The WOD Transmissometry Data: Illuminating the Ocean's Secrets

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Outline

- What is Transmissometry data:
  – Why is it important?
  – How is it measured?
- What we can find out:
  – At the surface?
  – At the deep?
- What do we have in WOD?
- What are the challenges?

What is Transmissometry Data?

Transmissometers – measure transmission of light and it is a proxy for particle mass in water

Transmissometry data allows to calculate

particle beam attenuation coefficient (c_p)

c_p is linearly correlated with particle mass

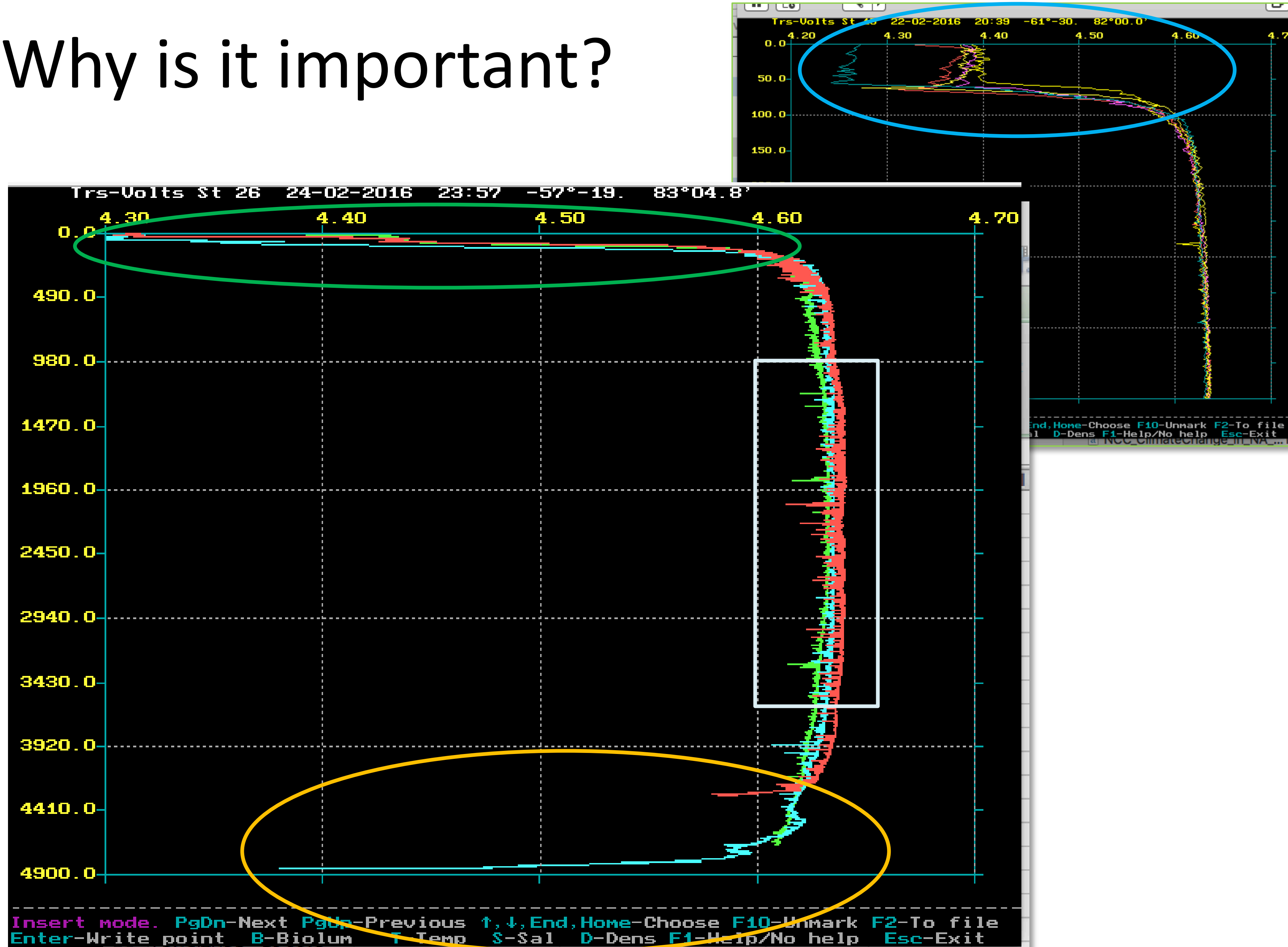
$$c = c_{water} + \mathbf{c_{particles}} + c_{dissolved\ organics}$$

λ of 660 nm minimizes interference from CDOM

$$c_{660} = c_w + \mathbf{c_p}$$

Particle part of signal is of interest

Why is it important?



Why is it important?

Transmissometers –> measure transmission of light and it is a proxy for **particle mass in water:**

$\boldsymbol{c_p}$ reflects Particulate Organic Carbon, (surface)
$\boldsymbol{c_p}$ reflects Particulate Matter (bottom)

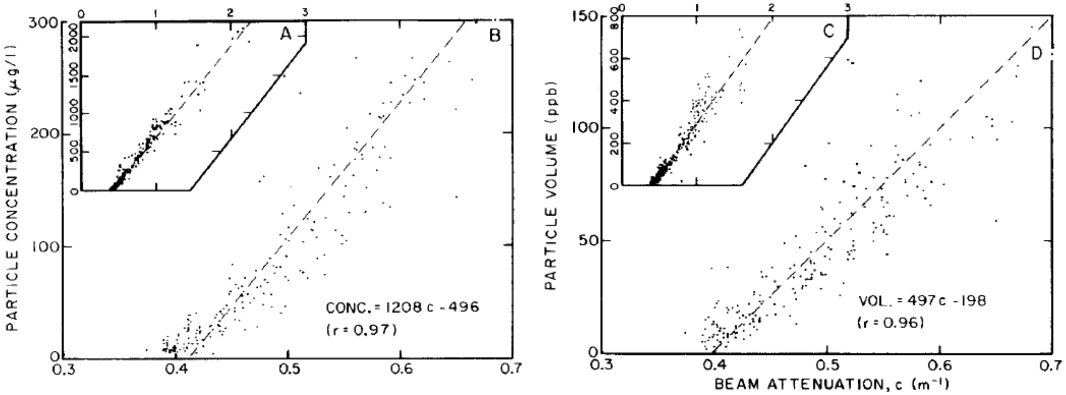


Fig.4. Beam attenuation versus particle weight concentration (a) and particle volume (b) measured with a Coulter Counter in the size range 1-24 µm. Linear least squares fits were made for c < 1.0.

