WHCOHH Results for DY169

Draft January 12, 2024

Partnership between DFO and WHOI, as described in the Collaborative Agreement dated 10 April 2023, facilitated WHCOHH participation in DFO's 2023 AZMP cruises on RRS *Discovery* Voyage 169, leg 2 (13 September – 1 October) and leg 3 (6-27 October).

This was a particularly opportune time to sample the region, given the extreme SST anomalies this year (Figure 1, left). For context, the average SST throughout the North Atlantic was outside the envelope of all prior observations in the satellite era (Figure 1, right).

WHCOHH sampling consisted of: (1) underway IFCB measurements, (2) discrete measurements for "omics" and *Pseudo-nitzschia* spp. and domoic acid at selected CTD stations, and (3) opportunistic collection of *Pseudo-nitzschia* for culture. Here we report initial findings on (1) only.

Underway IFCB measurements were collected along the ship's track every 20 minutes (Figure 2; also see https://habon-ifcb.whoi.edu/dy169). Automatic classification of the imagery, together with manual annotation, facilitates mapping the *Pseudo-nitzschia* distribution (Figure 3). Overall, concentrations were low, peaking at 19505 cells L^{-1}. Highest concentrations occurred in the Gulf of Maine and the northeast Laurentian Channel. Care must be taken in interpreting these patterns, owing to the low numbers of cells detected (Figure 4) and the associated uncertainties in computation of concentration from discrete observations of plankton. The IFCB will also underestimate *Pseudo-nitzschia* cell concentrations when cells are present in chains longer than 3-7 cells. This is most characteristic of actively growing populations. Longer chains may be excluded by the sensor's intake or, if imaged, may extend beyond the sensor's camera field of view.

Additional underway measurements (Figure 5) provide context in which to interpret the *Pseudo-nitzschia* distribution. The two water masses in which *Pseudo-nitzschia* is most abundant are clearly discernible in temperature / salinity space (Figure 6): relatively warm (T>16°C) and fresh (S<31) waters of the Laurentian Channel, and the cooler and saltier waters of the Gulf of Maine. The degree to which vertical mixing from Hurricane Lee impacted surface temperatures of the Gulf of Maine has not yet been assessed, and this should be easily quantifiable in before / after satellite imagery. There was little correspondence between *Pseudo-nitzschia* and fluorescence or oxygen saturation (Figure 5), likely owing to the fact that the relatively low concentrations probably constituted a small fraction of the total phytoplankton biomass.

IFCB measurements were also collected on leg 3 (Figure 7). We will conduct similar water mass analysis once the underway hydrographic data are in hand.

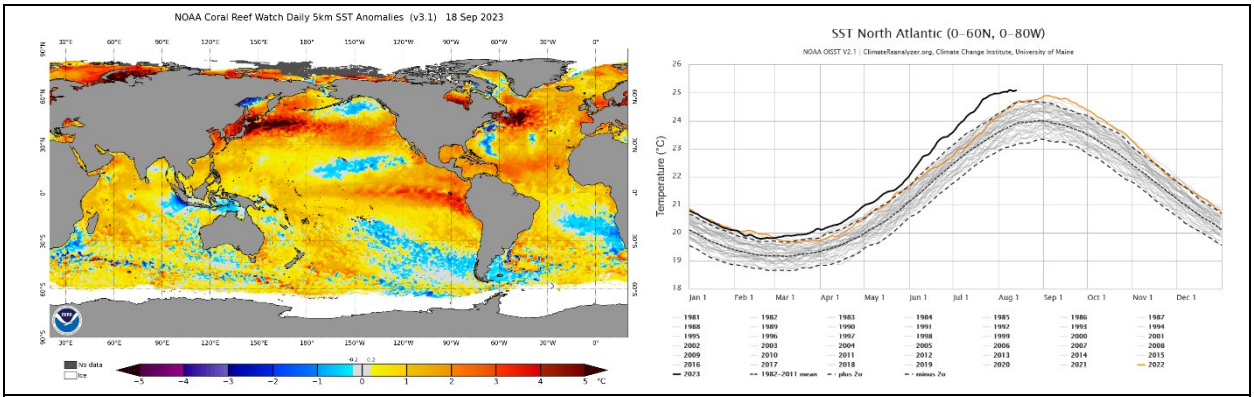

Figure 1. Left: global SST anomalies for 18 September 2023, from https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/. Right: SST in the North Atlantic (0-60N, 0-80W) 1981-2023. Dashed lines are the 1982-2011 mean ± 2σ. Orange line is 2022, and bold black line is 2023 through early August. From https://climatereanalyzer.org/clim/sst_daily/.

