

## **TIMOTHY M. MERLIS**

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### **Research Interests**

Climate dynamics of Earth and exoplanets, extreme weather and climate change, hurricanes, polar climate, atmospheric hydrological cycle & surface coupling

### **Awards and Fellowships**

- 2019–2022    Natural Sciences and Engineering Research Council of Canada Discovery Grant Accelerator Award
- 2018–2019    Tomlinson Professorship Award, McGill University
- 2015–2025    Canada Research Chair (Tier II)
- 2014          James R. Holton Early Career Scientist Award, Atmospheric Sciences Section of the American Geophysical Union Conference

### **Scientific Leadership Roles**

Organizer of Princeton University/Geophysical Fluid Dynamics Laboratory Atmospheric Dynamics group meeting, 2022–  
Vice-chair of AMS Atmospheric and Oceanic Fluid Dynamics Committee, 2021–  
Associate Editor *Journal of Climate*, 2021–  
Program Chair of AMS Atmospheric and Oceanic Fluid Dynamics Meeting, 2022  
Co-organizer of Princeton Center for Theoretical Science Workshop From Spectroscopy to Climate, 2022  
National Representative, International Association of Meteorology and Atmospheric Sciences, 2019–2022  
Chair of Canadian Meteorological and Oceanographic Society Scientific Committee, 2017–2020  
Co-organizer of California Institute of Technology workshop “Monsoons: Past, Present and Future” in May, 2015.

### **Positions**

- 2022–          **Princeton University Atmospheric and Oceanic Sciences & Cooperative Institute for Modeling Earth Systems**  
Manager, Science
- 2018–2022    **McGill University Department of Atmospheric and Oceanic Sciences**  
Associate Professor & Member of McGill Space Institute  
Canada Research Chair (Tier II) in Atmospheric and Climate Dynamics

- 2013–2018 **McGill University Department of Atmospheric and Oceanic Sciences**  
Assistant Professor & Canada Research Chair (Tier II, 2015–2018)
- 2011–2013 **Princeton University and Geophysical Fluid Dynamics Laboratory**  
Princeton Center for Theoretical Science Postdoctoral Fellow, Hosted by Isaac Held
- 2006–2011 **Ph.D. California Institute of Technology**

**Refereed Journal Publications** (See <http://timothymerlis.com/publications.html> for up-to-date list.) Advisees are underlined. H-index 26, cumulative citations 1833 (Google Scholar, Aug 2023).

- [56] Bolot, M., L. Harris, Cheng, K.-Y., P. Blossey, C. S. Bretherton, S. K. Clark, A. Kaltenbaugh, T. M. Merlis, L. Zhou, and S. Fueglistaler (2023): Kilometer-scale global warming simulations and active sensors reveal changes of convective velocities in the tropics. Submitted.
- [55] Meera, M., T. M. Merlis, and D. J. Kirshbaum (2023): Response of the current climate to land-ocean contrasts in parameterized cumulus entrainment. *Journal of Advances in Modeling Earth Systems*, revised.
- [54] Feldl, N. and T. M. Merlis (2023): An analytical model for radiative feedbacks in comprehensive climate models. *Geophysical Research Letters*, accepted.
- [53] Chang, C.-Y. and T. M. Merlis (2023): The role of diffusivity changes on the pattern of warming in energy balance models. *Journal of Climate*, in press, doi:10.1175/JCLI-D-23-0121.1.
- [52] Zurita-Gotor, P., I. M. Held, T. M. Merlis, C.-Y. Chang, S. A. Hill, C. G. MacDonald (2023): Non-uniqueness in ITCZ latitude due to radiation-circulation coupling in an idealized GCM. *Journal of Advances in Modeling Earth Systems*, **15**, e2023MS003736, doi:10.1029/2023MS003736.
- [51] Chen, Y.-T., Y. Huang, and T. M. Merlis (2023): The global patterns of instantaneous CO<sub>2</sub> forcing at the top-of-atmosphere and surface. *Journal of Climate*, **36**, 6331-6347, doi:10.1175/JCLI-D-22-0708.1.
- [50] Fortin, A.-S., C. O. Dufour, T. M. Merlis, and R. Msadek (2023): Drivers of the decline of the Atlantic Meridional Overturning Circulation under climate change in a hierarchy of climate models. *Journal of Climate*, **36**, 6481-6498, doi:10.1175/JCLI-D-22-0561.1.
- [49] Labonté, M.-P. and T. M. Merlis (2023): Evaluation of changes in dry and wet precipitation extremes with warming using a passive water vapor modelling approach. *Journal of Climate*, **36**, 2167-2182, doi:10.1175/JCLI-D-22-0048.1.
- [48] Cheng, K.-Y., L. Harris, C. S. Bretherton, T. M. Merlis, M. Bolot, L. Zhou, A. Kaltenbaugh, S. K. Clark, and S. Fueglistaler (2022): Impact of warmer sea surface temperature on the global pattern of intense convection: insights from a global storm resolving model. **49**, e2022GL099796, doi:10.1029/2022GL099796.
- [47] Merlis, T. M., N. Feldl, and R. Caballero (2022): Changes in poleward atmospheric energy transport over a wide range of climates: Energetic and diffusive perspectives and a priori theories. *Journal of Climate*, **35**, 2933-2948, doi:10.1175/JCLI-D-21-0682.1.
- [46] Hill, S. A., N. J. Burls, A. V. Fedorov, and T. M. Merlis (2022): Symmetric and antisymmetric components of polar-amplified warming. *Journal of Climate*, **35**, 3157-3172, doi:10.1175/JCLI-D-20-0972.1.
- [45] Kim, D., H. Kim, S. M. Kang, M. F. Stuecker, and T. M. Merlis (2022): Weak future Hadley cell intensity changes due to compensating effects of tropical and extratropical forcing. *npj Climate and Atmospheric Science*, **5**, 61, doi:10.1038/s41612-022-00287-x.

