Galen McKinley
Professor
Columbia U. & LDEO

- Global ocean carbon flux variability and trends
- Physical and biogeochemical mechanisms
- North Atlantic mechanisms
- pCO₂ data analysis
- Ocean and climate models

Decadal variability in global ocean CO₂ sink can be explained by external forcing

External forcing from pCO₂ atm and large volcanos

Large Ensemble testbed to statistically assess Neural Network reconstruction (SOMFFN)

Low bias, good seasonality.
Overestimates decadal variability < 35S

Amplitude of reconstructed decadal variability compared to truth

McKinley et al., AGU Advances, in press

Gloege, McKinley, Landschutzer et al., in review

OCB Working Group: Filling the gaps in observation-based estimates of air–sea carbon fluxes
Ice melt is an efficient but small sink of atmospheric CO2. A highly productive and efficient biological pump over the continental shelves facilitates long-term storage in sub-surface Arctic Waters. However, these sub-surface reservoirs are not perfect—and climate change may lead to further destabilization.

What does this mean for the Arctic Ocean Carbon Sink?

Cross et al., 2018. Formation and Transport of corrosive water in the Pacific Arctic Region. Doi: 10.1016/j.dsr2.2018.05.020. See also: Anderson et al., 2013; Qi et al., 2017; Manizza et al., 2019; Zhang et al., 2020;
Global ocean carbon cycle
Anthropogenic CO₂
Biological carbon pump
Ocean inverse modeling
Carbon cycle models

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DeVries et al. (2019), Decadal trends in the ocean carbon sink

OCB Working Group on Carbon Gaps
Judith Hauck
Group leader
Alfred-Wegener-Institut (AWI)

- marine carbon cycle modelling and model development (FESOM-REcoM)
- polar regions
- Global Carbon Budget: ocean carbon sink estimate
- RECCAP2 (REgional Carbon Cycle Assessment and Processes)

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mismatch in mean, trend AND multi-year variability dominated by Southern Ocean

Hauck et al. (in prep.)
Data: Global Carbon Budget 2019, Friedlingstein et al. (2019), ESSD
Observation-based estimates of the global ocean carbon sink and its variability

Artificial neural networks

Ocean Carbon Cycle

Data analysis and synthesis

Reconstructions of the ocean carbon sink based on surface pCO2 measurements suggest strong variations on decadal timescale (Landschützer et al 2016, GBC)

Combining open ocean and coastal ocean pCO2 to represent the full aquatic continuum in observation-based air-sea flux estimates

(Landschützer, Laruelle et al submitted to ESSD)
Goulven Laruelle
Research Associate
Université Libre de Bruxelles - FNRS

- CO2 exchange at the air-water interface in coastal seas and estuaries
- High resolution coastal data-products
- Estuarine modeling and dynamics

Climatological mean pCO2 over the 1998-2015 period derived from a two-step artificial neuron network (Laruelle et al., 2017)

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Nicole Lovenduski
Associate Professor
U Colorado Boulder

- role of the ocean in the global carbon cycle
- interpreting output from models in the context of observations
- the Southern Ocean has a special place in my heart

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Pedro M.S. Monteiro
Head: Southern Ocean Carbon – Climate Observatory (SOCCO)
CSIR, South Africa

- The variability and trends of Southern Ocean CO₂ fluxes (seasonal cycle – to decadal scales and meso to sub-mesoscales)
- Prognostic model biases – the fine scale ocean physics gap
- The need for high resolution (seasonal scale) and confidence CO₂ model constraints
- Sensitivity to Climate of the Southern Ocean biological carbon pump

Outputs from 6 empirical model approaches showing contrasting trends for global and regional air-sea fluxes
Gregor et al., - GMD

ESM Biases: Seasonal Cycle bias for FCO2 in CMIP5 models in the Southern Ocean
Mongwe et al., 2018 - BGS
Laure Resplandy
Assistant Professor
Princeton University

• Bio-physical coupling global scale to submesoscale

• Ocean carbon and oxygen cycle: variability, trends and mechanisms

• Land-ocean continuum

• Indian Ocean and Pacific Ocean

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Heat based global constraint on north-south carbon transport and river-driven natural ocean outgassing. Resplandy et al 2018
Data-based carbon cycle quantification:

- pCO₂-based ocean CO₂ fluxes
- Focus: IAV and its drivers
- Atmospheric Potential Oxygen (APO) as ocean flux constraint
- Atmospheric CO₂ inversion

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Current research:

- Coastal zone carbon and oxygen cycling
- Estuarine metabolism
- Climate change impacts on coastal waters

In a single estuarine system (Chesapeake Bay), alkalinity varies greatly among riverine endmembers and shows varying degrees of non-conservative behavior.

Najjar et al., 2020, J. Geophys. Res: Oceans
Christopher Sabine
Associate Dean
Univ. of Hawaii

- role of the ocean in the global carbon cycle
- interpreting ocean inorganic carbon measurements
- understanding ocean acidification

co-chair of IOC/UNESCO Integrated Ocean Carbon Research working group (IOC-R)

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Terlouw, et al. (2019)
Adrienne Sutton
Oceanographer
NOAA PMEL

- global air-sea CO$_2$ and ocean acidification time series observations
- ocean carbon sensor development
- autonomous surface vehicles
- ocean observing systems (e.g., OceanSITES, TPOS 2020, PIRATA)
- best practices for measurements and analyses

Sutton et al. 2019, ESSD: air-sea CO$_2$ and pH time series data product

Sutton, Williams et al. in prep: Saildrone air-sea CO$_2$
Southern Ocean observations

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• Member IOCCP SC (surface water CO$_2$ measurements)
• Operational SOOP-CO2 network
• SOCONET reference network ships and moorings (including MBL measurements) [Soconet.info]
• Best Practices
• Creating data products (SOCAT) [SOCAT.info] and GLODAP [Glodap.info]
• Co-chair IOC-R “thinktank” (IOC/UNESCO)

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Rik Wanninkhof
Senior Scientist
NOAA/AOML/Miami

Large Decadal Changes in Air-Sea CO2 Fluxes in the Caribbean Sea, Rik Wanninkhof, Joaquin Triñanes, Geun-Ha Park, Dwight Gledhill, and Are Olsen, JGR, 2019, 10.1029/2019JC015366

1.13 million, data point 2002-2018
9924 grid cells with observations
(1° by 1° by mo)
10 % of monthly grid cells filled
Southern Ocean’s role in the global carbon cycle and climate (SOCCOM)
• seasonality of carbonate chemistry now and in the future
• uncertainty analysis
• autonomous platforms/sensors (BGC Argo, Saildrone)
• derived carbonate system variables
• using in situ data to evaluate earth system models

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Calculating surface ocean pCO2 from biogeochemical Argo floats equipped with pH: An uncertainty analysis (Williams et al., 2017)