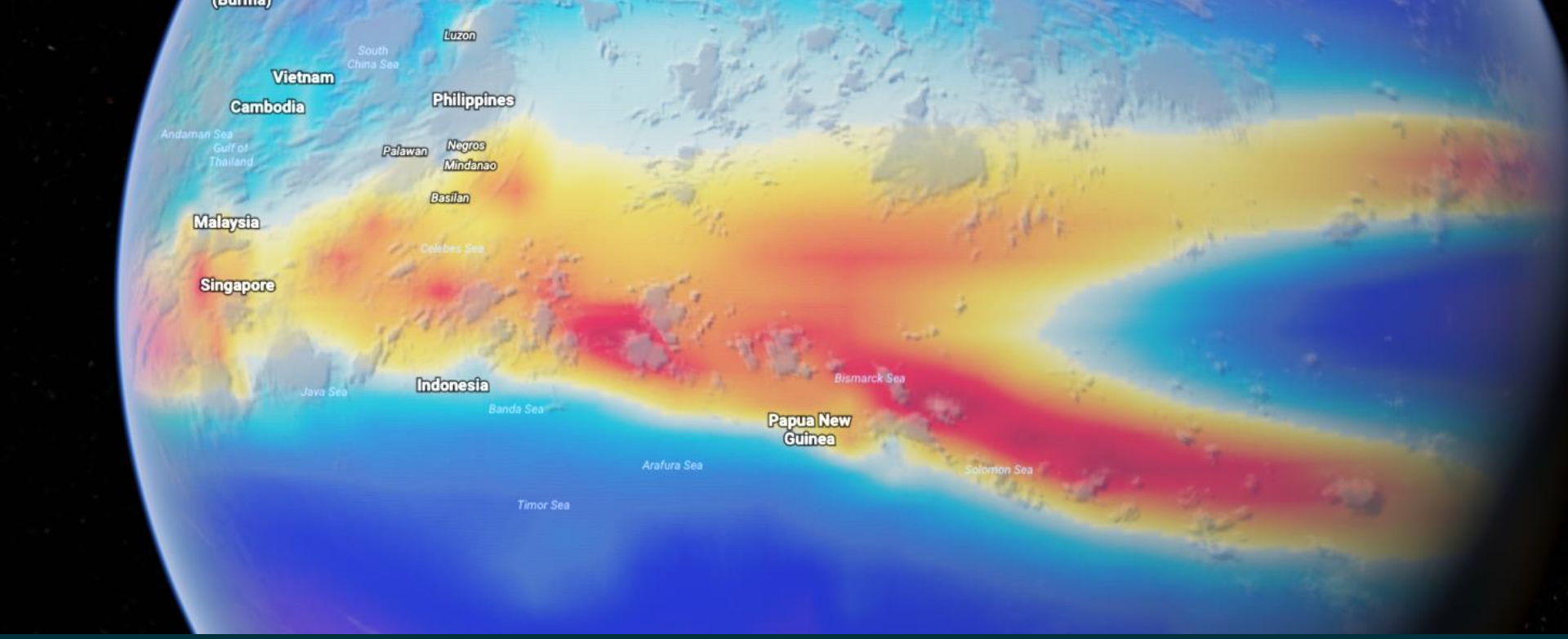


Coupled ocean-atmosphere-sea-ice assimilation

Paul Sandery

14 May 2018

CSIRO OCEANS AND ATMOSPHERE
www.csiro.au

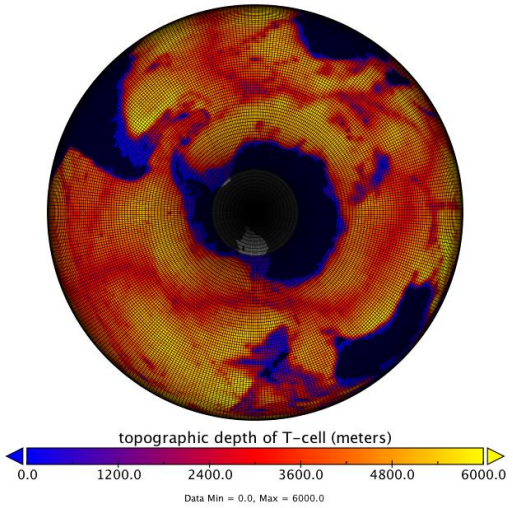
Coupled ocean-atmosphere-sea-ice assimilation

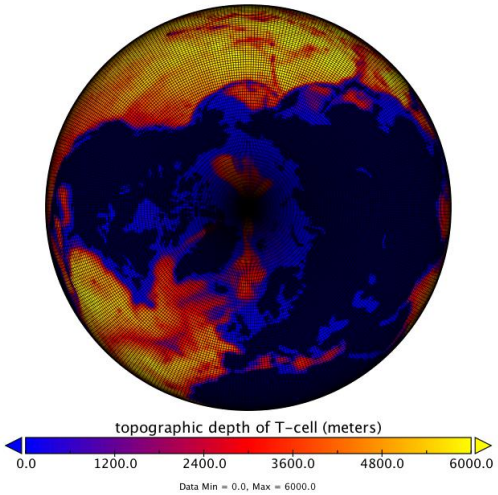
ACCESS-ESM
GFDL FLOR
GFDL CM2.4
GFDL CM2.5

GFDL CM2.1 ⟷ EnKF-C ⟷ Obs

CSIRO DFP V2 with BGC

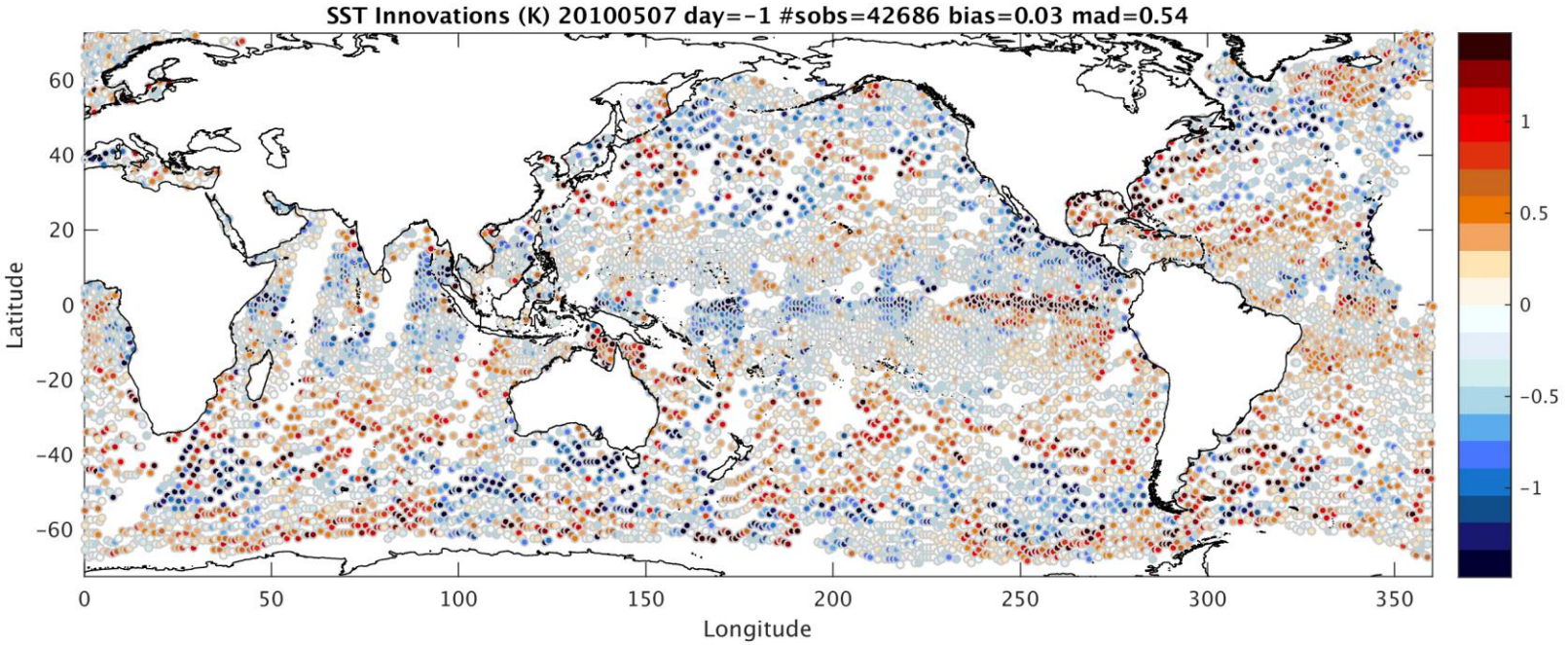
- Model independent
- Coupled state vector
- 96 member ensemble
- Asynchronous DA
- EnKF bias correction
- EnKF parameter estimation



