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Research Focus

I develop AI and computational methods that bridge fundamental Earth system science with actionable tools for long-range weather prediction, ecosystem management, and policy. My research has shaped US national AI strategy, informed international marine legislation, and contributed to global Earth System modeling efforts, demonstrating how rigorous interdisciplinary science can drive sustainable transformation.

Current position

2023–present	Assistant Professor at University of California, Davis
2022–present	Affiliate Assistant Professor at University of Washington
2022–present	Associate Editor: American Meteorological Society (AMS) AI for the Earth Systems
2024–present	Editorial Board: Institute of Physics (IOP) Machine Learning: Earth

Education

2011-2016	University of Southampton, UK. Ph.D. Complex Systems Simulation Dissertation: Ocean model utility dependence on horizontal resolution Advisors: George Nurser, Joel J.-M. Hirschi, James Dyke
2006-2011	University of Southampton, UK. M. Sci. <i>magna cum laude</i> , complex systems simulation, 2011 M. Sci. <i>magna cum laude</i> , physical oceanography, 2010

Professional history

2020–2023	Associate Research Scholar at Princeton University
2016–2020	Postdoctoral Associate at Massachusetts Institute of Technology

Other positions

2020–2026	Affiliate Researcher at NOAA Geophysical Fluid Dynamics Laboratory
2023–2025	Visiting Scholar at Princeton University
2023	Visiting Professor at Université Catholique de Louvain, Belgium
2019–2022	Visiting Scientist at University of Washington
2017–2019	Visiting Scientist at Harvard University
2018–2019	Visiting Scientist at Université Grenoble Alpes, France
2016–2018	Visiting Scientist at University of Texas at Austin

Selected grants (Direct \$1,197,500)

2025	Direct \$7500 – PI: “Building Resilient Fisheries Under Climate Change”. UC Davis Global Affairs Advancing Sustainable Development Goals.
2024	Direct \$612,000 – PI: “AI for Ocean of Mixed Layer Heat Variability”. NSF.
2023	Direct \$578,000 – PI: “Improving sea level predictions with ocean insight and ML”. NOAA.

2023	Unfunded – Co-I: “Bridging theory and reality of the monsoons”. National Environmental Research Council (UK) \$1,290,757.
2021-2020	\$79,127 – Co-I: Amazon Sustainability Data Initiative

Policy and Societal Impact

2026	Member of NOAA Model Diagnostic Task Force , improving weather and climate models
2025	Consulted Louisville Metro Government (Kentucky) in strategic plan for AI roll-out
2021	Featured in NOAA’s artificial intelligence strategic plan 2021-2025 , a response to the President’s Executive Order on Maintaining American Leadership in AI. View document
2021	Research methods adopted by IPCC climate modeling centers (NOAA-GFDL, IPSL) contributing to global climate assessments used by 195+ countries
2021	Citation by the World Meteorological Organization (WMO) of the UN in concept note on AI applications in environmental modeling. More information
2020	Research contributed to scientific basis for New Zealand’s Marine Protected Area legislation
2020	Cited in European Union policy recommendation: ”Artificial intelligence and the fisheries sector”. More information

Selected Recognition and Awards

2025	UC Davis, Grand Challenges advisor
2024	Expert Committee for US Computational System for Frontier Climate Simulation summit
2023	Certificate of recognition from the California State Assembly
2023	UC Davis Faculty Scholar of the Center for the Advancement of Multicultural Perspectives on Science (CAMPOS)
2021	Spotlight paper at the International Conference on Machine Learning (ICML)
2021	Core member in Kavli Institute for Theoretical Physics (KITP) ”ML in the Physics of Climate”
2019	Simons Foundation visualization competition winner
2017	Kaufman Teaching Certificate Program (KTCP) awarded from MIT
2011	Engineering and Physical Sciences Research Council graduate fellowship (UK)

Review articles (total: 5)