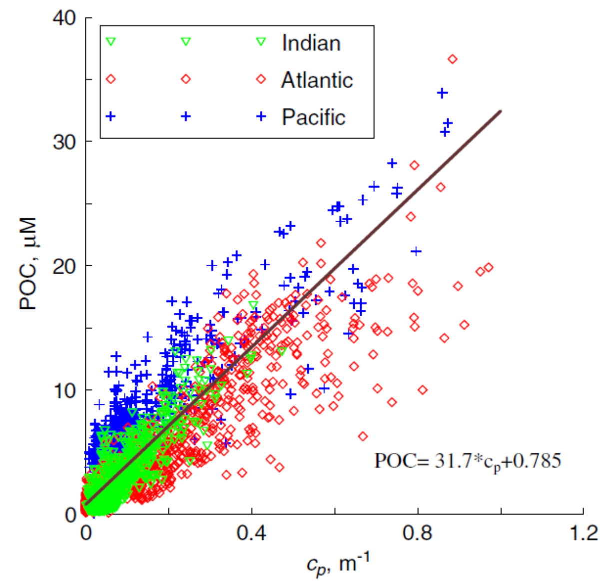
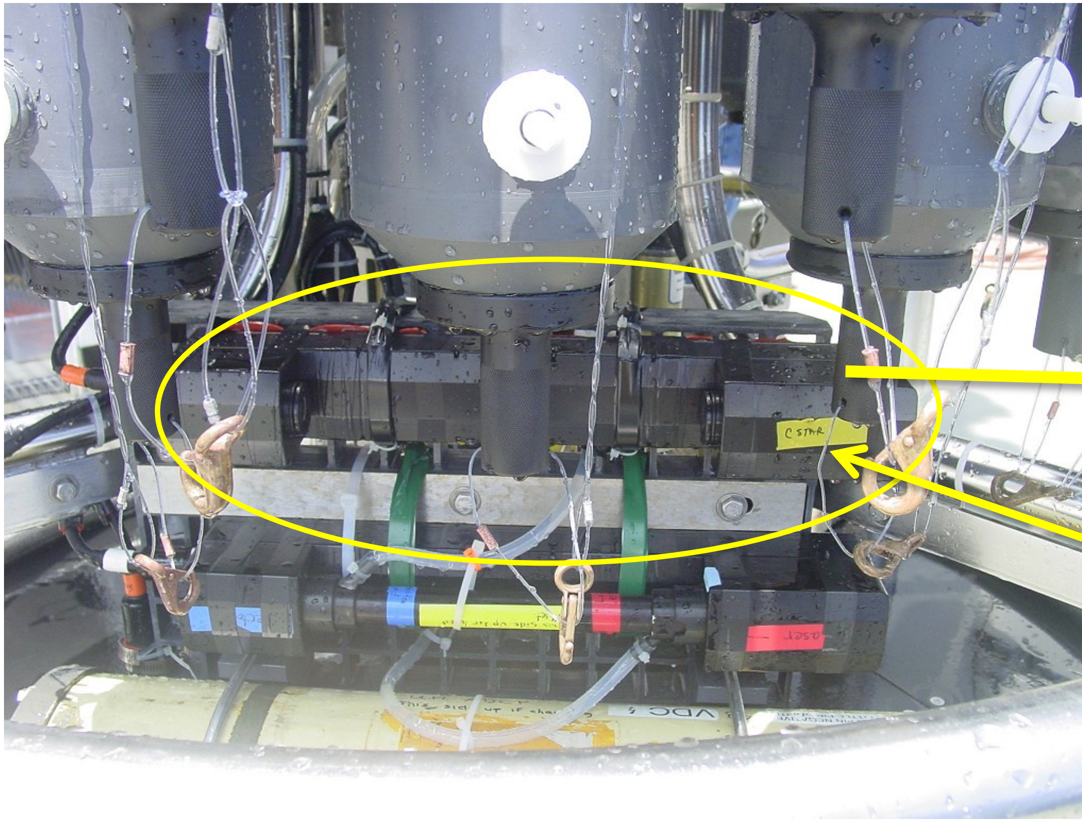
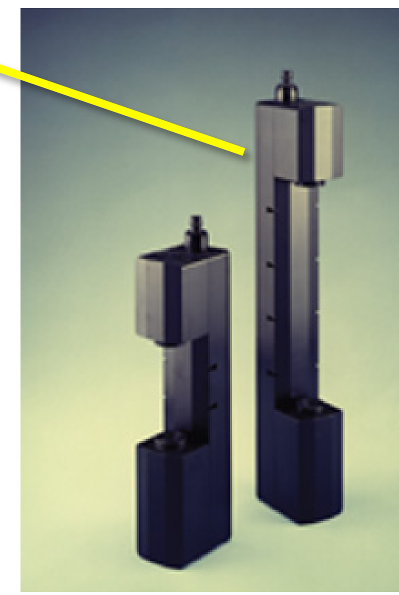


Fig. 3. Global POC—Beam c_p regression calculated on all available data collected in Indian (∇), Atlantic (◇) and Pacific (+) oceans. See Table 1, "All data" for regression parameters.

W.D. Gardner et al. Calibration and comparison of the LDGO nephelometer and the OSU transmissometer on the Nova Scotian rise. *Marine Geology*, 66 (1985) 323-344
W.D. Gardner, A.V. Mishonov, M.J. Richardson: Global POC concentrations from in-situ and satellite data. *Deep-Sea Research II* 53 (2006) 718–740

How is it measured?





WET Labs
C-Rover

SeaTech (before 2000)

WET Labs
C-Star

What it shows @ the surface (1)

Upper water column –> first optical depth

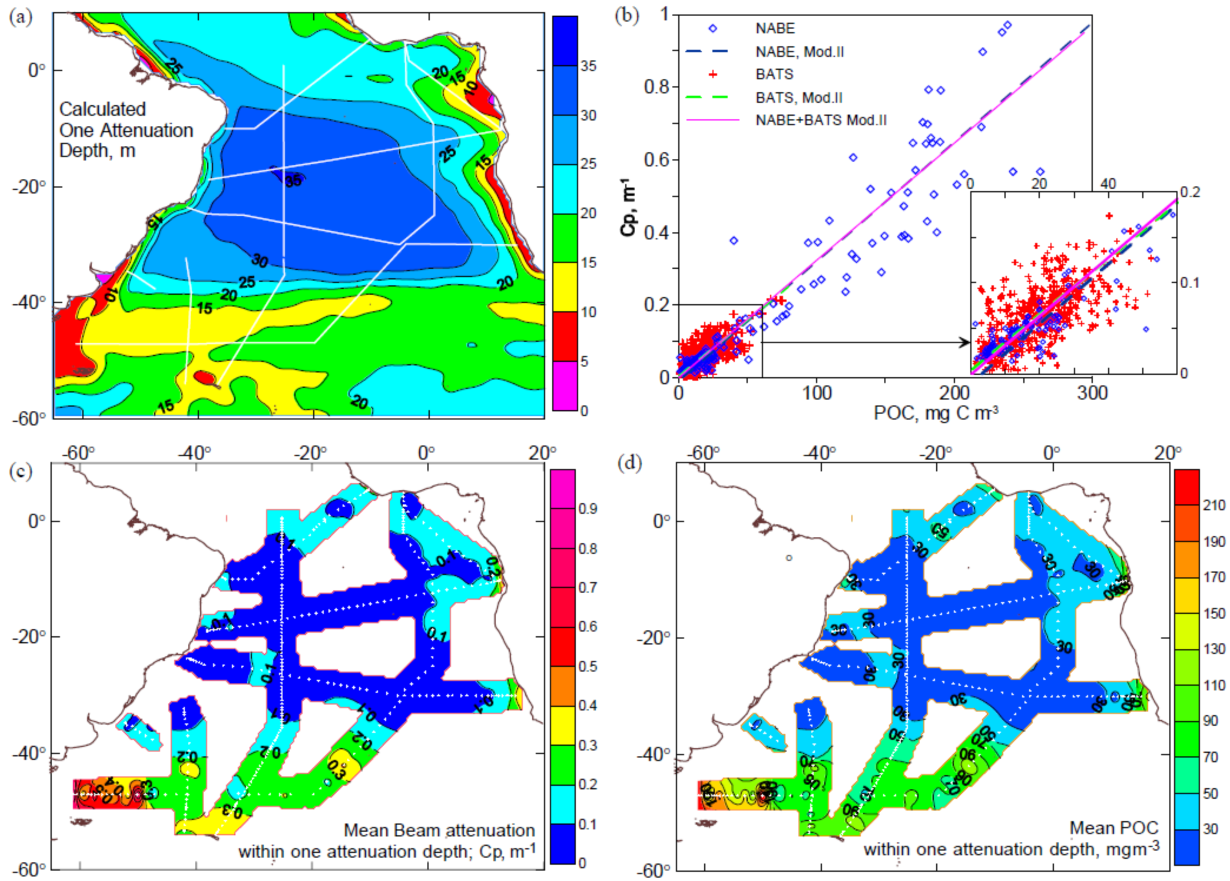
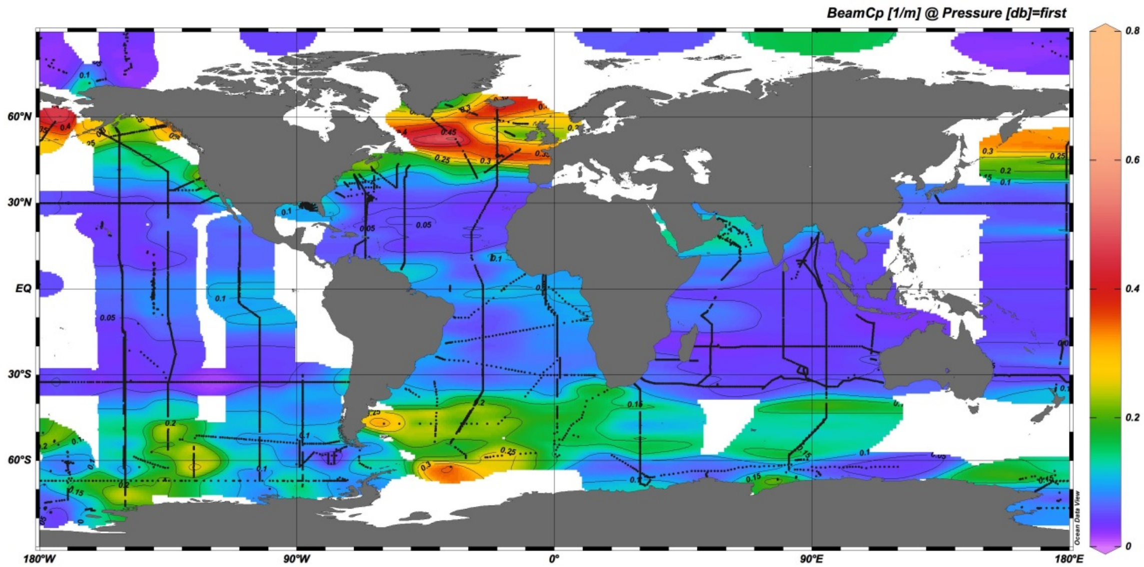


