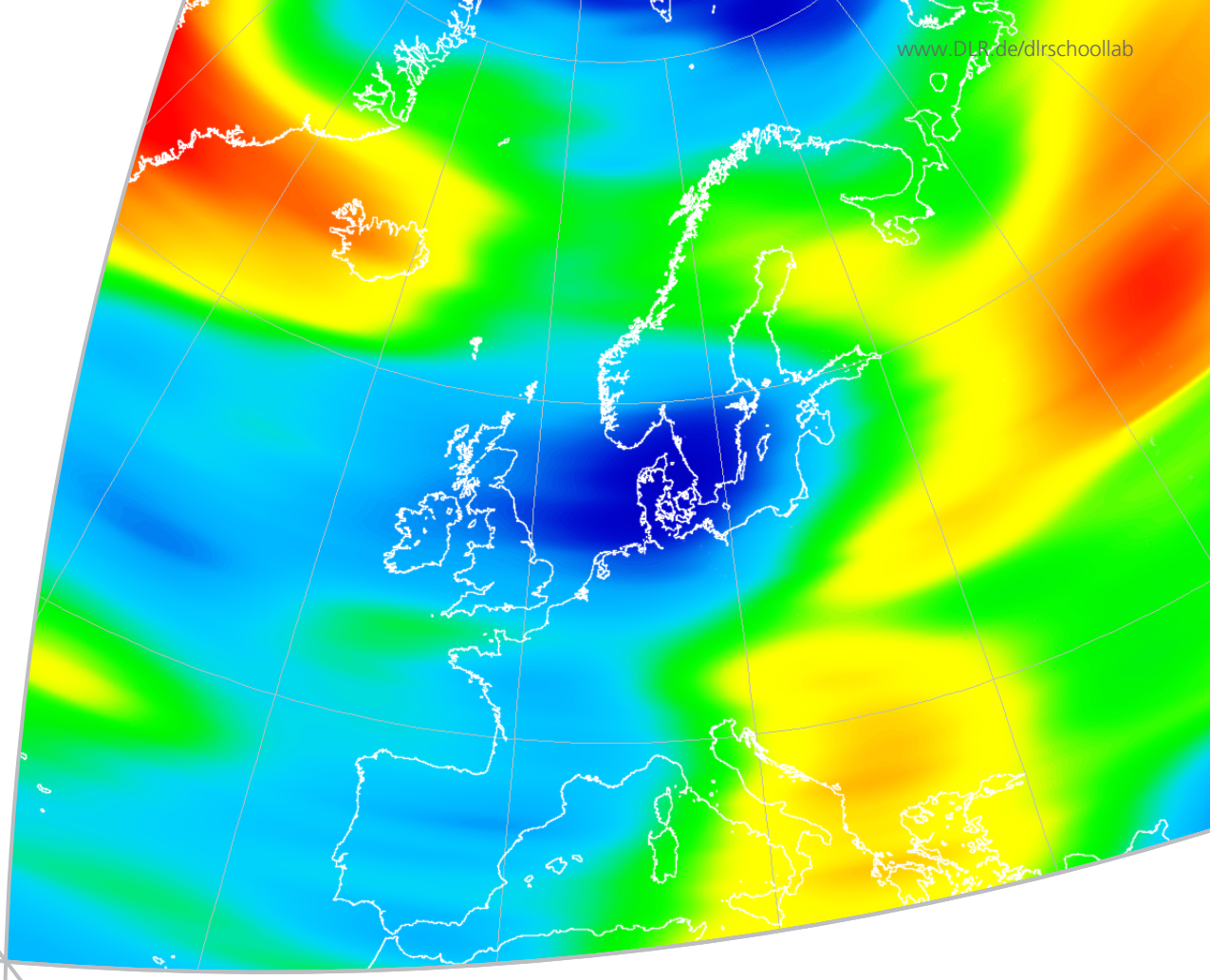

DLR

DLR_School_Lab

Oberpfaffenhofen

Environmental Spectroscopy

Habitats on Trial

The earth we inhabit undergoes constant change. Humans certainly make their contribution, one only has to recall smog-infected cities, polluted oceans and the ozone hole.

Highly sensitive measuring instruments are required to record and monitor in detail specific changes in the environment, and possibly to take countermeasures. Ever since the development of satellite measuring technology, we have an outstanding instrument in space for globally and continuously researching many of the changes taking place on the land surface and in the atmosphere. But studies on the ground are equally needed.

