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eReefs Data Assimilation

Mike Herzfeld

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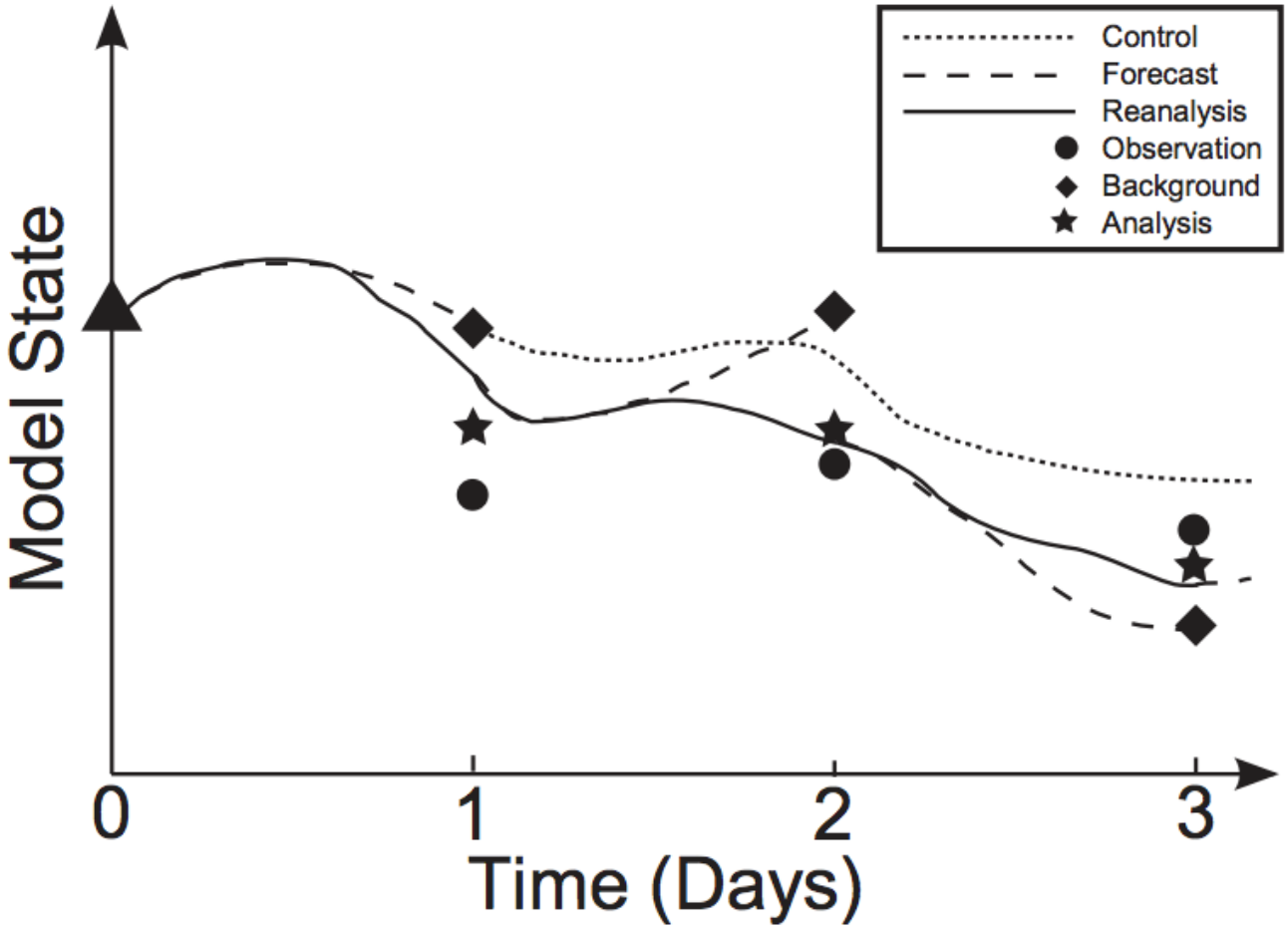
O&A