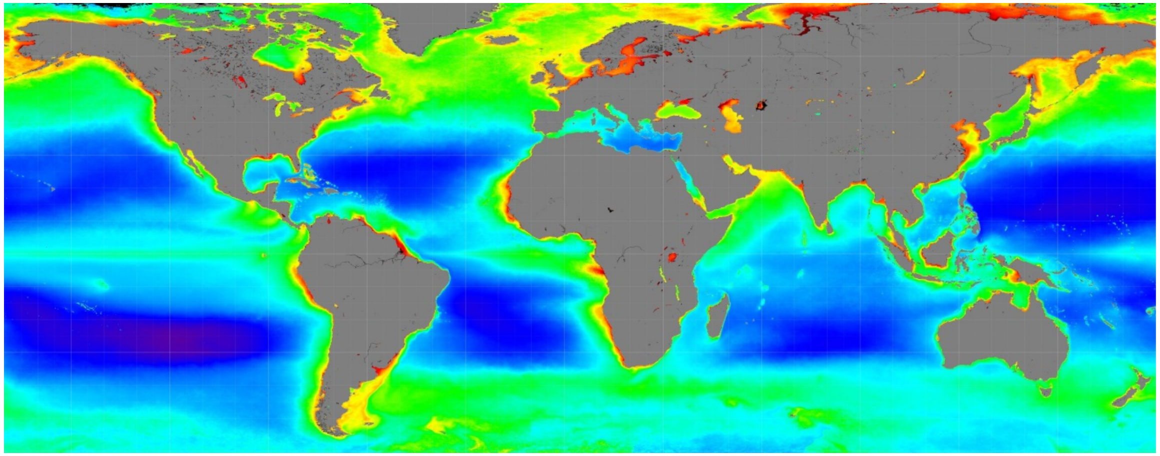
Fig. 4. (a) Spatial distribution of the one attenuation depth estimated from SeaWiFS-derived K_{490} (see text). (b) Model II regression between beam attenuation and POC concentration based on combined NABE and BATS data. (c) Mean beam attenuation due to particles down to one attenuation depth in the South Atlantic based on SAVE data. (d) Mean POC concentration down to one attenuation depth in the South Atlantic calculated from beam attenuation.

A.V. Mishonov, W.D. Gardner, M.J. Richardson: Remote sensing and surface POC concentration in the South Atlantic. Deep-Sea Research II 50 (2003) 2997–3015

What it shows @ the surface (2)



Global WOD 'climatic' field of the Beam attenuation at the surface



Global ocean color observations by NASA satellite sensors: 1997 - 2010.
https://www.nasa.gov/sites/default/files/thumbnails/image/15-037.jpg

What it shows @ the top

Upper water column – Euphotic Zone and below

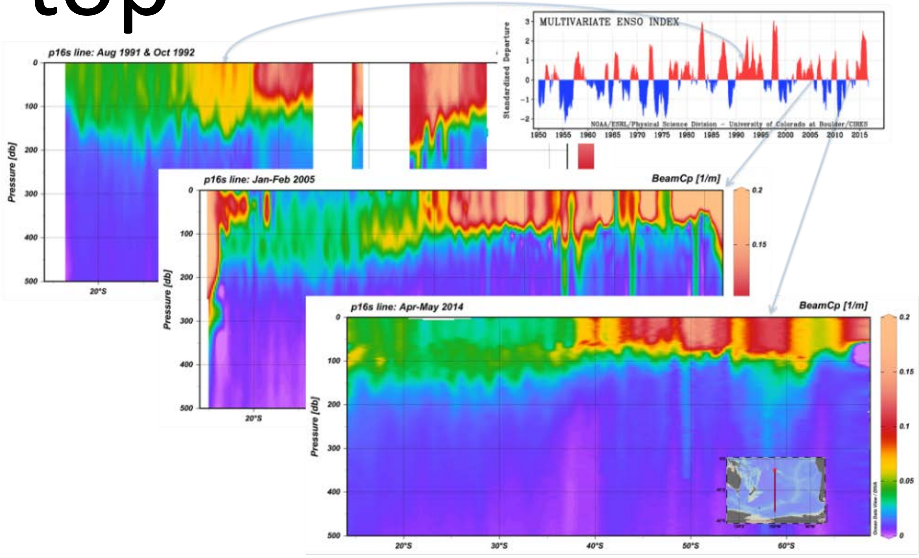
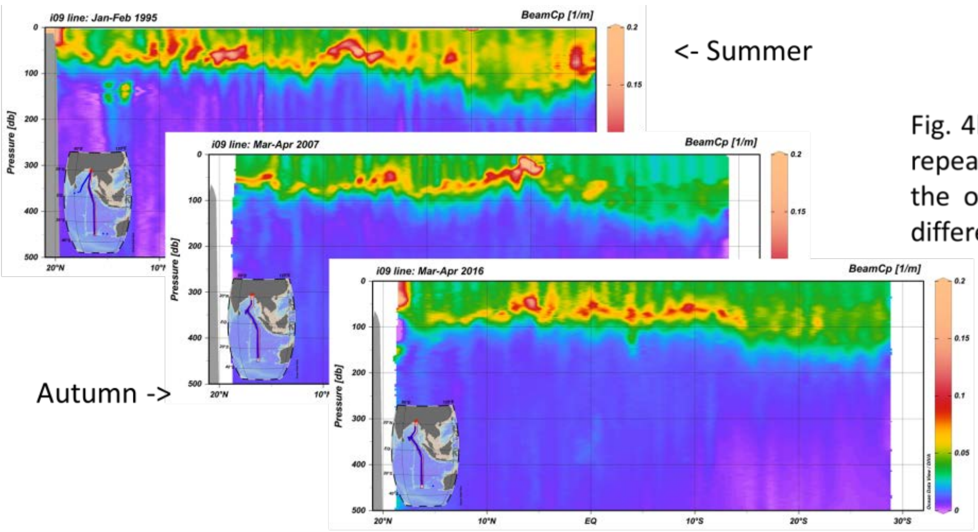


