updated 18 June 2021

Cruise Report for GEOTRACES GApr13-Leg 2 (BAIT-II, AE 1909, BATS 359)

R/V *Atlantic Explorer*, Bermuda Atlantic Time-series Study Region, 11-17 May 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-II Cruise Synopsis:

GEOTRACES cruise GApr13-Leg 2 (BAIT-II) was piggybacked on BATS cruise 359, with an extra two sea days added to the BATS program cruise to accommodate the BAIT program activities and another ancillary project (PIs Curry, Grundle and Lomas). Participants on GApr13-Leg 2 were were Peter Sedwick (Old Dominion University, BAIT PI), Rod Johnson (Bermuda Institute of Ocean Sciences, Chief Scientist, BATS PI, BAIT co-PI), Salvatore Caprara (University of South Florida, postdoctoral fellow), Dan Ohnemus (Skidaway Institute of Oceanography, BAIT co-PI), Bettina Sohst (Old Dominion University, research specialist), Alessandro Tagliabue (University of Liverpool, BAIT co-PI) and Ben Twining (Bigelow Laboratory for Ocean Sciences, BAIT co-PI).

Weather was generally favorable, with only one day of rough weather due to the passage of a cold front, which did not impede science operations. The BAIT project sampling followed a similar sampling strategy to that used on BAIT-I, and was largely successful. The crew and marine technicians aboard R/V *Atlantic Explorer*, and the BATS program team, provided invaluable assistance.

During the cruise period, the Mercator Ocean model forecast suggested surface flow towards the northwest in the BATS region (Fig. 1), around the southern perimeter of an anticyclonic feature that was pinched between two cyclonic eddies located to the northwest and northeast of BATS. This analysis was borne out by shipboard ADCP and hydrographic observations, as well as sediment-trap drift observed during the cruise.

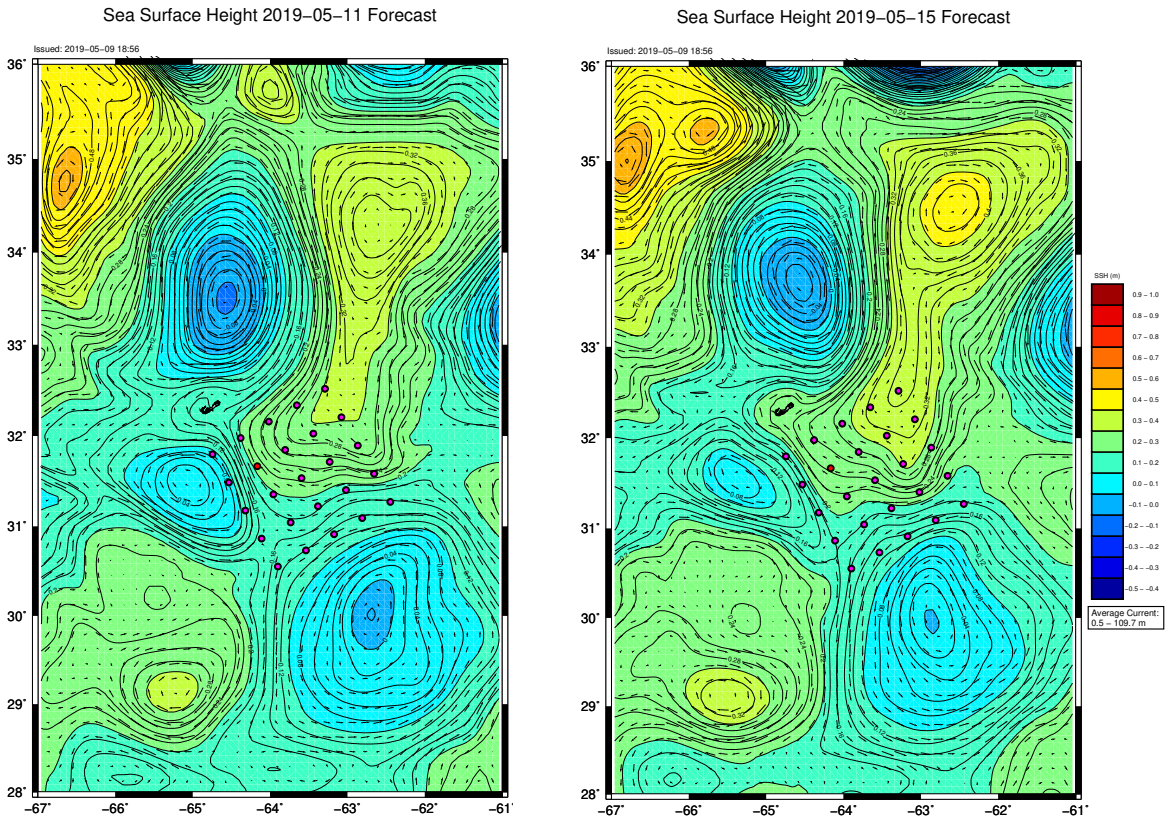

Figure 1. *Mercator Ocean model sea surface height forecasts for BATS region, 11 May (left) and 15 May (right) 2019.*

