



Kids **as** Airborne Mission Scientists -- **KaAMS** --

Aeronautics Pathway

Student Activity and Assignment Journal

Shadowing a NASA Mission

using

Aeronautics and Remote Sensing

to investigate active lava flows on the

Kilauea Volcano

Student's Name: _____

Teacher's Name: _____

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**Lesson: What is airborne remote sensing?
Mission request letter (ARS-1)**



Pacific Disaster Management Agency



NASA Airborne Mission Science Division
NASA Dryden Flight Research Center
Edwards, California 93536

Dear airborne mission scientist,

Our agency studies many types of natural hazards in the Pacific region including tsunamis, landslides, earthquakes, and volcanic eruptions. Kilauea, an erupting basaltic shield volcano on the island of Hawaii, has been continuously active since January, 1983. Since the beginning of the eruption, over 180 homes in many communities have been destroyed. In addition, the eruption has affected the island's road network. The main Chain of Craters Road linking the area near the top of Kilauea with the community of Kalepana has been covered by lava causing problems for the residents. Our agency constantly monitors Kilauea in a number of ways. We often utilize airborne image data to map the locations of recent lava flow deposits and, more importantly, the areas of the volcano where lava flows are currently active.

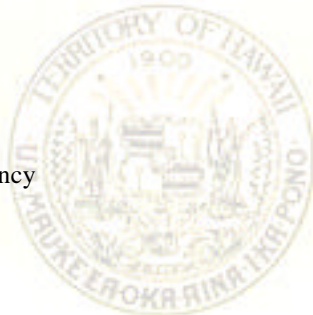
We would like to request your help in locating active lava flows on Kilauea. The knowledge of their location will aid the Agency in providing information concerning the location and extent of lava flow activity and support the Agency's on-going effort to re-examine our emergency evacuation plans in the event of substantial eruptions.

Thank you for your time and cooperation in this matter. I look forward to receiving your report after completing your study and data analysis.

Sincerely,

Gary Kilulani

Gary Kilulani, Director
Pacific Disaster Management Agency



**Lesson: What is airborne remote sensing?
Activity sheet: Defining the terms (ARS-2)**

Name: _____

Explore the given materials and develop definition of the following terms in your own words:

remote sensing:

aerospace:

aeronautics:

astronautics:

How are aerospace and aeronautics different?

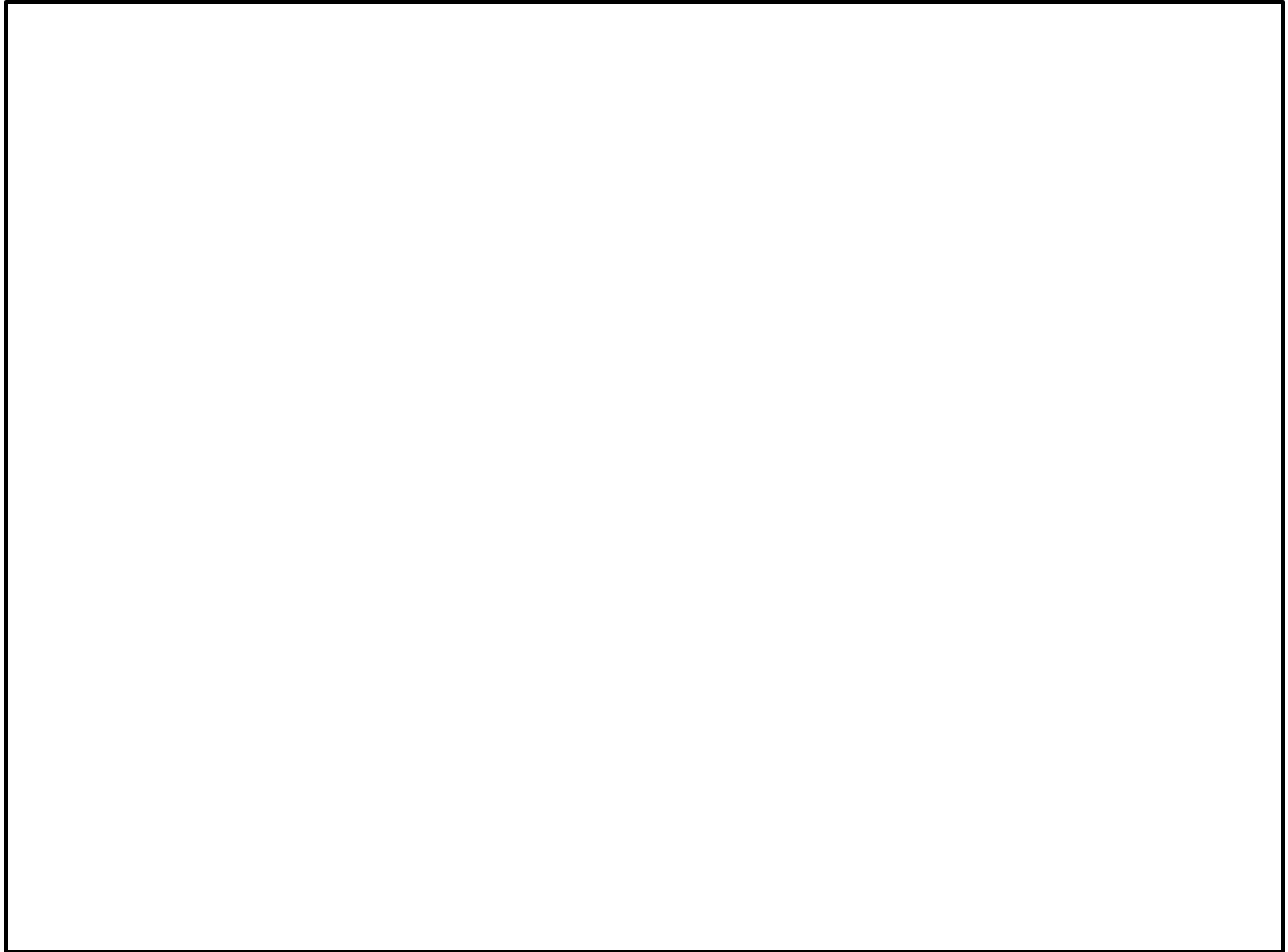
What is airborne remote sensing?

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Describing an airborne mission scientist (AMS-1)

Name: _____

Instructions: In the space below either describe what you think airborne mission scientists are and do, or draw and label a picture of airborne mission scientists at work.



