Acceleration of ocean acidification in the western North Pacific

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Introduction

- Ocean is a sink of approximately 30% of anthropogenic CO_2.
- The CO_2 uptake by the ocean leads to the increase of the total dissolved inorganic carbon (DIC) and the decrease of pH in seawater that are commonly referred to as "**Ocean Acidification**".
- Japan Meteorological Agency (JMA) has been routinely conducting shipboard measurements of CO_2 in the ocean and in the atmosphere in the western North Pacific.
- We present the results of the measurements at 137°E repeat line over the past 35 years since the early 1980s.

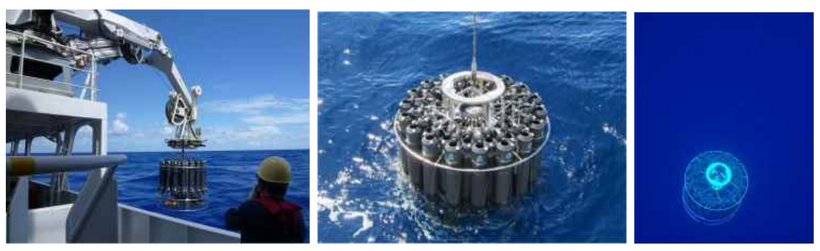

Fig.1 Seawater sampling using CTD system

R/V Keifu-maru *R/V Ryofu-maru*

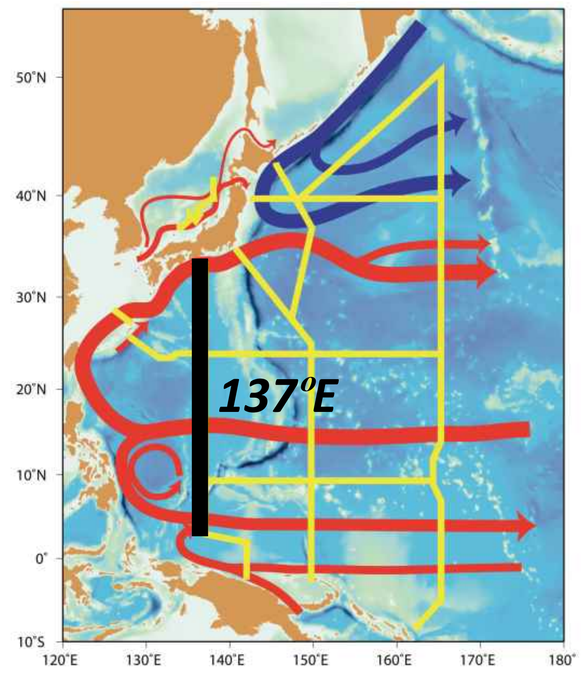

Fig.2 JMA's observation lines and main ocean currents

Result of JMA's shipboard CO_2 measurements

- A steady Increase of DIC and a decrease of pH have been observed in surface seawater together with their large seasonal variations.

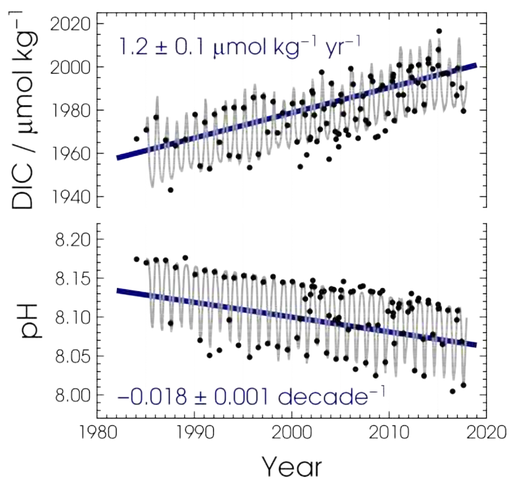

Fig.3
Time-series of DIC and pH derived from JMA's measurements (black dots) and their fitting curve (gray lines) at 137°E-30°N

Progress of DIC Increase and Ocean Acidification in surface seawater at 137°E

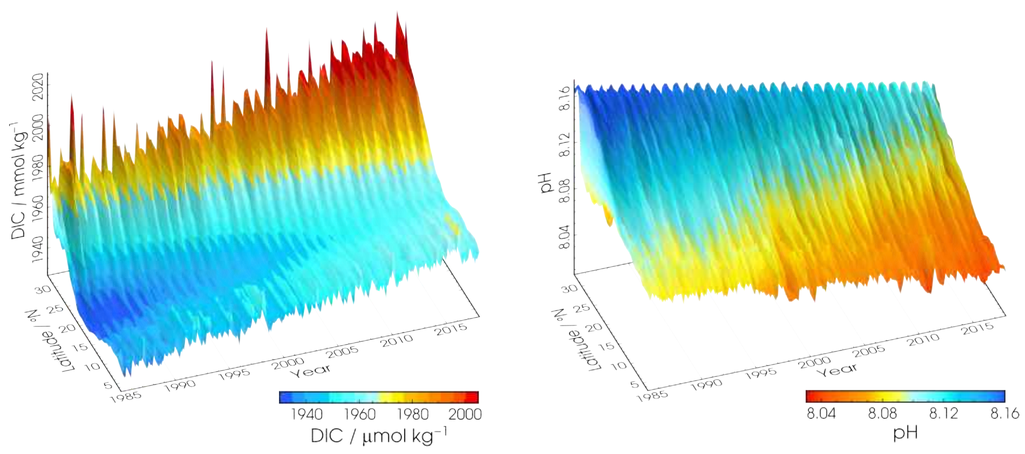

Fig.4 Three-dimensional diagrams of DIC and pH in surface seawater along 137°E

- The amplitudes of seasonal variation in DIC and pH were larger in the subtropical zone than in the tropical zone.
- Over the latitudinal zones from 3°N through 34°N, DIC increase and ocean acidification have been in progress.
- In the subtropical zone, the growth rates of DIC were comparable to those of pCO_2 in the atmosphere (pCO_2^{air}) and were faster in the tropical zone.