Fig. 4b. Beam Attenuation distribution along the p16s line (Pacific Ocean) repeated three times over the time span of 23 years showing variability of the optical conditions within the upper 500 m of the ocean reflecting different ENSO stages

<- Summer

Autumn ->



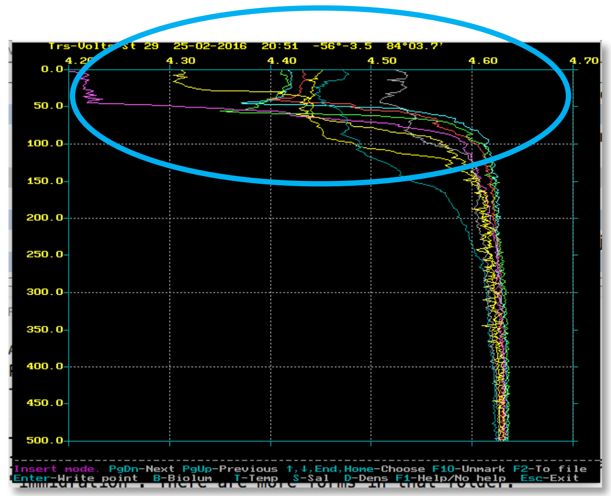
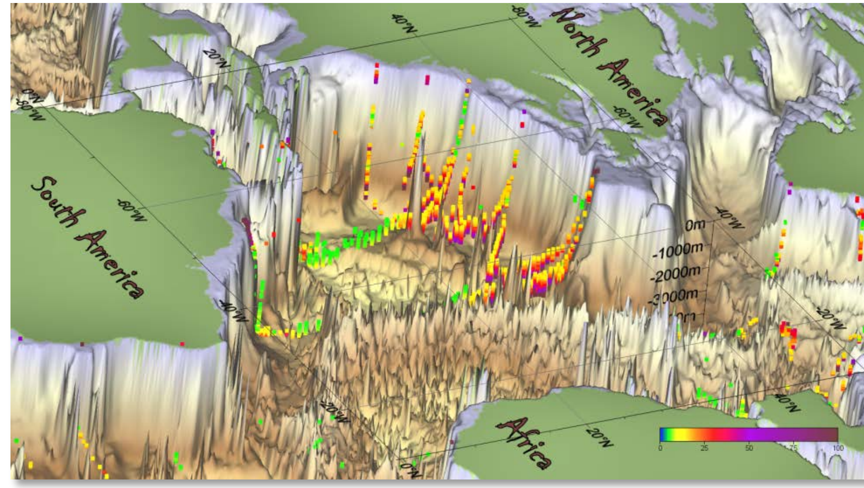


Fig. 4a. Beam Attenuation distribution along the i09 line (Indian Ocean) repeated three times over the time span of 21 years, showing changes of the optical conditions within the upper 500 m of the ocean reflecting seasonal variability (Summer–Autumn transition in Southern Hemisphere)

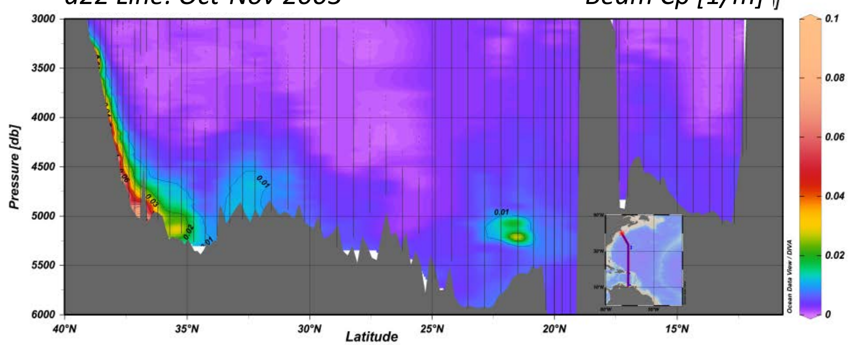
A.V. Mishonov, M.J. Richardson, W.D. Gardner, T. Boyer. Historical and Modern Deep-Sea Transmissometry Data in World Ocean Database – its Status, Challenges, and Utilization. Abs. IN51A-1828, AGU Fall Meeting 2016.

What it shows @ the bottom (1)

