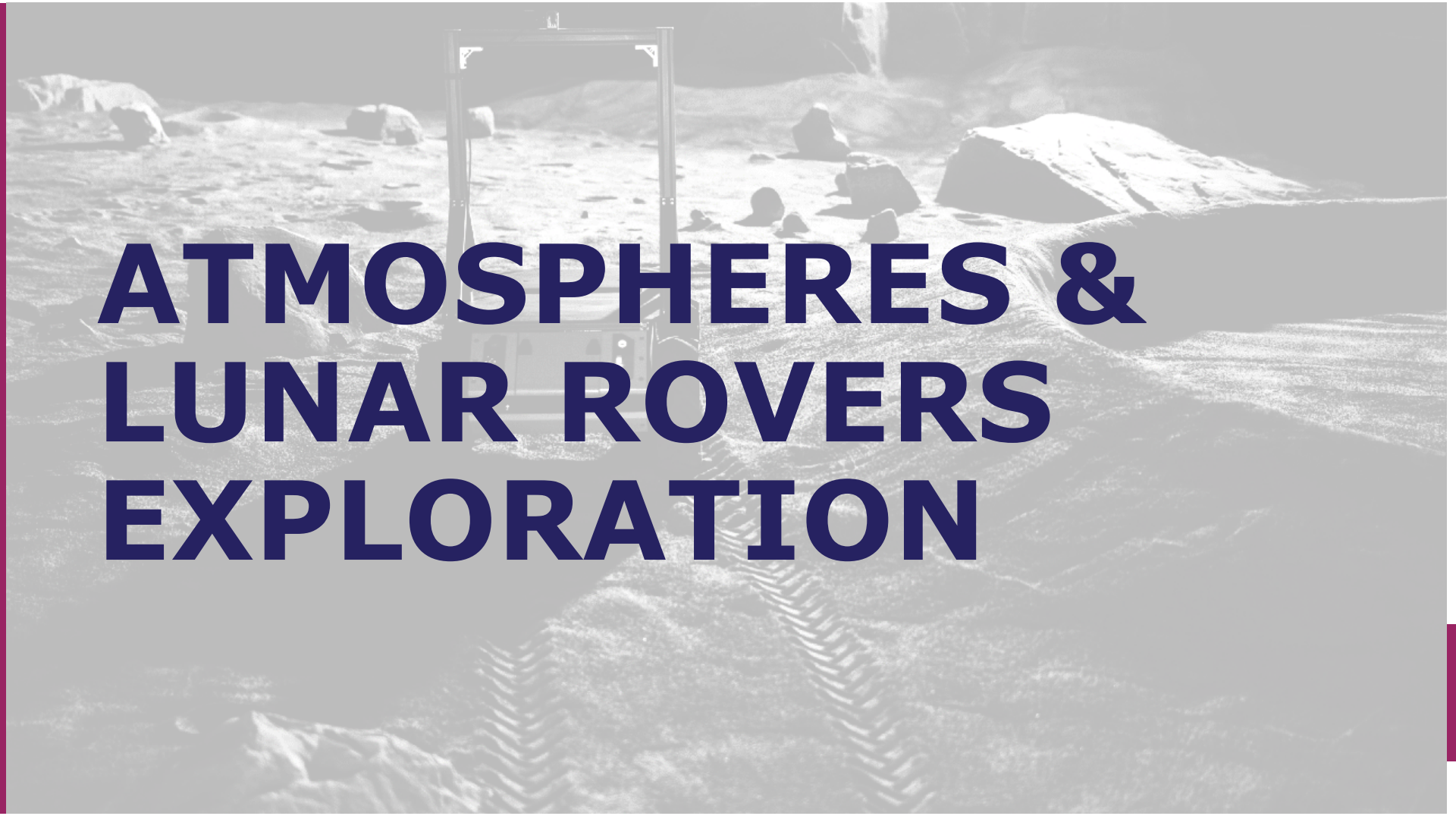
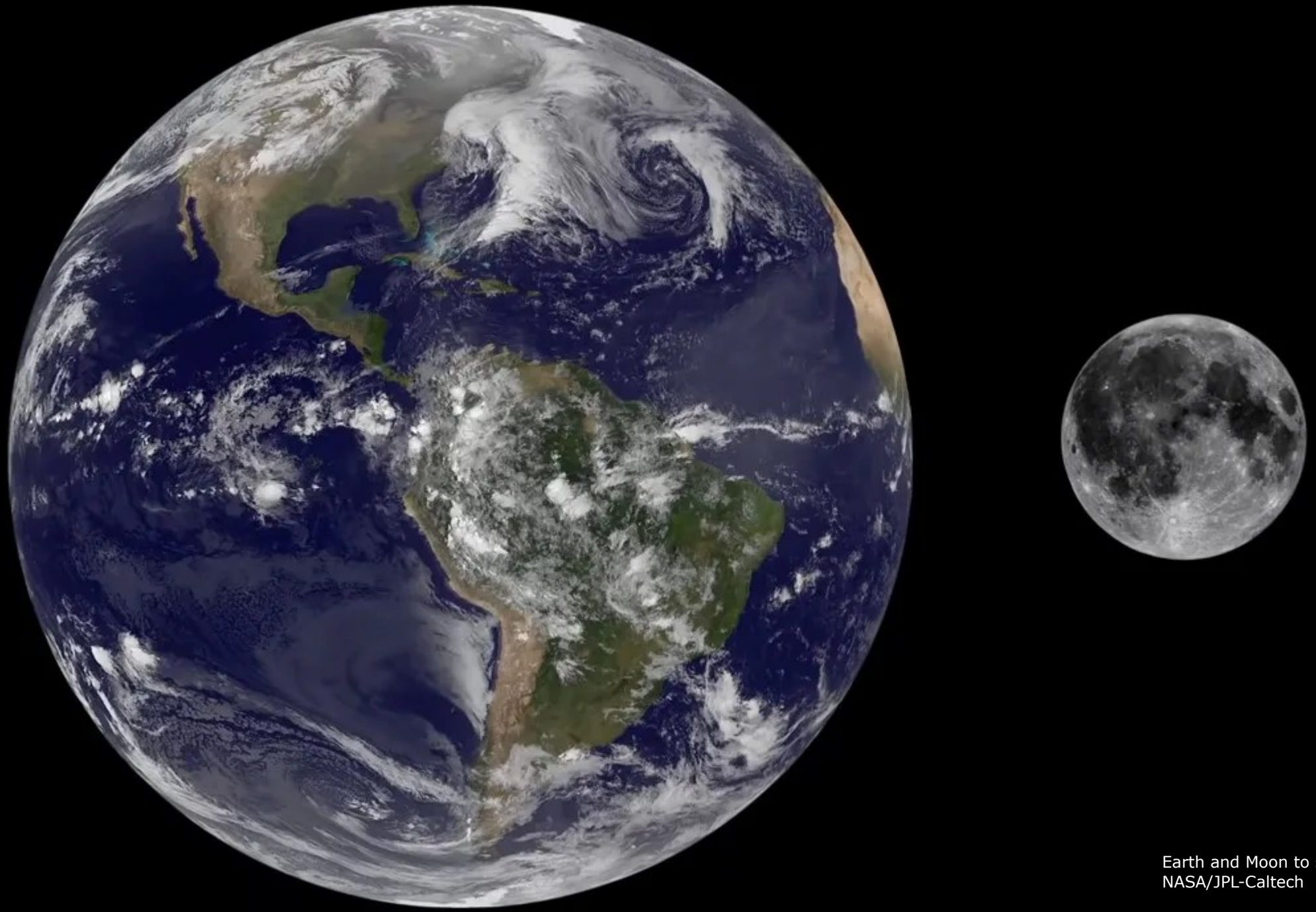


ATMOSPHERES & LUNAR ROVERS EXPLORATION

MISSION CONTROL



Earth and Moon to scale.
NASA/JPL-Caltech

MISSION CONTROL

LEARNING OBJECTIVES

- Understanding Earth's Atmosphere
- Exploring the Moon's Unique Conditions
- Connecting Atmospheres and Lunar Rovers
- Highlight the Importance of All of It

MISSION CONTROL

EARTH'S ATMOSPHERE

MISSION CONTROL

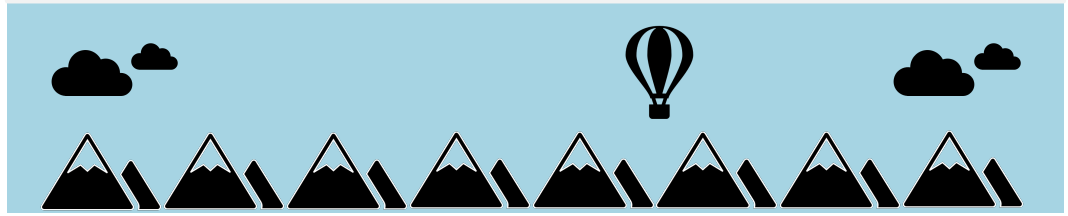
EARTH'S ATMOSPHERE

Earth's atmosphere is a dynamic layering of gases extending from the planet's surface. Composed primarily of nitrogen and oxygen, it supports life, regulates climate, and facilitates weather patterns.

