Name of research institute or organization:

Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center

Title of project:

Solar and terrestrial radiation measurements

Project leader and team:

Dr. Rolf Philipona, project leader
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Project description:

General

Within the Swiss Atmospheric Radiation Monitoring (CHARM) program, PMOD/WRC in collaboration with MeteoSwiss and IACETH conducts solar and terrestrial surface radiation measurements at Jungfraujoch and Gornergrat mainly for radiation budget, UV-radiation and aerosol optical depth (AOD) investigations. Within the CHARM program, Jungfraujoch and Gornergrat are key stations of the Alpine Surface Radiation Budget (ASRB) network, where shortwave solar and long-wave terrestrial radiation is accurately measured to determine the altitude dependence of the radiation budget and possible changes related to climate change. Jungfraujoch being the highest site within CHARM is also extensively used as reference and calibration station and for comparisons of radiation instruments.

Alpine surface radiation budget and greenhouse effect investigations

The ASRB network, comprising ten stations (the station Les Diablerets was discontinued in September 2002) from Locarno-Monti (370 m a.s.l.) to Jungfraujoch (3580 m a.s.l.), primarily measures downward and upward fluxes of shortwave and longwave radiation. Temperature and humidity at screen level height are also measured at each station. Measurements at the individual stations started in 1994 and an extensive radiation climatology over the Alps with data from 1995-1998 has now been bublished [Marty et al., 2002]. Clear-sky longwave radiation measured at the individual ASRB stations have been compared to radiative transfer model calculations. Nighttime calculated and measured values are in very good agreement, whereas daytime calculated downward longwave radiation is lower than measured values. Surface longwave radiation measurements (1996-2001) in combination with radiative transfer model calculations allowed to determine the greenhouse effect and its altitude dependnce over the Alps. A considerable larger greenhouse effect is found during daytime which is due to shortwave radiative heating.

Ultraviolet radiation in the Alps: the altitude effect

As part of the CHARM program solar direct and global broadband UVB (erytemally effective) as well as global broadband UVA radiation is continuously measured at Jungfraujoch since 1997. Together with UV measurements from Davos and Weissfluhjoch the altitude effect of UV radiation was investigated. Solar UV radiation increases with altitude mainly due to decreasing amounts of air molecules, ozone, aerosols and clouds in the atmosphere. The altitude effect plays an important role in the understanding of the UV radiation field in mountainous terrain. Under

clear-sky conditions, the altitude effect of daily noon-time yearly mean values of direct, diffuse and global erythemal UV radiation results in 17.4%/1000 m (direct), 8.5%/1000 m (diffuse) and 10.7%/1000 m (global). Seasonal variations of the altitude effect are mainly influenced by changes of solar elevation, albedo values and turbidity levels during the year. Measured altitude effects well compare to calculated altitude effects obtained by application of the MODTRAN radiative transfer model [Schmucki and Philipona, 2002].

Underestimation of solar shortwave radiation measured at Earth's surface
At the World Radiation Center at Davos reinvestigations of pyranometer calibration in conjunction with thermal offsets and pyranometer thermal control, demonstrated an underestimation of clear-sky solar global as well as diffuse irradiance by 8 to 20 Wm-2, caused by pyranometer differential cooling [Philipona, 2002]. Field measurements with 'conditioned' and 'unconditioned' pyranometers demonstrated that the so-called "night offset" is present and considerably larger during daytime measurements, and this not only for diffuse but as well, and as important, for global pyranometer measurements. Long-term comparisons between traditional 'unconditioned' and well 'conditioned' pyranometer measurements at Davos (midlatitude, 1580 m a.s.l.) show differences of several percent on the annual mean of global irradiance. Even though it is known that measurements at higher altitude are subject to larger thermal offsets and not representative for the global average, the results of these experiments lead to believe that surface solar irradiance, measured in the past throughout the globe by traditional 'unconditioned' pyranometers, is underestimated. Fortunately, at Jungfraujoch and at other ASRB stations pyranometers are installed with proper ventilation and heating systems that guarantee accurate measurements.

Key words:

Surface radiation budget; Radiative cloud forcing; Greenhouse effect; Spectral UV radiation; Aerosol optical depth.

Internet data bases:

http://www.pmodwrc.ch/

Collaborating partners/networks:

MeteoSwiss (MCH)
Institute for Atmospheric and Climate science at ETH (IACETH)

Scientific publications and public outreach 2002:

Refereed journal articles

Marty, CH., R. Philipona, C. Fröhlich, and A. Ohmura, Altitude dependence of surface radiation fluxes and cloud forcing in the alps: results from the alpine surface radiation budget network, Theor. Appl. Climatol. **72**, 137-155, 2002.

Schmucki, D., and R. Philipona, Ultraviolet radiation in the Alps: the altitude effect, Opt. Eng. **41** (12), 2002.

Philipona, R., Underestimation of solar and diffuse radiation measured at Earth's surface, J. Geophys. Res., **107**, 4654, 2002.

Conference papers

Philipona, R., and Ch. Wehrli, Towards radiometric standards for longwave radiation and aerosol optical depth measurements, Third GAW-CH Conference: Ozone, Radiation and Aerosols, Zürich, 76-79, 2002.

Marty, Ch., Surface radiation budget and cloud forcing in the Alps, Third GAW-CH Conference : Ozone, Radiation and Aerosols, Zürich, 85-87, 2002.

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