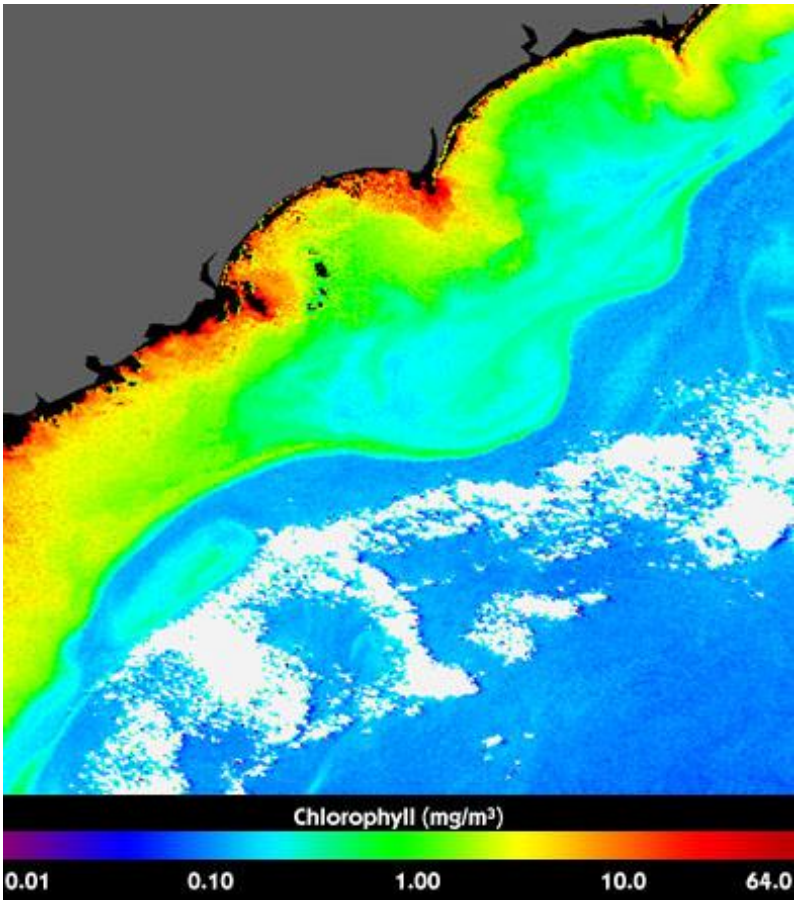
SCIENCE FOCUS: THE CHARLESTON BUMP

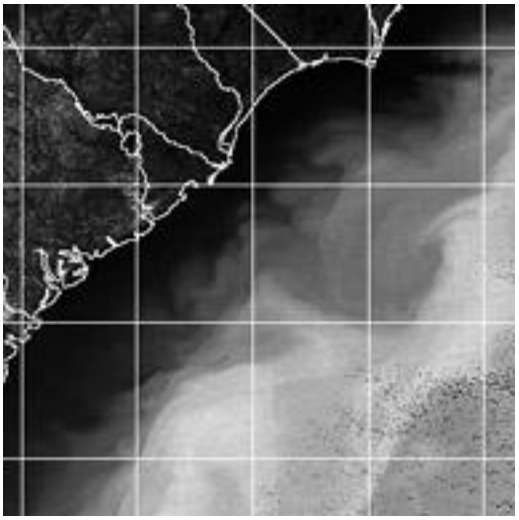
Charleston Bump - Making Waves in the Gulf Stream

If you use a World Wide Web search engine to search for the phrase "Charleston Bump", most of the hits are likely to be about a country-western line dance! Interspersed among the dance steps, however, there will be occasional references to an area located off the southeastern coast of the United States where the sea floor is elevated, east of Charleston, South Carolina and Cape Romain. This area is what most oceanographers and marine geologists are referring to when they talk about the "Charleston Bump".

On April 25, 1998, the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) instrument obtained a nearly cloud-free image of the entire U.S. East Coast. This image shows chlorophyll concentrations in the ocean waters off the shoreline of South Carolina. Both the flow of the Gulf Stream and the related communities of marine phytoplankton are affected by the Charleston Bump.

