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Frost and weather extremes in Europe: direct consequence of rising temperatures in polar regions

Cold and frosty springs after mild winters – there is a clear correlation between extreme weather conditions, crop failure, heavy rains, accelerated warming in both northern and central Europe, and the soaring temperatures recorded at both poles. Geoscientists and various other experts are using their research findings, forecasts and risk assessments to highlight the links between climate change in Europe and the polar regions, and how extreme weather events such as heatwaves and heavy downpours will come to shape a world in which temperatures rise by 2-4°C. From 23 to 27 May, leading researchers will be putting this subject matter in the spotlight during the European Geosciences Union (EGU) General Assembly at the Austria Center Vienna.

Climate and polar research confirms: “Human activity is behind rapid climate change, so we also have to be the solution to the problem. The most important building block at our disposal is the transformation of our approach to the natural world and the atmosphere,” explained Prof. Thomas Jung, Vice Director and Head of the Climate Dynamics Department at the Alfred Wegener Institute (AWI), and spokesperson of the Changing Earth – Sustaining our Future research programme.

Jet streams bringing weather extremes to Europe

Austrian farmers and gardeners are already struggling with extreme weather: shortly after an early spring ushered in by unseasonably warm temperatures, heavy frosts caused the kind of damage that nature simply cannot undo in the same year. And it is human beings that are to blame, having triggered climate change, as proven by analysis of physical indicators such as the melting of the permafrost, vanishing Arctic sea ice, the receding ice sheet in Greenland, melting ice caps in the Antarctic and rising sea temperatures. “These man-made changes are having a direct effect on many areas including the planet’s jet streams,” cautioned respected polar researcher Prof. Markus Rex, Head of the Department of Atmospheric Physics at the AWI and coordinator of the MOSAiC Expedition. Jet streams – the fast-flowing, meandering air currents found on Earth – are caused by differences in temperature between the polar regions and surrounding warmer latitudes. Due to the notable warming of the Arctic, the difference is now less pronounced, meaning that the jet stream in the northern hemisphere is moving in the wrong direction, allowing warm air to reach deep into the Arctic, as evidenced by the heatwave witnessed in the region last March. Much to the surprise of climatologists, at the same time an extreme heatwave occurred on the opposite side of the planet deep in the central Antarctic – an area which had previously been spared from such developments. “Even though heatwaves still mean below zero temperatures in the Antarctic, -17°C is 30°C warmer than the annual average and 15°C above the previous record high for the affected region in question,” Rex said. Particularly in late winter, forces acting in the opposite direction

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to the jet stream take on a major significance. “The wider reaches of the jet stream are increasingly bringing cold weather outbreaks to our latitudes from the Arctic, leading to periods of intense cold in Central Europe, Asia and North America,” he continued.

Heavy rain due to the changeability of the jet stream

The weaker jet stream in the north means that our weather systems move less quickly. This leads to an increase in extreme weather events such as heavy rains, which occur because areas of low pressure become entrenched, leading to severe rainfall in the same region for days on end. Among the outcomes is the sort of catastrophic flooding seen in Central Europe. In July 2021, floods in Germany’s Eifel region and the neighbouring Schiefergebirge in Rhineland-Palatinate claimed at least 170 lives, left 820 injured and caused damage estimated at over EUR 10 billion.

Double the rate of warming in the Arctic – direct impact on Europe

“The Arctic is Europe’s weather lab,” Rex said. “At present it is warming at a rate that is two to three times faster than that seen in the rest of the world,” he went on. During the heatwave there last March, the AWI team recorded temperatures that were up 20°C on the long-term average, as reflected in record precipitation and unprecedented warming of the entire Arctic climate. On average, the temperature of the Arctic has risen by 2-4°C, which is significantly above the 1.5°C threshold for the rise in global temperatures that countries are committed to meeting. This distinct increase in the pace of warming in the Arctic is leading to a loss of sea ice, with the total area covered now only reaching half of its maximum extent in summer. The Greenland ice sheet is also melting, causing global sea levels to rise and posing a significant threat to the half of humanity that lives in coastal regions. The Intergovernmental Panel on Climate Change warns that there will be no winners from climate change, and that northern and central Europe stand to be particularly hard hit.

Storylines look into the future to bring climate change home

“To bring climate change and its effects home, we look at what today’s weather could become in a world in which climate change continues unchecked. A world in which global temperatures rise by an average of 2 or 4°C on pre-industrial levels,” Jung commented. Again, jet streams have a key role to play in these climate simulations. These bands of air currents moving 10 kilometres above the Earth’s surface have a major impact on wider European weather conditions. “Due to the extreme heat in July 2019, during which temperatures reached a record 42°C in Germany, we can see that the heatwave is already 3°C hotter than in the pre-industrial period. In a world in which temperatures increase by 4°C, we would be looking at highs of 47°C – a jump nearing 10°C. That is comparable to summer in Dubai,” Jung confirmed.

Ozone layer shows that regulation works

But there is hope, with positive examples demonstrating that legislative measures work and allow the environment to recover, at least in some areas. After the discovery of the hole in the ozone layer above the South Pole in 1983, the chlorofluorocarbons (CFCs) responsible

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for causing the damage were banned worldwide. “We expect that the ozone layer will be fully restored by the end of this century,” Rex said. “However, this recovery could be hampered by the effects of climate change – in the Arctic of all places – or in a worst case scenario fail to materialise altogether in this region.”

1.5°C limit: even stronger transformation the key to reversing climate change

“At present, the climate goals put in place by countries all over the world are not enough to ensure that the 1.5°C limit will not be exceeded. We are not on track, either in terms of cutting carbon and methane emissions, or the speed at which targets are being implemented,” Jung warned. This means negative feedback loops: if the Earth’s temperature rises by more than 1.5°C the number of extreme weather events will increase in severity, as seen in the coupled climate models. Droughts, wildfires and wetland drying are increasingly commonplace. This in turn fuels CO_2 and methane emissions, while diminishing nature's ability to help us stop carbon escaping into the atmosphere. "In other words, we humans would then have to achieve even deeper CO_2 cuts to be able to live safely again," explained the climate researcher. As a result, overexploitation of resources and environmental pollution cannot be permitted to be a cheap or convenient option. With the help of the transformation – in other words, interlocking and mutually reinforcing changes in technologies, infrastructure, consumption, culture and politics – the European Commission’s Green Deal relies on carbon taxes and measures to promote the resilience of the planet as well as conserving the natural environment. "If we create the political ambition together – also through solidarity with the poorest countries – to leave a healthy planet to the next generation, we can achieve climate transformation," Rex concluded.

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