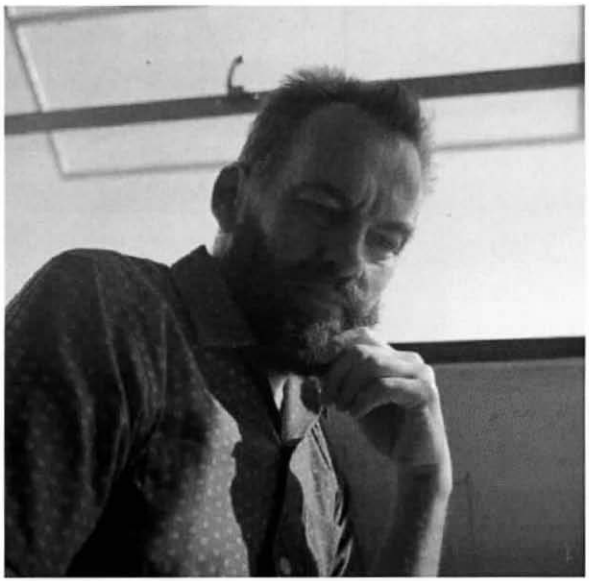
The Art, Music and Oceanography of Fritz Fuglister

by Jennifer Stone Gaines and Anne D. Halpin

When Fritz Fuglister graduated from high school in 1927, his goals in life were to become an artist and a musician. His parents, however, both immigrants from Switzerland, assumed he would immediately seek a job to help with family finances. Fritz took a night job as an elevator operator and watchman while taking day classes at the Corcoran Gallery of Art in Washington, D. C., for two years, and continuing lessons on the violin and the cello. He received a diploma from the Corcoran two years later, and sped off on a motorcycle to the artists' mecca of Provincetown, Massachusetts.



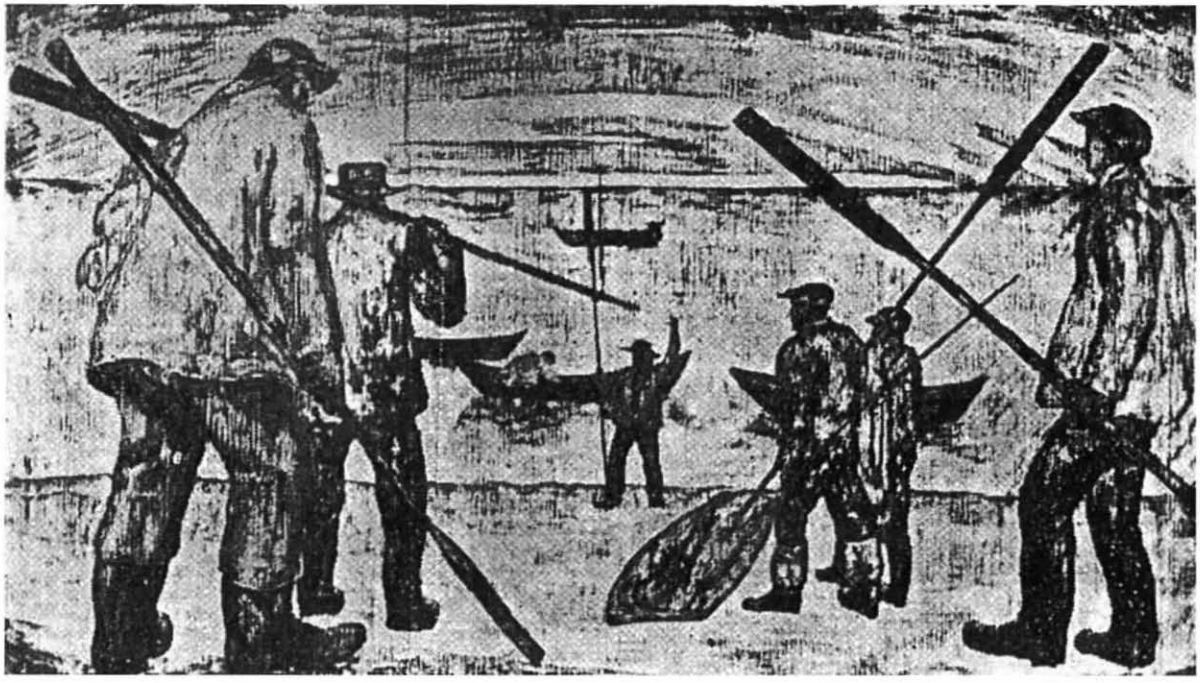
Fritz Fuglister. Photo by Jan Hahn. Courtesy of Woods Hole Oceanographic Institution Archives.

