



Aerosols: What are they?

Aerosols are....

made out of miniscule solid particles and small liquid droplets of various chemical compositions and sources suspended in the air.



Natural Occurring Aerosols

They can be found in every ecosystem.

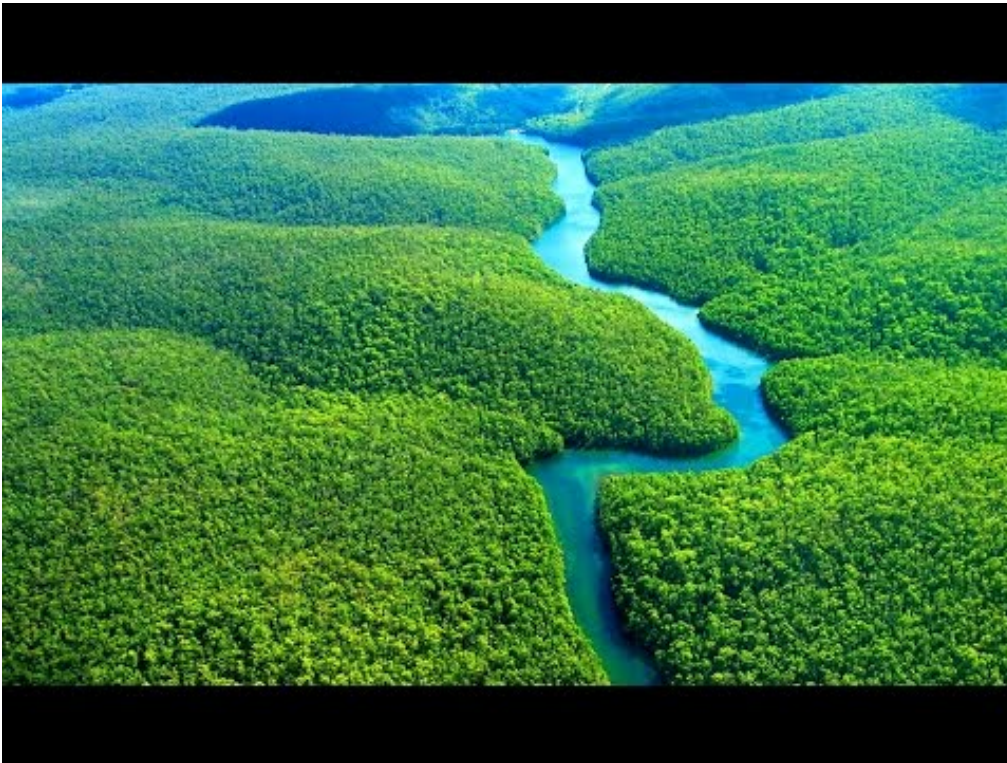


Desserts
Sahara Desert,
Africa



Natural Occurring Aerosols

They can be found in every ecosystem.



Amazon Forest

Forests



Natural Occurring Aerosols

They can be found in every ecosystem.



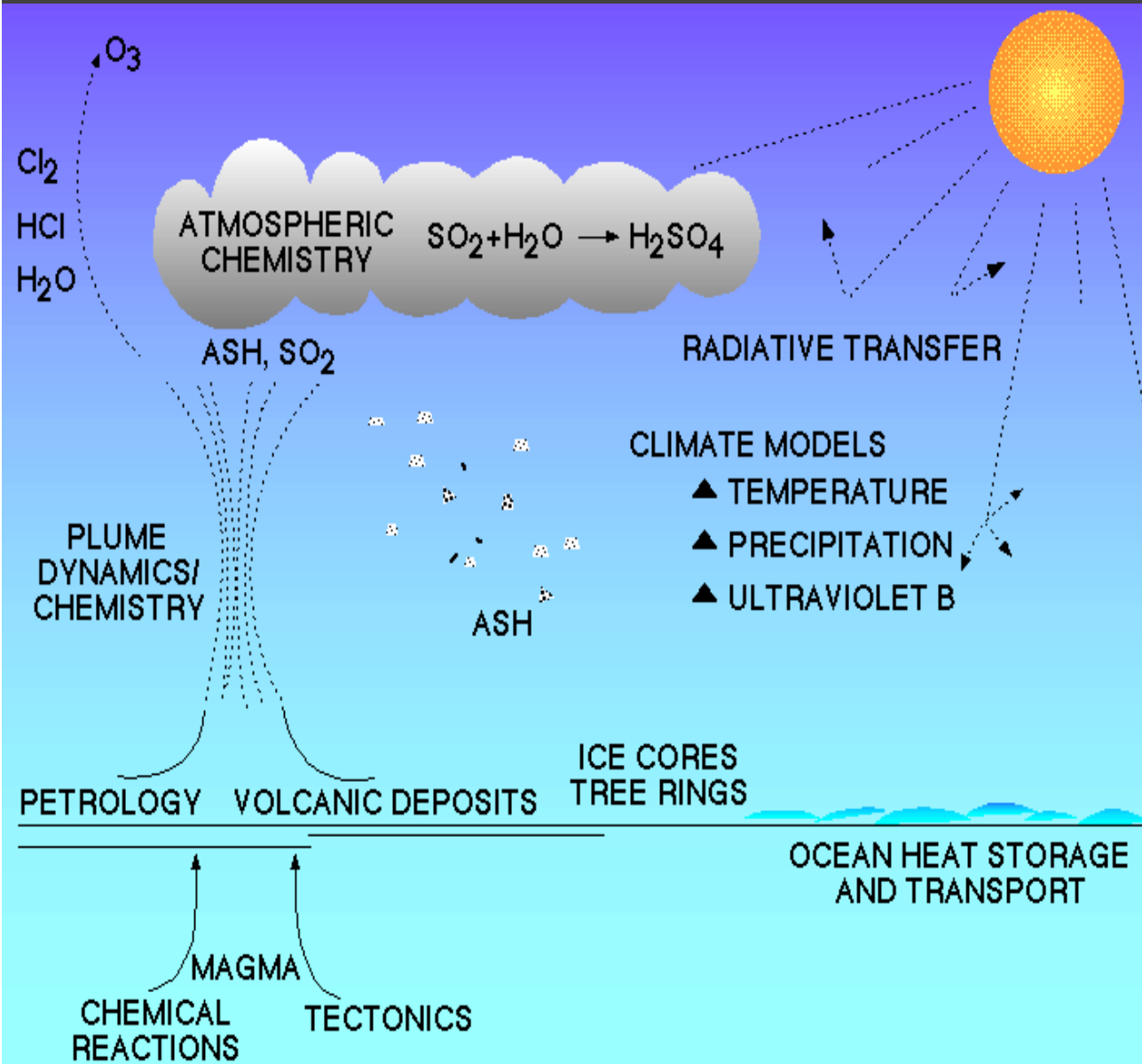
Oceans

Where do Aerosols come from?



Violent volcanic eruptions send **gas and ash** into the atmosphere producing large amounts of aerosols. Some eruptions are more gradual and manage to contribute a steady flow of aerosols but in smaller amounts.

