

EMANUELE SILVIO GENTILE

Postdoctoral Research Associate

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PERSONAL STATEMENT

As an Atmospheric Physicist and Climate Modeler, my research focuses on advancing our understanding of Earth's climate system, with particular emphasis on the drivers of midlatitude extreme winds and precipitation across various scales. My work spans from investigating the response of midlatitude cyclone tracks and associated mesoscale features to a warming climate, to examining how sub-grid turbulent processes within the atmospheric boundary layer influence the formation of extreme wind speeds near the Earth's surface. I also investigate how the interactions between atmospheric dynamics and other Earth system components, such as ocean-atmosphere exchanges and land-atmosphere feedbacks, control the Earth's system climate. Utilizing a combination of observations, reanalysis, higher-order turbulence closures, and climate simulations, I aim to improve the prediction of momentum transport and extreme winds in models like the GFDL-AM4. Furthermore, I have contributed to enhancing the accuracy of deterministic and probabilistic extreme midlatitude cyclone forecasts by investigating their sensitivity to physically consistent modeling of air-sea turbulent fluxes in the Met Office Unified Model. Currently, I am highly motivated to harness recent advancements in ML and AI to develop a deep learning Neural Network parametrization for turbulent momentum flux trained on km-scale climate model simulations. This parametrization is intended for implementation in coarser-resolution climate models, enabling cost-effective probabilistic projections of extreme winds and gust hazards across a range of warmer climate scenarios, from the sub-seasonal to centennial scales.

EDUCATION

- 2018-2022 **Ph. D. in Atmosphere, Oceans and Climate**, University of Reading, UK
- Supervisors: Suzanne Gray, Janet Barlow, Huw Lewis (Met Office).
 - Thesis by articles: "The impact of atmosphere ocean wave coupling on extreme surface wind forecasts".
 - Awarded a four-year CASE studentship by NERC, UK.
 - Completed Master 's level courses in Weather Systems, Atmospheric Physics, Fluid Dynamics, Numerical Modelling, Boundary Layer, and Machine Learning.
- 2015-2018 **BSc ARCS, Physics with Theoretical Physics**, Imperial College London, UK
- Graduated with First-Class Honours.
 - Final Year Project: "Calculating evanescent Floquet modes in photonic crystals: bringing topological surface states to light", supervised by Ortwin Hess.
 - Awarded the Department Tessella Prize for Software.

PROFESSIONAL AND RESEARCH EXPERIENCE

Princeton University, Program in Atmospheric & Oceanic Science, Princeton, NJ 2022-present
Postdoctoral Research Associate

- Leading comprehensive climate research advised by GFDL scientists Ming Zhao and Leo Donner, aimed at improving boundary-layer turbulence and cloud representation in GFDL's AM4 model.

- Investigating boundary-layer turbulence and cloud higher order parameterizations using the CLUBB framework to better align with the Navier-Stokes equations and enhance the representation of extreme wind events in climate models. Contributed as part of the broader Climate Processes Team efforts, collaborating with scientists from GFDL, NCAR, Penn State University, the University of Wisconsin Milwaukee, and the University of Stockholm.
- Successfully integrated the CLUBB scheme into the Fortran 95 GFDL's AM4 climate model enhancing wind speed simulation. Leading a comparative study with NCAR's CAM model to evaluate the advantages of higher order CLUBB scheme over traditional first-order approaches.
- Developed analytical tools in Python and Fortran 95 to assess extreme wind speeds and momentum transport within GFDL-AM4 simulations, including enhancements to the model's diagnostics for better understanding surface drag effects on global flow patterns.
- Conducted analyses of high-resolution AM4 and X-shield climate simulations assessing future extreme wind speed projections against present-day data and identifying key drivers such as midlatitude cyclones. The findings support stakeholders from businesses to policymakers in decision-making.
- Assessed the performance of the next generation GFDL climate model AM5 to accurately model extreme winds and precipitation.

