Community composition, biomass and photosynthetic competency of phytoplankton associated with microscale features and frontal zones of the Gulf Stream

A way forward for enhancing the utility of satellite Chlorophyll and SST for mapping coastal micro-scale features and frontal zones

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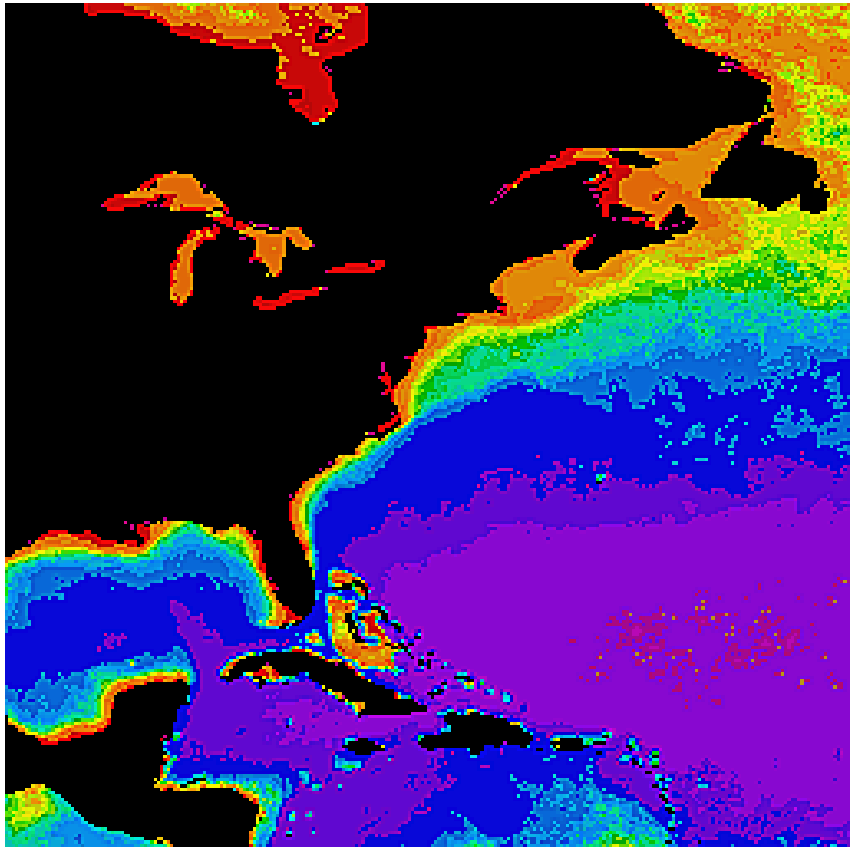
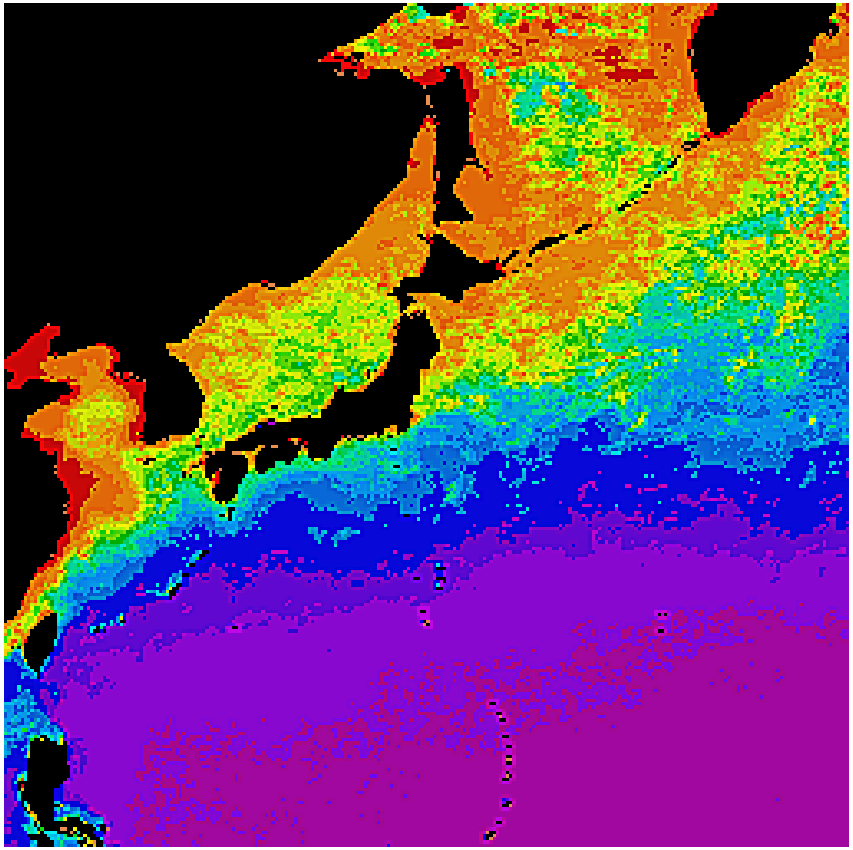
In 1978, NASA launched its first proof of concept ocean color satellite Coastal Zone Color Scanner (CZCS).

4 VIS and 1 IR band. Spatial Resolution - 825m

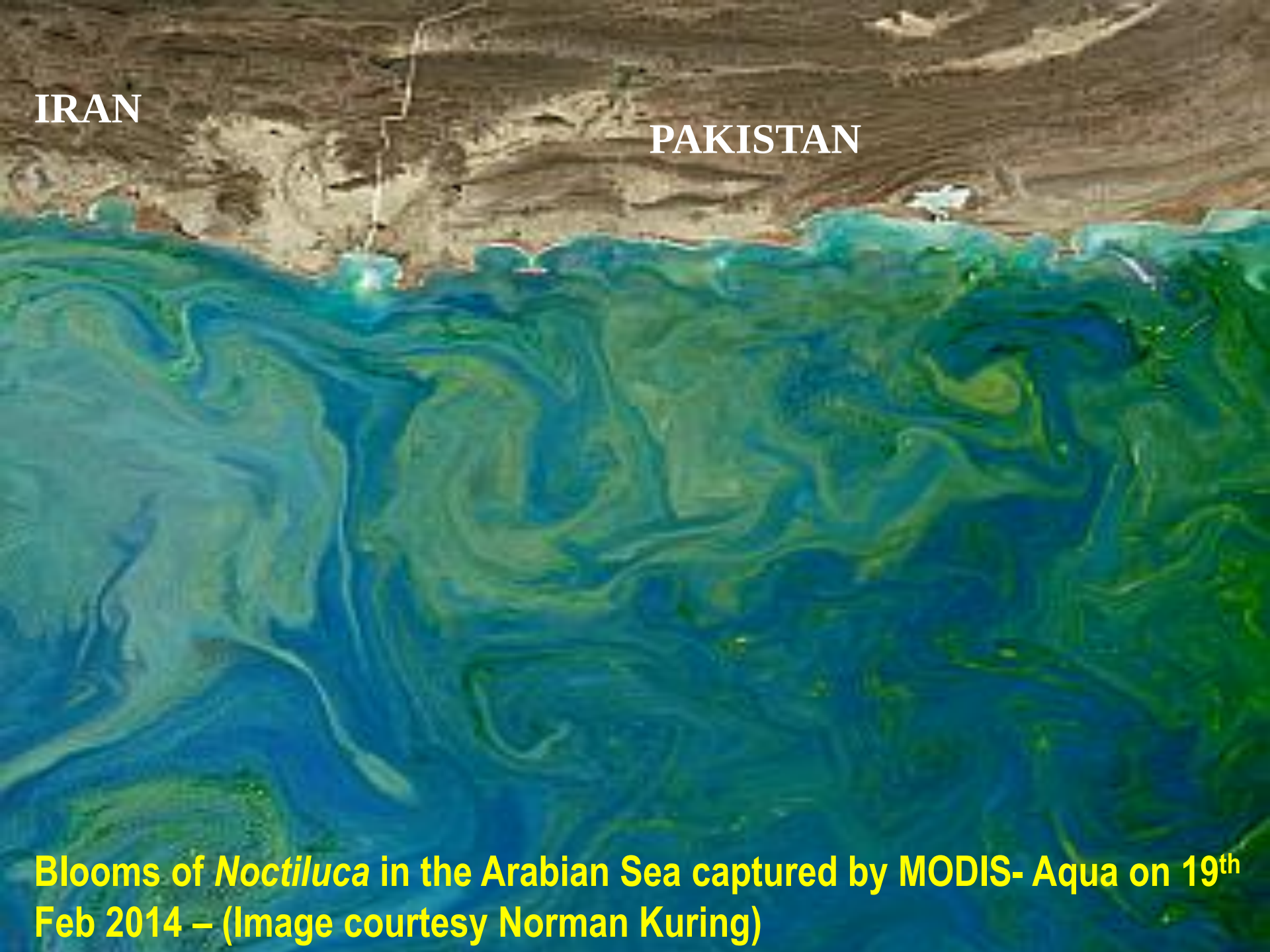
CZCS Chlorophyll Images





Missions and Sensors

- OCTS –1997, 8 VIS, 4 IR, 700m (JAPAN)
- SeaWiFS –1998, 6 VIS, 2 IR, 1.1km (USA)
- MERIS –2002, 9 VIS, 6 IR, 300m (EU)
- MODIS –2002, 7 VIS, 5 IR, 250m (USA)
- VIIRS –2011, 6 VIS, 5 IR, 375m (USA)
- HICO –2011, 3 UV, 15 VIS, 4 IR, 90m (USA)
- OLCI –2016, 9 VIS 2 NIR 300m (EU)
- PACE –2022, Hyperspectral (380-960 at 5.7nm) 1km



