POLAR RESOURCES NEWSLETTER
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Sunlit Snow and PESKY POLLUTANTS

It turns out that being as pure as the driven snow isn't really as pristine as one might think. Pesky organic pollutants such as chlorinated pesticides and PCBs commonly end up in polar regions after being carried far from their sources by atmospheric mixing and blowing winds. However, when organic pollutants come to rest in the Arctic, their travels are far from over. The accumulation of these toxic compounds can enter the food chain, thereby posing a threat to the plants, animals, and humans living in these environments. However, at the same time that these pollutants are being deposited in the snow of polar regions, they are also being slowly destroyed, mostly through reactions involving sunlight. Past research in polar regions indicates that photochemical reactions occurring in the snow can alter the chemistry and composition of the overlying atmosphere by degrading snow-bound pollutants into gaseous molecules, such as nitrogen gases, carbon monoxide, and formaldehyde. These reactions are also important because they can change the chemical composition of the snow—a process that complicates the interpretation of snow and ice core records.

Although a handful of organic pollutants are directly broken down, or photolyzed, by absorbing the sunlight that hits the snow's surface, the vast majority of the pollutants are probably destroyed by indirect photochemical reactions. In this process, other molecules in the snow are photolyzed into smaller, reactive compounds called oxidants that then react with organic pollutants. For example, sunlight splits hydrogen peroxide in half to result in the formation of a particularly reactive molecular species, the hydroxyl radical, that in turn attacks many of the organic compounds in the snow. Rather than direct photolysis, this indirect breakdown of organic pollutants is probably the predominant mechanism behind their destruction and conversion to other, generally less toxic species. However, almost nothing is known about these indirect reactions because no field studies have yet been performed.

What could be more fun than playing with liquid nitrogen? Keren and Eddie flash-freeze test samples of snow solution.

Cort Anastasio, an associate professor of atmospheric sciences at the University of California at Davis, and his two graduate students, Eddie Galbavy and Keren Ram, are working to fill in this research gap by performing both field and laboratory studies on snow photochemistry. Their goal is to better illuminate the degree to which reactive oxidants contribute to the destruction of organic pollutants. As Anastasio explains, "In order to understand the budgets of these organic pollutants and how they affect plant and animal life in the polar regions, we need to understand the mechanisms behind their destruction in the snow."

Galbavy and Ram labored away this summer in Summit, Greenland, to determine how much and how quickly reactive oxidants are formed when snow is exposed to sunlight and how these oxidants affect the breakdown of organic compounds. More specifically,

Continued on Page 4

Eddie collecting snow for use in future tests from depths down to 2.5 meters.

Eddie working hard at the high-performance liquid chromatography machine.

GREENLAND News

November 5th brought freshies—both in terms of food and staff—to Summit Station. Geoff Phillips, Emrys Hall, Pat Smith, and Al O'Kelly arrived for crew turnover, along with Summit Station project manager Sandy Starkweather. The evening meal was a festive one, as folks exchanged Summit and real-world stories over some fine vittles. For the next week, the phase 1 team brought the phase 2 team up on operations and research protocols, with Sandy assisting as needed. On November 12, Kathy Young, Steve Munsell, Larry Levin, and Kim Wolfe climbed into the waiting Twin Otter and soared off for their next adventures. Thanks for a great lead-in to winter, folks!

Pat Smith gets frosty on the way to the ATM site. Photo by Pat Smith

At Summit, the phase 2 team started its solo odyssey with frigid temperatures. Geoff reports that the crew had to spend some time getting to know the uplifted Big House, which "squeaks, crackles, and shakes like a 90-year-old man getting out of bed in the morning." The team also had to fix the big shop doors, which are hinged to accommodate a small drift outside, so they would not blow open on North wind days.

Folks readied their cameras on November 13 for the last sunrise and sunset of 2005. The sun peaked over the horizon at 10:40, floated upward for a few minutes, and then bowed again at 11:55. A gorgeous full moon three days later made for near-daylight on the ice cap, and frustrated attempts by our team to enjoy some aurora gazing.

