State of the Observing System

Biogeochemical observing networks: global-scale networks and data synthesis efforts

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Fourth GOOS Steering Committee Meeting
24-26 May 2015, AIMS, Townsville, Australia
Requirements, Observations, Data products and Impacts

Atm. CO₂ increase

- Quantify ocean CO₂ uptake
- Effect CO₂ on marine biota and geochemical cycles

Constrain sea-air CO₂ fluxes
Determine surface water CO₂ levels (OA)
SST, SSS, Atm Pres, Atm CO₂ (ECV&EOV)

In situ Networks
SOOP-CO₂
Moorings
Gliders
ARGO

Satellite Constellations
Wind, SST, Salinity, Color

Mitigation Greenhouse effect
Impacts on marine biota and cycles

Takahashi climatologies (pH, pCO₂)
SOCOM (trends and variability)
SOCAT v3 (semi-formalized)
SOCAT updates (not formalized)
Current SOOP-CO₂ network

- Two coordinated efforts (NIES (Japan); NOAA (USA))
- SOOP is currently the only way to obtain quality calibrated surface water carbon and biogeochemistry data
- Repeat occupations primarily along shipping lines in the Northern Hemisphere
- Data is collated in two datasets SOCAT (dissemination) and LDEO (climatology)
- Considerable effort in producing products based on irregular sampling schemes (SOCOM effort)

Example SOCAT data holdings for 2011 (preliminary V3)
Level of readiness SOOP-CO₂

An Ad Hoc Network of International Investigators
- Automated instrumentation
- Recommended procedures and QC
- Central data collation

Innovation
New Sensors:
- Lower cost,
- Less maintenance
Easier installs
New platforms:
- Floats, drifters, buoys

Current Operational Tasks & Challenges
1. Network formation and interoperability
   NIES (Japan), NOAA (USA), ICOS* (Europe)
2. Sustained funding
3. Formalizing data flow
4. Formalized product development
Products SOOP-CO$_2$*

- Surface water CO$_2$ climatology
- Sea-Air CO$_2$ fluxes
- Annual sequestration of atmospheric CO$_2$
- Estimates of airborne fraction ("Is the ocean CO$_2$ sink saturating")
- Surface water CO$_2$: Aragonite saturation state climatology
- Regional patterns and variability in surface water CO$_2$ and fluxes
- Regional and Global temporal trends

*All products require other observing system elements

Products are currently developed in research mode but capacity is in hand to provide operational products.
V3 will consist of ~14 million fCO$_2$ data (+40% over version 2) from > 4600 cruises (+35%) covering the years 1957-2013.

All data is citable using DOI (individual cruise files, synthesis products, gridded products).

Visit SOCAT.info for data and publications.
**SOCAT Data Products**

- Individual cruise overview plot
- Audit of QC evaluations
- Property-property viewer
- Map of user-selectable data subset

**SOCAT exposure**

- **SOCAT used** as data constraint for the annual Global Carbon Budget
- **approx. 40 publications** use SOCAT for global analysis – growing
- Ancillary **parameters to be added to SOCAT** increasing it’s value
- **SOCAT accepts sensor data** with a special set of quality flags
- **SOCAT data submission and data quality control system automation** to be launched within 2 years
- **SOCAT version 3 to be released in 2015**
SOOP-CO$_2$ Network: issues and action items

SOOP-CO$_2$ Network is an ad hoc group largely coordinated by IOCCP

- Improve Operational Linkage to SOOP (JCOMM)
- Develop targets and metrics for the network
- Scientific Linkage to Carbon Cycle programs (GCP)
- Formalize and streamline data submission and QC procedures for sensors data
- Update to LSCOP report (Arlyn Andrews, NOAA ESRL)
The 3rd decadal survey has begun. The US has recently submitted a NSF/NOAA proposal and European colleagues are preparing an EU Horizon 2020 proposal. Other nations are seeking funding to complete sections.

Discussions on various levels suggest that China and Korea are looking to become involved in GO-SHIP. During 2014 and 2015 official contacts were made with Chinese and Korean agencies to participate in GO-SHIP.
GO-SHIP Plans

GO-SHIP cruise plans have been collected by (submitted to) M. Kramp in JCOMMOPS.

http://www.go-ship.org/CruisePlans.html

On-line cruise information submission system to be launched this year.
Increasing importance of non-GO-SHIP high quality hydrographic sections

In addition to the GO-SHIP reference cruises, the high-frequency non-GO-SHIP cruises (or GO-SHIP “light” or “partner”) will be an important component of GOOS Framework for Ocean Observing.

The importance of non GO-SHIP hydrographic sections with high-quality data for ocean biogeochemistry is growing to understand the biogeochemical phenomena/processes:

• in societally important regions,

• in key regions for ocean CO₂ uptake and climate change,

• as opportunities of deploying/recovering and validating/calibrating autonomous sensors, thereby producing synergy with other ocean-observation programs such as Bio Argo and SOOP.
Overlappings of the time-space coverages/resolutions of the measurements will give the good opportunity of calibrating autonomous sensors and 2nd-level QC of the ship-based measurements for commonly measured parameters.
Interior Ocean Data Products

Global Ocean Data Analysis Project

CO₂, ¹⁴C, ¹³C
NO₃, PO₄, H₂SiO₄

CARINA

Biogeochemistry Panel

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Interior Ocean Data Products

168 new cruises
Interior Ocean Data Products

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Major Future Activities: Combining data products

Surface to bottom integrated biogeochemistry data atlas
Goals of the course

• Teach best practices for biogeochemical sensors; aim: improve the data generated by such sensors.

• Collate the collected wisdom of participants and instructors on best practices of operation of biogeochemical sensors and distill this into a document.

• Work on data reduction practices for sensor data, including reporting format and requirements (e.g. meta-data, accuracy/precision estimates etc.).
Instrumenting our oceans for better observation: a training course on biogeochemical sensors

Selected variables:
(mature technologies)

• Oxygen
• pH
• pCO2
• Nitrate – ISUS
• Bio-optics (theoretical session only)

Discussion on emerging technologies
• 28 selected participants
• 14 lecturers
• 4 manufacturers (CONTROS, Seabird Scientific, Sunburst, Aanderaa)

June 22-July 1, 2015, Sven Lovén Center for Marine Sciences (Kristineberg, Sweden)

Follow-up activity of capacity building (if funding available in 2016/2017)
Major Future Activities: Combining highly accurate data streams with sensors data

- Use of Argo to inform representativeness of GOSHIP
- Analysis/uncertainty of WOCE/CLIVAR/GOSHIP cross-section transports
- Basin-scale inventories
- Biogeochemical inventories
- Upper half of ocean volume (Argo)
- Lower half of ocean volume (Deep Argo and GOSHIP)
- What is the ocean general circulation?

14-18 September
Galway, Ireland
www.gaic2015.org
A communication and coordination service for marine biogeochemistry