

What On Earth · CBC Explains

What are atmospheric rivers, and how are they affecting the B.C. floods?

'Rivers in the sky' carry huge amounts of rain around the planet. Climate change makes them stronger: study

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Homes and farmland in the community of Sumas Prairie are pictured underwater during flooding in Abbotsford, B.C., on Nov. 16. (Ben Nelms/CBC)

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River above, trouble below: A What On Earth special report

The term "atmospheric river" may conjure images of water flowing through the air, like in a fantasy novel. In a way, that's right — only this weather phenomenon is totally natural, and responsible for providing a vast portion of much-needed moisture to many regions on the planet.

Depending on their strength and duration, atmospheric rivers can also be dangerous. They have been a major cause of the catastrophic flooding and landslides across swaths of B.C. this week, triggering a state of emergency and leading to at least one confirmed death.

Here's what you need to know about atmospheric rivers, and why climate change is expected to make them bigger and more lethal.

What is an atmospheric river?

An atmospheric river, or AR, is a large, narrow stream of water vapour that travels through the sky. It can stretch to 1,000 miles (1,600 kilometres) long and more than 400 miles (640 km) wide, and on average, carries an amount of water equivalent to 25 Mississippi Rivers, according to Marty Ralph, a researcher and director at the University of California San Diego's Scripps Institution of Oceanography.

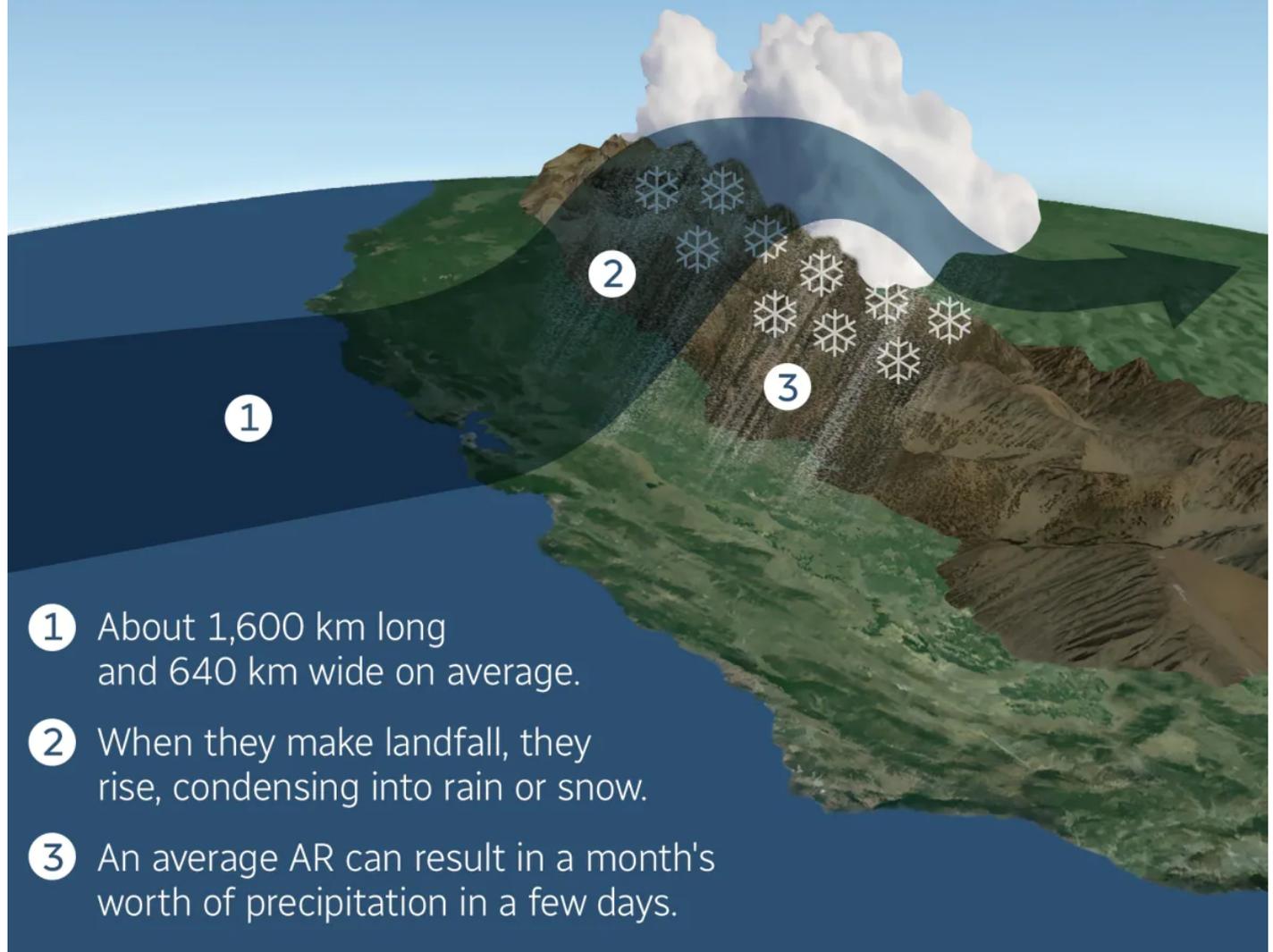
The term atmospheric river was first coined in 1998 by Massachusetts Institute of Technology researchers Yong Zhu and Richard Newell, but ARs had been observed before then. They usually begin life in the tropical ocean regions near the equator, and can bring large masses of warm air and water to areas like North America's west coast.

