[NICOLE] XUN CAI

Water Quality Modeling ORISE Fellow, US Environmental Protection Agency (EPA), Region 3, Chesapeake Bay Program Office

1750 Forest Drive, Suite 130, Annapolis, Maryland 21401

Work: 410-267-9829; Cell: 804-832-4816

Email: xcai@chesapeakebay.net; nicolecx12@gmail.com

Education

Ph.D. in Marine Science, 2022	College of William and Mary, Gloucester Point, VA
M.S. in Marine Science, 2018	College of William and Mary, Gloucester Point, VA
B.S. in Oceanography, 2015	Nanjing University, Nanjing, China

Appointments

Chesapeake Bay Program Office, EPA Region 3, MD	ORISE Fellow	2021 – present
Virginia Institute of Marine Science, VA	Research Assistant	2015 – 2021
University of Oldenburg, Germany	International Fellow	2017
National Chiao Tung University, Taiwan	Summer Intern	2014
Nanjing University, China	Undergraduate Research Assistant	2012 – 2015

Manuscripts in Progress

Cai, X., Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Impacts of sea-level rise on the tidal marshes and estuarine biochemical processes. In prep for *Journal of Geophysical Research: Biogeosciences*

Qin, Q., **Cai, X.**, and Shen, J. Identifying transport-determined accumulation locations of waterborne constituents in Chesapeake Bay. In prep for *Geophysical Research Letters*

Publications

Cai, X., Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., in press. The Roles of Tidal Marshes in the Estuarine Biochemical Processes: A Numerical Modeling Study. *Journal of Geophysical Research: Biogeosciences*

Xiong, J., Shen, J., Qin, Q., Tomlinsom, M., Zhang, Y., **Cai, X.**, Ye, F., Cui, L., and Mulholland, M., 2023. Biophysical interactions control the progression of harmful algal blooms in Chesapeake Bay: a novel Lagrangian particle tracking model with mixotrophic growth and vertical migration. *Limnology and Oceanography Letters*. https://doi.org/10.1002/lol2.10308

Cai, X., Qin, Q., Shen, J. and Zhang, Y., J., 2022. Bifurcate Responses of Tidal Range to Sea-level Rise in Estuaries with Marsh Evolution. *Limnology and Oceanography Letters*. *7*(3), pp.210-217. https://doi.org/10.1002/lol2.10256

Tian, R., **Cai, X.**, Testa, J., Brady, D.C., Cerco, C. and Linker, L., 2022. Simulation of high-frequency dissolved oxygen dynamics in a shallow estuary, the Corsica River, Chesapeake Bay. *Frontiers in Marine Science*, *9*, p.2580. https://doi.org/10.3389/fmars.2022.1058839

Qin, Q., Shen, J., Tuckey, T.D., **Cai, X.** and Xiong, J., 2022. Using Forward and Backward Particle Tracking Approaches to Analyze Impacts of a Water Intake on Ichthyoplankton Mortality in the Appomattox River. *Journal of Marine Science and Engineering*, *10*(9), p.1299. https://doi.org/10.3390/jmse10091299

Cai, X., Shen, J., Zhang, Y., J., Qin, Q., Wang, Z. and Wang H., 2021. Impacts of Sea Level Rise on Hypoxia and Phytoplankton Production in Chesapeake Bay: Model Prediction and Assessment. *Journal of American Water Resources Association*. https://doi.org/10.1111/1752-1688.12921

Cai, X., Zhang, Y., J., Shen, J., Wang, H., Wang, Z., Qin, Q., and Ye, F., 2020. A Numerical Study of Hypoxia in Chesapeake Bay Using an Unstructured Grid Model: Validation and Sensitivity to Bathymetry Representation. *Journal of American Water Resources Association*, 1–24. https://doi.org/10.1111/1752-1688.12887

Research Experience

Aug. 2021 – present	Develop and apply numerical models to support the historic Chesapeake Bay TMDL with technical support needed to restore and maintain Chesapeake living resources from challenges of climate change, growth, and other impacts, <u>funded by ORISE Research Participation Program at EPA</u>

Chesapeake Bay Phase 7 Model Development:

○ Develop main Bay model (MBM) and multiple tributary model (MTM): link the phase 7 watershed model to the estuary model using unstructured grids and extend the model simulations to the shallow water habitats.

○ Study the interactions between estuary and sub-estuaries.

○ Study the impacts of climate change on shallow water systems

Dissertation Chapter 4 Aug. 2021 – Mar. 2022	Study the Interactions of Vegetations with Nutrient Dynamics in Chesapeake Bay, <u>funded by Delta Stewardship Council</u>

○ Study the impacts of sea level rise (SLR) on tidal marshes and estuarine biochemical processes.

○ Cai, X. et al. 2022, *Limnology and Oceanography Letters*

○ Cai, X. et al. in prep for *Journal of Geophysical Research: Biogeosciences*

Dissertation Chapter 3 Apr. 2020 – Jul. 2021	Study the Interactions of Vegetations with Nutrient Dynamics in Chesapeake Bay, <u>funded by Delta Stewardship Council</u>

Chesapeake Bay Vegetation Modeling Development:

- ○ Develop vegetation model: couple both marsh and SAV into water quality model with linkage to both water column and sediments.
- ○ Study the roles of tidal marsh on estuarine nutrient dynamics and low-DO events.
- ○ Cai, X. et al. in press, *Journal of Geophysical Research: Biogeosciences*

Dissertation Chapter 2
Jul. 2019 – Mar. 2020

Study the Impacts of Sea Level Rise on Water Quality in Chesapeake Bay, <u>funded by CA Department of Water Resources</u>