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 and BATS Spatial Stations #2 and #13 to provide information on mesoscale lateral gradients. Following the BAIT-I sampling strategy, 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 10-40 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), indicating that the water column had stratified significantly since the BAIT-I cruise in mid March. Thus the cruise period appears to have been well timed, in relation to our desired "late-spring" seasonal snapshot of the study location. The SCM was generally located quite deep in the water column, at ~100 m depth or more.

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-II Sampling Operations:
(all sampling depths are nominal)

1). Test/bottle soak TMCTD cast, TM-000
Recovered 22:43 GMT, 11 May 2019, near 32°10'N, 64°30'W (Hydrostation S)
Deployed to ~1700 m depth, bottles closed sequentially at 160-140 m depth; no samples taken

2). TMCTD cast for particles, TMP-001
Recovered 22:33 GMT, 12 May 2019, at 31°42.639'N, 64°10.302'W (near BATS)
Samples collected at 20, 30, 50, 100, 140, 150, 200, 285, 500, 800, 1000, 1700 m depth
All bottles filtered through 0.4 μm membranes for particles

3). TMCTD cast for dissolved species, TM-001
Recovered 03:00 GMT, 13 May 2019, at 31°41.634'N, 64°10.448'W (near BATS)
Samples collected at 20, 30, 50, 100, 140, 150, 200, 285, 500, 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, 100, 200 m), cellular metals (20, 100 m), and dissolved macronutrients

4). Shallow McLane pump cast for particles, MCL-001
Recovered 08:48 GMT, 13 May 2019, at 31°41.217'N, 64°09.409'W (near BATS)
Pumps deployed at nominal depths of 30, 100, 150, 200 m

5). TMCTD cast for particles, TMP-002
Recovered 06:22 GMT, 15 May 2019, at 31°58.839'N, 64°23.701'W (near Spatial Station #2)
Samples collected at 20, 30, 50, 100, 112, 150, 200, 285, 491, 800, 1000, 1700 m depth
All bottles filtered through 0.4 μm membranes for particles

6). TMCTD cast for dissolved species, TM-002
Recovered 10:35 GMT, 15 May 2019, at 31°58.923'N, 64°23.670'W (near Spatial Station #2)
Samples collected at 20, 30, 50, 100, 112, 150, 200, 285, 491, 800, 1000, 1700 m depth
Subsamples taken for dissolved Fe, soluble Fe, dissolved Al, dissolved Fe isotopes, dissolved Fe ligands, cellular metals (20, 75 m), dissolved Pb, and dissolved macronutrients

7). Shallow McLane pump cast for particles, MCL-002
Recovered 15:26 GMT, 15 May 2019, at 31°58.179'N, 64°24.171'W (near Spatial Station #2)
Pumps deployed at nominal depths of 30, 112, 200, 285 m

8). Deep McLane pump cast for particles, MCL-003
Recovered 08:30 GMT, 16 May 2019, at 31°39.647'N, 64°11.145'W (near BATS)

Pumps deployed at nominal depths of 285, 500, 800 m

9). TMCTD cast for particles, TMP-003
Recovered 00:36 GMT, 17 May 2019, at 31°31.606'N, 63°37.671'W (near Spatial Station #13)
Samples collected at 20, 30, 50, 100, 130, 150, 200, 295, 565, 844, 1000, 1700 m depth
All bottles filtered through 0.4 μm membranes for particles

10). TMCTD cast for dissolved species, TM-003
Recovered 04:47 GMT, 17 May 2019, at 31°31.248'N, 63°35.860'W (near Spatial Station #13)
Samples collected at 20, 30, 50, 100, 130, 150, 200, 295, 565, 844, 1000, 1700 m depth
Subsamples taken for dissolved Fe, soluble Fe, dissolved Al, dissolved Fe isotopes, dissolved Fe ligands, cellular metals (20, 75 m), and dissolved macronutrients

11). Shallow McLane pump cast for particles, MCL-004
Recovered 09:15 GMT, 17 May 2019, at 31°28.731'N, 63°35.797'W (near Spatial Station #13)
Pumps deployed at nominal depths of 30, 100, 130, 295 m