University of Reading, Department of Meteorology, University of Reading, UK

2018-2022

PhD Researcher

- Investigated the impact of air-sea interactions on forecasting extreme winds in mesoscale systems using the Met Office's UKEP multi-model system.
- Developed the first coupled ensemble convective-scale prediction system for the UK, in collaboration with the Met Office during a 2-month remote internship, focusing on initial condition perturbations and their effect on forecast sensitivity.
- Built a comprehensive climatology of extreme winds and gusts of UK's surrounding seas by processing MIDAS and Marine Met Office data (2011-2020).
- Analyzed predictability factors of Mediterranean hurricanes in convection-permitting ensemble simulations, contributing to a European project on hurricane predictability.

Teaching assistant in Atmospheric Physics, Boundary Layer Meteorology, and Fluid Dynamics (2020-2022).

- Contributed to graduate teaching, developing educational materials, conducting tutorial sessions, and providing feedback on assignments.

Laboratory demonstrator in Boundary Layer Meteorology and Fluid Dynamics (2019-2021).

- Supported practical laboratory sessions, fostering students' understanding of atmospheric sciences.

RESEARCH VISITS

Stockholm University, Meteorology Department, Stockholm, Sweden

August 2024

Project: Developing metrics to assess the relative impact of boundary-layer choice of parametrization and surface drag, in collaboration with the group of Prof Gunilla Svensson

NCAR, Mesa Laboratory, Boulder, Colorado, US

March 2023

Project: Implementation of a higher-order scheme CLUBB in CAM and GFDL-AM4, in collaboration with the group of Dr Julio Bacmeister and Dr Richard Rotunno

Met Office, Exeter, UK

2020-2024 Bi-yearly visits

Project Development of model physics parametrization and intercomparison between different novel global km-scale climate models, in collaboration with Dr Adrian Lock, Dr Huw Lewis, Dr John Edwards, Dr Lorenzo Tomassini

Project: Synoptic and Mesoscale changes in midlatitude cyclone dynamics in present and warmer climate, in collaboration with Prof Pier Luigi Vidale, Dr Kevin Hodges, Prof Suzanne Gray, Prof Miguel Teixeira

RESEARCH SKILLS

Climate Modeling and Simulation:

- Expertise in implementing and optimizing the CLUBB higher-order parameterization scheme in GFDL's AM4 model using Fortran 95, enhancing model accuracy for extreme weather events.
- Proficient in conducting high-resolution global atmospheric climate simulations, employing custom-developed diagnostic tools to assess the impacts of global warming on extreme wind speeds.

Technical Development & Collaborative Projects:

- Conducted the technical development of the first ensemble convective-scale prediction system for the extended UK domain, in collaboration with the Met Office.
- Expanded the use of the UKEP multi-model system, integrating atmosphere, ocean, and wave models, and the ensemble functionalities of MOGREPS-UK, leveraging Jinja2, Django, and Python.

Data Analysis, Visualization & Tool Development:

- Demonstrated proficiency in analyzing and visualizing meteorological data using Python, with tools I developed interfacing with Iris, CF-Python, Pandas, and Matplotlib libraries, to characterize mesoscale weather systems and climatology.

Programming Skills:

- **Languages:** Skilled in Python and Fortran 95. Familiar with C, Object-Oriented Programming, and Unix Shell.
- **Machine Learning:** Familiar with Keras and TensorFlow for building and optimizing neural network models, NNs, CNNs, and RNNs.
- **Data Analysis Tools:** Skilled in using NumPy, Xarray, Pandas, CF-Python, Iris, and Matplotlib.
- **Development Environments:** Skilled with Jupyter Notebook and Spyder, familiar in using PyCharm.
- **Operating Systems:** Linux and Microsoft Windows environments.
- **Other Tools:** Efficient in utilizing MS Office, LaTeX and familiar with lab tools such as OriginLab, Labview, LTSPICE IV.

Professional Engagement & Remote Collaboration:

- Established and maintained collaborative partnerships across US-based, UK-based, and Europe-based institutions, contributing to the advancement of km-scale global climate models and participating in significant European COST actions.
- Proven ability to adapt to remote working conditions efficiently, ensuring continuous research productivity and collaboration during COVID-19 restrictions.
- Seminar Organization: successfully organized and moderated academic seminars, including virtual formats, for the Mesoscale Group at the University of Reading, expanding the network and promoting the exchange of scientific knowledge.

