Development and Implementation of *Sargassum* Early Advisory System (SEAS): An Investigation of the Loop System, Warm Water Eddies, Currents and Energy that Create Sargassum Locomotion.

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Abstract

Sargassum Early Advisory System (SEAS) of Texas A&M University at Galveston has compiled data that supports the existence of a loop system that flows from the Sargasso Sea, down into the Caribbean Sea, up into the Gulf of Mexico and then if not beached the sargassum will return again to the Sargasso Sea. Using The United States Geological Survey's (USGS) Landsat imagery a large footprint of the ocean is now being monitored for sargassum. SEAS also uses tools such as National Oceanic and Atmospheric Administration (NOAA) and Atlantic Oceanographic and Meteorological Laboratory (AOML) Kriged Drifters, weather buoys and beach cameras to increase the accuracy and reliability of the predictive model. By working along with local schools and beach managers, SEAS aims to create a community that learns to value and efficiently use sargassum.

Methods

SEAS uses many oceanographic techniques to deliver accurate predictions of the time, location and severity of sargassum landings. The SEAS predictive model is 90% accurate, forecasting sargassum's arrival two weeks out. The primary means of tracking the large sargassum mats is through USGS's Landsat imagery. These USGS satellite images are used to seek out signs of sargassum moving through the system. Between the researchers, the responsibility for eighty-one separate 31,820 square-kilometer images has been divided. The surveillance of these areas provides the system with a nearly foolproof net with which to catch the sargassum moving through the loop system. Weather buoys and beach cameras are also used for accurate monitoring of current weather conditions and confirmation of sargassum landings.

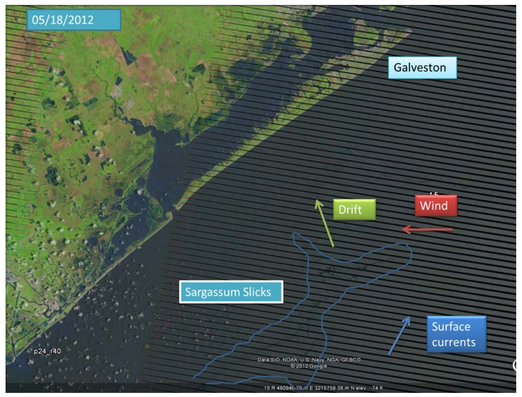

Fig. 1 Sargassum 05/18/2012, USGS, Galveston, path 25 Row 40

Langmuir Circulation

Langmuir circulation and transportation acts upon the sargassum. A combination of Stokes Drift and wind driven shear current, Langmuir Circulation blows across the surface of the water and creates cells of alternating upwelling and downwelling forming parallel areas of convergence and divergence. There is evidence that sargassum uses the shear flow created by the wind and is forced into this flow by the destabilized vortices on either side.

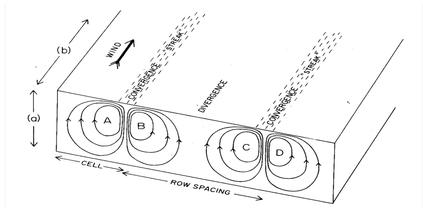

Fig. 2 Langmuir Circulation, Penn State Biol. 435, via www.powershow.com

Kriged Drifter Data

NOAA and AOML's historical databases of Kriged Drifter Data were accessed and used to increase the accuracy of the predictive model and add to the evidence in support of the existence of the loop system. These drifters have the capability to measure GPS position, water temperature and both horizontal and vertical velocity up to four times a day.

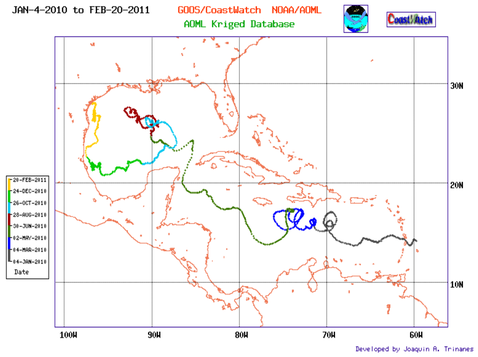

Fig. 3 Kriged Drifter Map NOAA, AOML

Landsat Imagery

The SEAS team has developed effective yet simple methods for spotting and correctly identifying sargassum through the use of USGS Landsat Imagery. Slicks appear as dark dendritic veins, through the water. The SEAS model uses set and drift to measure cross currents, whether that is the wind or oceanic current. These forces are averaged to find a mean drift which dictates the probable landing location and time frame.

