

Benjamin W. Barr

Postdoctoral Investigator, Department of Physical Oceanography

Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, MA 02543

Email: benjamin.barr@whoi.edu, Tel: (512)-415-7939, Web: <https://www2.whoi.edu/staff/bbarr/>

Research Interests

Air-sea interaction; air-sea flux processes in high winds (e.g., ocean surface waves, sea spray, bubble entrainment, upper ocean mixing); atmosphere and ocean boundary layers; energetics and dynamics of tropical and extratropical cyclones and connections to air-sea processes; coupled atmosphere-wave-ocean (AWO) modeling; model and parameterization development; high-wind in situ air-sea-wave observations

Education

Ph.D. in Atmospheric Sciences, University of Washington, Seattle 2023
Thesis Title: “Seastate-dependent sea spray heat fluxes and impacts on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations”
Advisor: Dr. Shuyi S. Chen
M.S. in Mechanical Engineering, University of Texas at Austin 2012
B.S. in Mechanical Engineering, University of Texas at Austin 2010

Research and Professional Experience

Postdoctoral Investigator Aug 2023 – Present
Woods Hole Oceanographic Institution, Woods Hole, MA
Developing air-sea interaction model physics using the AWO Scripps Coupled Ocean-Atmosphere Regional (SCOAR) model. This includes: 1) incorporating seastate-dependent sea spray heat flux physics into the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk air-sea flux algorithm, 2) calibrating the updated algorithm with multi-year in situ direct covariance flux datasets, and 3) testing the new algorithm in SCOAR model simulations of extratropical cyclones.

Graduate Research Assistant Sep 2017 – Sep 2018, Jan 2019 – July 2023
University of Washington, Seattle
Studied the impact of seastate-dependent sea spray heat fluxes on tropical cyclone structure and intensity by developing a new seastate-based parameterization for air-sea heat fluxes with spray, implementing it in the AWO Unified Wave Interface-Coupled Model (UWIN-CM), and performing numerical experiments.

Teaching Assistant – ATMS 101: Introduction to Weather Sep 2018 – Dec 2018
University of Washington, Seattle

Associate Analyst Jan 2015 – May 2017
July 2012 – Dec 2014
Stress Engineering Services, Inc., Houston, TX
Performed structural engineering analysis for a variety of applications related to offshore deep-water oil and gas drilling, including design and installation analysis for top-tensioned

risers deployed from a floating oil production facility subjected to a range of extreme wind-wave-current loading combinations.

Graduate Research Assistant Jan 2011 – May 2012

University of Texas at Austin

Investigated the thermo-chemo-mechanical degradation of thermal protection materials in atmospheric reentry scenarios and organic materials in wildland fire scenarios by developing numerical models for heat transfer, mass transfer, and chemical processes.

Teaching Assistant – ME 330: Fluid Mechanics Aug 2010 – Dec 2010

University of Texas at Austin

Structural Analyst (Co-op) Aug 2008 – Dec 2008, Jun 2009 – Aug 2009

L-3 Communications IS, Greenville, TX

Performed structural analysis to approve design modifications to military aircraft.

Honors, Awards, and Achievements

Second Place Student Oral Presentation 2023

AMS 23rd Conference on Air-Sea Interaction

First Place Student Oral Presentation 2021

AMS 22nd Conference on Air-Sea Interaction

Future Investigators in NASA Earth and Space Science and Technology Award 2019 – 2022

Licensed as a Professional Engineer (licensed in Texas) 2016 – Present

Service and Synergistic Activities

Proposal Reviewer – *NSF Physical Oceanography*

Journal Peer Reviewer – *Geophysical Research Letters, Journal of Geophysical Research:*

Atmospheres, Journal of Geophysical Research: Oceans, Journal of Physical Oceanography

Session Co-Chair – “The Air-Sea Transition Zone” 2024

AMS 36th Conference on Hurricanes and Tropical Meteorology

Session Co-Chair – “Air-Sea Interaction” 2022

AMS 35th Conference on Hurricanes and Tropical Meteorology

Mentoring Program Coordinator, Univ. of Wash. Atmospheric Sciences 2019 – 2023

Performed mentor-mentee matching, planned social and professional development events, and handled administrative tasks for department undergraduate-graduate mentoring program.

Graduate Mentor, Univ. of Wash. Atmospheric Sciences 2017 – 2022

Served as graduate student mentor to undergraduates in department mentoring program.