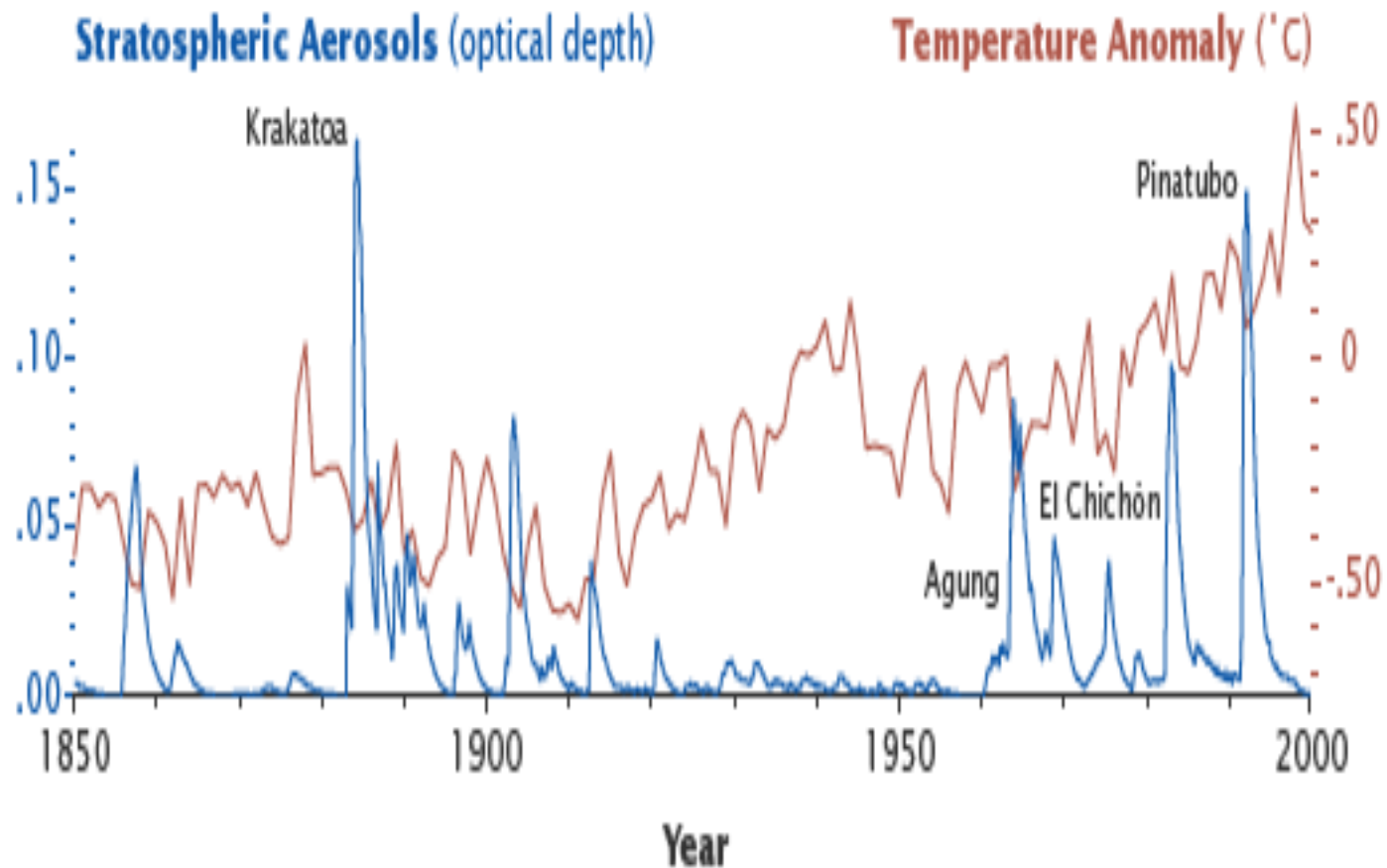
Liquid Aerosols from Volcanic Eruptions



When volcanoes erupt they send gases that can combine with water to form liquid aerosols.

- Water Vapor (most abundant)
- CO_2 (Carbon Dioxide)
- HCl (Hydrochloric Acid)
- Cl_2 (Chlorine)
- SO_2 (Sulfuric Acid)

Aerosols, Sunlight and Energy



Where do Aerosols come from?

Forest fires around the globe send large amounts of **organic carbon** into the atmosphere.



Where do Aerosols come from?



The Sahara desert is the largest desert in the world. It is located above the Sahel region in North Africa. Sand storms transfer sand, minerals and nutrients across the globe depositing them in large concentrations especially in the Amazon Forest.

Where do Aerosols come from?



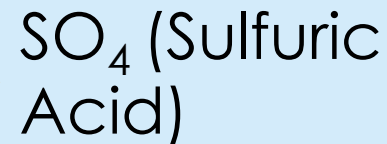
Dust storm
over Phoenix,
Arizona.

Video of Sand Storm in Burkina Faso, Sahel. The Effects of Desertification



Where do Aerosols come from?

OCEANS: Aerosols produced by sea water consist of sea salt and sulfur containing gases called (DMS) dimethylsulphide. The sulfur combines with water to form sulfuric acid a liquid aerosol.



Sea Salt

(DMS) Dimethyl Sulfide from
Marine Phytoplankton

Biological
Activity



90% of Aerosols are from Natural Sources



- Sea Salt
- Dust (Sand Storms)
- Natural Sulfates - SO₂ (Volcanic Eruptions and Microalgae)
- Forest Fires (Produce Organic Carbon)
- Organic Gases (Produced by some types of plants)

Where do Aerosols come from?



ANTHROPOGENIC
AEROSOLS:
PRODUCED BY
HUMAN ACTIVITY

Exhaust from all
types of vehicles
produce **black
carbon** and CO_2 ..

Where do Aerosols come from?



ANTHROPOGENIC
AEROSOLS:
PRODUCED BY
HUMAN ACTIVITY

Smoke stacks from power, incinerators and industry produce large amounts of Sulfates, Nitrates, and Black Carbon aerosols.



Deforestation of Amazon

Deforestation of Forests around the world can increase the level of aerosols in the atmosphere. Arid land creates lots of problems especially loss of biodiversity....

