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Science City Davos

How “strong” is solar radiation?

Scientists and climatologists around the world have been dealing with this question for more than 100 years. What exactly is meant by the “strength” of solar radiation and how is it measured?

Carl Dorno, the founder of the Davos Physical Meteorological Observatory (PMOD), also pondered the question of the strength of solar radiation. However, it is not so easy to answer and must be approached in a nuanced way. If we want to know how much sunscreen we should use, a different measured value is relevant than if we are interested in the question of how much energy the sun’s radiation provides.



The IPC 2015 enjoyed a record-breaking turnout. The hustle and bustle on the exhibition site in front of the PMOD institute building, the old Davos school building, was correspondingly busy. Photo credit: PMOD/WRC

Different wavelengths

The UV index is a simple measure of the sunburning strength of the sun’s UV radiation and helps us choose the proper sunscreen. In climatology - the science of climate - however, the so-called total radiation is relevant. This is also relevant with regard to the use of solar energy. Total radiation is measured in watts per square meter and indicates how much energy is irradiated by the sun per second onto a square meter of surface.

Measuring this quantity is not

easy, as it must be ensured that the measuring instrument measures the entire spectrum of sunlight from the ultraviolet through the visible to the infrared range - and does so with the same sensitivity for all wavelengths.

Measurement with a “black body”

A so-called black body is used to measure the total radiation. A black body theoretically absorbs all radiation of all wavelengths. The sensor is a cavity of the size of a thimble, blackened on the inside. If the opening of this cavity is directed towards the sun, it absorbs the incoming radiation and thus

heats up. This heating can be measured and the irradiated power can be determined from it. Such a measuring device is called a pyrheliometer.

In practice, however, the cavity is not a perfect black body. Therefore, measurements with different pyrheliometers give slightly different results. What does not seem to be serious at first sight because of the thimble-sized cavity would, however, lead to inadmissible conclusions in climatology if, for example, the total solar radiation in one country or part of the world were measured unnoticed but systematically higher or lower than elsewhere. In the solar energy industry, very small differences in total solar irradiance can determine whether a location is worthwhile for a solar power plant or not. These small variations are therefore central and are the focus of the PMOD-based World Radiation Center WRC (see box).

Reference measurement of solar radiation from Davos

To ensure that all pyrheliometers worldwide measure with the same sensitivity, the PMOD/WRC operates a reference group of pyrheliometers, the World Standard Group. Every five years, national and regional reference laboratories meet at the International Pyrheliometer Comparison (IPC) in Davos for three weeks to compare their pyrheliometers with the World Standard Group. The IPC planned for 2020 had to be postponed to 2021 due to the global pandemic and will take place from September 27 to October 15. However, the field of participants will also be reduced in 2021 because many laboratories are still subject to an international travel ban for employees. Fortunately, the world's biggest players will be represented at this year's IPC. The participation of the major reference laboratories is important, as it is through comparison with them that the stability of the world standard group can best be determined.

Next generation pyrheliometer

An important local participant is CSAR (pronounced "Caesar"). CSAR is a pyrheliometer developed and built by the PMOD/WRC in collaboration with the national meteorology institutes of Switzerland and the United Kingdom just over ten years ago. CSAR is the most advanced pyrheliometer ever built. In order to obtain more accurate and directly analyzable results of the total radiation, its sensor is cooled to about 30 Kelvin (about minus 243°C). The goal of the PMOD/WRC is to replace the World Standard Group with CSAR as the reference in the future. An international group of experts from the World Meteorological Organization (WMO) is currently working on the formal implementation of this generation change.

Wolfgang Finsterle, Physikalisches-Meteorologisches Observatorium Davos/World Radiation Center

The Physical Meteorological Observatory Davos/World Radiation Center is an international calibration center for meteorological radiation measuring instruments. It develops radiation measuring instruments for use on the ground and in space. It researches the influence of solar radiation on the earth's climate.

The Technology Department designs and develops measuring instruments and accessories and also manufactures most of them in Davos. State-of-the-art engineering tools and manufacturing facilities are available for this purpose. Currently, the group comprises 15 employees, project managers, electrical and mechanical engineers, technicians, IT personnel and apprentices.

www.pmodwrc.ch