Maike Sonnewald, Ph.D.

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Current position

2/2020–present	**Princeton University, NJ**, Associate Research Scholar
2/2020–present	**NOAA Geophysical Fluid Dynamics Laboratory (GFDL), NJ**, Research Affiliate
1/2022–present	**University of Washington, WA**, Affiliate Assistant Professor

Education

2011-2016	**University of Southampton**, UK. Ph.D. Complex Systems Simulation through the National Oceanography Center 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. *magna cum laude*, complex systems simulation, 2011 M. Sci. *magna cum laude*, physical oceanography, 2010

Academic positions

2/2019–1/2022	**University of Washington**, School of Oceanography, Visiting Scientist. Collaborator: L. Thompson
10/2015–2/2020	**Massachusetts Institute of Technology (MIT)**, Earth, Atmosphere and Planetary Sciences, Postdoctoral Associate. Collaborator: C. Wunsch, P. Heimback & S. Dutkiewicz
2/2017–10/2019	**Harvard University**, Earth and Planetary Science, Visiting Scientist. Collaborator: C. Wunsch
12/2018–1/2019	**Grenoble Les Alpes**, Lab. des Ecoul. Geophysiques et Industriels (Fr), Visiting Scientist. Collaborator: T. Penduff & N. Le Bihan
10/2018–10/2017 & 10/2016–2/2017	**University of Texas at Austin**, Inst. for Computational Engineering and Sciences, Visiting Scientist. Collaborator: P. Heimbach

Review articles (total: 2)

[1] **Sonnewald, M.**, Brajard, J., Duben, P., Lguensat, R. and Balaji, V., *Bridging theory, simulation, and observations of the global ocean using Machine Learning*, 2021, **Environmental Research Letters**.

[2] Irrgang, C., Boers, N., **Sonnewald, M.**, Elizabeth A. Barnes, Christopher Kadow, Staneva, J., and Saynisch-Wagner, J. *Towards neural Earth system modelling by integrating artificial intelligence in Earth system science*, 2021, Nature Machine Intelligence. DOI: 10.1038/s42256-021-00374-3 `https://arxiv.org/abs/2101.09126`. Featured on: Carbonbrief, Helmholtz Association of German Research Centers press release, Physics.org, enggtalks and Newsbreak.

Peer reviewed publications (total: 8, 4 in review/revision)[1]

[3] **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**. Available: `https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021MS002496`. Featured on cover, and separately in the "Machine Learning Application to Earth System Modeling" edition.

[4] **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**. Available: `https://www.climatechange.ai/papers/icml2021/13`

[1] Manuscripts in preparation and in revision available at co-authors' discretion.

[5] **Sonnewald, M.**, Dutkiewicz, S., Hill, C. and Forget, G. *Elucidating Ecological Complexity: Unsupervised Learning determines global marine eco-provinces*, 2020, **Science Advances**. DOI: 10.1126/sciadv.aay4740. Featured on: EOS science news by AGU, MIT News, Hakai Magazine, ECCO story map, The Batch, SciTechDaily, Yahoo! Finance, Dailyhunt, Firstpost and Scienceblog.

[6] 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**. DOI: 10.1175/JPO-D-19-0111.1.

[7] **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". 6. `https://doi.org/10.1029/2018EA000519`. Featured on: MIT News, Artificial Intelligence Research, Physics.org and ECN magazine.

[8] **Sonnewald, M.**, C. Wunsch, and P. Heimbach, *Linear Predictability: A Sea Surface Height Case Study*, 2018, **Journal of Climate**, 31, 2599–2611, `DOI.org/10.1175/JCLI-D-17-0142.1`

[9] 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**, 42, `DOI:10.1002/2014GL061796`.

[10] **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**, 9, (6), 1057-1069. `DOI:10.5194/os-9-1057-2013`.

[11] In review: J. Krasting, M. De Palma, J. Dunne, J. John, and **Sonnewald, M.** *Regional Sensitivity Patterns of Arctic Ocean Acidification Revealed With Machine Learning.* Major revisions, **Nature Communications Earth & Environment**.