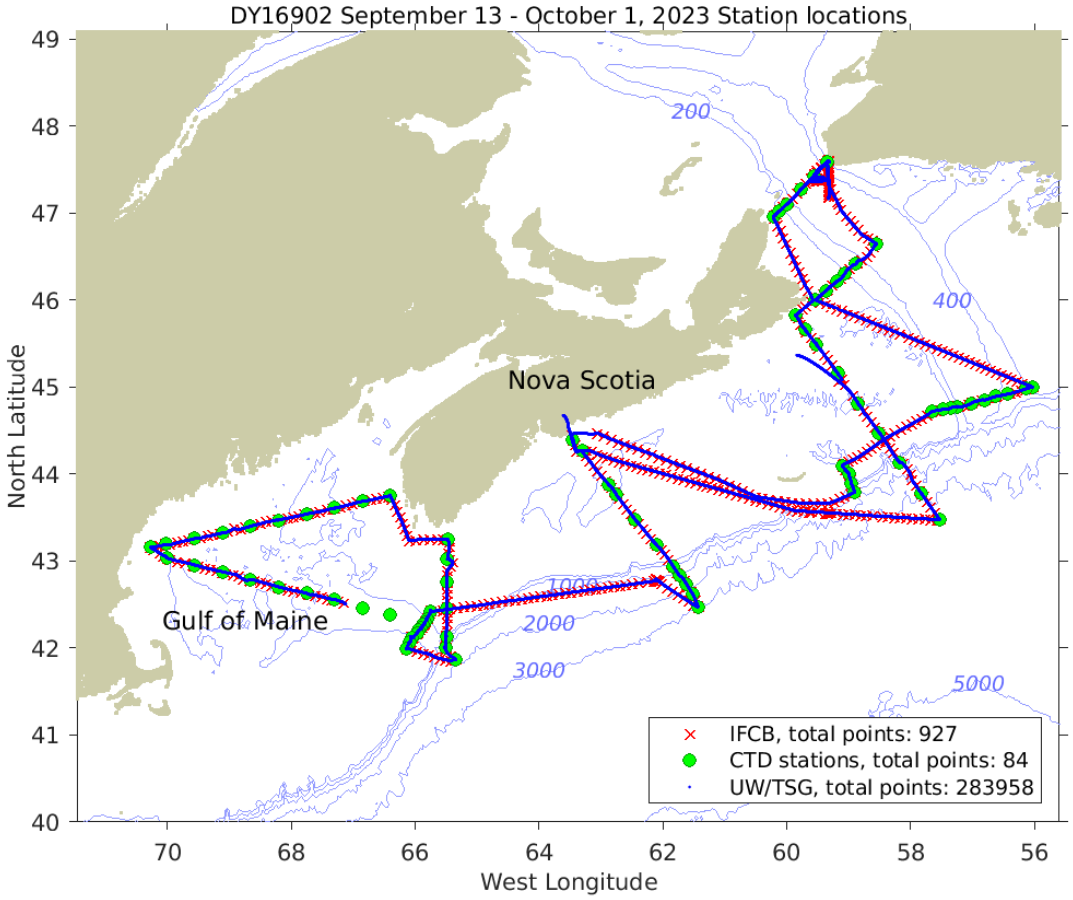

Figure 2. Sampling on DY169-02. Note that the underway data from the last part of the cruise needs to be added.

