# Topic: Global water stores & changes in magnitude
## *3.1.1.2 Water and carbon cycles*

| **What you need to know** |
|---|
| Recognise how global water stores are distributed within the lithosphere, hydrosphere, cryosphere and atmosphere. |
| Recognise the transfers that change the stores over time and space. |

**Introduction:**

Water is stored in the following places:

- The lithosphere (the solid outer crust and upper mantle). In oceanic crust it is stored within the rock structure which it is composed of and in continental crust it is also found in rocks, minerals, and also in clay and as groundwater.
- The hydrosphere (water on the surface of the planet). This includes oceans, seas, rivers, streams, lakes and ponds.
- The cryosphere (frozen areas on the planet). This includes glaciers and ice sheets as well as frozen sections of oceans, such as around the Antarctic.
- The atmosphere (the layer of gases surrounding the planet). Most obviously we see water storage in clouds, but water is stored in all layers of the atmosphere and even in clear air, microscopic particles of water vapour are carried.

**Distribution of global water stores**

| **Global water store** | **Approx. % of total stored water** |
|---|---|
| Hydrosphere | 96.5% |
| Atmosphere | 0.001% |
| Cryosphere | 1.7% |
| Lithosphere | 1.7% |

The size of the global water stores can change slightly. The largest store, the hydrosphere, has a limited change in volume over the short-term. However, if we consider longer timescales, such as during the last ice advance, the volume of ocean water will decrease as more of this water is contained in the cryosphere. Cryospheric stores can therefore increase in colder climatic conditions, whereas the lithospheric and atmospheric stores tend not to change a great deal.

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### Transfers that change the size (magnitude) of the stores

**Key point:** Whilst the overall volume of water contained in the stores does not change that significantly on the global scale, transfers and flows will affect the amount of water over time that remains in a store. A simple example of this is how levels of evaporation will increase in summer time which will lead to higher atmospheric storage and a slight drop in ocean storage. As mentioned earlier however, these are not significant changes in volume and the ocean will always remain the primary store in the water cycle.

### Evaporation

The process whereby liquid water changes into a gas (water vapour) when it absorbs heat energy. Approx. 90% of the atmospheric water store is from evaporation from the oceans and seas. The remaining 10% comes from plant transpiration.
High levels of evaporation can occur in some tropical and desert areas. These are regional scale changes. Increased global changes are likely to occur due to climate change and increased atmospheric temperature.
The level of evaporation on global scale ocean and sea level is minimal, but within a drainage basin evaporation can have a large regional scale impact. Lakes or rivers in an area with a high maximum summer temperature will experience high levels of evaporation and hydrospheric storage will reduce significantly in that area.

### Condensation

The process whereby the gaseous water vapour changes back into liquid water within the atmospheric water store. This occurs as temperature falls and humidity increases. Tiny, microscopic water molecules that develop around dust and smoke particles (known as aerosols) will be carried invisibly in the air. Where they combine into larger molecules of liquid water or ice they may be seen as mist, fog or clouds. This occurs on a global scale but could alter as climate change increases global atmospheric temperature.

### Cloud formation

Clouds form when water molecules aggregate (join up together). They are frequently noticed at the altitude where air temperature has fallen to a point where condensation of invisible water vapour occurs (condensation – or dew point), or where the humidity content has risen such that water vapour cannot remain in that state and condenses. As the molecules grow, clouds form with the tiny water or ice particles kept aloft by rising air currents (thermals).

### Precipitation

Generally, precipitation occurs when the water molecules within a cloud combine and become too big. This process is called coalescence. If the droplet's fall velocity is greater than the cloud's updraft velocity, then precipitation will occur. Simply put, if the droplet falls faster than the cloud moves it upwards, rain, snow or hail will fall from the cloud.

 

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Precipitation rates vary globally and over time. Rain doesn't fall in the same quantity in any place around the world.

There are a range of reasons for differing rainfall patterns:

- Desert areas (most lie between 15° and 35° north and south of the equator) have limited rainfall as they receive sinking, dry air from high pressure systems.
- Large continental interiors tend to be dry because of their distance from moisture sources and many clouds lose moisture before they can reach the centre of large continents. Central North America is an example of this.
- Polar areas are dry because cold air cannot hold as much moisture as warm air so precipitation can't occur so often.
- Areas near the equator receive high rainfall amounts because constant solar heating produces intense heating, large-scale evaporation, moist rising air that cools with altitude and forms **convectional rainfall**. In addition, air masses converge here which results in heavy rainfall.
- Mid-latitudes may experience convectional rainfall and polar and sub-tropical air masses meet here too which causes **frontal (or depressional) precipitation**. This is when a warm, moist air mass cools as it is forced to slide up over a colder, denser mass of air.
- Mountain ranges near water sources can receive high levels of precipitation because of uplift. Precipitation occurs when clouds rise to go over mountains and the air cools which encourages the water molecules to join and then precipitation occurs. Known as **relief, or orographic precipitation**, this accounts for many uplands receiving higher precipitation than similarly-located lowlands. This can also result in a sharp reduction in rainfall in regions behind (downwind of) the mountains. This phenomenon is commonly known as the rainshadow effect.

Future climate change could affect global precipitation patterns considerably. Some areas may see an increase in precipitation from increased evaporation while areas which have currently have regular rainfall could see a reduction. For example, Monsoon rainfall, which provides many countries in Asia with essential rainfall is reducing in duration.

### Cryospheric processes

These are the processes involving ice sheets and glaciers.

*Past events and their impact on cryospheric processes:*

The last ice advance (60 000 – 20 000 BCE) led to an increase in glacial accumulation (snowfall and increased ice coverage providing extra snow to glaciers and ice sheets) so the global cryospheric store was considerably larger at this point. Global sea level dropped at the same time; by about 120 m at the ice-maximum, although this was a relatively small proportion of total ocean storage.

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*Future events and their impact on cryospheric processes:*

The accumulation to glaciers and ice sheets (avalanches and snowfall) can vary depending upon global climate change. Recent warming of global climate has reduced accumulation and increased ablation (output) levels. Large volumes of summer meltwater and a reduction in winter accumulation has led to lower storage levels in global ice sheets and glaciers. In some areas of the world, for example in northern Bangladesh, the potential long-term risk is that the glaciers in the Himalayas that feed many of the rivers in the country, will melt completely and then important water supplies will disappear with catastrophic effects for farmers in the country. The impact on drainage basins across the world is potentially very serious, with seasonal river levels dropping due to a lack of meltwater from individual mountain glaciers.

Hill slope changes will occur also as individual glaciers will melt completely, depositing their encased material as moraines.