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91414



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Mana Tohu Mātauranga o Aotearoa  
New Zealand Qualifications Authority

## Level 3 Earth & Space Science 2023

### 91414 Demonstrate understanding of processes in the atmosphere system

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of processes in the atmosphere system.	Demonstrate in-depth understanding of processes in the atmosphere system.	Demonstrate comprehensive understanding of processes in the atmosphere system.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA). This area will be cut off when the booklet is marked.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**Achievement**

**TOTAL 10**

## QUESTION ONE: FLYING HIGH

Pilots of jet aircraft that fly long distances prefer to fly in the lower stratosphere. In the stratosphere, atmospheric conditions have less turbulence which is caused by the vertical movement of air. Aircraft also have better fuel efficiency, as the air is thinner. However, jet engines need sufficient oxygen to work. Sometimes pilots make use of jet streams in the upper troposphere.

**Figure 1: Jet stream locations**

**Figure 2: The stratosphere and troposphere**

Source: [www.weather.gov/jetstream/jet](http://www.weather.gov/jetstream/jet)

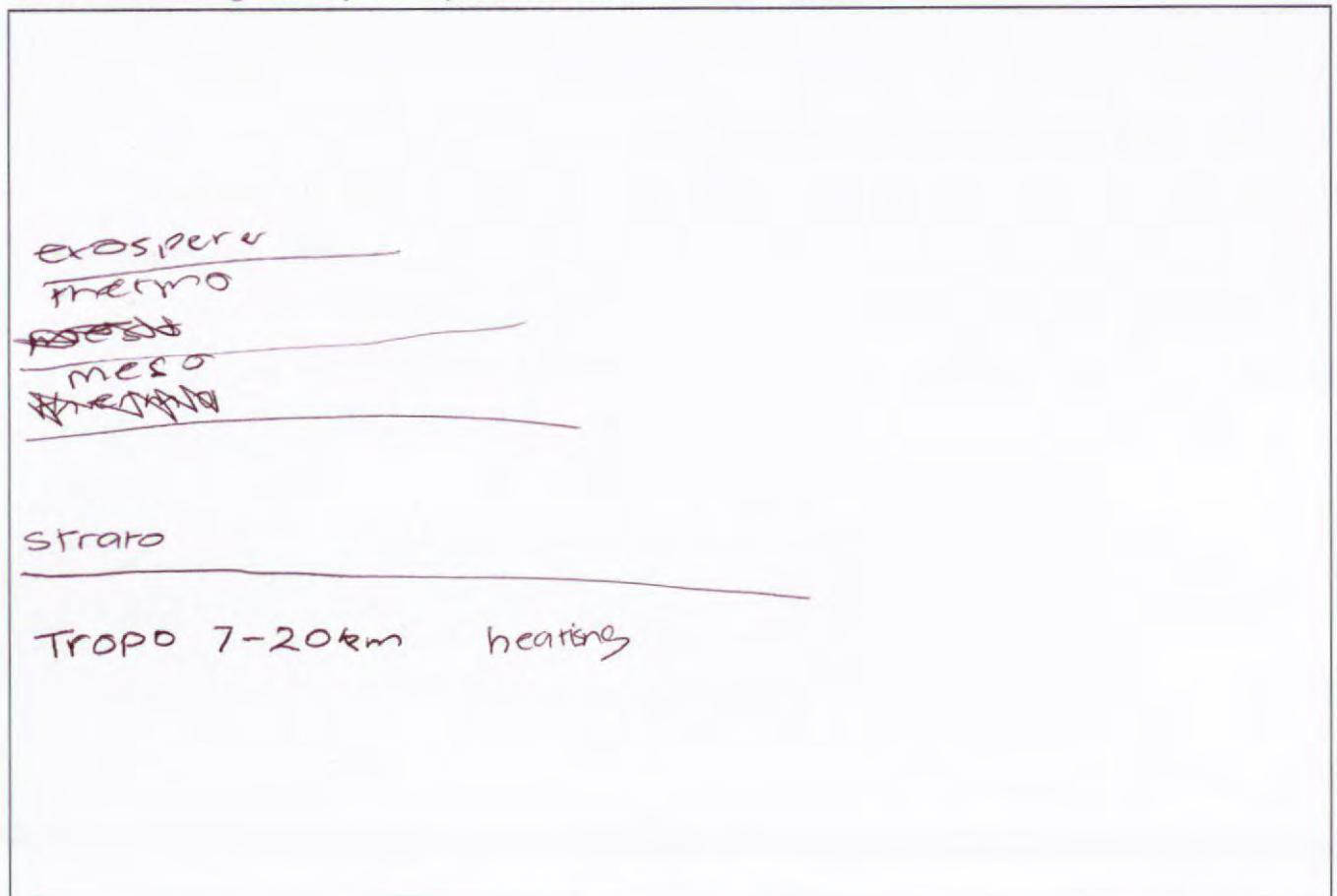
Source: <https://geoengineering.global/stratospheric-aerosol-injection/>

