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RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

Do tree ring chronologies have missing rings that distort volcanic cooling signal?

Fixing tree ring chronologies yields closer agreement with models

Climate models generally show that when a massive volcano erupts, scattering reflective aerosols across the globe, the planet's temperature declines for up to a few years. However, when researchers look at reconstructed temperature records built on annual tree ring measurements, this volcanic cooling often appeared much weaker than expected or was nonexistent. In a new study reanalyzing regional tree ring growth records, *Mann et al.* provide a possible explanation for the absence of the cooling effect.

In previous research, some of this study's authors proposed that the cooling effect of a massive volcanic eruption could create conditions that are so stressful that some trees may not grow that year. This gap would lead researchers to incorrectly interpret the growth from the warmer subsequent year as growth in the eruption year, minimizing the calculated cooling effect of the eruption. Because only some regions would be affected by these missing rings, combining regional records into global averages would spread the cooling across multiple years, diminishing the strength of the signal.

In the current study the authors reanalyzed regional tree ring records, testing the idea that they may be time shifted relative to each other. Using a numerical simulation, they found that when trees were randomly given modest numbers of missing rings, the agreement between modeled and proxy-derived temperature records could be greatly improved. For recent volcanic eruptions, the adjustment brought the proxy records more in line with thermometer observations.

The authors suggest that because most proxy-based temperature records rely on tree ring records, short-term volcanic cooling may be underestimated in many temperature reconstructions. The authors conclude that this may in turn have led to underestimates in the sensitivity of the climate system to both natural and human forcing in some past studies. (*Journal of Geophysical Research-Atmospheres*, doi:10.1002/jgrd.50609, 2013) —CS

Tree ring records not distorted by missing rings

Tree ring records are often used as a proxy for past climate. Trees form a new growth ring each year, and ring widths are related to temperature and other conditions at cold sites. Some recent studies have noted that tree ring width chronologies and resulting climate reconstructions do not appear to show the widespread cooling in the past millennium that would be expected following large volcanic eruptions. One hypothesis suggests that regional cooling after a volcanic eruption could be so severe that many trees do not form a ring at all, which leads researchers to misdate the tree ring chronology.

However, *D'Arrigo et al.* argue that, in fact, there is little or no physical evidence to support that hypothesis. They report that actual tree ring observations, as well as modeling analyses, show that while some trees may not lay down a ring along parts of their circumference in unusually cold years, only a small percentage of the trees in a given stand would be missing an entire ring.

The researchers suggest that the shortage of evidence for volcanic cooling in the tree ring reconstructions of temperature is related to factors other than misdating of tree ring chronologies. For instance, density, not ring width, is the preferred parameter for volcanic studies. Also, volcanic cooling is a regional effect that varies across the globe, so that regional cooling could be masked in tree ring composite records used to generate hemispheric reconstructions. (*Journal of Geophysical Research-Atmospheres*, doi:10.1002/jgrd.50692, 2013) —EB

Characterizing internal tides near the Luzon Strait

In the Luzon Strait, which lies between the Philippines and Taiwan and connects the western Pacific Ocean and the South China Sea, ridges extending along the ocean bottom generate large internal tides—waves with a tidal frequency within the ocean, not on its surface—that propagate into the South China Sea and the Pacific Ocean.

New observations from an array of autonomous gliders provide broad coverage of the area around the Luzon Strait, including the area near the Pacific Ocean, which had not been well covered by previous observations. *Rainville et al.* used these data to characterize the internal wave field and its variability in the uppermost 1000 meters of the water column. They capture the progression of internal tides as they propagate from their generation site and estimate the semidiurnal and diurnal internal tide amplitude and phase, as well as energy flux, over a region covering several hundred kilometers. (*Journal of Geophysical Research-Oceans*, doi:10.1002/jgrc.20293, 2013) —EB

Arctic is especially sensitive to nearby black carbon emissions

Black carbon, also known as soot, emitted from combustion of fuels and biomass burning absorbs solar radiation in the atmosphere and is one of the major causes of global warming, after carbon dioxide emissions. When black carbon is deposited on snow and ice, the soot-covered snow or ice absorbs more sunlight, leading to surface warming. Due to the large amount of snow and ice in the Arctic—which has warmed twice as fast as the global average over the past century—the region is likely to be especially sensitive to black carbon.