- [44] Navarro, T., T. M. Merlis, N. B. Cowan, and N. Gomez (2022): Atmospheric gravitational tides of Earth-like planets orbiting low mass stars. *Planetary Science Journal*, **3**, 162, doi:10.3847/PSJ/ac76cd.
- [43] Rousseau-Rizzi, R., T. M. Merlis, and N. Jeevanjee (2022): The connection between Carnot and CAPE formulations of TC potential intensity. *Journal of Climate*, **35**, 941-954, doi:10.1175/JCLI-D-21-0360.1.
- [42] Kim, D., S. M. Kang, T. M. Merlis, and Y. Shin (2021): Atmospheric circulation sensitivity to changes in the vertical structure of polar warming. *Geophysical Research Letters*, **48**, e2021GL094726, doi:10.1029/2021GL094726.
- [41] Feldl, N. and T. M. Merlis (2021): Polar amplification in idealized climates: the role of ice, moisture, and seasons. *Geophysical Research Letters*, **48**, e2021GL094130, doi:10.1029/2021GL094130.
- [40] Bembenek, E., T. M. Merlis, and D. Straub (2021): Influence of latitudinal and moisture effects on the barotropic instability of an idealized ITCZ. *Journal of the Atmospheric Sciences*, **78**, 2677-2689, doi:10.1175/JAS-D-20-0346.1.
- [39] Feng, P.-N., H. Lin, J. Derome, and T. M. Merlis (2021): Forecast skill of the NAO in Subseasonal-to-Seasonal Prediction Models. *Journal of Climate*, **34**, 4757-4769, doi:10.1175/JCLI-D-20-0430.1.
- [38] Rollings, M. and T. M. Merlis (2021): The observed relationship between Pacific SST variability and Hadley cell extent in reanalyses. *Journal of Climate*, **34**, 2511-2527, doi: 10.1175/JCLI-D-20-0410.1.
- [37] Henry, M., T. M. Merlis, N. J. Lutsko, and B. E. J. Rose (2021): Decomposing the drivers of polar amplification with a single column model. *Journal of Climate*, **34**, 2355-2365, doi: 10.1175/JCLI-D-20-0178.1.
- [36] Henry, M. and T. M. Merlis (2020): Lapse rate changes dominate residual polar warming in solar radiation management scenarios. *Geophysical Research Letters*, **47**, e2020GL087929, doi: 10.1029/2020GL087929.
- [35] Labonté, M.-P. and T. M. Merlis (2020): Sensitivity of the Atmospheric Water Cycle within the Habitable Zone of a Tidally-Locked, Earth-like Exoplanet. *Astrophysical Journal*, doi:10.3847/1538-4357/ab9102.
- [34] Bembenek, E., D. Straub, and T. M. Merlis (2020): Effects of Moisture in a Two-Layer Model of the Midlatitude Jet Stream. *Journal of the Atmospheric Sciences*, **77**, 131-147, doi:10.1175/JAS-D-19-0021.1.
- [33] Merlis, T. M. and I. M. Held (2019): Aquaplanet simulations of tropical cyclones. *Current Climate Change Reports*, doi:10.1007/s40641-019-00133-y.
- [32] Maher, P., E. P. Gerber, B. Medeiros, T. M. Merlis, S. Sherwood, A. Sheshadri, A. H. Sobel, G. K. Vallis, A. Voigt, and P. Zurita-Gotor (2019): Model hierarchies for understanding atmospheric circulation. *Reviews of Geophysics*, **57**, 250-280, doi:10.1029/2018RG000607.
- [31] Menzel, M. E. and T. M. Merlis (2019): Connecting direct effects of CO<sub>2</sub> radiative forcing to ocean heat uptake and circulation. *Journal of Advances in Modeling Earth Systems*, **11**, 2163-2176, doi:10.1029/2018MS001544.
- [30] Yang, J., J. Leconte, E. T. Wolf, T. M. Merlis, D. D. B. Koll, F. Forget, and D. S. Abbot (2019): Simulations of Water Vapor and Clouds on Rapidly Rotating and Tidally Locked Planets: A 3D Model Intercomparison *The Astrophysical Journal*, **875**, doi:10.3847/1538-4357/ab09f1.
- [29] Li, Y., D. W. J. Thompson, S. Bony, and T. M. Merlis (2019): Thermodynamic control on the poleward shift of the extratropical jet in climate change simulations: The role of rising high clouds and their radiative effect. *Journal of Climate*, **32**, 917-934.