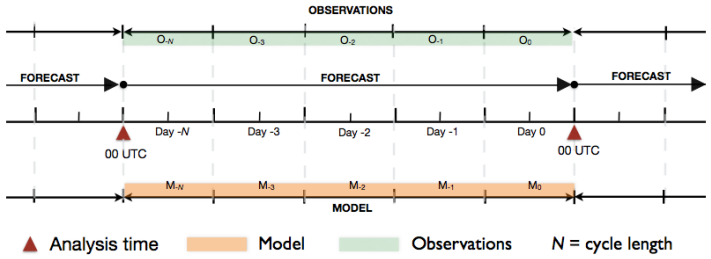


Observations

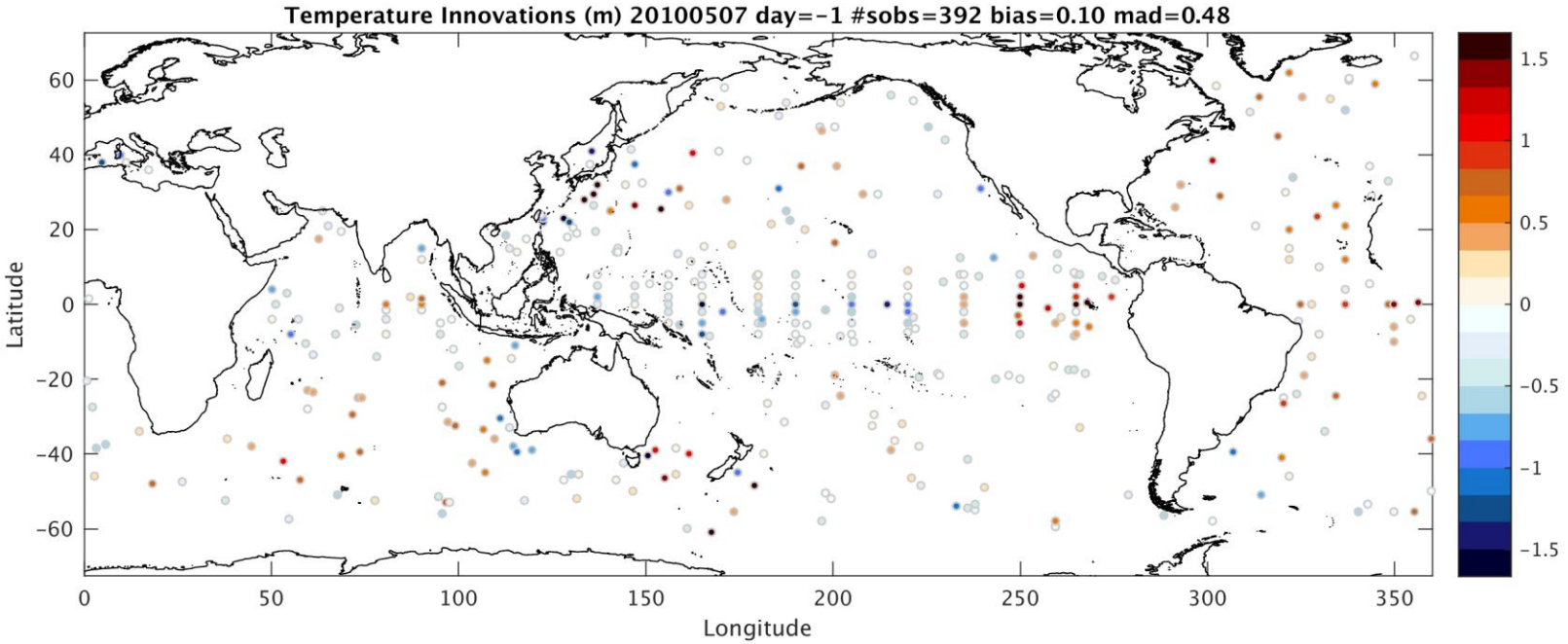
- RADS altimetry
- SST – NAVO-AVHRR, AMSR-E, AMSR-2, WindSat, PATHFINDER, VIIRS
- SSS – SMOS L2 debiased SMAP
- In-situ T/S from CARS and WMO GTS including ARGO, CTD, XBT, RAMA, PIRATA, TAO-TRITON.
- JRA-55 hybrid sigma-pressure level data
- OSISAF sea ice concentration
- Under ice freezing point SST derived from OSISAF
- MEOP polar T and S



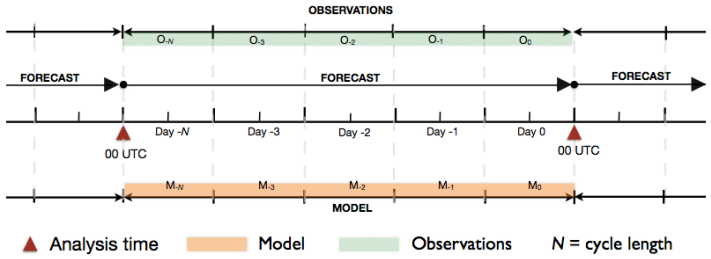
EnKF Analysis-Forecast cycle



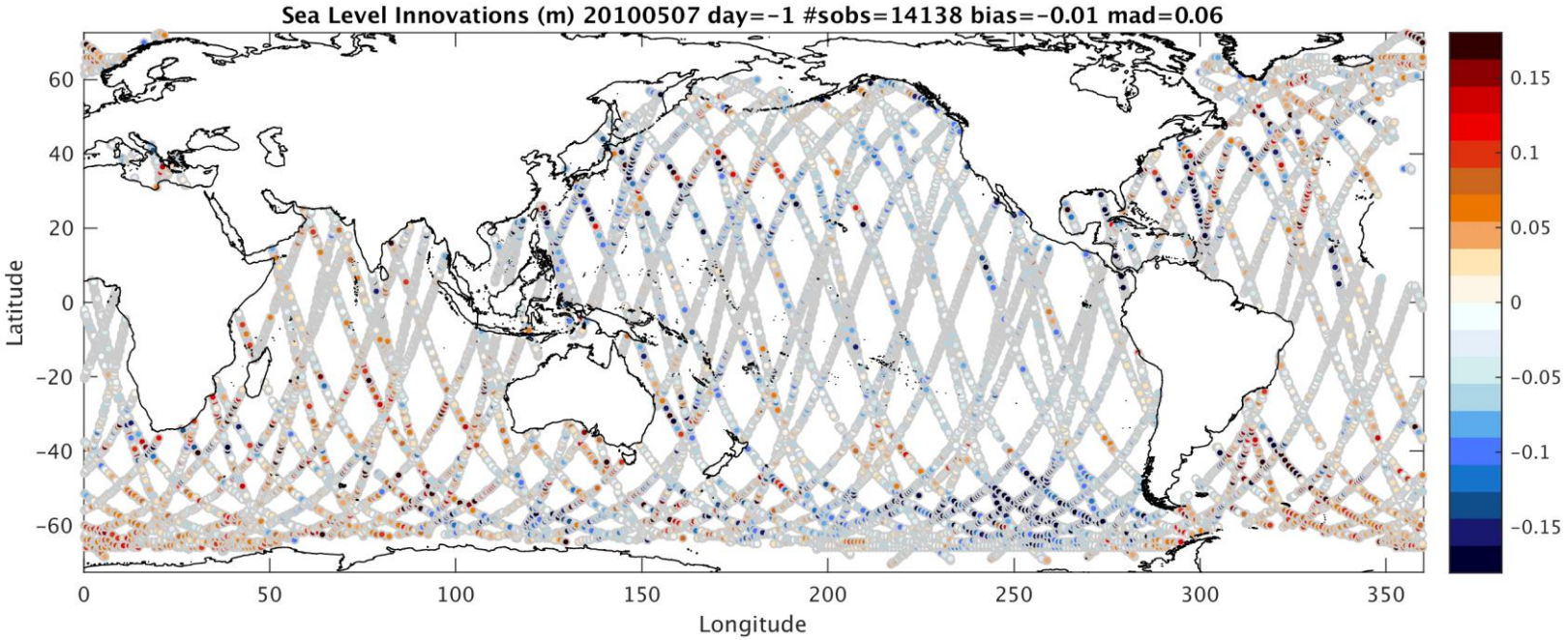
Asynchronous and asymmetric backwards in time scheme

