



UNSW
A U S T R A L I A



The impact of observing the East Australian Current from the coherent jet to the eddy field

8th meeting of the COSS-TT

Theme 1: Science in Support of Coastal Ocean Forecasting

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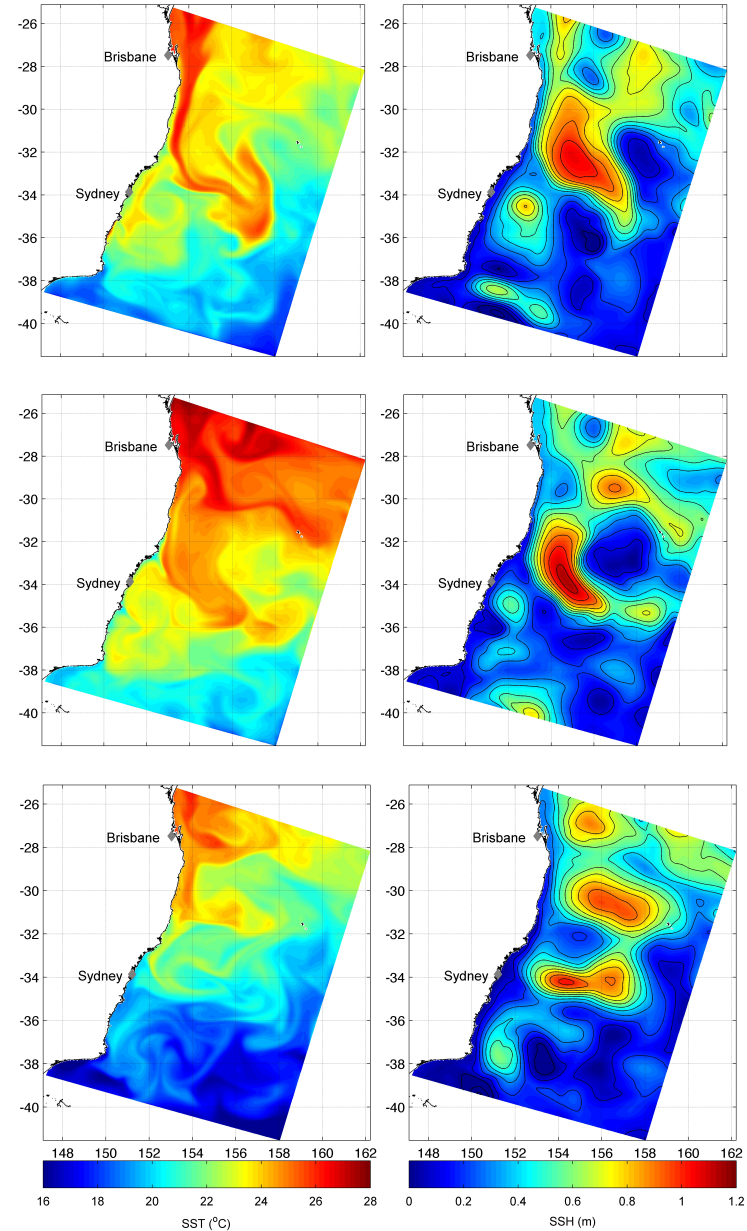
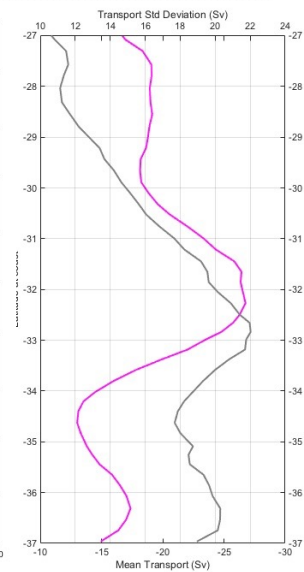
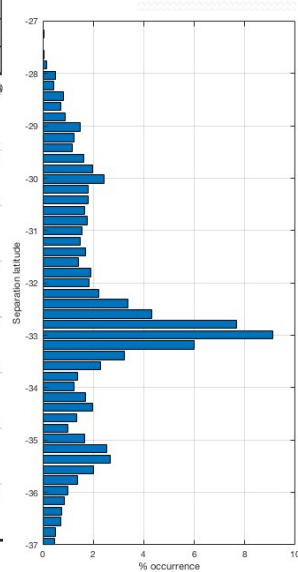
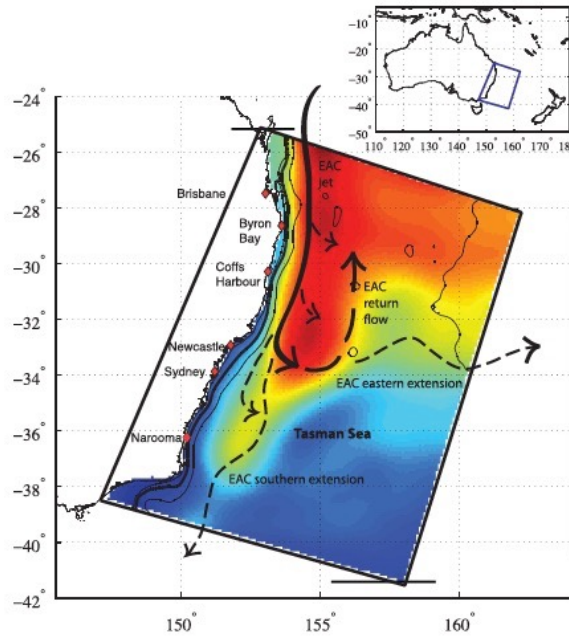
Introduction: Modelling the East Australian Current System

Prediction focused on the

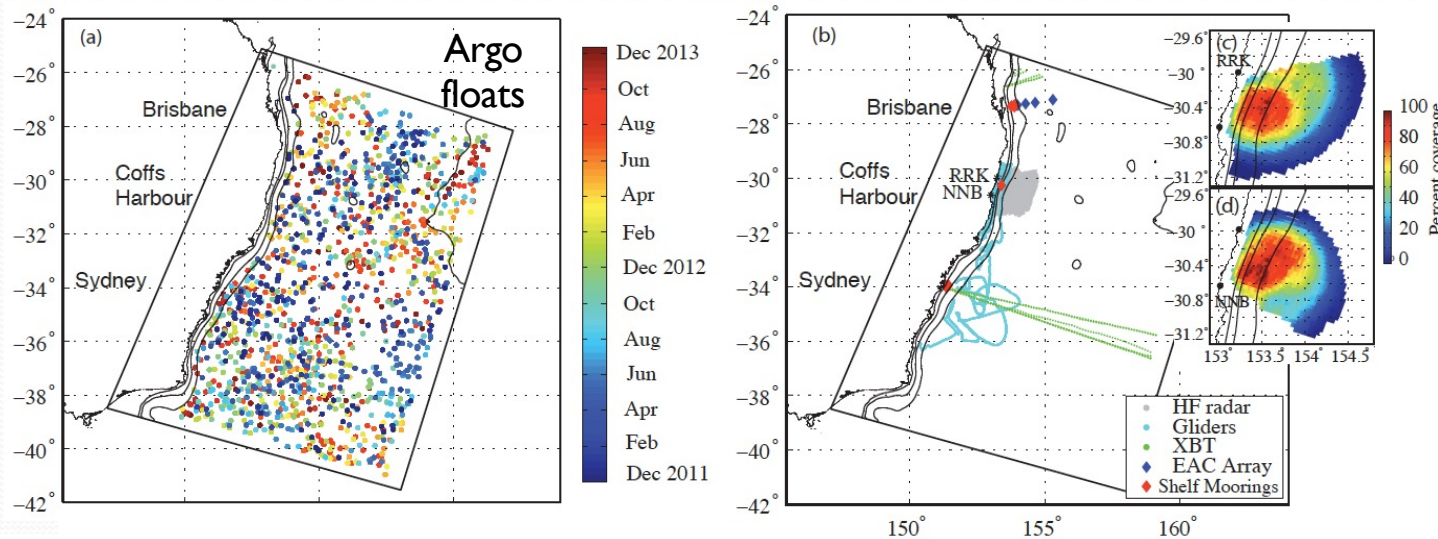
- Strength and structure of the EAC jet upstream of separation
- Separation of the EAC from the coast
- Eddy structure and evolution of the eddy field