- [1] Furtado, J.,..., **Sonnevald, M.** *Setting the Standard: Recommended Practices for Data Preprocessing in 2 Data-Driven Climate Prediction*, Invited to **Bulletin of the American Meteorological Society**. In press.Preprint.
- [2] Lai C.-Y., Hassanzadeh, P., Sheshadri, A., **Sonnevald, M.**, Ferrari, R., Balaji, V. *Machine learning for climate physics and simulations*, 2025, **Annual Reviews of Condensed Matter Physics**.
- [3] Bronner, U., **Sonnevald, M.** and Visbeck, M., *Marine modeling as the key to sustainable use and protection of the marine environment*, 2023, Invited: **The International Hydrographic Review**.
- [4] **Sonnevald, M.**, Lguensat, R., Jones, D., Duben, P., Brajard, J. and Balaji, V., *Bridging theory, simulation, and observations of the global ocean using Machine Learning*, 2021, **Environmental Research Letters**.
- [5] Irrgang, C., Boers, N., **Sonnevald, M.**, Elizabeth A. Barnes, Christopher Kadow, Staneva, J., and Saynisch-Wagner, J. *Towards neural Earth system modeling by integrating artificial intelligence in Earth system science*, 2021, **Nature Machine Intelligence**.

Peer reviewed publications (total: 20, ‘*’ indicates student/postdoc advised)

- [6] **Sonnewald M.** *A hierarchical ensemble manifold methodology for new knowledge on spatial data: An application to ocean physics*, **AIES**. Accepted. Preprint.
- [7] Rosenfeld, K. and **Sonnewald., M.** *Sparse Probes, Murky Physics: Interpretability Challenges in a Foundation Model for Continuum Dynamics*, **ICLR 2026** Workshop on Foundation Models for Science: Real-World Impact and Science-First Design. Available.
- [8] Griffies, S.M., ... **Sonnewald M...** *The GFDL-CM4X climate model hierarchy, Part I: model description and thermal properties*, 2025, **Journal of Advances in Modeling Earth Systems**.
- [9] Griffies, S.M., ... **Sonnewald M...** *The GFDL-CM4X climate model hierarchy, Part II: case studies*, 2025, **Journal of Advances in Modeling Earth Systems**.
- [10] Jenniges, Y.*, **Sonnewald, M.**, Maneth, S., Olsen, A. and Koch, B.P., *Unveiling 3D Ocean Biogeochemical Provinces in the North Atlantic: A Systematic Comparison and Validation of Clustering Methods*. 2025, **Ecological Informatics**.
- [11] Khatri, H., Griffies, S.M., Storer, B.A., Buzzicotti, M., Aluie, H., **Sonnewald, M.**, Dussin, R. and Shao, A., *A scale-dependent analysis of the barotropic vorticity budget in a global ocean simulation*. 2024, **Journal of Advances in Modeling Earth Systems**.
- [12] Yik, W.*, **Sonnewald, M.**, Clare, M.*, Lguensat, R. *Southern Ocean Dynamics Under Climate Change: New Knowledge Through Physics-Guided Machine Learning*. 2023, **Conference on Neural Information Processing Systems (NeurIPS) Climate Change AI workshop**.
- [13] **Sonnewald, M.**, Reeve, K., Lguensat, R. *A supergyre modulates the global overturning through upwelling in the Southern Ocean*. 2023, **Nature Commun. Earth and Environment**.
- [14] Jones, D., **Sonnewald, M.**, Rosso, I., Zhou, S., and Boehme, L., *Unsupervised classification identifies coherent thermohaline structures in the Weddell Gyre*. 2023, **Ocean Science**.
- [15] Clare, M.*, **Sonnewald, M.**, Lguensat, R., Deshayes, J. and Balaji, V., *Explainable Artificial Intelligence for Bayesian Neural Networks: Towards trustworthy predictions of ocean dynamics*. 2022, **Journal of Advances in Modeling Earth Systems**.
- [16] Kaiser, B., Saenz, J.A., **Sonnewald, M.** and Livescu, D., *Automated identification of dominant physical processes*, 2022, **Engineering Applications of Artificial Intelligence**.
- [17] J. Krasting, M. De Palma, J. Dunne, J. John, and **Sonnewald, M.**, *Regional Sensitivity Patterns of Arctic Ocean Acidification Revealed With Machine Learning*, 2022, **Nature Commun. Earth and Environment**.
- [18] **Sonnewald, M.**, and Lguensat, R. *Revealing the impact of global warming on climate modes using transparent machine learning*, 2021, **Journal of Advances in Modeling Earth Systems**.
- [19] **Sonnewald, M.**, and Lguensat, R., Radhakrishnan, A., Sayibou, Z.*, Wittenberg, A.T. and Balaji, V. *Revealing the impact of global heating on North Atlantic circulation using transparent machine learning*, 2021, **International Conference on Machine Learning: Spotlight paper at ClimateChangeAI Workshop**.
- [20] **Sonnewald, M.**, Dutkiewicz, S., Hill, C. and Forget, G. *Elucidating Ecological Complexity: Unsupervised Learning determines global marine eco-provinces*, 2020, **Science Advances**.
- [21] Le Bras, I., **Sonnewald, M.**, and Toole, J.M. *A bulk Potential Vorticity budget for the western North Atlantic based on observations*, 2019, **Journal of Physical Oceanography**.
- [22] **Sonnewald, M.**, Wunsch, C. and Heimbach, P. *Unsupervised Learning Reveals Geography of Global Ocean Dynamical Regions*, 2019, **Journal of Earth and Space Science** edition "Geoscience paper of the future".
- [23] **Sonnewald, M.**, Wunsch, C. and Heimbach, P. *Linear Predictability: A Sea Surface Height Case Study*, 2018, **Journal of Climate**.

