Ian Eisenman

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Research Description

Interests: Climate dynamics, including sea ice, climate feedbacks, large-scale circulations of the atmosphere and ocean, icebergs, and paleoclimate.

Approach: Construction and mathematical analysis of idealized physical models, numerical simulations using climate models with varying degrees of complexity, and analysis of observations.

Preparation and Appointments

Professor	UC San Diego	Scripps Inst. Oceanogr.	2021–present	
Assoc. Prof.	UC San Diego	Scripps Inst. Oceanogr.	2017–2021	
Asst. Prof.	UC San Diego	Scripps Inst. Oceanogr.	2012–2017	
Postdoc	Caltech Univ. Washington	Environ. Sci. and Eng. Atmospheric Sci.	2008–2012	Hosts: Tapio Schneider & David Battisti
Ph.D.	Harvard University	Earth and Planet. Sci.	2008	Advisor: Eli Tziperman
S.M.	Harvard University	Applied Mathematics	2005	
M.A.	UC Santa Barbara	Physics	2002	
B.A.	Williams College	Philosophy and Physics	1999	

Fellowships and Honors

Scripps Institution of Oceanography Graduate Teacher of the Year Award, 2017.

Hellman Fellowship, 2016–2017.

AGU Cryosphere Early Career Award, 2012.

Jerome Namias endowed faculty chair, Scripps Institution of Oceanography, 2012–2022.

Chapman Chair Lecturer, University of Alaska Fairbanks, 2010.

NOAA Climate and Global Change Postdoctoral Fellowship, 2008–2011.

Caltech TPF Foundation Postdoctoral Fellowship, 2008–2011.

Woods Hole Oceanographic Institution Geophysical Fluid Dynamics Fellowship, 2006.

NASA Earth System Science Graduate Student Fellowship, 2005–2008.

Harvard University Certificate of Distinction in Teaching, 2004.

UC Santa Barbara Dept of Physics Outstanding Teaching Assistant Award, 2000–2001.

U.S. Department of Education Robert C. Byrd Scholarship, 1995–1999.

Publications

[Members of group are underlined.]

[64] I. Eisenman, A. Basinski-Ferris, E. Beer, and L. Zanna (2024). The sensitivity of regional sea level changes to the depth of Antarctic meltwater fluxes. Submitted. (pdf)

[63] I. Eisenman and K. Armour (2024). The radiative feedback continuum from Snowball Earth to an ice-free hothouse. Submitted. (pdf)

[62] M. Luongo, N. Brizuela, I. Eisenman, and S.-P. Xie (2024). Retaining short-term variability reduces mean state biases in wind stress overriding simulations. *Journal of Advances in Modeling Earth Systems* 16, e2023MS003665. (pdf)

[61] D. Bonan, N. Feldl, N. Siler, J. Kay, K. Armour, I. Eisenman, and G. Roe (2024). The influence of climate feedbacks on regional hydrological changes under global warming. *Geophysical Research Letters* 51, e2023GL106648. (pdf)

[60] H.-Y. Tseng, Y.-T. Hwang, S.-P. Xie, Y.-H. Tseng, S. Kang, M. Luongo, and I. Eisenman (2023). Fast and slow responses of the tropical Pacific to radiative forcing in northern high latitudes. *Journal of Climate* 36, 5337–5349. (pdf)

[59] E. Beer, I. Eisenman, T.J.W. Wagner, and E. Fine (2023). A possible hysteresis in the Arctic Ocean due to release of subsurface heat during sea ice retreat. *Journal of Physical Oceanography* 53, 1323-1335. (pdf)

[58] L. Roach, I. Eisenman, T.J.W. Wagner, and A. Donohoe (2023). Asymmetry in the seasonal cycle of zonal-mean surface air temperature. *Geophysical Research Letters* 50, e2023GL103403. (pdf)

[57] Y. Si, A. Stewart, and I. Eisenman (2023). Heat transport across the Antarctic Slope Front controlled by cross-slope salinity gradients. *Science Advances* 9, eadd7049.

