DEPARTMENT OF ENVIRONMENTAL PROTECTION
Progress Report Form

Exhibit A

DEP Agreement No.:	**AT007 A01**		
Grantee Name:	University of South Florida		
Grantee Address:	4202 E. Fowler Ave., SVC 1039, Tampa, FL 33620-5800		
Grantee's Grant Manager:	Dr. Yonggang Liu	**Telephone No.:**	727-553-3508
Reporting Period:	7/1/2022 – 6/30/2023		
Project Number and Title:	Tampa Bay Circulation Water Quality Network, Modeling, and Analysis		

Task 2: Maintain WFCOM and TBCOM daily nowcasts/forecasts of currents, temperature and salinity and surface height fields with a targeted "up time" of 90%.

Despite the unexpected personnel change (losing a key modeler) and loss of open boundary forcing of WFCOM from Gulf of HYCOM, the USF Ocean Circulation Lab successfully maintained WFCOM and TBCOM daily nowcast/forecast systems throughout the fiscal year 2022-2023. Particularly, the WFCOM and TBCOM successfully predicted the extreme negative storm surge of Hurricane Ian in Tampa Bay three days in advance. The red tide short-term forecast systems provided timely HAB forecast information to governmental agencies and the general public during the major bloom event that occurred during the spring break season.

Five papers have been submitted for consideration of publication in peer-reviewed journals, one of which has been published. Some of the research results were presented in three national conferences.

Deliverables:

- WFCOM daily nowcast/forecast of currents, temperature and salinity and surface height fields are archived online at http://ocgweb.marine.usf.edu/Models/WFCOM/wfcom_index.html

- Particle trajectories and red tide tracking products are available at http://ocgweb.marine.usf.edu/hab_tracking/wfcom_hab.html, and their archives can be accessed through individual links on the right column of that web page.

- TBCOM daily nowcast/forecast of currents, temperature and salinity and surface height fields can be accessed online at http://ocgweb.marine.usf.edu/~tbm/index.html. This include the newly developed sea level projection product http://ocgweb.marine.usf.edu/~tbm/index_sealevel.html.

- TBCOM surface convergence/divergence product: http://ocgweb.marine.usf.edu/~tbm/TB_convergence.html.

- Key information about the spreading of the Piney Point plume (a manuscript is in preparation):

  An emergency discharge of nutrient-rich effluent into Tampa Bay from the defunct Piney Point fertilizer stack at Port Manatee occurred from 30 March – 8 April 2021, which resulted in a pollutant plume that evolved over time and spread across the bay, into estuaries, and out onto adjacent continental shelf region. The plume evolution was simulated using the high resolution, unstructured grid TBCOM, with an embedded tracer module that included realistic point discharge rates. Due to mixing and diffusion, tracer concentration was quickly reduced by two orders of magnitudes or more when the plume spread out (Figure 1). Higher concentration tracer mostly hugged the southeastern Tampa Bay coast in the first week. Lower concentration tracer gradually advected to the western Tampa Bay, and was slowly flushed out of the bay and mostly transported to the north along the coast (Figure 2).

  The tracer was slowly flushed out of Tampa Bay, with an e-folding time scale of 127 days (Figures 3 & 4). This is consistent with previous findings of residence time estimates for Tampa Bay.

  The effluent plume was influenced by tides, winds, rivers and the adjacent Gulf of Mexico. Within Tampa Bay, it initially tended southwestward before tending northward and across the bay; it did not affect the Little Manatee site (to the northeast) until a week after the discharge ended (Figure 5).

- Peer-reviewed publications:

  1. Chen, J., Weisberg, R.H., Liu, Y., Zheng, L., 2023a: Hillsborough Bay inflow modification study: An application of the Tampa Bay Coastal Ocean Model, *Estuarine, Coastal and Shelf Science,* 108213, https://doi.org/10.1016/j.ecss.2023.108213 (published)

