

# Procedures for calculating surface water $p\text{CO}_2/f\text{CO}_2$ from new observing platforms and incorporation into a surface water $\text{CO}_2$ network

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## Recommendations and conclusions:

- SOCAT should serve directly measured surface water [ $p\text{CO}_2$ ] data.
- “Directly measured” are all surface water sensor data that determines  $\text{CO}_2$  in equilibrium with a headspace, has a traceable calibration and well-defined accuracy.
- Calculated  $p\text{CO}_2$  should not be an integral part of SOCAT, but should be readily accessible and be of defined quality (precision and accuracy).
- SOCAT community should encourage proper data storage , and retrieval protocols for Non-conventional approaches “indirect measurements”..
- Indirect measurements should be easily incorporated through “modern data management practices” and automated -on the fly- collation of data from data assembly centers

# What should SOCAT serve

SOCAT should serve directly measured surface water pCO<sub>2</sub> data only

- There is insufficient expertise to properly calculate, handle and QC pCO<sub>2</sub> from indirect approaches.
- Chance of degradation of current data holdings

pCO<sub>2</sub> versus fCO<sub>2</sub>.

For CO<sub>2</sub> measurements based on headspace XCO<sub>2</sub> analysis, this is currently largely a esoteric question, and the conversion is easily done.

$$pCO_2 = XCO_2 (P - p_{H_2O}) \text{ and}$$

$$fCO_2 = f(T,S) pCO_2 \approx 0.997 pCO_2, \text{ moreover } \Delta pCO_2 = \Delta fCO_2$$

However, when determining CO<sub>2</sub> by indirect or other means it is unclear if the non-ideality already is implicit in the measurement. [similar to activity vs. concentration argument]

# [New] surface platforms (ASV's) for directly measured pCO<sub>2</sub>

An augmentation, not a replacement, for SOOP-CO<sub>2</sub> global observing network

Issues:

- Different level of measurement (closer to the surface)

- Less accurate measurements

- Fully autonomous not directly accessible (but great possibilities with 2-way com)

- Fouling

Advantages:

- Fit for purpose regarding deployment region (e.g. Remote areas)

- Greater temporal coverage

- Less issues with contamination/perturbations

- Easier deployment

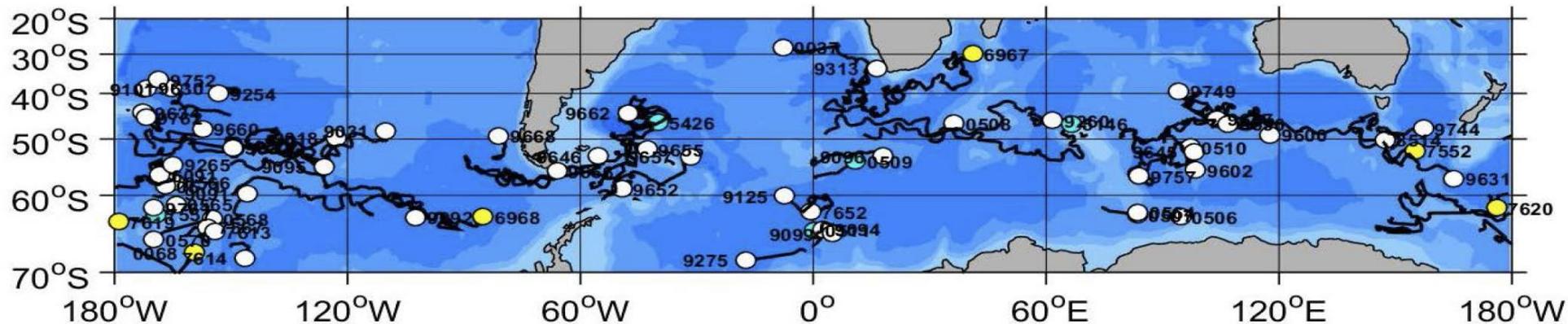
- Lower cost (??)



# Indirect measurements from profiling floats- BGC ARGO

*Huge promise, provocative results*

- Profiling floats SOCCOM (pilot 70 in water-200 total)
- BGC ARGO – aim 1000 floats  
Measure:
  - T, S, P, Oxygen optode, Nitrate, **pH**, Chlorophyll, Backscatter
- Challenges determining [changing] performance characteristics and drift.
  - Measurement accuracy
  - Offset
  - Unrecoverable failure
- Extremely precise pH measurements lead to very precise pCO<sub>2</sub> estimates but accuracy, in particular, bias, is not fully resolved. No direct in situ calibration procedure and no means to calibrate against air (vis a vis O<sub>2</sub>)