[56] M. Luongo, S.-P. Xie, I. Eisenman, Y.-T. Hwang, and H.-Y. Tseng (2023). A pathway for Northern Hemisphere extratropical cooling to elicit a tropical response. Geophysical Research Letters 50, e2022GL100719. (pdf)

[55] M. England, I. Eisenman, and T.J.W. Wagner (2022). Spurious climate impacts in coupled sea ice loss simulations. *Journal of Climate* 35, 3801-3811. (pdf)

[54] M. Luongo, S.-P. Xie, and I. Eisenman, (2022). Buoyancy forcing dominates cross-equatorial ocean heat transport response to Northern Hemispheric cooling. *Journal of Climate* 35, 3071-3090. (pdf)

[53] Y. Si, A. Stewart, and I. Eisenman (2022). Coupled ocean/sea ice dynamics of the Antarctic Slope Current driven by topographic eddy suppression and sea ice momentum redistribution. *Journal of Physical Oceanography* 52, 1563-1589. (pdf)

[52] T.J.W. Wagner, I. Eisenman, A. Ceroli, and N. Constantinou (2022). How winds and ocean currents influence the drift of floating objects. *Journal of Physical Oceanography* 52, 907-916.

[51] E. Beer and I. Eisenman (2022). Revisiting the role of the water vapor and lapse rate feedbacks in the Arctic amplification of climate change. *Journal of Climate* 35, 2975-2988. (pdf)

[50] L. Roach, I. Eisenman, T.J.W. Wagner, E. Blanchard-Wrigglesworth, and C. Bitz (2022). Asymmetry in the seasonal cycle of Antarctic sea ice driven by insolation. *Nature Geoscience* 15, 277-281. (pdf)

[49] L. Hahn, K. Armour, D. Battisti, I. Eisenman, and C. Bitz (2022). Seasonality in Arctic warming driven by sea ice effective heat capacity. *Journal of Climate* 35, 1629-1642. (pdf)

[48] X. Zhang, T. Schneider, Z. Shen, K. Pressel, and I. Eisenman (2022). Seasonal cycle of idealized polar clouds: large eddy simulations driven by a GCM. *Journal of Advances in Modeling Earth Systems* 14, e2021MS002671. (pdf)

[47] T.J.W. Wagner, I. Eisenman, and H. Mason (2021). How sea ice drift influences sea ice area and volume. *Geophysical Research Letters* 48, e2021GL093069. (pdf)

[46] D. Bonan, T. Schneider, I. Eisenman, and R. Wills (2021). Constraining the date of a seasonally ice-free Arctic using a simple model. *Geophysical Research Letters* 48, e2021GL094309.

[45] M. England, I. Eisenman, N. Lutsko, and T.J.W. Wagner (2021). The recent emergence of Arctic Amplification. *Geophysical Research Letters* 48, e2021GL094086. (pdf)

[44] S. Sun and I. Eisenman (2021). Observed Antarctic sea ice expansion reproduced in a climate model after correcting biases in sea ice drift velocity. *Nature Communications* 12, 1060. (pdf)

[43] A. Evan and I. Eisenman (2021). A mechanism for regional variations in snowpack melt under rising temperature. *Nature Climate Change* 11, 326-330. (pdf)

[42] M. England, T.J.W. Wagner, and I. Eisenman (2020). Modeling the breakup of tabular icebergs. *Science Advances* 6, eabd1273. (pdf)

[41] J. Rae, W. Gray, R. Wills, I. Eisenman, B. Fitzhugh, M. Fotheringham, E. Littley, P. Rafter, R. Rees-Owen, A. Ridgwell, B. Taylor, and A. Burke (2020). Overturning circulation, nutrient limitation, and warming in the Glacial North Pacific. *Science Advances* 6, eabd1654. (pdf)

[40] K. Golden, L. Bennetts, E. Cherkaev, I. Eisenman, D. Feltham, C. Horvat, E. Hunke, C. Jones, D. Perovich, P. Ponte-Castañeda, C. Strong, D. Sulsky, and A. Wells (2020). Modeling sea ice. *Notices Of The American Mathematical Society* 67, 1535-1555. (pdf)

[39] S. Sun, A. Thompson, and I. Eisenman (2020). Transient overturning compensation between Atlantic and Indo-Pacific basins. *Journal of Physical Oceanography* 50, 2151-2172. (pdf)

[38] E. Beer, I. Eisenman, and T.J.W. Wagner (2020). Polar amplification due to enhanced heat flux across the halocline. *Geophysical Research Letters* 47, e2019GL086706. (pdf)

[37] S. Sun, I. Eisenman, L. Zanna, and A. Stewart (2020). Surface constraints on the depth of the Atlantic Meridional Overturning Circulation: Southern Ocean versus North Atlantic. *Journal of Climate* 33, 3125-3149. (pdf)

[36] K. Pistone, I. Eisenman, and V. Ramanathan (2019). Radiative heating of an ice-free Arctic Ocean. *Geophysical Research Letters* 46, 7474-7480. (pdf)

[35] T.J.W. Wagner, R. Dell, I. Eisenman, R. Keeling, L. Padman, and J. Severinghaus (2018). Wave inhibition by sea ice enables trans-Atlantic ice rafting of debris during Heinrich Events.

