Essential Ocean Variable (EOV): Dissolved Organic Carbon

Background and Justification

Dissolved organic matter (DOM) represents one of the largest exchangeable reservoirs of organic material on earth. At ~662 ±32 Pg (10^{15} g) of carbon (C), dissolved organic carbon (DOC) exceeds the inventory of organic particles in the oceans by 200 fold, making it one of the largest of the bioreactive pools of carbon in the ocean, second only to dissolved inorganic carbon (38,100 Pg C). The size of the reservoir (comparable to that of atmospheric carbon dioxide), as well as its role as a sink for autotrophically fixed carbon, as a substrate to heterotrophic microbes, and as a sink/source of carbon involved in climate variations over long time scales, highlights its importance in the ocean carbon and nitrogen cycles. DOC is exported from the epipelagic zone at 1.9 Pg C yr^{-1}, contributing ~20% to the biological pump via meridional overturning circulation.

Table 1: EOV Information	
Name of EOV	Dissolved Organic Carbon (DOC)
Sub-Variables	
Derived Products	Global inventories and distribution of DOC, Contribution to net community production and to carbon export, Nutrient supply in oligotrophic systems
Supporting Variables	Dissolved Organic Nitrogen (DON), Dissolved Organic Phosphorus (DOP), Temperature (T), Salinity (S),Dissolved Inorganic carbon, nitrogen, and phosphate, Dissolved oxygen (O_2), transient tracers such as chlorofluorocarbons (CFCs), Particulate Organic Carbon (POC), Particulate Organic Nitrogen (PON)
Contact/Lead Expert(s)	Dennis Hansell (Rosenstiel School of Marine and Atmospheric Science, USA) or Craig Carlson (University of California, Santa Barbara, USA);

Table 2: Requirements Setting				
Responsible GOOS Panel	Biogeochemistry Panel			
Societal Drivers				
Scientific Application(s)	Q 1.1. How is the ocean carbon content changing? Q 2.2. What are rates and impacts of ocean acidification? Q 3.1. Is the biomass of the ocean changing? Q 3.2. How do the eutrophication and pollution impact ocean productivity and water quality?			
Readiness Level	Mature			
Phenomena to Capture	**1** **Export of DOC from euphotic zone**	**2** **Removal rates of DOC fractions**		
Temporal Scales of the Phenomena	Annual	Annual to centennial (depending on lability fraction)		
Spatial Scales of the Phenomena	Open Ocean 1-500 km	Open Ocean 25-1000 km		
Magnitudes/Range of the Signal	local export: 2-10 µmol C kg^{-1} $year^{-1}$	0.043-3.4 Pg C $year^{-1}$ (depending on lability fraction)		
Desired Detection Limit Relative to the Signal	±10%	±10%		