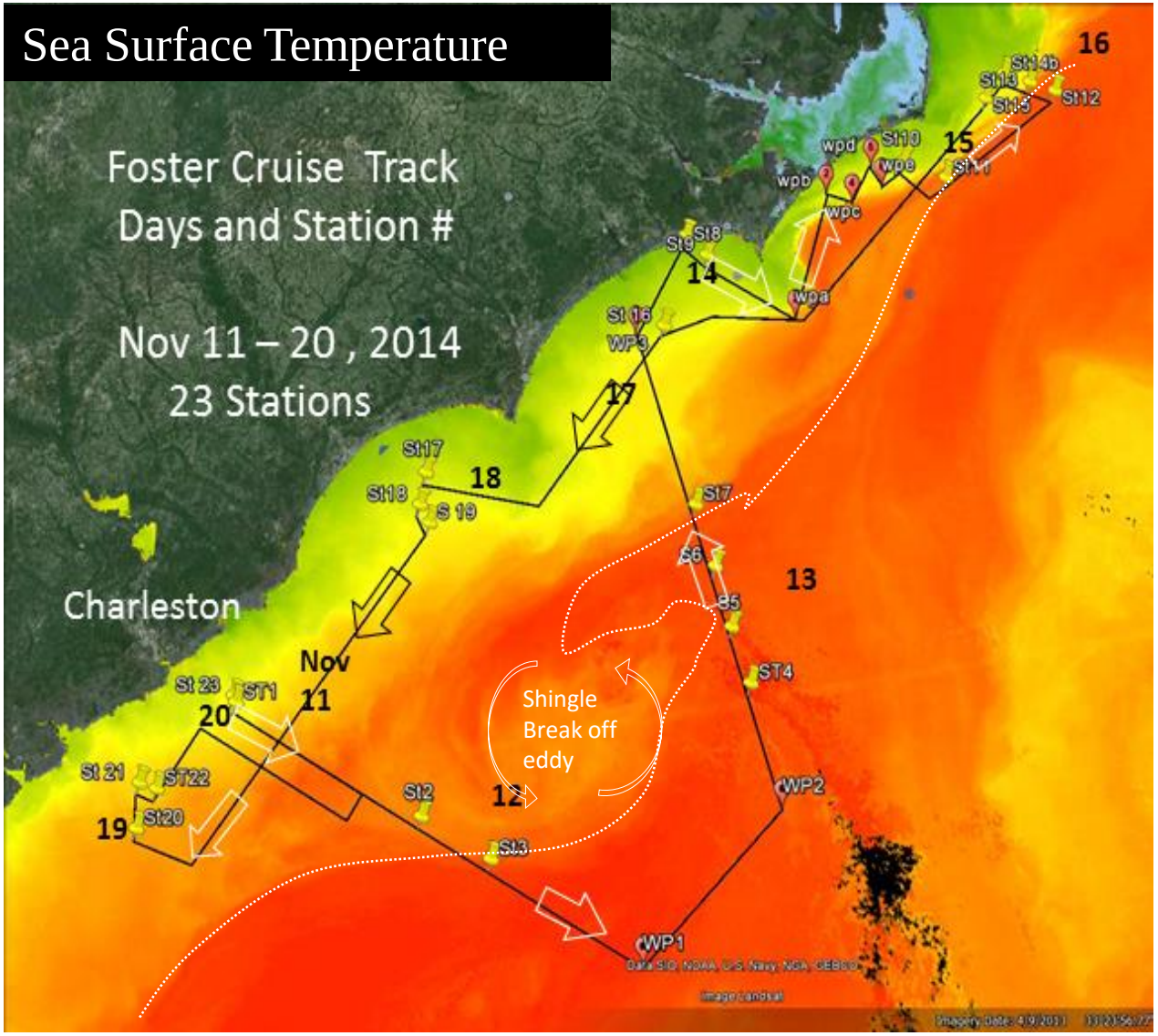
Blooms of *Noctiluca* in the Arabian Sea captured by MODIS- Aqua on 19th Feb 2014 – (Image courtesy Norman Kuring)

Where are we falling short?

- **Lack of match-up shipboard data for studying PFTs.**
- **Critical in coastal waters where diverse water types, ecological niches and PFTs exist.**
- **Unable to exploit satellite data for mapping the diversity and productivity of phytoplankton associated with these features.**

Broad Objective

To demonstrate how we can overcome this perennial problem of under-sampling and the lack of match up data through the use of high resolution flow through bio-optical measurements



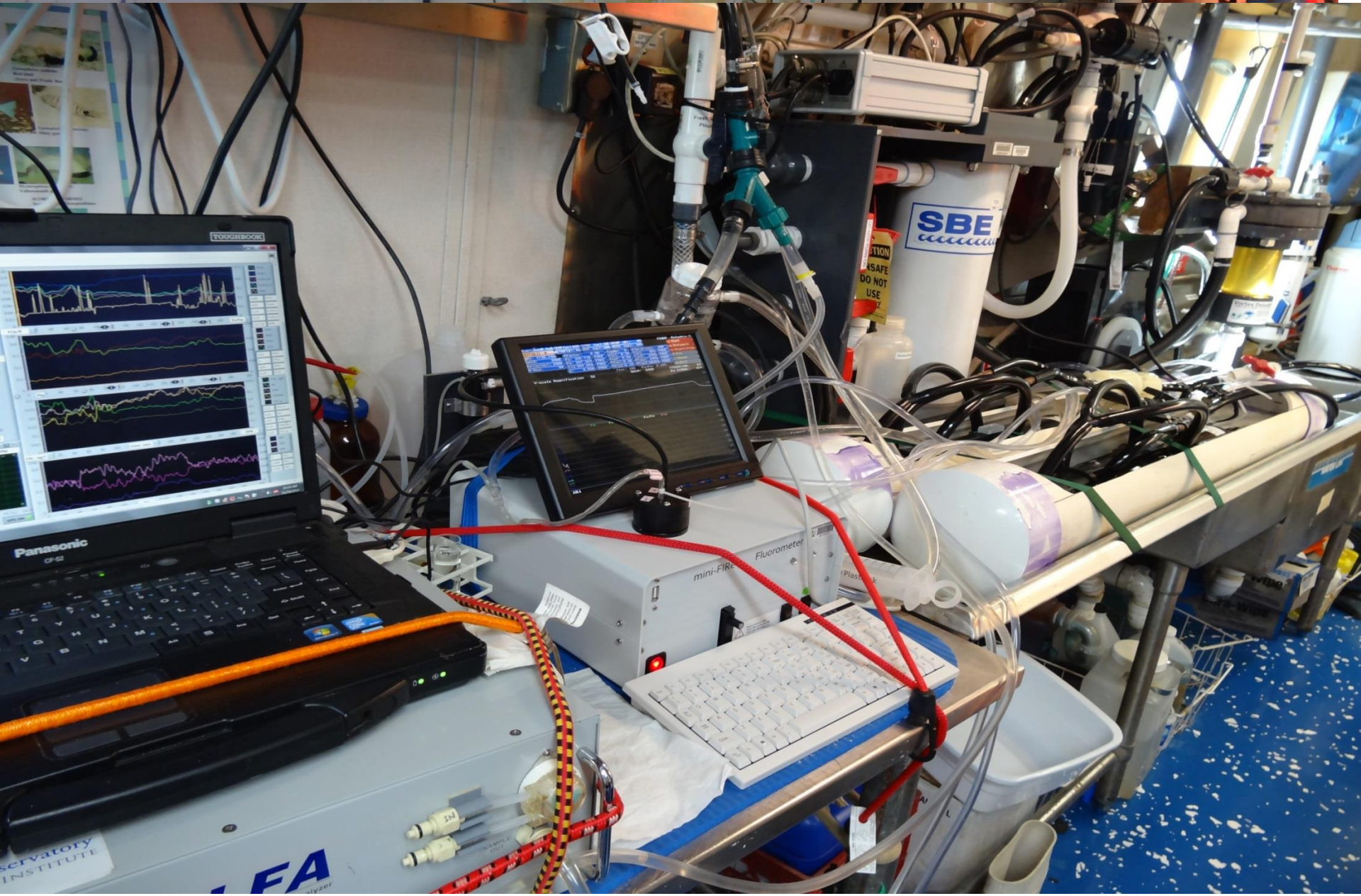
***R/V Nancy Foster* cruise track overlaid on SST for validation of VIIRS Ocean color satellite**

FLOW-THROUGH SETUP

- Automated Laser Fluorometer (Chl *a*, CDOM, PE-1, PE-2, PE-3, Fv/Fm, NPQ, PQ)
- Satlantic FIRe (Chl *a*, Fv/Fm, σPSII)
- bbe-Moldaenke AOA (Chl a - Diatoms, Cryptophytes, Green Algae, Cyanobacteria)
- FlowCAM in flow-through mode (Phytoplankton imaging, taxonomy and size classification)
- ac-9 (filtered) and (unfiltered) – Inherent Optical properties (*Arnone et al.*)
- Temperature and Salinity

