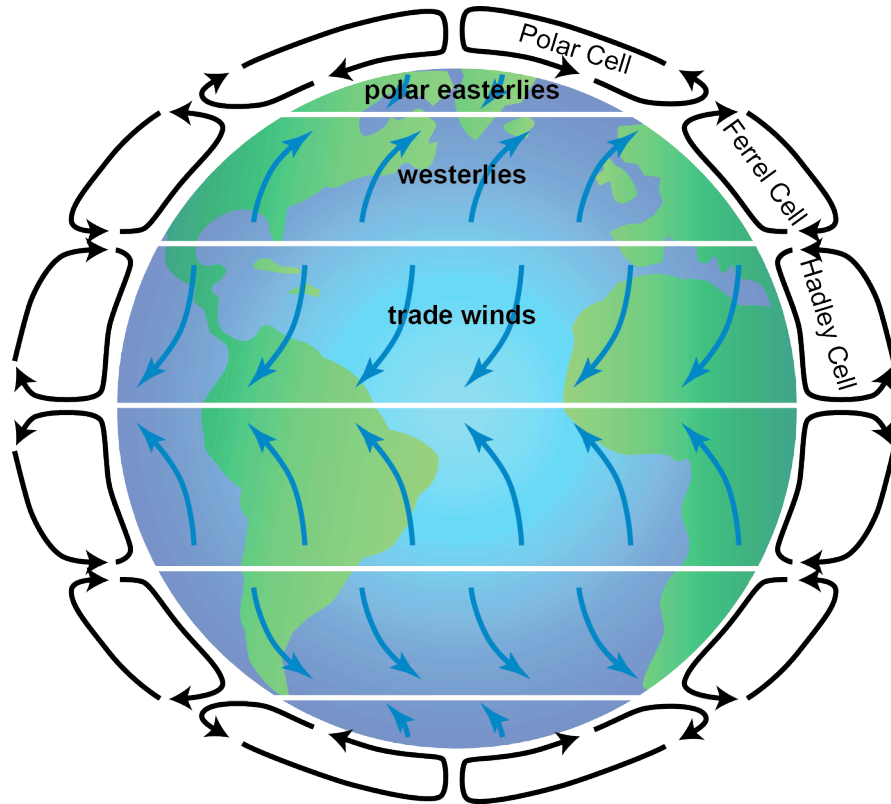


**Assessment Schedule – 2014****Earth and Space Science: Demonstrate understanding of processes in the atmosphere system (91414)****Evidence Statement**

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE	<p><b>Convection Cells</b></p> <p><b>A convection cell:</b> The term used to describe the phenomenon that occurs when density differences exist within a body of liquid, eg ocean or gas, eg atmosphere. Heat is different at the extremes of the body of gas (or liquid). When a volume of fluid is heated, it expands and becomes less dense and, thus, more buoyant than the surrounding fluid. The colder, denser part of the fluid descends to settle below the warmer, less-dense fluid and this causes the warmer fluid to rise. Such movement is called <b>convection</b>, and the moving body of gas (or liquid) is referred to as a <i>convection cell</i>.</p> <p><b>Hadley Cell:</b> A tropical atmospheric circulation, which features rising motion caused by solar radiation creating low pressure near the Equator. This creates a poleward air (airmass) flow 15–17 kilometers above the surface. This airmass cools and descends in the subtropics (30° latitude), then flows back towards the equator near the surface. This circulation is intimately related to extreme weather/climate conditions (eg easterly trade winds, tropical rain belts, hurricanes, subtropical deserts, and the jet streams). Hot air rises at the Equator and falls at about 30° latitude.</p> <p><b>Polar Cell:</b> Cold dense air descends over the Poles, which creates high pressure, this cold air moves along the surface to lower latitudes. At around 60° latitude north and south, this air has been warmed up and rises upwards, creating a zone of low pressure. The pressure difference allows convection current to form.</p> <p><b>Similarities:</b> Polar and Hadley cells show convection currents of warm air that rise, travel towards the poles and then fall when the air cools. Both are convection cells of the atmosphere. Both occur over 30° of latitude. Both cause easterly winds in their respective 30° of latitude, which travel towards the equator. Both the Hadley and Polar cells drive the Ferrel Cell.</p> <p><b>Differences:</b> Hadley temperatures are hotter, Hadley rises higher into the atmosphere. Hadley causes (easterly) trade winds while Polar causes polar easterly winds. Hadley cells contain more moisture in its air than the dryer Polar Cells. At the Equator, the air is hottest due to the direct fall of solar radiation from the sun. At the Poles, the same solar radiation is spread over a wider area due to the angle with which it strikes the surface resulting in a lower temperature of the Earth there. In the Hadley Cell, moist warm air, which is hot, rises to 15–17 km due to the energy that it has. In the Polar Cell, the temperature of the air at 60° latitude means that it does not rise as high as the Hadley Cell because it has less energy. At 60° latitude the top of the Polar cell reaches around 10 km.</p>	<ul style="list-style-type: none"> <li>• A description / diagram of a convection cell.</li> <li>• Correct placement of Hadley and Polar Cell on diagram.</li> <li>• Description of Hadley Cell.</li> <li>• Description of Polar Cell.</li> <li>• Describes the easterly wind movements in the convection cell.</li> </ul>	<ul style="list-style-type: none"> <li>• An explanation of how a convection cell works explaining the relationship between heat energy and convection cells.</li> <li>• An explanation of at least two features of the Hadley Cell.</li> <li>• An explanation of at least two features of the Polar Cell.</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensive discussion of at least two differences between Polar Cell and Hadley Cell.</li> <li>• Comprehensive discussion of at least two similarities between the Polar Cell and Hadley Cell.</li> </ul>



