Perturbed Physics Ensemble Results

May/Nov 1991 – 2001 Start Dates

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Original DePreSys hindcasts

- Hindcasts started from 1st March, June, September and December in each year from 1982 to 2001 (20 years x 4 seasons = 80 start dates)
- Each hindcast is 10 years long
- Sample uncertainty in initial conditions with 4 ensemble members (also include previous start dates)
- Account for sampling errors arising from finite ensemble size

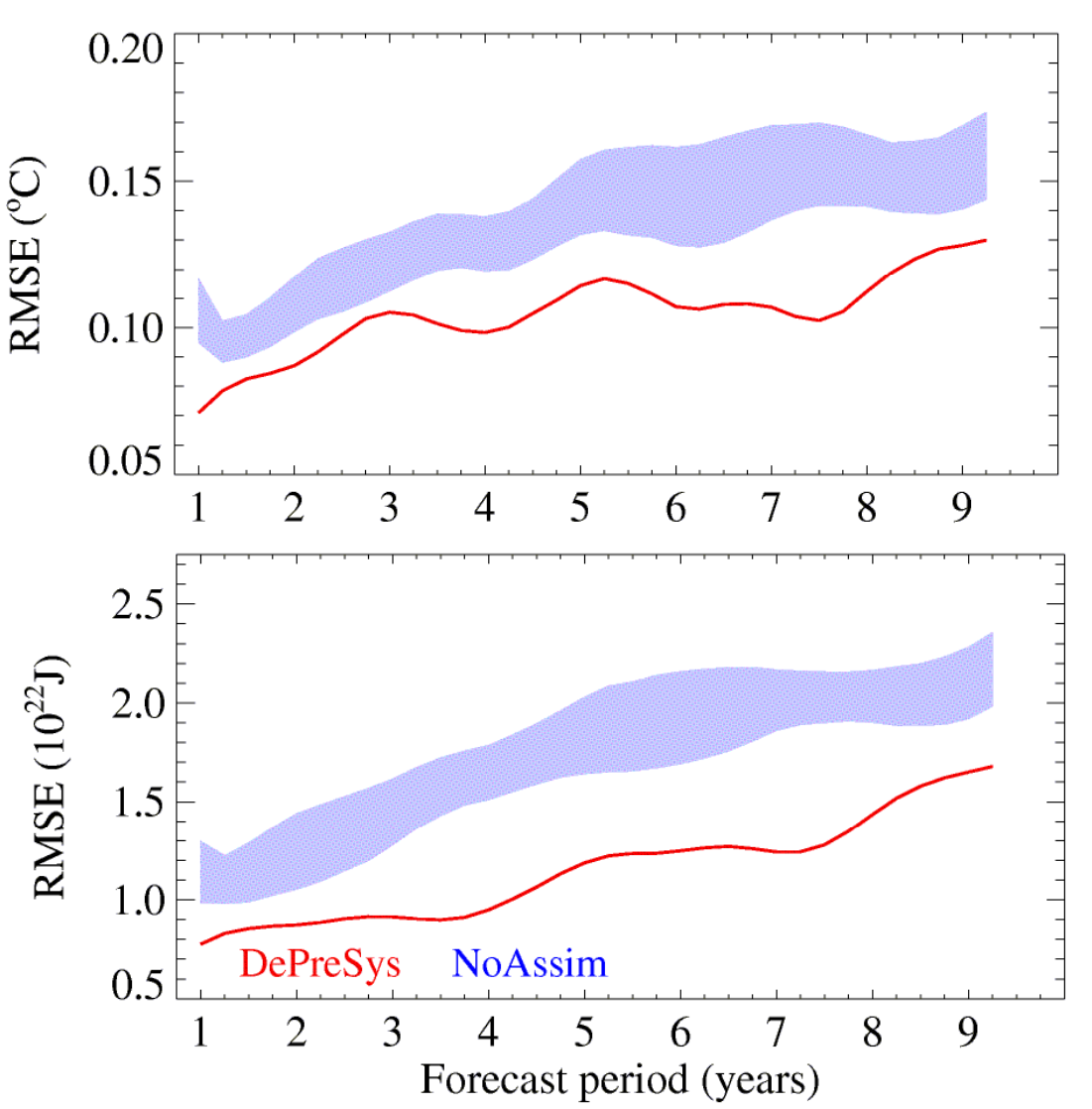
Impact of initial conditions on hindcast skill

- Key issue: Do we achieve additional skill by starting the model from observed initial conditions ?

- Test by making a new set of hindcasts (NoAssim) parallel to DePreSys

- NoAssim includes the same external forcings as DePreSys but omits the assimilation of observed initial conditions.

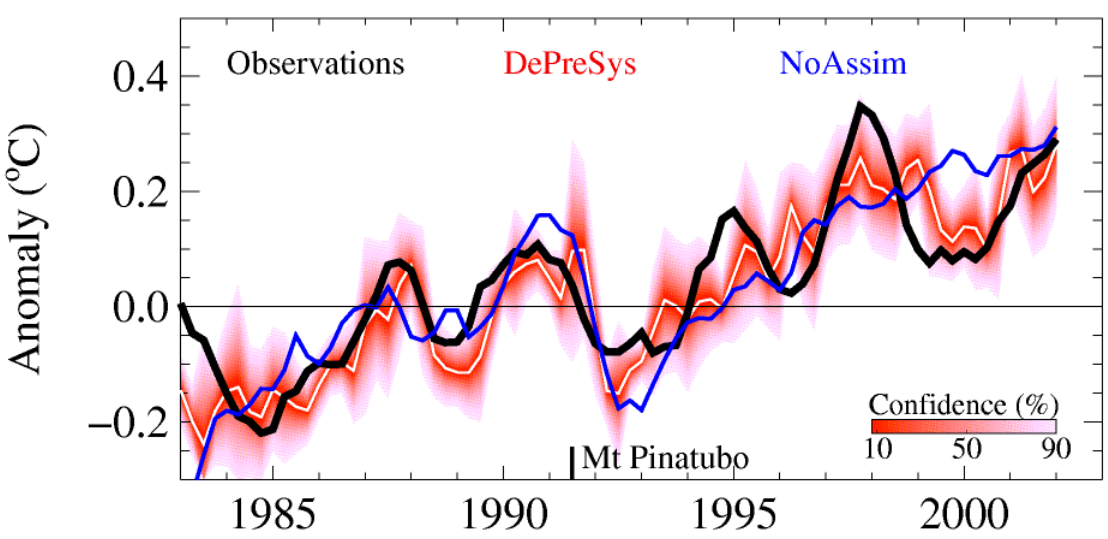
Impact of initial conditions on hindcast skill



