

Waves in concert fire inferno

ATMOSPHERIC CYCLES COMING TOGETHER HAVE BEEN INDICTED FOR FREQUENT HEAT WAVES, WRITES S ANANTHANARAYANAN

Close on the heels of brutal May-June in the plains of northern India and Pakistan, the heat is raging in Europe, with the temperature over 38° Celsius. The death toll in the Indian subcontinent has been in the thousands, with the heat wave in Pakistan reckoned the eighth worst in history and the one in India as the fifth worst. These events extend the series during the past decade, the last in Russia in 2010 and the USA in 2012, and studies show that the frequency of heat extremes would double by 2020 and quadruple by 2040.

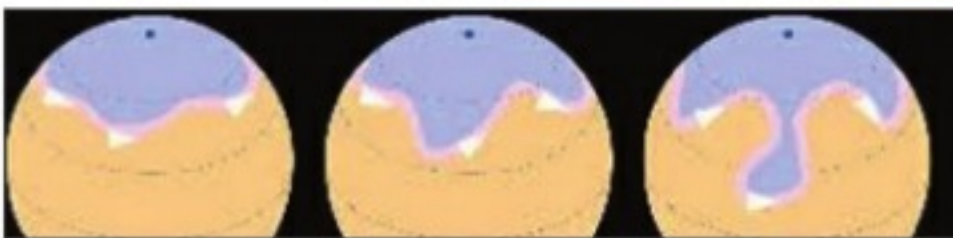
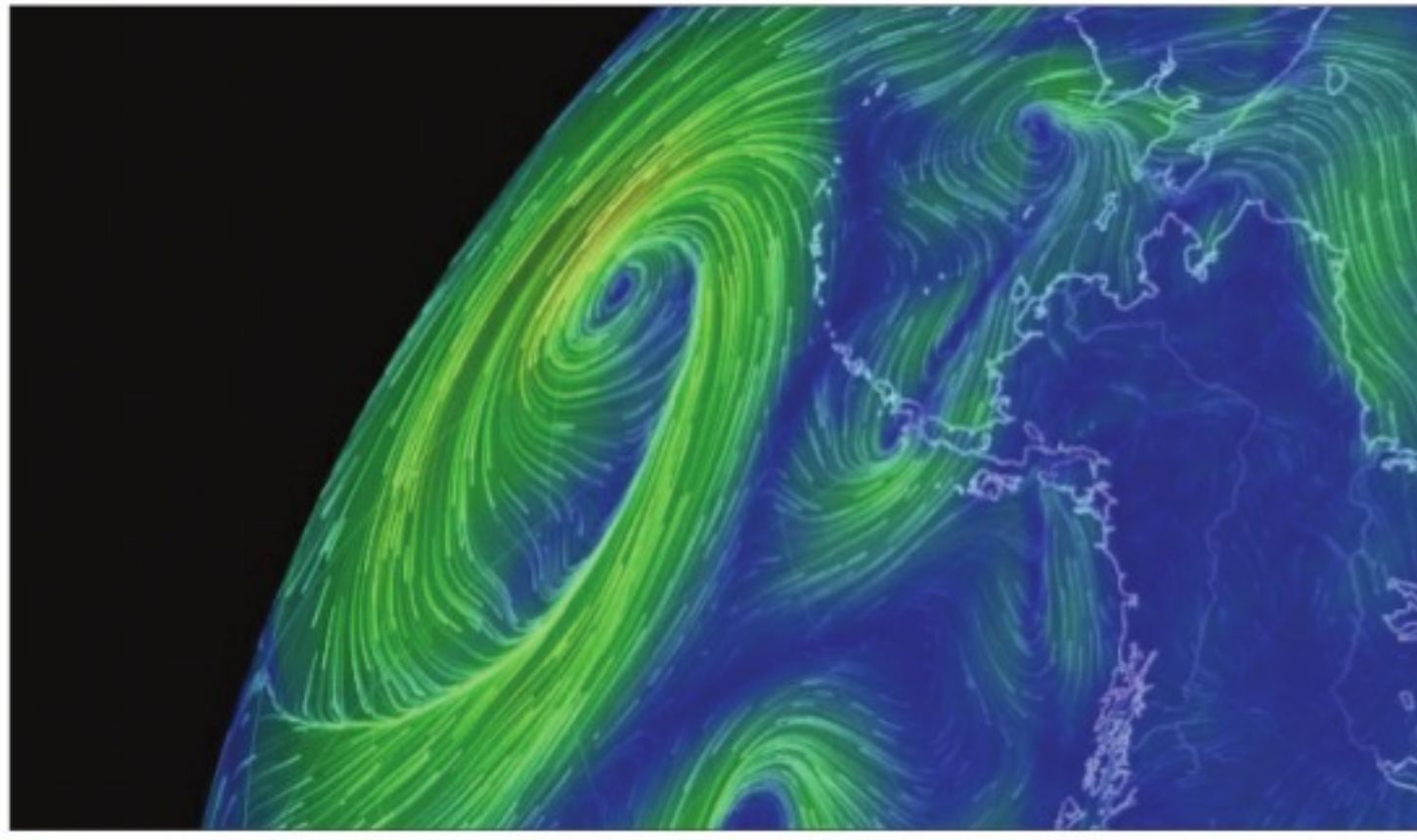
While man-made global warming explains the gradual increase in spells of severe heat, the intensity and duration of events that we are seeing cannot be understood as a result of just warming of the globe. "The large number of recent high-impact extreme weather events has struck and puzzled us," says Dim Coumou, lead author of a study at the Potsdam Institute for Climate Impact Research (Institut für Klim