At the end of the summer, Fritz returned to Washington where he joined artist friends in running a low budget gallery and club where they painted murals and exhibited other work. Drawn back to Provincetown in 1931, Fritz took classes with E. Ambrose Webster. Fellow students and friends in the vibrant and creative community included noted artists Phil Malicoat, Kenneth Stubbs, Bruce McKain and George Yates.

He was recalled to Washington in 1932 when his mother became very ill. Yet he was irrepressibly pulled back to Provincetown in 1935. Friends loaned him a shack in the dunes, which he prepared for the winter by covering it with tar paper and bringing in a little wood stove. Through that cold winter he spent long hours painting and playing the violin.

In the years of the Great Depression, the government formed the Works Progress Administration. Part of its mission was to employ artists through funding murals in public spaces. In 1933 Fritz won the competition for painting a large mural on two walls of a school auditorium in Washington, D.C. In 1937 he won the contract for the Falmouth Police Station, so he moved to Falmouth to work on the mural. While here, he frequented the Falmouth Public Library and met the reference librarian, Cecelia Bowerman, whose family roots had gone back to the 1680s in West Falmouth. What turned out to be their first date was an evening of chamber music at a friend's home in which Cecelia played the violin and to which Fritz invited himself, bringing his violin. They married in the autumn of 1939.

While Fritz was working in Brockton at the public library on a mural illustrating the history of printing (which not only still exists, but also has recently been restored), a Woods Hole friend stopped by and tried to persuade Fritz to help him on a short three-week



Dorymen embarking on a voyage. Part of a mural painted by Fritz Fuglister. Courtesy of Woods Hole Oceanographic Institution Archives.

oceanographic cruise. The voyage was on the Woods Hole Oceanographic Institution's research vessel *Atlantis* to Georges Bank, with no pay except for room and board. Since there was a pause in work on the mural while a new surface area was prepared, it was an opportune moment, and Fritz agreed to join. Months later, he was asked to go along on a cruise for an actual job with pay. By then, the Brockton mural was finished, and his proposal for a mural in New Bedford was rejected, so he agreed to go to sea.

Thus began Fritz Fuglister's long and productive career in the burgeoning science of oceanography. He initially became an expert as a technician of the BT, the bathythermograph, a relatively new instrument which recorded temperatures at different depths in the sea. More importantly, he became intrigued with the data collected and their interpretation. This topic was very important to the war effort, as underwater sound was greatly influenced by changes in water temperature. Submarines could even hide under a layer of warm water; BTs could detect and define warm layers in the water column. During the war years, the Navy deemed conditions on the Atlantic too dangerous for any ship except Navy vessels to collect samples. Fritz trained the seamen in handling the BT then returned to his desk in Woods Hole to work on the already accumulated data, transcribing and merging the information from many individual trips. He was charged by WHOI's director Columbus Iselin to devise a way to get the complex bathythermograph data onto charts. Under Fuglister's hands, the data emerged into a comprehensible and visible whole.

