WILD WEATHER!

GEN ACTION

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Wild Weather!

Origin Story:
WHAT CREATES EXTREME HEATWAVES AND COLD WAVES?

Air moves across the globe either from East to West or West to East depending on where we are. However, as the air moves, its direction is disturbed because of Earth's rotation, landscape, and temperature of a region.. These disturbances make waves in the air flow, causing it to flow from North to South as well as from West to East. These waves have a strong effect on our weather - bringing warm air from the South or cold air from the North. If a wave gets really large, then the air moves a long way South and North, and the weather it brings will also be very warm and very cold. Sometimes these waves stay in one region for a long-time along with the weather patterns they bring, and this can cause extreme temperatures - really hot, or really cold.

In order to prepare for and protect ourselves from extremely hot or extremely cold weather, we need to know some key details about these extreme events, such as: "how long will it stay super hot or cold?" To better predict such extreme events, scientists need to understand how the waves move and how strong they become. One possible pathway to investigate this is to find how far North or South the waves go. This is affected by atmospheric circulation patterns called waveguides. These are flow patterns in the atmospheric circulation that trap the atmospheric waves in a particular region. Dr. Rachel White and her colleagues discuss ways in which the waveguides can be used to better understand and predict extreme weather events.

Peek into the Future:
FORECASTING WEATHER EXTREMES

Extreme weather events such as heatwaves, floods, cold snaps, and droughts can have disastrous impacts on humans, destroying property and even causing death. Due to global warming, many extreme events are also expected to get stronger and occur more frequently. However, the skill of predicting extreme events in short-term weather and future climate carries large uncertainties.

Global warming will lead to, on average, hotter land, and ocean temperatures with more heat waves as a result. Since the atmosphere also gets more moisture from evaporation in a hot climate, rains are expected to get heavier, and flooding is also expected to get worse. On the other hand, global warming can also affect waves in the atmosphere by affecting how strong they are and how fast they move. Waves becoming strong or stagnant directly affect the duration and strength of extreme events. Unfortunately, this indirect effect of global warming on extreme events is much less understood due to its complexity.

Currently, prediction and forecast models attempt to capture the source and movement of waves along with their strength, which is quite a difficult task due to the complexity of the physics involved. So how do we solve this problem? Dr. White and her colleagues propose a possible method through which we can link waves to extreme events by using atmospheric waveguides. Dr. White finds that waveguides are very well aligned with strong waves. This makes perfect sense, since atmospheric waveguides constrain the flow of waves, stopping them from moving too far North or South. The strong waves controlled by the waveguides are seen together with extremely warm and cold events. This is quite a promising result since it implies that we may be able to use waveguides to predict extreme weather events without having to deal with the complexity of the waves themselves.

Of course, this does not mean that we have simplified extreme weather event prediction! We still need to figure out simple techniques to detect waveguides. We also need to understand the physics behind their existence and how they control wave movement. Dr. White and her colleagues recommend that we keep studying waveguides and waves to have a better understanding of how and when extreme weather events will happen. Most importantly, these topics are complex and require a lot of collaboration among climate scientists so that we can fill our knowledge gaps and prepare our communities for the impacts of climate change.

Time for GenAction!

Try this at Home:
EARTH IN YOUR HANDS

There is a lot of discussion among scientists regarding waves and atmospheric flow. However, it is not very intuitive to simply imagine how such waves form on a planet just because of rotation and temperature variations. But there is a way you can do experiments to see this, by building your own rotating fluid tank! This can help form a mental picture of waves and weather systems that are created by the flow of air on a rotating planet.

DIYnamics (Do-It-Yourself Dynamics!) builds a simple apparatus that can be used to illustrate different aspects of Earth science for students. Specifically, the Lego-based rotating fluid tank provides a visualization of how the atmosphere behaves in a rotating system. All you need to do is fill the tank with water and start the rotation. Then, you drop several drops of dye into the tank. You can then see how the colorful fluid moves inside the tank as it forms disturbances and instabilities because of the rotation. To find out what you need to buy, and instructions for building and conducting experiments, check out the DIYnamics webpage.

Climate Action
BECOME A CLIMATE SCIENTIST

Explore how impactful extreme weather events are for your community and how they are likely to change because of climate change. First, find out which extreme weather events are important for your region using the climate atlas (https://climateatlas.ca/map). Click on places on the map to find your region and select each extreme event type at the bottom of the map.

Look at different periods and scenarios or reduced climate change (if we minimize emissions now). Based on what you find out, discuss the following with friends and family:

1. Which extreme events are relevant for your region?
2. How are these events expected to change in the future with climate change?
3. How will these changes impact your community?
4. What can you do to prepare for such events if they are on the horizon?
5. Is it useful to check weather forecasts and warnings now and then?
6. How much impact does reducing the amount of greenhouse gas emissions make?
7. What can you, your community, and everyone else in the world do to minimize the amount of greenhouse gas emissions in the future?

MEET OUR LOCAL SCIENCE HERO
Dr. Rachel White

Dr. Rachel White is an Assistant Professor at the University of British Columbia in the Earth, Ocean, and Atmospheric Sciences department. She studies Rossby waves – a distinctive, massive type of wave in atmospheric circulation. At the moment, she is looking at how atmospheric dynamics can help us predict the likelihood of heat waves every summer, in places like Vancouver. She became interested in atmospheric science a long time ago. She explains "I remember watching the movie Twister when I was young. It seemed so cool – they go chasing after tornados and study them to see how they form. It was very clear there were so many things we did not understand about the world – even something as destructive as a tornado! To me, research is finding out things that nobody knew before, which is exciting."

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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.