Biogeochemical Measurements From Today to Tomorrow: AUVs to UAVs.

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Biogeochemical Measurements

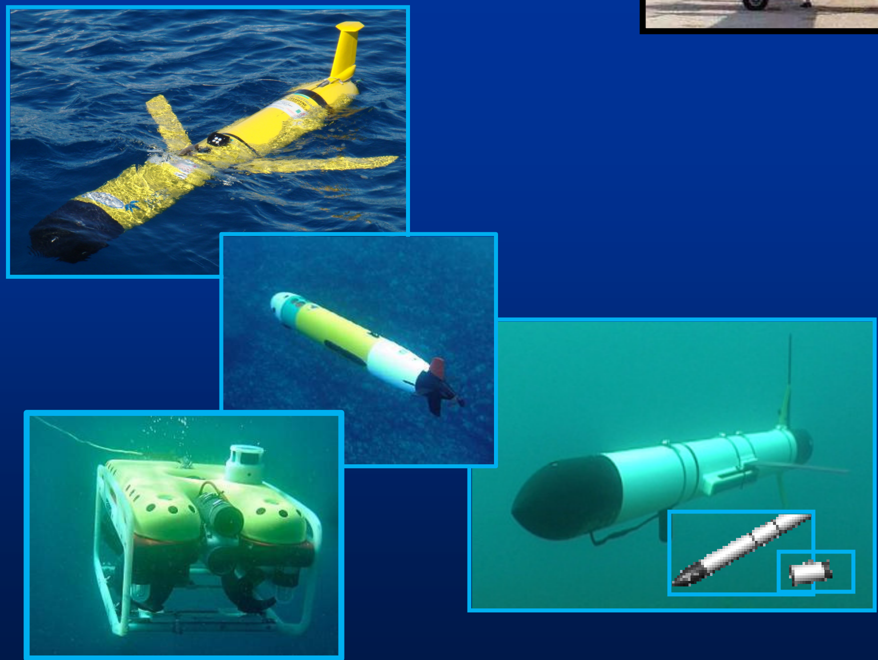
Measurements of or relating to the partitioning and cycling of chemical elements and compounds between the living and nonliving parts of an ecosystem.

Properties/measurements (JGOFS cruises; 2-NABE, 3-EqPac and 4-Arabian Sea)

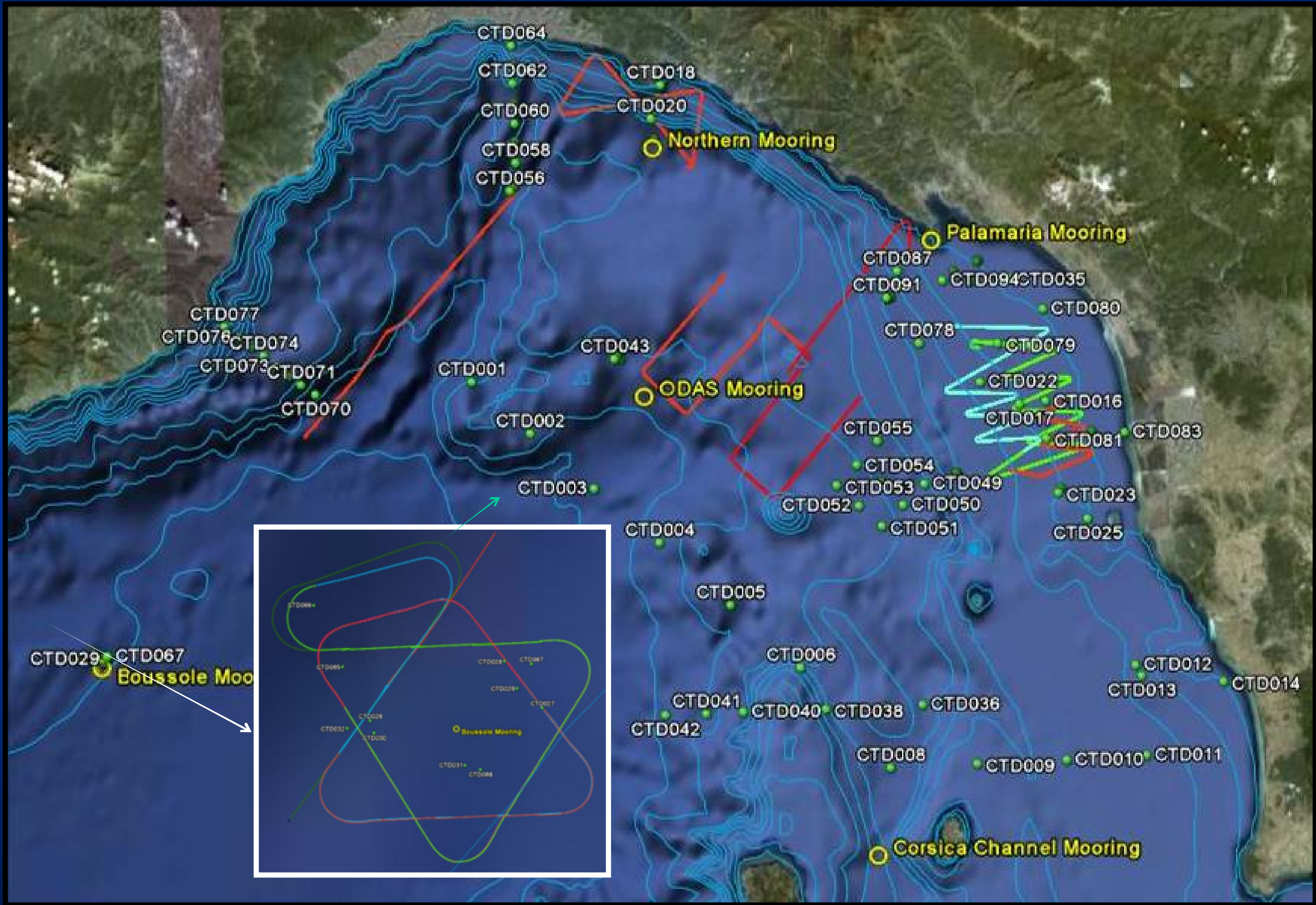
1. Nutrients
2. Carbon (Particles and dissolved/'yellow substances')
3. Productivity
4. Particle flux
5. Zooplankton
6. Optics/light penetration
7. Grazing
8. Megafauna

Platforms

Continuous-flow
Scientific Sea Chest
(2-3 meter depth)



Multi-Platform Approach



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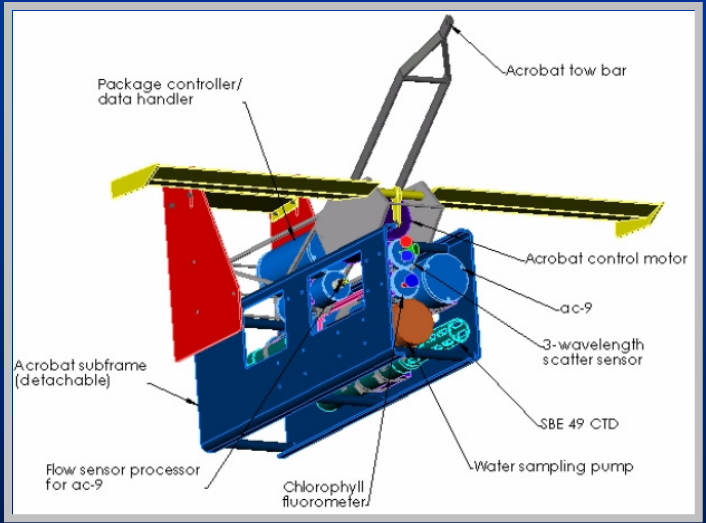
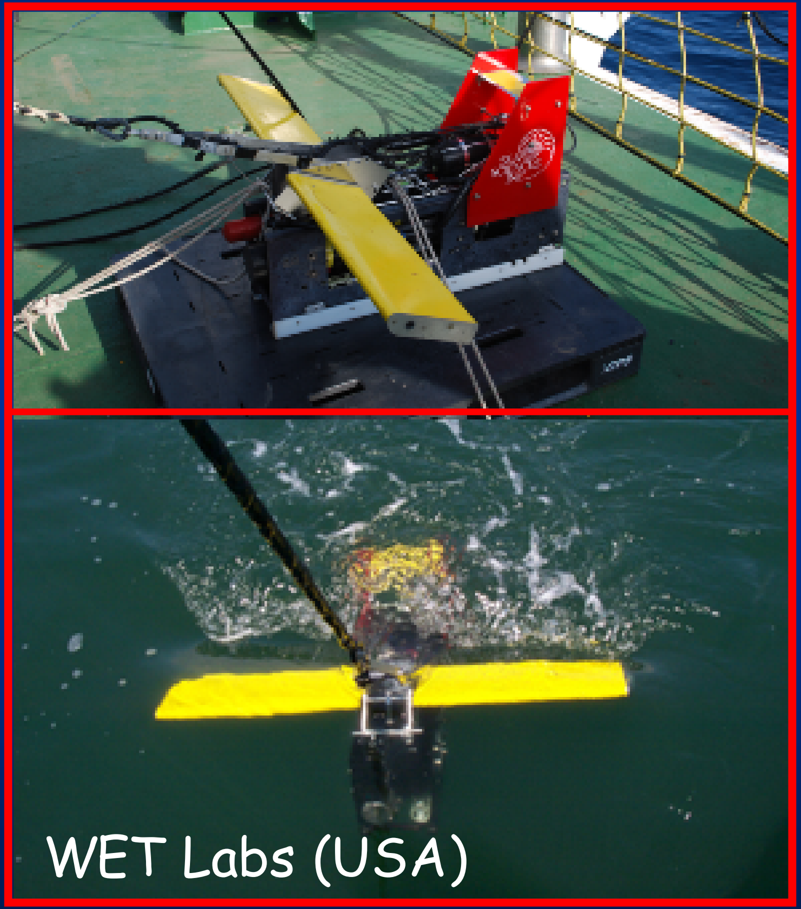
DOLPHIN (IOP)

