New Developments in CSEEP Attribution Method

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Short about the C_{seep} method

Process-based method developed to:

- Determine baseline dissolved inorganic carbon for a site - characterisation
- Distinguish CO_2 seepage signal from the natural variability - attribution
- Quantify excess CO_2 dissolved in seawater - quantification

Features:

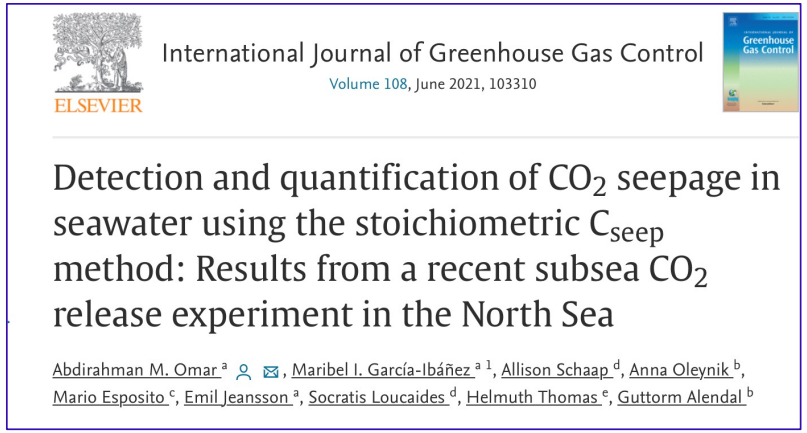
- Flexible implementation and area coverage
- Suitable for automation

Requirements:

- Math. model of main processes - site specific
- Data: CO_2system variables, hydrography and nutrients

Further development:

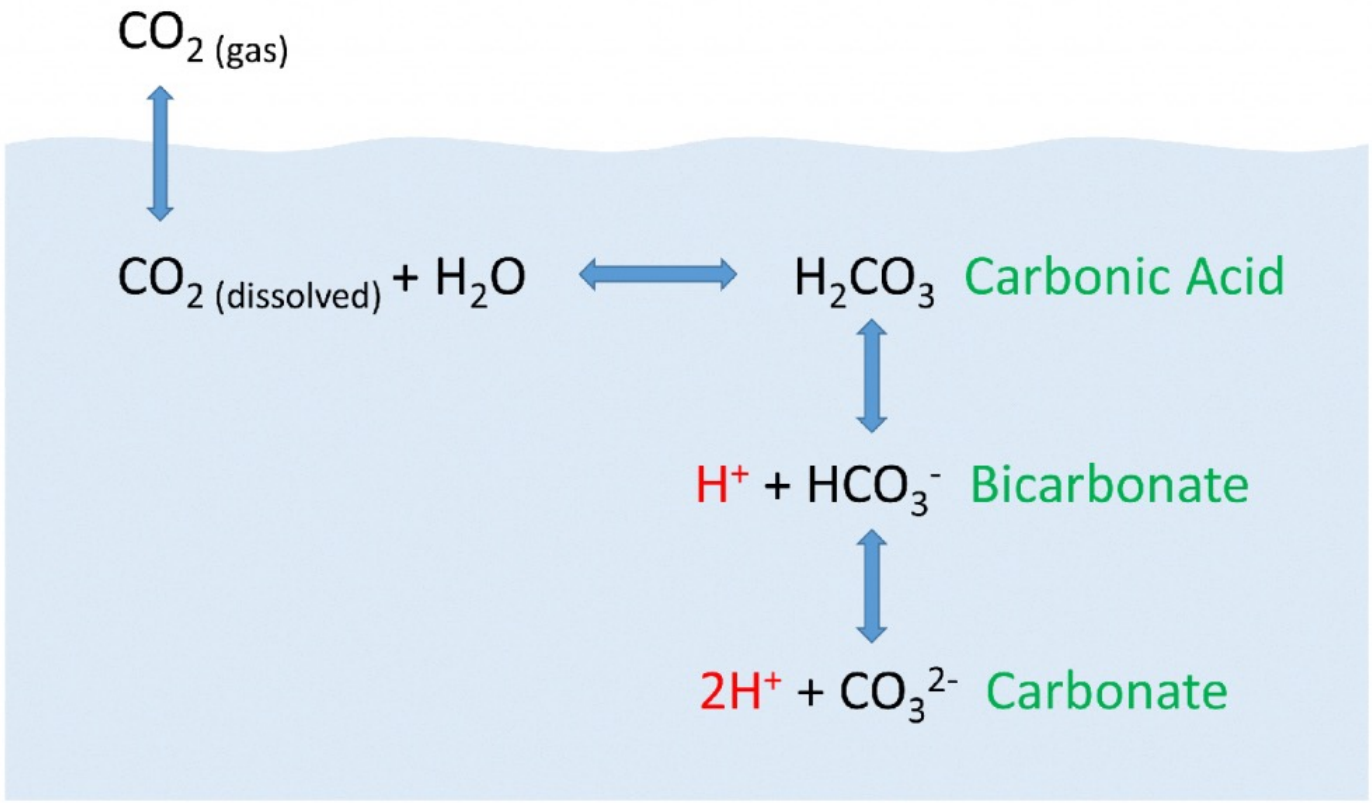
- New sites & stakeholder friendly presentation



