[NICOLE] XUN CAI

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Education

Ph.D. in Marine Science, 2022	Virginia Institute of Marine Science, William & Mary, VA
M.S. in Marine Science, 2018	Virginia Institute of Marine Science, William & Mary, VA
B.S. in Oceanography, 2015	Nanjing University, Nanjing, China

Appointments

Chesapeake Bay Program Office, EPA, MD	ORISE Postdoctoral Fellow	2022 – present
Chesapeake Bay Program Office, EPA, MD	ORISE Fellow	2021 – 2022
University of Oldenburg, Germany	International Fellow	2017
Virginia Institute of Marine Science, VA	Graduate Research Assistant	2015 – 2021

Peer-Reviewed Publications

[7]. **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., 2023. The Roles of Tidal Marshes in the Estuarine Biochemical Processes: A Numerical Modeling Study. Journal of Geophysical Research: Biogeosciences. doi: 10.1029/2022JG007066.

[6]. 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. doi: 10.1002/lol2.10308.

[5]. **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. doi: 10.1002/lol2.10256.

[4]. 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. doi: 10.3389/fmars.2022.1058839.

[3]. 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. doi: 10.3390/jmse10091299.

[2]. **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. doi: 10.1111/1752-1688.12921.

[1]. **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. doi: 10.1111/1752-1688.12887.

Manuscripts in Progress

Cai, X., Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Sea-level Rise Impacts on The Tidal Marshes and Estuarine Biogeochemical Processes. In revision. Journal of Geophysical Research: Biogeosciences.

Proposals and Collaborations (devoid of costs for the eligibility of the ORISE program)

"CHRP: An integrated study of Brown Shrimp responses to hypoxia and climate change in the northwestern Gulf of Mexico." proposal under 2nd review at NOAA in response to the grant NOAA-NOS-NCCOS-2023-2007528. PI: Dr. Jongsun Kim (University of Texas Rio Grande Valley), Co-PIs: Drs. Qubin Qin (VIMS), Carlos Cintra Buenrostro (University of Texas Rio Grande Valley), and MD Saydur Rahman (University of Texas Rio Grande Valley), Collaborators/Advisory team: Drs. Jennifer Leo (NOAA), **Xun Cai** (ORISE fellow at EPA CBP), Fernando Martinez-Andrade (Texas Parks & Wildlife Department), and Joseph Zhang (VIMS).

"Role of physical transport in shallow-water estuarine primary production." proposal submitted to the NSF Division of Ocean Sciences. PI: Dr. Qubin Qin, Co-PIs: Drs. Jian Shen and Mark Brush (VIMS), Collaborator: Dr. **Xun Cai** (ORISE fellow at EPA CBP) will work on modeling applications and data management.

Teaching and Mentoring

May – Jul. 2023	Mentor of undergraduate summer intern Philip Ignatoff, William & Mary, VA – design of an 8-week research project "Revisit sediment diagenesis, bioturbation, and nutrient cycling" as a case study in Gadeken et al., in prep for *L&O Letters*
Apr. 2019	Teaching lecture at SCHISM Summit workshop, Sacramento, CA – "Introduction of SCHISM-ICM water quality model"

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, funded by ORISE Research Participation Program at EPA

Chesapeake Bay Program Phase 7 Model Development:

- Develop the main Bay model (MBM) and multiple tributary models (MTM): link the phase 7 watershed model to the estuary model using unstructured grids and extend the model simulations to the shallow water habitats.
- Lead on the MTM developments in the James, York, Rappahannock, Potomac, and other rivers.
- Study the response of water quality criteria (oxygen, submerged aquatic vegetation (SAV), and chlorophyll a) and shallow water processes to the TMDL and climate change.
- Study the interactions between estuaries and sub-estuaries on the US east coast with generic tracer models

Dissertation Chapter 4 — Study the impacts of sea-level rise in tidal marshes in the Chesapeake Bay, funded by CA Delta Stewardship Council
Aug. 2021 – Mar. 2022

- 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. under 2nd review at *Journal of Geophysical Research: Biogeosciences*

Dissertation Chapter 3 — Study the role of tidal marshes in the estuarine biogeochemical processes, funded by VIMS Commonwealth Coastal Research Fellowship
Apr. 2020 – Jul. 2021

Chesapeake Bay Tidal Marsh 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. 2023, *Journal of Geophysical Research: Biogeosciences*

Dissertation Chapter 2 — Study the impacts of sea-level rise on water quality in Chesapeake Bay, funded by VIMS Graduate Research Grants
Jul. 2019 – Mar. 2020

- 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 — Study the impacts of sea-level rise on water quality in Chesapeake Bay, funded by VIMS Graduate Research Grants
Aug. 2018 – Jun. 2019

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, funded by CA Department of Water Resources

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, funded by Whitman, Requardt & Associates, LLP

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, funded by Public Science and Technology Research

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 (ASLO) and National Science Foundation (NSF), Honolulu,

	HI – "Enhanced Sulfide Flux by Resuspension: An Underestimated Piece to Estuarine Hypoxia" ($3,337)
Apr. 2022	**W&M Open Access Financial Assistance**, for publication in L&O Letter – "Bifurcate Responses of Tidal Range to Sea-level Rise in Estuaries with Marsh Evolution" ($2,400)
Mar. 2022	**Top Cited Article 2020-2021**, Journal of American Water Resources Association, Wiley – "A Numerical Study of Hypoxia in Chesapeake Bay Using an Unstructured Grid Model: Validation and Sensitivity to Bathymetry Representation."
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. ($31,245)
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"

Invited Talks and Conference 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"
Mar. 2023	Invited talk at the first annual meeting of NSF project CHALK – "Development of biogeochemical modeling of tidal wetlands estuarine waters of the York River"
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"
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"

Professional Skills

Numerical modeling	Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM); Integrated Compartment Model (ICM) multi-dimensional water quality model; Sediment Flux Model; Tidal Marsh Model; Submerged Aquatic Vegetation Model; Benthic Algae Model; Benthic Feeder Model; Bioturbation Model; Sediment Transport Model; Wind Wave Model; Watershed and Airshed Coupling
Data analysis and machine learning	Harmonic Analysis, Regressions, Decision Tree, Classification and Regression Trees (CART), Random Forest, Neural Network, Empirical Mode Decomposition (EMD), Empirical Orthogonal Function (EOF)
Programing skills	Fortran, Matlab, Python, HTML, Perl, and C
Software	SMS, ArcGIS, CorelDRAW, STELLA
Operating system	Unix for high-performance computing (HPC)

Service and Outreach

2021 - present	Reviewer for Geology, Ocean Modeling, Marine Pollution Bulletin, Journal of American Water Resources Association, and USGS Colleague Review
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?"