Guidance on Localization for Strongly Coupled Atmosphere-Ocean Data Assimilation

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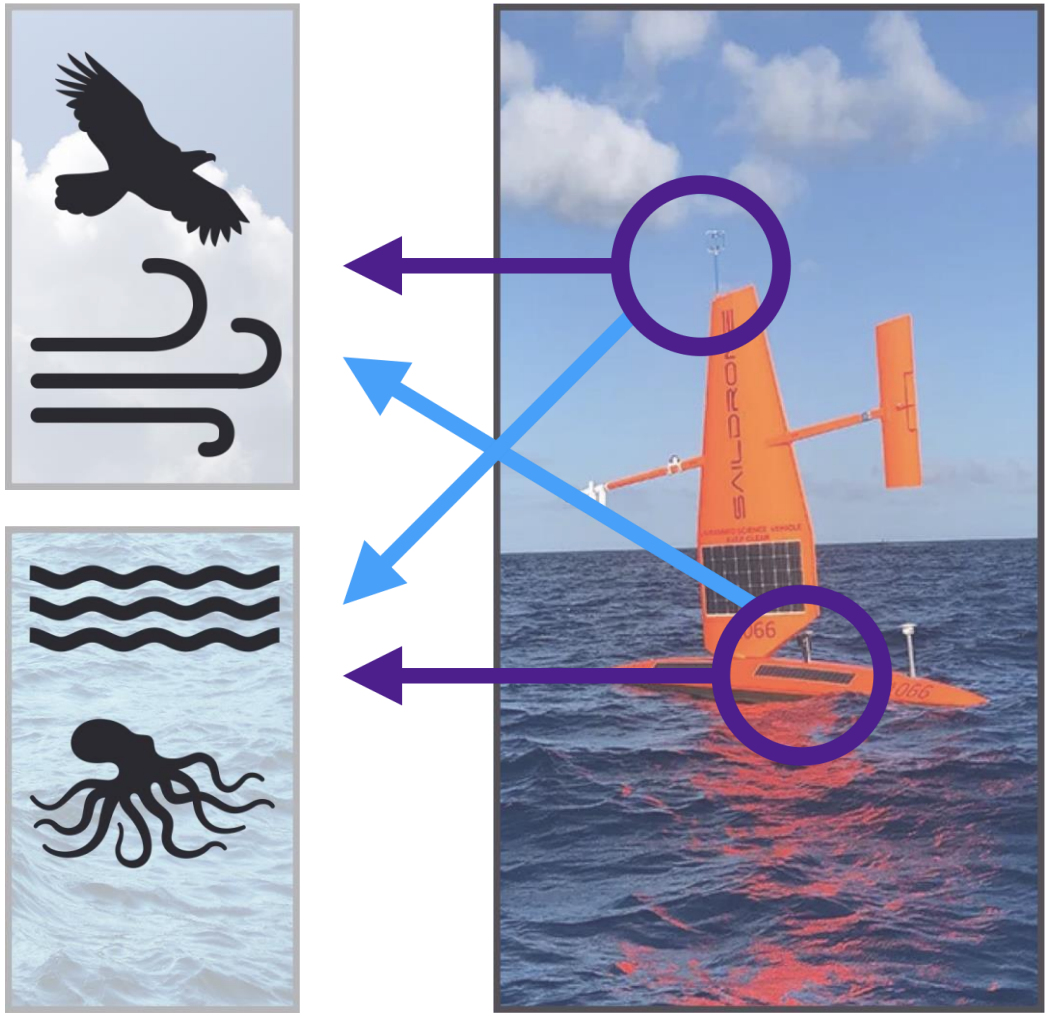
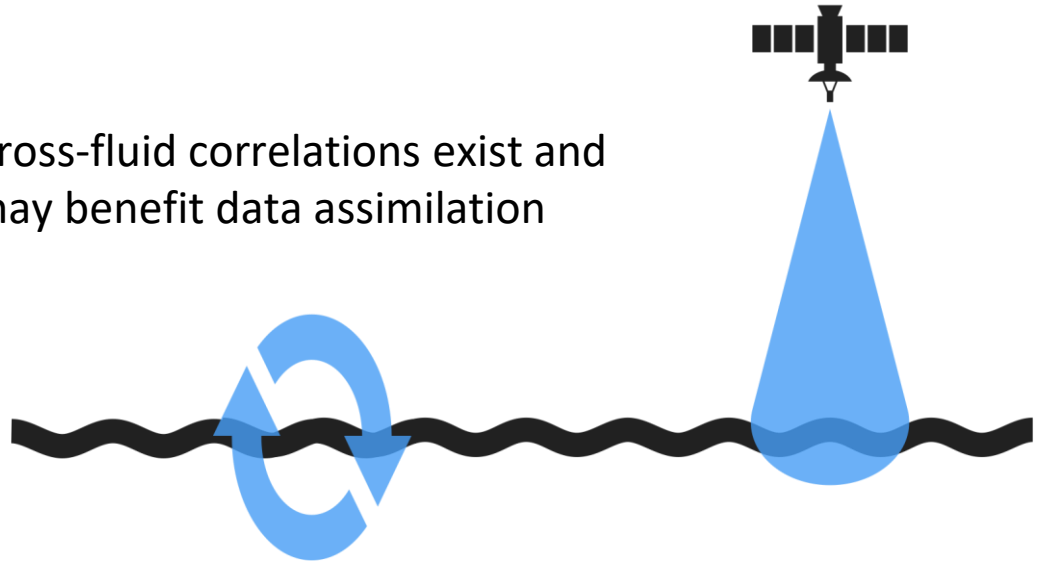
Strongly coupled systems allow observations of the atmosphere to update the ocean and vice versa.



