Curriculum Vitae
Penny M. Rowe, Ph.D.

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Education

Ph.D., Physical Chemistry, University of Washington

B.S., Chemistry, with Honors (Minor in Mathematics), University of Puget Sound

Programming / Technical Tools
- Python, Pandas, NumPy, SciPy, Jupyter Notebook, Django, FastAPI, TensorFlow
- C, Fortran, Java, R, MATLAB, HTML, CSS, JavaScript, React, Svelte, Sveltkit, Typescript
- SQL, SQLite, mySQL, NetCDF
- Linux, macOS, Windows

Professional Experience

Software Engineer Intern: 2nd Chair   Nov. 2023 – Feb. 2024
- Assisted in CI website development using Sveltekit on Vercel, Auth.js, DyanmoDB, AppSync, GraphQL, and AWS SAM, including testing database functionality and implementing UI.
- Developed module in Python to upload and parse PDFs in support of machine learning algorithm.
- Coordinated effort to achieve SOC2 attestation.
- Ideated key performance indicators, reviewed tracking methodologies and off-the-shelf solutions.

Research Scientist: NorthWest Research Associates, Inc   2016 – present
- Characterized clouds and radiation over the Southern Ocean based on in-situ and remote-sensing measurements from 2017-2023. Found that the Polar Weather Research Forecasting model and ERA5 reanalysis model underpredict longwave radiation and overpredict shortwave radiation, attributed to insufficient modeled cloud amount or cloud liquid relative to ice over the Southern Ocean.
- Investigated interactions between Antarctic clouds and radiation and effect on surface energy balance during atmospheric river and foehn events, determining that solar radiation was the main cause of surface warming during an extreme warming event in Feb. 2022.
- Developed 9 computational modules that teach polar research in a variety of courses using Excel, Jupyter Notebook, or RStudio. Several modules ranked exemplary by the Science Education. Resource Center of Carleton College. Used by 18 instructors, reaching ~300 students per year.
- Developed, cleaned, and analyzed student knowledge-test surveys. Students reported climate knowledge gains, improvements in comfort with computational tools and positive responses to the educational modules. Surveys demonstrated improvements in learning gains of 150%.
- Developed the CLoud and Atmospheric Radiation Retrieval Algorithm (CLARRA), using Levenberg-Marquardt inversion in a Bayesian framework, for retrieving cloud properties from surface-based remote-sensing downwelling infrared radiance spectra. Implemented at South Pole and McMurdo Stations, Antarctica; North Slope of Alaska; and Eureka, Canada; planned for Summit, Greenland.
- Interpolated and compiled temperature-dependent refractive indices of water based on statistical analysis of laboratory datasets. Created dataset of optical constants for supercooled liquid water from 240 to 273 K and 0.7 to 10,000 µm, using Kramers-Kronig transformation to compute real parts of complex refractive indices from literature values of imaginary parts and Mie theory to calculate single scattering albedos and Legendre moments. Refractive indices included in the database RefractiveIndex.INFO (https://refractiveindex.info/?shelf=main&book=H2O&page=Rowe-240K).

Research Affiliate: University of Santiago, Physics Dept.   2014 – 2020
- Conducted and led field work examining clouds and radiation at research platform at Chilean Antarctic station Escudero, using broadband fluxes, surface meteorology, radiosondes, lidar.
- Measured concentrations of black carbon in snow in Chilean Andes and estimate the impact on the radiative forcing.

Research Affiliate: University of Idaho, Dept. of Geography   2012 – 2014
- Retrieved atmospheric temperature and greenhouse gas concentrations from surface-based remote-sensing time series of downwelling infrared radiation.
- Analyzed satellite-based remote-sensing infrared radiance data from the Interferometric Monitor for Greenhouse Gases to retrieve cloud properties.

Communication and Leadership Skills

I have led eight grant-funded research projects on subjects ranging from working with international teams of up to 50, mentored 18 students, led one of the first virtual NSF summer research experience for undergraduate programs, given numerous conference presentations, invited talks, webinars and guest lectures, led workshops and focus groups, and participated in more than ten outreach events at local schools and museums. The products of my work include published datasets, educational modules, websites, and over 60 peer-reviewed published articles with over 1000 citations.