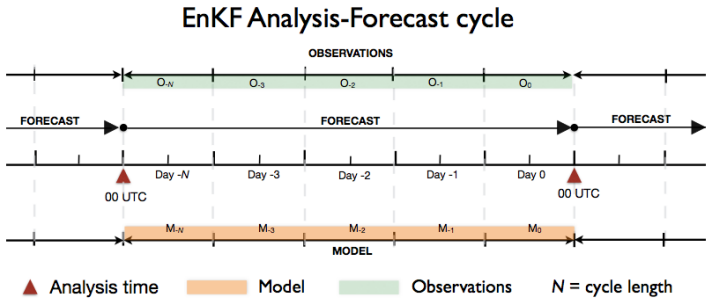


EnKF Analysis-Forecast cycle



Asynchronous and asymmetric backwards in time scheme

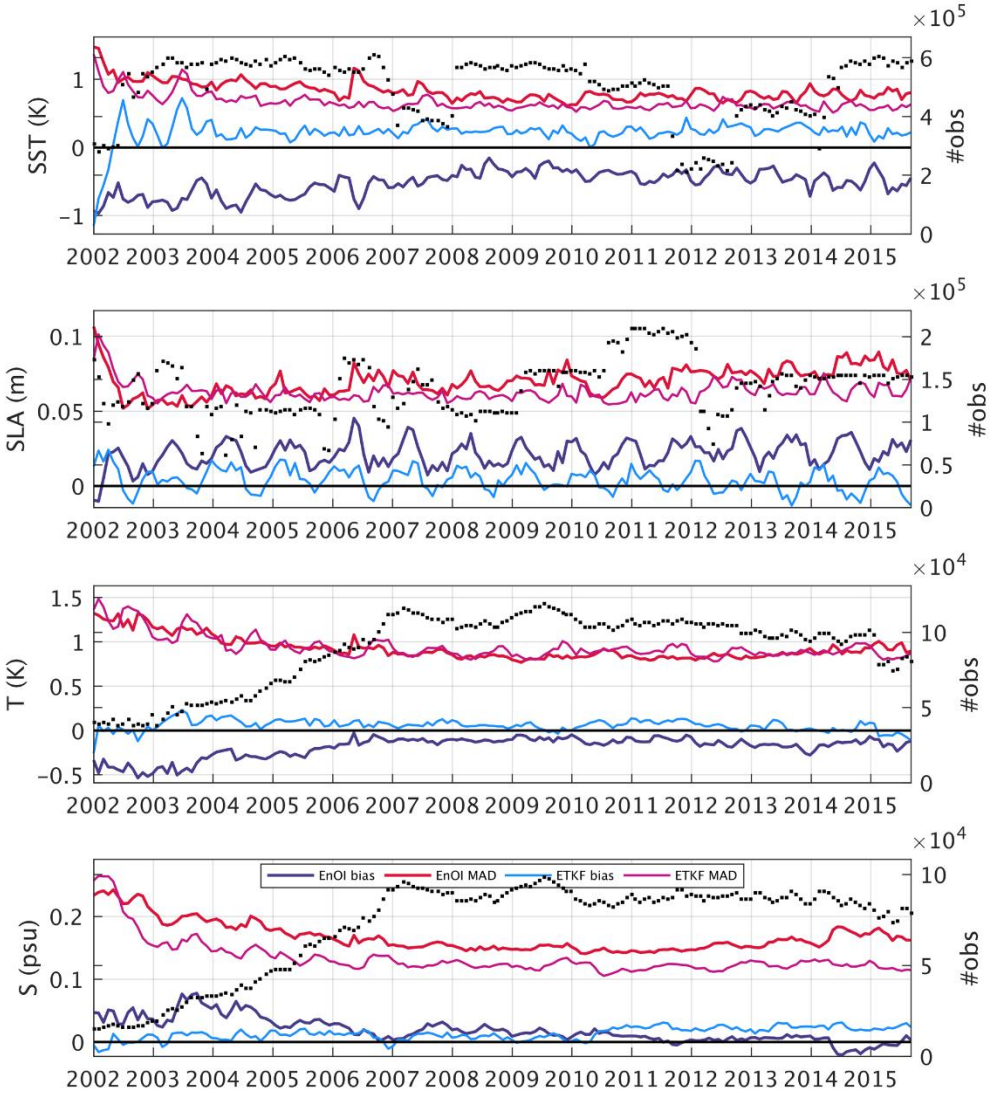




Asynchronous and asymmetric backwards in time scheme

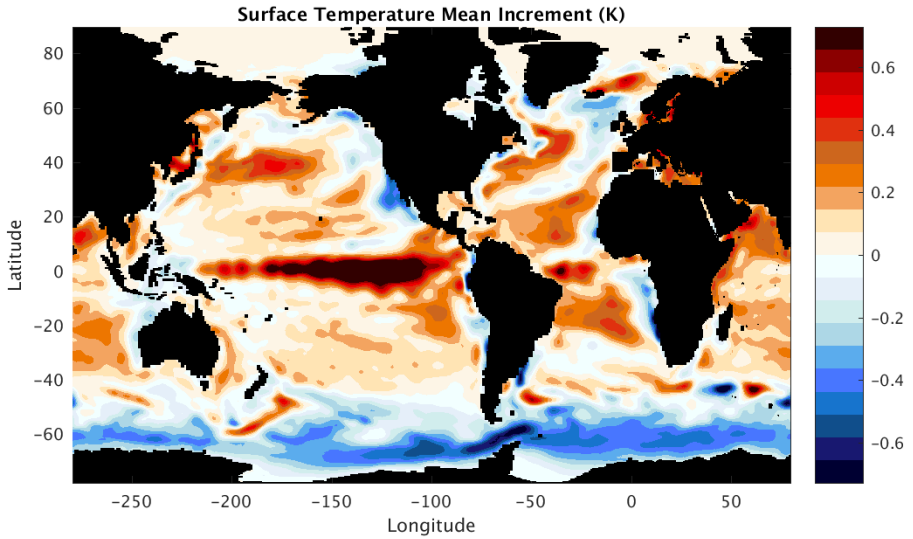
EnOI ⇒ D9 Forecasts 2002-2018

- **Forecast innovation bias and MAD for 20N to 20S**
- 28 day lead time

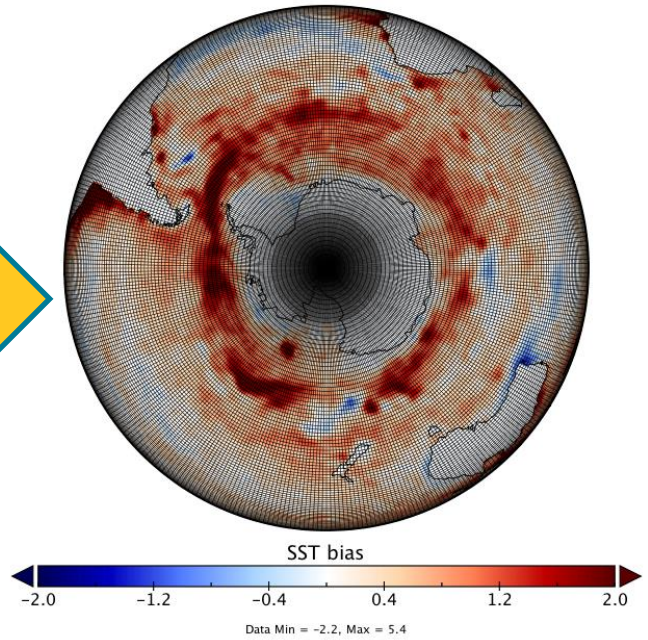


SST and SLA bias correction

- Start with ensemble of bias fields added to the state vector
- Stochastic model to maintain spread
- Estimate **mean forecast error** directly from observations and subtract this from innovations prior to analysis