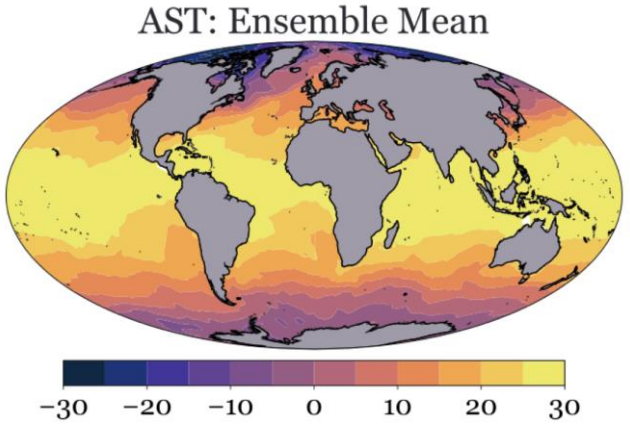
Cross-fluid correlations exist and may benefit data assimilation

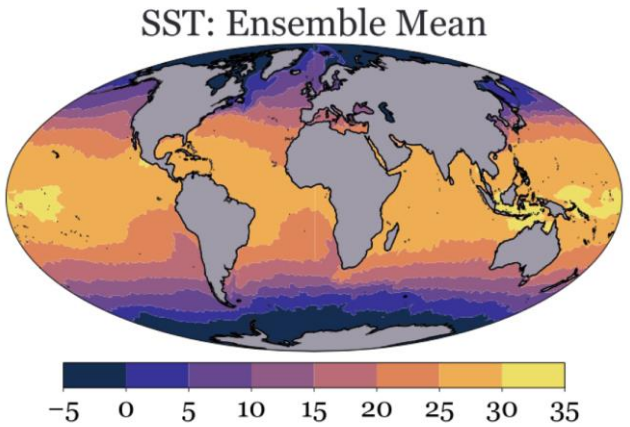


Satellite observations are sensitive to both fluids

Image credit: Saildrone Inc.

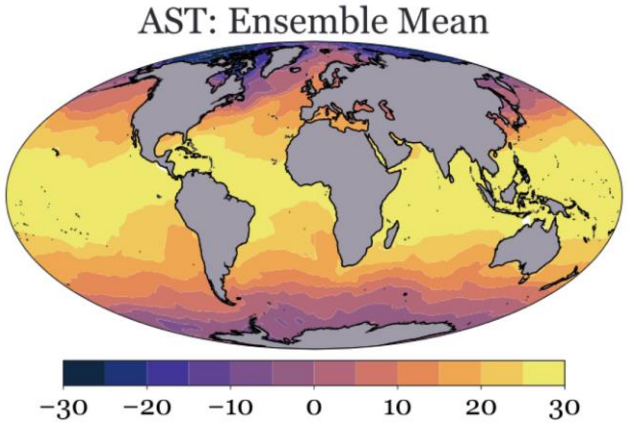
We study vertical localization with vertical columns from a global weakly coupled cycling system.

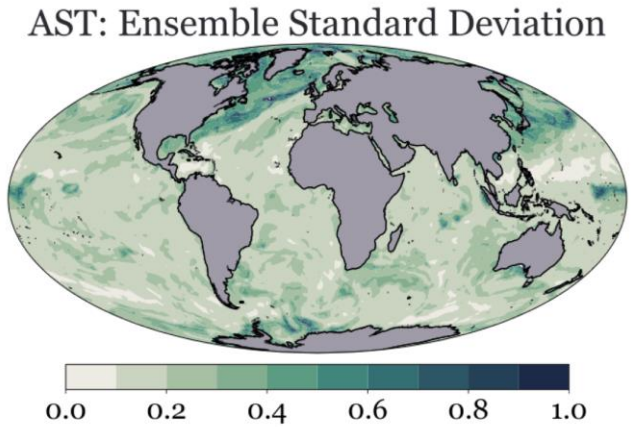


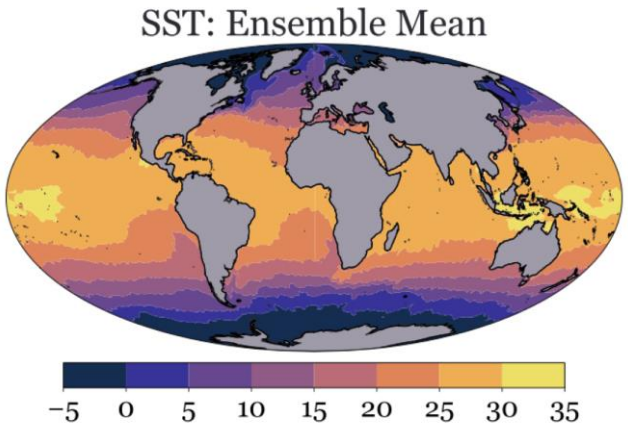


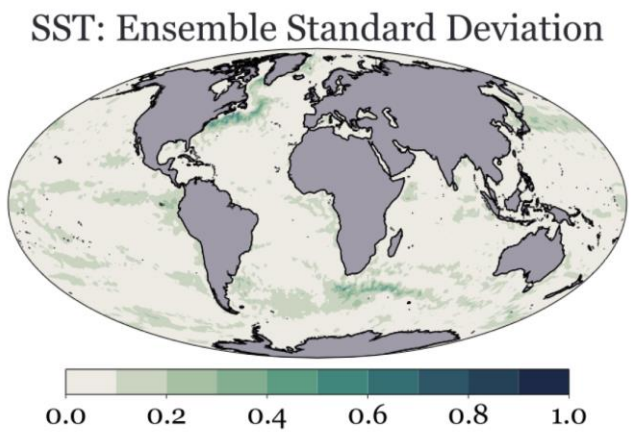
- Forecasts from UFS R2O project
- Data set produced by Henry Winterbottom & Wei Huang
- Coupled ensemble produced at 1 degree resolution
- Weakly coupled cycling system
- 80 member ensemble

We focus on simulated observations of surface temperature fields.

