Updated 14 May 2021

# Cruise Report for GEOTRACES GApr13-Leg 1 (BAIT-I, EN 631, BATS 357)

## R/V *Endeavor*, Bermuda Atlantic Time-series Study Region, 10-15 March 2019

### Overview of BAIT Project (GEOTRACES Process Study GApr13):

Jointly funded by the US National Science Foundation and the UK Natural Environment Research Council, the Bermuda Atlantic Iron Time-series (BAIT) project aims to combine field data from the Bermuda Atlantic Time-series Study (BATS) region with an established, state-of-the-art ocean biogeochemical model in order to constrain the pools, fluxes and physicochemical transformations that control the oceanic distribution of dissolved iron (DFe), thereby advancing our ability to model the ocean iron cycle and project its sensitivity to future change. Specifically, seasonally resolved data on the vertical (upper 2,000 m) and lateral (tens of km) distributions of particulate, dissolved, colloidal, soluble and ligand-bound iron species will be obtained from the chemical analysis of water column samples collected during five cruises, spanning a full annual cycles, shared with the monthly BATS program cruises. These data, along with ancillary data from then BATS program, will be used to test and inform numerical modeling experiments, and thus derive an improved understanding of the mechanisms that control the distribution and dynamics of DFe in the oceanic water column.

### BAIT-I Cruise Synopsis:

GEOTRACES cruise GApr13-Leg 1 (BAIT-I) was piggybacked on BATS cruise 357, with an extra sea day added to the BATS program cruise to accommodate the BAIT program activities. Participants on GApr13-Leg 1 were Peter Sedwick (Old Dominion University, BAIT PI,), Rod Johnson (Bermuda Institute of Ocean Sciences, Chief Scientist, BATS PI, BAIT co-PI), Bettina Sohst (Old Dominion University, Research Specialist), Dan Ohnemus (Skidaway Institute of Oceanography, BAIT co-PI), Sara Rauschenburg (Bigelow Laboratory for Ocean Sciences, Research Specialist), and Shannon Burns (University of South Florida, Graduate Student).

Weather was generally favorable during the cruise, with only one evening lost to rough conditions. The BAIT project sampling was largely successful, despite a number of problems with equipment that arose before and during the cruise. The crew and marine technicians aboard R/V *Endeavor*, and the BATS program team, provided invaluable assistance during the cruise.

During the cruise period, the Mercator Ocean model forecast suggested a cyclonic eddy in the BATS region (Fig. 1). However, this analysis was not borne out by the shipboard ADCP data, hydrographic observations, and floating sediment-trap trajectories, which were consistent with the presence of an anticyclonic circulation feature centered near BATS (we subsequently learned that the sea-level altimetry data that is usually assimilated by the Mercator Ocean model forecast was unavailable prior to and during the cruise, providing a likely explanation for the discrepancy between the model forecast and our at-sea observations).

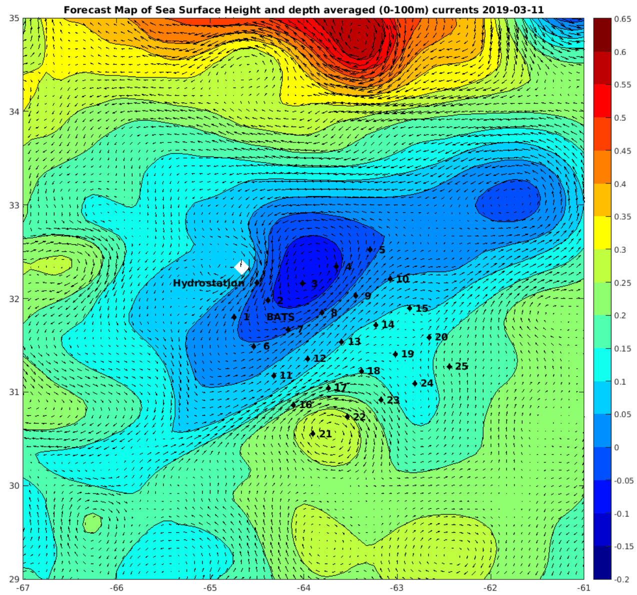


**Figure 1**. *Mercator Ocean model sea surface height forecast for BATS region, 11 March 2019.*

After a test/bottle soak cast of the trace-metal CTD (TMCTD) rosette at Hydrostation S, the BAIT water column sampling (TMCTD casts and McLane pump deployments) was undertaken at BATS, as well as at BATS Spatial Stations #11 and #3 to provide information on mesoscale lateral gradients. Nominal TMCTD sampling depths were selected between 20 m and 1700 m (limited by available line on winch and wire angle), and included the subsurface chlorophyll maximum (SCM), the dissolved oxygen minimum, and density surfaces of 26.1, 26.3 and 26.6 sigma, as estimated from immediately preceding BATS CTD casts. Nominal McLane pump deployment depths included those used by Mak Saito's ongoing sampling program (30 m, SCM, 150 m, 200 m), and other depths of interest where possible.

