Interreg CENTRAL EUROPE

Co-funded by the European Union

CONE

Climate change - crisis incident review

CONE – 2nd Workshop - Training of trainers

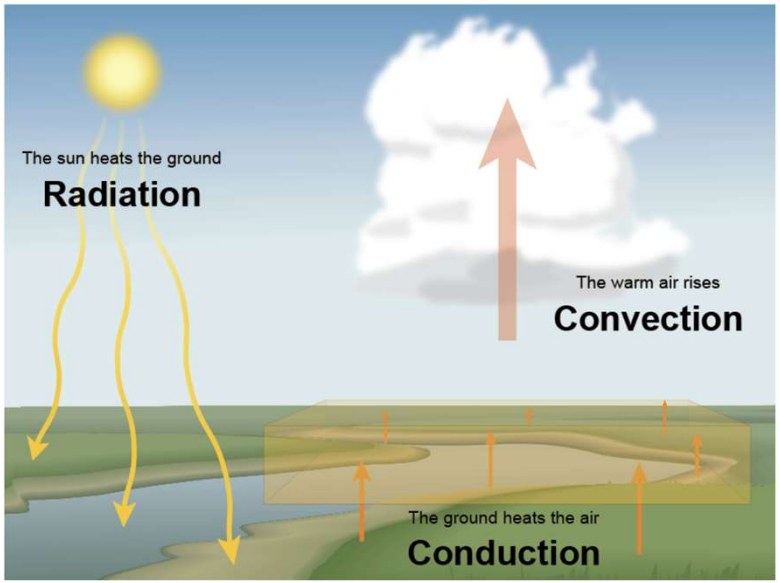
ONLINE | 11 of April 2025

Presenter: Wojciech Szpakowski

1. The Earth-Atmosphere Energy Balance
2. Distribution of Energy on the Earth
3. Climate phenomena on Earth
4. weather events review 2024
5. Gdansk PL weather records

The Earth-Atmosphere Energy Balance

The transfer of heat energy



frost during a cloudless night sky - radiation of the earth's surface energy

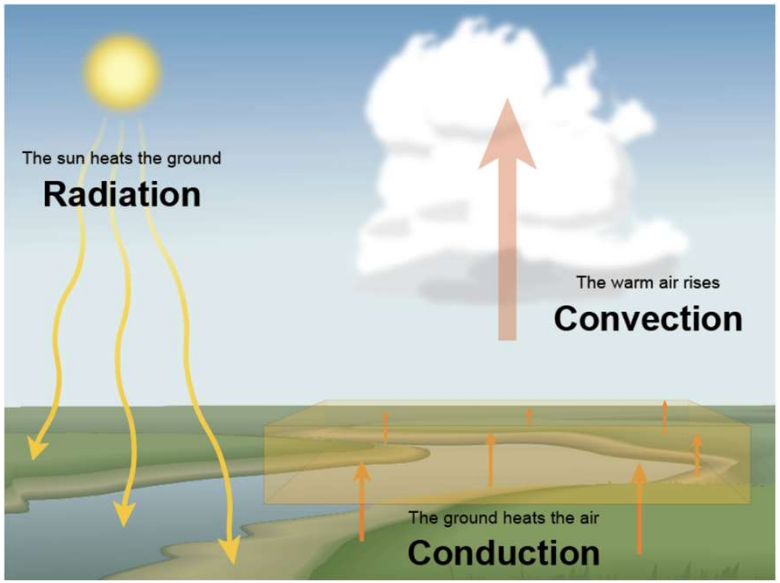
- **Conduction** - transfer of heat energy from one substance to another or within a substance (this is due to transfer of heat energy from molecule to molecule or from atom to atom).

Metals		Gases		Building Materials		Other Materials	
Aluminum	235	Air (dry)	0.026	Asphalt	0.75	Cotton	0.04
Brass	109	Argon (gas)	0.016	Brick dense	1.31	Cotton wool	0.029
Copper	401	Carbon dioxide (gas)	0.0146	Brick, fire	0.47	Diamond	1000
Gold	314	Helium	0.15	Brick, insulating	0.15	Engine Oil	0.15
Iron	67	Hydrogen	0.18	Concrete	0.8	Graphite	168
Lead	35	Krypton (gas)	0.0088	Fiberglass	0.048	Ground or soil, dry area	0.5
Nickel	91	Methane (gas)	0.03	Polyurethane foam	0.024	Ground or soil, moist area	1.5
Silver	428	Nitrogen (gas)	0.024	Rock wool	0.043	Polyethylene - low density	0.33
Sodium (liquid)	86	Steam, saturated	0.0184	White pine	0.11	Polypropylene, PP	0.1 - 0.22
Sodium (solid)	135	Xenon (gas)	0.0051	Window glass	1	Porcelain	1.5
Stainless steel	14			Wood, oak	0.17	Sulfur, crystal	0.2
Steel, Carbon 1%	43					Uranium dioxide	8.8
Thorium (metalic)	38					Water	0.58
Uranium (metalic)	27.6						
Zirconium	22.6						
Zirconium alloy (1% Nb)	18						

https://www.noaa.gov/jetstream/atmosphere/transfer-of-heat-energy
https://www.nuclear-power.com/nuclear-engineering/heat-transfer/thermal-conduction/thermal-conductivity/

The Earth-Atmosphere Energy Balance

The transfer of heat energy



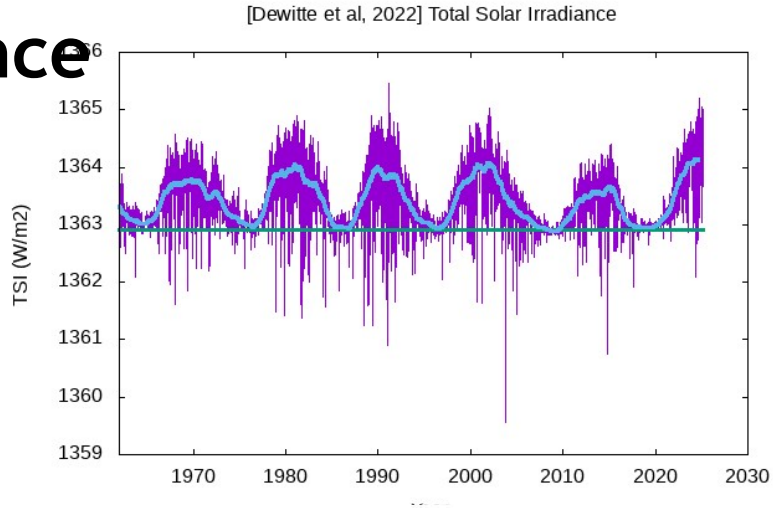
- **Convection** - movement of particles through a substance, transporting their heat energy from hotter areas to cooler areas.
- Convection is a vertical transport of heat and moisture in the atmosphere, especially by updrafts and downdrafts in an unstable atmosphere.

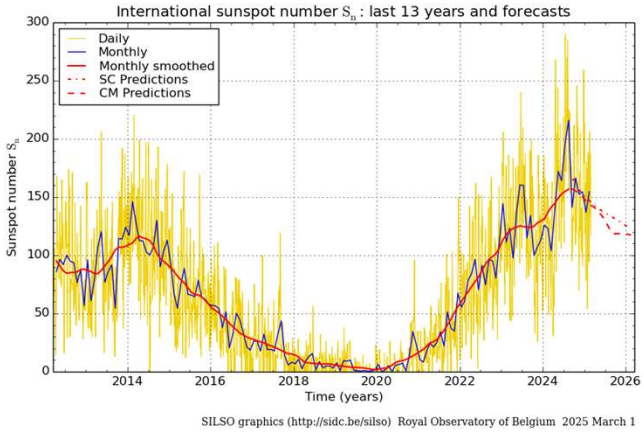
https://weather.metoffice.gov.uk/learn-about/weather/how-weather-works/what-is-convectionhttps://www.nesdis.noaa.gov/our-environment/severe-weather/convection

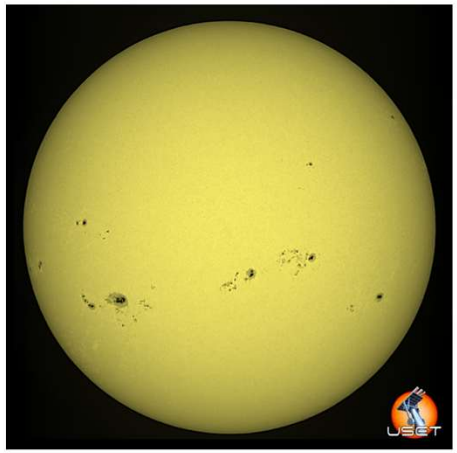
The Earth-Atmosphere Energy Balance

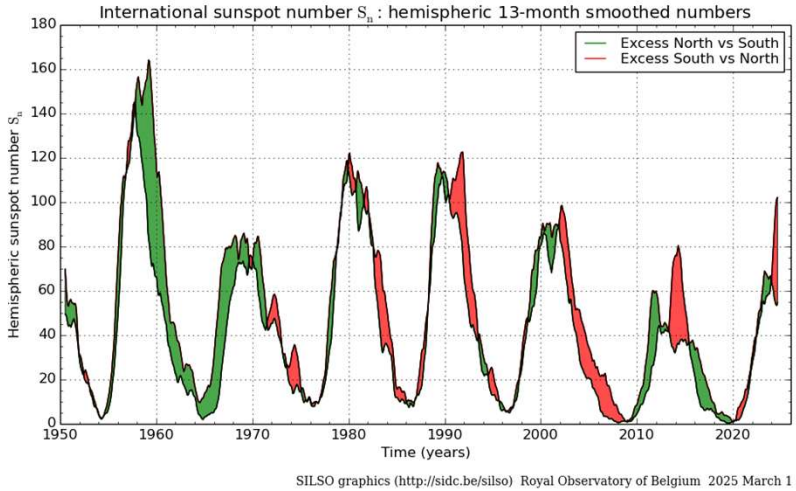
Solar radiation

- **Total Solar Irradiance** (TSI), which is defined as the incoming solar power per unit surface perpendicular to the sun-earth direction, at the mean sun-earth distance of 1 Astronomical Unit.









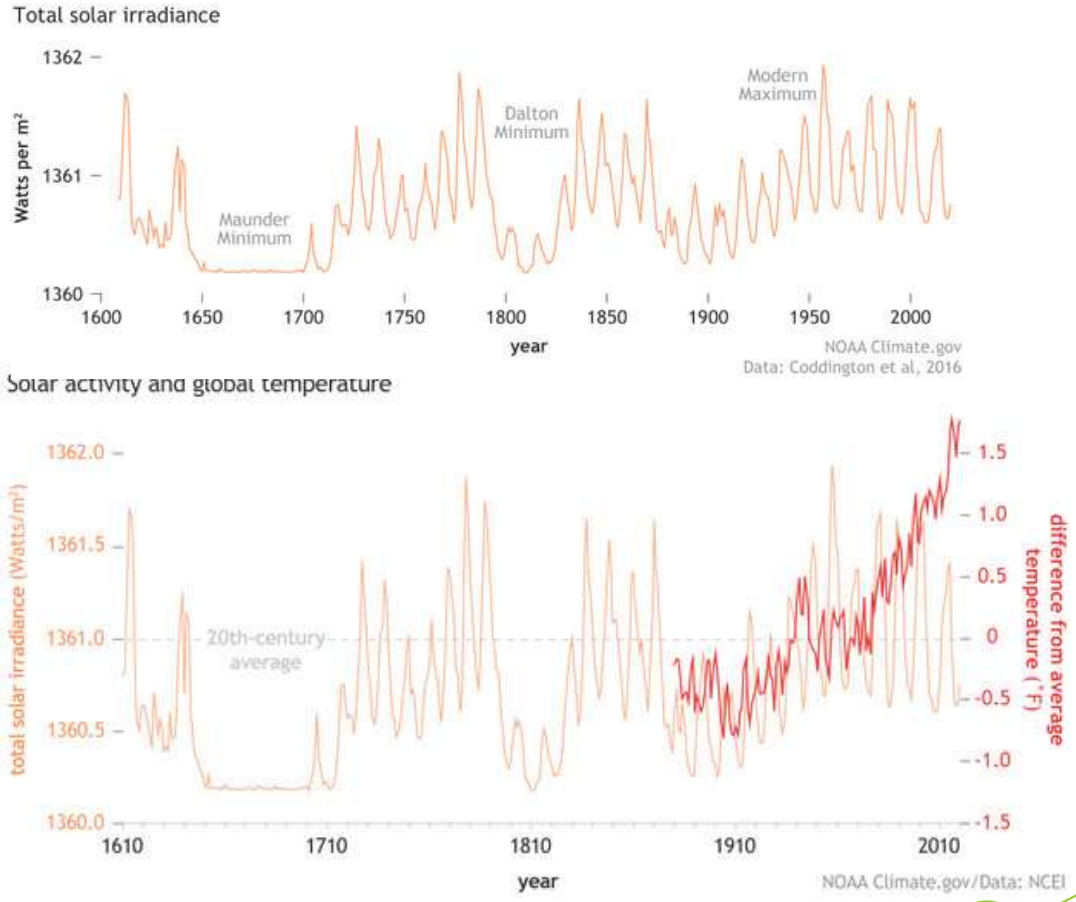
https://www.sidc.be/observations/space-based-timelines/tsi
https://www.sidc.be/SILSO/home https://www.sidc.be/SILSO/monthlyhemisphericplot

The Earth-Atmosphere Energy Balance

Solar radiation

- **Total Solar Irradiance** (TSI), which is defined as the incoming solar power per unit surface perpendicular to the sun-earth direction, at the mean sun-earth distance of 1 Astronomical Unit.