[12] In review: Kaiser, B., Saenz, J.A., **Sonnewald, M.** and Livescu, D., *Objective discovery of dominant dynamical processes with machine learning.* In review **Nature**.

[13] Submitted: **Sonnewald, M.**, Lguensat, R., A. Adcroft, V. Balaji and A. Radhakrishna *A supergyre modulates the global overturning throug upwelling in the Southern Ocean.* Submitted, **Geophysical Research Letters**.

[14] In revision: **Sonnewald, M.**, Hirschi, J.J.-M., Nurser, A.G., Firing, Y., Coward, A. and Hyder, P. *Increasing ocean model resolution reveals impact of tuning eddy permitting models.* In revision. **Journal of Advances in Modeling Earth Systems**.

[15] In revision: Bingham, R. and **Sonnewald, M.** *Stable Atlantic overturning circulation revealed by a dynamically-proximate reconstruction.* In revision, **Geophysical Research Letters**.

[-] Upcoming: **Sonnewald, M.**, Lguensat, R., A. Adcroft, V. Balaji and A. Radhakrishna *How Southern Ocean wind gyre circulation buffers global heating in climate models.* In preparation.

[-] Upcoming: **Sonnewald, M.**, Sayibou, Z., Wittenberg, A.T., Lguensat, R., A. Adcroft, V. Balaji and A. Radhakrishna *Tracking the equatorial undercurrent to understand the El Niño Southern Oscillation mean state in climate models.* In preparation.

[-] Upcoming: Jones, D., **Sonnewald, M.**, Rosso, I., Zhou, S., and Boehme, L., *Unsupervised classification identifies coherent thermohaline structures in the Weddell Gyre.* In preparation.

Other publications (total: 3)

[16] **The ECCO Consortium**. *A Twenty-Year Dynamical Oceanic Climatology: 1994-2013. Part 1: Active Scalar Fields: Temperature, Salinity, Dynamic Topography, Mixed-Layer Depth, Bottom Pressure*, 2017, **MIT DSpace**: `https://dspace.mit.edu/handle/1721.1/107613`.

[17] **The ECCO Consortium**. *A Twenty-Year Dynamical Oceanic Climatology: 1994-2013. Part 2: Velocities and Property Transports*, 2017, **MIT DSpace**: `https://dspace.mit.edu/handle/1721.1/109847`.

[18] Gille, S., Abernathey, A., Chereskin, T., Cornuelle, B., Heimbach, P., Mazloff, M., Menemenlis, D., Rocha, C., Soares, S., **Maike Sonnewald**, Villas Boas, B., and Wang, J. *Open Code Policy for NASA Space Science: A perspective from NASA-supported ocean modeling and ocean data analysis*, 2018, **NASA White Paper**, Available: `https://tinyurl.com/`

`NASA-WhitePaper`

[-]Upcoming: Abernathy, R., ... **Sonnewald, M.**, et al., *OpenOceanCloud*. **UN Ocean Decade White Paper**.

Selected awards and honours

Pending	**Principal Investigator**: *Revealing trophic dynamic provinces in the sea: using unsupervised machine learning to map energy and material fluxes from nutrients to fisheries production.* To NOAA Climate Program Office to fund a postdoctoral associate. $426,301.
2021	**University of California, Santa Barbara, Kavli Institute for Theoretical Physics (KITP)**. Core member. "Machine Learning and the Physics of Climate" activity.
2021	Work featured on cover of JAMES.
2021	**Paper received spotlight at ICML.**
2021	French National Centre for Scientific Research (CNRS) laboratory collaboration grant for Ph.D. student Mariana Clare. £2000.
2021	**NOAA AI strategy 2021-2025**, work featured.
2020-2021	Co-Investigator/Proposal in progress, ASDI. $31,032.
2020	Collaborator/Amazon Sustainability Data Initiative (ASDI). $48,595
2020	Work contributed to science basis for New Zealand's Marine Protected Area legislation.
2019	Simons foundation visualization competition winner.
2018-2020	Visiting Scientist Grant, Data Institute Univ Grenoble Alpes. €1700.
2017	**Award from the Kaufman Teaching Certificate Program (KTCP)**, MIT.
2016	Physical Oceanography Dissertation Symposium grant, University of Hawaii at Manoa, USA. $1500.
2014	Awarded grant to lead NOCS Software Carpentry workshop for Ph.D. students.
2010	Graduate Scholarship. Full tuition and stipend, Engineering and Physical Sciences Research Council (ESPRC, UK).