  2. Nickerson, A.K., Weisberg, R.H., Zheng, L., Liu, Y., 2023: Sea surface temperature trends for Tampa Bay, West Florida Shelf and the Deep Gulf of Mexico, *Deep-Sea Research II* (revised).
  3. Chen, J., Weisberg, R.H., Liu, Y., Zheng, L., Law, J., Gilbert, S., Murawski, S. 2023b: A Tampa Bay Coastal Ocean Model nowcast/forecast system, *Deep-Sea Research II* (submitted).
  4. Chen, J., Y. Liu, R.H. Weisberg, S. Murawski, S. Gilbert, D. Naar, L. Zheng, M. Hommeyer, C. Dietrick, M.E. Luther, C. Hapke, E. Myers, S. Moghimi, C. Allen, L. Tang, B. Khazaei, S. Peeri, N. Alvarado, and P. Wang (2023c), Hydrodynamics

response to bathymetry changes in Tampa Bay, Florida, *Deep-Sea Res. Part II* (submitted)

5. Liu, Y., R.H. Weisberg, L. Zheng, K.A. Hubbard, E.G. Muhlbach, M.J. Garrett, C. Hu, J.P. Cannizzaro, Y. Xie, J. Chen, S. John, and L.Y. Liu (2023), Short-term forecast of red tide trajectory on the West Florida Shelf, *Deep-Sea Res. Part II* (submitted)

- Conference presentations:

1. Liu, Y., Weisberg, R.H., 2022a: Coordinated Coastal Ocean Circulation Observing, Modeling and Applications on the West Florida Shelf, The Southeast Acoustics Consortium Workshop and Forum, FWRI, St. Petersburg, FL, September 11-13, 2022. (talk)

2. Liu, Y., Weisberg, R.H., Zheng, L., Chen, J., Hu, C., Law, J., Sun, Y., 2022b: Coastal Ocean Response to Hurricane Ian as Simulated by the WFCOM and TBCOM Nowcast/Forecast Systems, Abstract (NH43C-05) Presented at AGU Fall Meeting, December, 2022, Chicago, Illinois. (talk)

3. Chen, J., Liu, Y., Weisberg, R.H., Sun, Y., Zheng, L., Law, J., 2022: Storm surge simulations based on an Ian-like Hurricane over Tampa, Abstract (NH45G-2542) Presented at AGU Fall Meeting, December, 2022, Chicago, Illinois. (poster)