- ○ Study the impacts of SLR on hypoxia and phytoplankton production with numerical model SCHISM-ICM.
- ○ Analyze the contributions of each physical and biochemical process to the changes on oxygen budget under SLR.
- ○ Cai, X. et al. 2021, *Journal of American Water Resources Association.*

Dissertation Chapter 1
Aug. 2018 – Jun. 2019

Study the Impacts of Sea Level Rise on Water Quality in Chesapeake Bay, <u>funded by CA Department of Water Resources</u>

Chesapeake Bay Water Quality Model SCHISM-ICM Development:

- ○ Develop SCHISM-ICM in Chesapeake Bay to simulate hypoxia, phytoplankton production and other biochemical processes.
- ○ Calibrate and analyze the significance of using unstructured grid model with non-smoothed representation of bathymetry.
- ○ Cai, X. et al. 2020, *Journal of American Water Resources Association.*

Master Thesis
Feb. 2017 – July 2018

Study the Impacts of SAV on Water Quality in San Francisco Bay Delta, <u>funded by CA Department of Water Resources</u>

San Francisco Bay SAV Modeling Development:

- ○ Develop SAV model: introduce SAV sub-model into water quality model with three components – leaf, stem and root as state variables, and calculate its relationship with the water column and sediments.
- ○ Apply SCHISM-ICM to San Francisco Bay Delta, with SAV model imbedded, to simulate water quality and SAV biomass.
- ○ Calibrate and analyze SAV impacts on flow, turbidity, dissolved oxygen, nutrients and plankton community.

Feb. 2016 – Jan. 2017

Study the Effect of pH on Nutrients Release and Algal Bloom in the Back River, <u>funded by Whitman, Requardt & Associates, LLP</u>

Back River Water Quality and PH Modeling Development:

- ○ Develop pH model: introduce equilibrium chemistry and numerical method for pH calculation into water quality model to calculate pH temporally and spatially.
- ○ Introduce positive feedback mechanism between algal bloom, pH and internal processes into water quality model -- the nutrient release could be significantly

enhanced when the overlying water pH reached 8.5-9, and further boost the algal bloom, which would further increase the pH value.

○ Calibrate ICM water quality model coupling SCHISM model, covering Chesapeake Bay, with introduction of pH model, to simulate Back River water quality and test the mechanism.

Undergraduate Thesis May 2013 – Apr. 2015	Monitoring and Management Systems of the Topographical Change in Pearl River Estuary and Taiwan Shoal, <u>funded by Public Science and Technology Research</u>

Numerical Simulation of the Bed-forms in The Taiwan Shoal:

○ Analyze compiled sailing data in Taiwan shoal

○ Develop statistical approach and assess the numerical relationship between the simulation and the remote sensing images

Awards and Grants

Mar. 2023	**ECO-DAS XV Fellow**, Association for the Sciences of Limnology & Oceanography, National Science Foundation, Honolulu, HI – "Enhanced Sulfide Flux by Resuspension: An Underestimated Piece to Estuarine Hypoxia"
Oct. 2021	**Juliette B. & Carroll W. Owens, Sr. Fellowship**, VIMS, VA – for academic performance and progress in the Ph.D. Degree Program
Aug. 2020	**Commonwealth Coastal Research Fellowship**, VIMS, VA – for dissertation research focus which strategically advances VIMS' advisory service to the Commonwealth of Virginia in areas such as water quality research, and management and resilience approaches.
May. 2019	**CSDMS Integration Scholarship** at *Community Surface Dynamics Modeling System meeting 2019*, Boulder, CO – "Impact of Submerged Aquatic Vegetation on Water Quality in Cache Slough Complex, Sacramento-San Joaquin Delta: A Numerical Study"
May. 2019	**Best Poster Award** at *Southeastern Virginia Postdoctoral Symposium*, Gloucester Point, VA – "Numerical Study of Impact of Submerged Aquatic Vegetation on Water Quality in Cache Slough Complex, Sacramento-San Joaquin Delta"

Other Presentations

May 2023	Oral presentation at *International Society for Ecological Modelling Global Conference*, Toronto, Canada – "Impacts of sea-level rise on the tidal marshes and estuarine biochemical processes"
Jun. 2022	Oral presentation at *Chesapeake Bay Symposium,* Annapolis, MD – "Impacts of sea-level rise on the material exchange between tidal marshes and the estuary"

Jun. 2022	Oral presentation at *Chesapeake Bay Symposium,* Annapolis, MD – "Development of a Next-Generation Tributary Model in the tidal James River"
Jun. 2020	Oral presentation at *Chesapeake Bay Symposium,* virtual – "Impacts of Sea Level Rise on Hypoxia and Phytoplankton Production in Chesapeake Bay: Model Validation and Assessment"
Nov. 2019	Oral presentation at *Cerf*, Mobile, AL – "Numerical Simulation of Impacts from Sea Level Rise on Hypoxia in Chesapeake Bay Using an Unstructured Grid Model: Validation and Assessment"
Apr. 2019	Lecture at *SCHISM Summit*, Sacramento, CA – "Introduction of SCHISM-ICM water quality model"
Jun. 2016	Poster presentation at *Chesapeake Bay Symposium, 2016*, Williamsburg, VA – "Effect of pH on nutrients release and algal bloom in the Back River, Upper Chesapeake Bay"

Service to VIMS and Public Outreach

2019 - 2022	VIMS Ombudsperson – Peer mentor and confidential resource for graduate students to promote conflict resolution for problems that arise in the university setting.
Aug. 2019	Oral presentation at *A Scientist Walks into A Bar – Grad Student Edition* – "To Save the Fish by Removing Seagrass?"