Clara **Burgard**

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Born 30.11.1991 in Strasbourg, France

I am a polar climate scientist particularly interested in the cryosphere. My research focusses on understanding better the interactions between the polar cryosphere and the climate system, especially ice-ocean interactions, with climate models.

EMPLOYMENT HISTORY

Postdoctoral researcher
since 10.2023

Laboratoire d'Océanographie et du Climat: Expérimentations et Approches Numériques (LOCEAN), Sorbonne Université — *Paris, France*

- Work on ice-ocean interactions Antarctica in NEMO
- Modelling

Postdoctoral researcher
10.2022 - 08.2023

Institut des Géosciences et de l'Environnement, Université Grenoble Alpes (UGA) — *Grenoble, France*

- Development of deep learning parameterisations to represent the melt at the base of Antarctic ice shelves as part of the IDEX DEEP-MELT project.
- Modelling | Machine Learning

Postdoctoral researcher
10.2020 – 09.2022

Institut des Géosciences et de l'Environnement, Centre National de la Recherche Scientifique (CNRS) — *Grenoble, France*

- Evaluation, improvement and development of parameterisations to represent the melt at the base of Antarctic ice shelves as part of the H2020 PROTECT project
- Modelling | International collaboration

Scientific coordinator for the Earth League
01.2020 – 06.2020

Department "Climate Service Center Germany (GERICS)", Helmholtz-Zentrum Geesthacht — *Hamburg, Germany*

- Coordination of a voluntary alliance of prominent sustainability scholars (Earth League)
- Tasks included the preparation and follow-up of virtual meetings, the coordination of collaborative publications, the support in the development of future projects of the alliance.
- Project management | International collaboration | Microsoft Office

Postdoctoral researcher
06.2019 – 12.2019

Working group "Sea Ice in the Earth System", Max Planck Institute for Meteorology — *Hamburg, Germany*

- Development of a novel observation operator to translate the Arctic Ocean climate state as simulated by climate models (e.g. Max Planck Institute Earth System Model) into microwave brightness temperatures as could be observed by satellites from space.
- Data analysis | Project management | Climate models | 1D-modeling | Passive microwave remote sensing | Python | Bash | Climate Data Operators | Git

Doctoral researcher
04.2016 – 06.2019

Working group "Sea Ice in the Earth System", Max Planck Institute for Meteorology — *Hamburg, Germany*

- Analysis of the Arctic Ocean energy budget in simulations by a range of global climate models (CMIP5) to understand drivers of the ocean warming and sea-ice melting.
- Development of a novel observation operator to translate the Arctic Ocean climate state as simulated by climate models (e.g. Max Planck Institute Earth System Model) into microwave brightness temperatures as could be observed by satellites from space.
- This research was mainly funded by the ESA CCI Sea ice Phase 2.
- Data analysis | Project management | Climate models | 1D-modeling | Passive microwave remote sensing | Python | Bash | Climate Data Operators | Git

Student assistant
01.2015 – 12.2015

Working group "Sea Ice in the Earth System", Max Planck Institute for Meteorology — *Hamburg, Germany*

- Investigation of the Arctic Ocean energy budget in different reanalyses (ERA-Interim, NCEP, JR-25, C-GLORS).
- Data analysis | Reanalyses | Python | Bash | Climate Data Operators

Student assistant
04.2014 – 12.2014

Working group "Sea ice remote sensing", Institute of Oceanography, University of Hamburg
Hamburg, Germany

- Development of a program to compare satellite sea-ice observations from SMOS to in-situ observations conducted from a ship.
- Data analysis | Passive microwave remote sensing | Ship observations | Python

Student assistant
04.2013 – 07.2013

Working group "Integrated remote sensing", Institute of Geophysics and Meteorology, University of Cologne
Cologne, Germany

- Development of a program to format cloud and water vapor observations into a standard format for a project database.
- Data analysis | Observations | Fortran