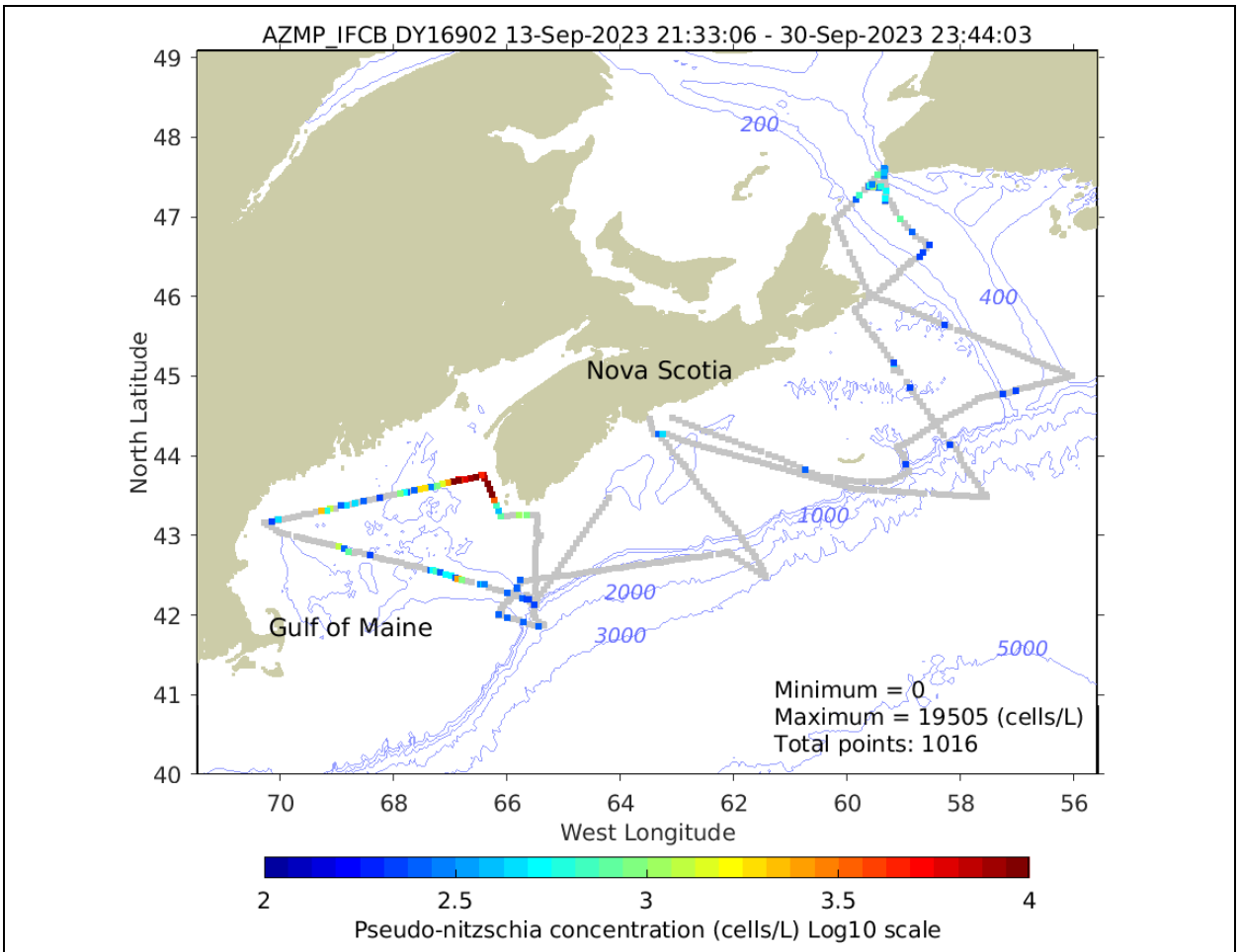

Figure 3. *Pseudo-nitzschia* concentrations (log scale) derived from underway IFCB measurements on DY169-02. Locations where no *Pseudo-nitzschia* were detected are plotted in gray.

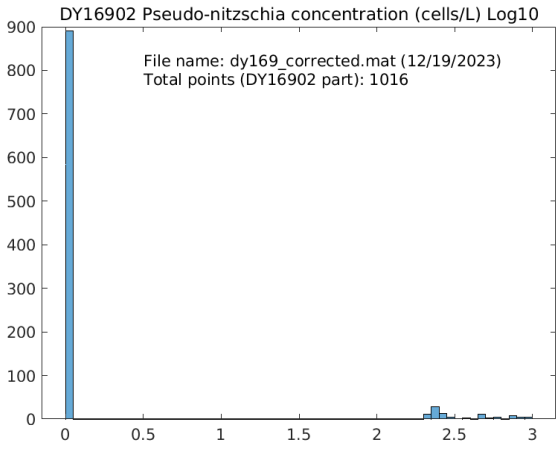

Figure 4. Histogram of log transformed *Pseudo-nitzschia* concentration. A value of 1 was added to the concentration data to remove zeroes.

