OSSEs show improvement from assimilating subsurface temperature in a WBC.

Heat content estimates improve with a single transect of observations

Skill of state estimate is sensitive to observation transect location and stability of WBC

OSSEs reveal subsurface temperature observations improve estimates of circulation and heat content in a dynamic WBC

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Background

Western Boundary Currents (WBCs) play critical role in weather, climate, ecosystems and biogeochemistry, but due to their chaotic nature, ocean models must be regularly updated by data assimilation (DA), in order to produce an accurate estimate of the ocean state.

Objective

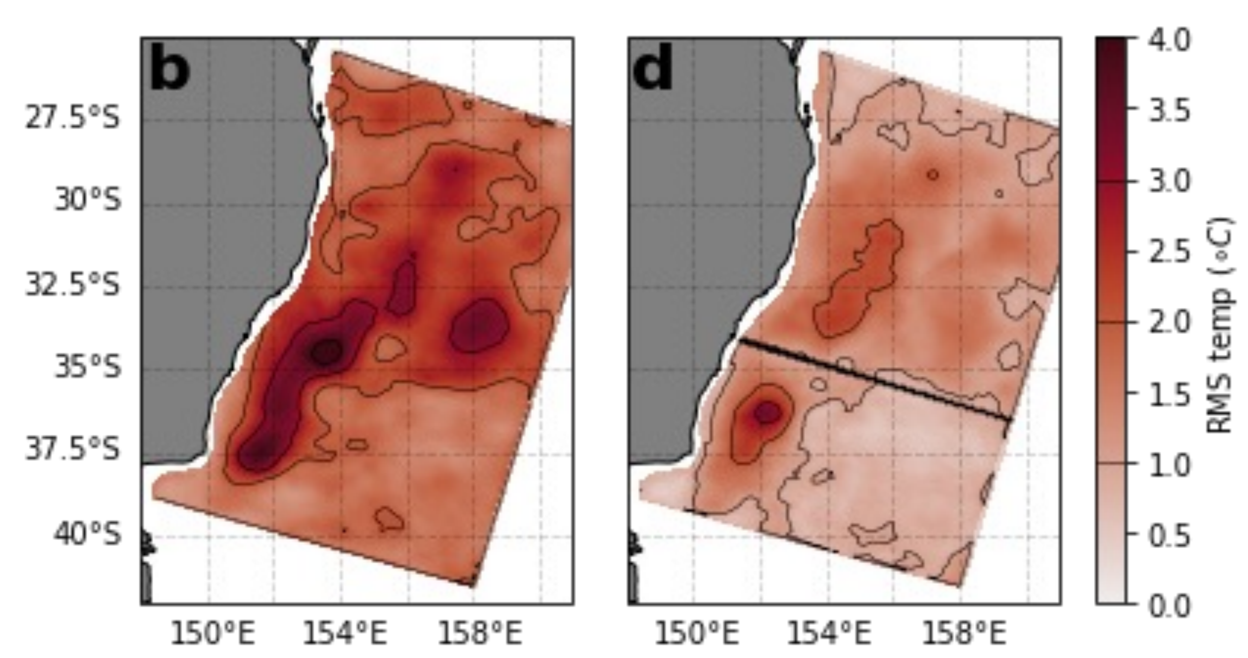
Assess the impact of surface and subsurface observations on estimates of the East Australian Current (EAC) using Observing System Simulation Experiments (OSSEs).