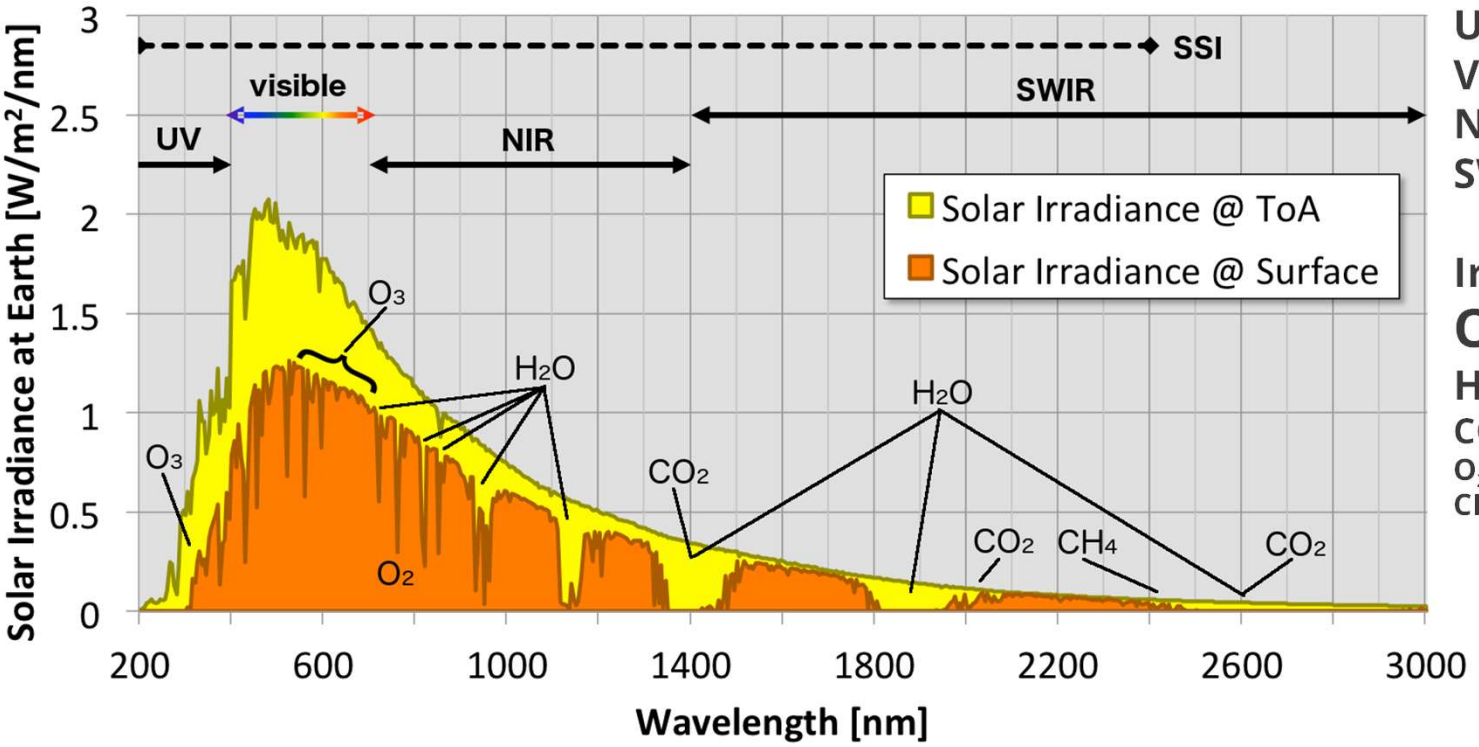
- The Solar constant is not constant



https://www.climate.gov/news-features/understanding-climate/climate-change-incoming-sunlight

The Earth-Atmosphere Energy Balance

Spectral Solar Irradiance T=5800-6000K



UV- ultraviolet
Visible
NIR – near infrared
SWIR – shortwave infrared

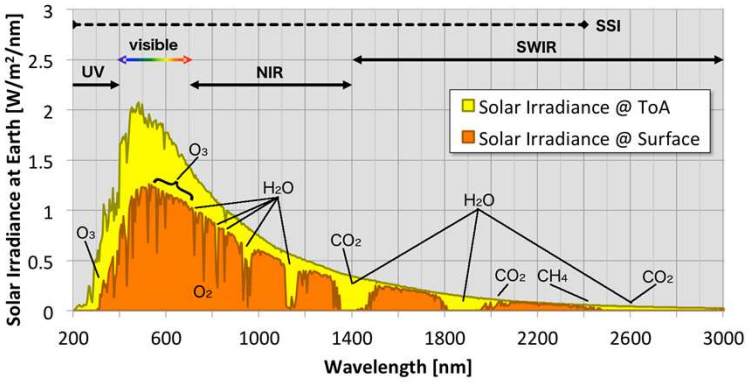
Irradiance is absorbed by:

O_3- ozone
H_2O- water vapour
CO_2-carbon dioxide
O_2- oxygen
CH_4- methane

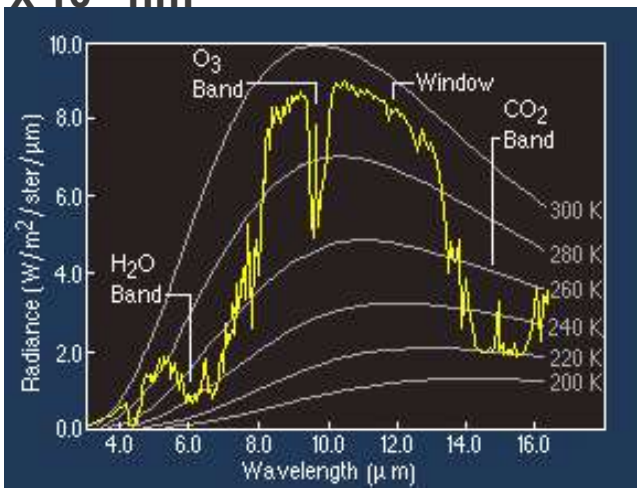
https://sunclimate.gsfc.nasa.gov/article/solar-irradiance

The Earth-Atmosphere Energy Balance

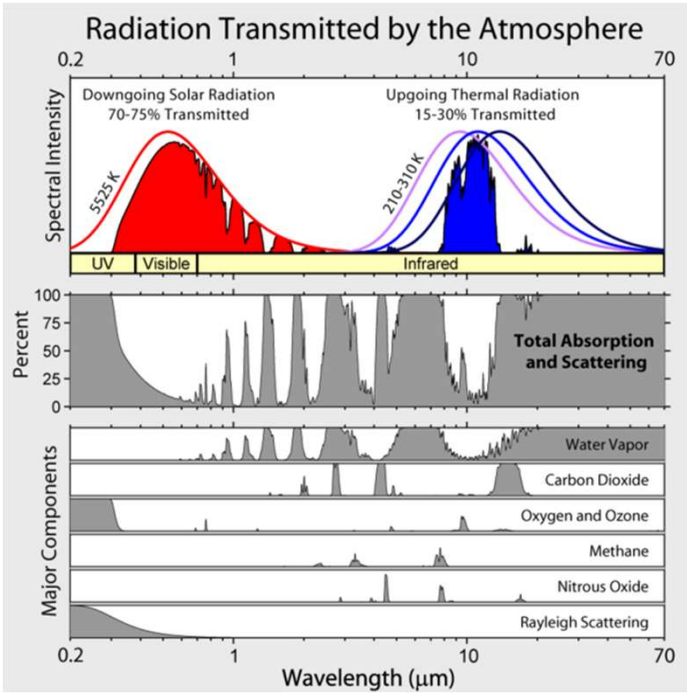
Radiation emission earth Surface …



x 10^{-3} nm



x 10^{3} nm



… 288K And atmosphere ~230K

Radiation is absorbed by:

H_2O- water vapour

CO_2-carbon dioxide

O_2- oxygen

CH_4- methane

NO- nitrous oxiede

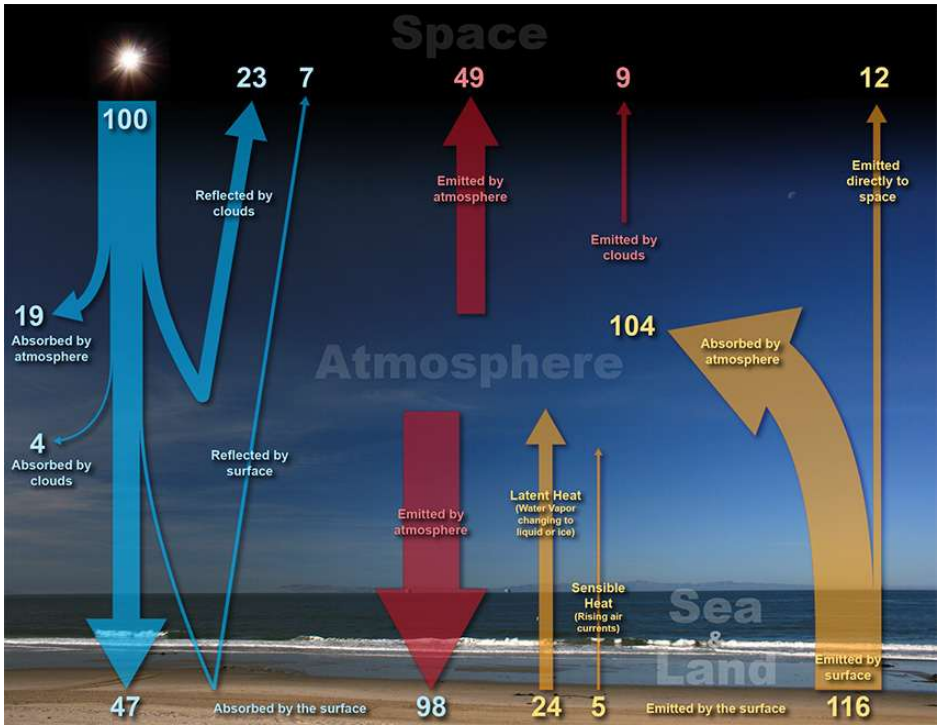
https://sunclimate.gsfc.nasa.gov/article/solar-irradiance

https://resources.eumetrain.org/data/4/460/navmenu.php?tab=2&page=3.0.0

https://pressbooks-dev.oer.hawaii.edu/atmo/chapter/chapter-2-solar-and-infrared-radiation/

The Earth-Atmosphere Energy Balance

At the top of the atmospere

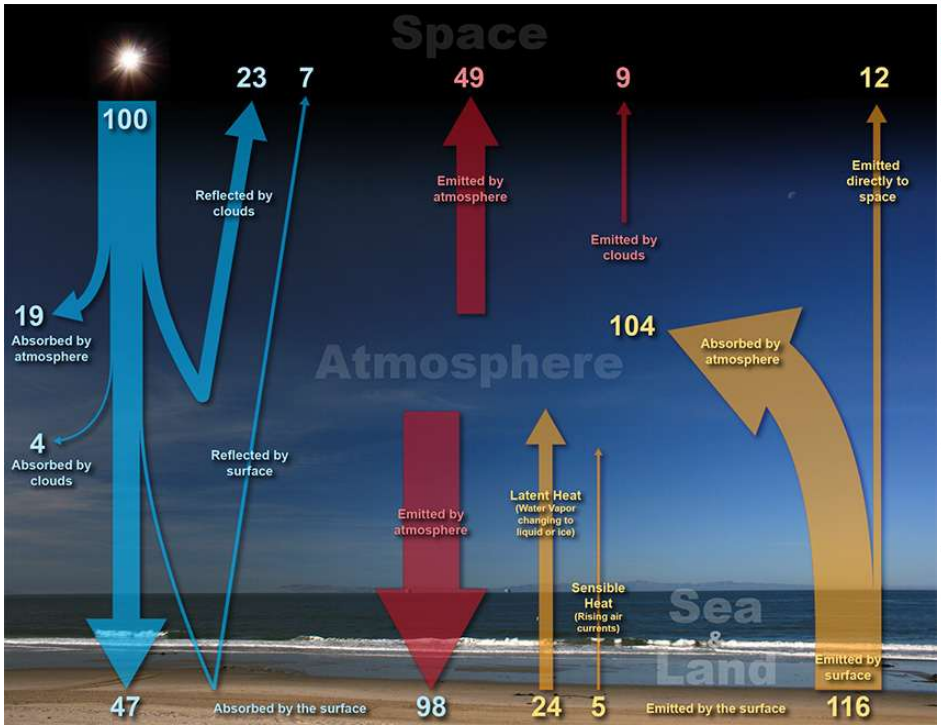


https://www.noaa.gov/jetstream/atmosphere/energy

INCOMING ENERGY		OUTGOING ENERGY	
UNITS	SOURCE	UNITS	SOURCE
+100	Shortwave radiation from the sun.	-23	Shortwave radiation reflected back to space by clouds.
		-7	Shortwave radiation reflected to space by the earth's surface.
		-49	Longwave radiation from the atmosphere into space.
		-9	Longwave radiation from clouds into space.
		-12	Longwave radiation from the earth's surface into space.
+100	Total Incoming	-100	Total Outgoing

The Earth-Atmosphere Energy Balance

The atmosphere itself (including clouds)

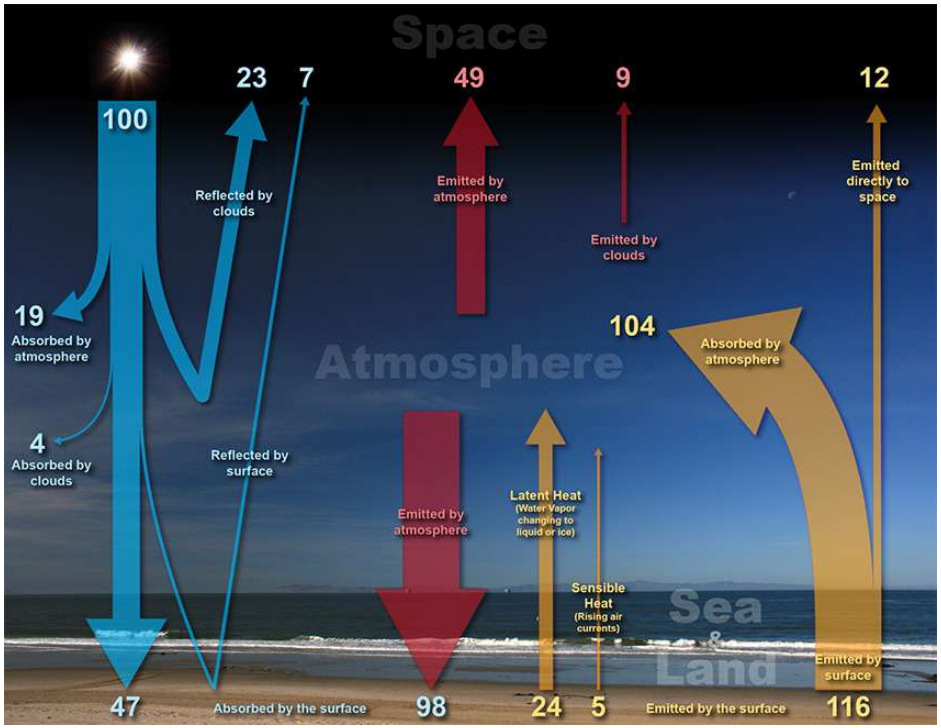


INCOMING ENERGY		OUTGOING ENERGY	
UNITS	SOURCE	UNITS	SOURCE
+19	Absorbed shortwave radiation by gases in the atmosphere.	-9	Longwave radiation emitted to space by clouds.
+4	Absorbed shortwave radiation by clouds.	-49	Longwave radiation emitted to space by gases in atmosphere.
+104	Absorbed longwave radiation from earth's surface.	-98	Longwave radiation emitted to earth's surface by gases in atmosphere.
+5	From convective currents (rising air warms the atmosphere).		
+24	Condensation /Deposition of water vapor (heat is released into the atmosphere by process).		
+156	Total Incoming	-156	Total Outgoing

https://www.noaa.gov/jetstream/atmosphere/energy

The Earth-Atmosphere Energy Balance

The atmosphere itself (including clouds)



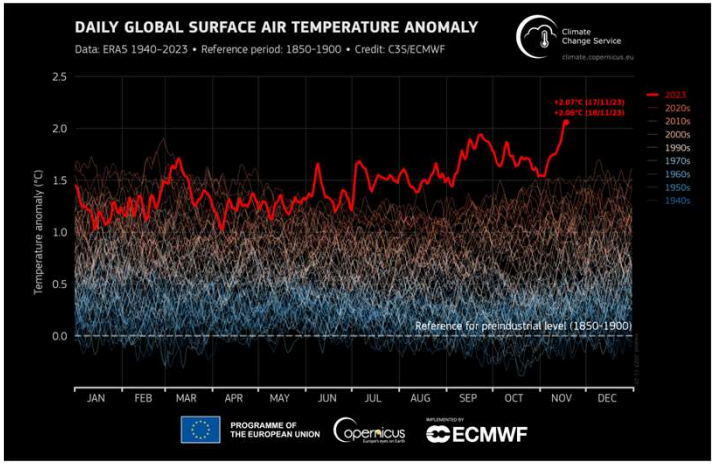
INCOMING ENERGY		OUTGOING ENERGY	
UNITS	SOURCE	UNITS	SOURCE
+47	Absorbed shortwave radiation from the sun.	-116	Longwave radiation emitted by the surface.
+98	Absorbed longwave radiation from gases in atmosphere.	-5	Removal of heat by convection (rising warm air).
		-24	Heat required by the processes of evaporation and sublimation and therefore removed from the surface.
+145	Total Incoming	-145	Total Outgoing