N0 = no response or no relevant evidence

N1 = 1 partial point, eg one definition

N2 = 1 point from Achievement

A3 = 2 points

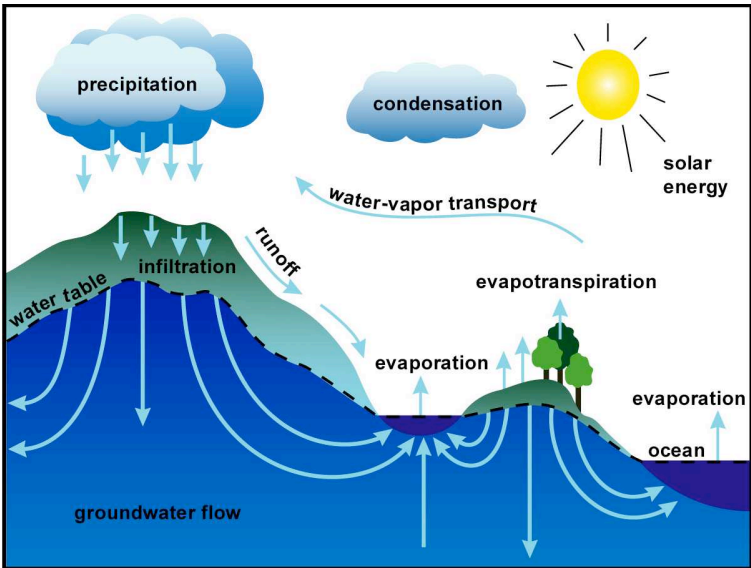
A4 = 3 points

M5 = An explanation of a convection cell with two features of one cell (Hadley or Polar).

M6 = An explanation of a convection cell with two features of a Hadley Cell and two features of a Polar Cell.

E7 = 1 complete point OR 1 difference and 1 similarity

E8 = 2 points

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO	<p><b>Water Cycle</b></p> <ul style="list-style-type: none"> <li>Water cycle diagram.</li> </ul>  <p><a href="http://extension.usu.edu/waterquality/images/uploads/educator_resources/lesson%20plans/water%20cycle/water%20cycle_NPS.jpg">http://extension.usu.edu/waterquality/images/uploads/educator_resources/lesson%20plans/water%20cycle/water%20cycle_NPS.jpg</a></p> <p><b>Evaporation</b> Evaporation is the process by which a substance changes from the liquid phase to the gas phase. On Earth, the most important substance is water. Energy is required for evaporation to occur (liquid water into water vapour). Energy can come from the Sun (radiation), the atmosphere (conduction) or the Earth (conduction). When energy is extracted from the atmosphere to evaporate liquid water, the atmosphere will cool. Evaporation is very important because it is how water vapour, which is needed for clouds and precipitation, enters the atmosphere. At the poles there is less evaporation than at equatorial regions.</p> <p><b>Condensation</b> Condensation is the process by which a substance changes from the gas phase to the liquid phase. As air containing water vapour rises into the atmosphere, it will expand and cool. If it cools to its dewpoint temperature, the air will become saturated and condensation will occur. Condensation can be observed in the atmosphere as clouds, fog, dew, or frost form. When</p>	<ul style="list-style-type: none"> <li>Describes changes of state in terms of ocean evaporation and water vapour condensation in the atmosphere.</li> <li>Describes the impact of changes of state on the environment (atmosphere / ocean).</li> <li>Describes changes of state in terms of energy absorbed or released.</li> <li>Describes the water cycle at Equator.</li> <li>Describes the water cycle at Poles.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the changes of state that take place in the water cycle.</li> <li>links these explanations to the energy transfer taking place. OR links the impact of the changes of state on air or ocean temperatures.</li> </ul>	<ul style="list-style-type: none"> <li>A comprehensive comparison of the water cycle (energy) at the Equator AND the Poles.</li> <li>A comprehensive comparison of the climatic conditions at the Equator AND the Poles.</li> </ul>

