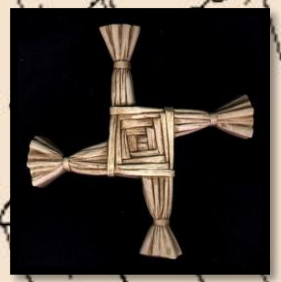
Meteorology and Myth Part II: "A Fair Candlemas"



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ABSTRACT

This paper is the second topic in my Geographic Education series “Meteorology and Myth”. The purpose of the project is to develop teaching modules which bridge the educational divide between 1) geography/meteorology and 2) history, religion and folklore. Students in the arts and humanities often struggle with physical science. Equally, students in geoscience and other STEM fields could benefit from a greater appreciation of the arts, humanities and social sciences. These lessons are delivered as special topics in general education courses, mostly for non-majors. One topic that students would commonly ask in meteorology class was if the “Groundhog Day” predictions are true. Although the groundhog and its shadow cannot predict the weather several weeks in advance, there are excellent teaching opportunities to be made by considering how the mythology developed. Although the folklore does not make short-term meteorological sense, it could be argued that there are long-term climatic circulation patterns which have allowed the legend to survive and diffuse. The lessons are developed not to “prove” whether or not Groundhog Day predictions are true – but instead to illustrate the relevant atmospheric processes in an interesting and accessible manner for introductory students. The goal is to stimulate further questions and answers, including common misunderstandings related to climate change. Furthermore, the development of the necessary skills to use synoptic weather maps, upper air charts and climate indices is also a proposed student learning outcome. A secondary pedagogical outcome is for students to develop a greater appreciation of folklore, religion and culture.

BACKGROUND AND PURPOSE:

I teach an introductory course in "Weather and Climate" ...

Whenever February 2nd rolls around, a student will often ask if the "Groundhog Day" predictions are true. I used to always answer *"NO!"* -- as a groundhog and its shadow cannot predict the weather several weeks in advance.

However, I got to thinking about it … and began to hypothesize that there may be *a teaching opportunity in this folktale*

Although the Groundhog's prediction does not make meteorological sense in the short term, perhaps there are long-term climatological associations about *prolonged-winters* and *early-springs*, which may have allowed the folklore to survive and diffuse.

This presentation is the second topic in my Geographic Education series *"Meteorology and Myth"*.

The purpose of my ongoing project is to develop teaching modules which bridge concepts in physical geography and atmospheric science with examples from history, folklore, art and culture. These teaching modules are delivered as special topic lectures in my general education courses.

Experience has taught me that even very bright students majoring in the arts or humanities will sometimes struggle with coursework in the physical sciences.

Equally, students in Geoscience and the other STEM fields sometimes need to have a greater appreciation for the arts and humanities.

The point here is not to have students “prove” if Groundhog Day predictions are true or not. Instead, this story is meant to present atmospheric concepts to a general education audience in an understandable or relatable way.

The primary goal is to stimulate interest in the meteorological concepts. A learning outcome is for students to be able to visualize upper-air atmospheric circulation and climate indices.

A second outcome is for students to develop an appreciation for folklore, art history and human-environment interaction. New questions, observations, comments and opinions are encouraged.

I hope that this presentation will inspire questions from you.

Other presentations in this Meteorology-and-Myth series:

Part I:
Thunderstorm and Wind Deities of Japan.

Part II:
A Fair Candlemas.

Part III:
Krishna's Monsoon Swing.

Part IV:
The Ephemeral Sprites.

Through the Meteorology-and-Myth series,
students will think about,
read about, and learn about
topics they have never heard of before,
and otherwise would not be part of
general education.

M & M is meant to reflect Geography's
integrative, holistic perspective.

“A Fair Candlemas” -- Geography terms and concepts to be learned:

Arctic Oscillation	Azores High	Candlemas	Climate Change
Cultural Diffusion	Cultural Landscape	Cross-Quarter days	Europe (world regions)
Groundhog Day	Humid Continental	Icelandic Low	Imbolc
Jet Streams	Little Ice Age	Marine West Coast	Medieval history
North European Plain	North Atlantic Oscillation	Peasant farming	Pennsylvania
Polar Front	Polar Vortex	Punxsutawney Phil	Rossby Waves
Singularity (climatic)	Spring Equinox	St. Brigid	Stratospheric warming
Teleconnection	upper-air charts	Westerlies	Winter Solstice

STUDENT ASSESSMENT QUESTIONS:

- ✓ What is Candlemas? Explain its cultural meaning.
- ✓ Reason why "Groundhog Day" predictions cannot be true meteorologically but could be based on long-term agrarian climatological observations.
- ✓ Explain and defend the apparent paradox that global warming contributes to record-setting cold temperatures.

http://www.getty.edu/art/collection/objects/1597/simon-bening-villagers-on-their-way-to-church-flemish-about-1550/

February 2nd – "Groundhog Day" in America –
was known in Medieval Europe
as **Candlemas Day**.

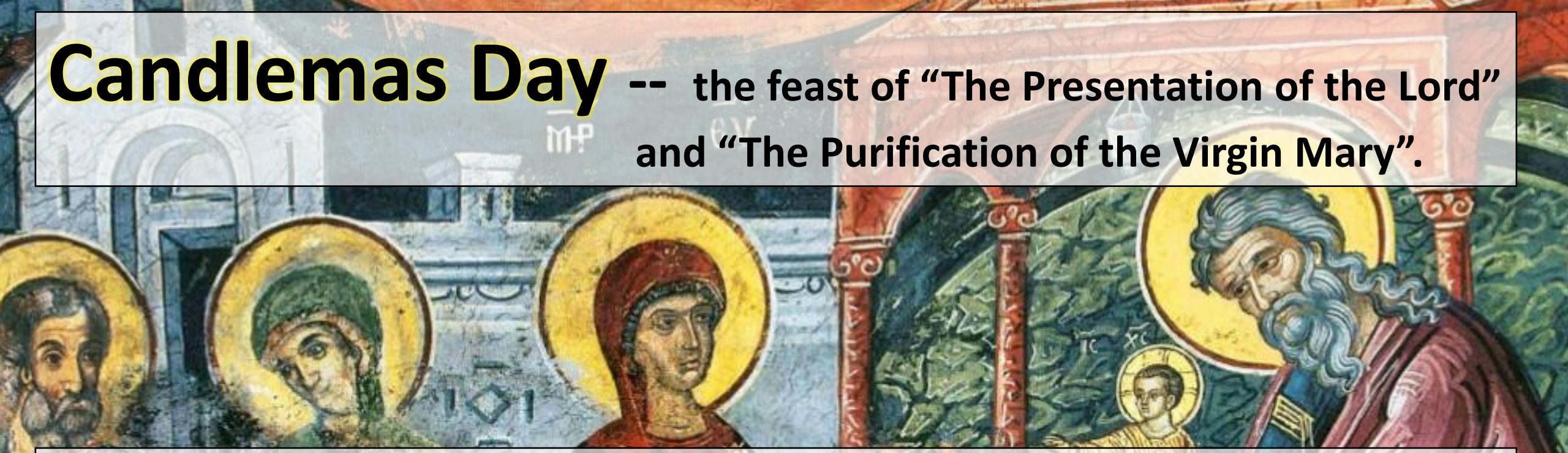
An old European folk proverb stated:

If Candlemas Day be fair and bright,
Winter will have another flight;
But if Candlemas Day brings clouds and rain –
Winter is gone and won't come again.

https://forallsaints.files.wordpress.com/2011/02/presentation-of-christ-luttrell-psalter.jpg

Source: "The Old Farmer's Almanac Book of Weather Lore." Ballantine Books, 1988.

Candlemas Day -- the feast of “The Presentation of the Lord” and “The Purification of the Virgin Mary”.



Forty days after His birth (December 25 to February 2), Mary and Joseph brought Jesus to the temple for the rites of purification and dedication.

According to the *Book of Leviticus (12:1-4)*, when a woman bore a male child, she was considered “unclean” for seven days. On the eighth day, the boy was circumcised. The mother continued to stay at home for 33 days for her blood to be purified. After the 40 days, the mother and the father came to the temple for sacrificial purification.

https://www.crossroadsinitiative.com/media/articles/the-presentation-of-the-lord/

Candlemas:

- Candles are blessed and lighted as an expression of faith.
- Jesus is a light upon the world.
- Pre-Christian cultures observed the lengthening of daylight as spring approaches.
- Lighting candles on February 1st-2nd is also a religious rite for …

http://celticanamcara.blogspot.com/2010/02/candlemas-imbolic-st-brigids-day.html

Imbolc

- Based on Celtic pagan tradition (pre-Christian).
- Celebrated by Wiccans and other neo-pagan religions, the holiday heralds the change of seasons.
- Honors the goddess **Brigid**, and is associated with fertility rites.
- Interpreted as *"in the belly"* and "Ewes milk".
- Candles are also lit in honor of Brigid.

How could this event possibly be recognizing the arrival of *Spring*?

http://celticanamcara.blogspot.com/2010/02/candlemas-imbolic-st-brigids-day.html

*The Irish **Saint Brigid** was likely based upon the pagan Celtic goddess.*

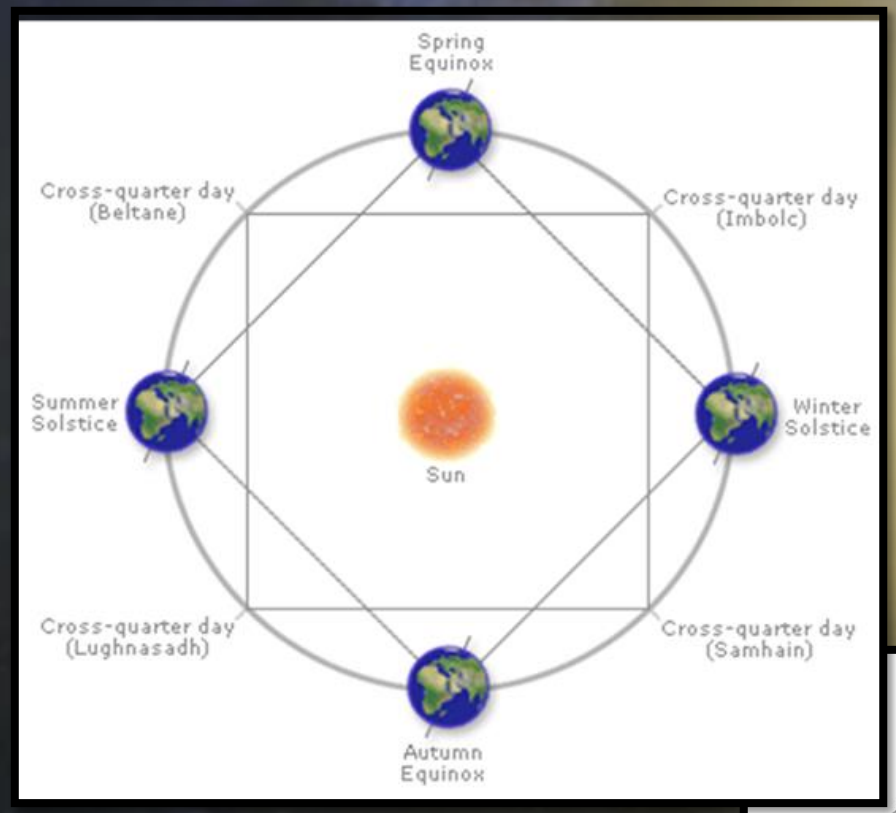
https://stairnaheireann.net/2019/02/01/the-feast-day-of-st-brigid-or-imbolc-the-traditional-first-day-of-spring-in-ireland/

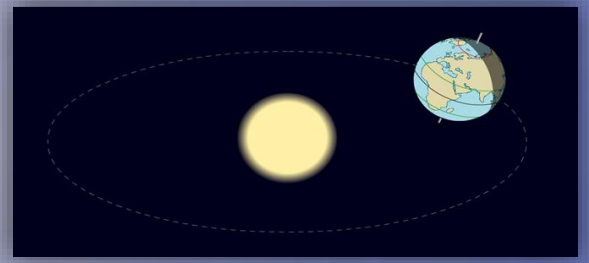
By Culnacreann - Own work, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=3500722

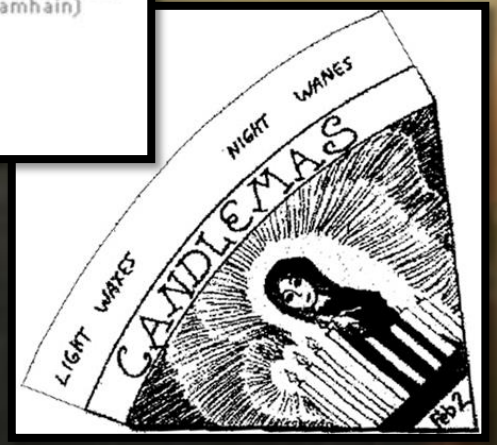
The Catholic
Feast of St. Brigid

https://i2.wp.com/gathervictoria.com/wp-content/uploads/2018/01/b1c412d8527fd823b187bace6e9cba5c-religious-icons-religious-art.jpg?w=736&ssl=1

Astronomically, February 1st - 2nd falls on one of the "Cross Quarter Days" of the solar year; midway between the Winter Solstice (December 21st - 22nd), and the Vernal Equinox (March 22nd - 23rd).

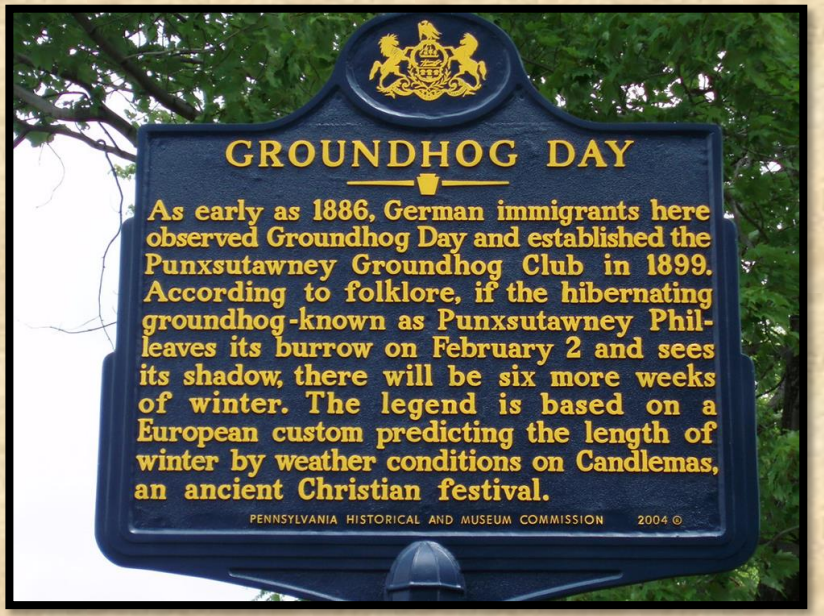






http://deep-high.blogspot.com/2011/01/last-supper-upper-room-alchemical-code.html

https://kittermanwoods.com/wp-content/uploads/2017/02/ThinkstockPhotos-624460244.jpg



https://www.onlyinyourstate.com/pennsylvania/pa-groundhog-day/

Meteorologically speaking:

NO

The presence or absence of sunshine on any one particular day can not be used to determine either a shortened or a prolonged winter.

-- The odds would be a 50-50 coin flip.

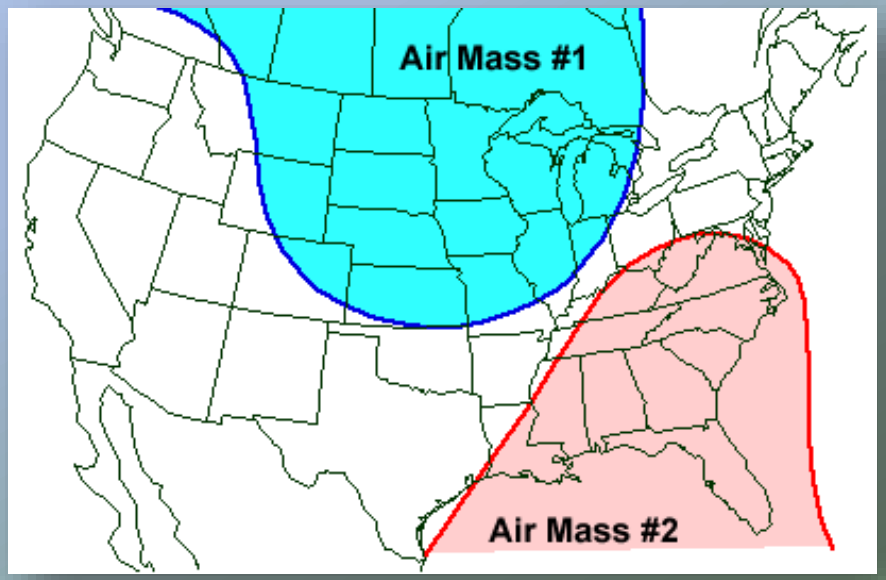
Could the tale refer to "AIR MASS WEATHER?

A sunny winter day in northeastern North America often indicates a high-pressure system with a cold continental polar air mass.

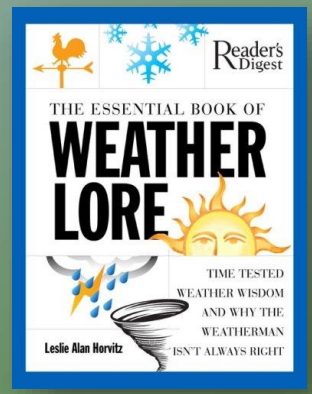
Cold but clear "air mass weather" may persist for a few days -- *though not for six weeks!*

Conversely, a cloudy winter day may indicate an approaching warm front and the influx of warmer, moister maritime tropical air mass from the Gulf of Mexico.

This brief warm up would also not last more than a few days – and does not indicate an early arrival of spring.



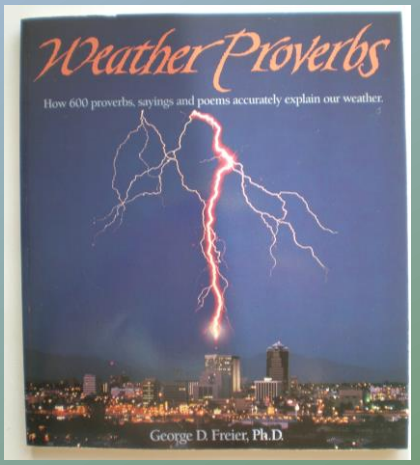
http://ww2010.atmos.uiuc.edu/(Gh)/guides/crclm/act/arms.rxml



Leslie Alan Horvitz. "The Essential Book of Weather Lore." 2007.