Invited conference panels

2021	**Incorporating Data Science and Open Science in Aquatic Research Summit**. Virtual, 624 participants.
2020	**AGU**, *Challenges and opportunities of applying AI, ML and DL to problems in the environmental and geosciences.* Virtual, ∼1200+ participants.
2020	**NOAA Workshop**, *Leveraging AI in the Environmental Sciences.* Virtual, 60+ participants.

Selected invited talks (total: 50)

2022-	Upcoming to date: 5
Others	**SIAM** (Mar.), **University of Cambridge** (Mar.), **Max Planck Institute for Meteorology** (Jan.), **Sorbonne University** (Aug.), **University of Wisconsin-Madison** (Feb.).
2021	Talks total: 14
-	**AGU**, Revealing the impact of climate change on North Atlantic circulation using transparent machine learning.
-	**Dept of Energy** workshop, Ocean Grand Challenges: Using AI/ML to push the frontiers.
-	**Climate Change AI**, A robust blueprint for trustworthy AI for climate analysis.
-	**NOAA**, workshop, Revealing the impact of global warming on climate modes using transparent machine learning and a suite of climate models. Virtual.
Others	**KITP**, **Scripps Institute of Oceanography**, **University of Washington**, **University of Chicago**, **International Conference on Machine Learning**, **Summit: Incorporating Data Science and Open Science in Aquatic Research**, **University Corporation for Atmospheric Research (UCAR)**, **University of California, Santa Cruz**, **GEOMAR Helmholtz Centre for Ocean Research**, **Technical University of Munich**, **Potsdam Institute for Climate Impact**.
2020	Talks total: 7
-	**NOAA Senior Management Meeting, Oceanic and Atmospheric Research**. Building geographies of ocean dynamical regimes.
Others	**Los Alamos National Laboratory**, **University of Washington** (engineering), **University of Washington** (physical oceanography), **University of British Columbia**, **NOAA**, workshop, **University of Washington** (biochemical oceanography).

2019	Talks total: 7
-	**AGU**, *The case for machine learning in geoscience.* San Francisco, USA.
-	**Norway-US bilateral AI workshop**, *Elucidating Ecological Complexity.* Austin, USA.
Others	**Princeton University**, **Norway-US bilateral AI workshop** (on dynamical regimes), **WHOI**, **University of Tromsø**, **University of Bergen**.
2018-2012	Total talks: 17
-	**WHOI**, *Unsupervised learning classifies global ocean dynamical regions.*
-	**Columbia University, Lamont-Doherty Earth Observatory**, *Linear predictability: A sea surface height case study.*
-	**Yale University**, *Ocean model utility dependence on horizontal resolution.*
Others	**MIT** (2018 & 2015), **Stony Brook University**, **University of Texas at Austin**, **University of Washington**, **Oregon State University**, **University of Oxford**, **MIT** (Two invited student talks), **University of Bristol**, **NOCS** (2015, 2014 & 2013) and **MONCACO meeting**.

Selected conference contributions (12 posters and 23 talks) [2]