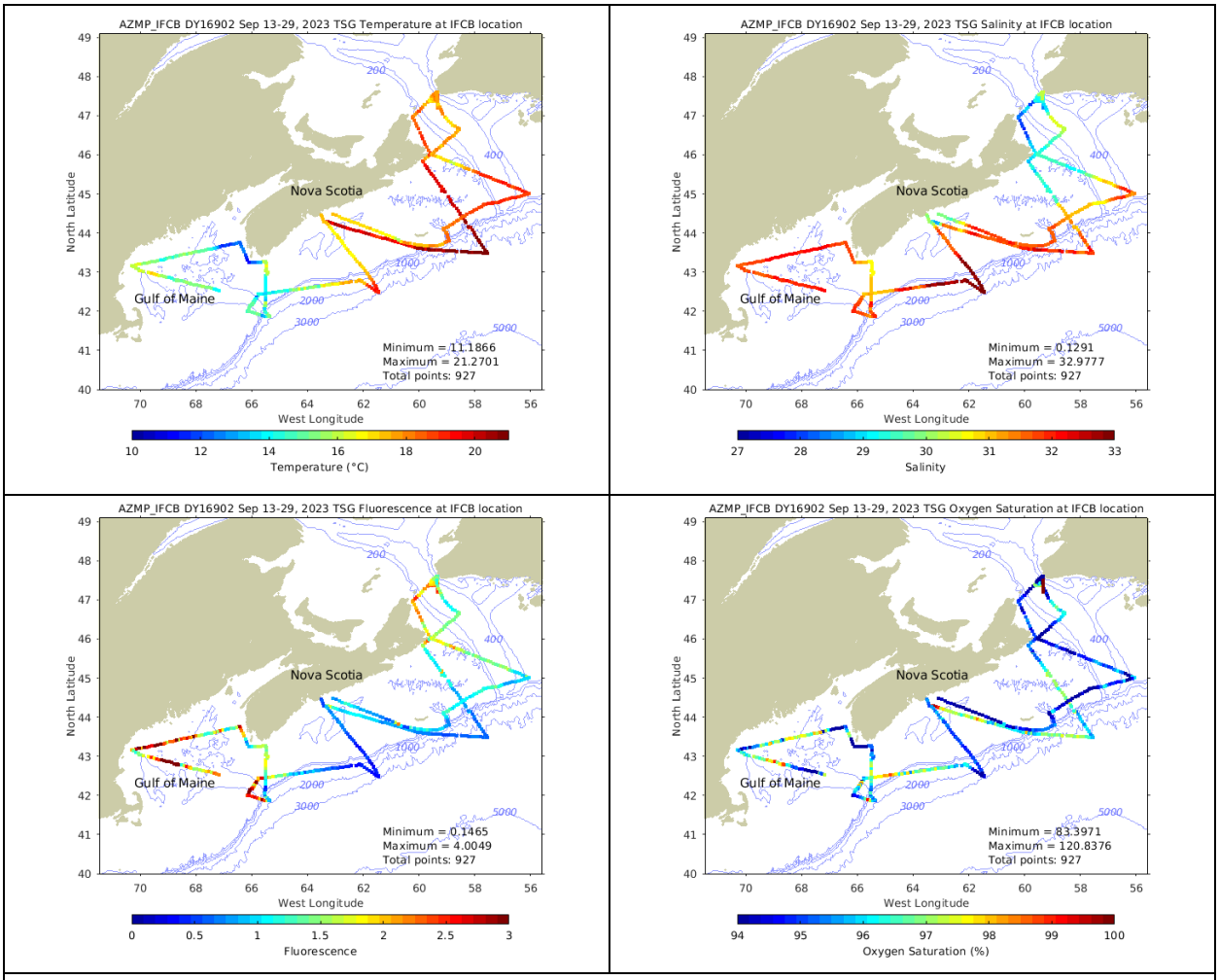

Figure 5. Underway temperature (top left), salinity (top right), fluorescence (bottom left) and oxygen saturation (bottom right) at IFCB measurement locations on DY169-02.

