



Seasonal Predictability of North Atlantic Climate in the ECMWF System II Forecasting System

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Aim



- To investigate predictability and skill in the ECMWF System II seasonal forecasting system
- Predictability
 - Is the ocean influence (**signal**) strong by comparison with weather noise?
- Skill
 - Is the model consistent with observations?





ECMWF Model System

- Details:
 - ECMWF IFS (TL95) atmosphere, coupled to HOPE ocean model.
 - 14 years of hindcasts, 40 member ensembles
- Verification:
 - Compared with ERA15/observational analysis





Interval Test

Skill Test!

- Seasonal (**DJF**) values: time mean extracted to remove bias
- If the observations are consistent with the model then we expect them to fall in the

range: $\bar{x}_{i,model} \pm 1.96\sigma_{i,model}$

95% of the time

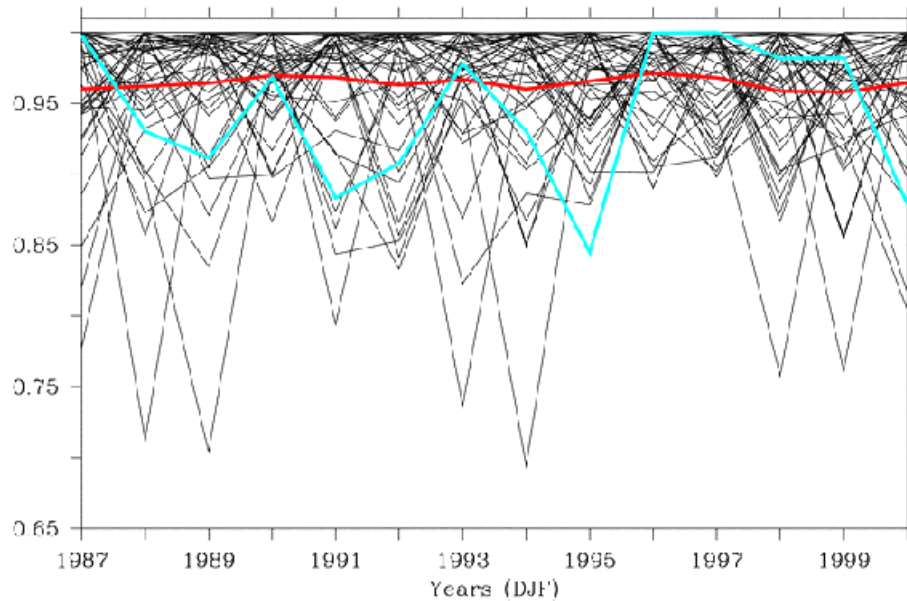




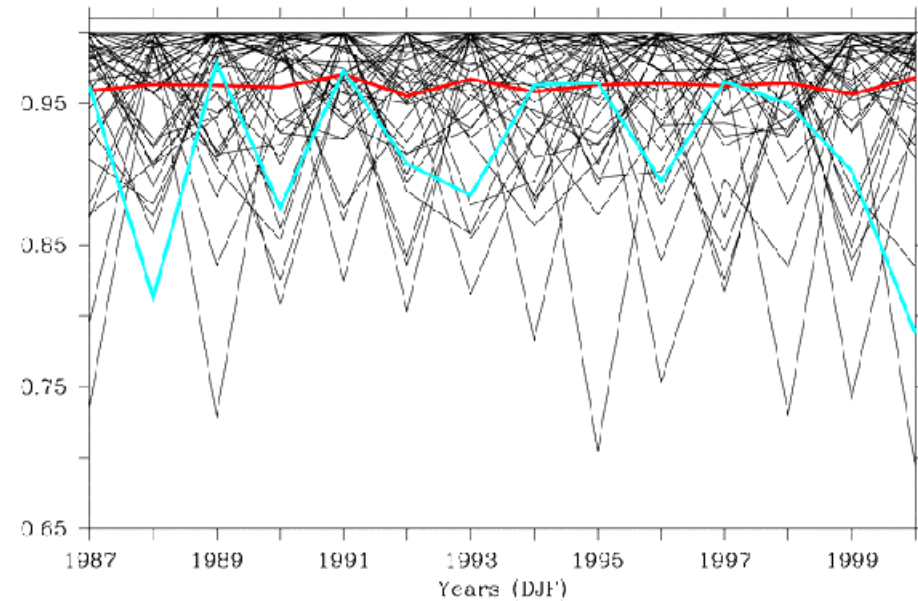
Interval Test

500mb geopotential height

Atlantic: 110W:35E, 20N:85N



Pacific: 260W:110W, 20N:85N



Expected coverage: ~95%



Test for Variance Explained by Ensemble Mean



Mixed Test!