Much of the data had been collected along the Gulf Stream, that "river of warm water in the ocean." As Fritz studied the data he began to see aspects of that Gulf Stream that others had not noticed. This was the beginning of his life's work, the pioneering study of the Gulf Stream. By organizing multi-ship surveys in which a large area of the Gulf Stream could be observed at one time, he was able to further his descriptions and analysis of the Gulf Stream as a fast meandering current with eddies forming at its edges. Another colleague said, "He has brought his artist's eye to this study." Altogether, Fritz spent the equivalent of three full years at sea, conducting 52 cruises.

During the course of these studies Fuglister devised several implements and methods to ease the interpretation of the data. One was called "The Harp," an implement to standardize BTs. Another was the sonar refraction slide rule.

During the late 1950s he left his study of the Gulf Stream to work on the International Geophysical Year, collecting data from both the North and South Atlantic. The results of this study were published in a large volume titled *Atlantic Ocean Atlas.* He quickly returned to his own studies, though he was distracted during 1962-1967, when he served as head of WHOI's new physical oceanography department.

Painting by Fritz Fuglister. My Violin: Acquired in 1920 from Prof. Christiani. Washington D.C. Former History unknown." Courtesy of Woods Hole Oceanographic Institution Archives.

Throughout his life Fritz continued his painting and his music. Both he and his wife Cecelia played in Cape-wide orchestras. Over the decades Fritz and Cecelia hosted many musical evenings at their home in Woods Hole joining with friends to play chamber music. William Simmons of Falmouth, a scientist and fellow musician, said, "Fritz's main instruments were violin and piano, although, if pressed, he could also play the viola and cello quite credibly. His main interest by far was chamber music, from trios to octets but with special emphasis on string quartets. Although he performed in most of Falmouth's orchestras, usually as concertmaster, he preferred to play informally at home with friends, reading and playing the music in real time without benefit of prior preparation or practice."

Of his artistic career, Dr. Simmons said, "Fritz's art was extremely varied. He did portraits and landscapes, several complex themed murals in public buildings, and used most of the modern techniques of impressionism, pointillism, and cubism. He ended with a fairly abstract phase in which his paintings

were basically irregularly shaped and irregularly sized patches of color."

"In his later years, he championed the idea of non-rectangular art," said Dr. Simmons. "Many of his later works have five to eight sides of unequal length. When asked about it, he liked to quip that his miter box was old and a little out of line when, in fact, he regarded his frames as part of his art and worked very hard to get them just right."

When the children were young, the Fuglister family took one long visit every summer to Provincetown, where the whole family was introduced to that artistic community, replete with friends and good humor. Fritz was able to keep in touch with artistic movements, experimenting there and back in Woods Hole. His paintings hung in his office and home and those of his friends.

Fritz Fuglister's Oceanography

by Philip L. Richardson, Oceanographer Emeritus, Woods Hole Oceanographic Institution

