Coastal acidification and fishery in Japan

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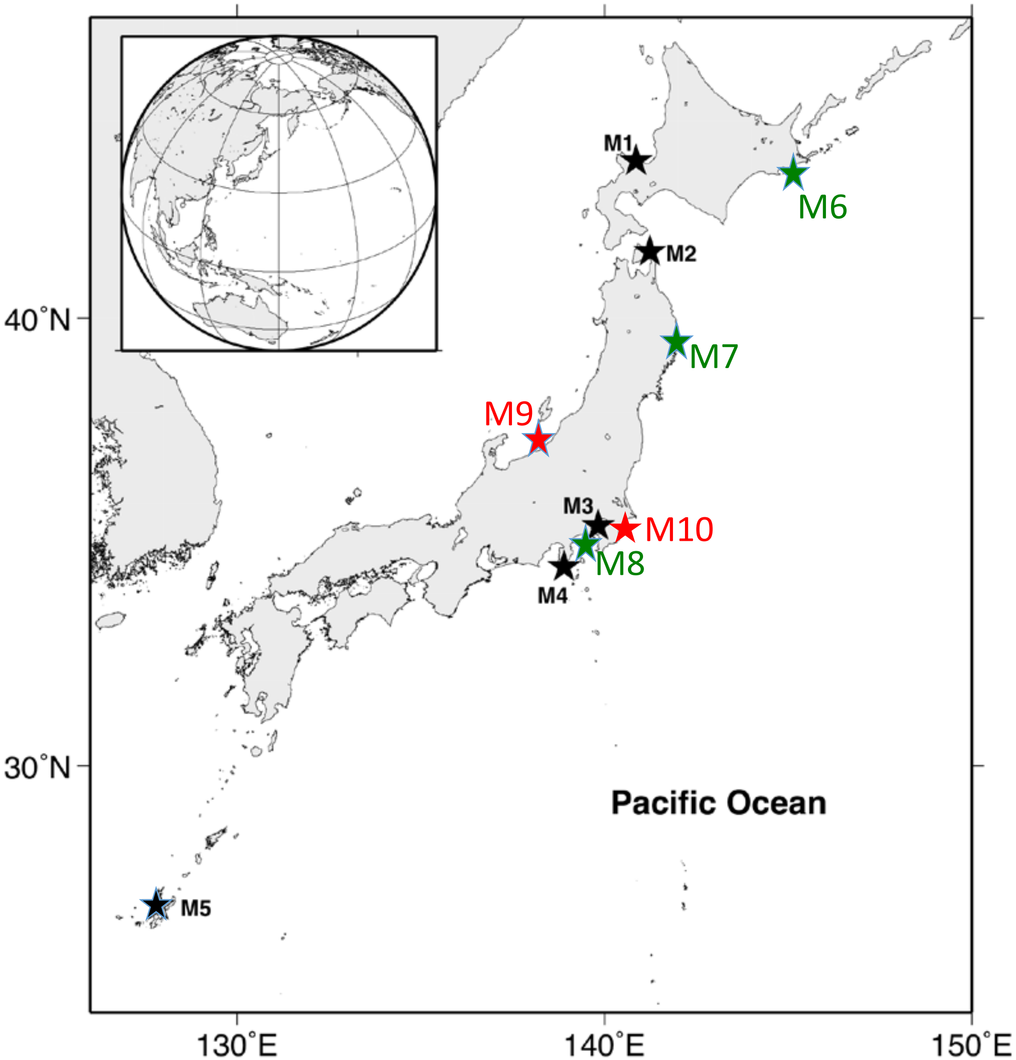
AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

NiPR National Institute of Polar Research

OPRI THE OCEAN POLICY RESEARCH INSTITUTE

ongoing Japan-coast pH monitoring sites *[after S. Takao/WESTPAC 2015]*



M1: Oshoro Bay [Japan Sea & origotrophic; 2013 – present]

M2: Tsugaru Straight [transition & origo-trophic; 2014 – present]

M3: Tateyama Bay [subtropic & eutrophic; 2011 – present]

M4: Shimoda Bay [Subtrophic & oligo-trophic; 2011 – present]

M5: Nago Bay [Coral coast; 2000 – present]

M6: Akkeshi Bay [subarctic eelgrass swamp; 2014 – present]

