Ocean acidification trends in coastal waters in Japan

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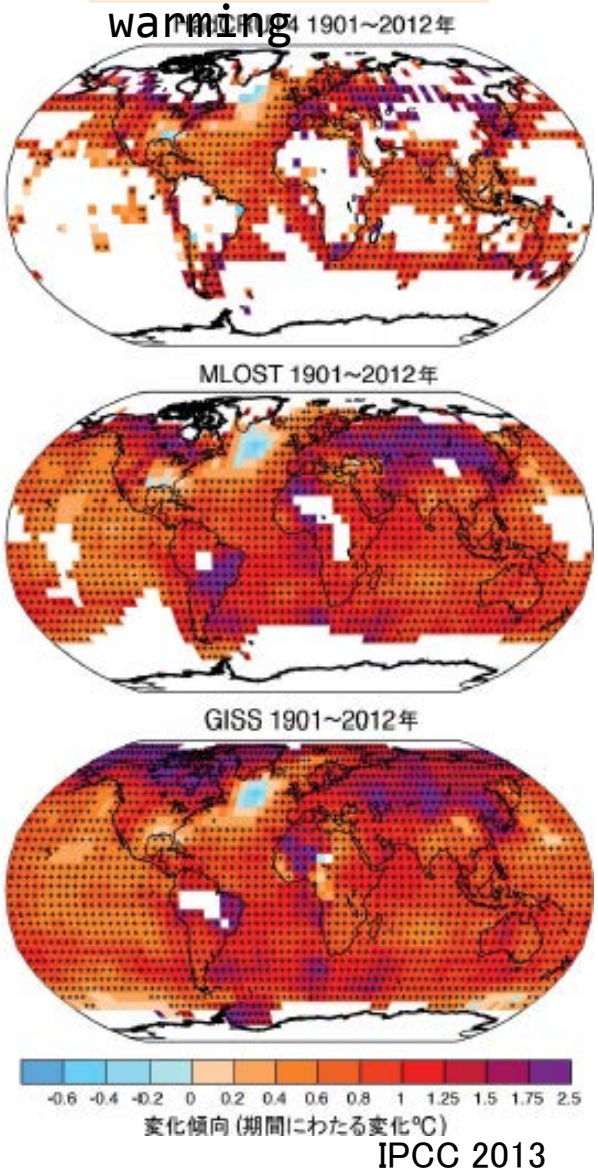
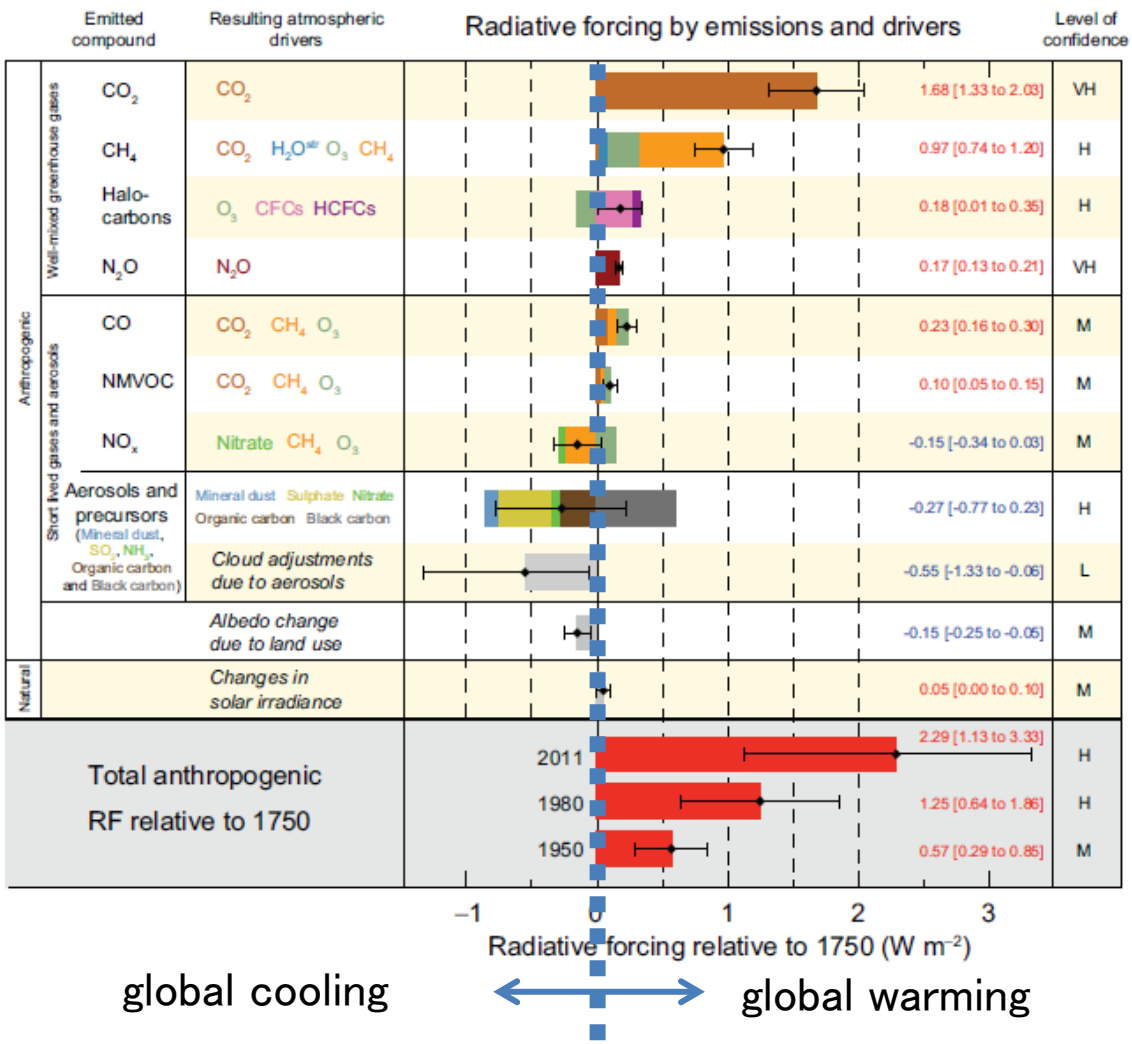
Background of ocean acidification