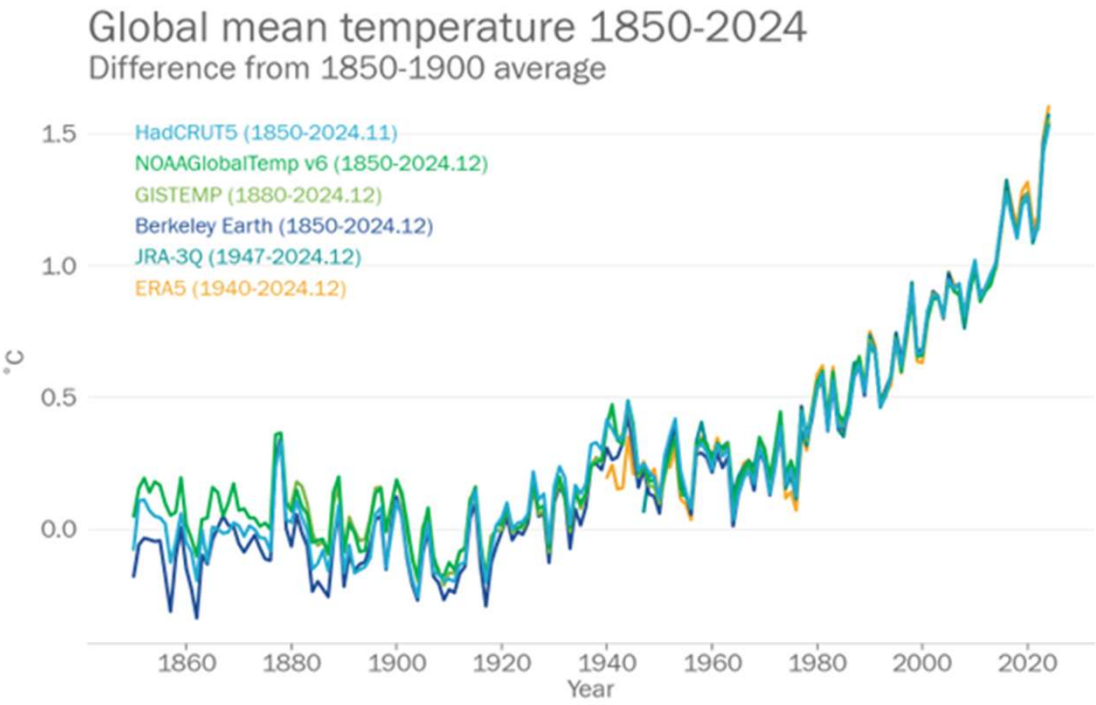
https://www.noaa.gov/jetstream/atmosphere/energy

The Earth-Atmosphere Energy Balance

disturbances in the energy balance of the atmosphere

- change in solar activity
- Albedo change
- …
- Greenhouse effect
  – more CO_2, H_2O, CH_4, NO in atmosphere
- Results:

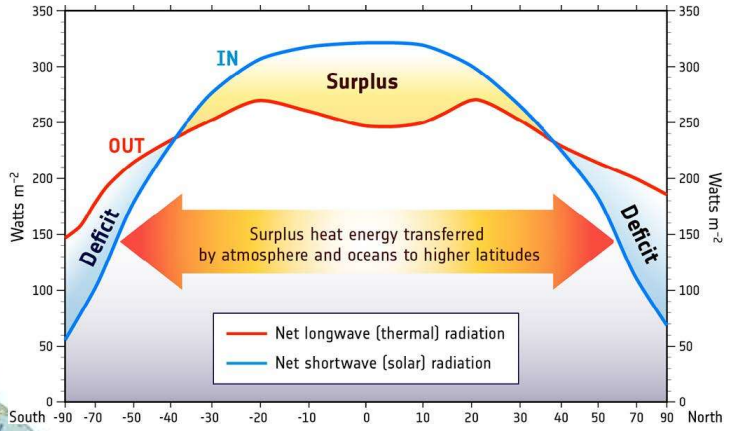




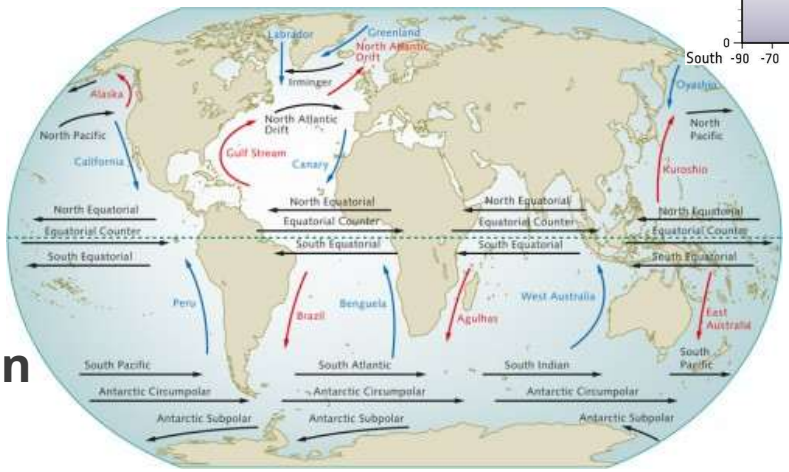
https://climate.copernicus.eu/global-temperature-exceeds-2degc-above-pre-industrial-average-17-november
https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level

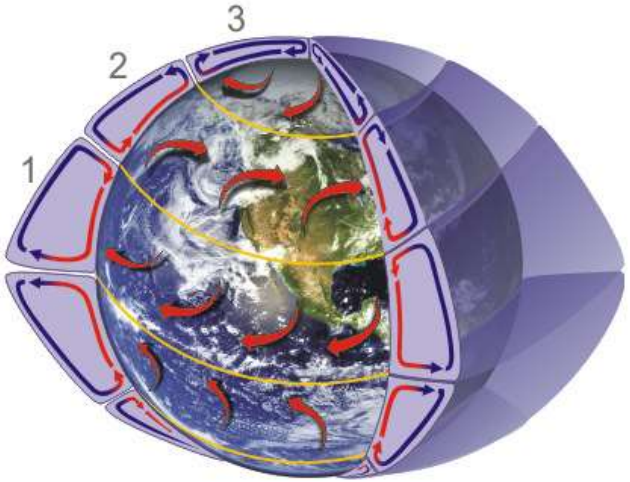
Distribution of Energy on the Earth

directions of energy flow



- **Heat gain, heat loss**
- **Sea currents**
- **Atmosperic circulation**
  1. **Hadley cell**
  2. **Ferrel cell**
  3. **Polar cell**

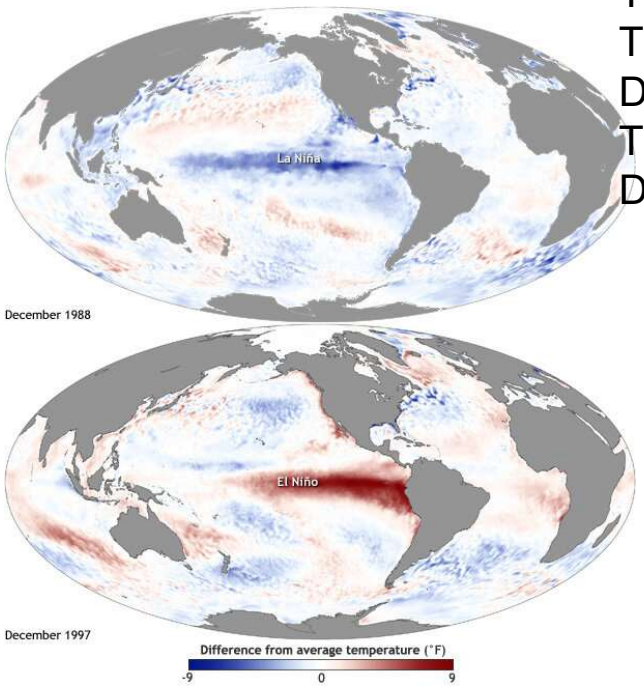




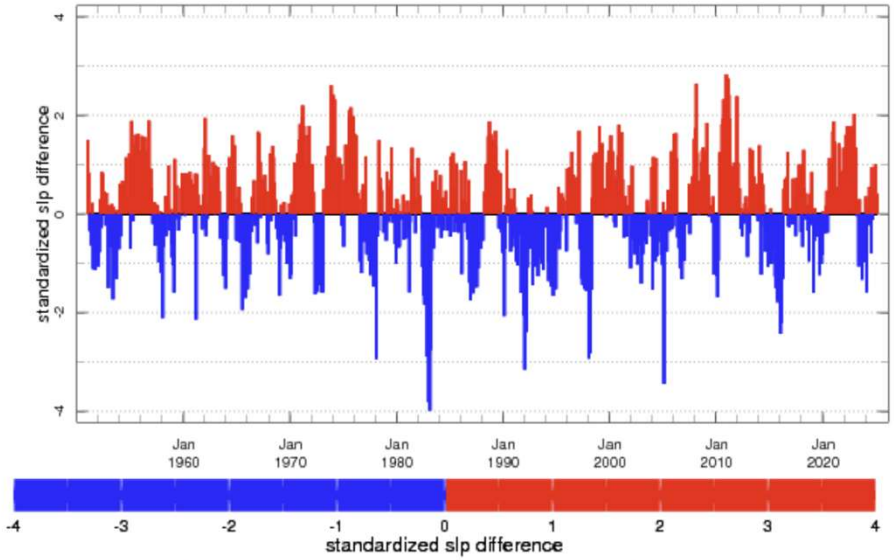
https://rwu.pressbooks.pub/webboceanography/chapter/8-1-earths-heat-budget/
https://worldoceanreview.com/en/wor-1/climate-system/great-ocean-currents/
https://www.noaa.gov/jetstream/global/global-atmospheric-circulations

Climate phenomena on Earth

ENSO - El Niño–Southern Oscillation



The **SOI** is calculated as the standardized difference between standardized Tahiti monthly average sea level pressure anomalies and standardized Darwin monthly average sea level pressure anomalies.
The base period used for calculating the anomalies is January 1991 to December 2020.

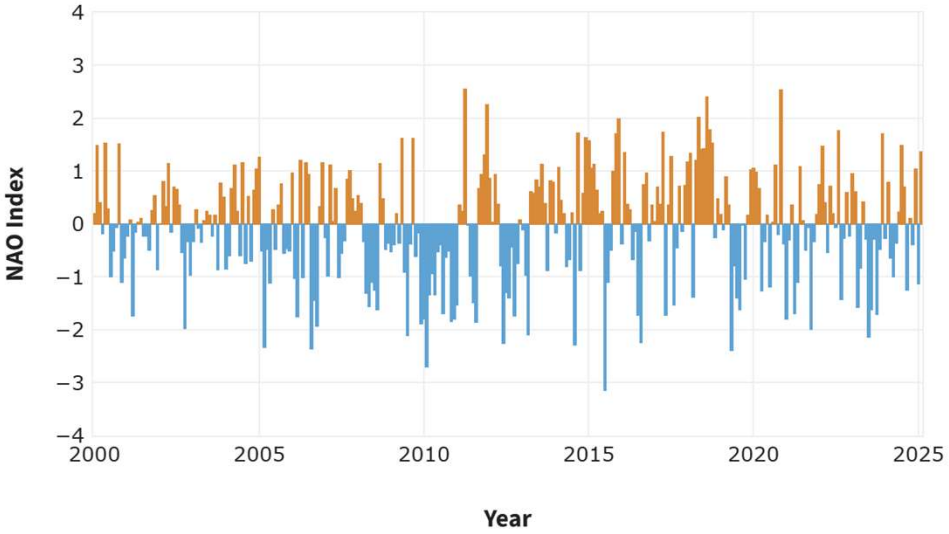


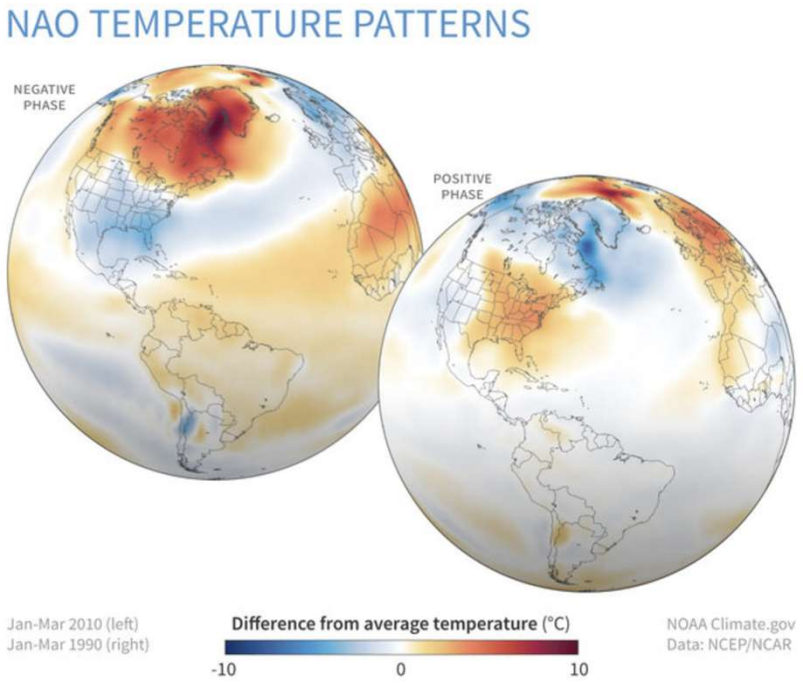
https://www.climate.gov/news-features/blogs/enso/what-el-niño-southern-oscillation-enso-nutshell
https://iridl.ldeo.columbia.edu/maproom/ENSO/Time_Series/SOI.html

Climate phenomena on Earth

NAO – North Atlantic Oscillation

The North Atlantic Oscillation (NAO) Index describes changes in the strength of two recurring pressure patterns in the atmosphere over the North Atlantic: a low near Iceland, and a high near the Azores Islands.

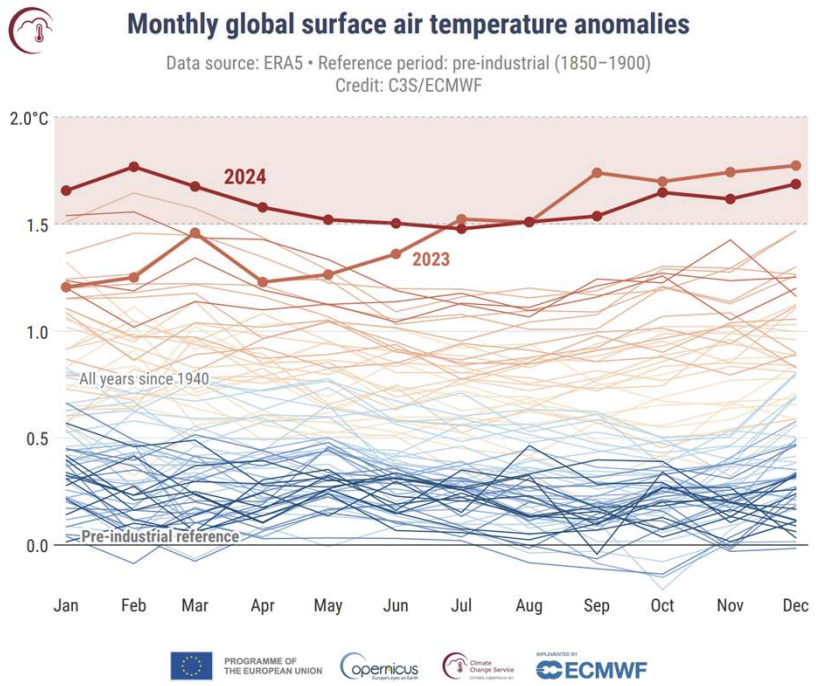


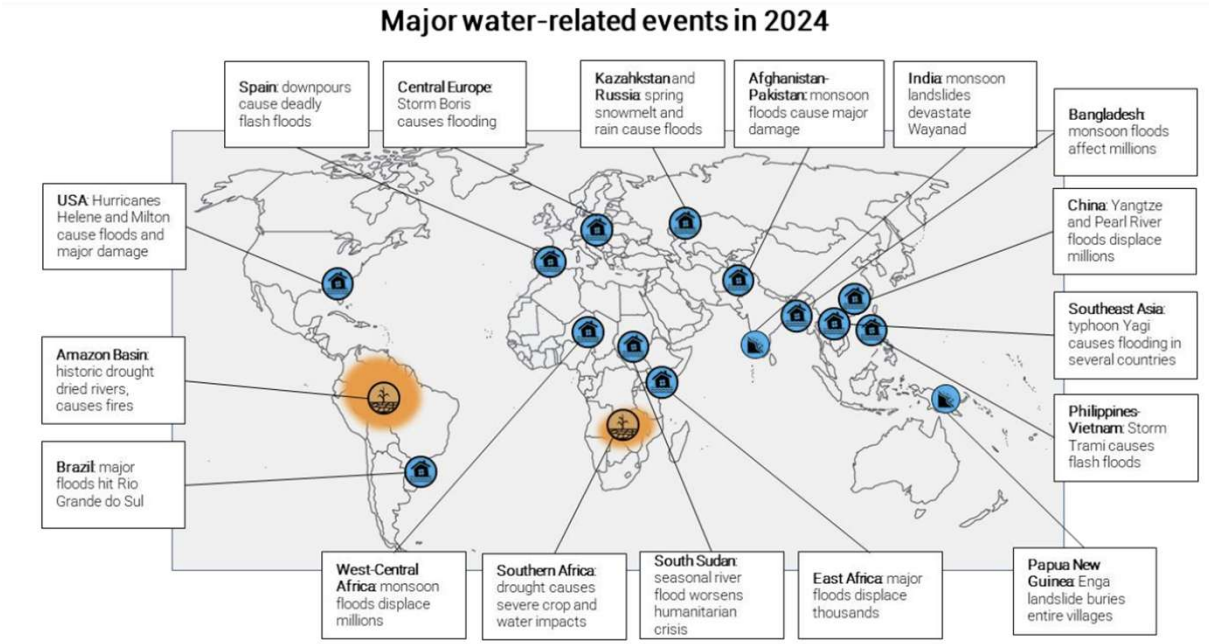


https://www.climate.gov/news-features/understanding-climate/climate-variability-north-atlantic-oscillation