Grant History
- Collaborative Research: Cloud Radiative Impact on the Surface Energy Budget of the Antarctic Peninsula. As PI for this collaborative grant from the National Science Foundation (NSF), I am working with a large, multinational and multidisciplinary team to understand the impacts of extreme weather events in Antarctica. (NSF; 2021-2024)
- Collaborative Research: Polar (NSF 19-601): RUI: Computational Polar ENgagement through GUided INquiry (Computational PENGUIN). As PI for this grant, I am working with two co-PIs to develop, disseminate, and test the efficacy of educational modules that bring polar research into undergraduate curricula. (NSF; 2020-2024).
- PROMESA: AtmosPheric RadiatiOn Measurements on King George Island (Southern Ocean/Antarctic Peninsula. As Co-PI in this project, I characterized the radiative impact of Antarctic clouds (Chile; Fondecyt; 2019-2023).
- Polar (DCL- 16-119): Collaborative Research: Computational Guided Inquiry for Incorporating Polar Research into Undergraduate Curricula. As PI for this grant, I worked with two co-PIs to produce [educational materials](#) using computational tools such as Python Jupyter Notebooks. (NSF; 2017-2021).
- The Infrared Radiative Impact of Antarctic Clouds. As PI for this grant, I produced software to ingest large amounts of geoscience data and use a Levenberg-Marquardt inverse retrieval in a Bayesian framework to retrieve cloud properties. (NSF; 2016-2020).
- Characterization of Low Clouds over the Antarctic Peninsula and the West Antarctic Ice Sheet (WAIS). As PI for this grant, I examined the role of clouds and radiation over the Antarctic Peninsula, led a team of students and researchers in Antarctic field work and participated in the Year of Polar Prediction Southern Hemisphere (YOPP-SH), a major international campaign (Chile; CONICYT/FONDECYT; 2016-2019).
- Development of the Autonomous Arctic Infrared Observer (AAIRO). As PI for this grant, I developed software to simulate the potential for a novel research instrument (NSF; 2011-2015).

Refereed Publications in the last five years (see www.researchgate.net/profile/Penny-Rowe/research for full list including all coauthors).

Bromwich et al, (2024), Winter Targeted Observing Periods during the Year of Polar Prediction in the Southern Hemisphere (YOPP-SH), *Bulletin of the American Meteorological Society,* submitted.

Clem et al. (2024), Meteorology and Climate of Antarctica, Book Chapter in Meteorology of the Southern Hemisphere, Cambridge University Press, submitted.

Rowe et al. (2024). Undergraduate-student knowledge gains in polar literacy and statistics after completing computational guided inquiry modules, *Journal of Geoscience Education*, in review.

Gorodetskaya et al. (2023). Compound drivers behind new record high temperatures and surface melt at the Antarctic Peninsula in February 2022, *NPJ Clim. Atmos. Sci*., accepted.

Wille et al. (2024), The extraordinary March 2022 East Antarctica "heat" wave. Part I: observations and meteorological drivers, J. Clim., 37(3), pp.757-778.

Wille et al. (2024), The extraordinary March 2022 East Antarctica "heat" wave. Part II: impacts on the Antarctic ice sheet. J. Clim., 37(3), pp.779-799.

Cordero et al. (2023). Surface Solar Extremes in the Most Irradiated Region on Earth, Altiplano. *Bulletin of the American Meteorological Society.*

Zou et al (2022). Strong Warming over the Antarctic Peninsula during Combined Atmospheric River and Foehn Events: Contribution of Shortwave Radiation and Turbulence. Journal of Geophysical Research: Atmospheres, p.e2022JD038138.

Guy et al. (2023). Observations of fog-aerosol interactions over central Greenland. *J. Geophys. Res. Atmos.,* in production.

Cordero et al. (2023) Ground-based measurements of the weather-driven sky radiance distribution in the Southern Hemisphere. PLOS ONE 18(6): e0286397. https://doi.org/10.1371/journal.pone.0286397.

Cordero et al. (2022). Black carbon footprint of human presence in Antarctica. *Nature communications*, *13*(1), pp.1-11.

Cordero et al. (2022). Black carbon in the Southern Andean snowpack. Environmental Research Letters, 17(4), p.044042.

Richter et al. (2022). A dataset of microphysical cloud parameters, retrieved from Fourier-transform infrared (FTIR) emission spectra measured in Arctic summer 2017. *Earth System Science Data*, *14*(6), 2767-2784.

Cordero et al. (2022). Persistent extreme ultraviolet irradiance in Antarctica despite the ozone recovery onset. *Scientific reports*, *12*(1), pp.1-10.

Rowe et al. (2021). Evaluation of Temperature-Dependent Complex Refractive Indices of Supercooled Liquid Water Using Downwelling Radiance and In-Situ Cloud Measurements at South Pole, *Journal of Geophysical Research: Atmospheres*, 127, e2021JD035182. https://doi.org/10.1029/2021JD035182.

Chyhareva et al. (2021). Precipitation phase transition in austral summer over the Antarctic Peninsula. *Ukrainian Antarctic journal*, (1), 32-46.