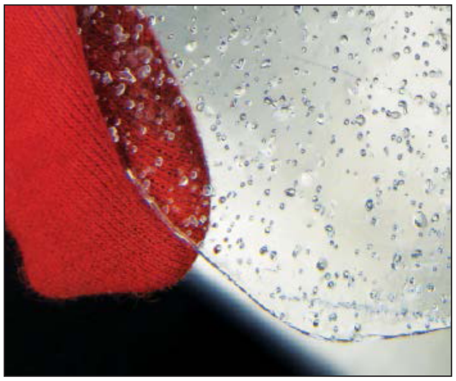
To investigate how sensitive the Arctic is to black carbon emissions from within the Arctic compared to those transported from midlatitudes, *Sand et al.* conducted experiments using a climate model that includes simulation of the effects of black carbon deposited on snow.

They found that most of the Arctic warming effect from black carbon is due to soot being deposited on snow and ice, rather than in the atmosphere. Black carbon emitted within the Arctic is more likely to stay at low altitudes and thus to be deposited on the snow and ice there, whereas black carbon transported into the Arctic from mid-latitudes is more likely to remain at higher altitudes. Because of this, the Arctic surface temperature is almost 5 times more sensitive to black carbon emitted from within the Arctic than to emissions from midlatitudes, the authors found.

The scientists note that although there are currently few sources of black carbon emissions within the Arctic (the most dominant ones are oil and gas fields in northwestern Russia), that is likely to change as human activity in the region increases. Therefore, the authors believe there is a need to improve technologies for controlling black carbon emissions in the Arctic. (*Journal of Geophysical Research-Atmospheres*, doi:10.1002/jgrd.50613, 2013) —EB

Updated ice core record captures industrial era carbon variability

In 1999, researchers published data from ice cores collected at Law Dome, a research



David Etheridge

Bubbles of air trapped in the ice preserve a record of the past atmospheric composition.

site in East Antarctica. These data are distinguished by their high time resolution and by their overlap with modern measurements, providing one of the most important records of how the atmosphere's chemical composition changed over the past 1000 years. Air trapped in bubbles in the ice core let researchers measure the concentration of carbon dioxide and other gases and analyze the ratio of carbon-13 to carbon-12 isotopes in the atmospheric carbon dioxide. Burning fossil fuel releases carbon dioxide that is depleted in carbon-13 isotopes, and the Law Dome record provided evidence that modern increases in atmospheric carbon dioxide are due to anthropogenic activity. In a new study, *Rubino et al.,* a team that includes some of the authors from the original analysis, use novel tools and techniques to update their ice core record.

The shallowest portions of the Law Dome core contain air that overlaps in age with direct marine boundary layer samples collected since 1978 in Cape Grim, Tasmania, and with samples collected from firn—compressed snow that forms beneath the snow surface—at Law Dome and at the South Pole, providing a bridge from paleoclimate measurements to direct modern observations.

The air within firn contains a record of recent atmospheric composition. Previous research had shown inconsistencies between the records of the carbon dioxide isotope ratio derived from these various locations. However, using modern techniques to reanalyze ice core and firn samples that were collected previously, the authors found that the records of the atmospheric carbon dioxide isotope ratio could be brought into agreement. In addition, the authors' new analysis improves the sampling density of the past 150 years, capturing decadal variability of atmospheric carbon fluxes during the industrial period. (*Journal of Geophysical Research-Atmospheres,* doi:10.1002/jgrd.50668, 2013) —CS

—Ernie Balcerak, Staff Writer, and Colin Schultz, Writer