Assessing the role of ocean currents on prey concentration from hourly to seasonal scales using lagrangian coherent structure

AUTHORS

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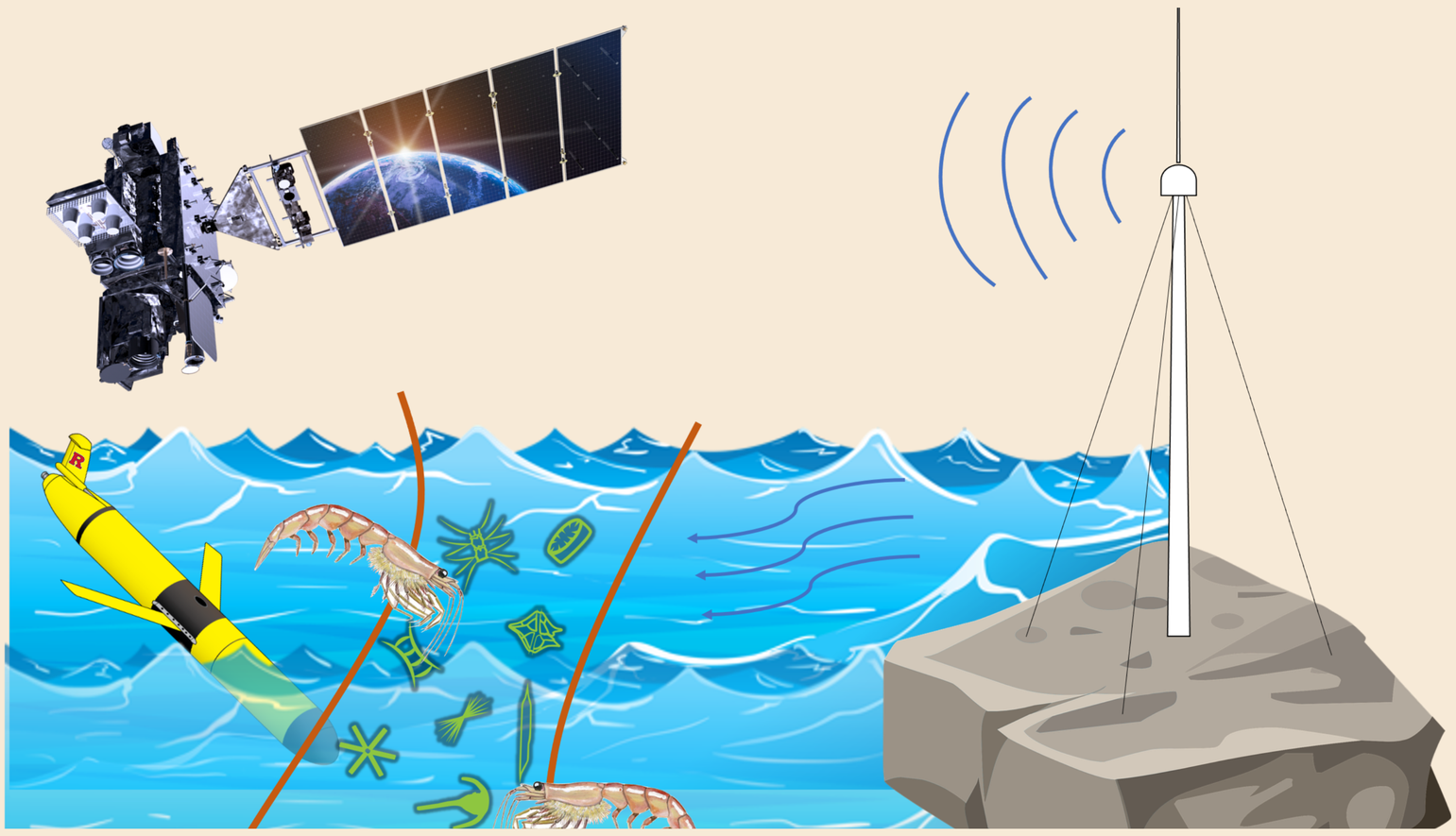
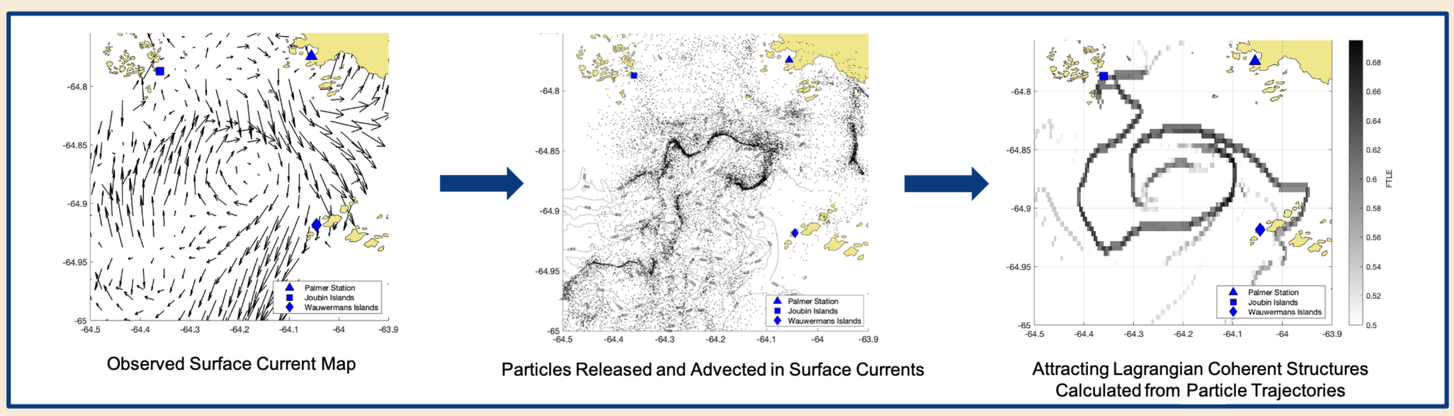
SUMMARY OF WORK

