

# Hansi K. A. Singh

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## Research Interests

Coupled climate dynamics. Atmosphere-ocean-ice interactions. Polar climates. Local and global climate feedbacks. Earth system modeling. Mathematical methods for geophysical data analysis.

## Current Position

Assistant Professor, School of Earth and Ocean Sciences, University of Victoria, Victoria BC, Canada.

## Education

**PhD, Atmospheric Sciences**, 2015, University of Washington, Seattle. *Committee:* Cecilia Bitz (chair), Dennis Hartmann, Christopher Bretherton. *Dissertation Title:* Energy and Moisture Transport in the Earth Climate System: Mean State and the Perturbation Response

**MS, Applied Mathematics**, 2015, University of Washington, Seattle.

**BA, Physics**, 2000, Rice University.

## Academic Honors

**Linus Pauling Distinguished Postdoctoral Fellowship**, Pacific Northwest National Laboratory, US Department of Energy Office of Science, 2016-2019.

**US Department of Energy Computational Science Graduate Fellowship**, 2011-2015.

**President's Honor Roll**, Rice University, 1996-2000.

**Welsh Engineering Scholarship**, Rice University, 1996-1998.

**Academic Publications (Peer-Reviewed)**

Bailey AR, **Singh HA**, Nusbaumer J. “Evaluating a Moist Isentropic Framework for Poleward Moisture Transport: Implications for Water Isotopes over High Latitudes”, *Geophysical Research Letters*, accepted, Jun 2019.

Garuba OA, Lu J, **Singh HA**, Liu F, Rasch PJ. “On the Relative Roles of the Atmosphere and Ocean in the Atlantic Multidecadal Variability”, *Geophysical Research Letters*, 2018, 45 (17), pp 9186-9196, doi: 10.1029/2018GL078882.

**Singh HA**, Garuba OA, Rasch PJ. “How Asymmetries Between Arctic and Antarctic Climate Sensitivity are Modified by the Ocean”, *Geophysical Research Letters*, 2018, 45 (23), pp 13-31, doi: 10.1029/2018GL079023.

**Singh HA**, Hakim G, Tardif R, Emile-Geay J, Noone DC. “The Atlantic Multidecadal Oscillation in the Last Millennial Reanalysis: Dynamics and Time Scales”, *Climate of the Past*, 2018, 14 (2), pp 157-174, doi: 10.5194/cp-2017-49.

Garuba OA, Lu J, Liu F, **Singh HA**. “The Active Role of the Ocean in the Temporal Evolution of Climate Sensitivity”, *Geophysical Research Letters*, 2018, 45 (1), pp 306-315, doi: 10.1002/2017GL075633.

**Singh HA**, Bitz CM, Donohoe A, Rasch PJ. “A Source-Receptor Perspective on the Polar Hydrologic Cycle: Source Regions, Seasonality, and Arctic-Antarctic Parity in the Hydrologic Cycle Response to CO<sub>2</sub>-Doubling”, *Journal of Climate*, 2017, 30 (24), pp 9999-10017, doi: 10.1175/JCLI-D-16-0917.1.

**Singh HA**, Rasch PJ, Rose BEJ. “Increased Ocean Heat Transports into the High Latitudes with CO<sub>2</sub>-Doubling Enhance Polar-Amplified Warming”, *Geophysical Research Letters*, 2017, 44 (20), pp 10583-10591, doi: 10.1002/2017GL074561.

**Singh HA**, Donohoe A, Bitz CM, Nusbaumer J, Noone DC. “Greater Aerial Moisture Transport Distances with Warming Amplify Interbasin Salinity Contrasts”, *Geophysical Research Letters* 2016, 43 (16), pp 8677-8684, doi:10.1002/2016GL069796.

**Singh HA**, Bitz CM, Nusbaumer J, Noone DC. “A Mathematical Framework for Analysis of Water Tracers: Part II, Understanding Large-Scale Perturbations in the Hydrological Cycle due to CO<sub>2</sub>-Doubling”, *Journal of Climate* 2016, 29 (8), pp 6765-6782, doi:10.1175/JCLI-D-16-0293.1.

**Singh HA**, Bitz CM, Nusbaumer J, Noone DC. “A Mathematical Framework for Analysis of Water Tracers: Part I, Development of Theory and Application to the Preindustrial Mean State”, *Journal of Advances in Modeling Earth Systems* 2016, 8 (2), pp 991-1013, doi:10.1002/2016MS000649.

