Evaluating AMSEAS Model Using HF Radar Data

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Abstract

Sargassum seaweed clumps together, floats, and can stretch over large areas of the Caribbean. These clumps of seaweed can make landfall and lead to large mats of seaweed piling up very quickly over long stretches of beach. Once on land, the seaweed decays and exudes a distinct rotting smell which can be detrimental to tourism and quality of life in the area. The observed mass of Sargassum seaweed has grown noticeably since 2011 and doesn't seem to be slowing down. The Sargassum has many oxygen-filled pneumatocysts, so it floats on the ocean surface. Given this information, we assumed in this project that the Sargassum's dynamics will be closely related to that of the surface currents themselves. Surface current data from High Frequency Radar (HFR) measurements along the south coast of Puerto Rico were used to produce animations of surface drift which revealed the general flow in the region. The surface current measurements from HFR were compared against NOAA's AMSEAS model to assess the model's ability to estimate the flow in the region. The HFR and model animations were examined over hourly, daily, and monthly time intervals. The model seems to predict faster currents than those measured by the HFR. The model estimates and the HFR measurements seem to agree much of the time, however, there are some time periods where the model would not help with the tracking of the floating particles. This research revealed that the movement of the surface particles are typically westward close to the southern shore of Puerto Rico during most of the time periods covered in our study. Sometimes a rapid change in this behavior was observed, where surface particles moved directly towards the southern shore of Puerto Rico, or toward the east.

Observations

Topic	Dates Covered	Additional Information
HFR Coverage Totals	12/01/2018 – 03/31/2019	Daily and monthly averages
Vector Plots:	12/01/2018 – 03/31/2019	
AMSEAS	12/01/2018 – 03/31/2019	Daily, monthly and 3rd grid pt option averages
HFR	12/01/2018 – 03/31/2019	Daily and monthly averages
AMSEAS_animations:	03/15/18 – 03/17/19	Short range plot, 2-day cov
	03/25/19 – 03/26/19	Long range, 1 day cov
	03/27/19 – 03/29/19	Long range, 2 day cov
	03/28/19	Short range, 1 day cov
	03/29/19 – 04/01/19	Long range, 3 day cov
	04/01/03 – 04/03/19	Long range, 2 day cov
	04/02/19 – 04/03/19	Long range, 1 day cov
HFR_animations:	03/15/19 – 03/17/19	Short range, 2 day cov

Figure 1: Inventory of created images and animations. All were created in MATLAB using user-defined functions which interpret the data from the HFR and AMSEAS model. Some animations span a period of one day, some span a period of two days, and some span a period of three days. We found that the one or two day span fit the study best, because if the HFR data has any holes, the drifter animation will stall on that section, and produce a sub-par drifter animation.

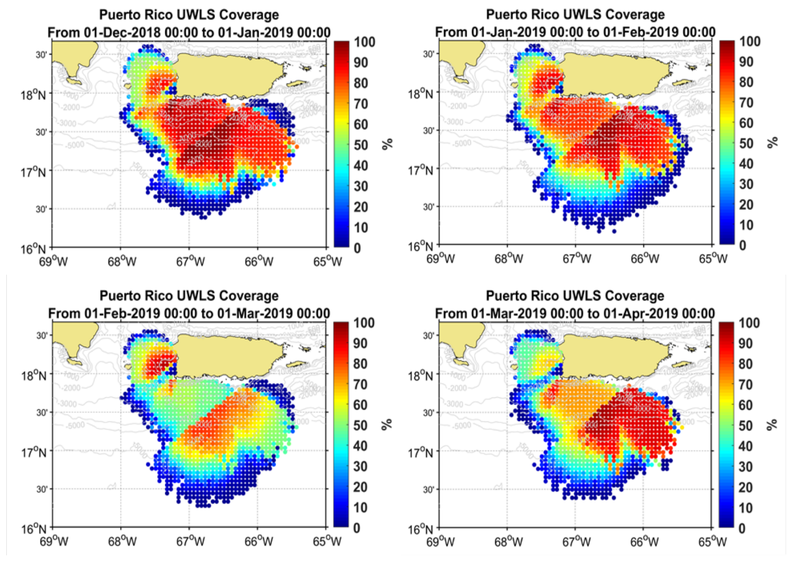

Figure 2: Monthly averages of HF Radar coverage from December 01, 2018 to April 01, 2019. Red denoting good coverage and blue denoting poor coverage.