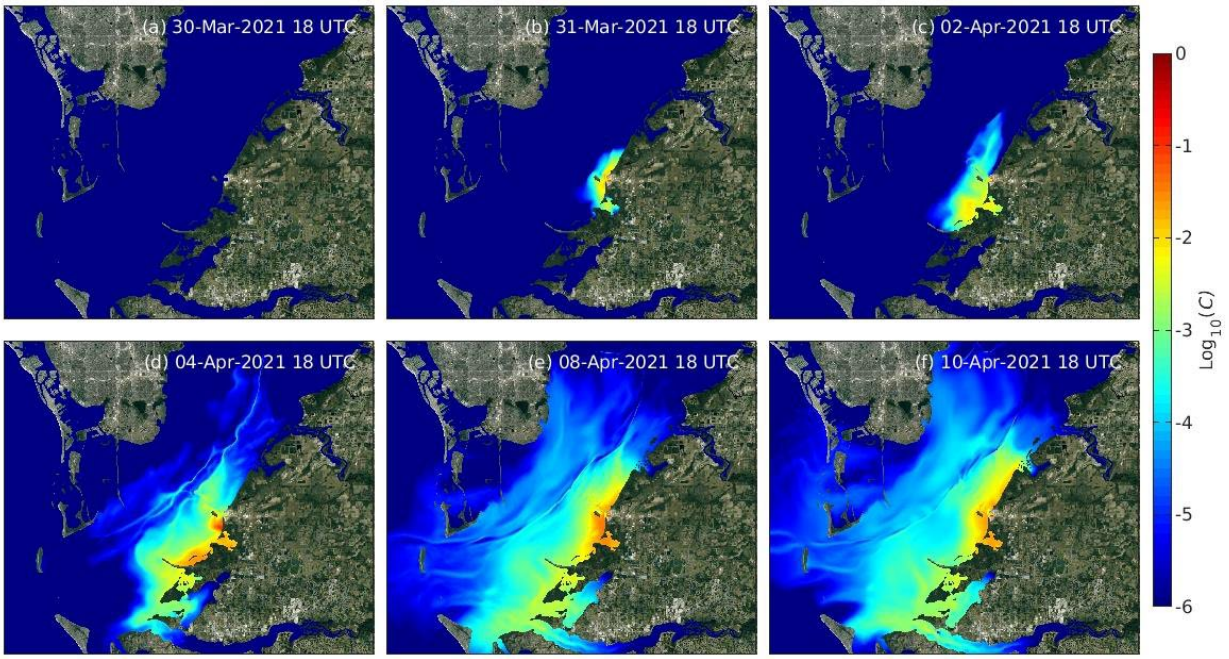

Figure 1. Snapshots of TBCOM simulated surface tracer concentration during the early days of the discharge, (a) 30 March 2021, (b) 31 march 2021, (c) 2 April 2021, (d) 4 April 2021, (e) 8 April 2021, and (f) 10 April 2021. The color coding uses a $\log_{10}$ scale so each decade (-1 through -6) is a successive 10 fold dilution, *e.g.*, the green colors center about 10^{-3}, or a 1000 fold reduction in tracer concentration.