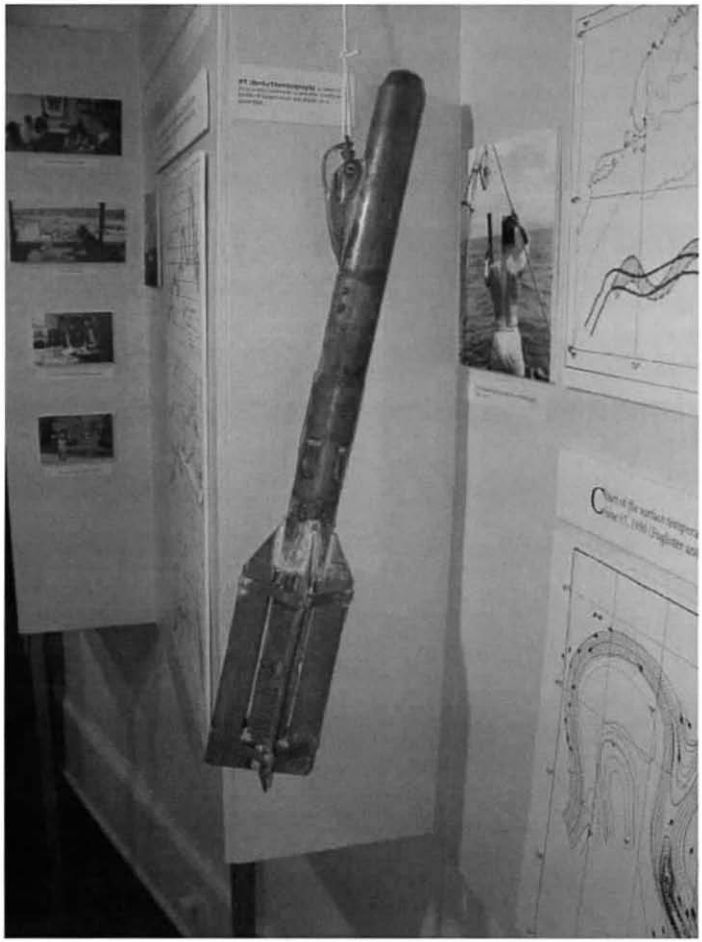
The Fuglister exhibit at the Woods Hole Historical Museum celebrated the art, music and oceanography of Fritz Fuglister. In his biographical sketch of Fritz, published in the special Fuglister issue of *Deep-Sea Research,* Henry Stommel linked two of these strands, art and science:

"...[T]he beauty of this tale is that Fritz never did abandon Art [when he joined WHOI in 1941], and that his work on the Gulf Stream has really been his most distinguished painting. He has brought to the problem of depicting the Gulf Stream all the techniques of the painter. He has pitched his easel on the deck of a ship, he has used a chart for a canvas, and temperature for a pigment. He has used his artist's inner eye to isolate the essential Form from the confusing mass of detailed data, he has used skill as a draughtsman to reduce this vision to the palpable representation of a drawing. And he has painted this picture of the Gulf Stream not once, but many times, each time trying to see some other aspect of the elusive Truth. It has involved him in 52 cruises totaling about three years at sea, a lifetime of patient effort and questioning, in imaginative forays, and in submission to the discipline of a stern self-imposed intellectual honesty."

Fritz entered a new phase that combined his abstract period with his earlier interest in realism and form. William Simmons, *Spritsail* Vol. 7 No. 2, p. 15. Courtesy of Woods Hole Oceanographic Institution Archives.

In 1966, as a new graduate student in oceanography at the University of Rhode Island, I began working with John Knauss off Cape Hatteras, North Carolina,

studying the structure and flow of the Gulf Stream, a major ocean current system (actually a gyre system) that spans the North Atlantic Ocean. I quickly discovered Stommel's book on the Gulf Stream and learned about Fritz Fuglister's work and his papers. We invited Fritz to give a seminar at URI so we could hear about his newest results. The first ten years of my research overlapped with the last ten years of Fritz's research. During that period, I chatted with him many times, especially after I came to Woods Hole in 1974, and I learned a lot from him about the Stream and its eddies.



A brass torpedo-shaped probe officially known as the bathythermograph or "BT." Courtesy of Woods Hole Oceanographic Institution Archives.

After the war, Fritz started using the BT and precise electronic navigation (Loran) to explore details of the Gulf Stream for the first time. The BT was cheap, fast, and usable in fairly bad weather and while the ship was underway. Loran, which had been developed during the war, provided sufficiently accurate and continuous navigation. Fritz used these tools to measure and portray the finer structure of the Gulf Stream in increasing complexity—the twists and turns of the current, its narrowness and intensity, the puzzle of eddies and meanders—and to determine how these evolved with time. The vessels he used, some of which were sailboats, were so slow that Fritz evolved an innovative zig-zag search pattern moving downstream with the current since the ships could not have made much headway against the Stream.