EDUCATION

Ph.D. in Geosciences
04.2016 – 06.2019

International Max Planck Research School for Earth System Modelling, Max-Planck-Institute for Meteorology and University of Hamburg
Hamburg, Germany

- Thesis topic: Rethinking the relationship between the observed, simulated and real Arctic sea-ice evolution
- Advisors: Dirk Notz, Lars Kaleschke

M.Sc. Integrated Climate System Sciences
10.2013 – 11.2015

University of Hamburg
Hamburg, Germany

- Thesis topic: Drivers of past and future Arctic sea-ice evolution in CMIP5 models
- Advisors: Dirk Notz, Lars Kaleschke

B.Sc. Geophysics and Meteorology
10.2010 – 07.2013

University of Cologne
Cologne, Germany

- Thesis topic: Schneebeobachtungen mittels Mikro-Regen-Radar in Polargebieten (Snow observations with a Micro Rain Radar in polar regions)
- Advisors: Maximilian Maahn, Susanne Crewell, Nicole van Lipzig

Abibac, German-French Secondary School leaving examination
09.2002 – 07.2009

Lycée International des Pontonniers
Strasbourg, France

- Graduated with high honours

INTERNATIONAL EXPERIENCE

Visiting scientist
03.2018 – 04.2018

Working group "Paleo and Polar Climate" of Marika Holland, National Center of Atmospheric Research
Boulder, CO, USA

- Investigation of the use of the 1D sea-ice model ICEPACK developed by the CICE Consortium (incl. Los Alamos National Laboratory and NCAR) for the simulation of microwave brightness temperatures.
- 1D-modeling | Python | Fortran

Visiting scientist
01.2018 – 04.2018

Working group of Alexandra Jahn at the Institute for Arctic and Alpine Research & Department for Atmospheric and Oceanic Sciences, University of Colorado
Boulder, CO, USA

- Exchange and collaboration on the development of the Arctic Ocean Observation Operator.
- Data analysis | 1D-modeling | Python

6-weeks Master's course
02.2015 – 03.2015

University Centre in Svalbard
Longyearbyen, Norway

- Course about the remote sensing of the cryosphere (glaciers, ice sheets, sea ice, snow).
- Remote sensing | Fieldwork

Internship
02.2013 – 03.2013

Department for Observation Systems, Météo France
Toulouse, France

- Experimental testing of an in-situ measurement system for snow height.
- Observations | Practical experiments

ERASMUS semester 08.2012 – 12.2012

University Centre in Svalbard *Longyearbyen, Norway*

- Course on Polar Meteorology, including one-week measurement campaign on land.
- Course on Polar Oceanography, including one-week measurement cruise.
- Data analysis | Observations | Fieldwork | Matlab

PEER-REVIEWED PUBLICATIONS

Burgard, C., N. C. Jourdain, P. Mathiot, R.S. Smith, R. Schäfer, J. Caillet, T.S. Finn and J.E. Johnson **(2023)**: "Emulating present and future simulations of melt rates at the base of Antarctic ice shelves with neural networks", *Journal of Advances in Modeling Earth Systems*, 5(12), e2023MS003829, doi: 10.1029/2023MS003829.

We present a proof of concept exploring the potential of simple deep learning techniques to parameterize basal melt. We train a simple feedforward neural network, or multilayer perceptron, acting on each grid cell separately, to emulate the behavior of circum-Antarctic cavity-resolving ocean simulations. We find that a simple feedforward neural network, or multilayer perceptron, acting on each grid cell separately, emulates well the behavior of circum-Antarctic cavity-resolving ocean simulations. This proof of concept is promising and provides a basis for further development of a deep learning basal melt parameterization.

Burgard, C., N. C. Jourdain, R. Reese, A. Jenkins and P. Mathiot **(2022)**: "An assessment of basal melt parameterisations for Antarctic ice shelves", *The Cryosphere*, 16, 4931–4975, doi: 10.5194/tc-16-4931-2022.