**Singh HA**, Bitz CM, Frierson DMW. “The Global Climate Response to Lowering Surface Orography of Antarctica and the Importance of Atmosphere-Ocean Coupling”, *Journal of Climate* 2016, 29 (11), pp 4137-4153, doi:10.1175/JCLI-D-15-0442.1.

Steig EJ, Huybers K, **Singh HA**, Steiger NJ, Ding Q, Frierson DMW, Popp T, White JWC. “Influence of West Antarctic Ice Sheet collapse on Antarctic surface climate”, *Geophysical Research Letters* 2015, 42, doi:10.1002/2015GL063861.

**Singh HA**, Battisti DS, Bitz CM. “A Heuristic Model of the Dansgaard-Oeschger Cycles: Description, Results, and Sensitivity Studies: Part I”, *Journal of Climate* 2014, 27 (12), pp 4337-4358, doi:10.1175/JCLI-D-12-00672.1.

Vaccaro JA, **Singh HA**, Anderson KS. “Initiation of Minus-Strand DNA Synthesis by Human Immunodeficiency Virus Type 1 Reverse Transcriptase”, *Biochemistry* 1999, 38 (48), pp 15978-15985.

#### Academic Publications (in progress)

**Singh HA**, Polvani LM, Rasch PJ. “Antarctic Sea Ice Expansion, Driven by Internal Variability, in the Presence of Increasing Atmospheric CO<sub>2</sub>”, in revision at *Geophysical Research Letters*, June 2019.

Wang H, Fyke J, Lenaerts J, Nusbaumer, JM, **Singh HA**, Noone DC, Rasch PJ. “Influence of Sea Ice Anomalies on Antarctic Precipitation Using Source Attribution”, in review at *The Cryosphere*, Jun 2019, doi: 10.5194/tc-2019-69.

Garuba OA, **Singh HA**, Rasch PJ, Hunke E. “Disentangling Coupled Ocean-Atmosphere Interactions and their Impacts on Arctic and Antarctic Sea Ice Responses to CO<sub>2</sub> Forcing”, in preparation for submission to *Journal of Climate* in Jul 2019.

**Singh HA**, Polvani LM. “Robust Reduction in Antarctic Climate Sensitivity due to Orography”, in preparation for submission to *Geophysical Research Letters* in Aug 2019.

**Singh HA**, Kay JE. “Ocean Heat Transport Changes with CO<sub>2</sub> Forcing Impact Global Climate Sensitivity through Lapse Rate and Cloud Feedbacks”, in preparation for submission to *Nature Geoscience* in Sept 2019.

**Singh HA**, Landrum L, Holland MM. “Antarctic Sea Ice Variability in the CESM2: Predictability, Atmosphere-Ocean-Ice Interactions, and the CO<sub>2</sub>-Forced Response”, in preparation for submission to *Journal of Climate, CESM2 Special Issue* in Oct 2019.

## Selected Presentations

“Antarctic Sea Ice Expansion, Driven by Internal Variability, Coincident with Increasing Atmospheric CO<sub>2</sub>”, Singh HA, Polvani LM, Rasch PJ. *Contributed Talk*. 15th Conference on Polar Meteorology and Oceanography, Spring 2019.

“Antarctic Climate and its Sensitivity: Orography, Moisture Transport, and Natural Variability of the Coupled Atmosphere-Ocean-Ice System”, Singh HA, Polvani LM, Rasch PJ, Raudzens-Bailey A, Garuba OA. *Invited Talk*. Atmospheric Physics Seminar Series (Mar 2019), Department of Physics, University of Toronto.

“How Asymmetries Between Arctic and Antarctic Climate Sensitivity are Modified by the Ocean”, Singh HA, Garuba OA, Rasch PJ. *Invited Talk*. AGU Fall 2018 Meeting, Session: Mechanisms of Low-Frequency Ocean-Atmosphere Variability and Implications for Earth’s Energy Budget I.

“Sea Ice as a Predictor of Atmosphere and Ocean States over the Arctic and Southern Oceans, and Implications for Attribution of Polar Climate Change”, Singh HA, Rasch PJ. *Contributed Talk*. AGU Fall 2018 Meeting, Session: Sea Ice as a Predictor of Atmosphere and Ocean States over the Arctic and Southern Oceans, and Implications for Attribution of Polar Climate Change I.