ROMS configuration

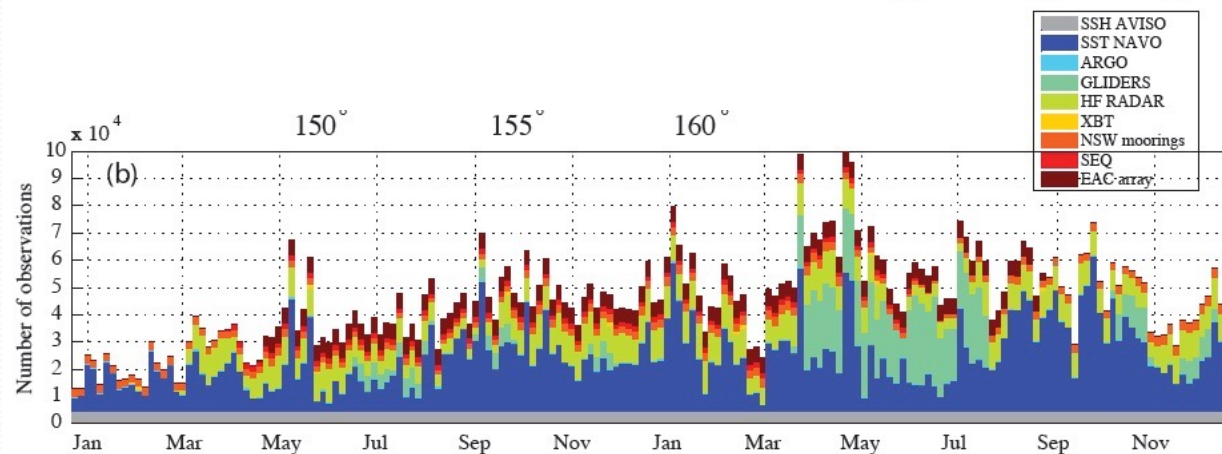
- Variable horizontal resolution
 - 2.5-6km cross shore, 5km alongshore
 - 30 s-levels



Introduction: Observation impact 3 ways



- AVISO SSH
- NAVO SST
- 1229 Argo profiles
- XBTs
- Shelf moorings
- EAC Array
- Gliders
- HF radar



We study the impact of novel observations by

1. **Direct quantification of observation impact** using the adjoint of the assimilation procedure
2. **Observing System Experiments**
Comparison of the system assimilating all observations and an experiment withholding the 'novel' observations
3. **Observation System Simulation Experiments**

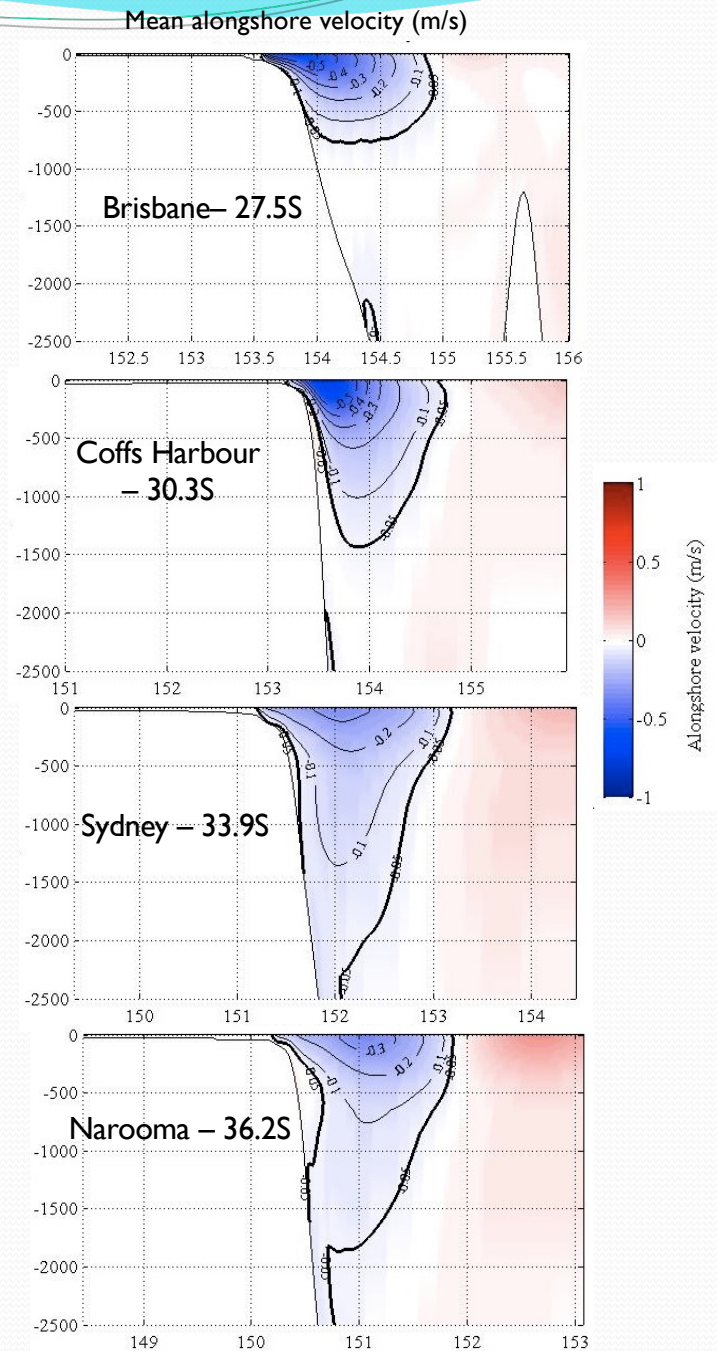
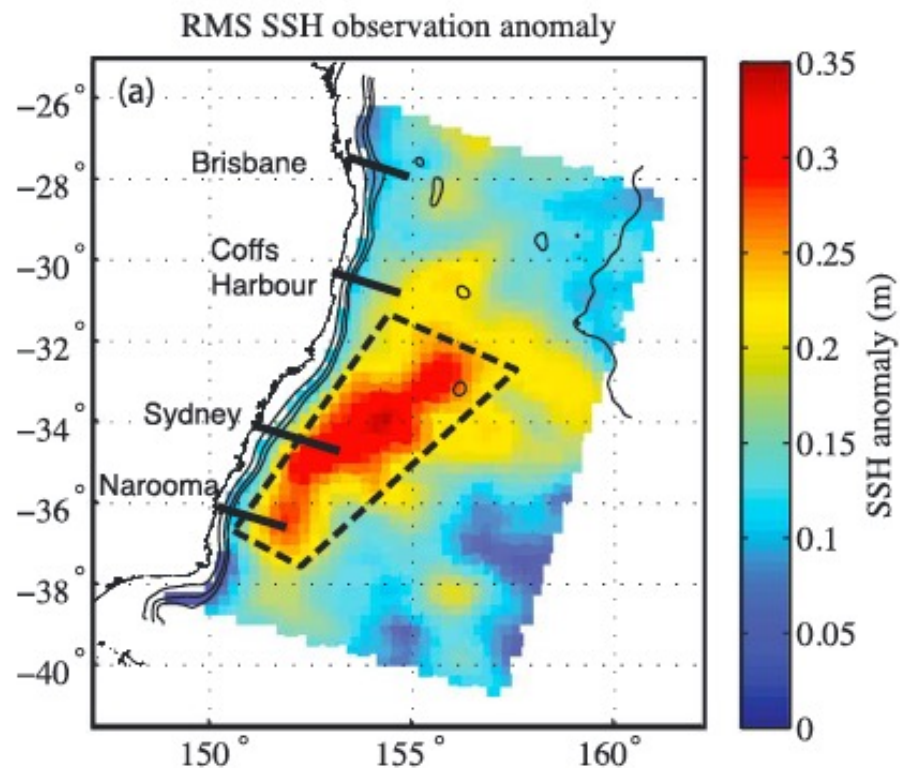
1. Direct quantification of observation impact

With 4D-Var, we can quantify how individual observations contribute to the changes in estimates of certain circulation metrics.

