1 - *Climate Science Study Group* - CSSG-2.33

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= Cyclones, Anticyclones, and Hurricane Beryl

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The purpose of this study is mainly definitional.

"Cyclones" and **"Anticyclones"** keep turning up - often without being named. But because we live on a rotating planet with heating from the sun, these two kinds of flows will constantly show up.

I think the term **Cyclone** originally was used for a hurricane in the northern hemisphere, because that was the weather the early European sailors had to deal with. Later, the term was more generalized but based on the larger behavior of a northern hemisphere hurricane: **surface air getting sucked into a low pressure area and rotating counterclockwise** (in the southern hemisphere the rotation would be in the opposite direction). **That's a Cyclone**.

So, let's look at Beryl. Was Hurricane Beryl a Cyclone? Who cares? Yes! Here it is just before it hits Texas. Surface air is getting sucked into a very low pressure area. Along its path the sea surface air was hot and rose from the surface causing and strengthening the low pressure suction. As the air rushed in, it was caused to rotate by the Coriolis Effect.

It was a **cyclone** because it was sucking air in from the sides and rotating. It was a **tropical cyclone** because: "***A tropical cyclone is a generic term used by meteorologists to describe a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has closed, low-level circulation. Hurricanes and typhoons are the same weather phenomenon: tropical cyclones.***" And that description definitely matches what we saw when we took apart **hurricanes in CSSG-2.22**.

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7/172024 maclankford@gmail.com

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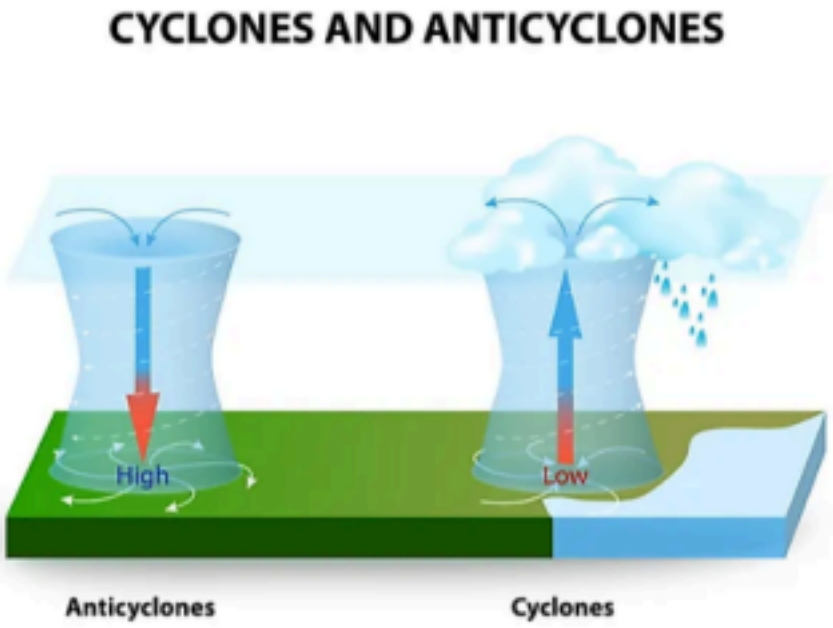
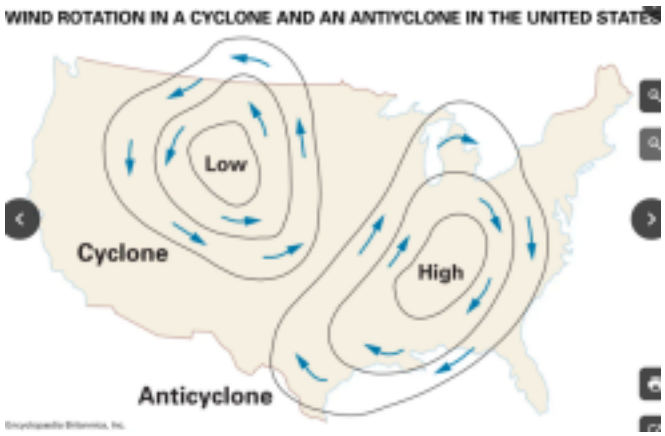
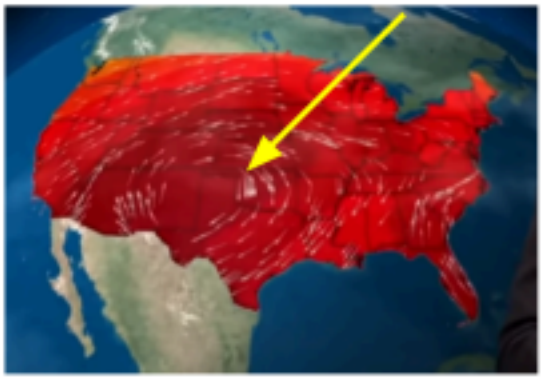