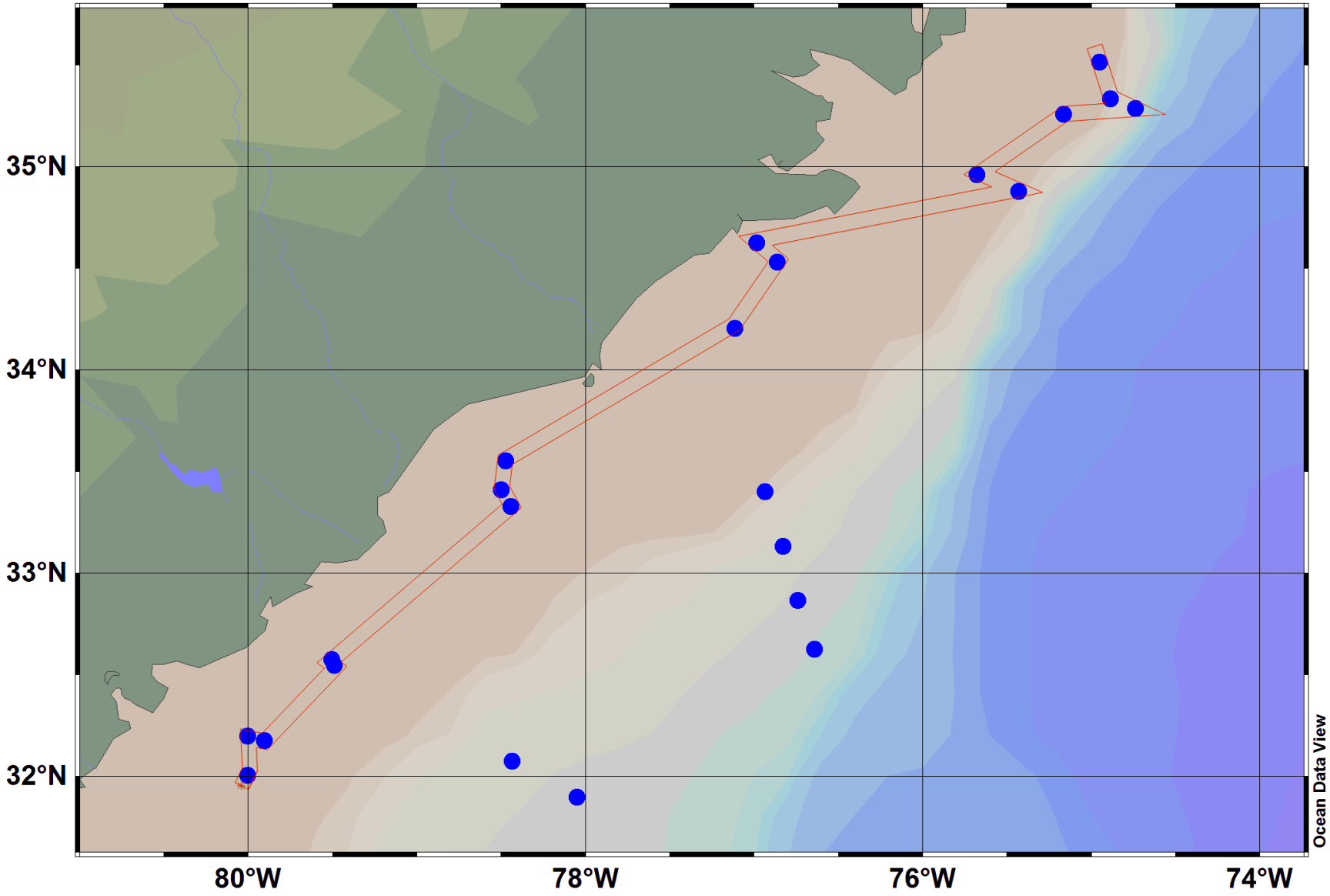
WATER COLUMN MEASUREMENTS

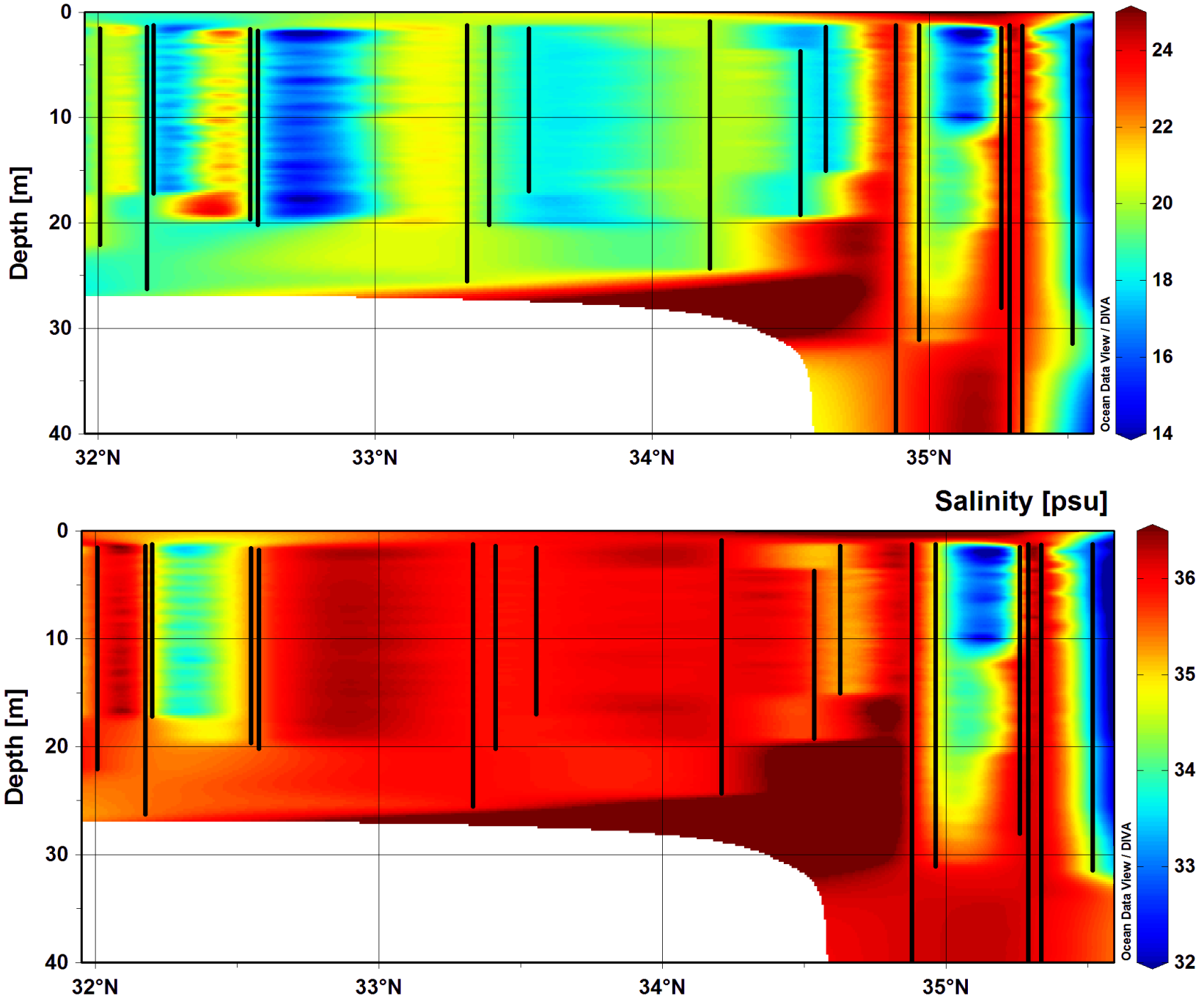
- Automated Laser Fluorometer (Chl *a*, CDOM, PE-1, PE-2, PE-3, Fv/Fm, sPSI)
- Satlantic FIRe (Chl *a*, Fv/Fm, sPSII, Electron Transport Reactions)
- FlowCAM (Phytoplankton imaging, taxonomy and size classification)
- Phycobilipigment estimates in seawater