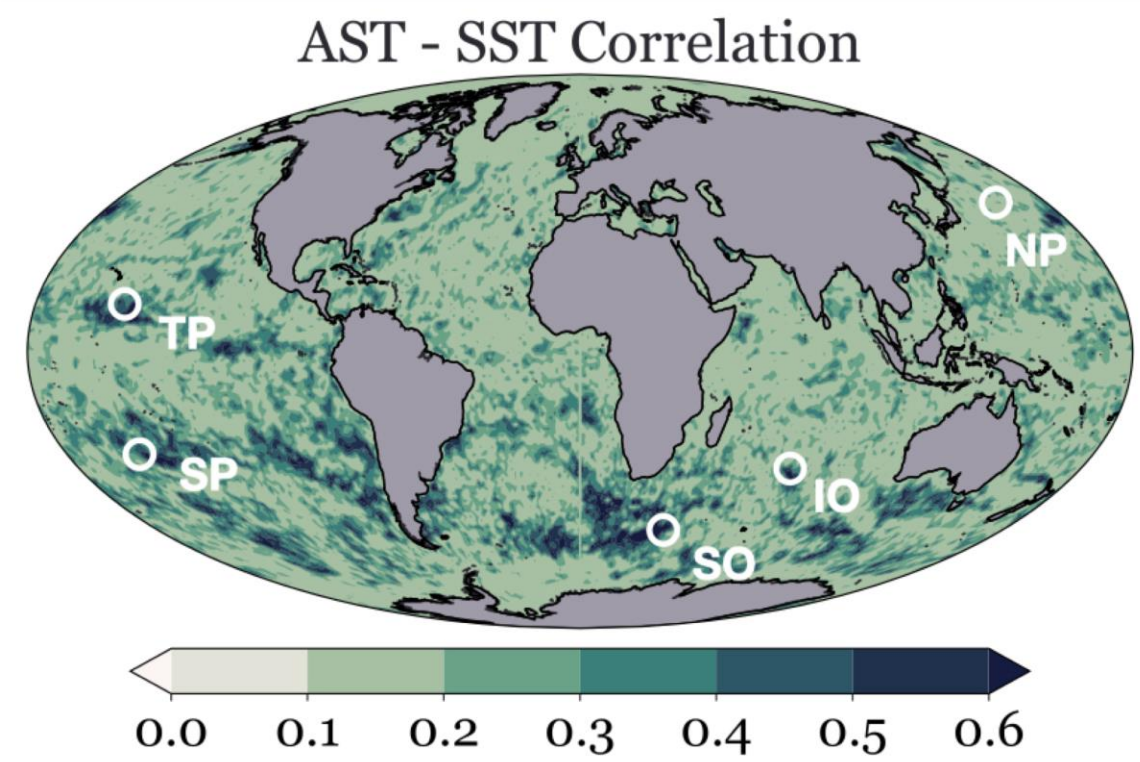


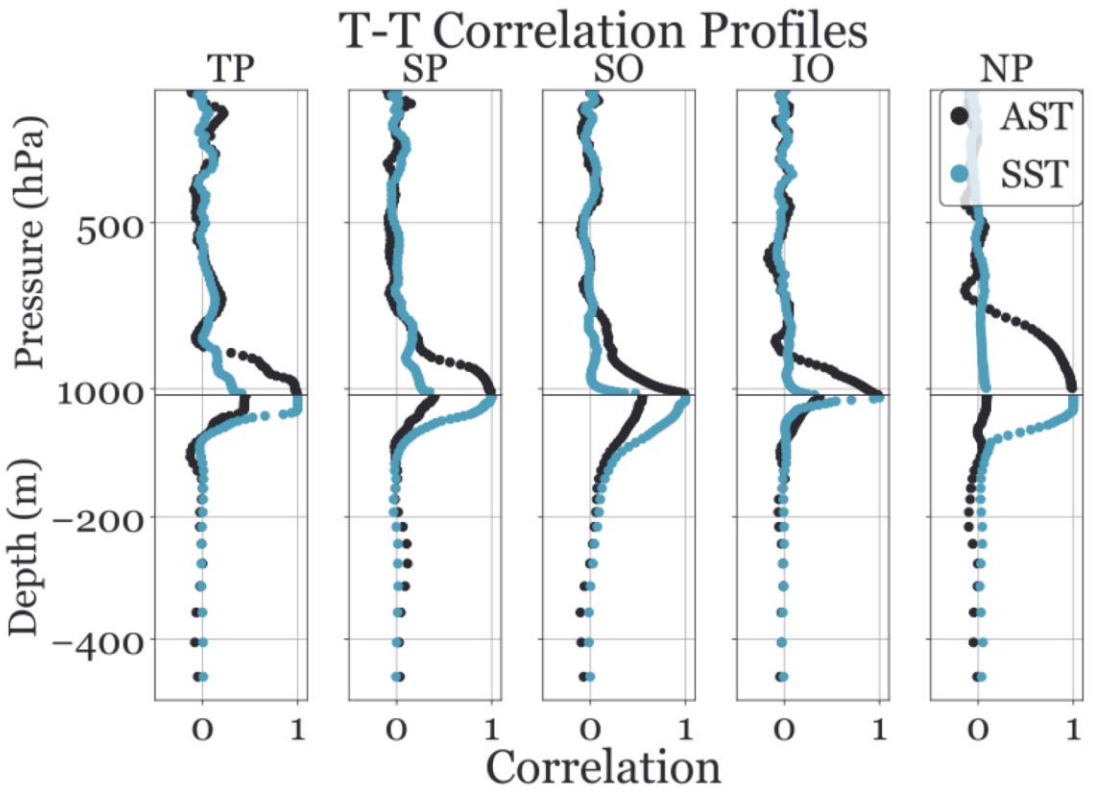