List 5 tasks that airborne mission scientists complete during explorations.

- 1.
- 2.
- 3.
- 4.
- 5.

Lesson: What are airborne mission scientists and what do they do?

Problem scenarios (AMS-2)

Problem scenario 1: Study the decrease in the amount of ozone in the Earth's atmosphere

Why is it important? How can we measure the amount of ozone in the atmosphere? How can we study ozone loss and the gain we hope occurs in the future?

Ozone is a gas found in Earth's atmosphere that screens the harmful form of radiation from the sun, ultraviolet radiation, that is responsible for sunburn and skin cancer. Most of the ozone in Earth's atmosphere is found in a part of the atmosphere known as the stratosphere. The stratosphere is the region from about 30,000 feet to 180,000 feet above the Earth's surface. Within the stratosphere, the amount of ozone is greatest between 50,000 feet and 100,000 feet. Even though we say greatest, it's not very much. Only one or two molecules of ozone for every one million air molecules found there! Remember that air is about 78% nitrogen, 21% oxygen, and 1% other elements.

Problem scenario 2: Study effects of smoke and aerosols on climate

Why is it important and how can we study the effects on the clouds and the climate due to smoke from burning biomass and aerosols? (Biomass is vegetation and wastes from animals, which includes wood, grass, algae, garbage, and plant products. It can be used as an energy source like gasoline or coal.)

Scientists are interested in things that man does on the earth that affect the atmosphere. When someone burns leaves in their backyard or uses an aerosol hairspray for instance, it can actually affect the weather. One or two people doing those things might not have any effect, but when you multiply one or two by the millions of people in cities and include industrial companies who do those things on a much larger scale, the weather and climate can actually be changed. Man can have a serious effect on his environment. A series of experiments to help scientists better understand the effects on the clouds and the climate due to smoke from burning biomass and aerosols are called The Smoke/Sulfate Clouds and Radiation experiments. In the experiments scientists carefully examined gases and clouds in the atmosphere containing chemicals from aerosols and biomass burning as well as those found on the Earth's surface.

Lesson: What are airborne mission scientists and what do they do?

Problem scenarios (AMS-2A)

Problem scenario 3: Study the effect of snow and ice on climate

Why is it important and how can we study the effect of snow and ice on climate?

Snow covers about 40% of the entire surface of the Earth during winter in the Northern Hemisphere. Because it is white, snow reflects a lot of light and therefore it has an effect on the amount of radiation falling on and being reflected from the Earth. The balance of radiation has an effect on biological (life processes), chemical (chemical processes), and geological processes (processes associated with the earth itself). Many areas of the earth depend on the melting of snow to water crops and for drinking water. It is necessary to carefully watch snowpacks throughout the winter and spring to keep track of the water supply and the possibility of flooding.

Problem scenario 4: Study moisture levels in hurricanes

Why is it important and how can we study the amount of moisture in hurricanes?

NASA uses remote sensing instruments to learn about the way hurricanes are formed, how they move, and how they change. Knowledge of this kind can help hurricane forecasters make better predictions. If they have a better idea where a hurricane will make landfall, fewer people may have to evacuate their homes. Better predictions could also improve the early warning times for areas that might be affected. This could potentially save lives.

Lesson: What are airborne mission scientists and what do they do?

Group activity instructions (AMS-3)

Your goal is to create a flight request for your given problem statement. You will need to determine what questions need to be answered to complete the request form. Then, working with your team, you will need to complete the flight request form. Your goal is not to "solve" the stated problem; it is to develop a plan on **how** to investigate this problem using aircraft and remote sensing.

1. **In your group**, review the NASA Airborne Science Flight Request Form and:
 - develop a list the questions or information needed to complete the form
 - separate the questions by expertise, who is most likely able to answer the question?
 - a science expert
 - an aeronautics expert
 - a remote sensing instrumentation expert
2. Assign each member of your team a different role:
 - Science expert - becomes familiar with information about the problem scenario
 - Aeronautics expert - becomes familiar with information about the aircraft
 - Remote sensing expert - becomes familiar with information about remote sensing instruments
3. When directed by the teacher, separate into **expert groups**, each member of your group will now meet with the team of aeronautics, remote sensing, or science experts.
4. **In expert groups**, review the provided expert information and work together to answer your assigned question.
5. When directed by your teacher, return to your **original group**.
6. **In your original group**, each member should share the information learned during the expert group meeting and together, complete the NASA Airborne Science Flight Request Form. Your group should develop a short presentation that explains your request to use NASA resources. Presentations should meet the following criteria:
 - Did we make a strong case for the importance of the environmental issue being studied?
 - Did we provide evidence supporting the choice of aircraft?
 - Did we provide evidence supporting the choice of remote sensing device?
 - Did we show evidence of working together as a team?

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Question categorization (AMS-4)



Record the types of questions you will need to find to complete the NASA Airborne Science Flight Request Form. Then, categorize the questions by expertise:

A=aeronautics, R=remote sensing, S=science

| Questions | Expert |
|---|---------------|
| <i>Sample: What is each type of remote sensing instrument used for?</i> | <i>R</i> |
| <i>Sample: How have the available aircraft been used for remote sensing missions in the past?</i> | <i>A</i> |
| <i>Sample: What will I need to “sense” to investigate my problem?</i> | <i>S</i> |
| | |
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| | |

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: NASA Airborne science flight request form (AMS-5)

| | | |
|---|---|---|
|  | <p>AIRBORNE SCIENCE FLIGHT REQUEST FORM National Aeronautics and Space Administration</p> |  |
| <p>Investigation title:</p> | | |
| <p>Reason for requesting use of NASA facilities:</p> | | |
| <p>Investigator(s):</p> | | |
| <p>Background and primary science objectives:</p> | | |
| <p>Aircraft required: <u>ER-2</u> <u>DC-8</u> <u>P-3B Orion</u> <u>King Air</u> <u>Pathfinder</u> <u>SR-71 Blackbird</u> (circle)</p> | | |
| <p>Data requirements and aircraft sensor:</p> <p>TYPE OF DATA BEING COLLECTED: (describe)</p> <p>SENSORS (circle):</p> <p style="text-align: center;"> <u>MODIS</u> <u>AVIRIS</u> MAMS <u>MACAWS</u> <u>Harvard Co2</u> <u>Dual-Beam UV-Absorption Spectrometer</u> <u>Aerial Camera Systems</u> </p> | | |
| <p>General flight window (month):</p> <p>A)</p> <p>B)</p> <p>C)</p> <p>D)</p> | | <p>General site location (state or country):</p> <p>A)</p> <p>B)</p> <p>C)</p> <p>D)</p> |
| <p>This form must be completed and returned to NASA/DFRC by:</p> <p>(Do not mark in this space/For office use only)</p> | <p><u>Mail completed forms to:</u> Dryden Flight Research Center National Aeronautics and Space Administration</p> | |

Lesson: What are airborne mission scientists and what do they do?