Global warming



IPCC 2013

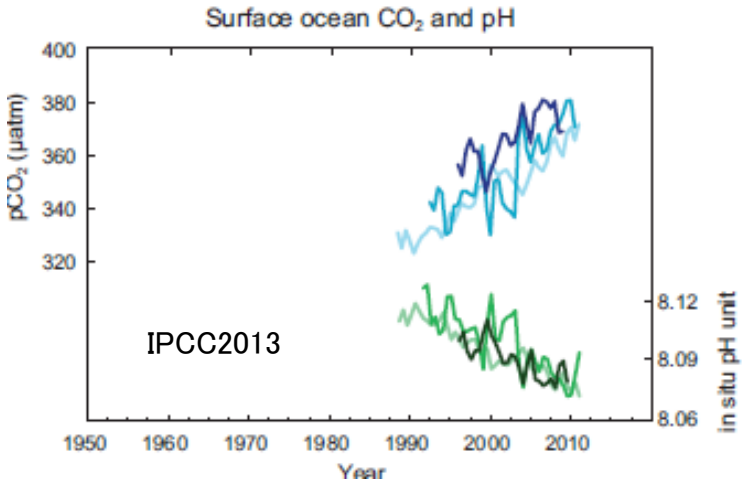
Anthropogenic gas after pre-industrial times



global cooling ⟷ global warming

The most efficient compound : CO_2.

Global warming also changes marine environments



Decrease in pH ⇒ Souring ocean

ΔpH values in open ocean

ESTOC in the North Atlantic :
ΔpH = −0.0017 yr^{-1} for 1995—2003 (Gonzalez-Davila et al. 2007).

HOT : ΔpH = −0.0019 yr^{-1} for 1988—2007 (Dore et al. 2009).

BATS : ΔpH = −0.0017 yr^{-1} for 1983—2005 (Bates, 2007).

Surface pH in winter in Iceland Sea :
ΔpH = −0.0024 yr^{-1} for 1985—2008 (Olafsson et al. 2009).

The repeat hydrographic line in 137 ° E in the western North Pacific by JMA :
ΔpH = −0.0018 yr^{-1} since early 1980s (Midorikawa et al. 2010).

ΔpH at −0.0013 to −0.0018 yr^{-1} (Bates et al., 2014).

We have realized that ocean acidification occurs in open ocean.

How is it in coastal waters?

Ocean acidification in coastal waters has not been clear especially in local regions covering a wide range because of limited amount of human resources and funds.

In 1950s to 1960s in Japan, we suffered from serious environmental pollutions in atmosphere and in water.

http://npo-jwg.com/seaforest.html

Water Pollution Control Law has been established since 1970. The purpose of this law is not to monitor the global warming effects but to protect coastal and ground water from water pollution and to retain water environment.

Several substances, including pH have been continuously measured since 1978 locally in coastal waters in Japan.

The data accuracy of pH : an error of less than ±0.07, based on JIS standard, which is not high level, compared to the oceanographic standard with an error of less than ±0.003.