Henry Stommel, a colleague of Fritz's at the Oceanographic, was stimulated by Fritz's findings of the narrow, meandering Stream. He was intrigued by the disparity between the fast Stream in the west, such as off Cape Hatteras, and the sluggish eastern part of the North Atlantic gyre, such as off the coast of Europe. Stommel proposed that this pattern of ocean gyres, not only in the Atlantic but also in other oceans with strong western currents and weaker eastern limbs, could be simply related to global wind patterns and effects of the Earth's rotation. Stommel's 1948 paper on this subject became a classic and is one of the most frequently cited papers in modern physical oceanography. Fritz told me that Stommel came up with the idea after listening to

one of Fritz's seminars about his BT-Loran mapping of the Stream.

In 1950, Fritz led a six-ship, Canadian-American effort, called Operation Cabot, to map the Gulf Stream for a period of three weeks between Cape Hatteras and Nova Scotia. The BT temperature data and Loran positioning were supplemented with a new geomagnetic technology (the GEK) for measuring surface currents. Hydrographic profiles of temperature and salinity were made, sampling water in bottles on a lowered wire to obtain subsurface data for calculating currents. Making hydrographic stations in the Gulf Stream was complicated by the very swift surface velocity and frequent strong winds. Ships had to rapidly "steam on the wire," motoring down current, in order to keep the wire vertical so water sampling bottles were at the correct depths.

These cruises revealed more details of the movements and evolution of the Gulf Stream. They showed, like rivers on land, the Gulf Stream meanders from side to side, except much more rapidly than rivers. They revealed, like rivers on land, that meanders develop to the extreme and pinch off "oxbows" in the ocean called "eddies", that would incorporate cold water from the north ("cold core eddies") or warm water from the south ("warm core eddies").

Thus, Gulf Steam rings were discovered, confirming that the large cyclonic eddies frequently found south of the Stream formed in this manner. Gulf Stream eddies were called "rings" because a ring of Gulf Stream water pinched off when the meander closed, differentiating them from other ocean eddies. In addition, the observations yielded maps of the temperature and surface currents of the Stream and of the meander pattern and its changes with time.

Fritz organized a second multi-ship survey of the Gulf Stream in 1960 called "Gulf Stream 60." As before, the ships mapped the currents, and another cold core ring was observed to detach from a southward meander. The really new information, however, was provided by neutrally buoyant submarine floats ("Swallow Floats") drifting with the current at depths of 6,000 to 12,000 feet under the surface Stream. The floats tended to drift in the same direction as the near-surface currents, indicating the Gulf Stream reached to the bottom of the ocean in depths of 15,000 feet with velocities of around 0.2 miles per hour. These measured deep current velocities were used as a basis to calculate the volume of water transported by the Stream, which Fritz estimated to be over two cubic miles of water per minute. (For comparison, all the fresh water rivers on the earth discharge less than 1% of that volume per minute.) Today, half a century later, these estimates provide a basis for us to estimate the transport of heat northward in Earth's global energy budget.

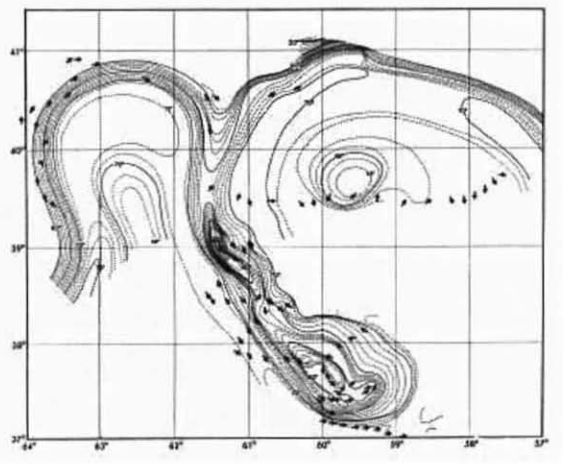


Chart of the surface temperature of the Gulf Stream and cold core ring as it formed on June 17, 1950. (Fuglister and Worthington, 1951). Courtesy of Woods Hole Oceanographic Institution Archives.

