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

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Introduction

Evidence from statistical analysis of observations, and from atmospheric model simulations, suggests some predictability of North Atlantic climate on seasonal timescales. This predictability arises primarily from the influence of changing ocean conditions. Here we investigate seasonal predictability in the ECMWF System II model.

Data and Methodology

Analysis is performed on 14 years of winter (DJF) hindcasts. Each forecast has a November start and consists of 40 ensemble members. Skill is assessed with respect to ECMWF ERA15 and operational analysis fields. Here we focus on ENSO years.

We examine ensemble mean anomalies and a t-statistic is used to assess the significance of ocean forcing with respect to the stochastic "weather" signal. Pattern correlations are used to investigate the model's skill in predicting North Atlantic and North Pacific atmospheric circulation patterns.

North Atlantic region: 20N:85N, 110W:35E
North Pacific region: 20N:85N, 260W:110W

Year	Type	North Atlantic			North Pacific		
		P_{f_obs}	P_{c_obs}	t_{avg}	P_{f_obs}	P_{c_obs}	t_{avg}
1987/88	EN	0.60	0.12	2.63	0.96	0.08	3.16
1988/89	LN	0.28	0.61	2.82	0.02	0.84	3.13
1991/92	EN	0.04	0.49	1.83	0.46	0.43	2.81
1994/95	EN	0.95	0.38	1.67	0.30	0.30	2.14
1995/96	LN	0.08	0.57	1.52	0.73	0.43	1.92
1997/98	EN	0.64	0.02	4.94	0.87	0.00	4.48
1998/99	LN	0.68	0.21	1.88	0.80	0.04	3.22
1999/00	LN	0.92	0.29	2.95	0.26	0.71	2.98
mean/stdev t				2.21/0.93			2.50/0.84

ENSO years statistical analysis (N.Atlantic and N.Pacific)

• Table indicates the probability of the observational anomaly patterns given the forecast ensemble (P_{f_obs}) and the model climatology(P_{c_obs}). t_{avg} represents the spatially averaged t-value for each region

• Useful forecasts are characterised by:
    1) high average t-score
    2) high probability of anomaly pattern given the forecast ensemble
    3) low probability of anomaly pattern given the climatology

• Over the North Atlantic these conditions are best fulfilled in the winters of 1997/98 (El Nino) and 1999/00 (La Nina)

Conclusions

• The model exhibits high seasonal predictability in the tropics and over the North Pacific during ENSO years