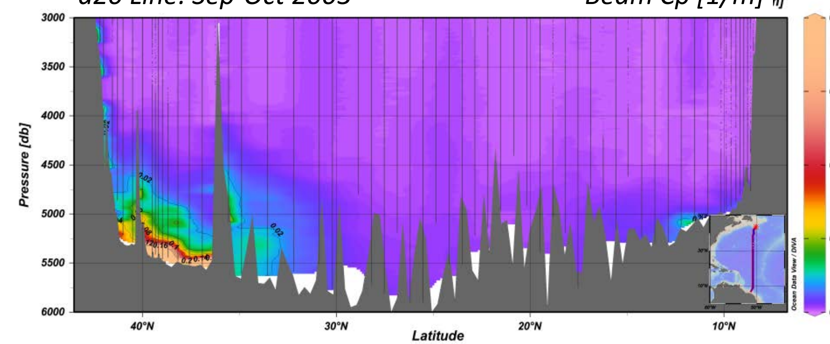
Bottom area – Benthic Nepheloid Layer



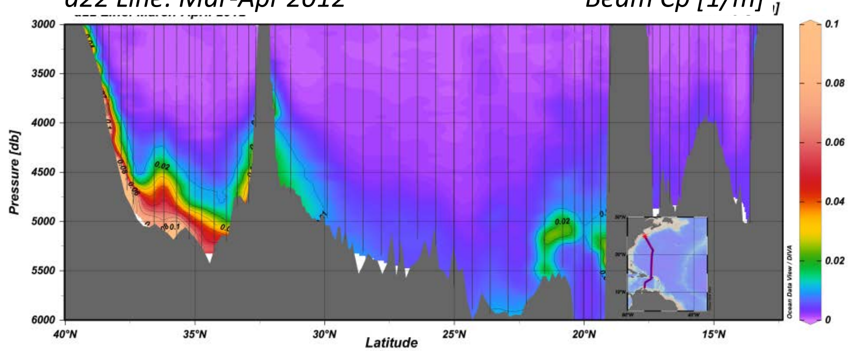
a22 Line: Oct-Nov 2003 *Beam Cp [1/m]*



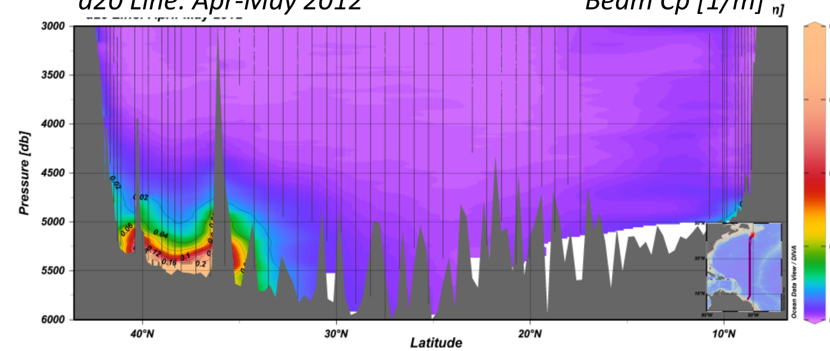
a20 Line: Sep-Oct 2003 *Beam Cp [1/m]*



a22 Line: Mar-Apr 2012 *Beam Cp [1/m]*



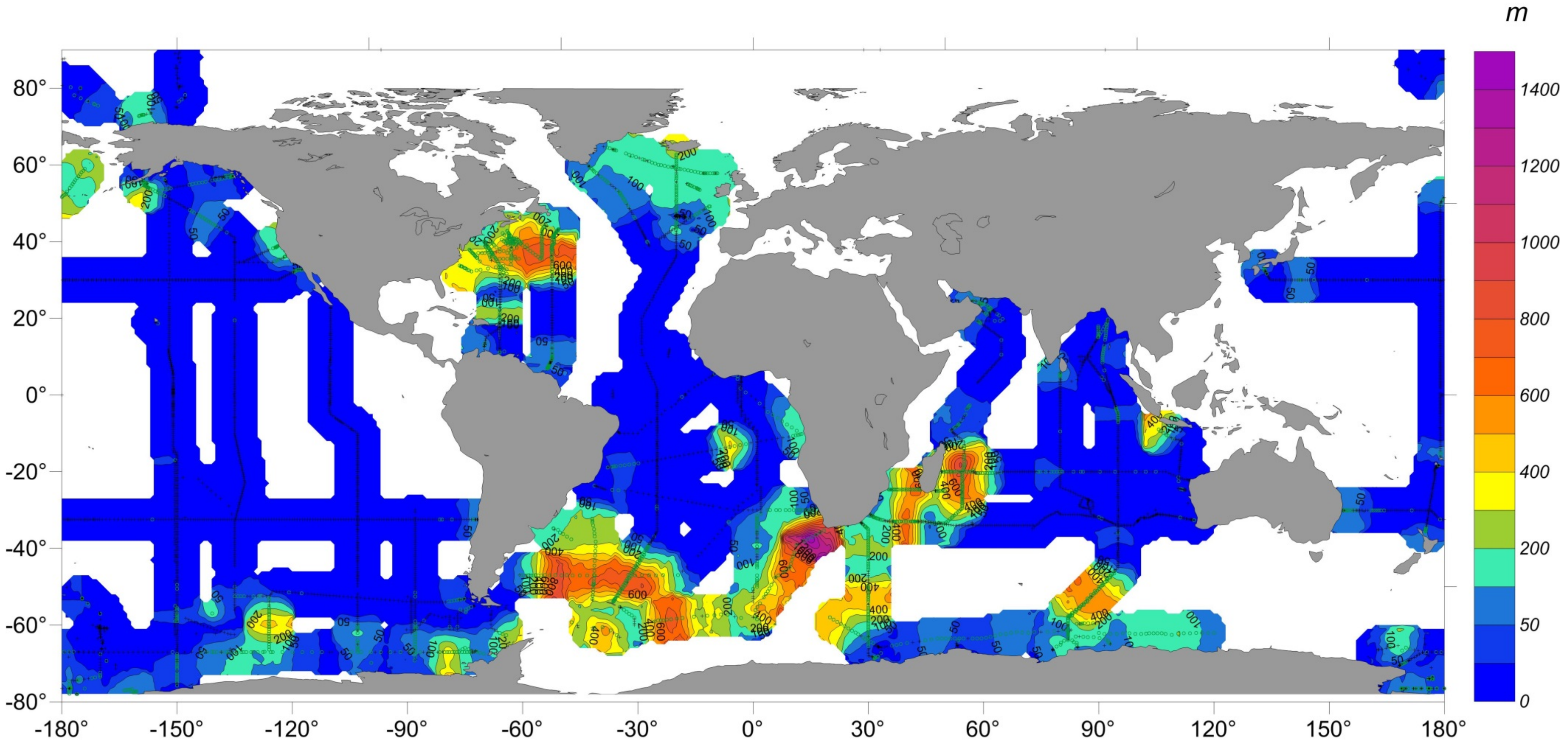
a20 Line: Apr-May 2012 *Beam Cp [1/m]*



W.D. Gardner, M.J. Richardson, A.V. Mishonov. Global Distribution and Intensity of Deep-Water Benthic Nepheloid Layers. Abs. B54B-0407. AGU OS Meeting, 2016.

What it shows @ the bottom (2)

Bottom area – Global Benthic Nepheloid Layer Thickness



W.D. Gardner, M.J. Richardson, A.V. Mishonov. Global Assessment of Benthic Nepheloid Layers and Linkage with Upper Ocean Dynamics, 2017; submitted EPSL-D-17-01119R1;

What do we have in WOD (countries)?