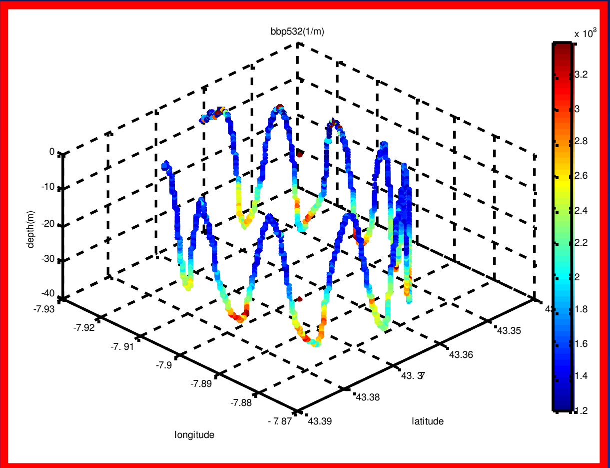
Diving OpticaL Profiler & High-speed Integration Network

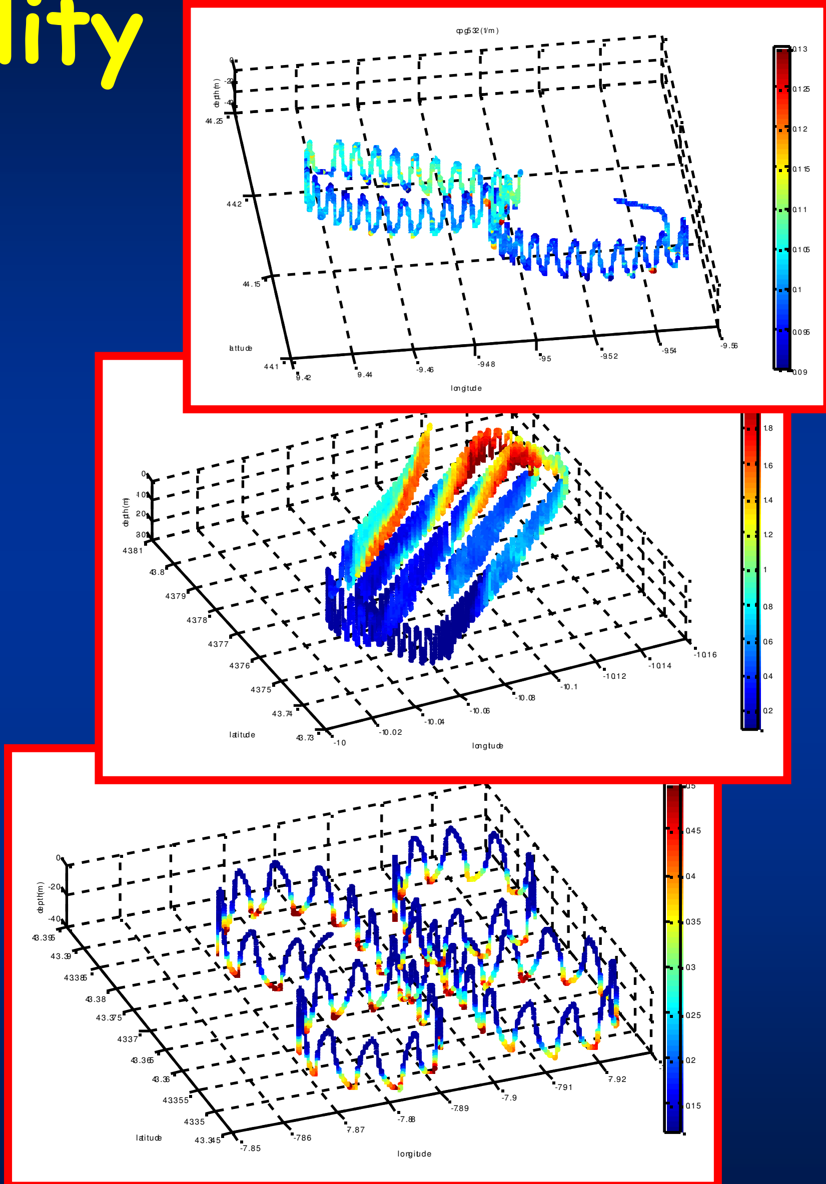
DOLPHIN contains a CTD, a, b and c meters, b_b sensor (Diver Vis). Undulates down to ~ 40 m.