“The Impact of the Time-Evolving Ocean Response to CO<sub>2</sub>-Doubling on Polar Climates”, Singh HA, Garuba O, Rasch PJ. *Contributed Talk*. AGU Ocean Sciences 2018 Meeting, Session: The Ocean as a Mediator of Climate and Climate Change.

“Climate Sensitivity and Natural Variability: Theoretical Frameworks and the Bounding of Radiative Feedback Estimates”, Singh HA, Leung LR, Rasch PJ, Garuba O, and Lu J. *Contributed Talk*. AGU Fall 2017 Meeting, Session: Climate Sensitivity and Feedbacks: Advances and New Paradigms I.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM, Garuba O. *Invited Talk*. Departmental Seminar (Dec 2017), Courant Institute of Mathematical Sciences, New York University.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM, Garuba O. *Invited Talk*. Departmental Seminar (Nov 2017), Department of Physics and Atmospheric Sciences, Dalhousie University.

“Impact of Ocean Dynamics on Polar Climate Change”, Singh HA, Rasch PJ, and BEJ Rose. *Contributed Talk*. American Meteorological Society 21st Conference on Atmospheric and Oceanic Fluid Dynamics, Session: Theory and Dynamics of Atmosphere-Ocean-Ice Interactions.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. Departmental Seminar (May 2017), Department of Atmospheric and Oceanic Sciences, University of California at Los Angeles.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. College Seminar (May 2017), College of Earth, Oceanic, & Atmospheric Sciences, Oregon State University, Corvallis.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. Departmental Seminar (April 2017), Department of Atmospheric & Environmental Sciences, University at Albany, SUNY.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. Departmental Seminar (April 2017), Department of Earth & Atmospheric Sciences, Cornell University.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. Departmental Seminar (March 2017), Department of Earth & Space Sciences, University of California at Irvine.

“Arctic-Antarctic Parity in Polar Climate Sensitivity: the Hydrological Cycle, Ocean Dynamics, and Meridional Energy Transports”, Singh HA, Donohoe A, Rasch PJ, Rose BEJ, Bitz CM. *Invited Talk*. Departmental Seminar (March 2017), Scripps Institute of Oceanography, University of California at San Diego.

“A Lagrangian Perspective on Aerial Hydrologic Cycle Change in a Warmer World”, Singh HA, Bitz CM, Donohoe A, Nusbaumer J, Noone DC. *Contributed Talk*. American Geophysical Union Fall 2016 Meeting, Session: Atmospheric Circulation and Hydrological Cycle under a Changing Climate – Monsoons, Storm Tracks, and the ITCZ.

“A New Perspective on Atlantic Multidecadal Variability from the Last Millennial Reanalysis”, Hakim GJ, Singh HA (presenting author). *Contributed Talk*. American Geophysical Union Fall 2016 Meeting, Session: Climate of the Common Era.

“A Lagrangian Perspective on Polar Hydroclimate Perturbations in a Warmer World”, Singh HA, Bitz CM, Donohoe A. *Invited Poster*. American Geophysical Union Fall 2016 Meeting, Session: Polar Hydroclimate in a Paleoclimate Context – Current Understanding and Future Challenges.

“A Novel Mathematical Framework for Analysis of Numerical Water Tracers and the Aerial Moisture Source-Sink Relationship”, Singh HA, Bitz CM, Donohoe A. *Contributed Talk*. European Geophysical Union Leonardo Conference, From Evaporation to Precipitation: the Atmospheric Moisture Transport, Fall 2016.

“Arctic-Antarctic Parity in Polar Precipitable Water Provenance in a Warmer World”, Singh HA, Bitz CM, Donohoe A. *Contributed Talk*. Community Earth System Model Workshop, Polar Climate Working Group, Summer 2016.

“Aerial Moisture Transport in the Earth Climate System: A Study of the Mean State and Perturbations Due to CO<sub>2</sub>-Doubling using Numerical Water Tracers and a Novel Linear Algebra Analysis Framework”, Singh HA, Bitz CM, Nusbaumer J, Noone DC. *Contributed Talk*. American Geophysical Union Fall 2015 Meeting, Session: Large-Scale Atmospheric Transport and Mixing: Observations, Modeling, and Theory.