Earth and Planetary Science Letters 495, 157-163. (pdf)

[34] S. Sun, I. Eisenman, and A. Stewart (2018). Does Southern Ocean surface forcing shape the global ocean overturning circulation? *Geophysical Research Letters* 45, 2413-2423. (pdf)

[33] T.J.W. Wagner, A. Stern, R. Dell, and I. Eisenman (2017). On the representation of capsizing in iceberg models. *Ocean Modelling* 117, 88-96. (pdf)

[32] T.J.W. Wagner and I. Eisenman (2017). How climate model biases skew the distribution of iceberg meltwater. *Geophysical Research Letters* 44, GL071645. (pdf)

[31] T.J.W. Wagner, R. Dell, and I. Eisenman (2017). An analytical model of iceberg drift. *Journal of Physical Oceanography* 47, 1605-1616. (pdf)

[30] C. Strong, D. Foster, E. Cherkaev, I. Eisenman, and K. Golden (2017). On the definition and analysis of the width of the marginal ice zone. *Journal of Atmospheric and Oceanic Technology* 34, 1565-1584. (pdf)

[29] E. Rosenblum and I. Eisenman (2017). Sea ice trends in climate models only accurate in runs with biased global warming. *Journal of Climate* 30, 6265-6278. (pdf)

[28] E. Rosenblum and I. Eisenman (2016). Faster Arctic sea ice retreat in CMIP5 than in CMIP3 due to volcanoes. *Journal of Climate* 29, 9179-9188. (pdf)

[27] S. Sun, I. Eisenman, and A. Stewart (2016). The influence of Southern Ocean surface buoyancy forcing on glacial-interglacial changes in the global deep ocean stratification. *Geophysical Research Letters* 43, 8124-8132. (pdf)

[26] J. Jones, S. Gille, H. Goosse, N. Abram, P. Canziani, D. Charman, K. Clem, X. Crosta, C. de Lavergne, I. Eisenman, M. England, R. Fogt, L. Frankcombe, G. Marshall, V. Masson-Delmotte, A. Morrison, A. Orsi, M. Raphael, J. Renwick, D. Schneider, G. Simpkins, E. Steig, B. Stenni, D. Swingedouw, and T. Vance (2016). Assessing recent trends in high-latitude Southern Hemisphere surface climate. *Nature Climate Change* 6, 917-926. (pdf)

[25] T.J.W. Wagner and I. Eisenman (2015). False alarms: How early warning signals falsely predict abrupt sea ice loss. *Geophysical Research Letters* 42, 10333-10341. (pdf)

[24] T.J.W. Wagner and I. Eisenman (2015). How climate model complexity influences sea ice stability. *Journal of Climate* 28, 3998-4014. (pdf)

[23] J. Zhu, Z. Liu, X. Zhang, I. Eisenman, and W. Liu (2014). Linear weakening of the AMOC in response to receding glacial ice sheets in CCSM3. *Geophysical Research Letters* 41, 6252-6258. (pdf)

[22] R. Ewing, I. Eisenman, M. Lamb, L. Poppick, A. Maloof, and W. Fischer (2014). New constraints on equatorial temperatures during a Late Neoproterozoic snowball Earth glaciation. *Earth and Planetary Science Letters* 406, 110-122. (pdf)

[21] L. Li, A. Miller, J. McClean, I. Eisenman, and M. Hendershott (2014). Processes driving sea ice variability in the Bering Sea in an eddying ocean/sea ice model: anomalies from the mean seasonal cycle. *Ocean Dynamics* 64, 1693-1717. (pdf)

[20] L. Li, J. McClean, A. Miller, I. Eisenman, M. Hendershott, and C. Papadopoulos (2014).

