Sonnblick (3105 m a.s.l.)

Kanzelhöhe (1520 m a.s.l.)

Innsbruck (578 m a.s.l.)

Graz (397 m a.s.l.)

Wien Hohe Warte (198 m a.s.l.)

ARAD

At a glance

What is ARAD?

ARAD ("Austrian Radiation") is a long term measurement project for solar radiation and thermal radiation of the atmosphere in Austria. Currently, the temporal and spatial variations of the radiative components are recorded at five sites (Vienna, Sonnblick, Graz, Innsbruck, Kanzelhöhe) using very high quality instruments.

Who is behind ARAD?

ARAD is a scientific research project lead by the Central Institute for Meteorology and Geodynamics (ZAMG) in collaboration with the University of Innsbruck, the Karl-Franzens-University Graz and the University of Natural Resources and Life Sciences (BOKU) in Vienna.

Why ARAD?

The sun is the "driver" for changes in the earth's climate. Small changes in surface solar or thermal radiation have important consequences on thermal properties and circulation of the atmosphere and the oceans. Thus, all data acquired during the ARAD project are an important step towards a better understanding of the past and future climate on earth.

What are the benefits of ARAD?

ARAD provides very accurate data of the temporal and spatial changes of the radiation components of the sun and atmosphere. Besides a continuous survey of our climate, these data can also be used to verify and improve regional climate models and weather forecasting models. Therefore, ARAD contributes to the public good.

ZAMG
Central Institute for Meteorology and Geodynamics

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UNI GRAZ | IMGI Institute of Meteorology and Geophysics · University of Innsbruck | BOKU Met | IGAM/KSO

ARAD

Radiation monitoring network Austria

ZAMG
Central Institute for Meteorology and Geodynamics

1. Background and aims of ARAD

The sun is the main "driver" for our weather and strongly influences the climate on earth over long periods of time. It sends a spectrum of electromagnetic waves, from radio waves to visible light to x-rays that cause diverse interactions with the earth's atmosphere. Radiation is an energy transfer in the form of electromagnetic waves, which can propagate in a vacuum as well as in an air filled volume like the earth's atmosphere. That is why solar radiation reaches the ground after travelling through space. For the climate system of the earth, two types of radiation are of special importance: solar and thermal radiation. Solar radiation comes either directly from the sun, or indirectly via scattering in the earth atmosphere. Thermal or infrared radiation is emitted by all bodies on the earth as a function of its temperature. Electromagnetic waves of solar radiation are much shorter and thus have a higher energy than thermal radiation. That is why they are called short- (solar) and long wave (thermal) radiation.

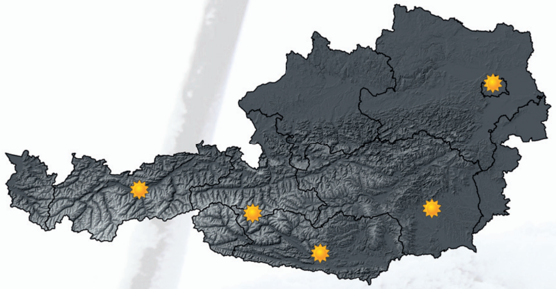

Fig. 1: Location of the ARAD radiation measurement stations in Austria.

Within the ARAD (Austrian Radiation) project, the different components of the radiation budget of the earth are measured very precisely to detect changes with time. This will help to improve understanding of human influence on earth's climate which can only be quantified by including model calculations and further supplementary measurements.

☞ **ARAD provides a long term and high quality radiation monitoring service in Austria.**

2. Data and methods

The sensors and data loggers used in ARAD are of a very high standard. They are also used in a worldwide network of around 40 stations called the BSRN (Baseline Surface Radiation Network; http://www.bsrn.awi.de/), which has the highest data quality standards available. Both short- and long wave radiation data are recorded. Data sampling takes place every second with one minute averages calculated and stored (http://www.zamg.ac.at/strahlung).

Measured components include: the direct solar radiation (pyrheliometer); the shortwave scattered (diffuse) radiation (shaded pyranometer) as well as their sum; the global radiation (pyranometer); and the long wave incoming radiation (thermal radiation) of the atmosphere (shaded pyrgeometer).

The sensors are mounted on a suntracker, which allows correct tracking of the solar path and guarantees the continuous alignment of the pyrheliometer to incoming direct solar radiation. The suntracker also ensures continuous shading of the pyranometer for recording scattered shortwave radiation and of the pyrgeometer to measure incoming long wave radiation.

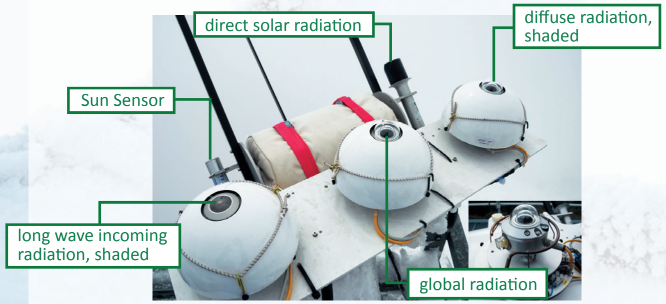

Fig.2: Typical ARAD station: Suntracker with different radiation sensors.

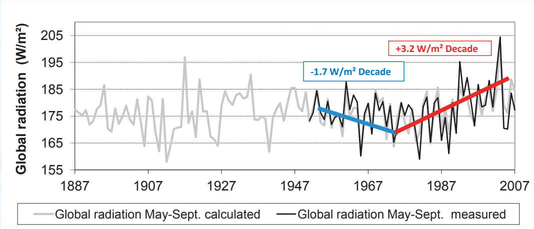

Fig.3: Time-series of global radiation (=direct + scattered solar radiation) in Vienna (Hohe Warte). The blue line indicates the effect of "global dimming", the red one "global brightening".

3. "Who wants to know more?": Solar and thermal radiation, gases, aerosols and clouds

After solar radiation reaches the top of the earth's atmosphere with a mean intensity of 1368 Watts per square meters, it is reduced to around half of the intensity by gases (e.g. water vapour, ozone, CO_2), clouds and aerosols (solid particles in the air, e.g. black carbon, sulfate). The composition and concentration of these gases as well as the amount, density and type of the clouds underlie natural variations but are also considerably influenced by human activity. The effect of the aerosols on solar radiation is especially interesting in this regard. The fraction of aerosols in the atmosphere increased until the 1980s due to different human activities, resulting in acid rain and forest dieback for example. This led to very effective clean air measures reducing the fraction of sulfate in the air. Only later on was it realised that these changes in air quality also had consequences on the radiation budget of the atmosphere. Because of the high quantities of sulfate aerosols and the induced reduction of solar radiation, air temperature cooled slightly in the 1970s. After the clean air measures, this effect disappeared and the atmosphere warmed. Thus, the aerosol effect masked the independently acting greenhouse effect.

Time-series of measured global radiation at station Hohe Warte (Vienna) (Fig. 3) clearly shows that near surface incoming solar radiation decreased in the 1960s and 1970s. This is referred to as "global dimming", which was then followed by a period of increase ("global brightening").

Besides the effect on solar radiation, certain gases in the atmosphere can impact the earth's long wave radiation by preventing its escape to space and therefore increasing the thermal radiation from the atmosphere to the ground. Because this works in the same way as a greenhouse, we call these gases "greenhouse gases" and the effect "greenhouse gas effect", which effects only long wave thermal radiation and not shortwave solar radiation.