Computational Skills

Programming Languages: Python, Fortran, MATLAB, HTML

Operating Systems: Windows, Linux

High Performance Computing: Experienced in developing and running regional coupled AWO weather forecast simulations in parallel computing frameworks, particularly for tropical cyclones with vortex-following nests

Commercial Software: Microsoft Office (Word, Excel, Powerpoint, Outlook)

Publicly Available Research Products

Model Parameterization: *Seastate-dependent air-sea heat fluxes with sea spray in high winds*
Fortran subroutines to incorporate seastate-dependent sea spray heat flux physics into an existing surface layer flux scheme in coupled regional or global Earth system models. B. W. Barr is the originator and developer of this repository, which is available at <https://github.com/bwbarr/sprayHFs>. The parameterization is currently being implemented and tested collaboratively in the DOE E3SM global Earth system model, the SCOAR coupled AWO model, and the MPAS-Atmosphere model.

Peer-Reviewed Publications

- Yang, S., H. Bae, M.-S. Park, M. Bourassa, C. C. Nam, S. Cocke, D. W. Shin, B. W. Barr, H. Seo, D.-H. Cha, M.-H. Kwon, D. Kim, K.-Y. Jung, and B.-M. Kim: Sea spray effects on typhoon prediction in the Yellow and East China Seas: Case studies using a coupled atmosphere-ocean-wave model for Lingling (2019) and Maysak (2020). *Submitted to Env. Research Lett.*
- Barr, B. W. and S. S. Chen: Impacts of seastate-dependent sea spray heat fluxes on tropical cyclone structure and intensity in fully coupled atmosphere-wave-ocean model simulations. *In revision at J. Adv. Model. Earth Syst.*
- Sauvage, C., H. Seo, B. W. Barr, J. B. Edson, and C. A. Clayson, 2024: Misaligned wind-waves behind atmospheric cold fronts. *J. Geophys. Res.: Oceans*, **129**, e2024JC021162, <https://doi.org/10.1029/2024JC021162>.
- Barr, B. W., S. S. Chen, and C. W. Fairall, 2023: Sea-state-dependent sea spray and air-sea heat fluxes in tropical cyclones: A new parameterization for fully coupled atmosphere-wave-ocean models. *J. Atmos. Sci.*, **80**, 933 – 960, <https://doi.org/10.1175/JAS-D-22-0126.1>.
- Anzalone, R., B. W. Barr, R. R. Upadhyay, and O. A. Ezekoye, 2017: Use of a quasi-steady ablation model for design sensitivity with uncertainty propagation. *J. Thermal Sci. Eng. Appl.*, **9**, 011004, <https://doi.org/10.1115/1.4034595>.
- Barr, B. W. and O. A. Ezekoye, 2013: Thermo-mechanical modeling of firebrand breakage on a fractal tree. *Proc. Comb. Inst.*, **34**, 2649 – 2656, <https://doi.org/10.1016/j.proci.2012.07.066>.

Conference, Seminar, and Workshop Presentations

* = Oral, # = Poster, ° = Invited, **Presenting author in bold**

- ^o#**Barr, B. W.**, S. S. Chen, C. W. Fairall, H. Seo, C. Sauvage, C. A. Clayson, and J. B. Edson, 2024: Seastate-dependent sea spray heat fluxes in extreme conditions: Physical processes, multiscale interactions, and future possibilities for observations and modeling. *AGU Annual Meeting 2024*, 9-13 December 2024, Washington, D.C., USA.
- ***Barr, B. W.**, 2024: Seastate-dependent air-sea heat fluxes with sea spray in high winds: Physical processes, multiscale interactions, and future possibilities for observations and modeling. *NCAR Mesoscale and Microscale Meteorology Seminar*, 26 September 2024, Boulder, CO, USA.
- ***Barr, B. W.**, 2024: Seastate-dependent air-sea heat fluxes with sea spray in high winds: Physical processes, multiscale interactions, and future possibilities for observations and

modeling. *NOAA Physical Sciences Laboratory Seminar*, 24 September 2024, Boulder, CO, USA.