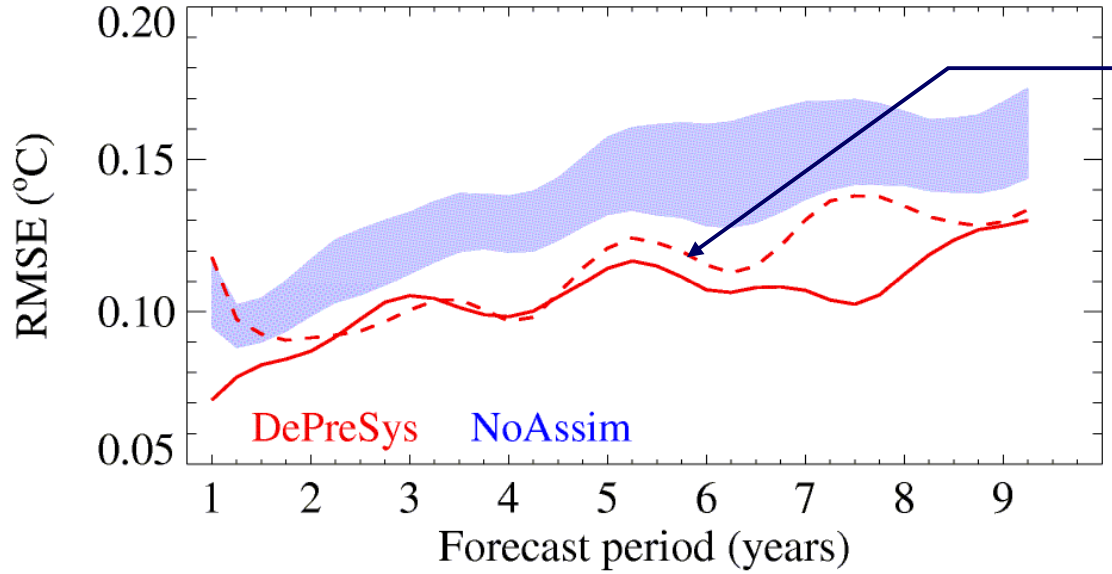
Global annual mean surface temperature (T_S)

Global annual mean ocean heat content in upper 113m (H)

Skill at short lead times due to El Niño



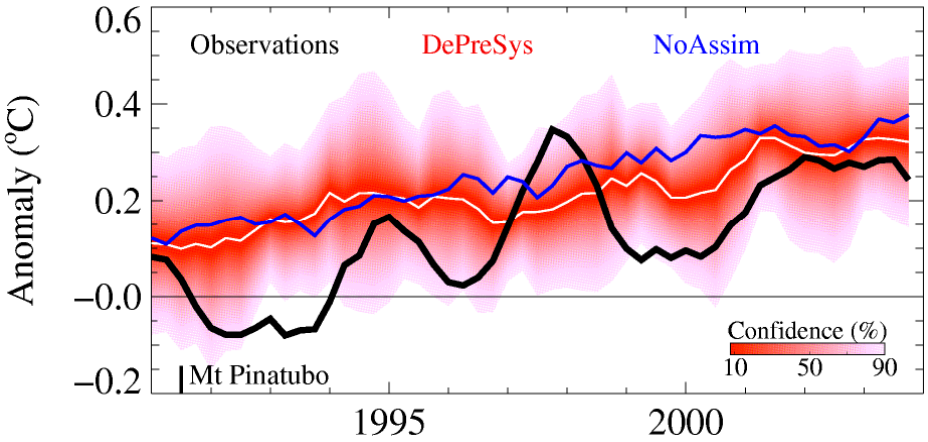
Time series of first annual mean hindcast T_S



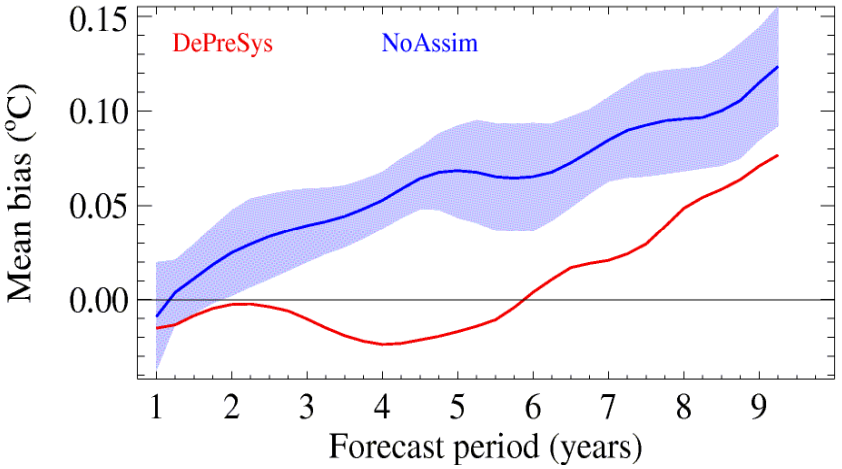
Difference between DePreSys and NoAssim El Niño linearly removed from DePreSys hindcasts

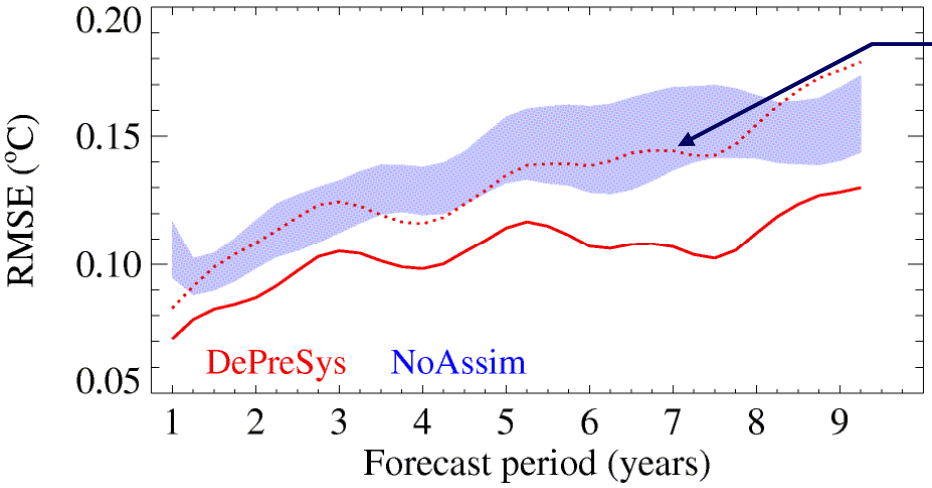
Skill at longer lead times due to bias removal