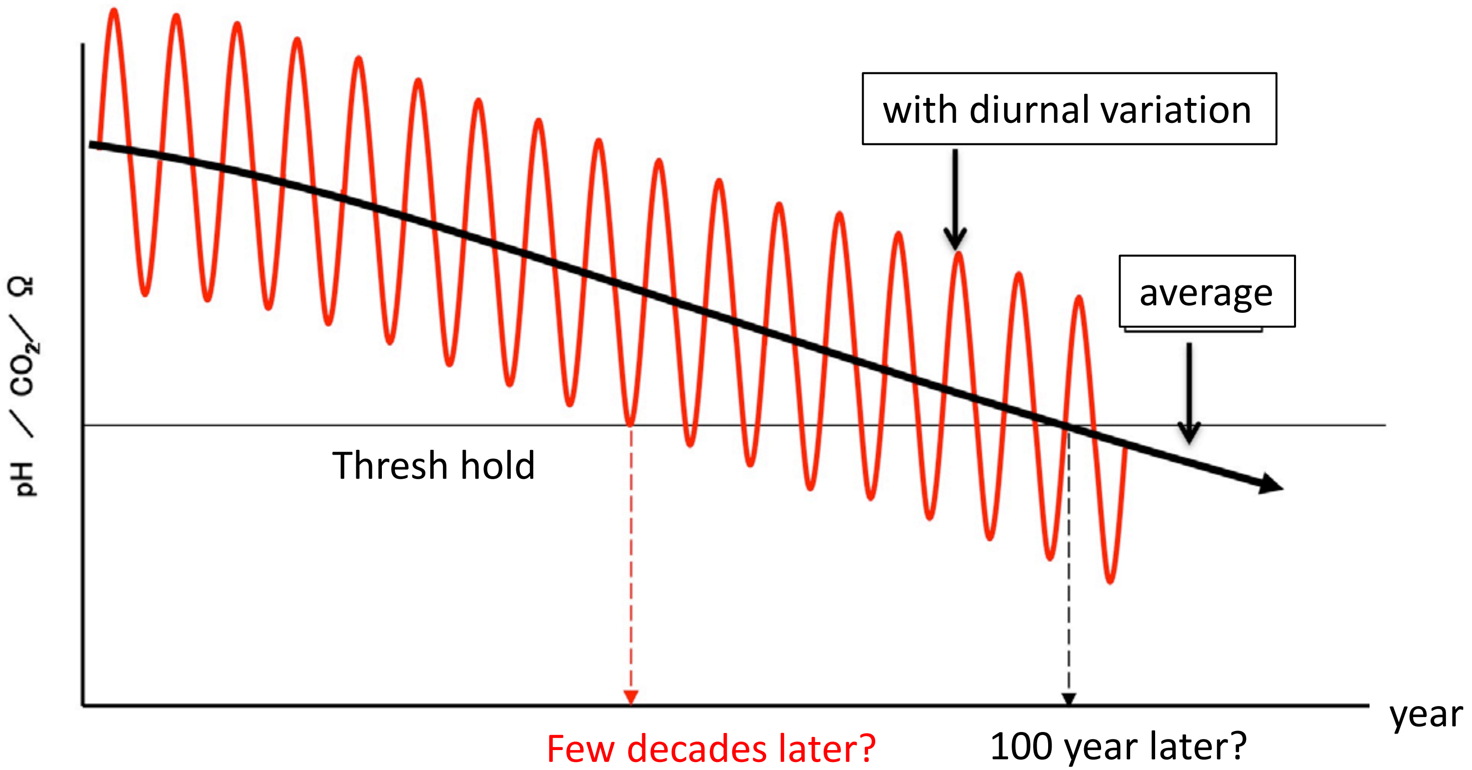
M7: Miyako station [transition & oligo-trophic; 2014 – present]

M8: Arasaki Station [Subtrophic & oligo-trophic; 2009 - 2011]

M9:Kashiwazaki Station [Subtrophic & oligo-trophic; 1982 –present]

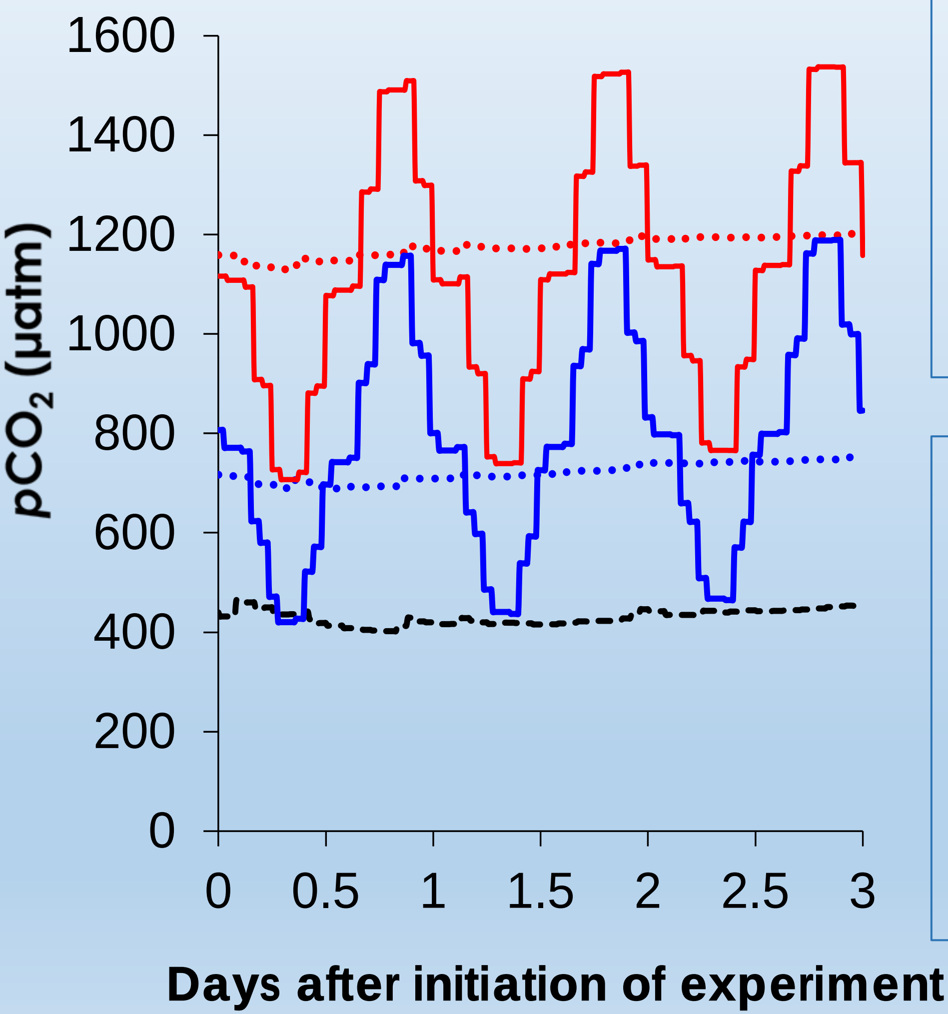
M10:Onjuku Station [Subtrophic & oligo-trophic; 1982 –present]

High diurnal/seasonal variation of pH in coastal area: What does biota respond to? Average or Minimum?



modified from Yamamoto-Kawai et al.