Meanwhile, charged with overseeing ongoing science experiments during phase 2, Pat and Emrys were busy "with the maze of spreadsheets and data that needs to be downloaded," Geoff reported, and with troubleshooting experiments needing a bit of extra attention. They also launched three large, helium-filled balloons for NOAA's ozone work—no easy feat in Summit's chill. Pat launched the first latex balloon on November 11th, only to find the instrumented payload wasn't fully operational. The second launch, on November 17th, paid off well, as the air-sampling instruments worked as expected, relaying measurements back to data recorders on the ground. The third launch on November 22nd of the bigger and more rugged plastic balloon ("really a blimp," Geoff noted) also was successful, although some of the Summiteers nearly froze solid due to outdoor temperatures of -60 F. The effort paid off, as NOAA was pleased with the data coming back from the launch. Balloons now launch weekly and are routinely successful. Way to go, guys!

Click here for information on the NOAA ozone research: http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=NOAASummit

High winds for much of the last week of November kept our staff mostly indoors. This suited the team well on November 24th, as they were busy preparing, eating, and then recovering from a fine Thanksgiving meal. As Geoff wrote, "we ate our fill and then some more."

As November gave way to December, Pat and Emrys worked on dataloggers attached to the Swiss tower, which takes meteorological and other measurements for Atsumu Ohmura's study of boundary-layer dynamics, as the 'loggers had stopped transmitting data automatically. http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=CHantenna

Relatively pleasant early December temperatures allowed folks to work and play a bit outside. Meanwhile, indoors, a new potato plant sent up its first few shoots, much to the delight of our freshie-loving team.

A dazzling aurora over Summit's Big House. Photo by Pat Smith

ALASKA News

Our Alaska team was busy this month. In addition to the VPR and AGU meetings, Jay Burnside, Naomi Whitty and Mike McKibben attended the Toolik Field Station planning meeting in Fairbanks November 30th to December 2nd. The Alaska staff also prepared to move into our new office and warehouse space.

Josh Schimel's "Bugs in Winter" research team spent November 8th – 13th at Toolik Field Station. The group collected soil samples in support of their study to better understand how microbial communities change between warm and cold seasons. http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0352863

DENVER News

VPR's far-flung team gathered in Denver during November for planning meetings. Folks from SRI, VECO and PFS met to review the 2005 field season—our busiest yet!—and to preview the 2006 effort. Among the attendees were two new full-time PFS employees, who got a whirlwind introduction to life with VPR. They are:

Matt Irinaga, VPR's new Project Manager in Alaska

Matt Irinaga, our new Alaska operations project manager, who joined Marin and Naomi in our Fairbanks office on November 1st. Matt's background is in wildlife biology. He's worked in Antarctica both as a researcher and as a support contractor, and in Alaska, most recently as the logistics coordinator for the Barrow Arctic Science Consortium. He test-drove the VPR machine when he filled in for Marin during her maternity leave last year. Matt, welcome aboard!

Richard "Chico" Perales joined the team in early November as project coordinator for the ongoing Barrow BEO manipulation, and to assist with work at King Island and Toolik Field Station. Chico worked in Antarctica for 15 years—including some winters—mostly as a construction supervisor, but also as a cartoonist for the McMurdo newspaper, *Antarctic Sun*. He also worked for VPR in the arctic during the last three austral summers. Chico, we're glad to have you!

Richard Perales, VPR's new Barrow BEO Project Coordinator

A number of us attended the fall American Geophysical Union meeting in San Francisco last week. We attended sessions where "our" scientists presented their latest findings, and met with researchers on funded projects as well as potential new researcher clients to discuss their support requirements. Between the AGU meeting and the UN climate change pow-wow in Montreal, it's been a busy news cycle for arctic research topics. (See below for links to a selection of stories.)

