Utahn explains a key step in how sea ice maintains Earth's climate and ocean life

BY LEE SIEGEL
THE SALT LAKE TRIBUNE

A Utah mathematician used a theory of how one substance percolates through another material to explain how slush forms on the surface of Antarctic sea ice. The study provides the first theoretical explanation of a process that is crucial for maintaining Earth's climate and life in polar oceans.

"You can call me the slush king," joked Ken Golden, a University of Utah math professor and main author of the study in the current issue of the journal Science.

Golden's study shows certain mathematical formulas describing percolation accurately predict the abrupt transformation of solid sea ice into a permeable layer that allows saltwater and nutrients to flow upward and flood the surface.

The flooding nourishes algae, which grow in the ice and live at the bottom of the polar food chain. The flooding also forms slush that later freezes, adding new ice to the floating ice pack covering the sea around Antarctica.

"Understanding what maintains that thin ice cover — it's often only 20 inches thick — is really important for understanding the climate," said oceanographer Miles McPhee of the University of Washington's Polar Science Center. "Any knowledge that adds to our understanding of how sea ice behavior can be described mathematically is quite valuable. That is the importance of what Ken is doing."

The Utah study "is definitely very interesting and important," said geophysicist Hajo Eicken of the University of Alaska, Fairbanks. "It is a big step forward in predicting a very difficult-to-predict phenomenon. It shows you can apply the same set of mathematical formulas and make predictions about materials as different as sea ice and a conducting surface on a microchip."

The layer of ice covering Earth's polar oceans often is a solid barrier separating the sea below from the sky above. But every few days, a storm blows in, warming the top of the ice and dumping snow on it.

That triggers a sudden change: Tiny pockets of air and briny saltwater in the ice grow larger and connect with each other. The entire ice pack becomes permeable. Sea water percolates up through the ice and floods the snowy surface, creating a vast expanse of slush.

Then, as air temperatures drop again, the slush freezes, creating new ice. That maintains the polar ice pack, preventing much of the heat in ocean water from reaching the colder atmosphere and overheating Earth's climate.

Ken Golden collected ice data and got idea for a study on 1994 Antarctic trip.
Baking on the Milk of Human Kindness

Charles and Sherrell Shaw feed their baby, Emily D’Anne, a bottle.

**Where They Are**

Breast-milk bank locations include:

- Mother’s Milk Bank, San Jose, Calif. (408-996-4550)
- Mother’s Milk Bank, Denver (303) 866-1888
- Triad Lactation Center & Mothers Milk Bank, Raleigh, N.C. (919) 250-5939
- National Capital Lactation Center & Community Human Milk, Washington, D.C. (202) 786-6455
- Wilmington Mothers’ Milk Bank, Wilmington, Del. (302) 733-2340
- Regional Milk Bank and Breast Feeding, Worcester, Mass. (508) 798-5005
- Lactation Support Service, Vancouver, B.C., Canada (604) 873-2345, x 7607
- Banco de Leche Humana, Veracruz, Mexico 52-55-14-45-00

**The Associated Press**

Nurse Pauline Sakamoto pasteurizes human milk at the Milk Bank in San Jose, Calif. Breast-milk banks were approved and a recorded a dose of 2,100 gallons this year.

Babies who are fed human milk are healthier and have fewer infections, research shows.

One in five infants is fed human milk.

Preliminary data from the National Institute of Child Health and Human Development’s First Thousand Days of Life Project showed that babies fed human milk were less likely to suffer from infections and had a lower risk of developing allergies.

Consumer groups have been calling for more widespread use of human milk.

Banks demand that the milk be donated by women who have no other use for it and that the milk be pasteurized to kill any bacteria.

The milk is then stored at 4 degrees Fahrenheit.

Shaw feed their baby, Emily D’Anne, a bottle.

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-Joe Slinger, ABC TV, Good Morning America

**Cool Math:**

Utah Professor Studies Sea Ice

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... climate.

As and the flush freezes, brine, or concentrated saltwater, percolates downward and drains into the sea below. Less salty sea water flows upward, carrying nutrients that feed algae living in the ice. Where the brine sinks into the sea, the algae serve as the base of a food chain that nourishes all creatures in the polar seas.

McPhee said that the ice temperature when the ice freezes is 1 degree Fahrenheit and becomes permeable.

Golden conduct the new study with geophysicists Stephen Ackley of the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, N.H., and Victoria Lytle of the Australian Antarctic Division at the University of Tasmania.

The Utah mathematician performed much of the study using a computerized spreadsheet calculator, but the data were collected during his 1994 expedition to Antarctica aboard a U.S. research ship and during Lyte’s 1995 trip on an Australian vessel. Golden witnessed brine flowing through the ice surface during his 1994 trip — prompting him to conduct the new study.

Golden, who first visited Antarctica in 1980, tried to make a third trip last July. But it was aborted when fire crippled the main engine of the research vessel, which drifted in the ice for three days before repairs allowed it to hobble back to Tasmania.

“I was scared,” Golden said, noting that winds could blow the ship below zero during the day the ship was without power. “You realize how much your life depends on the functioning of this ship.”