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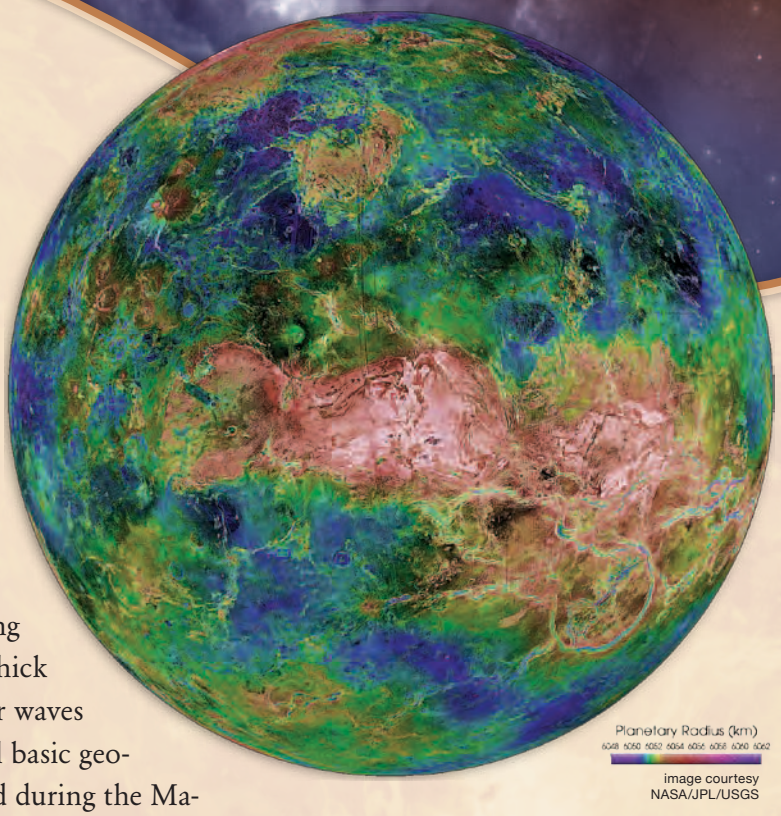
Improving upon the past:
Venus' topography and the future of planetary research

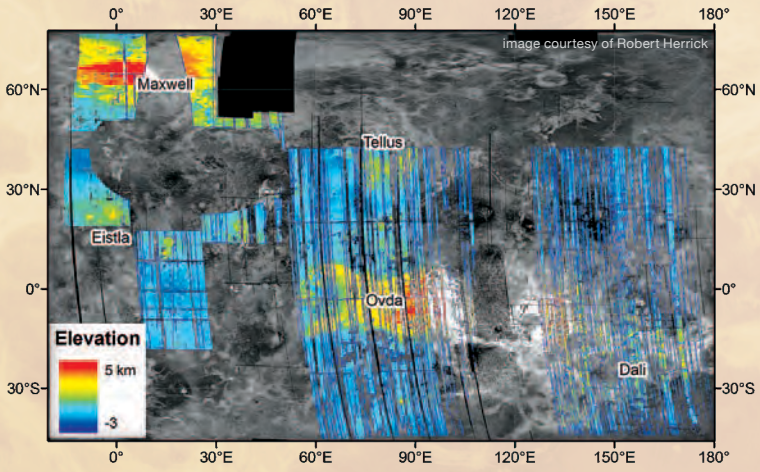


Long before Robert Herrick was a research associate professor at the Geophysical Institute he was a doctoral candidate at Southern Methodist University in Dallas, Texas, working on the Magellan mission. Launched by NASA in 1989, the imaging radar orbited Venus until 1994. Herrick's current research has brought him back to the second planet from the sun. Along with colleagues, Herrick has reprocessed the data collected by Magellan with clarifying results.

Previously, the topography of Venus was charted using radar altimetry. Lacking a clear line of sight through thick yellow clouds, scientists tracked the travel time of radar waves bouncing between the surface and the satellite to model basic geologic formations. Stereo radar images also were collected during the Magellan mission. Herrick uses the analogy of a View-Master® to describe the way in which satellite images of two separate perspectives are combined to achieve stereo-vision, or a three dimensional effect.

Herrick and his team have reprocessed those stereo radar images to produce a higher-resolution map of Venus. Though the computations for topography require only simple trigonometry, it is sophisticated image matching techniques and contemporary computer resources that make reprocessing the Magellan data possible. With the improved topography map, many of the complex tectonic features on Venus can now be studied in detail.

Renewed interest in the morning star has been a long time coming. After several Mars-focused missions, scientists have identified an obvious lack of high-resolution data available for Venus.



VIEWING VENUS – At top is a composite image of Venus that was color-coded to represent elevation. Due to spacecraft deterioration, the third imaging cycle of the Magellan mission only resulted in 22% stereo radar imaging coverage. However, even with limited data for the perspective comparison, Herrick and colleagues were still able to improve upon the topographic data in the colored areas above.

