The impact of large scale processes on CARICOOS regional currents

UPR Mayagüez Marine Sciences

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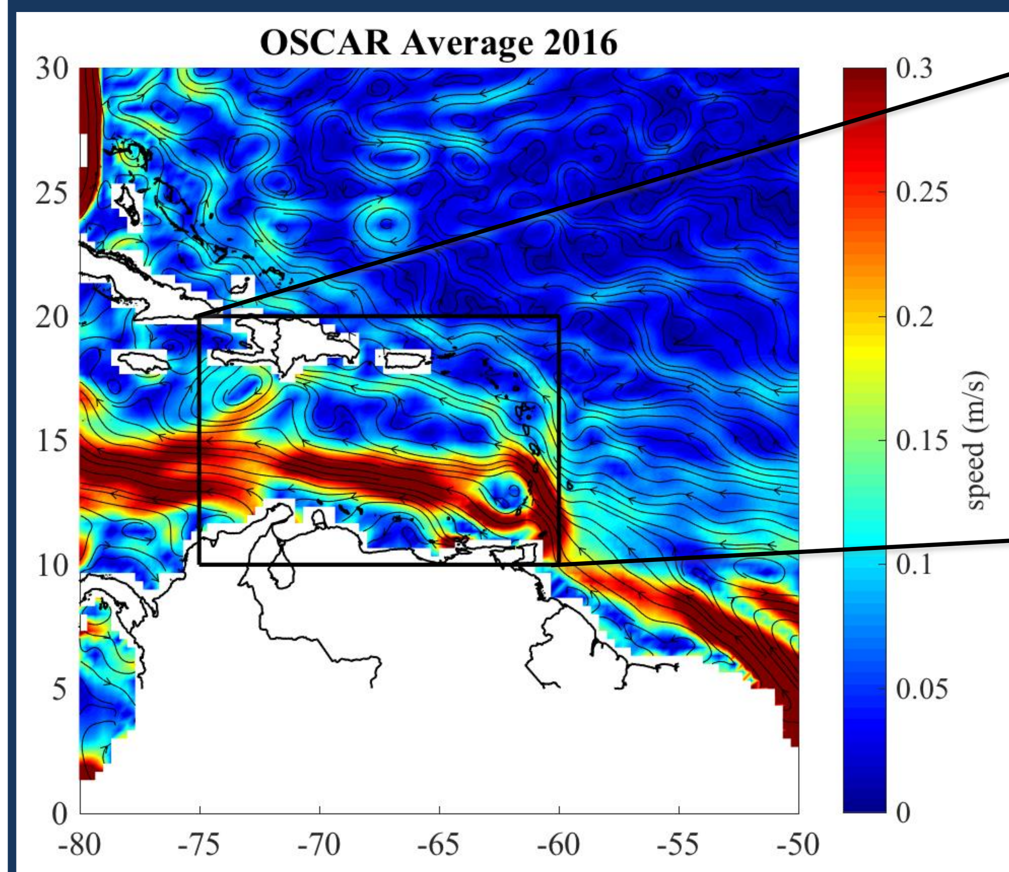
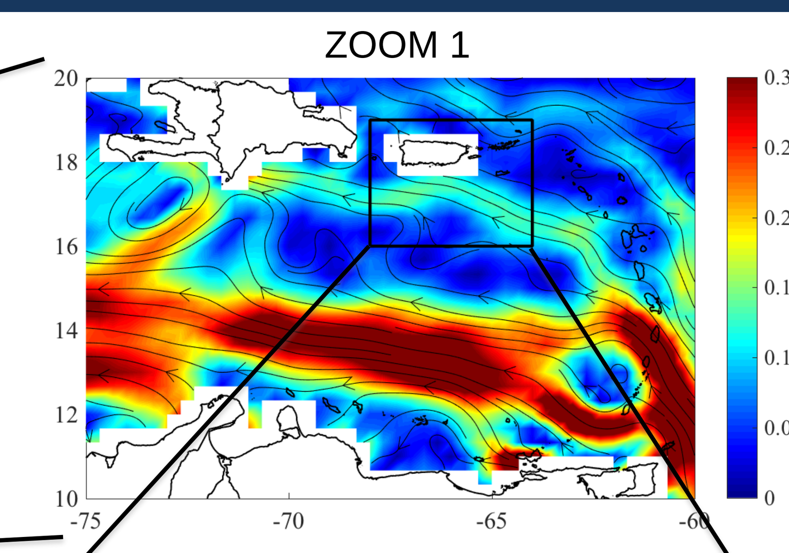
BACKGROUND