Processes driving sea ice variability in the Bering Sea in an eddying ocean/sea ice model: mean seasonal cycle. *Ocean Modelling* 84, 51-66. (pdf)

[19] I. Eisenman, W. Meier, and J. Norris (2014). A spurious jump in the satellite record: has Antarctic sea ice expansion been overestimated? *The Cryosphere* 8, 1289-1296. (pdf)

[18] K. Pistone, I. Eisenman, and V. Ramanathan (2014). Observational determination of albedo decrease caused by vanishing Arctic sea ice. *Proceedings of the National Academy of Sciences* 111, 3322-3326. (pdf)

[17] T. Merlis, T. Schneider, S. Bordoni, and I. Eisenman (2013). The tropical precipitation response to orbital precession. *Journal of Climate* 26, 2010-2021. (pdf)

[16] T. Merlis, T. Schneider, S. Bordoni, and I. Eisenman (2013). Hadley circulation response to orbital precession. Part II: Subtropical continent. *Journal of Climate* 26, 754-771. (pdf)

[15] T. Merlis, T. Schneider, S. Bordoni, and I. Eisenman (2013). Hadley circulation response to orbital precession. Part I: Aquaplanets. *Journal of Climate* 26, 740-753. (pdf)

[14] I. Eisenman (2012). Factors controlling the bifurcation structure of sea ice retreat. *Journal of Geophysical Research–Atmospheres* 117, D01111. (pdf)

[13] K. Armour, I. Eisenman, E. Blanchard-Wrigglesworth, K. McCusker, and C. Bitz (2011). The reversibility of sea ice loss in a state-of-the-art climate model. *Geophysical Research Letters* 38, L16705. (pdf)

[12] S. Finnegan, K. Bergmann, J. Eiler, D. Jones, D. Fike, I. Eisenman, N. Hughes, A. Tripati, and W. Fischer (2011). The magnitude and duration of Late Ordovician-Early Silurian glaciation. *Science* 331, 903-906. (pdf)

[11] I. Eisenman, T. Schneider, D. Battisti, and C. Bitz (2011). Consistent changes in the sea ice seasonal cycle in response to global warming. *Journal of Climate* 24, 5325-5335. (pdf)

[10] Y. Ashkenazy, I. Eisenman, H. Gildor, and E. Tziperman (2010). The effect of Milankovitch variations in insolation on equatorial seasonality. *Journal of Climate* 23, 6133-6142. (pdf)

[9] D. Abbot, I. Eisenman, and R. Pierrehumbert (2010). The importance of ice vertical resolution for snowball climate and deglaciation. *Journal of Climate* 23, 6100-6109. (pdf)

[8] I. Eisenman (2010). Geographic muting of changes in the Arctic sea ice cover. *Geophysical Research Letters* 37, L16501. (pdf)

[7] I. Eisenman, C. Bitz, and E. Tziperman (2009). Rain driven by receding ice sheets as a cause of past climate change. *Paleoceanography* 24, PA4209. (pdf)

[6] I. Eisenman and J.S. Wettlaufer (2009). Nonlinear threshold behavior during the loss of Arctic sea ice. *Proceedings of the National Academy of Sciences* 106, 28-32. (pdf)

[5] I. Eisenman, N. Untersteiner, and J.S. Wettlaufer (2008). Reply to comment by E. T. DeWeaver et al. on "On the reliability of simulated Arctic sea ice in global climate models". *Geophysical Research Letters* 35, L04502. (pdf)

[4] G. Gebbie, I. Eisenman, A. Wittenberg, and E. Tziperman (2007). Modulation of westerly wind bursts by sea surface temperature: a semistochastic feedback for ENSO. *Journal of the*

Atmospheric Sciences 64, 3281-3295. (pdf)

[3] I. Eisenman, N. Untersteiner, and J.S. Wettlaufer (2007). On the reliability of simulated Arctic sea ice in global climate models. *Geophysical Research Letters* 34, L10501. (pdf)

[2] I. Eisenman, L. Yu, and E. Tziperman (2005). Westerly wind bursts: ENSO's tail rather than the dog? *Journal of Climate* 18, 5224-5238. (pdf)

[1] I. Eisenman (2005). Non-normal effects on salt finger growth. *Journal of Physical Oceanography* 35, 616-627. (pdf)