2021	Contributions total: 4
-	**AGU**, Elucidating ecological complexity: Unsupervised learning determines global marine eco-provinces. **Talk**.
-	**EGU**, *Revealing mechanisms of change in the Atlantic Meridional Overturning Circulation under global heating.* **Highlighted vPICO**.
Others	**Ocean Science**, **ICML** and **Knowledge Guided Machine Learning (KGML)**.
2020	Contributions total: 3
	Climate Informatics, *Elucidating Ecological Complexity: Unsupervised Learning determines global marine eco-provinces.* Oxford/virtual. **Talk**.
Others	**Climate Informatics** and **AGU**.
2011-2019	Contributions total: 27
-	**EGU**, *Unsupervised Learning Reveals Geography of Global Ocean Dynamical Regions.* **Talk**.
-	**AGU**, *Unsupervised Learning Reveals Geography of Global Ocean Dynamical Regions.* **Poster**
-	**World Climate Research Programme (WCRP), Intergovernmental Oceanographic Commission of UNESCO (IOC) Sea Level**, *Linear predictability: A sea surface height case study.* **Poster.**
-	**International Association for the Physical Sciences of the Oceans (IAPSO)**, *Atlantic ocean meridional heat transport at 26N:Impact on subtropical ocean heat content variability.* Gothenburg, Sweden. **Talk, grant recipient**.
Others	**European Geosciences Union (EGU)** (2019, 2017, 2015x2, 2012x2), **AGU**, **ECCO meeting**(2018, 2017x2), **Ocean Science Meeting** (2016, 2018), **Society of Engineering Science**, **Physical Oceanography Dissertation Symposium (PODS)**, **SIAM** (2015, 2014), **Student Conference on Complex Systems (SCCS)** (2014, 2013, 2012, 2011), **Graduate Climate Conference**, **ICSS**, **Ocean Modeling Group** and **Challenger Conference**.

Mentoring and advising[3]

Upcoming	**Advising:** Lapenta Internship (NOAA). Student selection pending.
2021	**Advising:** Giangiacomo Navarra, Georgia Tech. Ph.D. student.
2021-	**Committee member:** Jacob Cohen, University of Washington. Ph.D. student.
2021	**Advising:** Mariana Clare, Imperial College London, French National Centre for Scientific Research (CNRS) internship program, Ph.D. student.
2021-	**Committee member:** Yvonne Jenniges, Alfred Wegener Institute (DE), Ph.D. student.
2021	**Advising:** Zouberou Sayibou, Bronx Community College, undergraduate. CIMES internship program.
2019-	**Mentoring:** Catherine Wilka, now postdoc at Stanford.

[2] Only first author presentations
[3] Only formal mentoring and advising listed

Teaching experience

2021	**Lecture:** Princeton University: "Deep learning in geophysical fluid dynamics", graduate level. *Participants 10, developed material, taught.*
2021	**Tutorial/workshop:** Society for Industrial and Applied Mathematics (SIAM): Conference on Mathematical and Computational Issues in the Geosciences. Milan, Italy, graduate and undergraduate level. *Participants 60, developed material, taught.*
2020	**Lecture:** Oceanhackweek 2020, *class size 20, developed material, taught.*
2020	**Lecture:** GFDL Holling, CIMES and Lapenta interns, undergraduate level: "Machine learning for the goesciences", undergraduate and graduate level. *Class size 6, developed material, taught.*
2019	**Lecture:** Harvard University EPS: "Machine Learning in Geoscience", graduate level. *Class size 10, developed material, taught*
2019	**Lecture:** Harvard University Data Science Club: "The good, the bad and the ugly of applied unsupervised learning", graduate and undergraduate level. *class size 60, developed material, taught.*
2019	**Tutorial/workshop (3 day course)**, Princeton University & GFDL workshop for graduate students: "Machine learning and climate modeling", graduate level. *Class size 20-30, developed material, taught*
2016	**Lecture:** University of Texas at Austin: "Vertical Mixing Schemes: Why we need them & what they do", graduate level. *Class size 5, developed material, taught.*
2014	**Tutorial/workshop:** Student Conference on Complex Sysytems (SCCS), "Finite differences methods". *Class size 40+, developed material, taught.*
2014	**Tutorial/workshop:** SCCS "Importance of model validation". *Class size 40+, developed material, taught.*
2013	**Teaching Assistant**: NOCS, "Physical Oceanography II", undergraduate level. *Class size 50, held lab sessions.*
2012	**Teaching Assistant**: NOCS, "MSc Fieldwork Boat Week", undergraduate level. *Class size weather dependent (5-9), instrument deployment (CTD, secchi disk and acoustic Doppler current profiler) on the Research Vessel Callista).*
2012	**Teaching Assistant**: NOCS, "Physical Oceanography I", undergraduate level. *Class size 50, held lab sessions.*