LANGUAGE SKILLS

English: Fluent (Near-native proficiency) - Moved to London at 18 to study at Imperial College, spending over 8 years in English-speaking academic and professional environments in the UK and the US. This immersion has honed my skills in academic writing, oral presentations, and scientific communication to the level of a native speaker.

Italian: Native - Born and raised in Italy, where I lived for 18 years.

French: Intermediate (Conversational proficiency) - Actively engaged in weekly meetings of the French society at Princeton University, enhancing my conversational skills and cultural understanding. Lived in France and Quebec, Canada for a fixed time. Actively used in informal and semi-formal contexts, demonstrating my capacity to engage in multilingual and multicultural environments.

TEACHING EXPERIENCE

Guest Lectures & Climate Change Outreach, Princeton University (2022-2023)

- Delivered lectures on midlatitude cyclones and Mediterranean hurricanes to undergraduate and graduate students, reaching up to 30 attendees.
- Engaged in public outreach initiatives, presenting to the City University of New York graduate students from minority backgrounds on critical topics such as climate change facts, the current state of climate models, and the future directions in climate modelling.

Teaching Assistant, University of Reading, UK (2019-2022)

- Conducted tutorial sessions in Atmospheric Physics, Boundary Layer Meteorology, and Fluid Dynamics, engaging up to 40 master's students, enhancing my pedagogical skills and scientific communication.
- Developed teaching materials, managed coursework evaluations, provided detailed feedback, and supported students with assignments.
- Received positive feedback for clarity of explanation and ability to inspire student interest in complex topics.

Laboratory Demonstrator, University of Reading, UK (2019-2021)

- Facilitated practical sessions in Boundary Layer Meteorology and Fluid Dynamics engaging up to 10 master's students.
- Provided guidance to students enhancing their experimental skill and understanding of subject matter.

Co-Supervisor, University of Reading, UK (2020)

- Co-supervised an MSc Thesis on atmospheric sciences, contributing to the design of the project and offering continuous guidance and assessment to ensure student success.

Science Specialist, Marie-Louise Banning Education Consultant, UK (2018-2021)

- Prepared students for Physics and Maths sections of university admission exams, delivering content online to enhance their academic readiness.

Math Tutor, Tutorfair, UK (2018)

- Provided one-on-one math tutoring to undergraduate students, tailoring lessons to individual learning needs and academic goals.

PAL mentor, Imperial College London, UK (2017-2018)

- During my 3rd-year of studying theoretical physics, I volunteered to mentor 1st and 2nd-year Physics students, facilitating discussions, offering academic advice, and supporting their learning journey.

LEADERSHIP AND ORGANIZATIONAL SKILLS

Climate Outreach Coordination: Collaborated with peers, senior GFDL staff, and PhD students to plan and execute climate outreach initiatives involving local communities, high schools, and the City University of New York Graduate Center (2023-2024).

Seminar Organization: Led the organization of the Mesoscale Group seminars at the University of Reading during 2020-2022, enhancing academic collaboration and knowledge exchange within the meteorology community.

Club Leadership: Served as President of the Reading University Volleyball Club (2019-20) and Chair of the Imperial College Italian Society (2017-18), showcasing leadership, event planning, and community building skills.

Peer support: member of the GFDL employee association, helping peers to network and facilitate scientific exchange by organising lab-wide social events.

COMMUNITY SERVICE

Peer Reviewer

Contributed as a peer reviewer for several journals including the Weather and Climate Dynamics, International Journal of Climatology, the Journal of Geophysical Research–Atmospheres, Atmospheric Research, and Earth and Space Science. I am also a reviewer of ERC grants.

Conference session chair

Co-chaired the AGU23 session “Extreme events: observations and modelling” (San Francisco, US)

Co-chaired the 2022 MedCylones meeting Working Group 1 session “Process-based understanding of Mediterranean cyclones at weather time scales” (Athens, Greece)

Advisory Contribution for the Academy of Medical Sciences, London, UK (2020)

Collaborated with the expert advisory group, volunteering expertise to the report "Preparing for a challenging winter 2020/21," focusing on analyzing how winter weather conditions could affect the UK's response to the second Covid-19 wave.

Undergraduate Research Opportunities Programme (UROP) Researcher, Department of Physics, Imperial College London, UK (2016-2018)

Participated as a funded UROP researcher within the Condensed Matter Theory Group over three summers, contributing to research on semiconductor technologies.