The ocean-induced melt at the base the floating ice tongues (ice shelves) around Antarctica is the highest uncertainty factor in the Antarctic contribution to future sea level. We re-tune, assess and compare the performance of several existing parameterisations to simulate basal melt rates on a circum-Antarctic scale, using an ocean simulation resolving the sub-shelf cavities as our reference. We find that simple quadratic slope-independent and plume parameterisations yield the best compromise.

Jourdain, N.C., P. Mathiot, **C. Burgard**, J. Caillet and C. Kittel **(2022)**: Ice shelf basal melt rates in the Amundsen Sea at the end of the 21st century, *Geophysical Research Letters*, doi: 10.1029/2022GL100629.

We build an ensemble of three ocean–sea-ice–ice-shelf simulations for both the recent decades and the late 21st century. Our simulations suggest that high-end melt projections previously used to constrain recent sea level projections may have been significantly overestimated.

Smith, A., A. Jahn, **C. Burgard**, D. Notz **(2022)**: "Improving model-satellite comparisons of sea ice melt onset with a satellite simulator", *The Cryosphere*, 16, 3235–3248, doi: 10.5194/tc-16-3235-2022.

The timing of Arctic sea ice melt each year is an important metric for assessing how sea ice in climate models compares to satellite observations. Here, we utilize a new tool for creating more direct comparisons between climate models projections and satellite observations of Arctic sea ice, such that the melt onset dates are defined the same way. This tool allows us to identify climate model biases more clearly and gain more information about what the satellites are observing.

Durand, G., M. van den Broeke, G. Le Cozannet, T.L. Edwards, P.R. Holland, N.C. Jourdain, B. Marzeion, R. Mottram, R.J. Nicholls, F. Pattyn, F. Paul, A.B. Slangen, R. Winkelmann, **C. Burgard**, C.J. van Calcar, J.B. Barré, A. Bataille, and A. Chapuis **(2022)**: "Sea-Level Rise: From Global Perspectives to Local Services", *Frontiers in Marine Sciences*, doi: 10.3389/fmars.2021.709595.

Overview paper of the motivation and working plan of the H2020 PROTECT project. We advocate that addressing the problem of future sea-level rise and its impacts requires (i) bringing together a transdisciplinary scientific community, from climate and cryospheric scientists to coastal impact specialists, and (ii) interacting closely and iteratively with users and local stakeholders to co-design and co-build coastal climate services, including addressing the high-end risks.

Burgard, C., D. Notz, L.T. Pedersen and R.T. Tonboe **(2020)**: "The Arctic Ocean Observation Operator for 6.9 GHz (ARC3O) – Part 2: Development and evaluation", *The Cryosphere*, 14, 2387-2407, doi: 10.5194/tc-14-2387-2020.

Presentation of the workflow of the Arctic Ocean Observation Operator (ARC3O) that we developed, including a comparison of the microwave brightness temperatures simulated with ARC3O from climate model output with brightness temperatures observed by satellites. We find that the two sets of brightness temperatures compare well in cold conditions and that differences in warm conditions are driven by uncertainty in the simulated sea-ice concentration and melt-pond fraction.

Burgard, C., D. Notz, L.T. Pedersen and R.T. Tonboe **(2020)**: "The Arctic Ocean Observation Operator for 6.9 GHz (ARC3O) – Part 1: How to obtain sea-ice brightness temperatures at 6.9 GHz from climate model output", *The Cryosphere*, 14, 2369-2386, doi: 10.5194/tc-14-2369-2020.

Investigation of the feasibility of an observation operator producing passive microwave brightness temperatures for sea ice at a frequency of 6.9 GHz. Experiments conducted in a 1D setup, using a complex 1D thermodynamic sea-ice model and a 1D microwave emission model. We find that realistic brightness temperatures can be simulated in winter from a simplified linear temperature profile and a self-similar salinity profile in the ice.