Effects of diurnally-variable pCO_2 on ezo-abalone larvae by culture experiment *[Onitsuka et al., submit.]*



Constant treatments

Targeted *p*CO_2

400 µatm, 800 µatm, 1200 µatm

Results of monitoring

(Dotted lines)

430±15, 732±19, 1175±20 µatm

Diel cycle treatments

Targeted *p*CO_2

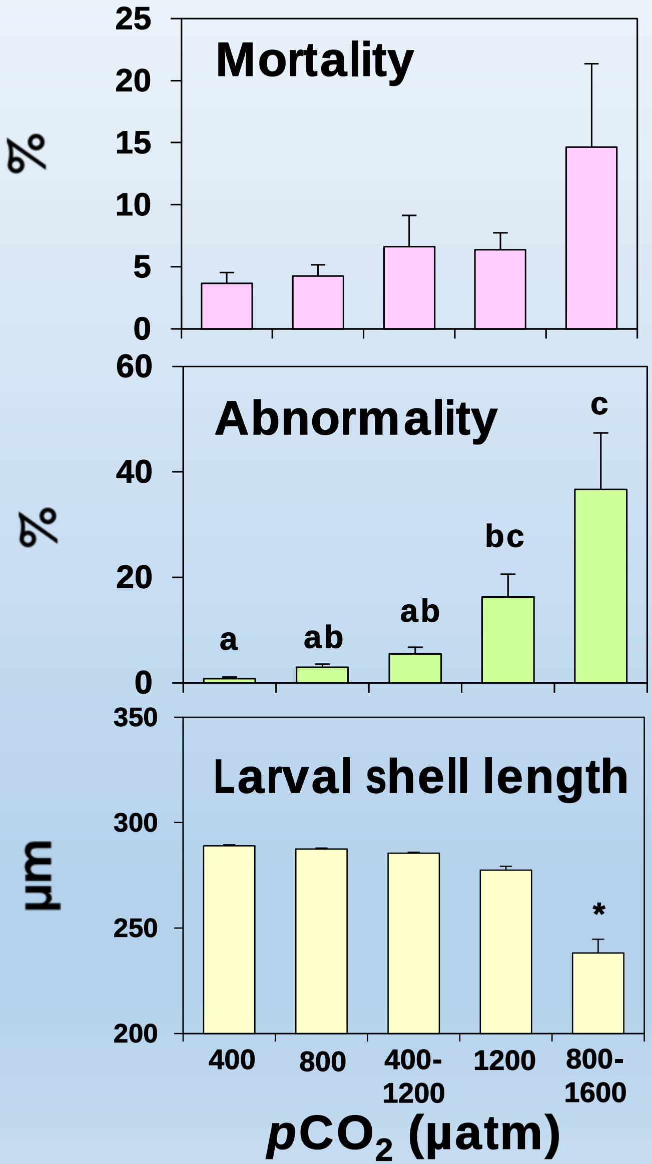
400-1200 µatm, 800-1600 µatm

Results of monitoring

(Solid lines)

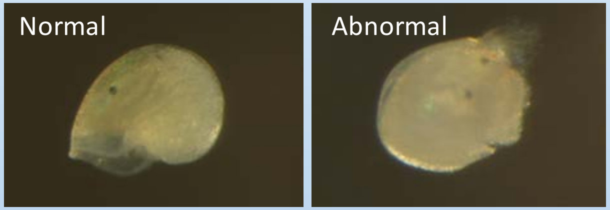
420-1189 µatm, 739-1537 µatm

Results : Effects on larval fitness



There were no significant differences in mortality rate among all the pCO_2 treatments.

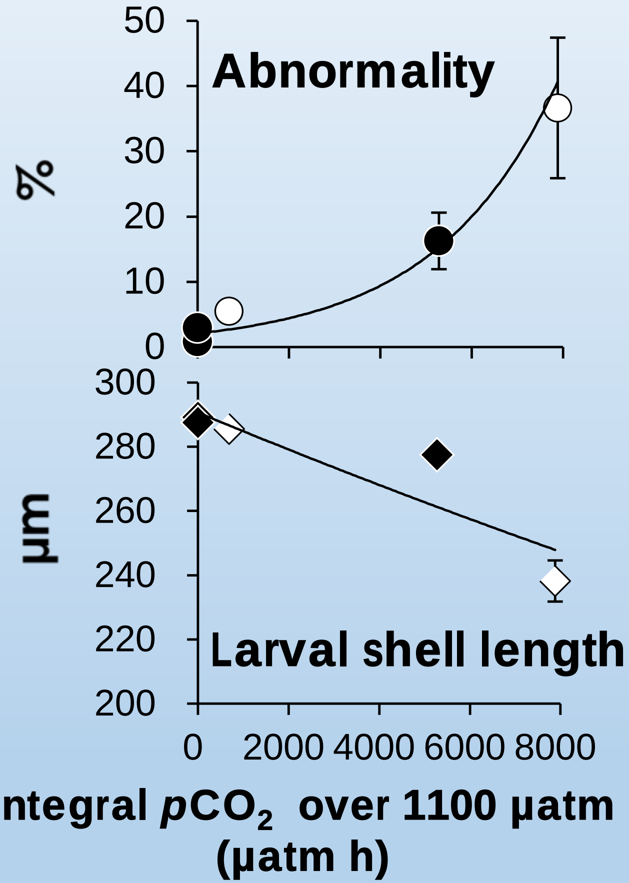
Abnormality rate was significantly higher in the 1200µatm, and more in 800-1600 µatm



Shell length in the 800-1600 µatm was significantly shorter but not in the 1200µatm.