Discuss why pilots prefer to fly in the stratosphere, instead of the troposphere.

In your answer, you should explain:

- differences in density, pressure, temperature, and composition of the troposphere and stratosphere ✓
- atmospheric conditions in both layers, and how this may impact on flights ✓
- how jet streams may help or hinder flights.

An annotated diagram may assist your answer.





pilots may prefer stratosphere over the troposphere because in the troposphere it is where the weather patterns occur which are always issues when flying. In the stratosphere weather does not play a major effect because there is little to no weather patterns. In the troposphere the temperature decreases with the increase in altitude. However in the troposphere the temperature increases with the increase in altitude. The air ~~pressure~~ density is also different in the two ~~sides~~ ~~at~~ areas because as they increase altitude in places from ~~from~~ troposphere to stratosphere it will become thinner with less particles being in the atmosphere. There is also the pressure which ~~becomes~~ becomes heavier as they increase in altitude so in the troposphere the air pressure would be ~~at~~ quite light where as the troposphere it would be heavier because when altitude increases the air pressure begins to ~~weigh~~ weigh more. The reason for the troposphere having a warmer area is because of the infra-red heating from the earth's surface but decreases the further it gets away. The stratosphere's temperature will increase the higher they increase in altitude because it has the ozone layer which holds the earth at a ressemblable temperature.

There is more space for  
 your answer to this question  
 on the following pages.









## QUESTION TWO: AEROSOLS

The highest concentrations of sea spray aerosols occur in the lower troposphere near 50 °S. The spray is transported towards New Zealand by strong prevailing westerly surface winds. This contributes to the west coast of the South Island being the wettest area in New Zealand.

**Figure 3: Production of sea spray aerosols**

**Figure 4: Sea-spray concentration at Earth's surface**

Adapted from: [www.mdpi.com/2072-4292/13/4/614](http://www.mdpi.com/2072-4292/13/4/614)

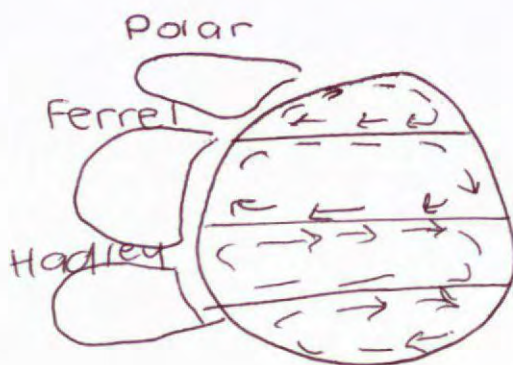
Source: [https://pdfs.semanticscholar.org/8eb9/33a0e3594e9c6f13ad6b17d020acea94b138.pdf?\\_ga=2.189352232.2063430432.1658545364-1415782361.1658545364](https://pdfs.semanticscholar.org/8eb9/33a0e3594e9c6f13ad6b17d020acea94b138.pdf?_ga=2.189352232.2063430432.1658545364-1415782361.1658545364)

Explain the processes that lead to cloud formation and high rainfall on the west coast of the South Island.

In your answer, you should consider:

- the formation of the Ferrel cell and surface winds around 50 °S latitude
- the production of salt spray aerosols and the role they play in cloud formation.