Non-refereed

- E. Blanchard-Wrigglesworth, I. Eisenman, S. Zhang, S. Sun, and A. Donohoe (2022). New perspectives on the enigma of expanding Antarctic sea ice. Eos 103, doi:10.1029/2022EO220076. (pdf)
- T.J.W. Wagner, R. Dell, and I. Eisenman (2017). The influence of winds versus ocean currents on iceberg drift. *Bulletin of the American Meteorological Society* 98, 2050-2051. (pdf)
- K. Pistone, I. Eisenman, and V. Ramanathan (2014). Reply to Legates et al.: Negligible role of Arctic cloud albedo changes in observed darkening. *Proceedings of the National Academy of Sciences* 111, E2159-E2159. (pdf)
- I. Eisenman and J.S. Wettlaufer (2009). Is Arctic sea ice approaching a tipping point? *Bulletin of the American Meteorological Society* 90, 1605-1606. (pdf)
- I. Eisenman (2008). Abrupt climate change: North Atlantic volatility during the last ice age and modern Arctic sea ice retreat. PhD thesis, *Harvard University*, 138 pages.
- G. Gebbie, I. Eisenman, A. Wittenberg, and E. Tziperman (2007). Could ocean-modulated wind bursts lead to better El Niño forecasts? *Bulletin of the American Meteorological Society* 88, 1356-1357. (pdf)
- I. Eisenman (2007). Arctic catastrophes in an idealized sea ice model. In *2006 Program of Study: Ice (Geophysical Fluid Dynamics Program)*, pp. 133-161. Woods Hole Oceanog Inst Tech Rept 2007-02. (pdf)
- P. Huybers and I. Eisenman (2006). Integrated summer insolation calculations. *NOAA/NCDC Paleoclimatology Program*, Data Contribution Series #2006-079. (url)
- T. Sasseen, I. Eisenman, and K. Mason (2002). New constraints on galaxy evolution from the optical monitor on XMM-Newton. In *New Visions of the X-ray Universe in the XMM-Newton and Chandra Era*, ed. F. Jansen, European Space Agency SP-488. (pdf)

Advising

PhD students

Ben Mackay (co-advised with Shang-Ping Xie, 2023-present)

Matt Luongo (NASA FINESST fellow co-advised with Shang-Ping Xie, 2020-present)

Emma Beer (2018-2023)

Shantong Sun (2014-2019)

Erica Rosenblum (NSF GRFP fellow co-advised with Sarah Gille, 2013-2018)

Postdoctoral scholars

Lily Hahn (NOAA C&GC fellow co-advised with Nick Lutsko, 2023-present)

Lettie Roach (part-time NOAA C&GC fellow, 2021-2023)

Mark England (co-advised with Till Wagner, 2019-2021)

Till Wagner (2013-2017)

Rebecca Dell (Scripps Postdoctoral fellow, 2013-2014)

Selected Presentations

(2024) Hebrew University *(invited seminar)*

(2023) National Taiwan University CHiA virtual forum *(invited seminar)*

(2023) ECS & Cloud Feedback Virtual Symposium *(invited talk)*

(2023) Antarctic Sea Ice and Southern Ocean virtual seminar series *(invited seminar)*

(2023) University of Washington *(invited colloquium)*

(2023) American Physical Society March Meeting *(invited talk)*

(2022) AGU Fall Meeting *(talk)*

(2022) Australian Mathematical Society Workshop on Mathematics of Sea Ice and Ice Sheets, Adelaide *(invited plenary talk)*

(2022) UCSD Dept of Mechanical and Aerospace Engineering *(invited seminar)*

(2022) Cambridge University Isaac Newton Institute of Mathematical Sciences *(invited talk)*

(2022) AMS Atmospheric and Oceanic Fluid Dynamics *(talk)*

(2021) AGU Fall Meeting *(talk)*

(2021) University of Reading *(invited seminar)*

(2021) University of Southern California *(invited seminar)*

(2019) American Physical Society Southeastern Section Annual Meeting *(invited banquet talk)*

