[NICOLE] XUN CAI

NSF Ocean Sciences Postdoctoral Fellow
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Research Interests

Coastal ecosystem, land-sea interactions; tidal dynamics; saltwater intrusion; coastal wetlands; sea-level rise; climate change; physical-biological interactions; surface water-groundwater interaction; hydrodynamics; carbon cycling; biogeochemistry; water quality

Numerical modeling; high-performance computing; data analysis; machine learning

Education

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

Experience

Aug. 2024 – present	**Yale University**, New Haven, CT *NSF Postdoctoral Research Fellow*, Yale School of the Environment Advisor: Peter Raymond
Aug. 2021 – Jul. 2024	**U.S. Environmental Protection Agency**, Annapolis, MD *ORISE Fellow*, Chesapeake Bay Program Office
Fall, 2017	**University of Oldenburg**, Oldenburg, Germany *Visiting Student* Host: Jörg-Olaf Wolff
Aug. 2015 – Jul. 2021	**William & Mary | VIMS**, Gloucester Point, VA *Graduate Research Assistant,* Department of Physical Sciences Advisors: Joseph Zhang, Jian Shen

Publications (mentee*)

Submitted

Cai, X., Qin, Q., Kirwan, M.L., Michael, H., Shen, J., Mach, K., and Raymond, P., Recognizing Salt Wave Events in Coastal Systems. Submitted to Geophysical Research Letters.

Cai, X., Qin, Q., Cui, L., Yang, X., Zhang, Y., J., and Shen, J., NAAC: A Seamless Two-Decade Cross-Scale Simulation from the North American Atlantic Coast to Tidal Wetlands Based on

the 3D Unstructured-grid Model SCHISM (v5.11.0). Submitted to Geoscientific Model Development.

Shen, J., **Cai, X.**, and Qin, Q., A Machine Learning Approach to Forecasting Saltwater Intrusion in the Chesapeake Bay and its Major Tributaries. Submitted to Water Resources Research.

Zhang, M.*, **Cai, X.**, Weston, N., Wu, Z., Giblin, A., Hunt, C., Tsao, S., Zhang, N., and Raymond, P., Spatiotemporal Modulation of Alkalinity and DIC Outwelling from Saltmarsh Porewater in New England's Largest Marsh Complex. In revision for Journal of Geophysical Research: Biogeosciences.

Yu, S., Li, X., Liu, X., Brunner, P., Yao, R., Yuan, B., **Cai, X.**, and Yu, X., Effects of Creek Topology on Salinization of Coastal Marsh Due to Storm Surges. In revision for Water Resources Research.

Peer-reviewed (first/total: 5/10)

[10] Graham, O., Griffiths, L., Munzer, K., Barbosa, C., **Cai, X.**, Ogashawara, I., Selak, I., Sun, X., Thellman, A., 2024. Engaging Beyond Academia: A Call to Act for Environmental Scientists. Limnology and Oceanography Bulletin.

[9] Tian, R., **Cai, X.**, Cerco, C., Zhang, Y., J., and Linker, L., 2024. Simulation of Benthic Microalgae Impacts on Water Quality in Shallow Water Systems, Corsica River, Chesapeake Bay. Frontiers in Marine Science.

[8] **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., 2023. Sea-level Rise Impacts on The Tidal Marshes and Estuarine Biogeochemical Processes. Journal of Geophysical Research: Biogeosciences.

[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.

[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.

[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.

[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.

[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.

[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.

[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.

Others

Ignatoff P.*, **Cai, X.**, Gadeken K., 2023. Baywide distribution of benthic ecological functions in the past decades in the Chesapeake Bay. [dataset doi: 10.25773/6zhs-pn89].

Graham, O., Al-Haj, A., Arrington, E.C., Arsenault, E.R., Barbosa, C.C., Bice, K., Brahmstedt, E., Bryant, S.R.D., **Cai, X.**, Calhoun-Grosch, S., ..., and Culpepper, J., 2023. Better Together: Early Career Aquatic Scientists Forge New Connections at Eco-DAS XV. Limnology and Oceanography Bulletin.