[Onitsuka et al., submit.]

Results 2: Effect of integral pCO_2 on larval fitness



Open markers: diel cycle treatments
Solid markers: constant treatments

The aragonite saturation state around Ω=1.0 is equivalent to 1100 µatm pCO_2.

Integral *p*CO2 over 1100 µatm

$= \sum(P - 1100)i$

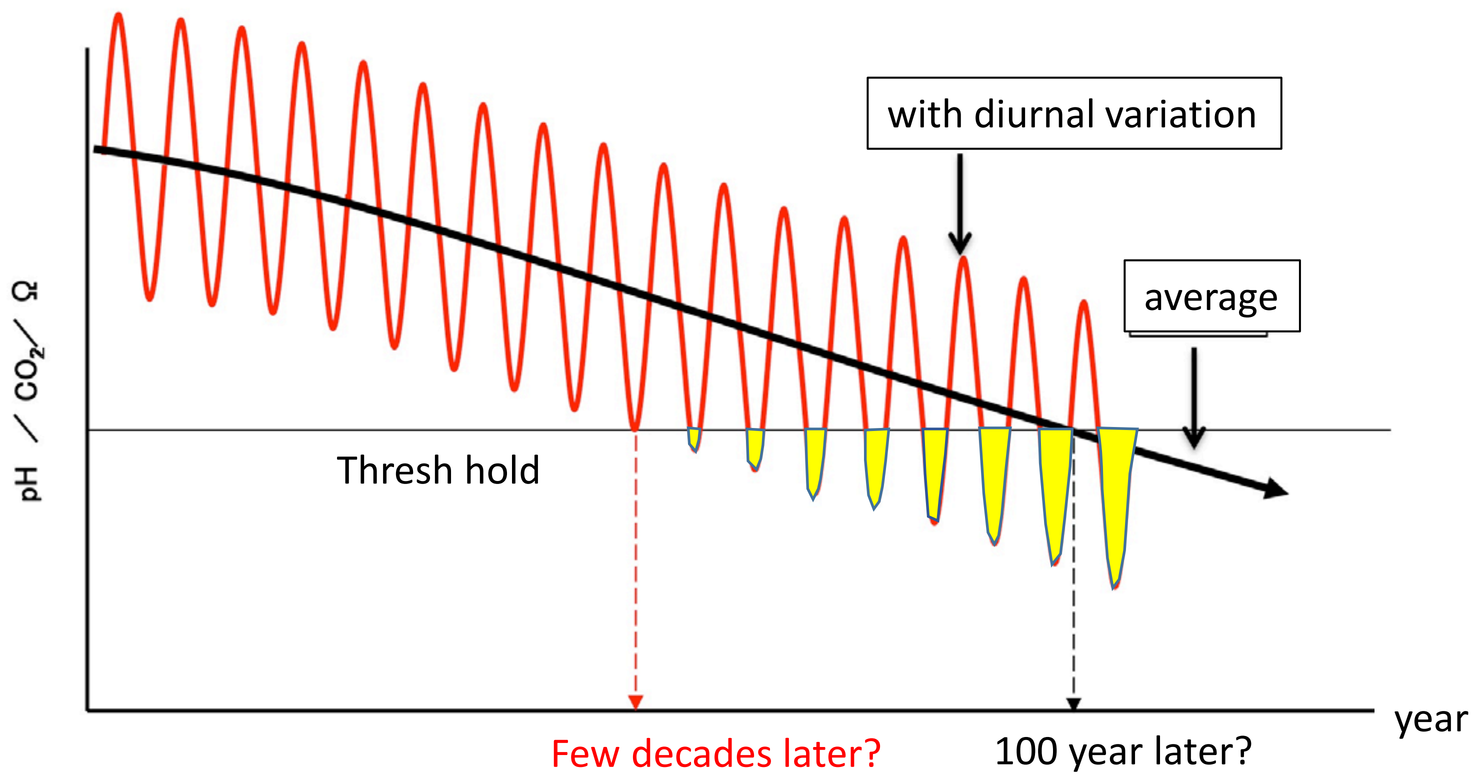
***P*: pCO_2 over 1100 µatm**

***i*: exposed hours to pCO_2 over 1100 µatm**

Abnormality rate increased with increment of integral pCO_2 over 1100 µatm .

Larval shell length decreased as integral pCO_2 over 1100 µatm increased.