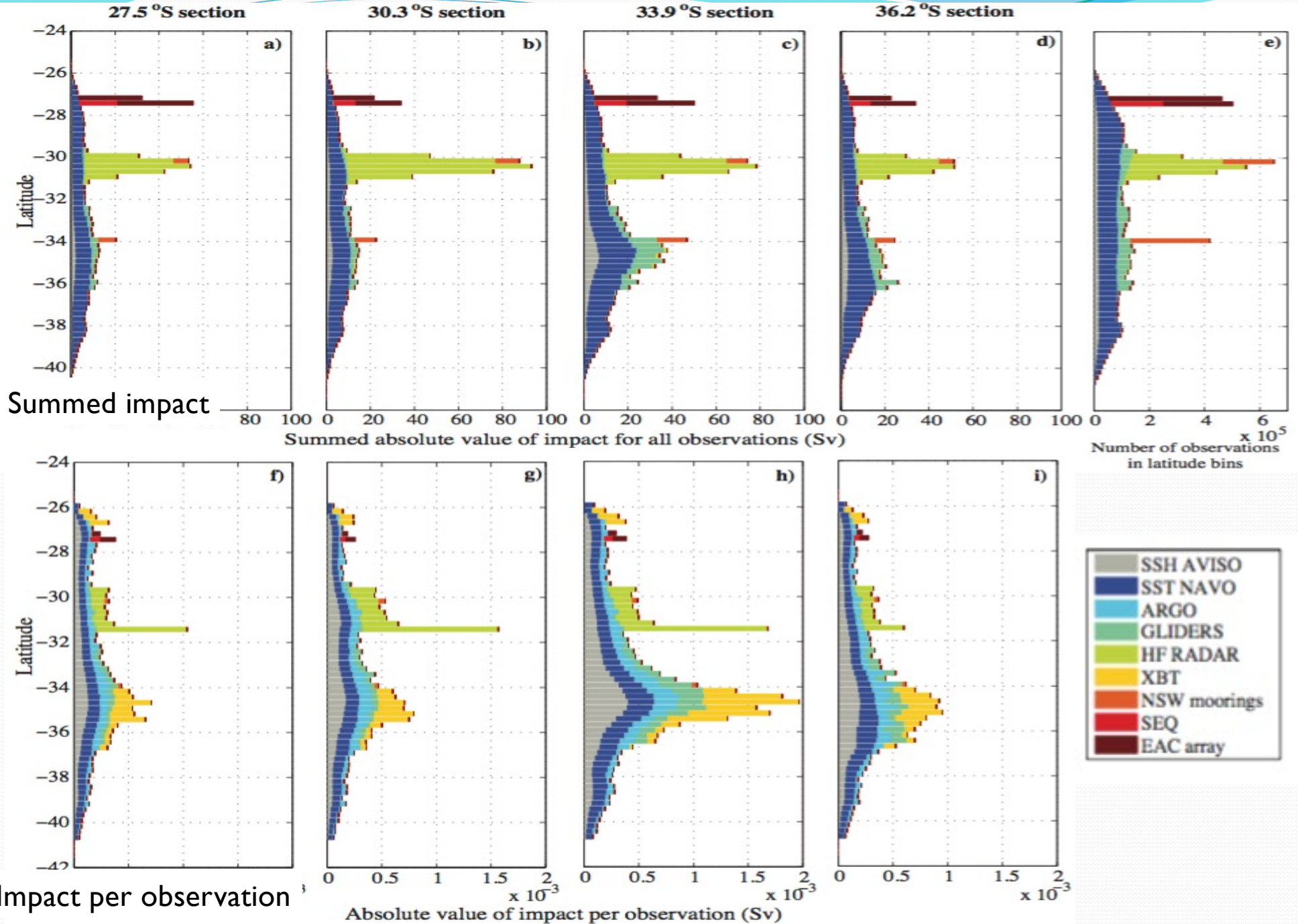
Alongshore volume transport:

$$S = \frac{1}{T} \int_{t_0}^{t_0+T} \int_{-D}^0 \int_{x_0}^{x_i} (\mathbf{v}) \delta x \delta z \delta t$$

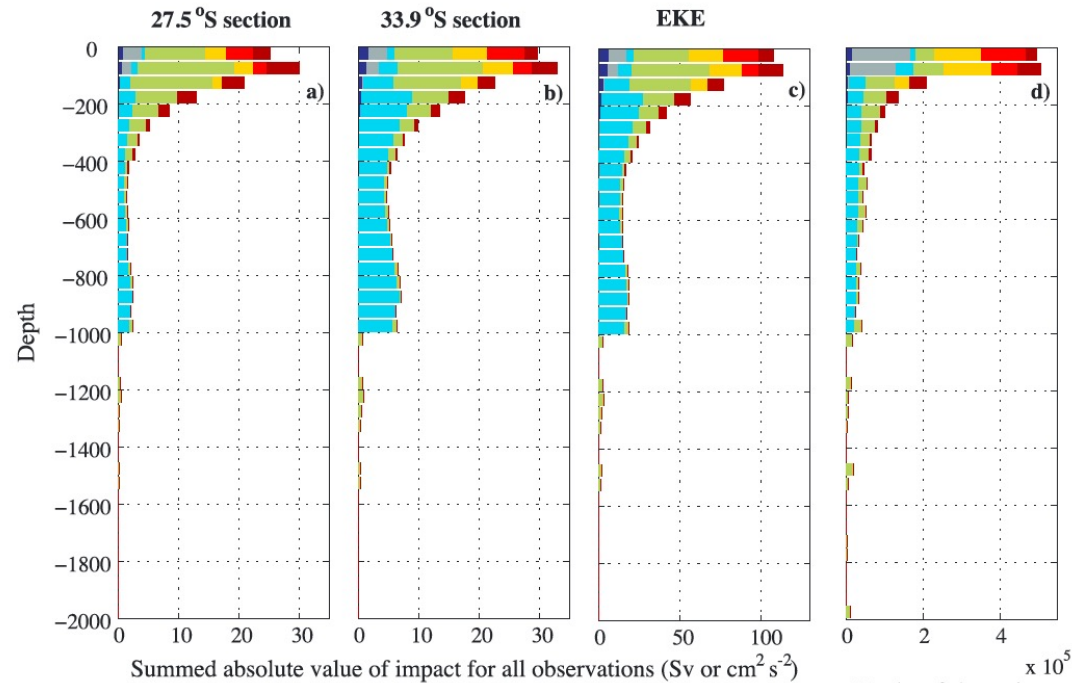
$$\Delta S = S(\mathbf{x}_a) - S(\mathbf{x}_b)$$



Alongshore volume transport - Impact with latitude

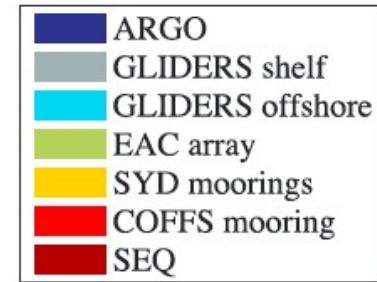
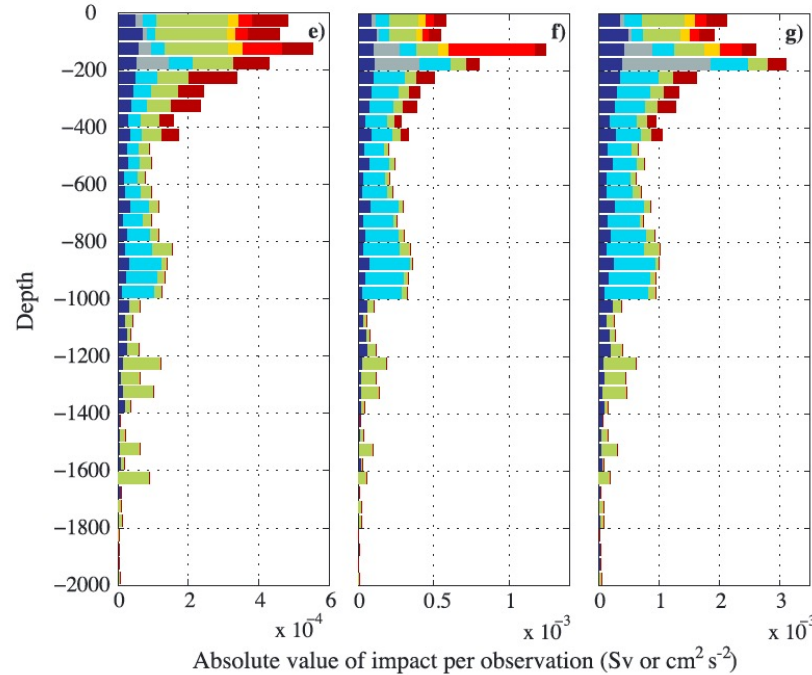