The juxtaposition of High and Lows: is offered as an explanation in this quotation from George D. Freier, in his book *Weather Proverbs*. Pages 74-75. Fisher Books, 1992.

"Candlemas Day, known by many as *Groundhog Day*, is about one week after the coldest day of the winter. Maybe there is a hunt of truth in this long-range forecast. High- and low-pressure systems are moving through the region as always.

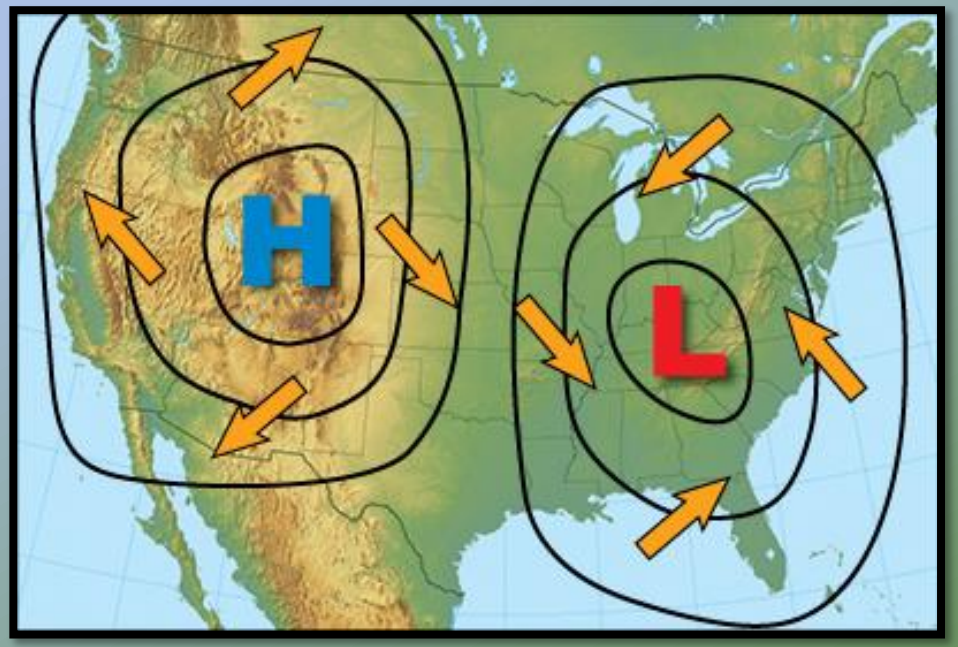


If Candlemas day is clear, we are experiencing a High-pressure system that may last for a week before a Low-pressure system moves in ...

This is followed by yet another High that also may be quite cold. By the time this is over, the days are getting much longer, the Sun is higher in the sky and there is a general warming ...
… But we may have experienced three more weeks of winter.

On the other hand, if it is cloudy on Candlemas Day, we are experiencing a Low to be followed by a high and another Low.

The temperature is usually considerably higher during Low pressure so that even though there is a High sandwiched in between two Lows, we tend to think of winter as having its *back broken*."



https://www.weather.gov/jetstream/wind

… but this is also an unlikely explanation...

The predictions are nonsense.

“Punxsutawney Phil” has a well-documented, but highly inaccurate track record.

Independent studies have put his ability of accurately predicting a early spring/prolonged winter at less than 40% .

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Formerly the National Climatic Data Center (NCDC)... more about NCEI »

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Groundhog Day

Every February 2, thousands gather at Gobbler's Knob in Punxsutawney, Pennsylvania, to await the spring forecast from a special groundhog. Known as Punxsutawney Phil, this groundhog will emerge from his simulated tree trunk home and look for his shadow, which will help him make his much-anticipated forecast. According to legend, if Phil sees his shadow the United States is in store for six more weeks of winter weather. But, if Phil doesn't see his shadow, the country should expect warmer temperatures and the arrival of an early spring.

History of Groundhog Day

Groundhog Day originates from an ancient celebration of the midway point between the winter solstice and the spring equinox—the day right in the middle of astronomical winter. According to superstition, sunny skies that day signify a stormy and cold second half of winter while cloudy skies indicate the arrival of warm weather.

The trail of Phil's history leads back to Clymer H. Freas, city editor of the *Punxsutawney Spirit* newspaper. Inspired by a group of local groundhog hunters—whom he would dub the Punxsutawney Groundhog Club—Freas declared Phil as America's official forecasting groundhog in 1887. As he continued to embellish the groundhog's story year after year, other newspapers picked it up, and soon everyone looked to Punxsutawney Phil for the prediction of when spring would return to the country.

https://www.ncdc.noaa.gov/customer-support/education-resources/groundhog-day

https://www.livescience.com/32974-punxsutawney-phil-weather-prediction-accuracy.html

https://www.ncdc.noaa.gov/news/groundhog-day-forecasts-and-climate-history

nett-
02/02/USATODAY/USATODAY/636531623516286241-020218-Groundhog-

Several analyses have been conducted by both academic researchers and the media.

Celebrating Groundhog Day is just a "folksy" tradition …

… but it is one way to have a little ***meteorological fun*** *in the dead of winter!*

It may have some use in stimulating people (including college students) to discuss weather and climate.

The folklore is not real meteorology …

How about *Climatologically* speaking?

Might there be some long-term correlation at particular locations?

Probably not …

In the northeast USA,
the three coldest months of the year are
December, January, and February.

-- Winter is not over by February 2!

https://www.onlyinyourstate.com/pennsylvania/snowy-winter-2018-pa/


How about only considering the centuries-long climatic history of agrarian northwestern Europe -- where the legend began?
... MAYBE.
https://diegofdezsevilla.wordpress.com/2018/10/18/arctic-dynamics-as-part-of-a-global-pattern-in-atmospheric-circulation-research-follow-up-october-2018-by-diego-fdez-sevilla-phd/

HYPOTHESIS:

Some winters are punctuated
by a series of below-normal cold spells, which
occur after several unseasonably warm days.

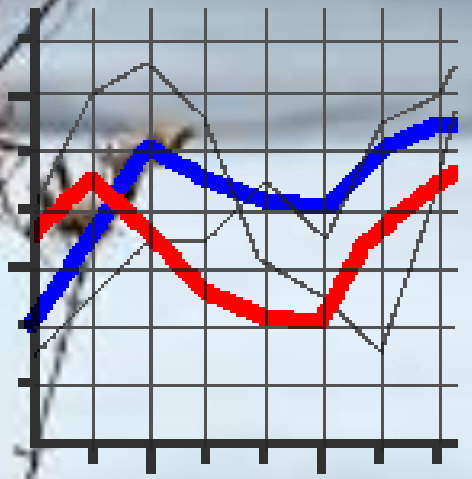
The appearance of unusual warm and sunny conditions – "fair weather" – in early February characterizes a wavy upper-air circulation pattern, preceding the later cold air outbreaks which extend the severity of winter.

https://www.youtube.com/watch?v=BkvJd_3thg4

Is there a possibility that a sunny Candlemas could be a climatic singularity* – similar to North America's "January Thaw" or "Indian Summer"?

***Singularities are observed statistical anomalies. They are weather phenomena that have recurred often enough -- at or near specific calendar dates -- to have become expected in certain climates.**

Once thought to be statistical outliers due to small sample sizes, singularities continue to merit further analysis – but they are not fully recognized as real climate phenomena.

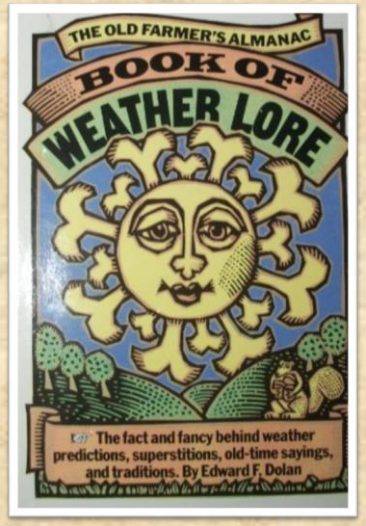


http://www.sahyadrica.com/2010/02/medway-creek.html

https://weather.com/science/weather-explainers/news/is-january-thaw-real-or-a-coincidence/

https://journals.ametsoc.org/doi/pdf/10.1175/1520-0477%282002%29083%3C0053%3AITJTAS%3E2.3.CO%3B2

"A Welshman had rather see his dam [wife] On the bier, Than see a fair Februeer"



From Edward F. Dolan's
The Old Farmer's Almanac Book of Weather Lore.
Ballantine Books, 1988.

http://exploringeastlondon.co.uk/jc/death/death.htm

"If Candlemas Da
Go saddle you
If Candlemas Da

"Just so far as the Sun shines in on Candlemas Day,

ow in

"A February spring

Is worth nothing."

"The Old Farmer's Almanac Book of Weather Lore."
Ballantine Books, 1988.

What was seen on Candlemas day was not folksy nonsense to European farmers centuries ago!

Weather was watched closely, and if there was anything a farmer did not want to see -- it was strong, shadow-inducing sunshine in early February.*

Farmers would have preferred a seasonally cold early winter, followed by a warm-up that would advance gradually, producing a slow and steady thaw.

February -- in the midst of winter, was the most critical month.

*** "The Old Farmer's Almanac Book of Weather Lore." Ballantine Books, 1988.**

https://liveasfreepeople.com/2018/05/18/glossary-of-medieval-terms-k-to-z/

Farmers had looked on February as a critical month centuries before the Candlemas tradition designated February 2 as the key day.

The February 2nd custom is a <u>Christian innovation</u> -- as the day celebrates the purification of the Virgin Mary.

https://www.pinterest.com/carlacanonica/medieval-art-calendars-i/

A sunny Candlemas Day became one of the most feared weather omens.

Could there be climatological reasons for this belief?

Unwanted -- within some time period in February -- was the sudden appearance of unseasonably warm spells.

These events caused a premature thawing that would very likely be followed by cold snaps, which would refreeze, damage and kill the developing winter crops.

http://www.survivorlibrary.com/library/weather_lore-a_collection_of_proverbs_sayings_and_rules_concerning_the_weather_1898.pdf

WARM-UPS AND REFREEZES DAMAGE FIELD CROPS THAT WINTER OVER:

Seedlings hardened by continuous low night and day temperatures are more resistant than seedlings hardened by alternating high and low day and night temperatures.

Environmental conditions before or immediately after a low temperature greatly influence the extent of freezing injury.

If the temperature drop is gradual, plants are in better condition to resist injury and can stand surprisingly low temperatures.

Similarly, slowly rising temperatures after a frost and satisfactory soil moisture conditions are desirable to aid recovery.

Wind and high evaporation are likely to aggravate the frost injury and lessen the chances of recovery.

https://www.sciencedirect.com/science/article/pii/S0378429017310572

https://gardensbefore1800.blogspot.com/2017/12/henryviii-uses-piero-decrescenzis-c.html

Freeze tolerance of field crops also can be influenced by the hardening off process

If it is cool or cold for several days such as 1*o* to 2*o* C at night, and the seedlings become somewhat accustomed to the lower temps, then perhaps a little better tolerance to lower temperatures is gained.

Its going from warm temperatures to sub-freezing temperatures in a short period that is the most injurious.

Wet soils and some dew also help in reduction of freeze injury

Cold and dry conditions add more to seedling injury.

https://gardensbefore1800.blogspot.com/2017/12/henryviii-uses-piero-decrescenzis-c.html

https://www.ag.ndsu.edu/winterstorm/winter-storm-information-farm-and-ranch-information1/farm-and-ranch-crops-general/spring-frost-damages-to-field-crops

Although “Groundhog Day” is an **American** folk event …

… any climatological “rule” about February 2nd –
or any generalization made about that day’s weather
teleconnection pattern with regards to winter severity –

– should be derived from an analysis of climatic patterns over northwest and central Europe.

The northwest European winter is mostly over by
Candlemas, while in North America –
many of the coldest days are yet to come.

Eric Sloane. “Folklore of American Weather”. Hawthorne Books, 1963.

*Originally, a German **badger** was the harbinger of extended winter conditions.*

Pennsylvania Germans and other settlers merely adopted the groundhog due to there being more groundhogs (woodchucks) than badgers.

Variations of the legend also include hibernating German bears and English hedgehogs.

*The badger/groundhog folk myth **diffused** from Europe to America.*

*"Groundhog Day" is an example of the cultural geography concept of **stimulus diffusion**.*

Although there is some similarity in cultural landscapes – living pattern, architecture, agriculture, and land use between the American northeast and northern Europe –

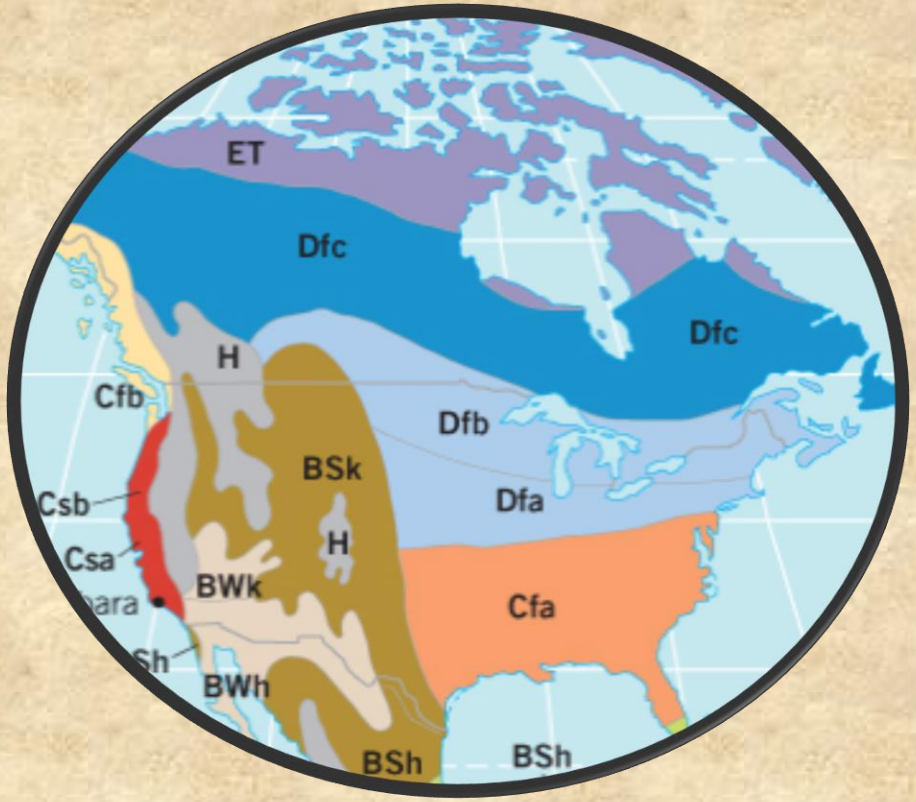
the two regions have markedly different climates …

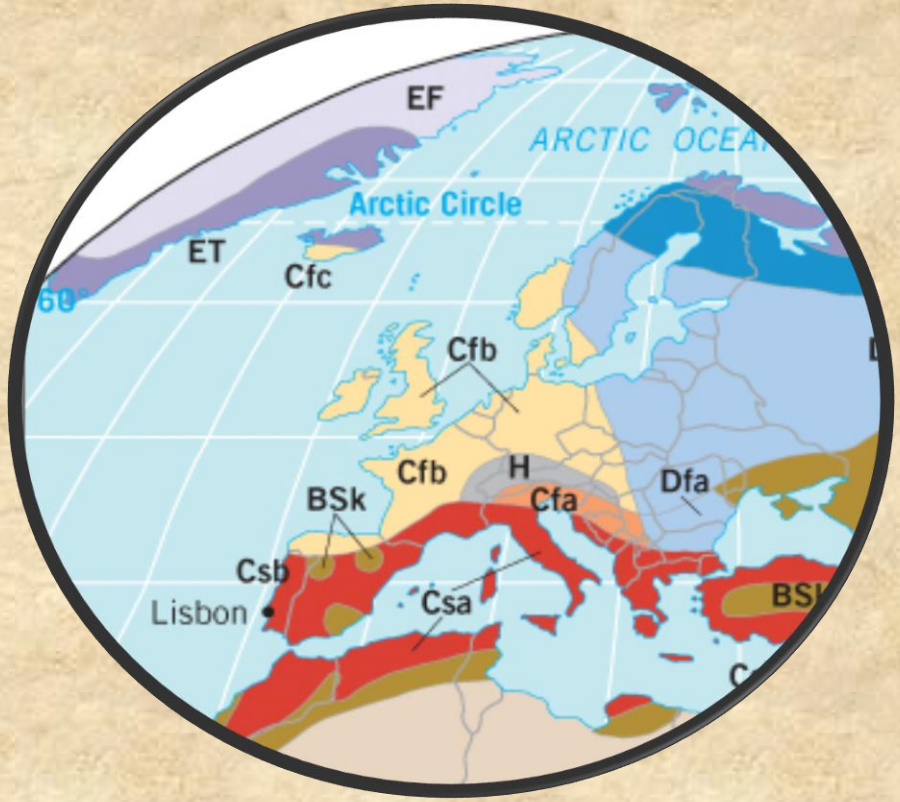
← Farms and fields along Interstate 80 West, Montour County, eastern Pennsylvania.

Rural northern Germany: A view from Desenberg to the Warburger Börde. →

… and their winters are controlled by different climatic influences (latitude, land-water contrast, pressure systems, ocean currents, etc.)