condensation occurs, the heat required to originally evaporate the water is returned to the atmosphere, causing the atmosphere to warm.

### **Precipitation**

Clouds are composed of millions of water droplets that have condensed. These water droplets grow into larger droplets by colliding and coalescing with one another. Eventually, the droplets can grow large enough so they will not be able to stay suspended in the cloud. When this occurs, they fall out of the cloud as precipitation. If the cloud's temperature is below freezing, it will contain ice crystals. Ice crystals collide and stick to other ice crystals and eventually fall from the cloud as snow. Precipitation is water, either liquid or solid, that falls from the atmosphere to the surface. [http://www.atmos.illinois.edu/earths\\_atmosphere/water\\_cycle.html](http://www.atmos.illinois.edu/earths_atmosphere/water_cycle.html)

Water that has evaporated from the ocean or land enters the atmosphere.

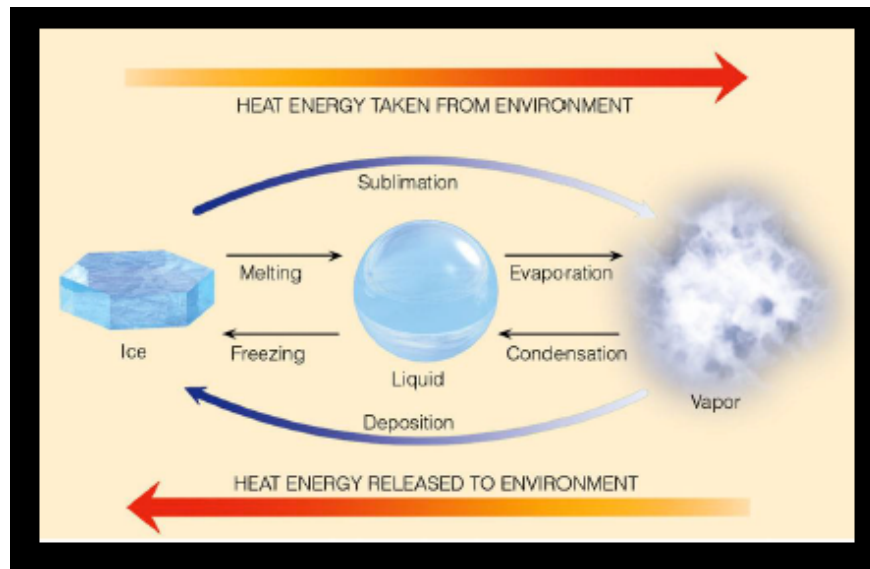
In the atmosphere water vapour in the gas state condenses into small droplets of liquid water in clouds, which coalesce (join together) into the precipitate rain (larger droplets). If cold enough, the liquid water will change into solid water, sleet, snow or ice (hail).

Summary:

gas → liquid → solid (states)

hot → cold → colder (temperatures)

As water vapour condenses into liquid water in the clouds, it releases heat energy into the atmosphere. This causes an increase in the high-altitude air temperature. As liquid water forms larger particles, there is no energy change, but more heat energy is released when / if water freezes. This causes an even greater increase in air temperature.



<p>Possible schematic diagram for answer.</p> <p>The <b>water cycle at the Equator</b> is mainly <b>evaporation</b> creating moist air that, when it is high enough, may condense to form clouds.</p> <p>The evaporation helps cool down the hot air. The Equator gets the direct rays of the sun so is very hot.</p> <p><b>At the Poles</b> the air is very dry as nearly all of the water is locked up in ice. While it snows at the Poles it does not rain as it is too cold for water to remain liquid in the cold air. There is seasonal melting of some of the ice but most remains as ice, eg approx. 20 000 years for Antarctica. <b>Precipitation</b> is the main process of the water cycle that happens at the Poles.</p> <p>The water cycle is the most fundamental system operating on the surface of the Earth. The varied processes of the water cycle control the global climate, shape the landscape, and allow life to exist.</p> <p>The movement and distribution of water across the planet determines broad climate patterns. Evaporation powers vast weather systems like hurricanes and cyclones, while uneven precipitation nourishes rainforests or parches deserts. Other weather events, such as floods, droughts, and blizzards, are all aspects of the water cycle.</p>									
	NØ = no response or no relevant evidence	N1 = 1 partial point described	N2 = 1 point from Achievement	A3 = 2 points	A4 = 3 points	M5 = 1 point fully explained OR 2 points partially explained	M6 = 2 points	E7 = 1 point fully detailed comparison OR 2 points partially detailed	E8 = 2 points fully detailed comparison