The **cyclone** sucks in surface air. Because of the Coriolis effect, it comes in rotating **counterclockwise**. On the other hand, high pressure pushes air to the surface and it spreads out. The Coriolis effect bends the flows right in the **clockwise direction**. This is an **anticyclone**.

The details of how this works are laid out in the **Supplemental Materials** at the end of this study.



We saw this circulation pattern recently when studying Heat Domes - CSSG-2.30. Being clockwise, it's an anticyclone.



So, that's how cyclones and anticyclones are defined. You'll love this:

A clockwise circulation is called anticyclonic, and an anticlockwise one is cyclonic.

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Hurricane Beryl

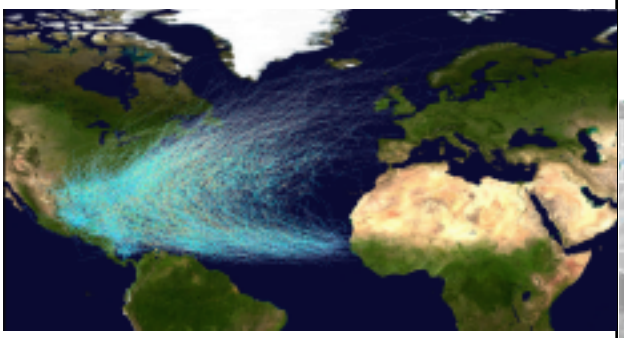
Last week, all the news was around Hurricane Beryl, the earliest major hurricane on record, and consistent with all the forecasts for a super hurricane season. Let's look at how it relates to our general study of hurricanes in CSSG-2.22 *Hurricanes and Climate Change*.

Beryl formed on **Friday, June 28**, becoming the second named storm of the 2024 Atlantic hurricane season. It first became a **hurricane on Saturday, June 29, and on Sunday, June 30, it became the earliest Atlantic Category 4 storm on record**. Beryl made landfall on the Texas coast near Matagorda – as NHC forecasters and others predicted – as a Category 1 hurricane and hit the Houston area around 4 a.m. **Monday, July 8**. However, the storm was stronger than just a Category 1 because it was rapidly intensifying as it hit land.

In the CSSG-2.22 Study, we saw the African origin story and path across the Atlantic for almost all Atlantic hurricanes.

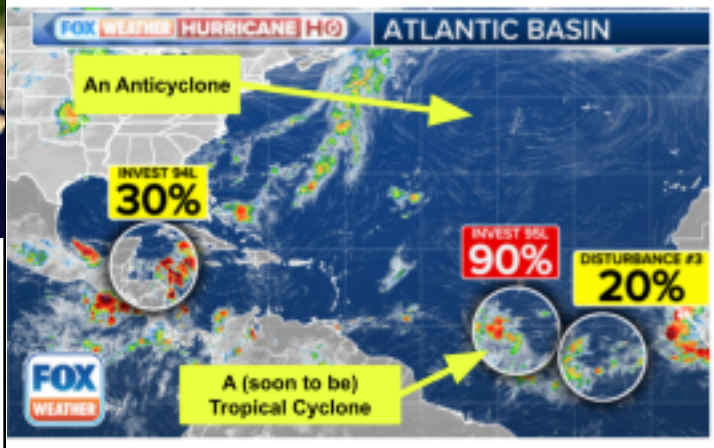
Guided by the persistent rotating high region as shown. **The Azores High creates an Anticyclone** which guides the **cyclones** across

Atlantic Hurricane tracks 1851 - 2019



This is exactly how Beryl originated, as seen to the right →

Note the high pressure area to the North as Beryl hit mid-Atlantic as 95L, It's an anticyclone going clockwise