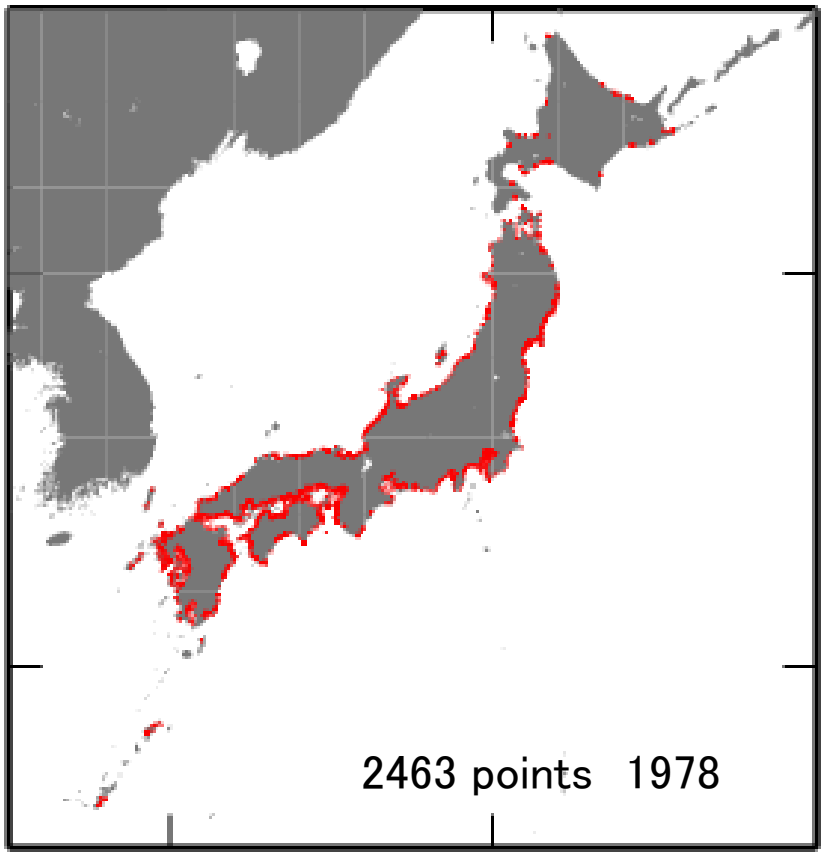
However,

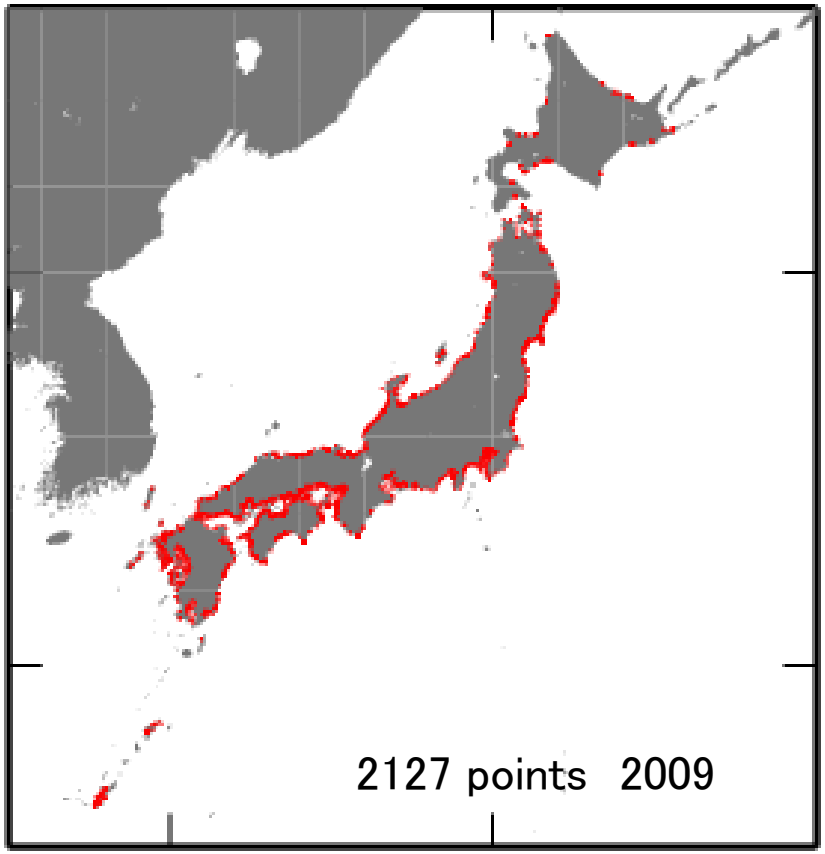
The number of the monitor sites : over 2000 points covers most of the coastal lines in Japan.

Highly promising and valuable data to comprehensively understand the current status of ocean acidification locally along almost the whole coastal lines in Japan.

In present study, we examine the local changes in the surface ocean acidification by using the long-term pH records measured in accordance with Water Pollution Control Law.

