Climate Analysis Forecast Ensemble (CAFE) System Design and Future Developments)

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https://research.csiro.au/dfp/ http://nespclimate.com.au/decadal-prediction/
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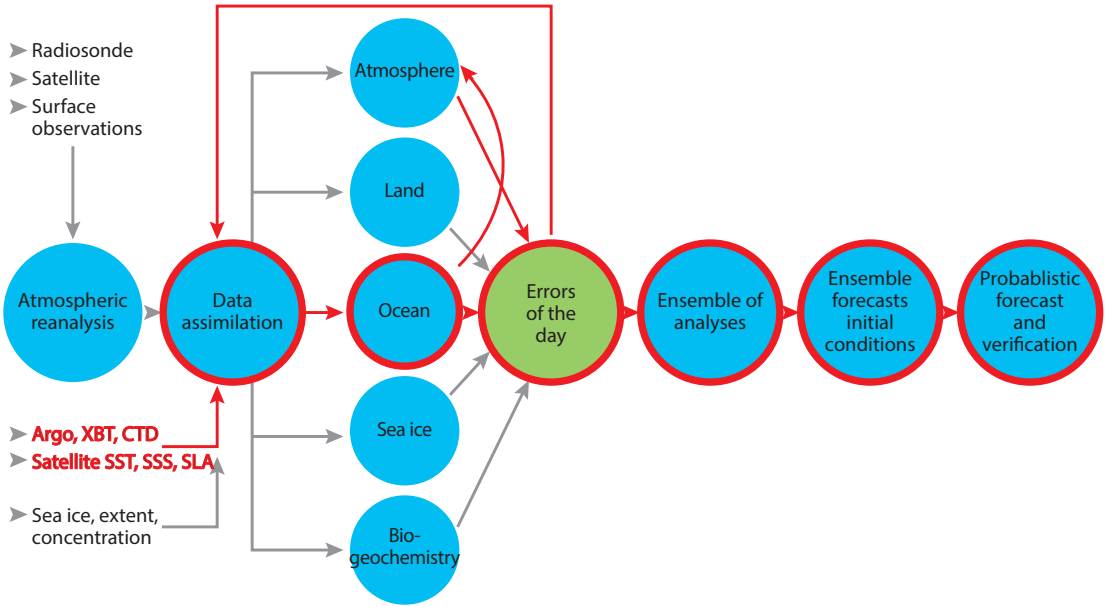
1: CAFE system design

Schematic of the CAFE system



2: ensemble forecasts (V0, V1, ETKF-9, ETKF-13)

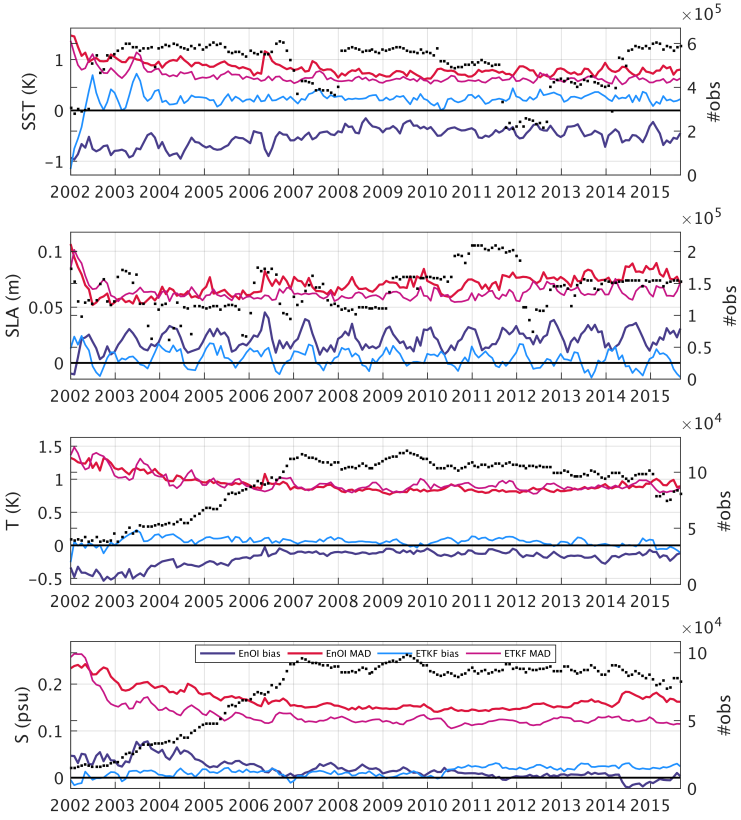
The aim of these Observing System Simulation Experiments (OSSE's) was to

