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Research Interests: My research focuses on the role of the ocean in climate on local and global scales, through the analysis of observations and a hierarchy of simulations. My main interests lie in ocean physics and climate dynamics; predictability and prediction; uncertainty quantification; (stochastic) closures for ocean turbulence. In the past year, I have led projects on the physics of extreme surface temperatures and storm surges, estimates of global and regional ocean warming and sea level rise since the industrial revolution, machine learning for both data inference and turbulence parametrization in climate models, ocean ensemble simulations for probabilistic seasonal to decadal forecasts.

Education

- 06/2009 PhD, **Harvard University**, Earth & Planetary Sciences. Adviser: Eli Tziperman.
Title: Optimal Excitation of Atlantic ocean circulation and implications for predictability.
- 06/2009 MA by special resolution, **University of Oxford**.
- 09/2003 MSc, **Weizmann Institute of Science**, Environmental Sciences.
- 09/2001 BSc, **Tel Aviv University**, Geophysics, Atmospheric & Planetary Sciences. *Magna Cum Laude*.

Professional Appointments

- 09/2019- Associate Professor (tenured), **New York University, Courant Institute**, USA.
Affiliated Faculty, **Center for Data Science**.
- 09/2019- Visiting Professor, **University of Oxford**, Dept of Physics, UK.
- 10/2011-09/2018 Associate Professor, **University of Oxford**, Dept of Physics, UK (tenured 07/2016).
 - 2018-2019 **David Richards' Fellow**, Wadham College.
 - 2011-2018 Fellow, St Cross College.
 - 2014-2017 Lecturer in Physics, Christ Church College.
- 2017-2018 Visiting Faculty, **Princeton University, AOS and GFDL**, USA.
- 2009-2011 James Martin Research Fellow, **Oxford Martin School** & Dept of Physics, Atmospheric, Oceanic & Planetary Physics, **University of Oxford**, UK.
- 2009-2011 Junior Research Fellow, **Balliol College**, UK.

Awards and Fellowships

- 2020 **Nicholas P. Fofonoff Award**, American Meteorological Society. Citation: "*For exceptional creativity in the development and application of new concepts in ocean and climate dynamics.*"
- 2019 **Sigma Xi** Scientific Research Honor Society.
- 2017-2018 **Visiting Research Scientist Fellowship**, Princeton University, AOS and GFDL.
- 2009-2012 **James Martin Fellowship**, Oxford Martin School.
- 2009-2012 **Junior Research Fellowship**, Balliol College.
- 2008: **Outstanding Student Paper Award**, American Geophysical Union, Fall Meeting (AGU).
- 2005, 2006, 2007 **Bertram J. Cohn Fellowship for Environmental Studies**, Harvard University.
- 2006 **Young Scientist Outstanding Paper Award**, European Geosciences Union, General Assembly.
- 2005-2008 3 **Certificates of Distinction in Undergraduate Teaching**, Harvard University.
- 2001 **Magna Cum Laude**, Tel Aviv University.