The C_{seep} approach

$$\text{Dissolved inorganic carbon(C)} = [CO_2] + [HCO_3^-] + [CO_3^{2-}]$$

$C_b = C - C_{nat}$



Approach: measure C and sequentially correct it for natural variations to recover the original concentration

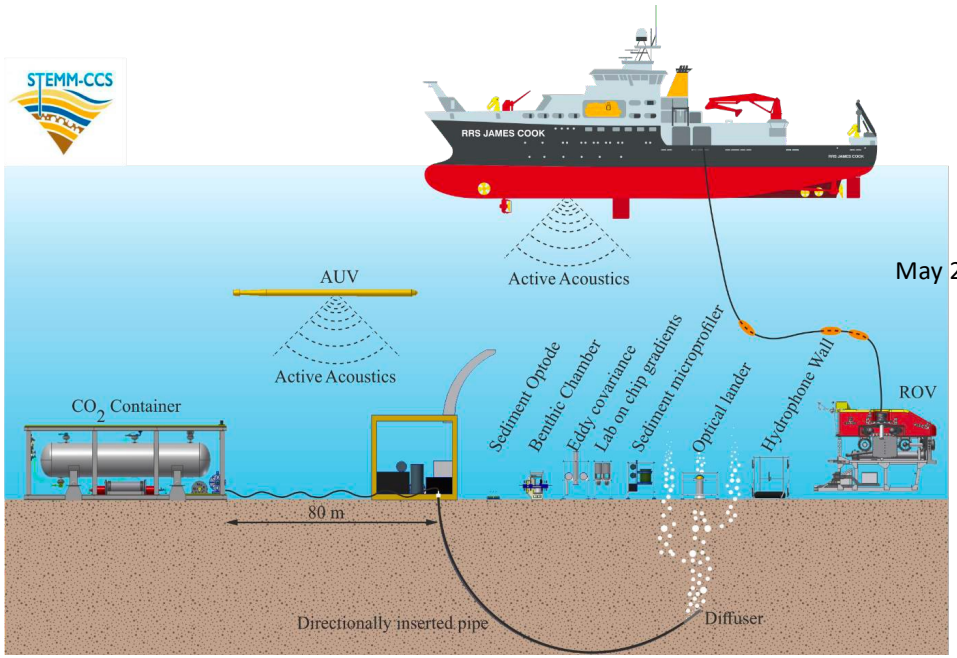
Estimatation of natural variability, an example

$C_b = C - C_{nat}$

Main processes governing C changes	**Parameterisation**
Organic matter cycling	$C_{omc} = R_{C:P} * \Delta PO_4$
Calcium carbonate cycling	$C_{ccc} = R_{C:PA} * \Delta PA$
Mixing between water masses	$C_{mix} = \mathrm{dPA/dS} * \Delta S$
Air sea CO_2 exchange	$C_{ant} = \mathrm{dC/dt} * \Delta time$

C_{nat}
(estimated natural variability)