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE	<p><b>Volcanic Aerosols</b></p> <p>Troposphere closest layer to surface of Earth, and Stratosphere layer above up to 50 km.</p> <p>Aerosols are very small particles of solid or liquid in a gas medium. Volcanic aerosols are the small particles of gases and ash, which originate from the magma within a volcano, which have high energy during a volcanic eruption.</p> <p>The gas particles and ash are the matter that is transported. When the volcanic aerosols are first erupted from the volcano during the volcanic eruption, they have high temperature and energy. They cool down and lose energy, but not mass, as they rise higher in the cool atmosphere as the heat energy is transferred to the cool air. To send aerosols into the stratosphere, an eruption must be big and explosive: strong enough to hurl volcanic matter at least 15 km high, above the troposphere.</p> <p>Unlike air in the troposphere, which is continuously churning, air in the stratosphere stays in separate layers. When aerosol particles enter this layer they can float in the stratosphere for years. In the troposphere, most aerosol particles would fall to the ground within weeks.</p> <p>The stratosphere and troposphere behave differently because they are heated differently. The troposphere is heated from below; warm air near the ground rises to the top of the troposphere, cools, and falls again. In the process, airborne particles in the troposphere are swept down to Earth's surface. Rain and snow also wash particles out of the troposphere.</p> <p>The stratosphere, in contrast, is heated from above, by the Sun's radiation. Since the warmest air is already at the top, there is no vertical circulation in the stratosphere. The lack of clouds and rain in the stratosphere also keep particles from washing to the ground. Aerosols in the stratosphere will be spread through this layer due to the rotation of the earth and the strong "geostrophic" winds. This movement spreads the aerosols around the globe.</p> <p>Volcanic Aerosols in the <b>troposphere</b> will cause a <b>short term change</b> to the regional climate. Eg, the smaller <b>Ruapehu eruption</b> only transported volcanic aerosols into the lower troposphere which had a short term effect on climate. Ash fell from the sky after a relatively short period of time – days to weeks. Due to the prevailing westerlies, most ash fell out at sea, but air transport in the middle of the North Island was interrupted for a week.</p> <p>Volcanic aerosols from the much larger <b>Taupo eruption</b> were transported into the stratosphere and distributed around the globe. Sunlight was prevented from reaching the surface of the earth in the usual amounts, so less photosynthesis could occur. This had an impact on plant life and contributed to cooling of the surface of the Earth. Also the increased gases present reflect more solar radiation out into space, so less reached earth. The effect of volcanic aerosols in the <b>stratosphere</b> were of a <b>much longer duration</b> – months to years – and regional climate <b>change was experienced over a greater area of the Earth.</b></p>	<ul style="list-style-type: none"> <li>• Annotates diagram to show troposphere and stratosphere or describes the troposphere and stratosphere layers.</li> <li>• Describes volcanic aerosols.</li> <li>• Describes matter transported.</li> <li>• Describes heat energy transported.</li> <li>• Describes climatic effect of an eruption.</li> </ul>	<ul style="list-style-type: none"> <li>• Explains transport of matter <b>to</b> the two layers.</li> <li>• Explains transport of heat energy <b>to</b> the two layers.</li> <li>• Explains transport of matter <b>within</b> the two layers.</li> <li>• Explains transport of heat energy <b>within</b> the two layers.</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensive discussion of effects of volcanic aerosols on regional climates for <b>both</b> layers of the atmosphere.</li> <li>• Comprehensive discussion of effects of volcanic aerosols on global climates for <b>both</b> layers of the atmosphere.</li> </ul>

	<b>(Note: the specifics of the Taupo/Ruapehu eruptions are not important but the general effects of the eruptions' sizes are required.)</b> <a href="http://www.amnh.org/education/resources/rfl/web/bulletins/earth/A/1/1/index.html">http://www.amnh.org/education/resources/rfl/web/bulletins/earth/A/1/1/index.html</a>								
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