- Regression analysis to assess the amount of ensemble member/observational variability that can be explained by the ensemble mean.

- Calculate R^2 values :
$$\frac{\sum (x_{i,F} - \bar{x})^2}{\sum (x_i - \bar{x})^2}$$

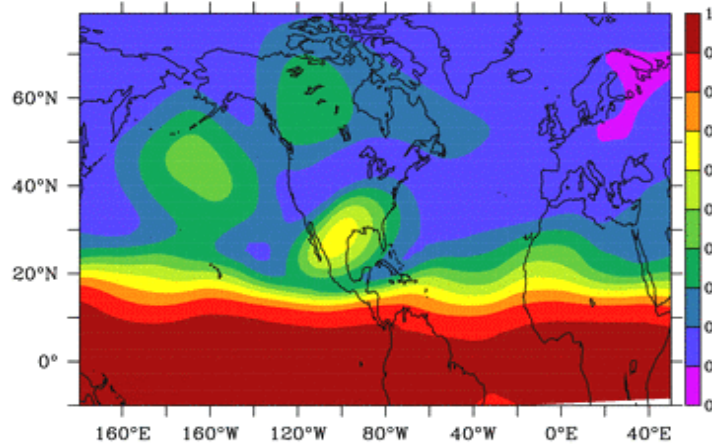
- High R^2 implies high **signal-to-noise**.



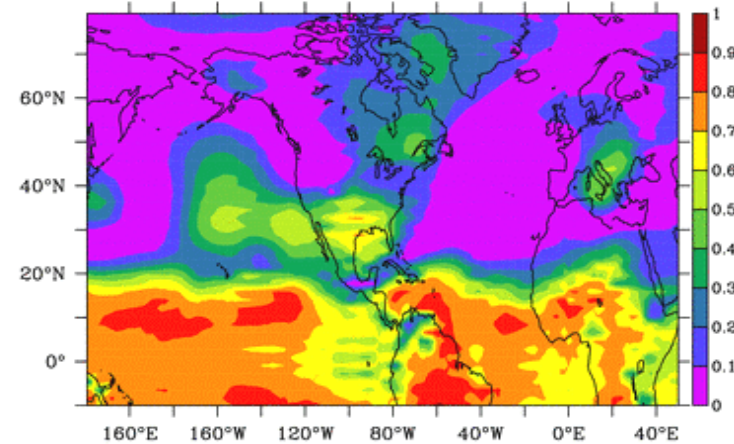
Variance Explained



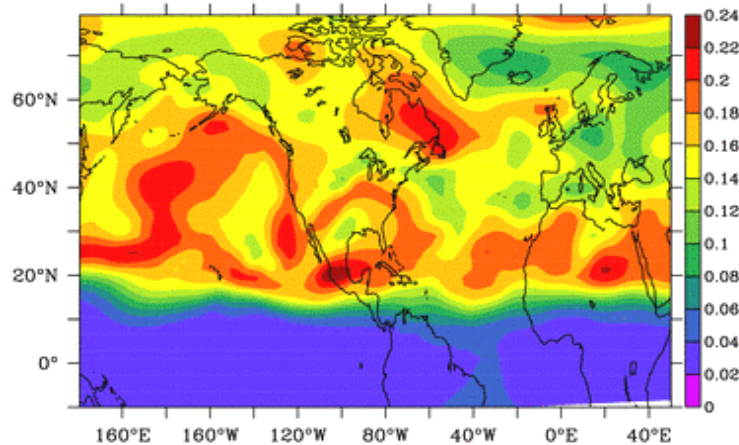
Model



Observations



Model St.Dev.