MISSION CONTROL

TROPOSPHERE

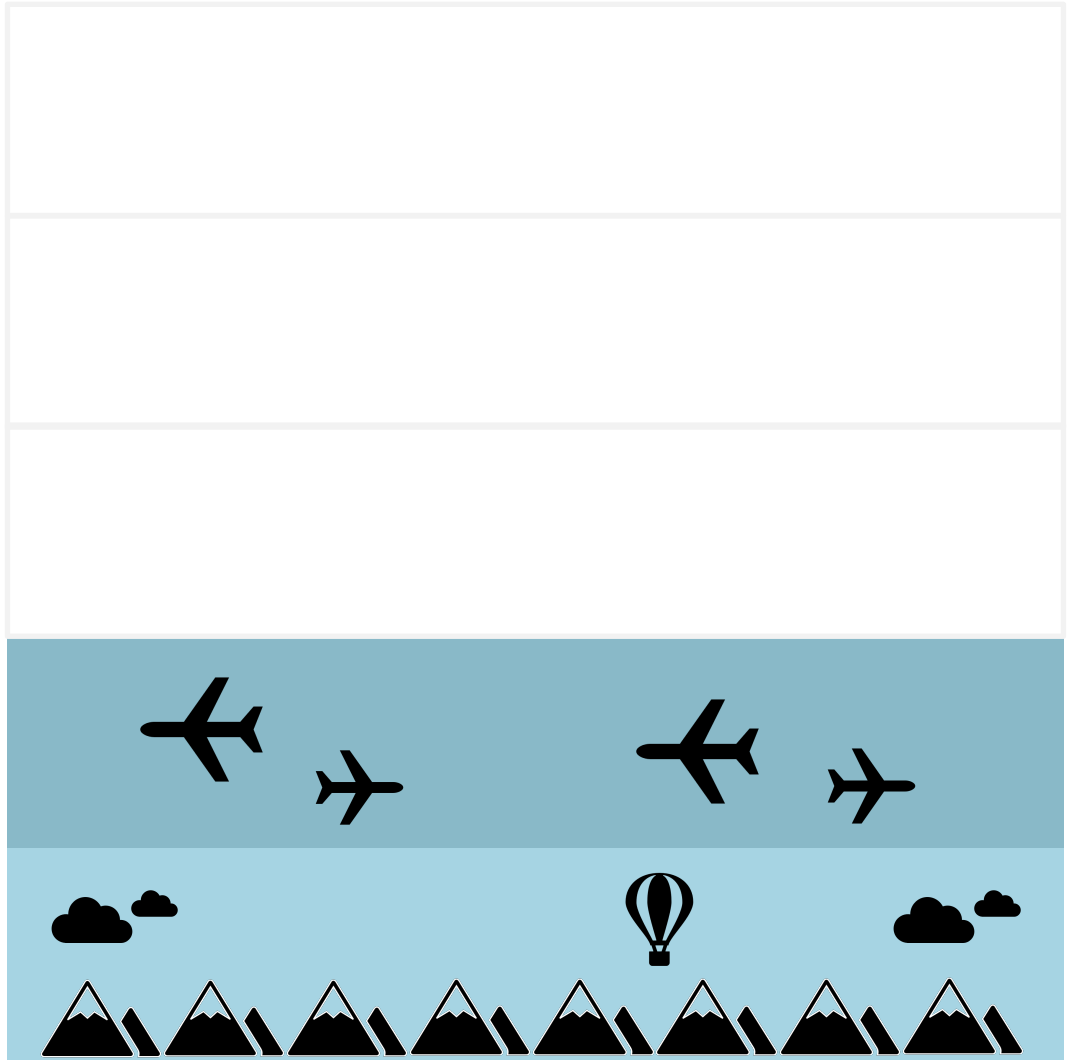
This is the layer closest to Earth's surface, where weather phenomena occur.



MISSION CONTROL

STRATOSPHERE

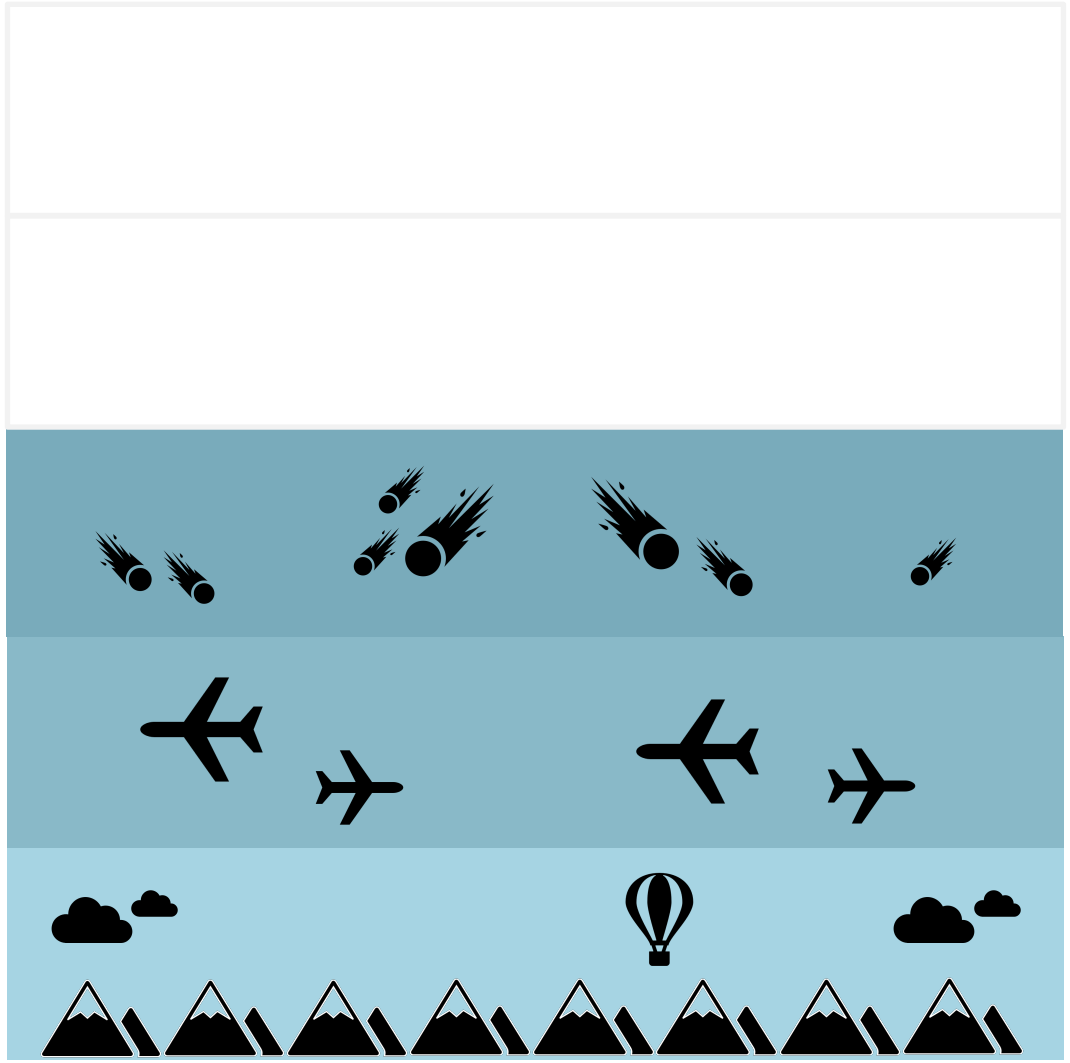
Above the troposphere, the stratosphere contains the ozone layer, which absorbs harmful ultraviolet (UV) radiation from the sun. This layer protects life on Earth from excessive UV radiation. For space missions, understanding the stratosphere is crucial to accounting for intensity of UV exposure and its impacts on materials.



MISSION CONTROL

MESOSPHERE

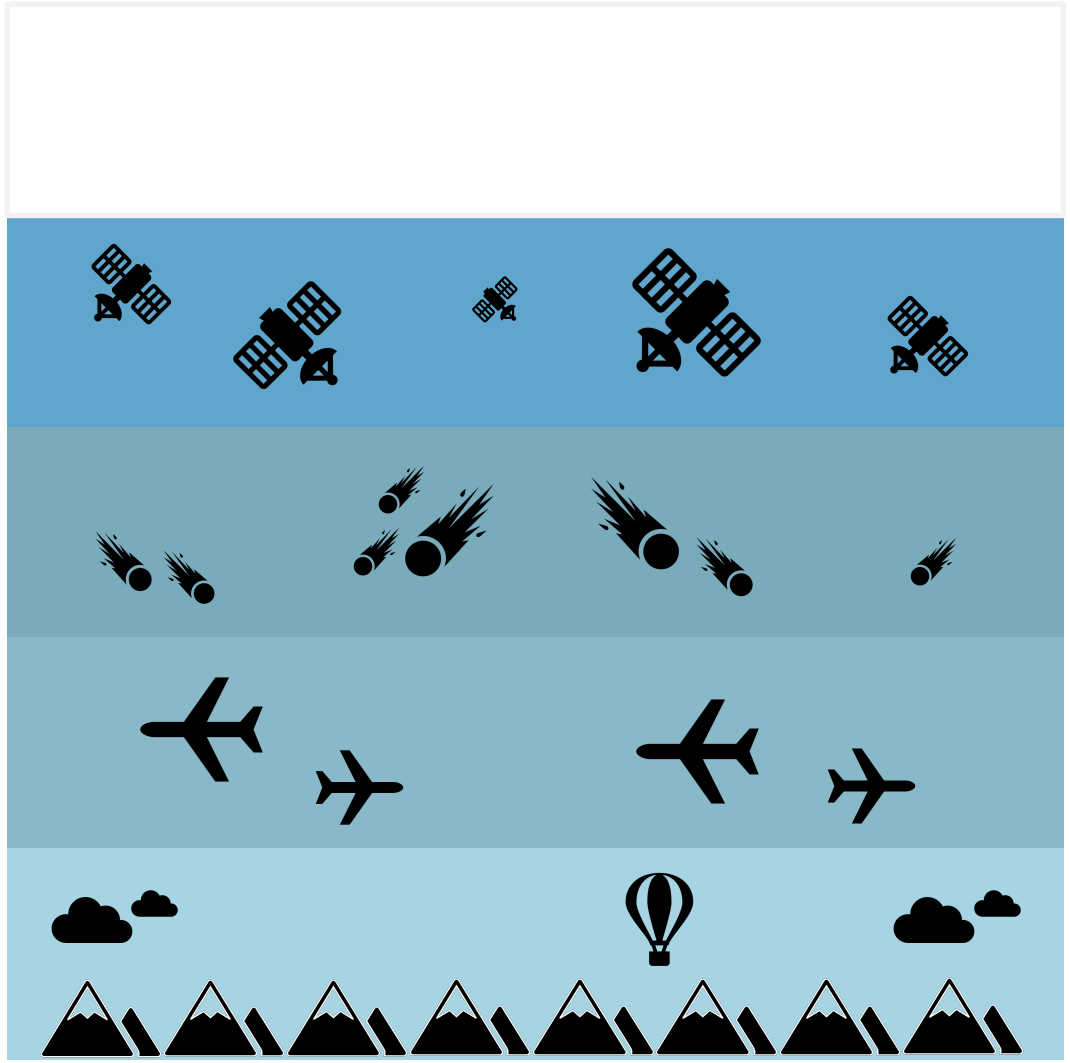
Beyond the stratosphere, the mesosphere is characterized by its extreme cold temperatures. It plays a role in the disintegration of meteors and other debris entering Earth's atmosphere.