- [28] Henry, M. and T. M. Merlis (2019): The role of the nonlinearity of the Stefan-Boltzmann law on the structure of radiatively forced temperature change. *Journal of Climate*, **32**, 335–348.
- [27] Merlis, T. M. and M. Henry (2018): Simple estimates of polar amplification in moist diffusive energy balance models. *Journal of Climate*, **31**, 5811–5824.
- [26] Jansen, M., L.-P. Nadeau, and T. M. Merlis (2018): Transient vs Equilibrium Response of the Ocean’s Overturning Circulation to Warming. *Journal of Climate*, **31**, 5147–5163.
- [25] Kirshbaum, D. J., T. M. Merlis, J. R. Gyakum, R. McTaggart-Cowan (2018): Sensitivity of idealized moist baroclinic waves to environmental temperature. *Journal of the Atmospheric Sciences*, **75**, 337–360.
- [24] O’Gorman, P. A., T. M. Merlis, and M. S. Singh (2018): Increase in the skewness of extratropical vertical velocities with climate warming: fully nonlinear simulations versus moist baroclinic instability. *Quarterly Journal of the Royal Meteorological Society*, **144**, 208–217.
- [23] Defforge, C. L. and T. M. Merlis (2017): Evaluating the evidence of a global sea surface temperature threshold for tropical cyclone genesis, *Journal of Climate*, **30**, 9133–9145.
- [22] Viale, F. and T. M. Merlis (2017): Variations in tropical cyclone frequency response to solar and CO<sub>2</sub> forcing in aquaplanet simulations. *Journal of Advances in Modeling Earth Systems*, **9**, 4–18, doi:10.1002/2016MS000785.
- [21] Defforge, C. L. and T. M. Merlis (2017): Observed warming trend in sea surface temperature at tropical cyclone genesis. *Geophysical Research Letters*, **44**, 1034–1040, doi:10.1002/2016GL071045.
- [20] Seo, J., S. Kang, and T. M. Merlis (2017): A model intercomparison of the tropical precipitation response to a CO<sub>2</sub> doubling in aquaplanet simulations. *Geophysical Research Letters*, **44**, 993–1000, doi:10.1002/2016GL072347.
- [19] Feldl, N., S. Bordoni, and T. M. Merlis (2017): Coupled high-latitude climate feedbacks and their impact on atmospheric heat transport. *Journal of Climate*, **30**, 189–201.
- [18] Galbraith, E. D., T. M. Merlis, and J. B. Palter (2016): Destabilization of glacial climate by the radiative impact of Atlantic Meridional Overturning Circulation disruptions. *Geophysical Research Letters*, **43**, 8214–8221, doi:10.1002/2016GL069846.
- [17] Yang, J., J. Leconte, E. T. Wolf, C. Goldblatt, N. Feldl, T. M. Merlis, Y. Wang, D. D. B. Koll, F. Ding, F. Forget, and D. S. Abbot (2016): Differences in water vapor radiative transfer among 1D models can significantly affect the inner edge of the habitable zone. *The Astrophysical Journal*, **826**, doi:10.3847/0004-637X/826/2/222.
- [16] Trossman, D., J. Palter, T. M. Merlis, Y. Huang, and Y. Xia (2016): Large-scale ocean circulation-cloud interactions reduce the pace of transient climate change. *Geophysical Research Letters*, **43**, 3935–3943.
- [15] Merlis, T. M. W. Zhou, I. M. Held, and M. Zhao (2016): Surface temperature dependence of tropical cyclone-permitting simulations in a spherical model with uniform thermal forcing. *Geophysical Research Letters*, **43**, 2859–2865.
- [14] Merlis, T. M. (2016): Does humidity’s seasonal cycle affect the annual-mean tropical precipitation response to extratropical forcing? *Journal of Climate*, **29**, 1451–1460.
- [13] Merlis, T. M. (2015): Direct weakening of tropical circulations from masked CO<sub>2</sub> radiative forcing. *Proceedings of the National Academy of Science*, **112**, 13167–13171.