- Model shows high S/N in tropics and some regions of extra-tropics
- Observations similar
- Model-Obs differences only partly explained by sampling

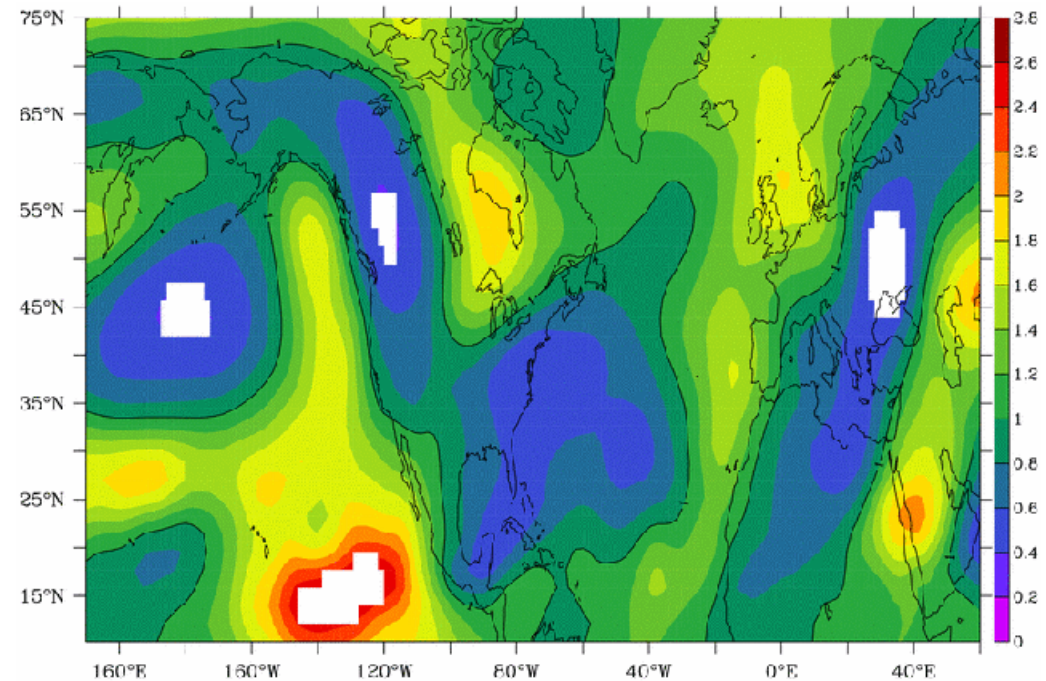


F-test Analysis



Mixed Test!

- Ratio of the observational variance to the average ensemble member variance.
- Significant differences in variances
- Supports previous analysis, suggesting model is too variable over the Mediterranean and Southern Europe.



- White areas show rejection at the 90% level of significance
- Expected value = 1



Model Predictability



Predictability Test!

- How does model predictability vary from year to year?
- Signal-to-noise problem. Calculate the size of a seasonal anomaly w.r.t to internal noise (weather) :

$$t_i = \frac{\sqrt{n}(\bar{x}_i - \bar{\bar{x}})}{\sigma_{INT}}$$



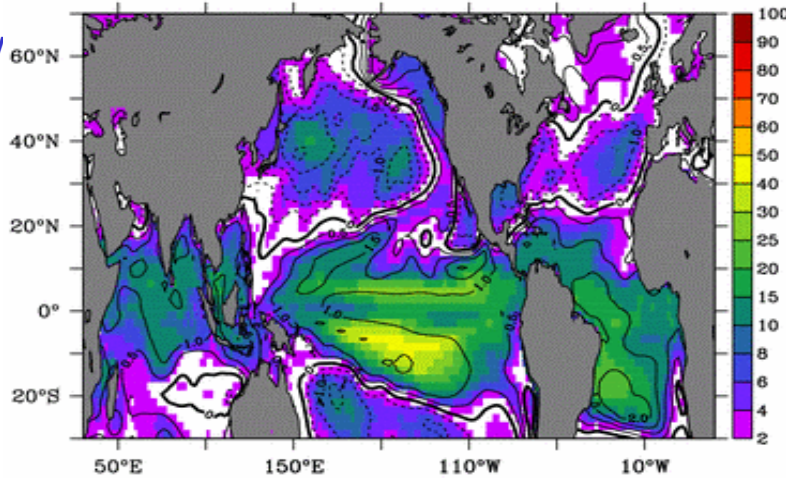
Significant Predictability (T2m)