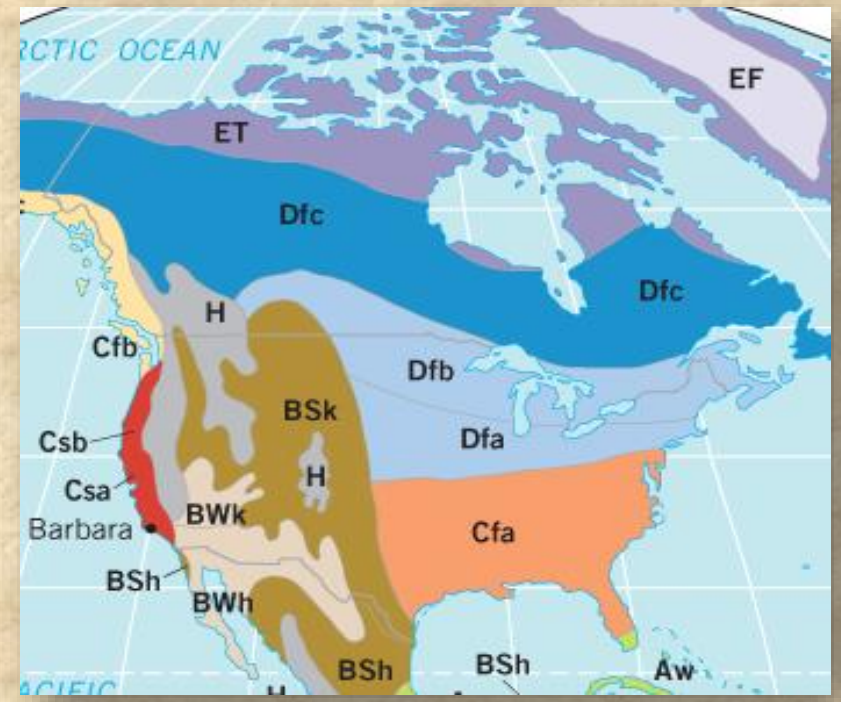
The climate of northeastern North America is a *Humid Continental* climate (Köppen-type Dfa). Long, harsh winters are to be expected.



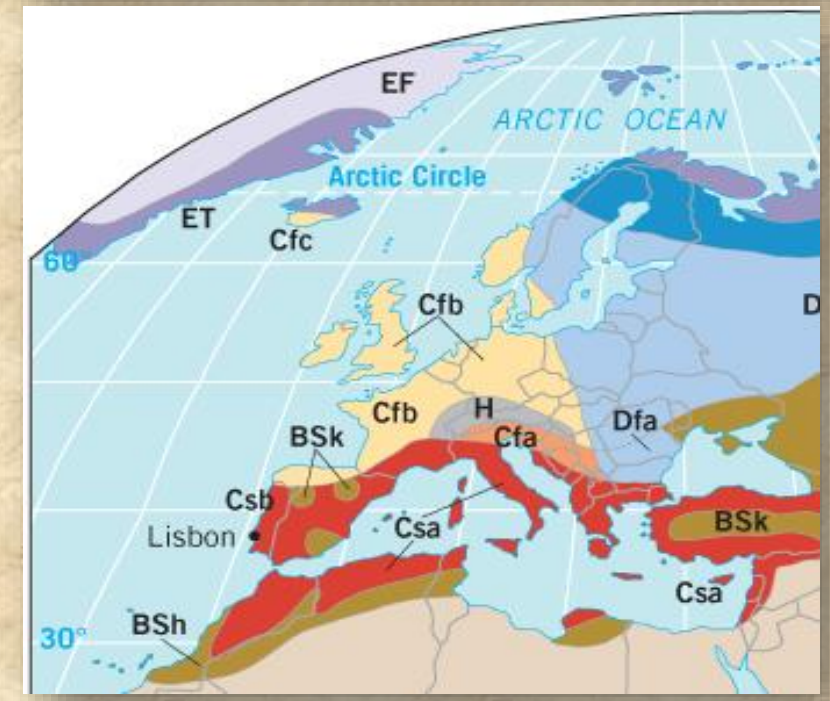


The climate of northern Europe is a *Marine West Coast* climate (Köppen-type Cfb), which has a typically milder winter.

Adapted from Lutgens and Tarbuck "The Atmosphere", Pearson Publishing 2019.



Eastern North America, located in the middle latitude zone of the westerlies -- receives most of its winter weather from the west -- *the cold, dry continental interior.*



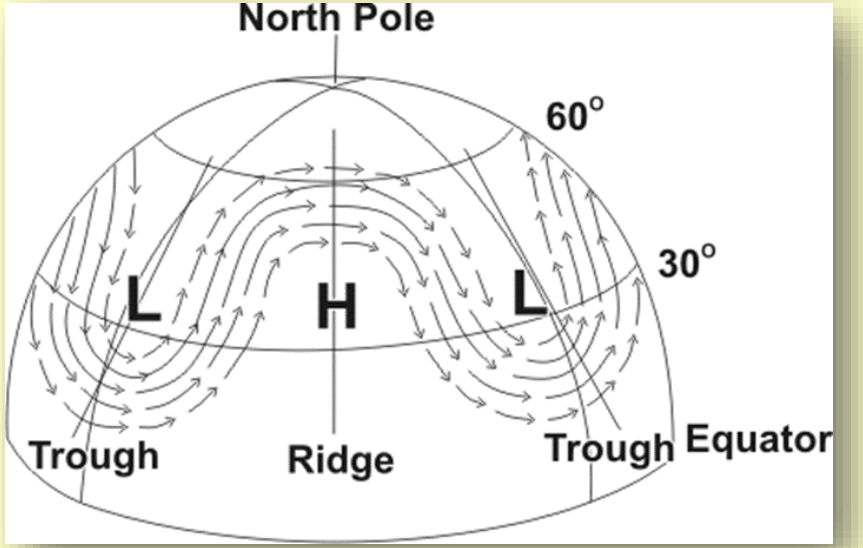
Northwest Europe also receives its weather from the west during winter.
The *maritime air from the Atlantic* and Gulf Stream is relatively mild for its latitude.

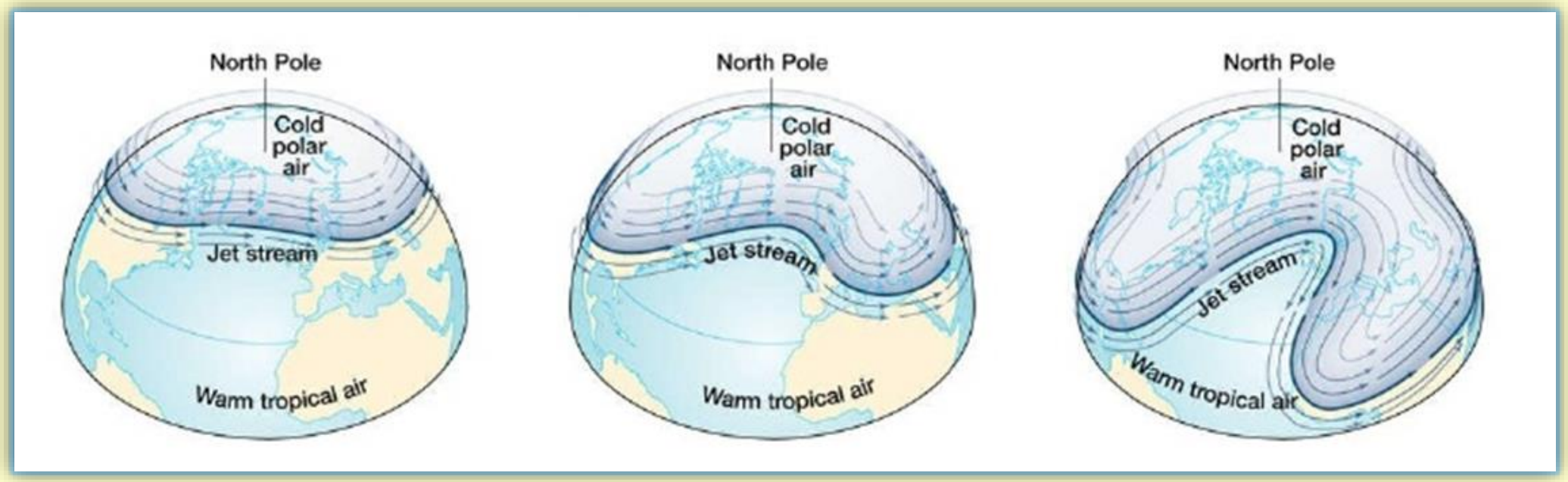
Adapted from Lutgens and Tarbuck "The Atmosphere", Pearson Publishing 2019.

An understanding of how pressure systems affect atmospheric conditions at any time or place is critical.

Part of the story involves understanding the importance of ***upper-air flow****, and how it influences weather and climate.*

- *UPPER AIR RIDGES AND TROUGHS*
- *ROSSBY WAVES*
- *JET STREAMS*
- *ZONAL vs MERIDIONAL FLOW*
- *SUDDEN STRATOSPHERIC WARMING*
- *POLAR VORTEX*





Rossby Waves are undulations in the upper-air westerlies extending from the middle to upper troposphere.

- They form along the **polar front**.
- The **polar jet stream** follows the Rossby waves.
- These are a major mechanism of poleward heat transport, and greatly influence weather patterns in the middle and high latitudes.

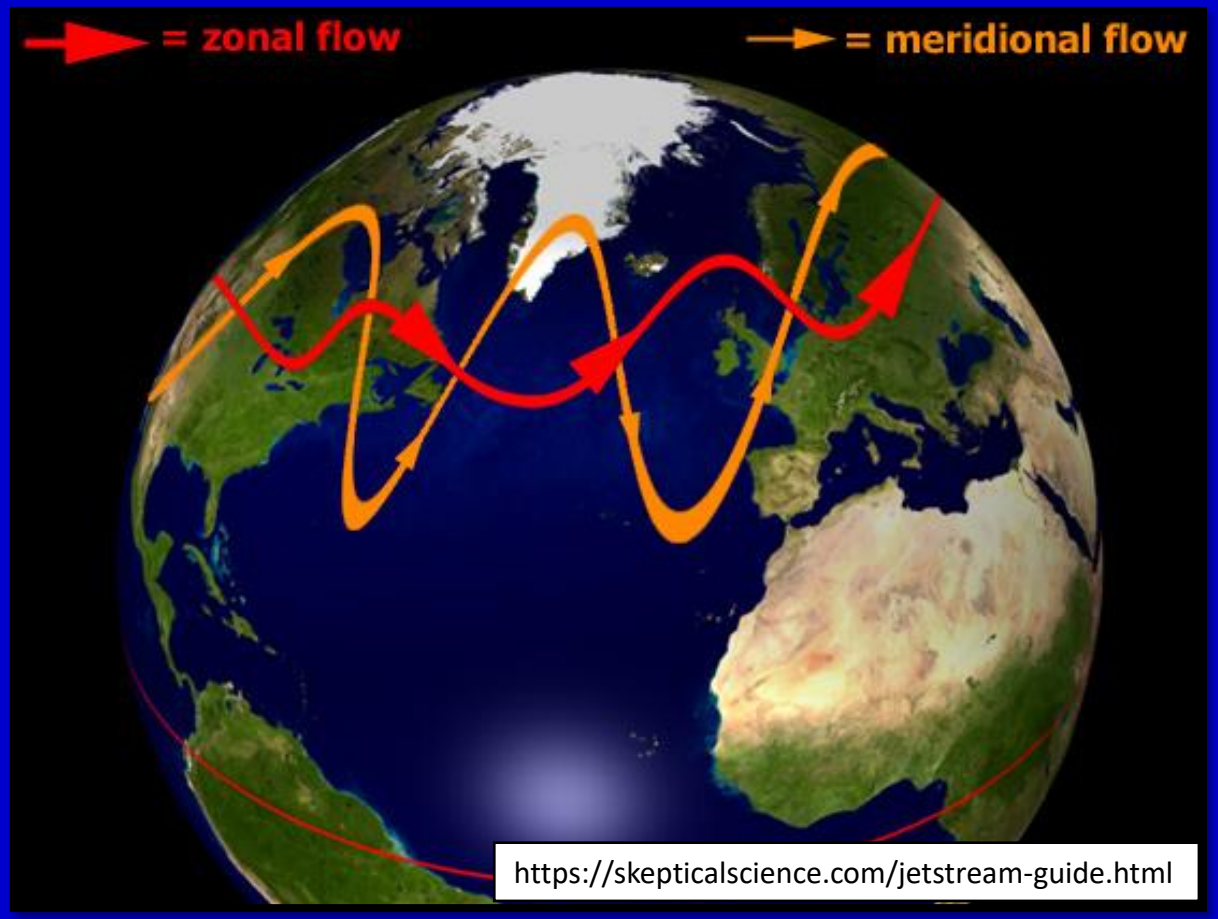
There is a very good introduction to the characteristics and importance of Rossby Waves available from the Postsdam Institute on the YouTube video linked below:

https://www.youtube.com/watch?time_continue=23&v=MzW5Isbv2A0

https://www.pik-potsdam.de/

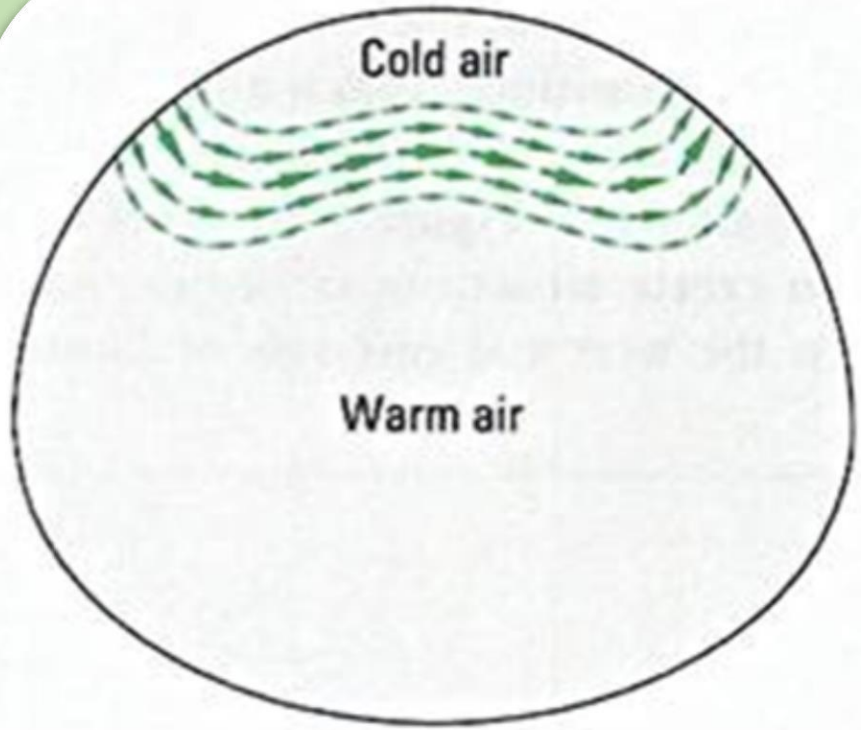
A seasonably cold winter followed by a slow, gradual warm up toward spring is more likely when the upper air flow is dominantly ***zonal***.

A winter characterized by highly variable day-to-day weather, and punctuated by unseasonable extremes, is produced when the upper air flow is dominantly ***meridional***.



"Zonal" means from West-to-East.

"Meridional" means up and down the meridians -- either North-to-South or South-to-North.



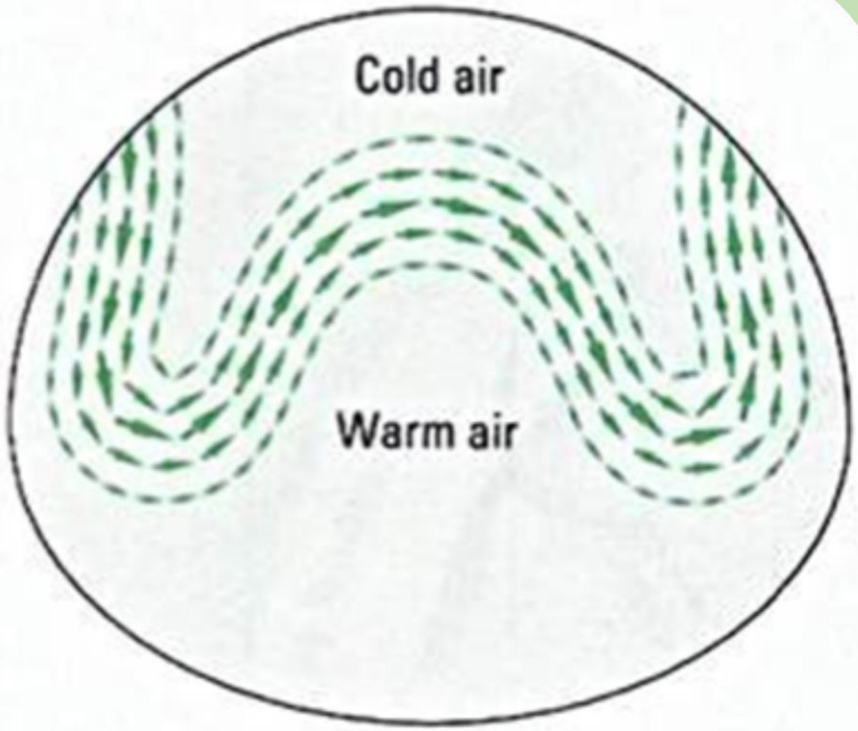
Zonal Waves

In any given winter, if Europe is largely influenced by **ZONAL** west-to-east flow, the odds are that winter weather will be seasonally cold, with steady, moisture-laden winds from the west.

Typically cool and overcast conditions by February 2nd would mean that the Badger (Hedgehog, Groundhog, etc.) would *NOT* see its shadow.

It would be seasonally cold by latitude, then **a steady, gradual warmup toward spring** would ensue.

https://wattsupwiththat.com/2014/10/29/magnetism-and-weather-interconnections-2/



Meridional Waves

If the upper-air flow over Europe is **MERIDIONAL**, then unseasonably warm weather will sometimes flow from the south into Europe, causing early thaws.

Then as the Rossby waves progress east, unseasonably cold, dry conditions will flow down from the Arctic, causing freeze damage to European farms.

Odds are -- that February 2nd would have **warm-and-sunny** conditions **OR cold-but-clear-sky** conditions, that would *induce shadows* on those days.

“An Early Spring”
vs
“Six More Weeks Of Winter”

Winters with:

- gradual thaw
- a slow warm-up
- few/no re-freezes

➔ *Perceived as **“an early spring”***

In general, Northwest Europe has an earlier “last frost” date than the Northeast USA.

Averaged out over centuries
--winters that had:

- Highly variable day to day weather …
- Alternating warm, sunny thaws to freezing, cold air outbreaks.
- Freeze-thaw-refreezes …

➔ Would be “a long winter”.