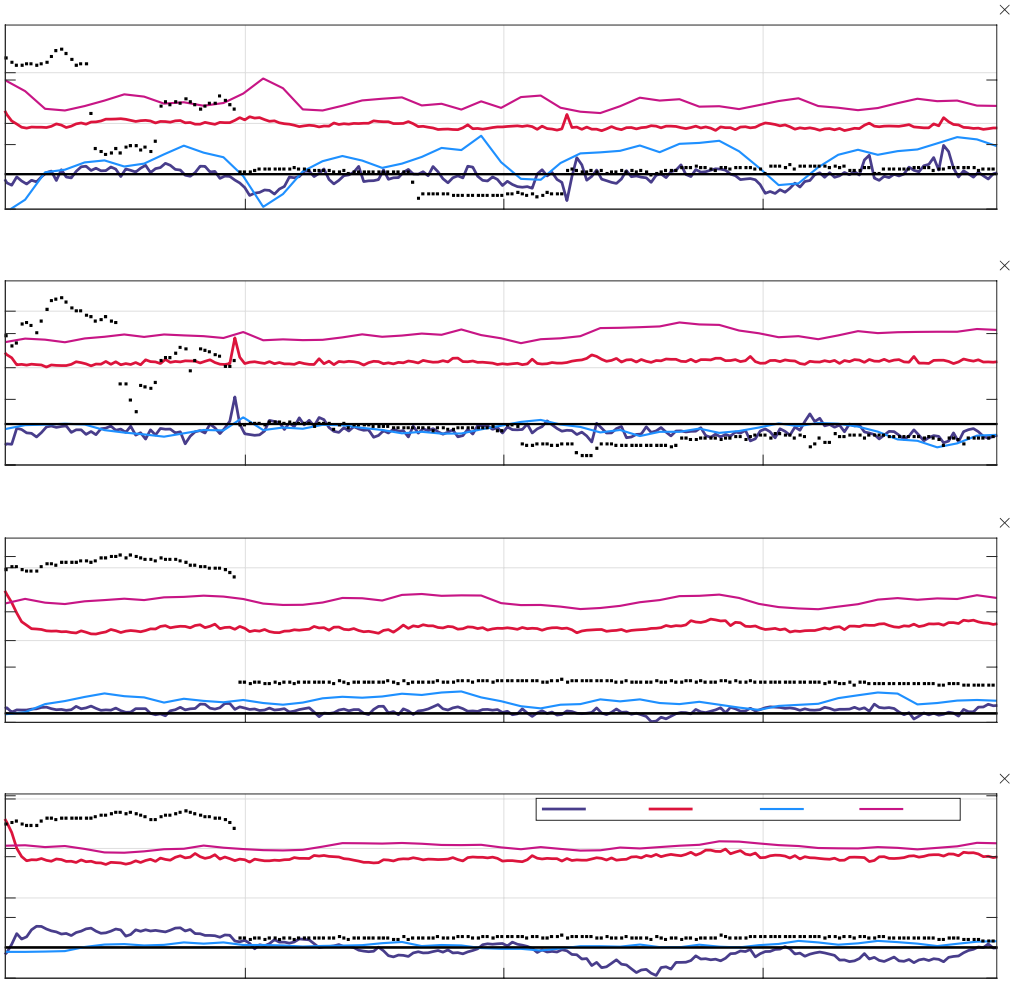
Bias corrected



Analysed bias 2010-2014

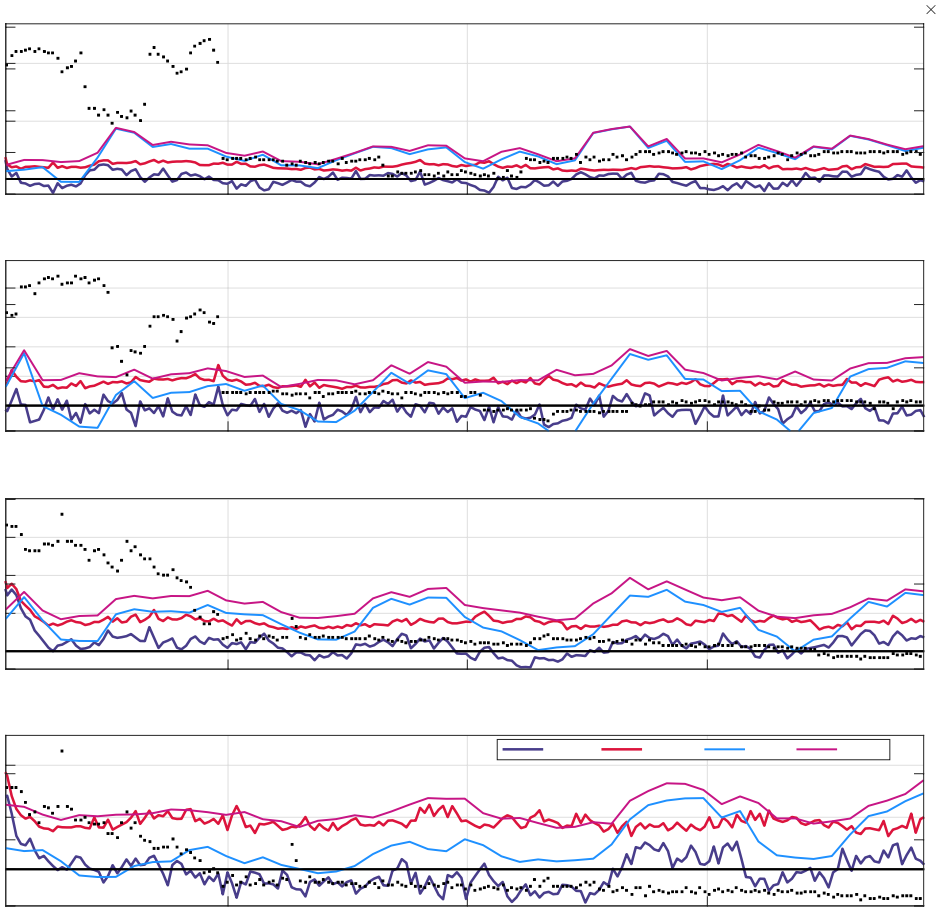
D9➡D49 Forecasts 2010-2014

- **GLOBAL**

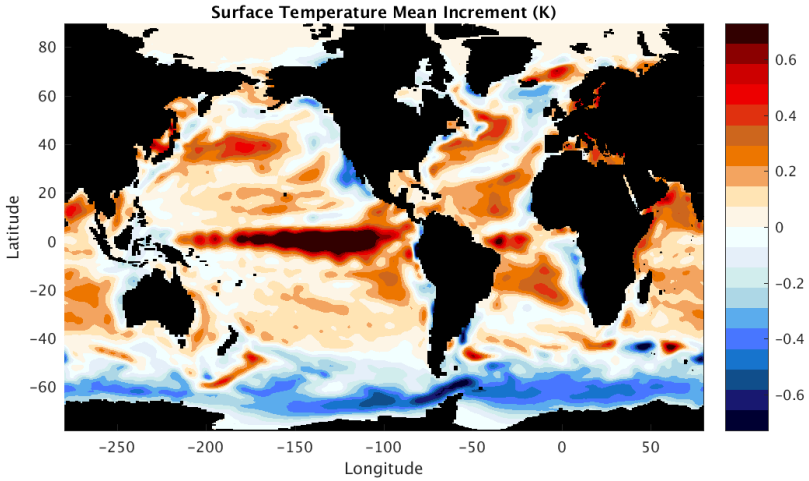


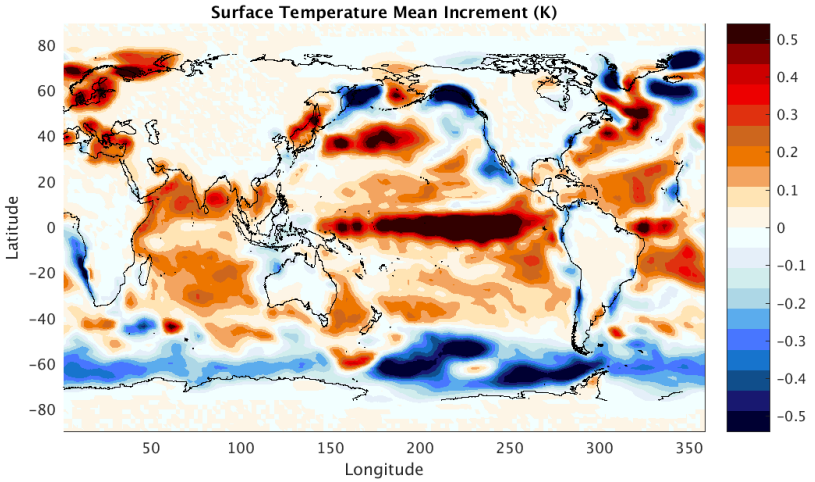
D9➡D49 Forecasts 2010-2014

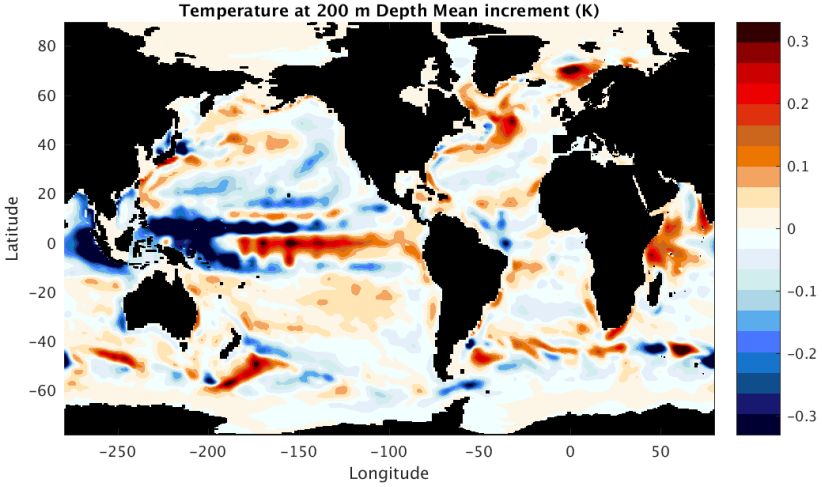
- **NINO34**

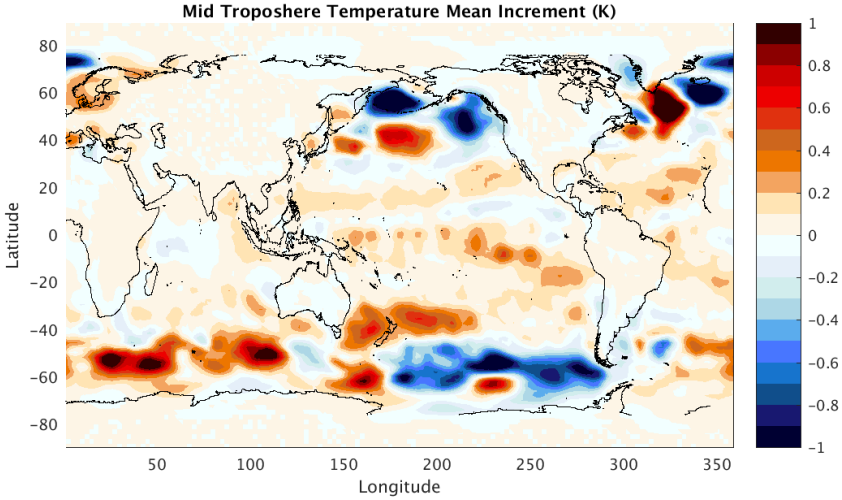


Mean Increments