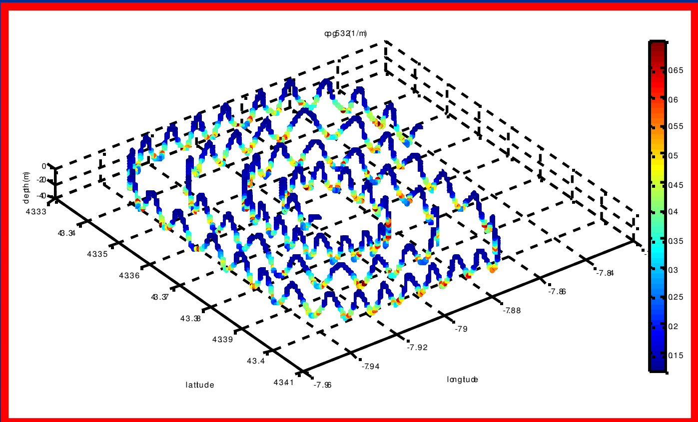




Intra- & Inter-Pixel Variability

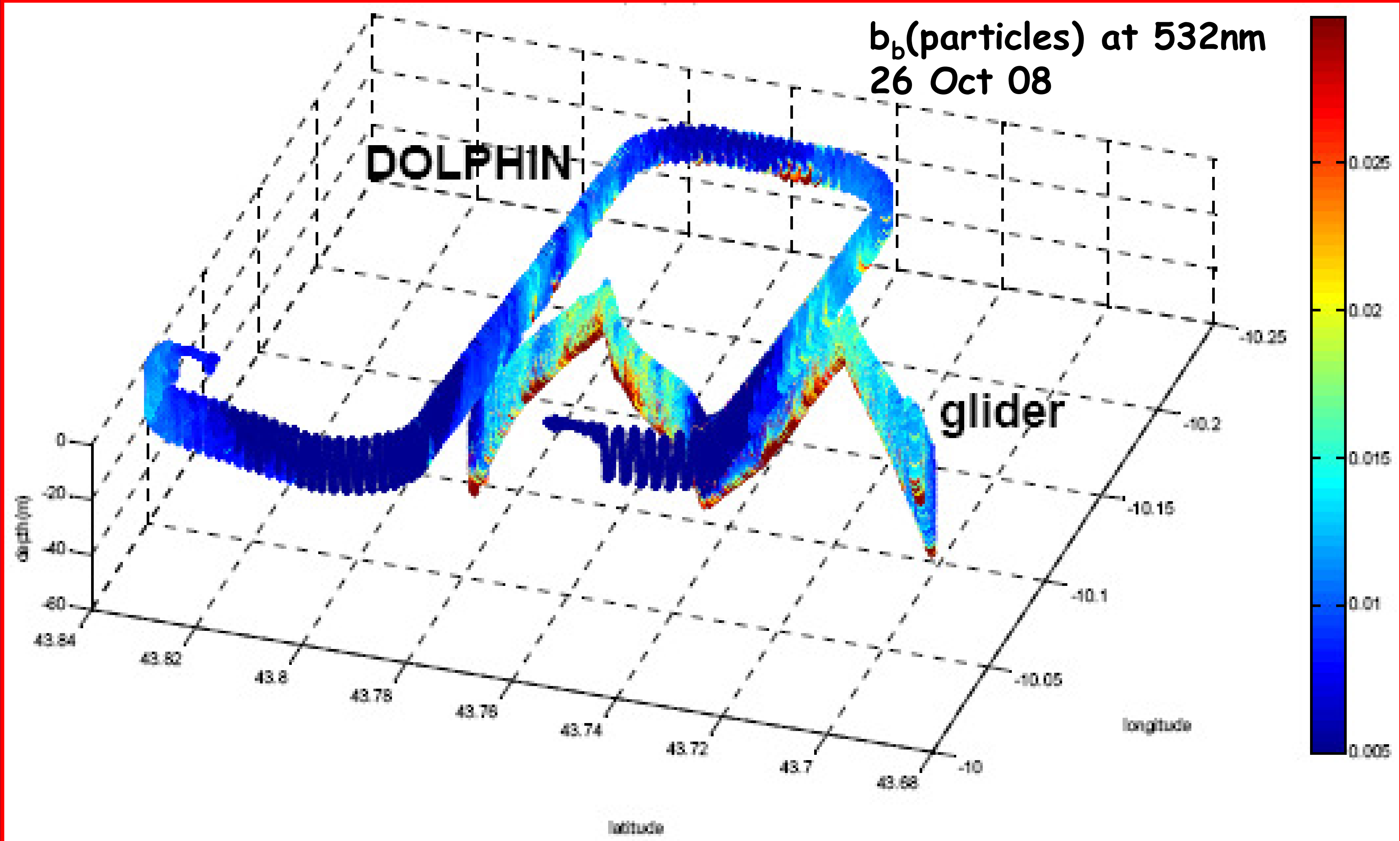






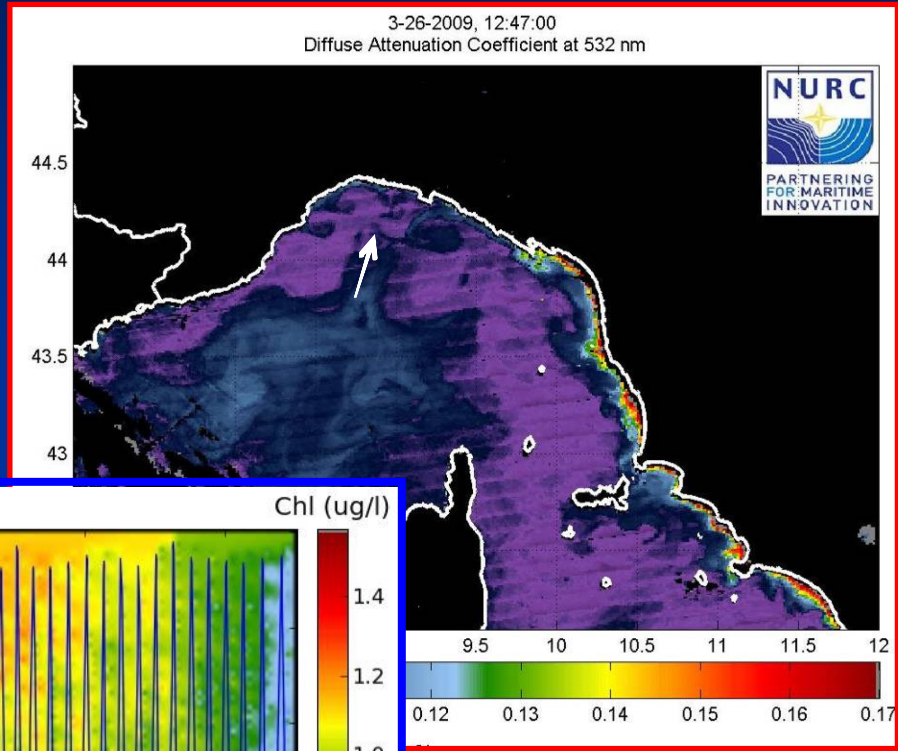
Optimal Sampling Strategy

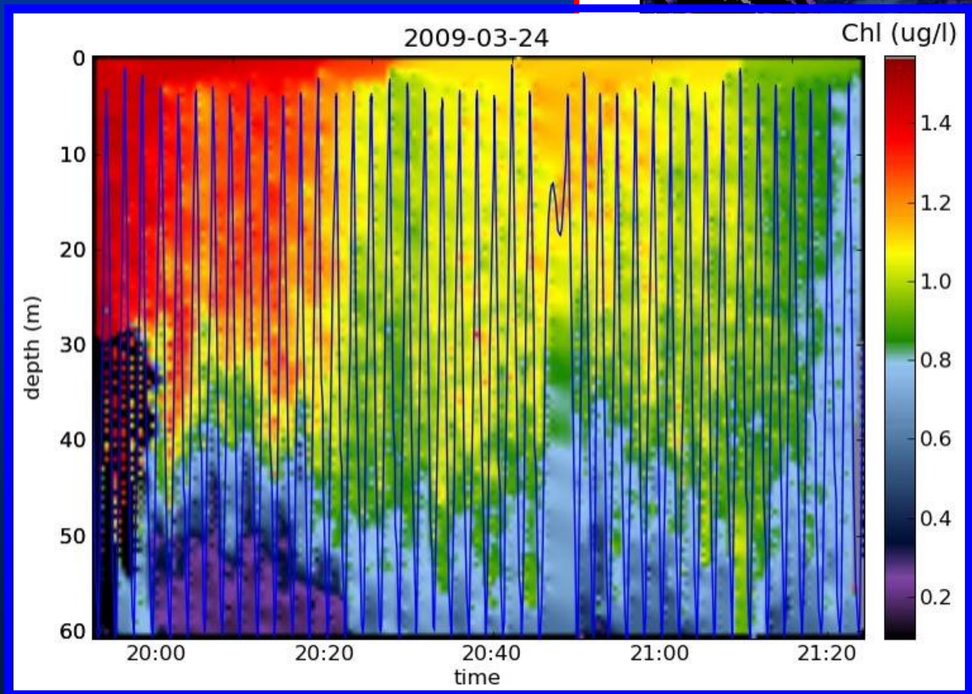
Glider & DOLPHIN Comparison



NURC's ScanFish MK II

High Res CTD
bb2f
ac-s

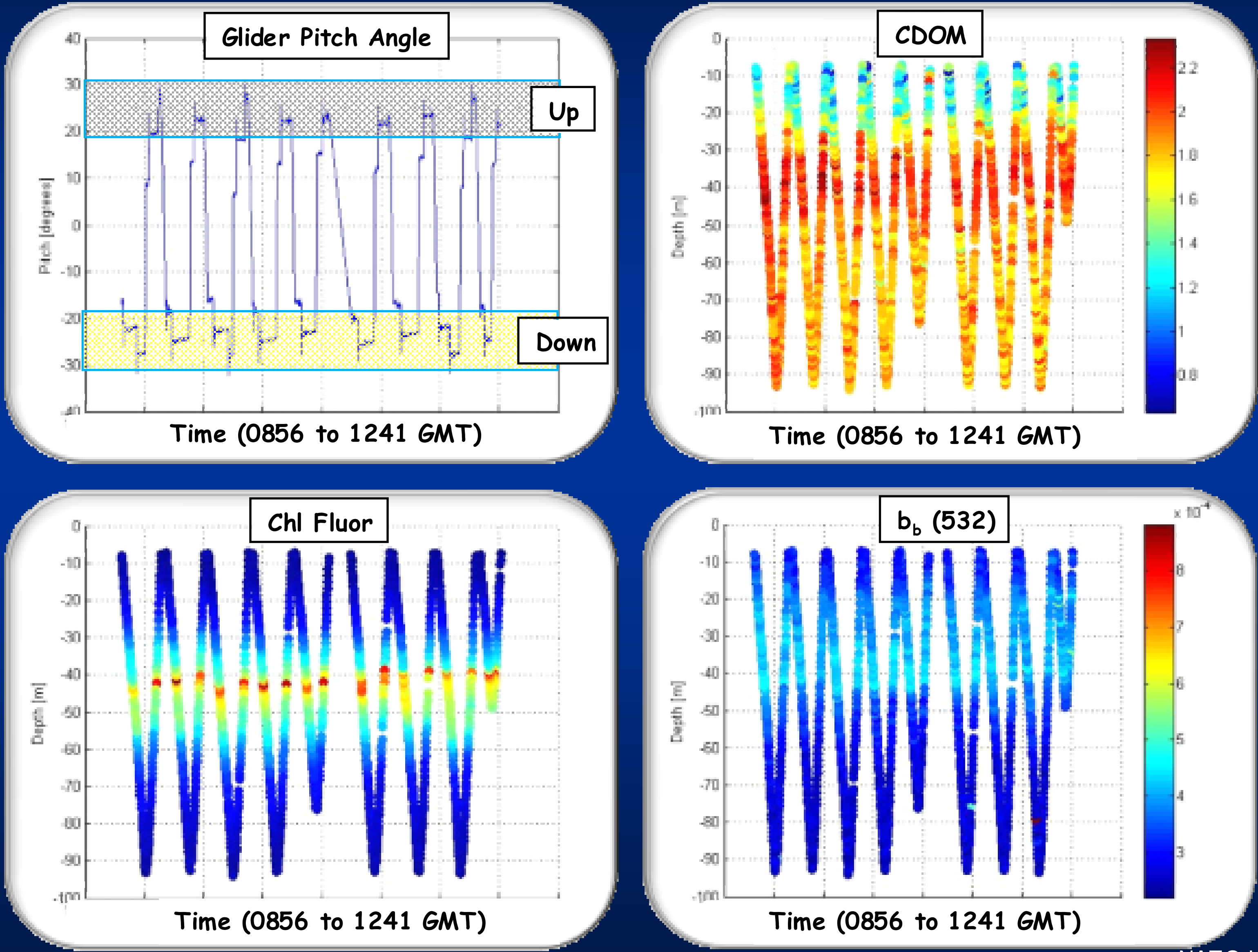




Slocum Glider Fleet

1. ELETTRA: max depth = 200 m, CTD, Chl, CDOM, Ed (4 λ), b_b (532 nm).
2. LAURA: max depth = 200 m, CTD, b_b (3 λ), BAM (532 nm).
3. GRETA: max depth = 200 m, CTD.