Academic Service

External

- 11/2019- Editor, Journal of Climate, **American Meteorological Society**.
- 2018- Committee Member, Lorenz Lecture Award, **American Geophysical Union**, Nonlinear Geophysics.
- 2017- Schmidt Fellowship Panel Member, **Schmidt Futures**, Earth Sciences.
- 2018 Panel Member, **National Academies of Sciences, Engineering, and Medicine**, Gulf Research Program.
- 2014-2018 International Scientific Council Member, **European Institute for Marine Studies (IUEM)**, Brest.
- 2013- Examiner for 2 external (**Southampton University, Columbia University**) & 3 internal (**Oxford**) PhD/DPhil, and 1 MRes/MSc defences.
- 2016 Member of Scoping group on the Role of Southern Ocean in the Earth System, **Natural Environment Research Council (NERC)**.
- 2011-2016 Peer Review College Member (Reviewer and Panel Member), **NERC**.
- 2015-2016 Expert Panel Member, **Belmont Forum & Joint Programming Initiative**. Connecting Climate Knowledge for Europe, Climate predictability & inter-regional linkages.
- 2017 Organizer, **Banff International Research Station**, Workshop on Transport in Unsteady Flow.
- 2012- Session organizer: **AGU Ocean Sciences 2020**, *Ocean Transport and Eddy Energy and Machine Learning for Ocean Sciences*; **AGU Fall Meeting 2019**, *Machine Learning for Climate Modelling*; **American Physical Society - GPC 2018**, *Multi-Scale Flows & Pathways in the Climate System*; **AGU Ocean Sciences 2014**, *North Atlantic ocean dynamics: from natural fluctuations to externally forced response*; **AGU Ocean Sciences 2012**, *Oceanic Uptake of heat and greenhouse gases: dynamic and thermodynamic controls and inferences from tracers*.
- 2006- **Reviewer, Proposals**: National Academies, NSF, NOAA, NERC, ISF, Irish Research Council, KAUST/CRG. *Articles*: J. of Climate, J. Phys. Ocean., Nature, Science, GRL, JAMES, Clim. Dyn., Ocean Modelling, J. of Phys. A, ERL, Q. J. Roy. Met. Soc., Phil. Trans. of the Royal Society. *Books*: SIAM, Cambridge University Press.

Service within Oxford

- 2015- Assessor, Flows, Fluctuations & Complexity (2016-), Invigilator, Physics of the Oceans & Atmospheres (2015-2016).
- 2011- Internal Examiner for 18 students (2011-19), Personnel Committee (2012-18), Parking Committee (2017-18), Dept of Physics.
- 2018- Governing body; Academic Committee; Nominating Committee, Wadham College.
- 2016-2017 NERC Demand Management Decision Panel, MPLS.
- 2011- 2018 Governing body (2011-2018); Fellowship Committee (2014- 2017), St Cross College.
- 2010- 2016 Organizer, Atmospheric, Oceanic and Planetary Seminar Series (2011-2019), Dept of Physics; Organizer, Physical Oceanography & Climate Meetings (2010-2011), Dept of Physics and Earth Sciences.
- 2009-2011 Governing body(2009-2011); Executive Committee (2010-2011), Balliol College.

Funding

- 2019-2022 **NOAA CVP + NSF PO**, lead PI. Climate Process Team: Ocean Transport and Eddy Energy: total: \$3M (9 universities, 3 modelling centres) with \$782K to NYU.
- 2020-2021 **Simons Foundation**, Symposium on Multi-scale Physics: Theoretical Astrophysics to Climate Science.
- 2017-2019 **Royal Society, International Exchanges Scheme**, PI. Quantifying the Variability of Tracer Transport across the Gulf Stream. £11,830.00.
- 2017-2022 **NERC Large Grant**, PI. Transient tracer-based Investigation of Circulation and Thermal Ocean Change (TICTOC), £3,342,981.

- 2017-2020 **NERC**, Co-PI. Addressing the Grand Challenge of regional sea level change prediction (UKFAFMIP), £584,852.
- 2014-2019 **NERC Directed**, Co-I. Summer: Testing Influences and Mechanisms for Europe, £764,189.
- 2014-2017 **NERC**, PI. Modelling the Ocean Circulation with Random Numbers, £301,109.
- 2012-2016 **NERC Directed**, Co-PI. Representing uncertainty in ocean observations and ocean model, for coupled ensemble data assimilation & ensemble extended-range prediction, £378,722.
- 2013-2017 **NOAA Earth System Science Program**, Co-PI. Variability, stochastic dynamics, and compensating model errors of the Atlantic Meridional Ocean Circulation in coupled IPCC models, \$287,032.
- 2011-2014 **John Fell Fund**, PI. Dynamical Impacts of Unresolved Ocean Processes in Climate Models: Lessons from Stochastic Physics, £98,538.
- 2015-2016s **Met Office- Oxford Academic Partnership**, Undergraduate Research Experience Placement. PI, 2016: two proposals funded; 2015: one proposal funded, each for £2,000.