MISSION CONTROL

THERMOSPHERE

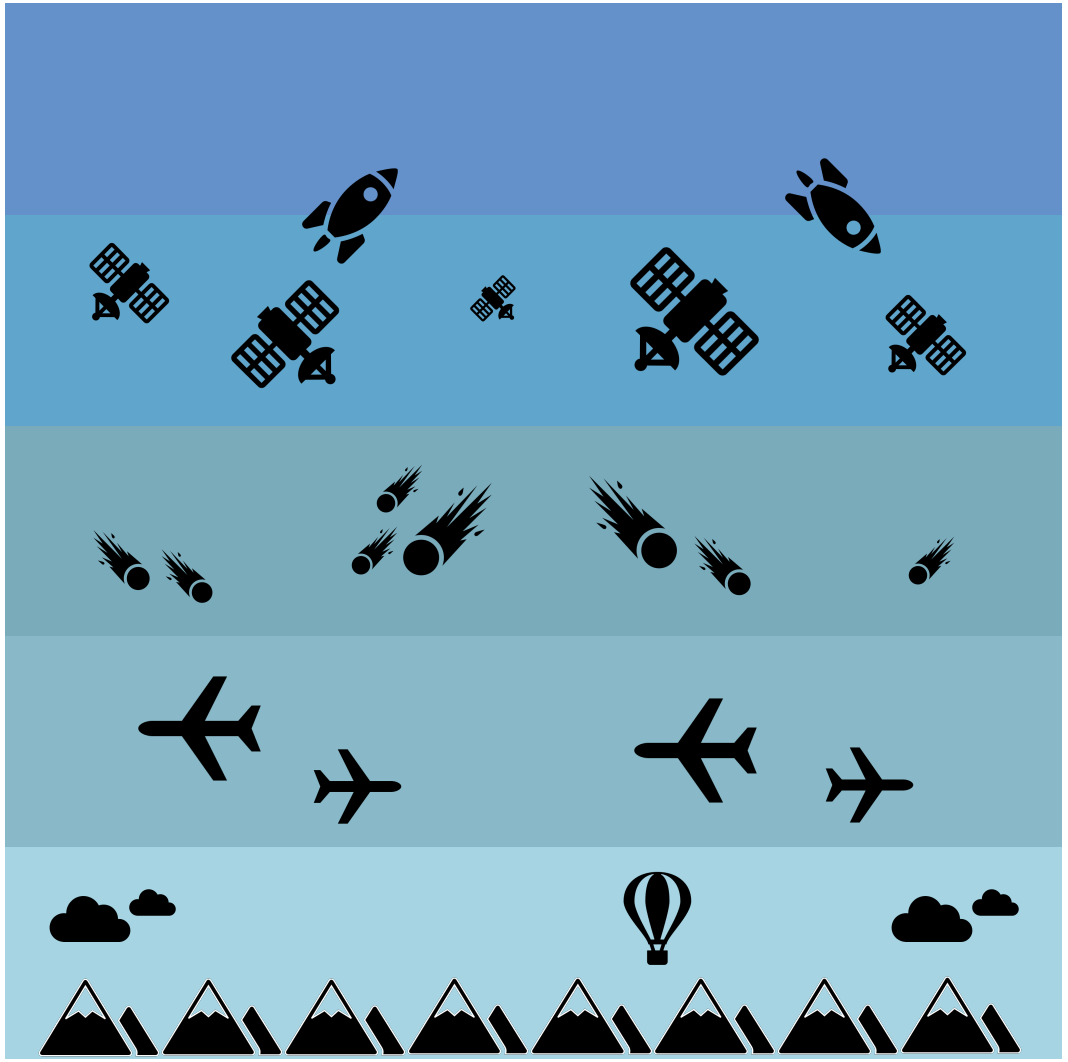
The thermosphere is where the International Space Station (ISS) orbits. Satellites and spacecraft also orbit in the thermosphere.



MISSION CONTROL

EXOSPHERE

It consists of sparse gas particles that can escape Earth's gravity. Satellites and spacecraft orbit in the exosphere, where they're exposed to solar radiation and space conditions.



MISSION CONTROL

THE MOON'S LACK OF ATMOSPHERE

MISSION CONTROL

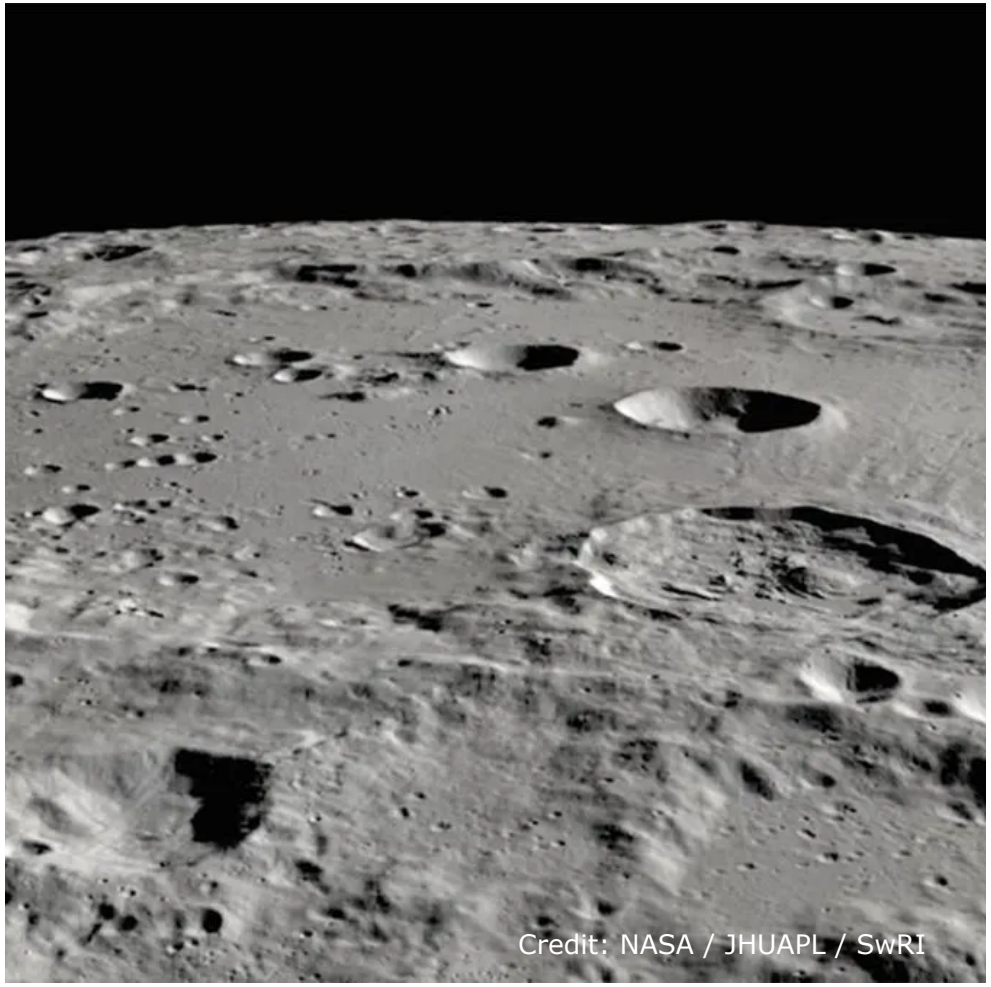
VACUUM

The Moon's surface is essentially a vacuum, meaning it has an almost complete absence of air and atmospheric pressure. This lack of air makes it impossible for humans to breathe or for sound to travel.