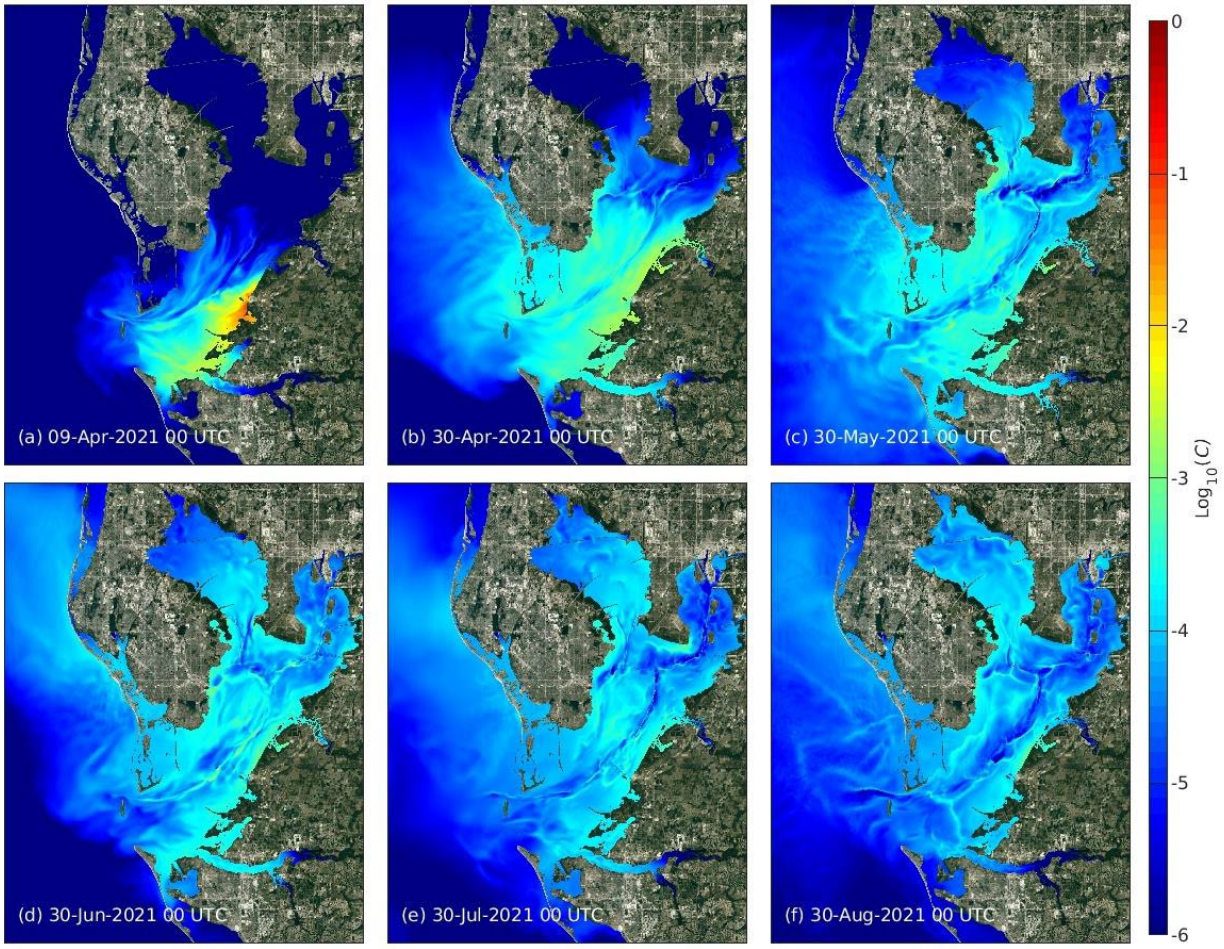

Figure 2. Snapshots of TBCOM simulated surface tracer concentration (a) when the discharge was stopped on 9 April 2021, (b) one month after the start of the discharge (30 Aril 2021), (c) 30 May 2021, (d) 30 June 2021, (e) 30 July 2021, and (f) 30 August 2021. The color coding uses a $\log_{10}$ scale so each decade (-1 through -6) is a successive 10 fold dilution, *e.g.*, the green colors center about 10^{-3}, or a 1000 fold reduction in tracer concentration.