- Worked on large-scale Fortran 95 FDTD simulations to analyze light fields' interaction with nano-plasmonic structures and semiconductors, applicable to laser technology.
- Advanced a C parallel FDTD program for semiconductor diffusion and pumping modeling, optimizing MPI/parallel performance on a cluster.
- Developed a Python algorithm for simulating 2D surface states at photonic crystal interfaces.

AWARDS AND PRIZES

NERC Industrial CASE PhD Studentship and Travel Grant, (NE/R007640/1), sponsored by the Met Office, UK (2018-2022)

Tessella Prize for Software, Imperial College London, UK (2018): Received for the most outstanding BSc final year computational project.

EPSRC Bursary for UROP Summer Placement, Department of Condensed Matter Theory, Imperial College London, UK (2016)

Italian State Honours Scholarship and Admission to the National Register of Excellence, Italy (2015) for achieving a perfect score of 100 with honours in the final exam

CURRENT PROFESSIONAL AFFILIATIONS TO SOCIETIES AND BODIES

American Geophysical Union: Member 2022-2024

American Meteorological Society: Member 2022-2024

US National Oceanographic Atmospheric Administration (NOAA): Affiliated 2022-2024

European Geophysical Union: Member 2019-2024

European Meteorological Society: Member 2019-2024

European Cooperation in Science and Technology – COST action CA1909: Member 2020-2024

ADDITIONAL TRAINING/ PROFESSIONAL DEVELOPMENT

Teaching Skills: Completed an Introduction to Teaching and Lecturing Methods, a 2-day course at the University of Reading, 2019. Also participated in a workshop on Supervising MSc Students, enhancing my capabilities in student guidance and academic mentoring

Writing and Presentation Skills: Attended courses on Presentation Skills and An Essential Guide to Critical Academic Writing at University of Reading. Also participated in a Public Engagement Workshop at University of Reading, 2018, focusing on effective communication of climate change challenges to diverse audiences, including pupils and top CEOs.

Proposals: My Future Leaders Fellowship proposal titled “Advancing Predictive Capabilities of Extreme Winds in a Warming Climate” was selected in the University of Reading's competition for sponsorship, advancing to the final round. The Future Leaders Fellowship offers funding up to £1.5 million.

Programming skills: Engaged in a two-weeks course at the University of Reading, 2018-2019, focusing on OOP principles and Python programming, culminating in the development of a library management software tool.

Machine Learning skills: Completed ML and AI master courses held in the Department of Computer Science at the University of Reading. Also completed the MOOC Machine Learning in Weather & Climate online course offered by the ECMWF.

Diabatic Processes in the Atmosphere: Attended the Diabatic Winter School, a week long course on atmospheric diabatic processes, held in Kvalheim Fritid, Norway, 2020.

Data Assimilation: Completed two courses on the theory and application of Data Assimilation in operational ECMWF forecasting systems, conducted by the University of Reading and ECMWF, 2020.

Entrepreneurship Skills: Participated in the YES competition, a two-month course offered by the University of Reading and Syngenta headquarters, 2019, on commercializing scientific and engineering innovations.

Environmental Sustainability Skills: Completed Innovating for Sustainable Development, a 3-day course at Elcot Park Hotel, Kintbury, 2019, aimed at integrating research projects with the 17 UN Sustainable Development Goals.