MISSION CONTROL

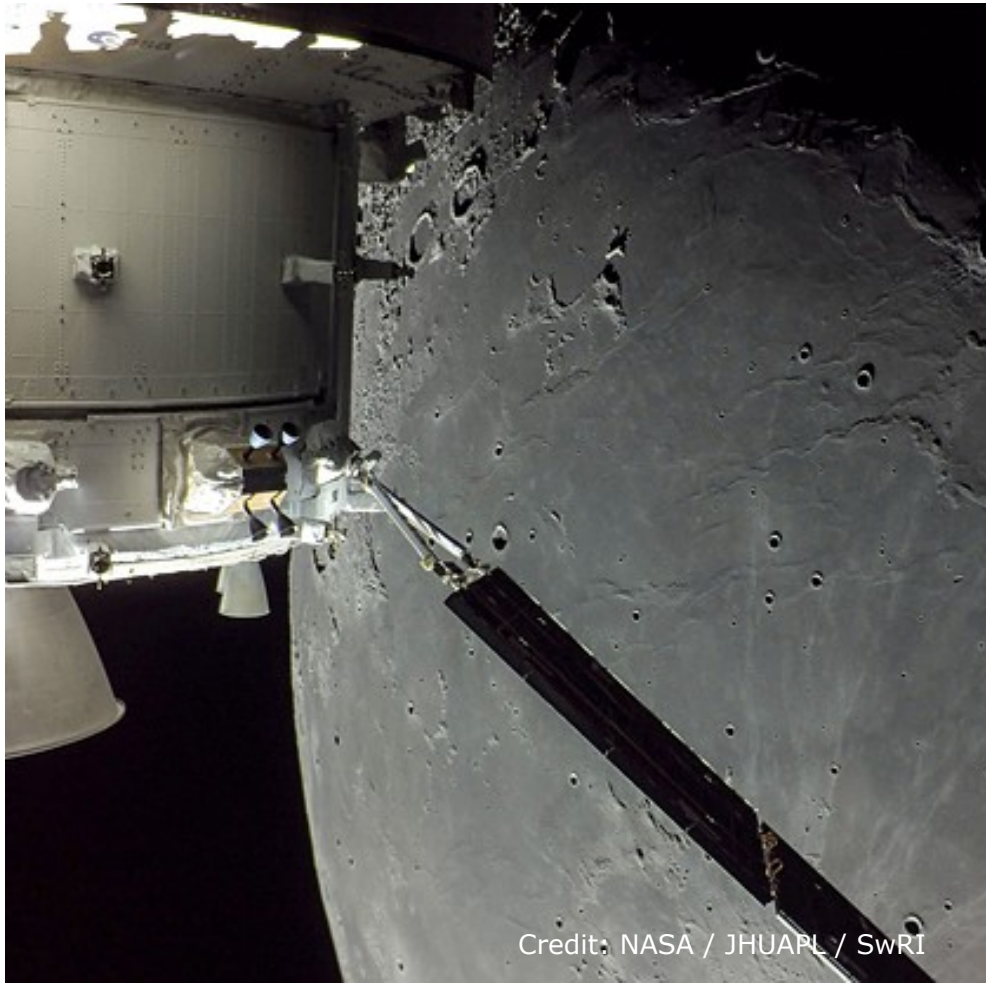
EXTREME TEMPERATURES

Without an atmosphere to trap heat, the Moon experiences extreme temperature variations. Daytime temperatures can soar to over 100 degrees Celsius (212 degrees Fahrenheit), while nighttime temperatures can plummet to around -150 degrees Celsius (-238 degrees Fahrenheit).



NO WEATHER

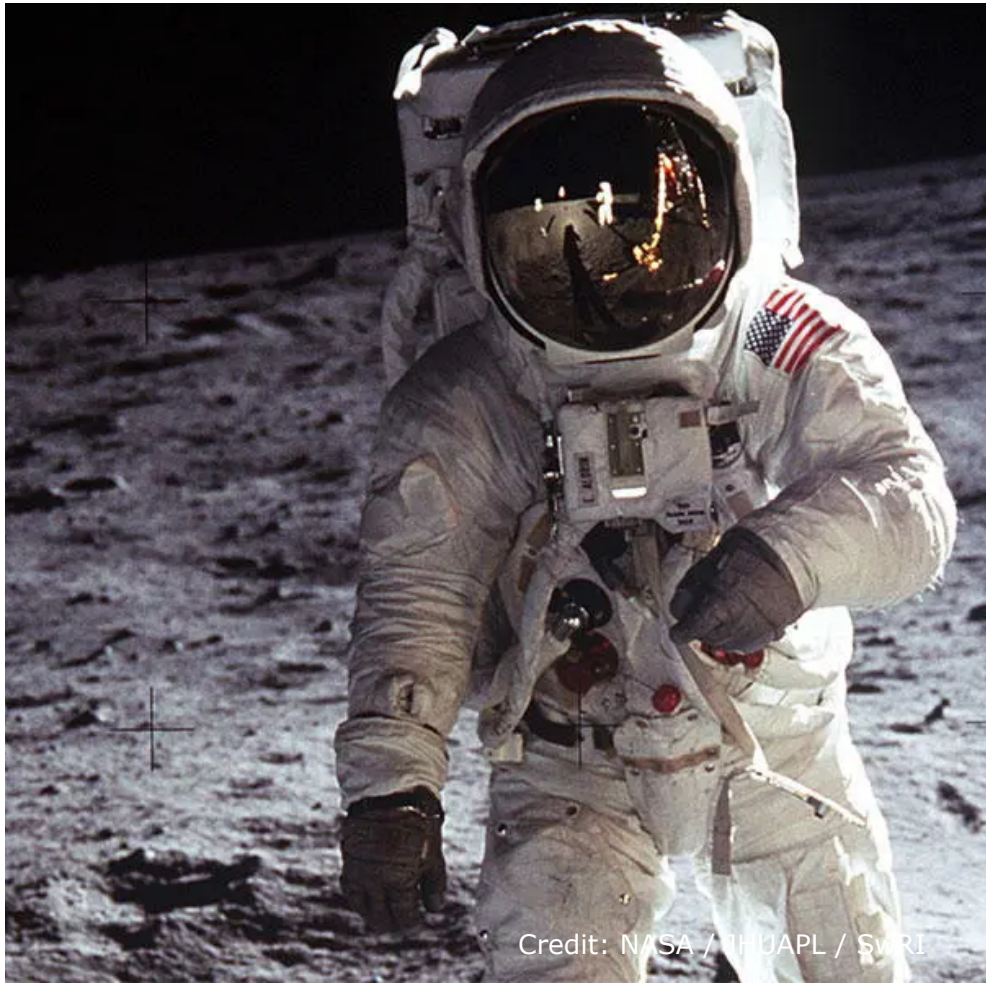
The Moon doesn't have weather phenomena like clouds, rain, or storms because these require an atmosphere. This stable environment is beneficial for lunar missions but poses challenges for generating resources like water.



MISSION CONTROL

NO PROTECTION

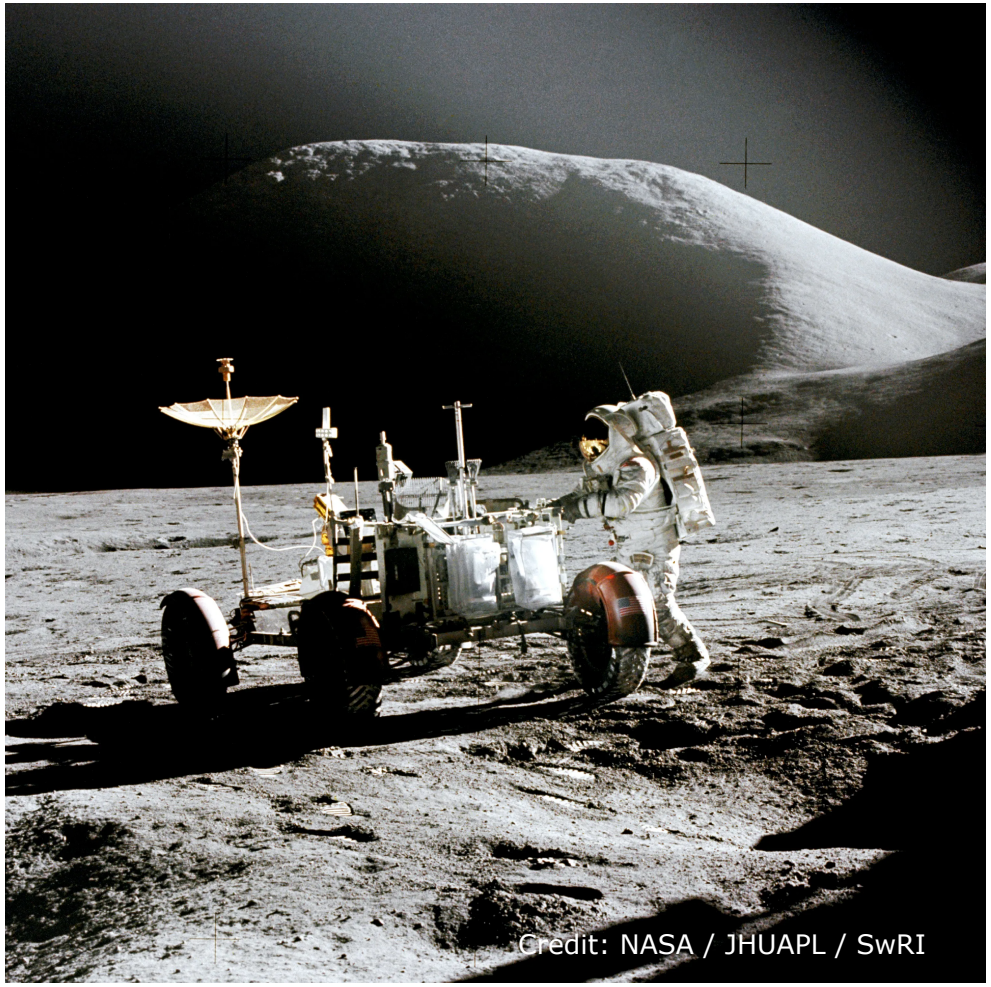
Earth's atmosphere shields us from harmful solar and cosmic radiation. On the Moon, there's no such protection. Lunar rovers and equipment must be designed to withstand radiation exposure.