Awards

Nov. 2023	**William R. "Randy" Boggess Best Paper Award**, American Water Resources Association – "A Numerical Study of Hypoxia in Chesapeake Bay Using an Unstructured Grid Model: Validation and Sensitivity to Bathymetry Representation."
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
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"

Grants and Proposals (funded in total: ~$394k)

Aug. 2024	**NSF Ocean Sciences Postdoctoral Research Fellowships (OCE-PRF)** – #2403359, "Connections Between Tidal Flooding, Saltwater Intrusion, and Alkalinity Exports in Tidal Marsh Wetlands" ($351,926) PI: **Xun Cai** (Yale); mentors: Peter Raymond (Yale), Holly Michael (U. Delaware), Sergio Fagherazzi (Boston U.)

Waiting list	**NSF Earth Sciences Postdoctoral Fellowships (EAR-PF)** – #2403359, "Linkages Between Estuarine Hydrodynamics and Hydrological Drivers at the Coastal Critical Zone" ($180,000) PI: **Xun Cai**; mentors: Holly Michael (U. Delaware), Matthew Kirwan (VIMS | W&M)
Jun. 2024	**CCRS Early Career Panel Funding Support**, Chesapeake Research Consortium and NOAA, Annapolis, MD – for joining plenary session "Beyond 2025, the Early Career Panel" ($1,850)
May 2024	**NSF Coastal Critical Zone Network Research Travel Award**, for on-site research visit to NSF Coastal Critical Zone Network Cluster, U. Delaware, DE (~$3,000)
Mar. 2023	**ECO-DAS XV Fellow**, Association for the Sciences of Limnology & Oceanography (ASLO) and National Science Foundation (NSF), Honolulu, HI ($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)
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 Travel Grant** 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" (~$1,000)

Mentoring and Teaching

Mentoring

Apr. 2025 – present	Master student Bella Garrioch, Yale, CT Hypothesis development, idea feedback, and draft review
Jul. 2024 – present	PhD student Mingyu Zhang, Yale, CT Model practicing, idea investigation, and manuscript revising
Aug. 2023 – present	Master student Julia Abrao Teixeira, VIMS, VA Thesis "Distribution and Fate of Floating Marine Debris from Major Estuaries along the US East Coast to the Mid-Atlantic Bight: A Lagrangian Particle Tracking Approach"
Summer, 2023	Undergraduate summer intern Philip Ignatoff, William & Mary, VA Design of an 8-week research project "Revisit sediment diagenesis, bioturbation, and nutrient cycling"

Guest lectures

Jan. 2025	COAS 4025: Society and the Sea Seminar (capstone course) at the East Carolina University – "Ocean salinity and estuarine circulations"
Oct. 2024	BIOL 7005: Coastal Ecological Processes (PhD level) at the East Carolina University – "Role of submerged aquatic vegetation, tidal marsh, and mangrove in the coastal ecosystem"
Oct. 2024	SpTp: Ocean Ecosystem Modeling (master level) at the University of Texas Rio Grande Valley – "Modeling complex ecosystems: integrating physical and biogeochemical processes" (UTRGV is a Hispanic Serving Institution)
Nov. 2023	ENVR 1401: Introduction to Environmental Science (undergraduate level) at the University of Texas Rio Grande Valley – "Water Quality Modeling, Climate Change, and Sea-level Rise" (UTRGV is a Hispanic Serving Institution)
Apr. 2019	SCHISM Summit workshop, California Department of Water Resources, Sacramento, CA – "Introduction of SCHISM-ICM water quality model"

Presentations (mentee*)