Mentoring & Teaching

Supervision (+ = co-advised with)

DPhil (=PhD) Students:

Apr 2018- Matthias Aengenheyster (+ J. Gregory)

Apr 2016- Thomas Bolton (won best prize for 2nd yr PhD research report, and best retreat talk 2018)

2013-2018 Robert Fraser, now Data Scientist; 2013-2017: Tomos David (+ D. Marshall), now postdoc at Oxford; 2011-2015: Ben Bronselaer, now postdoc at Princeton/GFDL.

Postdoctoral Scholars:

2019- Emily Newsom

2018- Mike Byrne (Marie Curie Fellow)

2018- Alex Todd

2015- 2019 Chris O'Reilly (+ T. Woollings), now postdoc at Oxford; 2016- 2017: Joakim Kjellsson, now researcher at Univ. of Kiel; 2015-2017: Stephan Juricke (+ T. Palmer), now researcher at Bremen Univ.; 2015-2016: Markus Huber (funded by a S-NSF fellowship); 2014-2015: James Anstey, now permanent researcher at CCCma; 2012-2015: Fenwick Cooper (+ T. Palmer), now postdoc at Oxford; 2011-2013: Mirek Andrejczuk (+ T. Palmer), now permanent researcher at UK-Met Office; 2011-2013: Luca Porta Mana, now researcher at the Kavli Institute.

MPhys Students (= senior thesis): (*=won a prize for best project in *Atmospheric, Oceanic and Planetary Physics*). 2016-2017: Jonny Ison, Kirill Mikhaylov. 2014-2015: Thomas Bolton*. 2013-2014: Andrew Bailey*; Michael Walker*. 2013: Tomos David. 2012: Shaomin Cai. 2011: Brodie Pearson.

Summer Students: Alex Gyoffry, Arnaud de Larturieri, Benjamin Huddart, Twm Jonathan, Andrey Orkney.

College Graduate Supervision (St Cross, Christ Church, Wadham): I act or acted as College supervisor for about 15 students in Physics, Earth Sciences, Engineering, Materials, Genomic Medicine & Statistics, Musculoskeletal Sciences, Physiology, Anatomy & Genetics, Organic Chemistry, Life Sciences, Healthcare Innovation, Bioscience.

Teaching Activities

Expected 2019-2020 *Lecturer*, **Courant Institute, NYU**; Atmosphere and Ocean dynamics (undergrad), Machine Learning in Atmosphere-Ocean Science (grad).

2010-present: *Lecturer and College Tutor*, **University of Oxford**

2013-present *Lecturer*, Physics of the Oceans & Atmospheres (undergrad).

2014-present *Lecturer*, Climate Dynamics and Variability (grad).

2016-present *Lecturer*, Advanced Math and Numerical Methods (grad).

2010-present *College Tutor* (undergrad): Mechanics & Special Relativity, Circuit Theory & Electromagnetism, Flows, Fluctuations & Complexity (Nonlinear Dynamics, Chaos, Stochastic Processes, Biophysics).

2009 *Invited Lecturer*.

Joint UW-MIT-Bjerknes Advanced Climate Dynamics Course, Bergen, Norway.

MIT Course on Adjoint methods: from large scale optimization to climate modeling.

2004-2008 *Teaching Fellow*, **Harvard University**: Climate & Physical Oceanography (undergrad/grad); The Atmosphere (undergrad); Ordinary and Partial Differential Equations (undergrad/grad); Nonlinear Dynamical Systems (undergrad/grad).

1999-2002 *Special Educator, Teacher and Tutor*, **Balfour High School**, Mathematics.

2015, 2016 *Organizer and Speaker*, **University of Oxford**, Atmospheric Physics Research Experience Day for NERC Doctoral Training Program incoming graduate students.

Presentations (as first author only)

Invited Departmental Seminars (55 since 2009):

2019: Univ of Reading (Met Dept); University of Southampton; IGE Grenoble.

2018: Caltech; Flatiron Institute/Simons Foundation; UW; NYU/Courant (APM); Harvard; U. Chicago; UCSD/Scripps; NCAR.