weather events review 2024

Year





https://sites.ecmwf.int/data/c3sci/global-climate-highlights/2024/chart-gallery/supplementary/GCH2024-gallery-figureS1/figureS1.pdf
https://www.globalwater.online/globalwater/report/index.html#gallery

weather events review 2024

January

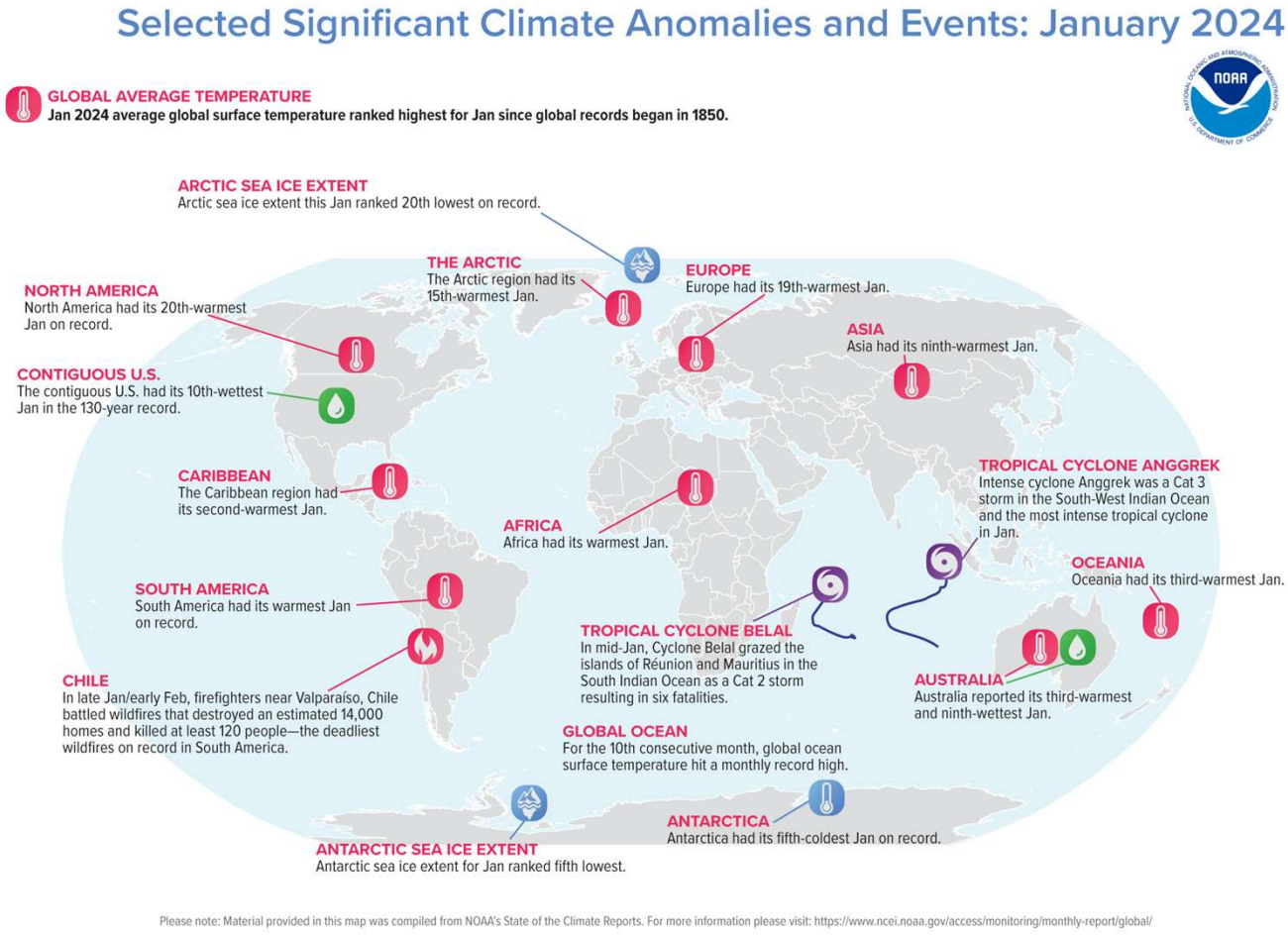
New Year's Earthquake Claims at Least 213 Lives in Japan

A 7.6 magnitude earthquake that hit the western coast of Japan on Jan. 1 killed at least 213 people. The AP reported at the time that eight of the deaths were caused not by the earthquake itself, but by injuries and sickness at evacuation centers. Nearly 2,000 homes were destroyed as well, officials said.

Here Are 10 of the Deadliest Natural Disasters in 2024 | Best Countries | U.S. News

weather events review 2024

January



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202401

weather events review 2024

February

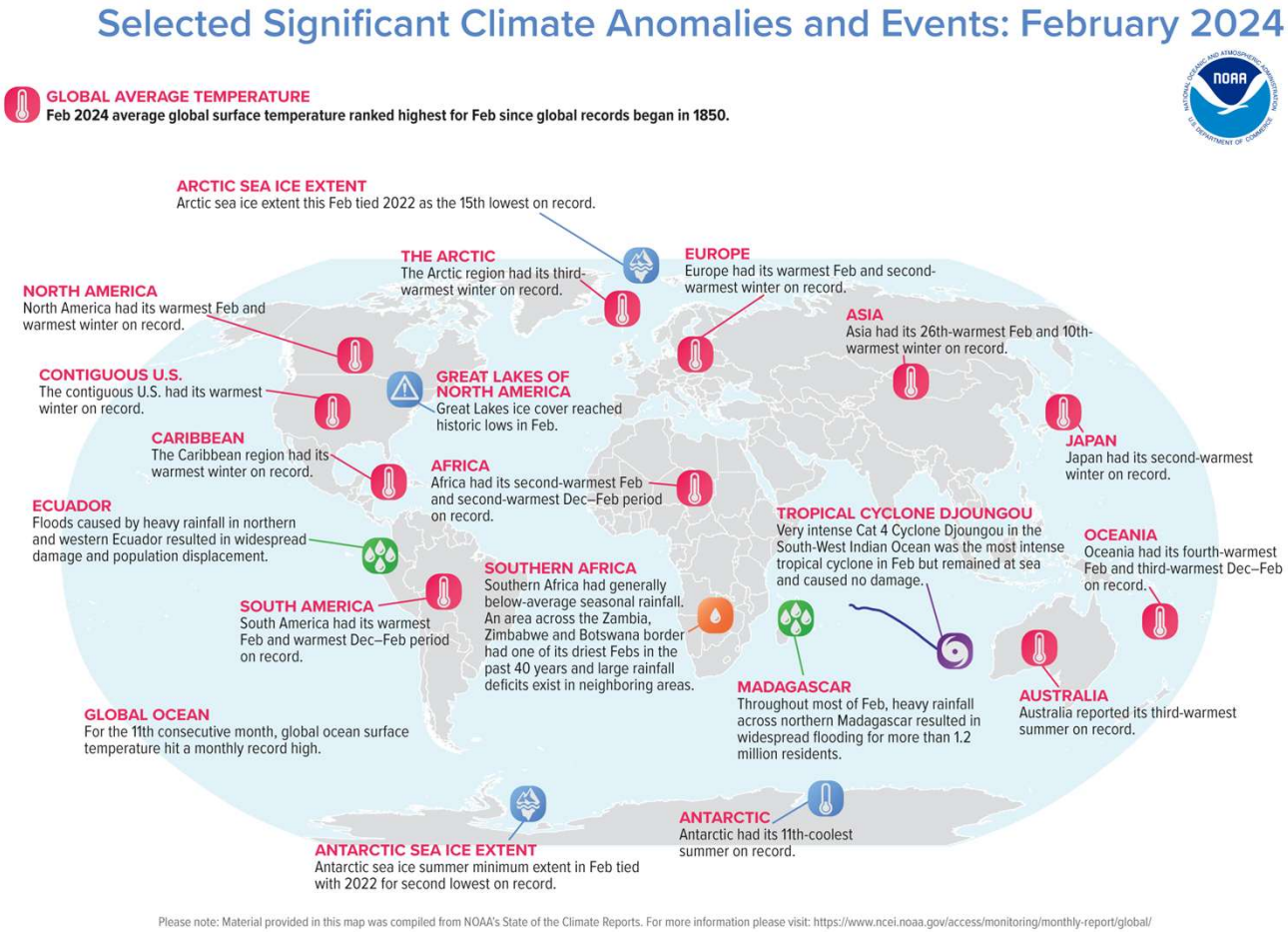
Wildfires Kill at Least 136 in Chile

What were reportedly the deadliest forest fires in Chilean history scorched the country in early February. At least 136 people died as of late February, according to Chilean government figures shared by the Center for Disaster Philanthropy. Damage was especially bad in Chile's Valparaíso region, including the coastal city of Viña del Mar.

Here Are 10 of the Deadliest Natural Disasters in 2024 | Best Countries | U.S. News

weather events review 2024

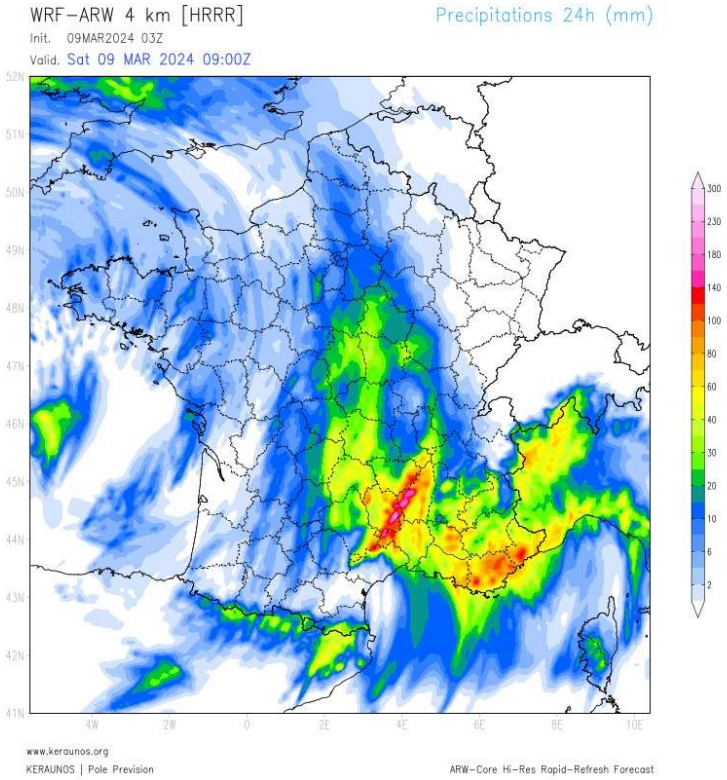
February



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202402

weather events review 2024

March



Observatoire Français des Tornades et des Orages Violents
Tornadoes and Severe Storms French Observatory

www.keraunos.org

Johan Rouquet
@JohanRouquet · **Suivre**

Nouvel éboulement chemin du Mont-Gros à #Nice06 après celui du week-end dernier quelques mètres à côté.

Les fortes précipitations font de nouveau dégâts ce dimanche.
(Documents récupérés)

6:37 PM · 3 mars 2024

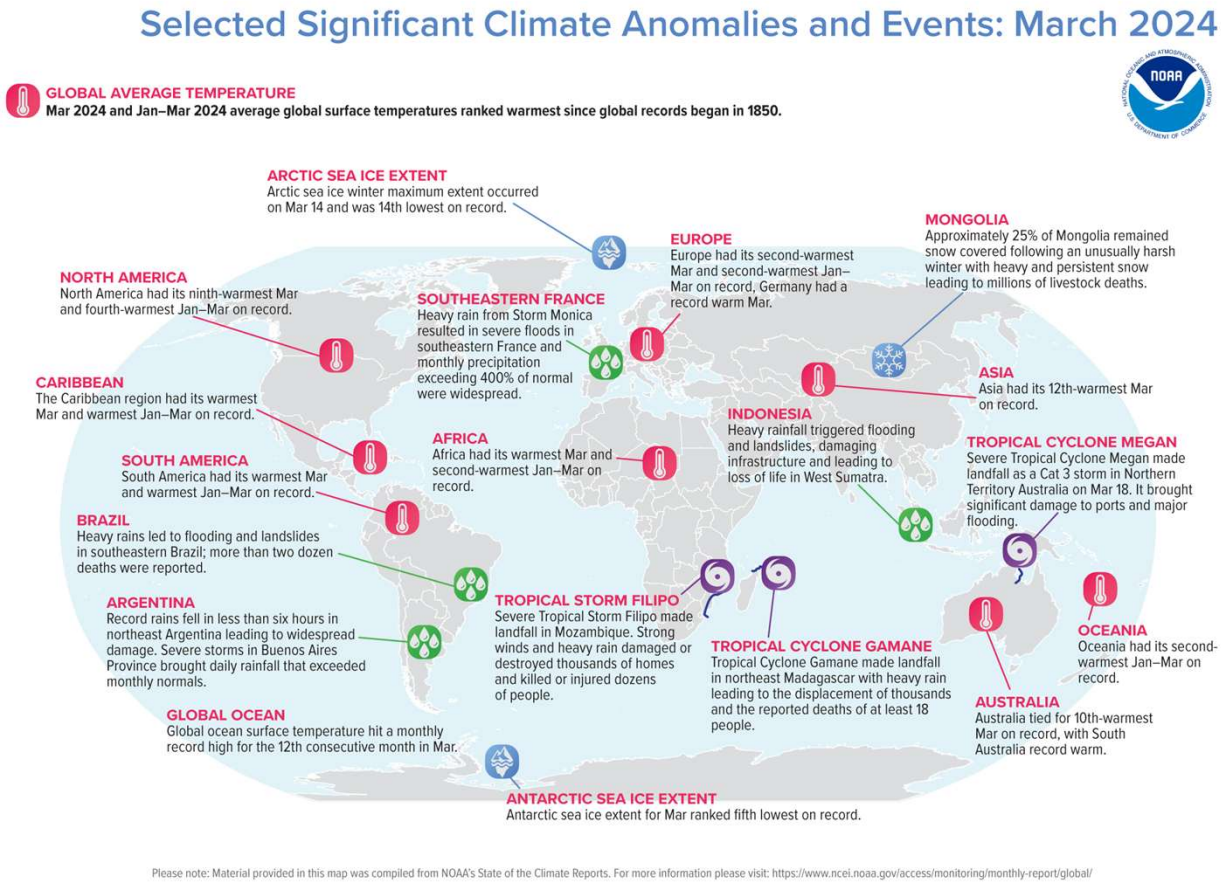
Andreas Miranda
@MirandaAndreas2 · **Suivre**

Une mini tornade a eu lieu sur Antibes l'heure est au constat... plusieurs arbres couchés sur des voitures, des routes barrées,...