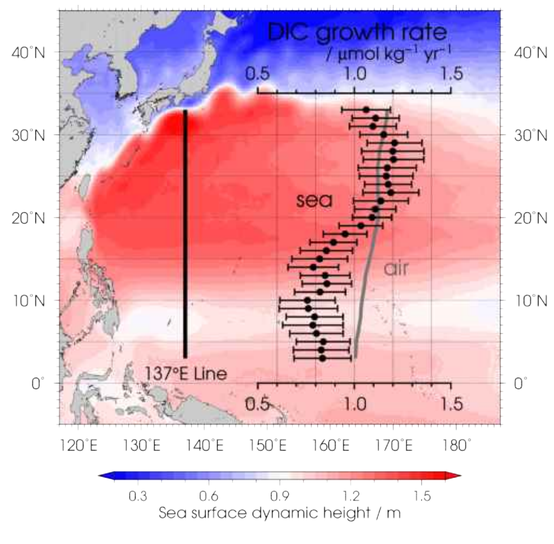

Fig.5 Latitudinal distribution of DIC growth rate along 137°E

Acceleration of Ocean Acidification

- The increase of pCO_2^{air} has been recently accelerating.
- Concurrently with the pCO_2^{air} increase, acceleration of ocean acidification has been observed in the subtropical zones in the latest decade.
- The rate of pH decrease at 26-30°N in the last decade was about 1.8 (1.4) times as high as that in the previous (entire) period.

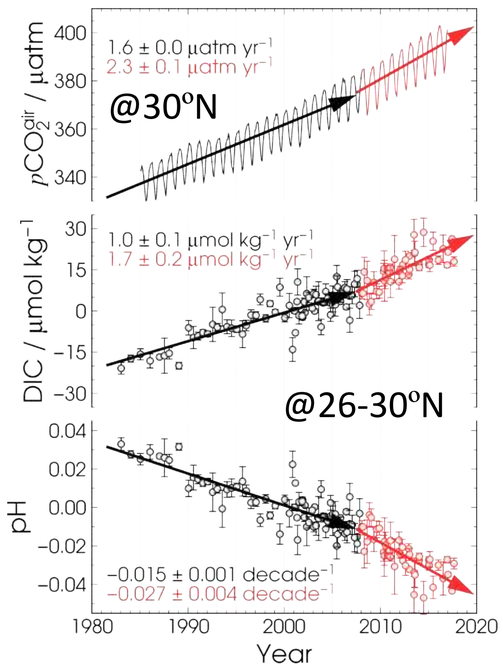

Fig.6 Time-series of pCO_2^{air} at 30°N, and those of DIC and pH averaged over 26°N to 30°N along 137°E

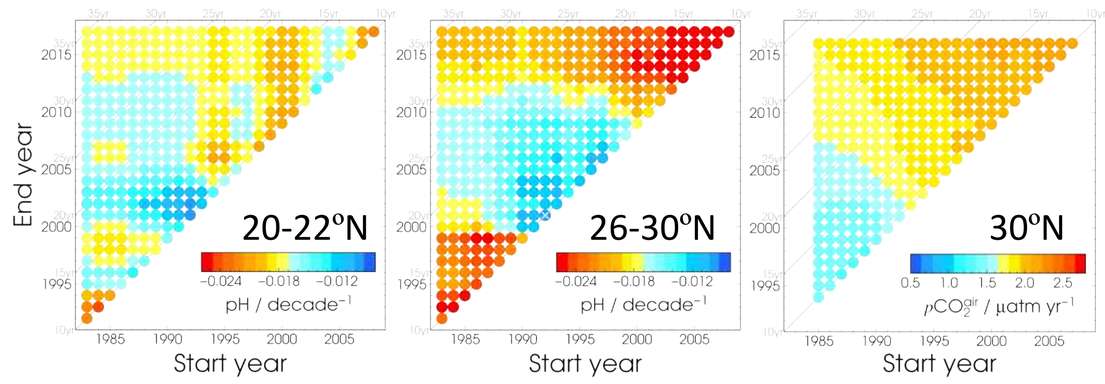

Fig.7 Decadal and longer-term variability of pH and pCO_2^{air} in the subtropical zone

- The decadal and longer-term variability of pH change at 20-22°N was in agreement with that of pCO_2^{air} increase, but was more drastic at 26-30°N.

(Ono et al., in preparation)

Summary

- JMA has been conducting shipboard measurements of CO_2 in the western North Pacific since the early 1980s.
- The DIC has been increasing and ocean acidification has been occurring in the upper layer of the ocean owing to the uptake of anthropogenic CO_2.
- In addition, the DIC increase and ocean acidification have been accelerating in the surface layer of the subtropical zone in the recent decade.
- Sustained monitoring of CO_2 in the ocean and in the atmosphere are necessary to understand how the ocean acidification is proceeding.