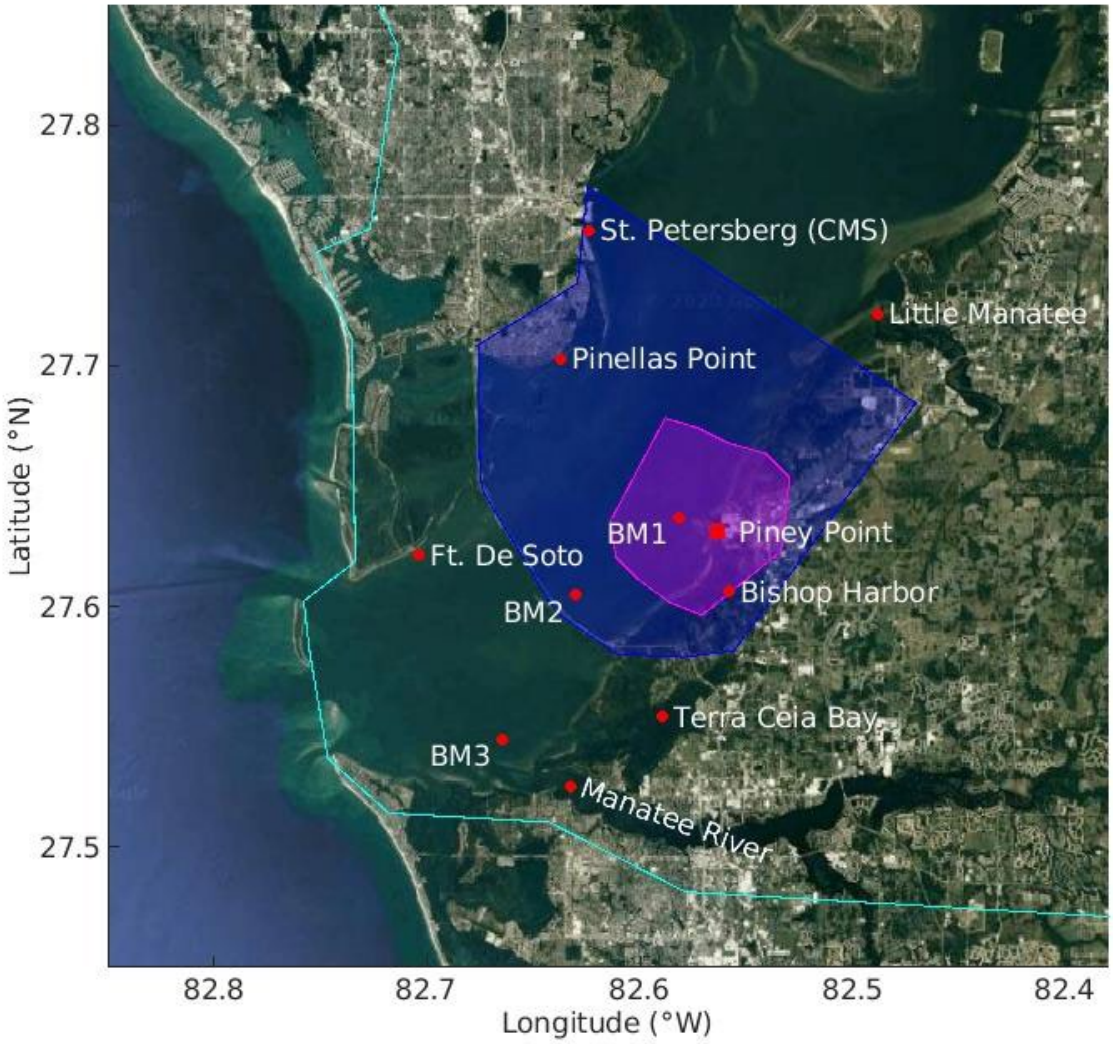

Figure 3. Three areas for calculating total tracer mass in the model and its change over time: (a) the near-field plume area from the Piney Point effluent (magenta area), (b) the middle Tampa Bay (blue area), and (c) the entire Tampa Bay (with the boundary indicated with cyan lines). Also shown are selected locations for monitoring the spreading of the tracer plume in Tampa Bay: three bottom mounted water quality stations (BM1, BM2, and BM3) deployed during the discharge event, four locations in the eastern Tampa Bay (Little Manatee, Bishop Harbor, Terra Ceia Bay, Manatee River), and three locations in the western Tampa Bay (the coastal area of the College of Marine Science, University of South Florida near St. Petersburg downtown, South St. Petersburg, and Ft. De Soto Park).

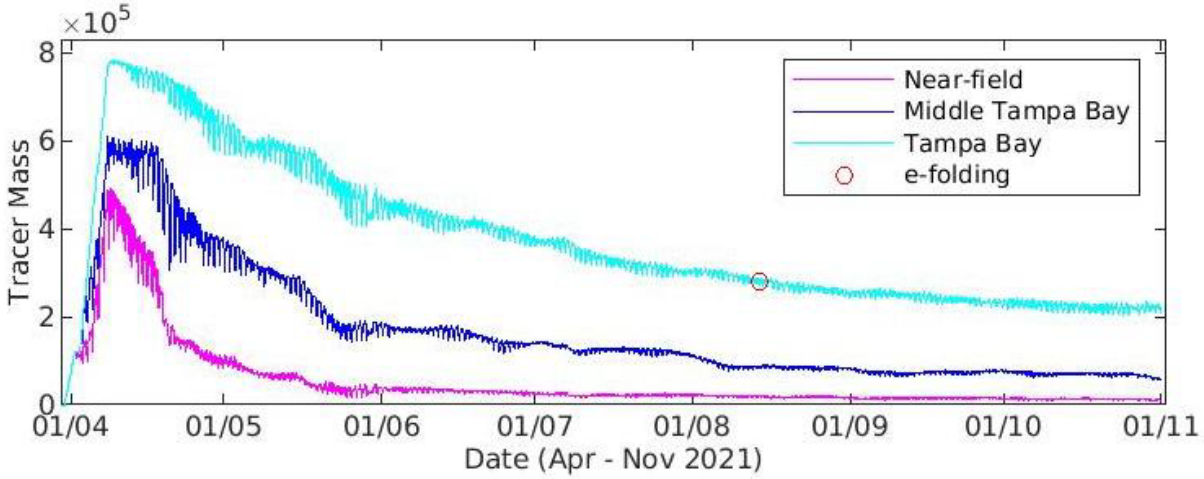

Figure 4. Time series of total tracer mass in the near-field plume area (magenta), in the middle Tampa Bay area (blue), and within Tampa Bay (cyan). The red circle indicates the e-folding reduction of the tracer mass in Tampa Bay, corresponding to 14 August 2021, 03:00 UTC, which was 127 days counting from the stopping of the discharge on 8 August 2021, 19:00 UTC.