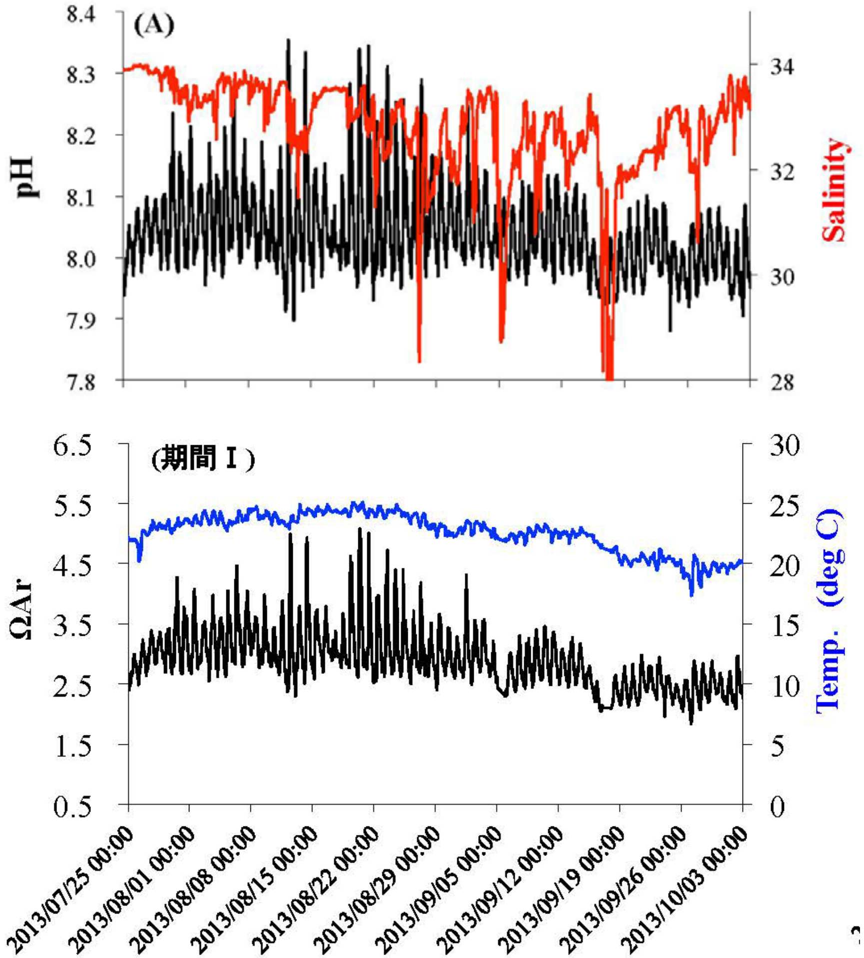
High diurnal/seasonal variation of pH in coastal area: What does biota respond to? Average or Minimum?



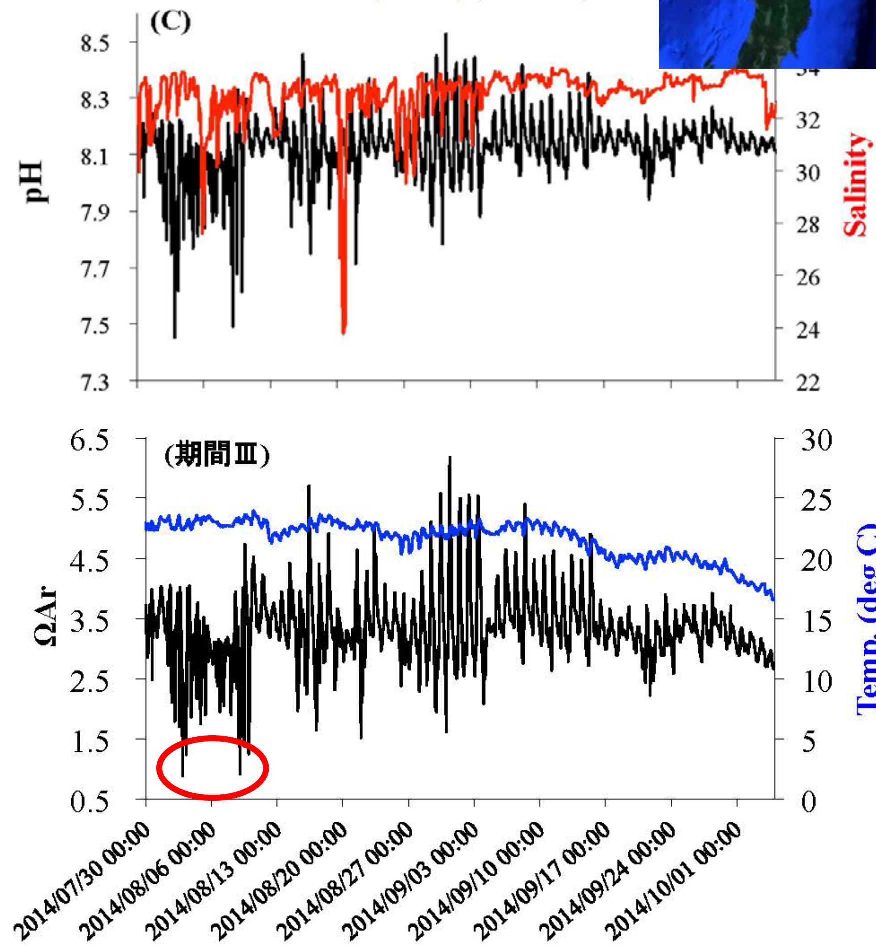
modified from Yamamoto-Kawai et al.