“Six more weeks of winter”
seems a reasonable observation if those weeks were punctuated by several cold snaps.

Even if the mean temperature of the winter was above average, it might *seem like a longer winter* if there were late season or otherwise memorable freezes.

The relationship between amplitude in the Rossby Waves and a fair weather February 2nd is clearly not a direct relationship …

however …

Climatology is a game of averages!

The "law of averages" would suggest that the region would be more likely to receive the extreme freeze-thaw-freeze cycle of events during times when there is a greater amplitude to the waves.

Folklore about the sunshine on Candlemas (or February) as a bad omen could have been reinforced -- in those years when it just happened to be correct!

The superstition would be remembered when it occurs –
and ignored when occurrences did not fit the mythology.

What constitutes a "fair" Candlemas?

- *A sunny, but cold day?*
- *An abnormally warm day with scattered clouds and precipitation?*
- *Would just a few minutes of sunshine on an otherwise overcast day count?*
- *How large of an area is to be affected?*

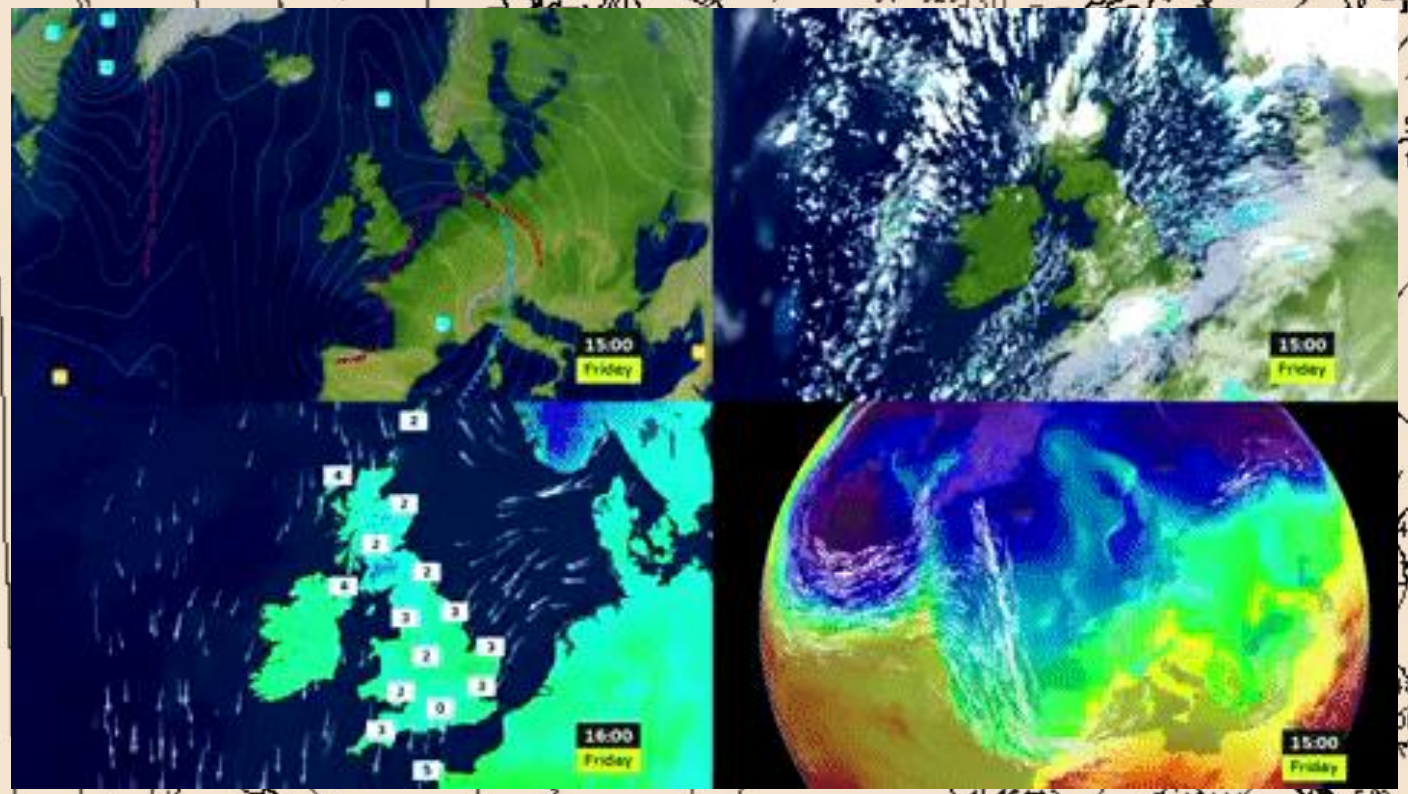
Original illustration from "Poetry of the Year: Passages from the Poets Descriptive of the Seasons. (With twenty-two colored illustrations from drawings by eminent artists.)" Joseph Cundall, Editor. 1853. British Library.

https://www.theparisreview.org/blog/2014/02/03/candlemas-day/

Twitter user: **Lore, Land & Spirit** @brotherurth Jan 31 #Imbolc Blessings to one and all, Spring is coming #Candlemas 🕯

Twitter user **Dave Allan** @boddave Feb 2 'If #Candlemas be bright and fair, there's half the winter yet and Mair'. Like today the sun shone brightly last year on 2nd February, so if the old Scots tradition holds true, brace yourself!

Weather patterns over Europe, February 1, 2019



https://www.youtube.com/watch?v=k2qpYfzi8M8

http://weather.uwyo.edu/upperair/uamap.shtml

www.metoffice.gov.uk

"The screen is split into four panels. The top left shows isobars and weather fronts. On the bottom left you'll find the wind and air temperature at the surface. The bottom right shows the jet stream and the temperature at 5000 feet above the ground. On the top right you'll see how all of this impacts the cloud, rain and snow over the UK."

"During the next 48 hours, cold air will remain over the UK. Saturday will be clear and dry for much of the country after a frosty and icy start. Wintry showers will continue to affect some coastal areas. A weather front will arrive from the west during Sunday to bring further rain, sleet and hill snow in places."

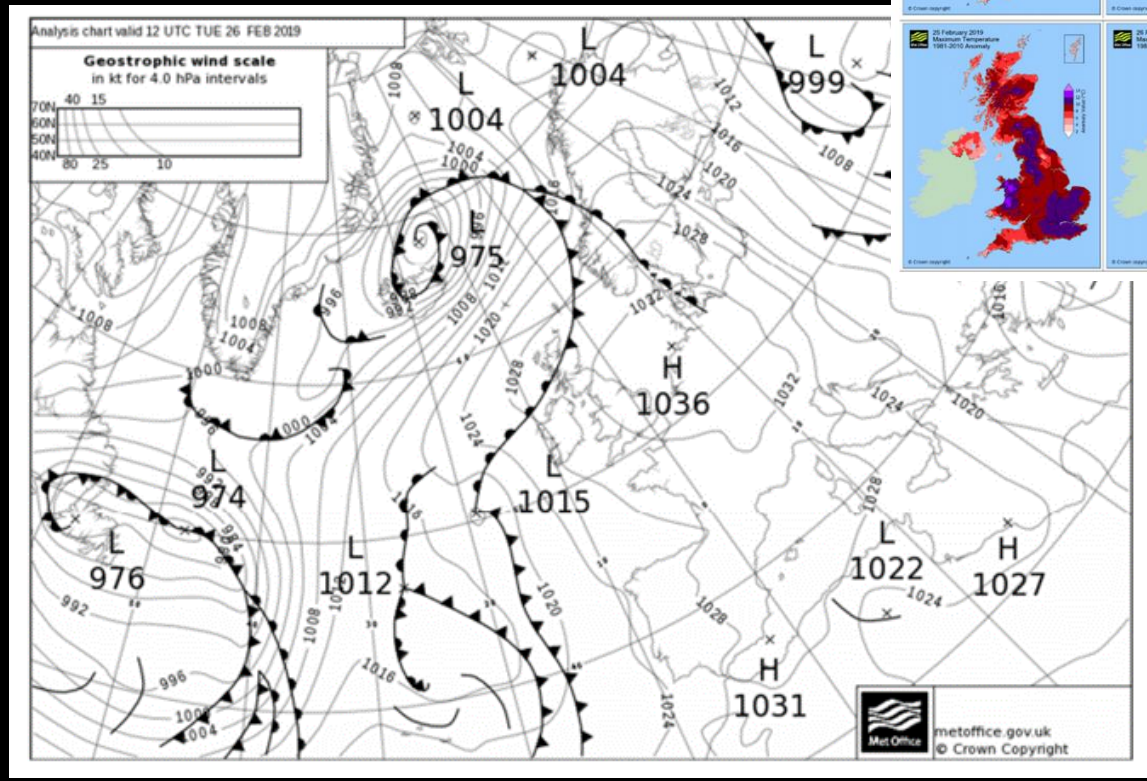
-- www.metoffice.gov.uk

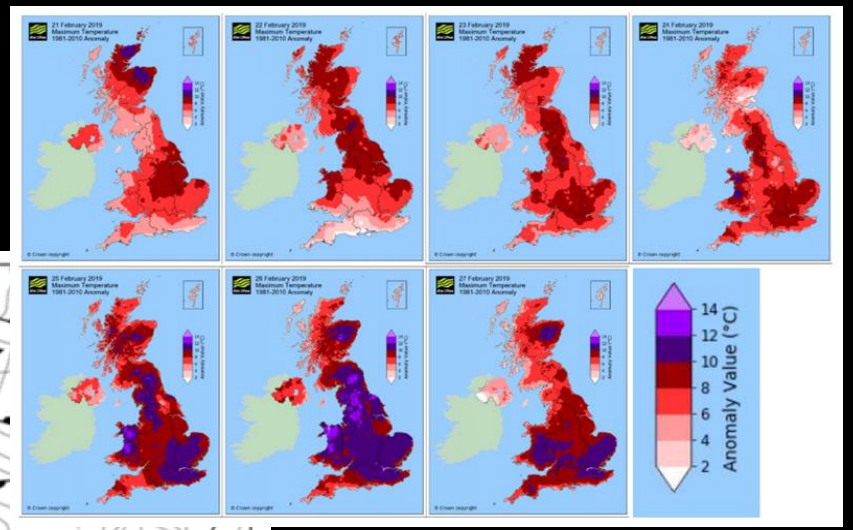
Exceptional warmth for the United Kingdom during February 2019:

On 26 February a maximum temperature of 21.2 °C was recorded at Kew Gardens (London), the UK's *highest temperature on record for a winter month.*

The satellite image at 1336UTC on 26 February 2019

A large area of High pressure over Europe drew exceptionally mild air from Iberia and North Africa.

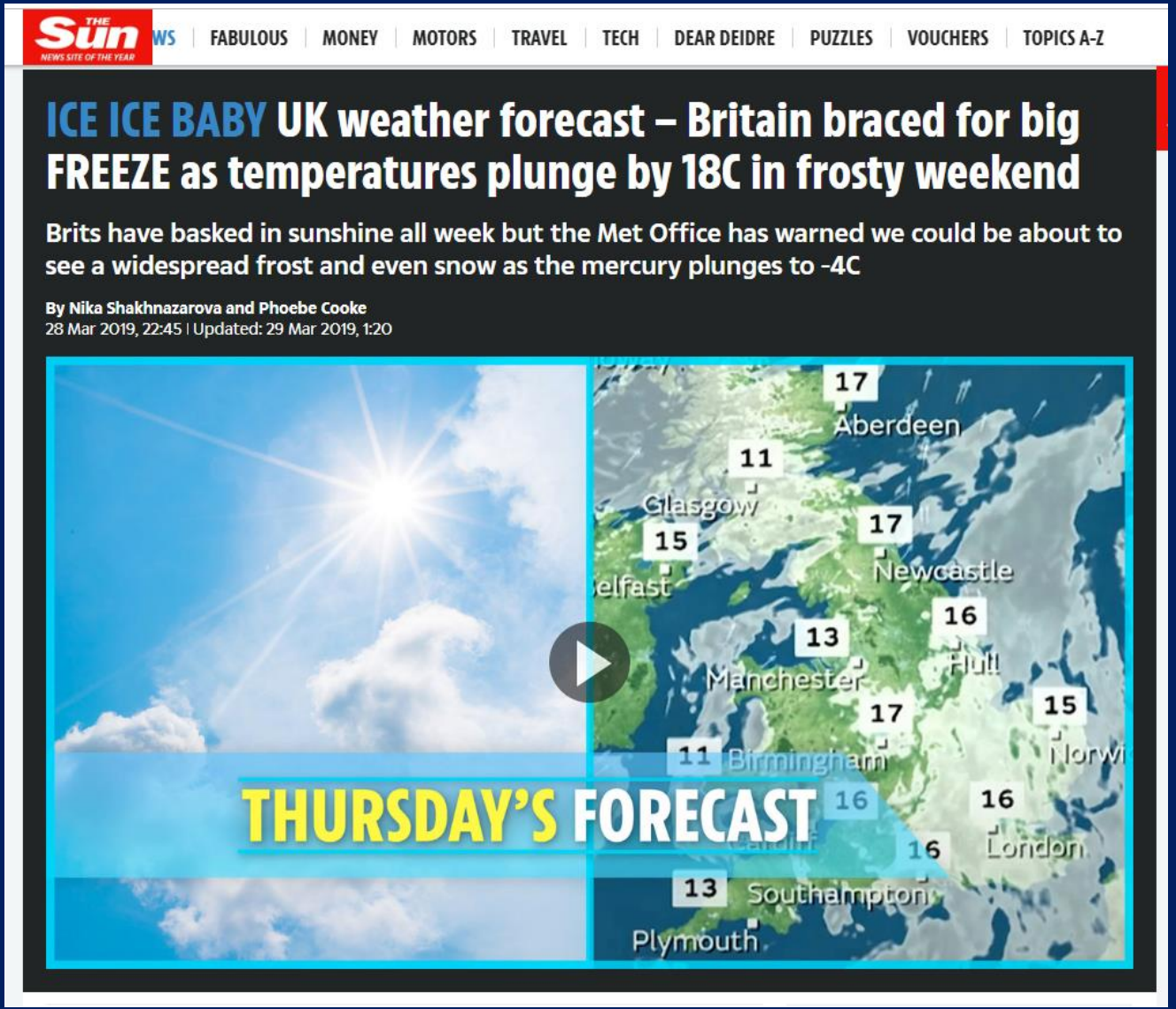




Exceptionally warm temperature anomalies for February 2019.

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2019/2019_002_february_warmspell.pdf

That exceptional warmth was followed by late season frost and sub-freezing temperatures!



https://www.thesun.co.uk/news/8742475/uk-weather-forecast-freeze-britain-weekend-met-office/

What can create these higher amplitude waves and thus form more cold air outbreaks?

Spatial and temporal variation of the
Arctic Oscillation and the North Atlantic Oscillation.

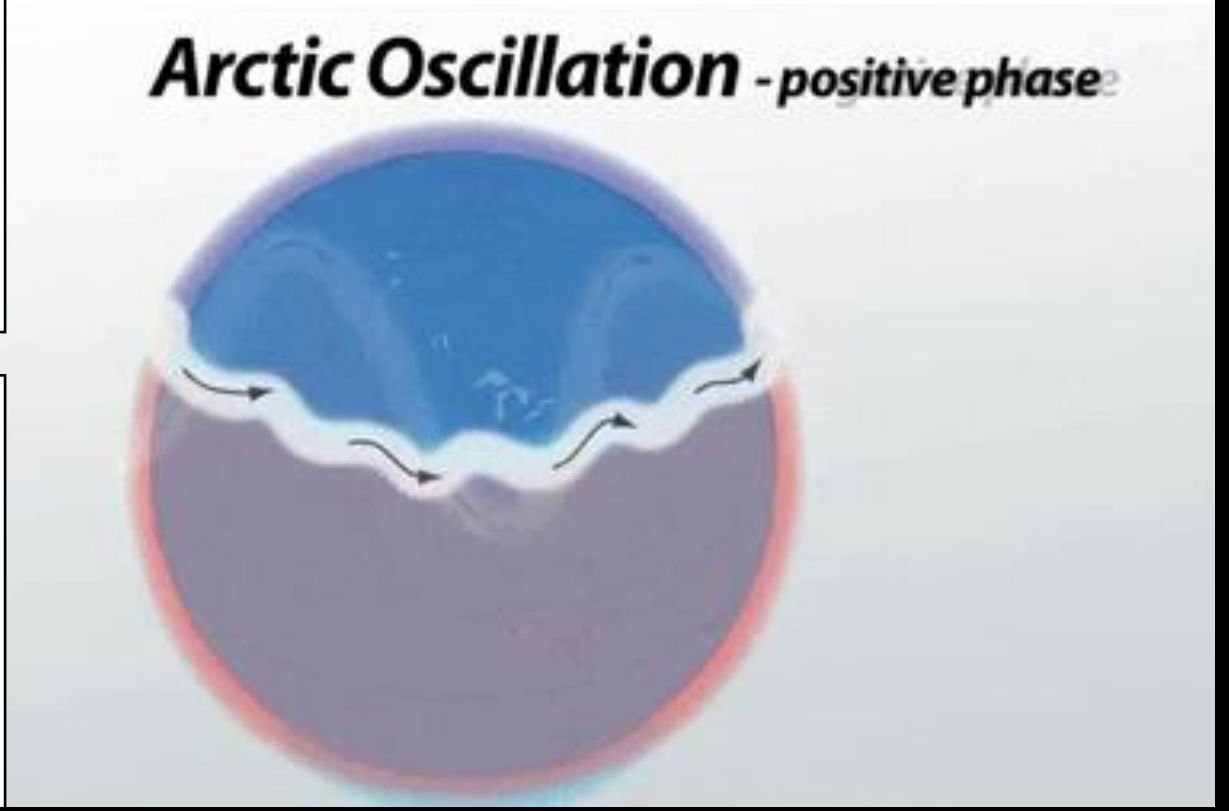
A lower temperature gradient between the middle latitudes and polar region -- means a lower pressure gradient.

A lower-pressure gradient phase creates much more meandering of the Rossby waves. These waves may stall in place for a time, creating blocking highs or cut-off lows which bring temperature extremes.

Undulations in the upper air flow are sometimes caused by pressure oscillations in the Arctic:

When the AO is in its **positive phase**, a ring of strong winds circulating around the North Pole acts to confine colder air across polar regions.