Summed impact

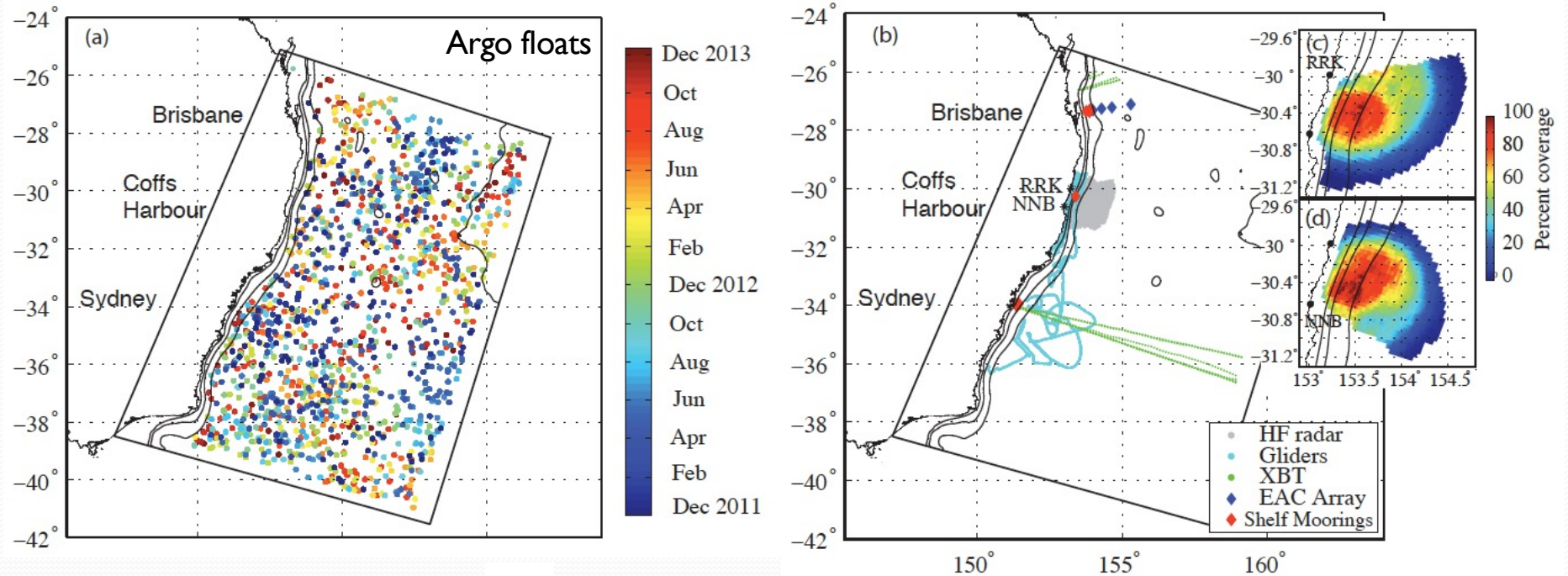


Number of observations in depth bins $\times 10^5$

Impact per observation

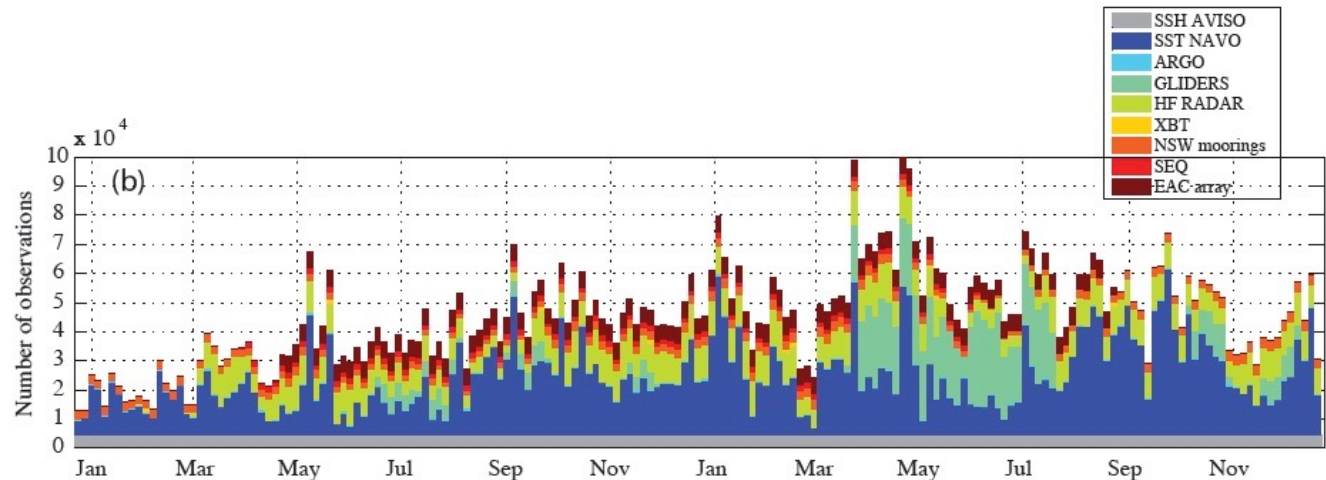


2. Observation System Experiments (withholding the 'novel' observations)

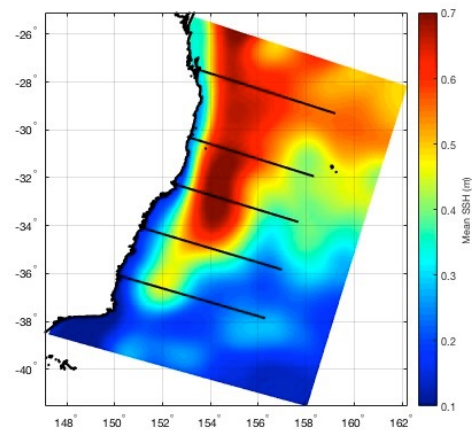


FULL= AVISO SSH, NAVO SST
 1229 Argo profiles, XBTs
 Shelf moorings
 EAC transport array
 Gliders
 HF radar

TRAD= AVISO SSH, NAVO SST
 1229 Argo profiles, XBTs

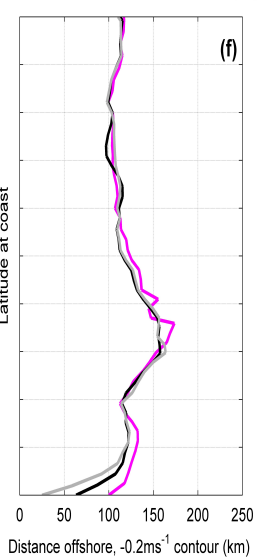
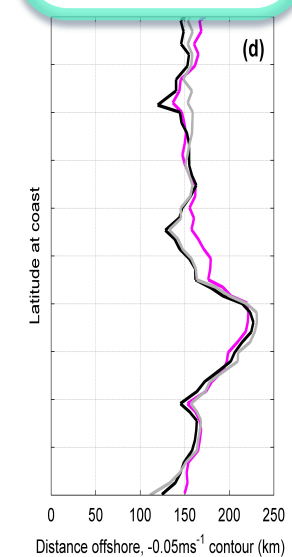
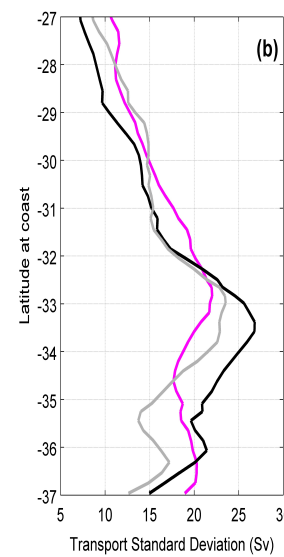
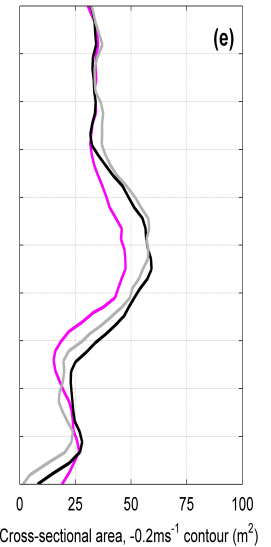
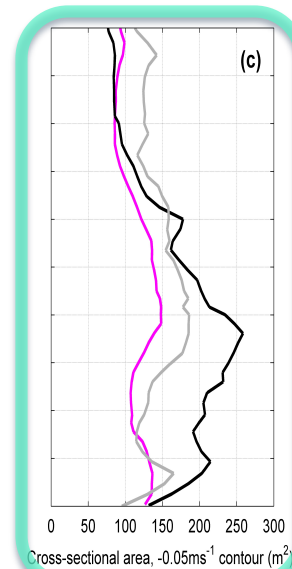
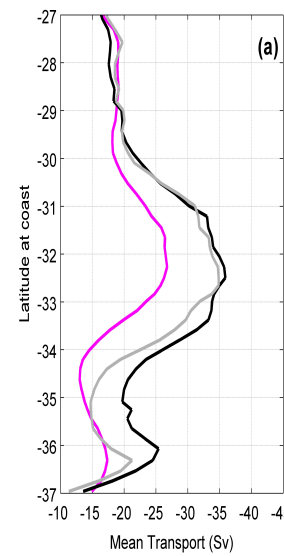
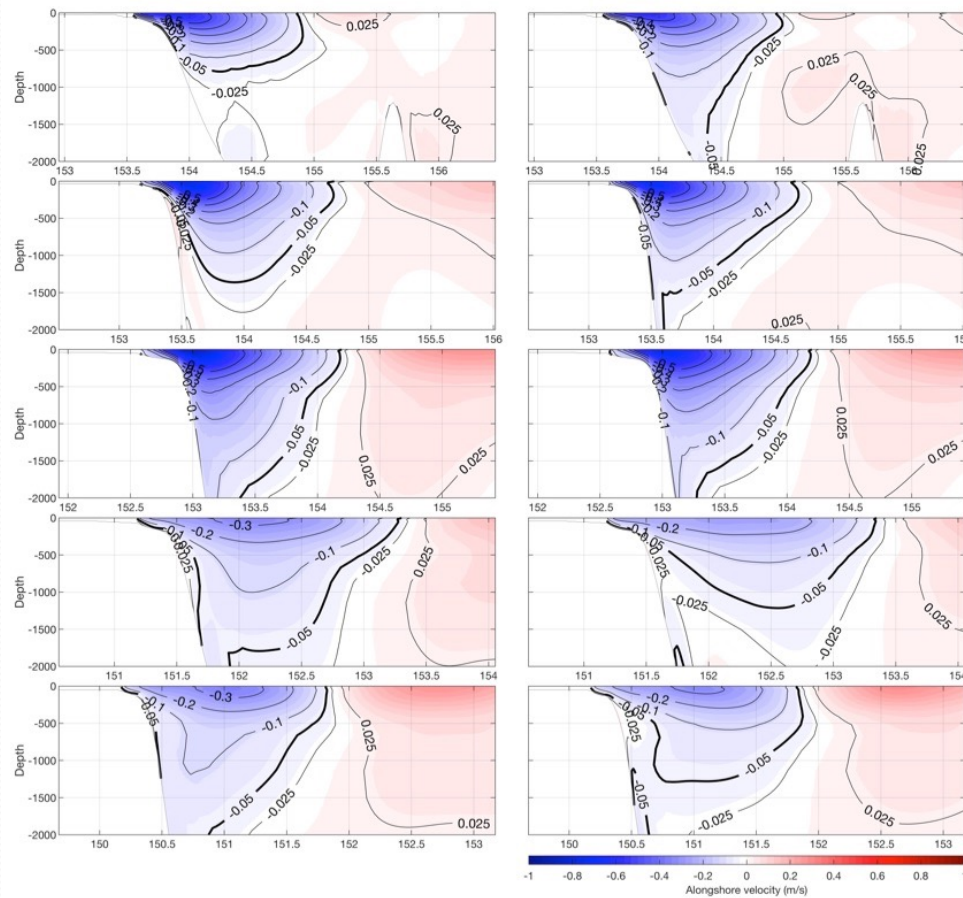