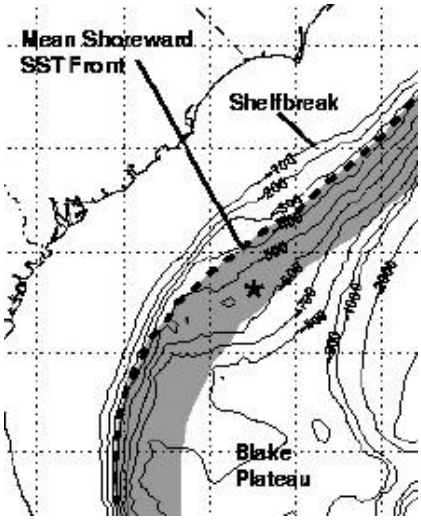


The Charleston Bump is only a small feature on bathymetric maps, but it exerts a strong influence on the Gulf Stream, one of the ocean's most familiar currents. The Gulf Stream parallels the coast as it flows smoothly northward from Florida and the Bahamas, with hardly a churn or ripple visible. SST images show the path of the Gulf Stream on the surface of the ocean, it should be remembered that ocean currents are three-dimensional, and thus they can influence, and be influenced by, the topography of the sea floor. A map of the region of the Charleston Bump is shown at left, and a grayscale sea surface temperature image at right. The image was acquired March 4, 1999.



Warm Gulf Stream waters head virtually straight north from the passage between West Palm Beach and Grand Bahama Island. Just after the current begins bending to the east, following the curve of the continental shelf, it runs directly over the Charleston Bump. The strength of the current has scoured the sea bottom in this area, which provides highly reflective areas in GLORIA side-scan sonar data obtained by the United States Geological Survey. The Charleston Bump can be seen in mosaic 18 of this data, which is shown at the end ofthis article. it is the small bright area at top center.)

As the name implies, the Charleston Bump isn't a gigantic undersea mountain jutting abruptly from the ocean bottom. The bathymetric map here shows that it is a fairly small feature, located with the (*) on the map. (A larger version of this image appears at the end of the article.) Note the confluence of the Ashley, Cooper, and Wando Rivers into Charleston Harbor in the SeaWiFS color image. The arrow designating the location of the Charleston Bump in the small color image is positioned slightly too far south. Even with detailed bathymetry, it's not easy to locate! A larger version of this image is also included at the end of the article.



When the Gulf Stream interacts with the Charleston Bump, the powerful current is suddenly disrupted. The direction of the flow deflects further eastward and immense oscillations are generated, appearing like waves that roll northward toward Cape Hatteras. At the same time, a reverse circulation forms in the trough of the first wave, forming a circulatory feature called the Charleston Gyre. This circulation is somewhat like the dangerous traps that form beneath waterfalls and "holes" in the rapids of a river. Most of the water continues to flow down the river channel, but the reverse circulation just behind the falls can trap driftwood and unskilled kayakers.

The Charleston Gyre was observed in ocean color imagery obtained on October 28, 1979, near the end of the first year of the Coastal Zone Color Scanner (CZCS) mission. Dr. Charles McClain and Dr. Larry Atkinson described observations of the Gyre that were correlated with measurements made from a surface research ship. The scientists observed elevated phytoplankton pigment concentrations within the Gyre, indicating that this feature induced upwelling, bringing nutrients to the surface and augmenting phytoplankton growth. They discussed their observations in the paper "**A note on the Charleston Gyre**", published in the *Journal of Geophysical Research* (Volume 90, Number C6, pages 11,857-11,861).

SeaWiFS obtained another clear view of the region on May 15, 1998. The true-color image on this page shows the appearance of land and near the southeastern coast of the United States. Note the strong contrast between the dark inshore waters (due to light absorption by organic material and chlorophyll) and the lighter blue of the Atlantic. The Charleston Gyre is the dark oval almost directly south of Cape Fear, the southernmost sharp point on the Carolina Coast. Cape Lookout, southern point of the Outer Banks, is also prominent in this image, and Charleston is approximately due west of the Charleston Gyre. The waves that are created by the interaction of the Charleston Bump and the Gulf Stream can also be seen downstream of the Charleston Gyre.

In the early 2000s, the Charleston Bump received a lot of attention due to the amount of fishing that takes place in the region. A moratorium was placed on catches of certain fish (notably swordfish), which had an economic impact. Interest in the oceanic circulation in the Bump region generated more research, as the currents are responsible for fish-related effects, particularly the transport and export of larval fish), and the upwelling in Gulf Stream meanders is responsible for a significant fraction of the nutrients used in primary production.