Pizarro et al. (2021). Contaminant emissions as indicators of chemical elements in the snow along a latitudinal gradient in southern Andes. *Scientific reports*, *11*(1), 1-10.

Rowe et al. (2021). Integrating polar research into undergraduate curricula using computational guided inquiry. *Journal of Geoscience Education*, *69*(2), 178-191.

Sepúlveda et al. (2021). Evaluation of Antarctic Ozone Profiles derived from OMPS-LP by using Balloon-borne Ozonesondes. *Scientific reports*, *11*(1), 1-11.

Bromwich et al. (2020). The year of polar prediction in the southern hemisphere (YOPP-SH). *Bulletin of the American Meteorological Society*, *101*(10), pp.E1653-E1676.

Fortmann et al. (2020). Teaching Modules for Estimating Climate Change Impacts in Economics Courses using Computational Guided Inquiry. *J. Econ. Educ.* DOI: 10.1080/00220485.2020.1731383.

Gladich, et al. (2020). Solvation and Stabilization of Single-Strand RNA at the Air/Ice Interface Support a Primordial RNA World on Ice. *The Journal of Physical Chemistry C*, *124*(34), 18587-18594.

Lubin et al. (2020). AWARE: The Atmospheric Radiation Measurement (ARM) West Antarctic Radiation Experiment. Bulletin of the American Meteorological Society, BAMS–D–18–0278.1. http://doi.org/10.1175/BAMS-D-18-0278.1

Rowe et al. (2020). Temperature-Dependent Optical Properties of Liquid Water From 240 to 298 K. *Journal of Geophysical Research: Atmospheres*, *125*(17), e2020JD032624. http://doi.org/10.1175/BAMS-D-18-0278.1

Alfonso et al. (2019). Elemental and Mineralogical Composition of the Western Andean Snow (18°S–41°S). *Scientific Reports*, 9(1), 1–13. http://doi.org/10.1038/s41598-019-44516-5.

Perro et al. (2019). Pan-Arctic measurements of wintertime water vapour column using a satellite-borne microwave radiometer. *Atmospheric Measurement Techniques Discussions*, 1-25.

Rowe et al., (2019). Black carbon and other light-absorbing impurities in snow in the Chilean Andes. Scientific Reports, 9(1), 4008. http://doi.org/10.1038/s41598-019-39312-0.

Rowe et al. (2019). Toward autonomous surface-based infrared remote sensing of polar clouds: retrievals of cloud optical and microphysical properties. *Atmos. Meas. Tech.*, 12(9), 5071–5086. http://doi.org/10.5194/amt-12-5071-2019

Educational Materials
- Polar ENgagement through GUided INquiry (PENGUIN) modules that use Python Jupyter Notebooks or Excel Worksheets to give undergraduate students hands-on experience obtaining and working with polar research and data: https://serc.carleton.edu/penguin
- PENGUIN modules for the High School level: https://people.nwra.com/rowe/penguin_high_general.shtml
- Modelling the spread of COVID-19: https://www.kaggle.com/pennyrowe/modeling-spread-covid-19
- Numerous other computational modules: https://www.kaggle.com/pennyrowe/notebooks

Contributed Datasets and Computer code
- Code for calling the Discrete Ordinates Radiative Transfer (DISORT) program to compute cloudy-sky downwelling infrared radiances using LBLRTM and DISORT:
  Python: https://bitbucket.org/clarragroup/rundisort_py
  Matlab/Octave: https://bitbucket.org/clarragroup/rundisort_mat
- Temperature-dependent refractive indices of liquid water
- Temperature-dependent single-scattering properties of liquid water:
- Simulated line-by-line clear and cloudy sky infrared radiances for atmospheric profiles characteristic of the Arctic (available on request).

Guest Lectures
- Applying Statistics to Polar Research, University of Puget Sound (Undergraduate), Tacoma, WA, 6 talks over two weeks in 2 classes, 2021.
- "Evaluating an Environmental Impact Statement: the Tacoma LNG Plant", University of Puget Sound (Undergraduate), Tacoma, WA, 2020, 2021.
- "The Greenhouse Effect and Climate Change," Seabury Middle School, Tacoma, WA, Oct. 11, 2016.
- "Climate Change and Atmospheric Science in the Cryosphere," Colegio Aleman de Valparaiso (High School), Vina del Mar, Chile, June 20, 2016.
- "Infrared Spectra of Clouds and Greenhouse Gases", Sammamish High School (High School chemistry class), Bellevue, WA, 2013.
- "Infrared Spectra of Clouds and Greenhouse Gases", University of Puget Sound (Undergraduate chemistry class), Tacoma, WA, 2013.
- "Cloud in a jar," Bryant Elementary (elementary class), Tacoma, WA, 2012.