MISSION CONTROL

DUSTY SURFACE

The Moon's surface is covered in fine lunar regolith, which is a layer of dust and small rocks. This regolith can affect rover mobility and equipment function.



MISSION CONTROL

ATMOSPHERE AND ROVERS

MISSION CONTROL

DISCUSSION

Imagine driving a car here on Earth. Our planet has a thick atmosphere, filled with different gasses that we call air. This air creates various conditions, like wind, temperature changes, and even storms. When you drive your car, you have to consider these factors. They affect how your car moves, how it handles turns, and how you control it.

What does the lack of atmosphere have on operating a lunar rover on the Moon?

MISSION CONTROL

ATMOSPHERE

On Earth: The atmosphere affects rover dynamics and provides challenges like weather conditions.

On the Moon: There's no atmosphere to impede or assist the rover. Extreme temperature variations (hot during the day, cold at night) pose challenges.

MISSION CONTROL

GRAVITY

On Earth: Gravity is approximately 9.8 m/s², significantly stronger than the Moon.

On the Moon: Gravity is about 1.625 m/s², much weaker than Earth. This affects how the rover moves and responds to commands.

MISSION CONTROL

COMMUNICATION DELAY

On Earth: Communication with rovers is nearly instantaneous.

On the Moon: There is a communication delay of about 1.28 seconds for a one-way signal. Operators need to account for this delay in controlling the rover.

MISSION CONTROL

TERRAIN AND SURFACE CONDITIONS

On Earth: Rovers encounter a variety of terrains, including vegetation, water bodies, and diverse landscapes.

On the Moon: The surface is barren, with lunar regolith, craters, and rocks. Rovers need to navigate unique lunar topography.

MISSION CONTROL

HUMAN PRESENCE

On Earth: Rovers may operate in areas with human infrastructure, facilitating repairs or interventions.

On the Moon: Human presence is absent, requiring rovers to be highly autonomous and resilient to technical issues.

