Cheng Zhang

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RESEARCH INTERESTS

Coastal Processes
Coastal Hazards
Numerical Modeling
Ocean Science
Machine Learning
Data Assimilation

EDUCATION

2015 - 2020 **Ph.D.** (advised by Dr. James Kirby)**:** Coastal Engineering, University of Delaware, United States
Dissertation: A two-layer non-hydrostatic landslide model for tsunami generation on irregular bathymetry

2008 - 2011 **M.S.:** Design and Manufacture of Naval Architecture and Ocean Structure, South China University of Technology, China
Thesis: Numerical simulation of free-surface viscous flow with submerged moving structures

2004 - 2008 **B.S.:** Naval Architecture and Ocean Engineering, South China University of Technology, China

RESEARCH EXPERIENCES

2021 - present **Postdoctoral Research Associate,** Program in Atmospheric and Oceanic Sciences, Princeton University

- To develop and implement the machine-learned parameterizations of various processes in MOM6, and to evaluate those implementations in the context of GFDL's OM4 and CM4.

2020 - 2021 **Postdoctoral Scholar**, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

- **Estimating the underlying bathymetry and the associated ocean states by using a combination of numerical models and collected data (funded by ONR).** Utilizing a data assimilative system consisting of ROMS and remote sensing and in-situ data to estimate ocean state at James River, VA.

2015 - 2020 **Research Assistant**, Center for Applied Coastal Research, University of Delaware

- **Development, experimental validation and case studies for the next generation of landslide tsunami models for coastal hazard mitigation (funded by NSF).** Developing a two-layer coupled model for water column and landslide motion to invest submarine landslides and resulting tsunami generation over irregular bathymetry.

2008 - 2011 **Research and Teaching Assistant**, South China University of Technology, China

- Developed a two-phase air-water model based on immersed boundary (IB) method and volume of fluid (VOF) method with adaptive mesh refinement (AMR) technique, to investigate wave-structure interaction problems with surface-piercing structures.

INDUSTRIAL EXPERIENCES

2011 - 2015 **Ship Performance Engineer**, Shanghai Rules & Research Institute, China Classification Society, China

- Made policies and regulations in terms of ship stability and hydrodynamics for ship building under the frame of International Maritime Organization (IMO) and International Association of Classification Societies (IACS), and developed software for corresponding computations.

TECHNICAL SKILLS

Programming Languages: FORTRAN, C/C++, Python.

High performance computing: distributed memory parallel programming (OpenMPI) and massive parallel programming on GPU (CUDA FORTRAN).

Science & Engineering software packages: NHWAVE, FUNWAVE, MOM6, ROMS, SWAN, MATLAB, PyTorch.

JOURNAL PUBLICATIONS

In preparation:

1. Kirby, J. T. and **Zhang, C.**, Three-dimensional structure of shallow, oscillatory flow behind a channel obstruction.
2. **Zhang, C.**, Özkan-Haller, H.T., Scully, M.E. and Thomson, J.M., An improved bathymetry estimation using an ensemble-based data assimilation method with adaptive observations and its application to guide the drifter deployment in field work.

Submitted:

3. Perezhogin, P., **Zhang, C.**, Adcroft, A., Fernandez-Granda, C. and Zanna, L., Implementation of a data-driven equation-discovery mesoscale closure into an ocean model (Submitted to *Journal of Advances in Modeling Earth Systems*).
4. Gultekin, C., Subel, A., **Zhang, C.**, Leibovich, M., Perezhogin, P., Adcroft, A., Fernandez-Granda, C. and Zanna, An Analysis of Deep Learning Parameterizations for Ocean Subgrid Eddy Forcing (Submitted to *Environmental Data Science*).