Demonstrated in the STEMM-CCS experiment



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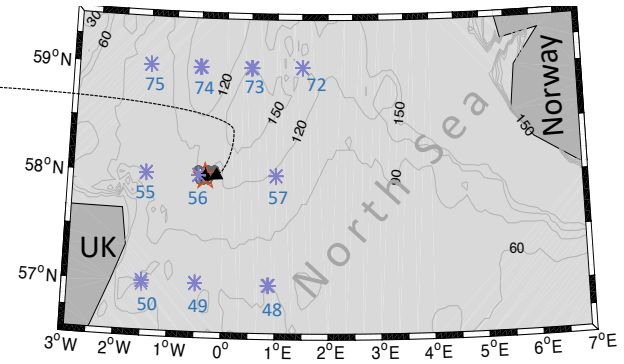
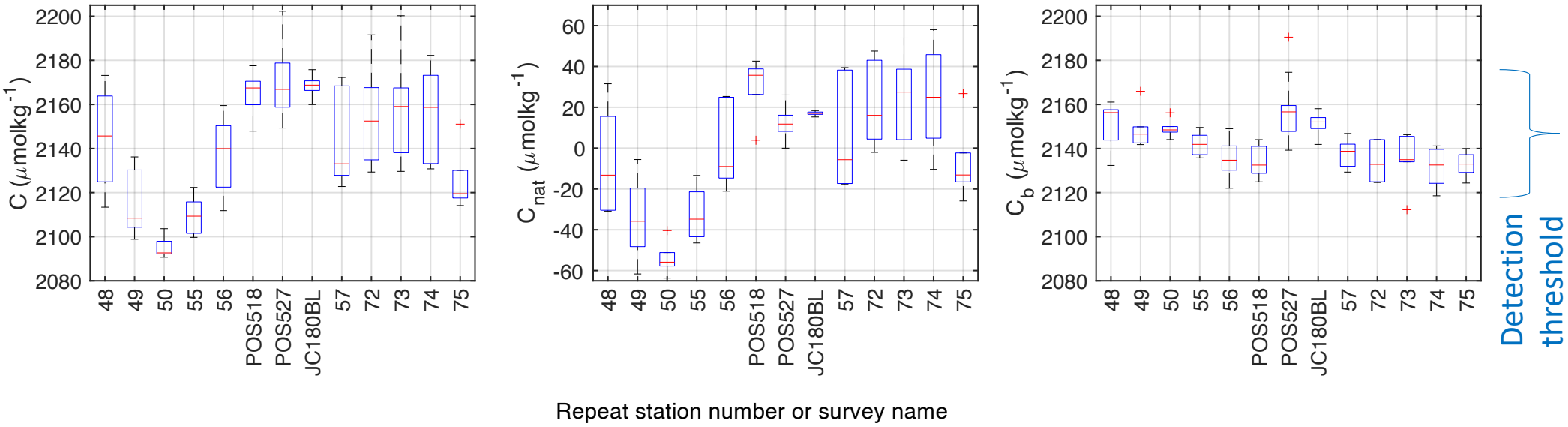