“An Analysis of Tropical Precipitation using Numerical Water Tracers in a Global Climate Model: Insights on the Mean State and Perturbations from CO<sub>2</sub>-Doubling”, Singh HA, Bitz CM, Nusbaumer J, Noone DC. *Contributed Poster*. Workshop on Monsoons and ITCZs, Columbia University, Fall 2015.

“Numerical Water Tracers in the Global Hydrological Cycle: A New Mathematical Approach with Applications”, Singh HA, Bitz CM, Nusbaumer J, Noone DM. *Invited Talk*. Pacific Northwest National Lab, US Department of Energy Office of Science, Division Seminar, Summer 2015.

“Numerical Water Tracers in the Aerial Hydrological Cycle: A New Mathematical Approach and Applications to Control and Doubled-CO<sub>2</sub> Scenarios”, Singh HA, Bitz CM, Nusbaumer J, Noone DM. *Contributed Talk*. University of Washington Department of Atmospheric Sciences, Atmospheric and Climate Dynamics Seminar, Winter 2015.

“Origin of Precipitation in the High Latitudes in Preindustrial and 2×CO<sub>2</sub> Climates: An Atmospheric Water Tagging Study with CESM 1.2”, Singh HA, Bitz CM, Nusbaumer J, and Noone DM. *Contributed Poster*. AGU Fall 2014 Meeting, Session: Extratropical and High-Latitude Storms, Teleconnections, and the Changing Polar Climate.

“Global Cooling with Lowering Surface Orography of Antarctica”, Singh HA, Frierson DMW, Bitz CM. *Contributed Talk*. AGU Fall 2013 Meeting, Session: Climate Change and Cryospheric Systems I.

“Investigating Mean States and Coupling in Hi-Resolution (Ocean Eddy-Permitting) Models”, Singh HA, Newsom E, Bitz CM. *Contributed Talk*. SCAR 2012 Meeting, Session: Status and trends in Antarctic Sea Ice and Ice Shelves.

“A Paleoclimate Puzzle: The Etiology of the Dansgaard-Oeschger Events”, Singh HA, Battisti DS, Bitz CM. *Contributed Talk*. University of Washington Department of Atmospheric Sciences, Atmospheric and Climate Dynamics Seminar, Fall 2011.

### Teaching Experience

Teaching Assistantship, University of Washington, Department of Atmospheric Sciences, Spring 2011. Co-taught ATMS 111: Global Warming with Professors Mike Wallace and Tad Anderson.

Academic Tutor, Bush School and several other local high schools, Fall 2002 through Summer 2011. Tutored students one-on-one in mathematics and the physical sciences.

High School Chemistry Teacher, Houston Learning Academy, Spring and Summer 2002. Developed curriculum for and taught a series of high school chemistry courses.

Student Instructor, MED199: Selected Review of the Basic Sciences, UTSW Medical School, Summer 2002. Developed curriculum for and taught the Neuroscience and Anatomy portions of the MED199 course.

Recitation Instructor, CHEM211/212: Organic Chemistry, Rice University, Fall 1997 through Spring 2000. Developed curriculum for and taught weekly review sessions for students. Answered student questions and graded exams.

### Professional Internships

Summer 2014: Visiting Scientist, Atmospheric Sciences and Global Change Division, DOE Pacific Northwest National Laboratory. *Supervisor*: Philip J. Rasch, Chief Scientist.

Summer 1999: NSF REU Intern, Department of Physics, University of Chicago.

Summer 1998: Welsh Undergraduate Research Fellow, Department of Chemistry, Rice University.

Summer 1997: Research Intern, Department of Pharmacology, Yale University School of Medicine.

### Grants

2013 - 2014: US Department of Energy Director's Discretionary Allocation at Argonne Leadership Computing Facility for “CESM Simulation of Transported Water Vapor in Polar Amplification” (Principal Investigator, 3 million CPU hours).

## **Computing**

Interests: Scientific Computing, Big Data Analysis, High Performance Computing.

Languages: Fortran, Python, NCL, R, SQL, XML, Shell Scripting.

Earth System Models: CESM, CCSM4.

Operating Systems: Unix/Linux.

High Performance Computing Systems: IBM Blue Gene Q, Intel, Cray.