wards, creating counter-currents.

There is one current of warm air moving towards the poles and another of cool air coming down from the poles. With opposing Coriolis forces, the mixing of the two streams leads to what is called the *Jet Stream*, at an altitude of nine kilometres, which airlines use to save fuel while flying east. Given the scale — viz, the mass and volume of air, the atmosphere weighs five billion million tonnes and the distances in hundreds of kilometres — these effects of warming and earth's rotation, which is twice the speed of sound at the equator, lead to effects that are beyond the capacity of human control.

The stream of the air mass also veers and strays in its flow and returns, due to restoring forces, to veer the other way, and so on, which leads to a meandering, periodic, wavy motion. These kinds of wavy motion are known as *Rossby waves*, after Carl-Gustaf Arvid Rossby, who explained how they came about. The wave formation in the cold circulation around the poles can become so strong that a portion of it could break free to form a cyclone or an anti-cyclone to cause extremes of cold at lower latitudes. And there are Rossby waves that move northwards from the equator, bringing heat from the tropics to Russia, Europe or the USA. The PIK study has shown that at times of extreme weather, the wave that brings great heat from the low to high latitudes could begin to move very slowly, so that the heat stays undissipated for a long time, according to a PIK press release.

"Behind this, there is a subtle resonance mechanism that traps waves in the mid-latitudes and amplifies them strongly," says Stefan Rahmstorf. The study cites a proposal by an earlier



A jet stream forms into waves and divides.



Dim Coumou, Vladimir Petoukhov, Stefan Rahmstorf and Hans Joachim Schellnhuber.

afolgenforschung), published in the *Proceedings of the National Academy of Science*. The team — Dim Coumou, Vladimir Petoukhov, Stefan Rahmstorf, Stefan Petri and Hans Joachim Schellnhuber, of PIK and the Santa Fe Institute — analysed massive sets of weather data from around the world and found that episodes of extreme heat were related to wave forms in the circulation patterns in the atmosphere acting together.

The fact that the earth is surrounded by extensive oceans and a massive atmosphere, coupled with its rotation, leads to complex and very high energy circulation patterns. First, rotation leads to days and nights and alternate warming and cooling of the sea and the atmosphere. Next, the tilt of earth's axis results in unequal warming of the hemispheres and low and high latitudes. Added to this is the rotation itself, which brings about an eastward driver, called the *Coriolis force*, of air that is moving towards the poles. This force varies when the moving air rises or descends and there are conditions when the force on the mass of air can be west-

ward, creating counter-currents. The group — Petoukhov, et al — that a combination of the right conditions could lead to the wave energy being trapped. The group had worked out the years, in July-August of the period from 1980 to 2011, in which these conditions, called resonance conditions, were fulfilled. The group used wind speed and other data and computed the timing of different components of the wave movement and found that there were 19 instances between 1980-2011 of the different components acting together, or a resonance, and these corresponded to events of extreme weather. A resonance is when the frequency of the up-down

motion of two or more wave motions finds a match, so that one takes up the energy of another and energy does not dissipate. In such an event, the extent of up or down of all the waves adds up and the swing can be very wide.