In response to the introduction of offshore wind in the Mid-Atlantic Bight, the following study quantifies the ocean's role in prey concentration.

- "Patchy" distribution of plankton is in part due to oceanographic features transporting and locally concentrating plankton
- Using decades of observed surface current maps, lagrangian particle tracking techniques quantify where/when prey concentrating features exist
- Results will aid in understanding animals' reliance on oceanography

Surface ocean features can be tested for **prey concentration** using lagrangian particle tracking from High Frequency Radar **surface current maps**.



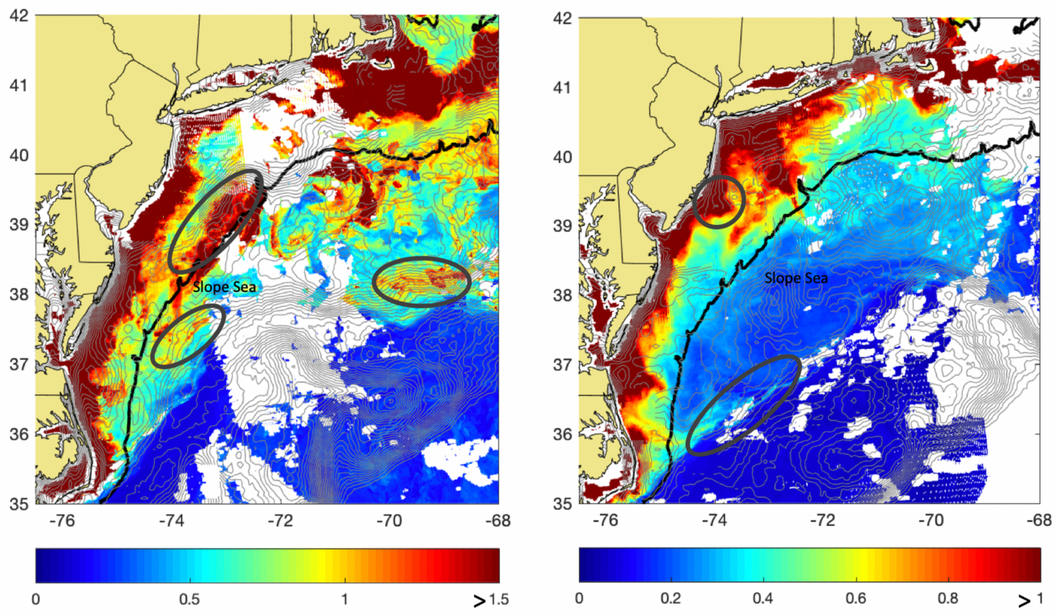


BACKGROUND & HYPOTHESIS

- High Frequency Radars (HFR) observe hourly maps of ocean surface currents
- Lagrangian Coherent Structures (LCS) use surface current data from HFRs to integrate over simulated particle trajectories. Results show areas of concentration.
- LCS occurrence corresponding to an increase in plankton will provide increased prey availability of fishes and mammals, like a **marine "grocery store"**
- LCS occurence appearing along marine animal migrations may provide navigation for fishes and mammals, like an **"ocean highway"**
- LCS appearing in the same location seasonally may be closely linked to local and migratory phenology