Method

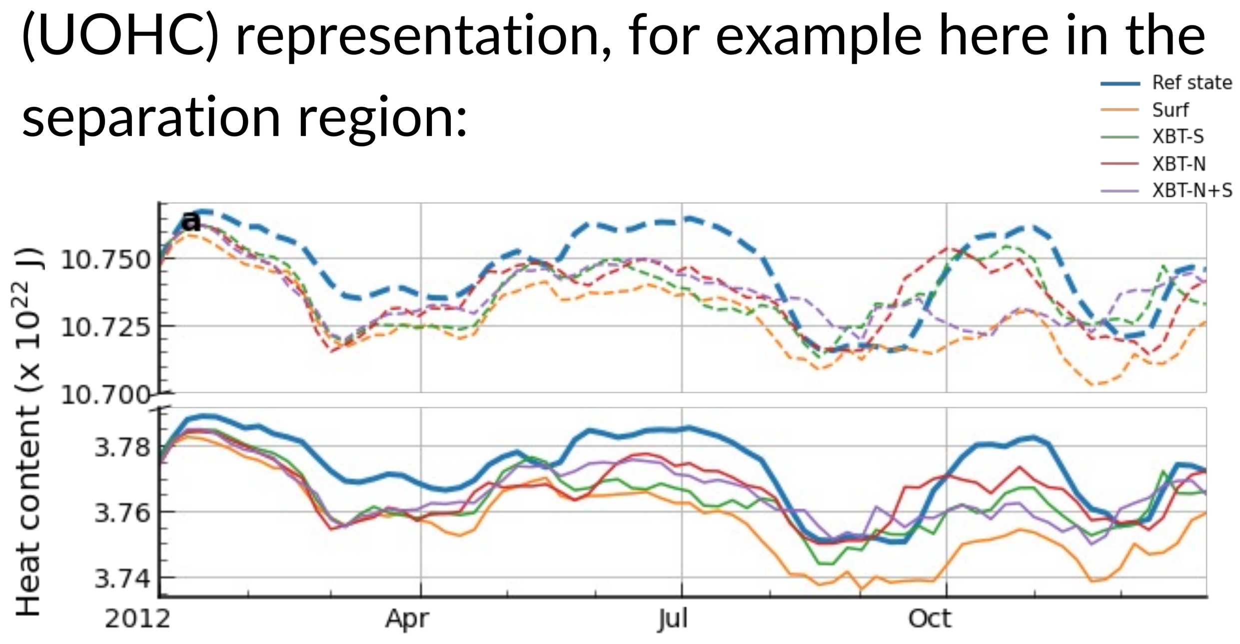
1. Free-running Ref state simulation of EAC
2. Extract values from Ref state + random noise = 'synthetic observations'.
3. Assimilate observations into a perturbed DA simulation, where the assimilated observations represent different observing platforms.
4. OSSEs will test surface-only SSH and SST observations (Surf OSSE) and surface plus subsurface high-resolution XBT observations at two transects (XBT-N, XBT-S, XBT-N+S OSSEs). The high spatial resolution XBT deployments extend to 900 m and repeat approximately weekly.
5. Compare Ref state to DA simulations to assess efficacy of observing platform.

Results

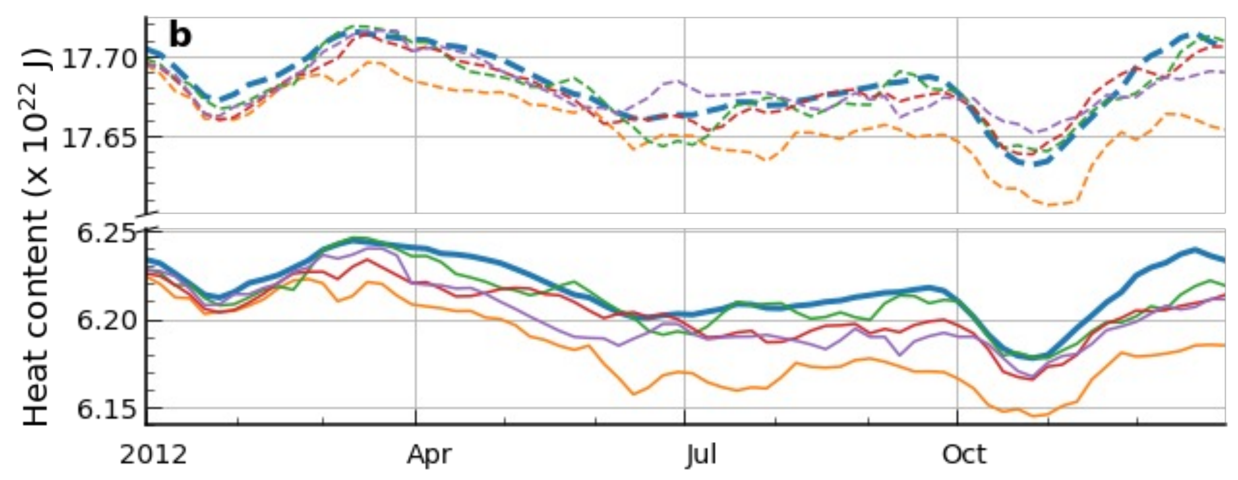
Southern XBT observations (XBT-S) improve ocean estimates and have far-reaching impact upstream, compared to the Surface-only (SSH + SST) observations, e.g. temperature at 250m:



