

The North Atlantic Subtropical Surface Salinity Maximum as Observed by Aquarius

Frederick Bingham (1), Julius Busecke, Arnold Gordon, Claudia Giulivi (2) and Zhijin Li (3)
 (1) Center for Marine Science, University of North Carolina Wilmington, binghamf@uncw.edu, (2) LDEO, Columbia Univ., (3) NASA/JPL

Abstract

The subtropical surface salinity maximum (SSS-max) in the North Atlantic was studied as part of the SPURS (Salinity Processes in the Upper Ocean Regional Study) experiment in 2012-2013. This poster documents the structure and variability of the SSS-max using Aquarius data during the two-year period August 2011 – September 2013. The Aquarius data show the seasonal migration and freshening of the SSS-max in good agreement with previous observations. The extent of the SSS-max has a surprisingly large amount of interannual variability. It has fluctuated in size during the course of the Aquarius era by about 27%. There has also been a general freshening of the area where the SSS-max is located, larger than any expected seasonal changes. The seasonal variability of sea surface salinity is documented. The salinity of the SSS-max itself shows almost no seasonal variability, whereas to the north and south of it there is a well-defined seasonal cycle. This highlights the important role played by Ekman transport in the formation of the SSS-max.

Introduction

The SPURS (Salinity Processes in the Upper ocean Regional Study) experiment seeks to understand the dynamics of the sea surface salinity maximum (SSS-max) in the North Atlantic ocean.

The SSS-max has been sparsely observed in the past, relying on observations that are coarse in space and time, so we have little knowledge of its structure or variability.

Figure 1. The North Atlantic SSS-max and the SPURS study region. Color is SSS from Aquarius (spurs.jpl.nasa.gov).

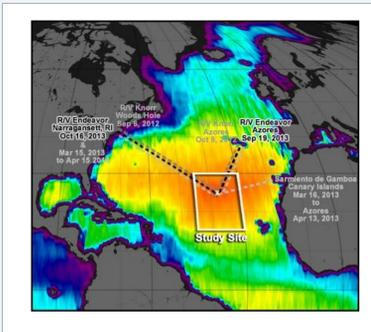
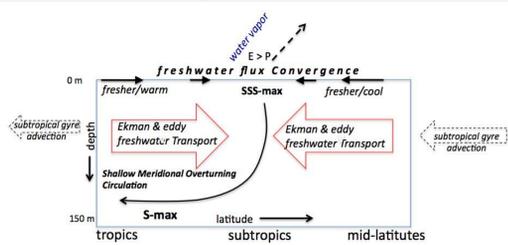


Figure 2. Schematic picture of formation of the SSS-max (Gordon and Giulivi, 2013).



Data and Methods

Aquarius data: Level 2 non-CAP, V.2.5.1, 10°N-35°N. Along-track passes were averaged into 0.5° latitude bins and put into repeat orbits to form time series at "nodes" (Fig. 3).

Time series at nodes were used to do a fit to an annual harmonic to get amplitude and phase

Results

Figure 3. Ground paths of the Aquarius satellite tracks used in this study (slanted black lines). There are 4 ascending (southeast-northwest) and 4 descending (northeast-southwest) tracks, each with 3 beams for a total of 24 lines. The SPURS region (15-30°N, 30-45°W; Fig. 1) is outlined as a black rectangle. Colored symbols indicate mean salinity over the length of the Aquarius mission for each particular node. Black symbols are the mean location of the maximum salinity for a particular track and beam. Note, the colored symbols are about 1/2 the size of the typical Aquarius footprint.

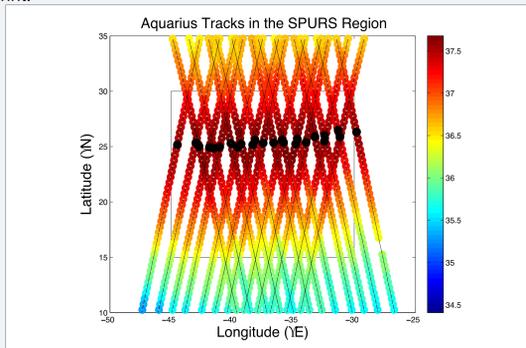


Figure 4. Average salinity as a function of latitude. Curves are color-coded by month, with the code shown in text at the bottom of the figure. a) Aquarius data. b) Volunteer observing ship data.