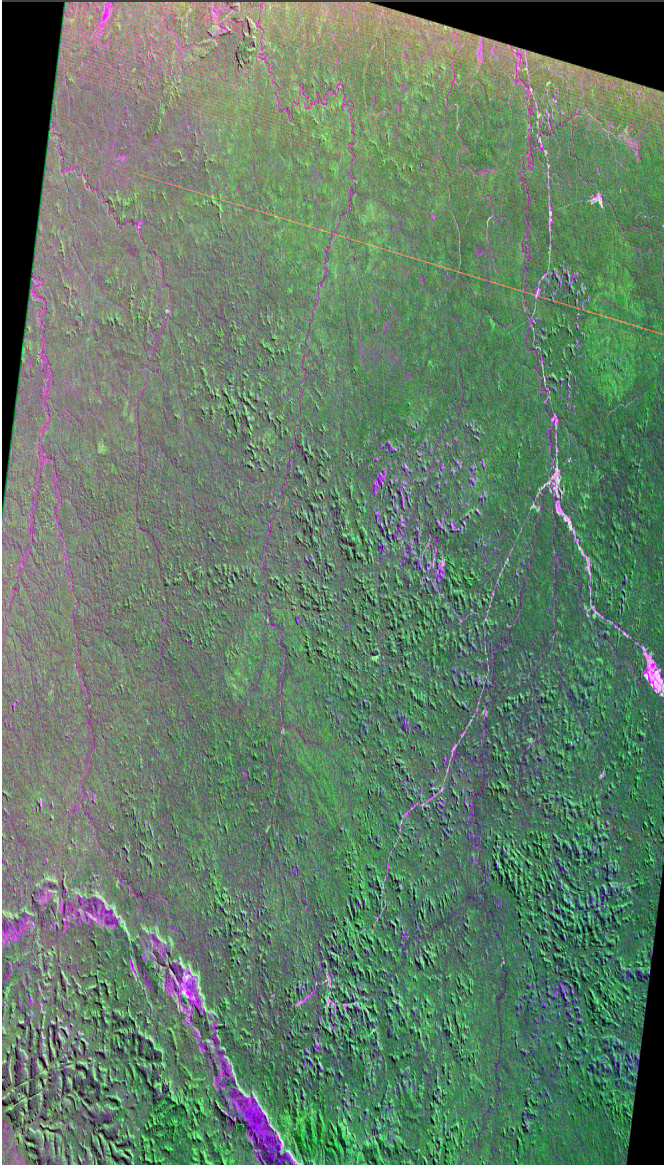
DEFORESTATION ACTIVITY

MATERIALS: Google Earth

Procedure:

1. Go to Earth Observatory NASA Amazon Deforestation
Link :<http://earthobservatory.nasa.gov/Features/WorldOfChange/deforestation.php>
2. On the right hand side of the play button press Google Earth button. If you have Google Earth installed on your computer it will download. Click on the download and it will take you to Google Earth if it is installed on the computer.
3. On the upper left of the screen there is a slide button beginning in the year 2000 and ending in the year 2010. To view the aerial data of the satellite image overlay slide the button and notice the changes in the topography.
4. For more information look for the UNEP blue icon on the right of the image and click on it. Read it carefully and answer the questions.

Amazon Deforestation Activity Part II



Equipment: Internet Access

Procedure:

1. Go to the US Geological web site (see link)
Link: <http://earthshots.usgs.gov/earthshots/node/39#ad-image-4th>
2. Make a graph using the information provided on the data chart titled: Area of rainforest cleared in Rondônia.
3. Under the table of contents on the same page, on the right hand side, there are a series of Landsat Satellite images of the region. Click on each one and describe what do you notice over time.

Deforestation Activity Questions

Name: _____

Date: _____

Task: Rondônia, Brazil – UNEP

Use the data chart below to construct and graph. Analyze and explain the data. What is the data showing over time? Use percentages to show changes on the graph. On the table create another column to show difference and percentages.

Year	Area Cleared	Difference	Percent %
1978	4,200 km ²		
1988	30,000 km ²		
1998	53,300 km ²		
2003	67,764 km ²		

Atmospheric Aerosols



Unit: Atmospheric Aerosols and Climate Change

- **Task: Dispersal of Aerosols**

Watch the animation on the next slide. Use the guiding questions on the student worksheet to assist you analyze the animation.



Aerosol Motion Activity

Questions: What is the video demonstrating? In what direction is the aerosol moving? Please be specific and use geographical coordinates in your description.

**Unit: Impact of Aerosols on
Climate**

Task: Dispersal of Aerosols

Animation: NASA Animation

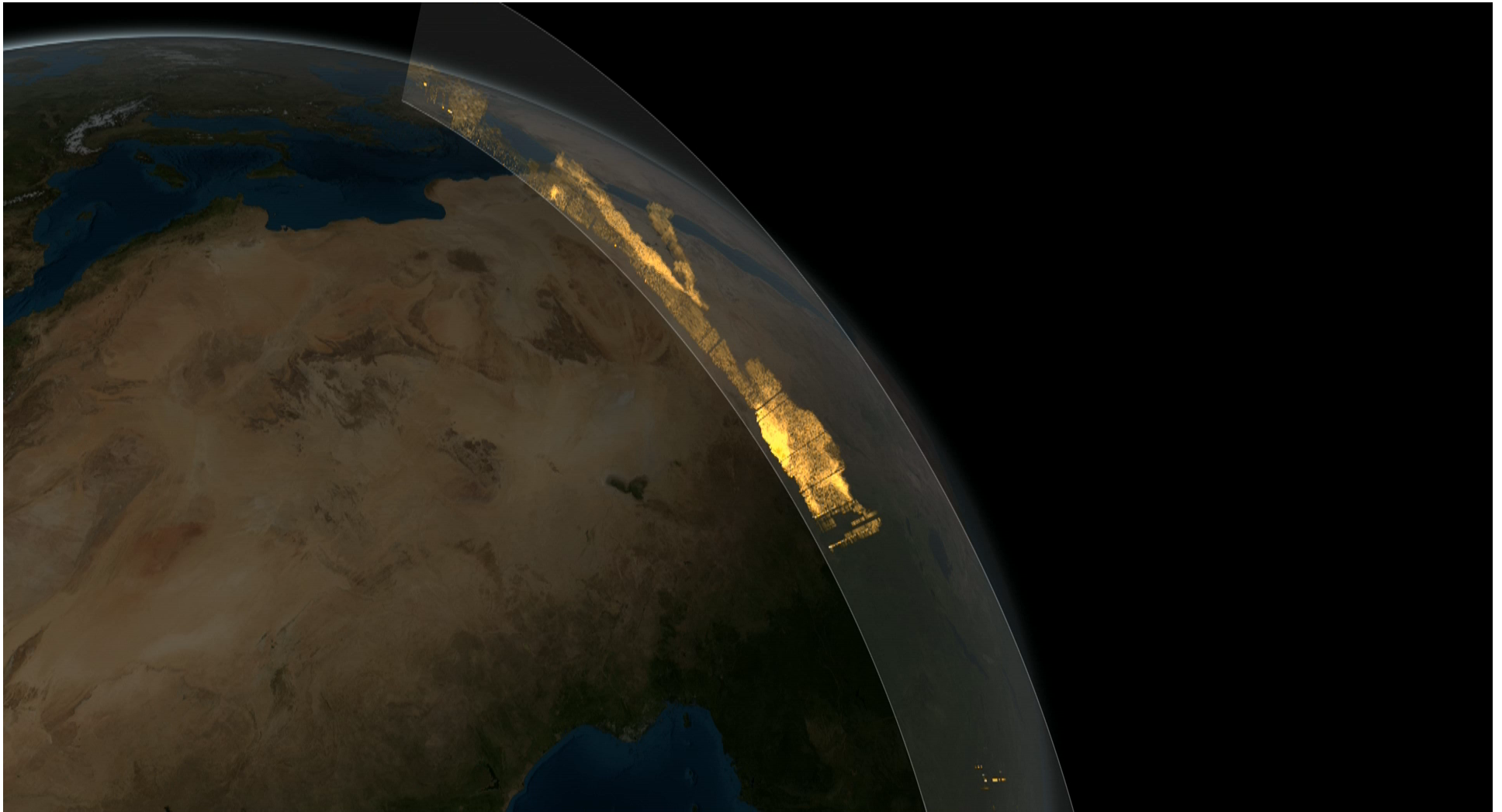
Name: _____

Date: _____

What is the animation trying to model? Describe in your own words. At least use two or more new terms in relation to aerosols.