4:40 PM · 3 mars 2024

weather events review 2024

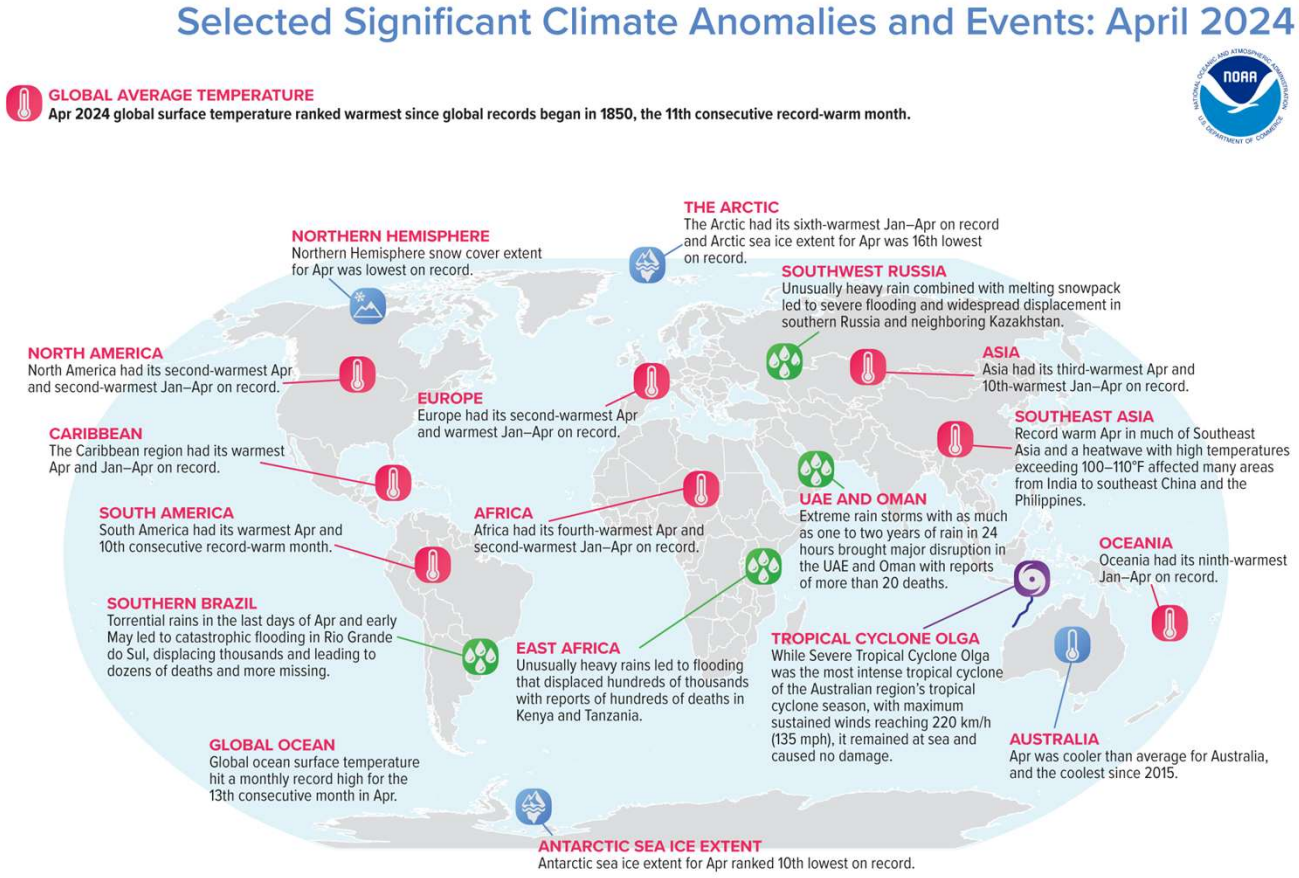
March



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202403

weather events review 2024

April

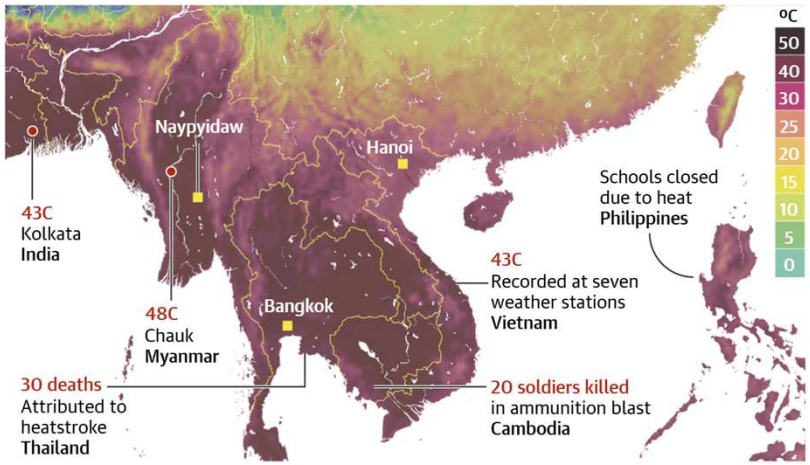


www.keraunos.org
https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202404

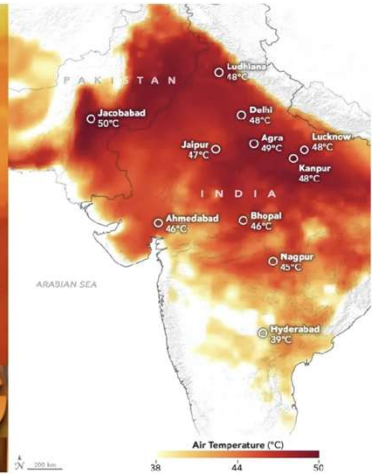
weather events review 2024

May

Extreme heat across southeast Asia



Guardian graphic. Source: Ventusky.com. Snapshot of 'feels like' temperatures at 4pm, Indochina time, 1 May



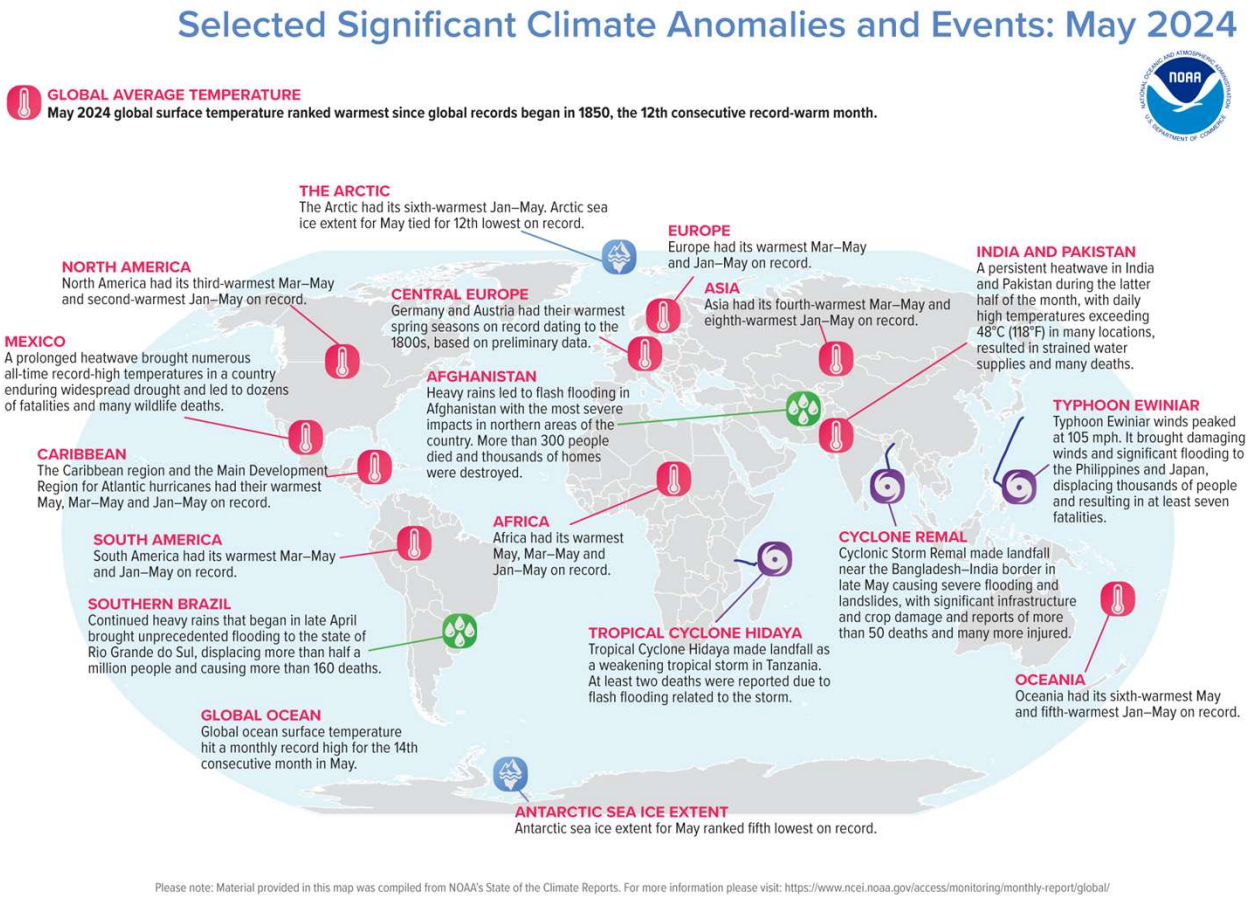
Landslide Claims at Least 670 Lives in Papua New Guinea

A deadly landslide in the South Pacific island nation of Papua New Guinea killed at least 670 people in late May, according to the U.N. But that number could have been higher in the end, as a government official told the U.N. that more than 2,000 people were believed to have been buried by the landslide.

https://www.theguardian.com/environment/article/2024/may/04/inside-an-oven-how-life-in-south-east-asia-is-a-struggle-amid-sweltering-heat
https://www.tgnns.com/news/extreme-heatwave-in-india-why-2024-is-the-hottest-year/2024/05/26
Here Are 10 of the Deadliest Natural Disasters in 2024 | Best Countries | U.S. News

weather events review 2024

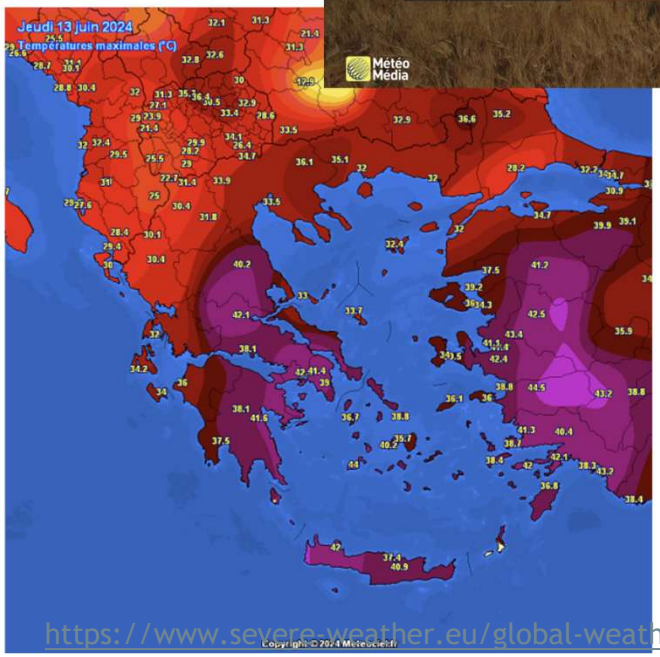
May

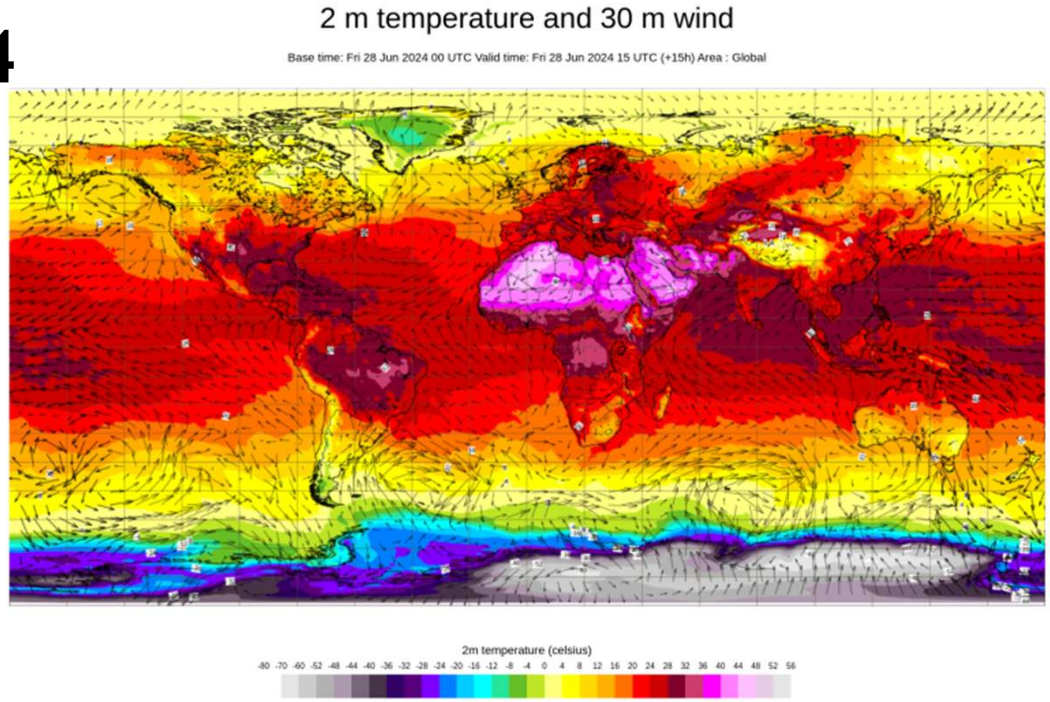


https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202405

weather events review 2024

June





Heat Wave Kills at Least 1,300 During Hajj Pilgrimage in Saudi Arabia

A brutal heat wave during the five-day Hajj – the annual Islamic pilgrimage to the holy city of Mecca – killed at least 1,300 people in June, according to the Washington Post. Saudi officials said many of the dead were unregistered pilgrims, who don't have access to air conditioned venues and face dangerous sun exposure. More than 2,000 people were treated for heat stroke during the Hajj this year, during which temperatures in Mecca topped 125 degrees Fahrenheit.