Oshoro Bay station, Hokkaido

2013 summer



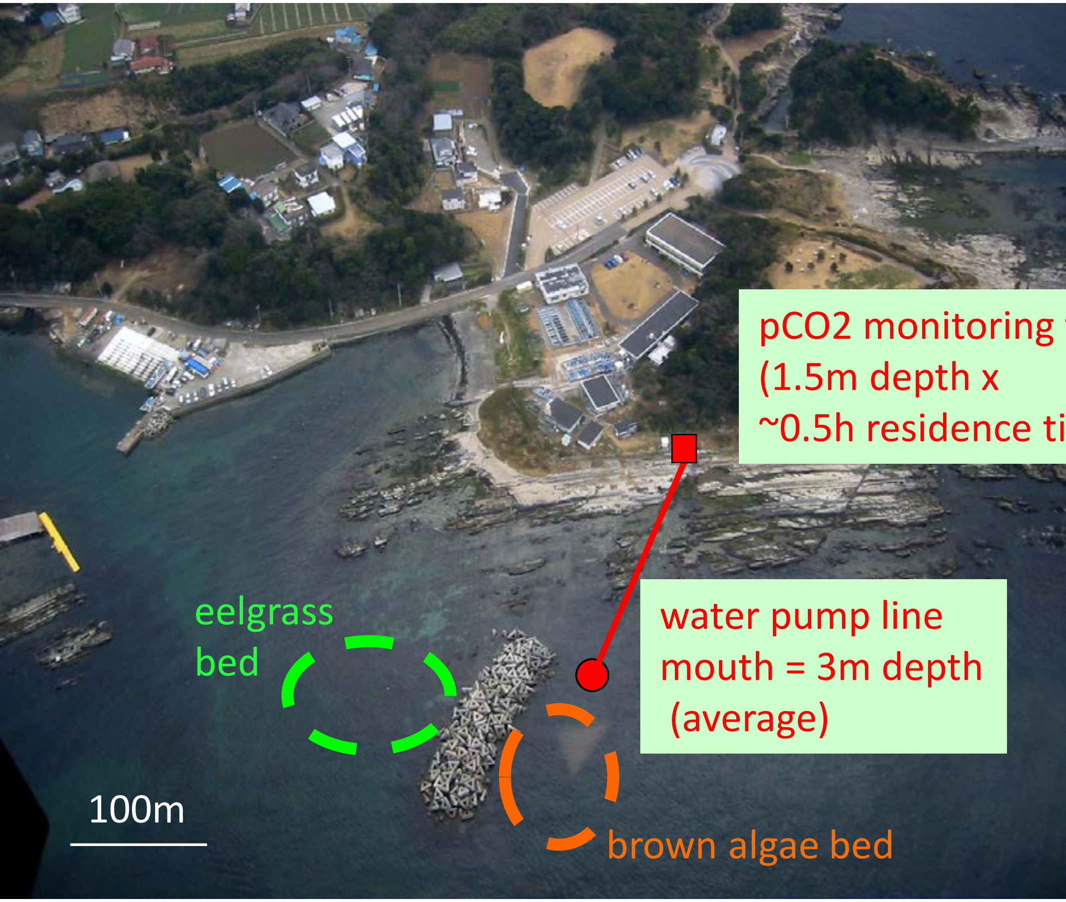
2014 summer

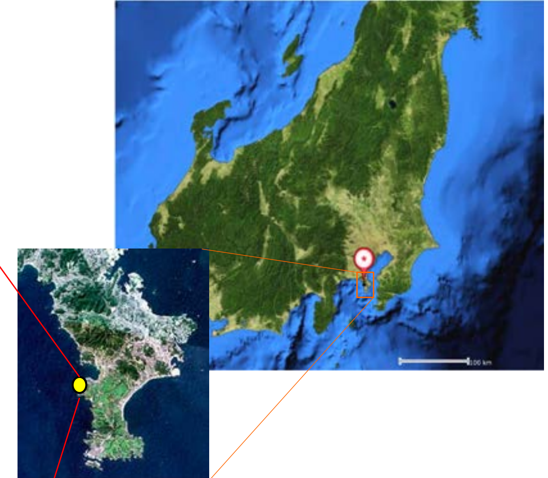


pH amplitude:
avg. 0.18 ± 0.08
max 0.44
min 0.08

pH amplitude:
avg. 0.28 ± 0.19
max 0.83
min 0.05

another example: Arasaki Station [FRA]





1-year composite pCO_2 variation

pCO_2 monitoring (continuous pCO2 monitoring system by Kimoto electronic) was occupied intermittently from 2009 to 2011 to make composite 1-year time series.

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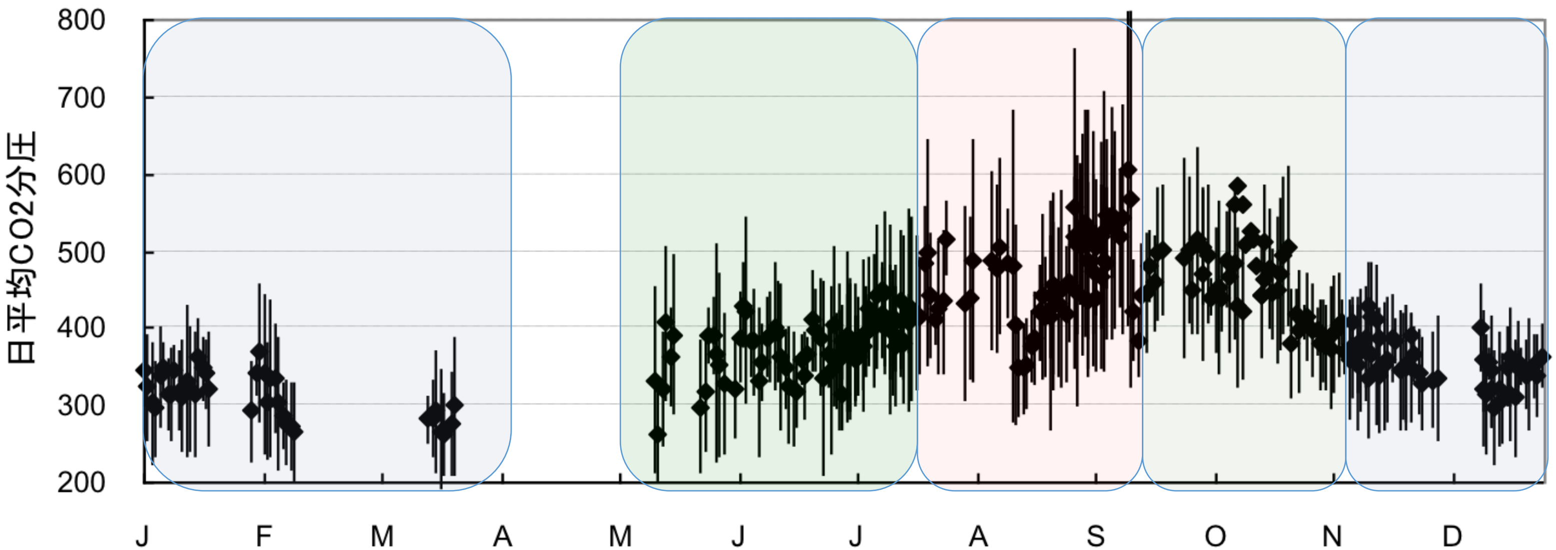
1-year composite data