Additional Information

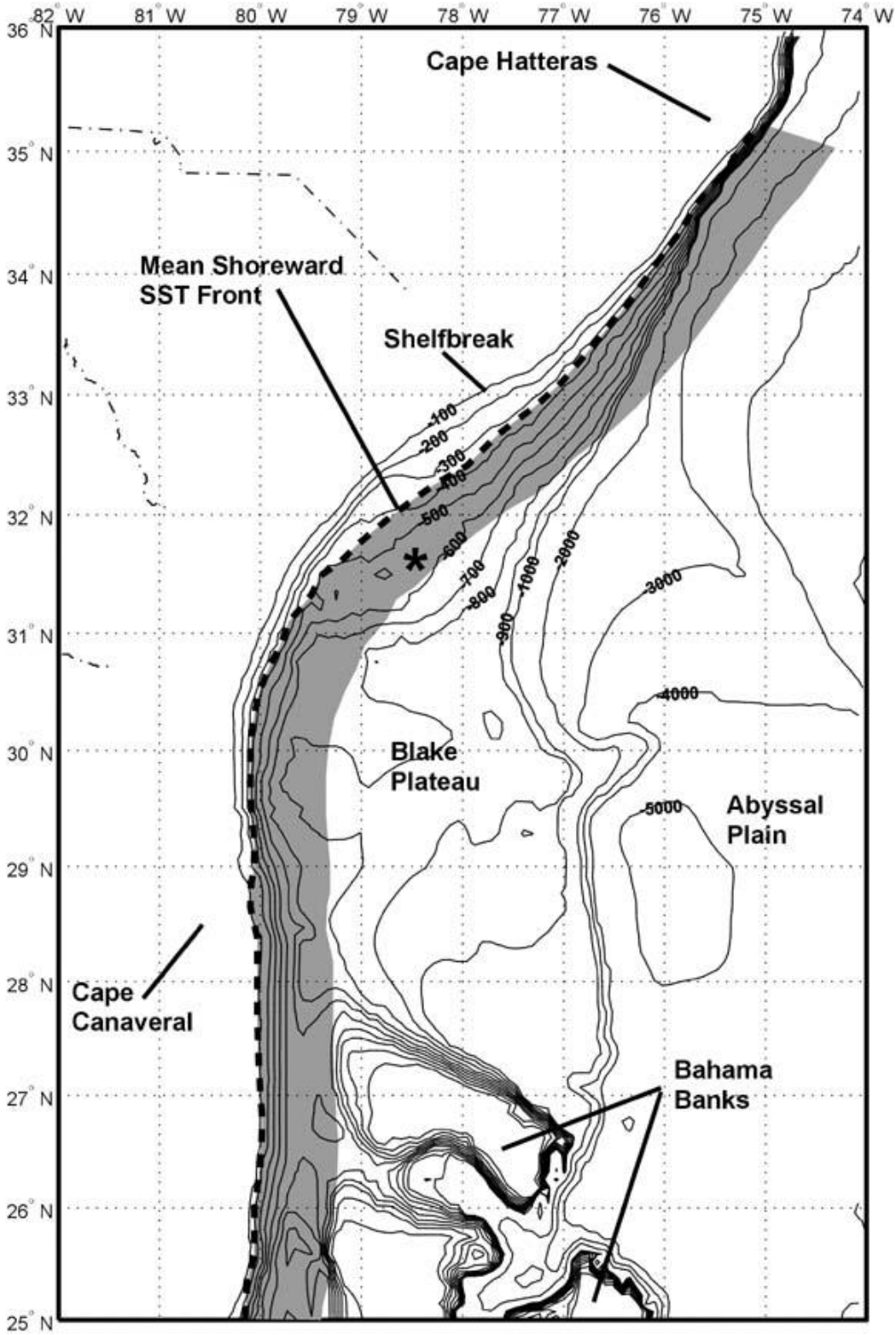
NOAA: A profile of the Charleston Bump

NOAA: Geology of the Charleston Bump

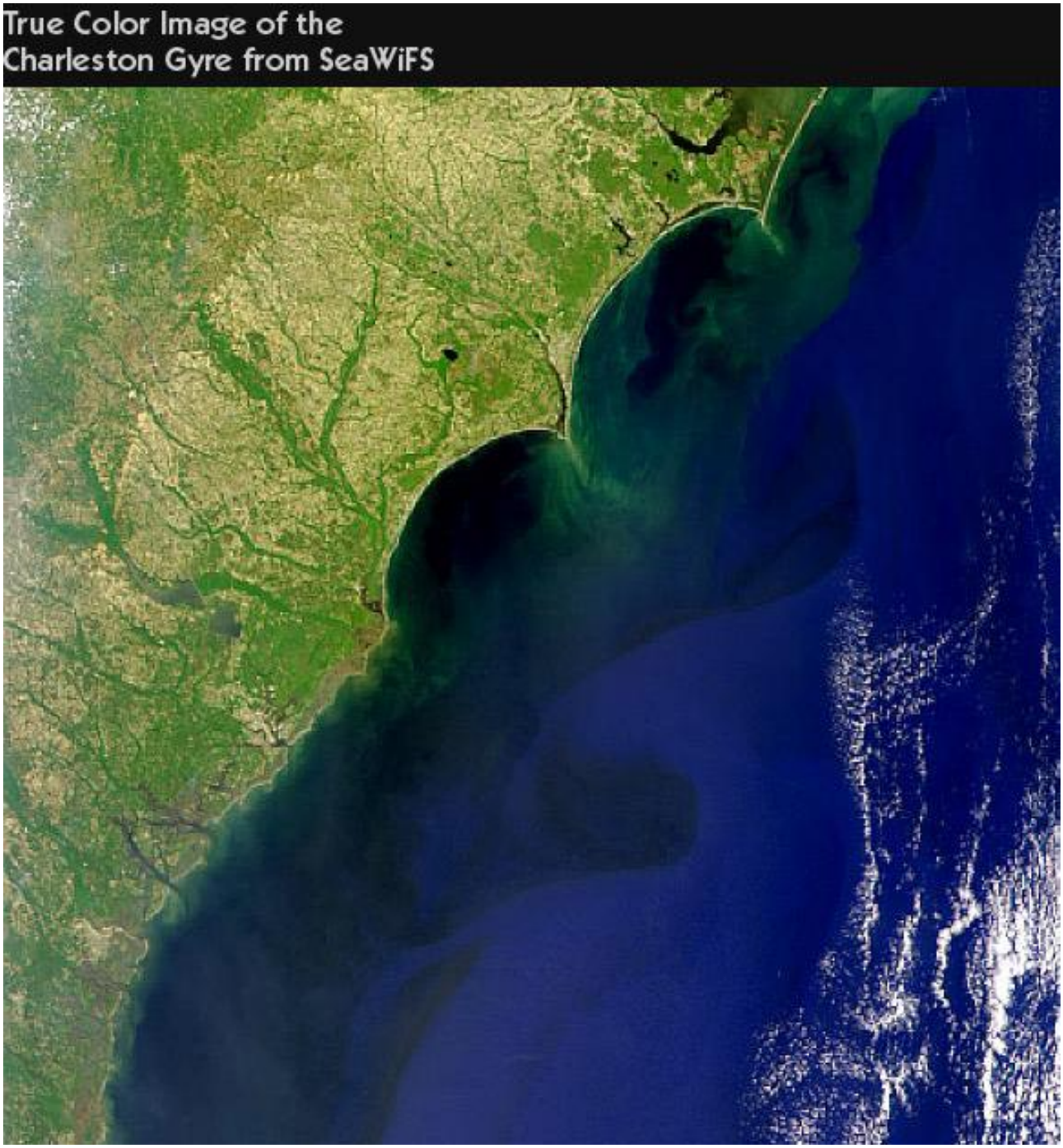
NOAA: The Charleston Bump – A Deep Reef 'Island' in the Gulf Stream

ACKNOWLEDGMENT
SeaWiFS images produced by Norman Kuring, SeaWiFS Project, NASA GSFC & James Acker, Raytheon ITSS. Page design by Robert Simmon, Research and Professional Services. Accompanying text by James Acker, Raytheon ITSS. Bathymetric map of the Charleston Bump provided by Dr. John Bane, Department of Marine Sciences, University of North Carolina at Chapel Hill.

Bathymetry of the northern Florida and Carolinas continental shelf



SeaWiFS image acquired May 15, 1998.



United States Geological Survey GLORIA side-scan sonar survey Mosaic 18.
The Charleston Bump is indicated with the white arrow.