4. SOPHIA: max depth = 200 m, CTD, Chl, CDOM, Ed (4 λ), b_b (532 nm).
5. NATALIE: max depth = 200 m, CTD, Chl, CDOM, b_b (532 nm), BAM (532 nm).
6. ZOE: max depth = 200 m, CTD, Chl, CDOM, Ed (4 λ), b_b (532 nm).
7. NONA: max depth = 1,000 m, CTD, passive hydrophone (marine mammals)
8. SPRAY (Blue Fin): max depth = 1,000 m, CTD.

Virtual Mooring (ELETTRA)



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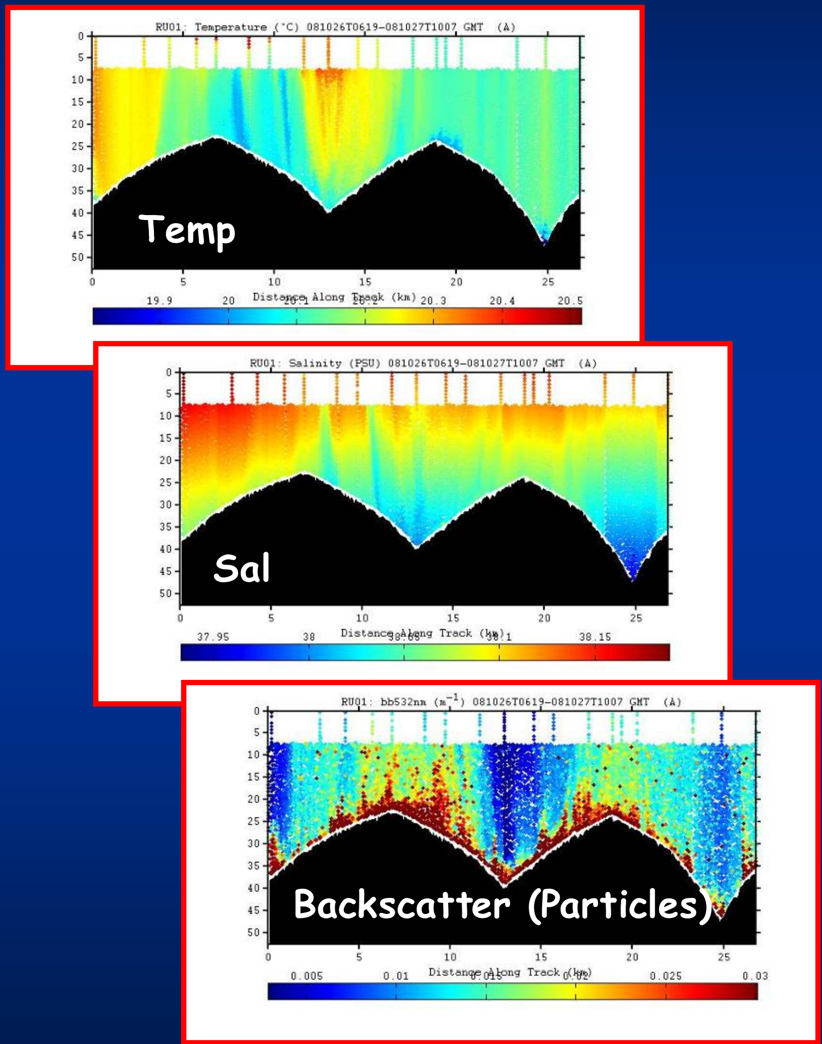
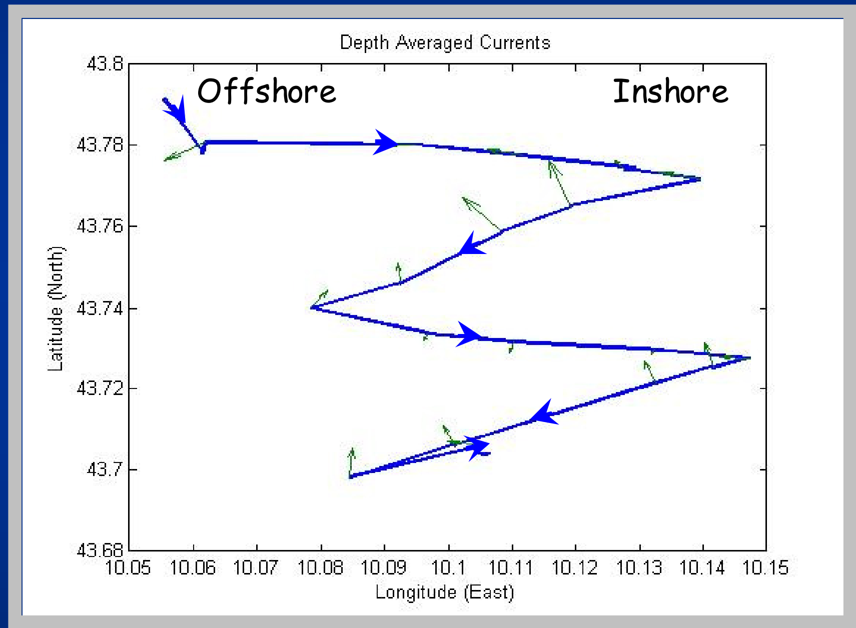
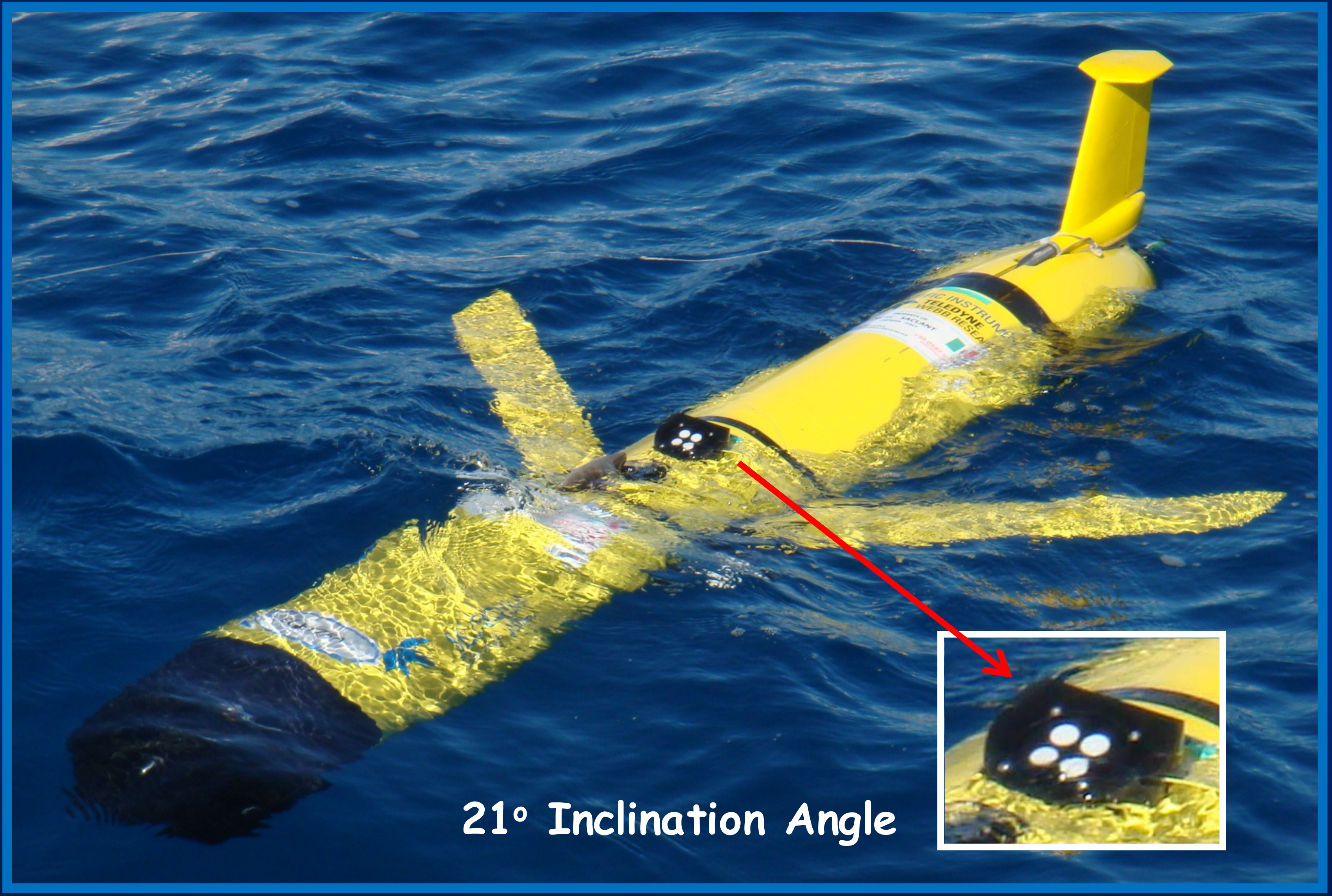
Glider Data Processed on Ship

