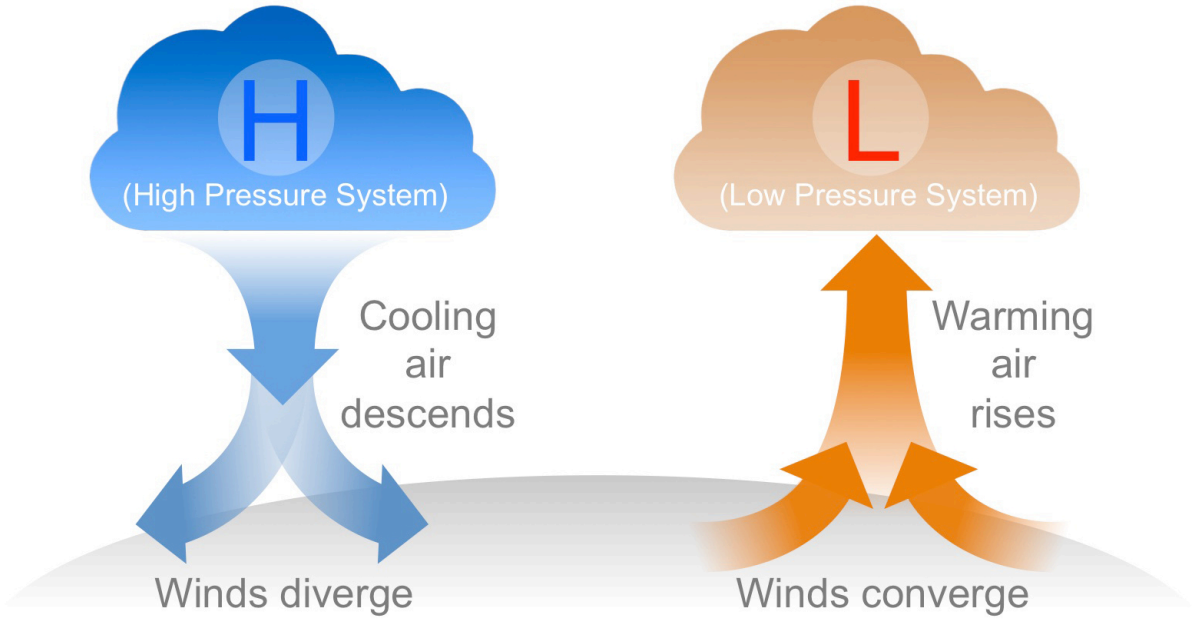
EXPEDITION EXPLORER GUIDE
THE WAYS OF **WIND AND WEATHER**

Dave spends a lot of time paying attention to the wind and weather patterns that control his journey. There are two types of weather patterns Dave is confronted with: global weather and local weather.

Warm air rises and cold air sinks

So how does it work?
Let's start with the most basic concept of weather: **warm air rises and cold air sinks**.
You've heard of a hot air balloon, right? Well, that's why they lift off. This concept is the first key to understanding wind and weather. Imagine the air around you isn't all one big cloud of air, but rather lots of pockets or parcels of air like cushions all packed together. This same bundling of globs happens under the ocean with seawater, as well as inside the earth's core with boiling magma. (Think of a lava lamp.)

Going back to the atmosphere, different pockets can have different temperatures and different moisture content, and can move independently of each other. A pocket that's close to the surface of the earth will receive more heat from the earth than a pocket of air higher up in the sky. This warm pocket of air will start to rise and as it rises, it cools down until it reaches a point where it starts sinking again. This process then starts all over again as parcels of air keep going up and down. The movement of air upwards is sometimes called an updraft.