PEER-REVIEWED PUBLICATIONS

Peer-reviewed publications

- Pantillon, F., Davolio, S., Avolio, E., Calvo-Sancho, C., Carrió, D.S., Dafis, S., Flaounas, E., **Gentile, E.S.**, Gonzalez-Aleman, J.J., Gray, S.L., Miglietta, M.M., Patlakas, P., Pytharoulis, I., Ricard, D., Ricchi, A. and Sanchez, C., The crucial representation of deep convection to predict the cyclogenesis of medicane Ianos. *Weather and Climate Dynamics* (2024) DOI: [10.5194/egusphere-2024-1105](https://doi.org/10.5194/egusphere-2024-1105)
- **Gentile, E.S.**, Zhao, M., Tan, Z., Larson, V., Zarzycki, C., The Effect of Coupling Between CLUBB Turbulence Scheme and Surface Momentum Flux on Global Wind Simulations. *Journal of Advances in Modeling Earth Systems* (2024) DOI: [10.1029/2024MS004295](https://doi.org/10.1029/2024MS004295)
- **Gentile, E.S.**, Zhao, M. and Hodges, K., Poleward intensification of midlatitude extreme winds under warmer climate. *npj Climate and Atmospheric Science Journal*. DOI: [10.1038/s41612-023-00540-x](https://doi.org/10.1038/s41612-023-00540-x).
- **Gentile, E.S.**, Gray, S.L. Attribution of observed extreme marine wind speeds and associated hazards to midlatitude cyclone conveyor belt jets near the British Isles. *International Journal of Climatology* 43, 2735-2753 (2023) DOI: [10.1002/joc.7999](https://doi.org/10.1002/joc.7999)
- **Gentile, E.S.**, Gray, S.L., Lewis, H.W., The sensitivity of probabilistic convective-scale forecasts of an extratropical cyclone to atmosphere-ocean-wave coupling. *Quarterly Journal of the Royal Meteorological Society* 148, 685-710 (2022) DOI: <https://doi.org/10.1002/qj.4225>
- **Gentile, E.S.**, Gray, S.L., Barlow, J.F., Lewis, H.W., Edwards, J.M., The impact of atmosphere-ocean-wave coupling on the near-surface wind speed in forecasts of extratropical cyclones. *Boundary-Layer Meteorology* 180, 105–129 (2021) DOI: [10.1007/s10546-021-00614-4](https://doi.org/10.1007/s10546-021-00614-4)

Under review

- **Gentile, E.S.**, Zhao, M., Harris, L., Hodges, K., Response of intense North Atlantic midlatitude cyclones to a warmer climate in the GFDL X-SHiELD global storm-resolving kilometer-scale model. Submitted to Geophysical Research Letters (2024). DOI: [10.22541/essoar.172745037.73408753/v1](https://doi.org/10.22541/essoar.172745037.73408753/v1)

In preparation

- **Gentile, E.S.**, Zhao, M., Larson, V., Zarzycki, C., Dong, Q., Tan, Z., Directly prognosing momentum flux with a generalised turbulent lengthscale in the higher-order scheme CLUBB implemented in the GFDL-AM4 model. In preparation for Geoscientific Model Development (2024).

CONFERENCE PRESENTATIONS AND SEMINARS

Oxford Model Uncertainty Workshop (In Person Poster), Oxford, UK, September 2024

- **Gentile, E. S.**, Zhao, M., Harris, L., Hodges, K., Tan, Z. What are the benefits of km-scale global climate model simulations for predicting extratropical cyclones extreme winds?

Met Office Seminar series “Path to High Resolution” (In Person), Exeter, UK, September 2024

- **Gentile, E. S.**, Zhao, M., Harris, L., Hodges, K., Tan, Z. Harnessing the benefits of global km-scale climate models.

EMS Annual meeting 2024 (In Person), Barcelona, Spain, September 2024.

- **Gentile, E. S.**, M Zhao, V Larson, C Zarzycki, Enhancing global wind climate simulations in the GFDL-AM4 model by unifying planetary boundary layer and cloud turbulence parametrizations with the higher-order scheme CLUBB

Stockholm University formal seminar (In Person), Stockholm, Sweden, August 2024

- **Gentile, E. S.** Predictions and projections of extreme winds and associated synoptic and mesoscale drivers with state of the art global climate models

EGU Annual Meeting 2024 (In person), Vienna, Austria, April 2024.

- **Gentile, E. S.**, Zhao, M., Hodges, K.I., Poleward intensification of midlatitude extreme winds under warmer climate.

GFDL Lunchtime seminar series (In person) Princeton, US, March 2024.

- **Gentile, E. S.** Advancing predictive capabilities of global circulation and extreme winds in a warmer climate.

M²LInES seminar series (Online) February 2024

- **Gentile, E. S.**, M Zhao, V Larson, C Zarzycki, Tan, Z., Modelling momentum transport in climate simulations of boundary-layer winds with a higher order parameterization scheme.

AMS Annual meeting 2024 (In Person), Baltimore, US, January 2024.