SCIENCE & Other News

At the American Geophysical Union meeting in San Francisco, scientists were discussing recent research results. Below are just a few of the findings:

• Digging deeper: Scientists are finding that the amount of carbon trapped in the soil of the high arctic is far greater than was suggested in a study completed in the early 1990s. This suggests, in turn, that a larger quantity of carbon (a so-called greenhouse gas) could be released to the atmosphere should the permafrost thaw. See the story here: http://www.uwnews.org/article.asp?articleID=13908

• Ozone recovery may take longer than was previously suggested, said researchers at the AGU. While the annual winter thinning of ozone in the upper atmosphere in the Arctic may return to the levels found before 1980 by the year 2040, scientists expect recovery over the Antarctic to take longer—normal levels may not be found in the late winter until 2065. http://www.nytimes.com/2005/12/07/science/07ozone.html

• Following on the heels of the above-mentioned *Nature* article, more (and sometimes contradictory) information was presented on the North Atlantic circulation: http://news.bbc.co.uk/1/hi/sci/tech/4524618.stm

Data show a 30 percent slowing since 1992 in the Atlantic "conveyor belt" that circulates water between the warm tropics and the frigid arctic, say British scientists in the 1 December issue of the journal, *Nature*. These currents have large impacts on global weather patterns, and also play a significant role in ocean productivity. For coverage of the story go to http://www.newscientist.com/article.ns?id=dn8398. Read the full article (with a subscription) at http://www.nature.com/nature/journal/v438/n7068/abs/nature04385.html.

Some 10,000 people were expected to attend the United Nations World Climate Change Conference in Montreal, 28 November to 9 December. It's the first meeting held for signers of the Kyoto Protocol since the historic agreement went into effect this year: http://unfccc.int/meetings/cop_11/items/3394.php. Andrew Revkin covered the meetings for the *New York Times*: http://www.nytimes.com/ref/science/earth/montreal-climate.html

SCIENCE & Other News Continued

Jose Kusugak, president of a Canadian Inuit organization, spoke at the UN conference, describing the effects of climate change on the lives and livelihoods of the 54,000 Canadian Inuits he represents. http://www.canada.com/vancouversun/story.html?id=50c89709-aa8f-4da9-bef8-27e051d2cfc8&k=26596

Expeditionary artist Maria Coryell-Martin, who spent much of last season working in Greenland, has posted images of her work on her website. These include several sketches of Summit Station. http://www.expeditionaryart.com

Ted Scambos uses satellite images to assess arctic sea-ice cover. He tells Earth and Sky radio that sea-ice extent for 2005 was less than any recorded since 1978, when the satellite data research began. http://www.earthsky.org/shows/observingearth.php?date=20051201

Our very own Mike McKibben wrote an article for VECO's corporate newsletter describing last summer's effort to lift the Big House above Summit's surface. http://www.vecopolar.com/Files/PDFs/uplift2005.pdf

Continued from Page 1

they measured the formation rates, lifetimes, and concentrations of two important oxidants on sunlit snow grains: the hydroxyl radical and singlet molecular oxygen. They then measured the lifetimes of several different model organic compounds in the snow and determined to what degree the oxidants caused the breakdown of the organic compounds, as opposed to other mechanisms.

Performing these experiments was no easy feat. Galabavy and Ram spent three months at Summit this summer investigating this chemistry. Each day they took surface snow samples, added the model organic compounds to the collected snow, refroze the snow into ice pellets, put the samples on the snow surface, and then sampled them in a mobile lab at Summit to monitor the appearance of the oxidants and the disappearance of the model organics.

Keren creates mini wells in the snow surface to measure gas phase oxidants.

Now back at home in Davis with boxes of snow shipped home from Summit, Anastasio's team will replicate these field experiments in the laboratory while seeing how the chemistry is affected by environmental variables such as temperature and pH. "Our final component will be to combine our field and laboratory data to estimate the lifetimes of a range of organic compounds in snow at a variety of locations," Anastasio says. This will allow researchers to compare and contrast the indirect breakdown of organic pollutants by oxidants at a range of snowy locales and under conditions where certain oxidants and/or organic pollutants may be more prevalent than others.

For more information about this research, go to: http://summit.ucdavis.edu/

The Snow Lab looking northwest.

In addition to sharing this information with other scientific researchers, college and middle school students also stand to gain from Anastasio's research. He currently teaches an introductory course on air pollution for undergraduates in which he incorporates a series of lectures on snow chemistry in Greenland. Anastasio is also collaborating with a local middle school science teacher, Martha Quenon, to develop a 3-5-day unit on global climate change and the Arctic to provide her 9th-grade students with a broad understanding of this topic.

—Kara Nyberg, PhD

Many thanks to Cort Anastasio for providing information and to Eddie Galbavy for providing photos.