2017: Lamont Doherty Earth Observatory - LDEO (colloquium); GFDL; Columbia University/LDEO (Ocean and Climate); NYU/Courant (CAOS); George Mason University; U. of Edinburgh; U. of Reading.

2016: ANU; U. Tasmania; U. of Copenhagen; Imperial College London (Physics); Leeds.

2014: UCLA; Caltech; Scripps Institute of Oceanography; British Antarctic Survey; UCL; NOC/Southampton; Weizmann Institute of Science; Tel Aviv University.

2013: Imperial College London (Math); Harvard; MIT; U. of Cambridge (DAMTP); Hebrew University of Jerusalem; Weizmann Institute of Science; Reading.

2012: LPO/IFREMER Brest; New York University; U. of Hamburg/Max Planck Institute of Meteorology.

before 2012: Imperial College London (Physics); U. of Reading; U. of Oxford; U. Cambridge (Earth Sciences); European Centre for Medium-Range Weather Forecast; Proudman Oceanographic Laboratory, Liverpool; U. of East Anglia; National Oceanography Centre, Southampton; MIT; Columbia University/LDEO; Princeton/GFDL; Tel Aviv University; Beer Sheva University.

Invited Workshops and Conferences (41 Invited since 2009):

Upcoming: ORCHESTRA workshop (UK); Equadiff 2019 minisymposium (Leiden).

2019: Physics and Mathematics of Turbulent Flows at Different Scales (Les Houches); Sources and Sinks of Ocean Mesoscale Eddy Energy US CLIVAR (Florida); International FAFMIP workshop (Reading); EGU, Sea level: Past, Present, Future (Vienna); Physical Society Club (London); Rotating Fluids (UCL)

2018: Machine Learning in Climate; Regional Atlantic Circulation and Global Change (Bremen, keynote); AGU fall meeting (DC); US AMOC/RAPID (Miami); AIMS Conference on Dynamical Systems (Taipei); Caltech - ESM Workshop; AGU Ocean Sciences (Portland); Understanding the relationship between coastal sea level and large-scale ocean circulation (ISSI, Bern); Oceans in Weather and Climate (Exeter, OiWC2018).

2017: ECMWF Annual Seminar on Ensemble Prediction; Intrinsic & Forced Ocean Variability Workshop; Max Planck Institute for the Physics of Complex Systems; Banff International Research Station for Mathematical Innovation and Discovery; MFO Oberwolfach Research Institute for Mathematics.

2016: Data Analysis and Modeling in Earth Sciences; Uncertainty Quantification SIAM (The Society for Industrial and Applied Mathematics).

2015: Future Lagrangian Ocean Modeling; ICIAM Beijing; Turbulence Days; Europe Dynamics Days; Workshop on Stochastic Physics in Climate; Theoretical Advances in Planetary Flow and Climate Dynamics; Met Office Academic Partnership; Ice2Ice (keynote).

2014: AGU Fall Meeting; ClimathNet (plenary).

2013: AGU Fall Meeting; The Institute of Mathematics and its Applications (IMA) Workshop on Stochastic Modeling of the Oceans and Atmosphere.

2012: AGU Fall Meeting; European Space Agency (ESA) workshop on model uncertainty.

before 2012: Workshop on Representing Model Uncertainty in Weather and Climate Prediction (2011), EGU General Assembly (2009); Advanced Climate Dynamics Course (2009).

Selected Contributed Presentations (total 27 since 2009): Model Hierarchies Workshop, Princeton 2016; AGU Ocean Sciences 2018, 2016, 2014, 2012; Workshop on Energy transfers in the atmosphere and in the ocean 2016, 2015; RAPID/US AMOC annual meeting 2015, 2013; Latsis Symposium on Climate Dynamics 2014; AGU Fall Meeting 2013, 2012; American Met. Soc. AOFD 2013, 2017; APS General Meeting 2013.