Data from: 2001, 2002, 2005, 2008, 2011, 2017, 2018, 2019

Natural variability minimised

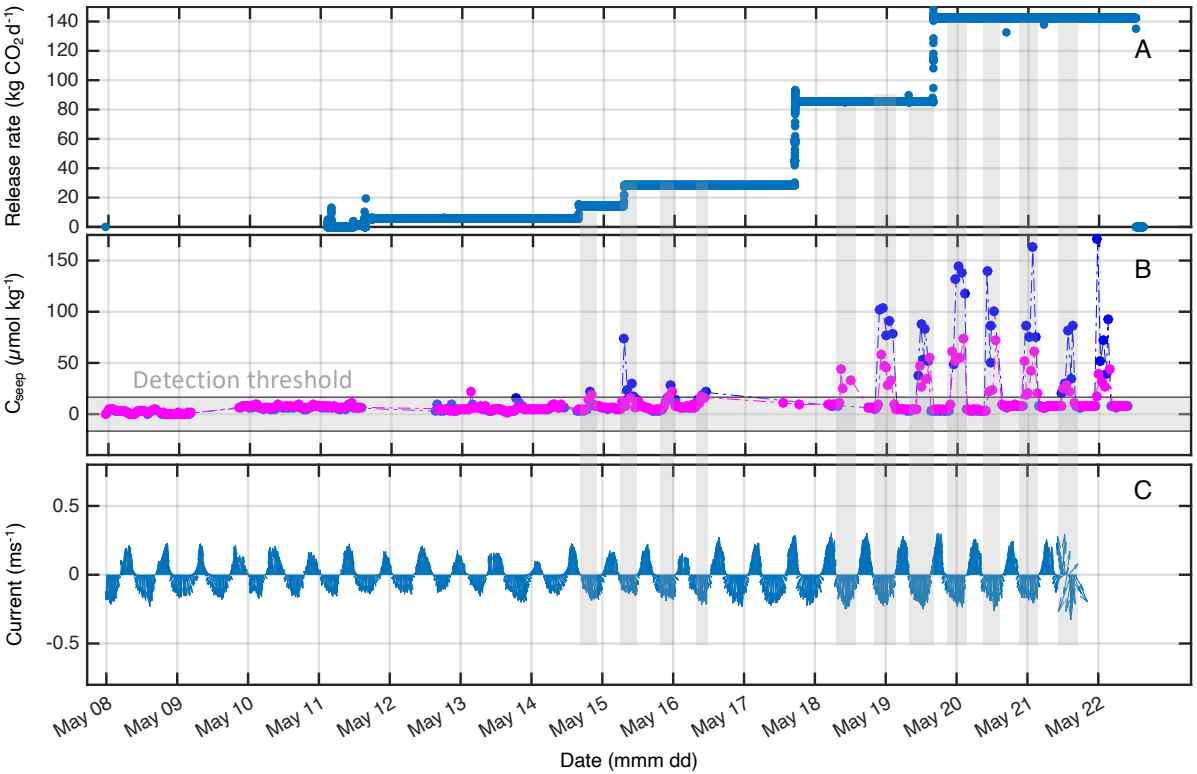
C - C_{nat} = C_b



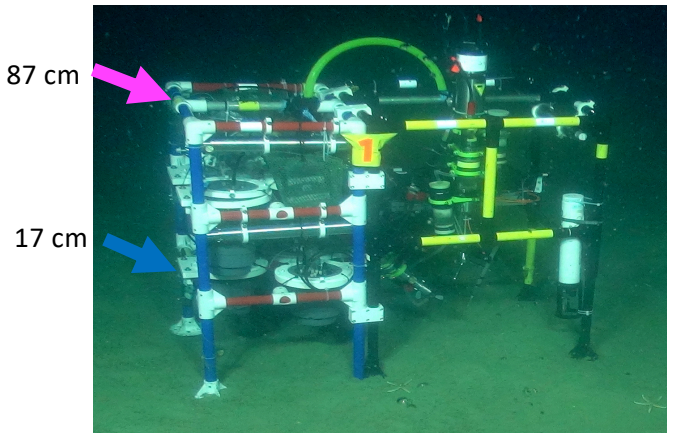
- C_b is on average more than 2 times less variable than measured C
- Remnant variability in C_b lay basis for detection threshold
- Note, correlation between observed C and estimated C_{nat}