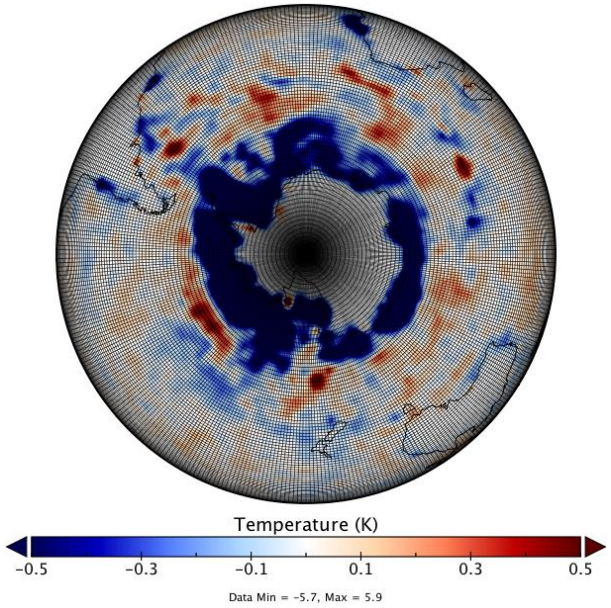




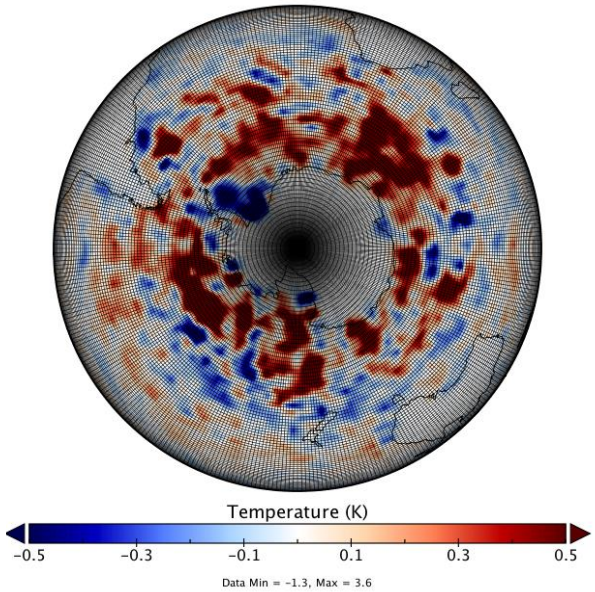




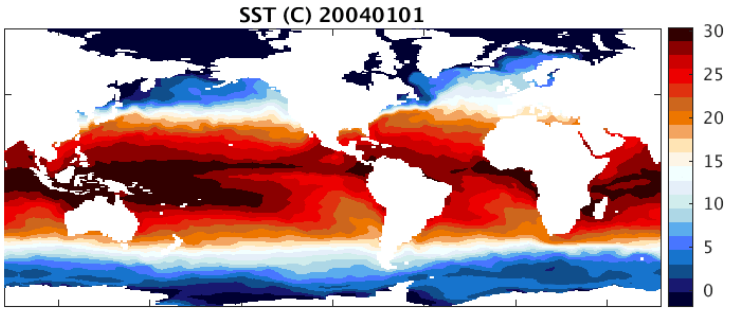
Atmospheric mean increments D49



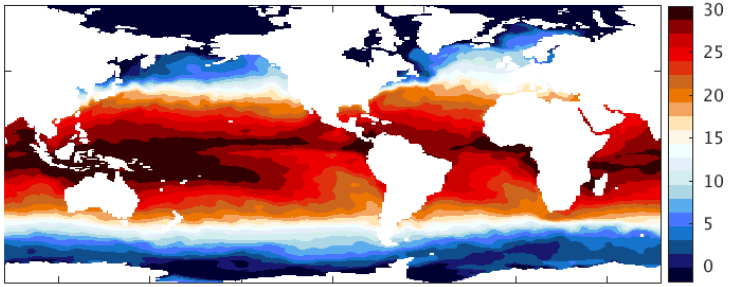
Surface



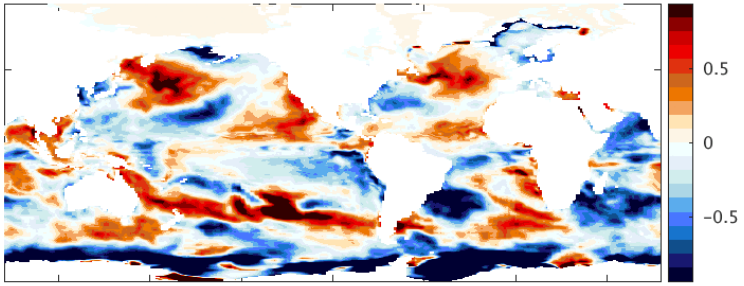
500hPa



Ensemble Mean



Ensemble Member

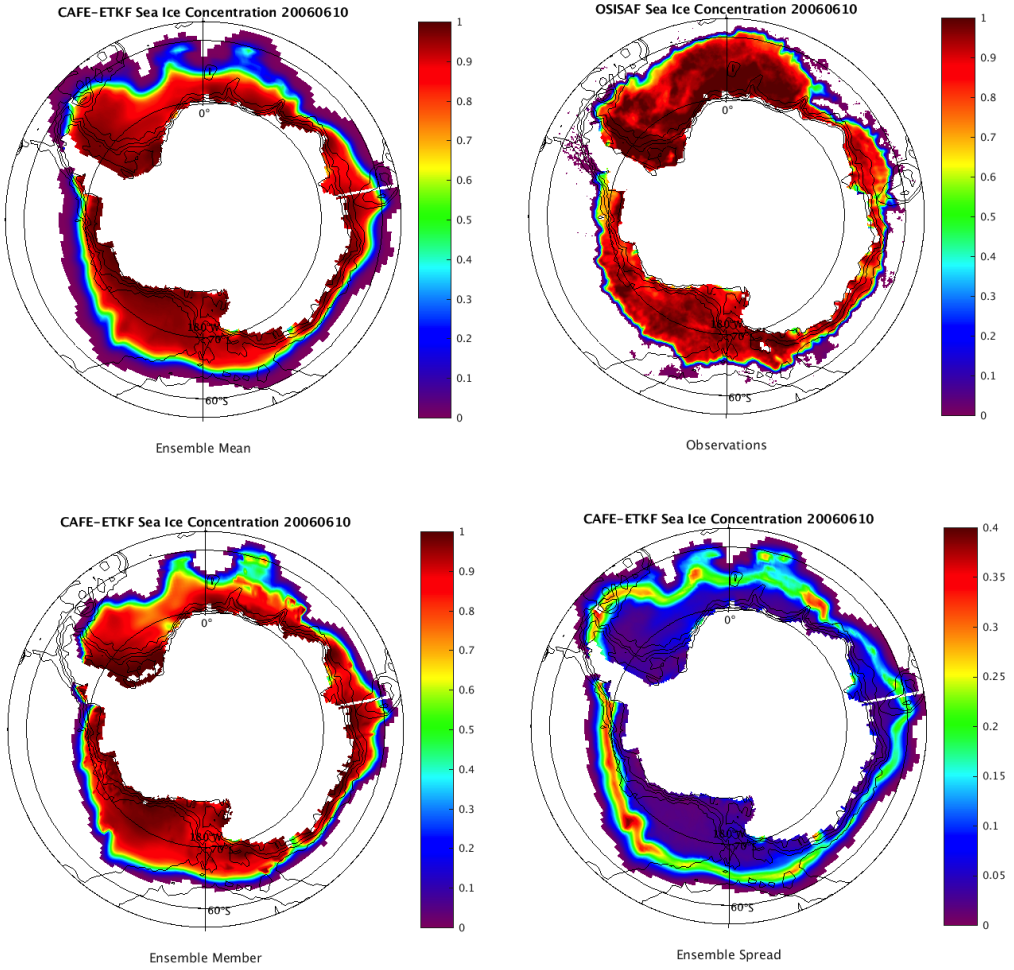


Ensemble Anomaly

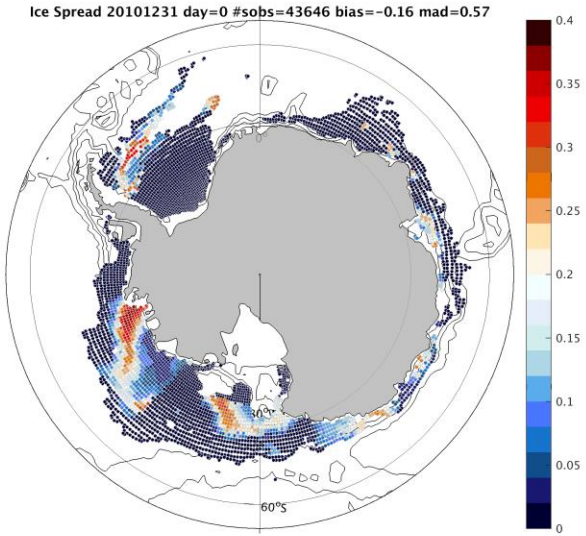
