

Resources for Learning and Teaching  
about [Air Quality](#), [Climate Change](#), and [Stratospheric Ozone](#)

on  
[NASA's Earth Observatory](#)  
<http://earthobservatory.nasa.gov>

#### ARTICLES ABOUT AIR QUALITY

##### Two articles about aerosols

##### **Changing Our Weather One Smokestack at a Time**

<http://earthobservatory.nasa.gov/Study/Pollution/>

Aerosol particles from factories and power plants increase the number of droplets in clouds they pollute. In doing so, the pollutants create brighter clouds that retain their water and do not produce rain.

##### **Every Cloud has a Filthy Lining**

<http://earthobservatory.nasa.gov/Study/ShipTracks/>

Cloud formation depends on microscopic particles (aerosols) from the surface of the Earth. Aerosols originate chiefly from natural sources, but humans may produce a large quantity through the burning of fossil fuels. By doing so, we may be creating huge changes in our environment.

##### Four articles about ozone

##### **Chemistry in the Sunlight**

[http://earthobservatory.nasa.gov/Library/ChemistrySunlight/chemistry\\_sunlight.html](http://earthobservatory.nasa.gov/Library/ChemistrySunlight/chemistry_sunlight.html)

*Chemistry in the Sunlight* explains basic aspects of ozone formation at ground level and provides a sample set of chemical reactions involved.

##### (About ozone) **Highways of a Global Traveler: Tracking Tropospheric Ozone**

<http://earthobservatory.nasa.gov/Study/GlobalTraveler/>

Atmospheric scientists using satellites have discovered that ozone and its precursor chemicals travel farther than previously believed.

##### **The Ozone We Breathe**

<http://earthobservatory.nasa.gov/Library/OzoneWeBreathe/>

Ozone affects human and plant health in important and sometimes dramatic ways.

##### **Watching the Ozone Weather**

<http://earthobservatory.nasa.gov/Library/OzoneWx/>

Standards and regulations for the ozone we breathe (in revised draft)

#### ARTICLES ABOUT CLIMATE CHANGE

##### **Aerosols and Climate Change**

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

Aerosols are tiny particles suspended in the air, generated by both human and natural activities. Scientists have much to learn about the way aerosols affect regional and global climate. Overall, we are unsure whether aerosols are warming or cooling our planet.

### **Aqua Mission for Earth System Science**

<http://earthobservatory.nasa.gov/Library/Aqua/Aqua.html>

Aqua carries six state-of-the-art instruments to observe the Earth's oceans, atmosphere, land, ice and snow covers, and vegetation, providing high measurement accuracy, spatial detail, and temporal frequency.

### **CALIPSO: A Global Perspective of Clouds and Aerosols from Space**

<http://earthobservatory.nasa.gov/Library/CALIPSO/>

Two of the biggest uncertainties in understanding and predicting climate change are the effects of clouds and aerosols (airborne particles). The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite mission will help scientists answer significant questions about climatic processes by providing new information on these important atmospheric components.

### **The Carbon Cycle**

[http://earthobservatory.nasa.gov/Library/CarbonCycle/carbon\\_cycle3a.html](http://earthobservatory.nasa.gov/Library/CarbonCycle/carbon_cycle3a.html)

### **Changing Global Cloudiness**

<http://earthobservatory.nasa.gov/Library/GlobalClouds/>

Clouds are one of the most influential features of Earth's climate system, and also one of its most variable components. The natural diversity and variability of clouds has intrigued and challenged researchers for centuries.

### **Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)**

<http://earthobservatory.nasa.gov/Library/CALIPSO/>

Two of the biggest uncertainties in understanding and predicting climate change are the effects of clouds and aerosols (airborne particles). The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite mission, currently under development, will help scientists answer significant questions about climatic processes by providing new information on these important atmospheric components.

### **Clouds and Radiation**

<http://earthobservatory.nasa.gov/Library/Clouds/>

The study of clouds, where they occur, and their characteristics, play a key role in the understanding of climate change.

### **Does the Earth have an Iris Analog?**

<http://earthobservatory.nasa.gov/Study/Iris/>

Scientists are still struggling to predict how the composition, structure, and extent of clouds change if the surface of our planet grows significantly warmer.

### **Global Warming**

<http://earthobservatory.nasa.gov/Library/GlobalWarming/>

The truth about global warming's threat to our planet lies somewhere between the most dire predictions and the brush-off.

