
# S2D C1-03: Coupled data assimilation and ensemble initialization with application to multi-year ENSO prediction.

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https://research.csiro.au/dfp/ http://nespclimate.com.au/decadal-prediction/
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# Observing System Simulation Experiments (OSSE's)

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* (in review J. Climate)

# Paradigm Model

Paradigm model for ocean-tropical-extra tropical atmosphere coupling (Peña and Kalnay(2004)):

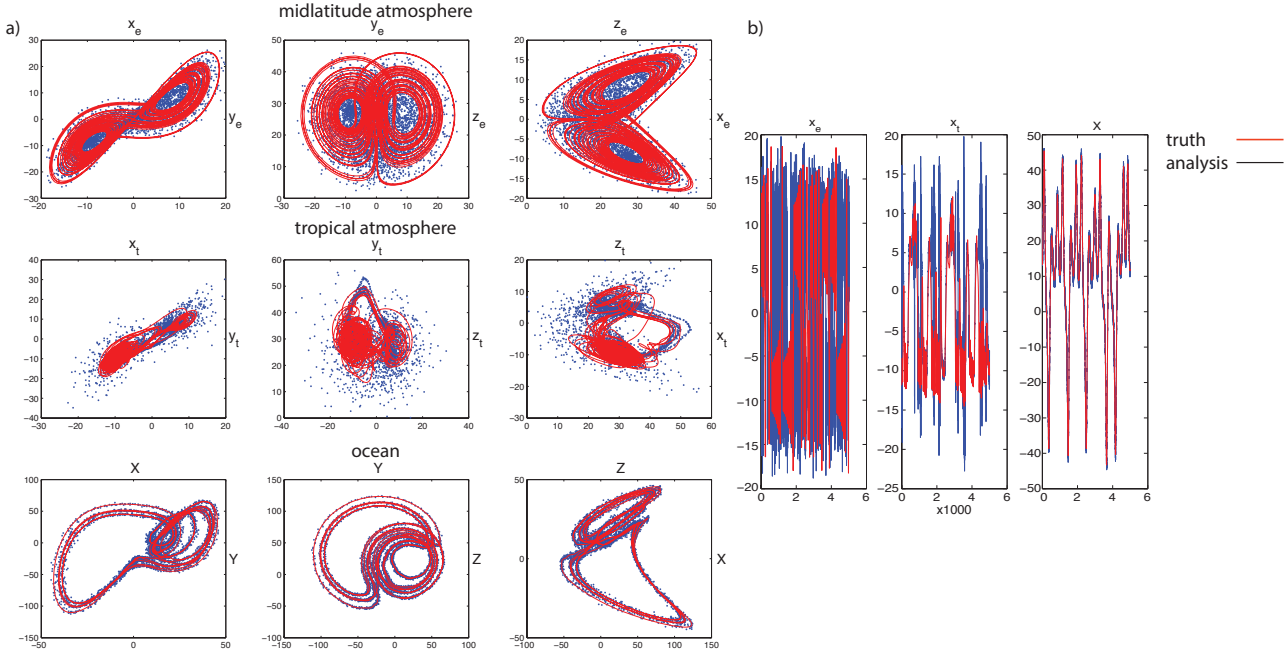
$$\dot{x}_e = \sigma(y_e - x_e) - c_e(Sx_t + k_1) \tag{1a}$$
$$\dot{y}_e = rx_e - y_e - x_e z_e + c_e(Sy_t + k_1) \tag{1b}$$
$$\dot{z}_e = x_e y_e - bz_e \tag{1c}$$

$$\dot{x}_t = \sigma(y_t - x_t) - c(SX + k_2) - c_e(Sx_e + k_1) \tag{2a}$$
$$\dot{y}_t = rx_t - y_t - x_t z_t + c(SY + k_2) + c_e(Sy_e + k_1) \tag{2b}$$
$$\dot{z}_t = x_t y_t - bz_t + c_z Z \tag{2c}$$

$$\dot{X} = \tau\sigma(Y - X) - c(x_t + k_2) \tag{3a}$$
$$\dot{Y} = \tau rX - \tau Y - \tau SXZ + c(y_t + k_2) \tag{3b}$$
$$\dot{Z} = \tau SXY - \tau bZ - c_z z_t \tag{3c}$$

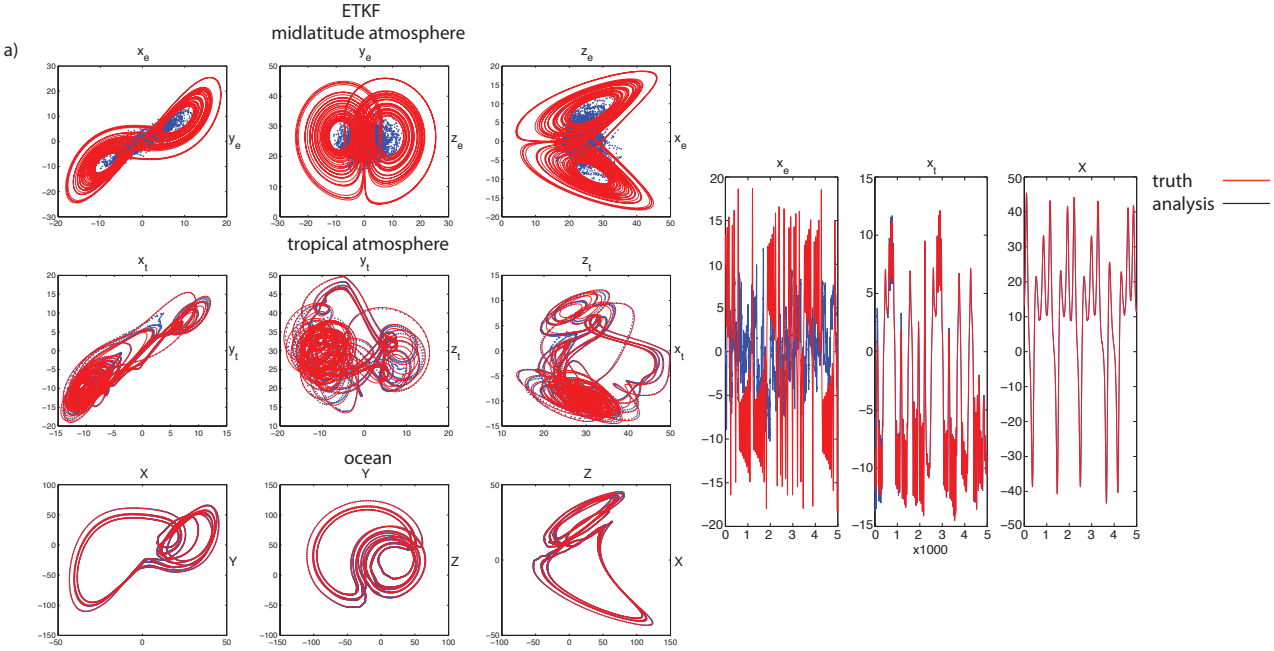
# Paradigm Model (EnOI)

”Ocean” assimilation coupled covariances: Static background covariances (50 mem)
Analysed tropical atmosphere is on a different attractor. Variance of extra-tropical atmosphere unchanged.



# Paradigm Model (ETKF)

”Ocean” assimilation - coupled covariances: Flow dependent background covariances (10 mem). Analysed tropical atmosphere is on the attractor. Variance of extra-tropical atmosphere is suppressed.



# CAFE system design

Schematic of the CAFE system