



The
42nd
JOHN D.
REGISTER
LECTURE

ICE SCIENCE IN A CHANGING CLIMATE



STEVEN NESHYBA

DEPARTMENT OF CHEMISTRY

Thursday, Nov. 12, 2015

7:30 p.m. | Kilworth Memorial Chapel

Reception following lecture

Ice science in a changing climate

There are a lot of reasons to be interested in ice. It's thought that the Earth was covered entirely by ice several times in the geologic past, for example, and recent research has shown that ice might have played a role in nurturing the beginning of life on Earth. We know that at present, ice—in the form of glaciers, snowfields, and clouds—plays a key role in the radiative balance and temperature of the planet. At the same time, the occurrence of ice on Earth is changing as the climate warms; we know that alpine glaciers are in retreat, and that parts of the Antarctic ice sheets are getting thicker, even while other parts of polar regions are experiencing significant ice loss. So, if you find yourself interested in ice in a changing climate, come hear what we have learned about it!

One focus of my research group has been ice clouds, called cirrus clouds. Cirrus clouds cover about 30% of the globe at any given time, and constitute an important radiative mechanism by which the planet regulates its temperature. Climate modelers need to understand this mechanism, e.g., how ice crystals scatter and transmit light, in order to predict how cirrus clouds will regulate climate in a warmer future. In fact we know enough about the shapes of typical cirrus ice crystals to predict how they reflect and transmit sunlight, which means that investigators flying through cirrus clouds have a way to compare theory to experiment.

That's where the problem arises: it turns out that real cirrus ice crystals reflect more light than theory says they should. A *lot* more. We've been exploring why that might be so. The research path that question has led us to has been pretty serpentine, with many more dead-ends than successes. It has involved the use of scanning electron microscopy, *in silico* radiative transfer experiments, Bayesian analysis, and molecular dynamics simulations. But we think we have an answer.

Another focus has been on the influence of anthropogenic soot, or black carbon, on snow. We know that increased atmospheric carbon dioxide has been the main driver of climate change in the last 100 years or so, but a second driver turns out to be airborne black carbon emitted by vehicles, fires, and cookstoves. If this black carbon lands on snow, the snow darkens and melts faster. Scientists have documented this process in lots of regions of the globe – except in South America, where much less work has been done, and none in Chile.

So we undertook a field campaign to measure the soot content in snow in the Chilean Andes. It was an international effort, with collaborators from Chile, Germany, and the United States, using a meltwater filtration sampling technique. We didn't know what to expect: on the one hand, we thought that because predominant winds come straight off the Pacific, we wouldn't find any black carbon, but on the other hand, Chilean glaciers and snowpacks are disappearing quickly, and black carbon has been found in snow in other parts of South

America. We encountered some significant challenges along the way, including iffy roads, high altitudes, an abundance of dust, and one fierce snowstorm. But we have a start, at least, of a map of black carbon in the Chilean Andes.

My lecture will conclude with some broader remarks about ice science in a changing climate.

Steven Neshyba

Steven Neshyba has taught in the Chemistry Department at University of Puget Sound for more than 20 years. Part of that teaching has included directing undergraduate research projects, often in collaboration with other science teams in the U.S. and abroad. Recent work has focused on characterizing the radiative properties of ice clouds. This has involved scanning electron experiments, atomistic numerical simulations of the ice-vapor interface, and the development of models to link knowledge gained about ice across the vast differences in time and space that these investigations entail.

Reading list

ICE SCIENCE

David Lynch, Cirrus. Atmospheric physicist Lynch has written a great guide to cirrus clouds, including a history of observations of these clouds and a discussion of how they affect climate. A great read for those interested in the nitty-gritty details of cirrus clouds.

Döscher, Vihma, and Maksimovich, Recent advances in understanding the Arctic climate system state and change from a sea ice perspective: a review.

A technical article in the geophysics literature, this review gives a great up-to-date summary of key climate mechanisms in the Arctic, including ice-albedo feedback and Arctic amplification.

CLIMATE CHANGE SCIENCE

Mark Lynas, Six Degrees: Our Future on a Hotter Planet. Journalist Lynas analyses the geophysics literature to anticipate how the planet will look and feel at each degree of warming.

Jim Hansen, Storms of my Grandchildren. Climate scientist Hansen communicates the science of climate change in an easy-to-understand but rigorous way. He predicts a stormier world in the coming decades, as weather patterns intensify and move poleward. Most dire is his analysis of climate sensitivity: if we burn all proven reserves of fossil fuels, we commit the planet to an unlivable future.

Mark Bowen, Censoring science. Journalist Bowen documents the development of a culture of censorship at NASA regarding the conduct and communication of climate change research.