Coastal maps with monitoring sites





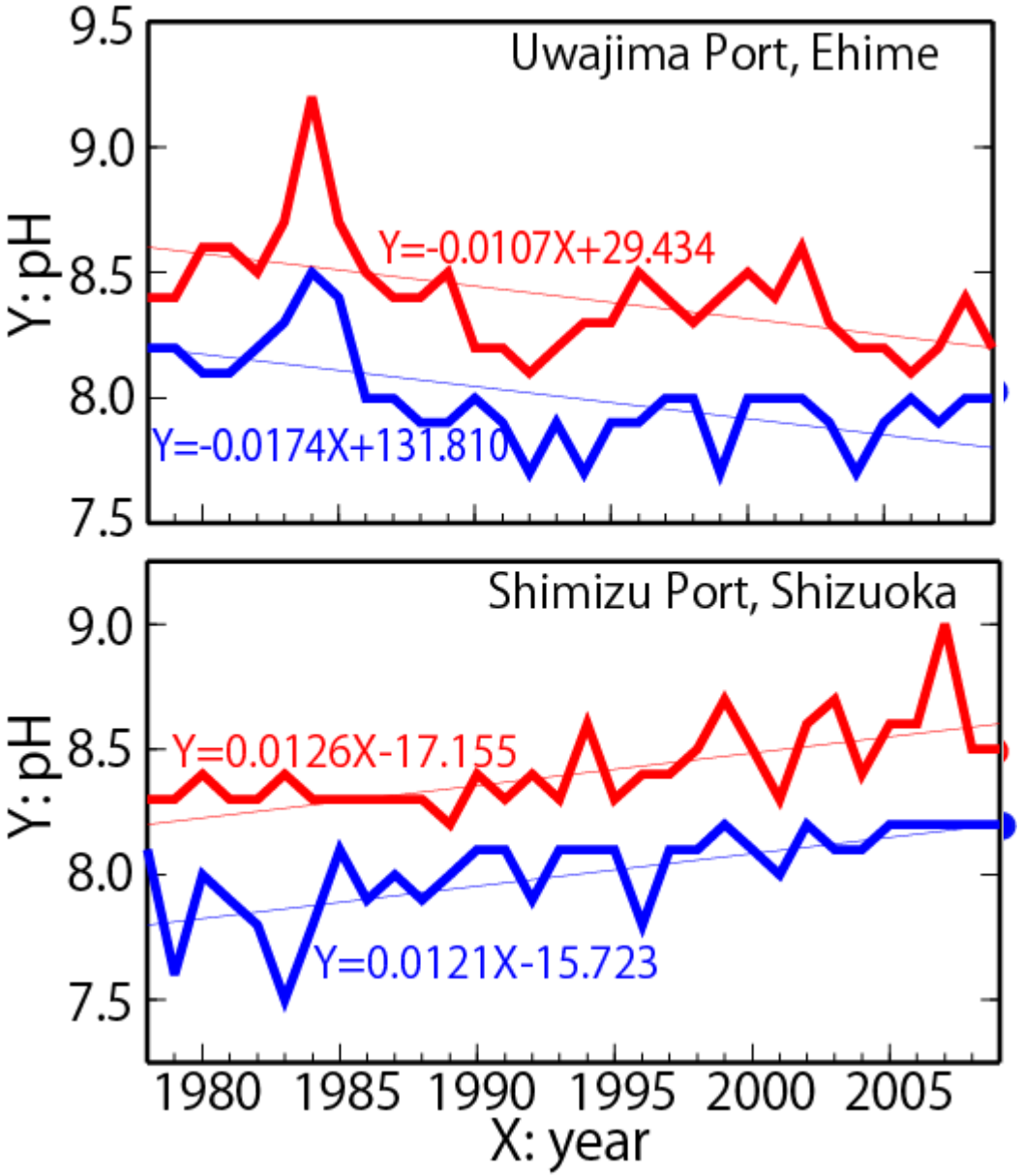
Monitoring : once a month

Glass electrode methods or a method using automatic water quality monitoring measurement has been adapted in accordance with their measurement program.

The pH data is provided by NBS pH scale.
Yearly averaged maximum and minimum data are provided throughout the website.