- compare variants of coupled data assimilation (DA) systems based on ensemble optimal interpolation (EnOI) and ensemble transform Kalman filter (ETKF) methods
- to assess the impact of assimilating ocean observations on the atmospheric state analysis update via the cross-domain error covariances from the coupled-model background ensemble.
- examine the relationship between ensemble spread, analysis increments and forecast skill in multi-year ENSO prediction experiments with a particular focus on the atmospheric response to tropical ocean perturbations.
- explore various approaches to generating initial forecast perturbations, either in terms of ETKF or bred vectors

O'Kane, T.J., P.A. Sandery, D.P. Monselesan, P. Sakov, M.A. Chamberlain, R. Matear, M. Collier & L. Stevens (2018) *Coupled data assimilation and ensemble initialization with application to multi-year ENSO prediction* (submitted J. Climate)

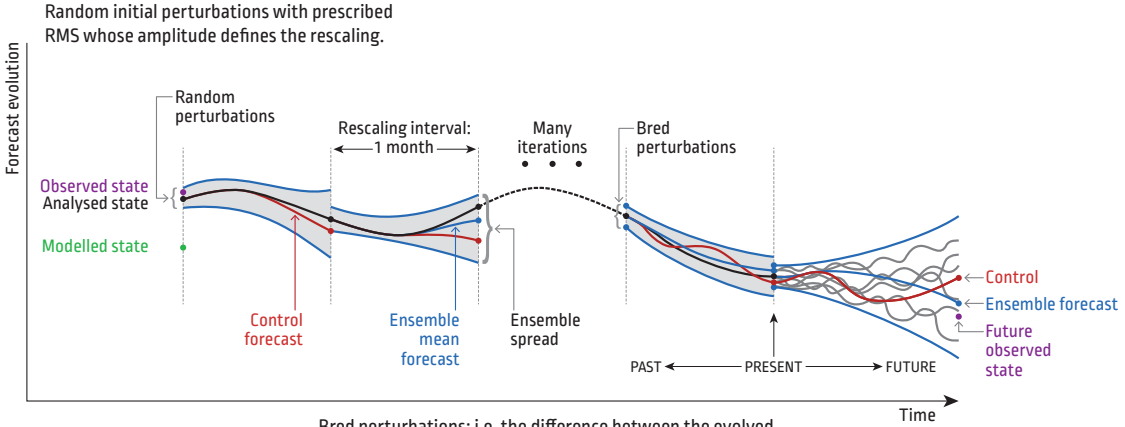
3: Analysed state (20°S-20°N)

”Ocean” assimilation. Comparison EnOI (1 analysis, static cov) versus ETKF (96 analyses,