### **Global Warming: Stratospheric Aerosol and Gas Experiment (SAGE III)**

<http://earthobservatory.nasa.gov/Library/SAGEIII/>

Highly accurate, long-term measurements are essential for gaining a better understanding of the processes that control climate change. SAGE III observes the long-term health of the upper atmosphere.

### **The Migrating Boreal Forest**

[http://earthobservatory.nasa.gov/Study/BorealMigration/boreal\\_migration.html](http://earthobservatory.nasa.gov/Study/BorealMigration/boreal_migration.html)

In their studies of the Earth's climate history, scientists have accumulated evidence that the tree species we think of today as belonging to the northern forest have migrated back and forth over entire continents, heading south with advancing ice age glaciers on their heels, and then north as climate warmed and glaciers retreated.

### **NOAA M Continues Polar-Orbiting Satellite Series**

<http://earthobservatory.nasa.gov/Library/NOAA-M/>

NOAA satellites carry instruments that provide data on temperature, humidity, ozone, and clouds as they track weather patterns affecting global climate and weather.

### **SAGE III**

<http://earthobservatory.nasa.gov/Library/SAGEIII>

With the Stratospheric Aerosol and Gas Experiment (SAGE III), a satellite instrument, scientists plan to measure high-resolution vertical profiles of key components of the upper atmosphere—the most important being ozone, aerosols, (suspended particles) and water vapor—in order to better understand climate change.

### **SOLar Radiation and Climate Experiment (SORCE)**

<http://earthobservatory.nasa.gov/Library/SORCE/>

SORCE will measure solar radiation incident at the top of the Earth's atmosphere. The total solar irradiance, or TSI, along with Earth's global average albedo, determines Earth's global average equilibrium temperature. Instruments on SORCE will observe some of the spectral properties of solar radiation for the first time.

### **Will Runaway Water Warm the World?**

<http://earthobservatory.nasa.gov/Study/WaterVapor/>

Across the globe, temperatures are slowly creeping up. Scientists don't entirely understand whether the atmosphere will become more humid as it warms, and humidity is one of the primary factors that will influence how much the climate will warm over the next century.

## **ARTICLES ABOUT STRATOSPHERIC OZONE**

### **Ozone**

<http://earthobservatory.nasa.gov/Library/Ozone/>

Most ozone resides in the stratosphere (a layer of the atmosphere between 10 and 40 km above us), where it acts as a shield to protect Earth's surface from the sun's harmful ultraviolet radiation.

### **Tango in the Atmosphere: Ozone and Climate Change**

<http://earthobservatory.nasa.gov/Study/Tango/tango.html>

A feedback system between ozone and climate in the stratosphere may delay recovery of the ozone layer for a decade or two longer than previously predicted.

## **Ultraviolet Radiation: How It Affects Life on Earth**

<http://earthobservatory.nasa.gov/Library/UVB/>

UV radiation at different wavelengths differs in its effects, and we have to live with the harmful effects as well as the helpful ones.

### **IMAGES**

#### **Visible Earth** – a searchable collection

<http://visibleearth.nasa.gov/>

#### **Image of the Day**

Find on *Earth Observatory* home page (<http://earthobservatory.nasa.gov>).

### **OTHER RELEVANT RESOURCES on EARTH OBSERVATORY**

#### **Ask a Scientist**

<http://earthobservatory.nasa.gov/Library/AskScientist/>

Questions and answers about Earth's environment and climate

#### **Research Satellites for Atmospheric Sciences: 1978 – Present**

<http://earthobservatory.nasa.gov/Library/RemoteSensingAtmosphere/>

The atmosphere changes chemically and physically on widely varying time scales—ranging from minutes to decades—and is therefore a challenge to measure precisely over the entire globe. For 25 years, NASA and its affiliated agencies and research institutions have collaborated to develop a series of research satellites enabling scientists to advance scientific understanding of both chemical and physical changes in the atmosphere.

#### **Space-based Observations of the Earth**

<http://earthobservatory.nasa.gov/Library/Observing/obs.html>

A history of space-based research and exploration from the early 1950s

#### **Natural Hazards**

-- such as dust and smoke, fires. Updated weekly

[http://earthobservatory.nasa.gov/NaturalHazards/natural\\_hazards\\_v2.php3?topic=dust](http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?topic=dust)

#### **Data**

<http://earthobservatory.nasa.gov/Observatory/datasets.html>

See especially:

Aerosol optical depth; Aerosol size, Aerosol index, Cirrus reflectance, Cloud forcing, Cloud fraction, Emitted heat radiation, Ozone, Rainfall, Snow cover, Snow cover and ice depth, Sea surface temperature, Reflected solar radiation; Surface temperature; UV exposure