## **Professional Service**

Chair, Session: Causes, Consequences, and Predictability of Polar Change I (Oral), AGU Fall Meeting 2018.

Chair, Session: Polar Climate: Processes and Predictability I (Oral), II (Oral), and III (Poster), AGU Fall Meeting 2017.

Chair, Session: Beyond the Interannual: Multidecadal and Centennial Time Scale Variability in the Climate System I (Oral) and II (Poster), AGU Fall Meeting 2016.

Chair, Session: Atmospheric Circulations and Their Role in the Hydrological Cycle: Monsoons, Storm Tracks, and the ITCZ I (Oral) and III (Poster), AGU Fall Meeting 2015.

Chair, Session: Polar Processes and Predictability I (Oral) and II (Poster), AGU Fall Meeting 2015.

Outstanding Student Paper Award Judge, AGU Fall Meeting 2015.

Manuscript Reviewer, Journal of Climate, 2014 - present.

Manuscript Reviewer, Climate Dynamics, 2016 - present.

Manuscript Reviewer, Journal of Advances in Modeling Earth Systems, 2016 - present.

Manuscript Reviewer, Nature Geoscience, 2017 - present.

Manuscript Reviewer, Geophysical Research Letters, 2018 - present

## **Professional Memberships**

Member, American Geophysical Union, 2013 - present.



Member, American Association for the Advancement of Science, 2014 - present.

### **Outreach & Inclusion**

Pacific Northwest Regional Science Bowl, US Department of Energy, 2017 - present. Volunteer judge at regional science and mathematics competition for high school students.

Undergraduate Mentoring Program Mentor, AGU Fall Meeting 2016. Assisted an undergraduate student from an under-represented group in navigating the AGU Fall Meeting and in preparing for the graduate school application process.

Departmental Diversity Initiative, UW Atmospheric Sciences Department, Summer 2016. Worked with departmental colleagues (Tom Ackerman, Angel Adames, Walter Perkins) to create a white paper on increasing and sustaining diversity (particularly with regards to gender and race) within the Atmospheric Sciences Department and the UW College of the Environment.

UW Atmospheric Sciences Outreach, 2010 - 2016. Organized and participated in monthly outreach events directed towards engaging K-12 students in math and science, including demonstrations of atmospheric science for general audiences at Polar Science Weekend and Paws-on-Science at the Pacific Science Center; presentations about weather, climate, and the earth sciences at several local public elementary schools; and tours of the Atmospheric Sciences meteorology observational equipment. Along with a colleague, developed a new demonstration on atmospheric radiative transfer; successfully obtained funding for the purchase of an IR camera for the demonstration.

Volunteer Science Instructor, Daniel Bagley Elementary School, Fall 2015 - Spring 2016. Prepared and presented weekly science demonstrations and laboratory experiments for a local public elementary school for grades 1 to 3.

Mentor, Expanding Your Horizons, 2014 - 2017. Participated as a mentor in the annual Expanding Your Horizons conference for high school girls by developing and teaching a workshop on climate, energy balance climate models, and computing with Python.

Conversations on Diversity Panelist, College of the Environment, Spring 2015. Participated in an initiative to improve conditions for students who are also parents.

Graduate Student Member, Diversity Committee, Department of Atmospheric Sciences, 2013 - 2014. Worked to improve recruitment and retention of students from under-represented groups into the UW Atmospheric Sciences department.

**Additional Activities**

Fiber Artist. Artistic work presented at various galleries in Seattle, San Francisco, and New York City, from 2006 through 2011. Book of selected work published in 2009 by Creative Publishing International: *Amigurumi Knits*.

Small Business Owner. Owned and operated *Hansigurumi*, a sole proprietorship fiber arts business, from 2007 through 2009. Responsible for all aspects of small business ownership, including design development, publicity, and finances. Business served as primary familial income source over this time period.

Dancer and Choreographer. Danced in several works and with various companies between 2001 and 2006, including Trisha Brown Company (Seattle & New York City), Bharatha Choodamani (Chennai, India), Frenetichore Performing Arts Collective (Houston), and Dance New Amsterdam (New York City).

## Professional References

**Philip Rasch**, Chief Scientist, Atmospheric Sciences and Global Change Division,  
Pacific Northwest National Lab, US Department of Energy.

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**Cecilia Bitz**, Professor of Atmospheric Sciences, University of Washington.

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Sciences, Columbia University.

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