As the rivers cross from the ocean to the land — particularly to mountainous regions like the B.C. coast — the vapour condenses into precipitation, sometimes dumping a month's worth of

rain or snow in a matter of days.

What are atmospheric rivers?

Atmospheric rivers (or ARs) are large, narrow streams of water vapour that travel through the sky.



CBC News

Source: NOAA

How common are atmospheric rivers?

According to a [2013 report co-produced by B.C.'s environment ministry](#), ARs typically form in eight oceanic regions around the world, some closer to continental coasts than others. One of those regions is just off North America's western coast and can produce between one to two dozen of them per year.

One commonly observed atmospheric river, which brings water vapour from the tropical Pacific Ocean near Hawaii to the American and Canadian west coast, is also known as the Pineapple Express.

- [Read more about the flood situation across southern B.C.](#)

Are they harmful or helpful?

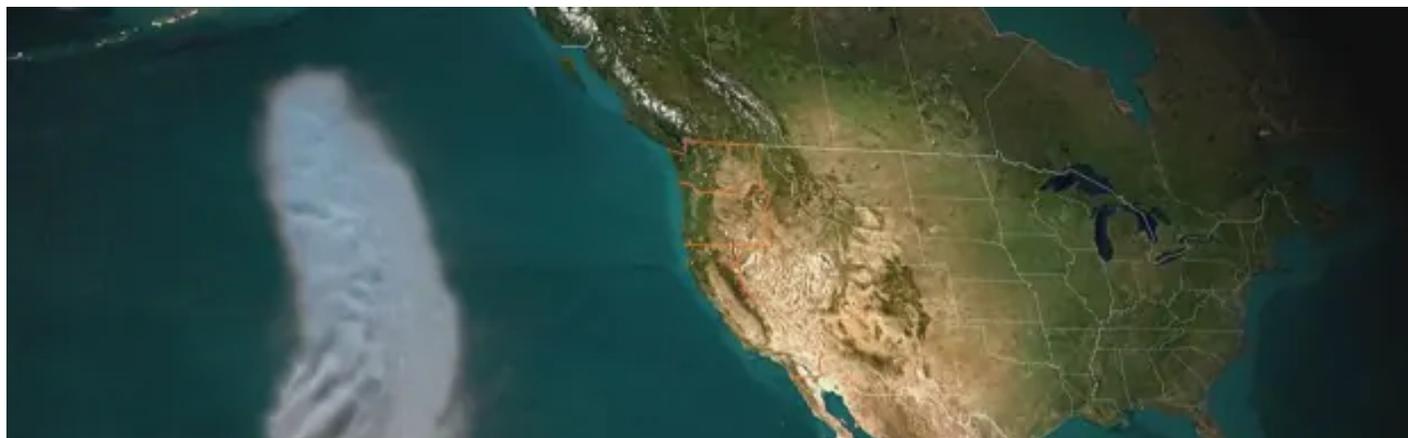
It depends.