Acidification/alkalization trends in coastal water regions

（pH data offered by the website of National Institute for environmental studies

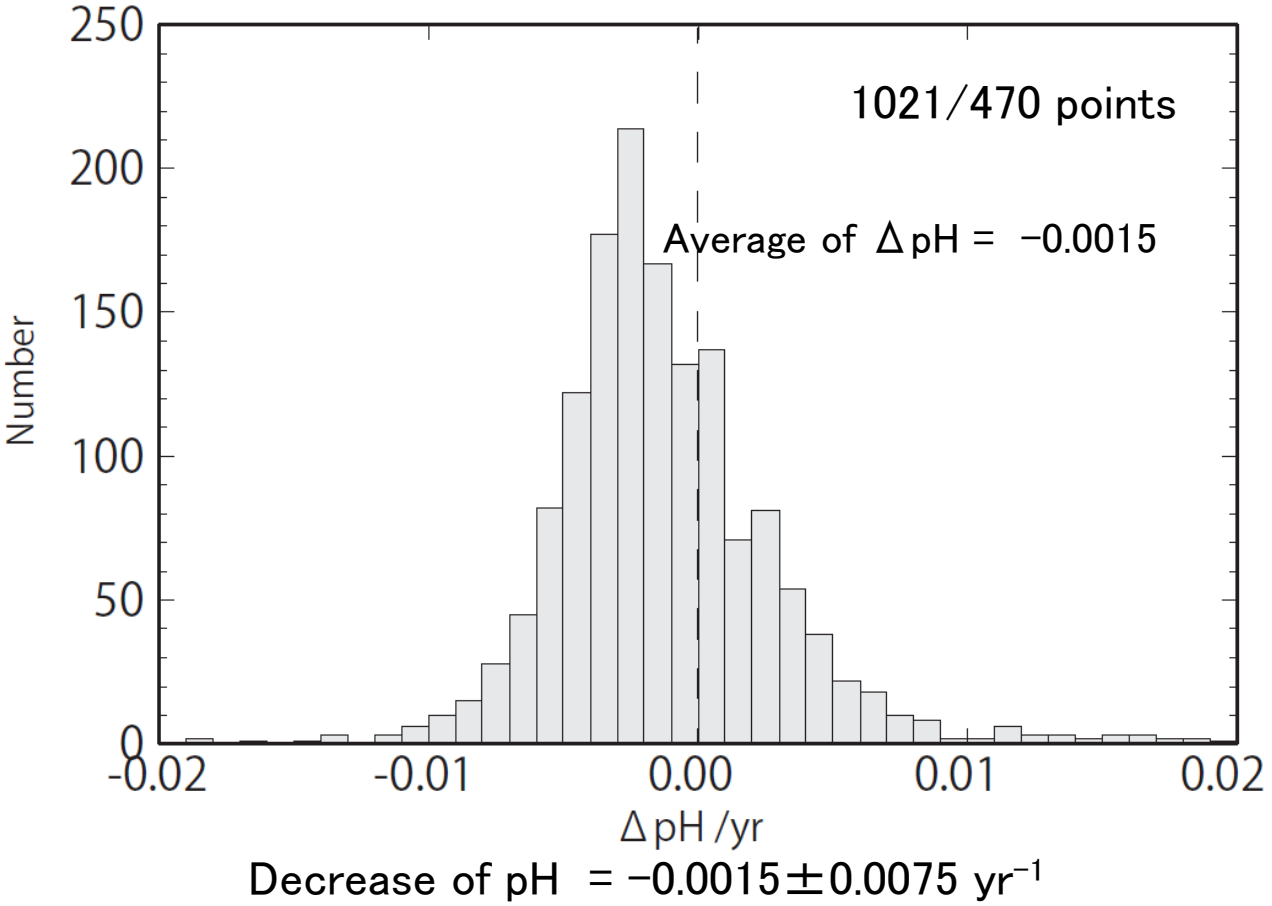


a: slopes（ΔpH）of linear regression line（y=ax+b）

Histograms of ΔpH

Without significance

ΔpH < 0.0 : acidification trends



Decrease of pH = −0.0015±0.0075 yr^{-1}

Decrease in pH

ESTOC : −0.0017 yr−1

HOT : −0.0019 yr−1

JMA along 135° E

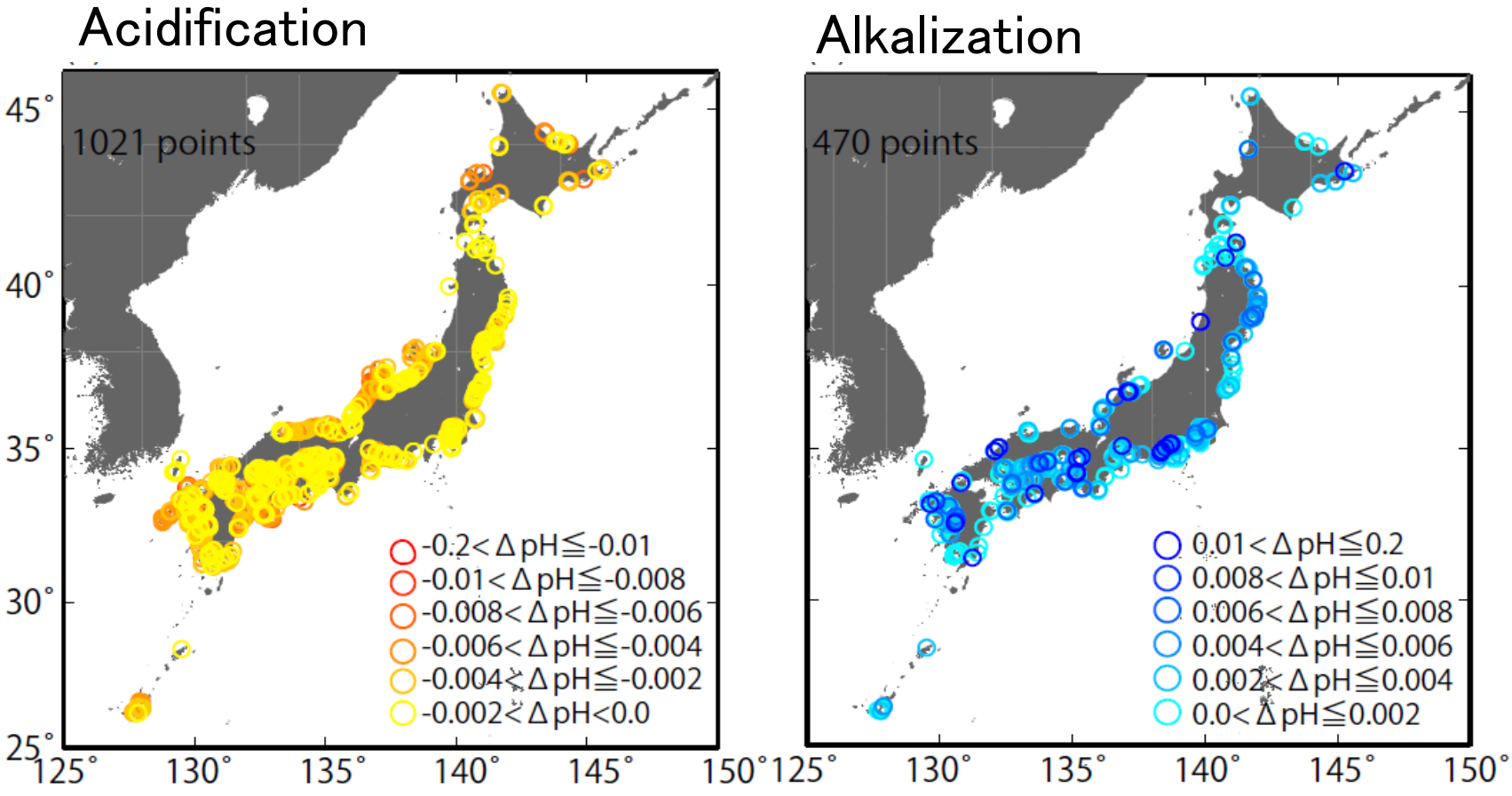
−0.0018 yr−1 in winter

−0.0008 yr−1 in summer

BATS

−0.0017 yr−1 in winter

Our averaged ΔpH is comparable to that in open oceans.