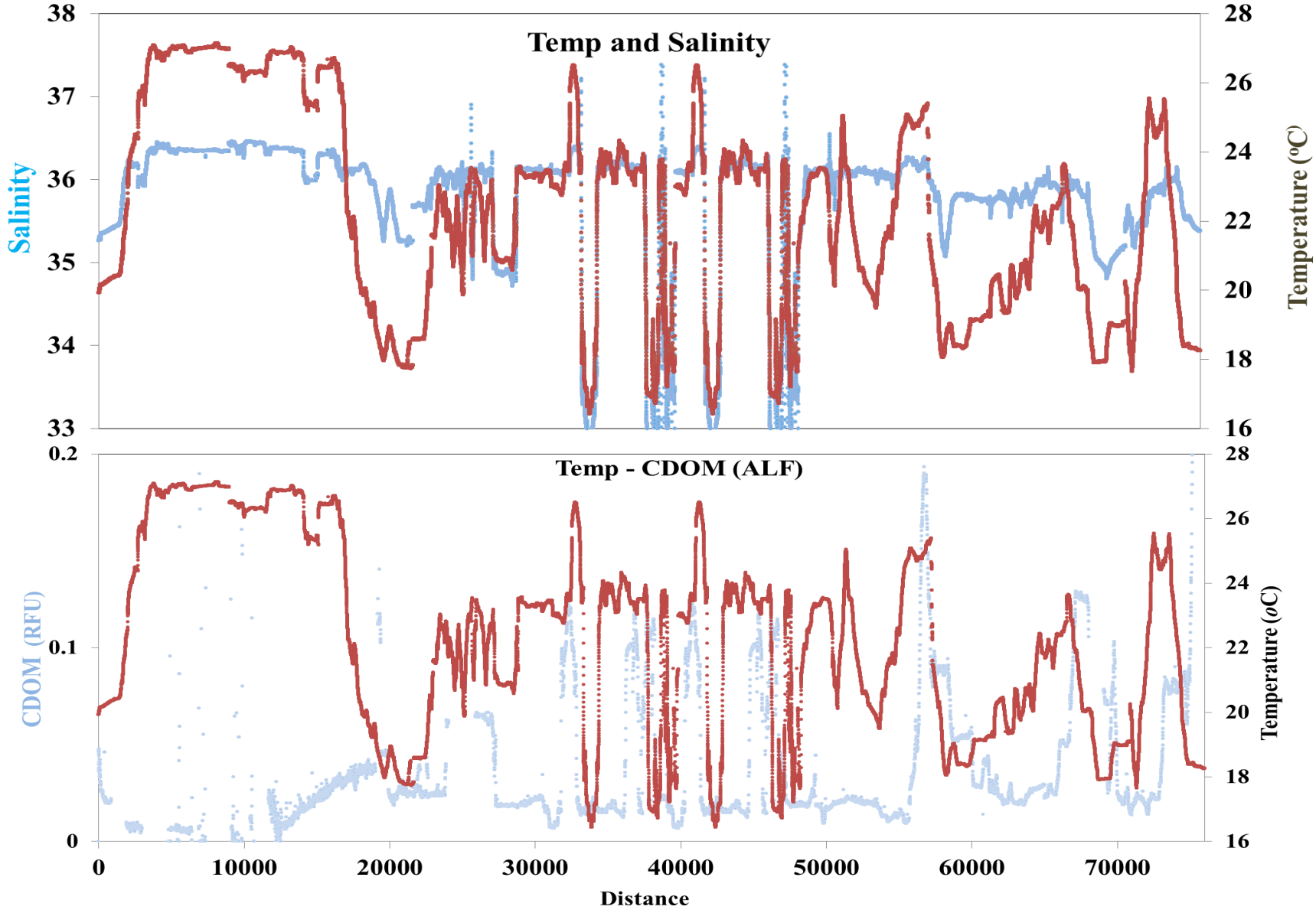


Set up of flow through system on R/V *Nancy Foster*

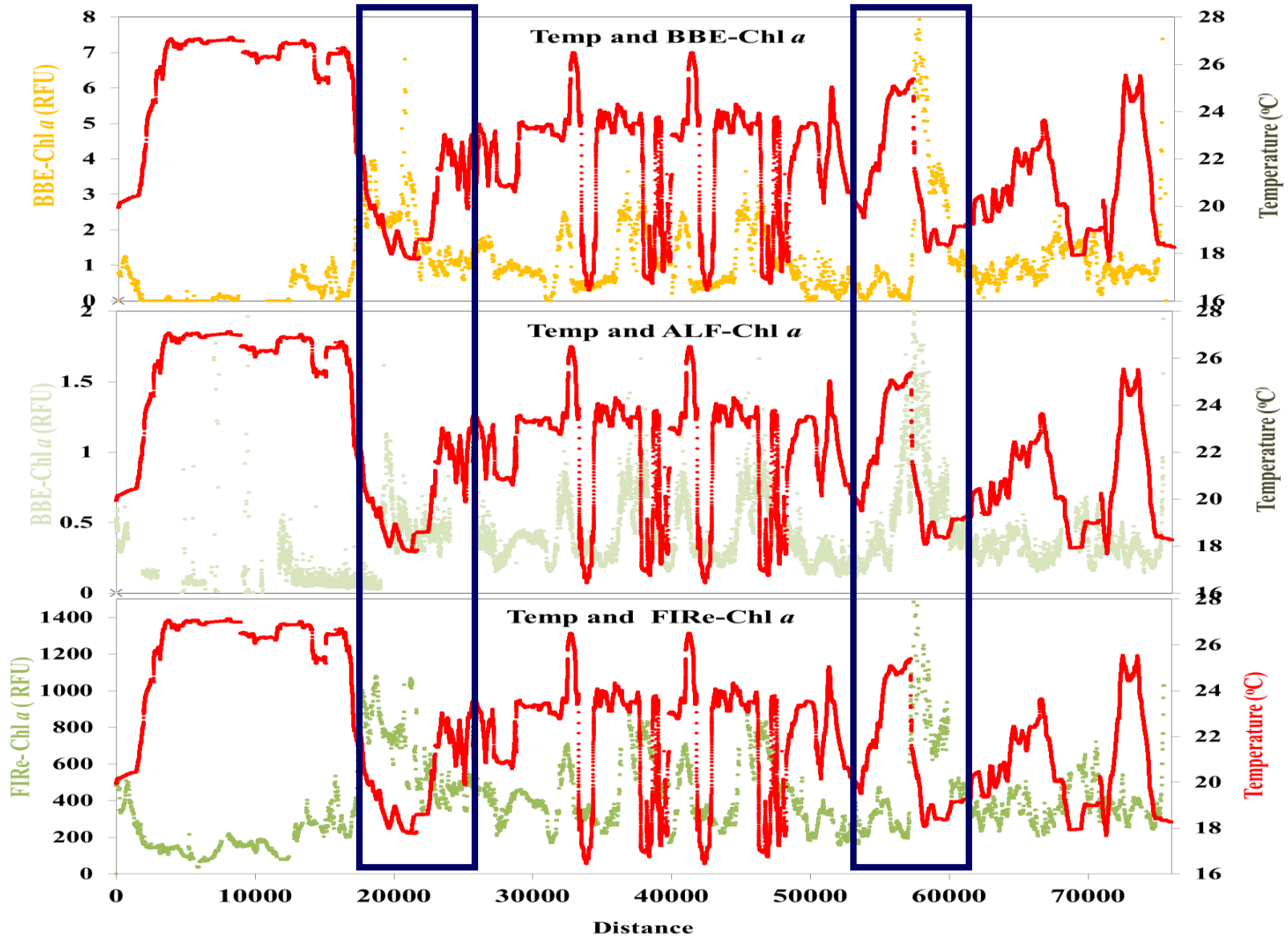
Map of the 23 Cruise Stations



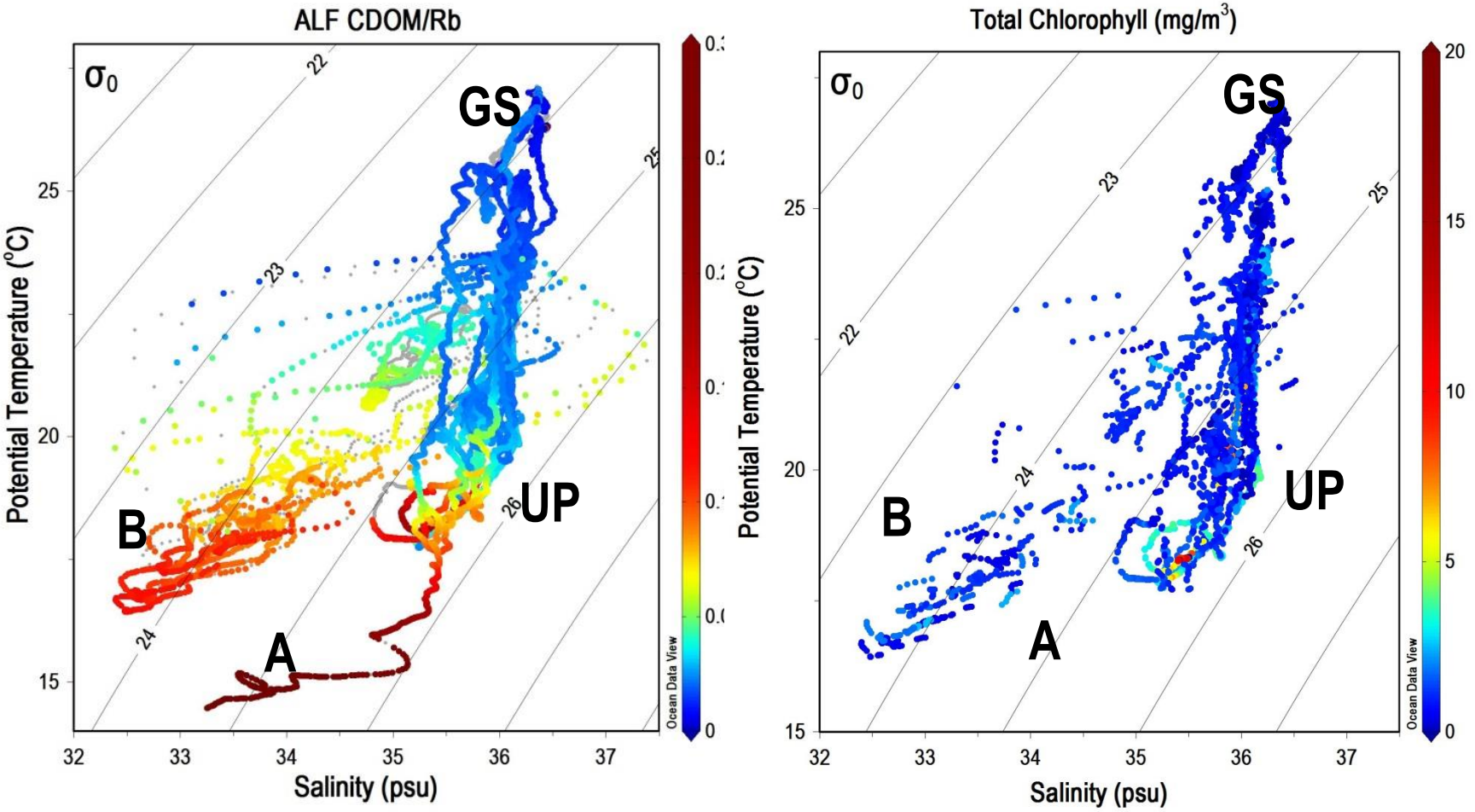

Temperature [°C]
Depth [m]
0
10
20
30
40
32°N
33°N
34°N
35°N
24
22
20
18
16
14
Ocean Data View / DIVA
Salinity [psu]
Depth [m]
0
10
20
30
40
32°N
33°N
34°N
35°N
36
35
34
33
32
Ocean Data View / DIVA



