Exercise 3: Wind

We can describe wind fields as **vectors**, because wind is a quantity which has a **direction** and a **magnitude** (= wind speed). The aim of this exercise is to make you reflect on why prevailing winds blow from a certain direction (e.g. westerlies in mid-latitudes) and why it is actually very useful to think about wind as vectors!

1 Geostrophic winds

Add labels to the two arrows in Fig. 1a to show in which direction the **pressure gradient force** and **Coriolis force** act. Remember from your class that geostrophic winds blow parallel to isobars because the Coriolis force and pressure gradient force are in balance with each other. This leads to a deflection of the wind to the right or left, depending on the hemisphere. Add an arrow which is parallel to the isobar in Fig. 1a to indicate in which direction the geostrophic winds flow in the Northern hemisphere and in the Southern hemisphere.

Now, draw the directions of the geostrophic flow in the schematic for global circulation in Fig. 1b based on the high and low pressure areas. Compare the geostrophic wind flow directions you drew with the directions of trade winds and westerlies.

Do we actually see geostrophic winds in reality and if yes, where?

The third force which acts on wind and therefore controls the wind direction is the **friction drag**. This is especially important in urban areas and regions with "rough surface", which simply means that there are a lot of surface variations (topography or buildings) which can affect the local wind patterns.

How would the arrows of forces and wind directions look like if the friction drag is the third force acting on an air mass?

What are thermal winds and what do they have to do with geostrophic winds and friction drag?(Try to search for an answer, if you do not remember this from class.)

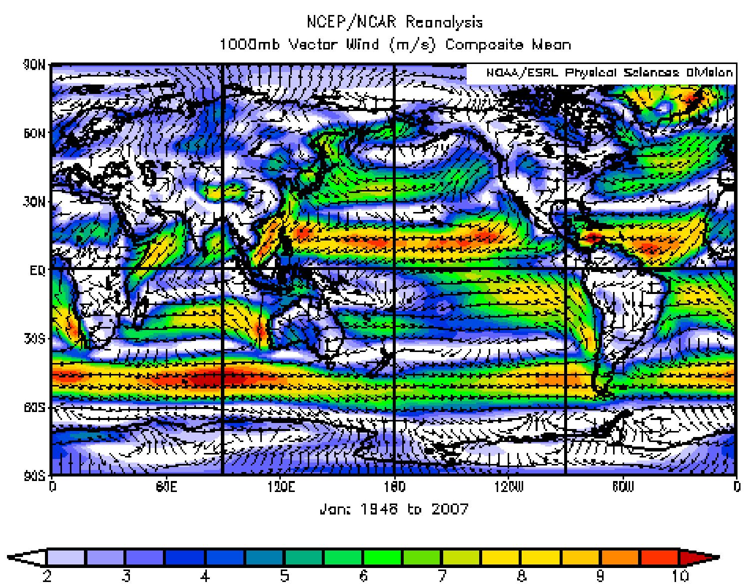
2 Wind directions and wind components

Recap, that you can decompose any vector into two components parallel to the x and y axis. We can, hence, decompose a wind vector with wind speed and wind direction into two components: the **u and v components** of the wind. In Fig. 2, you can see a hypothetical wind vector $\vec{v}$ which has a wind speed (e.g. 5 m/s) and a certain direction (e.g. 220° SW). Note that the meteorological wind direction in degrees always indicates where the wind blows **from**. The u component of $\vec{v}$ is parallel to the x-axis and the v-component of $\vec{v}$ is parallel to the y-axis. Draw in the u and v components in the diagram. With the help of **trigonometry**, can you find the equation how to derive the u and v components from the wind speed and the wind direction?

Discuss together in class how you derive the u and v components of the wind.

But why is it actually useful to do that? To give a simple example, we will now examine some wind measurements from Gothenburg. For that, open the Jupyter notebook called *wind.ipynb*!

> Here you can read more about the basic concept of wind and atmospheric motion: `https://www.e-education.psu.edu/meteo300/node/719`



Example for visualization of winds in map (from NOAA).