Nov. 2025 (submitted)	**Cai, X.**, Qin, Q., Kirwan, M.L., Michael, H., Shen, J., Mach, K., and Raymond, P., Recognizing salt wave events in coastal systems. *Coastal & Estuarine Research Federation (CERF) 2025*, Richmond, VA
Nov. 2025 (submitted)	Shen, J., **Cai, X.**, Qin, Q., Forecasting saltwater intrusion in Chesapeake Bay and its major tributaries: a machine learning approach. *Coastal & Estuarine Research Federation (CERF) 2025*, Richmond, VA
Nov. 2025 (submitted)	Zhang, M.*, **Cai, X.**, Weston, N., Giblin, A., and Raymond, P., Spatial and temporal variabilities of carbonate chemistry driven by porewater exchange in a saltmarsh-dominated estuary. *Coastal & Estuarine Research Federation (CERF) 2025*, Richmond, VA
Nov. 2025 (submitted)	Qin, Q., Ruiz, E., Chettanawanit K., and **Cai, X.**, Multi-decadal tidal range trends near coastal marshes across U.S. estuarine systems. *Coastal & Estuarine Research Federation (CERF) 2025*, Richmond, VA
May 2025	**Cai, X.**, Qin, Q., Kirwan, M.L., Michael, H., Shen, J., Mach, K., and Raymond, P., Coastal Saltwater Intrusion: From Long-Term Trends to Episodic Variability. *NSF Coastal Critical Zone* project meeting, virtual
Dec. 2024	Teixeira, J.*, Mazzini, P., **Cai, X.**, Qin, Q., and Zhang, Y., J., Distribution and fate of microplastics from estuarine sources in the Mid-Atlantic Bight: a lagrangian particle tracking approach. Oral presentation at *AGU24*, Washington DC
Dec. 2024	Zhang, M.*, **Cai, X.**, Weston, N., Wu, Z., Giblin, A., Hunt, C., Tsao, S., Zhang, N., and Raymond, P., Unveiling the spatial and temporal variabilities of carbonate chemistry driven by porewater exchange in a saltmarsh-dominated estuary. Poster presentation at *AGU24*, Washington DC

Dec. 2024 Movahedi, N., Zheng, L., **Cai, X.**, Tian, R., Linker, L., Skarke, A., and Heiss, J., A nested hydrodynamic modeling approach for simulating realistic pressures along estuarine bedforms. Poster presentation at *AGU24*, Washington DC

Dec. 2024 Griesel, M., Movahedi, N., Zheng, L., **Cai, X.**, Tian, R., Linker, L., Skarke, A., and Heiss, J., Benthic exchange in large estuaries: The role of alternating tidal currents and surface water salinity oscillations. Poster presentation at *AGU24*, Washington DC

Jun. 2024 Qin, Q., Shen, J., **Cai, X.**, Wang, Z., and St-Laurent, P., The transport and retention conditions in the middle-lower Rappahannock River. Oral presentation at *Chesapeake Bay Symposium,* Annapolis, MD

May 2024 **Invited** presentation at *Delaware Environmental Institute and the Coastal Critical Zone Network* – "Coastal Environment Facing Climate Change: Insights from Computational Methods", host: Holly Michael

Mar. 2024 **Invited** seminar at *Old Dominion University Ocean & Earth Sciences Department Spring Seminar Series* – "Coastal Environment Facing Climate Change: Insights from Computational Methods", host: Joseph Tamborski

Feb. 2024 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Impacts of sea-level rise on the tidal marshes and estuarine biogeochemical processes. Poster presentation at *Ocean Sciences Meeting 2024*, New Orleans, LA

Feb. 2024 Qin, Q., **Cai, X.**, and Shen, J., Freshwater Connectivity Between Major Subestuaries in Chesapeake Bay. Oral presentation at *Ocean Sciences Meeting 2024*, New Orleans, LA

Nov. 2023 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Impacts of sea-level rise on the tidal marshes and estuarine biogeochemical processes. Oral presentation at *Coastal & Estuarine Research Federation (CERF) 2023* Portland, OR

May 2023 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Impacts of sea-level rise on the tidal marshes and estuarine biogeochemical processes. Oral presentation at *International Society for Ecological Modelling Global Conference*, Toronto, Canada