MISSION CONTROL

GROUP ACTIVITY

MISSION CONTROL

GET INTO GROUPS

MISSION CONTROL

Group 1

EXOSPHERE

Group 2

THERMOSPHERE

Group 3

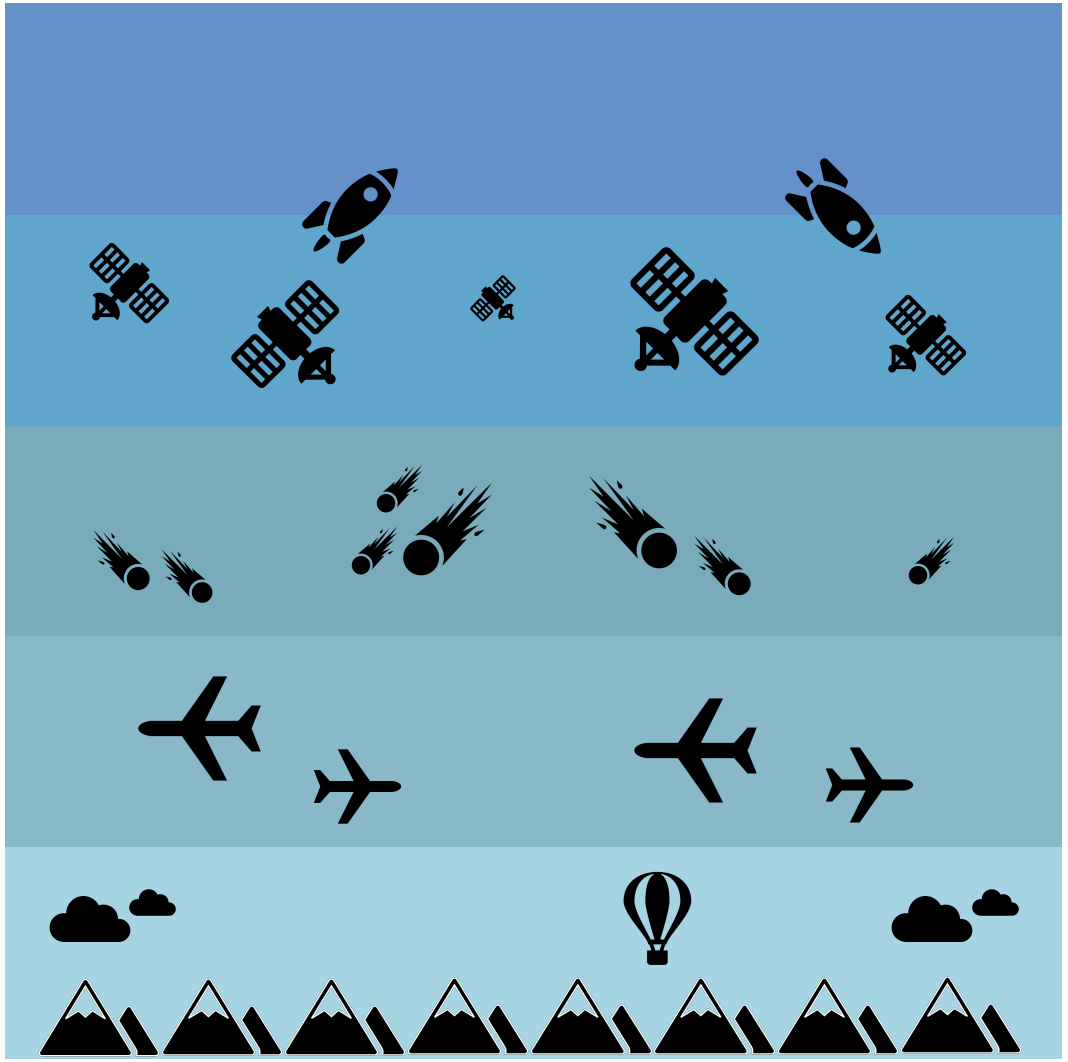
MESOSPHERE

Group 4

STRATOSPHERE

Group 5

TROPOSPHERE



MISSION CONTROL

RESEARCH TIME

MISSION CONTROL

PRESENTATIONS

MISSION CONTROL

Group 1

EXOSPHERE

Group 2

THERMOSPHERE

Group 3

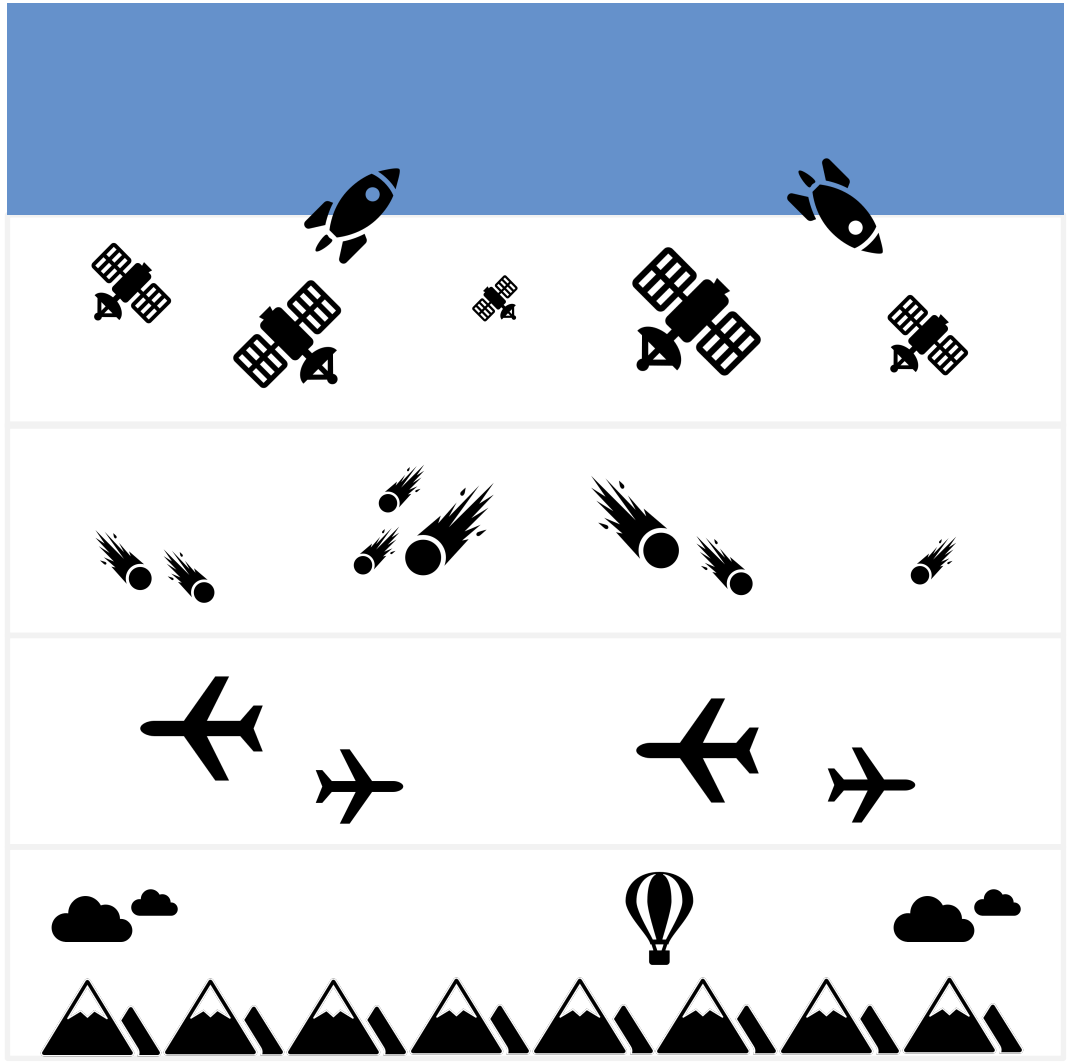
MESOSPHERE

Group 4

STRATOSPHERE

Group 5

TROPOSPHERE



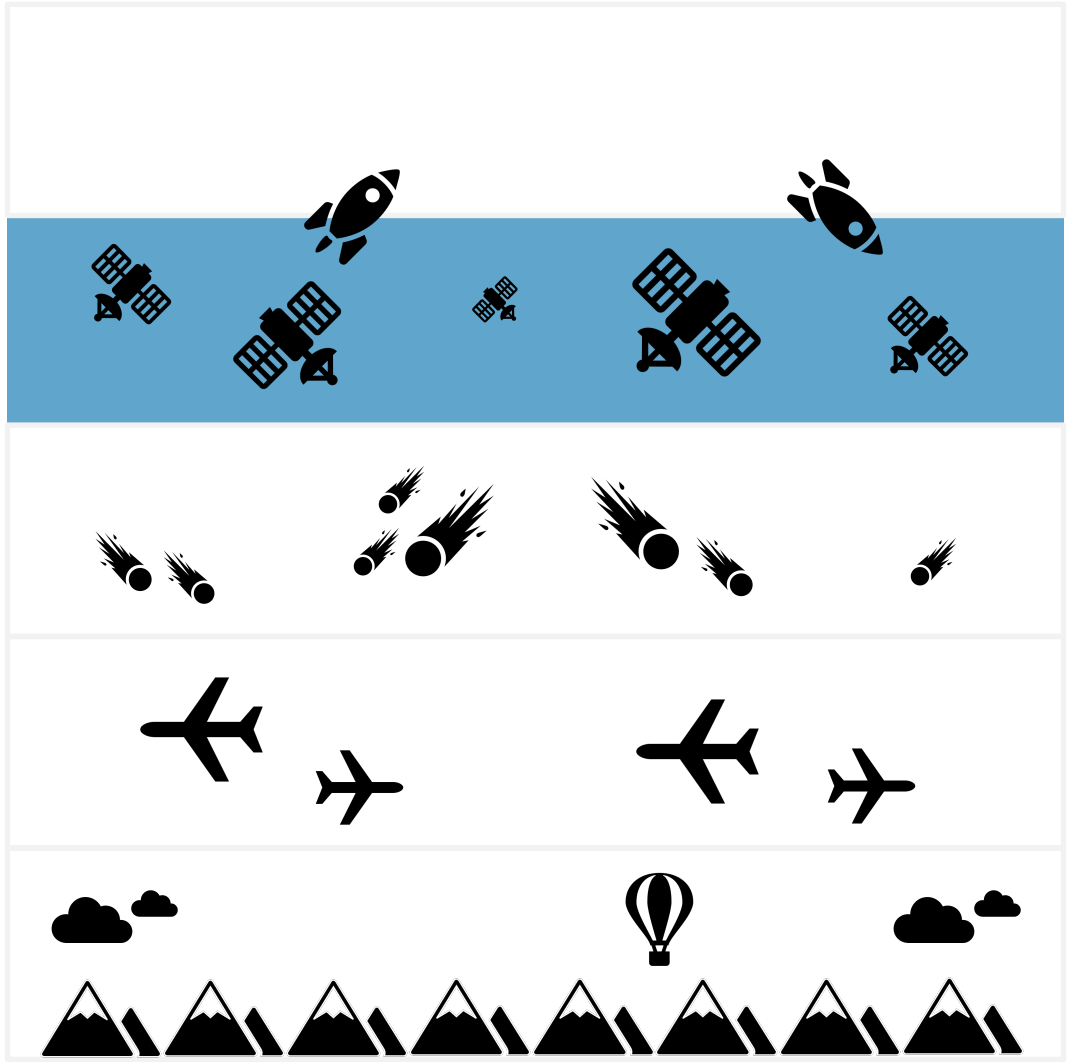
MISSION CONTROL

Group 1

EXOSPHERE

Group 2

THERMOSPHERE



Group 3

MESOSPHERE

Group 4

STRATOSPHERE

Group 5

TROPOSPHERE

MISSION CONTROL

Group 1

EXOSPHERE

Group 2

THERMOSPHERE