"For most of the last 15 years the emphasis for NASA's unmanned program was doing things related to the search for life. If your focus is on the search for life, Venus is not very useful. The surface temperature is about 900 degrees [Fahrenheit]," Herrick said.

But that harsh environment has again piqued research interest. As more planets are discovered orbiting distant stars, comparing the similarities and differences between Venus and Earth has allured researchers, Herrick said. Despite similar size and distance from the sun, the two planets have dramatically dissimilar atmospheres. Understanding why the stark contrasts exist is key to evaluating the likelihood that an Earth-sized planet will be an Earth-like planet.

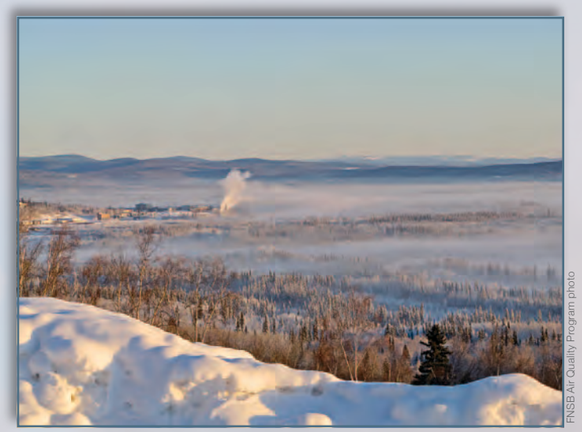
Investigations on Fairbanks air quality

Despite a minimal population and vast terrain, air quality is a challenge in some Alaska communities. In winter the Interior city of Fairbanks often exceeds the 24-hour National Ambient Air Quality Standard. Professor Nicole Mölders of the Geophysical Institute's Atmospheric Science group and doctoral candidate Huy Tran are investigating what causes elevated particulate matter levels in the community.

"When you have an air quality problem, the first thing you have to do is an inventory to see what is causing the problem," Mölders said. "You look at the meteorological situation and the emissions and the situation when you have the exceedences."

From the winters of 2004 to 2009, there were 128 exceedances of the air quality standards. Mölders and Tran examined observational data collected in Fairbanks' city center from the winters of 1999 to 2009. They found that concentrations of $PM_{2.5}$ – fine particulate matter smaller than 2.5 microns in diameter – occurred during winter under calm wind, extremely low temperature, low humidity and multi-day surface inversion conditions. The meteorological recipe for exceedances: the inversion traps the pollutants near the ground, in the breathing level, and the calm wind (<2.2 mph) inhibits transport of the noxious aerosols out of the area.

Surrounding topography compounds the air quality problem. Fairbanks is bordered by hills on three sides. This restrains the exchange of air in the horizontal direction, while the inversion inhibits the exchange in the vertical direction. Mölders compares it to being situated in a Crock-Pot with a tight lid, but without the heat.



FNSB Air Quality Program photo

HAZARDOUS AIR *– Emissions from traffic, home heating sources and power plants get trapped near Earth's surface when there is a surface inversion layer. Based on 10 years of data analyzed, Mölders and Tran found that temperature inversions exist 75 percent of the time during winter in Fairbanks.*

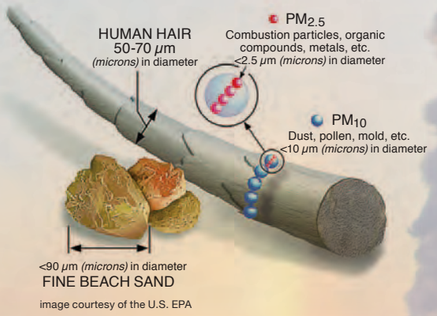
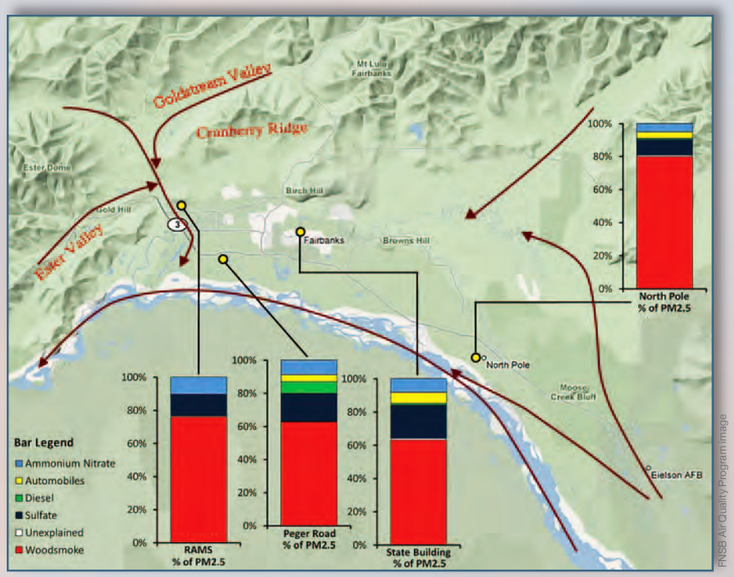


image courtesy of the U.S. EPA

Plummeting temperatures also play an important role in the air quality problem. From November through February, an abundance of $PM_{2.5}$ exists due to traffic and other combustion processes used for heating and power generation. Since it is unlikely that topographic and winter meteorological conditions will soon change, Mölders and her students use photochemical models to explore the impact of traffic and wood burning on $PM_{2.5}$ concentrations. These modeling activities aim at identifying ways to most efficiently reduce the $PM_{2.5}$ concentrations.