Seepage CO_2 detected & C_{seep} quantified

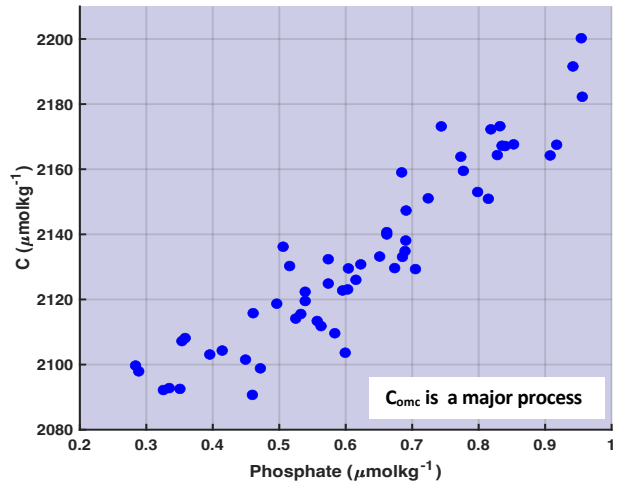
$$C_{seep} = C - C_{nat} - C_b$$

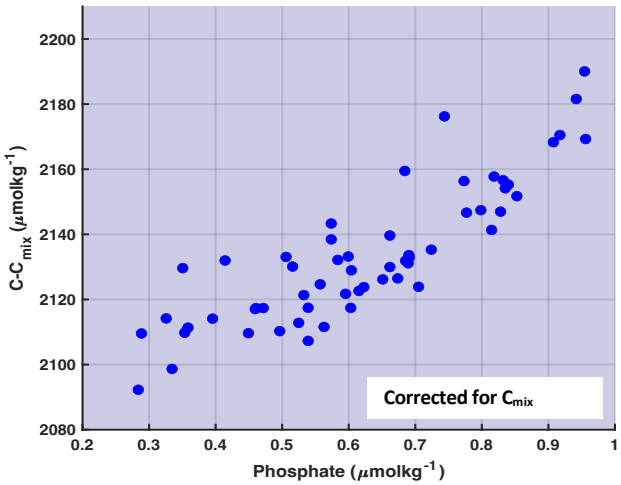


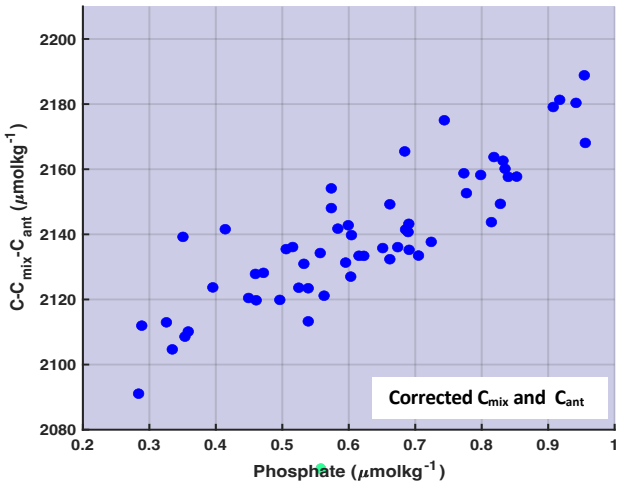
Sensors on a benthic lander with inlets at 87 and 17 cm above the seafloor

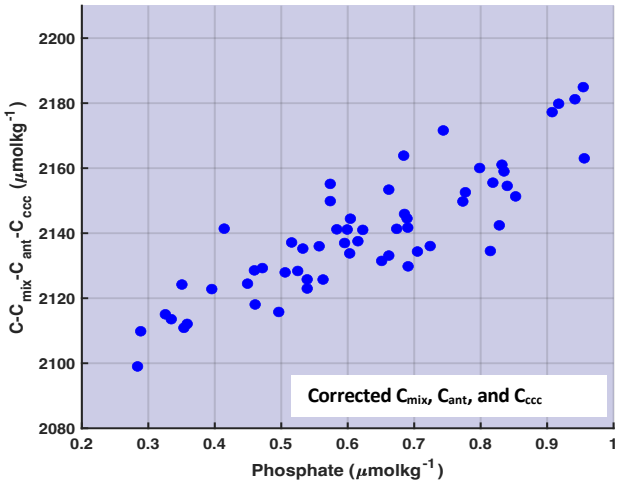


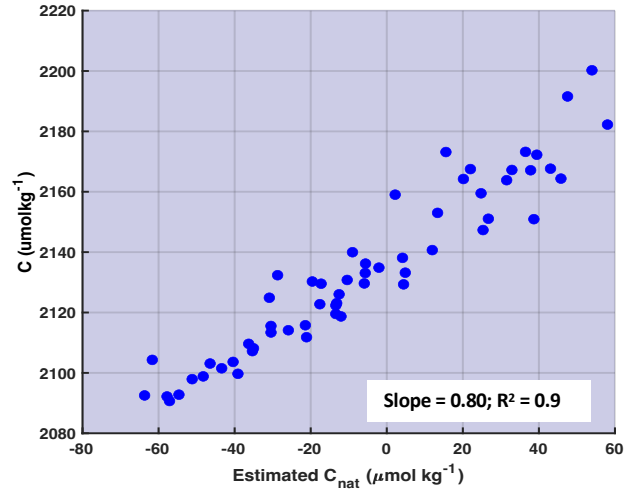
Further development: stakeholder friendly presentation

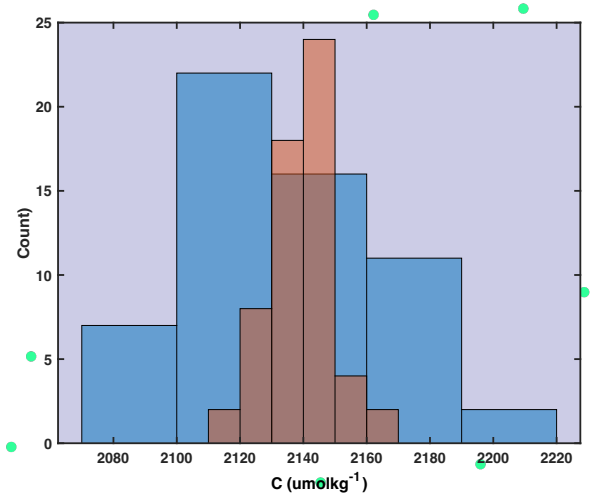












Further development: Gulf of Mexico data