What type of aerosol was used in the animation?

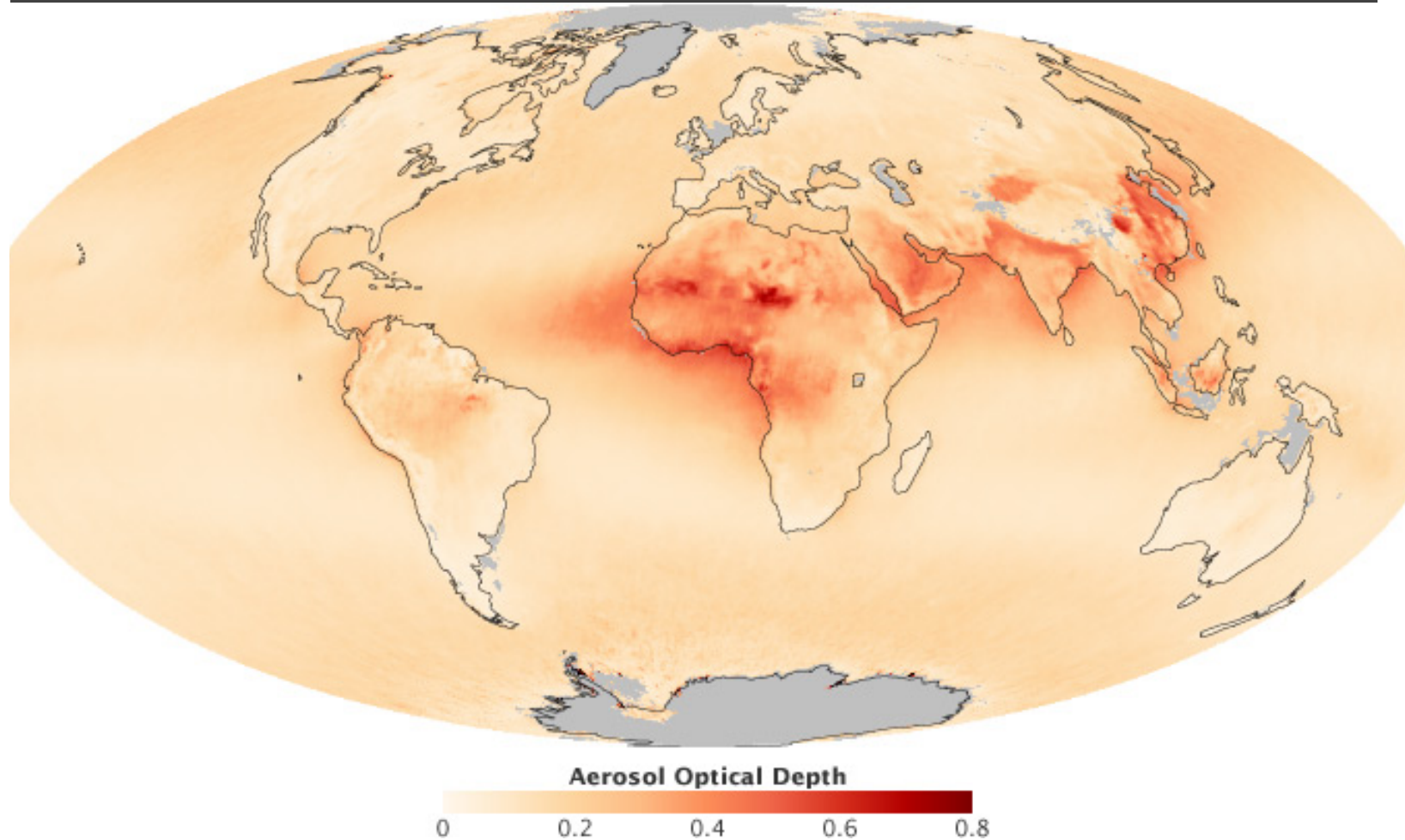
In what direction did the aerosol travel? Use the terms clockwise and counter clockwise. Use as many geographic coordinate related references as possible.



Sahara Dust Travels to the Amazon Forest to Seed Clouds and
Fertilize the Forest

Watch Video Above

Task: Measuring Aerosols



NASA Article: Aerosols: Tiny Particles, Big Impact

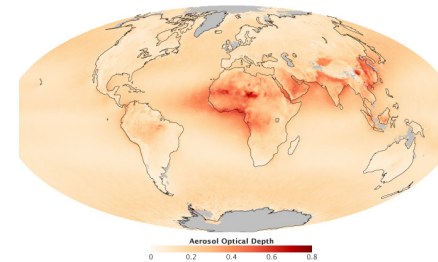
NASA Link:

<http://earthobservatory.nasa.gov/Features/Aerosols/>

Lesson: Measuring Aerosols

The questions will help you summarize the article.

Guiding Questions:



1. What are the different technological tools used by scientists to measure aerosols?
2. What does the optical depth measure?
3. Please explain the meaning of the optical depth scale.
4. Analyze and interpret the image of the illustration global optical depth general as well as making reference to the scale. Where on the map are the highest concentrations of aerosols? What do you think maybe causing it? (You can answer this question using prior knowledge or simply with an educated guess).

NASA Article: Aerosols: Tiny Particles, Big Impact

NASA Link:

<http://earthobservatory.nasa.gov/Features/Aerosols/>

Task: Measuring Aerosols

5. Why do scientists don't only rely on satellites for the data collection of aerosols?

 6. What are some of the remaining challenges in measuring aerosols at a global scale?
-

Aerosol Optical Depth DATA

Scale: Pale Yellow 0 (Low) – Orange is 1 (High)



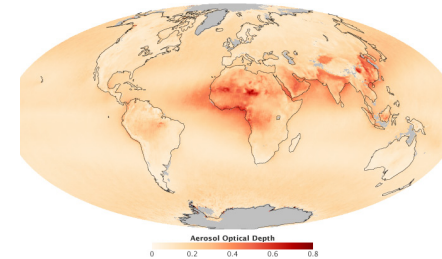
NASA Animation: Global Maps Aerosol Optical Depth

NASA Link: http://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MODAL2_M_AER_OD

Task: Measuring Aerosols

Name: _____

Date: _____



Description: The Optical Depth Animation shows aerosol data

Questions:



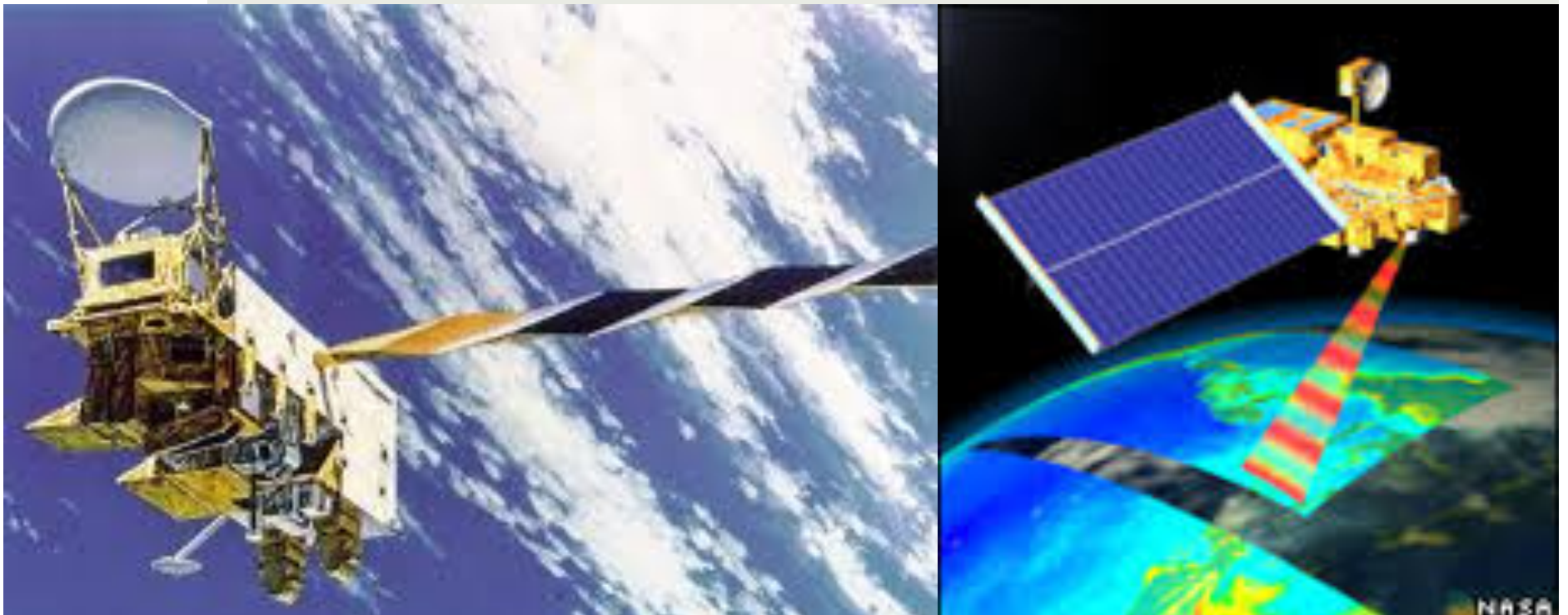
1. Which geographical areas on the map have a persistent optical depth of 1.
2. Are there any generalizations you can make in terms of the aerosols geographical distribution on the globe?
3. What would you attribute as a reason of the cause of the abundance of aerosols and certain geographic areas?
4. Which geographical areas persistently have an optical depth less than 4. Are there any generalizations you can make about the geographical position of these areas?

Activity: Analyzing Visual Data

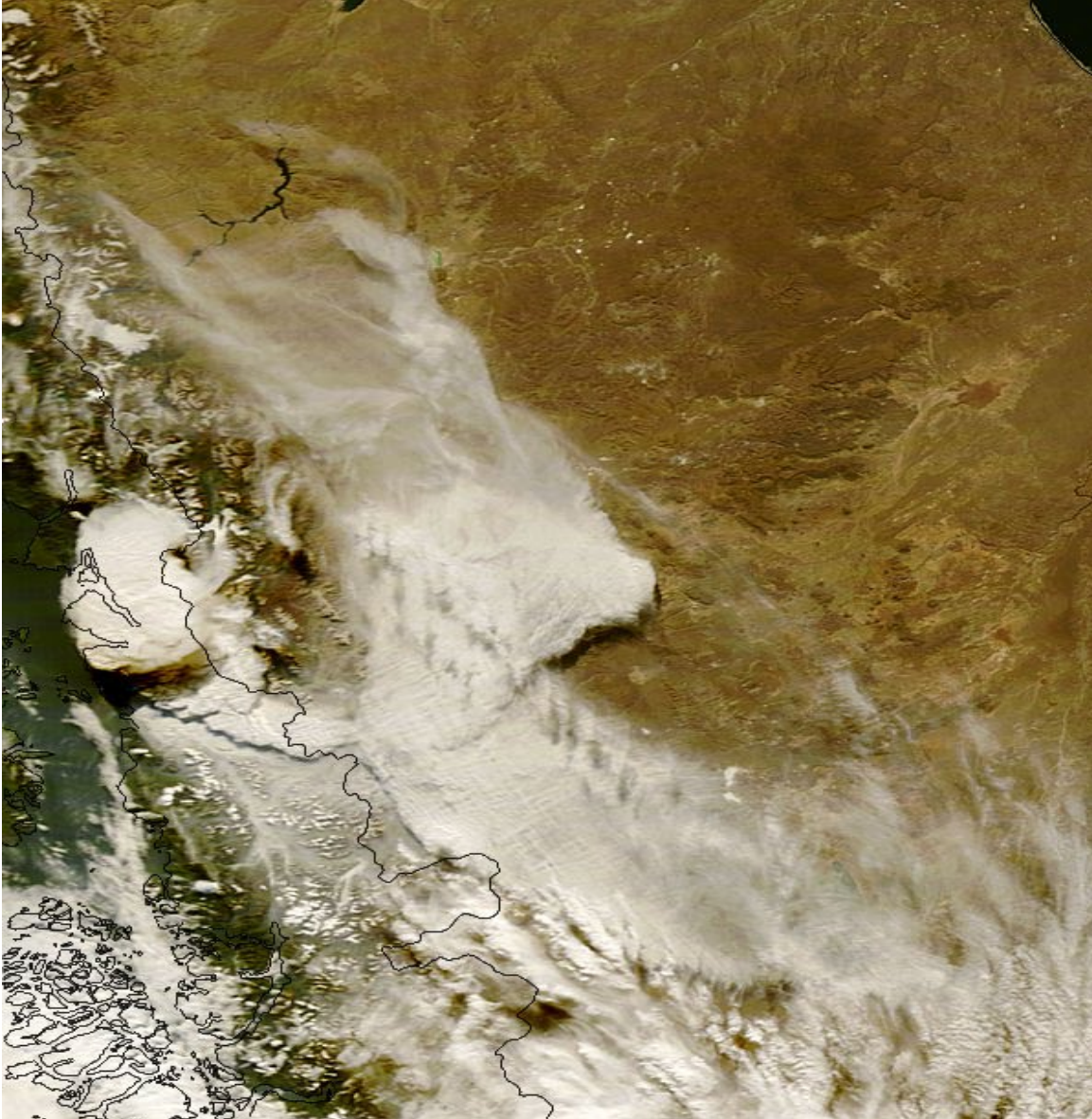
Aerosol Dispersal

Scientists collect atmospheric data to study the dispersal of aerosols in order to better understand their effect on the atmosphere at a local and global scale.

One of the tools they use is the MODIS (Moderate Resolution Image Spectrometer) Satellite. It has been orbiting Earth to collect data since 1999.