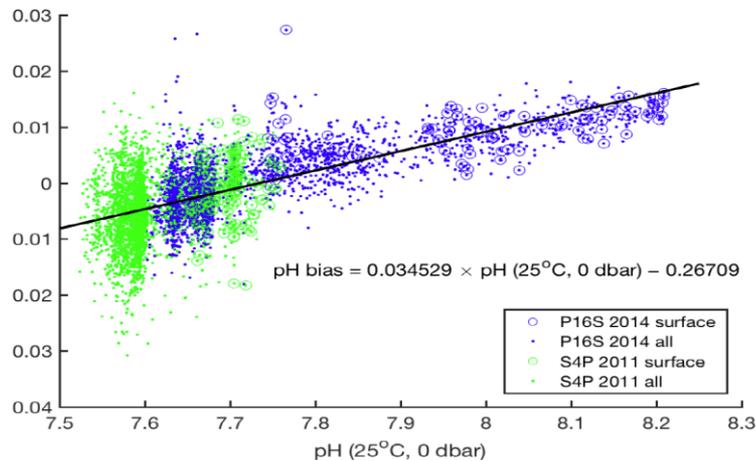
# BGC ARGO- determination of $f\text{CO}_2$ / $p\text{CO}_2$

- $f\text{CO}_2 = f(\text{pH}, \text{TALK})$
- $f\text{CO}_2$  uncertainty  $< 10 \mu\text{atm}$  ( $\text{pH} \approx 0.01$  [SOCCOM 0.007-0.009])

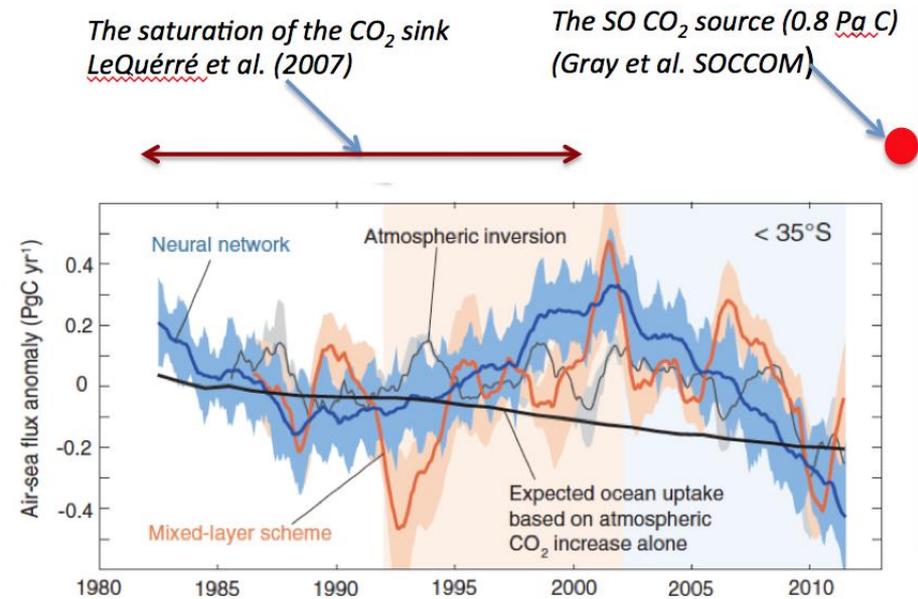
[SOCCOM: Gray et al. (submitted, 2017) the predicted error in  $p\text{CO}_{2\text{ocn}}$  is 2.7% (10.8  $\mu\text{atm}$  at a  $p\text{CO}_{2\text{ocn}}$  of 400  $\mu\text{atm}$ )

Estimated precision of estimate  $\approx 5 \mu\text{atm}$ ]

## Some unexplained internal consistency issues



N. Williams



Landschützer et al. 2015

# The future of SOCAT

- The great value of SOCAT

- Is one-stop shopping of a large comprehensive data source
- A general estimate of quality of data
  - (Many/ most users take our estimate of data quality and control as gospel)
- Up to date

- Expanding to other methods can lead to degradation of second objective.

- A way around this is data retrieval of many streams of data through data assembly center
- Indirect measurements should be easily incorporated through “modern data management practices” and automated -on the fly- collation of data from data assembly centers

## Recommendations and conclusions

- SOCAT should serve directly measured surface water  $p\text{CO}_2$  data (all platforms)
- All surface water sensor data that directly determines  $\text{CO}_2$  in equilibrium with a headspace and has a traceable calibration and well-defined accuracy
- Calculated  $p\text{CO}_2$  should not be an integral part of SOCAT, but should be readily accessible with defined quality
- Indirect measurements should be easily incorporated through “modern data management practices” and automated -on the fly- collation of data from data assembly centers