Name of research institute or organization:

Federal Office of Meteorology and Climatology MeteoSwiss, Payerne

Title of project:

Global Atmosphere Watch Radiation Measurements

Project leader and team:

Dr. Laurent Vuilleumier, project leader
Mr. Gilles Durieux

Project description:

Long-term monitoring of surface radiation flux at the Jungfraujoch in the framework of the GAW Swiss Alpine Climate Radiation Monitoring program (SACRaM) was conducted in 2011 with a high degree of data availability considering the challenging conditions at Jungfraujoch. In average, the data availability for radiation parameters reached 98% (01.11.2010–31.10.2011). Such continuous monitoring implies a constant effort to sustain the highest achievable accuracy, stability and continuity in the measurements.

The measurement program includes short-wave (solar spectrum) and long-wave (infrared thermal) broadband measurements as well as UV broadband measurements. Short- and long-wave measurement series are important for climate research, while UV measurements are of interest for both public health and exploring the relationship between the evolution of the ozone layer and radiation. Broadband radiation is measured both as global downward hemispheric irradiance and as direct sun irradiance. In addition, direct spectral irradiance is also measured, which allows the total column of several atmospheric constituents to be determined.

In collaboration within a project of the Physikalisch-Meteorologisches Observatorium Davos (PMOD) World Radiation Center (WRC) a trend analysis was performed concerning surface cloud-free down-welling long-wave radiation measured at four stations, including Jungfraujoch. This covered an altitude range between 370 and 3580 meters above sea level. Cloud-free down-welling long-wave radiation, screen-level temperature, and relative humidity were selected from 10 min measurements, and monthly means were calculated. From this, annual overall trends were determined applying least squares fitting, whereas nonparametric statistical methods were used to calculate monthly trends.

The cloud-free down-welling long-wave radiation time series show a consistent and significant increase of 3.5 W m^{-2} per decade in the last 12 years at all four stations. The monthly trend analysis of the down-welling long-wave radiation revealed a relatively large variability: trend estimates exceeding the overall annual trend by a factor of 4 and partly with opposite signs.

The monthly trends of the down-welling long-wave radiation are in agreement with the trends observed in screen-level temperature and specific humidity that have been determined using the same statistical methods. By applying a parameterization of cloud-free down-welling long-wave radiation, the causes for the observed cloud-free trends was quantitatively inferred. More than 50% of the down-welling long-wave radiation trends could be explained with the observed variations of temperature and humidity. There is some indication that the radiative effect of high-level clouds has

changed and considerably contributed to the down-welling long-wave radiation trends that are not induced by screen-level temperature and humidity.

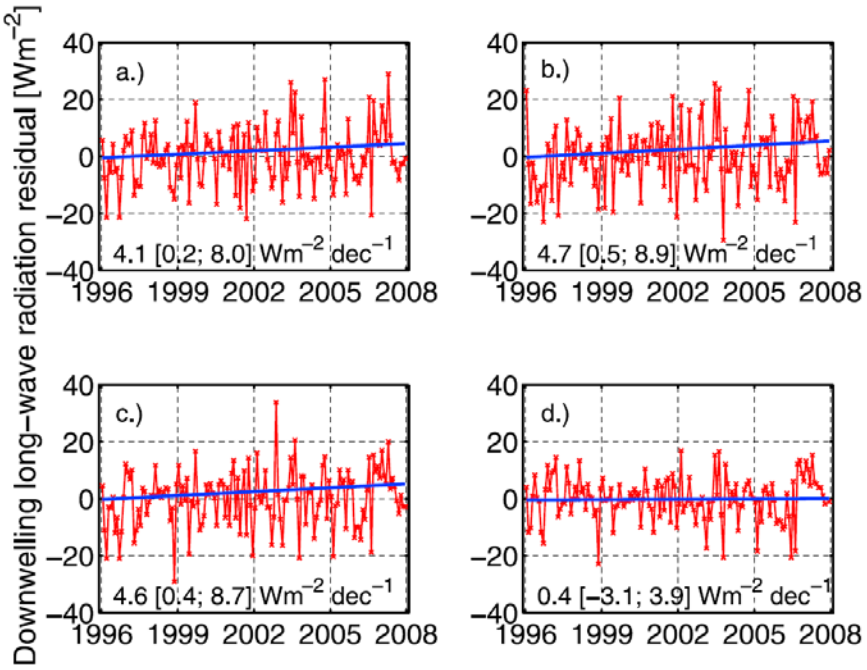

Figure 1. *Time series and linear trends (blue) of the deseasonalized monthly mean cloud-free down-welling long-wave radiation at (a) Locarno, (b) Payerne, (c) Davos, and (d) Jungfraujoch. The residuals of the deseasonalized data are shown in red. Least squares slope estimate and corresponding lower and upper bounds of the 90% confidence interval are also given.*

While the trends were significant at all other stations (Locarno, Payerne and Davos), Jungfraujoch trends were considerably smaller (only 0.4 W m^{-2}/decade over the whole time period). This trend was not significant, while at the other stations the trend was significant at the 90% confidence level.

Key words:

Solar irradiance, ultraviolet, visible, infrared, spectral irradiance, precision filter radiometer (PFR), pyranometer, pyrheliometer, UV biometer, total aerosol optical depth (AOD), integrated water vapor (IWV).

Internet data bases:

http://wrdc-mgo.nrel.gov/ (World Radiation Data Centre – WRDC)
http://www.iapmw.unibe.ch/research/projects/STARTWAVE/database/ (IWV STARWAVE data)

Collaborating partners/networks:

Radiation data submitted to the World Radiation Data Centre (WRDC, St. Petersburg, Russian Federation) within the framework of the Global Atmosphere Watch.

Study of solar photometry (aerosol optical depth) and long-wave infrared radiative forcing in collaboration with the "Physikalisch-Meteorologisches Observatorium Davos" (PMOD) World Radiation Center (WRC).

Scientific publications and public outreach 2011:

Refereed journal articles and their internet access

Wacker, S., J. Gröbner, K. Hocke, N. Kämpfer and L. Vuilleumier. Trend analysis of surface cloud-free down-welling long-wave radiation from four Swiss sites. J. Geophys. Res., **116**:D10, (2011), D10104, doi:10.1029/2010JD015343

http://dx.doi.org/10.1029/2010JD015343

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