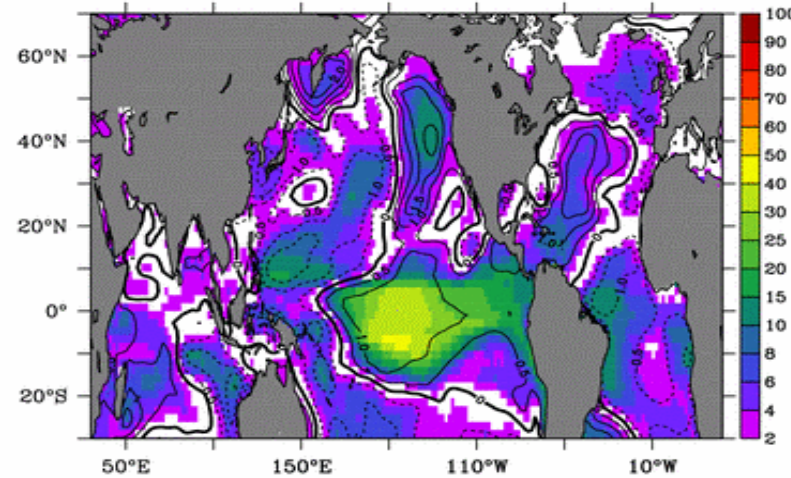
Contours show ensemble mean anomaly

All DJF season

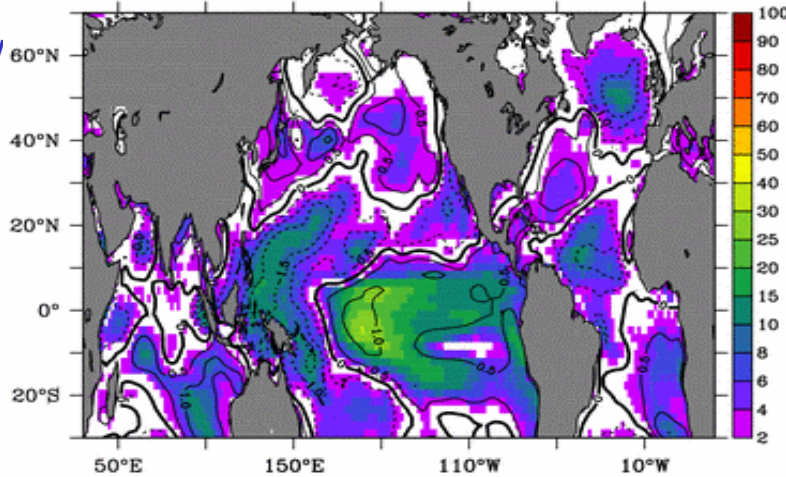
1987/
1988



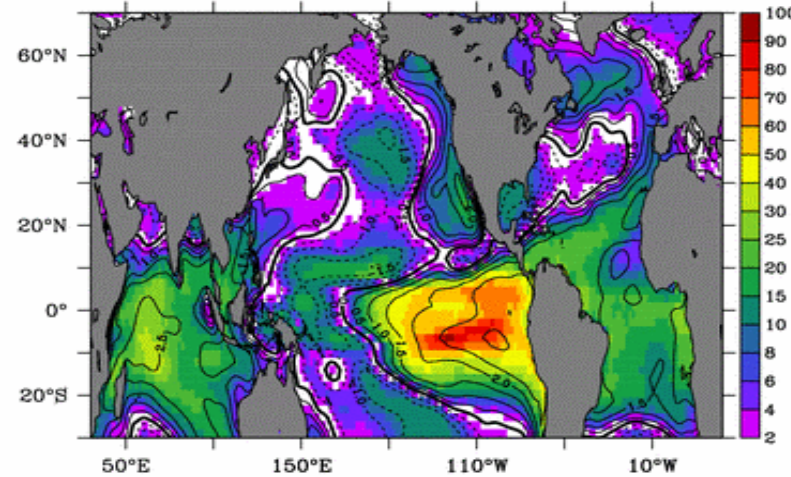
1991/
1992



1994/
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1997/
1998



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Shading shows sig. t-val

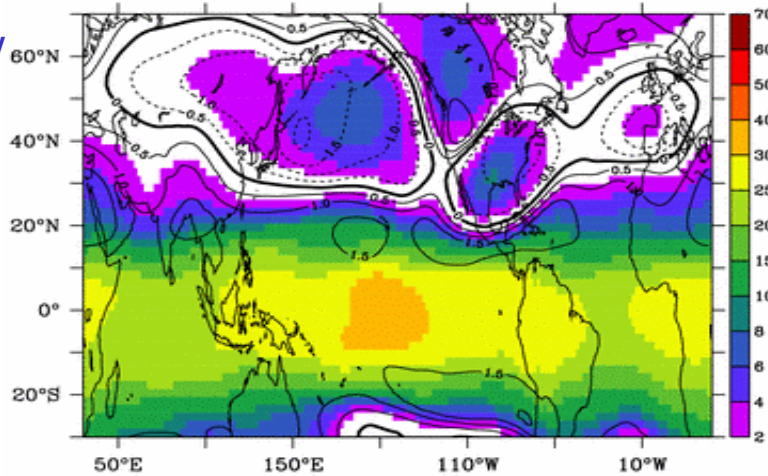
Significant Predictability (GPH500)