Remote sensing instrument descriptions (AMS-6)

| Instrument | Description | Example missions |
|---|---|---|
| Multispectral Atmospheric Mapping Sensor (MAMS) | The MAMS is designed to study weather related events including storm system structures, cloud-top temperatures, and upper atmospheric water vapor. MAMS measures reflected radiation from the Earth's surface and clouds and thermal (heat) emission from the Earth's surface, clouds, and atmospheric water vapor. It can provide detailed pictures of atmospheric and surface features as well as clouds and thunderstorm features. | <ul style="list-style-type: none"> ● Clouds and snow ● Water vapor in hurricanes |
| MODIS - Moderate Resolution Spectroradiometer - Airborne Simulator (MAS) | MAS is designed for the measurement of biological and physical processes and atmospheric temperature. The MODIS program remotely senses data to monitor variation in environmental conditions for assessing both natural and human-influenced global change. | <ul style="list-style-type: none"> ● Clouds and snow; ● Cloud & atmospheric radiation ● Smoke, Clouds, and Radiation ● Arctic Radiation ● Snow, Glaciers, and Sea Ice; ● Forest/Atmosphere Interaction. |
| Harvard Carbon Dioxide Experiment (Harvard CO2) | This instrument is used to explore carbon dioxide levels. It detects the concentration of carbon dioxide in the different layers of the atmosphere | <ul style="list-style-type: none"> ● Pollution levels ● Ozone depletion |
| Dual-Beam UV - Absorption Ozone Photometer | This instrument detects measures of radiation to determine the ozone density. | <ul style="list-style-type: none"> ● Ozone levels |
| Multicenter Airborne Coherent Atmospheric Wind Sensor (MACAWS) | MACAWS is an airborne Doppler laser radar which measures wind fields, vertical wind profiles, and aerosol backscatter from clear air and clouds. It was especially designed to map the speed and direction of winds in storms. | <ul style="list-style-type: none"> ● Wind directions inside hurricanes ● Strong wind storms |
| Aerial Camera Systems | <p>There are a variety of film camera systems used for remote sensing. Color infrared, natural color and black and white film may be used with the choice determined by investigator requirements.</p> <ul style="list-style-type: none"> ● RC-10 Mapping Cameras provide image scales of two miles to the inch and one mile to the inch. ● HR-732 Aerial Cameras are used to acquire high-resolution photography providing an image scale of half-mile to the inch. ● Iris II Panoramic Camera has been employed to acquire high-resolution land use and land cover data. | <ul style="list-style-type: none"> ● Forestry, wetlands inventories, wildlife habitat ● Assess timber resources ● Monitoring gypsy moth defoliation |
| Airborne Visible InfraRed Imaging Spectrometer (AVIRIS) | <p>The science objectives of the AVIRIS are:</p> <ul style="list-style-type: none"> ● Identify, measure, and monitor constituents of the Earth's surface and atmosphere based on molecular absorption and particle scattering signatures ● Research directed towards understanding processes related to the global environment and climate change. | <ul style="list-style-type: none"> ● Ecology ● Oceanography ● Geology ● Snow hydrology ● Cloud and atmospheric studies |

Lesson: What are airborne mission scientists and what do they do?



Activity Sheet: NASA Airborne science flight request presentation scoring rubric (AMS-7)

| | | | |
|---|--------|----------------------|------|
| Date: | | | |
| Reviewer's name: | | Presenter's name(s): | |
| Environmental problem description: | | | |
| | strong | good | weak |
| Did the presenter(s) make a case for the importance of the environmental issue to be studied with NASA resources? | | | |
| Did the presenters provide evidence supporting their choice of aircraft? | | | |
| Did the presenters provide evidence supporting their choice of remote sensing device? | | | |
| Did the presenters provide evidence of working effectively as a team? | | | |

Recommend to accept request

Recommend to deny request

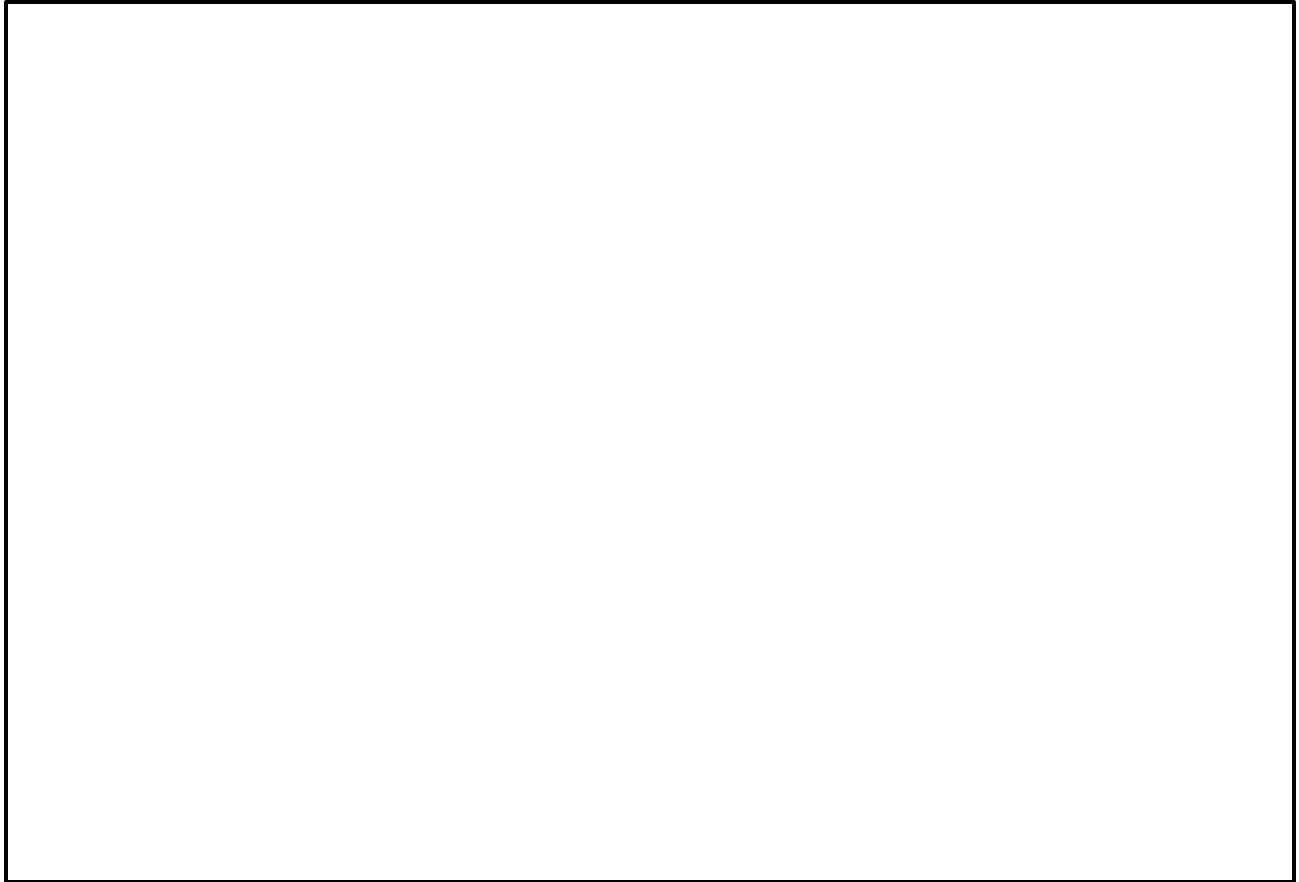
Why? Support your decision:

Lesson: What are airborne mission scientists and what do they do?

Activity Sheet: Describing an airborne mission scientist (AMS-8)

Name: _____

Instructions: Now that you have been an airborne mission scientist and worked with your classmates as airborne mission scientist, write a new description or draw and label a new picture of airborne mission scientists at work.



List 5 tasks that airborne mission scientists complete during explorations.

- 1.
- 2.
- 3.
- 4.
- 5.

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Reflection page (AMS-9)

Name: _____

Use this page to record your thoughts about the problems you are solving in KaAMS and what you are learning along the way. Since this is your first time using this worksheet sample answers have been provided to guide your responses. For now, use the open spaces to record your own ideas. Later versions of this worksheet are black.

What is the overall problem you are investigating?

Sample response: Where are the active lava flows on the Kilauea volcano?

What problem were you solving during this lesson?

Sample response: How can aeronautics and remote sensing help investigate the lava flows? What else would you add??

What did you learn during this lesson?

- Sample response: Many types of scientist who work together to explore the earth.*
- Sample response: NASA uses planes and remote sensing to conduct science missions.*
- _____
- _____
- _____

How did the findings help you investigate the overall problem?

Sample response: I need to know how scientists work together and what tools they use to explore the earth. Knowing these things will help me plan a mission to explore Kilauea. What else??

What new questions do you have about the overall problem?

- Sample response: How can I tell if there are active lava flows on a volcano?*
- Sample response: What airplanes and remote sensing instruments can I use?*
- _____
- _____
- _____

Lesson: Volcanology

Activity sheet: Volcano model (V-1)

Name: _____

1. Draw a picture of your volcano model and label its features.

2. What does this model demonstrate about real volcanoes?

Lesson: Volcanology

Activity sheet: Volcano research project (V-2)

**Research volcanoes and create a project on volcanoes that answers the following questions:
Be sure to get teacher approval for your group's project before you begin!**

- How do scientists determine whether a volcano is active, dormant, or extinct?
- What are the different types of volcanic eruptions? Describe each.
- What is lava and what are its characteristics?
- What types of shapes do lava flows form?
- How can you tell the difference between old lava flows and new lava flows?
- What are the different types of lava? Describe each.
- Where is lava on an active volcano?
- What do you need to know about the Kilauea volcano to determine if it has active lava flows?
- How can airplanes and remote sensing instruments help you investigate volcanoes?

Volcano vocabulary: Define each of these terms in your presentation

Active

Dormant

Extinct

Magma

Lava (types)

Lava layers

Eruptions (types)

Lava flow shapes

Re-vegetation

Lesson: Volcanology

Activity sheet: My understanding of volcanoes (V-3)

Name: _____

1. Is an ongoing eruption the only way to tell if a volcano is active? Are visible lava and gases the only signs of an active volcano?

2. What do we need to know about this volcano to determine if it is active? How can we do to get the information we need?

3. How can remote sensing instruments help determine if a volcano has active lava flows?

4. What role do aircraft have in collecting remote sensing images?

5. How would aeronautics scientists, remote sensing scientists, and volcanologists work together to determine if the Kilauea volcano currently has active lava flows?

Lesson: Volcanology

Activity sheet: Reflection page (V-4)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- _____
- _____
- _____
- _____
- _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- _____
- _____
- _____
- _____
- _____

Lesson: Airborne remote sensing mission: What do we need to know?**Mission planning letter (ARSM-1)**

Dear airborne mission scientist:

Planning an airborne remote sensing mission requires considering many factors that may affect the success of the mission. The first step in selecting the best research aircraft for this mission is to identify the right questions to ask about the mission. The answers to these questions will guide us in selecting the most appropriate aircraft. Then, it is important to explore the characteristics of each available research aircraft. Finally we analyze the information about the mission and the characteristics of the available aircraft to select the best one for the mission.

As airborne mission scientists, we would like to request your help in selecting the best aircraft for flying this mission. Specifically, we would like your recommendation on: Which is the best aircraft for our mission and why?

We look forward to hearing from you soon.

Sincerely,

M. Macarthy

Director of Airborne Mission
Science Division for KaAMS

Lesson: Airborne remote sensing mission: What do we need to know?**Activity sheet: Four forces (ARSM-3)**

Name: _____

What are the four forces of flight? Define each and draw and label arrows around the airplane below showing how each force acts on airplanes during flight.

| Force | Definition |
|--------------|-------------------|
| 1. | |
| 2. | |
| 3. | |
| 4. | |



Why do airplanes fly? Draw a picture to illustrate your answer. Hint: air and wings

What factors can affect flight? For example, weight of cargo, weather, etc.

Lesson: Airborne remote sensing mission: What do we need to know?

