COOL DOWN WITH URBAN TREES

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GEN ACTION

Canada

Children's MUSEUM

Cool down with Urban Trees

Origin Story:
HEAT TRAPPED IN CITIES

Humans live in lots of different places. Some people live in **rural areas** (the country), and other people live in **urban areas** (cities). Urban areas are home to many, many people all at once. If you have ever visited a city, you have probably noticed how busy and bustling it is.

Urban areas are also home to many buildings. With a high density of people, it is difficult for pollution to escape the canyon-like labyrinths buildings create. Concrete does not do a good job of reflecting the light that beats down on it. In fact, concrete often traps heat, resulting in higher temperatures at street level. Higher than normal temperatures mean people in cities have to try harder to keep cool, using things like air conditioning, which increases energy consumption and, as a result, greenhouse gas emissions.

Luckily, nature already has some great tools we can use to reduce heat trapped in cities. Adding vegetation to existing urban areas and increasing the number of green spaces in new urban growth helps keep people cool. Tree canopies create natural shade, while green spaces reduce the amount of heat-trapping concrete. These natural solutions work to keep people cool without the use of energy!

LET TREES ~~SHINE~~ SHADE LIGHT

In forests, trees are masters of regulating their environments. The forest floor is protected by the tops of trees, known as the canopy. Dense canopies stop some **radiation**, which is energy like heat and light, from getting to the forest floor. Trees can do this because of their **albedo**. Albedo is the fraction of light reflected by a surface. Lighter surfaces stay cooler because they are not absorbing as much radiation compared to darker surfaces.

As the day goes on and the sun's light and heat increase, trees keep forests from overheating by stopping as much radiation from hitting the ground. Forests with a dense canopy stay cooler during the day than areas outside of forests because of this cool feature! Warm air rises, and so at night, the high albedo of the canopy reflects heat back toward the forest floor. The canopy acts like a blanket over the forest at night, trapping warm air inside. This means forests have a more stable average temperature.

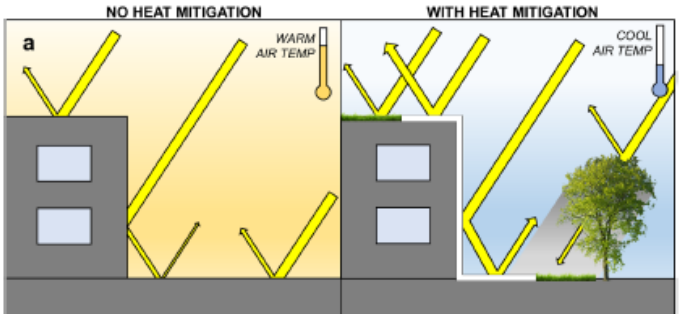


Image from E. Scott Krayenhoff *et al* 2021 *Environ. Res. Lett.* 16 053007. "Cooling Hot Cities: a Systematic and Critical Review of the Numerical Modelling Literature."

This same concept can be applied in cities. When there is more vegetation in cities, there is a decrease in the average daytime temperature. On average, cities with more green spaces are 3.3 degrees Celsius cooler than areas without urban trees. The heat that would usually be trapped in cities is reflected by the urban tree canopy. Like in the forest, the urban tree canopy acts like a blanket, keeping warmth in cities at night. City pedestrians experience a one-degree warmer nighttime temperature when urban trees are present.

The addition of trees and vegetation in cities also increases pedestrian comfort. They provide shade and shelter, unlike other light-reflecting materials such as reflective pavement, walls, and rooftops. If you have ever had the sun reflected in your face, you will know it is not very comfortable! Vegetation also alters radiation exchange, adjusts airflow and **convection** (a way heat moves), and changes the biometeorological experience of pedestrians. In other words, vegetation helps alter the way heat moves and changes the way people overall experience the seasons and weather. Vegetation provides cooling during the day and protection against severe weather elements. Urban trees also help prevent energy loss in buildings and reduce air pollution!

Trees also use something called **transpirational cooling**. Transpirational cooling is a process through which heat is absorbed, moved around, and transformed into something else. While trees do reflect some radiation, they also absorb some of the light they come into contact with. While trees convert this light into energy, they also release water vapour into the air. As this water evaporates off the tree, it cools down the air around it. This is kind of the same as when humans sweat to cool themselves down! The transpiration process increases rainfall since the air that passes through vegetation is twice as likely to produce rain! Increased rainfall helps prevent dry seasons and drought.

The science of how trees shade forests was written based on the work of Pieter De Frenne and colleagues, 2021. "Forest Microclimates and Climate Change: Importance, Drivers and Future Research Agenda." Global Change Biology 27 (11): 2279-97. https://doi.org/10.1111/gcb.15569

Time for GENACTION!

Local climate hero Dr. James Voogt and his fellow researchers conducted a survey in September 2017 in London, Ontario. Together, this group measured daytime temperatures at ground level on two streets. One street was dense with urban trees and one had very few urban trees. They collected data from the centre of the road, otherwise known as an **urban heat canyon**. The street with dense tree cover was cooler and showed less **radiative** (heat and light) information. Dr. Voogt and his colleagues confirmed that trees reflect and transform radiative heat before it reaches street level. Trees transform heat people can feel into energy, which cannot be felt. This creates a friendly and more comfortable environment with less drastic temperature changes.

With higher temperatures expected with climate change, we need to do what we can to cool off our cities. Planting trees in urban areas can be a great form of climate **adaptation**, or adjusting our lives to climate change. They also bring many other benefits, like making our cities prettier and storing carbon. So, the more trees, the happier the city!