- [24] Bulczak, A.I., Bacon, S., Naveira Garabato, A.C., Ridout, A., **Sonnewald, M.**, and Laxon, S.W. *Seasonal Variability of Sea Surface Height in the Coastal Waters and Deep Basins of the Nordic Seas*, 2014, **Geophysical Research Letters**.
- [25] **Sonnewald, M.**, Hirschi, J.J.-M., Marsh, R., McDonagh, E.L. and King, B.A. *Atlantic meridional ocean heat transport at 26N: impact on subtropical ocean heat content variability*, 2013, **Ocean Science**.

Preprints and in review (total: 8, ‘*’ indicates student/postdoc advised)

- [26] Rosenfeld K., **Sonnewald M.** et al., *Building Understandable Messaging for Policy and Evidence Review (BUMPER) with AI*. In review. Preprint.
- [27] Kaiser, B., Wu, T., **Sonnewald, M.**, Thackray, C., Callis, T. *A Moonshot for AI Oracles in the Sciences*. Erkenntnis. In review. Preprint.
- [28] Dräger S.*, **Sonnewald M.** *The Importance of Architecture Choice in Deep Learning for Climate Applications*. Preprint..
- [29] Navarra, G.G.*, Deutsch, C., Clare, M.*, **Sonnewald, M.** *Predicting Southern Ocean Dissolved Oxygen: Bayesian vs. Deterministic Approach to Forecasting*. **ML: Earth**. In review.
- [30] Wang, J.*, **Sonnewald, M.**, Pirlet, N., Massonnet, F., Goose, H., Chen, D., Yang, Q, *Identification of Antarctic sea ice regimes using objective data mining*, **Science Advances**. In review.
- [31] Suri, S.*, and **Sonnewald, M.** *Machine Learning at the Tipping Point: Validation of Physical Dependencies in Atlantic Circulation*, **Journal of Geophysical Research - Machine Learning and Computation**. In review.
- [32] McDevitt, M.*, **Sonnewald, M.**, and Dutkiewicz, S., *Inferring planktonic ecosystems from space: Lessons gained from AI*, **Nature Communications Earth & Environment**. In review.
- [33] Dutta, A.*, **Sonnewald., M.**, Geen, R., *Unlocking an atmospheric model hierarchy with interpretable machine learning*, **Science Advances**. In review.