Brian Sussman, Climategate. Meteorologist Sussman argues that the human-caused climate change theory is a sham, and that the green movement has “red roots.” Methods of extreme denialist rhetoric are prominently on display here, in a pervasively vitriolic tone and frequent use of ad hominem argument.

Naomi Oreskes and Erik Conway, Merchants of Doubt. Science historians Oreskes and Conway document the transition of a group of cold warriors as champions in the fight against communism, to champions in the fight against environmentalism.

BEYOND SCIENCE

Jorgen Randers, 2052: A Global Forecast for the Next Forty Years. Randers, who co-authored the futurist book *Limits to Growth* in 1972, takes a crack at the next forty years. The good news: population and CO2 emissions will peak earlier

than generally accepted. The bad news: it'll be too little too late, and the years following 2052 will be pretty rough.

Naomi Klein, This Changes Everything. Author and activist Klein argues that the commitment of western society to a trajectory ending in catastrophic climate change has also exposed new opportunities for solidarity among diverse people-based movements.

Chris Goodall, Ten Technologies to Save the Planet: Energy Options for a Low-Carbon Future. Businessman and author Goodall argues that existing renewable energy and sequestration technologies have the capability to allow humanity to phase out fossil fuels, if only investment were forthcoming.

Nigel Lawson, An appeal to reason. This former UK Chancellor of the Exchequer Lawson argues that avoidance of the future costs of climate change does not justify the high expenditures that climate activists are calling for.

As for data sources, a good place for technical details can be found in the IPCC report, 5th assessment report (<http://www.ipcc.ch/>). Other organizations' statements are given at <http://climate.nasa.gov/scientific-consensus/> — that includes NASA, NOAA, the US National Academy of Sciences, etc. Resources related to climate change denialism can be found at the Heritage Foundation, www.heritage.org/issues/energy-and-environment/climate-change.

John D. Regester Faculty Lectureship

THE JOHN D. REGESTER FACULTY LECTURESHIP was established in 1965 to honor the service of John. D. Regester, Ph.D., who joined the Puget Sound faculty in 1924. Regester taught philosophy throughout his career, served as dean of the university, and later was made first dean of the Graduate School.

Under the terms of the lectureship, the address is to be given by a member of the university who exemplifies the qualities of scholarship and intellectual integrity which professors and students have long associated with Regester.

The lecture series is a means of honoring members of the university faculty through an opportunity for them to address the university community on a subject of particular interest to the lecturer. The John D. Regester Lectures are both a recognition of the scholarship and accomplishments of the lecturer and an opportunity for the faculty to develop ideas further and explore them with colleagues and the public. The lectures provide a showcase where students and faculty members can witness their colleagues in the role of productive scholars.

- | | |
|--|---|
| 2013–Andy Rex, physics | 1991–Michael Veseth, economics |
| 2012–George S. Tomlin, occupational therapy | 1989–Kenneth Rousslang, chemistry |
| 2011–Nancy Bristow, history and African American studies | 1987–Terry A. Cooney, history |
| 2010–David Lupher, classics | 1985–Beverly K. Pierson, biology |
| 2009–Suzanne Holland, religion | 1983–Douglas M. Branson, law |
| 2008–David Tinsley, German | 1981–Michael J. Curley, English |
| 2007–D. Wade Hands, economics | 1980–Esperanza Gurza, foreign languages |
| 2006–A. Susan Owen, communication studies | 1979–Francis L. Cousens, English |
| 2005–Mott T. Greene, history | 1978–Delmar N. Langbauer, religion |
| 2004–Doug Edwards, religion | 1977–Jeffrey S. Bland, chemistry |
| 2003–Rob Beezer, mathematics | 1976–Esther B. Wagner, English |
| 2001–Geoff Proehl, communication and theatre arts | 1975–Richard E. Hodges, education |
| 2000–Helen (Ili) Nagy, art | 1974–Theodore L. Harris, education |
| 2000–James Evans, physics | 1973–Z. Frank Danes, physics |
| 1999–Geoffrey Block, music | 1972–Frank N. Peterson, sociology |
| 1998–Denise L. Despres, English | 1971–Robert G. Albertson, religion |
| 1997–William Breitenbach, history | 1970–John W. Prins, business |
| 1995–Alan S. Thorndike, physics | 1969–Leroy Ostransky, music |
| 1993–George M. Guilmet, comparative sociology | 1968–Gordon D. Alcorn, biology |
| | 1967–John D. Regester, philosophy |
| | 1966–Harold P. Simonson, English |
| | 1965–John B. Magee, religion |



UNIVERSITY *of*
**PUGET
SOUND**

Office of the Associate Deans

1500 N. Warner St. #1020

Tacoma, WA 98416-1020