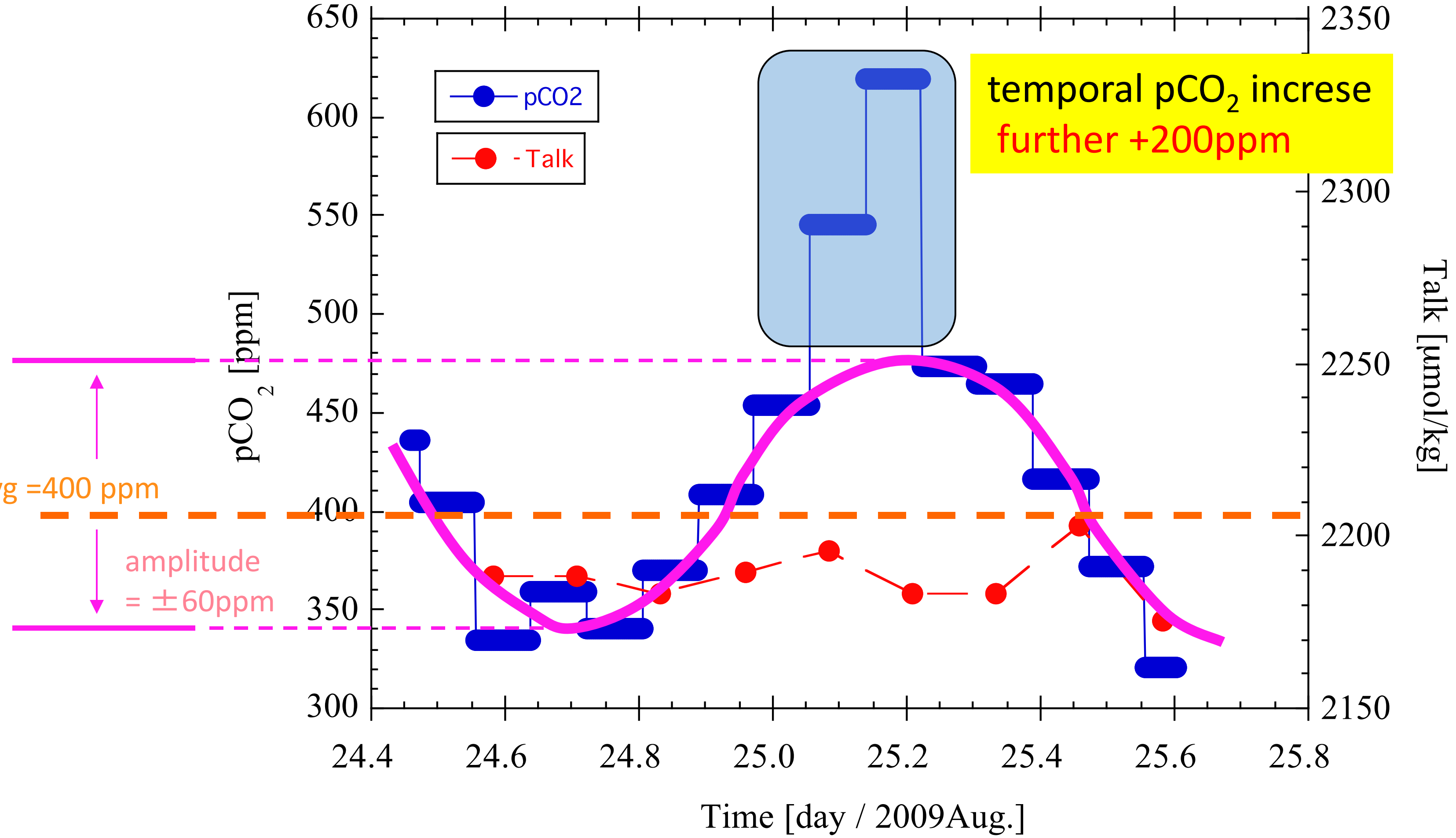


▪significant seasonal dependence in the amplitude of diurnal pCO_2 variation

#winter (Nov. – Mar.)	~150 ppm
#spring (May –mid July)	~200ppm
#summer (mid July – early Sept.)	>300ppm (max. 400)
#autumn(mid Sept.-Oct.)	~200ppm