www.csiro.au

CSIRO

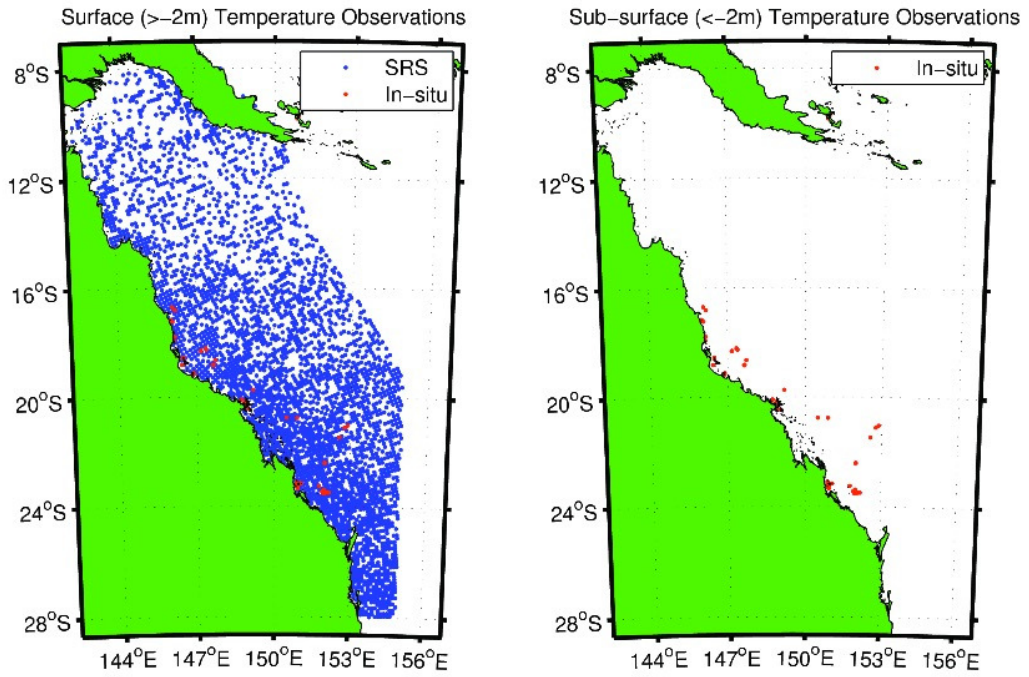
Data Assimilation (DA) Methodology



Applications

- State update
  - Use observations to change the sea level, currents, temperature or salinity in the model directly,
  - Usually implemented as increments or relaxation applied to state variables.
- Forcing optimization
  - Use observations to alter the initial conditions or forcing applied to the model,
  - E.g. Open boundary values, wind fields, initial conditions.
- Parameter estimation
  - Use observations to alter the parameters applied within numerical schemes,
  - E.g. short wave parameterization.

Available observations (temperature)



Sub surface now + gliders

SRS = Satellite remote sensing

Parameter estimation – short wave

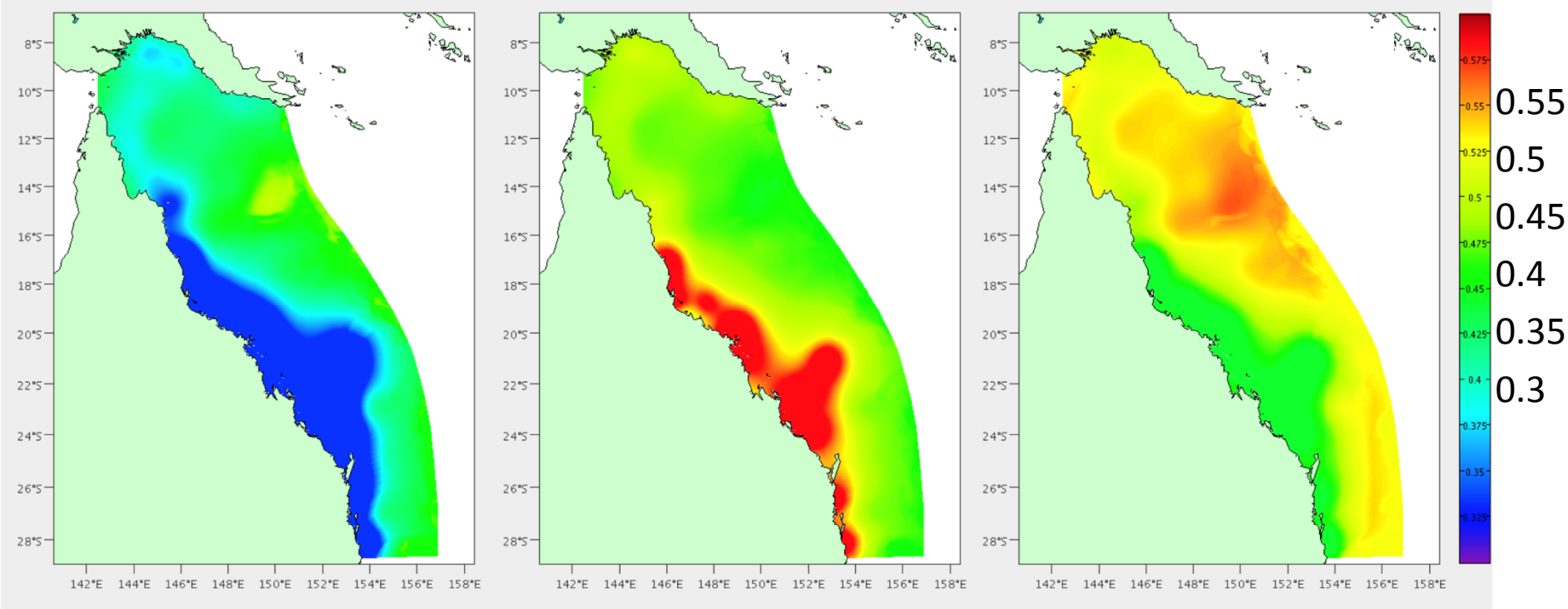
- Longer wavelengths are preferentially absorbed in the first few metres of the water column,
- Short wave radiation is attenuated exponentially through the water column,
- A residual at the sea floor must be absorbed or reflected,
- Three variables parameterize these processes
  - SWR transmission – the fraction of radiation that penetrates the water column (R_t),
  - SWR attenuation – the decay rate of the penetrating component (R_a),
  - SWR bottom absorption – the fraction that hits the bottom that is reflected (R_b).