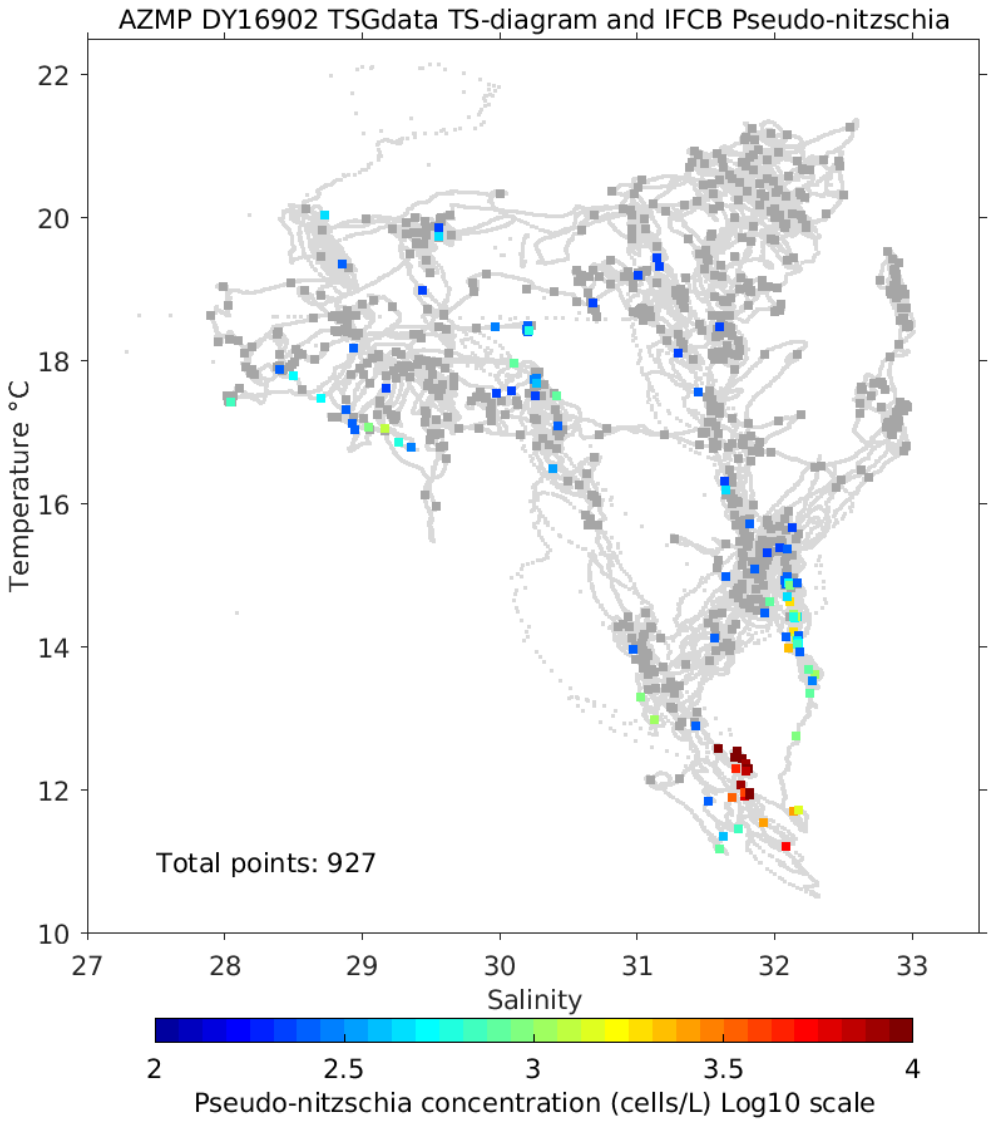

Figure 6. *Pseudo-nitzschia* concentrations derived from the IFCB plotted in temperature and salinity space. Locations where no *Pseudo-nitzschia* were found are shown as gray squares, with non-zero concentrations plotted in color (log scale). Gray dots indicate underway measurements for which there is no corresponding IFCB observation.

