Chih-Lun Liu

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Education

- **College of Earth, Ocean, and Atmospheric Sciences, Oregon State University** — Corvallis , OR, USA
  Ph.D.; GPA: 3.95/4.0; Thesis Advisor: Bill Smyth — *Sep 2019 - Dec 2023*
  Dissertation: *Kelvin-Helmholtz Turbulence in Complex Environments*
- **Institute of Oceanography, National Taiwan University** — Taipei, Taiwan
  MSc; GPA: 3.48/4.0; Thesis Advisor: Ming-Huei Chang — *Aug 2015 - Sep 2017*
  Master's thesis: *Numerical Studies of Small Island Wakes in the Kuroshio (Published in JGR-Oceans)*
- **Griffith University** — Gold Coast, Australia
  Study Abroad; Grade: 7/7 — *Feb 2015 - Jul 2015*
  Courses: *Fluid Mechanics and Hydraulics, Comp & Programming with MATLAB, Marine Ecosystem*
- **Marine Environmental Informatics, National Taiwan Ocean University** — Keelung, Taiwan
  BSc; GPA: 3.6/4.0 — *Sep 2011 - Jan 2015*
  Dean's Award *(for ranking top three in class in semester) *1*

Research Experiences

- **Postdoctoral Scholar** — Dec 2023 - current
  Supervised by Henri Drake — *Irvine, CA, USA*
  Department of Earth System Science, University of California, Irvine
  Project: Internal Tide-Driven Mixing: Efficiency and Equilibrium Energy Pathways, NSF
- **Fluid Dynamics of Sustainability and the Environment Summer School** — Cambridge, UK
  Department of Applied Mathematics and Theoretical Physics, University of Cambridge — *Sep 4-15 2023*
  Intense two-week lectures and laboratory experiments followed by a numerical project presentation
- **Graduate Research Assistant** — Sep 2019 - Dec 2023
  Supervised by Bill Smyth — *Corvallis, OR, USA*
  College of Earth, Ocean, and Atmospheric Sciences, Oregon State University
  Project: Kelvin-Helmholtz turbulence in complex environments, NSF
- **Faculty Research Assistant** — Oct 2018 - Sep 2019
  Supervised by Ming-Huei Chang — *Taipei, Taiwan*
  Institute of Oceanography, National Taiwan University
  Project: Development of Shipwreck Drifting and Oil Pollution Forecasting Technology, Central Weather Bureau

Academic Involvement

Journal Publications

- **Liu, C. L.**, A. K. Kaminski, W. D. Smyth, Turbulence and Mixing From Neighboring Stratified Shear Layers (2023), *J. Fluid Mech.* (Under review)
- **Liu, C. L.**, A. K. Kaminski, W. D. Smyth, The Effects of Boundary Proximity on Kelvin-Helmholtz Instability and Turbulence (2023), *J. Fluid Mech.*, 966, A2, doi.org/10.1017/jfm.2023.412
- **Liu, C. L.**, A. K. Kaminski, W. D. Smyth, The butterfly effect in stratified shear flow (2022), *J. Fluid Mech.*, 953, A43, doi.org/10.1017/jfm.2022.985
- Chang, M. H., Y. H. Cheng, Y. Y. Yeh, Y. J. Yang, **C. L. Liu**, T. Matsuno, T. Endoh, E. Tsutsumi, J. L. Chen, and X. Guo (2022), Internal hydraulic transition and turbulent mixing observed in the Kuroshio over the I-Lan Ridge off northeastern Taiwan, *J. Phys. Oceanogr.*, 52(12), 3179-3198, doi.org/10.1175/JPO-D-21-0245.1
- Chang, M. H., S. Jan, **C. L. Liu**, Y. H. Cheng, and V. Mensah (2019), Observations of Island Wakes at High Rossby Numbers: Evolutions of Submesoscale Vortices and Free Shear Layers , *J. Phys. Oceanogr*, 49(11), 2997-3016, doi.org/10.1175/JPO-D-19-0035.1
- **Liu, C. L.**, and M. H. Chang (2018), Numerical Studies of Submesoscale Island Wakes in the Kuroshio, *J. Geophys. Res. Oceans.*, 123(8), 5669-5687, doi.org/10.1029/2017JC013501

Oral Presentations

- Liu, C. L., W. D. Smyth (2023), Kelvin-Helmholtz Turbulence in Complex Environments *Ph.D. Defense*, Corvallis, OR, USA
- Liu, C. L., A. K. Kaminski, W. D. Smyth (2023), The effects of boundary proximity on Kelvin-Helmholtz instability and turbulence. *The 28th General Assembly of the International Union of Geodesy and Geophysics (IUGG)*, Berlin, Germany