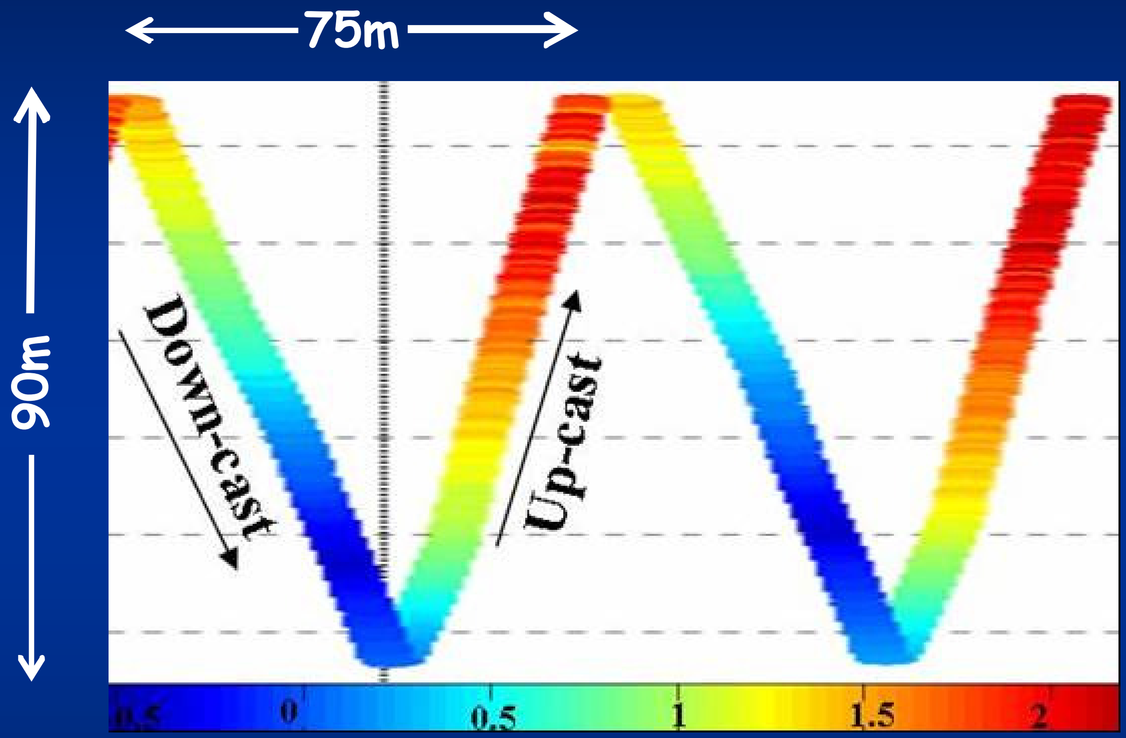




Slocum with OCR-504I Sensor

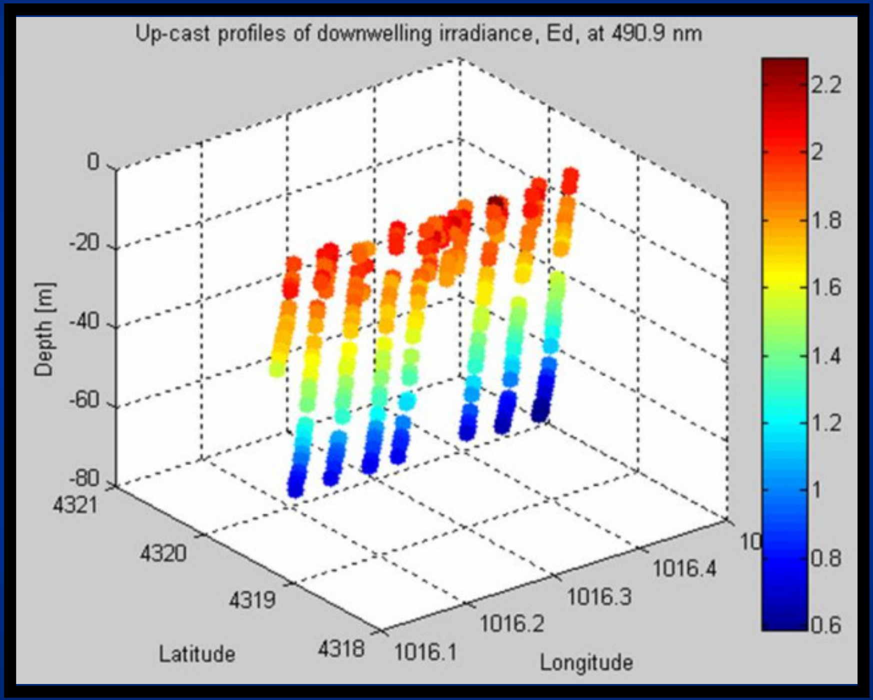


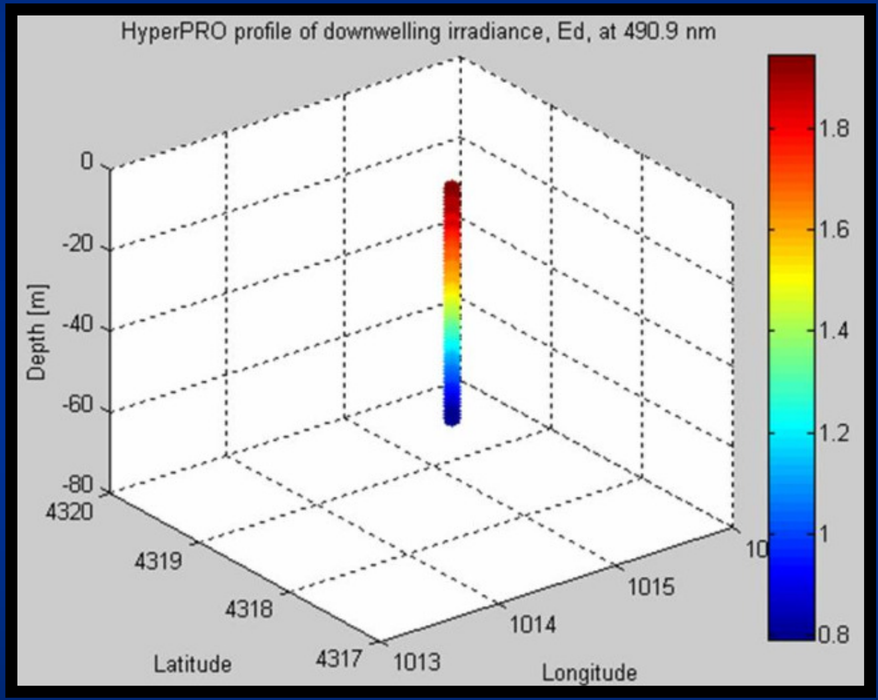
Downwelling Irradiance



Data from a Virtual Mooring Mission (555 nm)