Selected Outreach, College & Alumni Activities

- 1992- : Various activities and tutoring for middle- and high-school students (in France, Israel, USA and UK) with learning disabilities and/or from disadvantaged backgrounds.
- 2018- : Access to Excellence (students age 12 to 17), Wadham College.
- 2019: Wadham Cross-college Symposium: Disruption, *Ocean Physics & Climate Change*.
- 2017: Foundation Fellows Event, Wadham College, *Sea Level Rise*.
- 2015: Atmospheric Physics Alumni Event, Royal Society, *Oceans in Climate Change*.
- 2016: Oxford Physics Society, *Physics of Climate Change*.
- 2013: Oxford Alumni Weekend, *The Oceans in a Warming Climate*.

Publication List

A total of 44 published papers, with 31 with myself or a member of my group as lead author.

* = first-author is a student or postdoc supervised by LZ; underline = group member

PDFs of published manuscripts are available at <https://laurezanna.github.io/publication/>.

Manuscripts Submitted for publication

- [48] Chemke, Zanna, Polvani. Human influence on North Atlantic surface temperature. *Submitted*.
- [47] Sun, Eisenman, Zanna, Stewart. Surface constraints on the depth of the Atlantic Meridional Overturning Circulation: Southern Ocean vs North Atlantic. *Submitted*.
- [46]* Bronselaer, Zanna: Coupling of ocean heat and carbon storage reveals past and future warming patterns due to circulation changes. *Revised version submitted*.
- [45] Yin, Griffies, Winton, Zhao, Zanna, 2019: Response of Storm-related Extreme Sea Level along the US Atlantic Coast to Combined Weather and Climate Forcing. *Submitted*.

Peer Reviewed Manuscripts Published/Accepted

2019

- [44]* O'Reilly C., T. Woollings, L. Zanna, 2019. Assessing external and internal sources of Atlantic Multidecadal Variability using models, proxy data and early instrumental indices. *J. Of Climate*, <https://doi.org/10.1175/JCLI-D-19-0177.1>.
- [43]* O'Reilly, Woollings, Zanna and Weisheimer, 2019. An interdecadal shift of the extratropical ENSO teleconnection during boreal summer. *GRL*, doi.org/10.1029/2019GL084079.
- [42] Carson, Lyu, Richter, Becker, Domingues, Han, Little, Zanna. Climate model uncertainty and trend detection of regional sea level projections in the open ocean and coastal zone. *Surveys in Geophysics*, <https://doi.org/10.1007/s10712-019-09559-3>.
- [41] Ponte, et al: Ocean Obs' 2019: Towards comprehensive observing and modeling systems for monitoring and predicting regional to coastal sea level. *Frontiers in Marine Science*, doi: 10.3389/fmars.2019.00437.
- [40]* Bolton, Abernathy, Zanna, 2019: Regional and temporal variability of lateral mixing in the North Atlantic. *JPO, In Press*.
- [39]* Fraser, Palmer, Roberts, Wilson, Zanna, 2019: Predictability of Interannual Sea Level Variability in the North Atlantic. *Climate Dynamics*, doi:10.1007/s00382-019-04814-0.
- [38] Rodrigues, Subramanian, Zanna, Berner, 2019. ENSO bimodality and extremes. *GRL*, DOI:10.1029/2019GL082270.
- [37] Zanna, Khatiwala, Gregory, Ison, Heimbach, 2019: Global reconstruction of historical ocean heat storage and transport. *Proc. of the National Academy of Sciences*, 116 (4) 1126-1131, doi: 10.1073/pnas.1808838115. **Link to press coverage**.
- [36]* Bolton, Zanna, 2019: Applications of Deep Learning to Ocean Data Inference and Sub-Grid Parameterisation. *JAMES*, 11, doi: 10.1029/2018MS001472.

