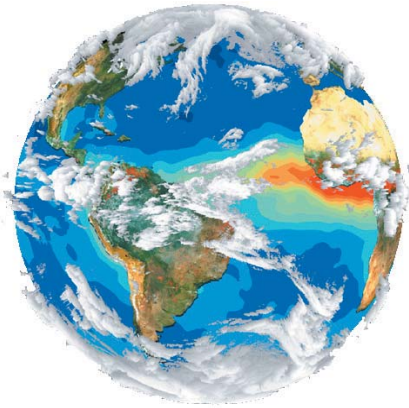


NASA Scientists Use Empty Skies to Study Climate Change

by Julia Cole, SAIC-NASA Langley Research Center

When the tragic events of September 2001 temporarily halted U.S. commercial air traffic, it created an opportunity to study the relationship between aviation and clouds. From satellite observations taken during the air traffic shutdown, NASA scientists gained insight into the atmospheric conditions that govern the formation of contrails -- clouds caused by aircraft emissions.

This Earth image is a compilation of data from several different remote sensing satellites.



"Because air traffic is expected to grow over the next 50 years, contrail coverage will also increase and may significantly impact the Earth's radiation budget by 2050," said Patrick Minnis, a senior research scientist at NASA's Langley Research Center in Hampton, Va.



Jet Contrails: NOAA Image; Flagstaff, AZ

The Earth's radiation budget -- the balance between the planet's incoming sunlight and outgoing heat energy -- drives climate change. Contrails can spread into extensive high, thin cirrus clouds that tend to warm the Earth because they reflect less sunlight back to space than the amount of heat they trap.

Tracking the formation of contrails is key to determining their contribution to cirrus clouds and their effect on the energy balance. But contrails typically form in large numbers from overlapping commercial flights, making it difficult for scientists to follow their development.

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NASA National Aeronautics and Space Administration

S'COOL
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Students Grades 3-12
EW-2004-10-04-LARC

CLOUD IDENTIFICATION CHART

Altitude of Cloud Base

High	cirrus	cirrostratus	circumulus	contrails
Mid	altostratus	altocumulus	CONVECTIVE CLOUDS	
Low	stratus	stratocumulus	cumulonimbus	nimbostratus
	fog	cumulus		

CERES S'COOL Project
Students' Cloud Observations On-Line
<http://scool.larc.nasa.gov>
<http://asd-www.larc.nasa.gov/SCOOOL/clidchart.html>

THE CLOUD COOKERY

How to Make a Cloud

Have you ever wondered how clouds form? Well it's quite simple! Clouds form from the condensation or freezing of water vapor. Want to see for yourself? You'll need an adult for supervision and the following household items: warm water, metal tray, ice, see-through jar, match. Condensation occurs when a gas (water vapor in this activity) changes into a liquid (the cloud). Water vapor condenses onto a surface when cooled. For instance, take a cold water bottle outside on a warm day, and notice that water droplets form on the surface. This is CONDENSATION and clouds form the same way. Here's how to make your own cloud.

Procedure:

1. Fill a jar with 2 inches (5cm) of warm water and stir.
2. Ask an adult to light a match, blow it out and drop it into the jar.
3. When the smoke, clears place an ice-filled metal tray on top.
4. Watch carefully and a cloud will form near the top of the jar.

So what exactly happens?

The warm liquid water forms water vapor. This process of changing liquid water to gas is called EVAPORATION. As the water vapor rises and nears the ice-filled tray, the water cools. The smoke particles provide a surface for the water to condense. Did you realize that evaporation is the opposite of condensation? If you remove the metal tray, the cloud will disappear as it mixes with the warmer surrounding air. The same events occur in our environment. Evaporated water condenses to form clouds which may later produce rain. The production of rain is referred to as PRECIPITATION. Together, EVAPORATION, CONDENSATION and PRECIPITATION play an important role in the WATER CYCLE.

In 1803 Luke Howard used Latin terms to classify four main cloud types. Cumulus means pile and describes heaped, lumpy clouds. Cirrus, meaning hair, describes high level clouds that look wispy, like locks of hair. Featureless clouds that form sheets are called Stratus, meaning layer. The term Nimbus, which means cloud, refers to low, grey rain clouds. Alto is used to describe mid level clouds. Finally, convective clouds have a vertical development extending through large portions of the atmosphere.

Cloud Type
There are specific cloud types associated with the low cloud levels. There are low, mid and high level cloud types.

Cloud Level
Three levels of clouds have been identified based on the altitude of a cloud's base.

Cloud Type	Low Level Cloud Cover	Visual Opacity
<input type="checkbox"/> Fog	<input type="checkbox"/> Clear 0% - 5%	<input type="checkbox"/> Transparent
<input type="checkbox"/> Nimbostratus	<input type="checkbox"/> Partly Cloudy 65% - 95%	<input type="checkbox"/> Opaque
<input type="checkbox"/> Cumulonimbus	<input type="checkbox"/> Mostly Cloudy 80% - 95%	<input type="checkbox"/> Transparent
<input type="checkbox"/> Stratus	<input type="checkbox"/> Overcast (95% - 100%)	

Cloud Cover
Determination of the amount of cloud cover is done by estimating the percentage of the sky covered with clouds.

Visual Opacity
The thickness of a cloud determines the amount of light being transmitted through the cloud. Shadows often provide a clue.

Ground Truth Data

Clouds are powerful agents of global change. They affect the temperature of the Earth and play a large role in controlling our climate. The study of clouds takes teamwork and NASA scientists need students all over the world making ground truth measurements. Ground truth measurements of clouds are hard based observations to compare with satellite retrieved data. Satellites are an important tool for cloud studies and making sure satellite instruments are accurate is very important. Ground truth observations made by S'COOL participants help NASA scientists test the accuracy of satellite instruments.

CERES S'COOL Project
<http://scool.larc.nasa.gov>

As you begin your Cloud Observations be sure to visit the S'COOL website for great downloadable resources on clouds and valuable lesson plans and activities related to weather. S'COOL Resources URL: <http://asd-www.larc.nasa.gov/SCOOOL/teachers.html>