The PIK group notes that in recent years there has been a cluster of resonance events and this rise coincides with the rapid warming of the Arctic. The press release observes that since 2000, the Arctic has been warming nearly twice as fast as the rest of the globe. The reason for this is again global warming and the loss of Arctic sea ice. Loss of ice reduces the proportion of heat reflected back to space and a darker sea warms faster. And the rise in the frequency of resonance effects in planetary waves since 2000, with a rise in Arctic temperature by about one degree Celsius, indicates how closely factors like temperature differences, which drive the weather, are linked with events like extreme climate.

The study, in fact, puts a finger on a mechanism by which marginal changes in global temperature act as a switch to turn on forces that have drastic consequences. "The planetary waves topic illustrates how delicately interlinked components in the earth system are, and it shows how disproportionately the system might react to our perturbations," says Joachim Schellnhuber.

If climate change continues unabated, severe heat extremes may affect 85 per cent of the land area of the earth by 2100 and 60 per cent would face extremes that are unknown today, the press note says.

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10 worst heat waves in history

1. Europe, 2003	71,310
2. Russia, 2010	55,736
3. Europe, 2006	3,418
4. India, 1998	2,541
5. India, 2015	2,500
6. USA and Canada, 1936	1,693
7. USA, 1980	1,260
8. Pakistan, 2015	1,250
9. India, 2003	1,210
10. Greece and Turkey, 1987	1,030

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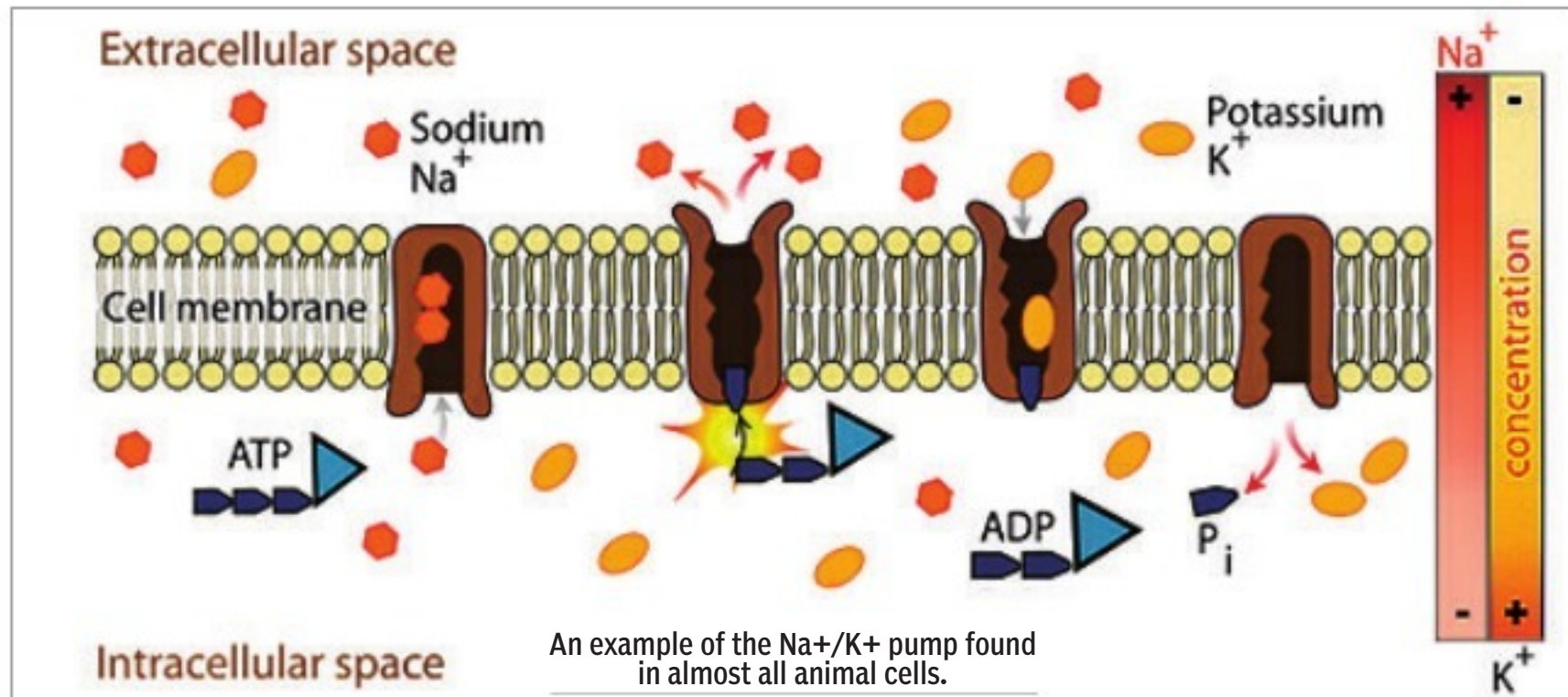
ACTIVE TRANSPORTERS