Positive values of the AO index indicate high pressure in the polar region and thus a tendency for **strong zonal winds that minimize cold air outbreaks** to the middle latitudes.



This belt of winds becomes weaker and more distorted in the **negative phase** of the AO, which allows an easier **southward penetration of colder, Arctic airmasses** and increased storminess into the mid-latitudes.

https://www.ncdc.noaa.gov/teleconnections/ao/

Dr. James E. Hansen:

"The degree to which Arctic air penetrates into middle latitudes is related to the AO index, which is defined by surface atmospheric pressure patterns.

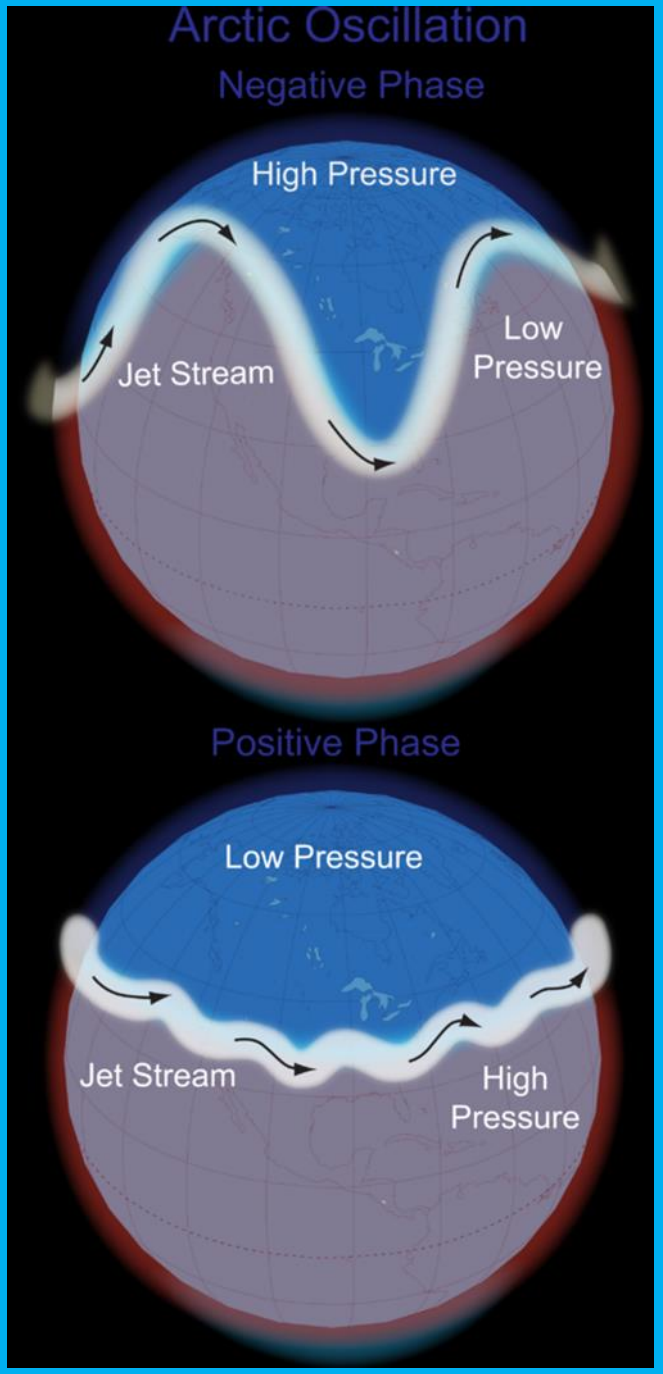
When the AO index is positive, surface pressure is low in the polar region.

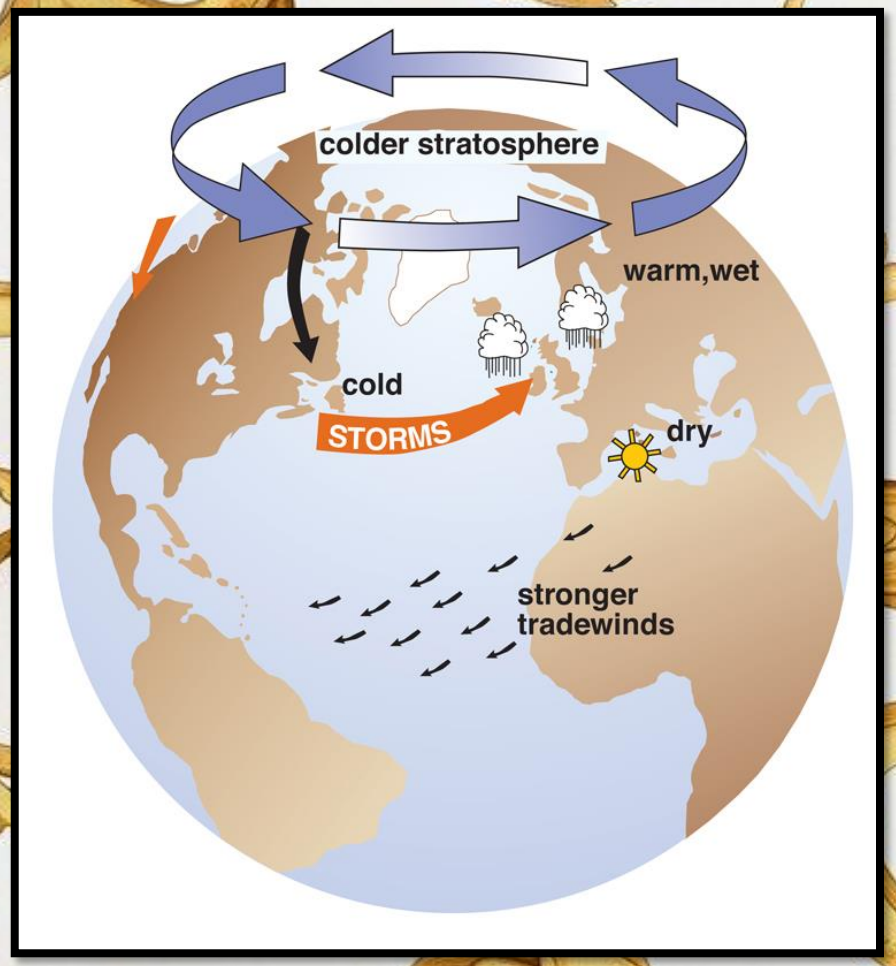
This helps the middle latitude jet stream to blow strongly and consistently from west to east, thus keeping cold Arctic air locked in the polar region.

When the AO index is negative, there tends to be high pressure in the polar region, weaker zonal winds, and greater movement of frigid polar air into middle latitudes."

From: **"If It's That Warm, How Come It's So Damned Cold?"**
Hansen, James; Reto Ruedy; Makiko Sato; Ken Lo. (2009).

http://www.columbia.edu/~jeh1/mailings/2010/20100115_Temperature2009.pdf





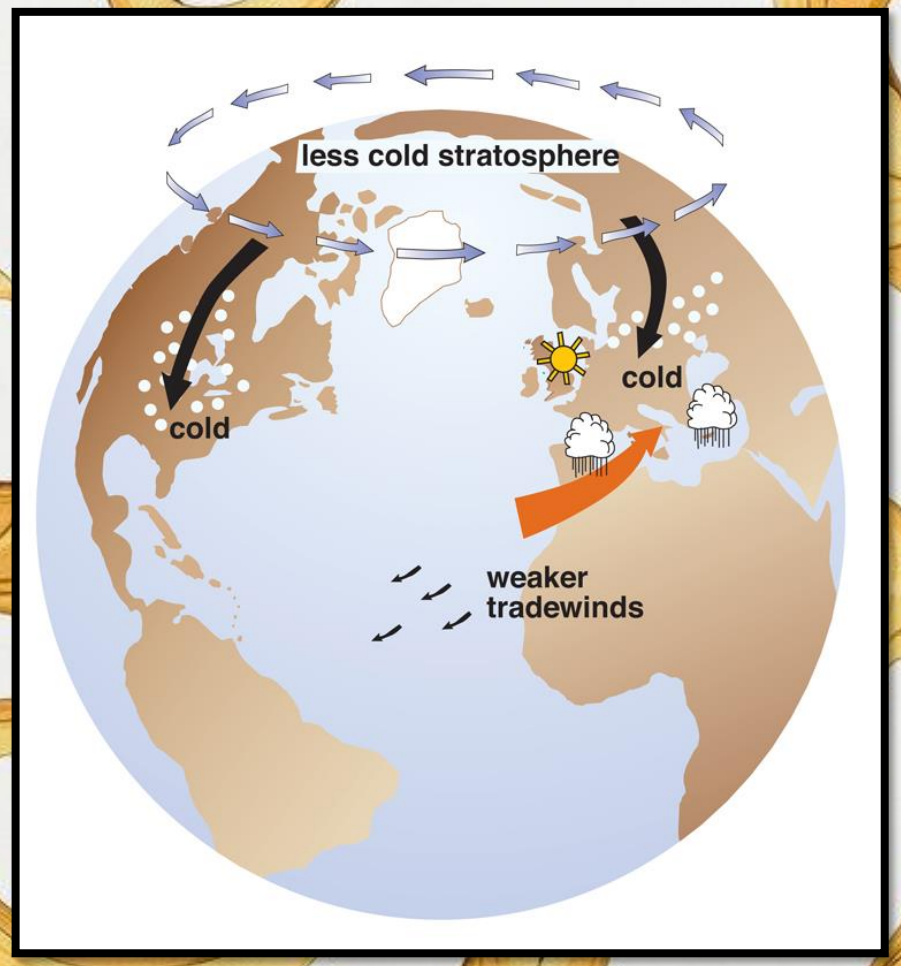


Image Credit: J. Wallace, University of Washington

https://www.pinterest.com/carlacanonica/medieval-art-calendars-i/

<u>Candlemas with Positive AO</u>:
Warmer and wetter winter for NW Europe.
Badger does NOT see shadow.

<u>Candlemas with Negative AO</u>:
Cold, but clear weather for NW Europe.
Badger sees shadow.

https://www.discoveranimals.co.uk/category/animals/animals-animals/mustelids/

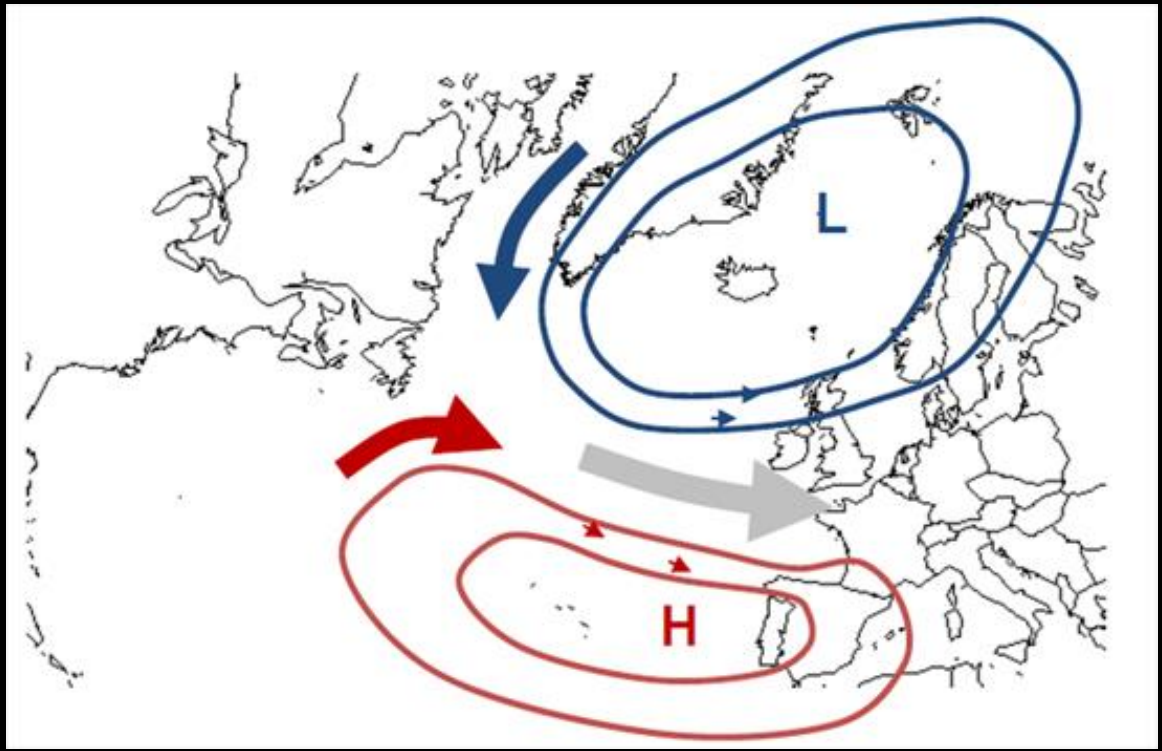
https://nsidc.org/about/monthlyhighlights/2013/05/all-about-arctic-climatology-and-meteorology/

Similar to the Arctic Oscillation, The **NORTH ATLANTIC OSCILLATION** also influences the wind pattern.

Whether prevailing weather flow is zonal or meridional is influenced by oscillations of the semi-permanent pressure systems in the North Atlantic –

the **Icelandic Low** and

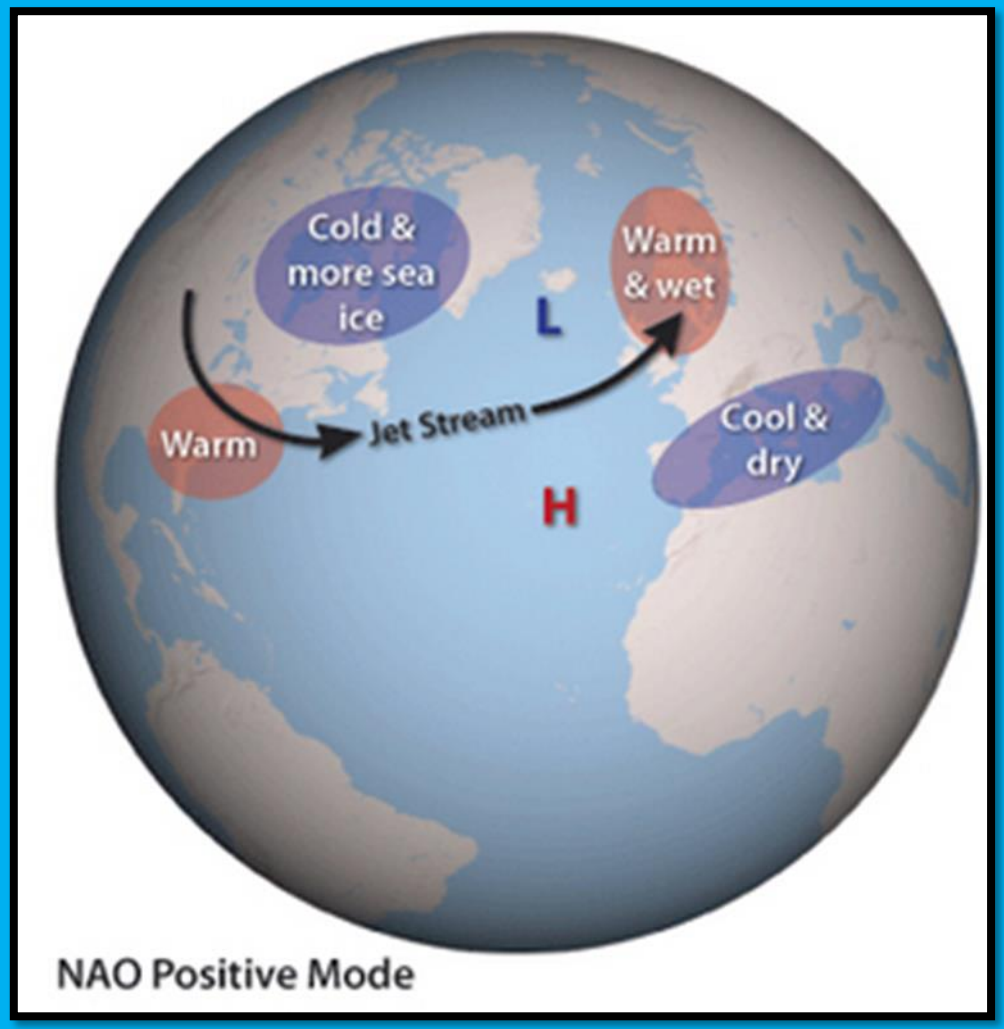
the **Azores High**.