Fuglister Refers Me to Ben Franklin

Shortly after I arrived at WHOI in 1974, I asked Fritz about the best general chart of the Gulf Stream. Instead of showing me one of his own, Fritz told me that Ben Franklin's chart of the Stream was still best for showing the general location, speed and overall width (including meander bends) of the Stream. He encouraged me to read Franklin's (1786) article "Maritime Observations," which includes a history of the chart. I was surprised

Benjamin Franklin and Captain Timothy Folger's 1769-70 chart of the Gulf Stream (Richardson, 1980). This figure shows the northwestern part of the chart printed by Mount and Page in London. Two copies of this chart were found in the Biblioteque Nationale in 1978. Courtesy of Woods Hole Oceanographic Institution Archives.

to learn that there were three versions of the Gulf Stream chart published sequentially in London, Paris and Philadelphia. In 1769-70, Franklin, who was Deputy Postmaster General in London for the American colonies, tried to speed up the mail packets by publishing the location of the Stream as sketched by his cousin Timothy Folger, a Nantucket ship captain. If the position of the Stream were mapped, Franklin thought it could be avoided by ships sailing westward and used for advantage sailing eastward. But the chart was ignored by the British captains, who thought they knew more than American fishermen. Franklin published the second version in Paris around 1778, when envoy to France and trying to speed French ships bringing arms and supplies to the colonies. He published the third version of the chart in 1786 in his "Maritime Observations," after returning to Philadelphia. The surprising new information in his paper was that the 1786 Franklin chart of the Gulf Stream that most books and papers show was really a copy of a copy of the first chart and could have been very different from the original Folger sketch and the Nantucket ship captains' knowledge of the Stream.

One night after a seminar, Fritz and I met over dinner and discussed Franklin's paper and charts of the Stream. He strongly encouraged me to try and find the earlier versions to see what Folger had really drawn. The next day I sent off letters to various libraries and museums searching for the early versions. It turned out that the French version was relatively well known, but no copies of the London version were known to exist. During the next few years, I periodically reported back to Fritz about my continuing search and failure to find a copy of the London version. In 1978-79, I spent a year in Paris on sabbatical and, based on my French colleagues' suggestions, visited the Bibliotheque Nationale. After fruitless results using their index, the librarians were very helpful and allowed me to search through their holdings in the usually inaccessible vault.

There I discovered they had two copies of the London version and, of course, a copy of the French version in their holdings. The library was not aware they had any copies of the London chart; it was not filed under "Gulf Stream," but I found it by looking through a portfolio in their holdings of North Atlantic charts. It was an exciting, lucky find and mainly stimulated by my conversations with Fritz. Every time I see a copy of the chart I think of him and the fun we had discussing Franklin's charts of the Gulf Stream.

Fritz conducted the first study to concentrate on the life cycle of cold-core rings in the mid-1960s. From 1965-1967 he used 16 cruises to follow the evolution of three cold core rings. These data served as the basis for the first good description of the distribution, movement and decay of cold-core rings by Fritz and his colleagues. Rings are important because they transport water from one side of the Stream to the other and tend to homogenize the water characteristics of the region as they decay. Rings are also very energetic eddies and are a key part of the huge pool of kinetic energy coinciding with the Stream caused by meandering and ring shedding. These short term fluctuations of the Stream cause massive re-circulating gyres located on both sides of the Stream, which increase its transport.

Fritz Fuglister at the chart table. Courtesy Woods Hole Oceanographic Institution Archives.

In the Spring of 1969 Fritz was awarded the Agassiz Medal by the National Academy of Sciences for his original contributions in oceanography. He was cited for his "stimulating and successful observations of the Gulf Stream and its vortices." As one of his colleagues from Scripps Institute of Oceanography stated: "Fritz is ...the private biographer of the Gulf Stream."