Assimilating sea-ice concentration

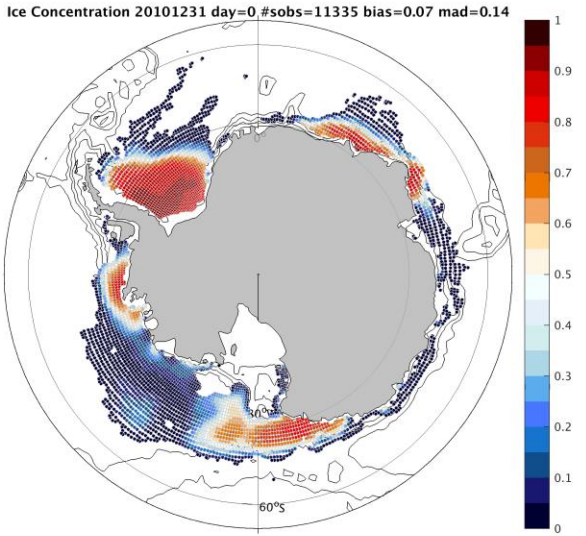
96 MEMBER GFDL CM2.1 (MOM5-SIS1-AM2) ENSEMBLE

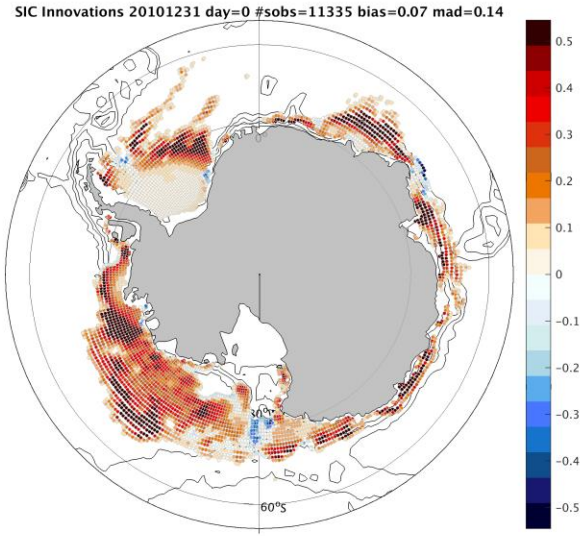
- Assimilation Methods
  - SIC observations are 2D
  - SIS has 5 ice thickness categories
  - RED, RFT (Smith et al, 2016)
  - Augment state vectorwith thickness categories (Barth et al, 2015)
  - Use SIC to derive freezing point SST observation