Burgard, C. and D. Notz **(2017)**: "Drivers of Arctic Ocean warming in CMIP5 models". *Geophysical Research Letters*, 44, 4263-4271, doi: 10.1002/2016GL072342.

Investigation of changes in the Arctic Ocean energy budget simulated by 26 general circulation models from the CMIP5 framework to understand whether the Arctic Ocean warming between 1961 and 2099 is primarily driven by changes in the net atmospheric

surface flux or by changes in the meridional oceanic heat flux. We find that the models strongly disagree, due to different changes in the meridional oceanic heat flux.

Maahn, M., **C. Burgard**, S. Crewell, I.V. Gorodetskaya, S. Kneifel, S. Lhermitte, K. Van Tricht and N.P. van Lipzig **(2014)**: "How does the spaceborne radar blind zone affect derived surface snowfall statistics in polar regions?". *Journal of Geophysical Research: Atmospheres*, 119(24), 13-604, doi : 10.1002/2014JD022079.
Investigation of the effect of the blind zone of the CloudSat satellite near the surface on snowfall estimates by comparing snowfall estimates based on CloudSat measurements with snowfall estimates based on a ground-based Micro-Rain-Radar (MRR). Two blind zone heights were investigated. We find that the resulting snowfall statistics from CloudSat are biased compared to the MRR, for both blind zone heights.

OTHER PUBLICATIONS

Bouissou, B., **C. Burgard** and N.C. Jourdain **(2022)**. Parameterising ocean-induced melt of an idealised Antarctic ice shelf using deep learning, *ECCOMAS22 Conference proceedings*, doi: 10.23967/eccomas.2022.216.
Short conference paper summarising the results of B. Bouissou's master internship. We find that ocean-induced sub-shelf melt can be parameterised using a neural network in an idealised geometry and taking a few limitations into account.

Regoto, P., **Burgard, C.** and Jones, C. **(2022)**. What Do We Mean By "Climate" And "Climate Change"?, *Frontiers for Young Minds*, doi: 10.3389/frym.2022.671886.
Nogherotto, R., **Burgard, C.** and Jones, C. **(2022)**. What is causing our climate to change so quickly now?, *Frontiers for Young Minds*, doi: 10.3389/frym.2022.668763.
Contributions to special issue "Climate Change" of the *Frontiers for Young Minds* journal, which is aimed at a young audience. The manuscripts are reviewed by children.

Burgard, C. (2019). "Rethinking the relationship between the observed, simulated and real Arctic sea-ice evolution". *PhD Thesis*, Universität Hamburg, Hamburg. doi:10.17617/2.3165898.

10 single-author and 4 co-author blog posts for the *EGU Cryosphere Blog* between 2016 and 2021, e.g.
Burgard, C. (2016). Image of the Week – The Journey of a Snowflake, *EGU Cryosphere Blog*, awarded best EGU Blog Post 2016.
Blog posts about diverse cryospheric topics.

Bell H., **C. Burgard**, A. Winkler, M. Yasir **(2015)**: Common Impacts of Mining, Natural Gas Extraction and Shipping Activities in the Arctic. *ACCESS newletter 11*.
Synthesis of student summer school projects investigating the impacts of different activities in the Arctic on the environment, economy and population.