HyperPRO vs. Glider Ed(490)

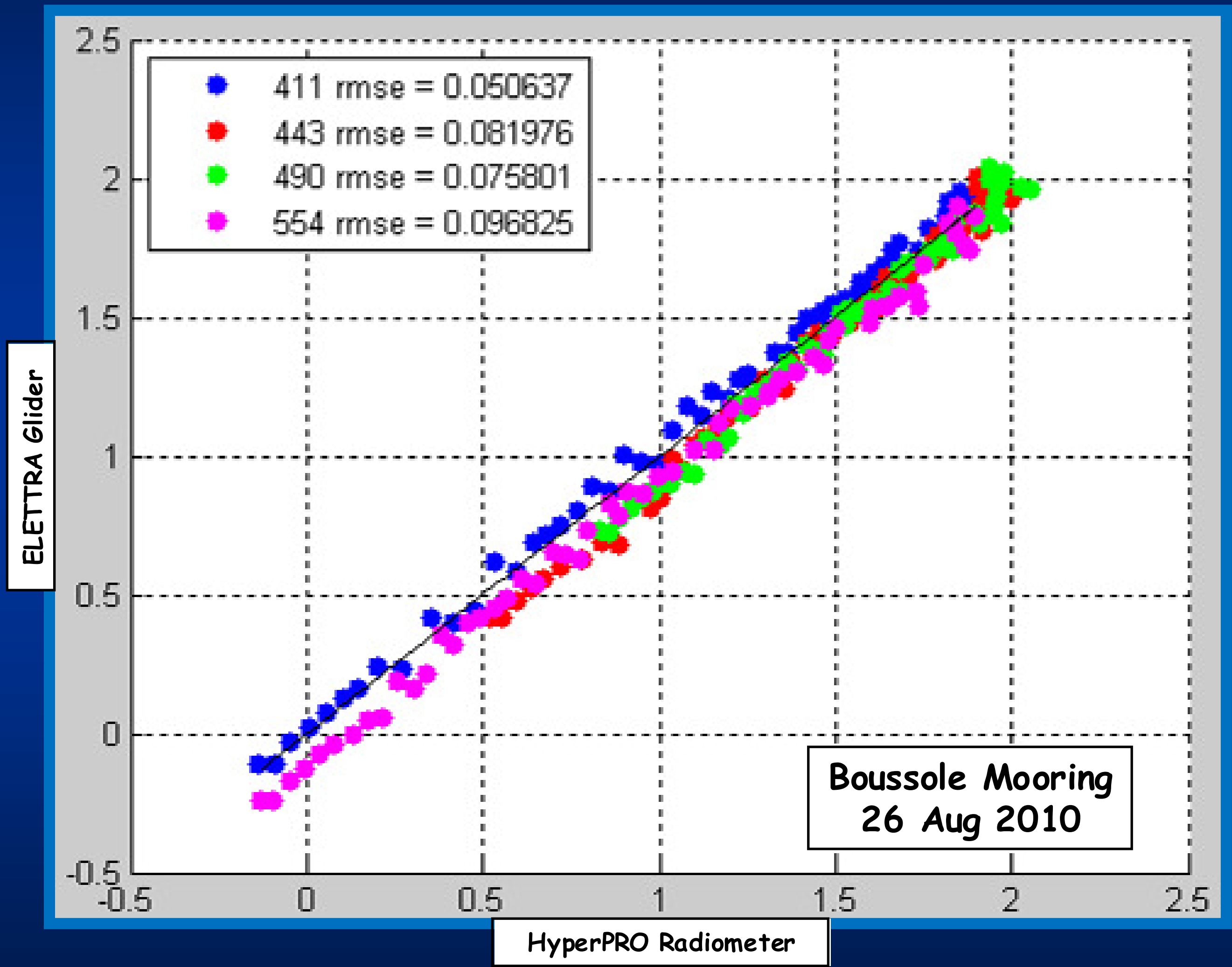




ELETTRA

HyperPRO

HyperPRO to Glider Comparison



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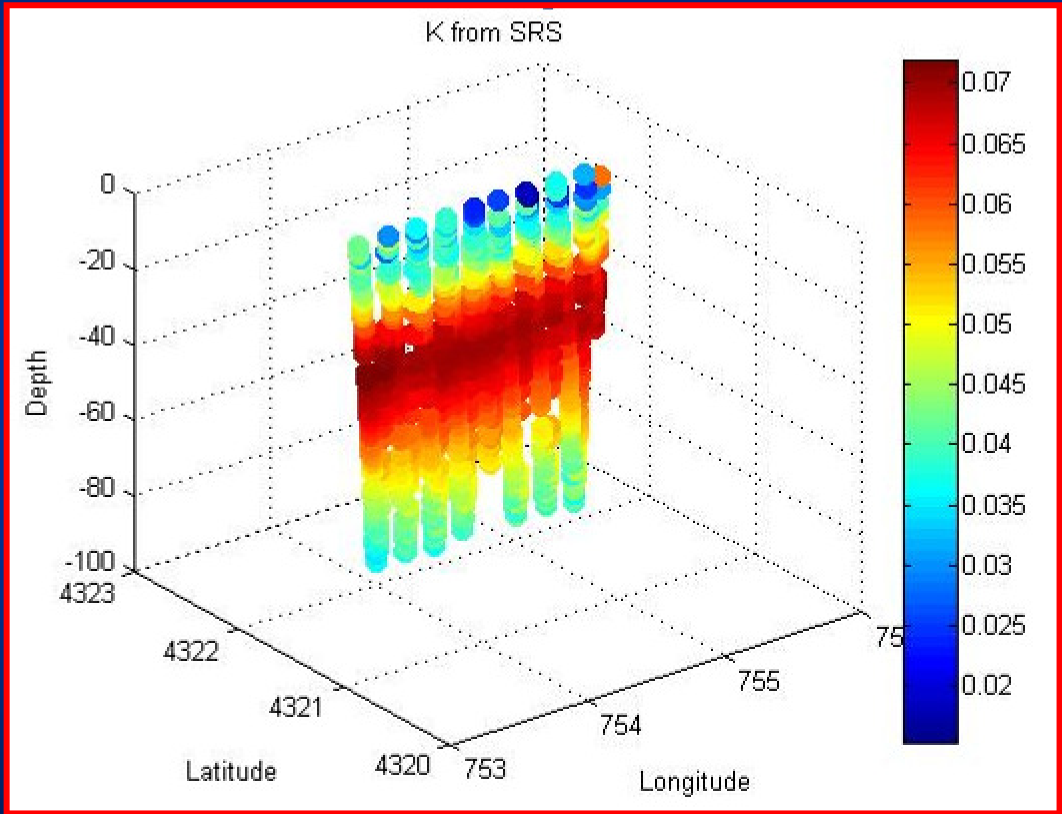
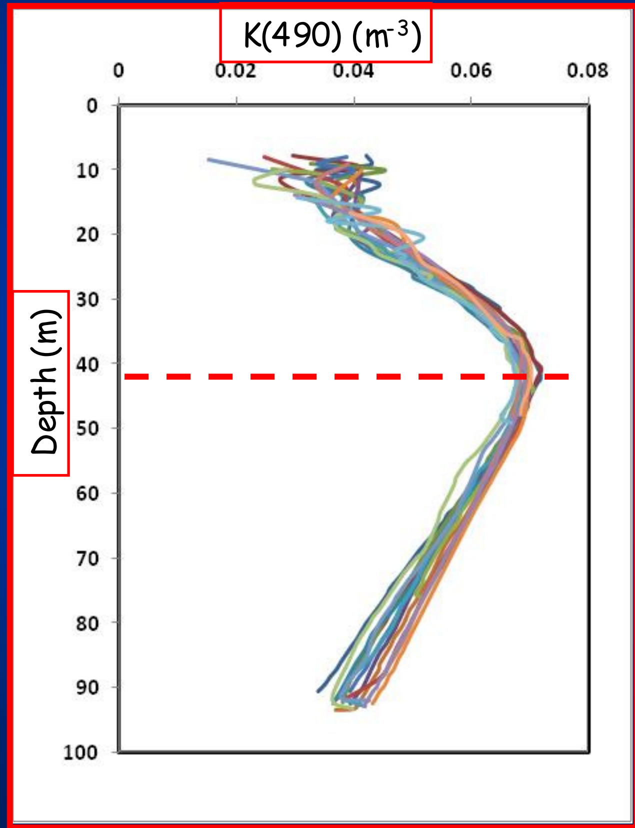
Glider K(490) from SRS Model