Time series of year 9 hindcast T_S



Mean bias of hindcast T_S

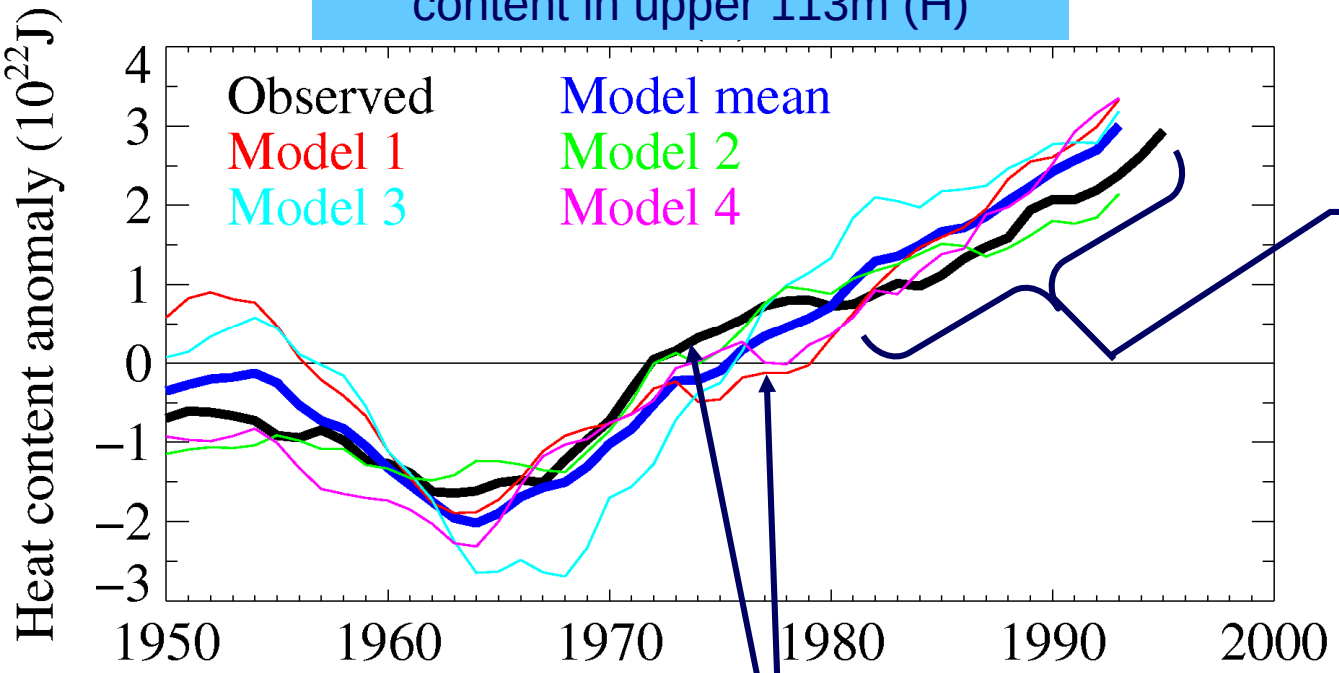




Difference between DePreSys and NoAssim mean bias linearly removed from DePreSys hindcasts

Ocean heat content bias removed by DePreSys

Decadal mean ocean heat content in upper 113m (H)



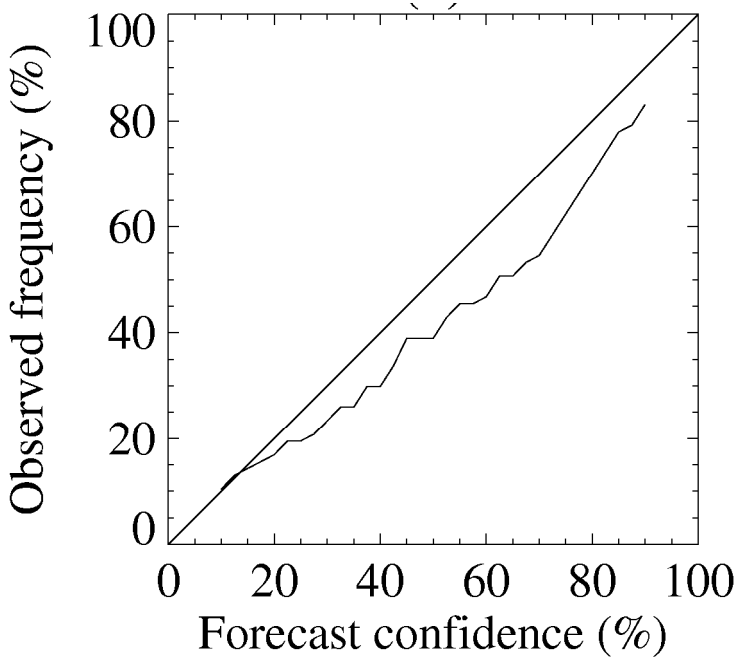
Observed H cooler than model during hindcast initialisation

Observed multi-decadal variability of H is consistent with individual model members

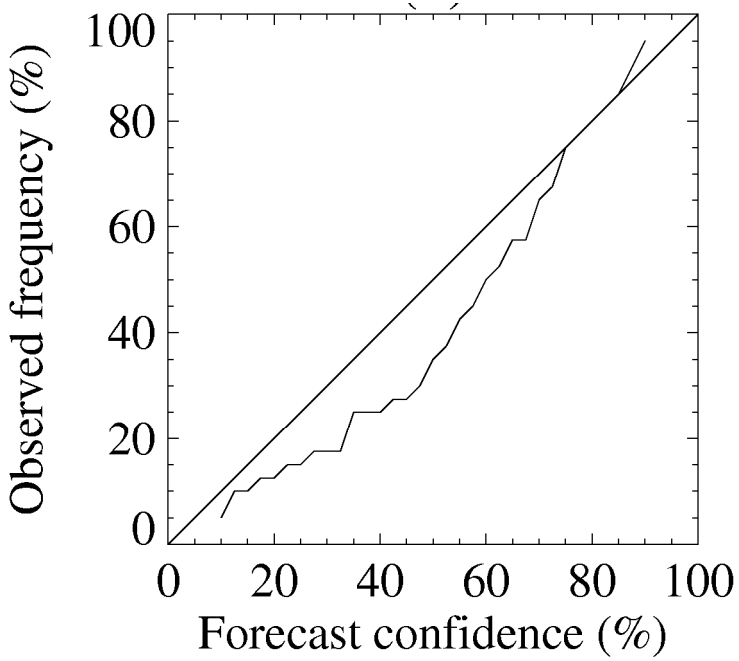
Reliability of global annual mean T_s

- Hindcast confidence ***overestimates*** observed frequency
- Need to increase ensemble spread → sample model errors in addition to initial condition uncertainties