TAPAN KUMAR MAITRA PROVIDES A LOWDOWN ON FOUR PROTEINS THAT CONSTITUTE A PARTICULAR CLASS OF ENZYME

The most common mechanism employed for direct active transport involves ATPases that link the transport to the hydrolysis of ATP. Four main types of transport ATPases have been identified — P-type, V-type, F-type and ABC-type. Though the four types of transport proteins differ in structure, mechanism, localisation and physiological roles, all use the energy of ATP hydrolysis to transport solutes against a concentration gradient or an electrochemical potential.

ions against their electrochemical potential. As noted earlier, these transport proteins can also facilitate the reverse process, in which the exergonic flow of protons down their gradient is used to drive ATP synthesis. F-type ATPases illustrate an important principle — not only can ATP be used as an energy source to generate and maintain ion gradients, but such gradients can be used as an energy source to synthesise ATP.

The fourth major class of ATP-driven pumps is the ABC-type ATPases, also called ABC transporters. The ABC designation is for "ATP-binding cassette", with the term cassette used to describe catalytic domains of the protein that bind ATP as an integral part of the transport process. The ABC-type ATPases comprise a large super family of transport proteins that are related to each other in sequence and probably also in molecular mechanism. Most of the ABC-type ATPases discovered initially were from prokaryotic species, but increasing



An example of the Na⁺/K⁺ pump found in almost all animal cells.

P-type ATPases (P stands for "phosphorylation") are reversibly phosphorylated by ATP as part of the transport mechanism, with an aspartic acid residue phosphorylated in each case. They also share several other properties — all have eight-10 transmembrane segments in a single polypeptide that zigzags back and forth across the membrane; they are all cation transporters and they are all sensitive to inhibition by the vanadate ion VO₄³⁻, which is, therefore, used by researchers as a means of identifying them. The best known example is the Na⁺/K⁺ pump found in almost all animal cells. Most P-type ATPases are found in eukaryotes, although there is at least one bacterial K⁺ ATPase.

V-type ATPases (V for stands for "vacuole") pump protons into such organelles as vacuoles, vesicles, lysosomes, endosomes and the Golgi complex. Typically, the proton gradient across the membranes of these organelles ranges from 10-fold to over 10,000-fold. V-type pumps are not inhibited by vanadate and do not undergo phosphorylation as part of the transport process. They have two multi sub-unit components — an integral component embedded within the membrane and a peripheral one that juts out from the membrane surface, which contains the ATP-binding site.

F-type ATPases (F stands for "factor") are found in bacteria, mitochondria and chloroplasts. F-type ATPases are involved in proton transport and have two components, both of which are multi sub-unit complexes. While the integral component, called F₀, serves as a trans-membrane pore for protons, the peripheral component, called F₁, includes the ATP-binding site. F-type ATPases can use the energy of hydrolysis to pump pro-

numbers are being reported in eukaryotes as well, some of great clinical importance. At last count more than 90 genes for ABC-type ATPases have been identified in the human genome.