DA estimated SWR parameters

Transmission

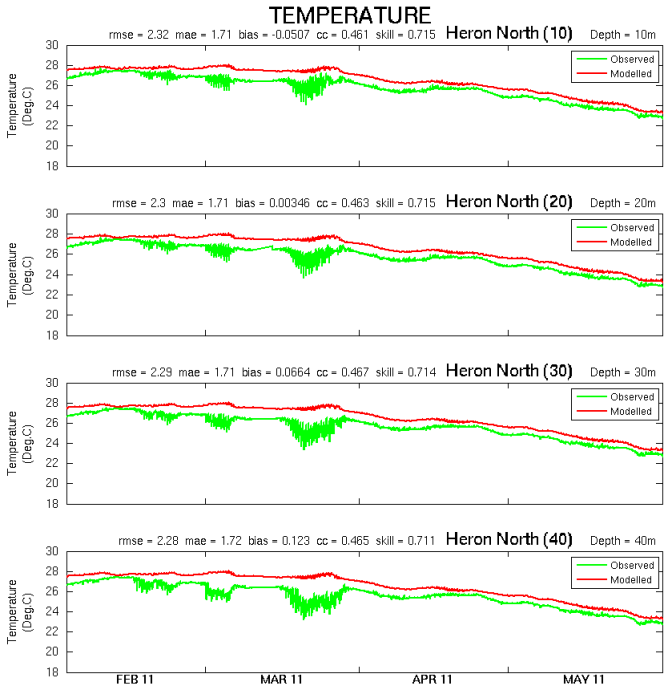
Attenuation

Bottom absorption

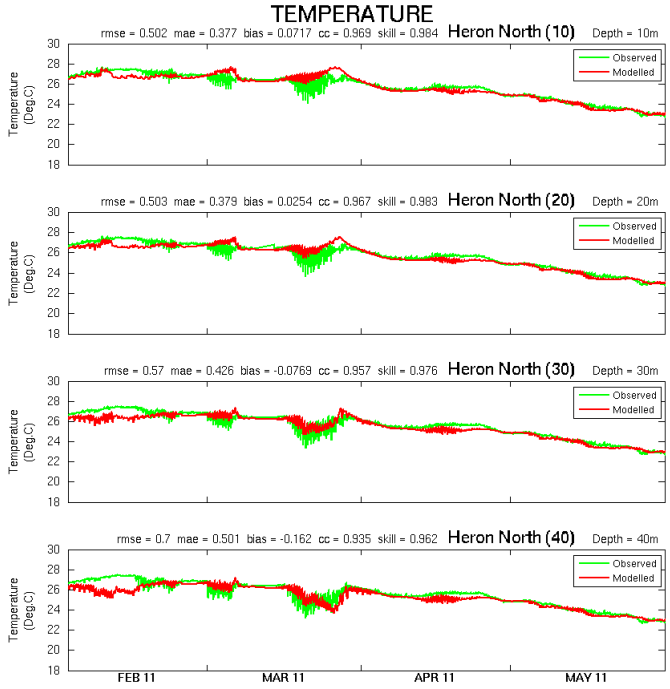


- Less transmission, attenuation and bottom absorption than the prior estimate
  … less heat goes in; *and more heat is distributed nearer the surface*
- Relatively clear offshore water with high transmission and low attenuation
- Turbid inshore waters due to river discharge, tidal mixing, and mixing due to waves