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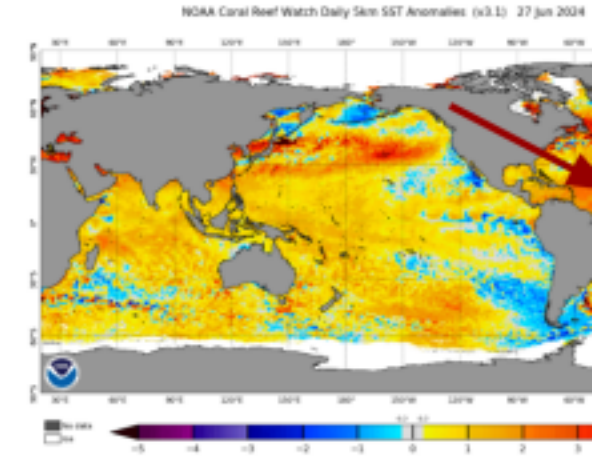
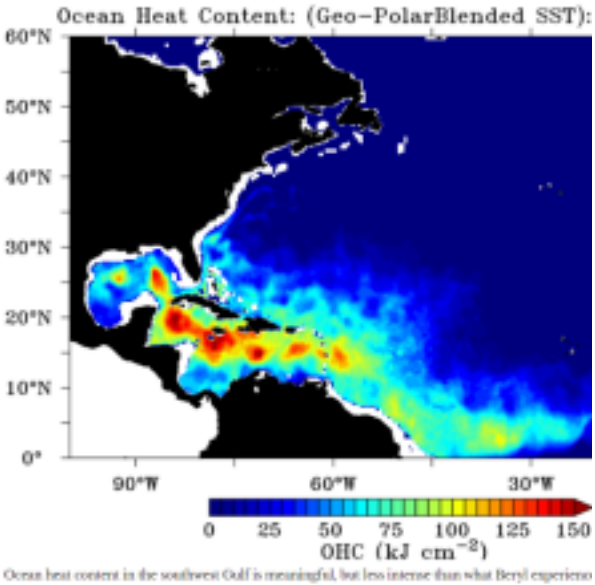
In meteorology, "invest" is short for "investigative area" and is a term used to describe a region of disturbed weather in the tropics that is being monitored for possible tropical cyclone development.

Another key ingredient for hurricane formation is **warm water**. Note the especially warm North Atlantic along its path:





Ocean heat content in the southwest Gulf is meaningful, but less intense than what Beryl experienc

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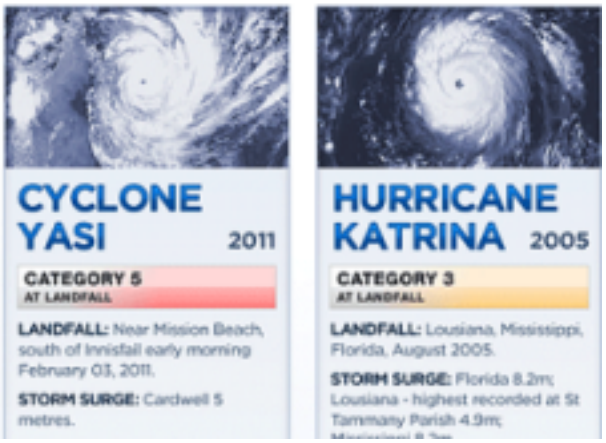
For Fun:

Which hurricane is from the Southern Hemisphere?



Some Resources

https://www.abc.net.au/news/2011-02-01/tropical-cyclones-explained/1926870

https://www.worldatlas.com/articles/what-is-an-anticyclone.html

https://houstonlanding.org/a-storm-of-misinformation-followed-hurricane-beryl-ashore-heres-what really-happened/#:~:text=July%207%20and%20July%208,Monday%2C%20July%208.

https://www.bloomberg.com/opinion/articles/2024-07-09/hurricane-beryl-makes-a-mockery-of-texa s-climate-deniers?embedded-checkout=true

https://study.com/academy/lesson/the-characteristics-formation-of-anticyclones.html

Approximate "Cheat Sheet":

1 meter → 3 feet **1 degree Celsius (°C)** → 2 degree Fahrenheit (°F)
ppm = parts per million **CO_2** = Carbon Dioxide
1 tonne = 1000 kilograms = 2205 pounds **1 gigatonne (1 Gt)** = 1 billion tonnes
1 trillion tonnes (1Tt) = 1000 gigatons