Group 3

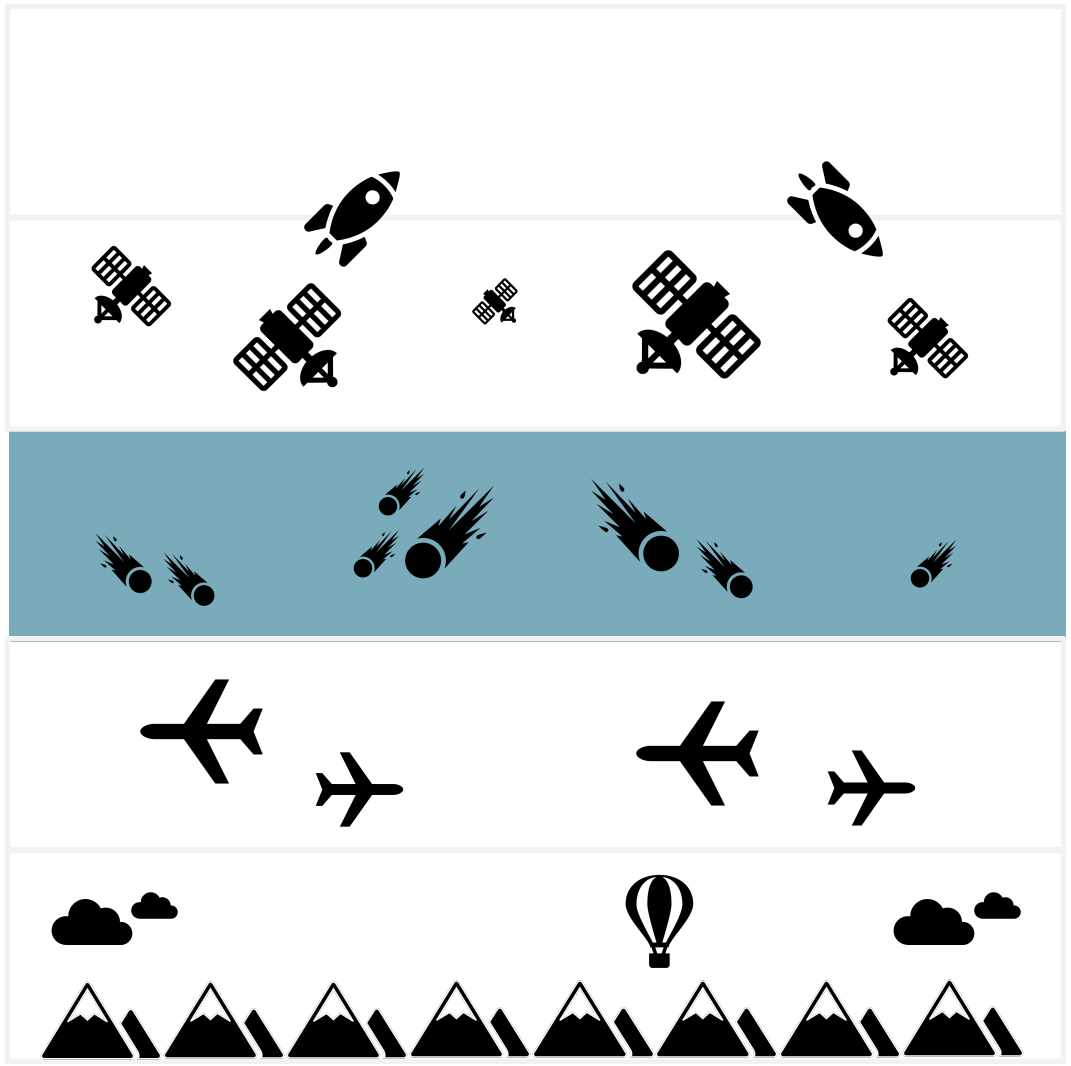
MESOSPHERE

Group 4

STRATOSPHERE

Group 5

TROPOSPHERE



MISSION CONTROL

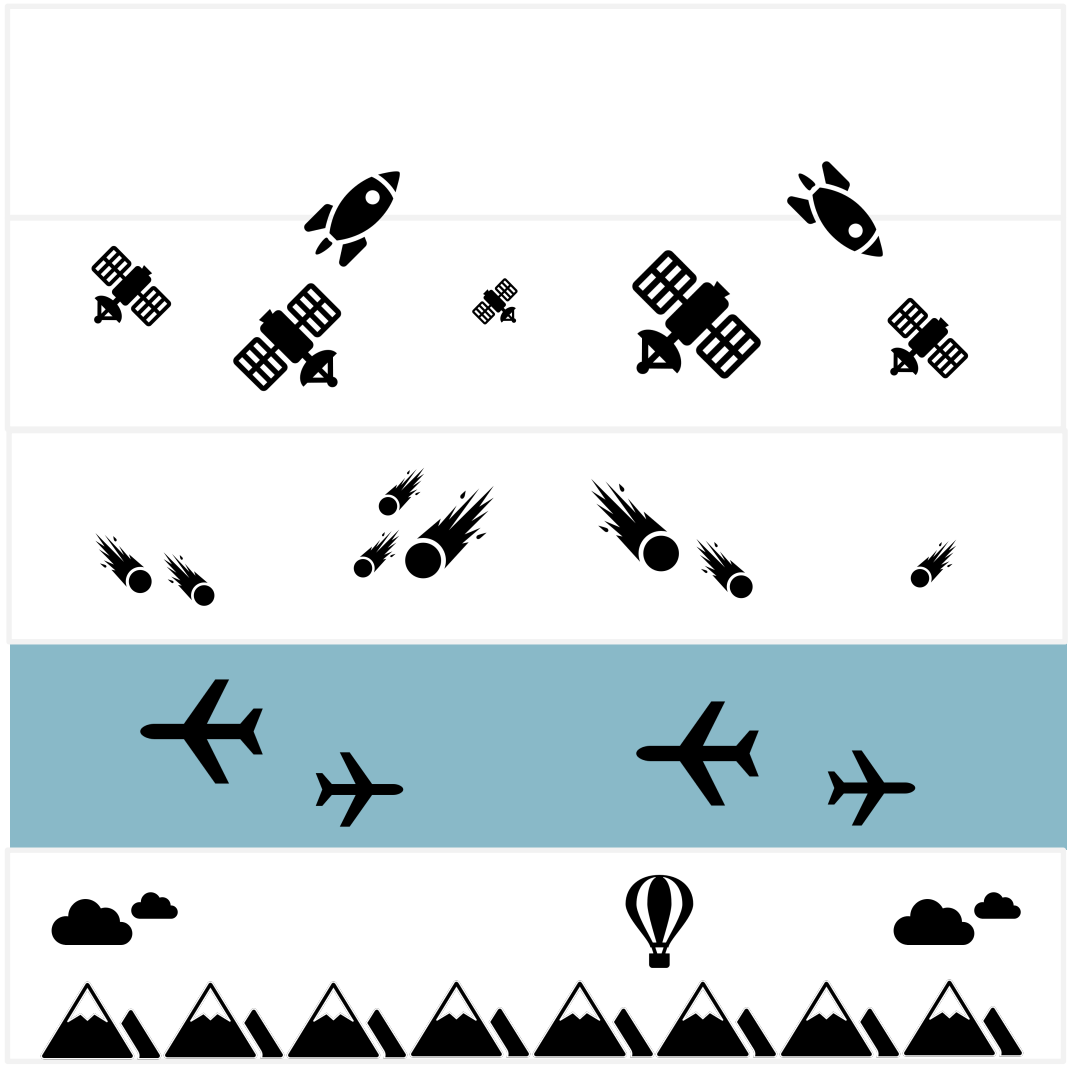
Group 1
EXOSPHERE

Group 2
THERMOSPHERE

Group 3
MESOSPHERE

Group 4
STRATOSPHERE

Group 5
TROPOSPHERE



MISSION CONTROL

Group 1

EXOSPHERE

Group 2

THERMOSPHERE

Group 3

MESOSPHERE

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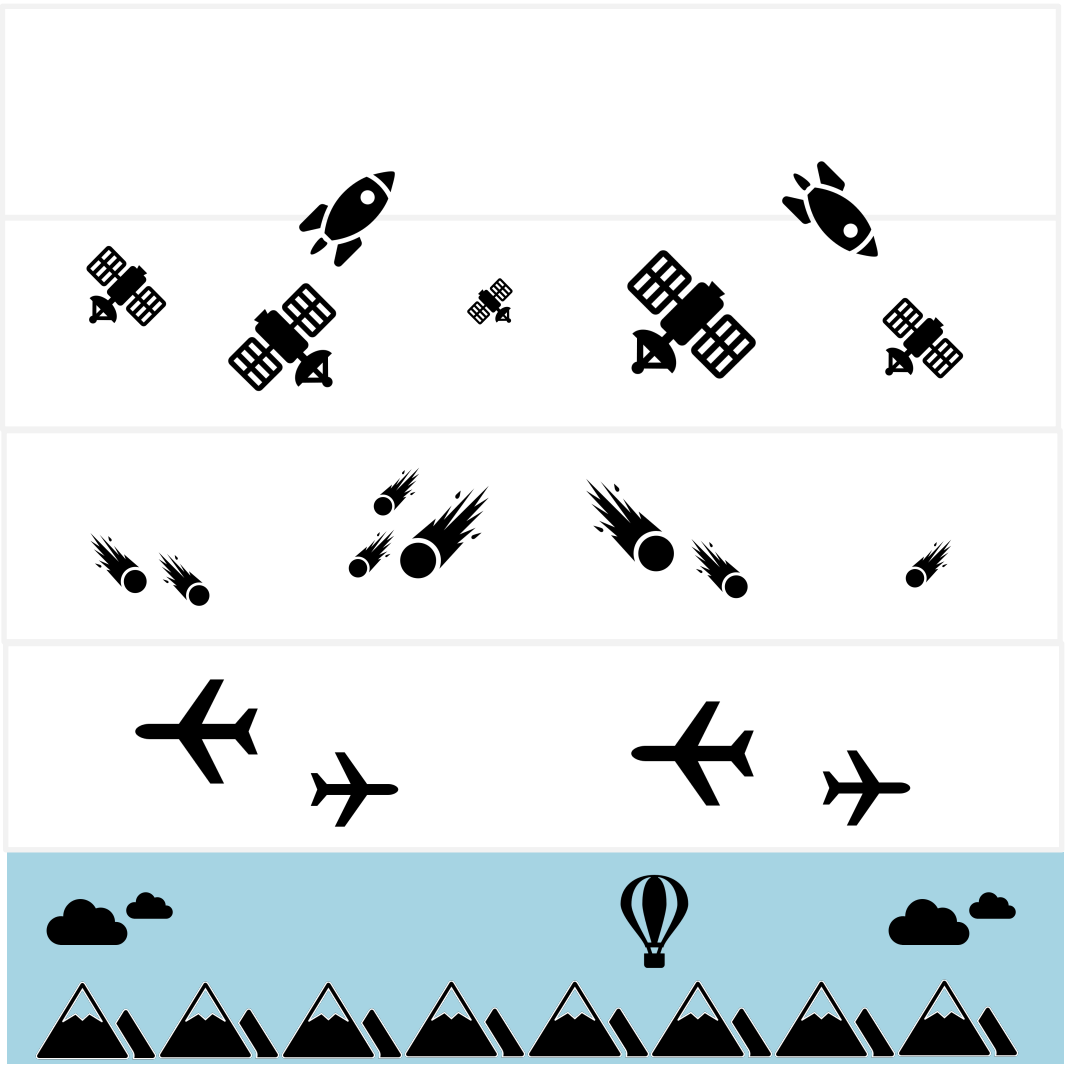
Group 5

TROPOSPHERE

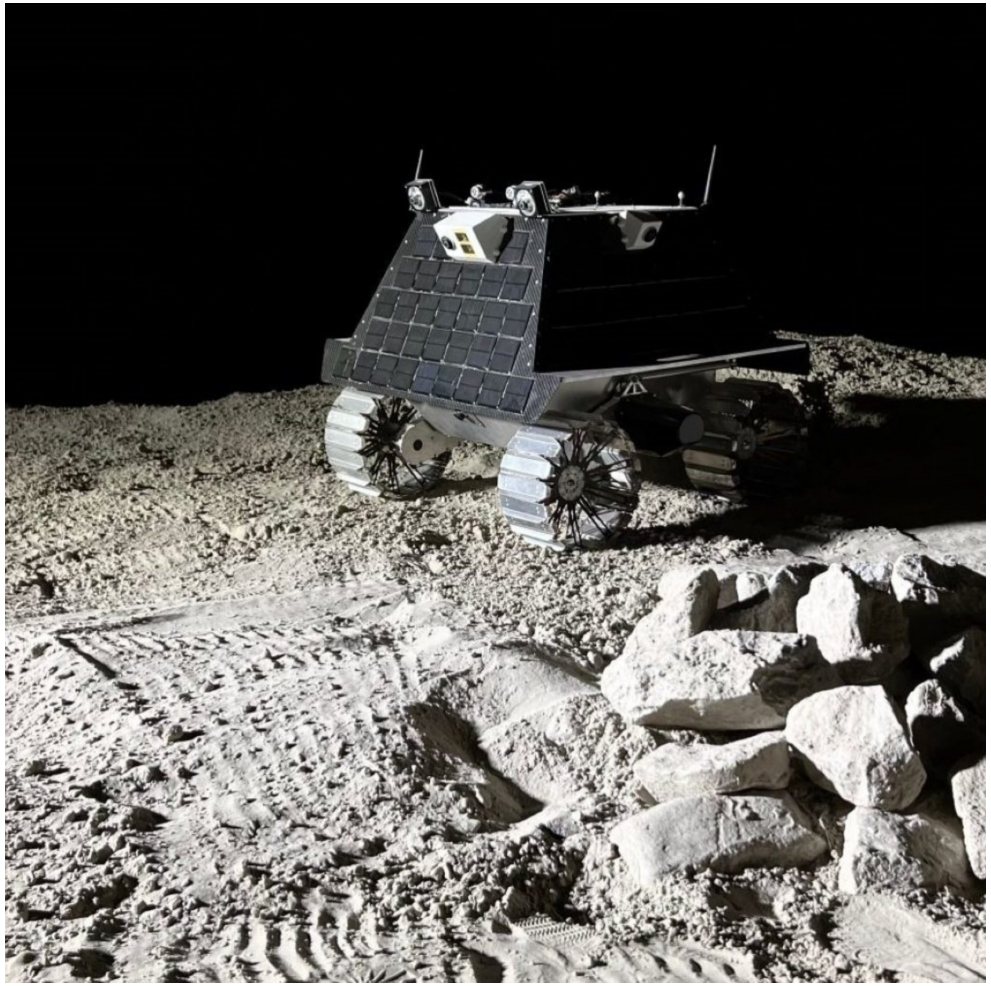


MISSION CONTROL

DISCUSSIONS

MISSION CONTROL

How do you think the exposure from the elements in space impact rover design and the safety of future astronauts who might accompany them?