Selected invited talks (97 total, policy-facing venues highlighted)

Policy-facing	US CLIVAR (UN World Climate Research Program), NOAA Senior Management , DOE workshop keynote, California Ocean Science Trust , AMS Washington Forum , United Nations International Telecommunication Union
Plenary	SIAM Conference on Mathematics of Planet Earth (upcoming July)
2024-2026	AMS Annual Meeting, UC San Diego, Technical University Munich (Ger.), ELLIS Summer School keynote (Ger.)
2023	University of Toronto Nobel Seminar, University of Miami, UC Davis, Sorbonne University
2022	MIT (EAPS & Mech. Eng.), UC Berkeley, Max Planck Institute (Hamburg), Cambridge University
2021	AGU, Climate Change AI, KITP, UC Santa Cruz, GEOMAR Helmholtz

Teaching and advising

Postdoc advising, 3 at present

2026–present	Lauren Hoffman, with UC Santa Cruz.
2025–present	Sanah Suri, UC Davis
2025–present	Laique Merlin Djuetchang, UC Davis.
2023–present	Arijeet Dutta, with U. Birmingham.

Graduate advising, 5 at present, 7 graduated.

2025–present	Kieran Ringel, UC Davis
2025–present	Lumina Kinsinger-Dang, UC Davis
2025–present	Jake Tallman, UC Davis
2024–present	Makayla McDevitt, UC Davis
2023–present	Lily Walker, Okinawa Institute for Science and Technology (JP)
2021–present	Yvonne Jenniges, Alfred Wegener Institute (DE)
2023–2025	Jinfei Wang, Université Catholique de Louvain (BE) Subsequently postdoc at Université Catholique de Louvain (BE).
2024–2025	Avery Wood, UC Davis. M.Sci.
2024–2025	Sanah Suri, Washington University in St. Louis Subsequently postdoc at UC Davis.
2023	Simon Draeger, UC Davis
2021	Mariana Clare, Imperial College London, National Centre for Scientific Research (CNRS, Fr), Subsequently researcher at European Center for Medium-Range Weather Forecasting.
2021–2022	Giangiaco Navarra, Georgia Tech Subsequently postdoc at Princeton.
2021–2025	Jacob Cohen, University of Washington

Instructor of record since 2020

2024-2026	UC Davis ECS171: “Introduction to ML”, undergraduate. <i>Participants: 150, developed material, taught.</i>
2023-2025	UC Davis ECS199/299: “Special Study for Advanced Students”, u/graduate.
2023	European Centre for Medium-Range Weather Forecasts (ECMWF) Massive Open Online Course: “ML in Weather and Climate”. Registered: over 9000, developed material, taught.
2021	Princeton University AOS 551: “Deep learning in geophysical fluid dynamics”, graduate. Participants: 10, developed material, taught.

Service

Selected program committee, conference, workshop, and seminar organization since 2020

Program Chair	Climate Informatics (2026)
Convening	Ocean Science Meeting (2026, 2024), American Geophysical Union (2024, 2023, 2022, 2020 (2), 2019), European Geosciences Union (2023, 2022, 2021, 2020).
Program Committee	Climate Informatics (2026), Platform for Advanced Scientific Computing (2024), NeurIPS Climate Change AI workshop (2021).
2024-2025	Research colloquia UC Davis CAMPOS .
2021	Research colloquia NOAA GFDL seminar series .
2020	Workshop NOAA on Leveraging AI in Environmental Sciences

Selected public engagement

2024	The Guardian: Interviewed for “Atmospheric river storms are getting stronger”.
2024	Exploratorium museum San Francisco: “Open Question: Extreme Environments” talk series.
2023	Podcast: AGU “Third pod from the sun” - “Solving for climate: Coasts in the machine”.