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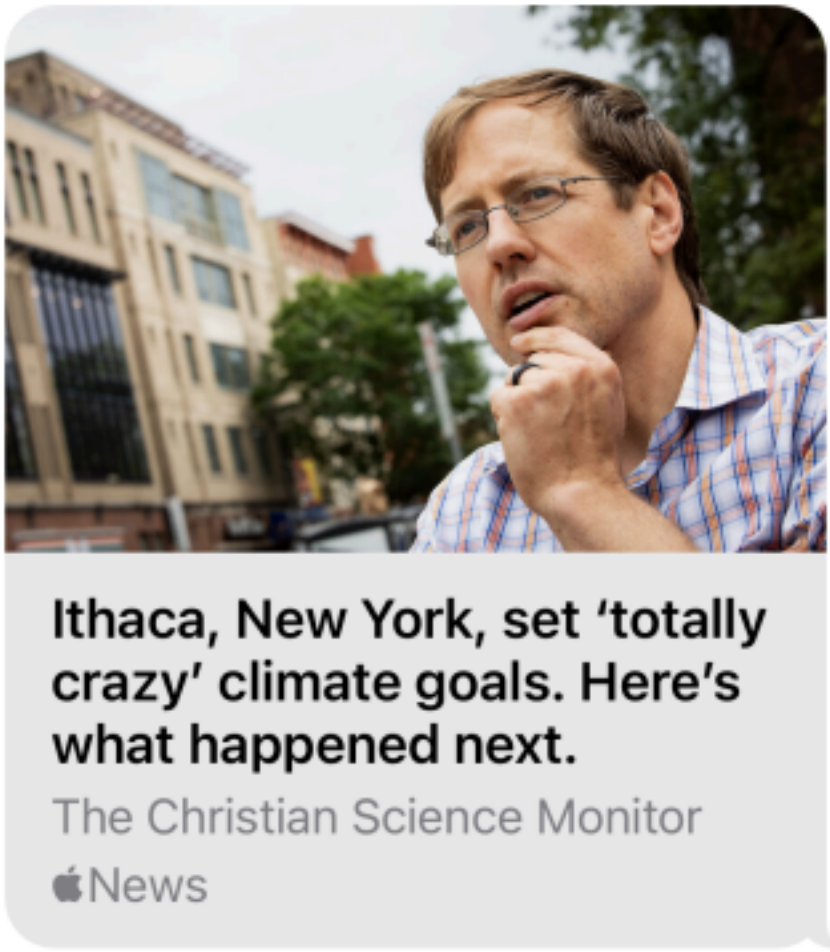
GOOD NEWS CORNER