Impact on calibration



Constant parameters



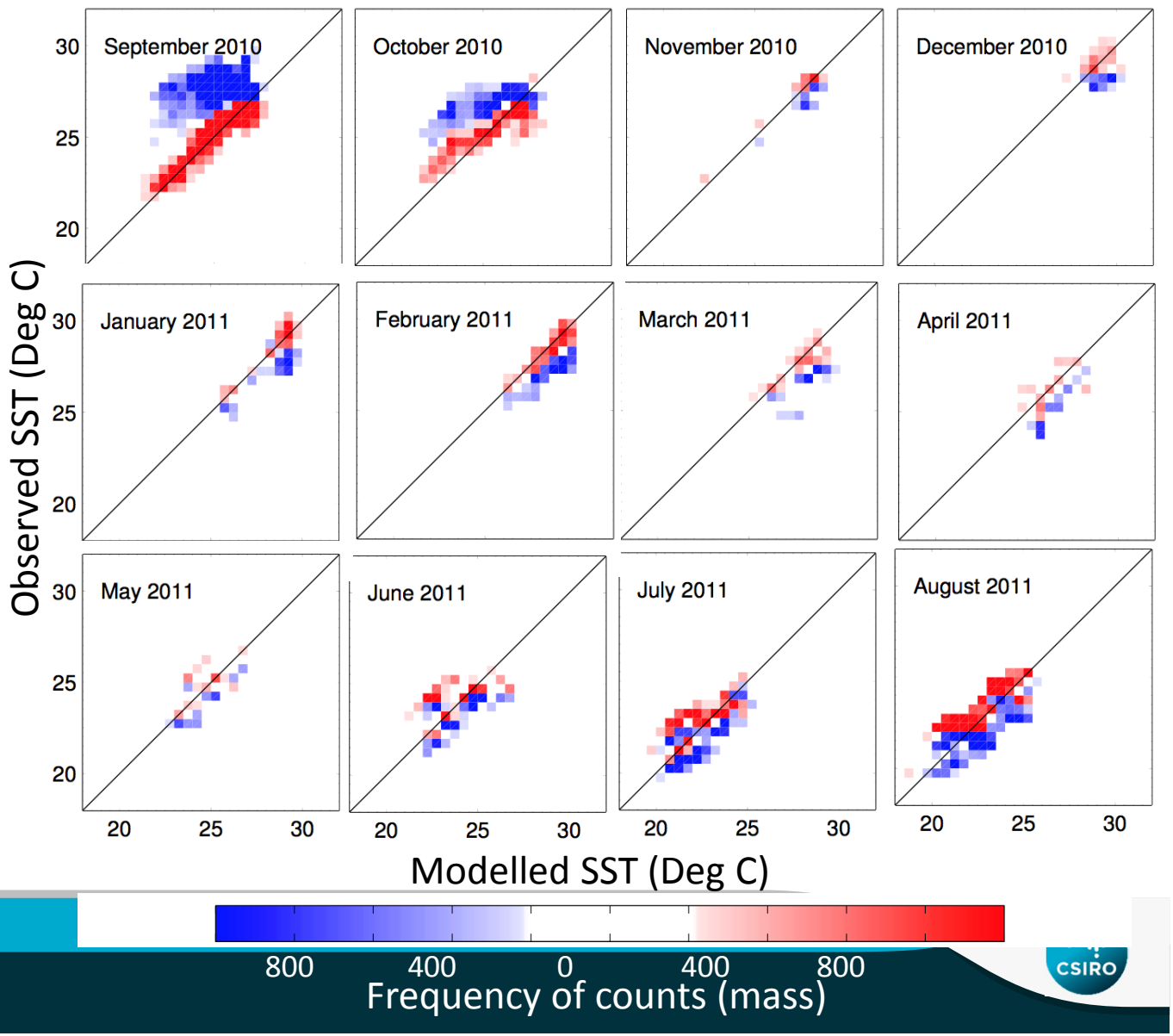
DA estimated parameters

Parameter Estimation using a DEnKF

2D histograms comparing modelled and observed SST

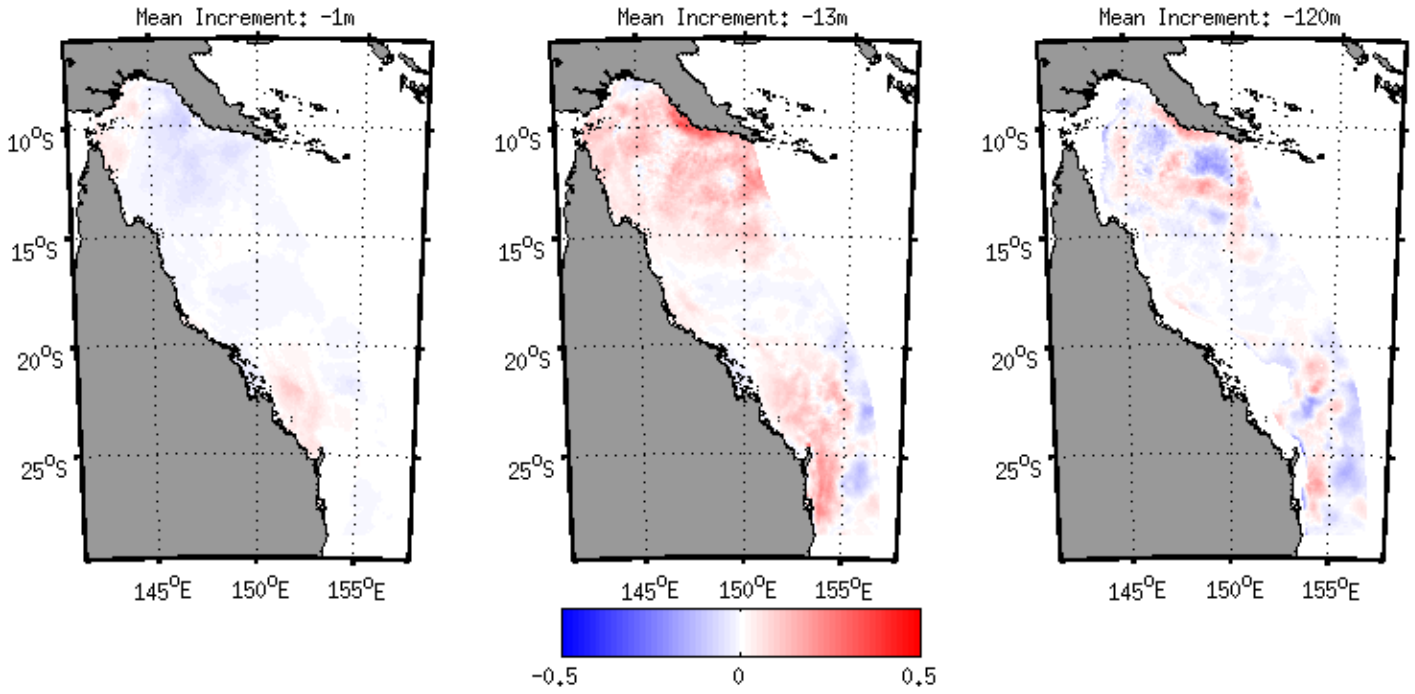
Blue = with original parameters … constant in time and space