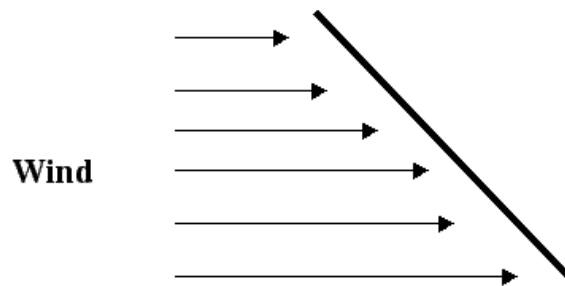
Understanding the four forces that can affect flight (ARSM-4)

Name: _____

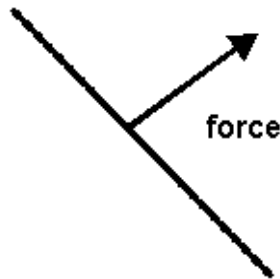
The four forces

How many forces act on an airplane? 4? 3? 2? 1? _____

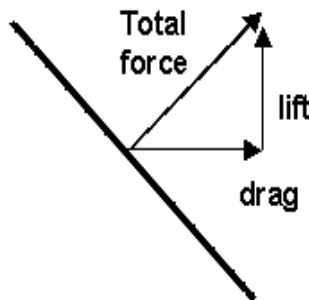
What happens when you stick your hand out the car window while the car is moving? When you raise your hand at an angle to the airflow, it acts exactly like a flat plate.



The aerodynamic force it feels pushes it diagonally backward.



This force can be broken up into a system that is easier to work with.



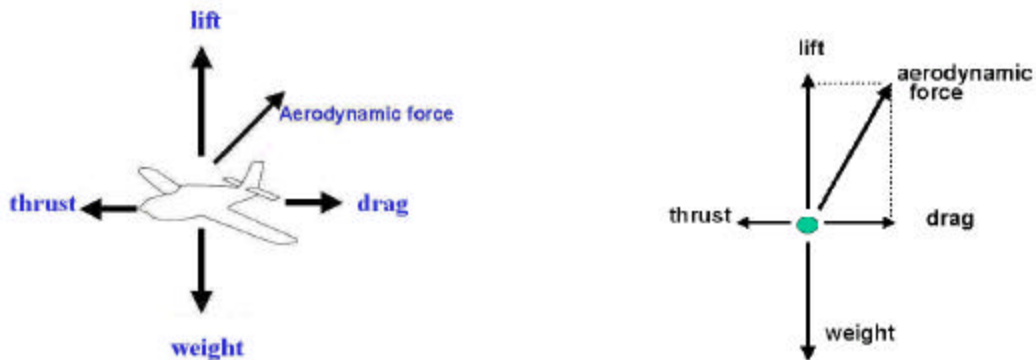
The lift and drag are the horizontal and vertical components of the force acting on the plate. The lift is always taken to be perpendicular to the wind, and the drag is parallel to the wind.

Lesson: Airborne remote sensing mission: What do we need to know?

Understanding the four forces that can affect flight (ARSM-4A)

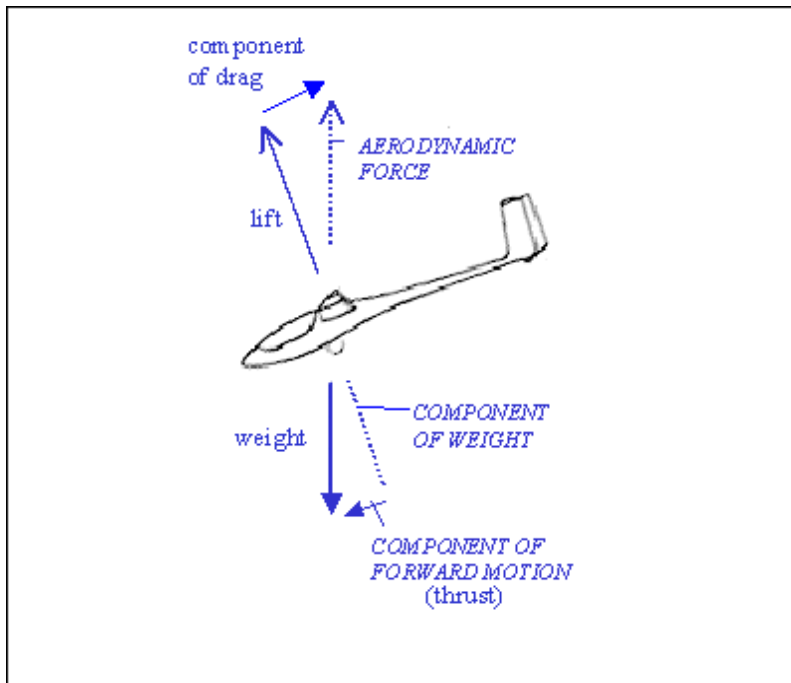
Four forces and flight

This is the same way we can describe the forces acting on an aircraft.



In a glider thrust is not provided from an engine, but comes from the component of gravity in the direction of flight. (Note: If the forces are all in balance (equilibrium), the aircraft will not change its direction of flight. If the forces are NOT in balance, see the explanation for four forces websites for further explanation.)

<http://www.grc.nasa.gov/WWW/K-12/airplane/Animation/frsmot.html>



Lesson: Airborne remote sensing mission: What do we need to know?**Activity sheet: Weather and flight (ARSM-6)****Team members:** _____**Name:** _____**1. Weather at Hawaii and Dryden Flight Research Center**

- What is the weather like in Hawaii this time of year?

- What is the weather like at Dryden Flight Research Center - DFRC (southern California) this time of year?

2. About weather and aircraft

- What are the most critical weather elements that influence flying a mission?

- Why is it important to examine weather for an airborne remote sensing mission?

3. Why is weather important in planning the KaAMS missions?

- Where is the target location for data collection?

- What weather phenomenon may cause problems for an airborne remote sensing mission?

- Why can flying airborne remote sensing missions around volcanoes be hazardous?

Lesson: Airborne remote sensing mission: What do we need to know?

Activity sheet: Planning to fly there (ARSM-7)

Team members: _____

Name: _____

Departure time: What time will we leave? (hint: day or night, morning or afternoon?)

Departure airport: From what airport will we leave? (hint: what is the home base of the aircraft?)

Route of flight: How will we get there? (hint: What is the best path between the take-off point and data collection target?)

Weather and flight: What are the acceptable weather conditions for this flight?

Arrival airport: Where will we land? (hint: will you need to stop somewhere else before returning to your original airport?)