- **Gentile, E. S.**, M Zhao, V Larson, C Zarzycki, Momentum transport in boundary-layer wind climate simulations and its parametrization by CLUBB: challenges and opportunities.

AGU Annual Meeting 2023 (Online), San Francisco, December 2023.

- **Gentile, E. S.**, Zhao, M., Hodges, K.I., Poleward intensification of midlatitude extreme winds under warmer climate.

CMCC Seminar, (In Person), Bologna, Italy, May 2023.

- **Gentile, E. S.**, Gray, S.L., Attribution of observed extreme marine wind speeds and associated hazards to midlatitude cyclone conveyor belt jets near the British Isles.

EGU General Assembly (EGU23 and EGU22), (In Person), Wien, Austria.

- **Gentile, E. S.**, M Zhao, V Larson, C Zarzycki, Modelling momentum transport in climate simulations of boundary-layer winds with a higher order parameterization scheme. April 2023.

- **Gentile, E. S.**, Gray, S.L., Midlatitude cyclone features associated with extreme winds and gusts in the seas surrounding the UK. April **2022**.

NCAR Informal Happy Hour Seminar, Colorado, US, March 2023 (Online).

- **Gentile, E. S.**, Gray, S.L., Attribution of observed extreme marine wind speeds and associated hazards to midlatitude cyclone conveyor belt jets near the British Isles.

Mesoscale Group Talk, University of Reading (Online). March 2021.

- **Gentile, E. S.**, Gray, S.L., Attribution of observed extreme marine wind speeds and associated hazards to midlatitude cyclone conveyor belt jets near the British Isles. February 2023.
- **Gentile, E.S.**, Sanchez, C., Segolene, B., Gray, S.L. On the predictability of Ianos, a hurricane in the Mediterranean. University of Reading.

GFDL Seminars, Princeton (Online)

- **Gentile, E. S.**, Gray, S.L., Barlow, J.F., Lewis, H., The impact of atmosphere-ocean-wave coupling on extreme surface wind speed. (Online). Interview Seminar.

University of Reading, Meteorology Department Seminar (Online). October 2021.

- **Gentile, E.S.**, Gray, S.L., Barlow, J.F., Lewis, H., Forecasting midlatitude cyclone winds with a convective-permitting model coupled to ocean and wave models. University of Reading, Meteorology Department seminar.

Meeting on Mediterranean Cyclones and Aerosol, Castro Marina, Italy, September 2021.

- **Gentile, E.S.**, Gray, S.L., Barlow, J.F., Lewis, H., Sensitivity of ensemble convective-scale coupled system: an atmosphere-ocean-wave coupling in a cyclone case study.

EMS21 (Solicited, Online), Bonn, September 2021.

- **Gentile, E.S.**, Gray, S.L., Barlow, J.F., Lewis, H., The importance of atmosphere-ocean-wave coupling in ensemble regional convective-scale forecasts of midlatitude cyclones.

Laboratoire d'Aerologie and Meteo France (Invited, Online), Toulouse, France, April 2021.

- **Gentile, E. S.**, Gray, S.L., Barlow, J.F., Lewis, H., The importance of atmosphere-ocean-wave coupling in deterministic and ensemble regional km-scale forecasts of midlatitude cyclones.

Seminar Talk (online) to the Mesoscale Group, University of Reading, June 2020; Atmosphere-Ocean Dynamics Group, Cambridge University, November 2020 (invited) ; Mesoscale Group, University of Reading, November 2020 (Invited, Online).

- **Gentile, E. S.**, Gray, S.L., Barlow, J.F., Lewis, H., The impact of atmosphere-ocean-wave coupling on extreme surface wind speed.

Poster Sessions (In Person), Diabatic Winter School, March 2019, Norway; RMetS Student Conference, July 2019, Birmingham University; DTP Scenario Conference London, September 2019; European Windstorm Workshop, October 2019, Birmingham University.

- **Gentile, E. S.**, Gray, S.L., Barlow, J.F., Lewis, H., The impact of atmosphere-ocean-wave coupling on extreme surface wind speed forecasts.

Climate Conference COP24, Katowice, Poland, 2018. Short presentation of my PhD research to a non-scientific audience.