- [12] Ballinger, A. P., T. M. Merlis, I. M. Held, and M. Zhao (2015): The sensitivity of tropical cyclone activity to off-equatorial thermal forcing. *Journal of the Atmospheric Sciences*, **72**, 2286–2302.
- [11] Merlis, T. M. (2014): Interacting components of the top-of-atmosphere energy balance affect changes in regional surface temperature. *Geophysical Research Letters*, **41**, 7291–7297, doi:10.1002/2014GL061700.
- [10] Merlis, T. M., I. M. Held, G. L. Stenchikov, F. Zeng, and L. Horowitz (2014): Constraining transient climate sensitivity using coupled climate model simulations of volcanic eruptions. *Journal of Climate*, **27**, 7781–7795.
- [9] Merlis, T. M., M. Zhao, and I. M. Held (2013): The sensitivity of hurricane frequency to ITCZ changes and radiatively forced warming in aquaplanet simulations. *Geophysical Research Letters*, **40**, 4109–4114, doi:10.1002/grl.50680.
- [8] Merlis, T. M., T. Schneider, S. Bordoni, and I. Eisenman (2013): The tropical precipitation response to orbital precession. *Journal of Climate*, **26**, 2010–2021.
- [7] Merlis, T. M., T. Schneider, S. Bordoni, and I. Eisenman (2013): Hadley circulation response to orbital precession. Part II: Subtropical continent. *Journal of Climate*, **26**, 754–771.
- [6] Merlis, T. M., T. Schneider, S. Bordoni, and I. Eisenman (2013): Hadley circulation response to orbital precession. Part I: Aquaplanets. *Journal of Climate*, **26**, 740–753.
- [5] Merlis, T. M. and T. Schneider (2011): Changes in zonal surface temperature gradients and Walker circulations in a wide range of climates. *Journal of Climate*, **24**, 4757–4768.
- [4] Merlis, T. M. and T. Schneider (2010): Atmospheric dynamics of Earth-like tidally locked aquaplanets. *Journal of Advances in Modeling Earth Systems*, **2**, Art. #13, doi:10.3894/JAMES.2010.2.13
- [3] Merlis, T. M. and T. Schneider (2009): Scales of linear baroclinic instability and macroturbulence in dry atmospheres. *Journal of the Atmospheric Sciences*, **66**, 1821–1833.
- [2] Merlis, T. M. and S. Khatiwala (2008): Fast dynamical spin-up of ocean general circulation models using Newton-Krylov methods. *Ocean Modelling*, **21**, 97–105.