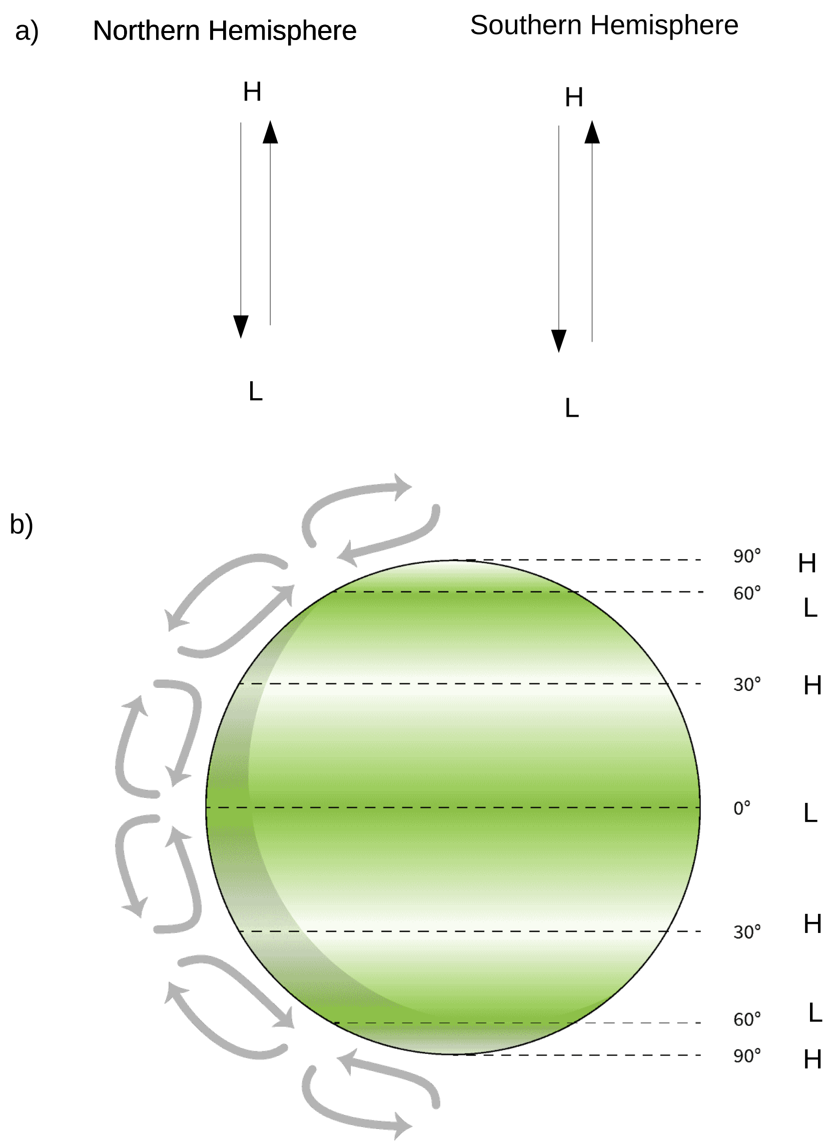


Figure 1: Draw the geostrophic wind flow in the Northern and Southern hemisphere.

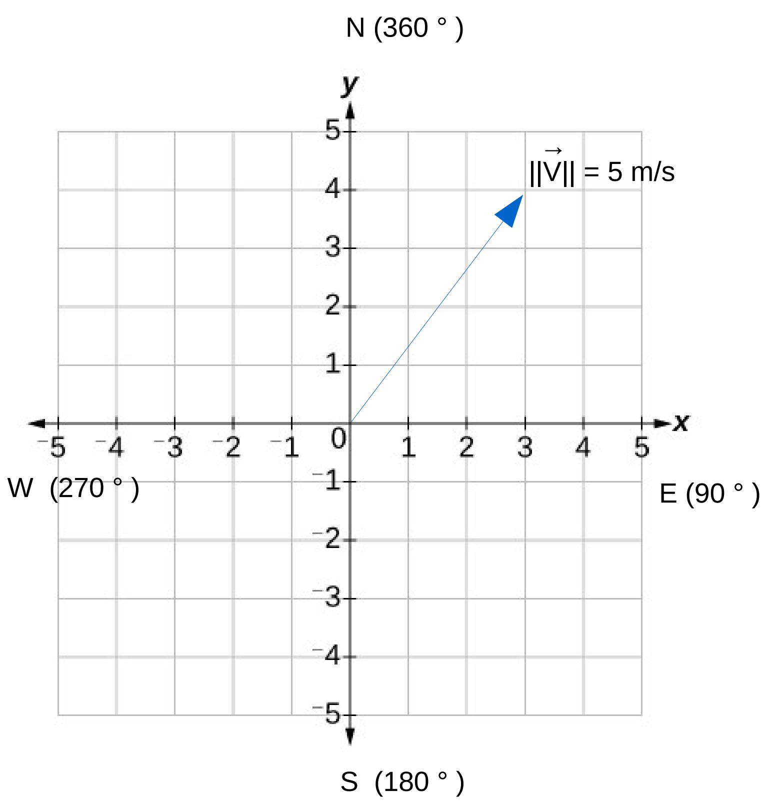


Figure 2: v displays a hypothetical wind vector blowing towards the northeast (from southwest) at a wind speed of 5 m/s.