2018

- [35]* Juricke, MacLeod, Weisheimer, Zanna, Palmer, 2018. Seasonal to annual ocean forecasting skill and the role of model and observational uncertainty. *QJRM*S, 144(715), 1947-1964.
- [34]* O'Reilly, Zanna. The signature of oceanic processes on extratropical decadal SST anomalies. *GRL*, 45, 77197730.
- [33] Zanna, Brankart, Huber, Penduff, Williams. Uncertainty and Scale Interactions in Ocean Ensembles: From Seasonal Forecasts to Multi-Decadal Climate Predictions. *QJRM*S, <https://doi.org/10.1002/qj.3397>.
- [32] Faggiani Dias, Subramanian, Zanna, Miller: Remote and Local Influences in Forecasting Pacific SST: a Linear Inverse Model and a Multimodel Ensemble Study. *Clim. Dyn.*, pp 1-19; doi:10.1007/s00382-018-4323-z.
- [31]* David, Zanna, Marshall, 2018. Eddy-mixing entropy as a measure of turbulent disorder in barotropic ocean jets. *J. of Stat. Mech.:Theory and Experiment*, 7, 073206.
- [30]* O'Reilly, Woollings, Zanna and Weisheimer. The impact of tropical precipitation on summertime Euro-Atlantic circulation via a circumglobal wave-train. *J. Climate*, 31(16), 6481-6504.
- [29] Bachman, Anstey, Zanna, The relationship between a deformation-based eddy parameterization and the LANS- α turbulence model. *Oc. Modelling*, doi.org/10.1016/j.ocemod.2018.04.007.
- [28]* Bronselaer, Zanna, Munday, Lowe: Southern Ocean carbon-wind stress feedback. *Clim. Dyn.*, doi:10.1007/s00382-017-4041-y. **Highlight in MITgcm news.**
- [27] van Sebille et al.: Lagrangian ocean analysis: fundamentals and practices. *Oc. Modell.*, doi:10.1016/j.ocemod.2017.11.008.

2017

- [26]* Kjellsson, Zanna, 2017: Spectral Fluxes of Kinetic Energy in Global Ocean Models and the Impact of Horizontal Resolution. *Fluids*, 2(3), 45, doi: 10.3390/fluids2030045
- [25] Zanna, Porta Mana, Anstey, David, Bolton, 2017: Scale-Aware Deterministic and Stochastic Parametrizations of Eddy-Mean Flow Interaction. *Oc. Modell.*, 111, 66-80, doi:10.1016/j.ocemod.2017.01.004
- [24]* Juricke, Palmer, Zanna, 2017: Stochastic parametrizations of sub-grid scale ocean variability: Impacts on low frequency variability. *J. Climate*, doi:10.1175/JCLI-D-16-0539.1
- [23]* Anstey, Zanna, 2017: Deformation-based parametrization of ocean mesoscale eddies. *Oc. Modell.*, 112, 99-111, doi:10.1016/j.ocemod.2017.02.004
- [22]* David, Marshall, Zanna, 2017: The statistical nature of turbulent barotropic ocean jets. *Oc. Modell.*, 113, 34-49, doi:10.1016/j.ocemod.2017.03.008
- [21]* O'Reilly, Woollings, Zanna, 2017: The dynamical and thermodynamical influences of the Atlantic Multidecadal Oscillation on continental climate. *J. Climate*, doi:10.1175/JCLI-D-16-0345.1 .
- [20]* Huber, Zanna, 2017: Drivers of uncertainty in simulated ocean circulation and heat uptake. *GRL*, 44, 14021413, doi:10.1002/2016GL071587.
- [19] Grooms, Zanna, 2017: Statistical Parameterization of Mesoscale Eddies. *Oc. Modelling*, 113, 30-33, doi:10.1016/j.ocemod.2017.03.007.
- [18]* Huddart, Subramanian, Zanna, Palmer, 2017: Seasonal and Decadal forecasts of Atlantic SST using a Linear Inverse Model: *Clim. Dyn.*, DOI: 10.1007/s00382-016-3375-1.