Environmental Spectroscopy

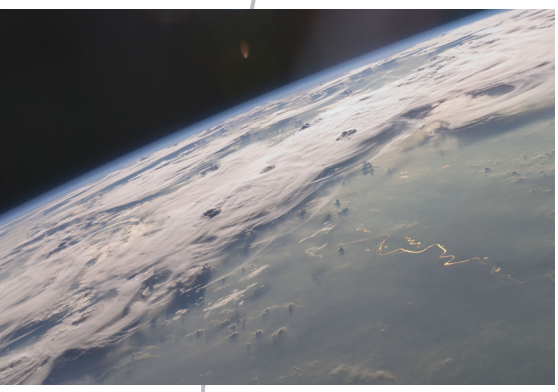

Fig. 1: Astronaut photo of the atmosphere

The Atmosphere and its Trace Gases

The atmosphere is that part of the Earth System which is enclosed between the earth's surface and outer space. With its multitude of gaseous, liquid and solid substances, the atmosphere undergoes constant change.

The atmospheric trace gas ozone is harmful to humans at ground level, and for good reason weather services regularly warn of increased ozone values, particularly in summer. But in the stratosphere, by contrast, ozone forms a crucial protective layer, known as the ozone shield, which safeguards us from biologically damaging ultraviolet radiation. If it is no longer there, this radiation can reach the earth unhindered. That Australia and New Zealand have one of the highest rates of skin cancer in the world is attributed to this situation.

Continual measurement of ozone levels worldwide are thus essential, particularly over the Antarctic, where the shield often weakens. Only with continuous monitoring and measuring will it be possible to understand the complex interrelationships leading to changes in the density of the ozone shield.

The oceans as well as the land surface have a significant impact on the climate, and as a result both are directly linked to the atmosphere-biosphere system. Today it is assumed that global changes in land use and land cover not only modify terrestrial ecosystems, but also influence the global climate.

NDVI is the abbreviation for "Normalized Difference Vegetation Index." It is probably the most frequently used vegetation index and is calculated from satellite image data. The NDVI gives information about the "greenness" and density of vegetation. From it, important

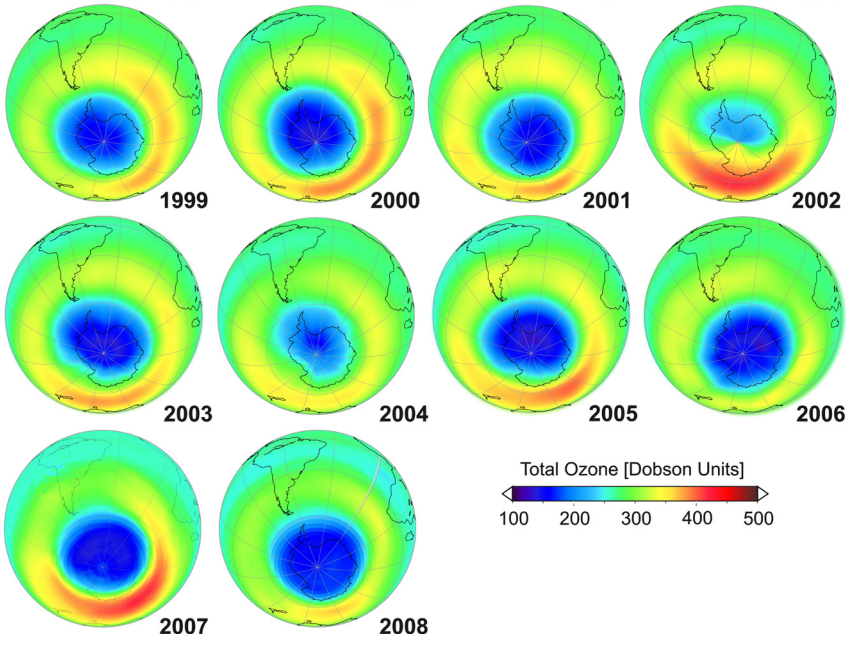

Fig. 2: Development of the ozone hole 1999 - 2008

DLR_School_Lab
Oberpfaffenhofen

parameters can be derived such as FAPAR (Fraction of Absorbed Photosynthetically Active Radiation), LAI (Leaf Area Index), and land surface coverage or use.

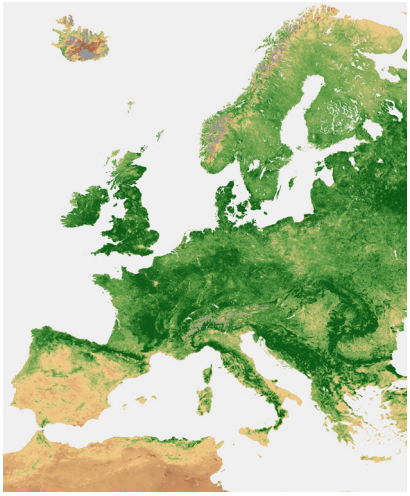

Fig. 3: NDVI monthly composite for June 2009

The Experiment

In the environmental spectroscopy experiment students acquaint themselves with various types of equipment and technologies used to measure changes in the environment. It is possible for them to determine the total ozone column, water vapor content, temperature, and humidity of the atmosphere, as well as the reflection characteristics of various surfaces.