Steep island shelf slopes and a rich hydrodynamic field have challenged CARICOOS hydrodynamic numerical modeling efforts since the beginning of their efforts. Improved resolution and computational capabilities allowed for modest improvements but still can't provide operational quality forecasts for the region coastal areas. Recently we started assessing the large (>100km) and mesoscale (~10 - 100km) circulation processes and hydrography present in the eastern Caribbean (EC) and the immediate north tropical Atlantic which may drive dynamics not well resolved for CARICOOS current forecast region. Using CARICOOS observational network we have found that the boundary and initial conditions input, coming from parent operational models (NCOM & HYCOM)**, is not up to par** with the dynamics CARICOOS needs to forecast to withhold its mission of providing reliable coastal forecasts. While looking for data that could provide the best boundary input possible for the regional model, we have come upon the occurrence of persistent mesoscale features, not accurately captured by NCOM that significantly modulates near coastal circulation off the south of Puerto Rico (Figure 1-2). These features were previously described by Richardson et al. (2005) and others as the EC 17N jet. Our analysis, based on CARICOOS observational network, indicate that it is more than a jet, plus it's been frequently associated to meso and submesoscale (~1 - 10km) eddies incorrectly resolved by our source for initial boundary conditions (NCOM). One dataset capable of adequately resolving the observed mesoscale features is the Ocean Surface Currents Analysis-Realtime (OSCAR), its quasi-geostrophic surface currents (surface to 30m) have showed to capture the large features of interest – Richardson's EC 17N jet and mesoscale eddies. We believe these features are key phenomenon that we need to capture correctly to improve CARICOOS coastal dynamics forecast.

GOAL: Study the 2D spatial extent and variability, the vertical structure and the frequency of the feature's intrusion into Puerto Rico's south coast.

EC FEATURES





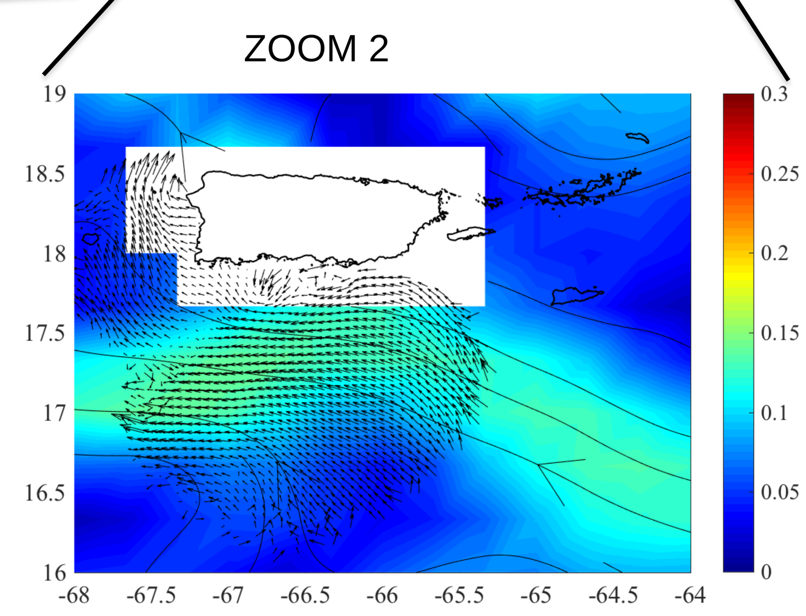


Figure 1. Caribbean Current during the year 2016 observed using OSCAR data. ZOOM 1 illustrates the EC 17N Jet impacting Puerto Rico's south coast. ZOOM 2 solely focuses on this 17N Jet superimposed with CARICOOS HFR data average for the 2016 year.

More than a jet!

As noted on Figure 1, the EC 17N jet feature is the product of the Caribbean Current and can be seen as a secondary circulation impacting PRs southern coast circulation.