ECMWF

https://www.severe-weather.eu/global-weather/first-significant-heatwave-summer-2024-forecast-europe-mk/
https://wmo.int/media/news/more-extreme-heat-demands-coordinated-action
Here Are 10 of the Deadliest Natural Disasters in 2024 | Best Countries | U.S. News
https://www.meteomedia.com/fr/nouvelles/meteo/previsions/chaleur-une-region-du-quebec-se-souviendra-longtemps-de-ces-records

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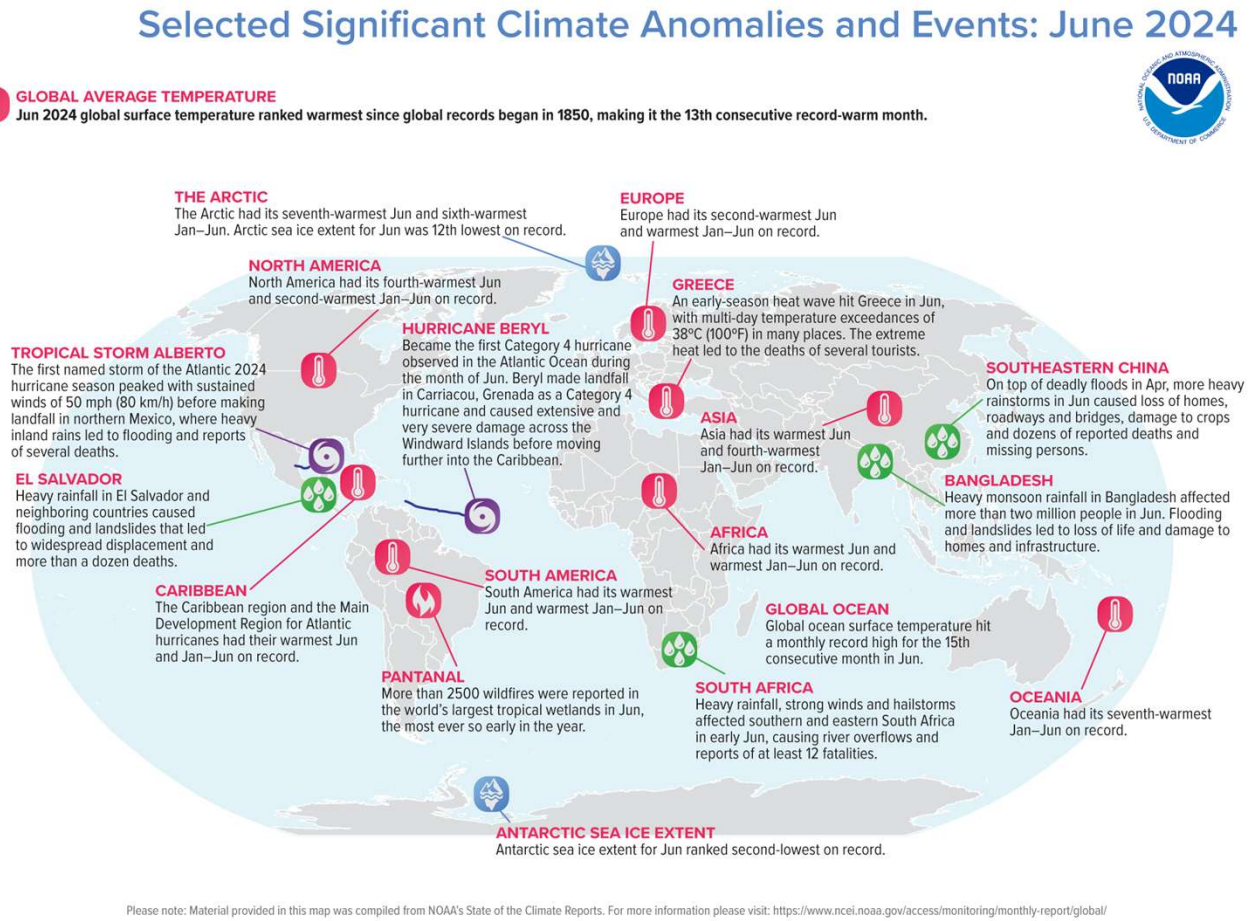
June

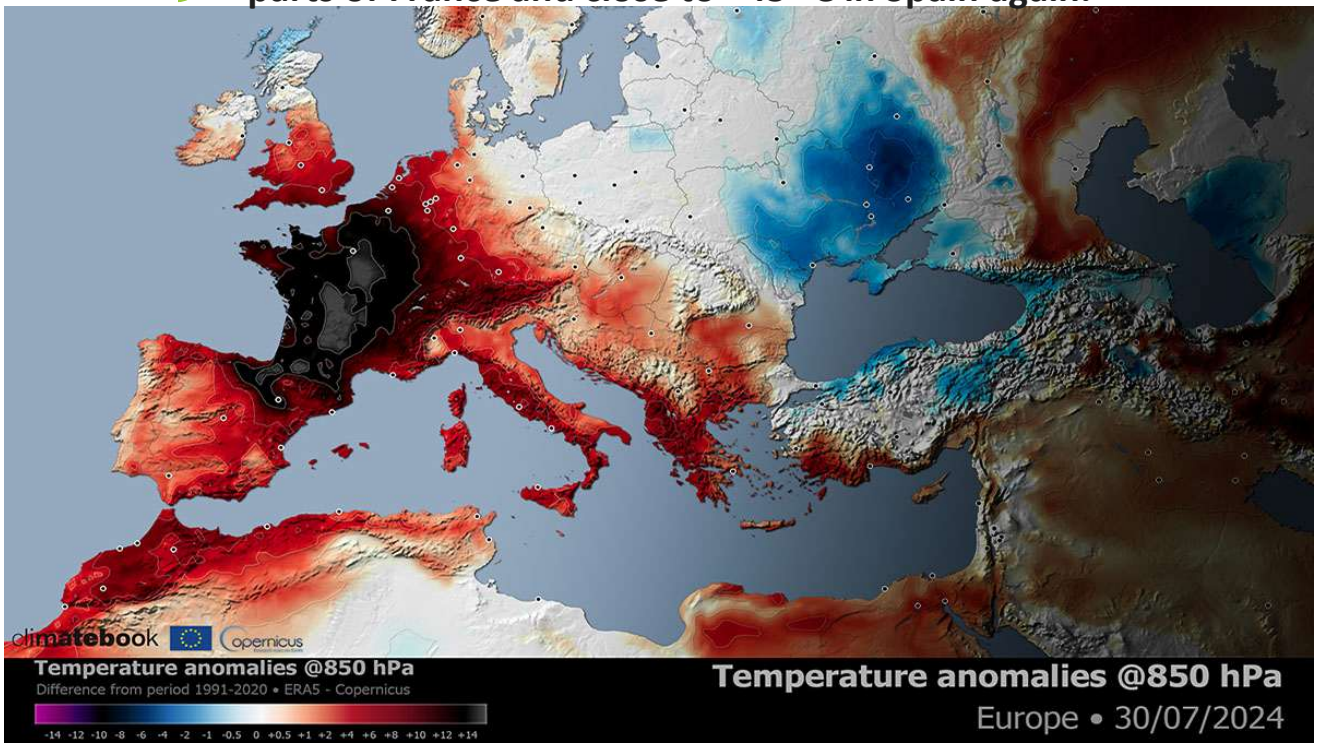


https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202406

weather events review 2024

July

Most of Western Europe will face a short but intense heatwave as the Olympic Games 2024 kick-off. A warm plume of air mass will spread temperatures exceeding the +40 °C threshold across parts of France and close to +45 °C in Spain again.



Japan sweltered through its hottest July since records began 126 years ago, the weather agency said, as extreme heat waves fueled by climate change engulfed many parts of the globe.
Temperatures in the country were 2.16 degrees Celsius higher than average, breaking last year's record for July of 1.91 degrees Celsius above average

https://www.severe-weather.eu/global-weather/heatwave-olympic-games-weather-forecast-france-2024-western-europe-mk/
https://phys.org/news/2024-08-japan-hottest-july-began.html

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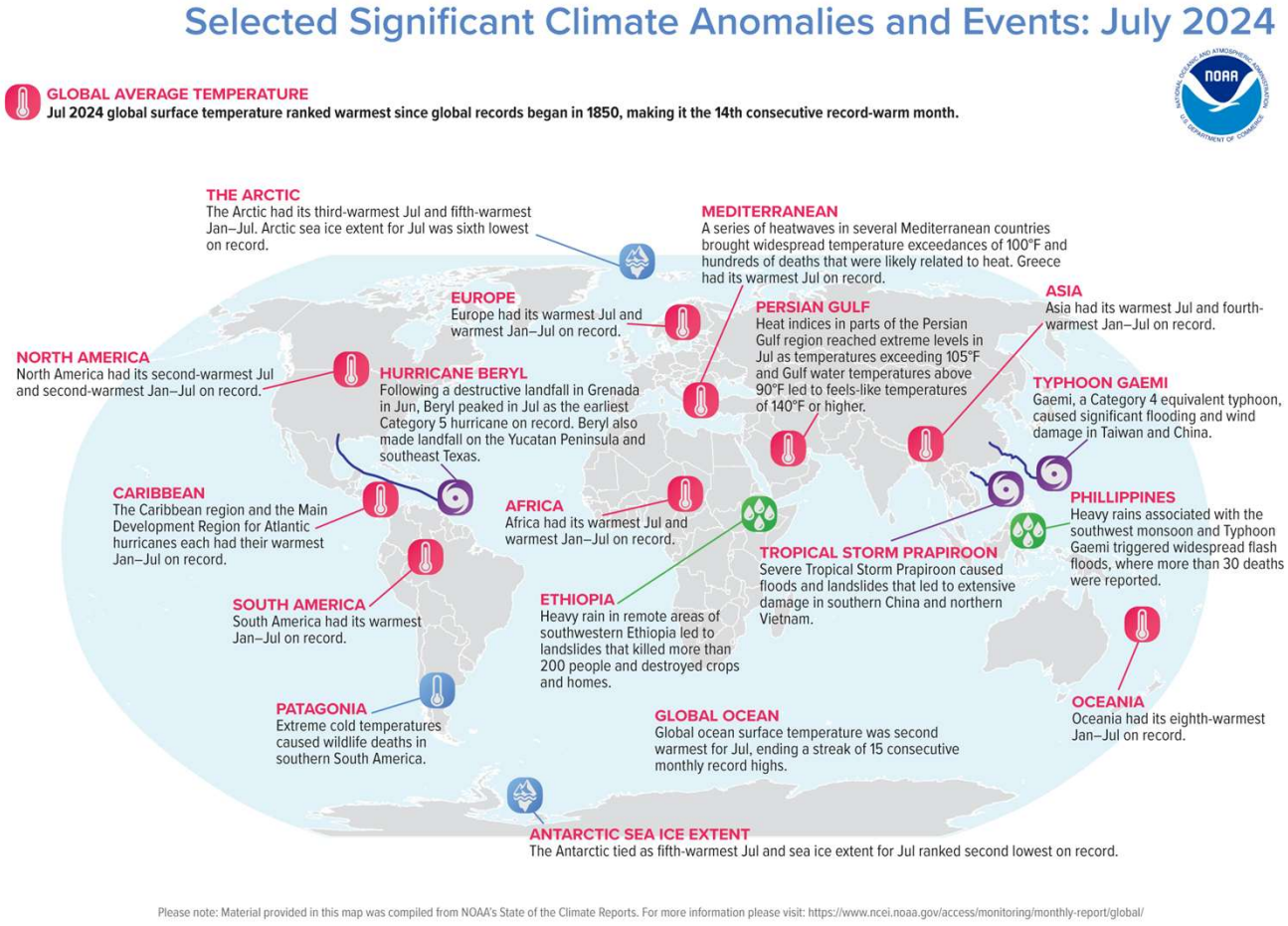
July



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202407

weather events review 2024

August

LE 28 AOÛT 2024 À 15:58

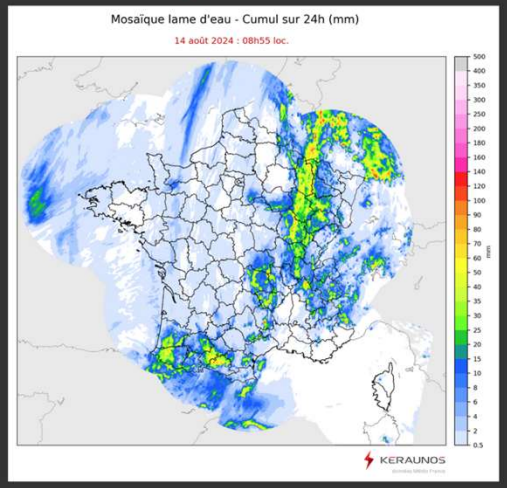
Des inondations catastrophiques touchent le Gujarat en Inde en raison de la présence d'une zone de basse pression stationnaire (qui pourrait évoluer en cyclone en mer d'Arabie plus tard). Des cumuls de plus de 500 mm sont localement relevés et les pluies vont se poursuivre. Certaines modélisations envisagent des cumuls totaux localement supérieurs à 1000/1200 mm.

Orages très pluvieux le 13 août

KERAUNOS

Des pluies intenses ont été observées sous orages le 13 août et dans la nuit du 13 au 14, notamment près des Pyrénées, ainsi que de l'Auvergne/Rhône-Alpes jusqu'à la Bourgogne et à la Lorraine. Les lames d'eau dépassent parfois 100 mm en quelques heures, et 12 stations ont mesuré plus de 60 mm.

ST-MARTIN-DU-M (21)	**100,9 mm**
COS (09)	**93,6 mm**
ST-GLADIE (64)	87,2 mm
CHAUMONT-SEMOUTIERS (52)	76,4 mm
LANNE-EN-BARETOUS_SAPC (64)	75,6 mm
MAXEY-SUR-VAISE (55)	72,7 mm
MOTTE-MOLINES (05)	69,8 mm
NONSARD (55)	67,9 mm
FAVERGES (38)	64,8 mm
VILLAR LOUBIERE (05)	63,4 mm
LE MAS D AZIL (09)	63,0 mm
MENDIVE_SAPC (64)	61,3 mm



www.keraunos.org

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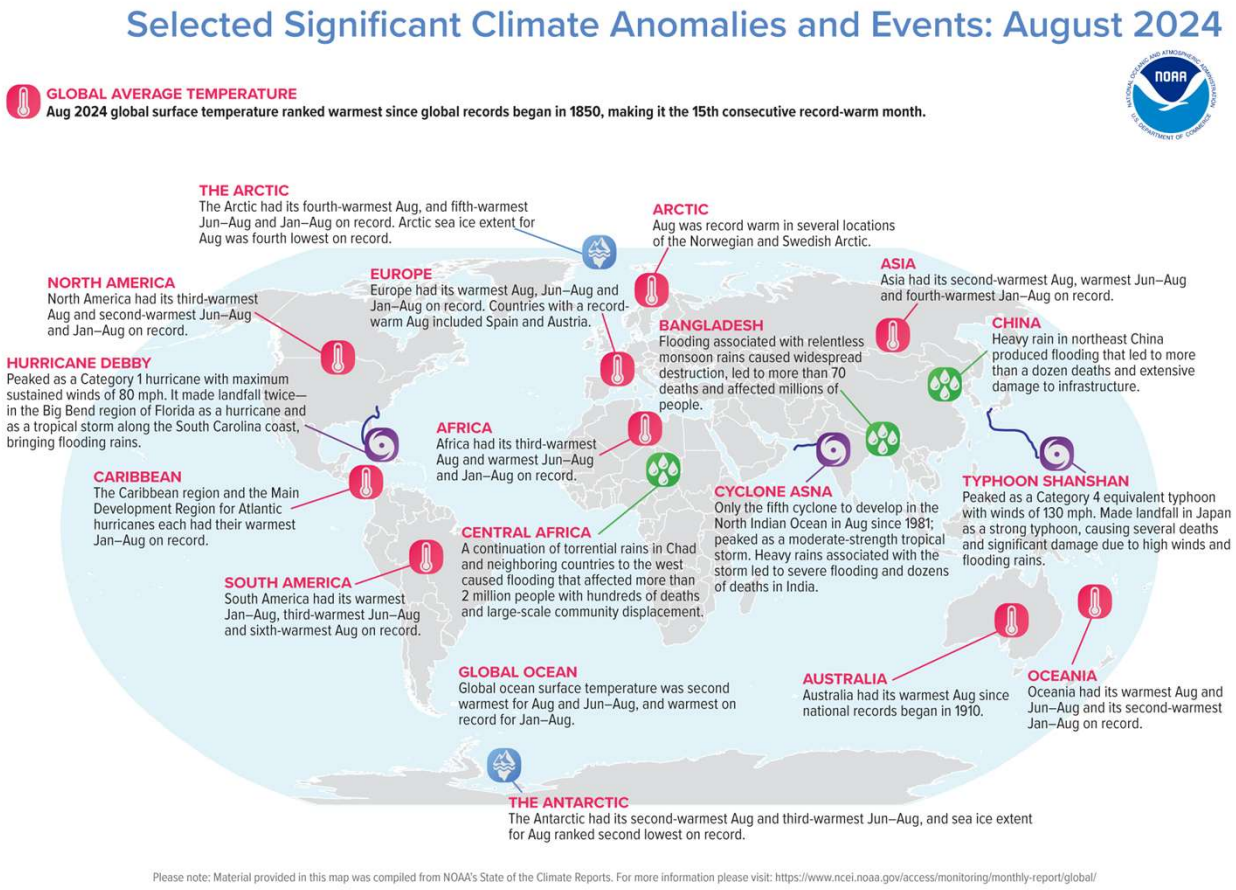
August