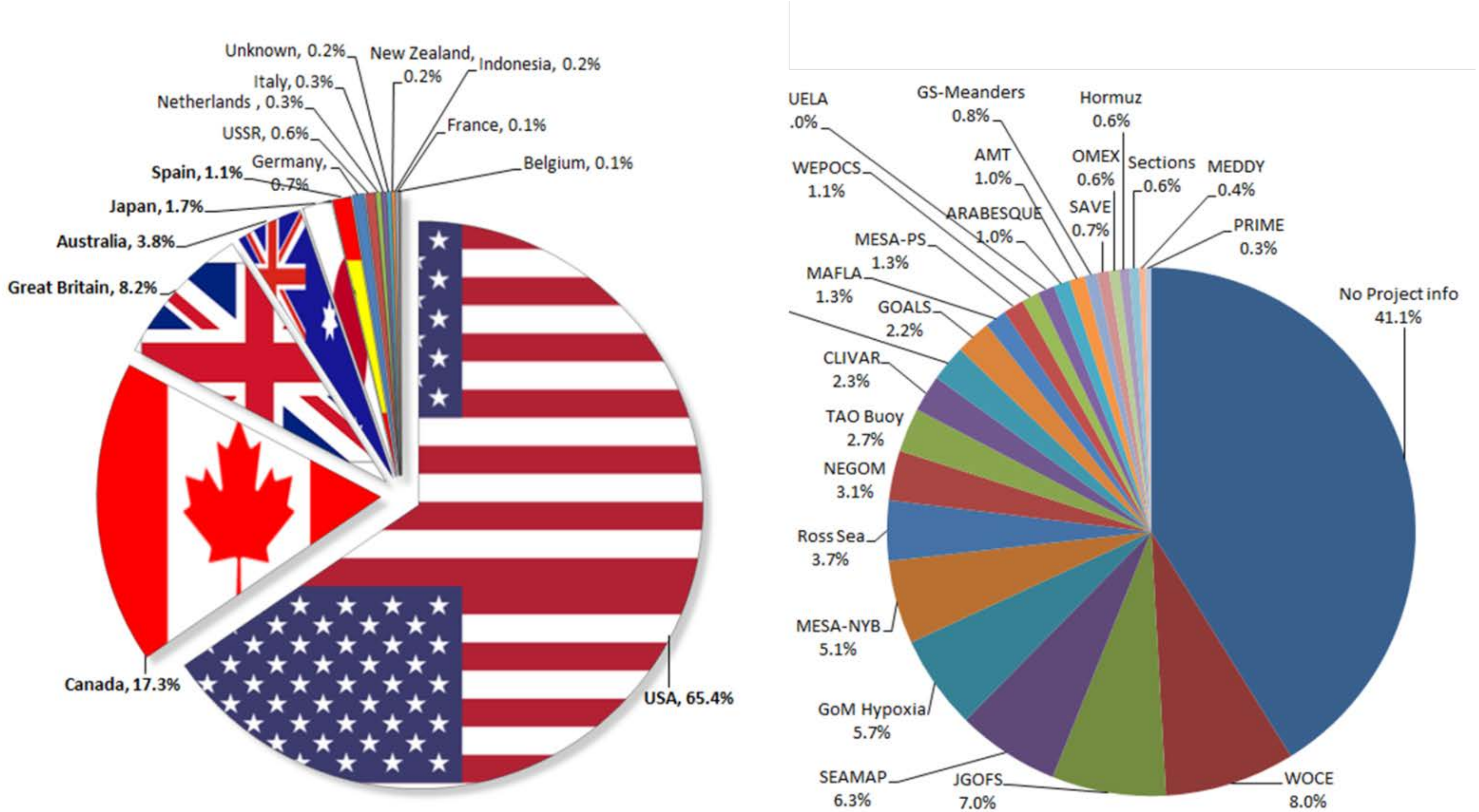


Fig. 3. Countries and Projects contributed to WOD Beam Attenuation data holding (in %).

A.V. Mishonov, M.J. Richardson, W.D. Gardner, T. Boyer. Historical and Modern Deep-Sea Transmissometry Data in World Ocean Database – its Status, Challenges, and Utilization. Abs. IN51A-1828, AGU Fall Meeting 2016.

What do we have in WOD (years)?

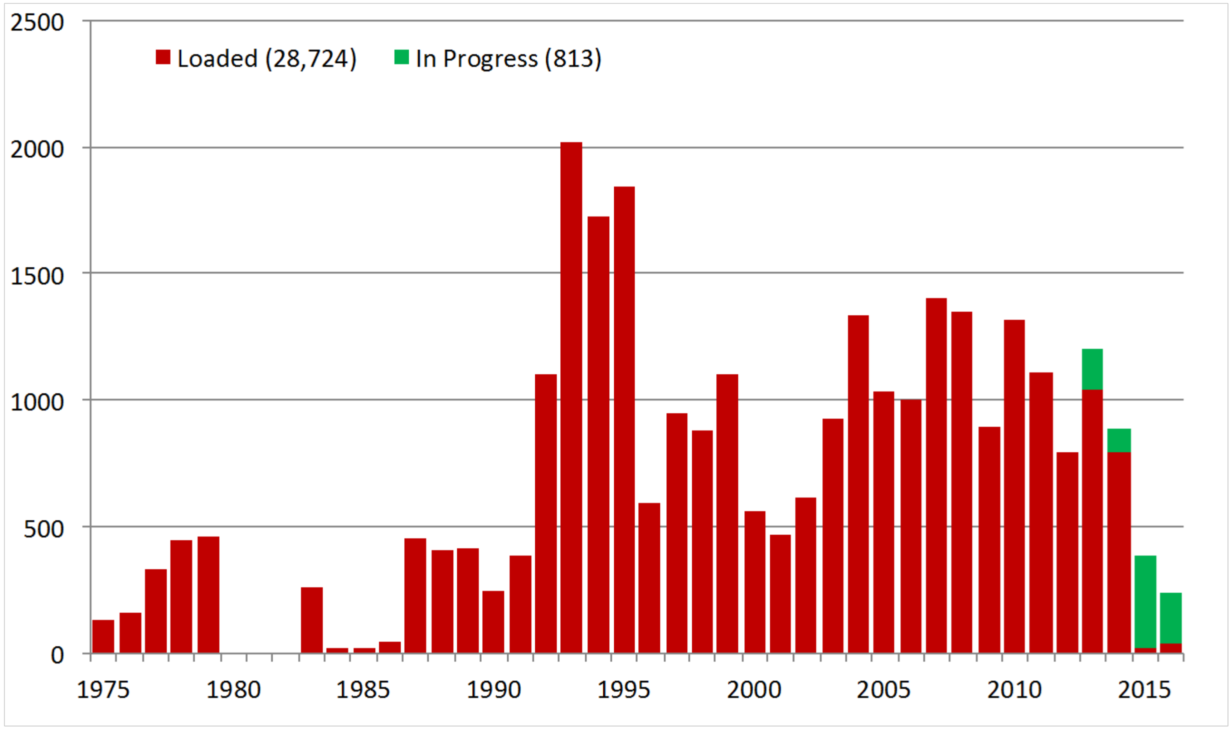


Fig. 2 Temporal acquisition of the Beam Attenuation data held in WOD as of November 2016.

A.V. Mishonov, M.J. Richardson, W.D. Gardner, T. Boyer. Historical and Modern Deep-Sea Transmissometry Data in World Ocean Database – its Status, Challenges, and Utilization. Abs. IN51A-1828, AGU Fall Meeting 2016.