### Book Chapters

- [1] Showman, A. P., R. D. Wordsworth, T. M. Merlis, and Y. Kaspi (2013): Atmospheric Circulation of Terrestrial Exoplanets. *Comparative Climatology of the Terrestrial Planets*, S. J. Mackwell, A. A. Simon-Miller, J. W. Harder, and M. A. Bullock, Eds., University of Arizona Press, pp. 277–326.

### Teaching

2020	McGill ESYS 301: Earth System Modelling, Winter 2020
2018	Instructor of McGill's ATOC/PHYS 404: Climate Physics, Fall 2018
2017-2018	Instructor of McGill's ATOC 215: Oceans, Weather and Climate, Winter 2017, 2018
2016-2019	Instructor of McGill's ATOC 531: Dynamics of Current Climates, Winter 2016, Fall 2016, Fall 2017, Fall 2018, Fall 2019
2015	Instructor of McGill's ATOC 183: Climate and Climate Change, Winter 2015
2014-2016	Instructor of McGill's ATOC 513: Waves and Stability, Winter 2014, 2015, 2016

## Outreach

- 2019, 2021    Lecturer at McGill University undergraduate outreach event *Soup & Science*
- 2016        Lecturer at McGill University high school outreach event *Snappy Science*
- 2016        McGill University Atmospheric and Oceanic Science department high school outreach *Canada Wide Science Fair*
- 2016        Lecturer at McGill University undergraduate outreach event *Soup & Science*
- 2014        Lecture on physical climate science for McGill University *Under the Weather: Climate Change Research and Justice* series
- 2014        Lecture on climate change for Science Undergraduate Society of McGill University
- 2013        Interviews with *Le Devoir* newspaper and radio station CJAD 800 about Typhoon Haiyan and climate change

## Advising

Post-doc Advisees, current (1): Ilai Guendelman (2022–present, co-advisor with Prof. Stefan Fueglistaler)

Post-doc Advisees, past (2): Thomas Navarro (2019–2022, co-advisor with Prof. Natalya Gomez & Nicholas Cowan) Eric Bembenek (2021, co-advisor with Prof. David Straub)

Ph.D. Advisees, current (1): Yan-Ting Chen (2019–present, co-advisor with Prof. Yi Huang)

Ph.D. Advisees, completed (5): Matthew Henry (2016–2019), Eric Bembenek (2014–2020, co-advisor with Prof. David Straub), Pei-Ning Feng (2014–2020, co-advisor with Dr. Hai Lin, ECCC), Nicholas Soulard (2015–2020, co-advisor with Dr. Hai Lin, ECCC), Marie-Pier Labonté (2018–2023)

M.Sc. Advisees, completed (7): Flora Viale (2014–2016), Cécile Defforge (2015–2016), Molly Syme (2015–2017), Marie-Pier Labonté (2016–2017, fast tracked to Ph.D.), Zhong Yi Chia (2016–2018, co-advisor with Prof. Daniel Kirshbaum), Michael Rollings (2017–2019), Anne-Sophie Fortin (2018–2021, co-advisor with Prof. Carolina Dufour), Meera Mohan (2020–2023, co-advisor with Prof. Daniel Kirshbaum)

Undergraduate Research Assistants (8): Bryn Ronalds (2013–2014), Valérie Losier (2013–2014, co-advisor with Prof. Daniel Kirshbaum), Luke Davis (2014–2016), Kaiti Jiang (2015), Michael Rollings (2017), Anne-Sophie Fortin (2018), Jessica Di Bartolomeo (2019), Han Szeptycki (2020–2021)

## Advisee Awards and Fellowships

- 2022        Yan-Ting Chen, Outstanding Student Presentation Award (2nd Place) AMS Conference on Atmospheric Radiation
- 2021        Yan-Ting Chen, Mysak Fellowship (McGill AOS Department Award)
- 2019        Thomas Navarro, McGill Space Institute Post-doc Fellowship
- 2019        Matthew Henry, Eben Hopson Fellowship, McGill University
- 2018        Michael Rollings, NSERC M.Sc. Fellowship (CGS-M)
- 2018        Anne-Sophie Fortin, Hydro-Quebec Fellowship, McGill Faculty of Science