(2019) California Geophysical Fluid Dynamics Meeting @Caltech *(talk)*

(2019) Williams College physics department *(invited seminar)*

(2019) NASA JPL *(invited Distinguished Climate Lecture)*

(2019) NCAR CGD Seminar *(invited seminar)*

(2018) AGU Fall Meeting *(talk)*

(2018) NYU Courant Institute of Mathematical Sciences *(invited seminar)*

(2018) MIT PAOC Colloquium *(invited seminar)*

(2018) SIAM Conference on Mathematics of Planet Earth *(invited talk)*

(2018) UCSB Kavli Institute for Theoretical Physics *(invited talk)*

(2017) AGU Fall Meeting *(talk)*

(2017) Cambridge University Isaac Newton Institute of Mathematical Sciences *(invited talk)*

(2017) Oxford University *(seminar)*

(2017) University of Oregon *(invited seminar)*

(2016) UCSD Dept of Mechanical and Aerospace Engineering *(invited seminar)*

(2016) CLIVAR PSMI Meeting *(invited talk)*

(2016) Barrow Sea Ice Camp *(invited workshop presentation)*

(2016) Woods Hole Oceanographic Institution *(invited seminar)*

(2016) Harvard University *(seminar)*

(2016) UCLA *(invited seminar)*

(2016) University of Washington *(invited seminar)*

(2016) American Mathematical Society Joint Mathematics Meeting *(invited talk)*

(2015) PIMS Conference on the Mathematics of Sea Ice *(talk)*

(2015) SIAM Geosciences Meeting *(invited talk)*

(2015) Canadian Meteorology and Oceanography Society Meeting *(talk)*

(2015) World Climate Research Program (WCRP) Southern Ocean variability workshop *(talk)*

(2014) AGU Fall Meeting *(invited talk)*

(2014) Caltech *(invited seminar)*

(2014) University of Toronto *(invited seminar)*

(2014) ETH Zurich *(invited seminar)*

(2014) NSF Mathematics and Climate Research Network *(invited seminar)*

(2014) UC Irvine *(invited seminar)*

Selected Recent Professional Service

(2022-present) Faculty coordinator of SIO Physical Oceanography graduate program

(2023-2024) SIO Physical Oceanography organizer of prospective graduate student Open House

(2013-2023) SIO Climate Sciences organizer of prospective graduate student Open House

(2021-2022) SIO Physical Oceanography Ph.D. Curricular Review committee member

(2021-2022) SIO Climate Sciences Ph.D. Curricular Review committee member

(2021-present) SIO Diversity Advisory Committee member

(2017-present) SIO Computing Committee member

(2023-present) NOAA Climate and Global Change Postdoctoral Fellowship Steering Committee

(2024) National Academy of Sciences NRC Research Associateship Programs Fellowship review panelist

(2023) NASA Postdoctoral Program Fellowship review panelist

(2022) Ford Foundation Fellowship Program review panelist (designed to increase the diversity of college and university faculties and administered by the National Academy of Sciences)

(2024-present) Co-chair of International Association of Cryospheric Sciences working group on Dynamic Processes in the Marginal Ice Zone

(2021) Co-led a 2-day Polar Climate Science Workshop for high school teachers (targeting one of the most ethnically diverse and economically depressed school districts in California)

(2018) Co-developed and presented a course on climate science curricula for 6th grade teachers at the California Science Teachers Association annual meeting

Reviewer for *Science*, *Nature*, *Science Advances*, *Nature Geoscience*, *Nature Climate Change*, *Nature Communications*, *Scientific Reports* (Nature), *Proceedings of the National Academy of Sciences USA*, *Journal of Climate*, *Geophysical Research Letters*, *The Cryosphere* (EGU), *Paleoceanography*, *Journal of Geophysical Research–Oceans*, *Journal of Geophysical Research–Atmospheres*, *Journal of Advances in Modeling Earth Systems*, *Quarterly Journal of the Royal Meteorology Society*, *Proceedings of the Royal Society A*, *Ocean Modelling*, *SIAM Journal on Applied Dynamical Systems*, *Earth System Dynamics* (EGU), *Environmental Research Letters*, *Climate Dynamics*, *Annals of Glaciology*, *Cold Regions Science and Technology*, *Current Climate Change Reports*, *PLoS ONE*, *Monthly Weather Review*, *Earth's Future* (AGU), *Remote Sensing* (MDPI), National Science Foundation (for programs including Arctic Natural Sciences Program, Arctic System Science Program, Antarctic Ocean and Atmospheric Sciences, Antarctic Sciences, Physical Oceanography, Marine Geology and Geophysics, Climate and Large-Scale Dynamics, Applied Mathematics), European Research Council, Israel Science Foundation.