Year 1

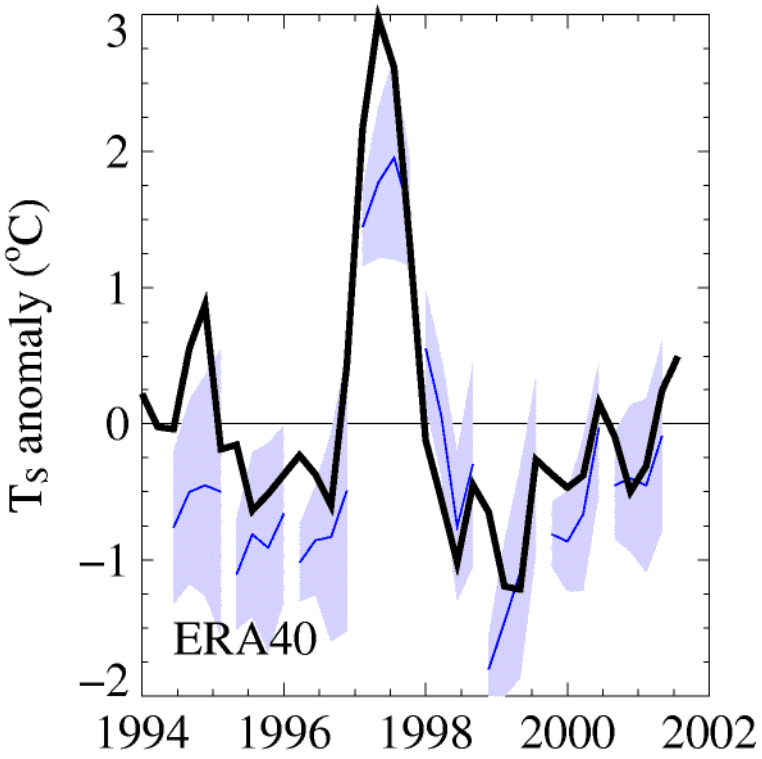


Year 9

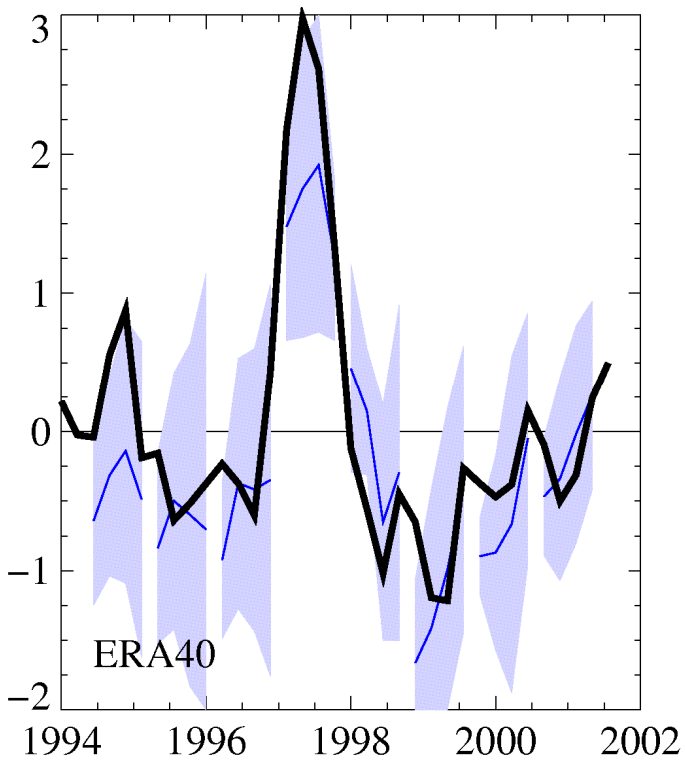


Perturbed physics : monthly Niño3 T_s

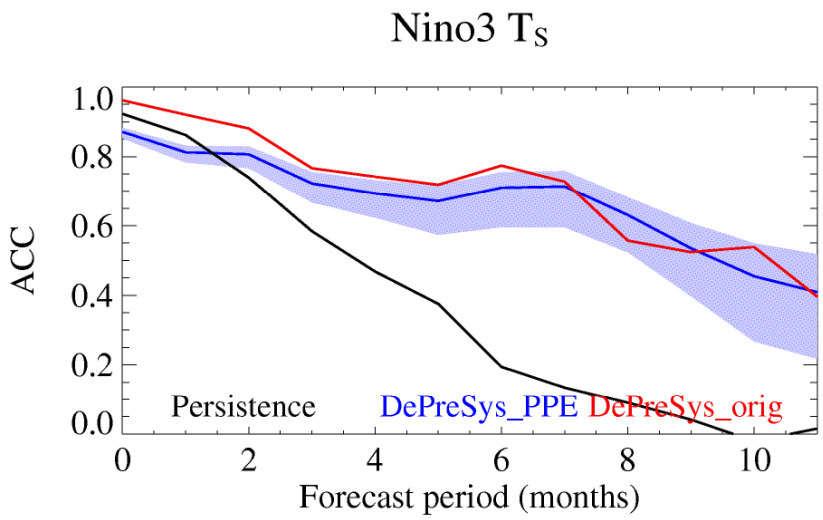
Initial condition ensemble

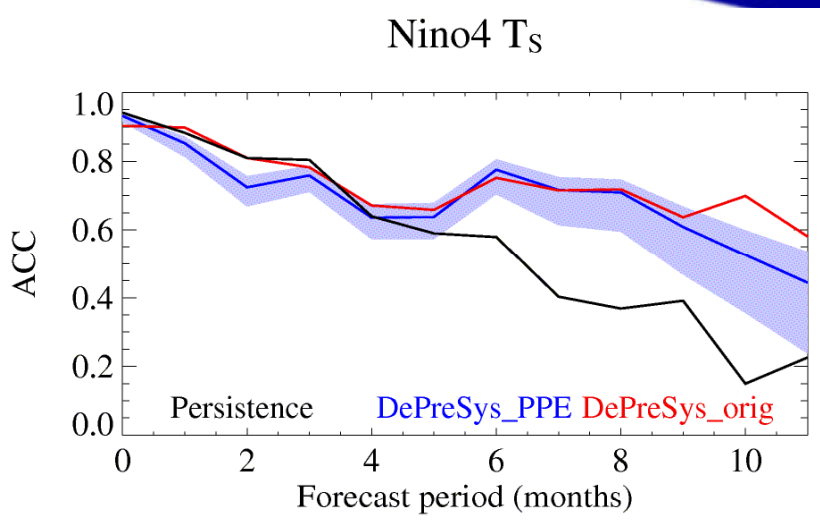


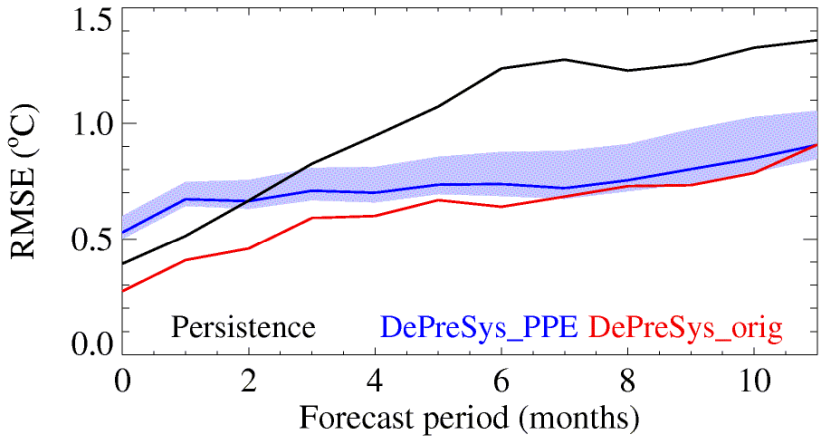
Perturbed physics ensemble

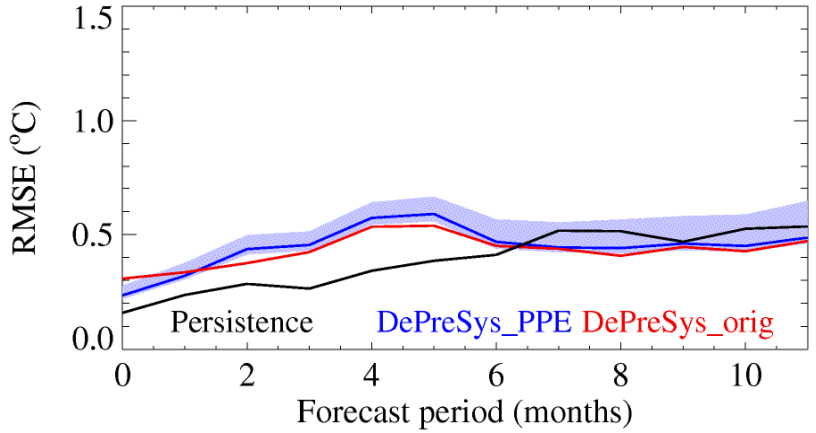


Comparison of PPE with original DePreSys









Note: only 4 ensemble members

PPE = May/Nov : Orig = Jun/Dec

Experiments

9 member PPE Ensemble runs for years 1991-2001 with May and November start dates (i.e., 22-ten year long runs)