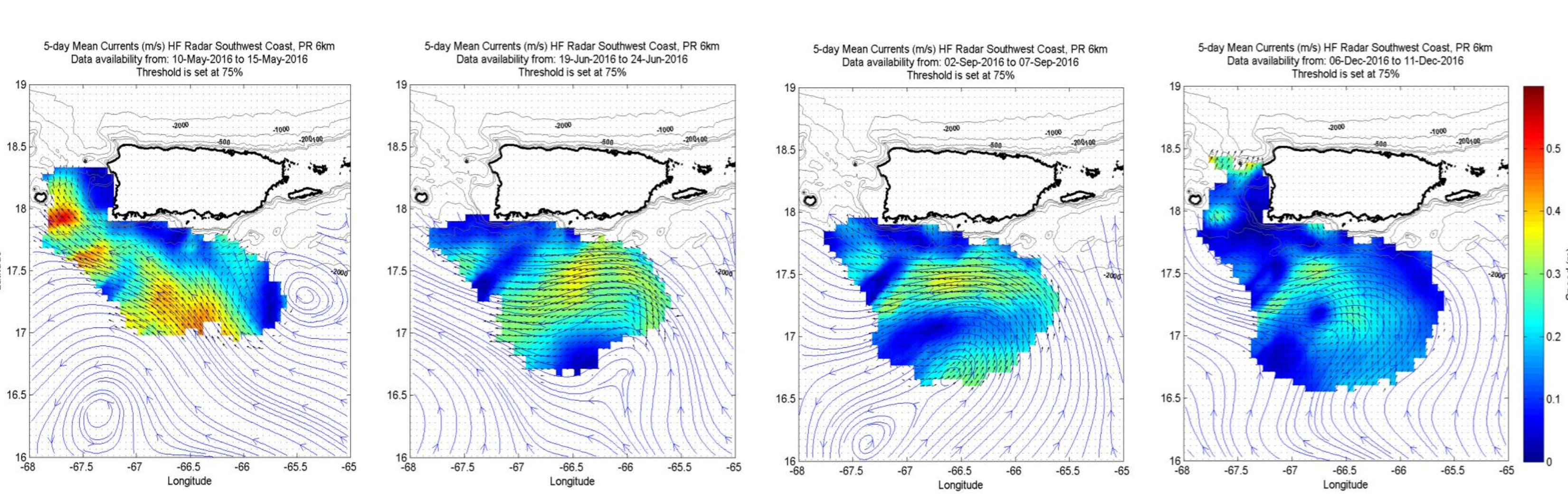


Figure 2. All four figures illustrate the variety of dynamics from the EC 17N jet being captured by CARICOOS HFR network at times scales averaged to 5 days through different months of the year.

Through visual inspection of the observations repeatedly taken during 2016 we have seen that the EC 17N jet is something more similar to a meander, capable of initiating and shedding small mesoscale and submesoscale eddies.

INTERCOMPARISON OF HFR AND OSCAR

Since the EC 17N jet is major feature that is not being adequately captured by current operational models in the region but it is being captured by HFRs and OSCAR, we decided to test the correlation between HFR and OSCAR datasets for the 2016 year. There are some differences in sampling time, and space resolution and coverage between the two datasets. So to make up for that the dataset with the "best quality" (HFR, hourly data with 6 km of resolution) was downgraded to match OSCARs time step (5-days) and spatial resolution (1/3 degree ~ 37 km). The results (shown in Figure 3) illustrate how reliable the OSCAR data can be around the current ROMS boundary, and it feeds the idea of possibly using OSCAR as surface currents boundary conditions for the CARICOOS regional model. It also shows how the low RMSE numbers along a zonal gradient tend to rise seaward, this goes along with the fact that HFRs have a hard time capturing high quality data at the end of their range.