Less-intense ARs are essential to many continents' water supply by bringing a whole lot of it from the warmer tropical oceans. But the bigger and more intense they get, the more dangerous they can be, triggering landslides and flooding resulting in tens to hundreds of millions of dollars in damage or more.

"Basically, all of your biggest storms in terms of big damage, like we just saw, in the West Coast [U.S.] states, including British Columbia, are from atmospheric river storms," said Ralph.

Despite being relatively small compared to the rest of the atmosphere, ARs can carry up to 95 per cent of the water vapour that travels around the Earth's surface, and can bring anywhere between 30 and 50 per cent of a given region's yearly water supply.

WATCH | Johanna Wagstaffe explains the science behind atmospheric rivers:



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1 year ago | 2:10

Johanna Wagstaffe explains the latest in climate science 2:10

Why have recent atmospheric rivers been so devastating in B.C.?

In 2019, Ralph and his team at the [Scripps Institution of Oceanography developed a new scale of categories for ARs](#), similar to how hurricanes are rated on a scale of intensity, from 1 (the weakest) to 5 (the strongest). An AR1, as it's called, is considered mostly beneficial, while AR4s and AR5s are dangerous and potentially deadly to humans.

Matthias Jakob, a geoscientist at the Vancouver consulting firm BGC Engineering, estimated that the recent storms that have battered B.C. would rate between a Category 4 or 5 on that scale, described as "mostly or primarily hazardous."

Ralph said that two ARs, both of which would rank a Category 4 or 5, recently hit the B.C. coast "back to back," inundating the landscape with moisture, leading to the massive scale of flooding and landscapes.





People are transported on a boat after being rescued from an area that was cut off due to flooding in Abbotsford on Nov. 16. (Ben Nelms/CBC)

Is climate change making atmospheric rivers worse?

The warmer the air is, the more water vapour it can carry. As the atmosphere's average temperature rises, then, an atmospheric river can grow — and when it makes landfall, it can release more rain or snow than in years past.

According to [a 2018 study in the journal Geophysical Research Letters](#) co-authored by Ralph, we can expect atmospheric rivers that reach the B.C. coast to become up to 25 per cent wider, 25 per cent longer and overall 50 per cent more intense than before.

Jakob said the resulting rainfall events will also become longer, potentially lasting four or five days as opposed to the usual one or two.

WATCH | Bob McDonald explains intense weather phenomena behind B.C. flooding:



Bob McDonald explains intense weather phenomena behind B.C. flooding



4 days ago | 2:31

Bob McDonald, host of CBC's Quirks & Quarks, says the catastrophic flooding in B.C. shows that evidence of how climate change can impact weather is now 'in our face' after decades of scientific predictions. 2:31

As the rivers drench and destabilize the terrain — especially mountainous regions like the West Coast — it will lead to more frequent and more damaging landslides.

Jakob estimated that if an atmospheric river's storms could trigger up to 20 landslides over the North Shore Mountains overlooking North Vancouver, a stronger AR by the end of the century could cause 80 landslides.

Compounding the threat are increasingly severe wildfires, which incinerate trees, leaves and the forest floor that would otherwise absorb moisture and precipitation. More ash on the hillsides can lead to more "fluid landslides," said Jakob, leading to even more damaging outcomes.

What's being done to protect us from atmospheric rivers?

Jakob and his team at BGC Consultants are working with Environment and Climate Change Canada (ECCC) to create a new warning system that would act as a Canadian version of the scale used in the U.S. It would include the aforementioned categories, but also identify and track ARs early enough to warn the general public when one is estimated to make landfall.

The system, which the ECCC hopes will be ready to launch as early as December, would also include the potential types of damage the AR is expected to cause, such as washouts, debris flows, landslides, bank erosion and bridge closures.

Ralph added that an early warning system for ARs would also help flood control, as reservoirs could be kept at a low level when such a large system of precipitation was imminent.

Written by Jonathan Ore. Produced by Serena Renner.