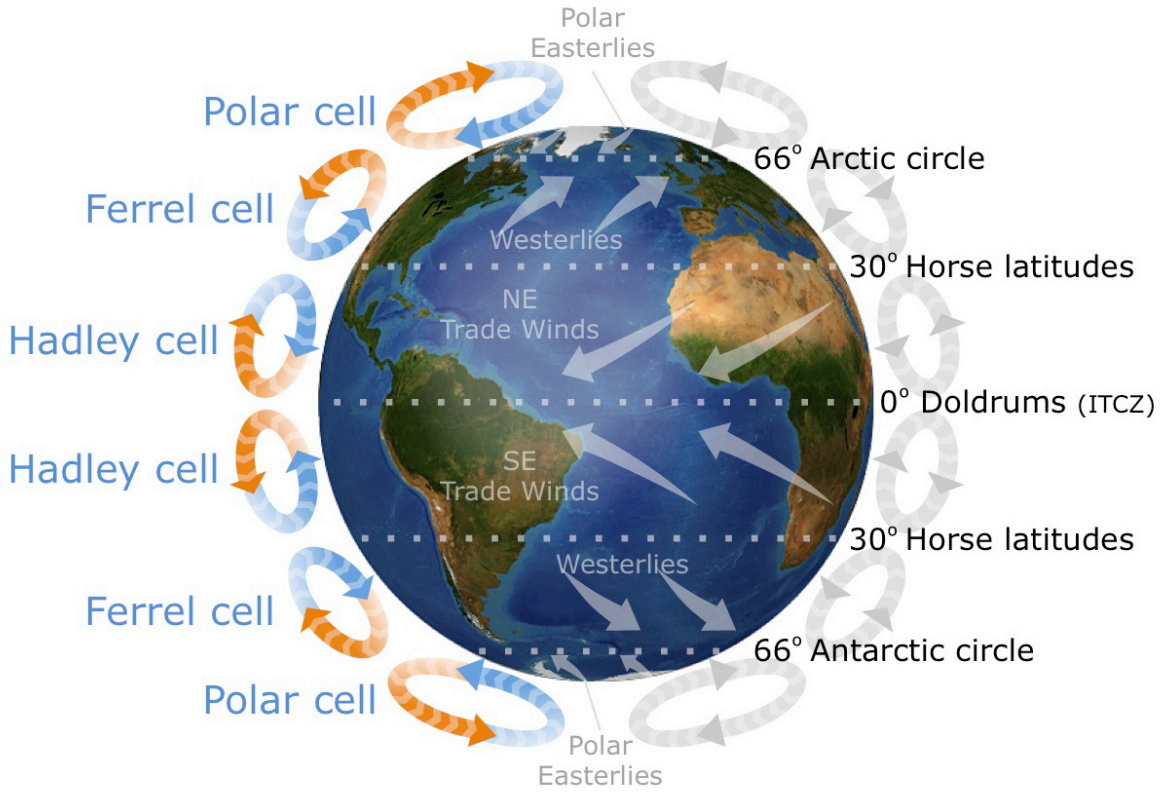
What does this have to do with winds?

Wind flows from areas of high pressure to areas of low pressure. This is due to density differences between the two air masses. High-pressure systems contain cooler or drier air, the air is more dense and flows towards areas that are warm or moist. The stronger the difference in pressure is between the two areas, the stronger the wind.

Global wind and weather patterns occur over very large parts of the globe and don't change very much if they change at all. These are things like the trade winds and the doldrums.

Now, let's imagine this process of air heating and cooling over a longer distance. The surface of the earth is covered by a series of these rising and sinking cells.

Global Wind Patterns



In the diagram, we see three wind cell types. We will talk about the Northern Hemisphere here, but it is exactly the same in the Southern Hemisphere - just flipped the other way! **Hadley Cells** transport air from the tropics towards the equator where it rises and is carried northward. The **Ferrel Cells** cover the mid-latitudes and carry air which sinks at the tropics north to the **Polar Cells** which then transport cold air south from the poles. This whole system distributes heat from the equator and tropics out to the mid-latitudes and polar regions. Also, notice where this system of circulation gives rise to the major winds, especially the trade winds which are so essential to sailing trans-Atlantic crossings.