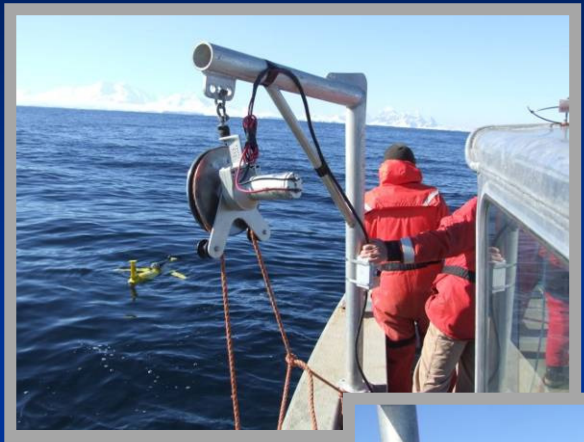


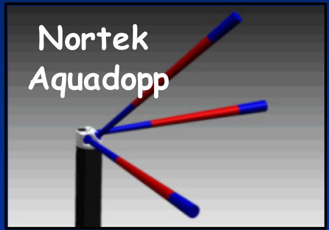


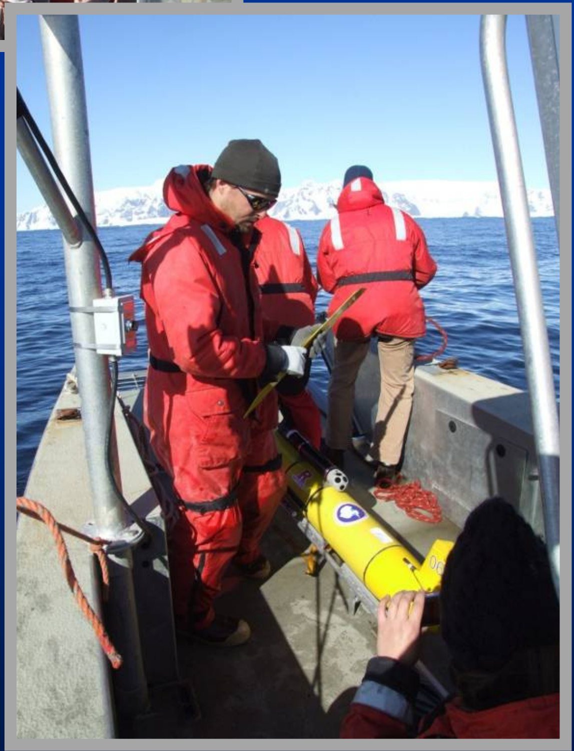
Glider Sensors

- Oxygen
- Fluor
- Optical
- PAR
- Spectrophotometer
- Acoustic Recorder
- ADCP
- Echosounder
- pH
- Turbulence
- Nutrients
- Carbon Dioxide
- Methane
- Magnetometric
- Mass/RAMAN Spectrometry
- Isotope Detection

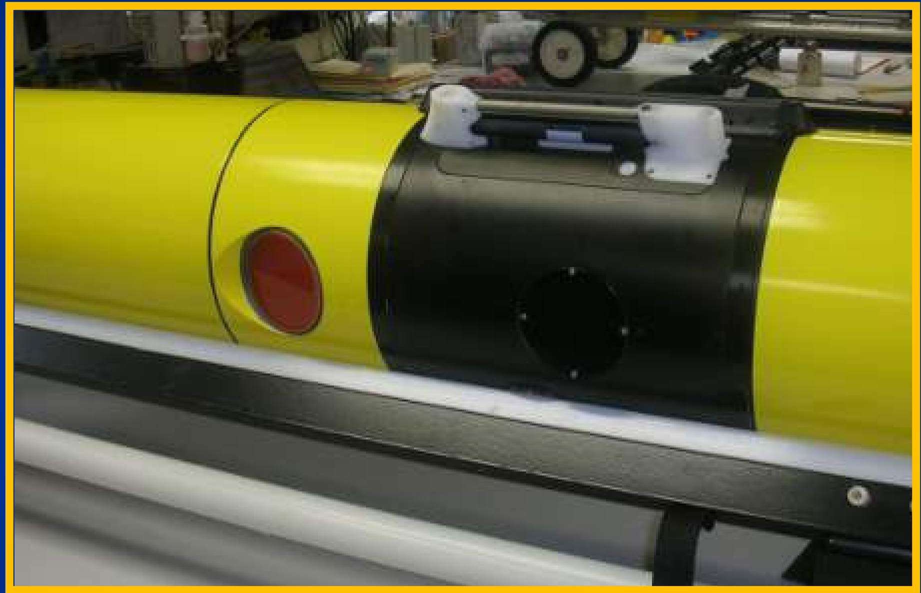
ADCP Externally & Internally





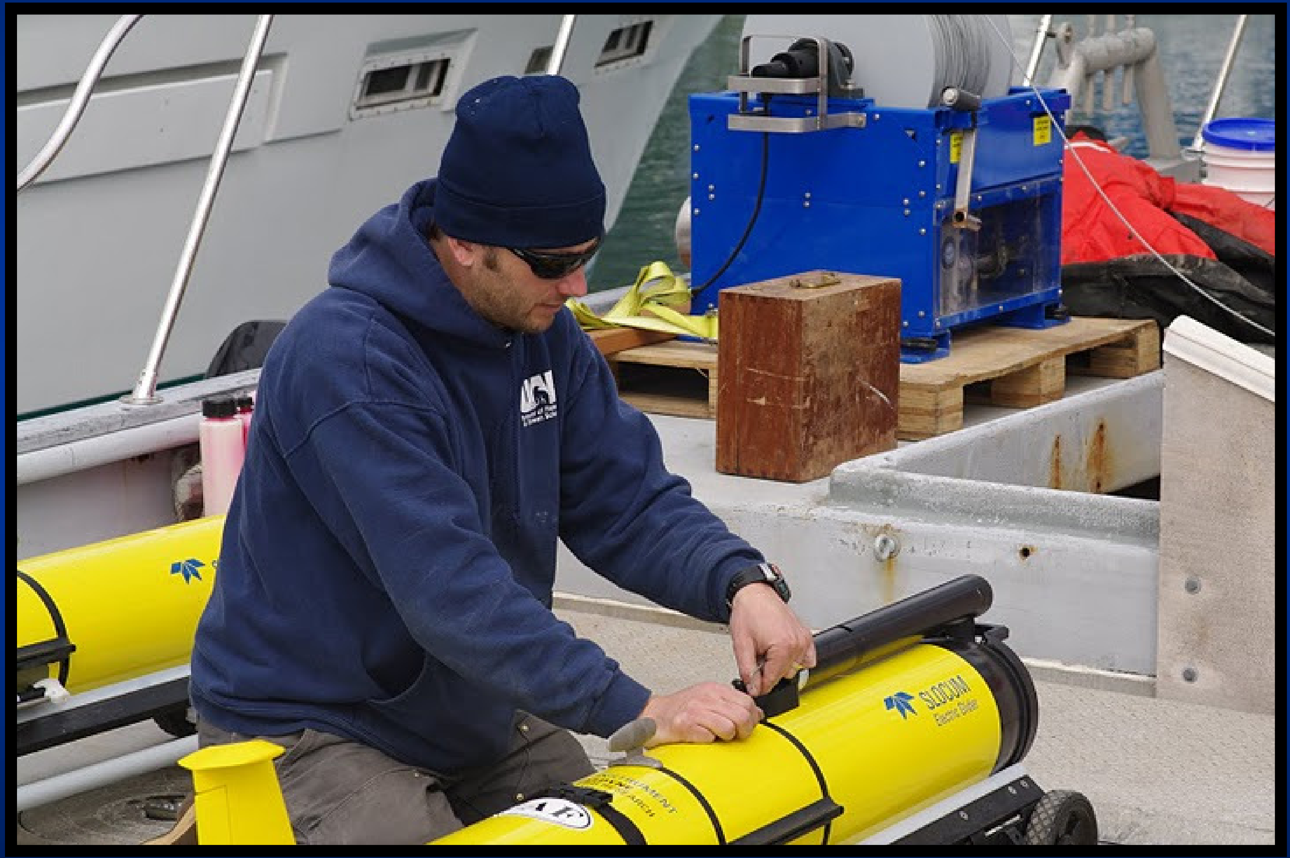


Oscar Schofield
Rutgers
(Antarctic)



Teledyne RDI ADCP into the Teledyne Webb Research Slocum glider (2011).

Suna UV Nitrate Sensor (Satlantic)



Un. of Alaska Fairbanks

LIDAR

LIght Detection And Ranging (LIDAR) systems have been used in the past to measure Digital Elevation Maps (DEM) of land, ice and coastal areas. There have been

(1)space-based LIDARs for measuring clouds and atmospheric aerosols,

(2) airborne systems for bottom bathymetry and mine detection and

(3) ground based systems for atmospheric profiles of water-vapor, aerosols and temperature.

