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Frosty business – digging deep to uncover snow's hidden secrets

EU-funded researchers are braving extreme Arctic conditions to shed light on snow's crucial role in Earth's climate system.

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An average temperature of -30°C and up to 24 hours of darkness a day. Those were the working conditions for a team of EU-funded scientists who spent nine months researching snow in the Arctic.

"Very white, vast and cold," is how snow expert Dr Marie Dumont describes the field campaign in Cambridge Bay, also known as Iqaluktuuttiaq, a hamlet in Canada's far north inhabited mostly by the indigenous Inuit population.

"The coldest temperature we experienced was -50°C. It's certainly a special kind of life," she added.

The field research is part of a six-year project named IVORI, which was funded by the EU and runs until 2027, to improve our understanding of snow, glaciers, ice sheets and permafrost.

Mysteries of snow

Why snow, one might ask? Because there is much more to it than meets the eye. It is, in fact, a pillar of our climate system.

"There are three main properties of snow that impact the Earth's climate system," explains Dumont, IVORI coordinator and director of the Snow Research Centre at Météo-France, the official French meteorological administration.

Firstly, it is white. Snow reflects solar radiation back to the atmosphere and therefore limits the warming of the Earth.

Secondly, snow consists of ice and air, which gives it great insulating properties. A covering of snow insulates the ground and protects everything in the soil from increasing temperatures.

And lastly, melting snow influences the water cycle in nature.

However, despite its considerable impact, snow still holds many unanswered questions.

“Everyone feels that they understand snow, but we actually know very little about it,” says Pascal Hagenmuller, a researcher specialising in snow mechanics and avalanche studies at the Snow Research Centre, part of France’s National Centre for Meteorological Research.

“Even simple observations such as why snow sometimes makes sounds when you compress it – and sometimes not – are unclear. Snow is still a mystery.”

Arctic snow

To the untrained eye, all snow looks the same, but the IVORI researchers know that Arctic snow is very different from the type we encounter in Europe.

“We know a bit about how to model snow in the Alpine regions, but we don’t know much about the snow in the Arctic Circle, even though this snowpack is much more important for the global climate,” said Dumont.

This is why the IVORI team is working to understand the different types of snow and develop a universal numerical model that can represent snow evolution worldwide, with all its physical variables.

“We aim to change the way we describe and model snow,” says Hagenmuller, who is an expert on the description of snow’s microstructure.

EU-backed researchers are digging into Arctic snow to shed light on its crucial role in Earth's climate system. © Kevin Fourteau

"The snow microstructure is the 3D arrangement of ice and air," he explains. "It determines the properties of the snow, such as whether it is mechanically stable or not, whether it will insulate the ground well or not, and how much water it will produce once it melts."

Monitoring the evolution of the snow's microstructure was the main objective behind the IVORI team's two field campaigns.

While the first one was conducted in the French Alps, the second took the research team to the Canadian High Arctic Research Station. There, they worked stints of two months, collecting and analysing snow samples on a daily basis with a tomograph, a special X-ray scanner similar to medical scanners.

Global warming, local impact

Through this experience, the scientists learned first-hand how indigenous communities are being impacted by the warming climate.

"In the Arctic, people live in and with snow in a completely different way than we do in Europe. It is a very big part of their lives, and it is changing very quickly," says Dumont.

"In Europe, we see and feel the effects of climate change, but the North Pole feels it much more."

She explained that Arctic communities face very rapid changes, requiring them to adapt their way of life.

"For instance, the locals would normally use sea ice to travel from one village to the next in the winter because it is much faster, but the sea ice is melting and it is not safe anymore."

As a result, she said, local communities are faced with growing risks ahead. "People were afraid that their house would not be there anymore in a few days," recalls Dumont. This is because the permafrost – the permanently frozen ground – is melting. The soil is becoming unstable, which can cause houses to collapse.

"Remembering this constantly reminds me of what I do and why," says Dumont.

Climate forecast

Although the IVORI research is focused on snow, it can also be applied to broader climate models and forecasting.

"We know that snow is a major component of the climate system. If we fail to predict the impact of snow, we fail to predict the climate," stresses Hagenmuller.

Dumont explains that the model IVORI scientists are developing can lead to improved hydrological forecasts, create better predictions for permafrost and possible landslides, and even predict avalanches.

"It can help with climate mitigation and help us adapt to what is going on with more accurate projections."

This way, Dumont hopes, the magic of snow will not be lost.

“Already as a child, I was fascinated by snow. To me, it makes everything look great and perfect. It’s the wild rough nature and I hope we can preserve its beauty.”

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- IVORI
- IVORI project website
- EU Climate change science