What do we have in WOD: total

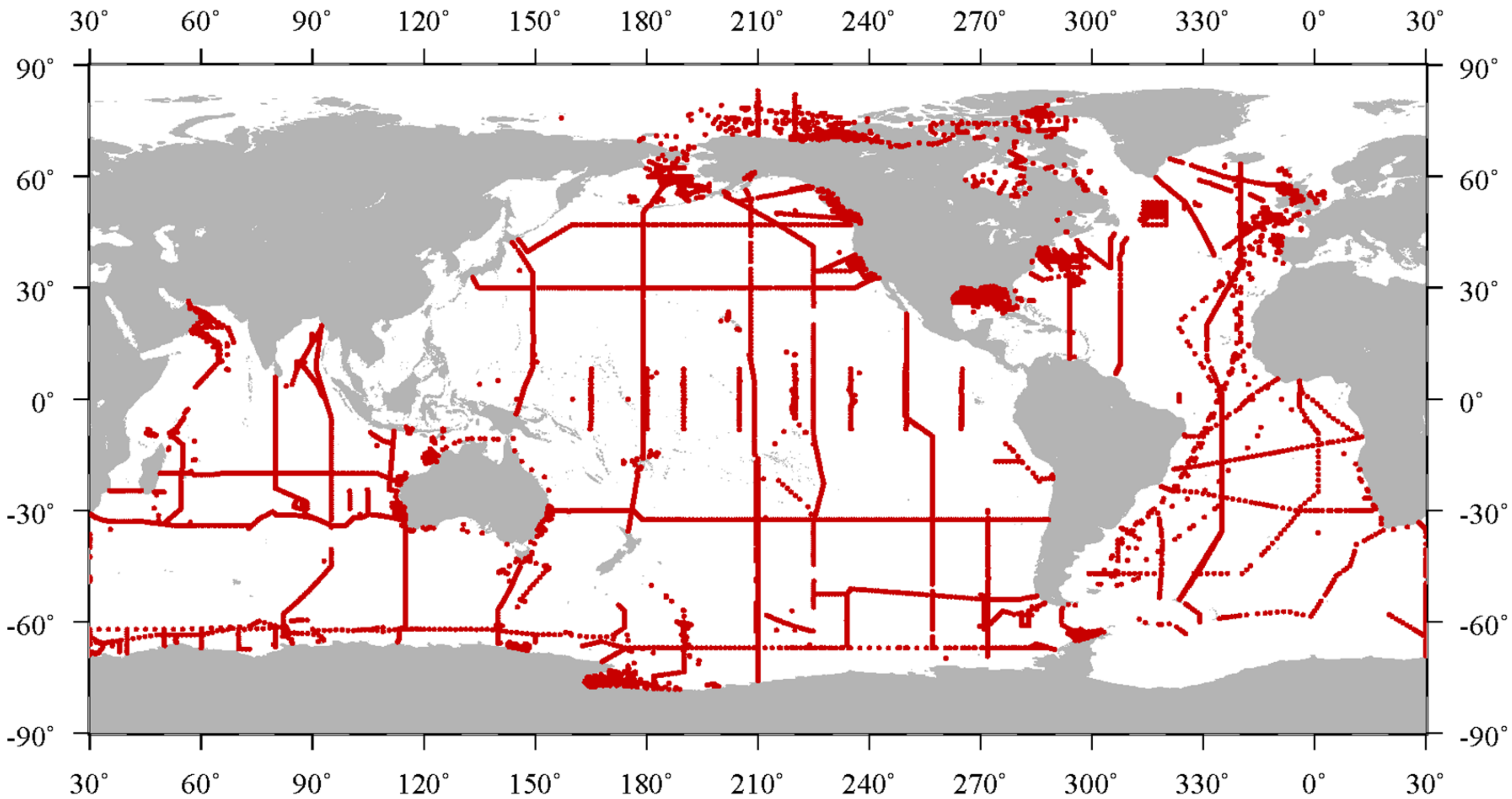


Fig. 1. Spatial distribution of the Beam Attenuation data held in WOD as of November 2016: 627 cruises, 29,248 profiles.

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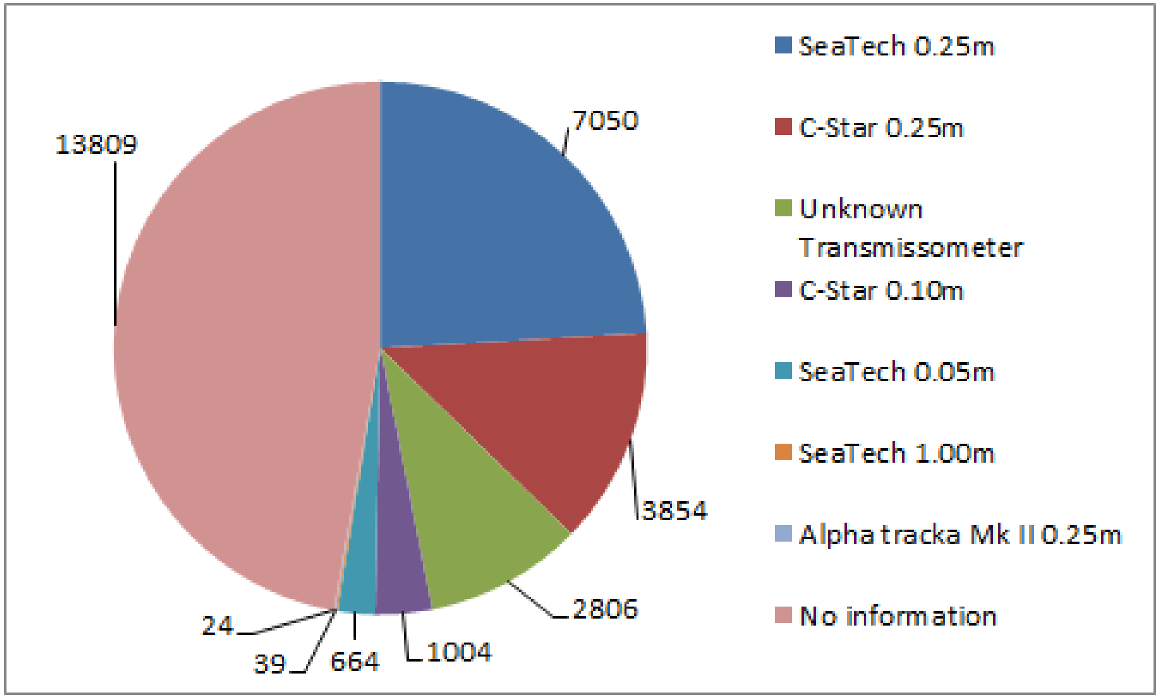
What are the challenges?



About 10K profiles have all metadata, post-processed, calibrated, and converted to the Beam Attenuation (by Prof. W. Gardner's team from TAMU Oceanography Dept).
Metadata must include instrument name & serial number for access to manufacturer's calibration and service records.

NO Instrument info means:

- Unknown pathlength
- Unknown wavelength

Without such metadata there is no way to convert data to physical units of Beam Attenuation (1/m) and, therefore, such data can not be made comparable with the rest.