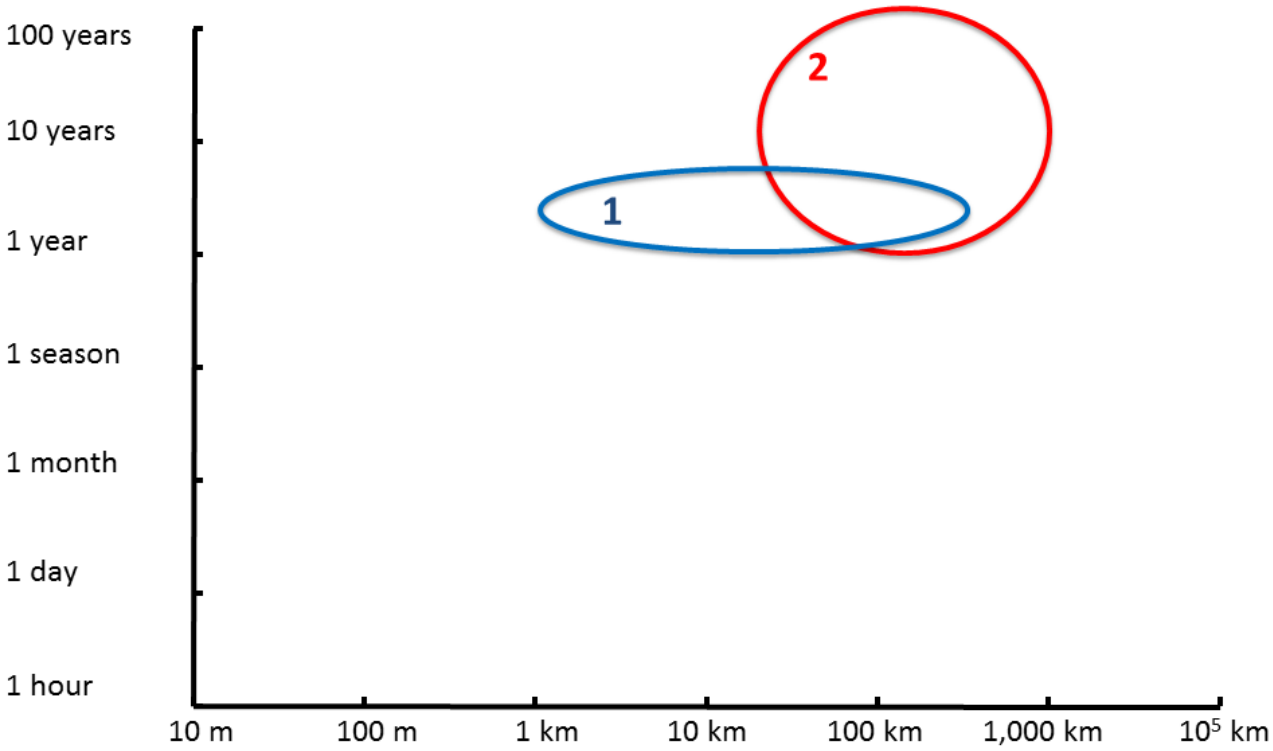

Figure 1: Spatial and temporal scales of phenomena (as color-coded and listed in Table 2 above) to be addressed.

Table 3: Current Observing Networks*						
Observing Network	**Repeat Hydrography (RH)**	**Ship-based Time-Series (STS)**				
Phenomena Addressed	**1,2**	**1,2**				
Readiness Level of the Observing Network (as defined in the FOO)	Mature	Mature				
Spatial Scales Currently Captured by the Observing Network	Typically every 60 nm	Typically every 60 nm				
Typical Observing Frequency	Monthly to decadal	Monthly to decadal				
Supporting Variables Measured	DON	DON				
Sensor(s)/ Technique	High temperature detection with NDIR	High temperature detection with NDIR				
Accuracy/Uncertainty Estimate (units)	~ 1.5 µmol C kg^{-1}	~ 1.5 µmol C kg^{-1}				
Reporting Mechanism(s)	IOCCP Report					

*By an Observing Network we understand a number of reasonably well coordinated observing platforms equipped with technology allowing measurements of this particular EOV.

Table 4: Future Observing Networks					
Observing Network					
Phenomena Addressed					
Readiness Level of the Observing Network (as defined in the FOO)					
Spatial Scales Captured by the Observing Network					
Typical Observing Frequency					
Time-Scale ntil Part of Observing System					
Supporting Variables Measured#					
Sensor(s)/Technique					
Accuracy/Uncertainty Estimate (units)					