- Liu, C. L. (2022), Application of Quasi-Realistic Numerical Modeling to Mitigate Ocean Pollution: An Oil Spill Example, *International Conference on UNCLOS 40th Anniversary and Its Implementation of Marine Policy*, virtual
- Liu, C. L., A. K. Kaminski, W. D. Smyth (2022), The effects of Boundary Proximity on Kelvin Helmholtz Instability and Turbulence, *International Symposium on Stratified Flows*, University of Cambridge, UK
- Liu, C. L., A. K. Kaminski, W. D. Smyth (2022), The effects of Boundary Proximity on Kelvin Helmholtz Instability and Turbulence, *POA Research Symposium*, Oregon State University, USA
- Liu, C. L., M. H. Chang, S. Jan, Y. J. Yang, Y. L. T. Matsuno, E. Tsutsumi, T. Endoh, A. Sakai, S. Shimada, X. Guo , J. L. Chen (2019), Numerical Simulation of Kuroshio Topography Interaction Over the I-Lan Ridge, *Forthcoming collaborative meeting*, Kyushu University, Japan
- Liu, C. L. and M. H. Chang (2017), Numerical Studies of Small Island Wakes in the Kuroshio, Thesis Defense National Taiwan University
- Liu, C. L. and M. H. Chang (2017), Numerical Studies of Small Island Wakes in the Kuroshio, *Pacific Asian Marginal Seas (PAMS) Meeting*, Session 02, Jeju, Korea
- Liu, C. L and M. H. Chang (2017), Numerical Studies of Small Island Wakes in the Kuroshio, *Ocean Sciences Conference*, Kaohsiung, Taiwan (winning **1st place** in youth forum competition)

Poster Presentations

- Liu, C. L., A. K. Kaminski and W. D. Smyth (2023), Neighboring Shear Instability and Turbulence. *Fluid Dynamics of Sustainability and the Environment Summer School*, University of Cambridge, UK
- Liu, C. L., A. K. Kaminski and W. D. Smyth (2022), The effects of Boundary Proximity on Kelvin Helmholtz Instability and Turbulence, *AGU Fall Meeting*, Chicago, USA
- Liu, C. L., A. K. Kaminski and W. D. Smyth (2022), The effects of Boundary Proximity on Kelvin Helmholtz Instability and Turbulence, *Ocean Sciences Meeting*, virtual
- Liu, C. L and M. H. Chang (2019), Instabilities and Turbulence Mixing in the Strong and Unsteady Flows Over a Sill: A Numerical Study, *Ocean Sciences Conference*, Taipei, Taiwan
- Liu, C. L and M. H. Chang (2019), Instabilities and Turbulence Mixing in the Strong and Unsteady Flows Over a Sill: A Numerical Study, *Pacific Asian Marginal Seas (PAMS) Meeting*, Kaohsiung, Taiwan
- Liu, C. L and M. H. Chang (2016), A Preliminary Study on Green Island Wake with Observation and Numerical Modelling, *Ocean Sciences Conference*, Taipei, Taiwan

Research Cruises

- *R/V Legend*, Underway VMP 250 mapping, on the I-Lan Ridge, Chief Scientist, Ming-Huei Chang, Jul 2019
- *R/V Ocean Research I*, VMP 500 deployment and biological sampling at Kaoping Canyon, SW of Taiwan , Chief scientist, Chih-Lin Wei, Mar 2019
- *R/V Ocean Research III*, Mixing processes in the frontal region of the island wake, North of Green Island, Chief Scientist: Ming-Huei Chang, March 2017
- *R/V Revelle* Submesoscale resolving survey of the region southwest of Taiwan, South China Sea, Chief Scientist: Lou St., Laurant, Feb/March 2017
- *R/V Ocean Research I*, Typhoon buoy deployment; recovery of moorings for recharging ADCP batteries, Philippine Sea, Chief Scientist: Yiing-Jang Yang, Oct 2016
- *R/V Ocean Research II*, Deployed mooring at the north of the Green Island, Philippine Sea, Chief scientist, Ming-Huei Chang, Sep 2016
- *R/V Ocean Research III*, Vertical structure of the Kuroshio, Philippine Sea, Chief scientist, Sen Jan, Jun 2016
- *R/V Ocean Research III*, Observe K-H instability above the ocean ridge, Philippine Sea, Chief scientist, Ming-Huei Chang, May 2016
- *R/V Ocean Research II*, Observe K-H instability above the ocean ridge, Philippine Sea, Chief scientist, Ming-Huei Chang, Mar 2016
- *R/V Ocean Research I*, Kuroshio variability, Philippine Sea, Chief scientist, Yiing Jang Yang, Nov 2015
- *R/V Ocean Research II*, Sea going Internship, Keelung Islet, Convener, Jian-Hua Hu, Sep 2014