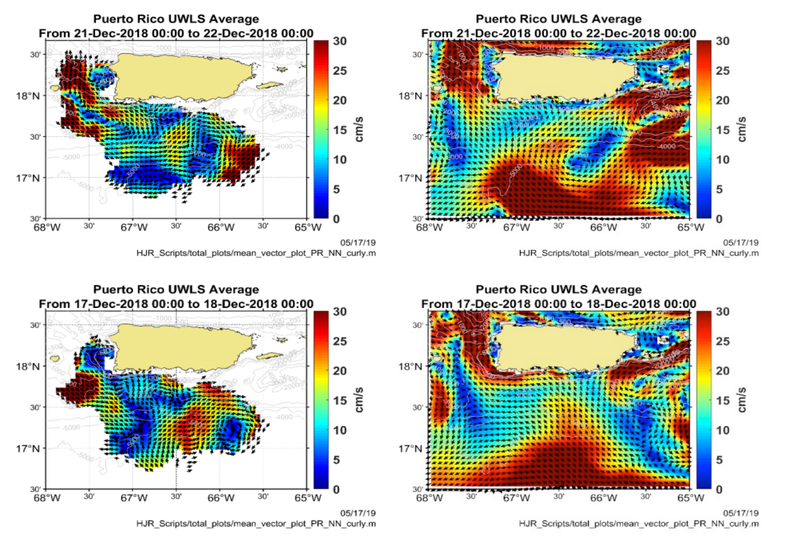

Figure 3: Top: Surface current daily average for 12/21/18 using HFR (left) and AMSEAS model (right). Bottom: Surface current daily average for 12/17/18 using HFR (left) and AMSEAS model (right).

The top row represents a date where the HFR surface current map and AMSEAS model are a good match. They have similar current directions, and although there are some differences in velocity between the two products, much of the map covered by HFR is in agreement with the AMSEAS model.

The bottom row represents a date where the HFR surface current maps and AMSEAS model are a poor match. A gyre mapped by the HF radar was not captured by the model, so the resulting current directions in the model are opposite the HF radar for much of the study area. The velocity profile of the map is in some agreement, but the current direction is still off.