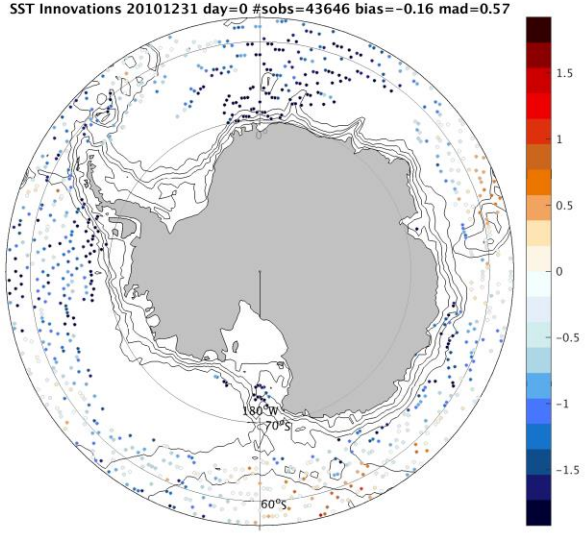


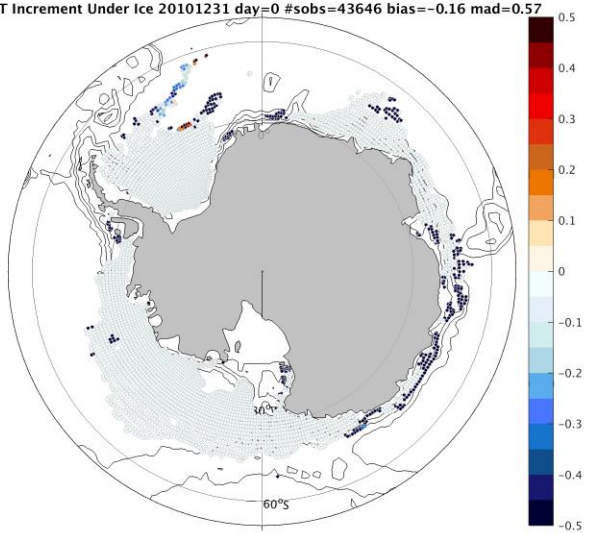
Assimilating sea-ice concentration

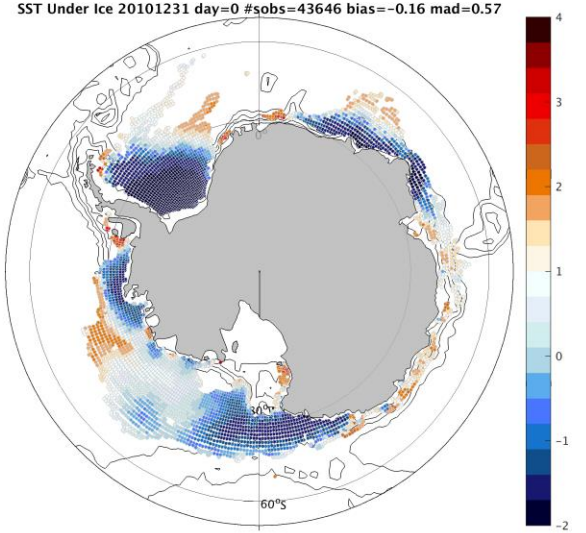






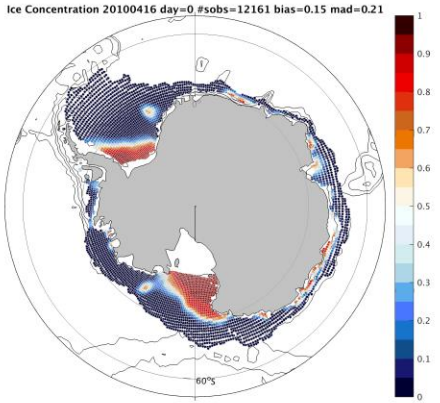


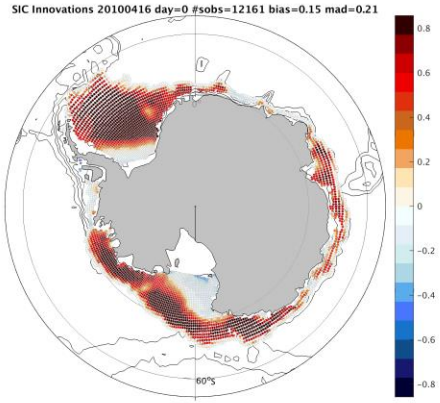


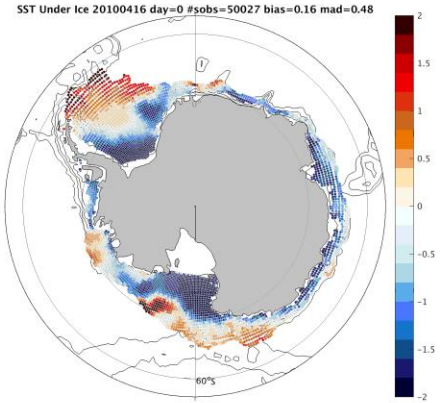


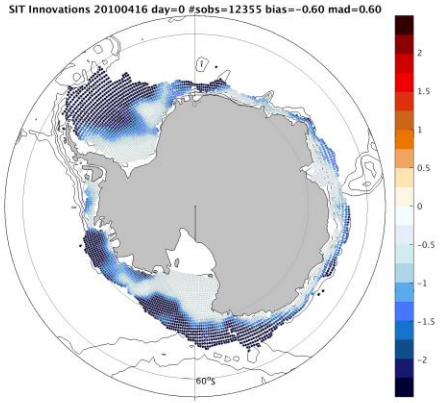
Assimilating under-ice freezing point temperature