EXPEDITION EXPLORER GUIDE
THE WAYS OF **WIND AND WEATHER**

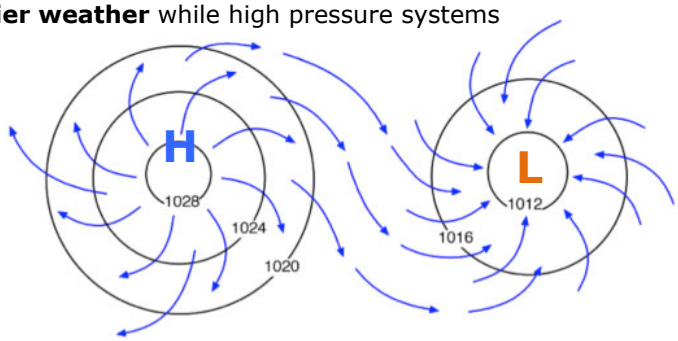
You've probably heard about high and low pressure in local weather reports. High or low means either higher or lower than the surrounding sea level pressure.

High and low pressure systems

The GENERAL RULE is that air flows INTO a low pressure and AWAY from a high pressure. In the Northern Hemisphere, winds flow clockwise around a high pressure zone and counter-clockwise around a low pressure one, and it's the opposite direction in the Southern Hemisphere. Low pressure systems are usually associated with **cloudy, wet, and windier weather** while high pressure systems bring **dry, clear and less windy conditions.**

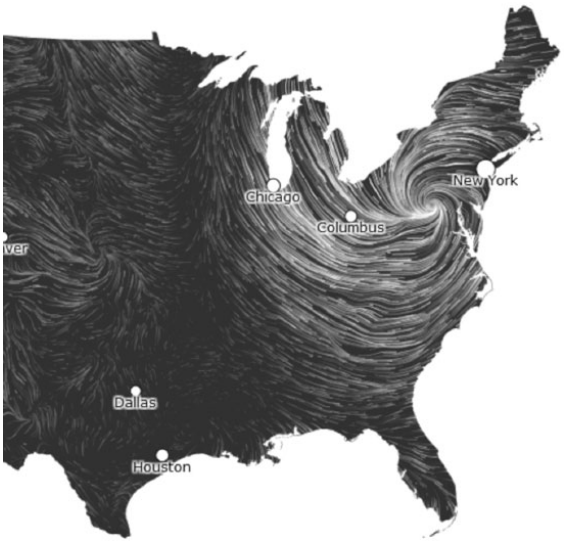
High and low pressure centers showing wind directions. (Northern Hemisphere)

Circles are isobars with pressure in millibars (mds, which are units of pressure)



How does this affect local weather?

Below is a picture of winds forming into a weather system. Based on the map we can say a lot about the local weather. From what we've learned so far, we can figure out if this is primarily a high or a low pressure based on the counter-clockwise circulation of the winds in the Northern Hemisphere.



Q: Are we looking at a high pressure or a low pressure?

Q: What types of weather are associated with low pressures?

Q: What do you think the conditions are like around Columbus and New York?

In the map, winds are circulating counter-clockwise which means this is a LOW pressure system. Another clue is that winds are circulating into a tight center as we see around the low pressure center. The HIGH pressure areas out west show much lighter winds. Since we know low pressure brings rain and cloudy weather, we can say that most of the northeastern United States is experiencing rainy or stormy weather with very high winds. In fact, this is a map showing wind conditions during Hurricane Sandy in 2012.

Nature's most powerful storms begin over the oceans. They are a natural part of wind and weather dynamics. But, if conditions change to a significantly warming planet these storms will become more powerful and cause more destruction.

Hurricanes

Hurricanes are their own very special kind of weather. They are also a natural hazard in the Atlantic, but mainly in the northern half of it. Rarely do tropical cyclones form in the southern parts, though the recent Hurricane Haiyan that hit the Philippines would suggest overall patterns may be changing. Hurricanes usually form between the beginning of June and the end of November. A Hurricane (or tropical cyclone) is a rapidly-rotating storm system characterized by a low-pressure center, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain.

Hurricane Sandy impacted the east coast of the United States in October 2012.
This epic storm caused more than $50 billion in damages