MISSION CONTROL

How do you think the extreme temperatures on the Moon impact the functioning of the lunar rovers?

MISSION CONTROL

WRAP UP

MISSION CONTROL

EARTH ATMOSPHERE

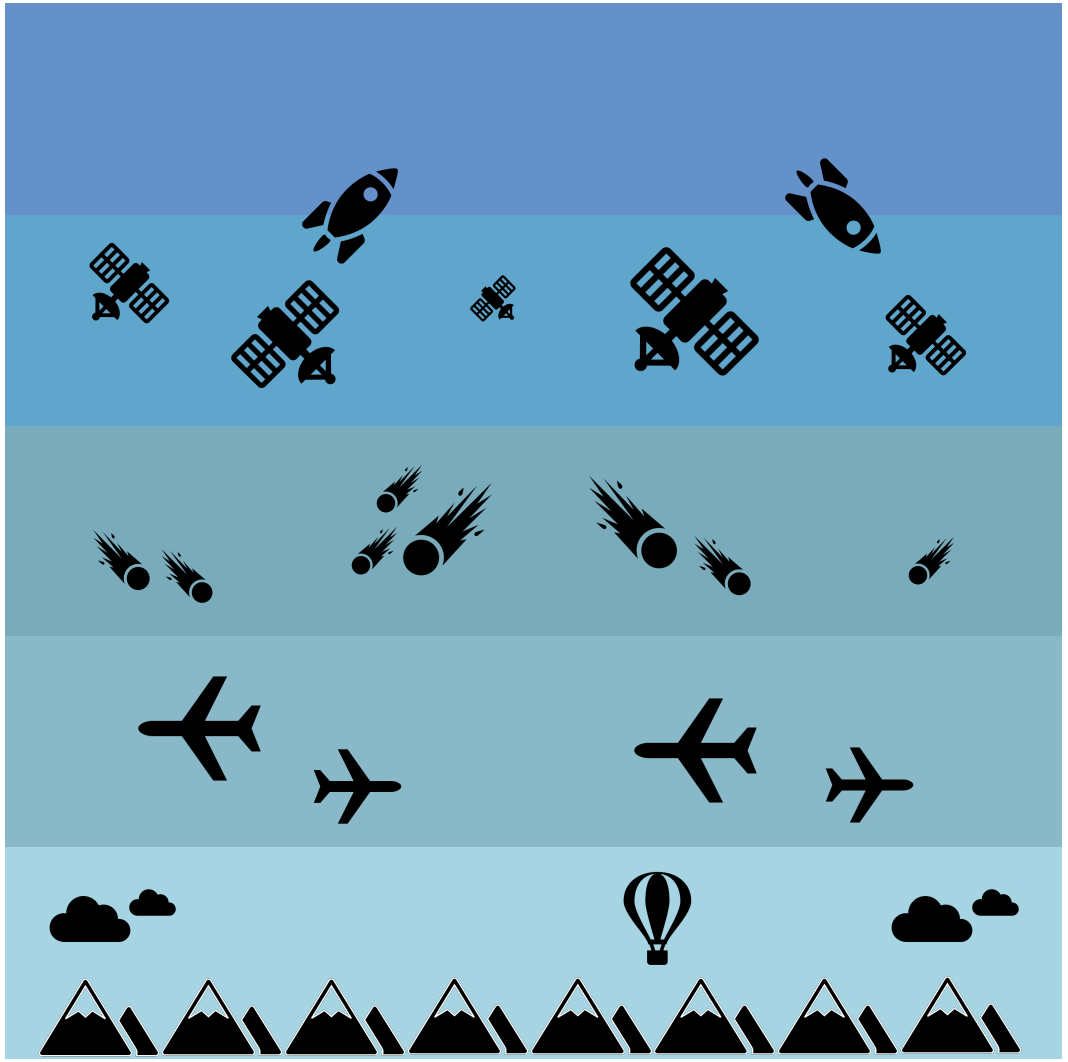
EXOSPHERE

THERMOSPHERE

MESOSPHERE

STRATOSPHERE

TROPOSPHERE



MISSION CONTROL

VACUUM

EXTREME TEMPERATURES

NO WEATHER

NO PROTECTION

DUSTY SURFACE

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ATMOSPHERE

COMMUNICATION DELAYS

TERRAIN AND SURFACE CONDITIONS

GRAVITY

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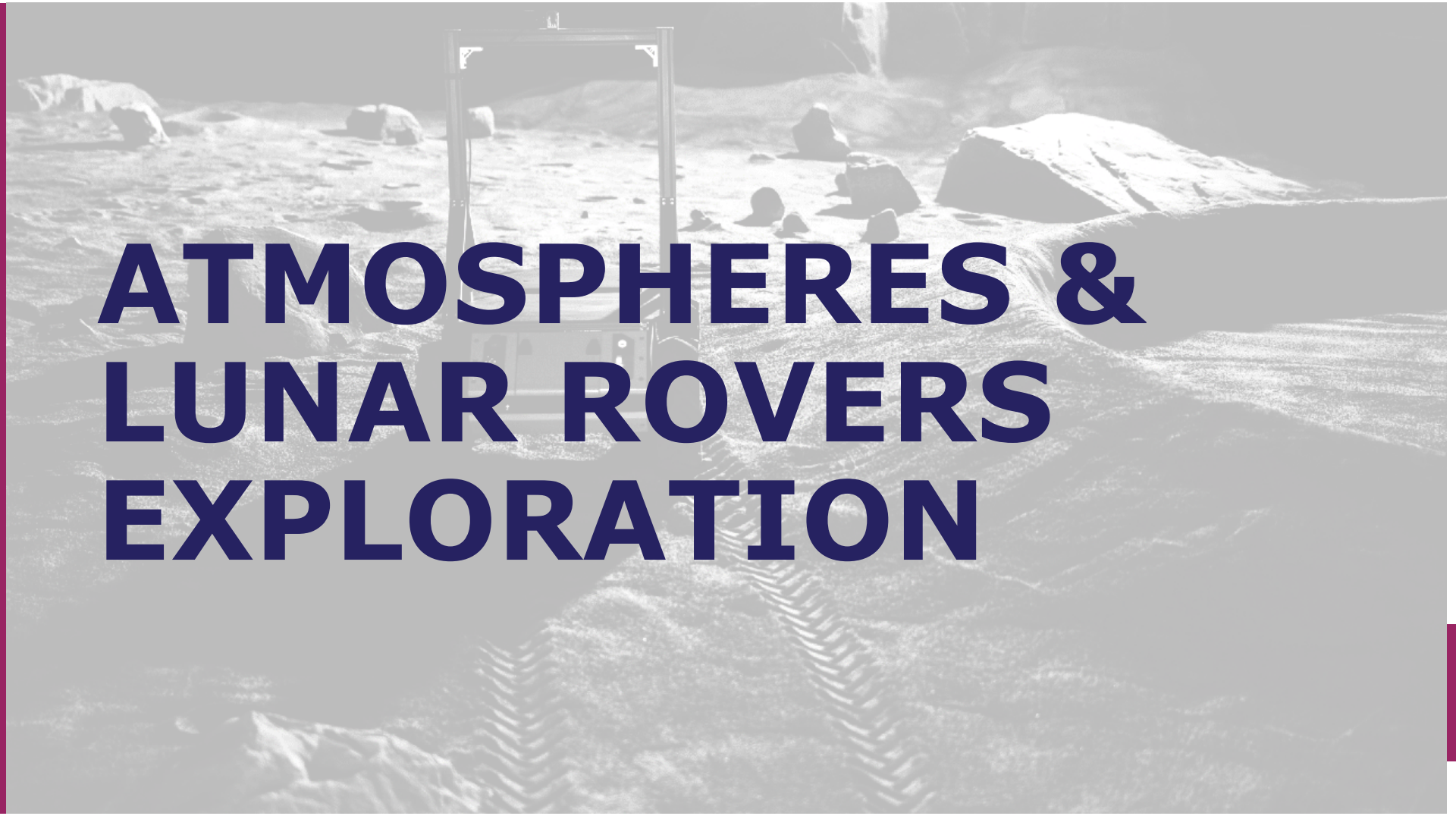

ATMOSPHERES & LUNAR ROVERS EXPLORATION

MISSION CONTROL