Loop System and the Azores

The SEAS research team has uncovered and compiled evidence suggesting the existence of the loop system and that it is both wind shear and ocean current driven. This loop begins at the Sargasso Sea and is triggered by the Azores High Pressure System that oscillates between the West coast of Africa and the East coast of North America. The pressure change forces sargassum down into the Caribbean Islands where it is swept up in the Caribbean current and into the Gulf of Mexico. Here it can be torn off into tourbillions referred to as warm water eddies. These eddies are either taken back up by the Gulf Stream or spin until they run out of energy and break up, releasing the sargassum and debris that was trapped within them. If the sargassum was taken up by the Gulf Stream, it travels swiftly up the coast of Florida and the east coast of the US, where it is pushed back into the Sargasso Sea by the sub-tropical currents of the North Atlantic Gyre

Sargassumn

Sargassum is a Brown Macro Algae in the class Phaeophyceae. It is free floating having no holdfasts, depending on its gas-filled pneumatocysts to float in the first few feet of the water column.

Fig. 4 Sargassum Natans, http://en.wikipedia.org/wiki/Sargassum

Environmental Importance

Sargassum is a critical component in a multitude of environments. While floating, it forms a mid-ocean oasis serving as a refuge for sea turtles and as a fish nursery. When approaching the land, coastal birds feed off of the organisms that live within the large mats. Even while it decomposes on the beach sargassum becomes an important factor in slowing beach erosion as well as providing vital nutrients to the halophytic dune grasses and other beach plant life.

Fig. 5 loggerhead hatchlings in sargassum, http://sandiegoseaturtles.blogspot.com/2010_06_01_archive.html

Results

The research supports the existence of a loop system in the Gulf of Mexico, Atlantic Ocean and Caribbean Sea as well as explaining the historically cyclical fashion in which sargassum episodes tend to occur. Oceanic currents in the Gulf, Caribbean and parts of the Atlantic Ocean drive the sargassum to and from its home in the Sargasso Sea. The other gaps in the system are filled in by wind shear driven Langmuir cells and warm water eddies. Through drifters, satellite imagery and ground-truthing the system has been tied together and supported by multiple mediums.

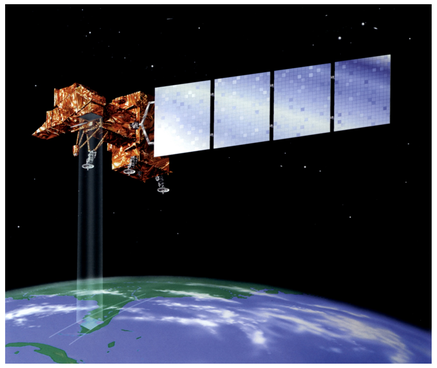

Fig. 6 USGS Landsat, http://landsat.usgs.gov/

Conclusion

The SEAS team has focused a large part of its energy and resources on getting USGS's Landsat information out to the public whether that would be a school or beach managers. High schools were specifically targeted as a way to reach out to the public. Students were invited to TAMUG's computer laboratories and trained on the processes of analyzing Landsat images. In every instance, the SEAS team was successful in training the students. Beach managers are also a target audience for the SEAS Team. They too picked up the how to use SEAS fairly easily. It has become as easy as checking the weather for these individuals and now plays a pivotal role in their decision making when it comes to beach management practices.

The SEAS Team also presented at NASA's 2013 Gulf Of Mexico Initiative, Research Opportunities in Space and Earth Sciences (ROSES) Workshop. The Team was a featured presenter and touted as the prime example of how to take scientific data and make it applicable to the "end users" .

Literature cited and Acknowldgements

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