When that pressure difference is large, strong zonal winds bring mild and wet westerlies from the Atlantic.

https://www.air-worldwide.com/Publications/AIR-Currents/2012/A-Windy-Winter-Season/

North Atlantic Oscillation



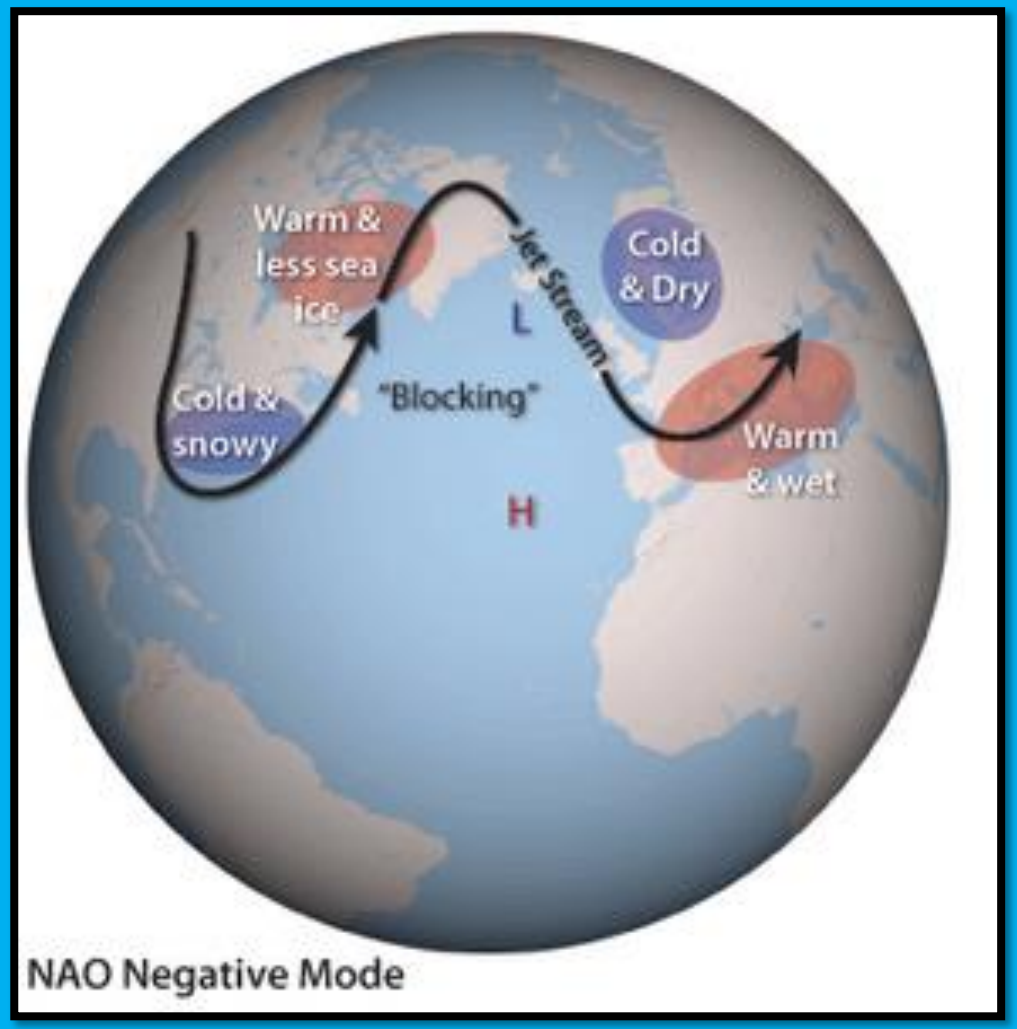
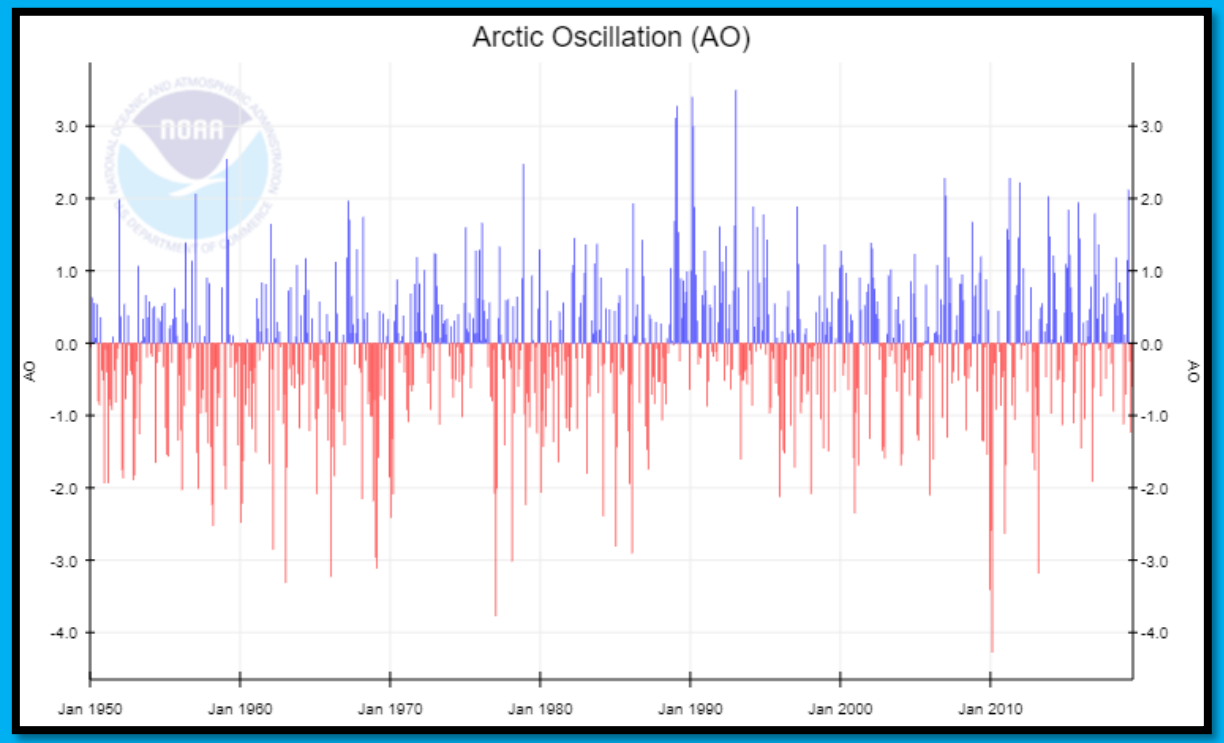


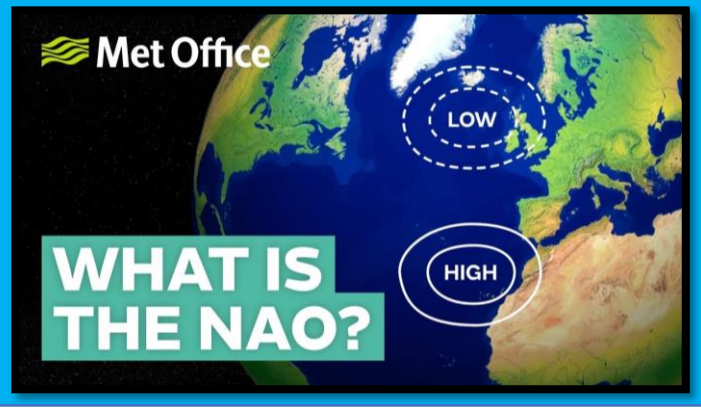
Image: Ned Gardiner and David Herring/NOAA)

https://www.mnn.com/earth-matters/wilderness-resources/stories/half-of-greenlands-warming-tied-to-natural-causes



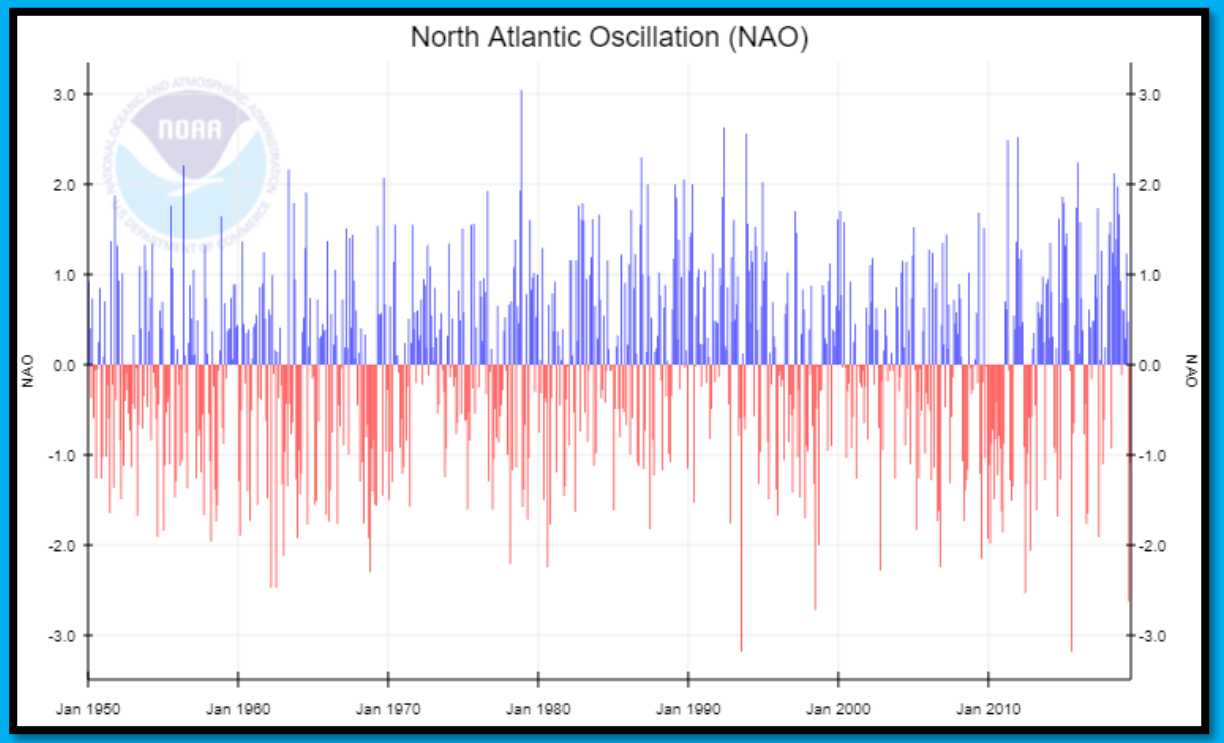
https://www.ncdc.noaa.gov/teleconnections/ao/

2019	01	-0.713
2019	02	1.149
2019	03	2.116
2019	04	-0.255
2019	05	-1.231
2019	06	-0.601



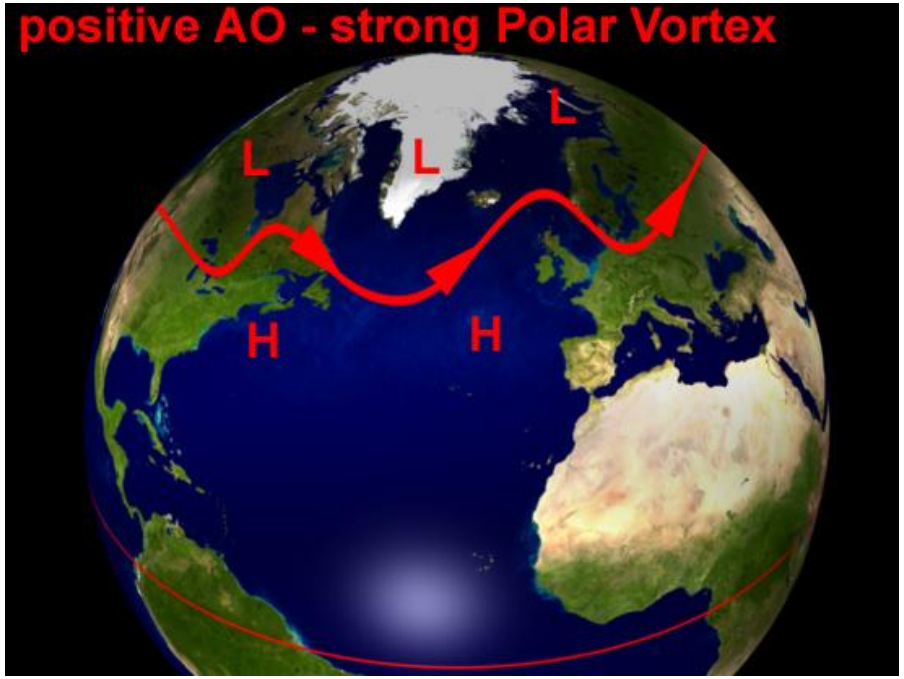
https://www.youtube.com/watch?v=KOYJG7j4Iy8

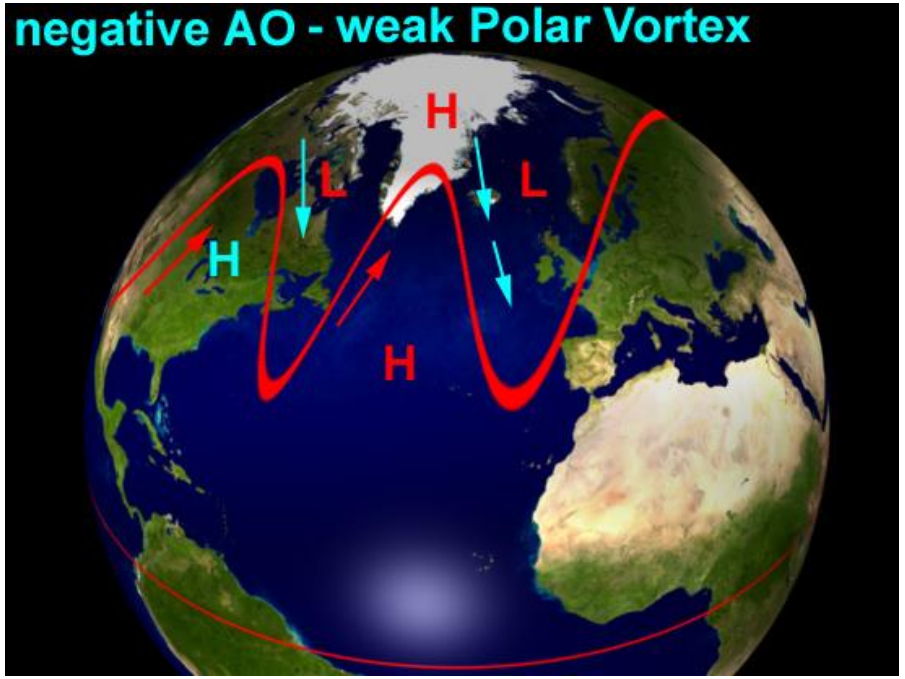
https://www.whoi.edu/multimedia/north-atlantic-oscillation/



https://www.ncdc.noaa.gov/teleconnections/nao/

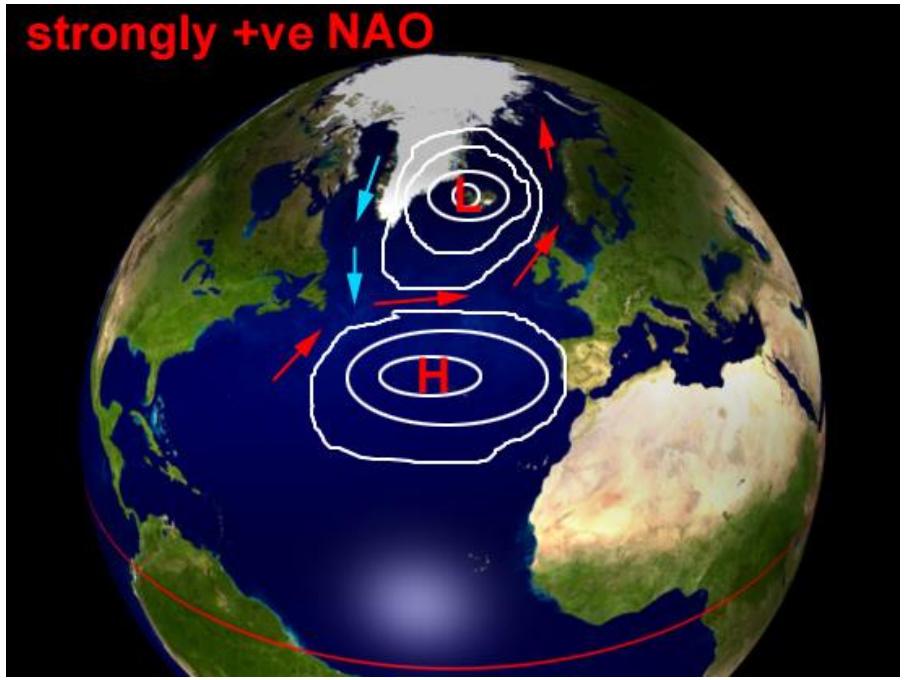
2019	01	0.59
2019	02	0.29
2019	03	1.23
2019	04	0.47
2019	05	-2.62
2019	06	-1.09

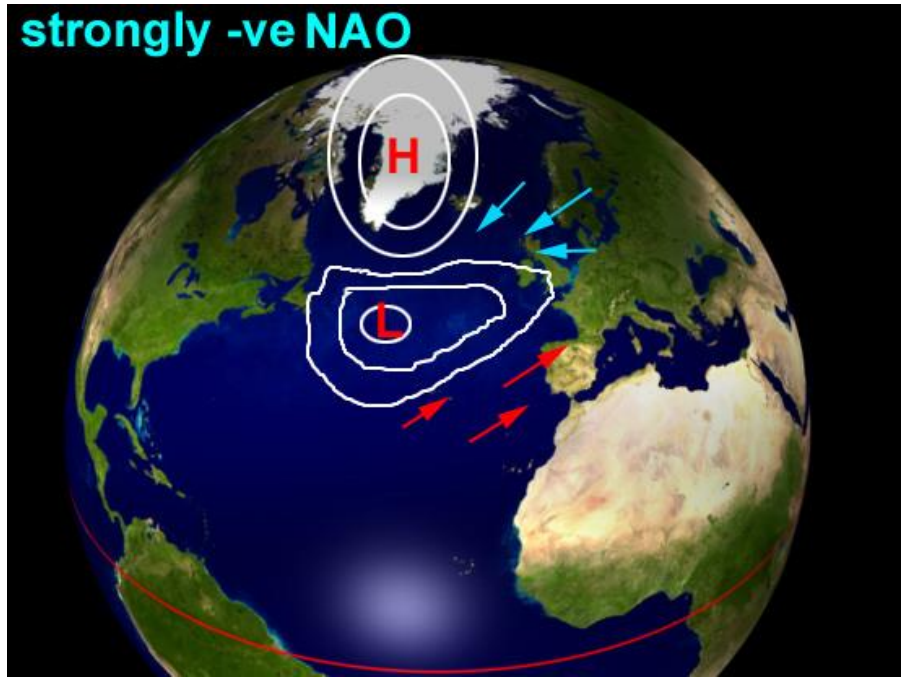




An analogy: “Think of a river's flow weakening as it leaves the mountains and enters the lowlands, where it becomes sluggish and develops meanders as it propagates seawards along the flood plain over many decades.”

-- John Mason





Graphics by

John Mason,

Skeptical Science.com

May 22, 2013.

https://skepticalscience.com/jetstream-guide.html

Greater vorticity of these waves causes some waves to “break”, pushing some air from the troposphere into the stratosphere.