ABC transporters are of considerable medical interest because some of them pump antibiotics or other drugs out of the cell, thereby making the cell resistant to the drug. For example, some human tumours are remarkably resistant to a variety of drugs that are normally quite effective otherwise. Cells of such tumours have unusually high concentrations of a large protein called the multidrug resistance transport protein, which was in fact the first ABC-type ATPase to be identified in humans.

The MDR transport protein uses the energy of ATP hydrolysis to pump hydrophobic drugs out of cells, thereby reducing the cytoplasmic concentration of the drugs and hence their effectiveness as therapeutic agents. Medical interest in this class of transport proteins was heightened when cystic fibrosis was shown to be caused by a genetic defect in a plasma membrane protein that is structurally related to the ABC transporters. We have long known that people with cystic fibrosis accumulate unusually thick mucus in their lungs, a condition that often leads to pneumonia and other lung disorders. Now we understand that the underlying problem is an inability to secrete chloride ions and that the genetic defect is in a protein that functions as a chloride ion channel.

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Looking to recruit?

COMPANIES NEED TO OPEN UP TO MOBILE TO ATTRACT MILLENNIALS, SAYS MONICA MEHTA

Sheryl, a highly skilled software engineer with several years of experience in Silicon Valley, waits in line at the coffee shop, checking her e-mail on her smartphone. After staying up all night working on a project, she arrived at the office at 9:13 am, only to listen to her boss yell at her for the umpteenth time about coming in late.

She sees she has received yet another e-mail from a recruiter who has been contacting her for months. This time, instead of pressing "delete", she decides to follow a link the recruiter provides. By the time she gets her coffee, Sheryl has decided she likes the look and feel of the recruiting company's career site, has determined that the job suggested may be a great fit for her, and has started the application process.

Sheryl is not an anomaly. Nine out of 10 job seekers say they're likely to use a mobile device during their job search, and 45 per cent of job seekers use their mobile device to search for employment at least once a day, according to a 2014 Glassdoor survey.

This is in line with the general skyrocketing of digital media consumption on mobile devices. According to comScore, over the past four years mobile has overtaken desktop as the most-used digital platform in the USA. "Smartphone usage is up 394 per cent and tablet usage is up a whopping 1,721 per cent as these platforms now combine to account for 60 per cent of digital media time spent," writes Kate Dreyer in a comScore blog post.

Pair this information with Google's recent move to update its algorithms so that a site's "mobile-friendliness" determines how high it appears in search results and the takeaway is clear: If your recruiting site isn't optimised for mobile, you're getting left behind in the hunt for talent.

"It's critical that you have an experience for the potential job candidate that's built for a mobile device — the interface, the messaging, the content — so that it all

isn't lost in a clunky experience," says Jeff Haynes, Oracle vice-president of HCM transformation. "If someone's experience with your company is bad within the first 10 seconds, what kind of an impression does that leave with them in terms of what it's going to be like working for your company?"

Much of the increase in mobile device usage is attributed to millennials. An estimated 21 per cent of this demographic no longer use desktop computers to go online, according to comScore. After growing up cyberliterate, they expect a high level of usability and ease in their interactions with businesses. This group, born between the early 1980s and the early 2000s, makes up 30 per cent of the workforce. In 10 years, it will make up 75 per cent. Obviously, companies must optimise not only their recruiting websites but all of their recruiting processes so that they're mobile-friendly.

Haynes offered an example of a company at a college job fair, vetting potential job candidates. Traditionally, the hiring manager would take the paper candidate's resume, or point her/him to the company website to submit an application. Now, however, more savvy companies might have a poster with a QR code. By scanning the code on her/his mobile device, the candidate can immediately launch into the application process.

"To us, that's a more modern job application process. To a 22-year-old, that's the experience that she/he is expecting, and it is a critical step in recruiting top talent," says Haynes. "If company A requires me to come back later to a website, and company B enables me to immediately launch in with my handheld device, who am I going to be more attracted to?"