Members were selected to represent a range of climate sensitivity and ENSO variability based on the free running QUMP (HadCM3) expts.

Assimilation

Anomaly Assimilation: 6-hourly pstar, theta, u and v for atmosphere [ERA40]
Monthly Temperature and Salinity for Ocean [Smith et al. (2006)]
44-year climatology for atmosphere
46-year climatology for ocean

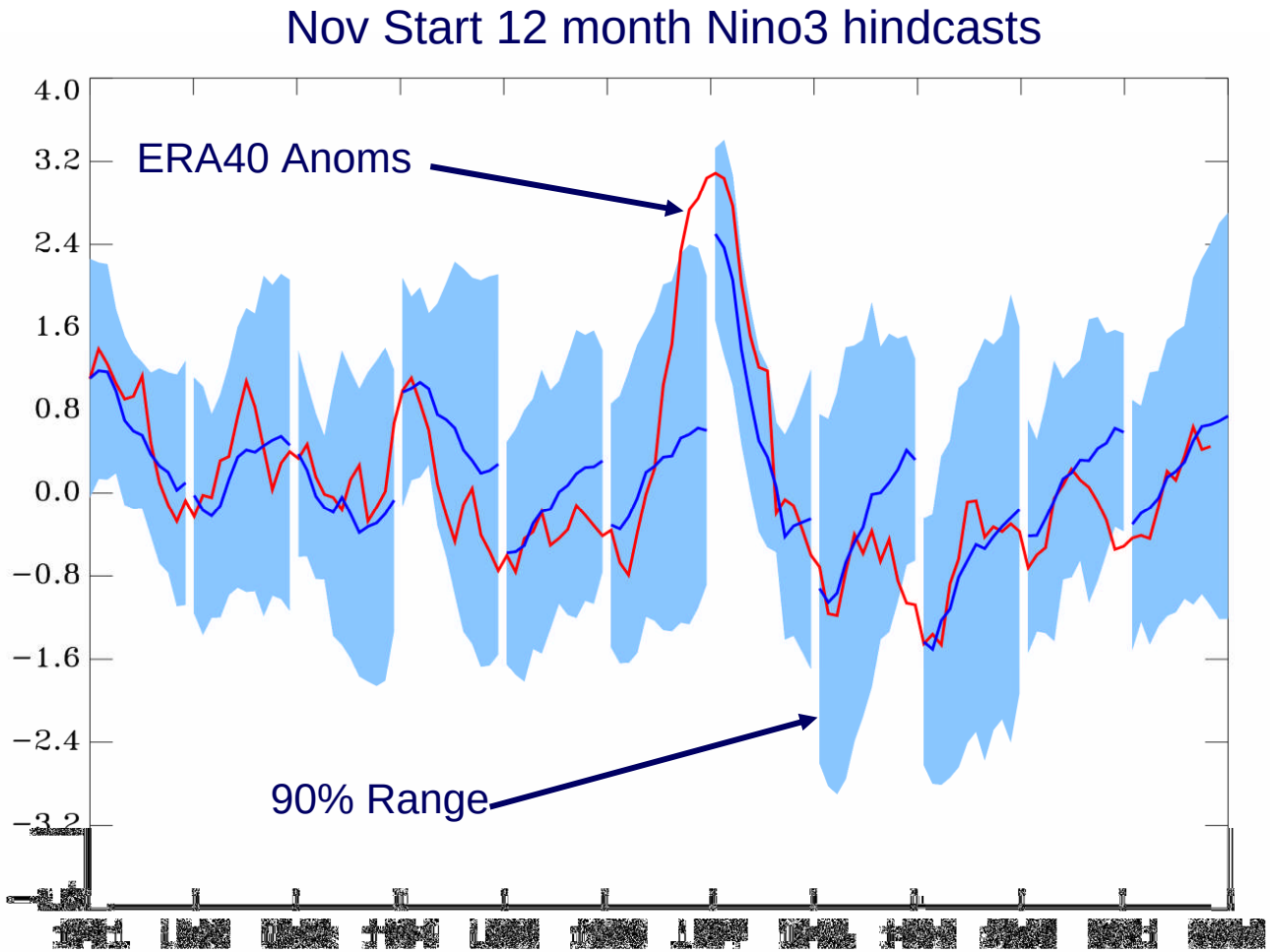
Forecast Anomalies

Produced by **removing** corresponding model climatology used for assimilation

12 Month hindcasts for NINO3 T1.5M (Nov Start)

90% sigma range envelopes Observed anomalies.