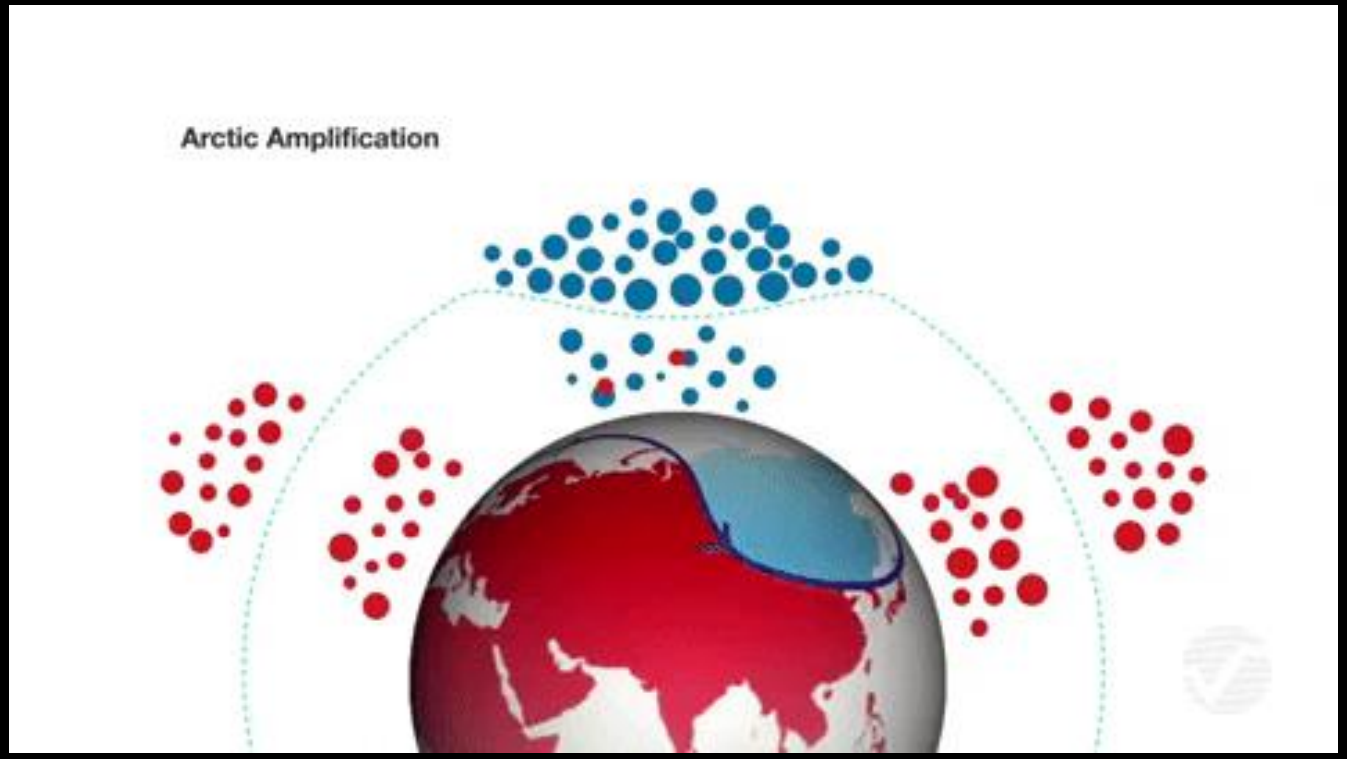
When this air descends back down through the stratosphere, it compresses, causes a warming of the lower stratosphere –

Sudden Stratospheric Warming.

This SSW weakens or splits the low-pressure spin of the stratospheric **Polar Vortex**.

This higher pressure over the pole pushes cold air out of the Arctic, causing cold waves and record cold extremes further south.

ARCTIC AMPLIFICATION



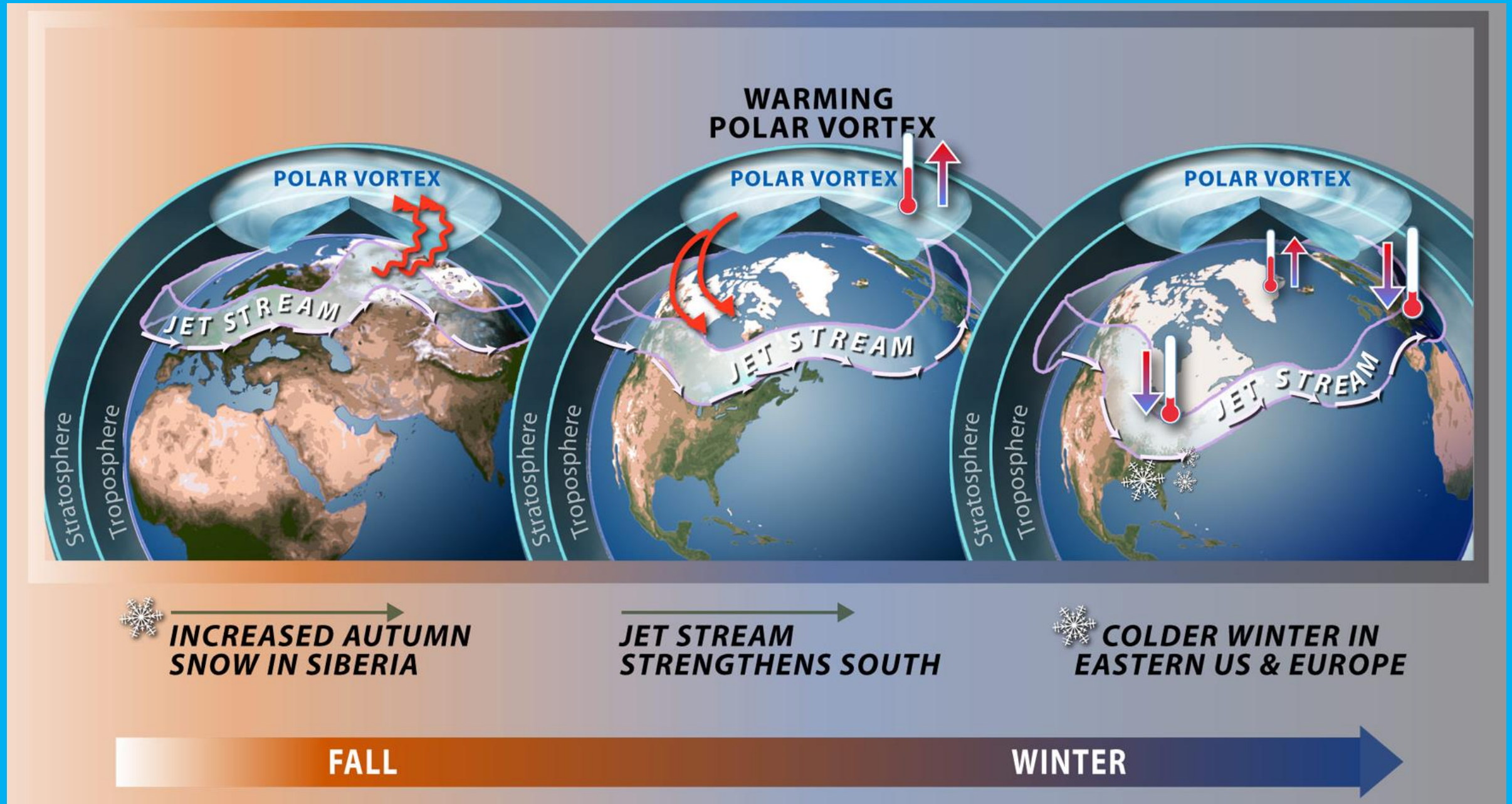
YouTube publisher **AER**, animated and explained how the accelerated warming of the Arctic, known as *Arctic Amplification*, is increasingly disrupting the polar vortex.

This has led to widespread severe winter weather across the Northern Hemisphere's mid-latitudes.

https://www.youtube.com/watch?v=EMeI4N5dui4&feature=youtu.be

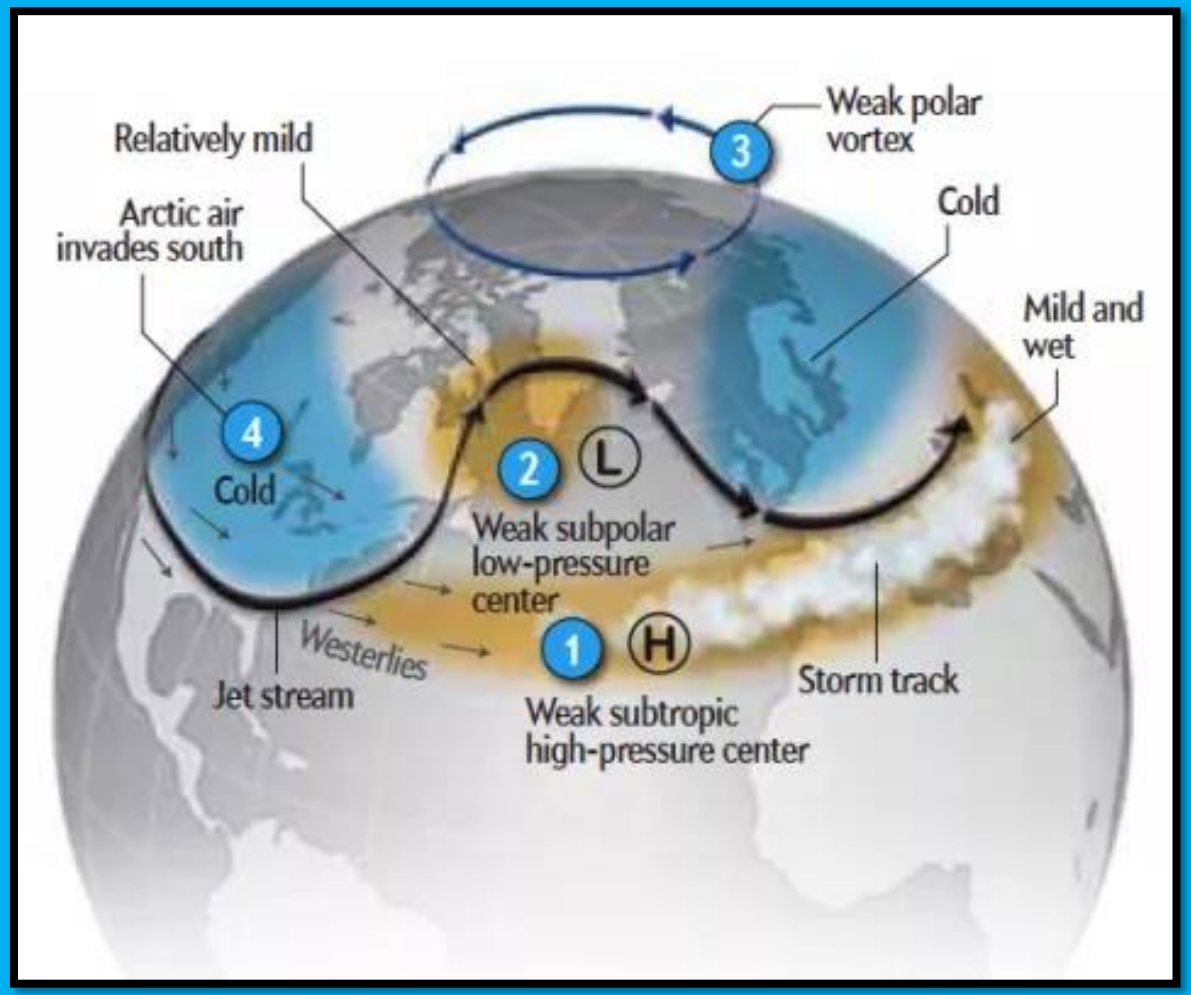
Cohen, J. et al., 2014: Recent Arctic amplification and extreme mid-latitude weather. Nature Geoscience, 7, 627, doi:10.1038/ngeo2234

https://www.aer.com/science-research/climate-weather/climate-dynamics/seasonal-weather-forecasts/polar-vortex-impact-winter-weather/

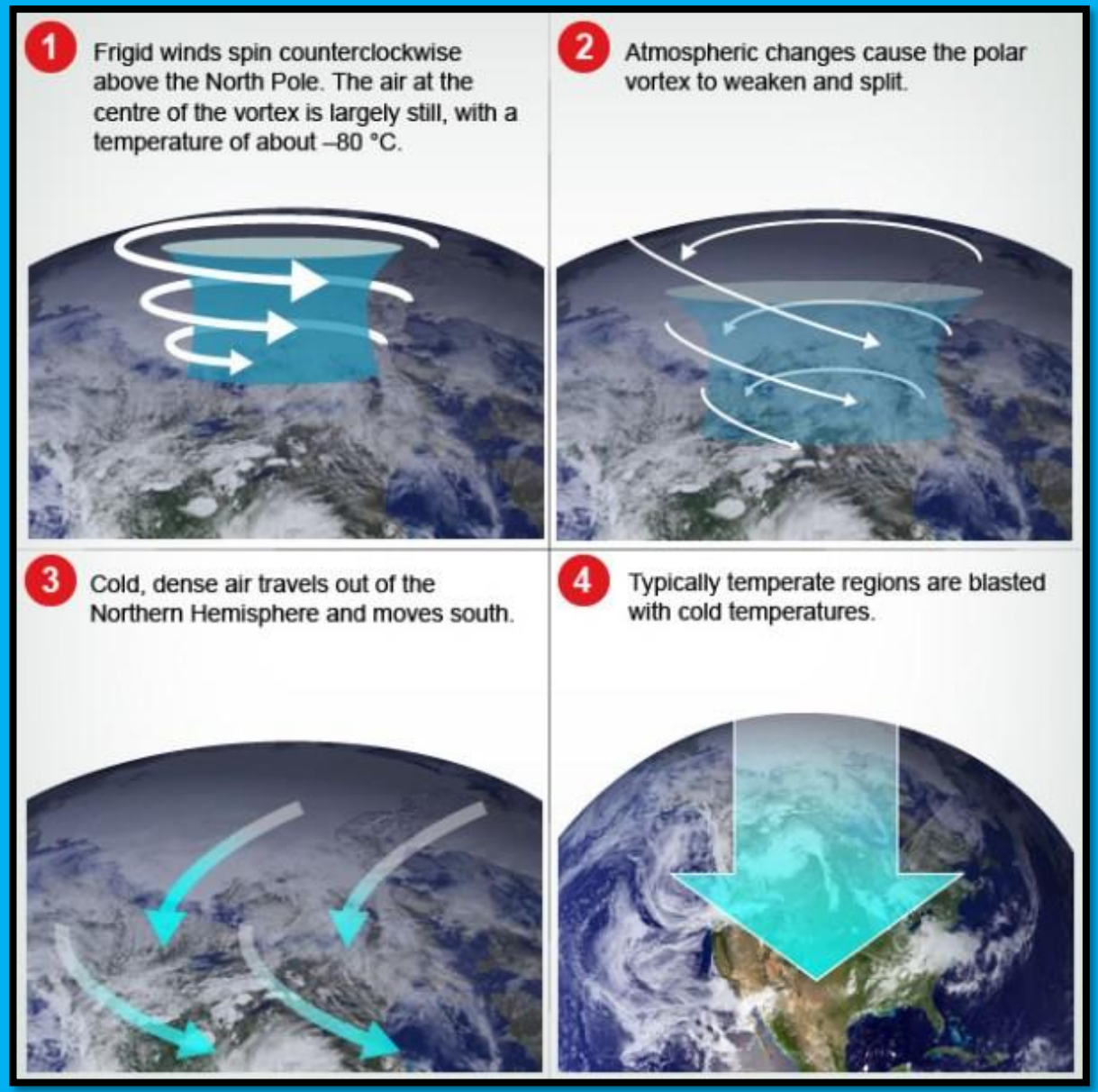


http://ecowest.org/2014/02/25/visualizing-polar-vortex/

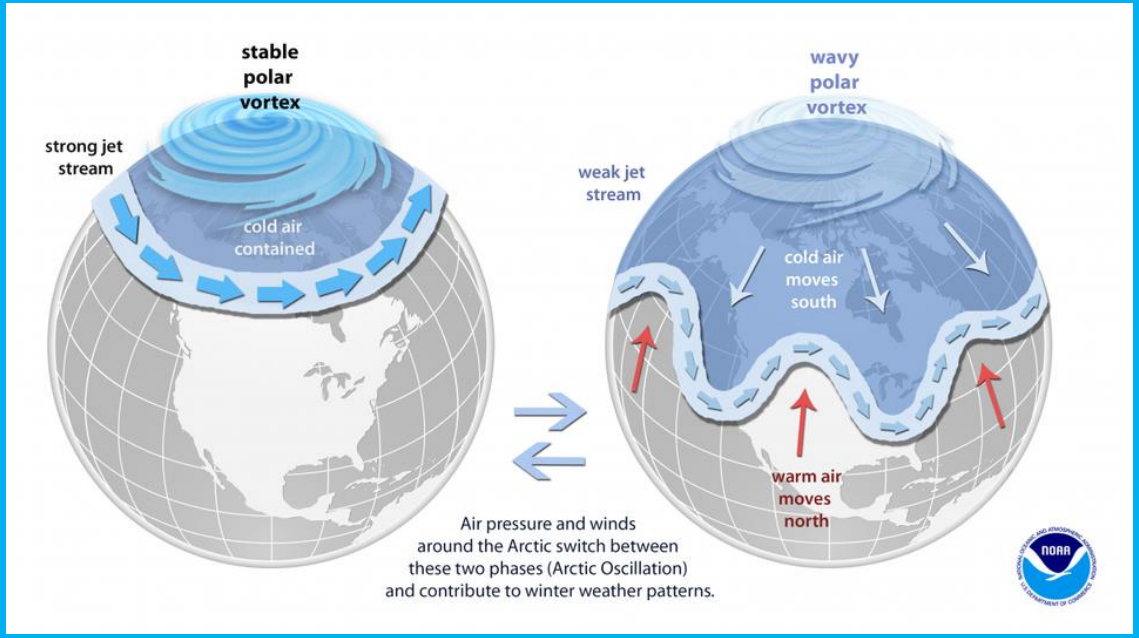
Source: Nicolle Rager Fuller, National Science Foundation