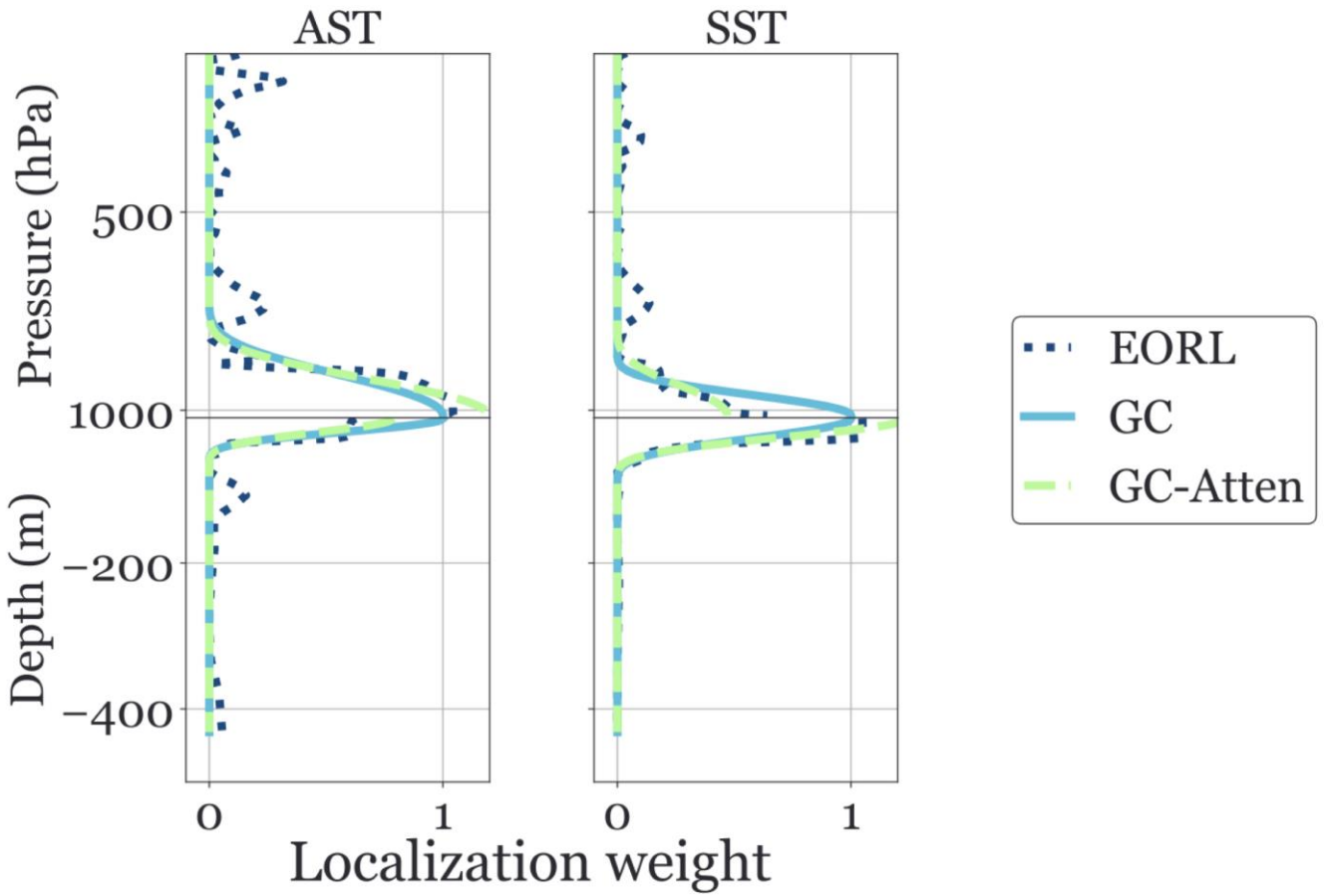
Modeled cross-fluid correlations are small compared to within-fluid correlations.