4: Ensemble Prediction System

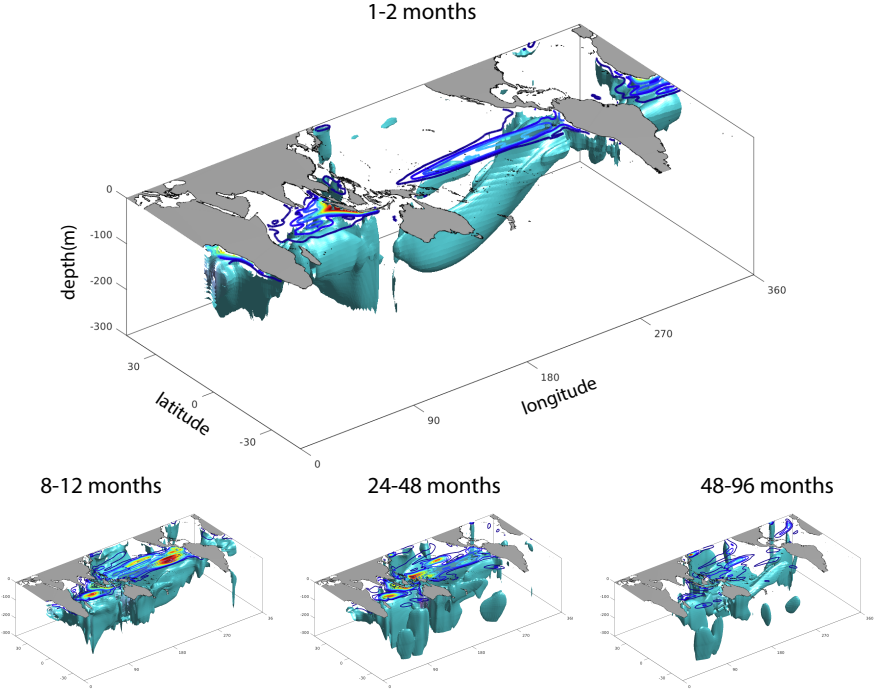
Bred vector generation



Bred perturbations: i.e. the difference between the evolved perturbed forecasts and the control, renormalised via the norm defined by the RMS of the initial perturbations and the length of the rescaling interval.

5: Scale selection

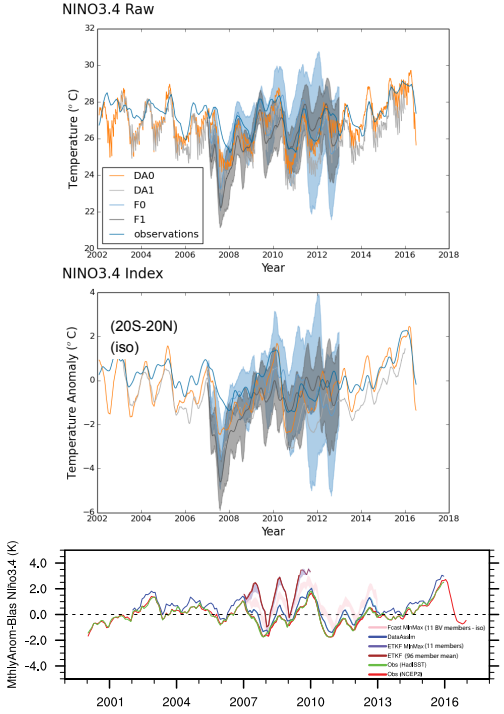
• localisation length scales and adjustment of observation impact factors to ”tune” increments to select spatio-temporal scales of relevance to given forecast lead times.
• mask regions of variance relevant to those chosen spatio-temporal scales such as the in band variance for temperature with an appropriate threshold (0.5 RMSE calculated from 500 years of control simulation).



7.1: ENSO Prediction

- Ensemble forecasts beginning January 2007 comparing isosurface BVs to BVs generated between 20°N-20°N BVs (renormalised to 1% of the background RMSE).
- Spread reduced in isosurface ensemble due to reduced spurious error growth.
- DA0 & DA1 are reanalysed state estimates.