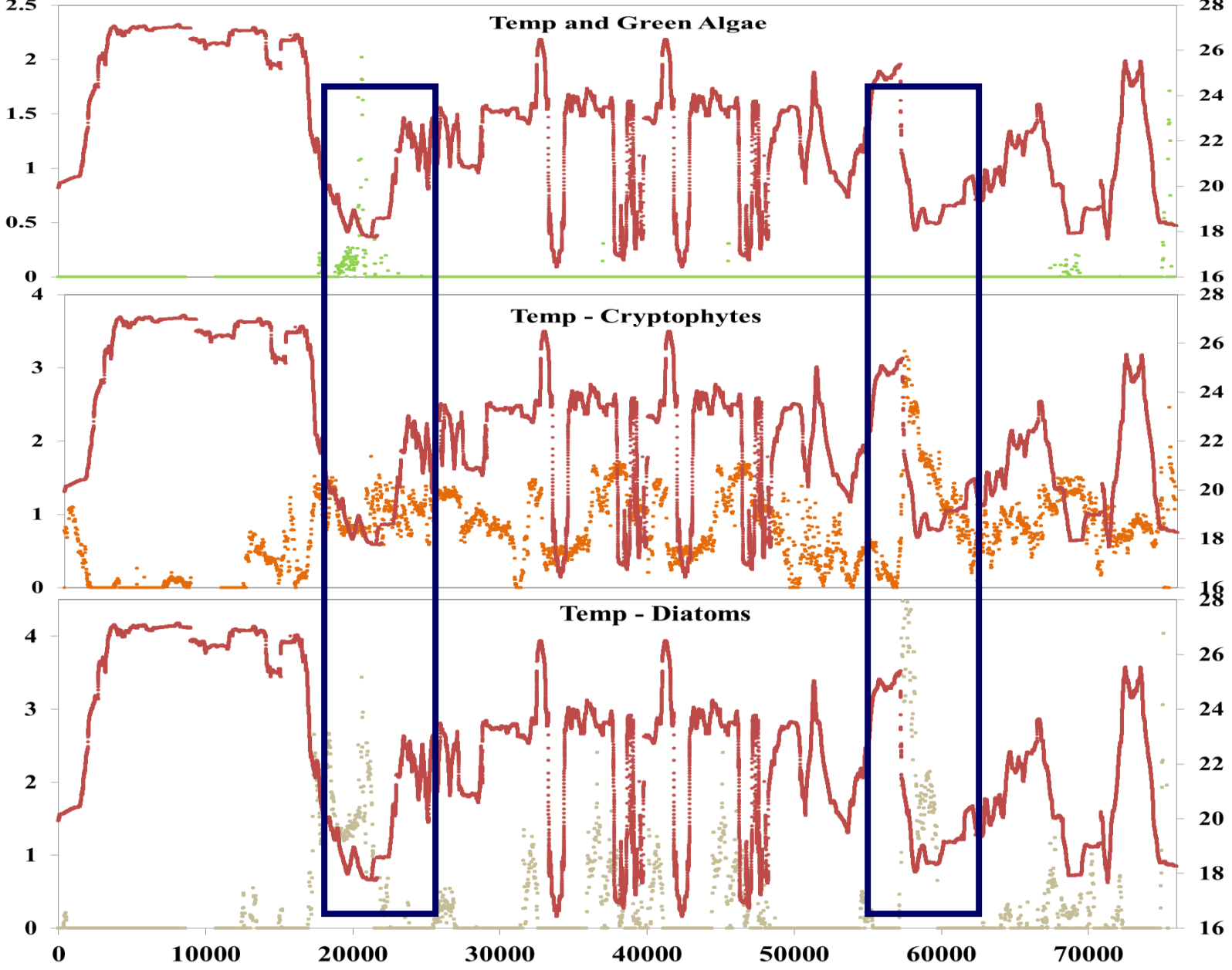
Distribution of CDOM, temperature and salinity along the cruise track



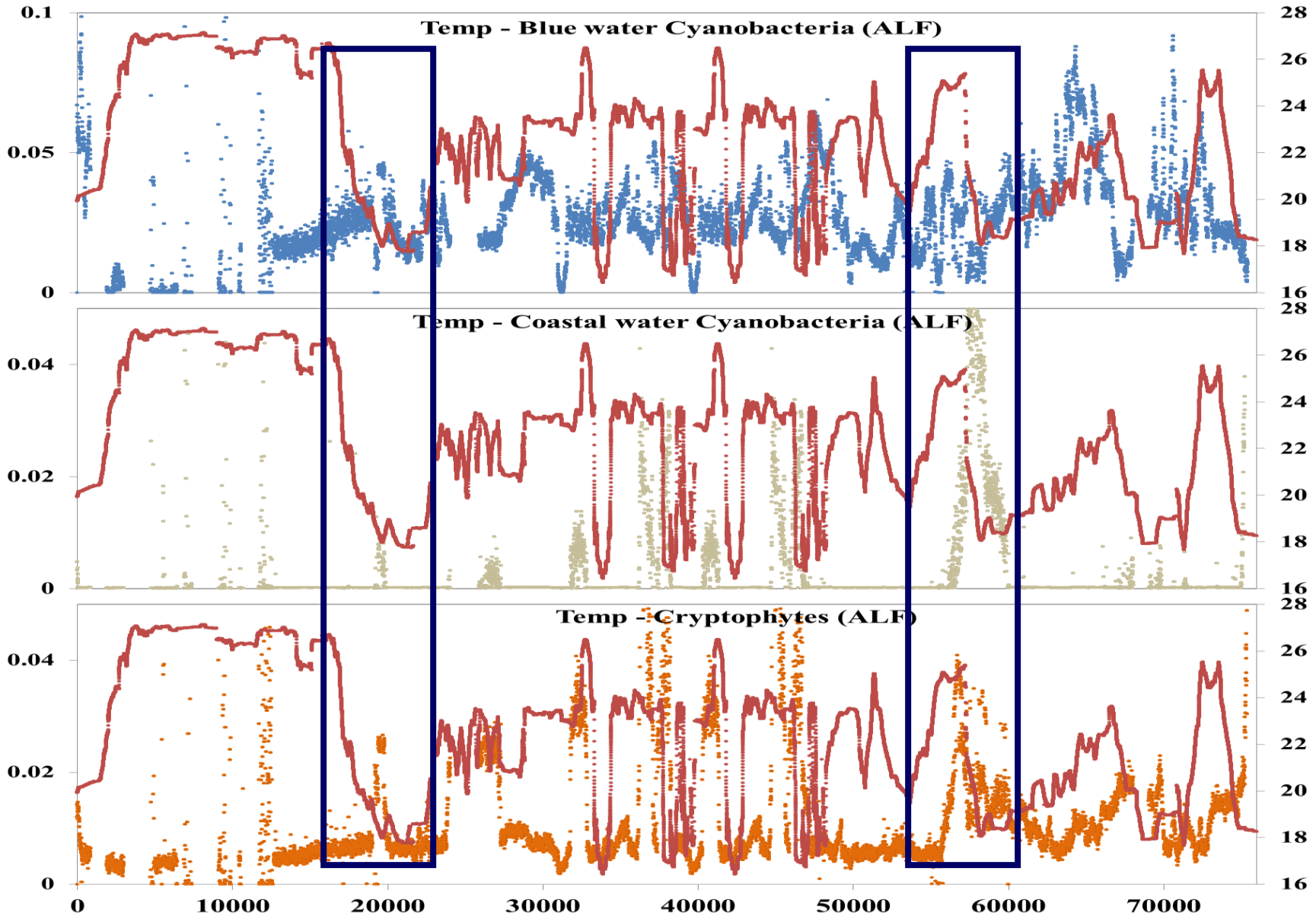
Distribution of Chl a (measured by three different instruments) temperature along the cruise track



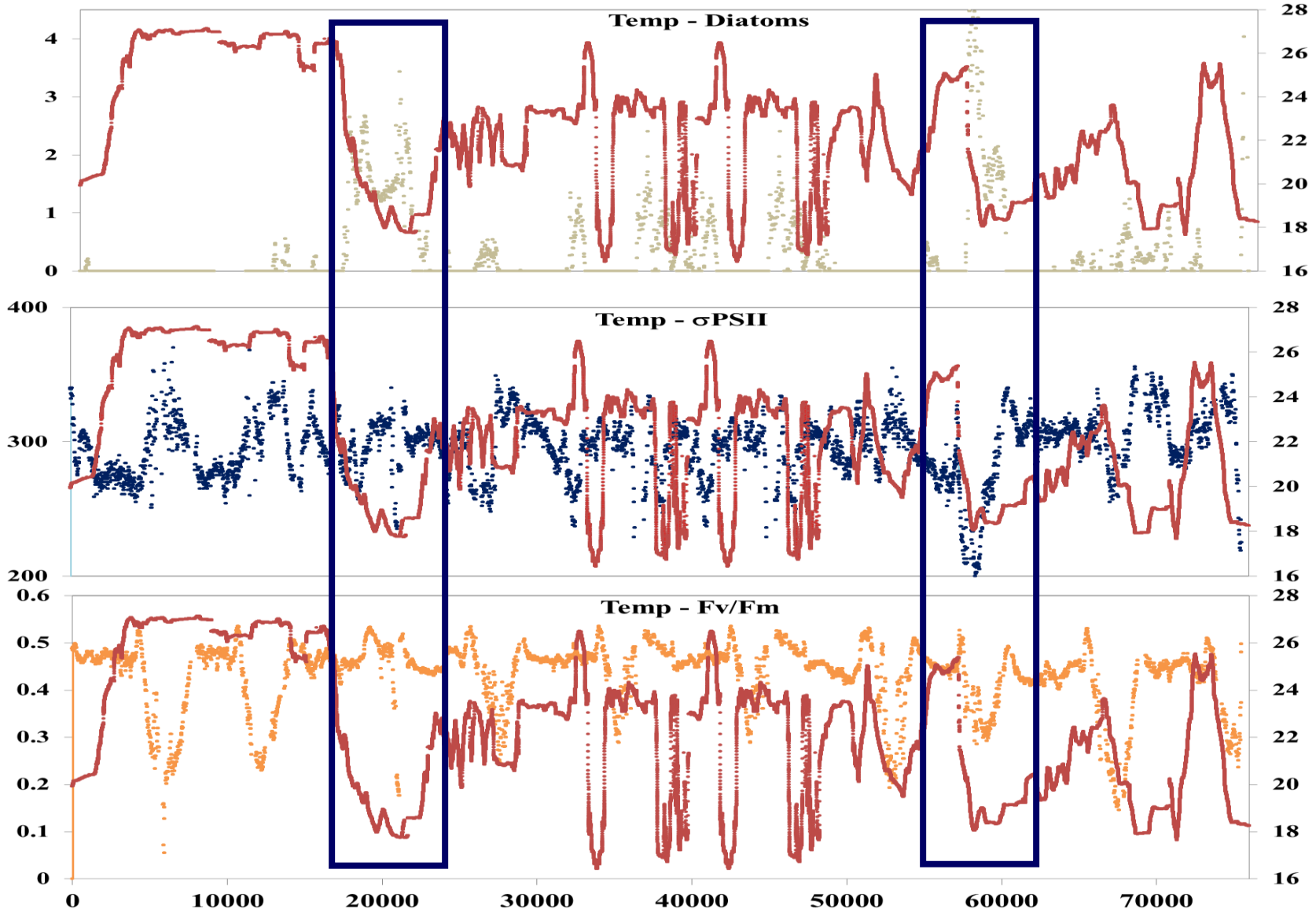
T-S plots showing CDOM concentrations and total Chl *a* associated with different water types