Invited Science Talks
- Cloud property retrievals from downwelling infrared radiances from polar atmospheres, Seminar on Physics and Chemistry of the Atmosphere, SoSe 2021, Institute of Environmental Physics (IUP) Bremen, Germany, May 218, 2021.
- Retrievals of polar cloud properties from infrared radiance spectra, Thompson Hall Science and Mathematics Seminars, University of Puget Sound, September 19, 2013.

- Importance of new Temperature-Dependent Refractive Indices of Water for Simulated Thermal Emission from Super-Cooled Liquid Water Clouds, Noble Seminar Series. Reginald and Murial Noble Fund, University of Toronto Atmospheric Physics Group, November 5, 2012.

Research Mentoring Experience
- Charles Henning: Black carbon on snow on Mt. Rainier, Washigton. Summer 2023.
- Danielle Dolan and Anna Van Boven: Developed a module applying statistics to ice core data for the project Polar ENgagement through GUided INquiry (PENGUIN). Summer 2021.
- Isabella Hedly, Anoushka Adhav, Augustin Kalytiak-Davis, Reid O'Brien, Cameron Markovsky, Jodie McClennan, and Lydia Gilbert. Mentored students and led one of the first virtual summer research experience for undergraduate (REU) programs of the National Science Foundation, with 14 students total. Summer 2020.
- Katie Gray and Emma Sevier: Computational Guided Inquiry for bringing polar data into undergraduate classrooms. Summer 2018.
- Mathew Fergoda: Infrared radiance of Antarctic Clouds. Summers 2017 and 2018.
- Connor Krill: Infrared radiance of Antarctic Clouds. Summer 2017.
- Aedin M. Wright: Temperature inversions in radiosoundings and Computational Guided Inquiry for bringing polar data into undergraduate classrooms. October 2016 – August 2018.
- Edgardo Sepulveda: Clouds and atmospheric structure over King George Island, Antarctica. 2016-2020.
- Alec Pankow, Emily Stewart, and Chilean graduate and undergraduate students: Snow sampling and filtering for black carbon in the Chilean Andes, Austral winters 2015, 2017.
- Alessio Spassiani: NSERCE CREATE Undergraduate Summer Internship, June - August 2011.

Public Outreach
- Presented talk about careers in climate science at Seabury Middle School, Tacoma, WA (2023)
- STEM Career fair panelist at Sammamish High School, Bellevue, WA, (2017-2019).
- Organized and implemented Spanish language translation for High-Adventure Science online educational module (HAS.concord.org; "What is the Future of Earth's Climate?") (Completed 2018).
- Participated in the Pacific Science Center Polar Science Weekend with an exhibit "Where is the Polar Front?" Seattle, WA (2015)
- Participated in the University of Puget Sound Art+Science salon hosted by the Tacoma Art Museum, Tacoma, WA (2013)
- Judge for the Bryant Middle School Science Fair (2011, 2012, 2014, 2015)

In the Media
- Twitter feed for NorthWest Research Associates: https://twitter.com/NWRA_science
- Twitter feed for Antarctic Research Group of the University of Santiago: https://twitter.com/Antarcticacl.
- Article in the Chilean Antarctic Bulletin special edition "Women of Antarctic Climate Change" (Spanish): Olas de Calor en la Antarctica?, Feron, S. and Rowe, P.M. (2021) 40(2), 29-31.
- Year of Polar Prediction (YOPP) PolarPredict News Newsletter #4: Describes YOPP-endorsed project: Characterization of Low Clouds and the Atmosphere over the Antarctic Peninsula and West Antarctic Ice Sheet (CAALC): https://www.polarprediction.net/fileadmin/user_upload/www.polarprediction.net/Home/News/PolarPredictNews/PolarPredictNews04_final.pdf, Nov 2017.
- Sampling black carbon in the Chilean Andes: Incluida la Región de Coquimbo: Científicos estudian niveles de carbón presentes en la nieve de la Cordillera de Los Andes, in Centro de Estudios Avanzados en zonas aridas (Ceaza.cl), 21 July 2015.
- Antarctic research at King George Island near the northern end of the Antarctic Peninsula: Participation in the Chilean Antarctic School Trip in 2018 (in Spanish): EXPEDICIÓN ANTÁRTICA ESCOLAR: UNA EXPERIENCIA ÚNICA (https://www.radiofestival.cl/expedicion-antartica-escolar-una-experiencia-unica/ and http://www.radiopolar.com/noticia_146739.html), Dec 2018.