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202408

weather events review 2024

September

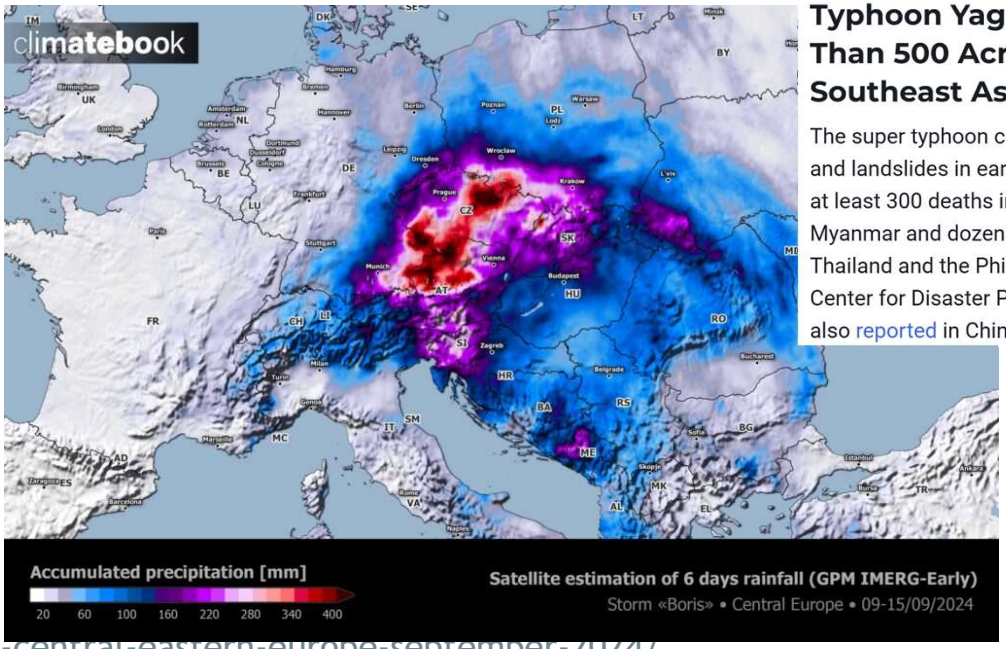
Floods in central-eastern Europe - September 2024

On 11 September, central Europe was hit by an unusual low-pressure storm called Boris. Heavy rain caused flooding in several European countries including Poland, the Czech Republic, Slovakia, and Romania.

Storm Boris then moved southwards, leading to very heavy rainfall in northern and central-eastern Italy, in particular the Emilia Romagna and the neighbouring Marche regions, also causing floods and triggering landslides.

The CEMS On-demand mapping component has received the following activations to monitor the flood extent and assess the damage:

1. EMSR766 Flood in Croatia
2. EMSR764 Flood in Lower Austria, Austria
3. EMSR763 Flood in Germany
4. EMSR762 Flood in Emilia-Romagna, Italy
5. EMSR761 Flood in Dresden, Germany
6. EMSR759 Flood on the Danube in Hungary, Austria, and Slovakia
7. EMSR758 Flood in Galati and Vaslui counties, Romania
8. EMSR757 Flood in March, Morava Basins, Slovakia
9. EMSR756 Flood in South West Poland
10. EMSR755 Flood in Brandenbourg, Germany



Flooding and Landslides Claims at Least 192 Lives in Nepal

Two days of heavy late September rain in Nepal proved to be deadly, with the resulting floods and landslides leaving at least 192 confirmed dead and more reported missing as of Sept. 30, according to Reuters. The effects were particularly devastating in the Kathmandu Valley, home to millions of residents and the country's capital of Katmandu, where officials recorded some of the highest 24-hour rainfall totals in decades. The effects of the low-pressure system also left more than 100,000 people stranded in northern areas of Bangladesh.

Typhoon Yagi Kills More Than 500 Across Several Southeast Asian Countries

The super typhoon caused severe flooding and landslides in early September. There were at least 300 deaths in Vietnam, 226 in Myanmar and dozens more across Laos, Thailand and the Philippines, according to the Center for Disaster Philanthropy. Deaths were also reported in China.

https://emergency.copernicus.eu/news/floods-in-central-eastern-europe-september-2024/
https://smoglab.pl/europa-walczy-z-powodziami-2024/
Here Are 10 of the Deadliest Natural Disasters in 2024 | Best Countries | U.S. News

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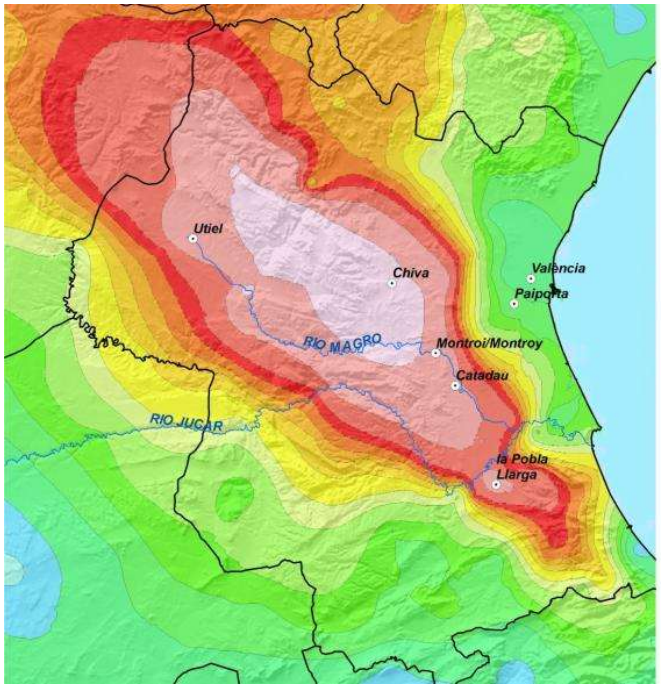
October



Tropical Storm Trami Claims More Than 100 Lives in the Philippines

The tropical cyclone, called Kristine locally, caused major flooding and landslides in the northwestern Philippines in late October, killing at least 141 people and injuring dozens more, according to the U.N. The Associated Press reported at the time that some areas got one to two months' worth of rainfall in a 24-hour span.

Heavy Flooding Kills at Least 224 in Spain

Catastrophic floods that hit eastern Spain at the end of October claimed at least 224 lives. At least 216 of the deaths occurred in the region of Valencia, and about half of Valencian dead were 70 or older, according to police data reported by The Guardian. Valencia residents have been strongly critical of local authorities and the national government over their handling of the disaster.

https://wmo.int/media/news/devastating-rainfall-hits-spain-yet-another-flood-related-disaster
https://www.usnews.com/news/best-countries/slideshows/here-are-10-of-the-deadliest-natural-disasters-in-2024?slide=2

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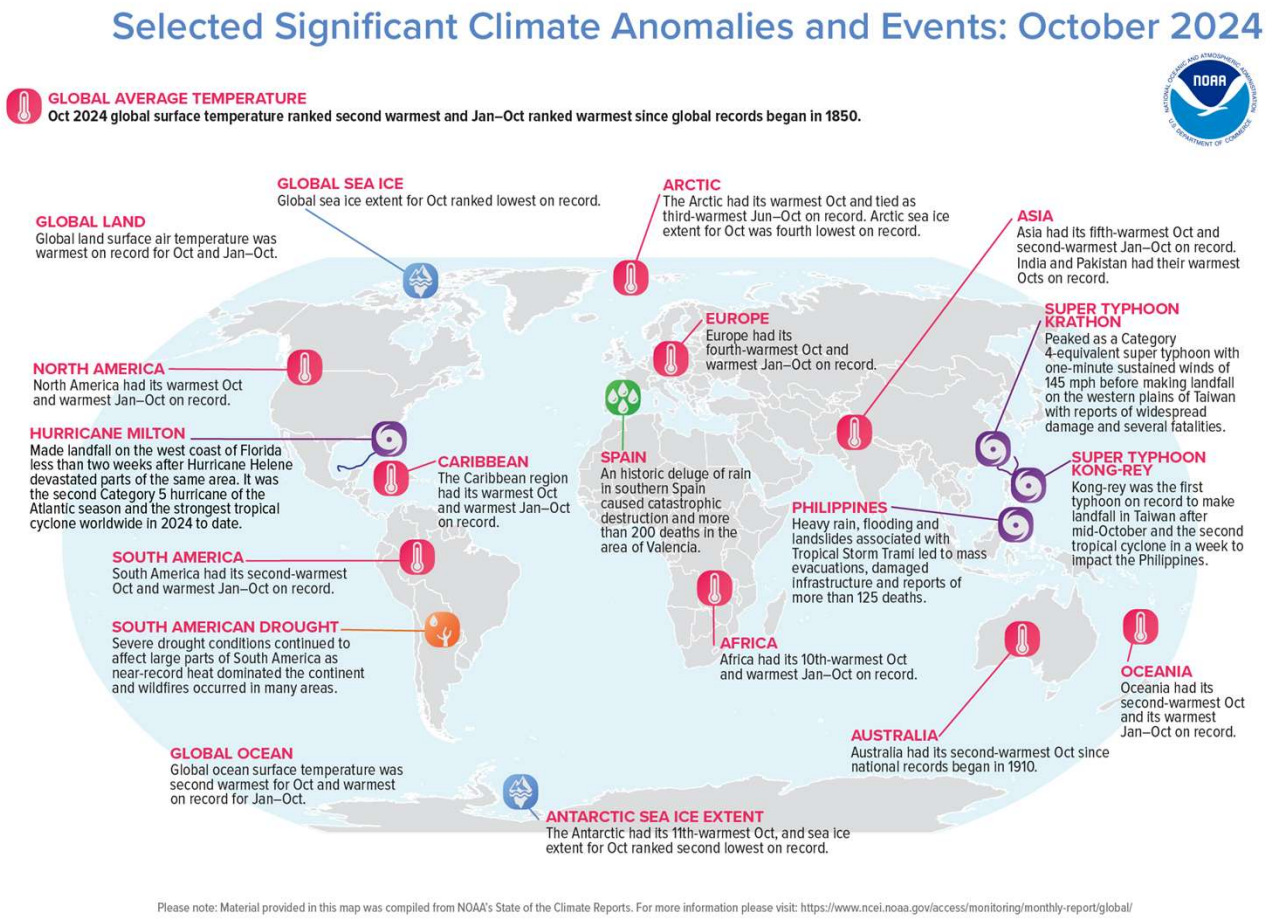
October



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202410

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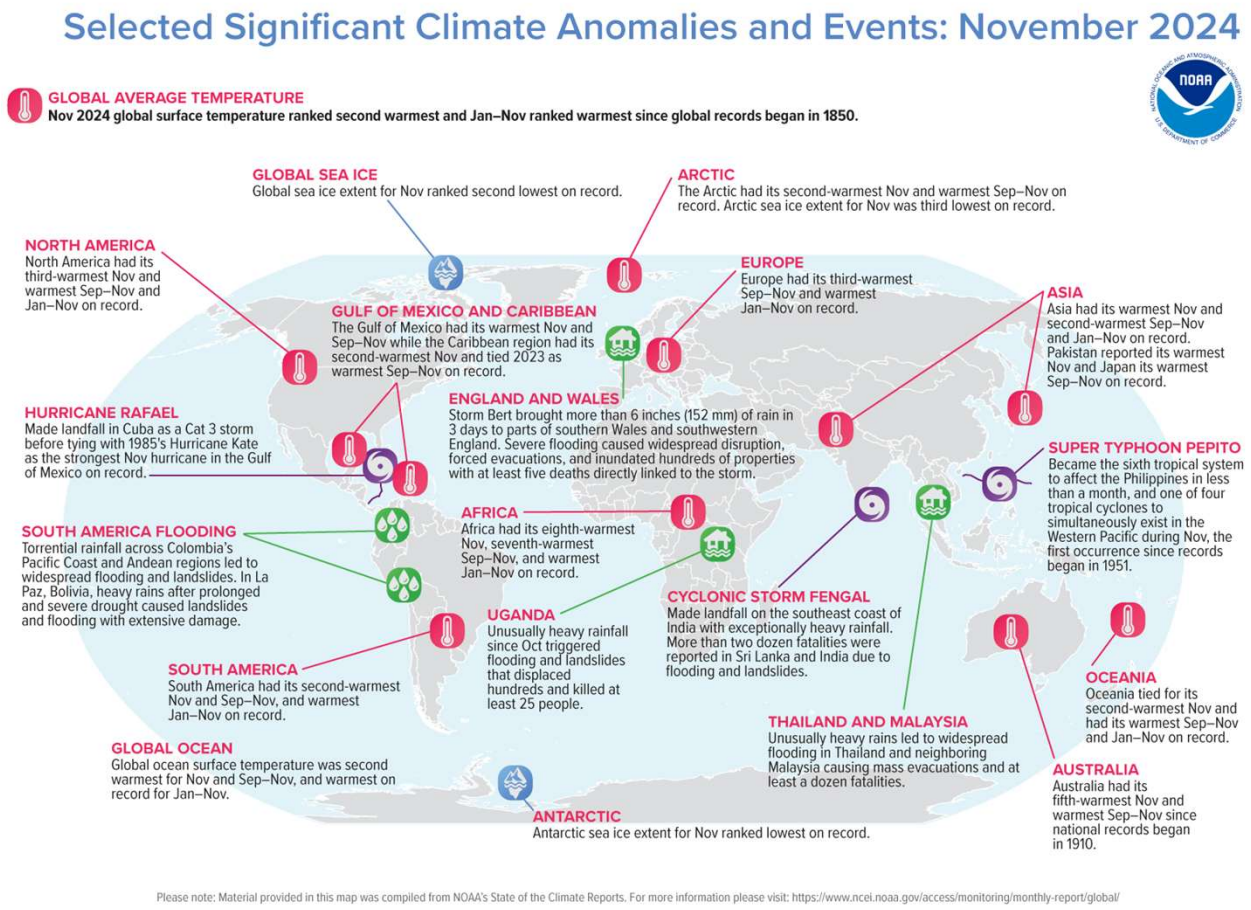
November