Published:

5. **Zhang, C.**, Perezhogin, P., Gultekin, C., Adcroft, A., Fernandez-Granda, C. and Zanna, L. (2023). Implementation and evaluation of a machine learned mesoscale eddy parameterization into a numerical ocean circulation model. *Journal of Advances in Modeling Earth Systems*, 15, e2023MS003697.
6. Luo, Y., Shi, H., Zhang, Z., **Zhang, C.**, Zhou, W., Pan, G. and Wang, W., Wave field predictions using a multi-layer perceptron and decision tree model based on physical principles: A case study at the Pearl River Estuary. *Ocean Engineering*, 277, 114246, 2023.
7. Luo, Y., **Zhang, C.**, Liu, J., Xing, H., Zhou, F, Wang, D., Long, X., Wang, S., Li, M. and Shi F., Identifying ship-wakes in a shallow estuary using machine learning. *Ocean Engineering*, 246, 110456, 2022.
8. Kirby, J. T., Grilli, S.T., Horrillo, J., Liu, P.L.F., Nicolsky, D., Abadie, S., Ataie-Ashtiani, B., Castro, M.J., Escalante, C., Fine, I., González-Vida, J.M., Løvholt, F., Lynett, P., Ma, G., Macias, J., Ortega, S., Shi, F., Yavari-Ramshe, S. and **Zhang, C.**, Validation and intercomparison of models for landslide tsunami generation. *Ocean modelling*, 101943, 2022.
9. Grilli, S.T., **Zhang, C**., Kirby, J.T., Grilli, A.R., Tappin, D.R., Watt, S.F.L., Hunt, J.E., Novellino, A., Engwell, S., Nurshal, M.E.M., Abdurrachman, M., Cassidy, M., Madden-Nadeau, A.L. and Day, S., Modeling of the Dec. 22nd 2018 Anak Krakatau volcano lateral collapse and tsunami based on recent field surveys: comparison with observed tsunami impact. *Marine Geology*, 106566, 2021.
10. **Zhang, C.**, Kirby, J. T., Shi, F., Ma, G. and Grilli, S. T., A two-layer non-hydrostatic landslide model for tsunami generation on irregular bathymetry. 1. Theoretical basis. *Ocean modelling*, 101749, 2021.
11. **Zhang, C.**, Kirby, J. T., Shi, F., Ma, G. and Grilli, S. T., A two-layer non-hydrostatic landslide model for tsunami generation on irregular bathymetry. 2. Numerical discretization and validation. *Ocean modelling*, 101769, 2021.
12. Grilli, S. T., Tappin, D. R., Carey, S., Watt, S. F., Ward, S. N., Grilli, A. R., Engwell, S. L., **Zhang, C.**, Kirby, J. T., Schambach, L. and Muin, M., Modelling of the tsunami from the December 22, 2018 lateral collapse of Anak Krakatau volcano in the Sunda Straits, Indonesia. *Scientific reports*, 9, 2019.
13. Zhou, Y., Ma, N., Shi, X. and **Zhang, C.**, Direct calculation method of roll damping based on three dimensional CFD approach, *Journal of Hydrodynamics, Ser. B*, 27 no.2 176-186, 2015.

14. **Zhang, C.**, Lin, N., Tang, Y. and Zhao, C., A sharp interface immersed boundary/VOF model coupled with wave generating and absorbing options for wave–structure interaction, *Computers & fluids*, 89, 214-231, 2014.
15. Chen X., **Zhang, C.**, Tang, Y., Zhao, C. and Lin, W., An immersed boundary method with an approximate projection on non-staggered grids to solve unsteady fluid flow with a submerged moving rigid object, *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, 228 no. 3, 272-283, 2014.
16. **Zhang, C.**, Zhang, W., Lin, N., Tang, Y., Zhao, C., Gu, J., Lin, W., Chen X. and Qiu, A., A two-phase flow model coupling with volume of fluid and immersed boundary methods for free surface and moving structure problems, *Ocean Engineering*, 74, 107-124, 2013.
17. Zhang, W., Tang, Y., Zhao, C. and **Zhang, C.**, A two-phase flow model with VOF for free surface flow problems, *Applied Mechanics and Materials*, 232, 279-283, 2012.

