

Ocean Carbon Hot Spots Workshop 25-26 September 2017, MBARI, Moss Landing, CA

Impact of Cyclonic Eddies on Biogeochemistry in the Oligotrophic ocean based on Biogeochemical / Physical / Meteorological time-series at station KEO

> Makio C. Honda (JAMSTEC) Yoshikazu Sasai (JAMSTEC) Eko Siswanto (JAMSTEC) Akira Kuwano-Yoshida (Kyoto Univ.) and Meghan Cronin (NOAA PMEL)

(Honda et al. submitted to PEPS)

Unexpected high primary productivity in the oligotrophic area



Surface Chl-a (annual average)

Winter mixing Regeneration + Meso-scale eddy? Typhoon? Eolian input? N₂ fixation ?



(Matsumoto et al. JO 2016)

Station KEO and Time-series sediment trap (since 2014)







Station KEO and NOAA KEO buoy (since 2008)







Temporal variability in sinking particle at 5000 m



(Honda et al. submitted)

Time-series contour plots of seawater temperature and density upper 550 m (Honda et al. submitted)



Pass of cyclonic eddy #1, 2 over station KEO



(Honda et al. submitted)

Pass of cyclonic eddies over station KEO between 2008 and 2015



Simulated-SSHA (cyclonic eddy) and time-series contour plots of simulated nitrate concentration between 2000 and 2012



Simulated-increase of integrated nitrate concentration upper 100 m by pass of cyclonic eddy with SSHA < -50 cm

Year	S/N	Period with SSHA < -50 cm	Δ _{int} N _(eddy) (mol-N m ⁻²)	Δ _{mt} AN(_{etdy)} (mol-N m ⁻² yr ⁻¹)	ک _{int} AN _(eddy) (mol-N m ⁻² yr ⁻¹) without WCM data
2000	0		0.00	0.00	0.00
2001	1	11 May - 30 May	0.22	0.32	0.32
	2	3 Oct 11 Oct.	0.08		
	3	10 Oct 2 Nov.	0.02		
2002	1	31 Mar 26 Apr.*	0.68	0.68	0.00
2003	1	1 Oct 12 Oct.	0.10	0.10	0.10
2004	0		0.00	0.00	0.00
2005	0		0.00	0.00	0.00
2006	1	7 Apr 25 Apr.	0.36	0.99	0.99
	2	28 Apr 11 May	0.63		
2007	1	18 Jan 26 Jan.*	0.16	0.27	0.12
	2	16 May - 16 May	0.12		
2008	1	16 Apr 23 May	0.10	0.34	0.34
	2	16 Dec 21 Dec.	0.24		
2009	1	8 Jan 30 Jan.*	0.33	0.33	0.00
2010	1	20 Jun 16.Jul.	0.65	0.65	0.65
2011	1	13 Mar 13 Mar.*	0.06	0.44	0.38
	2	9 Jul 26 Aug.	0.38		
2012	1	4 Oct 31 Oct.	1.07	1.07	1.07
			average of $\Delta_{int}AN_{(eddy)}$	0.40	0.31
			stdv (σ)	0.36	0.38

* This period is in the Deep Winter Mixing (DWM) period .

(Honda et al. submitted)

Potential increase of OCF by eddy-induced nutrient



(based on N supply by eddy_(SSHA < ~50cm)) CE1/CE2-induced N supply 0.08 mol-N m⁻²

> (assuming 100% eff. and C/N: 6.6) Supported PP 6.02 g-C m⁻²

> > (assuming Export ratio: 0.6%) Increase of OCF_(potential) 36.6 mg-C m⁻²

Increase of OCF_(CE1) 24.3 mg-C m⁻²

Increase of OCF_(CE2) 40.0 mg-C m⁻²

Comparison of simulated Eddy-induced N-supported Production with **Carbon export flux** (Honda et al. submitted) mol-C m⁻² yr⁻¹ References $\Delta_{int}AN_{(eddy)}$ -supported 2.0 - 2.6* This study production* annual N export flux based on Matsumoto et al. (2016); Honda 3.2** New production at S1 et al. (2017); Sasai et al. (2016) 1.7 POC flux at 100m of S1 Honda et al. (2016) 2.5 POC flux at 200m of S1 Wakita et al. (2016) aNCP in surface mixed layer at 7 ± 3 Fassbender et al. (2017) **KEO**

^k Δ_{int}AN_(eddy) (0.31 - 0.40 mol-N m⁻² yr⁻¹) multiplied by the Redfield Ratio (6.6) ** Net Primary Productivity (10.6 mol-C m⁻² yr⁻¹) multiplied by f-ratio (0.3)

Tracks of typhoons during experimental two years



J./Keene, NOAA/PMEL/OCS

Time-series contour plots of seawater temperature upper 300 m before and after typhoons



"Climatological" Nitracline in September near KEO (WOA2013)



(Honda et al. submitted)

Concluding remarks

KEO time-series observation of settling particle from JAMSTEC sediment trap deployed adjacent to NOAA surface buoy, instrumented for meteorology, physical oceanography, and biogeochemistry, revealed Cyclonic eddies are likely an important mechanism for nutrient supply.

While we have focused on the supply of nutrients from deep winter mixing, eddies and typhoons, other sources may also contribute. In particular, further work is needed to quantify the role of N₂ fixation and eolian input for supplying nutrients in this oligotrophic ocean region.

Temporal change in current at around 36 m during pass of typhoon



Large attenuation of OCF In the twilight zone



(Honda, unpublished data)