▪Annual pCO_2 maximum: daily avg. 600ppm
with diurnal variation: >800ppm

result of 24-hour pCO_2 monitoring

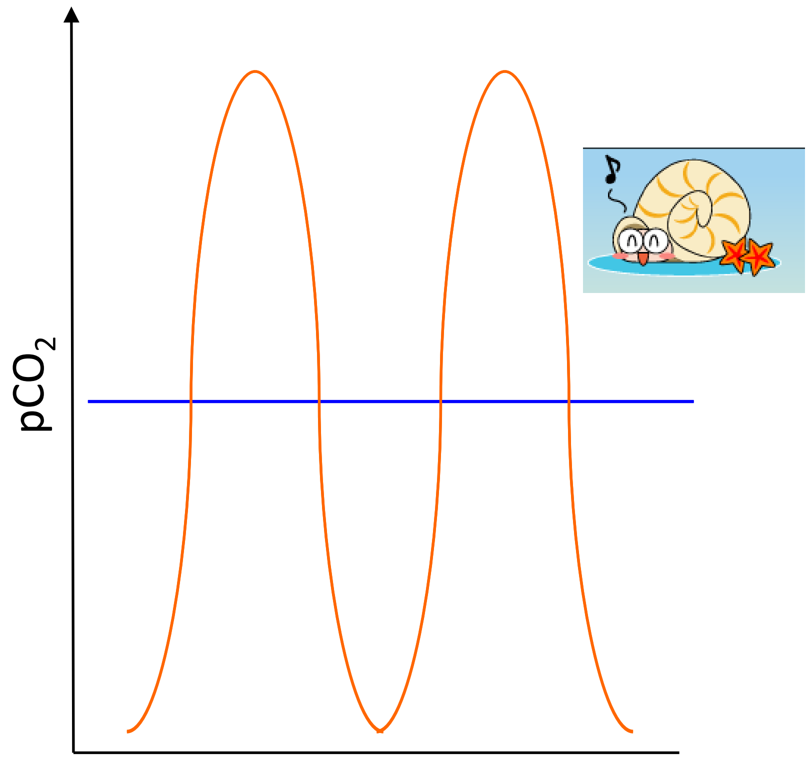


total diurnal pCO_2 variation……..about 300 ppm

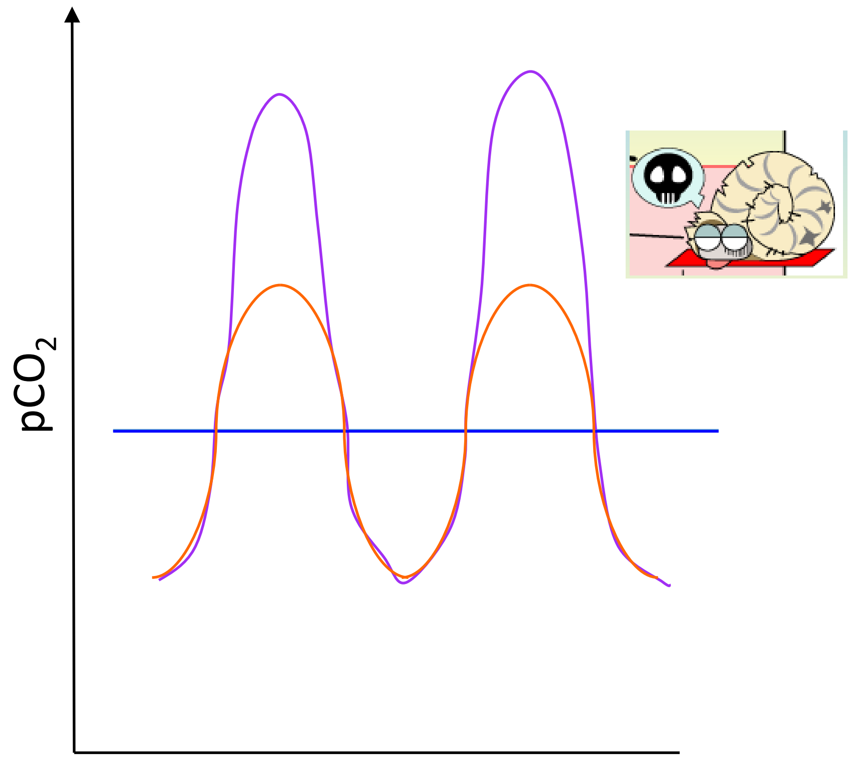
Existence of local hot spot of pH and pCO_2 among the Arasaki station

different biotic response between "natural eutrophication" and "polluted eutrophication"

natural eutrophication
(inner-Bay, estuary etc.)



polluted eutrophication
(arasaki district)



Summary: present knowledge on ocean acidification In the coastal waters around Japan

1] pH decrease in Japan coast: -0.003/y at one station, but should be subject to high local variation *(more long-term data needed!)*

2] existence of high diurnal / seasonal variation of pH even in one site, and some fisheries species exhibit high sensibility not against daily average but daily <u>minimum</u> pH (or daily integral of pH deficit from the level equivalent to Ω_{ara} =1)
We need high-res., continuous pH monitoring to acquire this information.

3] detailed OA-mapping observation showed that there are many local hot spot of pCO2 (pH) along the Japan coast as the result of the anthropogenic eutrophication. This may cause severe effect to local biota (incl. fisheries resources) when considering historical biological adaptation.

4] Anthropogenic CO2-derived OA, naturally eutrophicated OA, and anthropogenically -eutrophicated OA affect to ecosystem DIFFERENTY.
We need multi-parameter monitoring data (e.g., nutrient and Chla in parallel with pH) to determine different cause of ocean acidification.