Subsurface temp observations improve velocity representation and upper ocean heat content (UOHC) representation, for example here in the separation region:

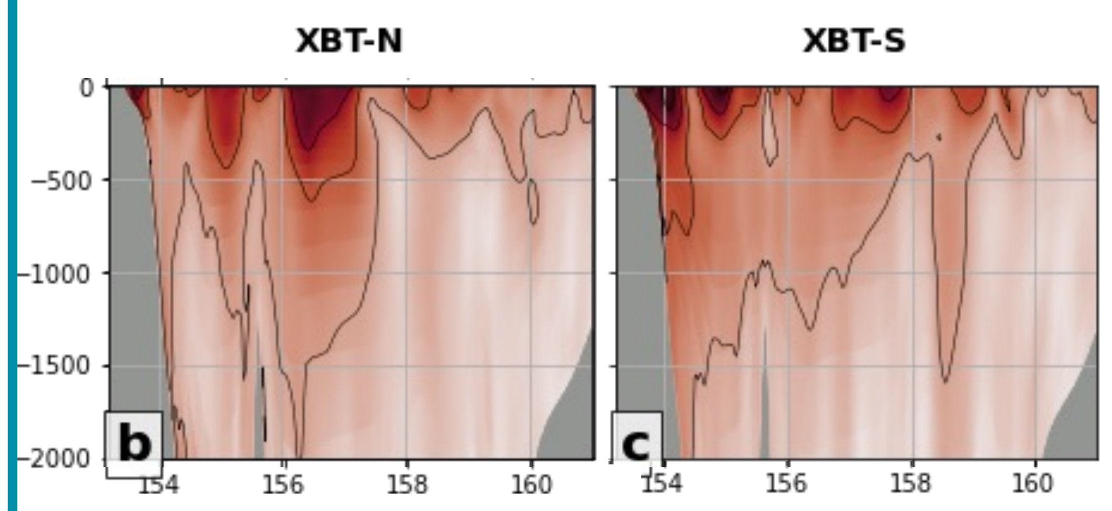


In the top 2000m (dashed lines) and top 700m (solid lines), XBT-S (green) and XBT-N (red) better match the Ref state (blue line).
And likewise in the eddy-rich region:

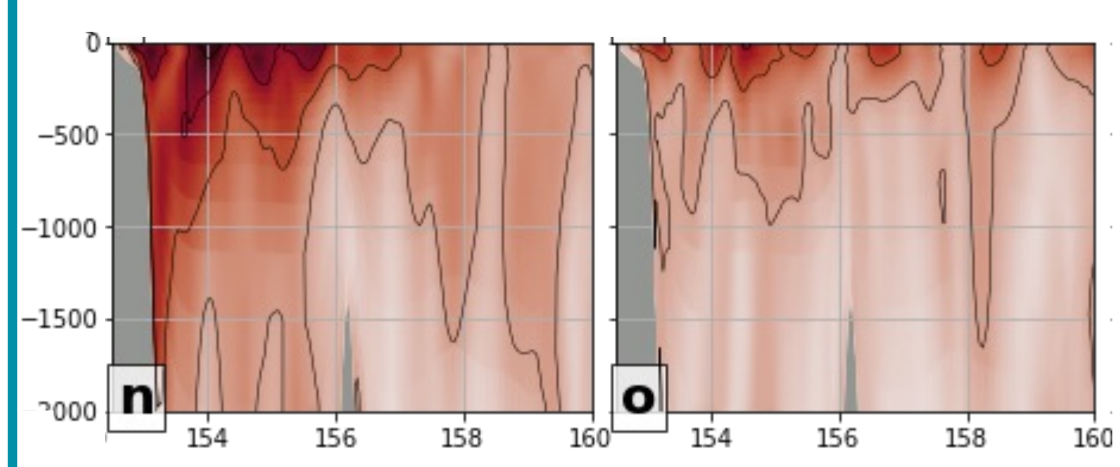


Results (cont.)

Separation latitude of EAC impacts error in state estimates. Northern phase has higher error and XBT observations perform similarly:



Southern separation phase has lower error and XBT observations perform differently:



Discussion

Subsurface temperature observations in eddy-rich region of the Tasman Sea are effective at improving representation of EAC circulation and UOHC. Impact from these observations is felt 600 km upstream.

The energy of the EAC jet and separation latitude has strong impact on error in representation of EAC.

Sampling strategies could adapt to EAC separation phase e.g. more sampling in conditions more conducive to estimating ocean state.

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