

Is Extreme Weather on the Increase?



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Outline of my talk

1. Introduction & definitions
2. The physics of extreme weather
3. Extreme weather types & trends
4. Attribution of extreme weather
5. **Conclusions / Wrap-up**

And so... are extreme weather events on the increase?

- Heatwaves? Yes ✓
- Wildfires? Yes ✓
- Cold spells? No, but it depends ✗
- Rain & floods? Yes, but it depends ✓
- Windstorms? Yes, but it depends ✓
- Coastal floods? Yes ✓
- Tornadoes? No, not generally ✗
- Hail / Lightning? Insufficient data ?
- Marine heatwaves? Yes ✓
- Various compound events? Yes ✓



Extreme weather: Wrap-up

1. Extreme weather... **lots** of different types!
2. Lots of them are **increasing** (but not all) ...
depends on **location, duration, intensity**...
3. Complex feedbacks & multiple drivers of risks & hazards -> “**compound events**” (final impact greater than the sum of each individual event)
4. **Dangerous underestimation** of some extreme weather e.g. heatwaves, wildfires



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THANK YOU FOR YOUR ATTENTION!

Selected citations, sources & references for further reading:

- Beobide-Arsuaga, G., Suarez-Gutierrez, L., Barkhordarian, A., Olonscheck, D. and Baehr, J., 2025. Increasing central and northern European summer heatwave intensity due to forced changes in internal variability. *Nature Communications*, **16**(1), p.9485.
- Bhatia *et al.* 2022. A potential explanation for the global increase in tropical cyclone rapid intensification. *Nature Communications*, **13**(1), p.6626.
- Fowler, H. 2021. *Anthropogenic intensification of short-duration rainfall extremes and increasing flood risks*. AGU Fall Meeting Abstracts (2021, A21B-02).
- Francis, J. (2024) <https://arctic-council.org/news/shifting-winds-how-a-wavier-polar-jet-stream-causes-extreme-weather-events> <3 Dec 2025>
- Graham, E. & Petricca, G. (2020) Advances in Numerical Modelling and Weather Forecasting: *Observation And Modelling Of Precipitation In Northwest Scotland*. 4th International Rain Enhancement Forum (Abu Dhabi, UAE).
- Hanna *et al.* (2024) Influence of high-latitude blocking and the northern stratospheric polar vortex on cold-air outbreaks under Arctic amplification of global warming.. *Environmental Research: Climate* **3**,4: 042004.
- Hobday *et al.* 2018. Categorizing and naming marine heatwaves. *Oceanography*, **31**(2), pp.162-173.
- Seneviratne *et al.* 2021: Weather and Climate Extreme Events in a Changing Climate. In: *Climate Change 2021: The Physical Science Basis* https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter11.pdf
- Kornhuber *et al.* 2024. Global emergence of regional heatwave hotspots outpaces climate model simulations. *Proceedings of the National Academy of Sciences*, **121**(49), p.e2411258121.
- Kumar, P. Lightning forcing of tornado. *Acta Geophys.* 71, 1967–1981 (2023). <https://doi.org/10.1007/s11600-022-00984-4>
- Li *et al.*, 2023. Recent increases in tropical cyclone rapid intensification events in global offshore regions. *Nature Communications*, **14**(1), p.5167.
- Marine heatwaves <https://www.marineheatwaves.org/mhw-overview.html> <27 Nov 2025>
- Otto, F.E., 2023. Attribution of extreme events to climate change. *Annual Review of Environment and Resources*, **48**(1), pp.813-828.
- Quante *et al.*. 2021. Regions of intensification of extreme snowfall under future warming. *Scientific Reports*, **11**(1), p.16621.
- Schiermeier, Q., 2011. Climate and weather: Extreme measures. *Nature* **477**, 148–149.
- Stott, P.A. and Mitchell, J.F., 2021. Detection and attribution of climate change. *Weather* **76**(10).
- United Nations Children's Fund (UNICEF) <https://www.unicef.org/press-releases/air-pollution-accounted-81-million-deaths-globally-2021-becoming-second-leading-risk> <28 Nov 2025>
- Vautard *et al.* 2024. Heat extremes linearly shift with global warming, with frequency doubling per decade since 1979. *Environmental Research Letters*, **19**(9), p.094033.
- Wang *et. al.* 2023. Evidence and controls of the acceleration of the hydrological cycle over land. *Water Resources Research*, **59**(8), p.e2022WR033970.
- World Health Organisation (WHO) <https://www.who.int/health-topics/air-pollution> <28 Nov 2025>
- World Weather Attribution. <https://www.worldweatherattribution.org/> <26 Nov 2025>
- World Meteorological Organization [WMO] Extreme Weather <https://wmo.int/topics/extreme-weather> <26 Nov 2025>