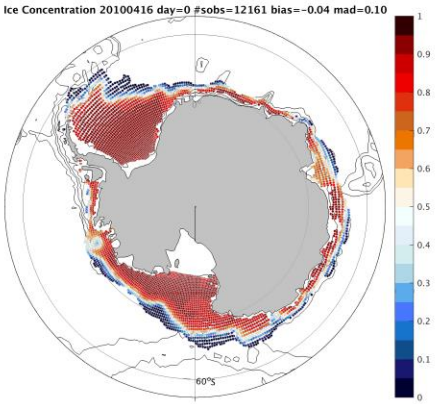
CONTROL

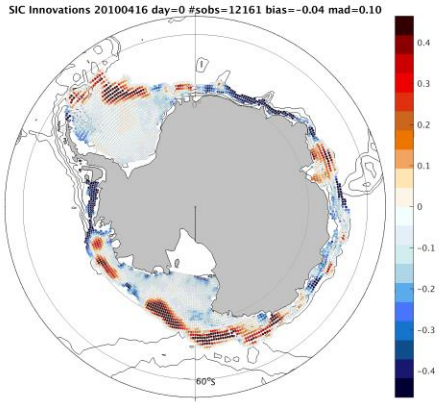


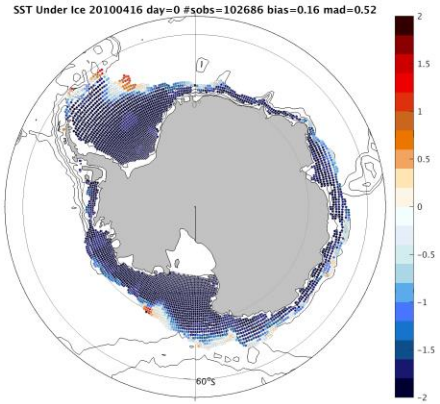


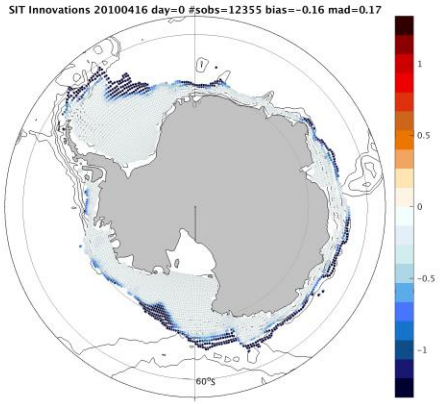




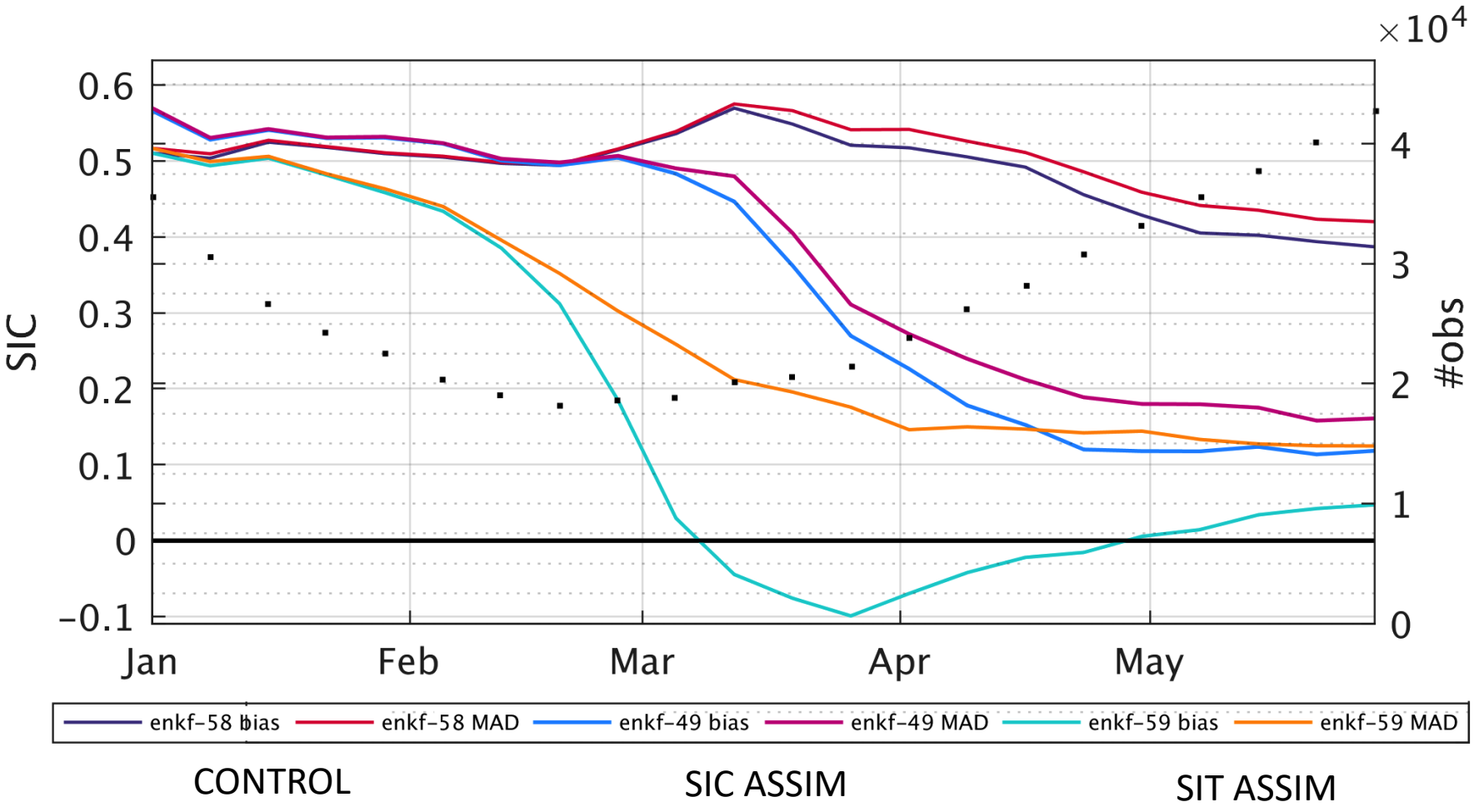






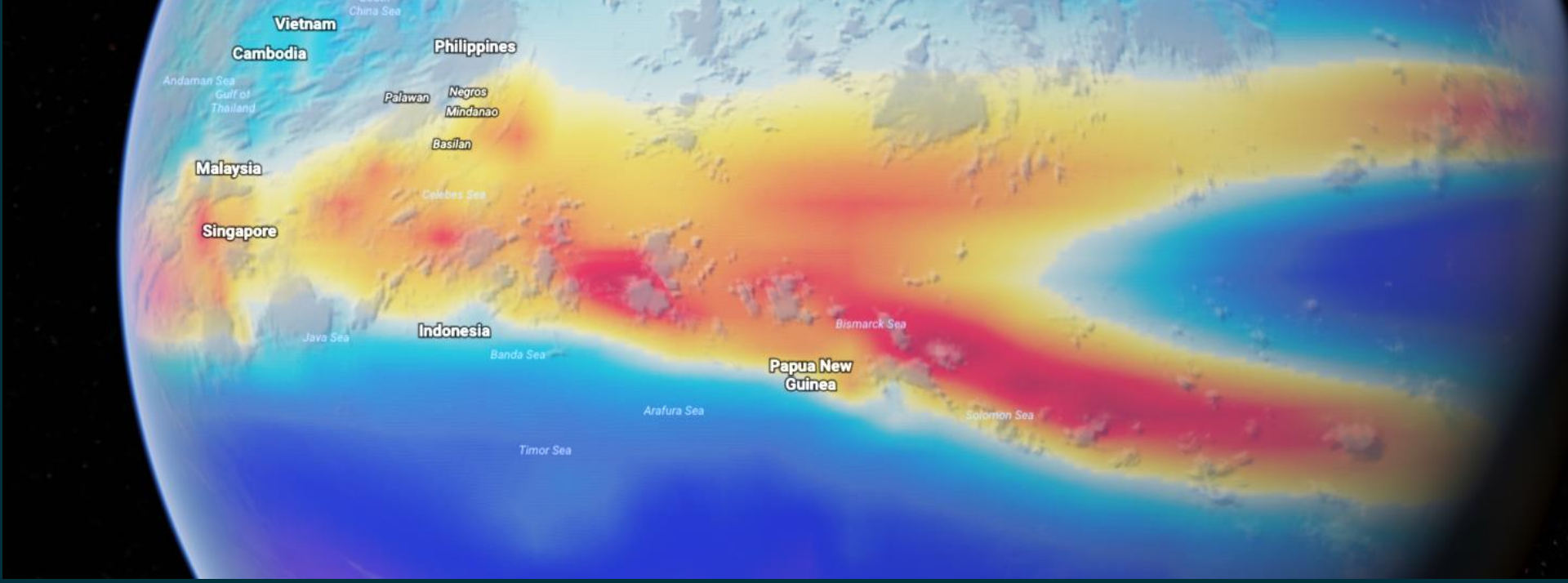


ASSIMILATION


×10^4
SIC
#obs
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
4
3
2
1
0
Jan
Feb
Mar
Apr
May
enkf−58 bias
enkf−58 MAD
enkf−49 bias
enkf−49 MAD
enkf−59 bias
enkf−59 MAD
CONTROL
SIC ASSIM
SIT ASSIM

Activities underpinning CAFE-EnKF reanalysis and forecasting

- Strong and weakly coupled DA experiments
- Sea-ice assimilation experiments
- Impact of remotely sensed salinity in tropics
- Assimilation of under ice observations
- Forecast model improvements through parameter estimation using the EnKF
- Adoption of various other coupled models eg. CM2.5, ACCESS-ESM when resources permit.



Paul Sandery
t +61 3 6232 5035
e paul.sandery@csiro.au