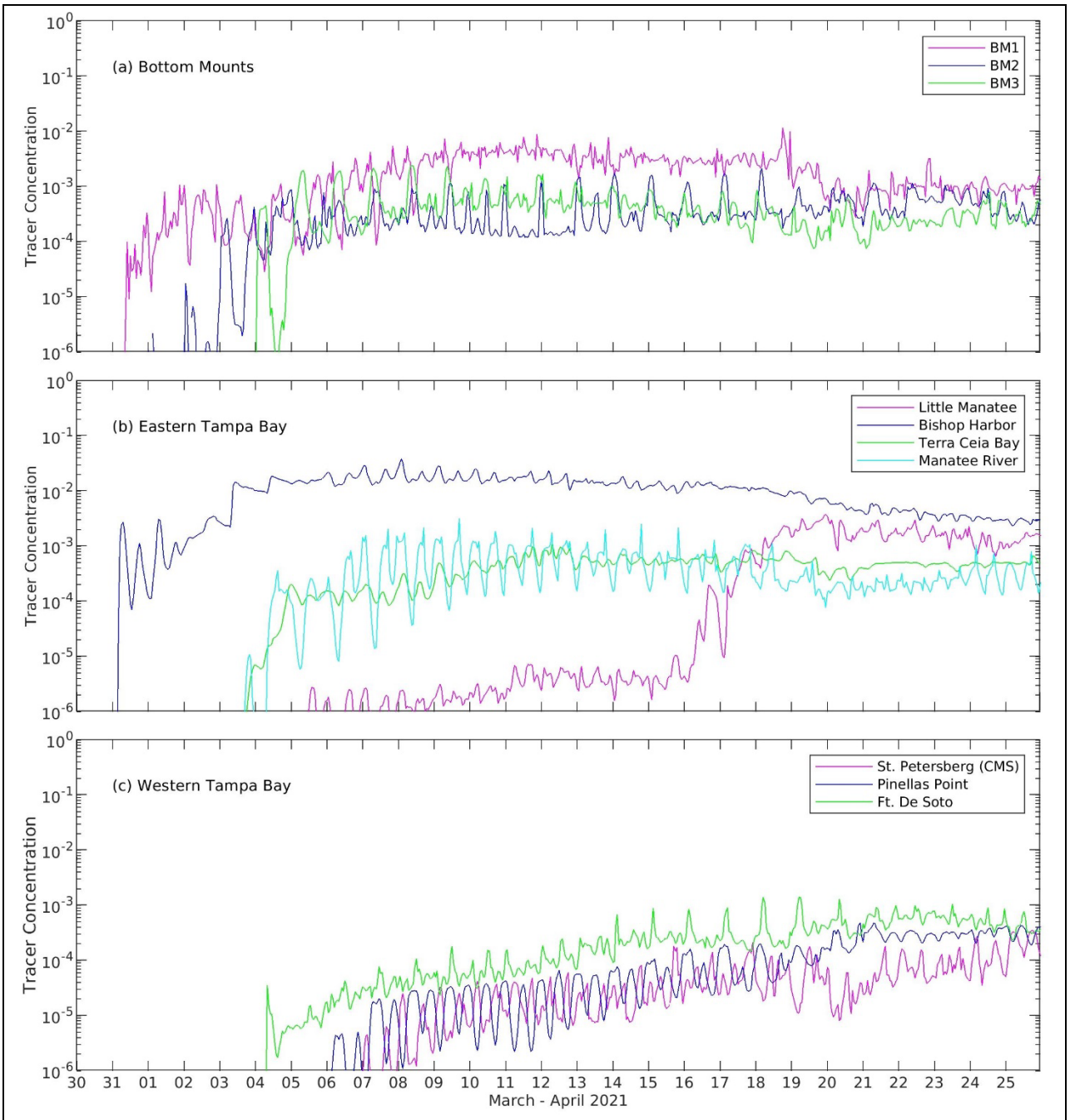

Figure 5. Time series of surface tracer concentration at selected locations in Tampa Bay, (a) the bottom mounted stations deployed by USF College of Marine Science, (b) the eastern Tampa Bay, and (c) the western Tampa bay.

This report is submitted in accordance with the reporting requirements of DEP Agreement No. AT007 A01 and accurately reflects the activities associated with the project.

	6/26/2023
Signature of Grantee's Grant Manager	Date