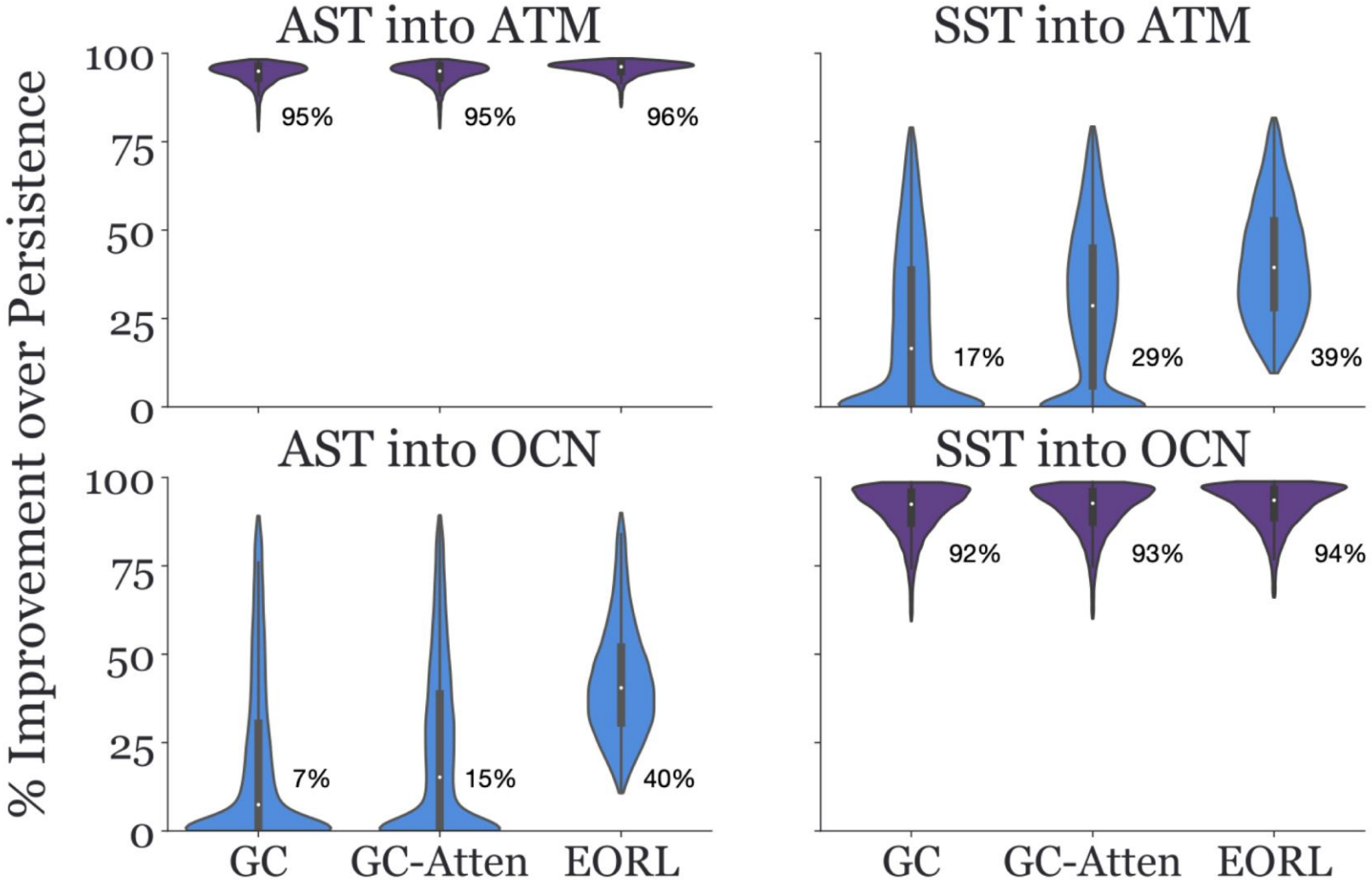


We look at three ‘optimal’ strategies for vertical localization.

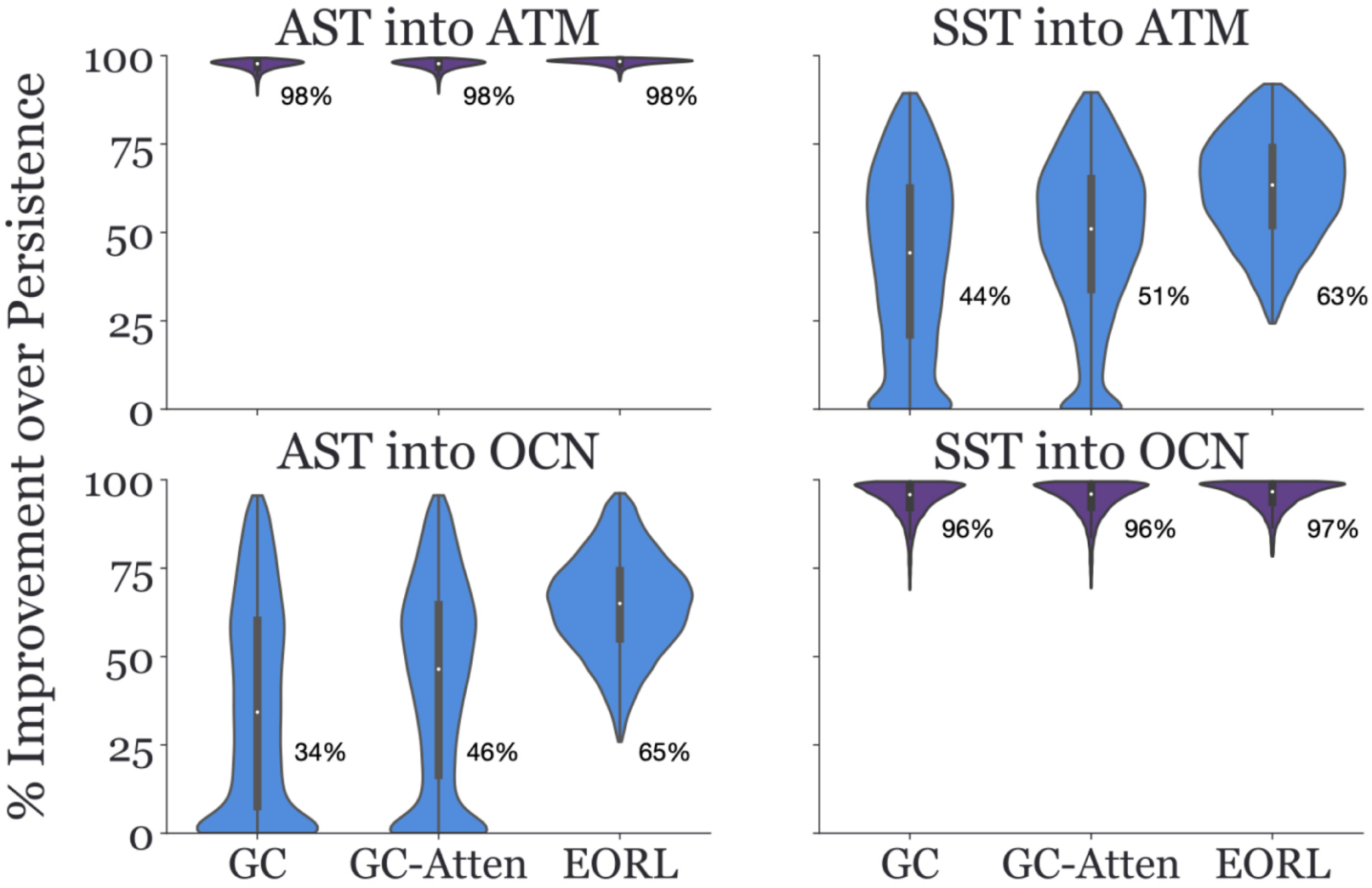
- Empirical Optimal Localization (EORL)
- Gaspari-Cohn (GC)
- Gaspari-Cohn with Attenuation Factor (GC-Atten)