https://apple.news/AYaiAnyOkRwO_5DoqzMdiVA

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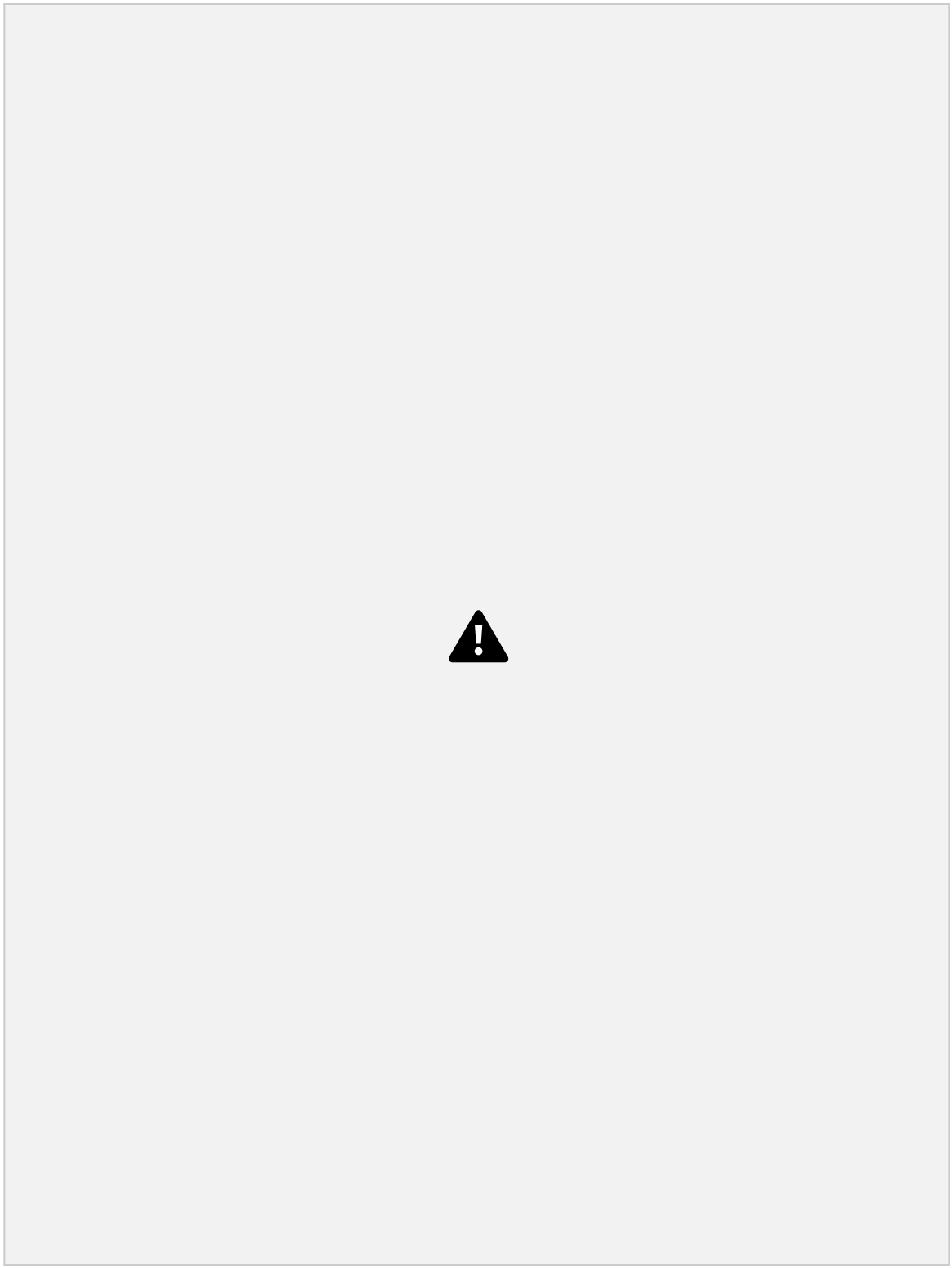

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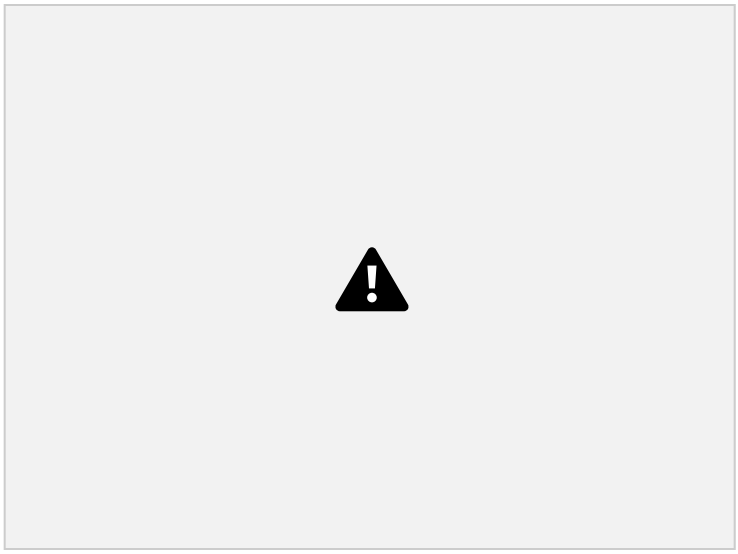
Supplemental Material -The Mechanisms of Cyclones and Anticyclones

To clarify, and the main reason I decided to touch on this topic, we look yet again at the **Coriolis Effect** (you can't escape this - the Earth rotates and you can't ignore it!)

As we saw in **CSSG-2.14** ***Atmospheric Cells, Climate Change, and Arctic Blasts*** using this graphic from **CSSG-2.6** ***The Great Conveyor Part 2 - The Amazing CO2 Suckers***…

… as surface air flows towards the equator (in the Northern Hemisphere) it is reaching out its arms (i.e., getting further from the earth's axis), it is slowing down compared to the earth's spin and curves to the right. Likewise, as surface air flows towards the pole, it is pulling in its arms (i.e., getting closer to the earth's axis and speeds up curving again to the right.