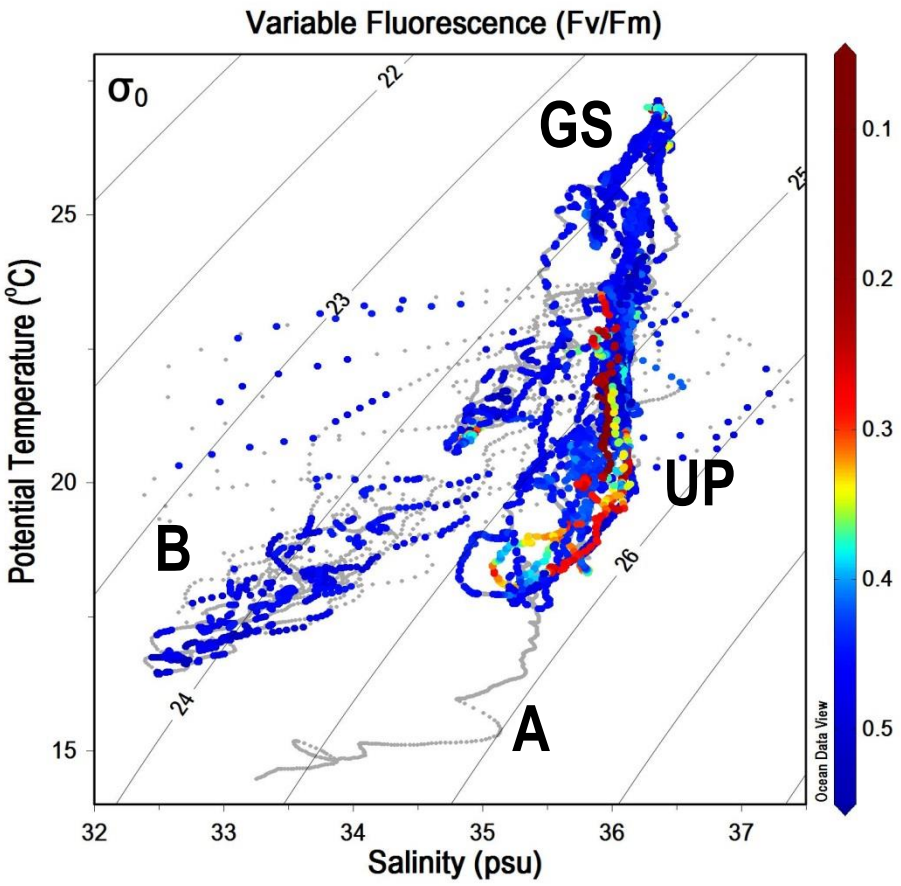
Variations in major PFTs with temperature along the cruise track (measured by bbe)

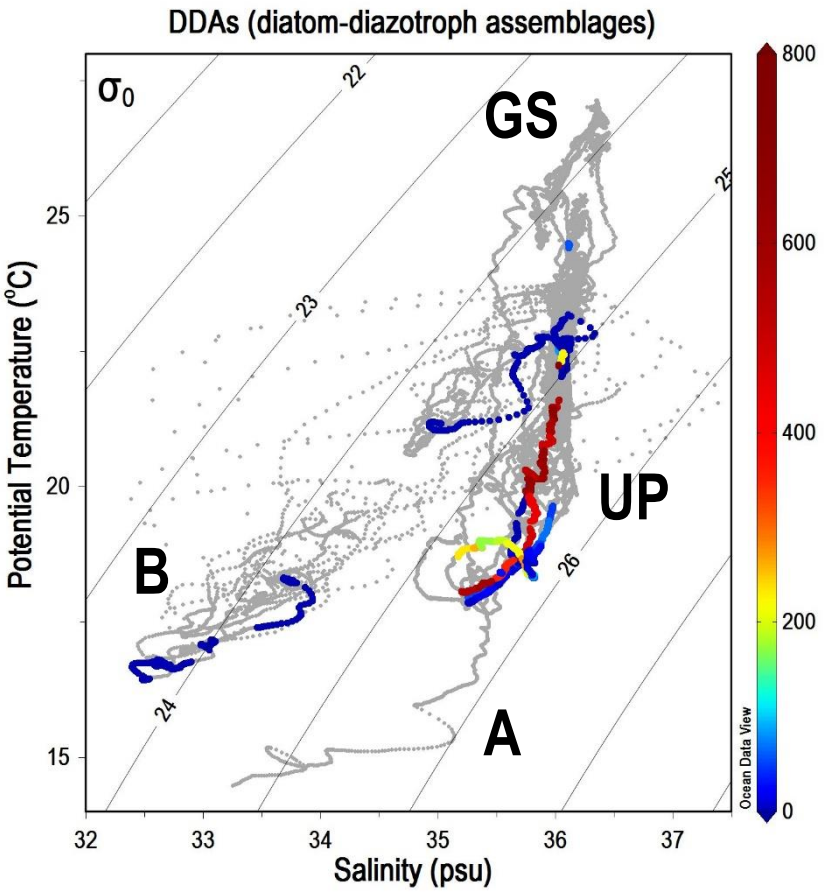


Variations in major phycobilipigment containing PFTs with temperature along the cruise track (measured by bbe)

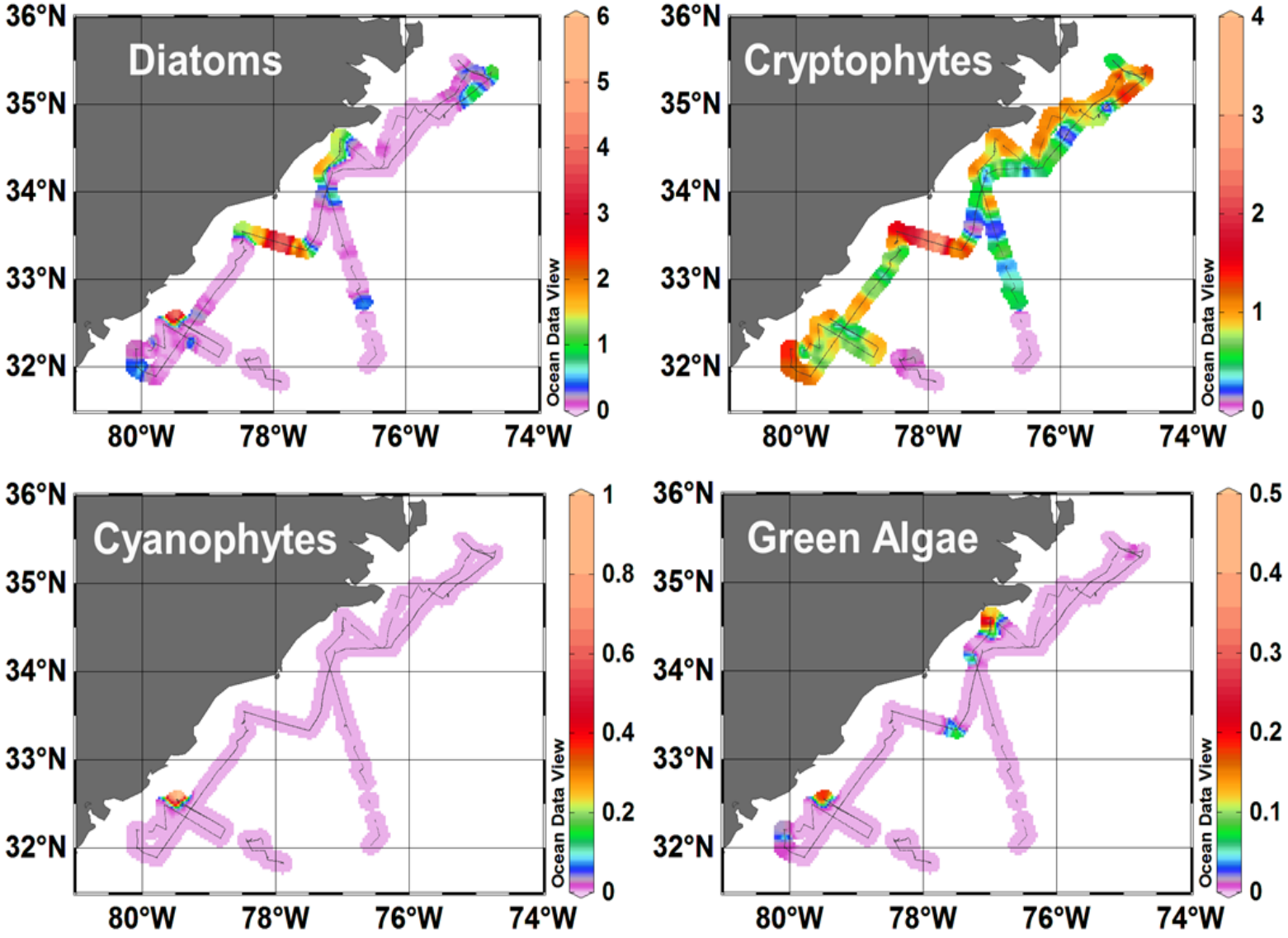


Variations in diatom biomass and photosynthetic competency of phytoplankton populations