*An annotated diagram may assist your answer.*





aerosols are particles that minute liquid and solids found in the earth's atmosphere. They contribute to the formations of clouds in the west coast because as long as there are particles such as dust, sea spray aerosols can contribute to cloud formations. For a cloud to form there needs to be aerosols and water vapours which is a gas. These two would bump into each other ~~reg~~ regularly eventually they will fully collide and stick together. As they fuse together they start to create water droplets and with multiple ~~droplets~~ being created it creates the cloud. With the high production of sea ~~spray~~ spray in means there are a lot of aerosols rising into the atmosphere allowing the process to form a cloud to keep reoccurring.

With the force of the wind going across the earth's surface and pushing at the currents it collides with breaking waves sending ~~aer~~ sea spray aerosols into the atmosphere and contributing to the constant cloud formation.

There is more space for your answer to this question on the following pages.









### QUESTION THREE: GLOBAL CLIMATE TIPPING POINTS

An estimated 28 trillion tons of ice disappeared from the Earth's surface between 1994 and 2017. Over the same period, the average global temperature increased by 0.7 °C. Climate scientists consider this to be a potential “tipping point”, which is a small change in the climate system that could lead to much greater irreversible changes. This is also referred to as a positive feedback loop.

**Figure 5: Global change in ice mass  
(1994–2017)**

**Figure 6: Average global surface temperature,  
(1994–2017)**



Adapted from: [https://www.researchgate.net/figure/Global-ice-mass-change-between-1994-and-2017-partitioned-into-the-different-floating\\_fig4\\_348753744](https://www.researchgate.net/figure/Global-ice-mass-change-between-1994-and-2017-partitioned-into-the-different-floating_fig4_348753744)

Adapted from: [https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series/globe/land\\_ocean/12/1/1994-2017](https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series/globe/land_ocean/12/1/1994-2017)

Discuss the causes and effects of a decline in polar ice on the atmosphere and global climate.

In your answer, you should explain:

*thermal expansion*

- the greenhouse effect, including changes due to human activity
- how surface ice regulates atmospheric temperature
- how change in surface ice may lead to faster climate change.

*You do not need to discuss sea level change or ocean processes.*

*An annotated diagram may assist your answer.*



the greenhouse effect is the effect of gases such as carbon dioxide and methane being released into the atmosphere, there are natural causes such as carbon being released into the atmosphere from the ocean, fresh water areas such as lakes and rivers these are just a few of the things known as carbon sinks which naturally released carbon into the atmosphere these sinks keep the earth's temperature at a relatively even balance. However with carbon being one of the biggest ~~components~~ components to earth's ~~surface~~ temperature change there are human activities that release greenhouse gases. Some being fossil fuels, transport, and agriculture which is the biggest methane gas contributor. ~~and~~ These human activities have added to the atmosphere's temperature and off sets its natural balance which has meant heat is being stored around us off setting the regular patterns. Surface ice regulates atmospheric temperature by storing carbon and reflecting heat to the atmosphere. This is a regular pattern however if there is more heat being reflected into the atmosphere and back to the ocean there will be a thermal expansion because as it gets warmer it expands and then with the ocean being a carbon sink it will release

There is more space for your answer to this question on the following pages.



It into the atmosphere this means the average temperature that holds surface ice will change meaning it is harder to hold the surface ice or for it to form as the warm air continues to rise. Climate is a change over time in an area and affects the regular patterns of a process such as an atmospheric temperature change will have a change on the formation of surface ice as well as ocean temperature.





## Achievement

**Subject:** Earth & Space Science

**Standard:** 91414

**Total score:** 10

Q	Grade score	Marker commentary
One	A4	Describes with understanding the weather, temperature gradient and heating sources for both layers. There is no clear explanation of why gradients exist or why weather occurs, thus the grade is limited to A.
Two	A3	Describes with understanding what aerosols are and how they contribute to cloud formation with the addition of water vapour. There is no evidence of a clear explanation of the interaction between aerosols and water vapour for merit.
Three	A3	Describes with understanding how human activities increase GHGs, how they cause higher temperature and how ice reflects incoming solar radiation. Detail explanations are lacking.