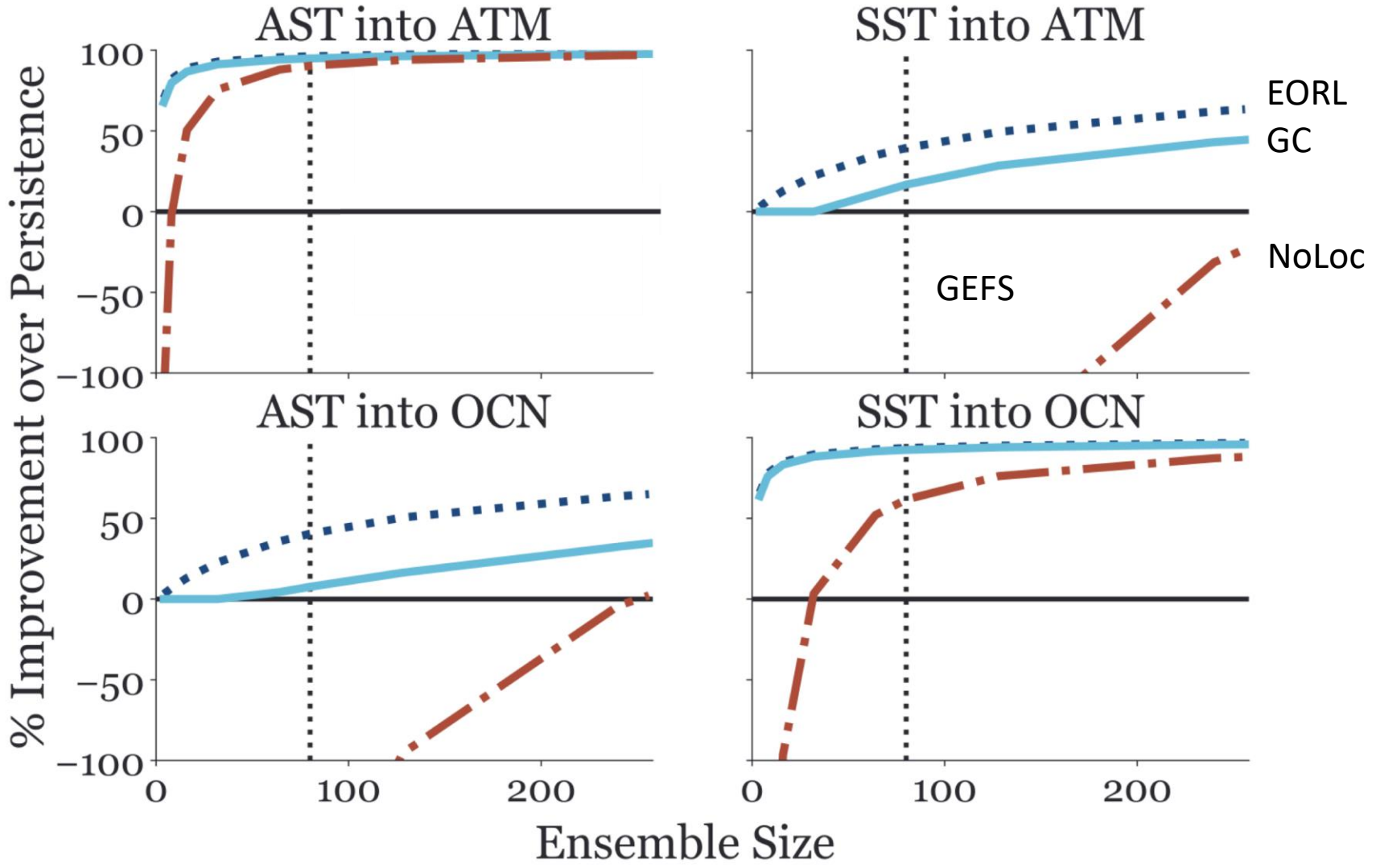
Optimal localization tells a very different story for within-domain assimilation and cross-domain assimilation.



Increasing the ensemble size improves cross-fluid performance.