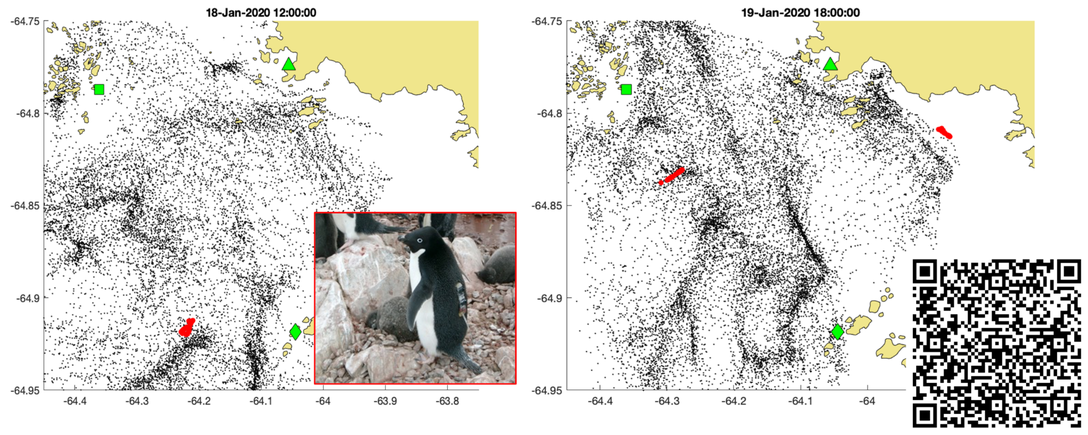
RESULTS

Lagrangian Coherent Structure Contours mapped to Chlorophyll Concentration



Colorbars show 8-day composite of chlorophyll concentration (mg/m^3) from MODIS-A ocean color satellite. One LCS technique, Finite Time Lyapunov Exponents (FTLE), are contoured in grey (day^{-1}), calculated from DOPPIO model surface currents. Shelf break at the 200 m isobath in black contour. Grey circles indicate regions where FTLE appear to contribute to phytoplankton patch structure. Future work will calculate FTLE with higher resolution using HFR observed surface currents.

Foraging Penguins (red dots) selecting for Lagrangian Coherent Structures (Relative Particle Density) in Palmer Deep

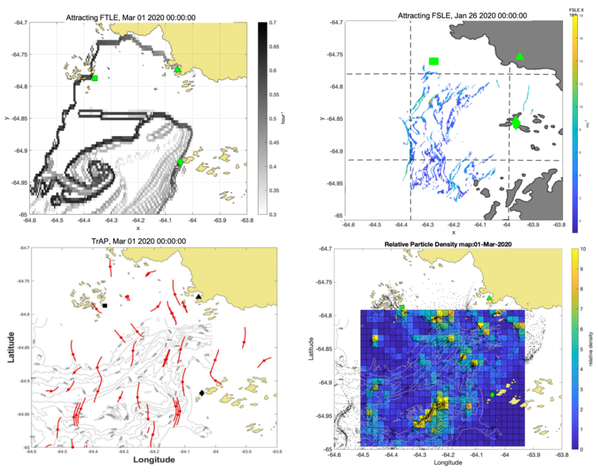


FUTURE WORK & DISCUSSION

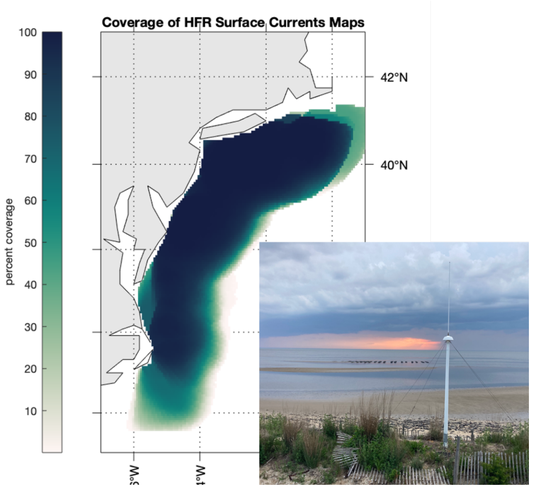
- LCS metrics will also be analyzed for interannual and seasonal variability to quantify the persistence of concentrating features during important life cycle stages of MAB species.
- LCS results will be compared to bioactivity from phytoplankton to whales.

Results will provide a new quantitative methodology for assessing marine animals' reliance on ocean currents, inform ecosystem models, and deepen understanding of the role of physical ocean features in structuring the ecology of marine mammals and fishes.

ANALYZING LCS TECHNIQUES



Four popular LCS techniques are being compared to in-situ phytoplankton, zooplankton, and penguin abundance in Palmer Deep, Antarctica. Resulting relationships between LCS and bioactivity in this relatively short food web will be applied to the MAB.



An array of High Frequency Radars continuously measures surface current maps in the Mid-Atlantic Bight. Results are processed into hourly averages.