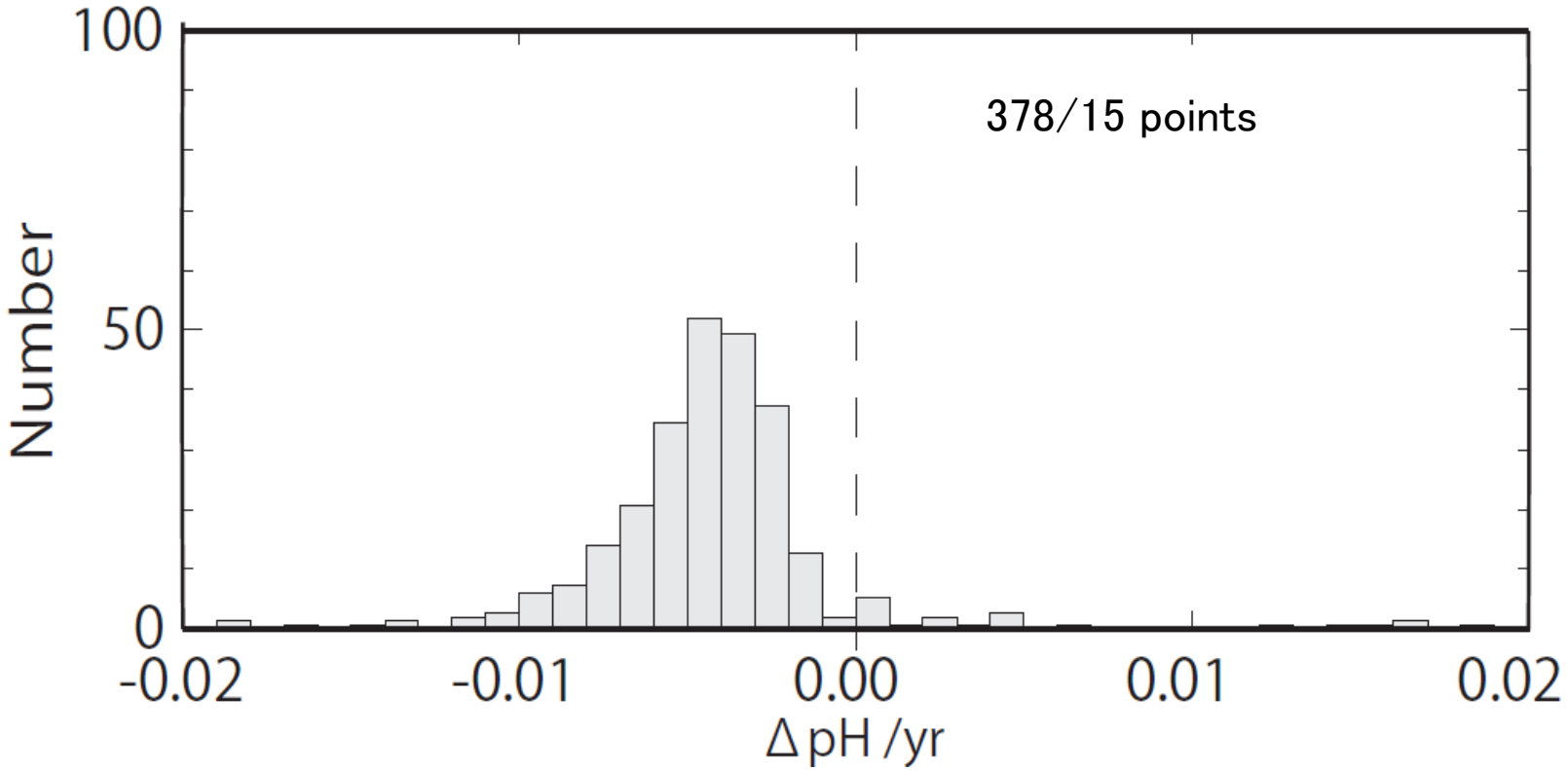

Acidification
1021 points
45°
40°
35°
30°
25°
125°
130°
135°
140°
145°
150°
-0.2< ΔpH≦-0.01
-0.01< ΔpH≦-0.008
-0.008< ΔpH≦-0.006
-0.006< ΔpH≦-0.004
-0.004< ΔpH≦-0.002
-0.002< ΔpH<0.0
Alkalization
470 points
125°
130°
135°
140°
145°
150°
0.01< ΔpH≦0.2
0.008< ΔpH≦0.01
0.006< ΔpH≦0.008
0.004< ΔpH≦0.006
0.002< ΔpH≦0.004
0.0< ΔpH≦0.002

For more rigorous checking, the data within 3 standard deviations of the mean each year were removed.