CONFERENCES & WORKSHOPS AND TRAINING SCHOOLS

Presentations

GISS Sea Level Rise Seminar, NASA GISS - Invited — *online*, 02.2023
Cryosphere BXL seminar, VUB and ULB - Invited — *Brussels, Belgium*, 02.2023
IGS Global Seminar Series - Invited — *online*, 02.2023
Polar Oceans Seminar, British Antarctic Survey — *Cambridge, UK*, 01.2023
Forum for Research into Ice Shelf Processes 2022 — *Northumbria, UK*, 09.2022
Machine Learning for Polar Regions Workshop — *online*, 06.2022
8th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS) 2022 — *Oslo, Norway*, 06.2022
EGU General Assembly 2022 — *Vienna, Austria*, 05.2022
Ocean Sciences Meeting 2022 — *online*, 02.2022
vEGU 2021 — *online*, 04.2021
shareEGU 2020 - Pico Presentation (Highlight) — *online*, 05.2020
IGS Symposium "Sea Ice at the Interface" — *Winnipeg, MB, Canada*, 08.2019
European Security Seminar - North, George C. Marshall Center - Invited — *Garmisch-Partenkirchen, Germany*, 02.2019
3 Cluster Conference - Invited — *Berlin, Germany*, 09.2018
POLAR2018 — *Davos, Switzerland*, 06.2018
Cryospheric and Polar Processes Seminar, National Snow and Ice Data Center — *Boulder, CO, USA*, 02.2018
Workshop on improved satellite retrievals of sea-ice concentration and sea-ice thickness for climate applications - Invited — *Hamburg, Germany*, 10.2017
Joint Seminar at the Max Planck Institute for Meteorology — *Hamburg, Germany*, 08.2017
Polar Prediction Workshop & 2nd Sea Ice MIP Meeting — *Bremerhaven, Germany*, 03.2017

Posters

Forum for Research into Ice Shelf Processes 2023 — *Stalheim, Norway*, 06.2023
EGU General Assembly 2023 — *Vienna, Austria*, 04.2023
Arctic System Change Workshop, National Center for Atmospheric Research — *Boulder, CO, USA*, 04.2018
Workshop on Multi-scale modelling of ice characteristics and behavior — *Cambridge, UK*, 09.2017
EGU General Assembly 2017 — *Vienna, Austria*, 04.2017
EGU General Assembly 2016 — *Vienna, Austria*, 04.2016

Training schools

GeoScience Communication School — *Trieste, Italy*, 09.2019
Snow Winter School — *Hailuoto, Finland*, 02.2019
Polar Prediction School — *Abisko, Sweden*, 04.2018
Summer School on Earth System Modelling — *Hamburg, Germany*, 09.2017
NERC Advanced Training Course - Earth Observations for Weather and Climate Studies — *Reading, UK*, 09.2016
Arctic Climate Change, Economy and Society and Arctic Resilience Report Summer School — *Stockholm, Sweden*, 09.2014

TEACHING & SUPERVISION ☺

Mentor — 02.2023
of two teams during the CryoHackathon organised by the IGS Early Glaciologists Group — *online*

Supervisor — 02.2022 - 06.2022
Master internship of Benjamin Bouissou: "Parameterization of basal melting of an ice shelf with idealized geometry via a neural network" — *Université Grenoble Alpes*

Presenter & Convener — 05.2020
Short course webinar "Science Blogging for Beginners" at shareEGU 2020 — *online*

ACADEMIC SERVICE

Reviewer since 12.2016
for scientific publications such as The Cryosphere, Journal of Geophysical Research – Oceans, Science Advances, IPCC assessment reports, Journal of Climate

Postdoctoral representative 01.2023 - 08.2023
at the IGE Lab Council *Grenoble, France*

Member of the Organization team 09.2021 - 08.2023
for the weekly IGE seminars *Grenoble, France*

Convener 05.2023
Session "Advances in sea-ice modelling and Polar & Cryosphere attribution" at the EGU General Assembly 2023 *Vienna, Austria*

Convener 06.2022
Mini-Symposium "Mathematics of Sea Ice, Ice Sheets and Ice Shelves" at ECCOMAS 2022 *Oslo, Norway*

Early Career member 10.2020 - 09.2021
of the H2020 PROTECT Steering Committee

Convener 04.2018
Short course "Polar Science Career Panel" at the EGU General Assembly 2018 *Vienna, Austria*

Convener 04.2017
Short courses "Polar Science Career Panel" and "Successful strategies to design, develop and write a scientific paper" at the EGU General Assembly 2017 *Vienna, Austria*

Member of the Organization Committee 11.2016 - 10.2017
Max Planck PhDnet "Visions in Science" conference *Berlin, Germany*

PhD representative 10.2016 - 10.2017
International Max Planck Research School for Earth System Modelling *Hamburg, Germany*

OUTREACH & OTHER ACTIVITIES

Co-Developer since 04.2022
of the in-presence and virtual Escape game on glacier melt
- A game full of enigmas for young and less young people eager to learn about glacier melt. This escape game has been developed at the IGE and funded by H2020 PROTECT. People can play it for example during pedagogic visits at IGE.