Note however that wider the range higher the uncertainty

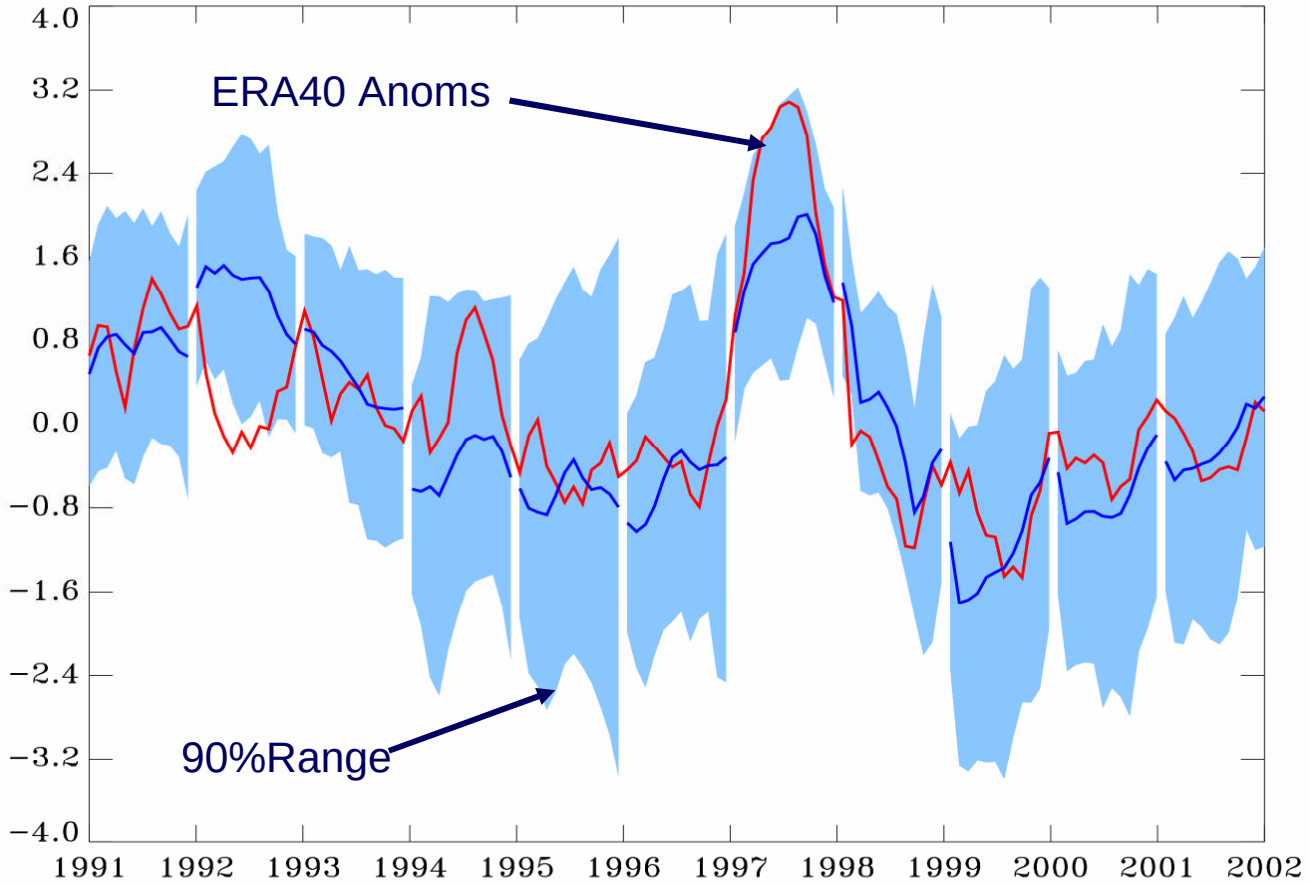


12 Month hindcasts for NINO3 T1.5M (May Start)

Ensemble Means are relatively less skilful for May start dates

Spring Barrier?

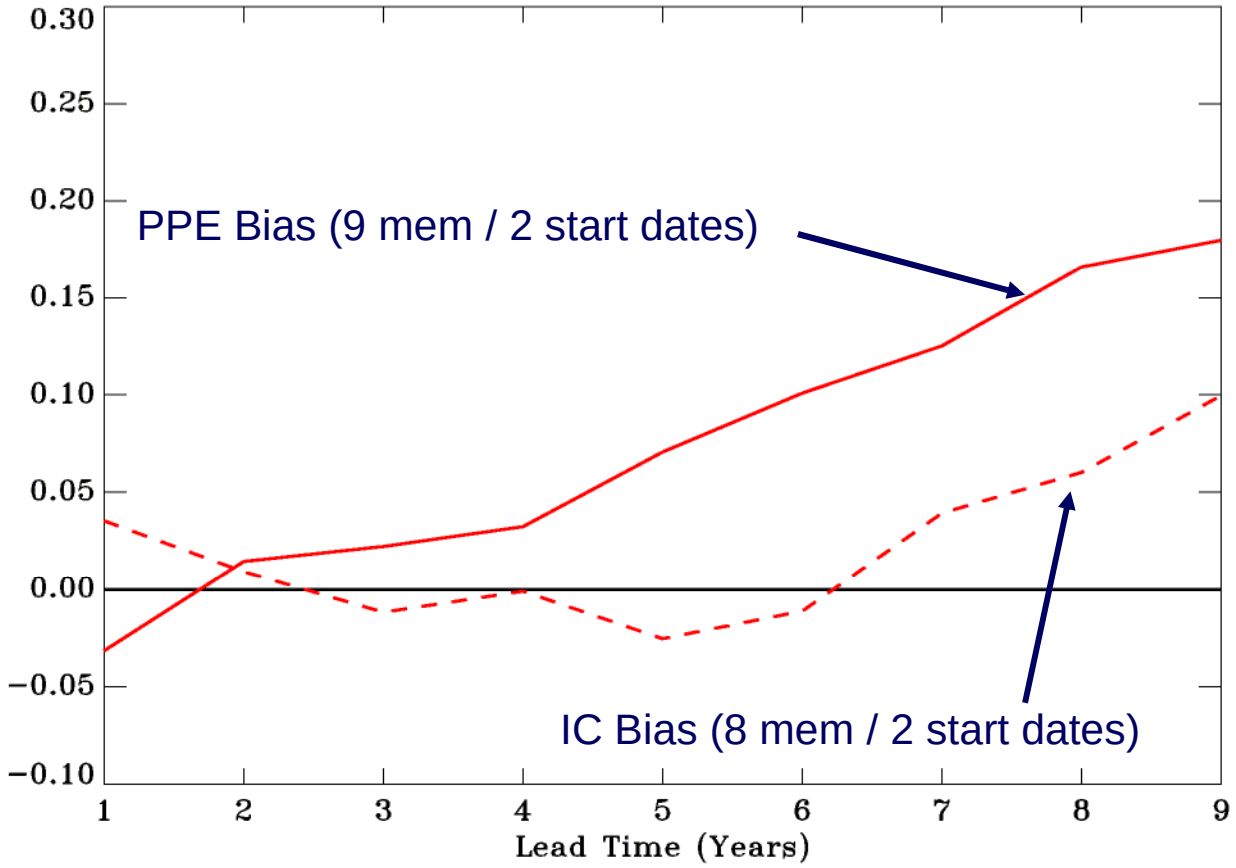
May Start 12 month Nino3 hindcasts



Global Annual Mean T1.5M (May/Nov Start)