Histograms of ΔpH

with checking significant test

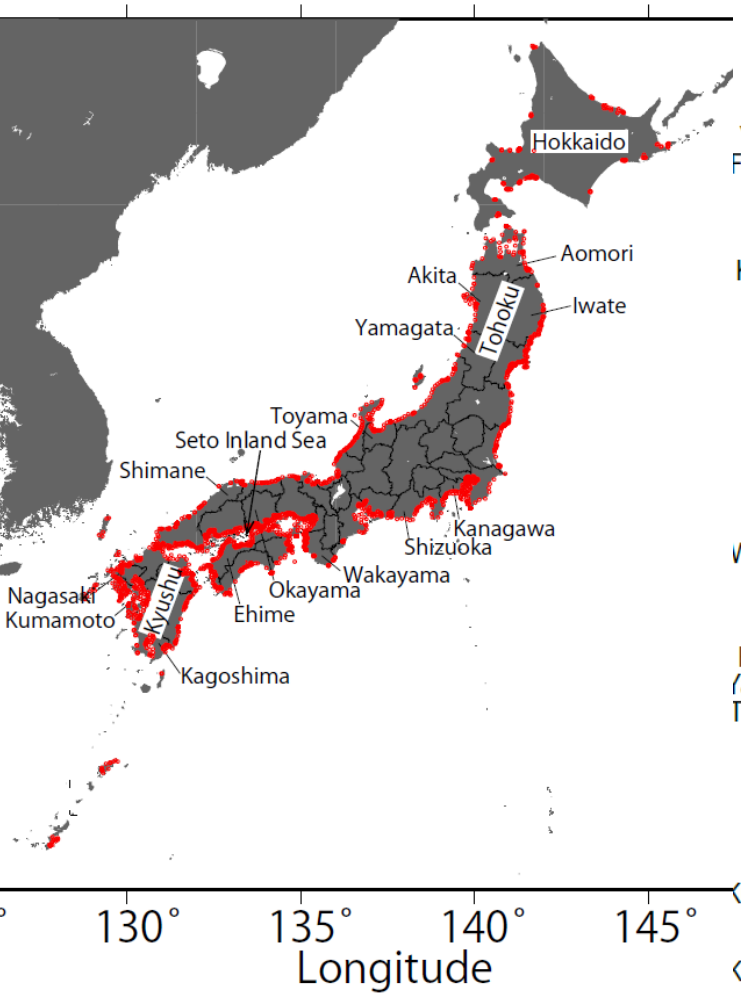
ΔpH < 0.0 : acidification trends (p<0.05)