What do we have in WOD: post-processed

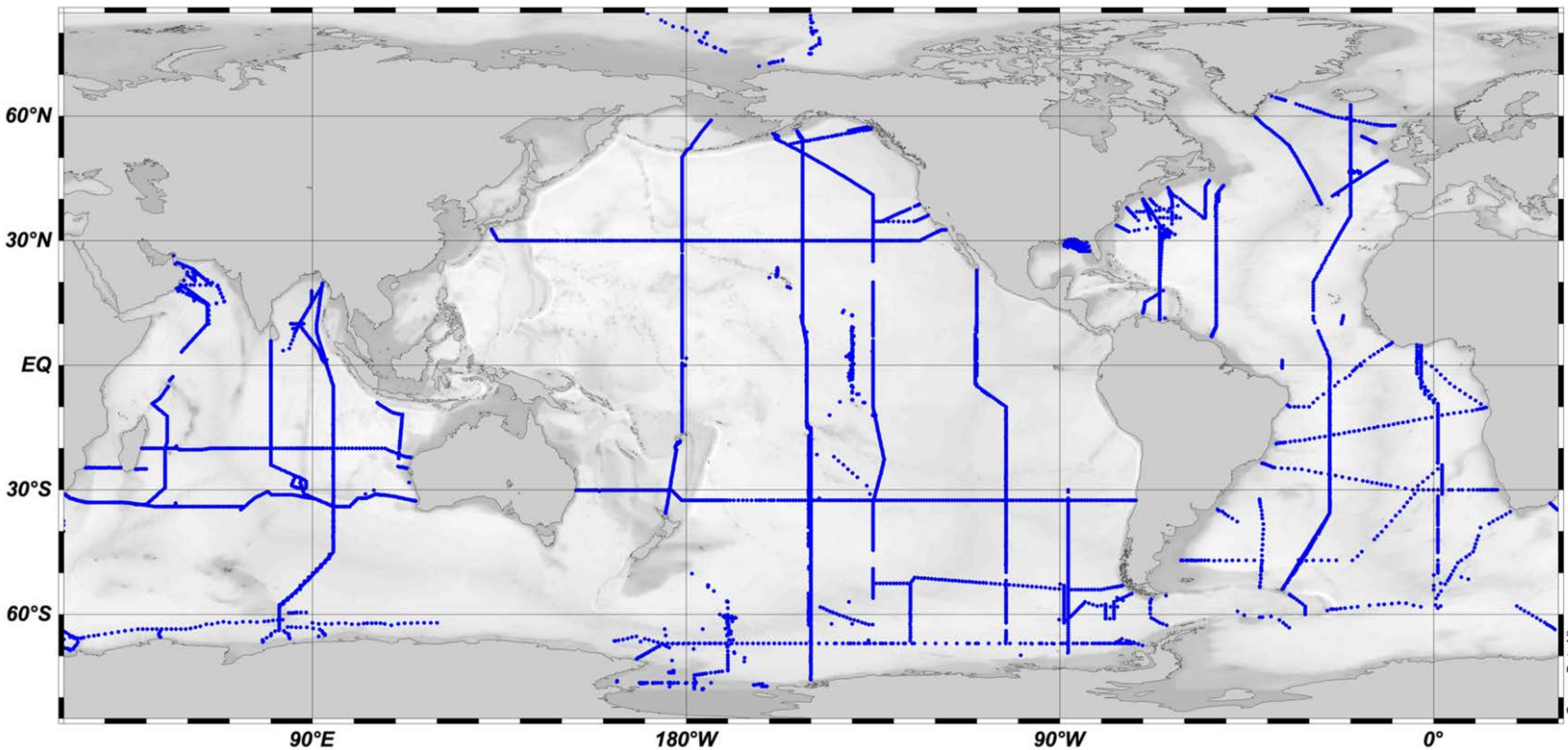
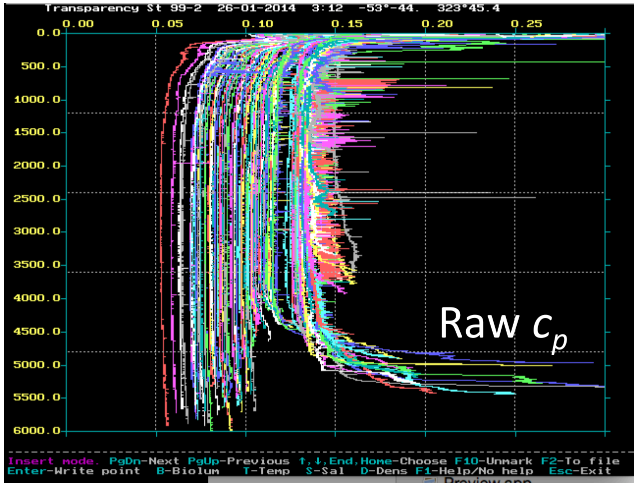
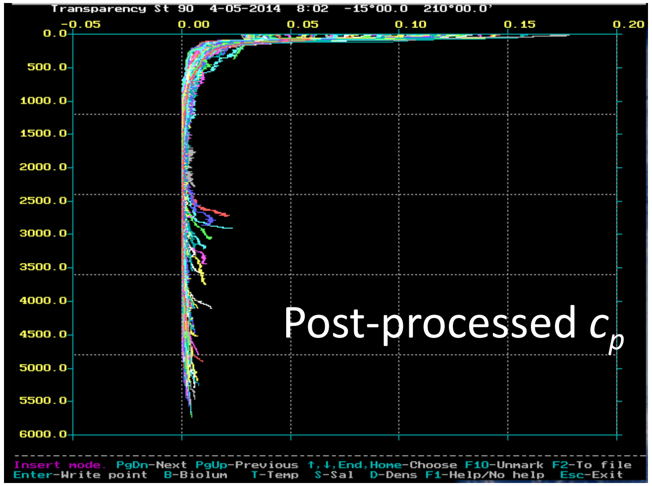


Fig. 5. Post-processed, calibrated, quality controlled Beam Attenuation data held in WOD (9,268 profiles), converted to 1/m units

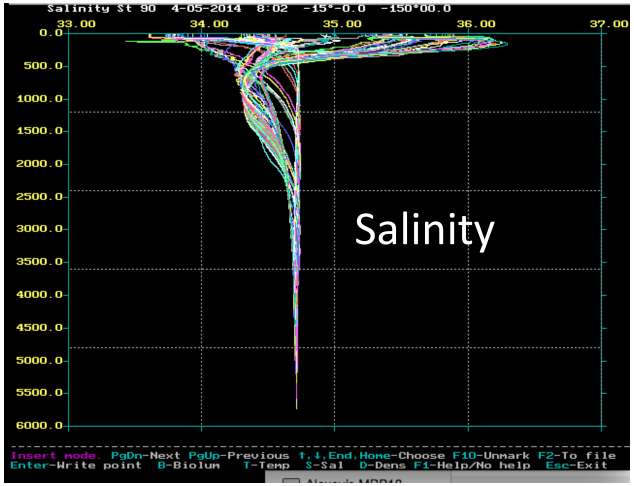
A.V. Mishonov, M.J. Richardson, W.D. Gardner, T. Boyer. Historical and Modern Deep-Sea Transmissometry Data in World Ocean Database – its Status, Challenges, and Utilization. Abs. IN51A-1828, AGU Fall Meeting 2016.

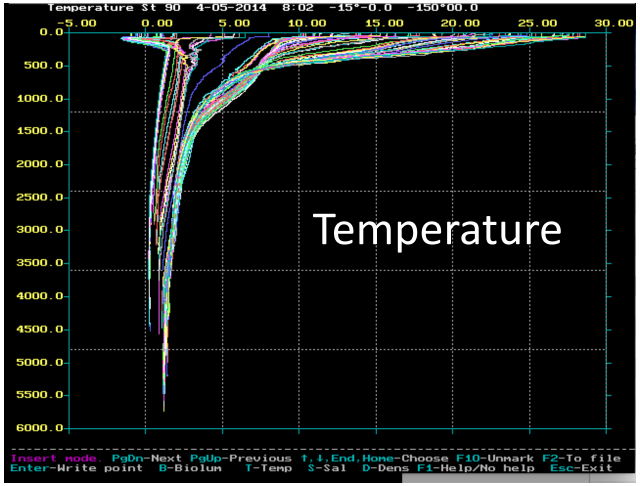
What are the challenges (2)?





Unlike T&S data, raw transmissometry data needs more demanding post-processing.

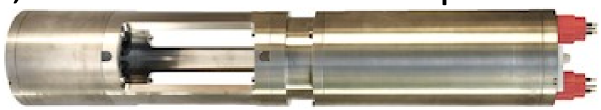




How is it developing? – new instruments 1

1 .Transmissometers evolves to **profiling system** and to **hyper-spectral** domain:

- HOBI Labs Gamma/Abiss Spectral Transmissometers (30cm or 1m; 2 ,4, or 8 wavelength; 500m and 6000m depth rating



- WET Labs c-ROVER transmissometer – C-Star version for long-term deployment aboard profiling floats (25cm, 2000m depth rating)

- WET Labs ac-s In-Situ Spectrophotometer: absorption and beam attenuation in flow-through system (10 or 25cm, 400-730 spectral range, 4nm spectral resolution)

- WET Labs Beam Attenuation Meter designed for Autonomous Underwater Vehicles (10cm, 1000m depth rating)

How is it developing? – new instruments 2

2. New instruments for measuring different optical parameters being developed and modernized:

- HOBI Labs In-Situ Spectrophotometer / Absorption Meter (360-750nm spectral range, 0.3nm spectral resolution, 330m depth rating)

- HOBI Labs HydroScat Optical Backscattering Sensor / Fluorometers (2, 4, 6 wavelengths, up to 4000 depth rating)

- WET Labs ECO BB9 Backscattering Sensor
- WET Labs Triplet and SeaOWL UV-A™ (Sea Oil-in-Water™ Locator) mounted on SeaGlider

Thank You!

Questions?