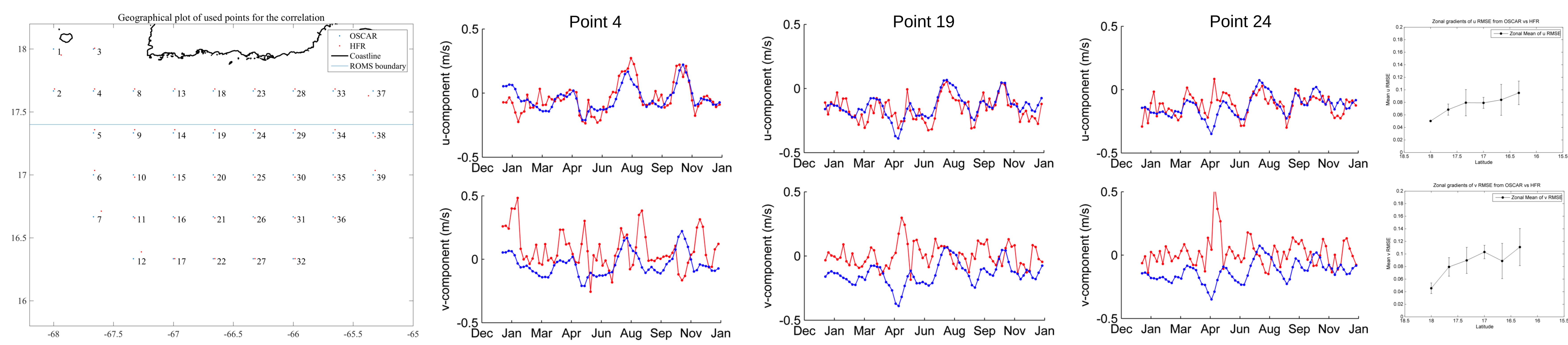


Figure 3. Illustrates a handful of stations that were analyzed through the whole 2016 year, the importance of these time series (Blue – OSCAR & Red – HFR) shown here lies in their closeness to the actual ROMS boundary. For the most part velocity component u has the best agreement between data sets, which suggests that the mostly westward flow is being equally captured, and component v has some interesting differences – suggesting that the data sets are sensitive to different spatio-temporal features or it could be a caveat of OSCARs course spatial resolution.