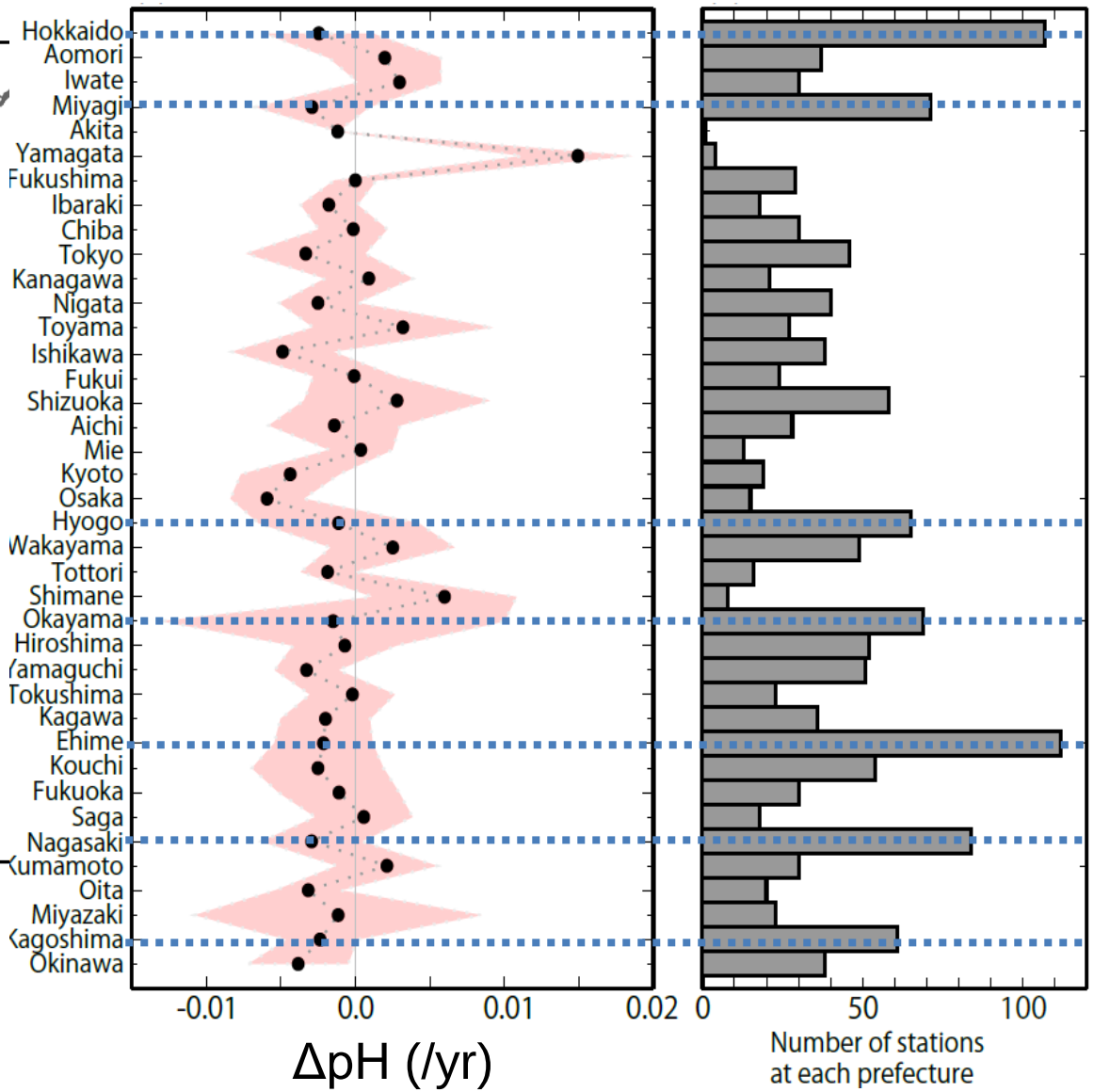


Decrease of pH = −0.0045 yr^{-1}

Averaged Δ pH in each prefecture

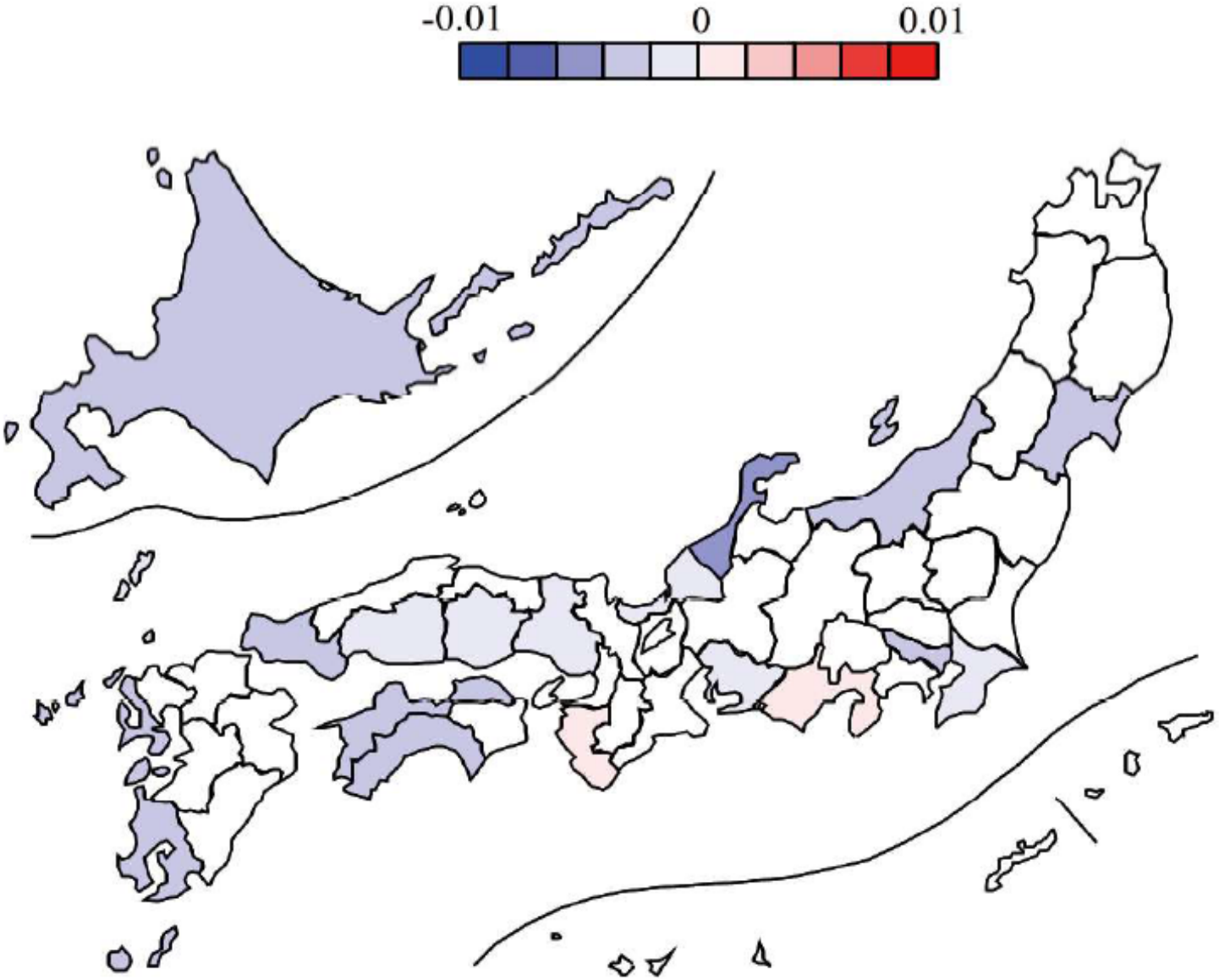
without checking significant test





Geographical mapping of ocean acidification in Japan

Prefectures with the large sampling number of monitoring sites



Conclusion

Long-term pH trends in coastal waters around Japan were examined by using water quality measurements in public waters from 1978 to 2009, obtained under the monitoring program in accordance with the Water Pollution Control Low.

1. General tendency to acidify were detected even in coastal regions in Japan.

2. The average: −0.0015 and −0.0045 without and with significance, respectively.

3. Unlike the results in the open ocean, alkalization trends were also detected in some monitoring sites.

4. No latitudinal and longitudinal dependence of these trends

Distinct trends to acidify evidently have progressed to ocean acidification faster than or comparable to the rate in the open ocean. We need to recognize this progress of ocean acidification, which gives us a caution in terms of marine environment.

Thank your for your attention.