Co-Developer since 06.2017
of the role play game "Cold Cooperation"
- A role game for older pupils, students, and adults about the trade-off between reducing CO2 emissions and sustaining a thriving economy, through the example of the sea-ice loss in the Arctic region.

Regular member of the EGU Cryosphere Division Blog Team since 04.2016
Author & Editor, Chief Editor (04.2017 - 05.2020), Outreach Officer (05.2020 to 05.2022)
- Writing and review of blog posts
- Management of content and team, recruitment of authors and editors.

Co-Initiator and Member of the Editorial Team 01.2018 – 12.2019
of the Max Planck Institute for Meteorology Twitter account
- Co-author on the proposal for the creation and management of the institutional @MPI_Meteo Twitter account
- Communication with paper authors on the redaction of tweets and preparations of figures to be published through the Twitter account

Climate scientist providing input 07.2018 & 07.2019
at the I.C.E. Camp organized by the in.media.vitae Foundation and Arved Fuchs
- Yearly recurring educative expedition in the Baltic Sea for a group of 16- to 18-year-olds, including lectures and practicals on climate change

Initiator and organizer 11.2018 & 11.2019

*of the internal Clim*art contest at the Max-Planck Institute for Meteorology*

- Internal institute contest that had the aim to consider more or less scientifically meaningful figures from an artistic perspective

Initiator and coordinator 2018 & 2019

of the Climate Model Calendar 2019 and 2020

- Early career researchers from Hamburg posed in a setting artistically representing their research topic related to climate modeling. The calendar was distributed within the Hamburg climate science community.

Contributor 11.2017

of the Nacht des Wissens Hamburg

- Quiz for the lay public about polar and ice facts

Support for school workshops 2016, 2017, 2019

at the Hamburger Pupil Congress (Schülerkongress) about climate change

- Debate about potential measures to slow down climate change
- Playing our "Cold Cooperation" game
- Discussion about mobility concepts for a climate-friendly future

SCHOLARSHIPS & AWARDS

Participant in the German-French Young Leaders programme Génération Europe/Generation Europa 01.2023 - 12.2023

launched by the German-French Office for Youth (OFAJ/DFJW) to build the future of the French-German relationship in a European context

Recipient of Max Planck Institute Bonus 06.2019

given for an exceptional contribution to the Max Plank Institute for Meteorology

- Development of a concept and editorial structure of an institutional Twitter account

Recipient of a Travel Award 06.2018

funded by the World Climate Research Programme (WCRP)'s Climate and Cryosphere (CliC) and APECS to attend the POLAR2018 conference in Davos, Switzerland.

- Award worth up to 890 CHF

Author of the Best EGU Blog Post 2016 01.2017

for the blog post "The Journey of a Snowflake"

Scholarship 04.2012 - 11.2015

by the Heinrich Böll Stiftung

- Support during the second half of my B.Sc. studies and full M.Sc. studies

2nd place 06.2009

in the Concours Général, category "German"

1st place 02.2008

in the journalistic contest "Chassé-Croisé" organized by the French-German Youth Foundation

SKILLS

Programming

Expert: Python, CDO, UNIX
Advanced: Bash, Matlab, LaTeX
Beginner: Fortran 95, Git

Software

Expert: Microsoft PowerPoint
Advanced: Microsoft Excel, Microsoft Word

Languages

Bilingual: German, French
Fluent: English
Good: Spanish
Basic: Norwegian, Italian