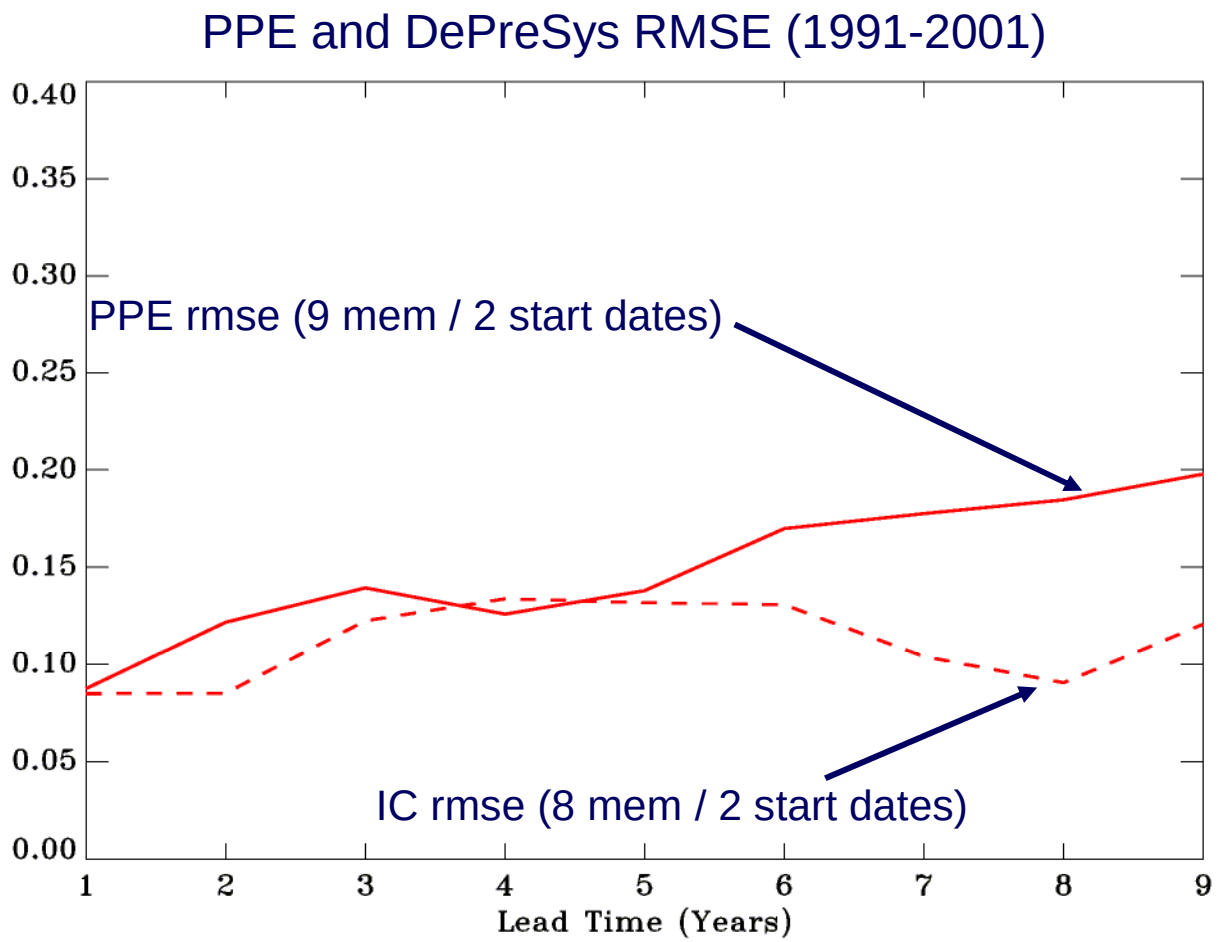
PPE – the average bias is positive in general, and increases at longer lead times

PPE and DePreSys bias (1991-2001)



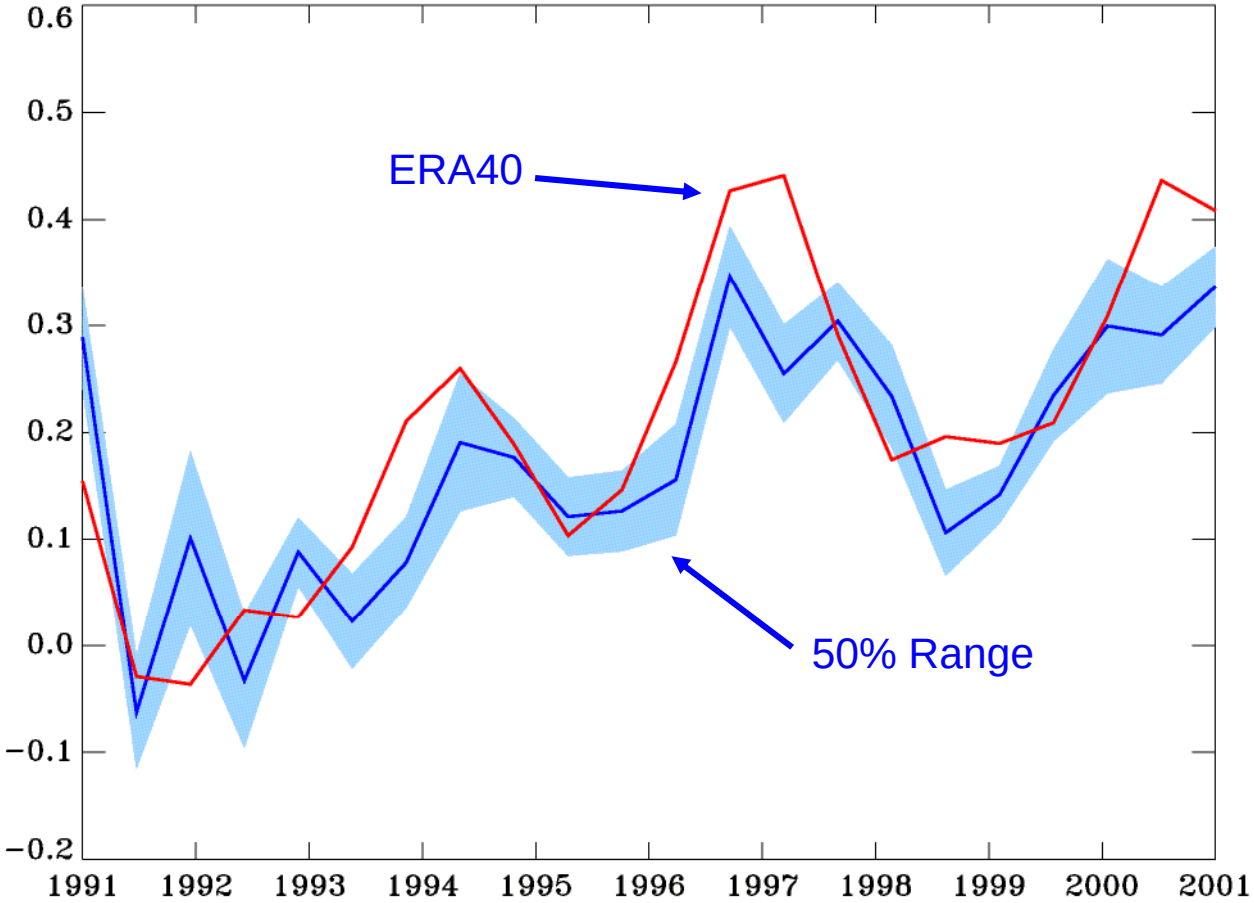
Global Annual Mean T1.5M (May/Nov Start)