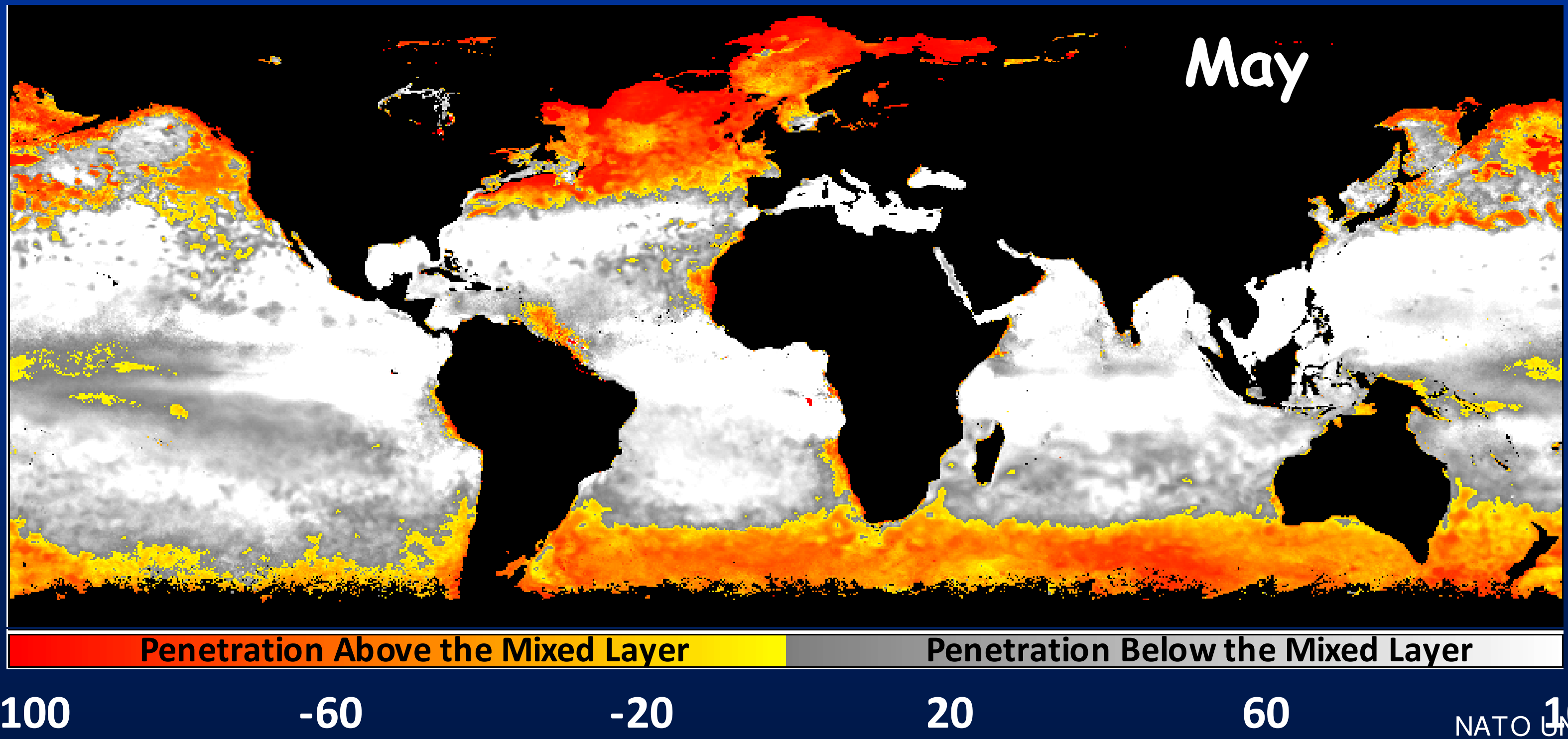
New Research Initiative

- LIDARs offer a new capability in ocean research for remotely sensing processes below the surface.

- What has not been investigated thoroughly are the capabilities of LIDARs to profile temperature (Brillouin-Scattering) and optical properties, which would provide a new tool for understanding ecological and physical ocean processes.

LIDAR vs MLD

- Present LIDARs have demonstrated that above water systems can retrieve measurements as deep as 3-4 optical depths. We estimate that optical and physical properties can be measured through the thermocline for ~70% of the world's oceans.



LIDAR Derived Products

Bathymetry, bottom reflectance & classification

Temperature, salinity, sound speed

Vertical current speed, internal waves, mean wave slope, individual surface waves

Turbulent gas exchange speed, short wavelength radiation absorption, bubbles,

Pollution, particle size & type, suspended sediment,

Phytoplankton biomass & physiology, CDOM

Zooplankton, megafauna,

Optical properties (backscattering, diffuse attenuation, absorption & attenuation).

LIDAR Platforms

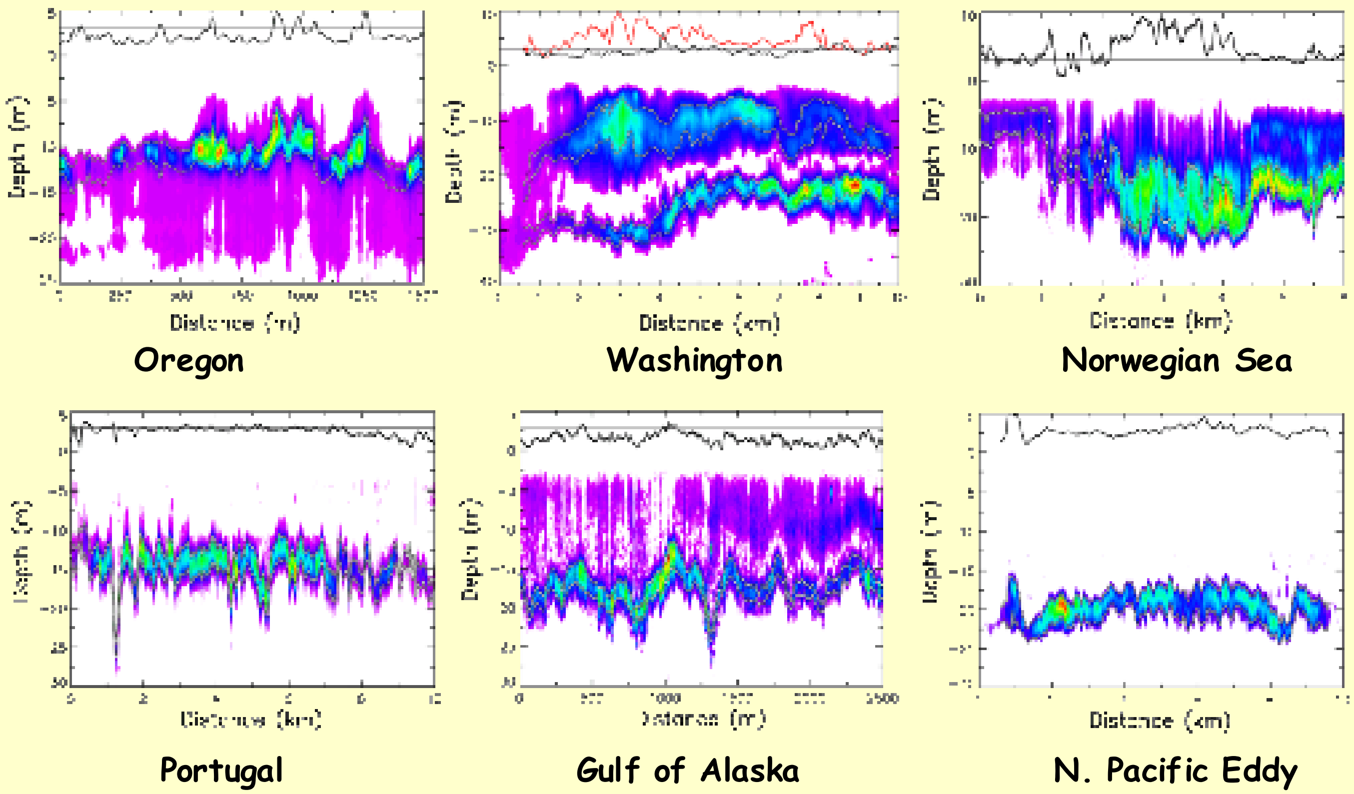
Shipboard
(O. Kopelevich)

ALTM™ Orion
(~1ft^3, Wt. 60 lbs).

Unmanned
Aerial Vehicle
(V. Feygels)

Aircraft LIDAR Examples

Plankton Layers
(J. Churnside)



UAVs

- SORTIE Network – Smart Optoelectronic technologies, aiRborne plaTform and Ict for Environement and security applications.
- 30 partners – Propose to FP7 Call

- UAV Movie

Questions?