• Over the North Atlantic:
    1) There is evidence of potential predictability, especially in El Nino years
    2) The probability of the observational anomaly pattern given the forecast ensemble is less than 5% in only 1 event out of 8 (91/92)
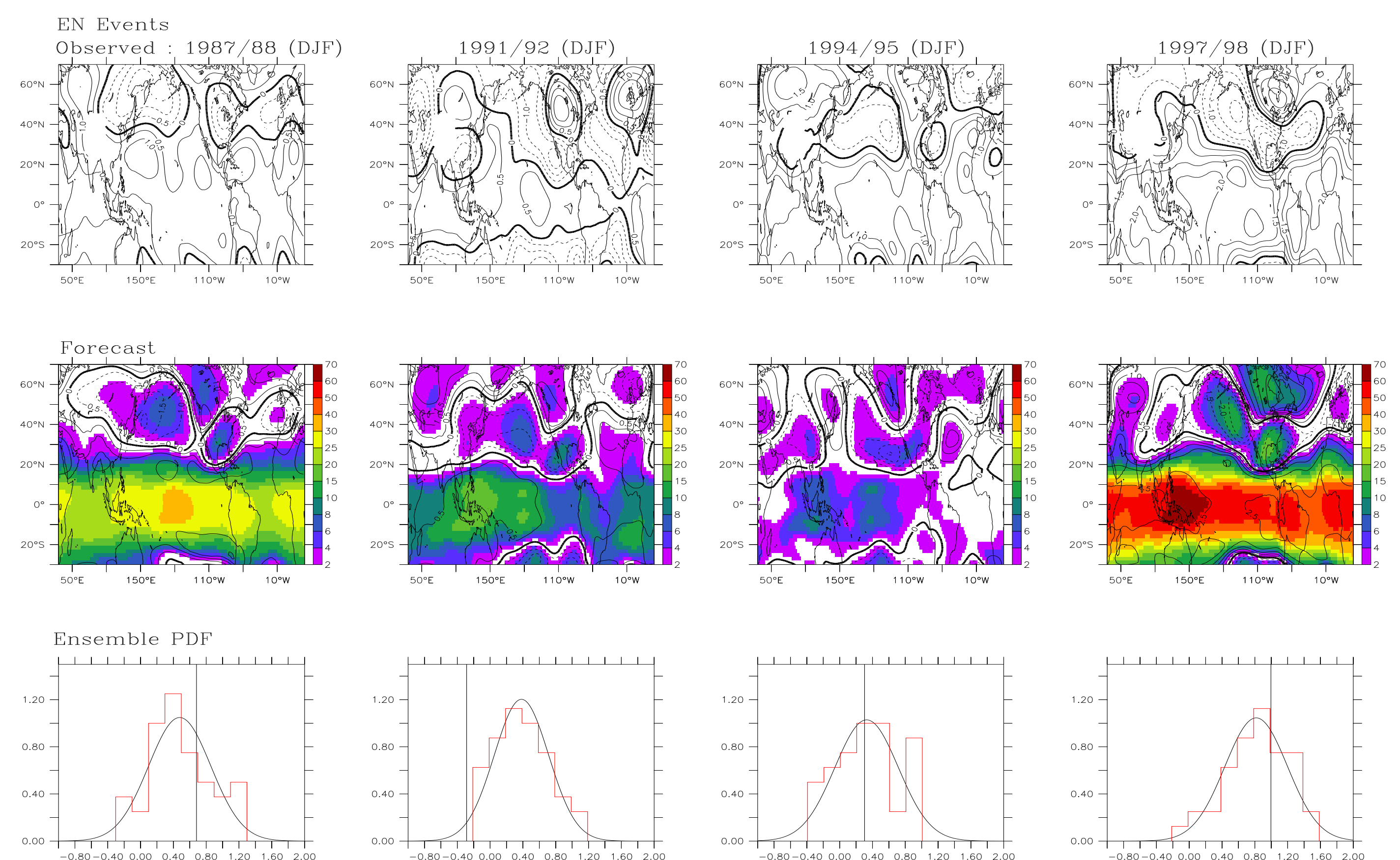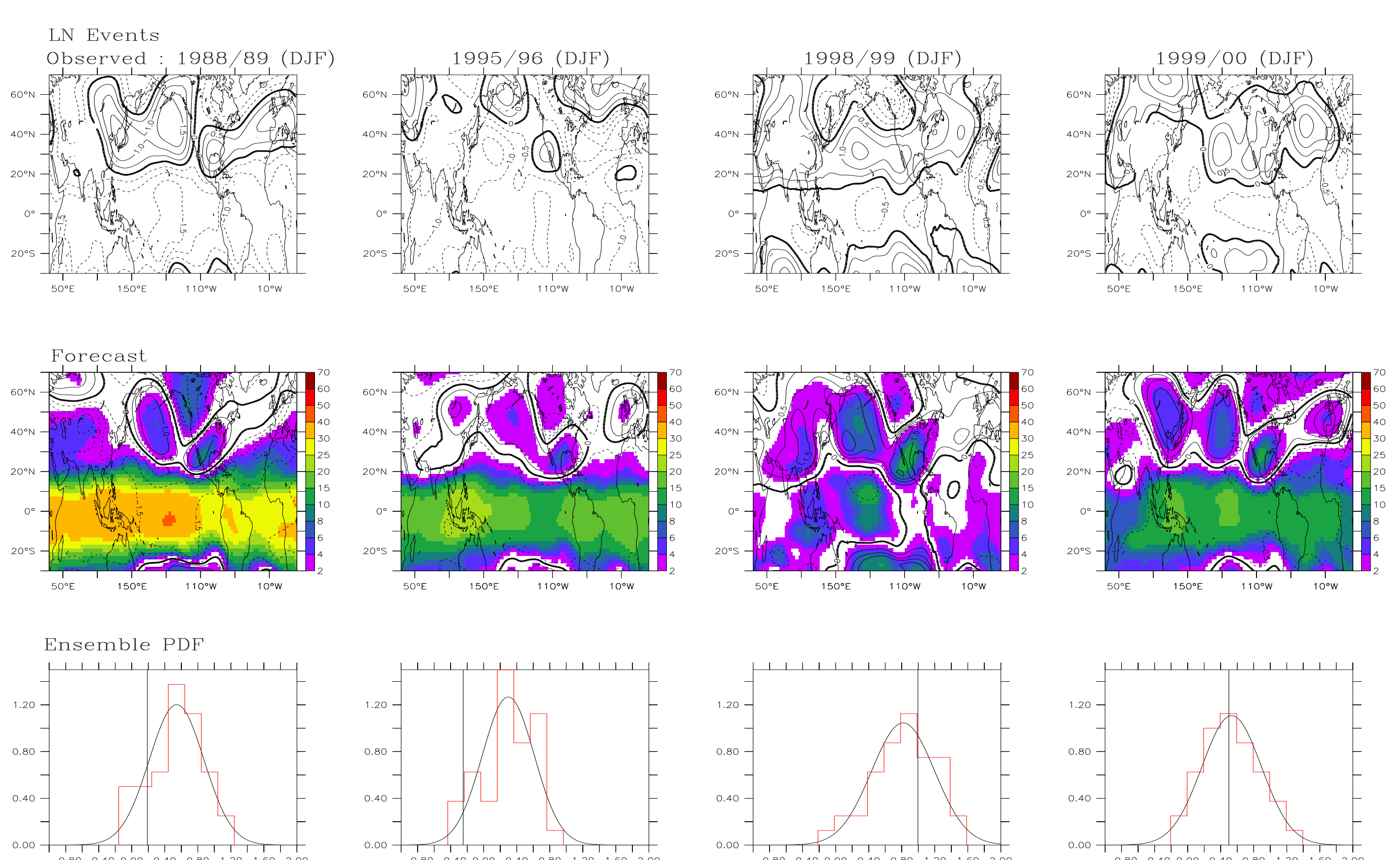
Observed and forecast 500mb GPH anomalies for El Nino Years

Key points:
• t-values indicate signal-to-noise ratio is highest in the tropics, but is also significant over the North Pacific and North Atlantic in all four El Nino years.
• The highest signal-to-noise ratios are found in 1997/98
• Over the North Atlantic the forecasts indicate a high probability of the observed anomaly pattern (p>0.6) for all events except 1991/92.

First two rows show contoured analysis and forecast ensemble mean fields. Coloured overplot values indicate t-values (values not significant at 2 sigma level are blanked). Final row shows probability distributions (PDF's) derived by computing the pattern correlation of each ensemble member with the ensemble mean for the winter of interest (A Z transform is applied to make the statistics approximately Gaussian). The vertical line indicates the pattern correlation of the observations with the ensemble mean.

Observed and forecast 500mb GPH anomalies for La Nina Years

Key points:
• t-values indicate signal-to-nose ratio is highest in the tropics, and over the Pacific - North American region.
• Over the North Atlantic the forecasts indicate a high probability of the observed anomaly pattern (p>0.6) for 1998/99 and 199/00, a substantial probability (p~0.3) for 1988/89 and a low probability (p<0.1) for 1995/96