EXPECT Science explainer

Large-scale drivers of local climate impacts

REGIONAL IMPACTS

CLIMATE DYNAMICS | ADAPTATION





FULL NAME

Paul Kushner

INSTITUTION & DEPARTMENT

University of Toronto, Physics

EXPERTISE

Climate Dynamics

SUMMARY

After working in an interdisciplinary team to develop a next-generation climate model in the early 2000s, I returned to the University of Toronto to continue research into cryosphere-atmosphere interactions. My research examines large-scale drivers of extreme climate and how well climate models represent these processes. Understanding these processes helps us assess the reliability of climate forecasts and translate them into data that can support adaptation planning and risk assessments in Canada and Europe.

Can you explain why/how your expertise is related to climate change?

Paul Kushner: I started out as a physics graduate interested in how the atmosphere and oceans move and interact. I became interested in climate modelling when I joined the Geophysical Fluid Dynamics Laboratory in Princeton, NJ, USA, where I worked as part of a team developing a climate model.

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How is your research contributing to filling the gaps in understanding and predicting regional climate changes and extreme weather?

P-K: My connection to EXPECT began later in my career when colleagues in our university's civil engineering group asked me to explore how climate change could affect the built environment. This led me to dive into climate downscaling - how we can use large-scale climate information to understand what may happen at a more local level -and eventually to EXPECT's focus on the large-scale drivers of local climate impacts.

Within EXPECT, we are working to better understand and project these extremes across different timescales, from weeks and months to decades. Together with Hamed Ibrahim, we are developing a toolkit to translate this information into regional climate impact assessments across Canada.

One of the challenges we face is that climate models can struggle to capture the most extreme events. My research looks at why this happens and how we can make climate predictions more reliable. Within EXPECT, we are working to better understand and project these extremes across multiple timescales, from weeks and months to decades. Together with Hamed Ibrahim, we are setting up a toolkit on downscaling, aiming to translate this information into regional climate impact assessments across Canada.

What is a common misbelief about the topic we are covering?

People often don't realise how much climate models have improved over time, or how much valuable information their predictions can provide. Even though we are still slow to respond to climate change, we are getting better at using and understanding climate information. As the models become easier to interpret and connect to local conditions, engagement with the public or other disciplines should not fall behind. Having a set of stories ready on the impacts of climate change on fires, coastal flooding and extreme weather requires using the best possible climate information.

For instance, EXPECT's climate information could help communities in Alberta understand how changing patterns of heavy flooding around Calgary, including flooding linked to snowmelt in the Rockies, could affect future development (Figure 1).

If insurance companies and the federal government have better information about these risks, they can make more informed decisions about where and how to build, invest in safer options, and prepare for future impacts.

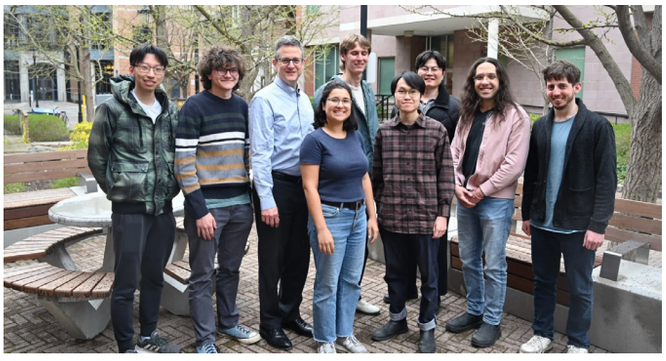

Figure 1. Paul Kushner with his research group. The Kushner group works on many aspects of the atmosphere related to climate variability and change.



LOOKING FORWARD

As EXPECT focuses on the fundamentals of climate science by understanding why extreme events can be difficult for climate models to represent, there are communities waiting for that knowledge and ready to investigate possible effects. By better understanding how large-scale atmospheric circulation shapes extreme events, we can capture important interactions that influence their local impacts. Climate services and the necessary tools can then be developed to help communities prepare for and adapt to these impacts

WHY A SCIENCE EXPLAINER

Through short, focused questions, project researchers share what they study, why it matters, and how their investigations lead to real-world findings.



By opening up the day-to-day challenges and thinking behind climate research, these explainers make science more accessible, transparent, and trustworthy for other researchers and decision-makers alike.

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Funding

Funded by the European Union

UK Research and Innovation

Government of Canada

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