EAC core depth



FULL

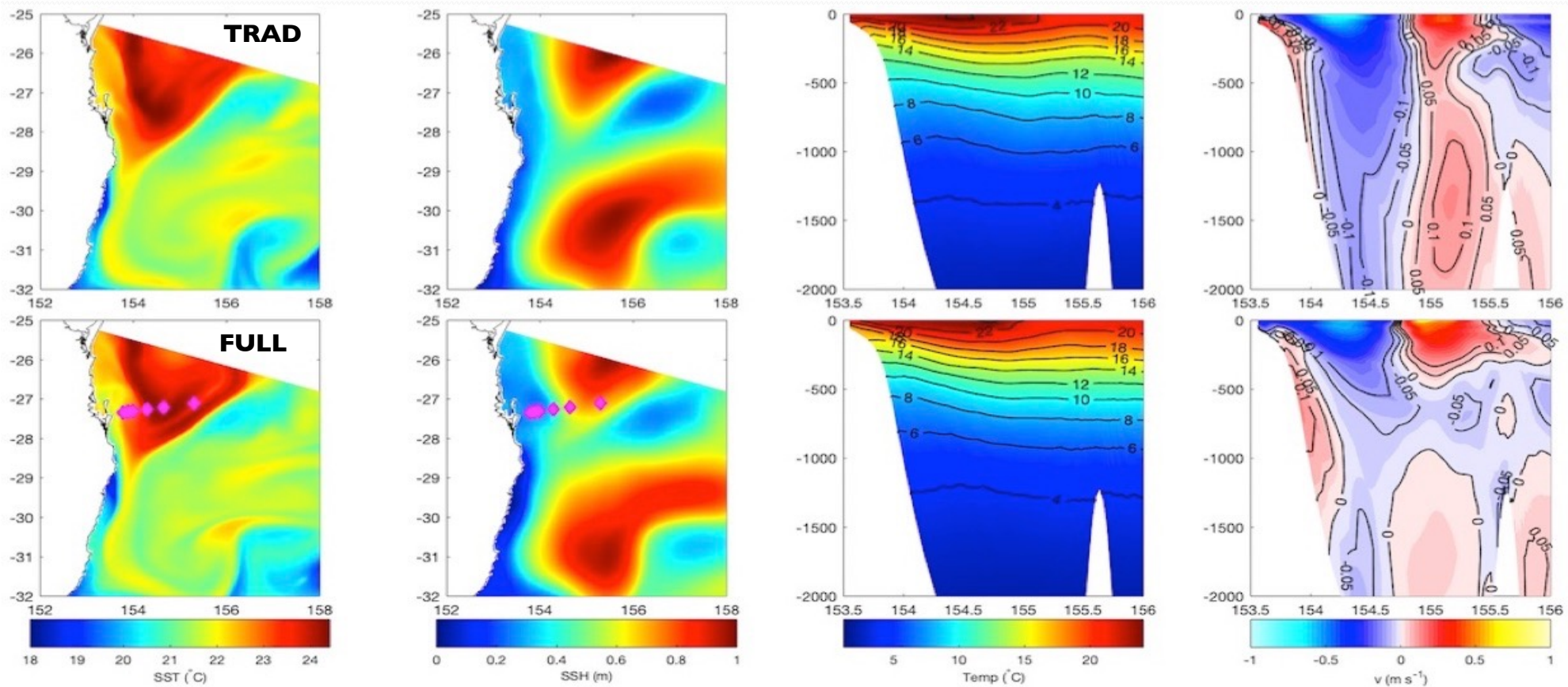
TRAD



Free-run
FULL
TRAD

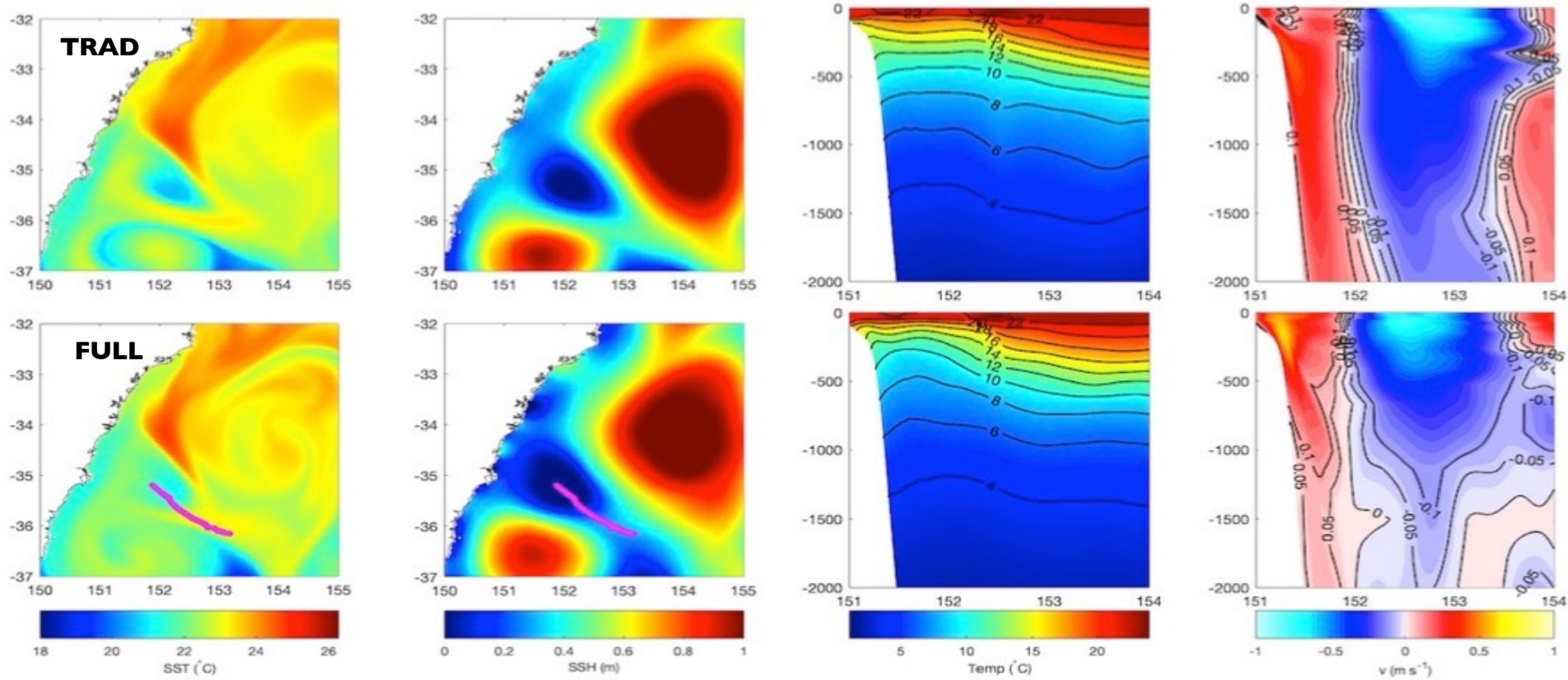
Eddy depth

EAC mooring array

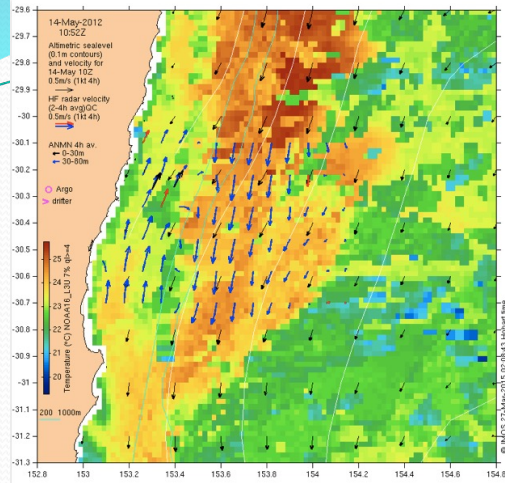


Eddy depth

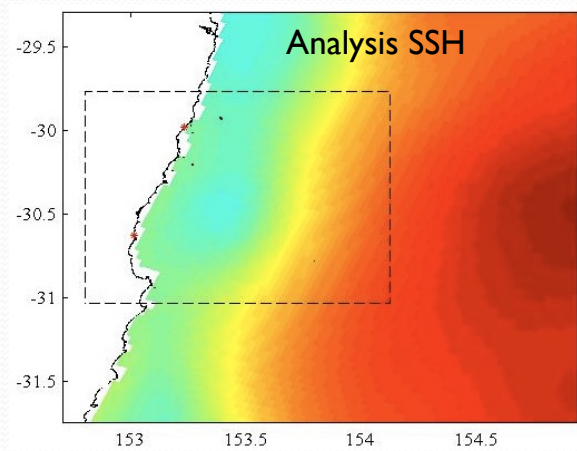
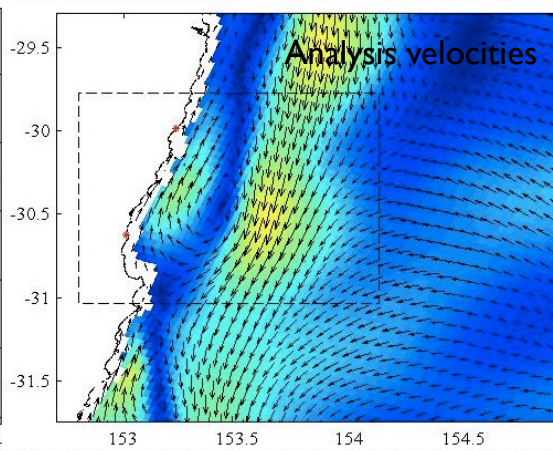
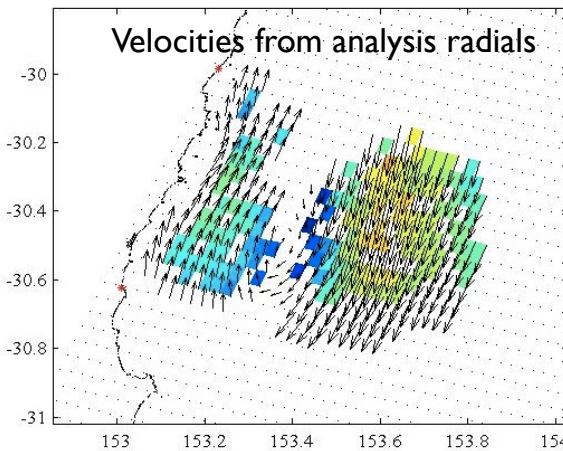