Surface mixed layers were generally in the 150-200 m thickness range (defined as the depth at which temperature changes by 0.2°C relative to a 10 m or 30 m reference depth, after de Boyer Montegut et al. 2004), with shallower, transient surface mixed layers forming during the day, indicating the physically dynamic nature of the water column where temperature stratification is readily lost as a result of wind mixing and nighttime cooling. In addition, the pump samples and BATS drifting sediment trap samples indicated that particles in the larger size fraction were relatively abundant to the depth of the oxygen minimum, suggesting that there was active production, aggregation and export of particulate organic matter before and during the cruise period. Thus the cruise period seems to have been well timed, in relation to the desired "late-winter/early-spring" seasonal snapshot of the study location.

**Reference**:

de Boyer Montégut, C., Madec, G., Fischer, A.S., Lazar, A. and Iudicone, D., 2004. Mixed layer depth over the global ocean: An examination of profile data and a profile-based climatology. *Journal of Geophysical Research: Oceans*, *109*(C12).

**Summary of BAIT-I Sampling Operations:**
(all sampling depths are nominal)

1). Test/bottle soak TMCTD cast, TM-000
Recovered 23:40 GMT, 10 March 2019, near 32°10'N, 64°30'W (Hydrostation S)
Deployed to ~1700 m depth, bottles closed sequentially near 150 m depth; no samples taken

2). TMCTD cast for particles, TMP-001
Recovered 10:38 GMT, 11 March 2019, at 31°40.918'N, 64°10.997'W (near BATS)
Samples collected at 20, 30, 50, 75, 90, 150, 200, 360, 540, 800, 1000, 1700 m depth
All bottles filtered through 0.4 µm membranes for particles

3). TMCTD cast for dissolved species, TM-001
Recovered 15:02 GMT, 11 March 2019, at 31°40.140'N, 64°11.157'W (near BATS)
Samples collected at 20, 30, 50, 75, 90, 150, 200, 360, 540, 800, 1000, 1700 m depth
Subsamples taken for dissolved Fe, soluble Fe, dissolved Co, dissolved Al, dissolved Fe isotopes, dissolved Fe ligands, soluble Fe ligands (20, 75, 200 m), cellular metals (20, 75 m), and dissolved macronutrients

4). Shallow McLane pump cast for particles, MCL-001
Recovered 21:45 GMT, 11 March 2019, at 31°40.687'N, 64°10.645'W (near BATS)
Pumps deployed at nominal depths of 30, 75, 150, 200 m

5). Deep McLane pump cast, MCL-002
Recovered 05:00 GMT, 12 March 2019, at 31°40.914'N, 64°8.733'W (near BATS)
Pumps deployed at nominal depths of 360, 540, 800, 1000 m (failed)

6). TMCTD cast for particles, TMP-002
Recovered 23:54 GMT, 13 March 2019, at 31°10.613'N, 64°21.000'W (near Spatial Station #11)
Samples collected at 20, 30, 50, 60, 85, 150, 200, 270, 485, 800, 1000, 1700 m depth
All bottles filtered through 0.4 µm membranes for particles

7). TMCTD cast for dissolved species, TM-002
Recovered 05:07 GMT, 14 March 2019, at 31°10.745'N, 64°22.429'W (near Spatial Station #11)
Samples collected at 20, 30, 50, 60, 85, 150, 200, 270, 485, 800, 1000, 1700 m depth
Subsamples taken for dissolved Fe, soluble Fe, dissolved Al, dissolved Fe isotopes, dissolved Fe ligands, cellular metals (20, 60 m), and dissolved macronutrients

8). McLane pump cast for particles, MCL-003
Recovered 09:30 GMT, 14 March 2019, at 31°02.867'N, 64°24.689'W (near Spatial Station #11)
Pumps deployed at nominal depths of 60, 150, 270, 485 m

9). TMCTD cast for particles, TMP-003
Recovered 22:39 GMT, 14 March 2019, at 32°09.060'N, 64°01.314'W (near Spatial Station #3)

Samples collected at 20, 30, 50, 60, 95, 150, 200, 315, 528, 800, 1000, 1700 m depth
All bottles filtered through 0.4 µm membranes for particles

10). TMCTD cast for dissolved species, TM-003
Recovered 02:22 GMT, 15 March 2019, at 32°08.409'N, 64°01.158'W (near Spatial Station #3)
Samples collected at 20, 30, 50, 60, 95, 150, 200, 315, 528, 800, 1000, 1700 m depth
Subsamples taken for dissolved Fe, soluble Fe, dissolved Al, dissolved Fe isotopes, dissolved Fe ligands, cellular metals (20, 60 m), and dissolved macronutrients