- 2016 Cécile Defforge, Best Student Poster Award AMS Hurricanes and Tropical Meteorology Meeting
- 2016 Marie-Pier Labonté, McGill Space Institute M.Sc. Fellowship
- 2015 Arkadiusz Bembenek, NSERC Ph.D. Fellowship
- 2015 Cécile Defforge, Mysak Fellowship (McGill AOS Department Award)

### **Additional Professional Activities and Memberships**

Member of AMS Atmospheric and Oceanic Fluid Dynamics Committee, 2017–2024

Member of US CLIVAR Working Group: Changing Width of the Tropical Belt, 2016–2018

Member of AMS Atmospheric and Oceanic Fluid Dynamics Committee, 2011–2013

Co-convenor of session “Atmospheric Circulations and Climate Change” at AGU Fall Meeting, 2010

Reviewer for funding agencies: *NSERC*, *NASA*, *NSF*, *ISF*

Reviewer for journals: *Journal of the Atmospheric Sciences*, *Journal of Climate*, *Geophysical Research Letters*, *Nature*, *Nature Geoscience*, *npj Climate and Atmospheric Science*, *Nature Communications Earth & Environment*, *Bulletin of the American Meteorological Society*, *Proceedings of the National Academy of Science*, *Nature Climate Change*, *Journal of Marine Research*, *Quarterly Journal of the Royal Meteorological Society*, *Journal of Geophysical Research*, *Environmental Research Letters*, *Biogeosciences*, *Geoscientific Model Development*, and *Climate Dynamics*

Member of American Meteorological Society, American Geophysical Union, and Canadian Meteorological and Oceanographic Society

### **Department Seminars**

- 2022 Peking University, Lamont Doherty Earth Observatory
- 2021 University of Michigan, Yale University
- 2020 Columbia University (canceled due to COVID-19), Yale University (rescheduled due to COVID-19)
- 2019 University of Waterloo, University of Chicago
- 2018 Stony Brook University
- 2017 Scripps Institution of Oceanography, UCSD (Climate, Atmospheric Sciences, and Physical Oceanography Department), Seoul National University
- 2016 McGill University (Department of Physics), Columbia University, Lamont Doherty Earth Observatory
- 2015 University of Michigan
- 2014 MIT, Weizmann Institute of Science, Tel Aviv University

2013	University at Albany, University of Oxford, Caltech, Geophysical Fluid Dynamics Laboratory, McGill University, Harvard University, Stanford University, University of Toronto
2012	Cornell University, Yale University, Columbia University, Institute for Advanced Study, Harvard University
2011	MIT, Brown University, Caltech (thesis defense), University of New South Wales
2010	Geophysical Fluid Dynamics Laboratory
2009	MIT

**Conference Presentations**

2024	AMS Annual Meeting (invited, forthcoming)
2023	AMS Annual Meeting, Tropospheric Lapse Rate workshop, CFMIP
2022	AMS Conference on Atmospheric and Oceanic Fluid Dynamics, MIT Symposium in Honor of Kerry Emanuel, GEWEX Pan-GASS Understanding and Modeling Atmospheric Processes, Princeton University From Spectroscopy to Climate, 2nd Model Hierarchies Workshop
2021	AGU Fall Meeting
2020	AMS Annual Meeting, AGU Fall Meeting
2019	AMS Conference on Atmospheric and Oceanic Fluid Dynamics, IUGG/CMOS Congress, Northeast Tropical Workshop
2018	CMOS Congress (invited plenary), MIT Lorenz Center Water and Climate Change (invited), Princeton University Heldfest (invited)
2017	CMOS Congress, AMS Conference on Atmospheric and Oceanic Fluid Dynamics, Northeast Tropical Workshop, AGU Fall Meeting (invited)
2016	AMS Conference on Hurricanes and Tropical Meteorology, CMOS Congress, AGU Fall Meeting (invited), WCRP Model Hierarchies Workshop, CLIVAR Width of the Tropical Belt Workshop
2015	Caltech Monsoon Workshop, Northeast Tropical Workshop, AMS Conference on Atmospheric and Oceanic Fluid Dynamics
2014	AMS Conference on Hurricanes and Tropical Meteorology, Latsis Symposium, World Weather Open Science Conference, AGU Fall Meeting (two invited presentations)