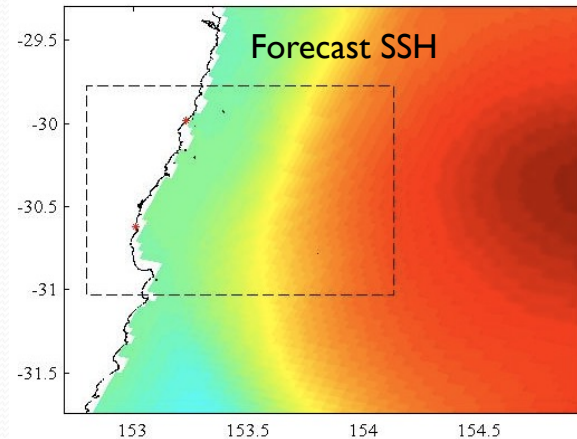
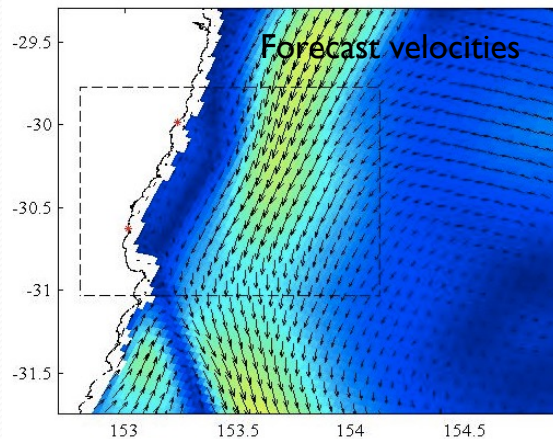
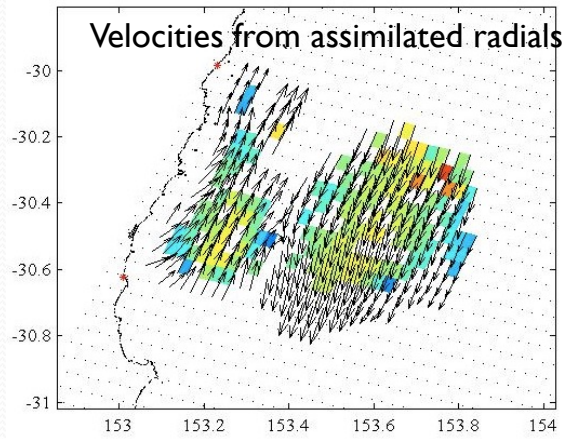
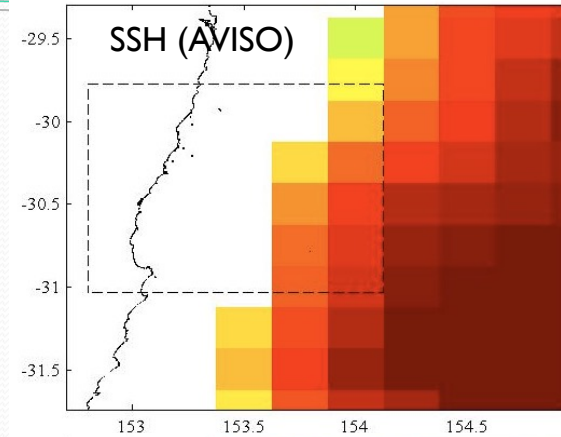
Gliders



HF radar impact example



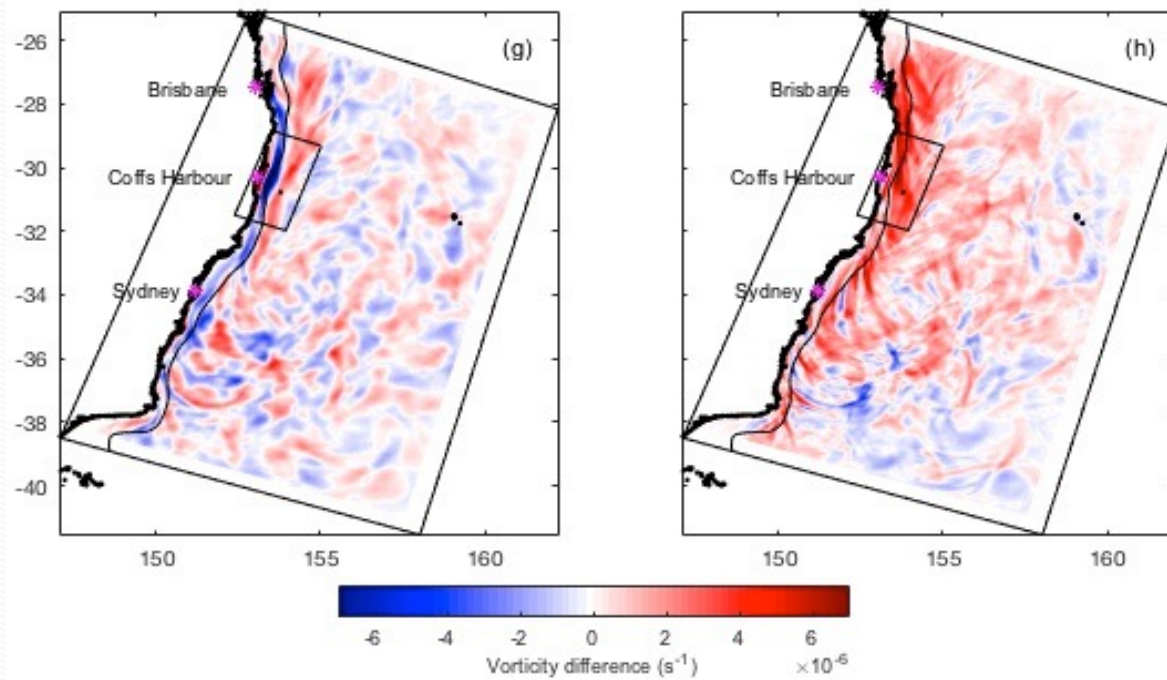
Assimilation of radial velocities from HF Radar array, specific example (May 14 2012)