This makes sense of the Trade Winds and the Westerlies - but not Hurricanes

The Trade Winds and Westerlies don't come from localized airflows, which are very often what we experience from local HIGHs and LOWs. From these we will sort out **Cyclones** and **Anticyclones**.

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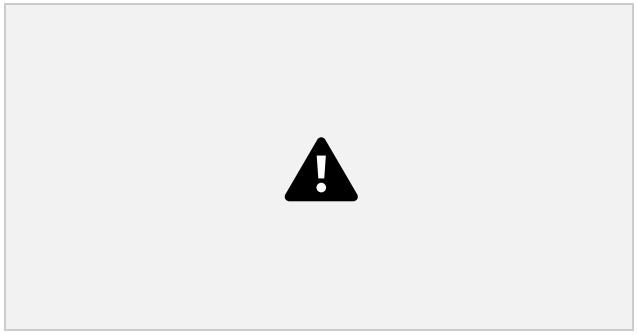
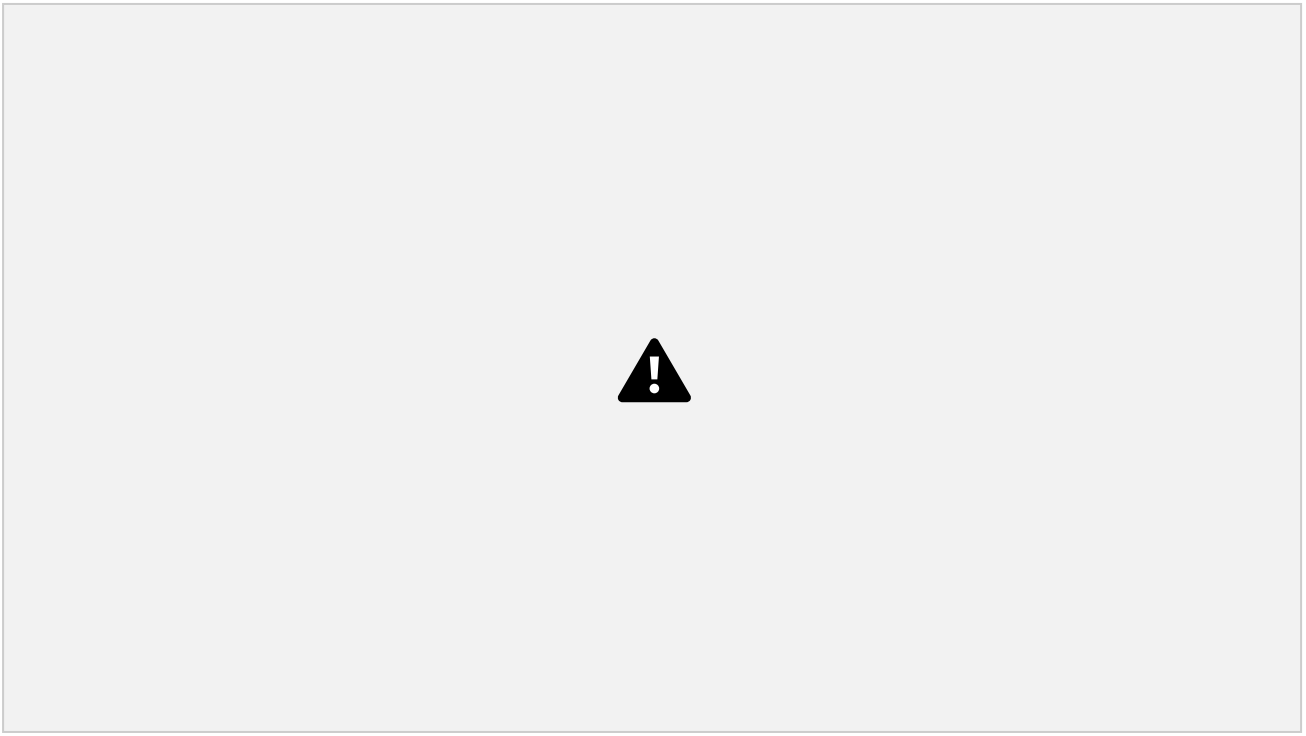
Here's the things that influence "which way the wind blows"	And here's the type of local low pressure area that sucks in surface air and starts a hurricane
	

We're not going to dwell on the details, but here they are for reference:



If this is a general flow towards a low pressure spot, it's called a Cyclone; if it's over warm water and organized, it can develop into a

Tropical Cyclone = a Hurricane

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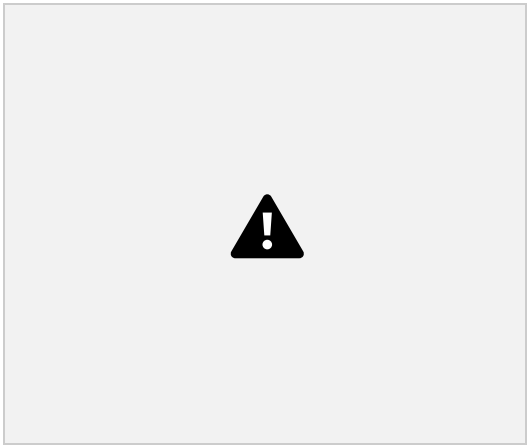
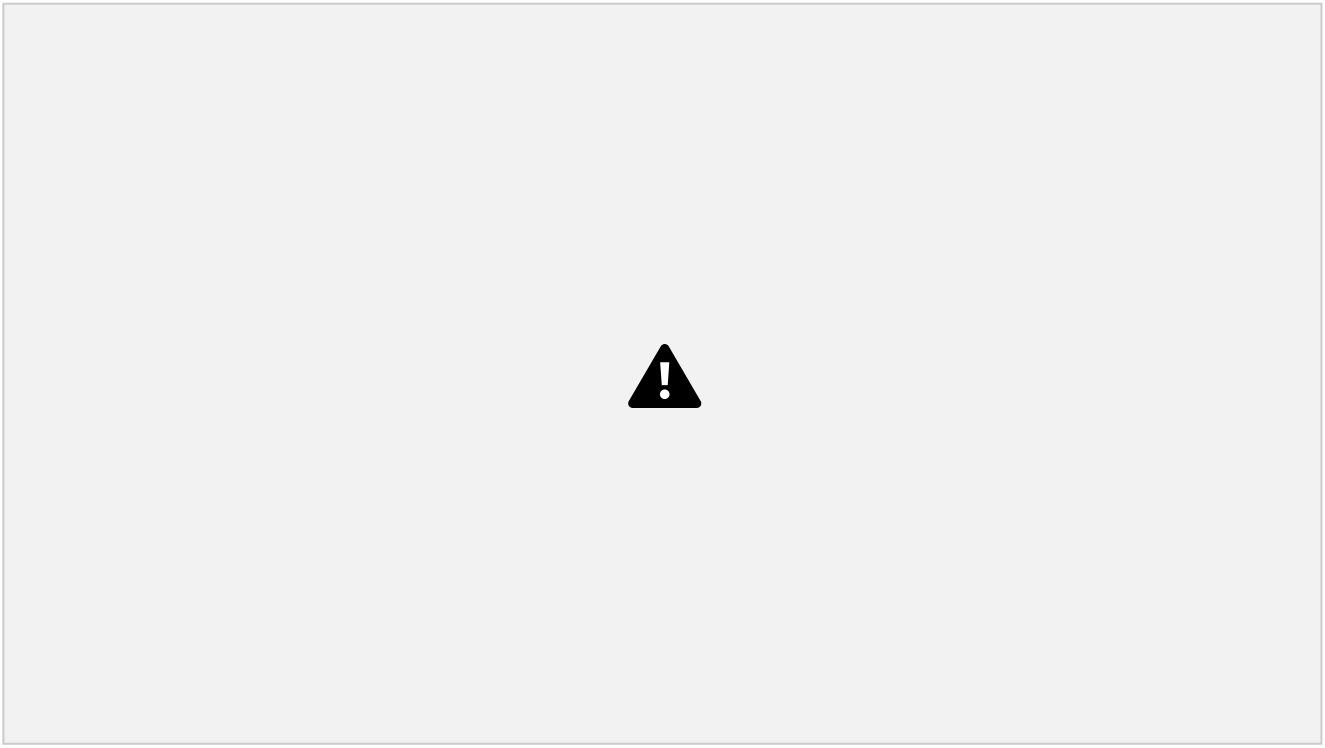
More recently, when we looked at **"Heat Domes" in CSSG-2.30**, a couple of the "News and Weather" graphics were:

This is definitely NOT "*a rotating, organized system of clouds and thunderstorms"*	**It may be sunny and hot under the dome (i.e., <u>not</u> a hurricane) but it IS ROTATING.**
	

Here's how that high pressure flow at the surface works. It presses down and flows out in all directions:



This rotating flow out from a high pressure area is now defined as an **Anticyclone**.