Estimated time en route: How many hours will it take to get to each destination? (hint: rate x time = distance)

Arrival time: What time will we land at each destination? (hint: what time did you take off and how long is your flight?)

What else do you need to include in your flight plan?

Lesson: Airborne remote sensing mission: What do we need to know?

Activity sheet: Mission defining questions (ARSM-8)

What would you need to know in order to select the best aircraft for your remote sensing mission? Generate a list of important mission defining questions. Be prepared to share your list of questions and rationale why the question is important.

| Categories of questions | Specific questions |
|--|---------------------------|
| Factors related to the aircraft and remote sensing instruments | |
| Factors other than the aircraft and remote sensing instruments | |
| Factor involved in the actual flight planning process | |

Lesson: Airborne remote sensing mission: What do we need to know?

Activity sheet: Presentation rubric (ARSM-9)

Kids as Airborne Mission Scientists

Defining the parameters of the airborne remote sensing mission

- Presenters: _____
- Reviewers: _____
- Date of review: _____

| Presentation elements | Rating | | |
|--|--------|------|-----------------|
| | Strong | Good | Needs more work |
| Assess the questions that addressed issues related to the type of aircraft and remote sensing instruments. | | | |
| Assess the questions that addressed factors other than aircraft and remote sensing instruments. | | | |
| Assess the questions that addressed factors involved in planning a flight. | | | |
| In general, the questions presented were clearly stated. | | | |
| In general, the questions were organized effectively. | | | |
| In general, the types of questions listed were important to the to overall mission. | | | |
| Evidence was presented that justified each of the questions. | | | |
| The presenters provided evidence of working effectively as a team. | | | |

Specific comments:

Lesson: Airborne Remote Sensing Mission: What do we need to know?

Activity sheet: Reflection page (ARSM-10)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- _____
- _____
- _____
- _____
- _____

How did the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- _____
- _____
- _____
- _____

Lesson: Developing the mission flight plan

Activity sheet: Aircraft characteristics (DMFP-1)

Name: _____

| | | SR-71 | ER-2 | DC-8 | King-Air | Pathfinder |
|---------------------------------|---------------------------------|--------------------------|---------------------------------------|---|--|---|
| Aircraft characteristics | Purpose | | | | Environmental research, people transport | |
| | Maximum equipment weight | 2,000 lbs. (mostly fuel) | | 30,000 lbs. | 4400 lbs. | |
| | Maximum equipment power | some available | 28 volts DC | high capacity AC/DC 125 KW 400 hz & 60 hz | some available AC/DC 60 amps DC | 2 KW |
| | Altitude | | | | | |
| | Maximum cruise speed | | | 570 mph | | |
| | Maximum cruise range | | | | | |
| | Crew | | | | | |
| | Weather requirements | clear, stable | take-off in up to 15 knot cross winds | take-off in up to 35 knot cross winds | anything but icy weather | maximum 12 mph wind at take off, limited or no clouds |
| | Needed runway length | . | 500 to 1500 ft. | 6,000 ft | 1900 ft. | 200 ft. |
| | Expense | very high | moderate | | low | low |

Can you select the best aircraft for KaAMS mission based on what you know?

Which aircraft is the best aircraft? Why?

Lesson: Developing the mission flight plan

Activity sheet: Selecting aircraft based on remote sensing instrument parameters (DMFP-2)

Group names: _____

There are many different kinds of remote sensing instruments. They come in a wide variety of sizes and weights based on their purpose and the methods they use for data communication and storage. Some remote sensing instruments work best at certain altitudes or below certain speeds. Others may be limited to the certain weather conditions. All of these factors must be considered when choosing the most appropriate aircraft for the mission.

- The remote sensing instrument for this mission is the [AVIRIS](#). Characteristics of the AVIRIS include:
 - weight: 720+ pounds
 - power requirements: 28 volts DC, 400 hz
 - best altitudes for data collection: 35,000 to 65,000 feet
 - best speed for collecting data: 450 mph

Consider the following questions as you consider the optimal aircraft for flying a mission using the AVIRIS:

- How much power does the remote sensing instrument need to operate? Is it available on the aircraft?
- At what altitude can the aircraft fly? What is the optimal altitude for operating AVIRIS?
- How fast does the aircraft fly? What is the optimal speed for collecting data using the AVIRIS?

Aircraft selection table based on remote sensing instrument (DMFP-2A)

| | | | SR-71 | ER-2 | DC-8 | King-Air | Pathfinder |
|---------------------------|---------------------------|--------------------|-------|------|------|----------|------------|
| Remote sensing instrument | Equipment weight | 720 lbs. | | | | | |
| | Necessary equipment power | 28 volts DC, 400hz | | | | | |
| | Aircraft altitude | 30,000-65,000 ft. | | | | | |
| | Aircraft speed | 300-470 mph | | | | | |
| | Select the best aircraft | | | | | | |
| | Why or why not? | | | | | | |

Lesson: Developing the mission flight plan

Activity sheet: Selecting aircraft based on mission planning factors (DMFP-3)

Group names: _____

Suppose that you are preparing to take a vacation. Generally you think about where you are going, when you will leave and arrive, and what will you do while away. You might also think about other possibilities that might affect your journey such as car trouble, weather, and money. Like planning a vacation, mission planners think about factors that might affect a mission. What factors do you think need to be considered when developing a mission plan?

Here is information provided by a mission planner that needs to be considered for this mission.

Mission planning factors

Maximum cruise range: 3000 miles

How often will data need to be collected? 1 time

What time of day will data need to be collected? daylight

What are the weather requirements for the mission? clear skies, less than 15% clouds

Select the optimal aircraft while thinking about the following questions:

- What is/are the best aircraft considering the range of the flight?
- What is/are the best aircraft considering time of day for data collection?
- What is/are the best aircraft considering the required weather conditions?

Aircraft selection table based on mission planning factors (DMFP-3A)

| | | | SR-71 | ER-2 | DC-8 | King-Air | Pathfinder |
|-----------------------|---|-------------|-------|------|------|----------|------------|
| Mission possibilities | How far do I need to be able to fly the aircraft to collect data? | 3000 miles | | | | | |
| | How many passes are needed for data collection? | 1 time | | | | | |
| | When do I need to sense data? | day | | | | | |
| | Weather requirements | clear skies | | | | | |
| | Select the best aircraft | | | | | | |
| | Why and why not? | | | | | | |

Lesson: Developing the mission flight plan

Activity sheet: Selecting aircraft based on flight planning parameters (DMFP-4)

Group names: _____

When a mission planner develops a flight plan, many different parameters are defined that help select the aircraft and plan the mission. The following questions are commonly researched: What aircraft is available to fly the mission? What is the necessary runway length for the available aircraft? Where will the aircraft need to fly, how long will it fly? What airports are near the target site? Do we have access to those airports? Do the available airports have the necessary equipment to support the aircraft?