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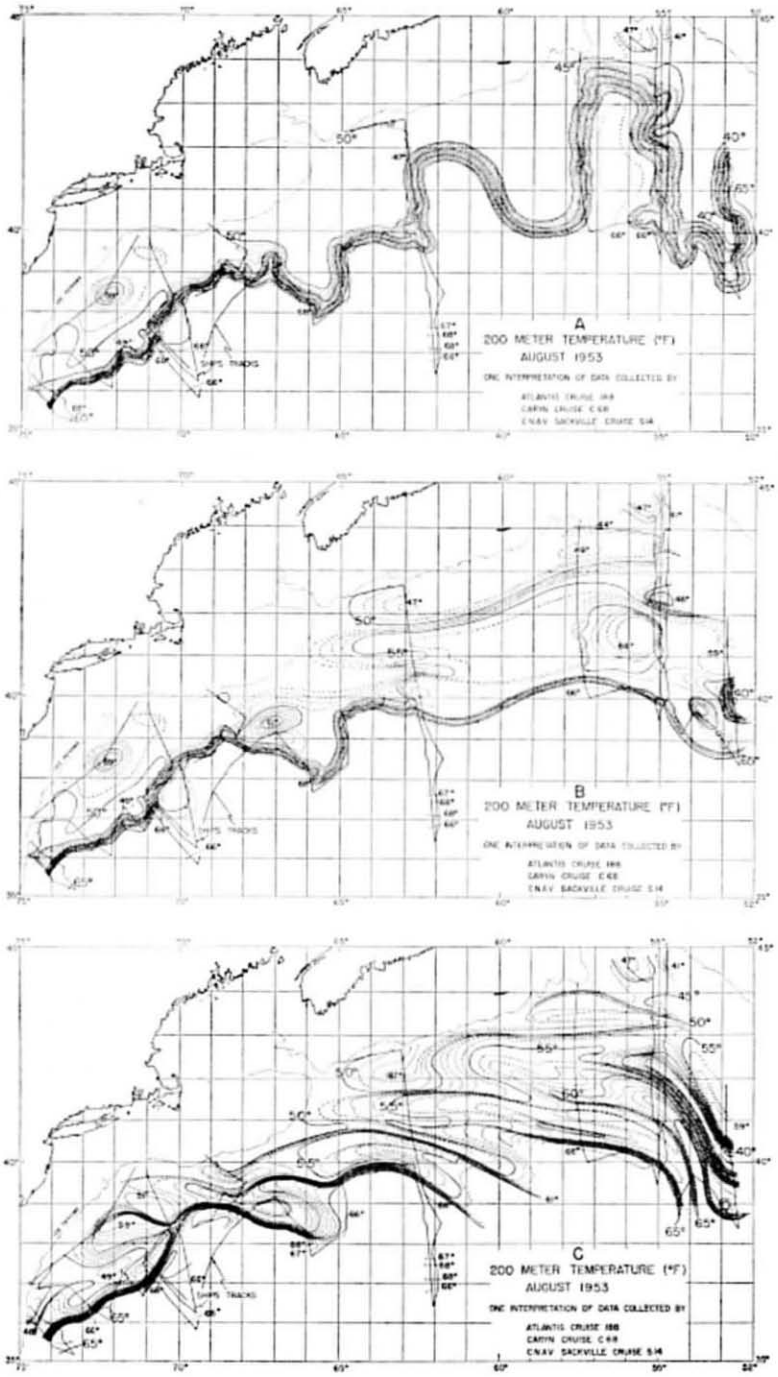

Three different contour charts of temperature at 200 meters depth in the Gulf Stream using the same data from August 1953 (Fuglister, 1955). These charts show three different interpretations of the complex temperature structure of the Stream and illustrate the effect of using different assumptions for contouring. Courtesy of Woods Hole Oceanographic Institution Archives.