The environmental spectroscopy experiment has two parts:

The **Atmosphere Experiment** is specifically concerned with measuring ozone and water vapor concentrations. A solar photometer is used to make these measurements on the spot. The required input data and especially the results of the measurements are discussed and compared with satellite recordings.

In the **Ground Experiment** the focus is on measuring with the help of a ground-based spectrometer. After a brief introduction on how it functions and how to operate it, various measurements are taken and interpreted, as in the previous experiment.

The measurements in the environmental spectroscopy experiment are based on the characteristics of the total solar spectrum. Both atmospheric and ground-specific parameters are derived with the help of shortwave, longwave, and visible radiation.

Questions to Think About

Why is ozone harmful on the one hand, but on the other hand essential for humans? What could be done to avoid higher ozone concentrations? What is a greenhouse gas?

Why does the ozone hole form over the South Pole, although the destructive pollutants are chiefly being released in the northern hemisphere?

Glossary

Ozone
Ozone is a molecule composed of three oxygen atoms. Because of its oxidizing effect it can lead to irritation in the respiratory tracts of humans and animals. Ozone originates in the atmosphere and forms a layer there protecting us from the ultraviolet rays of the sun.

Spectrometer
An optical spectrometer is used to investigate the visible range of the electromagnetic spectrum and neighboring regions. It is used to obtain emission spectra (spectral investigation of light sources) as well as absorption spectra and information about frequency-dependent reflection.

Greenhouse gases
Greenhouse gases are various atmospheric gases which prevent longwave infrared radiation coming from the earth's surface from directly reaching space. They act like the glass panes of a greenhouse, with the result that the entire atmosphere heats up.

Photometer
A photometer is an instrument for measuring photometric quantities such as luminance or brightness. It is used in astronomy to measure the light intensity of heavenly bodies, in analytic chemistry to determine concentrations in solutions (Beer–Lambert law), and in photography as a light meter.

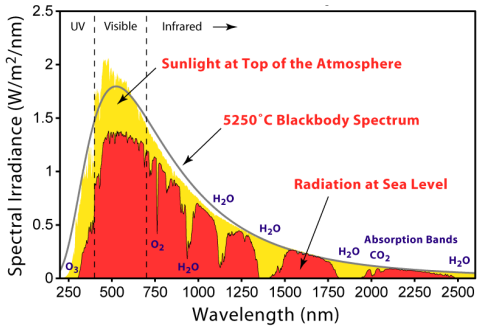

Fig. 4: A solar spectrum provides information about the atmosphere

Additional Information

More information about atmospheric ozone can be found at wdc.dlr.de

List of Figures

Cover image: Ozone situation over Europe
German Aerospace Center

Fig. 1: Astronaut photograph of Earth
NASA Johnson Space Center - ISS020-E-47807

Fig. 2: Development of the ozone hole since 1999
German Aerospace Center; EUMETSAT; ESA

Fig. 3: NDVI monthly composite for June 2009
German Aerospace Center

Fig. 4: A solar spectrum provides information on the atmosphere
Robert A. Rohde, Global Warming Art project

DLR at a Glance

DLR is Germany's national aeronautics and space research center. Its extensive research and development activities in the fields of aeronautics, space, transportation and energy are integrated in national and international cooperative ventures. In addition to this research, as Germany's space agency the federal government has given DLR the responsibility to plan and implement the German space program and to represent German interests internationally. DLR is also the umbrella organization for Germany's largest project management agencies.

Approximately 6,500 people are employed at DLR's 13 locations, which include Köln (headquarters), Berlin, Bonn, Braunschweig, Bremen, Göttingen, Hamburg, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stuttgart, Trauen and Weilheim. DLR also operates offices in Brussels, Paris and Washington D.C.

DLR Oberpfaffenhofen

Aerospace, environment and transportation are DLR's primary fields of interest in Oberpfaffenhofen. Some 1,500 people work there in nine different institutes and facilities, making DLR Oberpfaffenhofen the largest DLR location.

DLR **Deutsches Zentrum für Luft- und Raumfahrt** e.V.
in der Helmholtz-Gemeinschaft

DLR_School_Lab Oberpfaffenhofen
Münchner Straße 20
82234 Weßling

Contacts:
Head: Dr. Dieter Hausamann
Telephone +49 8153 28-2770
Telefax +49 8153 28-1070
E-Mail schoollab@dlr.de

School_Lab team assistant: Stefani Krznaric
Telephone +49 8153 28-1071
Telefax +49 8153 28-1070
E-Mail stefani.krznaric@dlr.de

www.DLR.de/dlrschoollab

Identifikationscode