Since vehicle exhaust contributes to the $PM_{2.5}$ problem in downtown Fairbanks, cold starts and the idling of vehicles could be reduced. In addition, smarter choices for home heating would benefit local air quality.

"People have to burn wood efficiently to reduce the problem," Mölders said. "It's important that people are educated on how they burn wood and that they burn seasoned wood."



FNSB Air Quality Program image

SOURCE OF THE PROBLEM *– Wood smoke is the source of more than 60 percent of the $PM_{2.5}$ particles found at most monitoring sites in Fairbanks. This figure shows the source apportionment of $PM_{2.5}$ measured at four locations in the Fairbanks area.*

According to the Fairbanks North Star Borough, wood smoke is the source of more than 60 percent of the $PM_{2.5}$ particles found at monitoring sites in the Fairbanks area. Burning dry, seasoned wood could make a difference by curtailing the amount of harmful emissions.

Exploration of the Fairbanks air quality issue allows Tran the opportunity to do applied research and his studies could improve the very city in which he lives. This opportunity may be fairly common among graduate students at the GI, but it is unique when compared to most graduate programs in the country.

"I'm always interested in doing research that contributes to the community," Tran said. "This research gave me a great opportunity [that will help] when I apply for jobs after graduation."

The graduate student continues to research Fairbanks air quality and is currently examining the impacts of traffic and wood stoves on the issue. Tran graduates in 2012.

Preparing wood to burn

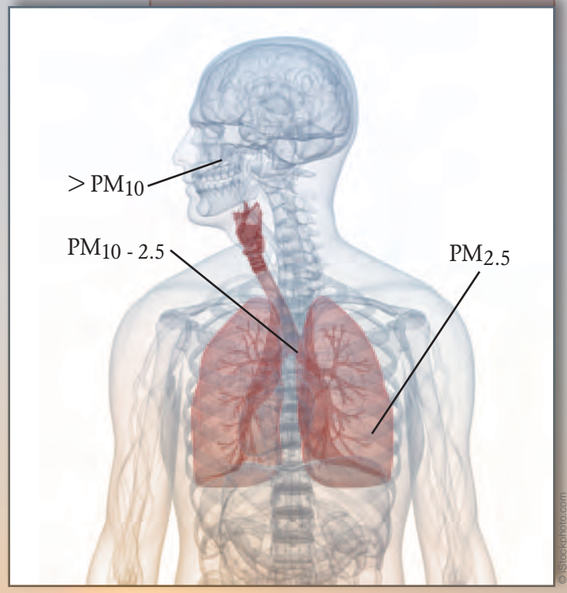
source: FNSB Air Quality Program

SPLIT wood in half at least once. It should be less than two feet in length.

STACK in a pile for adequate air flow.

STORE by covering the wood pile to protect it from rain/snow, leaving the sides of the stack open to breathe. Store for six months to two years before burning, depending on location, the weather, and type/species of wood. Store in an area with good exposure to the sun.

SAVE money and the air. Burning dry wood creates a hotter fire so less wood is needed and less $PM_{2.5}$ is produced.



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HEALTH EFFECTS *– Particulate matter smaller than 2.5 microns in diameter are small enough to reach deep into the lungs when inhaled and can trigger inflammation in the lungs, blood vessels or the heart. (source: U.S. EPA)*

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Leaving a legacy: Roger Smith retires as GI director

Roger Smith has presided over the Geophysical Institute for more than a decade, serving as the chief administrator for all aspects of the facility. With roughly 350 employees, a $35 million budget and active research underway, the job takes both mental and physical stamina. Despite challenges experienced in the position, the outgoing director feels he's met the goals he set out to achieve in his administration.

"Over the 11 years I've been director there has been considerable improvement in remote sensing. There have been very successful applications of remote sensing in volcanology, ice, the technique of SAR (synthetic aperture radar), and more recently, the unmanned aircraft program," Smith said.

In addition to the advances in remote sensing, several other projects are underway. Smith has created an eighth research group – the Education group – and the Undergraduate Research Program is in development.

Smith came to Alaska in 1984 to serve as an associate professor of physics in a dual appointment between the GI and the Physics Department at the University of Alaska Fairbanks. Beyond the scientific strides seen during his tenure here, Smith is fond of the unique culture that exists at the GI.

"We are a community in and of ourselves," Smith said. "Everyone has a recognizable part in the work that we do. It's a team of people united for the success of the whole. I like that idea."

Smith will remain in the post until his successor comes on board.

UAF photo by Todd Paris