- #**Barr, B. W.** and S. S. Chen, 2024: Impacts of seastate-dependent sea spray heat fluxes on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations. *AMS 36th Conference on Hurricanes and Tropical Meteorology*, 06-10 May 2024, Long Beach, CA, USA.
- ***Barr, B. W.**, C. Sauvage, H. Seo, C. A. Clayson, and J. B. Edson, 2024: Constraining sea spray heat fluxes in high winds using direct covariance heat flux observations. *AMS 36th Conference on Hurricanes and Tropical Meteorology*, 06-10 May 2024, Long Beach, CA, USA.
- ***Sauvage, C.**, H. Seo, B. W. Barr, J. B. Edson, and C. A. Clayson, 2024: Misaligned wind-waves behind atmospheric cold fronts. *ECMWF 5th Workshop on Waves and Wave-Coupled Processes*, 10-12 April 2024, Reading, UK.
- ***Barr, B. W.**, H. Seo, C. A. Clayson, and J. B. Edson, 2024: Using high-wind observations to constrain a seastate-dependent air-sea heat flux parameterization with spray for use in coupled atmosphere-wave-ocean models. *ECMWF 5th Workshop on Waves and Wave-Coupled Processes*, 10-12 April 2024, Reading, UK.
- ***Barr, B. W.**, H. Seo, C. A. Clayson, and J. B. Edson, 2024: Use of in situ air-sea-wave and direct covariance flux observations to constrain a model for seastate-dependent sea spray-mediated air-sea heat fluxes in high winds. *IEEE/OES 13th Currents, Waves, and Turbulence Measurement Workshop*, 18-20 March 2024, Wanchese, NC, USA.
- o***Barr, B. W.**, 2024: Seastate-dependent sea spray heat fluxes and impacts on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations. *University of Rhode Island Graduate School of Oceanography Physical Oceanography Seminar*, 1 March 2024, Narragansett, RI, USA.
- ***Barr, B. W.** and S. S. Chen, 2024: Impacts of seastate-dependent sea spray heat fluxes on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations. *AGU Ocean Sciences Meeting 2024*, 18-23 February 2024, New Orleans, LA, USA.
- o***Barr, B. W.**, 2023: Seastate-dependent sea spray heat fluxes and impacts on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations. *NOAA EMC Coupled Systems and Dynamics Seminar*, 28 November 2023, College Park, MD, USA.
- ***Barr, B. W.**, 2023: Seastate-dependent sea spray heat fluxes and impacts on tropical cyclone structure and intensity using fully coupled atmosphere-wave-ocean model simulations. *WHOI Physical Oceanography Dept. Seminar*, 19 September 2023, Woods Hole, MA, USA.
- ***Barr, B. W.** and S. S. Chen, 2023: Multiscale air-sea interactions in hurricanes: From seastate-dependent sea spray to surface and boundary layers in coupled atmosphere-wave-ocean model simulations. *AMS 23rd Conference on Air-Sea Interaction*, 08-12 January 2023, Denver, CO, USA.
- ***Barr, B. W.** and S. S. Chen, 2022: Interactions between seastate-dependent air-sea heat fluxes and hurricane boundary layers using a fully-coupled atmosphere-wave-ocean model. *AGU Ocean Sciences Meeting 2022*, 24 February – 4 March 2022, Virtual.

- ***Barr, B. W.** and S. S. Chen, 2021: Rapid intensification of Hurricane Michael (2018) and its sensitivity to upper ocean temperature. *AMS 34th Conference on Hurricanes and Tropical Meteorology*, 10-14 May 2021, Virtual.
- ***Barr, B. W.** and S. S. Chen, 2021: Interactive processes among sea spray, enthalpy flux, and surface layer temperature and humidity in hurricanes. *AMS 22nd Conference on Air-Sea Interaction*, 10-15 January 2021, Virtual.
- ***Barr, B. W.** and S. S. Chen, 2020: Effects of sea spray on air-sea fluxes and the wave boundary layer in high winds. *AGU Ocean Sciences Meeting 2020*, 16-21 February 2020, San Diego, CA, USA.
- ***Barr, B. W.** and S. S. Chen, 2019: Understanding spray-mediated air-sea fluxes and boundary layer processes in tropical cyclones. *American Geophysical Union Fall Meeting 2019*, 09-13 December 2019, San Francisco, CA, USA.
- #**Barr, B. W.** and S. S. Chen, 2018: Impacts of sea spray on air-sea fluxes in tropical cyclones: Results from coupled atmosphere-wave-ocean modeling of Hurricane Harvey (2017). *American Geophysical Union Fall Meeting 2018*, 10-14 December 2018, Washington, D.C., USA.
- ***Barr, B. W.** and **O. A. Ezekoye**, 2012: Analysis of the equilibrium approximation in chemical ablation of thermal protective systems. *ASME 2012 Heat Transfer Summer Conference*, 08-12 July 2012, Rio Grande, Puerto Rico, USA.
- *Anzalone, R., **B. W. Barr**, R. R. Upadhyay, and O. A. Ezekoye, 2011: Use of a quasi-steady ablation model for design sensitivity with uncertainty propagation. *ASME 2011 International Mechanical Engineering Congress and Exposition*, 11-17 November 2011, Denver, CO, USA.

Conference Proceedings

- Barr, B. W. and O. A. Ezekoye, 2013: Analysis of the equilibrium approximation in chemical ablation of thermal protective systems. *Proceedings of the ASME 2012 Summer Heat Transfer and Fluids Meeting*, HT2012-58462, 223 – 234, <https://doi.org/10.1115/HT2012-58462>.
- Anzalone, R., B. W. Barr, R. R. Upadhyay, and O. A. Ezekoye, 2012: Use of a quasi-steady ablation model for design sensitivity with uncertainty propagation. *Proceedings of the ASME 2011 International Mechanical Engineering Congress and Exposition*, IMECE2011-63677, 1253 – 1261, <https://doi.org/10.1115/IMECE2011-63677>.

Last updated December 2024.