Work Experiences

- **Military Service**, Chiayi, Taiwan (Oct/2017 - Oct/2018)
- **Internship**, Taipei, Taiwan (Jul/2012 - Aug/2013)
    1. Asia Environmental Technical Corporation (1 month)
    2. Eastern Media International Corporation (2 months)

Honors and Awards

- CEOAS Student Research Fellowship (Outstanding academic performance and engagement in the university community, 1000 USD award) - May 2023
- Wayne V. Burt Award (In recognition of outstanding achievement in the fields of physical oceanography or atmospheric sciences, 3000 USD award) - May 2022
- Ocean Sciences Conference Youth Forum Competition (1^{st} place) - May, 2016
- Dean's Award (1^{st} place in a semester) - June, 2015

Skills

- **Computer Languages**: MATLAB, Fortran, new to Julia and Python
- **Technical Skills**: Numerical Ocean Modeling (MITgcm), Direct Numerical Simulation (DIABLO), Large Eddy Simulation (Oceananigans), High Performance Computing (HPC), Data Visualization (VAPOR), LaTex, Unix Shell, Adobe Illustrator, Microsoft Office
- **Preparation, Setups and Operations of Oceanic Instruments**: ADCP, CTD, VMP 250/500 and Mooring deployment and pre-setups
- **Plan Cruise Experiments**: Assist the Chief Scientist to plan a compendium sea-going experiment
- **Platforms**: Extensive experience in Linux, MacOS, and Windows
- **Soft Skills**: Problem-solving and Communication, Writing, Time Management
- **Languages**: Fluent Mandarin and English

Research Experiences

- **Island Wakes (Master's thesis, published in JGR-oceans)**: We used the MIT general circulation model (MITgcm) to resolve wakes downstream of Green Island, east of Taiwan and obtained wake patterns and periods consistent with field observations. We discovered that (i) the wakes exhibit sequentially detached recirculation cells, which contain upwelling of cold water and propagate downstream; (ii) island wakes resemble the von Kármán vortex street but have been modified by inertial and barotropic instabilities; (iii) the hotspot of turbulent mixing is located where horizontal shear is large. Due to the island-shelf effect and tilting of the vertical vorticity, the lateral shear is partly converted to vertical shear resulting in turbulent diapycnal mixing. This was my first research project and has honed my modeling skills and theoretical understanding of oceanography.
- **Model Oil Spill Trajectories (1^{st} project as a Research Assistant)**: We focused on an oil spill incident in the Philippine Sea. A "nested model" was created, where the open boundary conditions for MITgcm are obtained from HYCOM velocity and temperature fields. We also considered modulation by the barotropic tide. A passive tracer was released from the southern boundary where marine traffic is densest. The oil spill was trapped for more than 10 hours near Green Island due to island wakes, which form a reverse flow immediately downstream of the island. These experiments aided my understanding of the MITgcm model. I was amazed that numerical models can address such practical problems.
- **Interaction Between Kuroshio and I-Lan Ridge (2^{nd} project as a Research Assistant)**: Based on a sequence of field experiments, we employed a two-dimensional model implemented in MITgcm to investigate the mixing processes occurring in the vicinity of the sill. Our primary focus was to comprehend the fundamental mechanisms of mixing, taking into account the energetic passage of the Kuroshio current across the sill and the associated variations induced by the M2 tide. During the flood tide, Lee waves are generated, subsequently undergoing disruption due to the presence of Kelvin-Helmholtz instability (KHI) during various tidal phases. The obtained findings provided valuable insights into the evolution of the flow dynamics and offered anticipations for distinct tidal phases encountered in the field.
- **The Butterfly Effect in Stratified Shear Flows (1^{st} PhD project, published in JFM)**: Our goal was to understand whether KHI, the transition to turbulence and the overall mixing efficiency are sensitive to the details of the initial conditions. Using ensembles of nearly-identical direct numerical simulations (DNS), we found that with slightly different initial random perturbations, the result can be drastically different. This has important implications for future DNS studies, as a single simulation may not represent the whole picture.
- **Boundary Effects on KH Instability and Turbulence (2^{nd} PhD project, submitted to JFM)**: Previous studies of KHI have neglected boundary effects. In the atmosphere and oceans, however, instability often occurs near boundaries, e.g., flow over I-Lan Ridge described above. Our goal is therefore to understand the impact of boundary proximity on KHI and turbulent mixing using DNS. We find that boundary effects suppress both vortex pairing and secondary convective instability; it also decreases both the amount and the efficiency of turbulent mixing.