather than operational, interest at this stage.

User survey summary

- Wide range of respondents, wide range of uses, and a variety of priorities
- All possible enhancements are of interest to at least some users

Strongest support for enhanced ensemble size and frequency for real-time seasonal

Substantial support for enhanced re-forecast ensemble size and re-forecast period for seasonal
Also substantial support for increased frequency for annual-range

Some support for increased ensemble size and re-forecast period for annual range
Lowest level of interest in extending range of annual range – but some are still very interested

- Also a lot of detailed comments on products, access methods, uses made of the data and other feedback.

SEAS6 configuration summary

- **Enhancement 1: Real-time forecasts with 100/101 member ensembles**
- **Enhancement 2: Issue SEAS twice per month**
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- **(Enhancement 5: shorter lifetime of SEAS6, keep closer to operational cycle)**

Final decisions on (3) and (4) will be made in due course
Still time for feedback!