CONFERENCE

1. **Zhang, C.**, Perezhogin, P., Gultekin, C., Adcroft, A., Fernandez-Granda, C. and Zanna, L., Stochastic-Deep Learning Parameterization of Subgrid Ocean Processes in the MOM6 Ocean Model (Talk). *AGU Fall Meeting*. Chicago, Dec. 12-16, 2022.
2. **Zhang, C.**, Kirby, J. T., Grilli, S. T., Shi, F. and Ma, Numerical modelling of tsunami generated by submarine landslides on irregular bathymetry (Poster). *Ocean Science Meeting*. San Diego, CA, Feb. 16-21, 2020.
3. Grilli, S. T., Schambach, L., **Zhang, C.**, Kirby, J. T., Grilli, A. R., Tappin, D. R., Carey, S., Watt, S., Day, S. J., Engwell, S. L., Ward, S. N. and Muin, M., Modeling of the slide and tsunami generation from the 12/22/18 lateral collapse of Anak Krakatau volcano (Sunda Straits, Indonesia): comparison with recent field surveys of slide deposits and tsunami impact. *AGU Fall Meeting*. San Francisco, CA, Dec. 9-13, 2019.
4. **Zhang, C.**, Kirby, J. T., Grilli, S. T., Shi, F. and Ma, G., Numerical modeling of the tsunami generated by the collapse of Anak Krakatau volcano in the Sunda Straits of Indonesia on Dec. 22, 2018, with a two-layer non-hydrostatic wave-slide model (Talk). *THESIS*, Newark, DE, Sep. 17-19, 2019.
5. **Zhang, C.**, Kirby, J. T., Grilli, S. T., Shi, F. and Ma, G., Numerical modeling of submarine mass failure by a two-layer non-hydrostatic wave-slide model (Poster). *AGU Fall Meeting*. Washington DC, Dec. 10-14, 2018.
6. **Zhang, C.**, Kirby, J. T., Grilli, S. T., Shi, F. and Ma, G., A two-layer non-hydrostatic landslide model for tsunami generation on irregular bathymetry (Talk), *ICCE*. Baltimore, MD, July 30 – Aug. 6, 2018.
7. Ma, G., **Zhang, C.**, Kirby, J.T., Shi, F. and Grilli, S.T., Simulating tsunami wave generation using a two-layer non-hydrostatic landslide model, *15th Annual Meeting of Asia Oceania Geosciences Society*. Honolulu, Hawaii, Jun. 03-08, 2018

TECHNIQUE REPORTS

1. Kirby, J.T., Grilli, S.T., **Zhang, C.**, Horrillo, J., Nicolsky, D., Liu, P.L.-F., The NTHMP Landslide Tsunami Benchmark Workshop, Galveston, January 9–11, 2017. Research Report No. CACR-18-01, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware, 2018.
2. **Zhang, C.**, Kirby, J. T., Ma, G., Shi, F., Grilli, S. T. and Shelby, M., NTHMP landslide benchmark results for NHWAVE, Version 3.0, Research Report No. CACR-17-05, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware, 2017.
3. **Zhang, C.**, Tehranirad, M., Kirby, J. T., Derakhti, M., Nemati, F., Grilli, S. T., Ma, G. and Shi, F., Tsunami benchmark

results for the non-hydrostatic wave model NHWAVE, Version 3.0, Research Report No. CACR-17-03, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware, 2017.

PROFESSIONAL ACTIVITIES

Reviewer for Ocean Modelling; Journal of Fluid Mechanics; Journal of Computational Physics; Natural Hazards; Journal of Waterway, Port, Coastal, and Ocean Engineering; Applied Mathematical Modelling; Natural Hazards and Earth System Sciences; Engineering Applications of Computational Fluid Mechanics; Water Wave; Journal of Mountain Science; Journal of Marine Science and Engineering; Journal of Water Resources Planning and Management; Water; Physics of Fluids; Marine Georesources & Geotechnology; Dynamics of Atmospheres and Oceans

Recent talk AGU meeting (2022), M²LInES Annual meeting (2022), Princeton University Ocean Division Seminar (2021), NOAA Coastal Ocean Modeling Science Seminar (2021)

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