Mar. 2023 **Invited** talk at *annual meeting of NSF project CHALK* – "Development of biogeochemical modeling of tidal wetlands estuarine waters of the York River", host: Marjorie Friedrichs

Jun. 2022 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., and Linker, L., Impacts of sea-level rise on the material exchange between tidal marshes and the estuary. Oral presentation at *Chesapeake Bay Symposium,* Annapolis, MD

Jun. 2022 **Cai, X.**, Linker, L., Shen, J., Zhang, Y., J., Qin, Q., Xiong, J., and Tian, R., Development of a Next-Generation Tributary Model in the tidal James River. Oral presentation at *Chesapeake Bay Symposium,* Annapolis, MD

Jun. 2020 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., Wang, Z., and Wang H., Impacts of Sea-level Rise on Hypoxia and Phytoplankton Production in Chesapeake Bay: Model

Validation and Assessment. Oral presentation at *Chesapeake Bay Symposium,* virtual

Nov. 2019 **Cai, X.**, Shen, J., Zhang, Y., J., Qin, Q., Wang, Z., and Wang H., Numerical Simulation of Impacts from Sea-level Rise on Hypoxia in Chesapeake Bay Using an Unstructured Grid Model: Validation and Assessment. Oral presentation at *Coastal & Estuarine Research Federation (CERF) 2019*, Mobile, AL

Nov. 2017 Qin, Q., Shen, J., and **Cai, X.**, The contribution of phytoplankton to primary production dynamics in shallow areas of York River, VA. Oral presentation at *Coastal & Estuarine Research Federation (CERF) 2017*, Providence, RI

Jun. 2016 Wang, Z., **Cai, X.**, and Wang H., Effect of pH on nutrients release and algal bloom in the Back River, Upper Chesapeake Bay. Poster presentation at *Chesapeake Bay Symposium, 2016*, Williamsburg, VA

Career Development, Service, and Outreach

2021 – present Reviewer for *Geology, Journal of Advances in Modeling Earth Systems, Journal of American Water Resources Association, Journal of Geophysical Research: Biogeosciences, Limnology and Oceanography, Marine Pollution Bulletin, Ocean Modeling, Ocean Science,* and USGS Colleague Review.

2025 Participant at American Geophysical Union's (AGU) LANDInG Postdoctoral Research Fellows Program (PRFP) as NSF-funded Postdoctoral Fellowship awardee

2025 Participant at *Mentoring Physical Oceanography Women to Increase Retention (MPOWIR)* mentorship program

2024 Mentor at *Women in Coastal Geoscience and Engineering (WICGE)* mentorship program

Jun. 2024 Panelist at plenary session "Beyond 2025, the Early Career Panel" at *Chesapeake Community Research Symposium 2024*.

Jun. 2024 Session convener at *Chesapeake Community Research Symposium 2024* – "Exploring the Linkage Between the Tidal Marsh Dynamics and the Key Processes in the Chesapeake Bay" (session proposal accepted).

May 2024 Participation at *Scientific and Technical Advisory Committee (STAC) workshop* titled 'CBP Climate Change Modeling III: Post-2025 decisions.'

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?"

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; Groundwater model HydroGeoSphere
Data analysis and machine learning	Harmonic Analysis, Empirical Mode Decomposition (EMD), Regressions, Decision Tree, Classification and Regression Trees (CART), Generalized Linear Models (GLM), Generalized Additive Model (GAM), Random Forest, Neural Network, Empirical Orthogonal Function (EOF), Mann-Kendall (MK) test
Programing skills	Fortran, Matlab, Python, HTML, Perl, C, Git, and R
Software	SMS, ArcGIS, CorelDRAW, STELLA
Operating system	Unix for high-performance computing (HPC)

Field Experience and Research Cruises

May 2024	On-site visit to NSF Coastal Critical Zone Network Cluster sites on the Delmarva Peninsula, 1 day.
Oct. 2017	RV HEINCKE HE498, CTD profiling at North Sea, 7 days.
Sep. 2017	Fish tagging cruise at Sacramento-San Joaquin delta, 1 day.