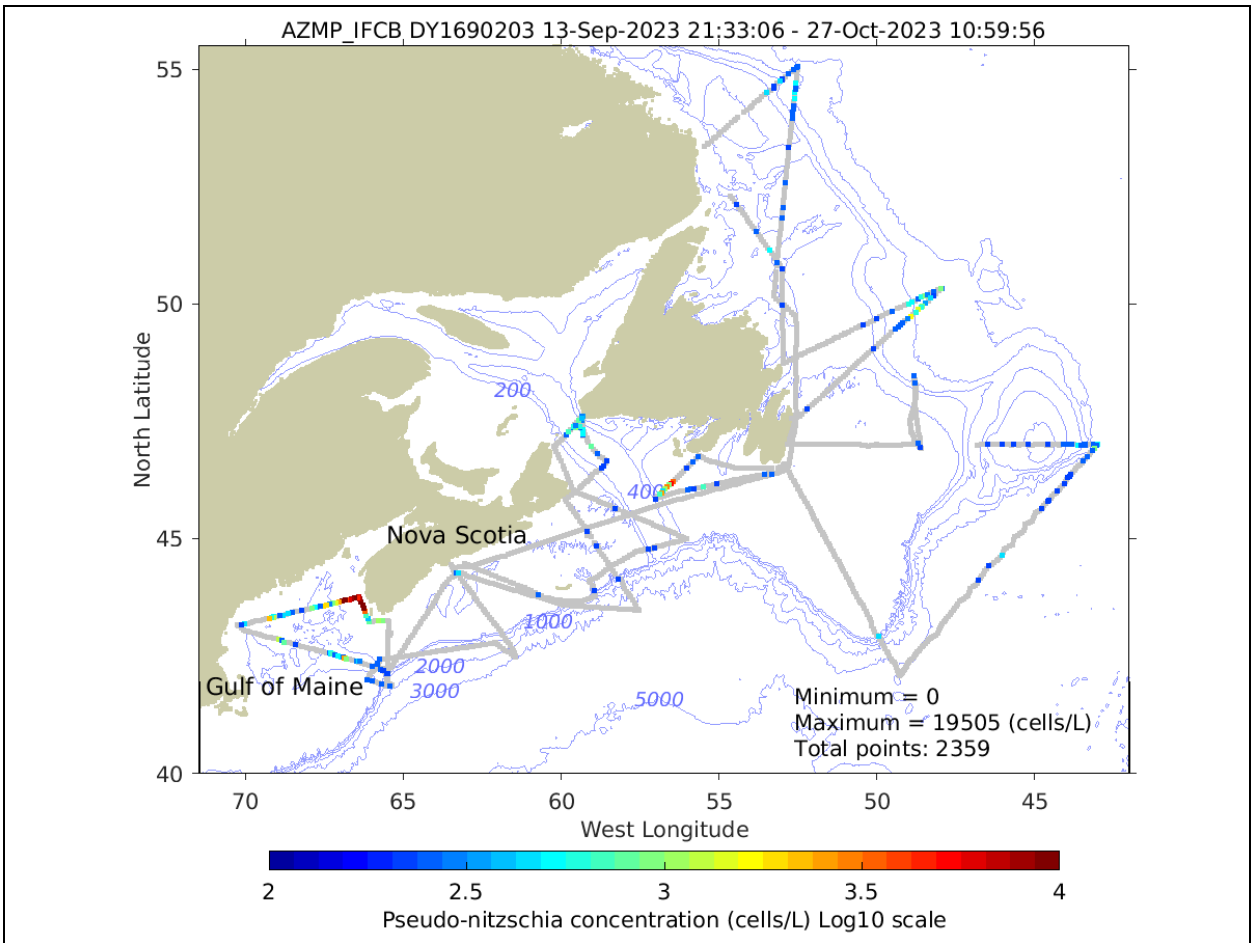

Figure 7. *Pseudo-nitzschia* concentrations (log scale) derived from underway IFCB measurements on DY169-02 and DY169-03. Locations where no *Pseudo-nitzschia* were detected are plotted in gray.