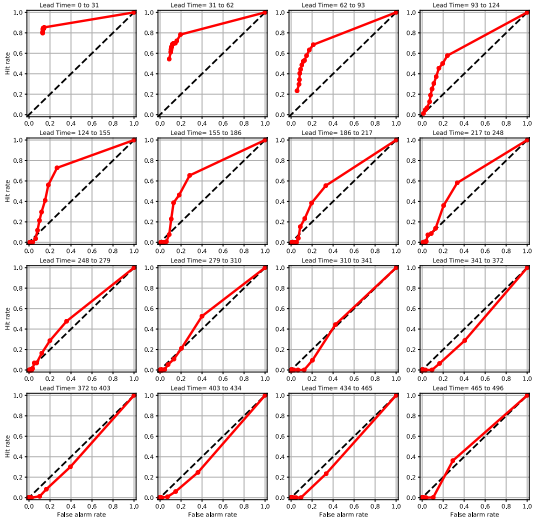
Note: no SST perturbations are used in isosurface BVs - predictability comes from thermocline perturbations)



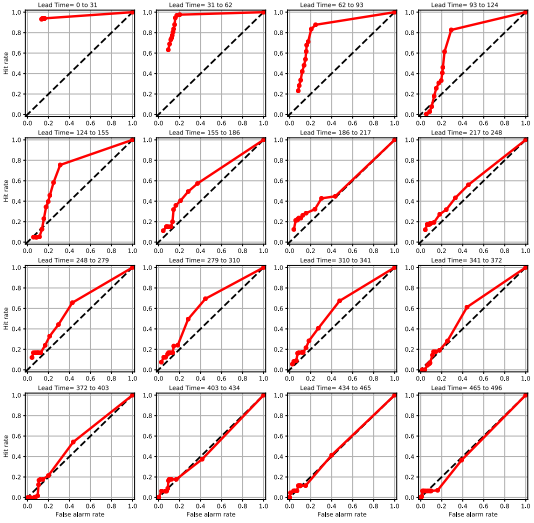
7.2: ENSO Prediction

V0 and V1 ROC curves for NINO4

v0



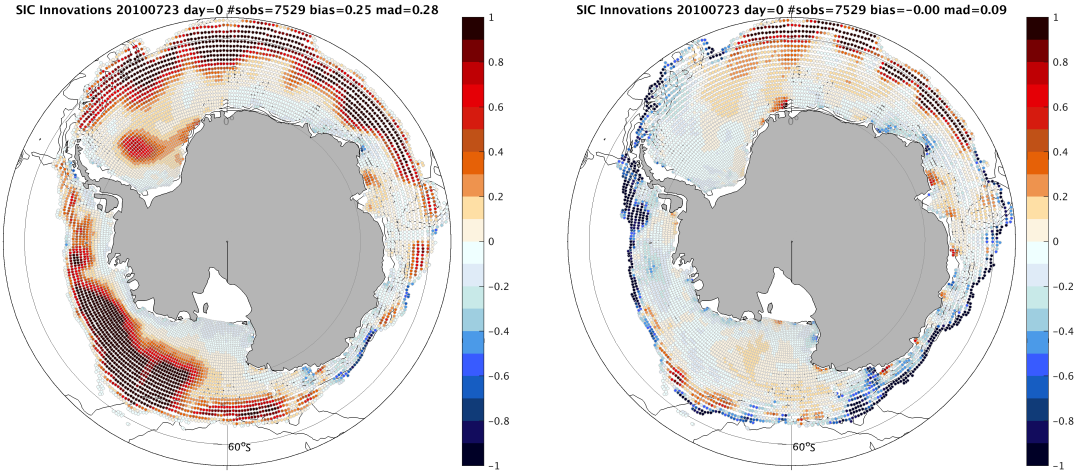
v1



8.1: Current work - DA (Sandery, Sakov)

- Assimilation of high resolution JRA-55 reanalysis data (hybrid sigma-pressure levels)
- Sea-ice assimilation