Red = with optimised parameters … spatially varying

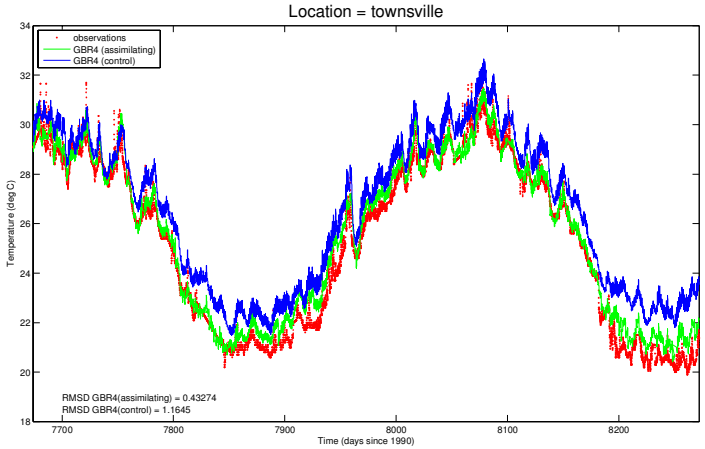


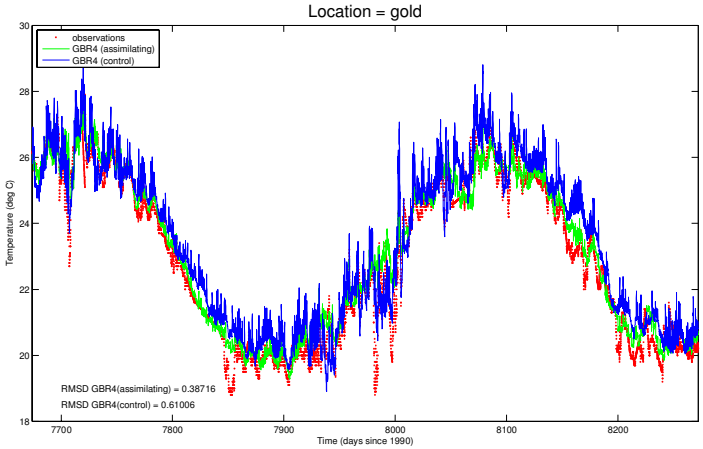
EnOI 4 year reanalysis

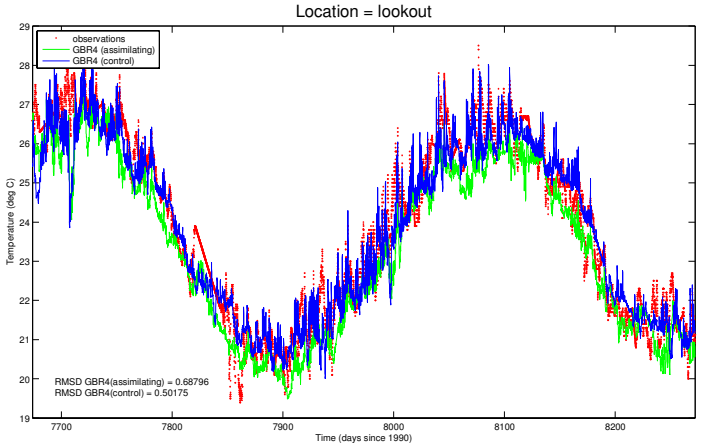
Mean increment added to background temperature field (indicator of bias).