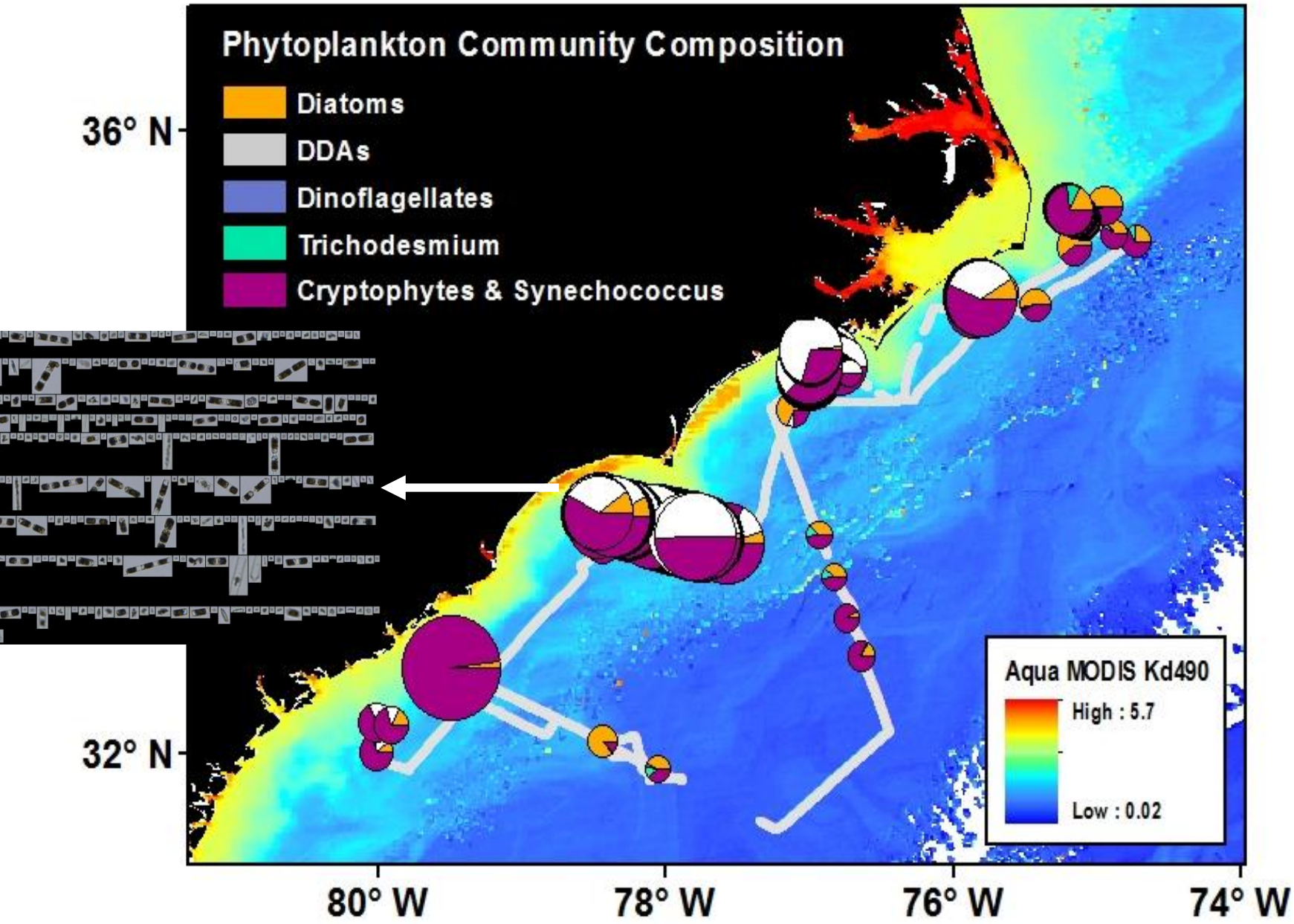




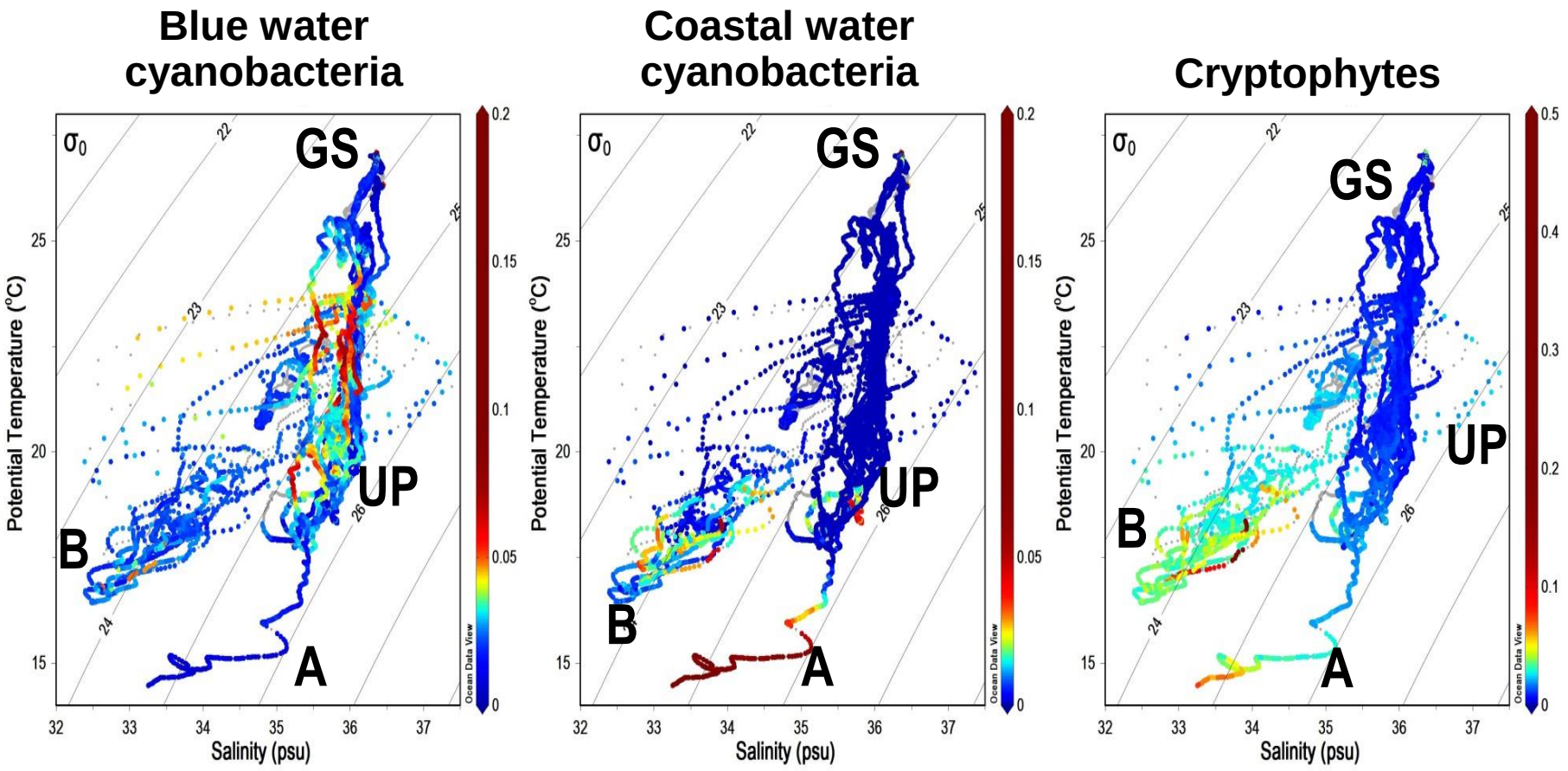
T-S plots showing photosynthetic performance of PFTs in different water types



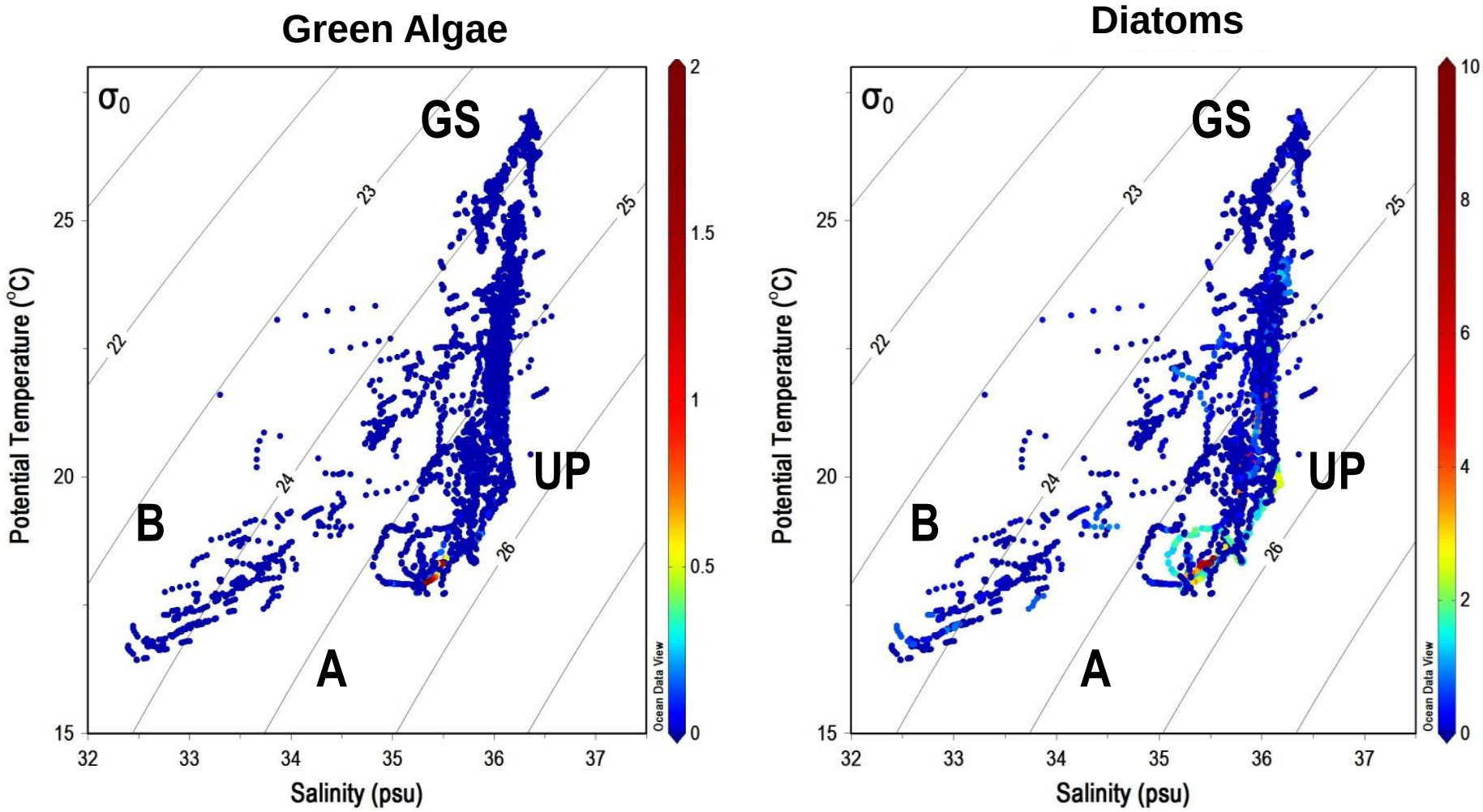
Distribution of biomass of PFTs along cruise track measured by bbe Molaedanke