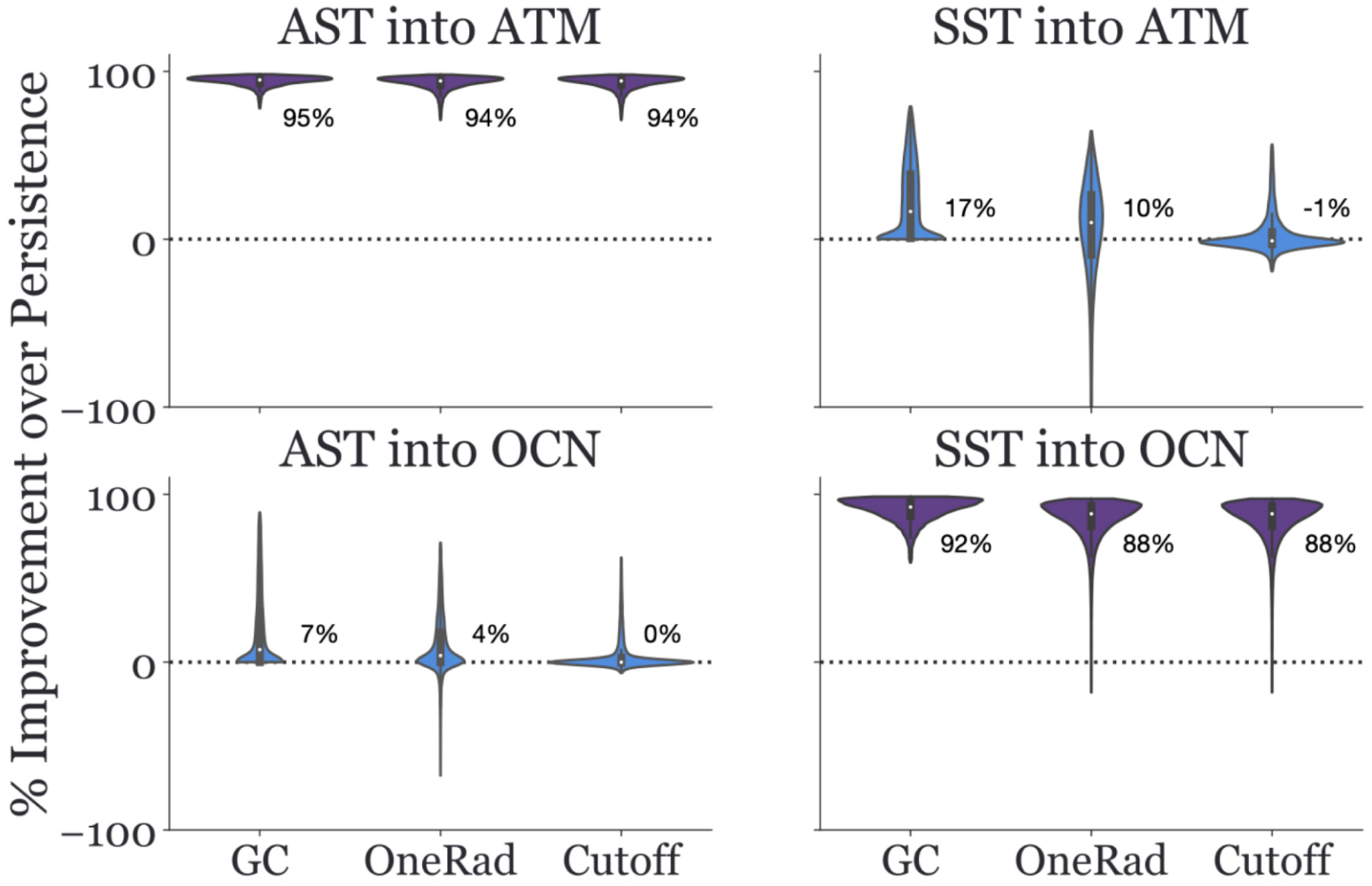
Localization scheme is an important factor in determining performance for cross-fluid assimilation.



We also look at two ‘practical’ strategies for vertical localization.

- **OneRad:** Gaspari-Cohn with single localization radius globally
  - Localization radius chosen separately for each observation/fluid pair
  - Chosen to be the median of the optimal localization radii
- **Cutoff:** As in OneRad, but only assimilate when AST—SST sample correlation is greater than 0.3
  - Threshold 0.3 is chosen to be ~90th percentile of the true cross-fluid temperature correlations