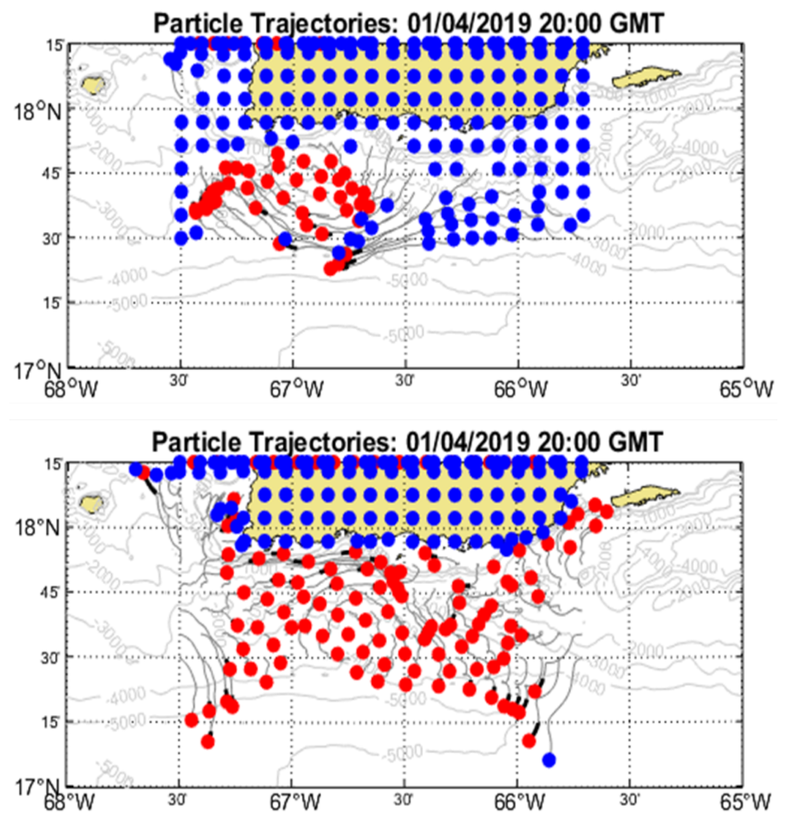

Figure 4: Top: HFR for 40-hour period beginning 00:00 on 01/03/19. Bottom: AMSEAS model for 40-hour period beginning 00:00 on 01/03/19. These are drifter models created in MATLAB using one of the dates of a good match between HFR and AMSEAS model, matched up using the coverage maps in figure 2.

Results

Grade	Grade Count	% of Count
A	49	40%
B	22	18%
C	14	12%
F	36	30%
Total	121	100%

Figure 5: Table showing the quality of coverage, per day, over the 121 day period (December 1, 2018 to March 31, 2019) summarized by the average coverage maps similar to Figure 1.

- A = Very good coverage. All radar stations seem to be producing data on the given day, and most of the study area is accounted for in the data.
- B = Good coverage. All radar stations producing data, with perhaps some slight gaps in the study area, still get a good idea of the dynamics.
- C = Fair coverage. One station might not be functioning on the given day, or limited that day, but we can still see the convention of the current velocities, although it is over a limited area.
- F = Poor coverage period, unable to compare AMSEAS model to the HFR data because not enough HFR stations are functional on the given day.

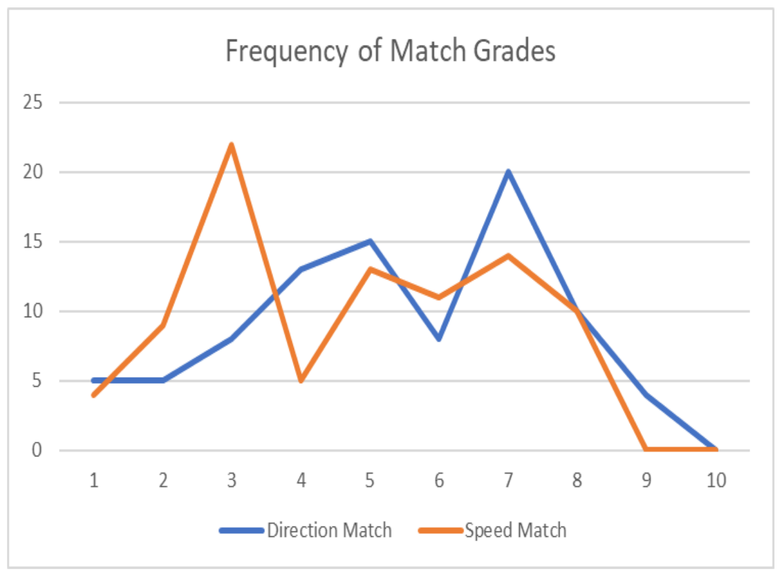

Figure 6: Line chart showing the quality of match grades of the "A", "B" and "C" days of data listed above. Only days with at least a C grade were considered in match grade assigning. Each day of legible coverage was assigned two variables of coverage analysis between HFR and AMSEAS images on the particular day (1 is poor match, 10 is good match):

1. Direction grade (1-10): How well the current vectors in the model follow similar directions of HFR
2. Speed grade (1-10): How well the speed magnitude matches.

Conclusion

The HFR data was at least "Good" 58% of the time over the study period, so we were able to analyze a good amount of AMSEAS comparisons. The vector comparisons showed many days with good matches, as well as some poor matches, but the model was in reasonable agreement with the actual dynamic observed by the HF radar more than 50% of the time.

The HFR surface current data was used to evaluate the AMSEAS model in this study. The AMSEAS model consistently yields faster current velocity magnitudes than that of the HFR surface current data. This is true for both the surface current average maps and the virtual drifters.

Acknowledgements

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