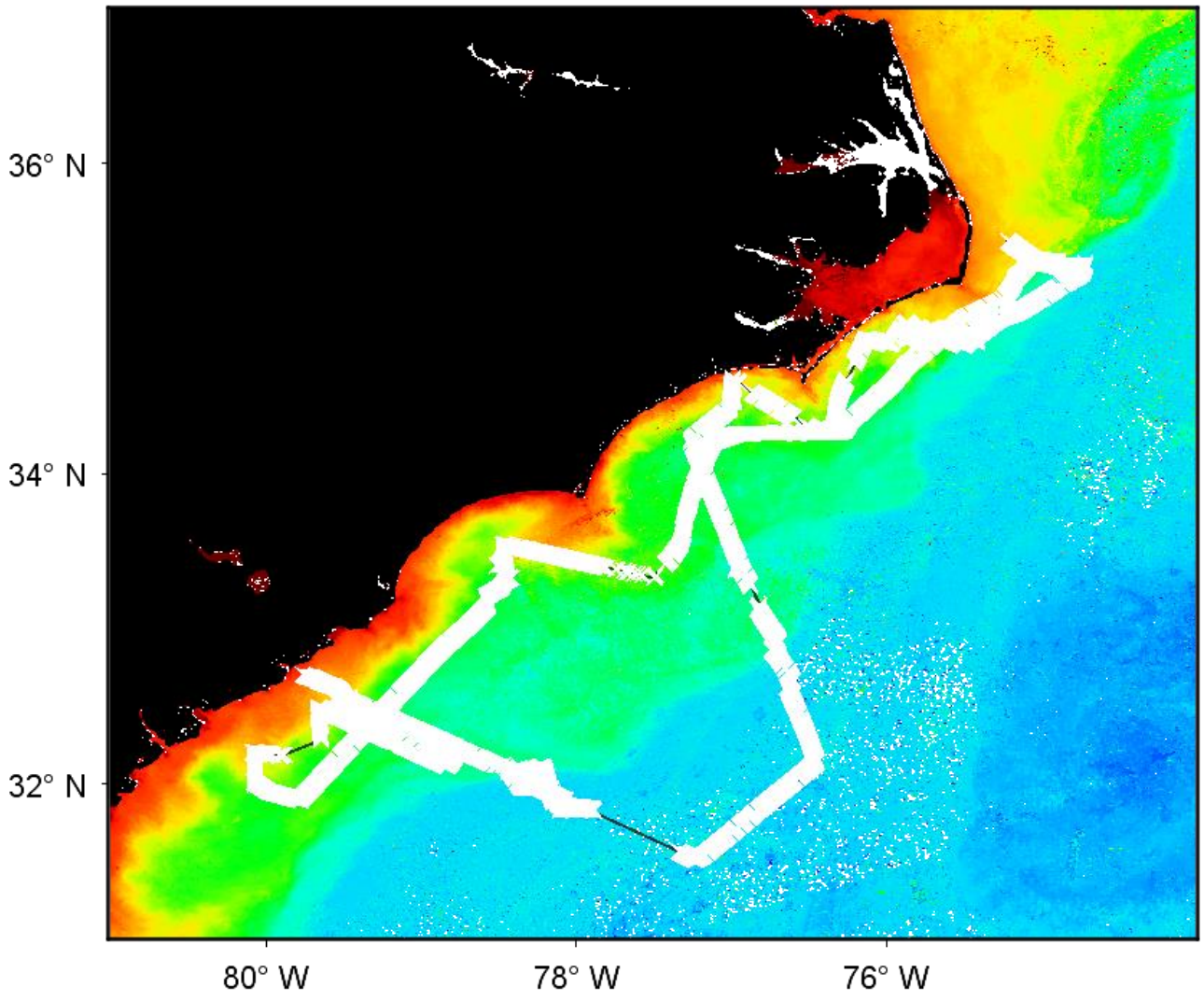
Distribution of major PFTs along the cruise track using FlowCAM



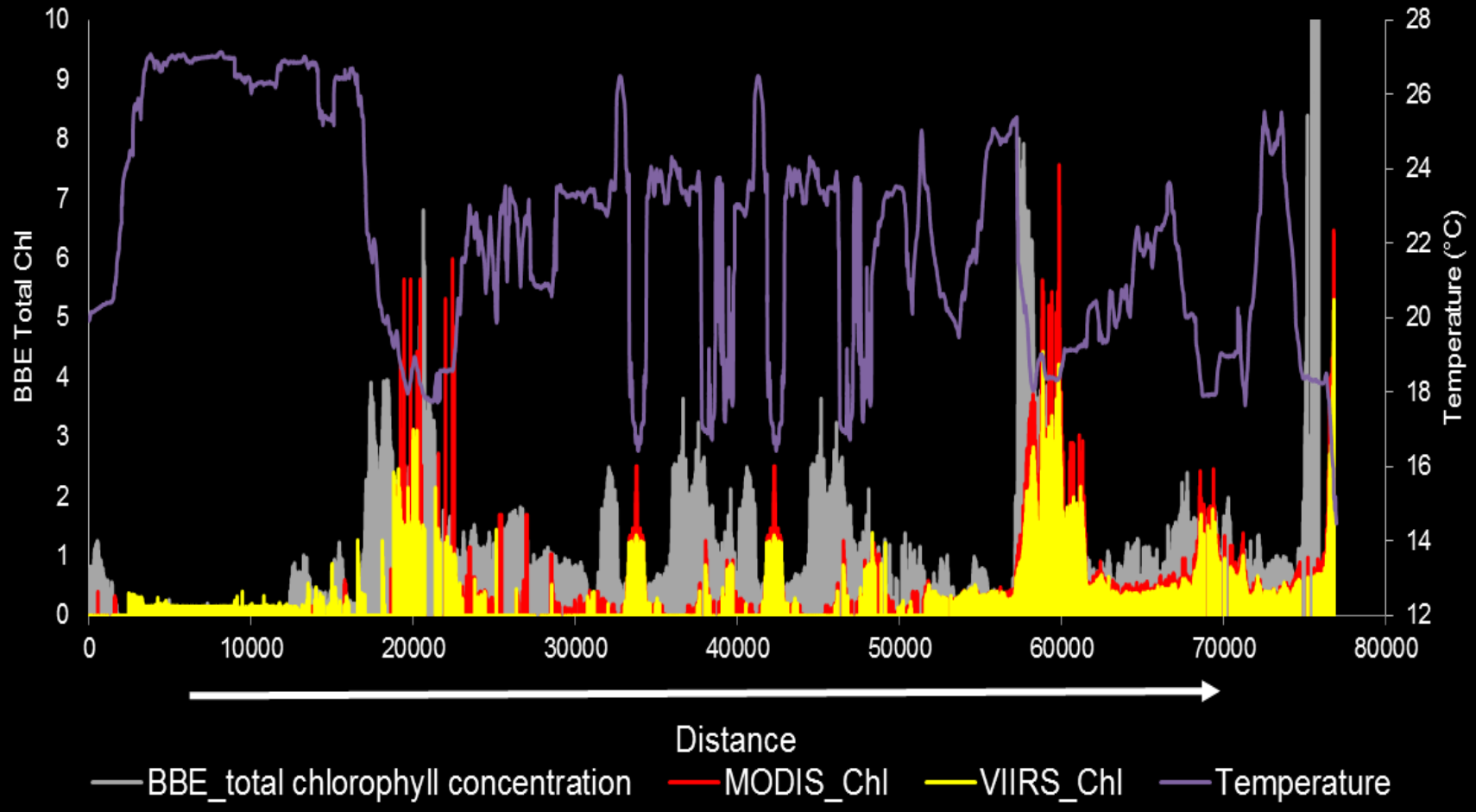
T-S plots showing PFTs associated with different water types



T-S plots showing PFTs associated with different water types



***R/V Nancy Foster* cruise track overlaid on VIIRS Chl data binned for the 1st week of Nov. 2014**


Aqua MODIS, VIIRS, and BBE Chlorophyll vs Temperature
BBE Total Chl
Temperature (°C)
0
1
2
3
4
5
6
7
8
9
10
12
14
16
18
20
22
24
26
28
0
10000
20000
30000
40000
50000
60000
70000
80000
Distance
BBE_total chlorophyll concentration
MODIS_Chl
VIIRS_Chl
Temperature

Future Plans

- **Development of PFT and phytoplankton size distribution algorithms using a combination of flow-through in-situ optical and hydrography measurements with special focus on microscale features and frontal zones in coastal waters**

- **Estimation of primary productivity using measurements of phytoplankton biomass and FRRF derived -photo-physiology**

Questions?

THANK YOU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U.S. DEPARTMENT OF COMMERCE


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