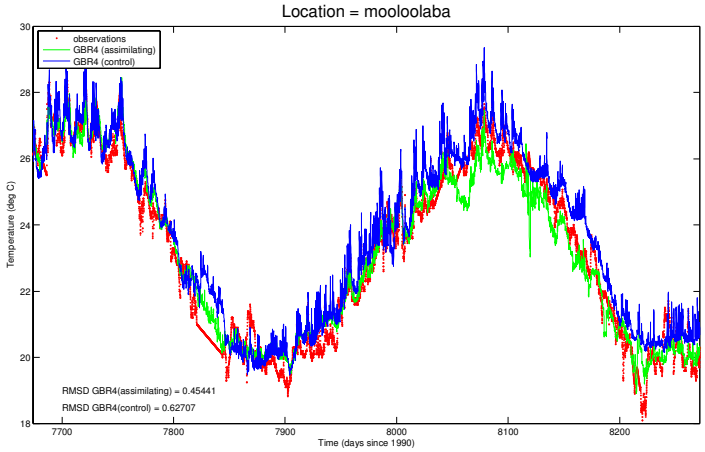


EnOI reanalysis

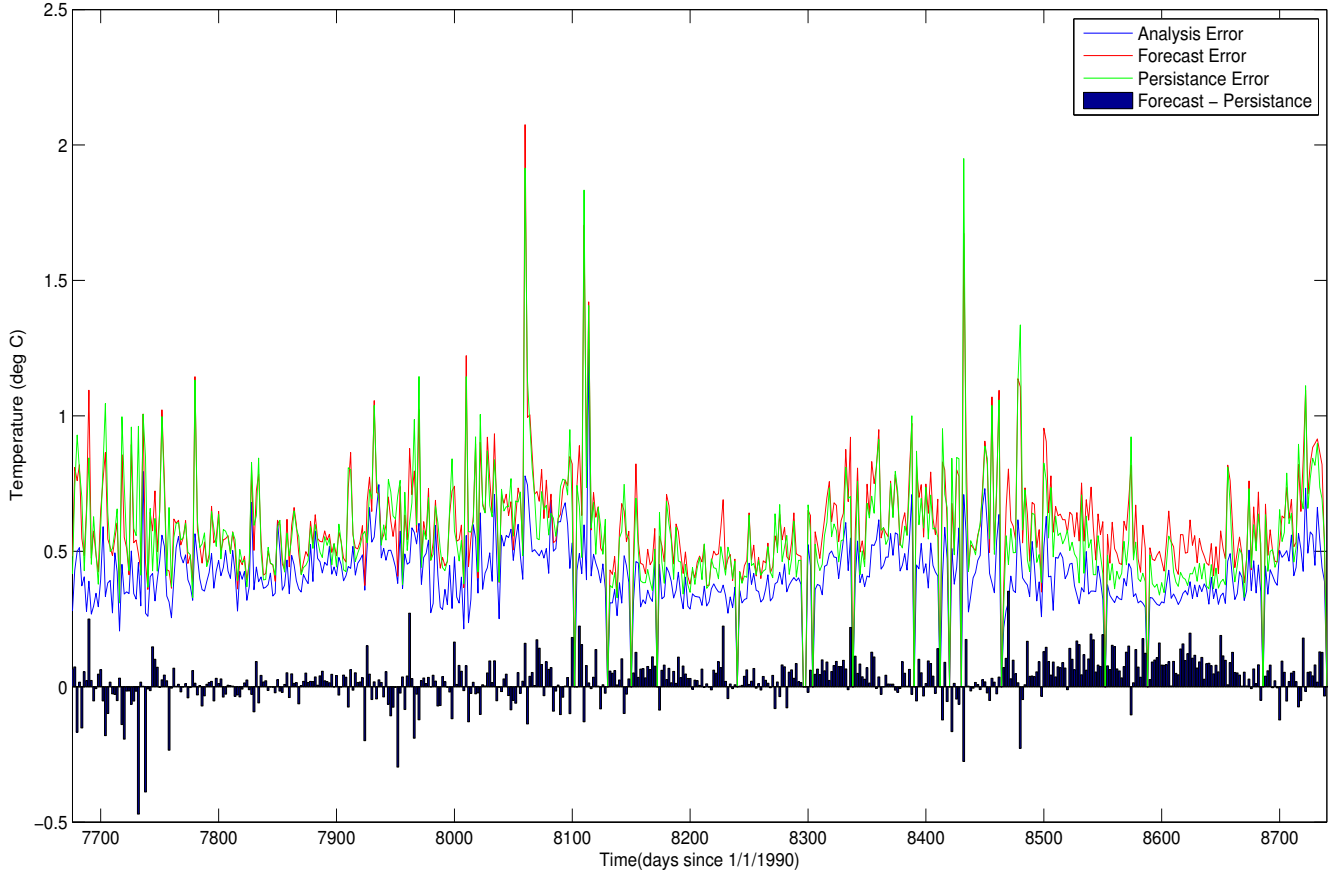








EnOI Reanalysis skill



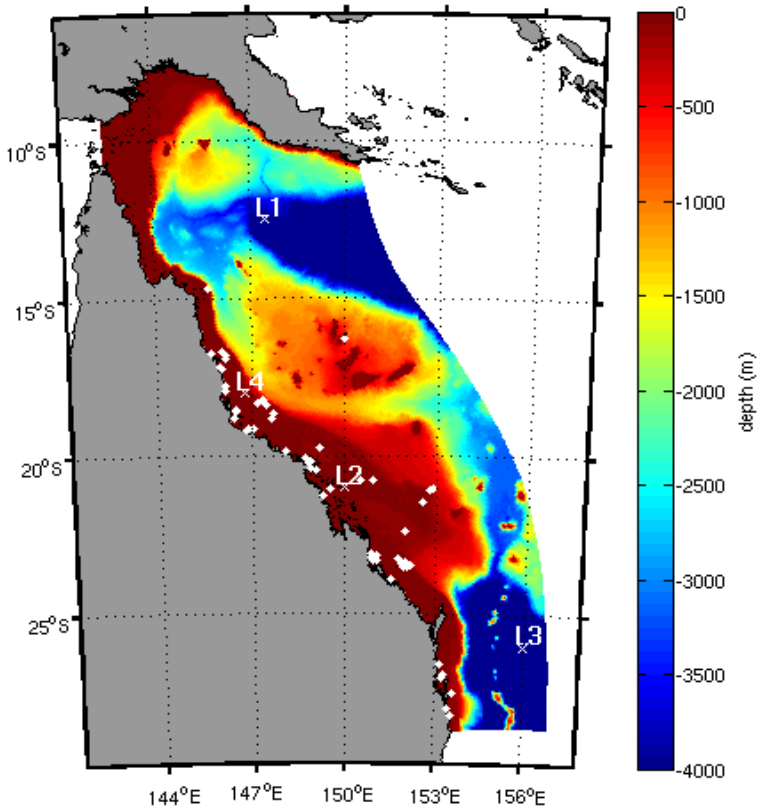
Thank you

Coastal Development and Management
Mike Herzfeld

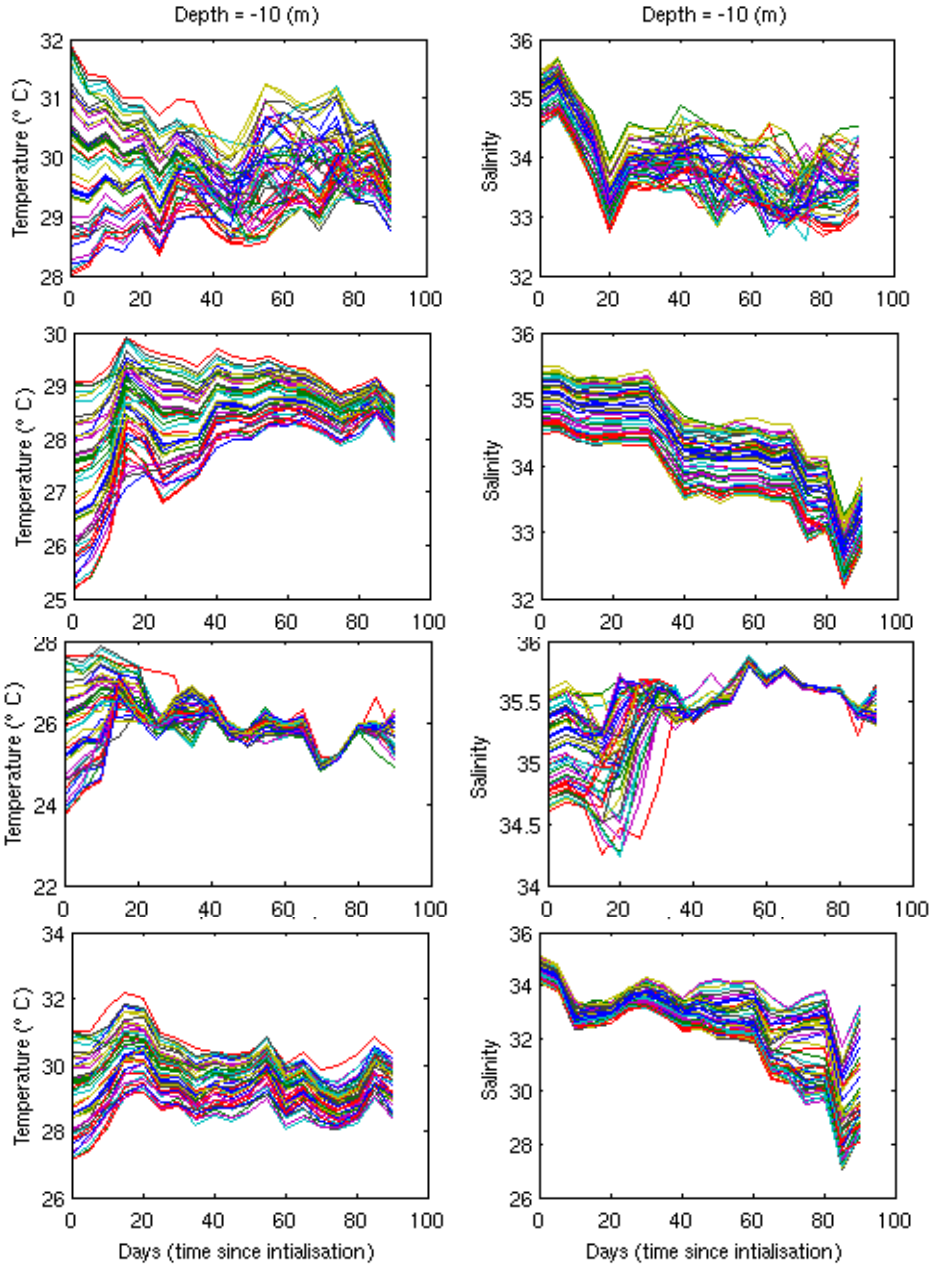
t +61 3 6232 5167
e mike.herzfelde@csiro.au
w http://www.emg.cmar.csiro.au/www/en/emg.html

System characterization using ensemble methods

- 30 member ensemble.
- Perturb SWR parameters and T/S initial conditions.
- Ensemble provides insight into spatial variation due to initial condition bias.
- Time series at 4 sites L1 – L4 used to investigate ensemble behavior;
  - L1 deep offshore
  - L2 & L4 inshore lagoon
  - L3 deep boundary influenced



Ensemble behavior



L1

L2

L3

L4

- Different behavior at each site
- Inshore sites temperature. asymptote after 60 days – interaction with heat fluxes.
- L3 influenced by open boundaries.
- L4 salinity impacted by riverflow.
- Inshore behaves linearly wrt initial condition and parameter perturbations, except near rivers. This is due to bottom friction damping chaotic behavior.
- Offshore sites show non-linear and chaotic behaviour – non-linear growth of instabilities.