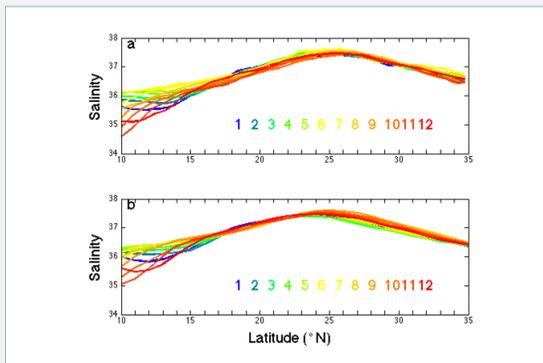
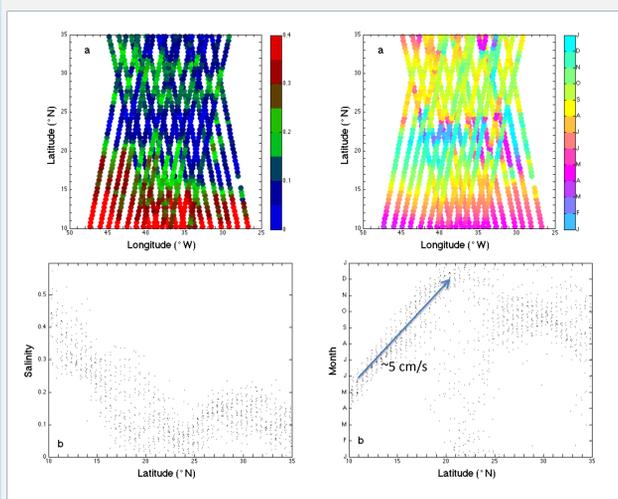


Figure 5. Amplitude (left column) and phase (right column) of the seasonal harmonic of SSS in the SPURS region. Top panels present amplitude and phase as a function of latitude and longitude with color scale at right. Bottom panels present a scatter plot of amplitude and phase as a function of latitude with one dot for each node. Phase value indicates month of maximum in SSS.

The SSS-max is at a location of minimum in seasonal amplitude. Larger amplitudes are seen in the ITCZ (10-12°N) and 26-30°N.



Results

Figure 6. Mean (1993-2012) surface velocity from OSCAR. Color indicates speed with scale at right in m/s. Overlain arrows show direction and speed with scale at bottom. This figure was produced on the OSCAR website (www.oscar.noaa.gov).

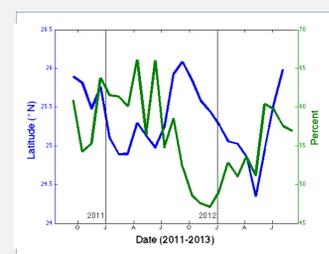
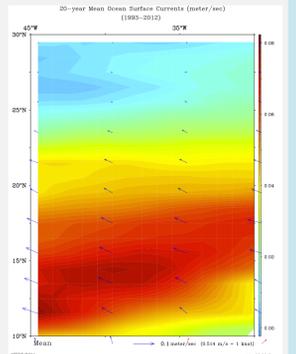
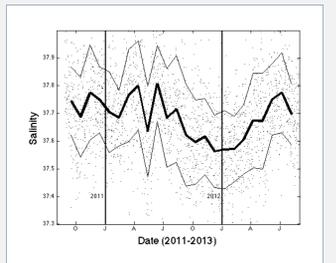


Figure 7. (Blue curve and left axis) Latitude of SSS maximum as a function of date, averaged over all Aquarius tracks and beams in Fig. 4. (Green curve and right axis) Percent of nodes with SSS > 37 in the Aquarius data 15-35°N. Values are monthly averages for both curves.

Figure 8. Along-track maximum salinity. Dots are individual passes. Heavy curves is monthly average. Light curves are standard deviation.



A freshening occurred in late 2012 and early 2013, indicating previously unobserved large scale changes in the SSS-max.

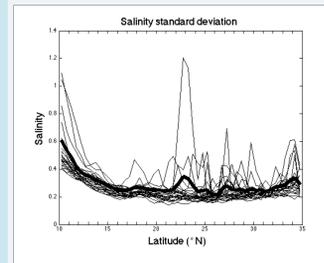
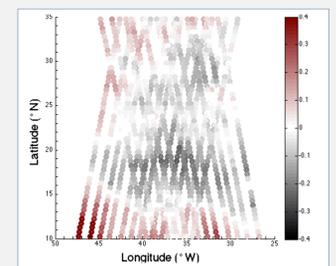


Figure 9. Standard deviation of salinity as a function of latitude for all Aquarius tracks in the SPURS region. Light curves are from individual tracks and beams. Heavy curve is standard deviation of all tracks and beams put together.

The SSS-max, while having low variability overall relative to areas around it, does often have very large deviations from the mean.

Figure 10. Linear trend of SSS from Aquarius data in the SPURS region. Color code at right indicates the slope of the salinity-time curve in pss/year.



SSS has been decreasing over most of the SPURS region since Aquarius went into orbit.

Acknowledgments

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