Ocean surface vorticity

Time-mean vorticity, FULL- TRAD

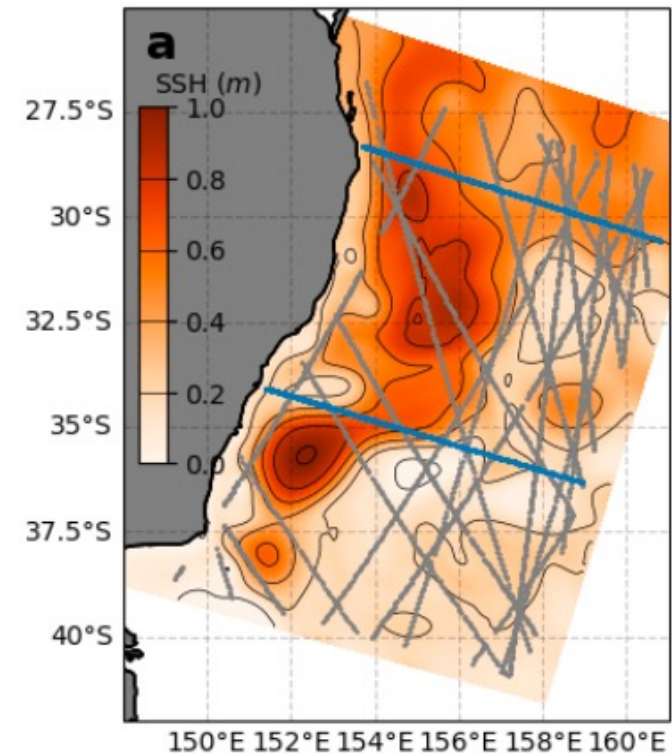
Vorticity standard deviation, FULL-TRAD



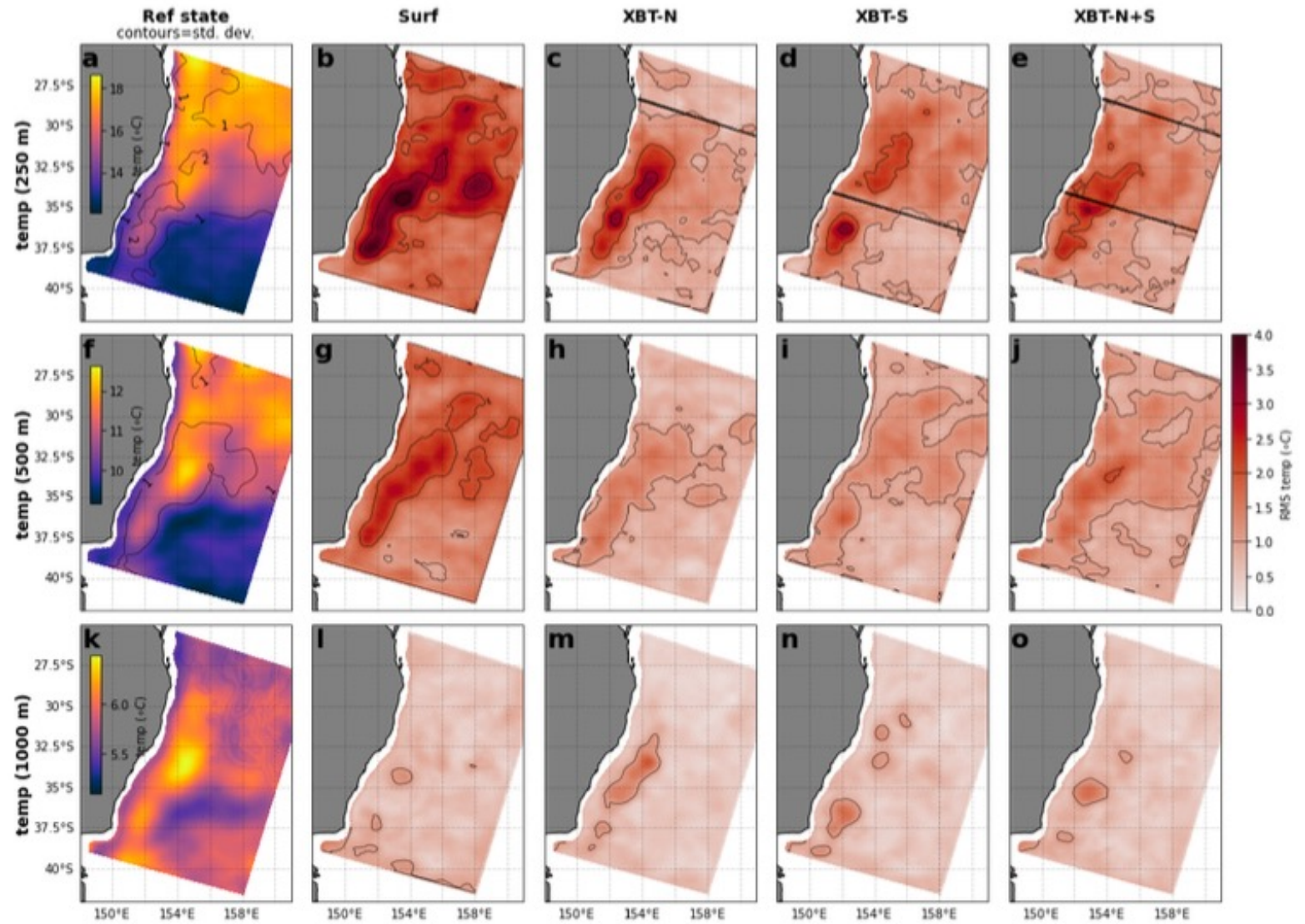
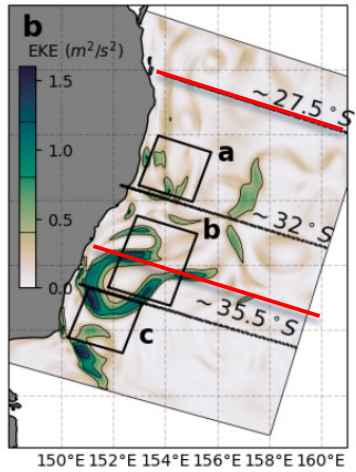
Positive (negative) means more anticlockwise (clockwise) when HF radar are assimilated

3. Observation System Simulation Experiments

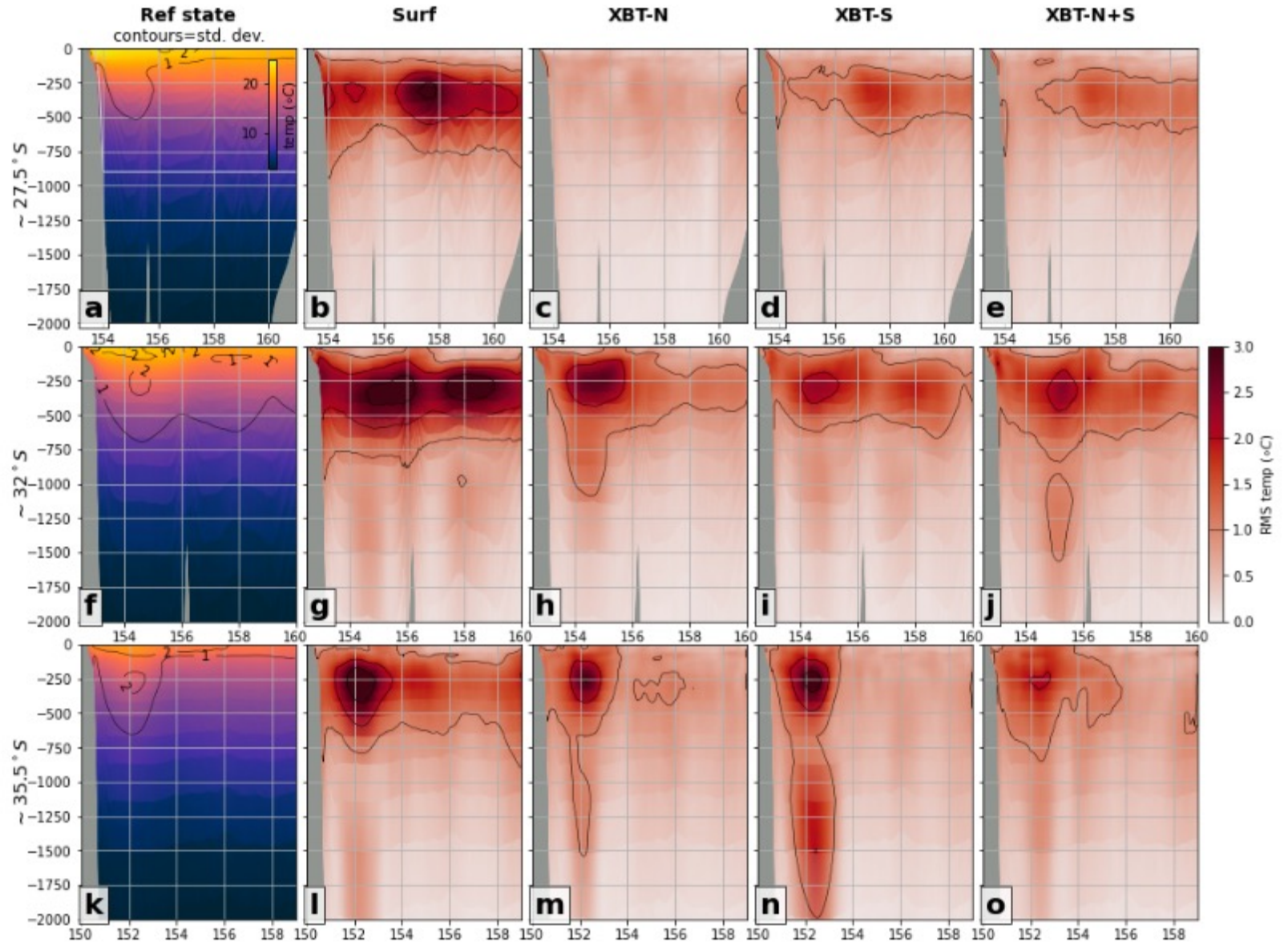
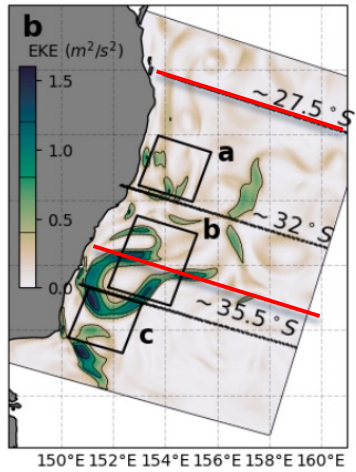
Experiment name	Model configuration details	Synthetic observations
Reference state	Free-running simulation covering period of Nov 2011 - Jan 2013. Observations extracted from this simulation.	
Surf	4DVar simulation covering period of Nov 2011 - Jan 2013; assimilating SSH and SST 'observations' synthesised from Reference state	Along-track satellite-observed sea surface height altimetry and sea surface temperature.
XBT-N	Surface observations plus XBT observations along the northern transect.	XBT temperature profiles to 900 m starting at ~28°S.
XBT-S	Surface observations plus XBT observations along the southern transect.	XBT temperature profiles to 900 m starting at 34°S.
XBT-N+S	Surface observations plus XBT observations along both transects.	XBT temperature profiles to 900 m starting at 28°S and 34°S.