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202411

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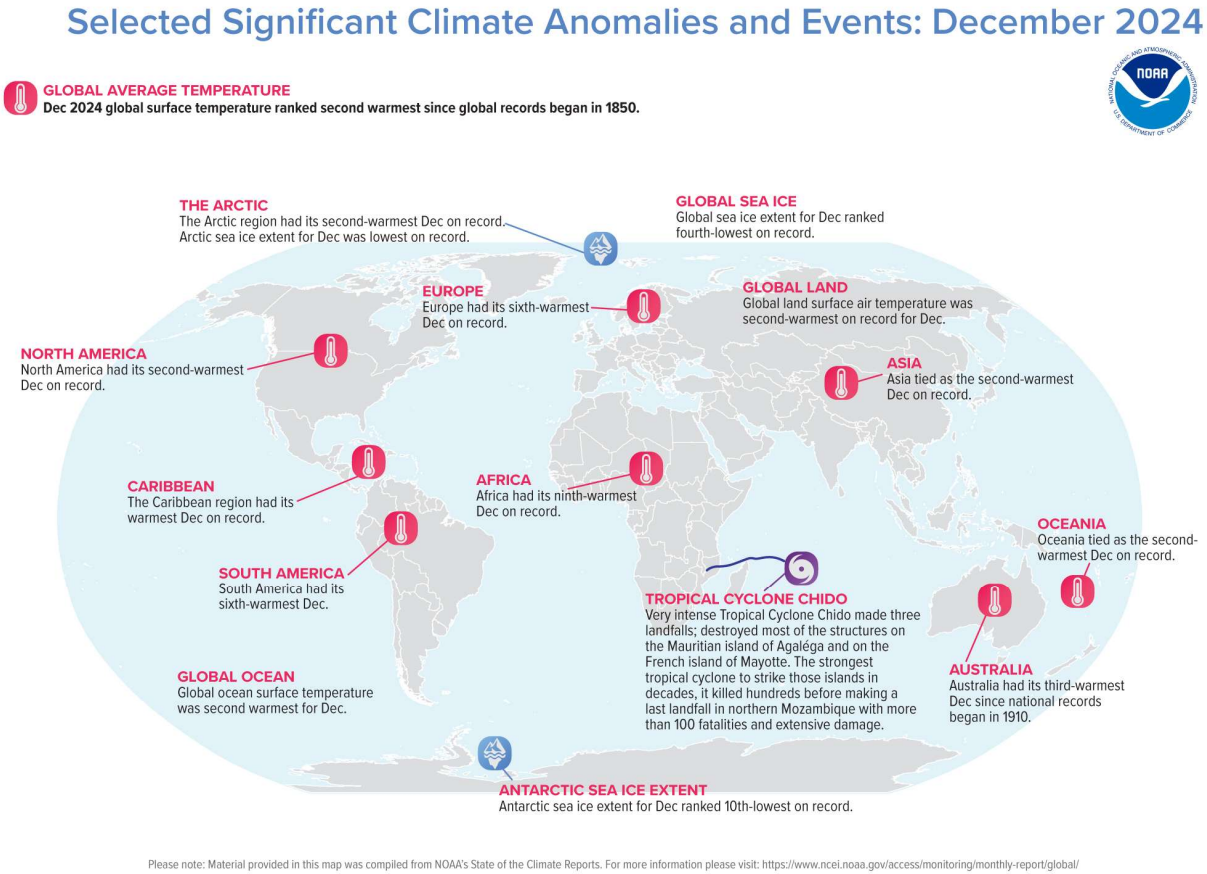
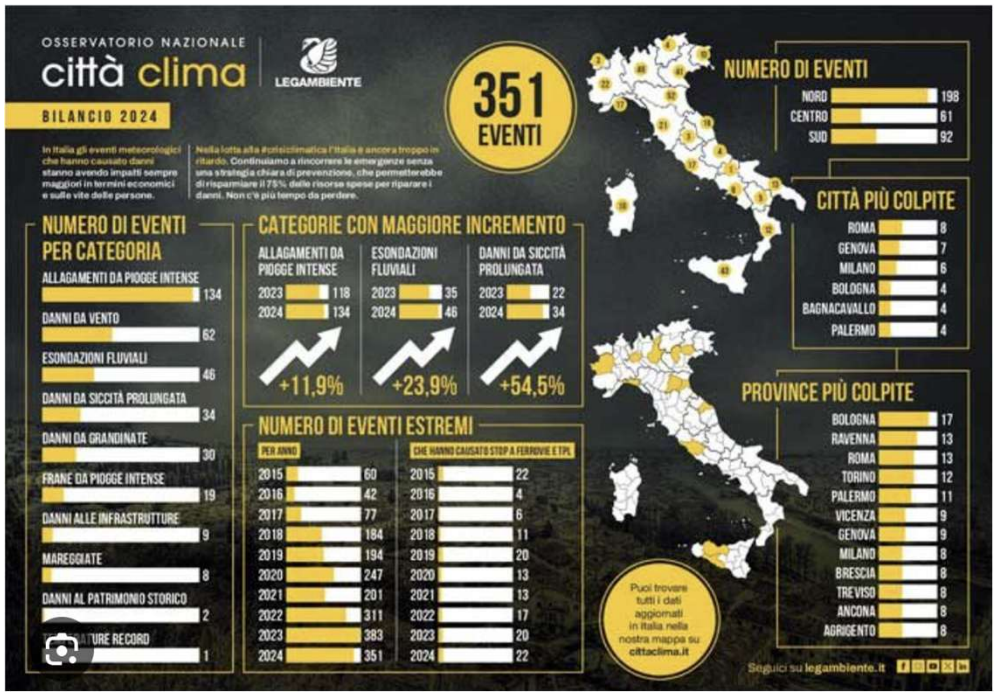
December



https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202412

weather events review 2024



www.keraunos.org

https://www.controluce.it/osservatorio-citta-clima-nel-2024-a-roma-il-record-di-eventi-meteo-estremi/

New Zealand https://blog.metservice.com/node/1192

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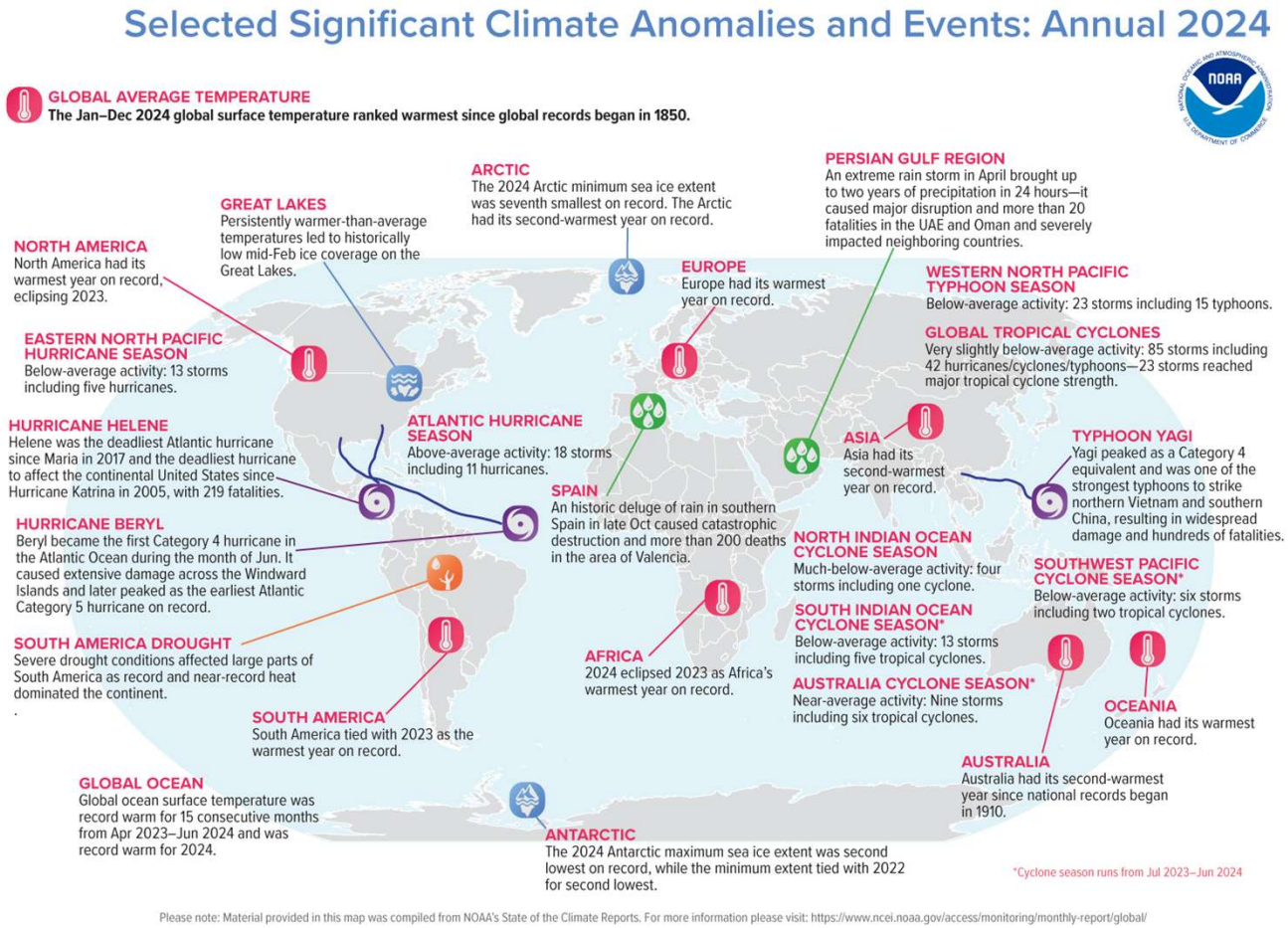
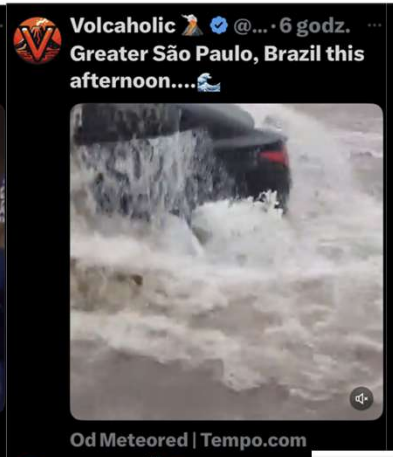
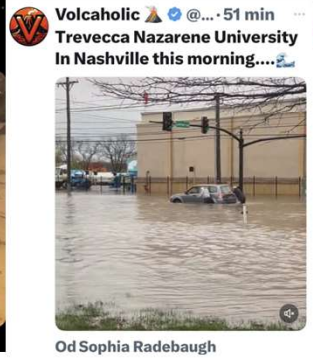


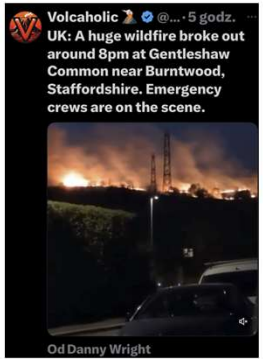
https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202413

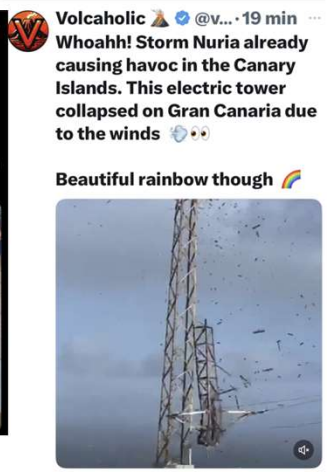
weather events review 2025

Last 2 weeks





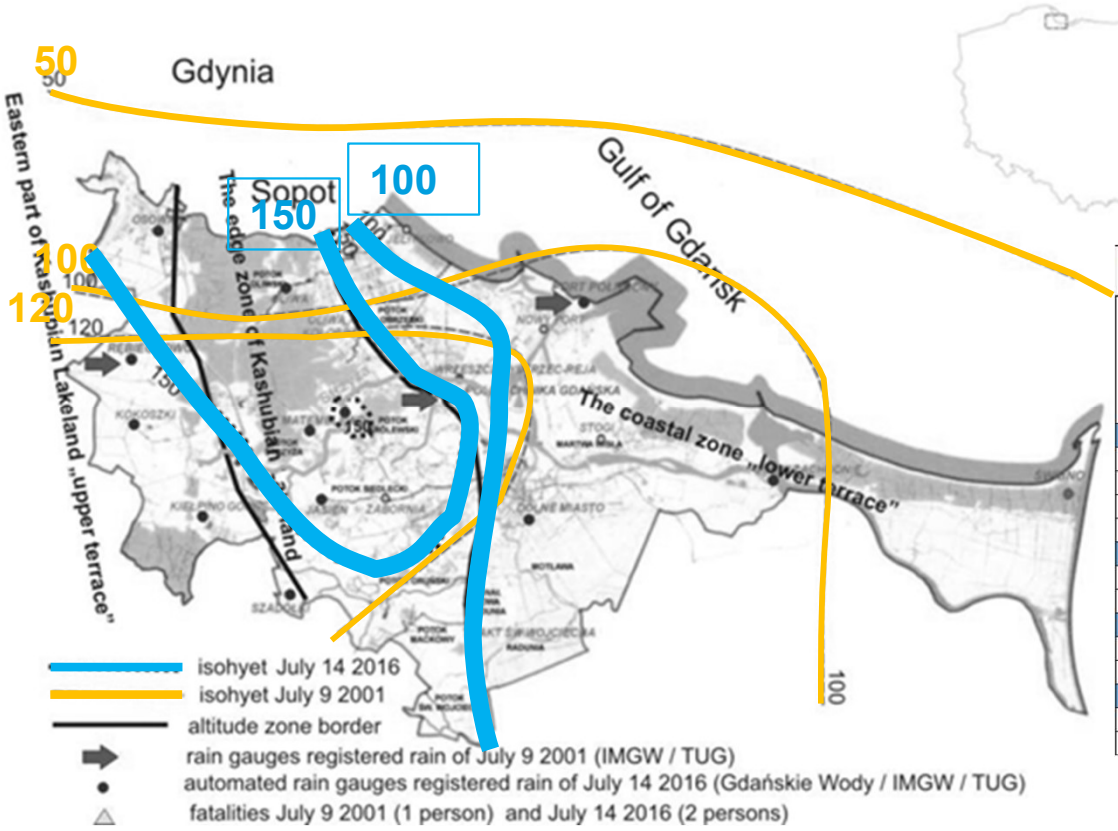


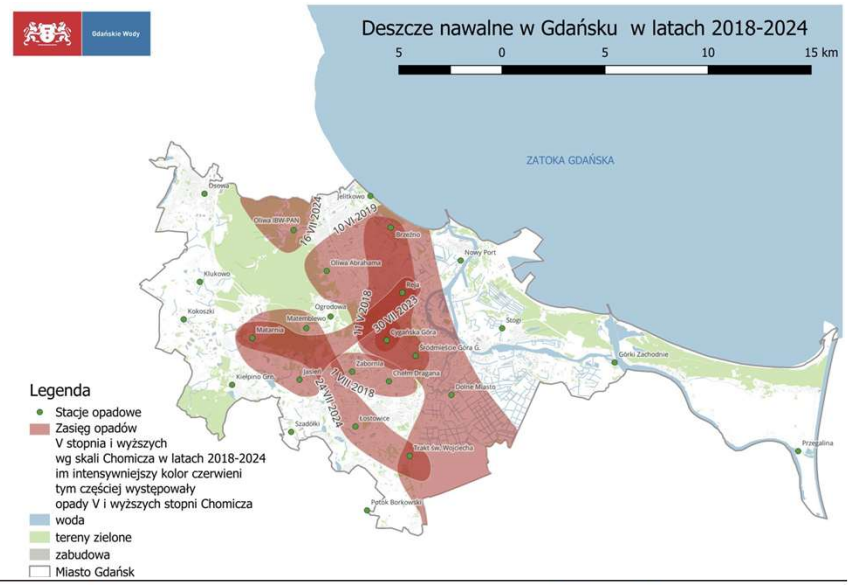


x.com

Gdansk PL weather records

Rainfall





Największe epizody opadowe od roku 2018 (26 stacji opadowych) w Gdańsku. Uwzględniono opad gdy co najmniej 2 stacje z natężeniem opadu według skali Chomicza IV

lp	data	Liczba stacji na której zarejestrowano opad o stopniu Chomicza co najmniej:			Maksymalna suma opadu w czasie w mm:				
		VI	V	IV	10 min	15 min	30 min	60 min	120 min
1	24 lipca 2024	2	4	7	25,8	33	41,3	47,8	
2	11 maja 2018	1	3	4	28,3	30,6	38,3	39,4	
3	1 sierpnia 2018	1	2	4	26,3	35,8	45,5	52,3	52,6
4	10 czerwca 2019		7	22	24,5	27	30,6	33,8	51
5	30 lipca 2023		3	8	21,4	25,3	30,9		
6	16 lipca 2024		1	11	21	24,7	29,8	36,2	
7	20 maja 2019		1	5	20	20,7	27,7		
8	15 sierpnia 2022			11	17,4	19,4	22,9		
9	18 sierpnia 2024			4	16	20,3	26,5		
10	20 lipca 2020			4	16,3	20,9	23,5		
11	16 sierpnia 2022			3	17,3	17,3			
12	28 czerwca 2024			3	13,5				
13	29 lipca 2018			2	14	18	22,6		
14	20 sierpnia 2022			2	13,5	19,3			

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