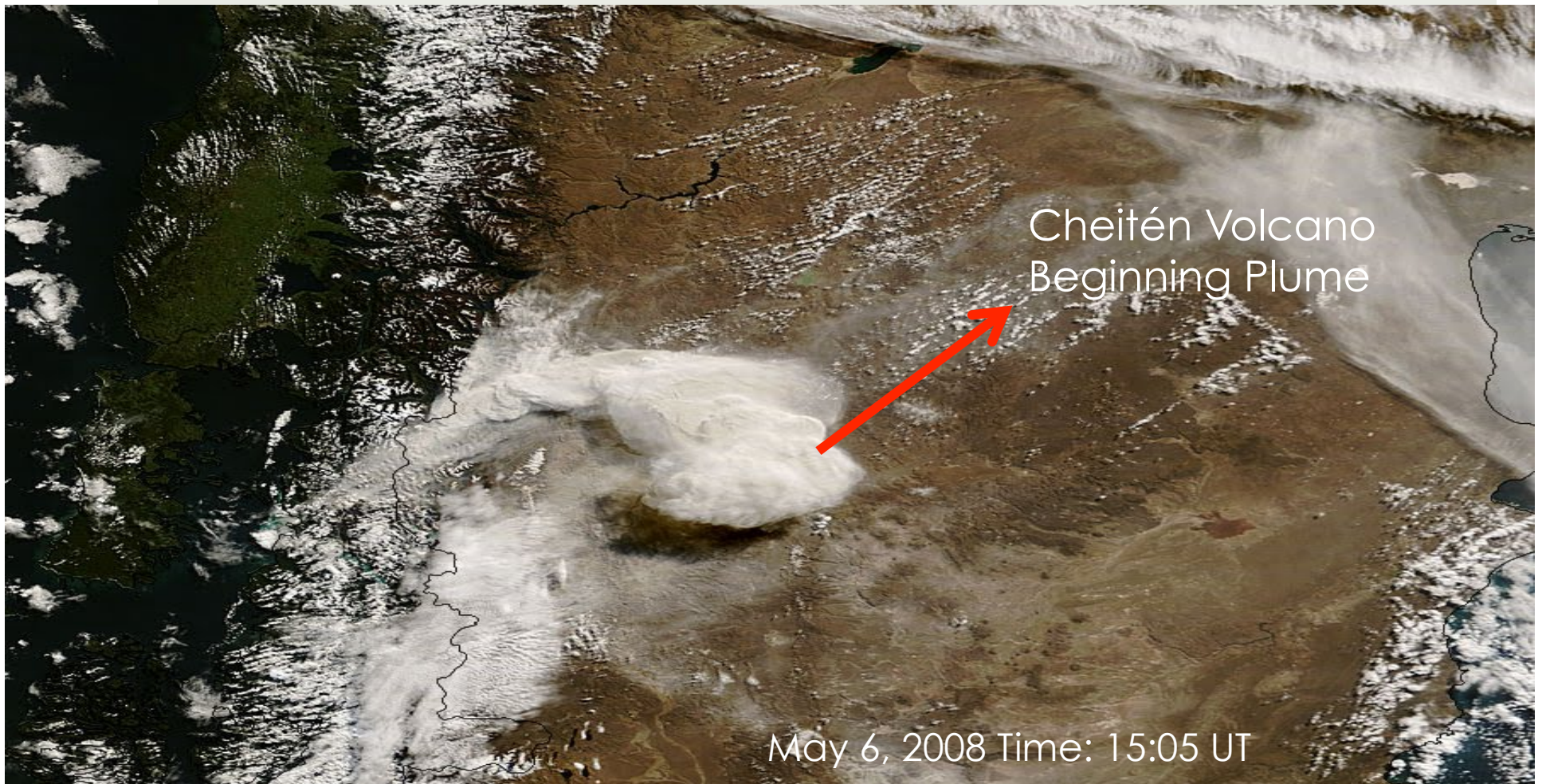
MODIS (Moderate Resolution Image Spectrometer) VOLCANIC DATA



The following series of aerial MODIS satellite images show the smoke and gas plume of the Chaitén Volcano in southern Chile, South America. The eruption spread ashes and gas into the atmosphere.

MODIS (Moderate Resolution Image Spectrometer) DATA

According to this data image can you identify the Cheitén's volcano's eruption origin? Where did the eruption begin?



MODIS (Moderate Resolution Image Spectrometer) VOLCANIC DATA

A satellite image from MODIS showing a volcanic eruption. A large, dense white plume is rising from a coastal area and moving towards the left. The land is brown and arid, and the ocean is dark blue. The plume is very thick and extends over a large area of the ocean.

In what direction is the plume moving? Please use geographic coordinates to describe.

What new information can be obtained from this satellite image in relation to volcanic aerosols?

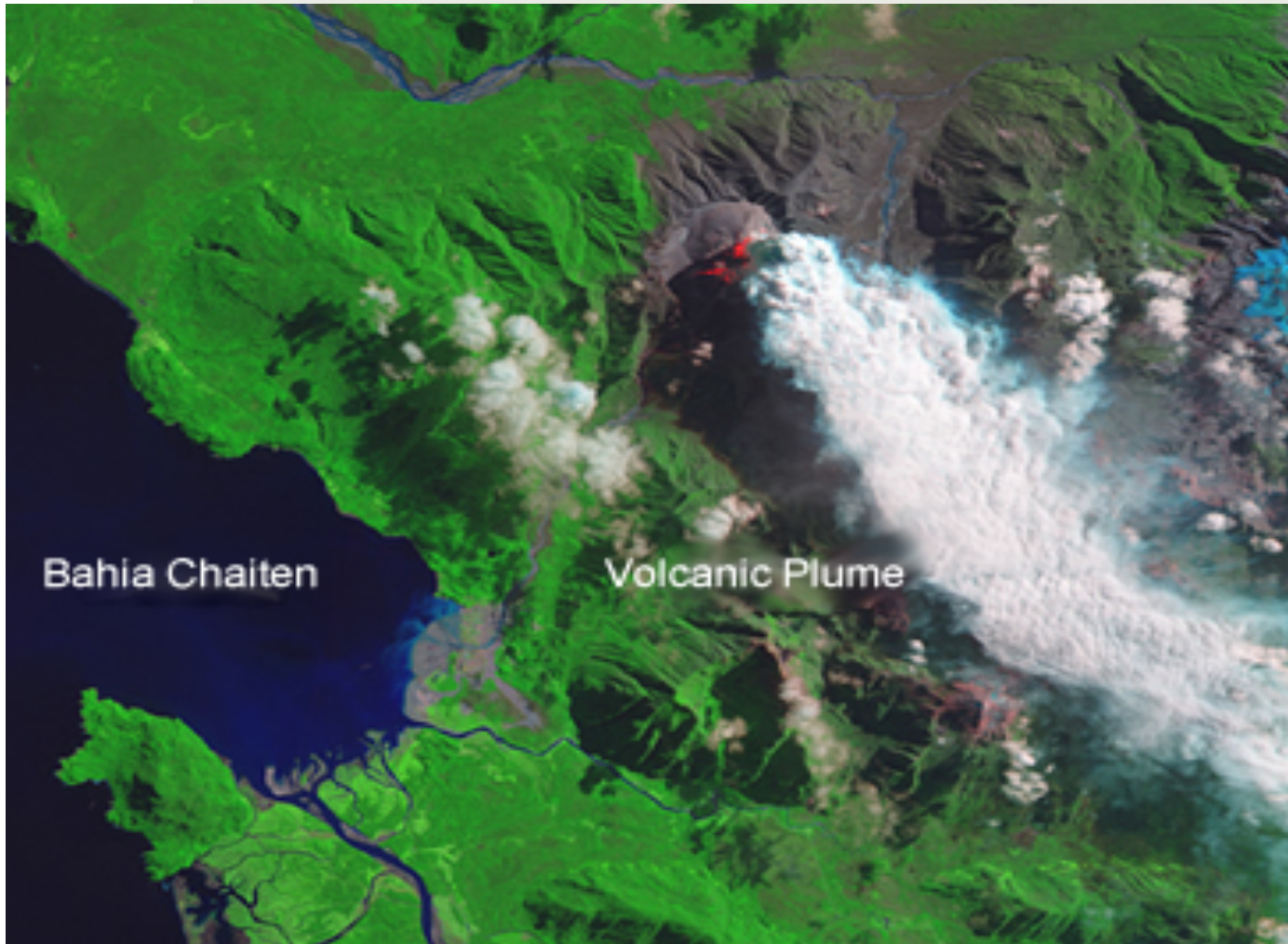
What changes if any can be noticed from the previous image?