Temperature representation



Temperature representation



Summary – Observation Impact in the EAC

- Observation impact 3 ways gives consistent results
- Observation impact is far-reaching; up and downstream, and forward and backward in time (4D-Var (and EnKF))
- Observations taken in regions with greater natural variability are most impactful
 - *We need to sample in the eddy-rich region*
 - *Downstream controls upstream*
 - *Upstream cannot control downstream due to chaos of separation and eddy shedding*
- EAC core and eddy depth extend too deep when not constrained by observations

Future work

- Improved representation of depth structure through improved specification of P (Hybrid Ensemble-Var method)
- Does this correspond to improved predictability?
 - EAC separation, eddy shedding, eddy interaction

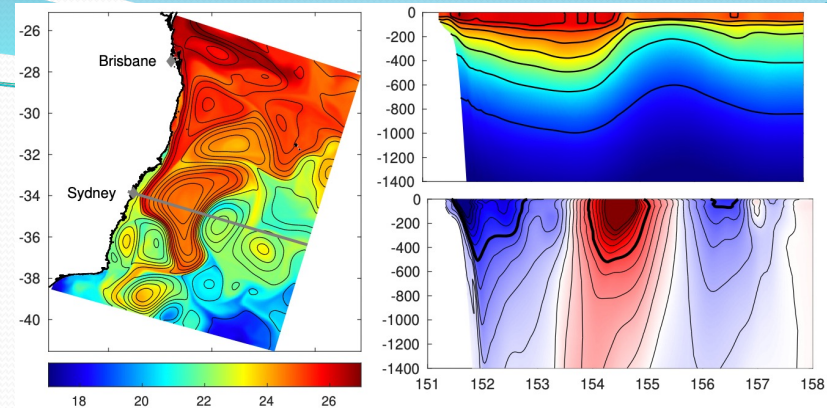


Fig. 1: Snapshot of SST (SSH contours every 10cm), temperature cross section (density contours every 0.5 kg/m³), alongshore velocity section (0.05m/s velocity contour in bold).

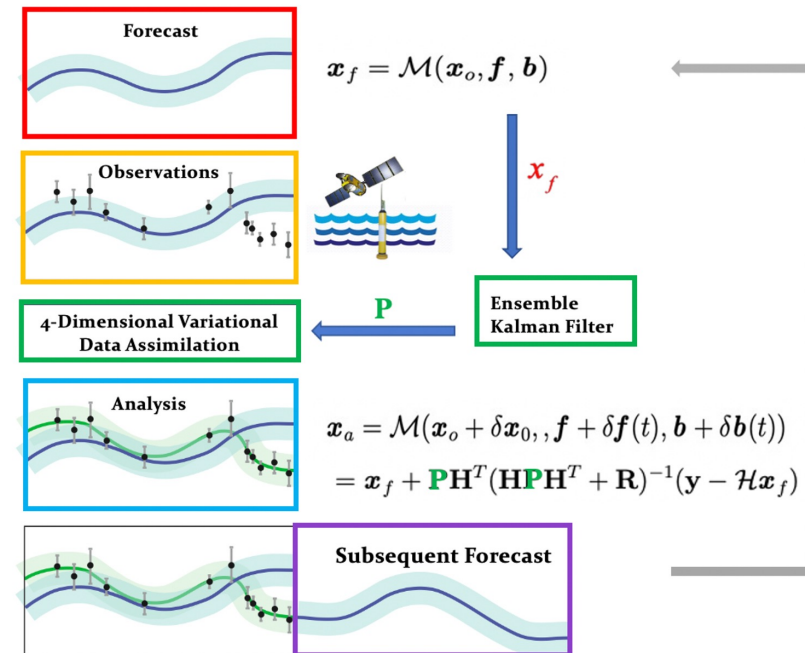
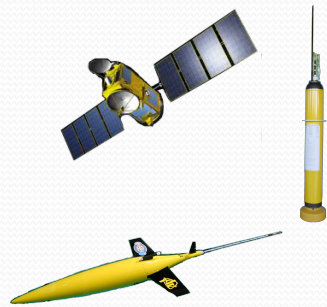


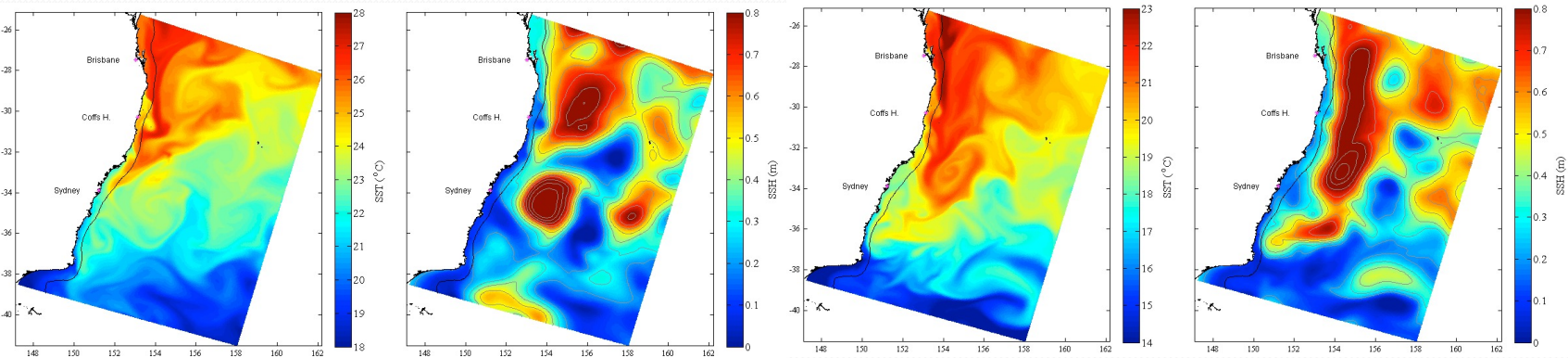
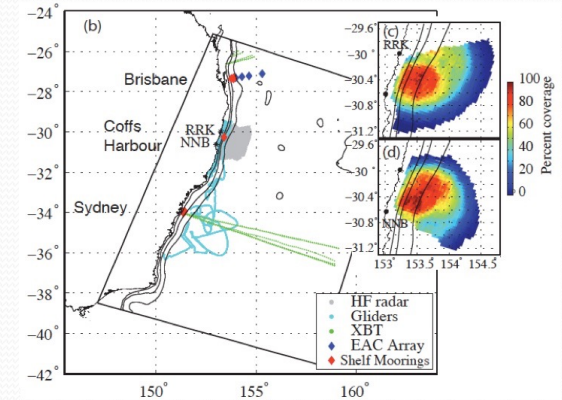
Fig. 2: A schematic representation of the Hybrid Ensemble-4DVar system. The EnKF passes the ensemble-derived covariance P to 4D-Var at the start of each cycle, and 4D-Var passes the control analysis \bar{x}_f to the EnKF which is used to re-centre the ensemble.

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Questions?



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