Service

Review duties

Journals	**Nature, Journal of Advances in Modeling Earth Systems, Geophysical Research Letters, Ocean Modelling, Journal of Geophysical Research, Journal of Physical Oceanography, Data Science, Frontiers in Marine Science**.
Review Panel	**NASA review panel 2017**

Conference, workshop and seminar organization

2022	**EGU**, *Machine learning for Earth system modelling*
2021	**Conference on Neural Information Processing Systems (NeurIPS**, *Climate Change AI's workshop on "Tackling Climate Change with Machine Learning*, Program Committee.
2021	**EGU**, *ITS4.4/AS4.1: Machine learning for Earth system modelling.*
2020	**AGU**, *OS014: Innovation and exploration in observed and model oceanographic data using interpretable machine learning*, oral and poster, **head-convener.**
2020	**AGU**, *A084: Machine Learning for Weather and Climate Modeling*, oral and poster, **co-convener.**
2020	**The 2nd NOAA Workshop on Leveraging AI in Environmental Sciences** "Exploiting Space- and Ground-Based Observations and EnhancingEarth System Prediction". **Session chair**.
2020	**EGU**, *ITS4.3/AS5.2: Machine learning for Earth System modelling*, oral and poster, **co-convener.**
2019	**OceanObs'19**, breakout session, *Open Source Software Revolution*, **co-convener**.
2019	**AGU**, *GC33C - Innovation and Exploration of Observations and Earth System Models Using Machine Learning and Big Data Analysis*, oral and poster,**head convener.**
2015–2016	**MIT Sack Lunch**, seminar, **organizing member.**
2014	**SCCS**, conference, **web-design, organizing member.**
2014	**SCCS**, conference, Earth System Complexity session, **head-convener**.

2014	**SCCS**, workshop on "The importance of model validation", **organized with Martin Wood**.
2014	**SCCS**, Workshop on "Finite differences methods"**organized with Martin Wood**.
2014	**NOCS Software Carpentry**, workshop, **single organizer**.
2014	**Polar Network Workshop: Science and Society**, workshop, **organizing member**.
2014–2015	**POETS Corner**, seminars **organizing member**.
2013-2015	**Dynamical discussions series**, seminars, **organizing member.**
2012–2013	**Complex earth system modelling and physical Understanding**, seminars, **organizer**.
2012	**SCCS**, conference, **ICSS representative**.
2012	**SCCS**, conference, **ICSS representative**.
2011–2013	**Rhubarb series**, seminars **organizing member**.
2011	**SCCS**, conference, **organizing member**.
2011	**SCCS**, conference, Physical Systems Chair, **convener**.

Diversity, equity and inclusion activities

2021-present	*POD member*, **Unlearning racism in Geoscience (URGE)**. Program to develop anti-racist policies and strategies at Princeton University, POD member.
2021	*Advising:* CIMES internship.
2020	*Speaker at*, **Bronx Community College**, NYC, USA. Effort by the Bronx Community College STEM Advisory Board to encourage students to consider STEM careers.
2017	*Leader*, **Massachusetts Institute of Technology Outing Club**. Organization aimed at enabling students and MIT associates of varied cultural and financial backgrounds to access the outdoors by providing leadership expertise and access to gear (such as skies).

Selected public engagement and outreach

2020	*Taught "Climate change 101"*, **Virtual "Summer Climate Camp" by SynergyEd**. Class size 10, ages 11-13 years, developed material, taught.
2019	*Helper: Nautical day at the MIT museum*, **MIT Museum**, USA.
2018	*Attendee*, **US Software Sustainability Institute NSF workshop**, Berkeley, USA.
2016	*Copezilla team*, **Red Bull Flugtag**, Boston, USA. **MIT outreach activity**.
2013	*Speaker: Ocean Model fidelity and resolution*, **ICSS Open Day**, Southampton, UK.
2012	*Speaker: Impact of resolution in ocean models*, **ICSS Industrial and International Advisory Board meeting**, Southampton, UK. **Invited talk.**
2012	*Speaker: Ocean Model fidelity and resolution*, **ICSS Open Day**, Southampton, UK.
2009	*Information tent scientist helper for "Climate Change"*, **United Nations Climate Change Conference (COP 15)**, Copenhagen, Denmark.