What's happening to the ash and gas plume?

May 10, 2008 Time: 14:25 UT

False Color Satellite Image of Volcanic Data

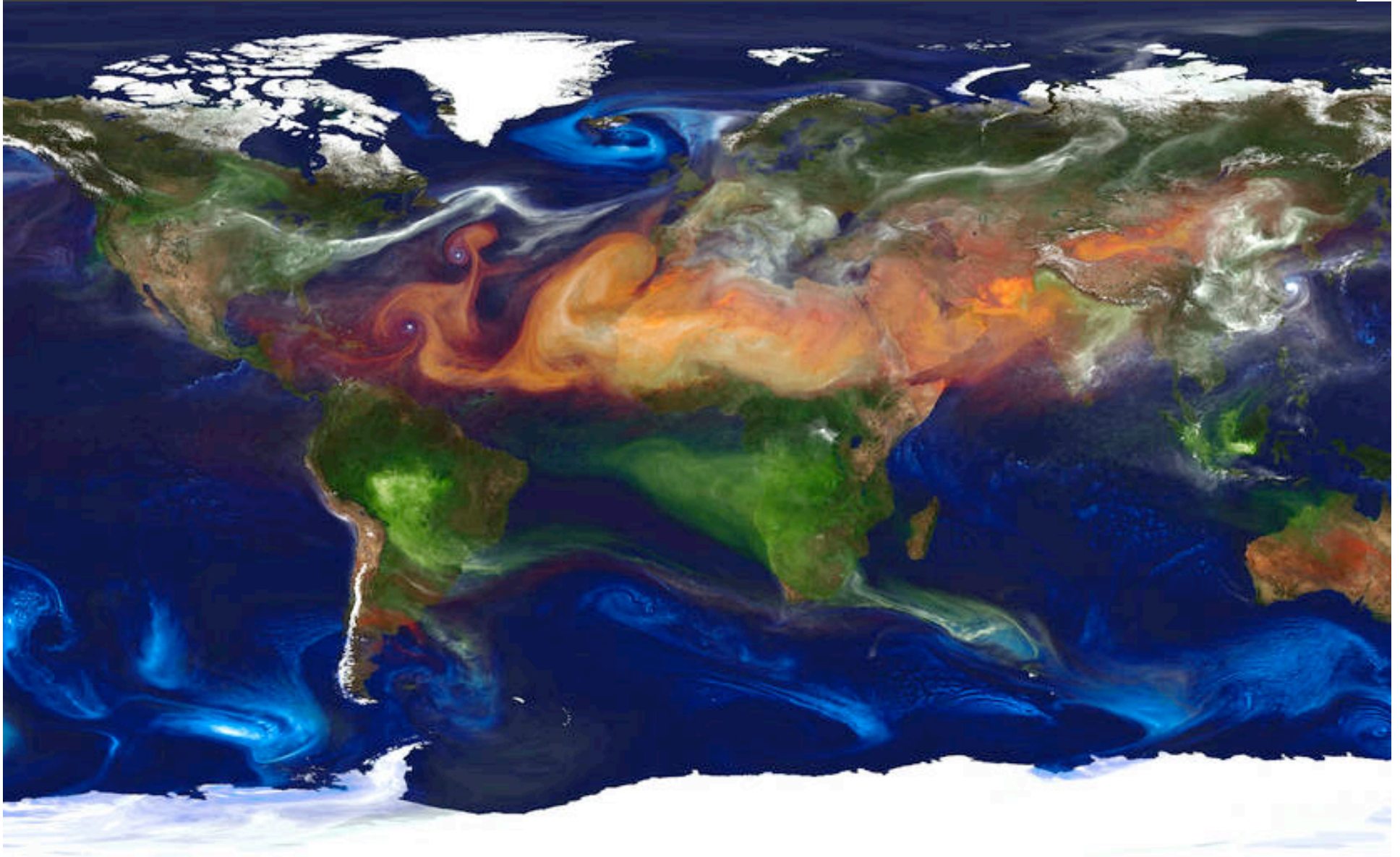
False color image of Cheitén Volcanic eruption in southern Chile in 2008.