For this mission, consider the available airports between the aircrafts' home base and the target remote sensing location. Where are the airports that can be used to support this mission?

Where is NASA Dryden located? _____ Where is the remote sensing target location? _____ How far is it from the home base to the target? _____

Here is additional information provided by mission planning:

- One pilot is available who is prepared to fly the mission, no other pilots are available, ground and support crews are available to support any type of aircraft at all airports.
- Data need to be gathered from an altitude of 65,000 ft.
- Airport runway lengths are between 5,600 and 12,000 ft.

Consider the following questions while selecting the optimal aircraft for this mission.



- What aircraft is best given the availability of crew?
- Which aircraft is best given the altitude requirement?
- Which aircraft is best given the runway length of the available airports?

Aircraft properties table for mission possibilities for flight plan (DMFP-4A)

| | | | SR-71 | ER-2 | DC-8 | King-Air | Pathfinder |
|--|--------------------------|--------------------|-------|------|------|----------|------------|
| | Airport runway | 5,600 - 12,000 ft. | | | | | |
| | Crew available | 1 | | | | | |
| | Altitude of image | 65,000 ft | | | | | |
| | Select the best aircraft | | | | | | |
| | Why and why not? | | | | | | |

Lesson: Developing the mission flight plan

Activity sheet: NASA Airborne science flight request form (DMFP-5)

| | | |
|---|---|---|
|  | <p>AIRBORNE SCIENCE FLIGHT REQUEST FORM National Aeronautics and Space Administration</p> |  |
| <p>Investigation title:</p> | | |
| <p>Reason for requesting use of NASA facilities:</p> | | |
| <p>Investigator(s):</p> | | |
| <p>Background and primary science objectives:</p> | | |
| <p>Aircraft required: <u>ER-2</u> <u>DC-8</u> <u>P-3B Orion</u> <u>King Air</u> <u>Pathfinder</u> <u>SR-71 Blackbird</u> (circle)</p> | | |
| <p>Data requirements and aircraft sensor:</p> <p>TYPE OF DATA BEING COLLECTED: (describe)</p> <p>SENSORS (circle):</p> <p style="text-align: center;"> <u>MODIS</u> <u>AVIRIS</u> MAMS <u>MACAWS</u> <u>Harvard Co2</u> <u>Dual-Beam UV-Absorption Spectrometer</u> <u>Aerial Camera Systems</u> </p> | | |
| <p>General flight window (month):</p> <p>A)</p> <p>B)</p> <p>C)</p> <p>D)</p> | | <p>General site location (state or country):</p> <p>A)</p> <p>B)</p> <p>C)</p> <p>D)</p> |
| <p>This form must be completed and returned to NASA/DFRC by:</p> <p>(Do not mark in this space/For office use only)</p> | <p><u>Mail completed forms to:</u> Dryden Flight Research Center National Aeronautics and Space Administration</p> | |

Lesson: Developing the mission flight plan

Activity sheet: Flight planning table (DMFP-6)

Group names: _____

| Key activity | Questions for flight plan | Answers for flight plan | Why is it important? |
|-------------------------------------|---|-------------------------|----------------------|
| Identify mission | What is your mission? | | |
| | Which aircraft have you chosen? | | |
| | Where is the volcano? | | |
| Gather airport information | Where is the departure airport? | | |
| | When will the aircraft take off? | | |
| | What will be the cruise speed of ER-2 aircraft? | | |
| | What weather is required for take off? | | |
| | What is the landing site for a mission? | | |
| | Can you directly fly over Kilauea? | | |
| Identifying the airport code | NASA Dryden Flight Research Center at Edwards Air Force Base | | |
| | Honolulu Airport | | |
| Creating flight plan | Write your overall flight path | | |
| | Calculate the distance from take-off to data collection pattern | | |
| | Calculate the flight time from Dryden to Honolulu Airport | | |
| | Calculate the time for data collection | | |

Lesson: Developing the mission flight plan

Activity sheet: Maps of airborne remote sensing mission flight path (DMFP-7)

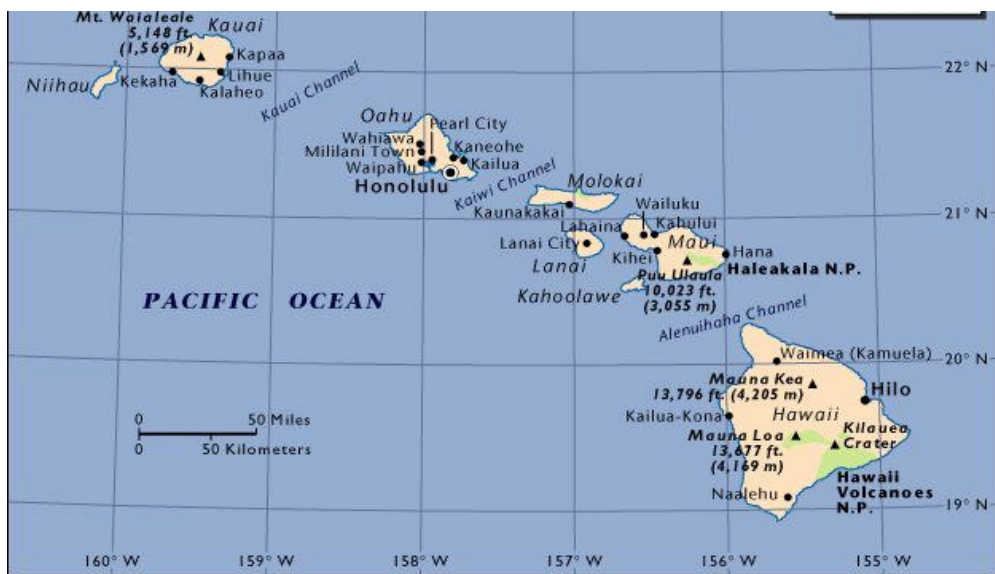
MAP-1

Draw the flight path from NASA Dryden Flight Research Center at Edwards Airforce Base to Honolulu airport



MAP-2

Draw the flight path to and from Honolulu Airport and Kilauea



Lesson: Developing the mission flight plan

Activity sheet: My flight plan for the KaAMS mission (DMFP-8)

Based on the flight planning table, flight path maps, and all information about flight planning, briefly write a description about your own flight plan for KaAMS mission.