Meanwhile, by the time she gets home that evening, Sheryl has already received a reply from the recruiter asking when she's available for a first interview.

SPECIAL TO ANN



PLUS POINTS



Swapping mode

The sex of some animals, including humans, is dictated by genetics. Others are influenced by environmental conditions, such as temperature. Certain lineages appear to have flipped from genetic- to thermal-based sex determination over the course of evolutionary time, but no experimental data have shown exactly how these transitions occurred. Now researchers have caught a real-time glimpse of a sex-determination switch in bearded dragons (*Pogona vitticeps*) native to Australia.

About one-fifth of wild-caught female lizards carried the male sex chromosomes (ZZ), according to a study published in *Nature* on 1 July, and these animals were able to mate and produce offspring whose sex was determined by the temperature at which the eggs were incubated. The findings suggest that sex reversal — the development of females with male chromosomes — may be a mechanism for the transition from a genotypic to a thermal-based mode of sex determination in a population.

"The spectacular story from this paper is that this is not just a laboratory artifact," said Rick Shine, an evolutionary ecologist at the University of Sydney who reviewed the paper. "This is really something that is going on out there in the Australian semi-desert environment. There are lots of girls running around out there that are genetically male. And I think that's really a phenomenal result."

KERRY GRENS/THE SCIENTIST

Police sketches

DNA left behind at a crime scene may help give some idea of what suspects look like and a Virginia-based company, Parabon Nanolabs, has developed a



product that predicts the appearance of a person's face based on his/her genetic sequence. "A sketch artist uses information pulled from an eye witness to create a sketch," Steven Armentrout, the founder and CEO of Parabon, told *NBC News*. "And our algorithms are doing the same thing with a genetic witness, with that DNA that was left at the crime scene to create a sketch."

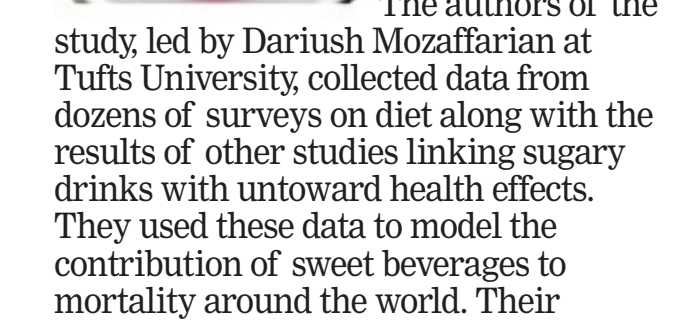
The news station put the "Snapshot" service to the test, sending Parabon a water bottle from which reporter Kate Snow drank. The resulting sketch does not resemble Snow's facial details, but it got her hair color and complexion right.

Criminal investigators are currently using the technology for "lead generation, narrowing suspect lists, and identifying unknown remains", according to a press release from Parabon. In one such case, it provided a sketch to law enforcement of a white man with dark hair and light eyes connected to the 1988 murder of a child, *The Journal Gazette* reported. "In this tragic case and the many like it, we aim to bring renewed hope to the families and friends of crime victims that their loved ones will get the justice they deserve," Armentrout said.

THE SCIENTIST

Not so sweet

Each year across the globe, the consumption of soda and other sweet drinks is associated with about 184,000 deaths related to diabetes, cardiovascular disease and cancer, according to an analysis published in *Circulation*.



The authors of the study, led by Dariush Mozaffarian at Tufts University, collected data from dozens of surveys on diet along with the results of other studies linking sugary drinks with untoward health effects.

They used these data to model the contribution of sweet beverages to mortality around the world. Their estimates include 133,000 deaths from diabetes, 45,000 from cardiovascular disease and 6,450 from cancers that stem from imbibing sugary drinks. The American Beverage Association responded with a statement downplaying the study's results. "This study does not show that consuming sugar-sweetened beverages causes chronic diseases, and the authors themselves acknowledge that they are at best estimating effects of sugar-sweetened beverage consumption," it read. "America's beverage companies are doing their part to offer consumers the fact-based information and the beverage options they need to make the right choices for themselves and their families."