7 day forecast innovation errors assimilating under ice freezing point SST

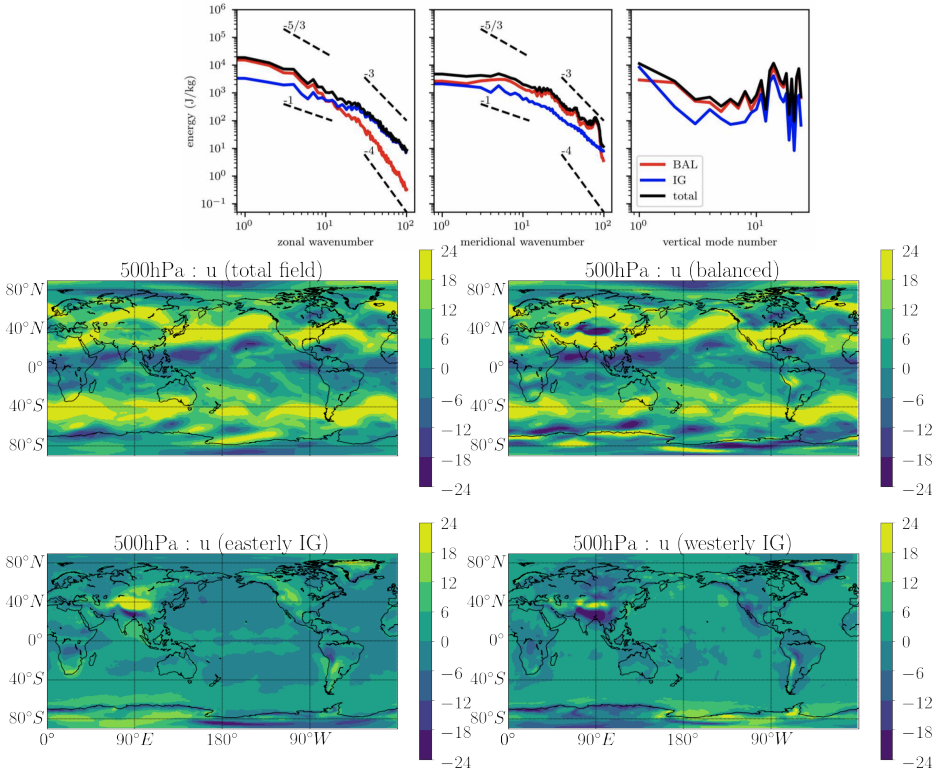


CONTROL

ASSIMILATION

8.2: Current work (Kitsios)

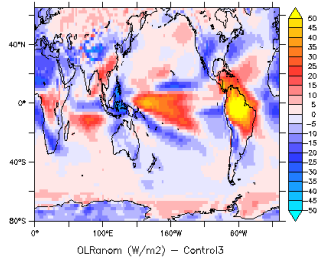
- Normal Mode Initialization

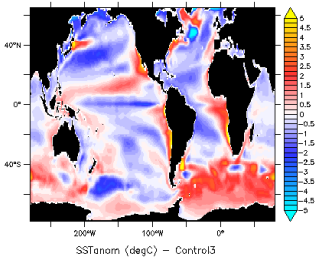


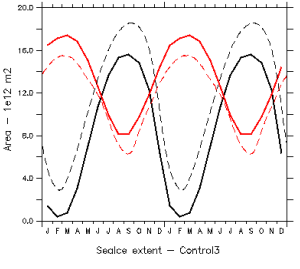
8.3: Current work (Chamberlain, Fiedler, Stevens)

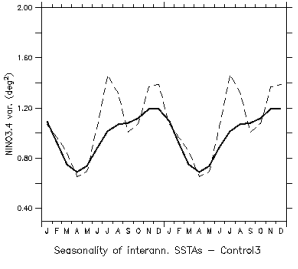
Model configurations

- CM2.1 (2 degree atmosphere, 1 degree ocean (MOM5)
- CM2.5 (50km atmosphere (AM2/LM2, 1/4 degree ocean (MOM5))
- CMFLOR (50km atmosphere, 1 degree ocean)
- ACCESS ESM1.5 comparison studies (future model for decadal MIPS)
- KPP ocean surface boundary layer parameterization (CVMix Griffies et al 2015)









8.2: Future work

- 2018-2019 Coupled reanalysis 2000 to present (ETKF + breeding spinup + new initial background state)
- V2 forecast - ETKF (atmos - ocean - sea ice) + multiscale breeding
- Incorporate BGC state estimation
- CM2.5 upgraded to AM4/LM4

Thank You

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