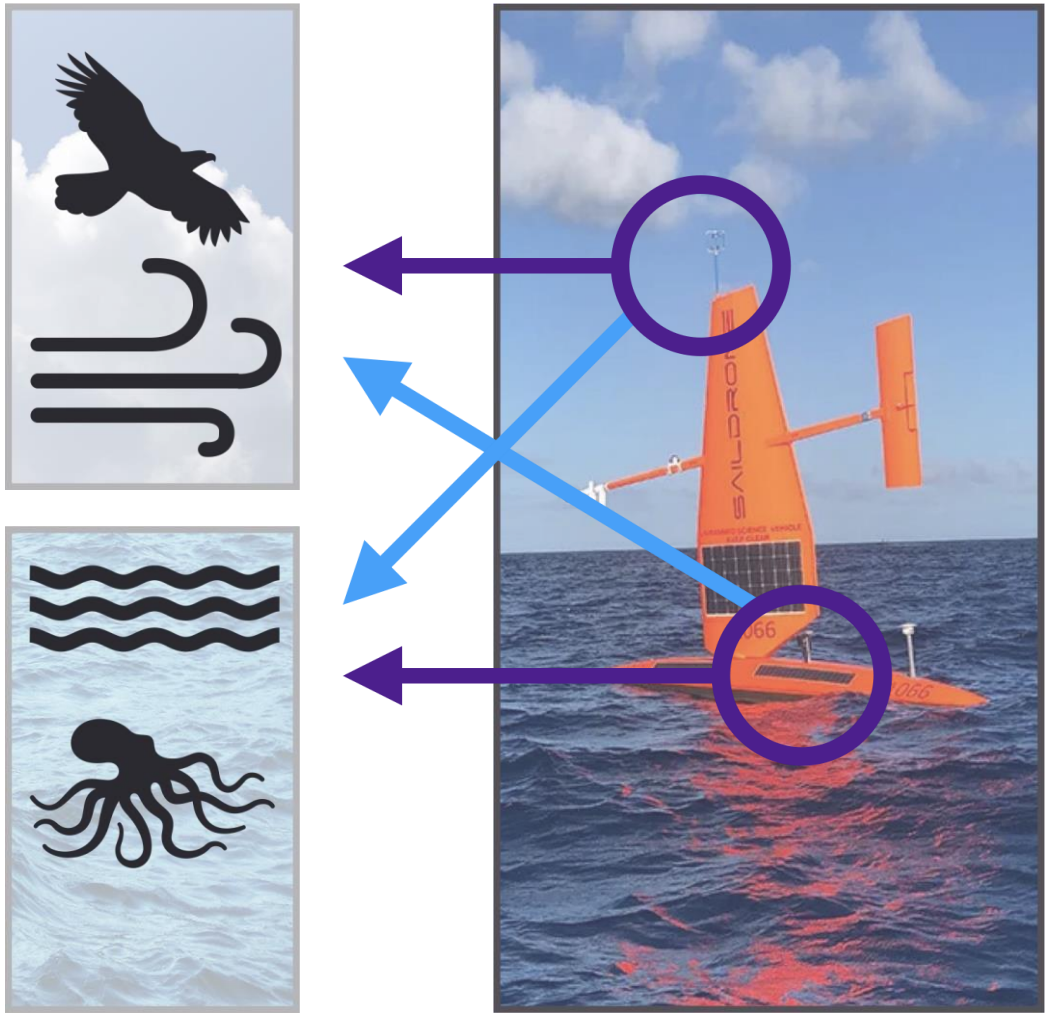
Practical localization schemes for cross-fluid assimilation show little to no improvement over persisting the background state.



Outlook: more work is needed on strongly coupled data assimilation.

- Strongly coupled data assimilation has the potential to be an improvement over weakly coupled data assimilation when large ensembles are used.
- Based on this work, it is unlikely that a simple parametric scheme is going to be sufficient to properly localize correlations in strongly coupled data assimilation.
- Possible further advances:
  - Increase ensemble size (expensive)
  - Improve estimates of correlation at lower computational cost (ML?)
  - Improve localization schemes (how?)

Questions?



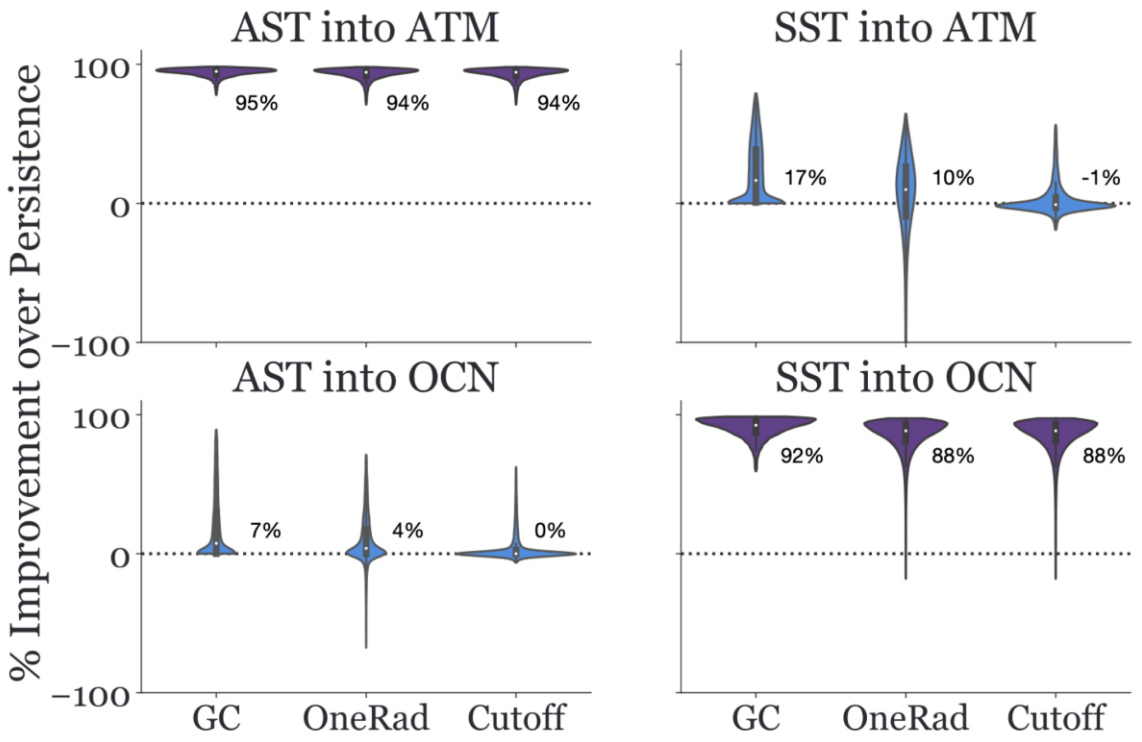


Image credit: Saildrone Inc.