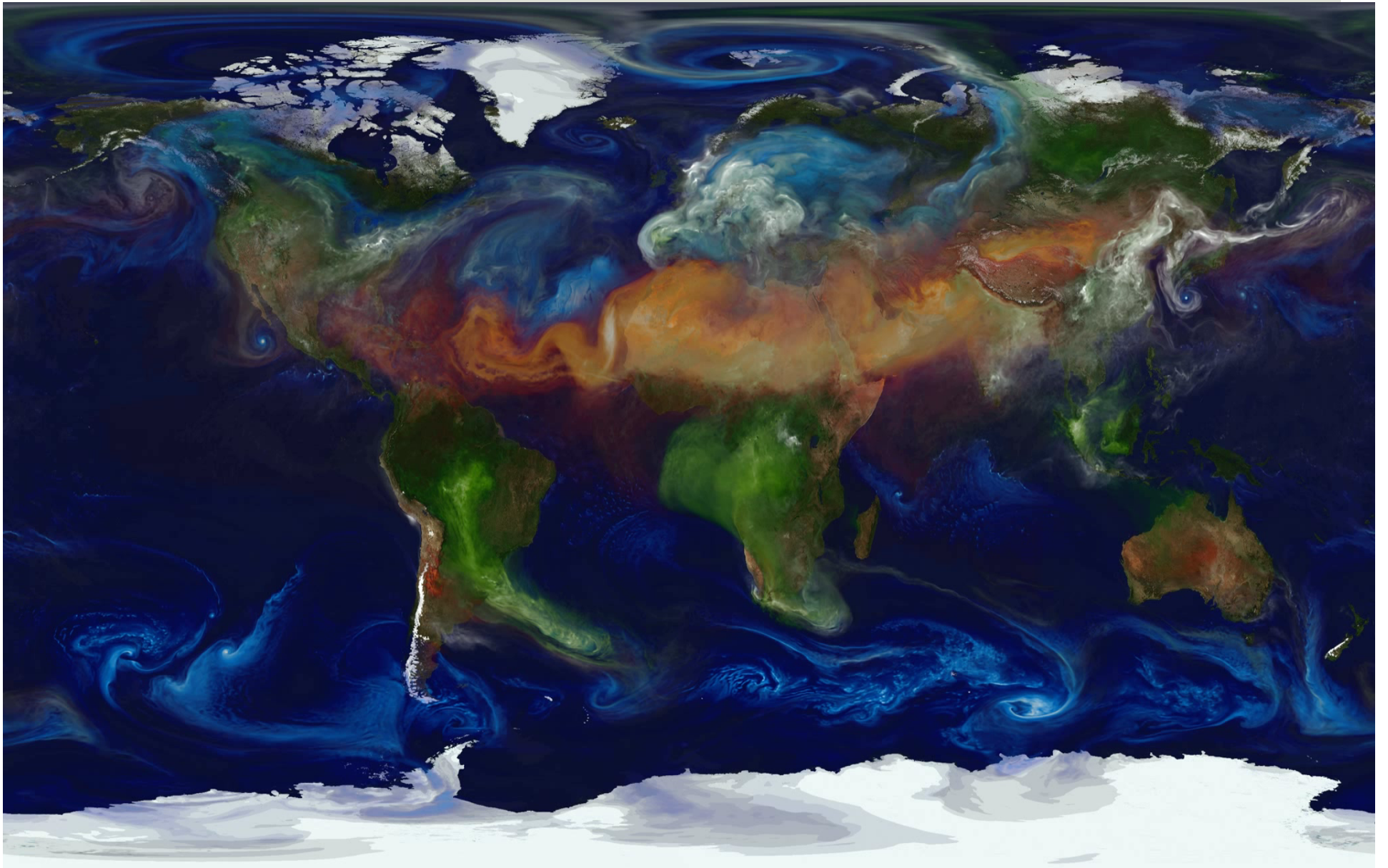


What new information can this false color image produce?

Can it be discerned from this image what the different colors mean?

Global Motion of Aerosols





Activity: Global Motion of Aerosols

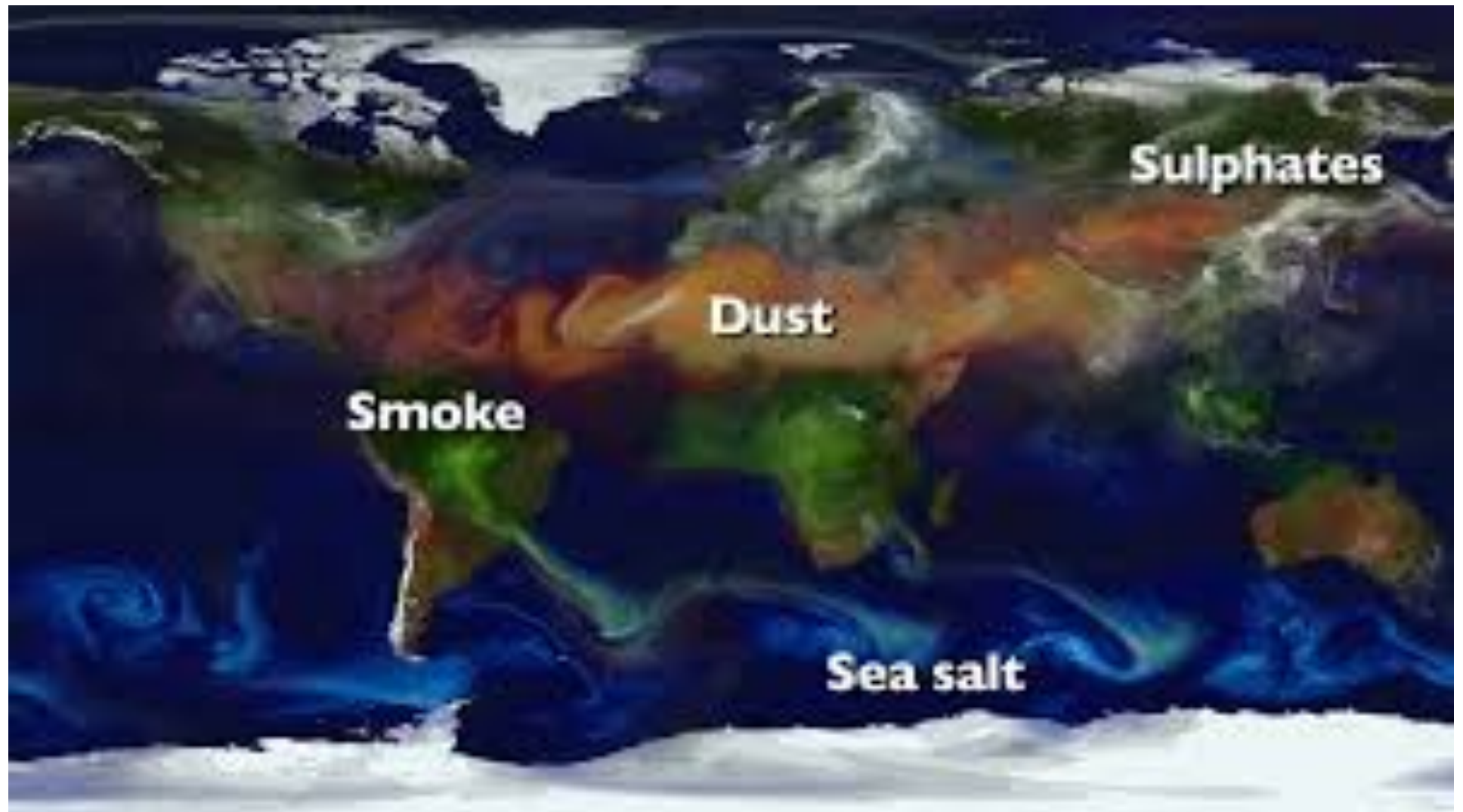
Name: _____

Date: _____

Questions:

1. The colors in the image have a meaning. Can you decipher what the colors in the image mean?
2. Fill the chart below. Use your knowledge to try to figure out which color is assigned to what type of aerosol.
3. Please describe the wind patterns. Use geographic coordinates.

Color	Aerosol Type	How is it Moving?



Activity: From the Sahara to the Amazon

Name: _____

Date: _____

Questions:

1. How far does the dust from the Sahara travel? What geographical region does it have the most impact? Where is the Sahara located?
1. What nutrients does the dust carry and where does it deposit it?
2. How vital are these nutrients for that particular region? How important are the sandstorms to the region where the aerosols are deposited?
3. What do you think would happen if this cycle was interrupted? Are there any mitigating factors that are already affecting the transport of aerosols and nutrients?
4. How much dust leaves Africa each year ?
5. What technology is used to study the Sahara dust?