Lesson: Developing the mission flight plan

Activity sheet: Reflection page (DMFP-9)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- _____
- _____
- _____
- _____
- _____

How did the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- _____
- _____
- _____
- _____
- _____

Lesson: Collecting data - Kite aerial photography

Activity sheet: Team assignments (CD-1)

Name: _____

Task 1: Assign team member to roles.

| Rigging team - skills | Pilot / Mission planning - skills |
|------------------------------|--|
| | |
| Team members | Team members |
| | |

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission planning (CD-2)

Task 2: Mission planning.

Be sure to address the following questions:

- What is the target for the mission?
- What conditions are necessary for the mission?
- When will the mission be flown?
- Will there be practice flights? When? How long?
- Who will coordinate the mission? How?
- How will the data be analyzed? Who will analyze the data? How will it be reported?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission debrief (CD-3)

Task 3: Conducting the mission.

What happened during the mission? Record your observations. Was it successful in meeting the planned objectives?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission debrief (CD-3A)

Task 4: Analyzing the data.

Were the images useable? What did they tell you?

Task 5: Comparing this experience to collecting data on the Kilauea Volcano.

How is this activity similar to collecting aeronautics remote sensing data on Kilauea? How is it different?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Reflection page (CD-4)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- _____
- _____
- _____
- _____
- _____

How did the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- _____
- _____
- _____
- _____
- _____

Lesson: Analyzing data

Activity sheet: ER-2 Mission information (A-1)

Name: _____

Read the NASA Dryden Flight Research Center news release on the ER-2 missions over South Africa and answer the following questions.

1. What was the mission of the ER-2?
2. What data were collected?
3. How were data presented to the scientists?
4. What do you think the data could tell the scientists?
5. What could the visible images tell the scientists? Provide an example of what you might see in visible data from this mission.
6. What could the non-visible or infrared images tell the scientists? Provide an example of what you might see in non-visible data from the mission.

Lesson: Analyzing data

Activity sheet: Watching over our planet from space (A-2)

Name: _____

1. What types of features should you look for when analyzing visible remote sensing images?

2. Brief description of the activity you completed:

3. What did you see in the visible images?

4. Why are these images important? (What did they tell you?)

Lesson: Analyzing data

Activity sheet: Decision support tool (A-4)

Student Decision Support Tool: Where are there active lava flows in the images?

1) Are images day or night scenes?

| Type of Data | Day scene | Night Scene |
|--------------|----------------------------------|-------------------------|
| | Objects are visible in the image | Objects are not visible |

2a) Are there light reddish-brown flow shapes on or around the sides of the volcano?

| Answer | Day scene | Night Scene |
|------------|-------------------------------|-----------------------------|
| Yes | Indications of old lava flows | Not visible in night images |
| No | No old lava | Not visible in night images |

2b) Are there dark, reddish brown flow shapes on or around the sides of the volcano?

| Answer | Day scene | Night Scene |
|------------|---------------------------------|-----------------------------|
| Yes | Indications of newer lava flows | Not visible in night images |
| No | No new lava flows | Not visible in night images |

3) Are there any bright spots in Mid-IR bands?

| Answer | Day scene | Night Scene |
|------------|-----------------------|-----------------------|
| Yes | Could be lava or fire | Could be lava or fire |
| No | No active lava | No active lava |

4) Do bright spots in Mid-IR correspond to bright spots in the visible image?

| Answer | Day scene | Night Scene |
|------------|---------------------------------|------------------------------------|
| Yes | It is reflected solar radiation | It may not be lava. It may be Fire |
| No | Could be lava | It is most likely Lava |

5) Do bright spots correspond to an area of existing lava flows?

| Answer | Day scene | Night scene |
|------------|---------------------------------------|-------------|
| Yes | It is most likely an active lava flow | |
| No | Most likely a fire | |

Lesson: Analyzing data

Activity sheet: Analyzing the KaAMS mission data (A-5)

Group members: _____

Name: _____

Answer each of these questions by completing the table on the next page.

Part 1: Searching volcano location

- What objects can we see in visible image?
- Where are there clouds in this image?
- Where is the forest in this image?
- Where is there lava in this image?

Part 2: Identifying the previous vs. new lava

- Where is the area of lava flow?
- How can you differentiate between old lava and new lava?
- What is the color of old lava?
- What's the color of new lava?

Part 3: Identify active lava flow

- Can you find active lava flow among the area of lava occupied?
- What are the features of active lava flow?

Lesson: Analyzing data

Activity sheet: Analyzing the KaAMS mission data (A-5A)

Group members: _____

Name: _____

What did our team find from analyzing data image?

| Analyzing Elements Observing Objects | Location on image | Color of object (in visible image) | How do you know what this object is? |
|--|-------------------|---------------------------------------|---|
| <p style="text-align: center;">Clouds</p> | | | |
| <p style="text-align: center;">Forest</p> | | | |
| <p style="text-align: center;">Lava</p> | | | |

Lesson: Analyzing data

Activity sheet: Reflection Page (A-6)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- _____
- _____
- _____
- _____
- _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- _____
- _____
- _____
- _____
- _____

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1)

Group members: _____

Name: _____

Instructions: This chart is to help you think about what you did throughout this unit and organize the information that you will present in your final project. Answer the questions or fill-in the table and then use your answers to help design your project.

What was the key question you were investigating?

What process did you go through while investigating this question and what did you learn a long the way?

| Steps: What did you do? | What did you learn? |
|-------------------------|---------------------|
| | |
| | |

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1A)

| Steps: What did you do? | What did you learn? |
|--------------------------------|----------------------------|
| | |
| | |
| | |

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1B)

| Steps: What did you do? | What did you learn? |
|--------------------------------|----------------------------|
| | |
| | |
| | |

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1C)

What was most exciting to you during this unit?

What five things did you learn that you want to share with others?

Lesson: Go Public! Presenting your results

Activity sheet: Final project design (GP-2)

Use this space to draw ideas for your final project:

- What information will you include?
- What will it look like?
- How will you present this information to the public?
- How will you organize the work among your team?