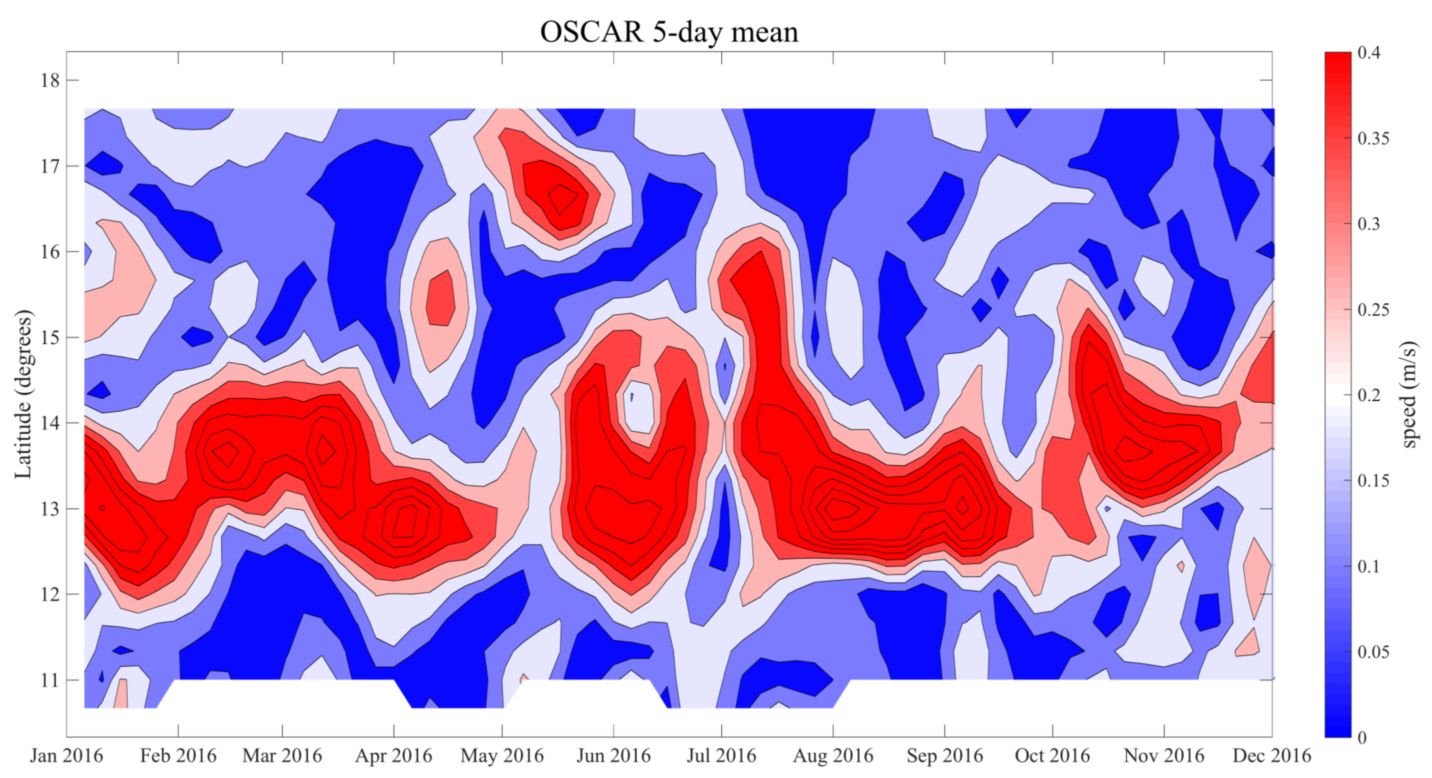


Figure 4. Illustrates a Hovmöller diagram made with OSCAR data for 2016 on the 66 W along a latitudinal gradient, from this we look at the latitudinal intrusions of the Caribbean Current into the south coast of Puerto Rico. Some intrusions are more significant (May 2016) than others but still there is a 2 to 3 month frequency between intrusions shown here for speeds of > 0.2 m/s.

As part of the future work on studying the vertical structure of this feature, in colaboration with AOML a Sea Glider performing sustained observations will be used ocasionally to survey the vertical extent and hydrography of the EC 17N jet. Figure 5 illustrates the proposed route to survey, which would be from points S7 to S9.

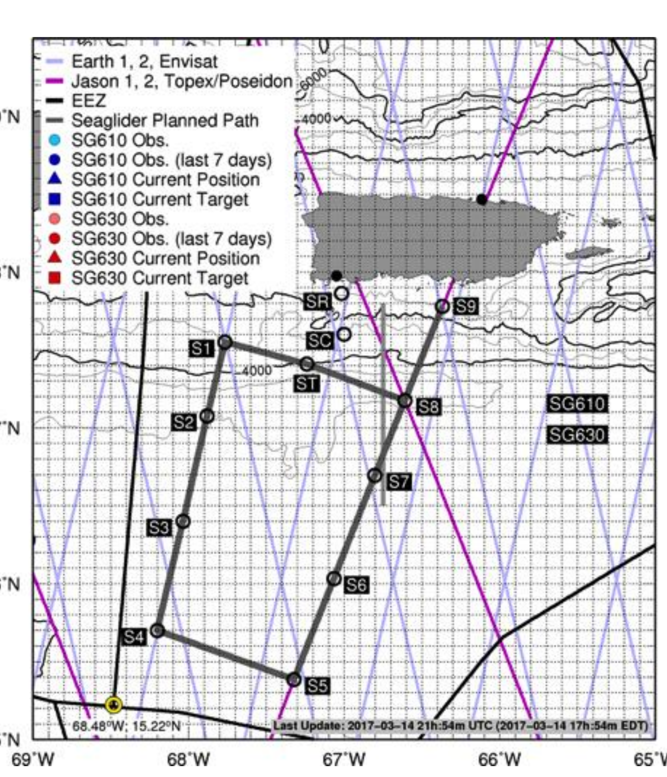


Figure 5. Proposed Sea Glider track for the Caribbean Sea part.

FUTURE WORK

- We aim to study the vertical structure of the persistent EC 17N jet south of Puerto Rico using a NOAA/AOML sea glider with the objective of exploring an empirical relationship between its observed surface vector field and its subsurface structure.
- Correlate steric height against satellite dynamic topography in order to explore and evaluate how to use the satellite derived geostrophic currents data as an input in our initial boundary conditions.
- Assess sea glider depth averaged currents against OSCAR and satellite derived geostrophic currents with the same objective of exploring empiric correlations.

ACKNOWLEDGEMENTS & REFERENCES

Huge thanks to the CARICOOS project, team and observational assets for giving me the opportunity to work with them on this and previous projects, outreach activities and experiences!

- Richardson, P. L. (2005). Caribbean Current and eddies as observed by surface drifters. Deep-Sea Research II 52, 429-463