Forecast skills comparable at shorter lead times with the old hindcast set. The positive bias shows up at the longer lead times.



Global T1.5M (May/Nov Start)

First year forecast (22 start dates)

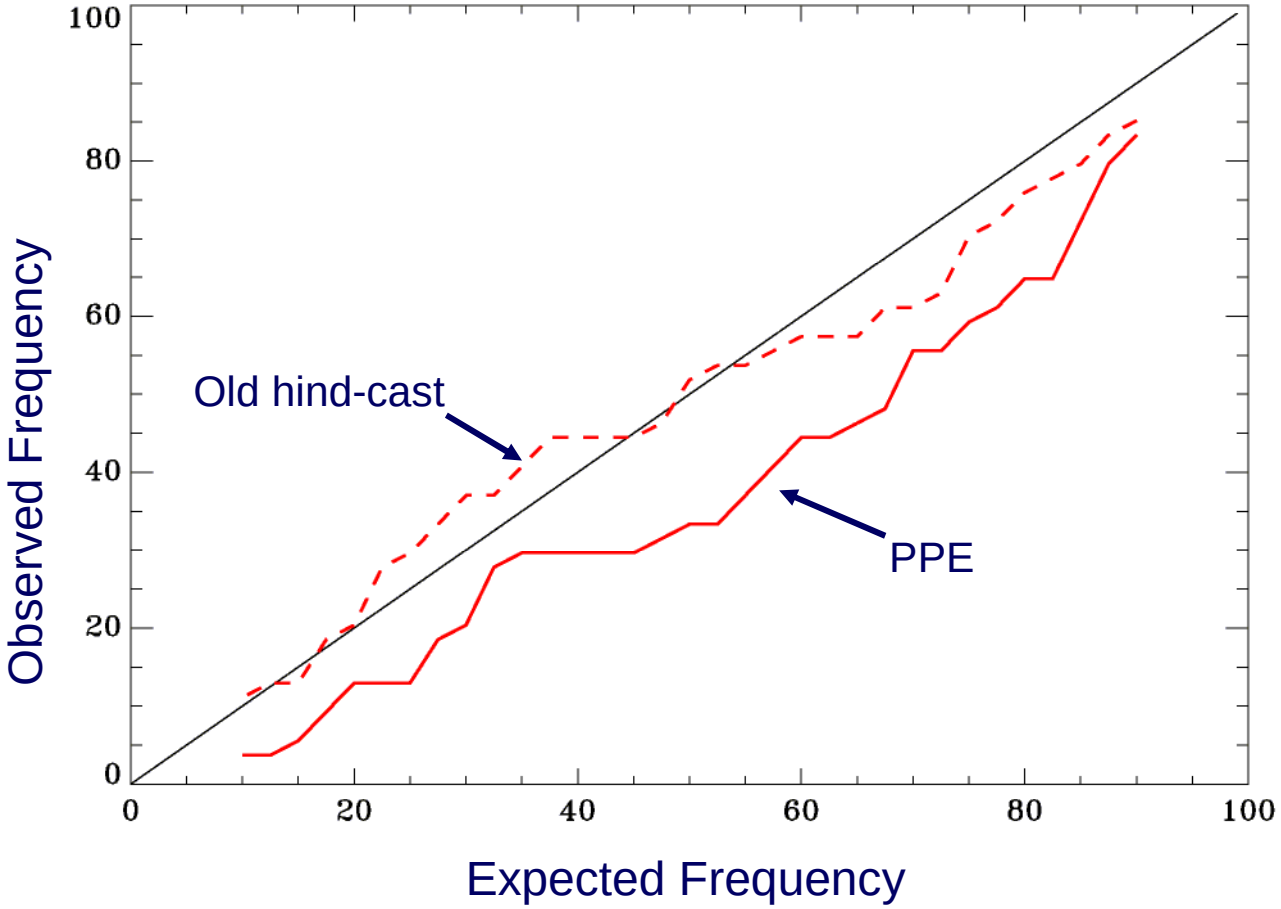


For example,

32% of the observed anomalies over the hind-cast period fall within the 50% expected frequency range of the forecast anomalies

Global T1.5M (May/Nov Start)

Reliability Diagram 1.5mT



For any pre-assigned frequency the new PPE system captures the observed anomalies a fraction less.

The old hind-cast system appear to perform relatively better.

Global T1.5M (May/Nov Start)

In Summary, the preliminary results shows that:

1) The new PPE prediction system appear to a positive bias, especially at the longer lead times, and that reflects in the rmse scores as well; and

2) The reliability estimates, even for the shorter lead times, are lower compared to the old DePreSys system

However note that the s2d PPE prediction system combines two extremely complex systems: QUMP and DePreSys.

The PPE members warm faster than their free-running QUMP counterparts during 1991-01.

A possible Source of Error:

Physics perturbation and flux adjustments may have introduced mismatch in assimilated ocean analyses.

Future Plans:

1) Understand the causes for the decreased skills in the new PPE system (Ocean assimilation, Flux adjustments).

2) Repeat 9-member PP Ensemble with a one-day lagged IC for May and Nov start dates for years 1991-2001.

3) Produce 9-member Initial condition ensemble using the standard DePreSys configuration.