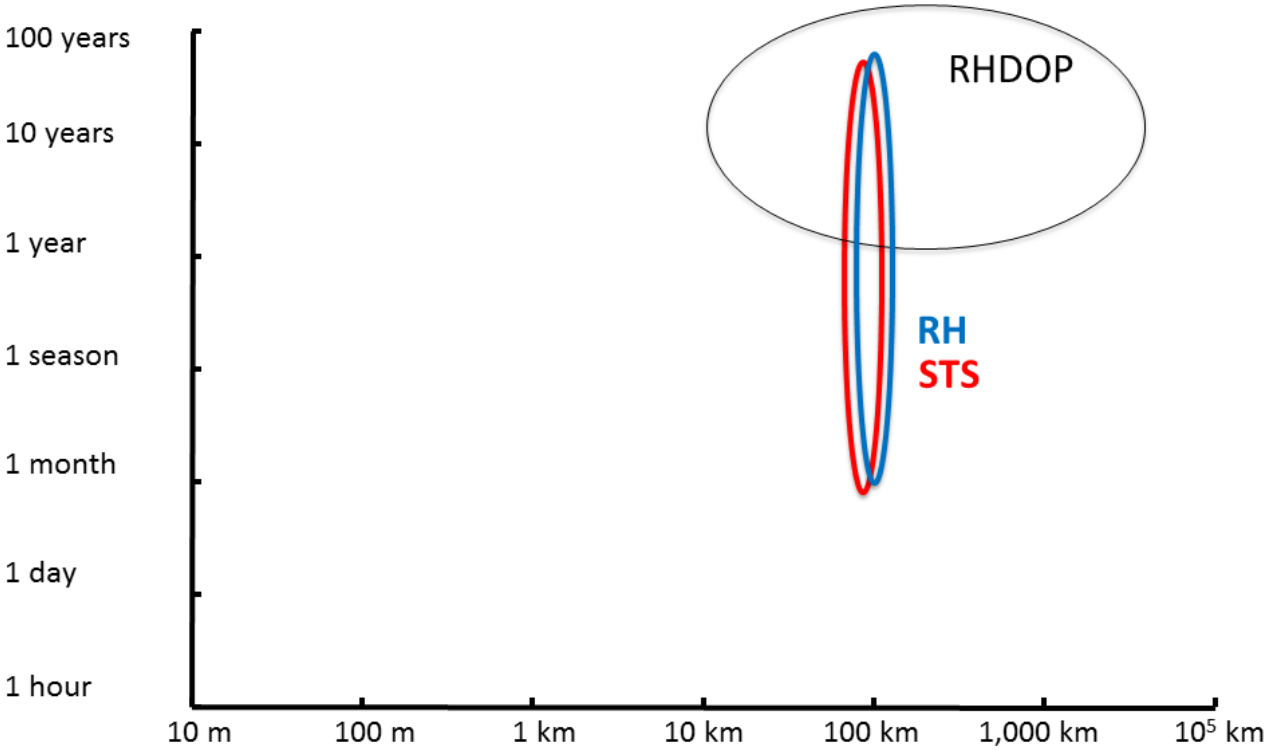

Figure 2. Spatial and temporal observation scales of component networks listed in Table 3 (thick coloured circles) and in Table 4 (thin black circles).

Table 5: Data & Information Creation					
Responsible entity and readiness level in each category per observing network	**Oversight & Coordination**	**Data Quality Control**	**Near Real-Time Data Stream Delivery**	**Data Repository**	**Data Product**
Repeat Hydrography	No formal group established, but coordination provided through GO-SHIP	CCHDO, CDIAC, BATS, HOT data systems	CCHDO, CDIAC, BATS, HOT data systems	CCHDO for Repeat Hydrography and time-series stations data sets	Global distribution patterns of DOC Temporal variability at BATS for DOC
	Mature				
Ship-based Time Series					

Table 6: Links & References	
Links (especially regarding Background and Justification)	Hansell, D.A., Carlson, C.A., Repeta, D.J., and Shlitzer, R., (2009). Dissolved organic matter in the ocean: A controversy stimulates new insights. *Oceanography* **22**, 202-211. Carlson, CA., D.A. Hansell (2014). DOM sources, sinks, reactivity and budgets in the ocean. In Biogeochemistry of Marine Dissolved Organic Matter 2nd Edition, eds. DA Hansell, CA Carlson, San Diego, CA: Academic Press In press. Hansell, D.A. and C.A. Carlson (1998). Net community production of dissolved organic carbon. Global Biogeochemical Cycles 12: 443-453. Hansell, D.A., Carlson, C.A., Repeta, D.J., and Shlitzer, R., (2009). Dissolved organic matter in the ocean: A controversy stimulates new insights. Oceanography 22, 202-211. Letscher, R.T., Hansell, D.A., Carlson, C.A., Lumpkin, R., and Knapp, A.N., (2013). Dissolved organic nitrogen in the global surface ocean: Distribution and fate. Global Biogeochem. Cycles 27, 141-153. Lomas, M.W., Burke, A.L., Lomas, D.A., Bell, D.W., Shen, C., Dyhrman, S.T., and Ammerman, J.W., (2010). Sargasso Sea phosphorus biogeochemistry: an important role for dissolved organic phosphorus (DOP). Biogeosci. 7 Sexton PF, Norris RD, Wilson PA, Pälike H, Westerhold T, et al. 2011. Eocene global warming events driven by ventilation of oceanic dissolved organic carbon. Nature 471:349-53
Links for Contributing Networks	http://www.go-ship.org/index.html
Data References	http://cchdo.ucsd.edu/, CDIAC

List of abbreviations

EOV – Essential Ocean Variable
GOOS – Global Ocean Observing System
IOCCP – International Ocean Carbon Coordination Project
FOO – Framework for Ocean Observing
GO-SHIP – The Global Ocean Ship-Based Hydrographic Investigations Program
DOM – Dissolved Organic Matter
DOC – Dissolved Organic Carbon
DON – Dissolved Organic Nitrogen
DOP – Dissolved Organic Phosphorus
RH – Repeat Hydrography
STS – Ship-based Time-Series
RHDOP – Repeat Hydrography for DOP
nm – nautical mile = 1.852 km
CDIAC – Carbon Dioxide Information Analysis Center
CCHDO – The Clivar & Carbon Hydrographic Data Office
BATS – Bermuda Atlantic Time-Series Station
HOT – Hawaii Ocean Time-Series
NDIR – Nondispersive Infrared Detector