2016

- [17]* Bronselaer, Zanna, Munday, Lowe, 2016: The Influence of Southern Ocean Winds on the North Atlantic Carbon Sink. *Global Biogeochem. Cycles*, 30, 844-858.
- [16]* O'Reilly, Huber, Woollings, Zanna, 2016: The signature of low frequency oceanic forcing in the Atlantic Multidecadal Oscillation, 2016. *GRL*, 43, 2810-2818. **Research Spotlight: Eos, 97, doi:10.1029/2016EO050997.**
- [15] MacMartin, Zanna, Tziperman, 2016: Suppression of AMOC variability at increased CO₂. *J. Climate*, 29, 11, 4155-4164, doi:10.1175/JCLI-D-15-0533.1.
- [14]* Andrejczuk, Cooper, Juricke, Palmer, Weisheimer, Zanna, 2016: Oceanic stochastic parametrizations in a seasonal forecast system. *Mon. Wea. Rev.*, 144, 5, 1867-1875, doi:10.1175/MWR-D-15-0245.1.

2014-2015

- [13]* Cooper, Zanna, 2015: Optimisation of an idealised ocean model: stochastic parameterisation of sub-grid eddies. *Oc. Modell.*, 88 (0), 38-53.

- [12] Marshall, Zanna, 2014: A Conceptual Model of Ocean Heat Uptake under Climate Change. *J. Climate*, 27, 8444-8465.
- [11]* Porta Mana, Zanna, 2014: Toward a Stochastic Parameterization of Ocean Mesoscale Eddies. *Oc. Modell.*, 79, 1-20.

2013

- [10] Wilson, Horsburgh, Williams, Flowerdew, Zanna, 2013: Tide-Surge Adjoint Modelling: A New Technique to Understand Forecast Uncertainty. *JGR-Oceans*, 118 (10), 5092-5108.
- [9] MacMartin, Tziperman, Zanna, 2013: Frequency-domain Multi-model Analysis of the Response of Atlantic Meridional Overturning Circulation to Surface Forcing. *J. Climate*, 26, 21, 8323-8340.
- [8] Palmer, Zanna, 2013: Singular Vectors, Predictability and Ensemble Forecasting for Weather and Climate. **Invited Contrib.**. Special issue: Lyapunov analysis: from dynamical systems theory to applications, *J. Physics A*, 46, 254018.

2012

- [7] Zanna, 2012: Forecast Skill & Predictability of Observed Atlantic Sea Surface Temperatures. *J. Climate*, 25, 14, 5047-5056.
- [6] Zanna, Heimbach, Moore, Tziperman, 2012: Upper Ocean Singular Vectors of the North Atlantic Ocean with Implications for Linear Predictability and Variability. *Q.J.R.M.S.*, 138, 500-513.

2010-2011

- [5] Zanna, Heimbach, Moore Tziperman, 2011: Optimal Excitation of Interannual Atlantic Meridional Overturning Circulation Variability. *J. Climate*, 24, 2, 413-427.
- [4] Zanna, Heimbach, Moore, Tziperman, 2010: The Role of Ocean Dynamics in the Optimal Growth of Tropical SST Anomalies. *J. Phys. Ocean.*, 40, 5, 983-1003.

2005-2008

- [3] Tziperman, Zanna, Penland, 2008: Non normal Thermohaline Circulation Dynamics in a Coupled Ocean-Atmosphere GCM. *J. Phys. Ocean.*, 38, 3, 588-604.
- [2] Zanna, Tziperman, 2008: Optimal Surface Excitation of the Thermohaline Circulation. *J. Phys. Ocean.*, 38, 8, 1820-1830.
- [1] Zanna, Tziperman, 2005: Non normal Amplification of the Thermohaline Circulation. *J. Phys. Ocean.*, 35, 9, 1593-1605.

Grey Literature

- Zanna and Gebbie, 2019: New Ocean Heat Content Histories, RealClimate.org <http://www.realclimate.org/index.php/archives/2019/01/new-ocean-heat-content-histories/>.
- Zanna, 2012. Ocean Model Uncertainty in Climate Prediction. *ECMWF Proceedings, Workshop on Representing model uncertainty and error in numerical weather and climate prediction models*.
- Zanna, 2009. Optimal excitation of Atlantic Ocean variability and implications for predictability. Harvard University, PhD Thesis.