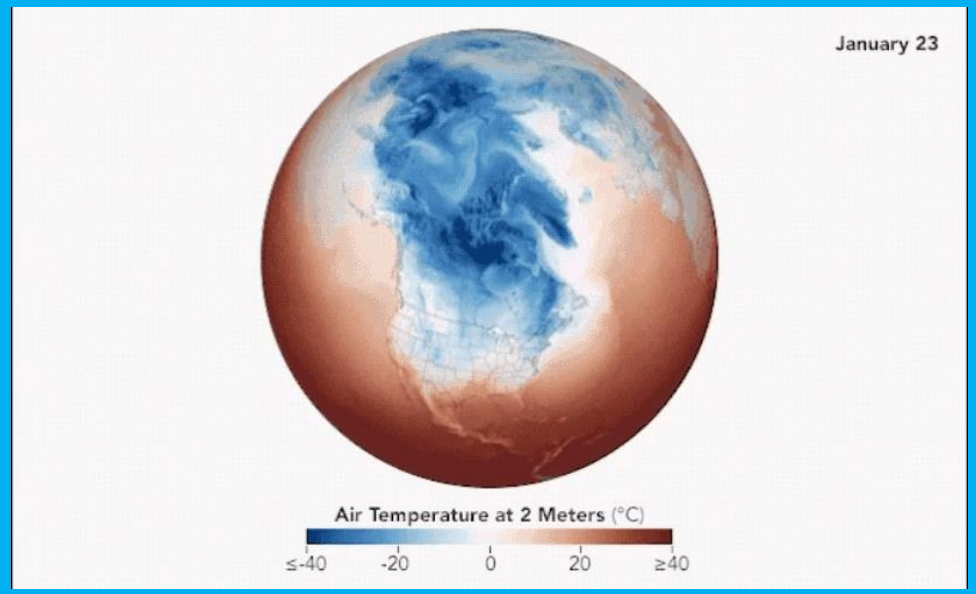
http://www.orgs-evolution-knowledge.net/Index/Essays/ClimateEmergency/Start%20of%20Runaway%20Warming.html



http://ecowest.org/2014/02/25/visualizing-polar-vortex/

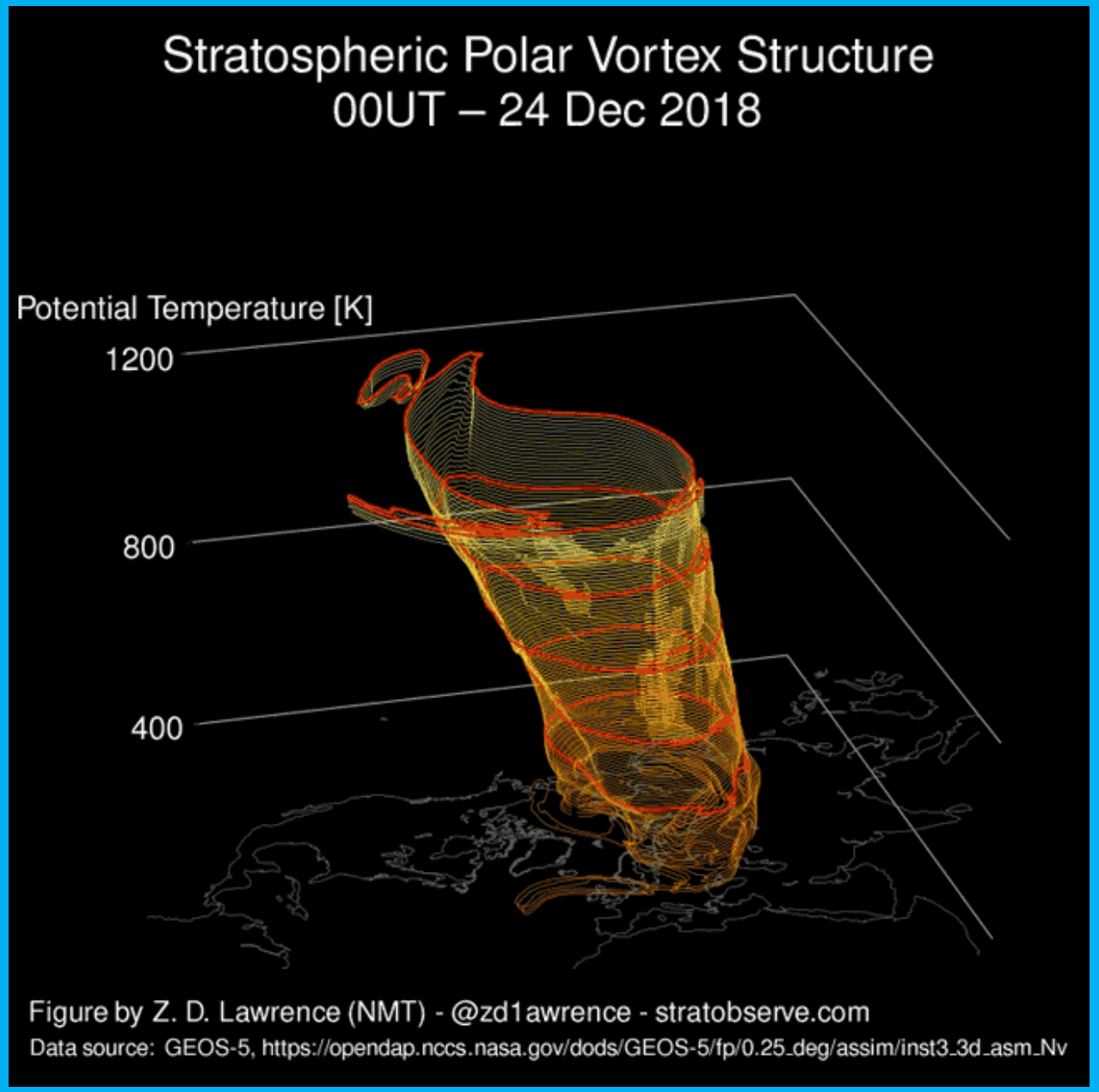


Source: NOAA (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION)



Low pressure air dips in from the Arctic, Source: NASA EARTH OBSERVATORY

2018-2019 stratospheric polar vortex split by Zac Lawrence.



https://www.forbes.com/sites/amysterling/2019/01/30/visualizing-a-polar-vortex/#3fbdbe112735

Warming temperatures in an overall warming climate will decrease the temperature/pressure gradients between the Arctic and the lower latitudes.

Thus …

"Global Warming causes more subfreezing temperatures".

FOR FURTHER DISCUSSION:

Candlemas has been celebrated in Europe for centuries, as was the Badger/Groundhog/Bear/Hedgehog legend.

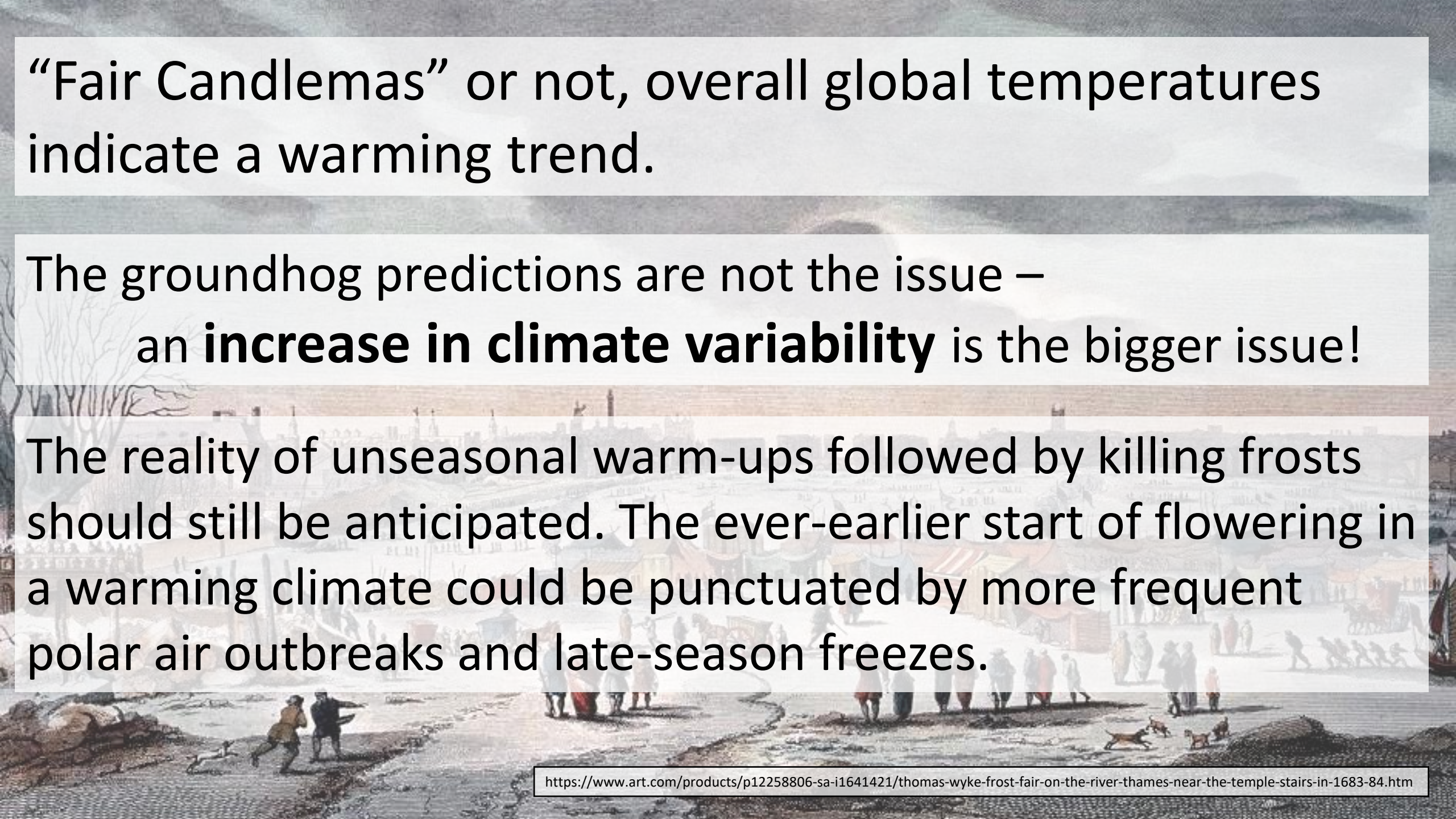
These folk observations would have been made during Europe's **"Medieval Warm Period"**, as well as through its "**Little Ice Age**", to the present.

To what extent would the "Fair Candlemas" observation and generalization have to change along with a ***warming climate,*** producing more **cold extremes**?

“Fair Candlemas” or not, overall global temperatures indicate a warming trend.

The groundhog predictions are not the issue –
an **increase in climate variability** is the bigger issue!

The reality of unseasonal warm-ups followed by killing frosts should still be anticipated. The ever-earlier start of flowering in a warming climate could be punctuated by more frequent polar air outbreaks and late-season freezes.



https://www.art.com/products/p12258806-sa-i1641421/thomas-wyke-frost-fair-on-the-river-thames-near-the-temple-stairs-in-1683-84.htm

CONCLUSIONS/SUGGESTIONS:

- ❑ Rather than following the Groundhog Day predictions, follow the long-range forecasts from NOAA and NWS.
- ❑ Refer to upper-air charts for daily/weekly jet stream positions.
- ❑ Follow the AO and NAO trends.

Suggested links:

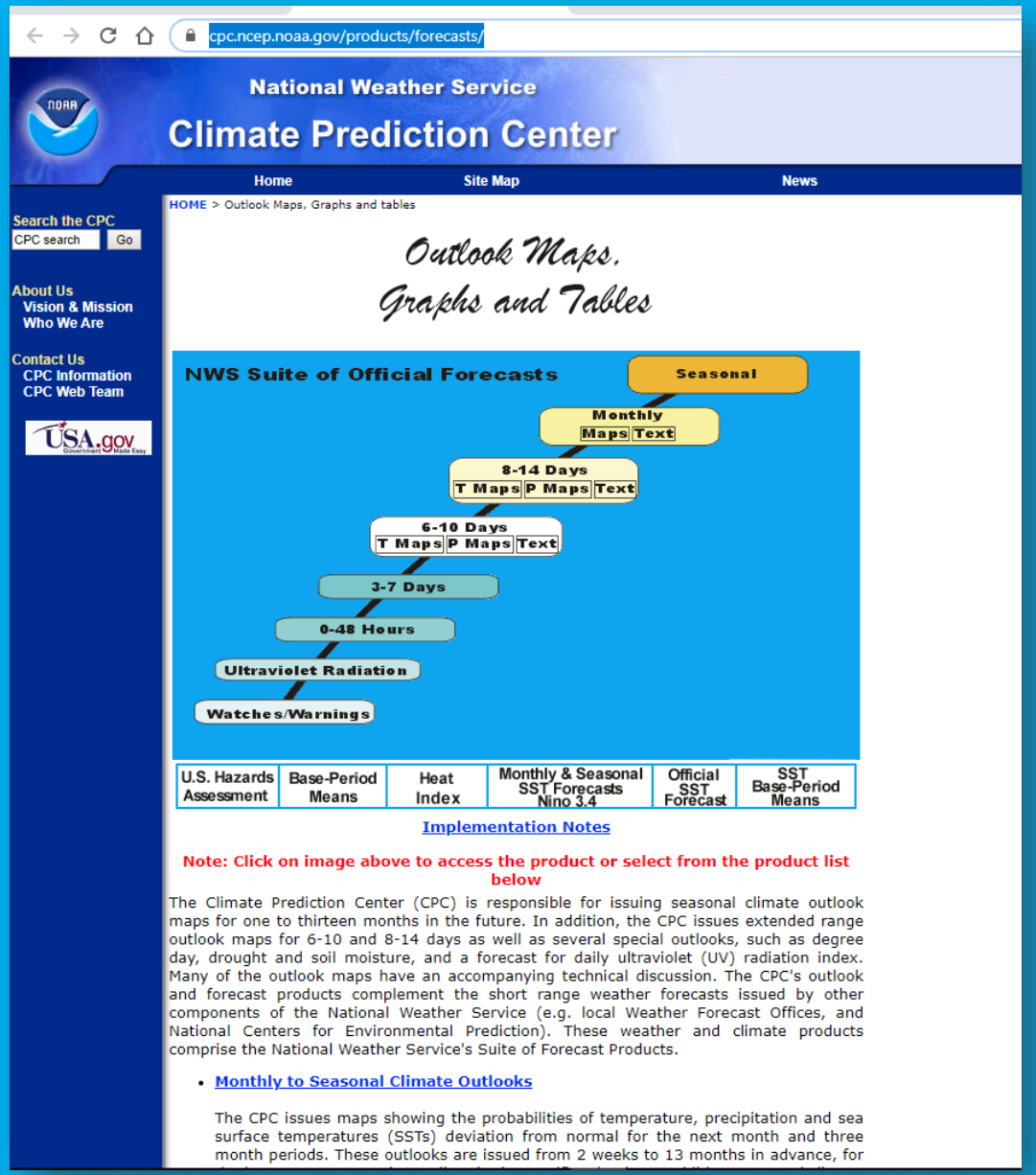
https://www.cpc.ncep.noaa.gov/products/forecasts/

https://www.weather.gov/hun/climateforecast

https://www.weather.gov/phi/longrange

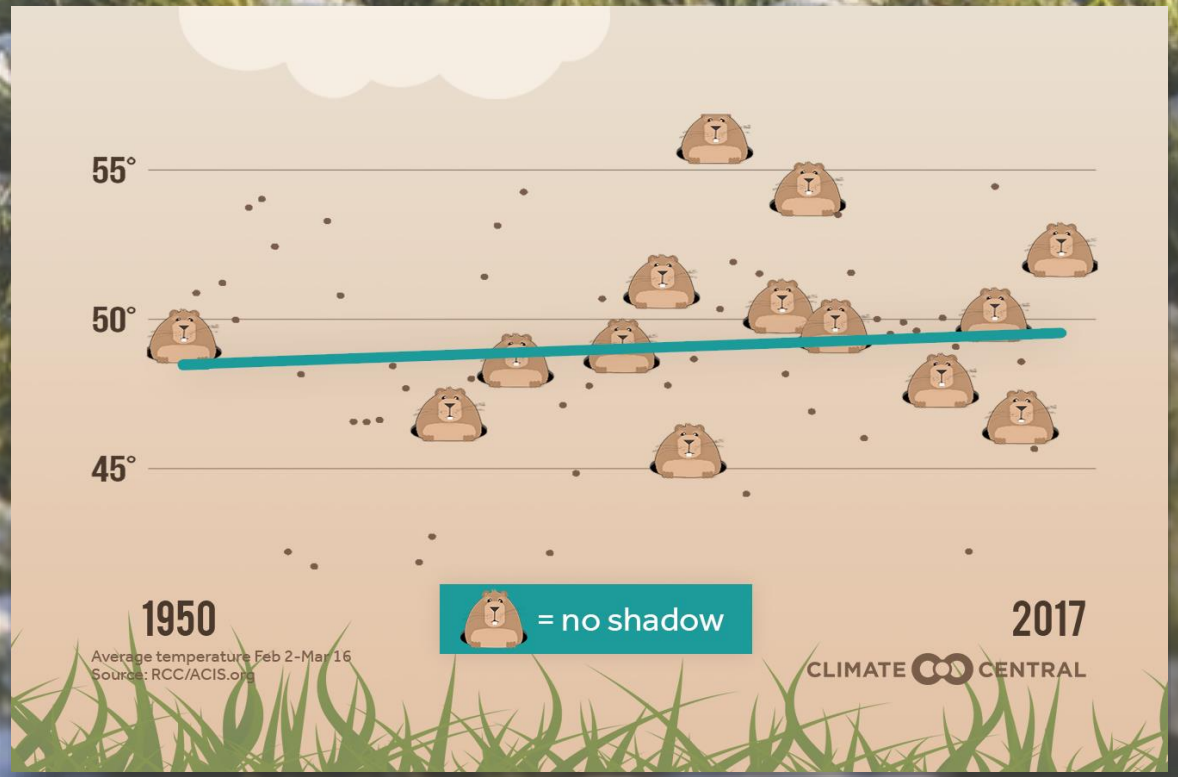
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao_index.html

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao_index.html



A NOD TO PUNXSATAWNEY PHIL'S PHANS:

The Groundhog should predict more *"early springs"* as the overall trend is for the warmer.



🡐 Of the 18 times Phil did not see his shadow since 1950, 13 have come after 1970.

Average temperature for the six-weeks period following Groundhog Day has shown a warming trend since 1950.

http://www.rcc-acis.org/

https://www.climatecentral.org/outreach/alert-archive/2018/2018GroundhogDay-ARCHIVE.html

ADDITIONAL REFERENCES, LINKS, ARTWORK AND FURTHER READINGS:

SCAN THIS QR CODE ➔

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https://www.researchgate.net/profile/Dennis_Edgell

https://mapleforestricepaddy.wordpress.com/