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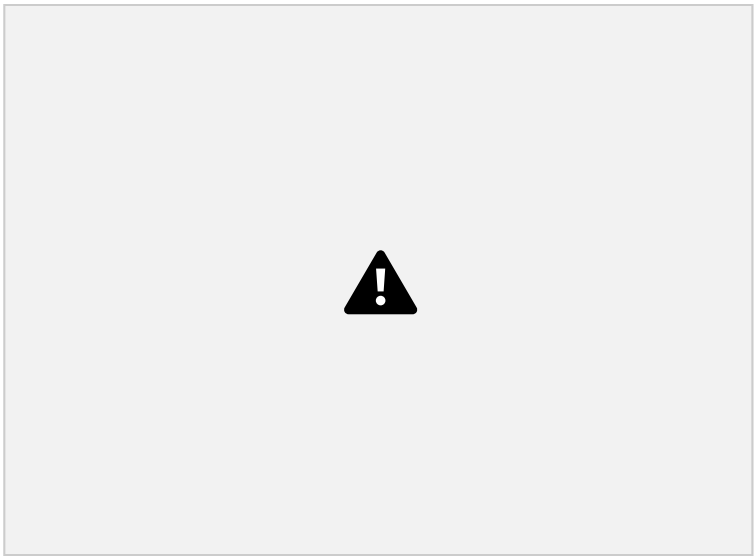
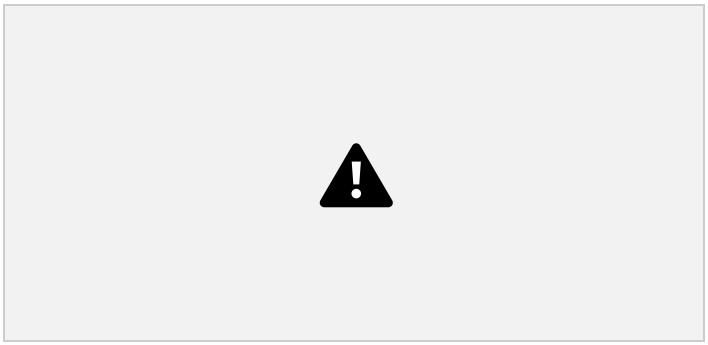
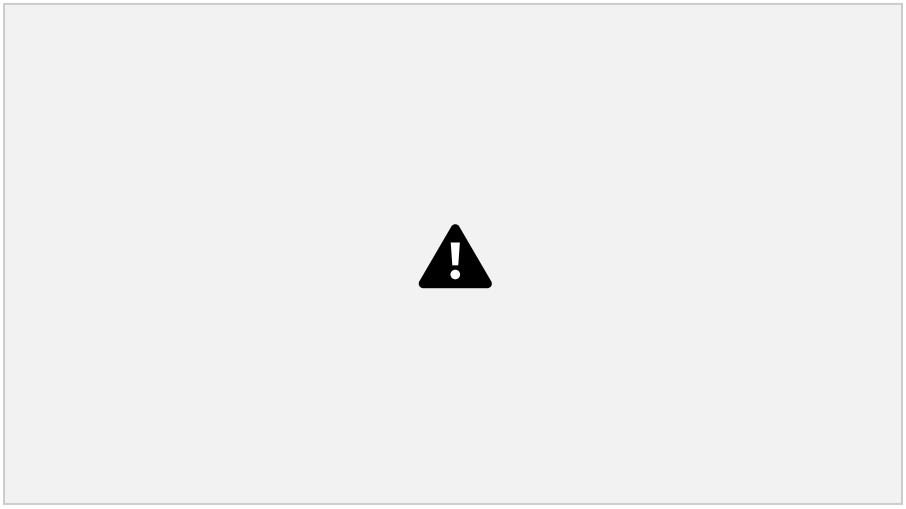


The surface of the Earth exerts a frictional drag on the air blowing just above it. This friction can act to change the wind's direction and slow it down -- keeping it from blowing as fast as the wind aloft. Actually, the difference in terrain conditions directly affects how much friction is exerted.





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