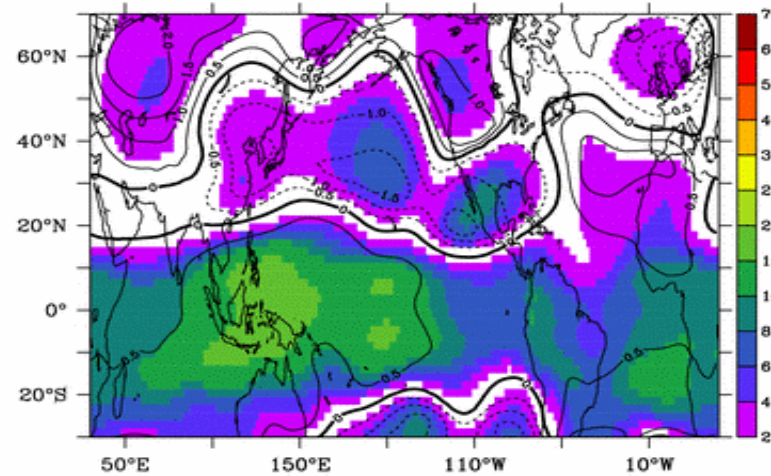
Contours show ensemble mean anomaly

All DJF season

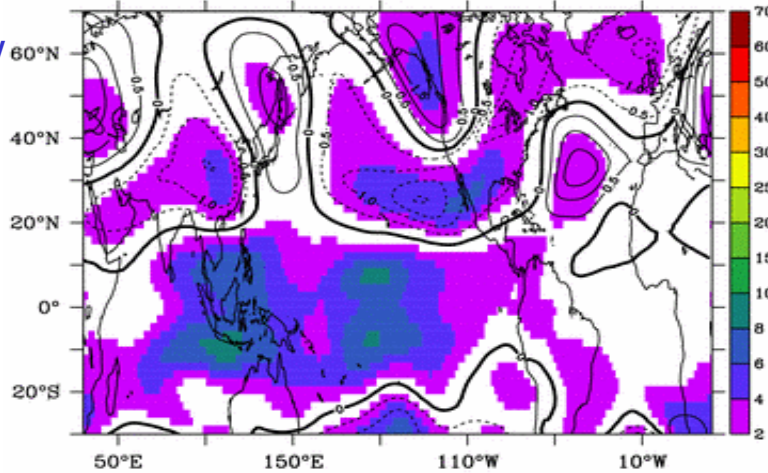
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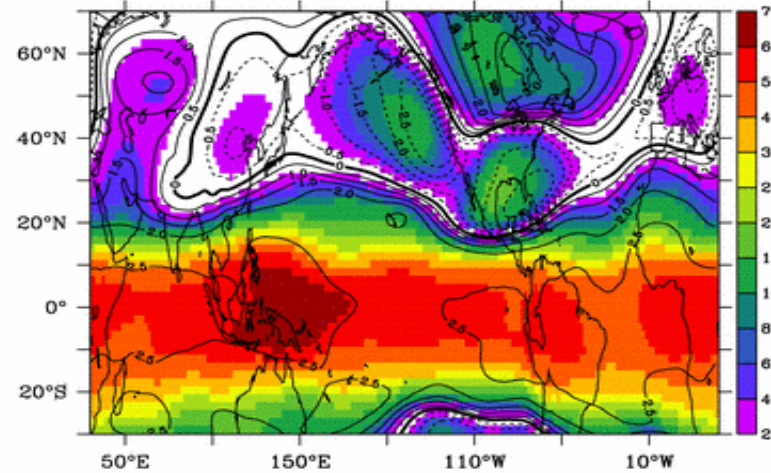
1991/
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1998



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Shading shows sig. t-val



Conclusions

- Interval test shows that, in a broad sense, the model is consistent with the observations.
- Test for variance explained show that the model exhibits significant predictability in tropical and some extra-tropical regions
- Differences between model and observations only partly explained by sampling.
- There is evidence that the model may have too much variability (& hence **too low signal-to-noise**) over the Mediterranean/Southern Europe.

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