Measurements of carbonate system parameters

**pCO₂ measuring system**
This system continuously measures pCO₂ of atmospheric sample drawn from bow and surface seawater sample pumped up from bottom of vessel using the following instruments:
- Detector (Li-COR Li-7000)
- Dehumidifier
- Electronic cooling unit
- Nafion tube (Perma Pure)
- Heatless drier
- Chemical desiccant (Mg(ClO₄)₂)

A set of CO₂ standard gases
NDIR (Non Dispersive Infrared) is calibrated at an interval of 1 hour using a set of CO₂ standard gases. The concentrations of CO₂ standard gases are pre- and post-calibrated with WMO mole fraction scale. The range of CO₂ concentration in the standard gases is from 215 to 450 ppm.

**Thermo-salinograph (TSG)**
Temperature and salinity in surface seawater taken from the same intake as that for pCO₂ are continuously measured and used to calculate pCO₂:

**DIC, TA and pH measuring systems**
Discrete water samples have been collected from standard depths by using the CTD multi-sampler system mounted with Niskin bottles (36-positions/10-liter). Using these samples, carbonate system parameters have also been measured.

**DIC and TA measuring system**
- Analysis methods and Standards: DIC and TA are determined simultaneously from a single bottle of seawater sample (300 ml) using a custom-made DIC and TA analyzer (Nihon ANS, JAPAN).
- DIC: Coulometric analysis using an automated CO₂ extraction unit and a coulometer.
- Certified Reference Material (CRM) provided by Prof. A. G. Dickson (SIO).
- TA: Spectrophotometric analysis by means of one-point addition of a mixture of HCl and indicator dye (m-nitroresorcinol) using an open cell and an automated titration system.
- CRM provided by Prof. A. G. Dickson (SIO).
- pH: Spectrophotometric analysis using m-cresol purple as the indicator dye.

**pH measuring system**
- pH: Spectrophotometric analysis using m-cresol purple as the indicator dye.
- pH: Spectrophotometric analysis using m-cresol purple as the indicator dye.

**Outcome of JMA’s observation**
The trend of pCO₂, DIC and pH and Omega decrease have been observed along 137°E and 165°E repeat lines together with the increase of pCO₂. They mainly ascribed to the uptake of anthropogenic CO₂ into the ocean.

**Long-term trends of CO₂ concentration and pH in surface seawater**

**The seasonal variation of ΔpCO₂ (=pCO₂,sea-pCO₂,air) in the western North Pacific**

**Global ocean CO₂ uptake**

**The anthropogenic CO₂ has been accumulated in the ocean interior.**

**Changes in the column inventory of the anthropogenic CO₂**
These CO₂ data and products are publicly available from:
- WDCGG: http://wcdms.jma.go.jp/kmd/wdcgg/wdcgg.html
- SOCAT database: http://www.socat.info/
- PACIFICA database: http://taco.mml.nos.noaa.gov/oceans/PACIFICA/