Climate Action:
REDUCING OUR EMISSIONS

Increasing the number of urban trees in cities is only one step towards addressing climate change. There are other ways you and your family can make an impact! Families can use alternate modes of transportation, like public transit, biking, walking, or carpooling. These activities cut down on greenhouse gas emissions and allow your family to experience your community in a new way. You can also help conserve energy by keeping doors and windows closed when heating or air conditioning is turned on inside the home. Your family can replace old light bulbs with energy-efficient bulbs and reduce the number of lights left on in your house.

It is crucial to remember that children and youth have a voice! While working to reduce individual energy consumption is important, large-scale action is required at every level of society. You can write letters to your local politicians to let them know your thoughts on climate change. You can add your voice to international movements for climate justice. You can even volunteer with local, provincial, and national groups working to protect the environment.

Finally, if you can, help your community by planting a tree, building a community garden, or creating new green spaces!

MEET OUR LOCAL SCIENCE HERO:

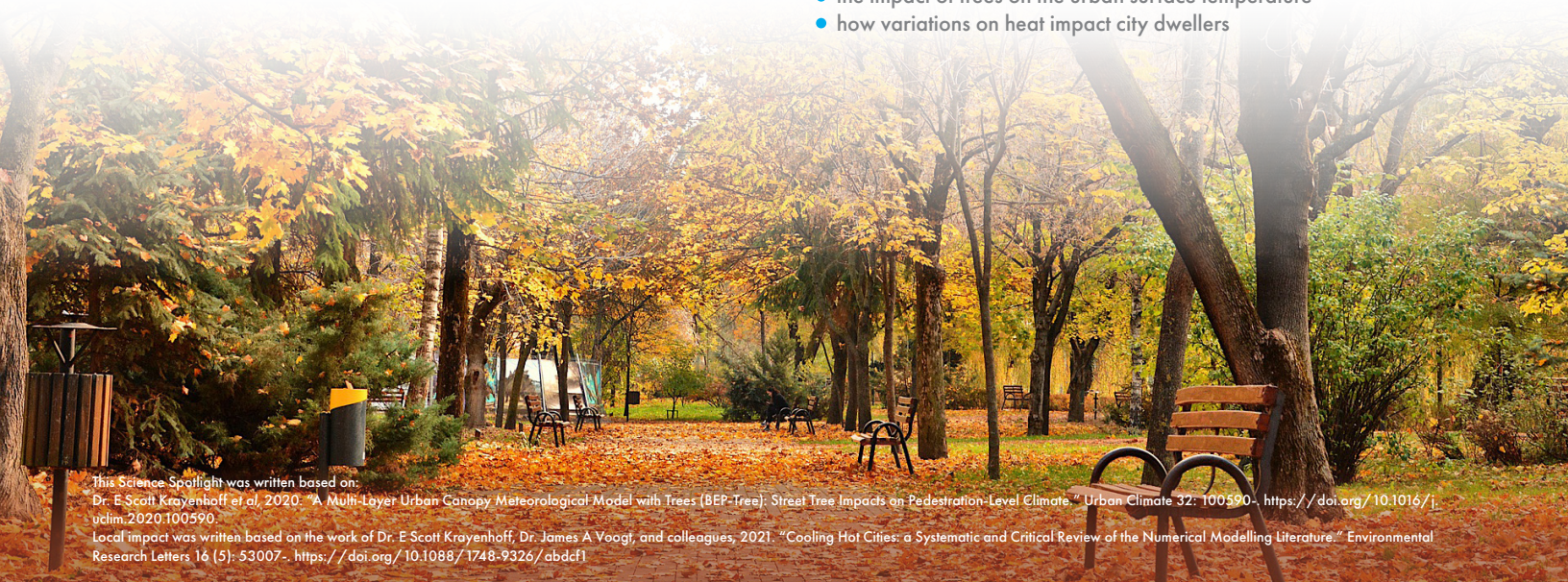
Dr. James Voogt is a professor, author, and urban climatologist.

Dr. James Voogt is a professor in the Department of Geography and Environment at the University of Western Ontario, in London, Canada. He is an urban climatologist who specializes in the measurement and modelling of urban surface temperatures. He received his B.Sc. in 1986 from Queen's University and M.Sc. (1989) and Ph.D. (1995) from the University of British Columbia.

Dr. Voogt is an Editorial Board member for the journals *Remote Sensing of Environment* and *Anthropocene*. He was previously president of the International Association for Urban Climate, a co-author of the text 'Urban Climates' published by Cambridge University Press, and the winner of the 2022 Luke Howard Award from the International Association for Urban Climate. Who says you can't have all your dream jobs?!

He has contribued to research projects on:

- surface temperature in cities
- the property of materials that retain heat over urban areas
- the use of remotely-sensed surface temperatures for urban climate model evaluation
- the effect of green roofs
- the impact of trees on the urban surface temperature
- how variations on heat impact city dwellers



This Science Spotlight was written based on:
Dr. E Scott Krayenhoff *et al*, 2020. "A Multi-Layer Urban Canopy Meteorological Model with Trees (BEP-Tree): Street Tree Impacts on Pedestration-Level Climate." Urban Climate 32: 100590-. https://doi.org/10.1016/j.uclim.2020.100590.
Local impact was written based on the work of Dr. E Scott Krayenhoff, Dr. James A Voogt, and colleagues, 2021. "Cooling Hot Cities: a Systematic and Critical Review of the Numerical Modelling Literature." Environmental Research Letters 16 (5): 53007-. https://doi.org/10.1088/1748-9326/abdcf1

Climate Change
Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.

Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions. Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance Truth and Reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.