Name of research institute or organization:

Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center

Title of project:

Cloud Climatology and Surface Radiative Forcing over Switzerland (CLASS)

Project leader and team:

Julian Gröbner
Stefan Wacker

Project description:

A detailed trend analysis of down-welling short-wave and long-wave radiation and the corresponding cloud radiative forcings was performed for Jungfraujoch. The cloud radiative forcing describes the radiative impact of clouds on the short-wave and long-wave radiation over time and is defined as the difference between the measured fluxes and the calculated (hypothetical) cloud-free fluxes at the same time. The cloud radiative forcing remains the largest uncertainty in the assessment of climate change and might be larger than the radiative forcing of any of the other constituents of the atmosphere (e.g., aerosols, greenhouse gases). In order to determine the short-wave cloud radiative forcing, radiative transfer calculations for a cloud-free atmosphere in dependency on the solar zenith angle, the aerosol load and the water content of the atmosphere were performed. The underestimation of the calculated cloud-free short-wave fluxes due to the highly reflective environment at this site that cannot be accounted for by the calculations was corrected by an empirical function that was derived by comparing observations to calculations around noon during completely clear days. For the long-wave cloud effect, a cloud-free model that parameterizes the long-wave radiation as a function of humidity and screen-level temperature but also accounts for the temperature lapse rate was used.

While the all-sky long-wave radiation has considerably increased since 1996 and a significant decrease in the short-wave radiation could be observed, the total cloud radiative forcing composed of the short-wave and long-wave cloud forcings shows an insignificant trend. Thus, no conclusive statement can be currently made even though the results of the long-wave cloud effect and the short-wave and long-wave radiation indicate the possibility of an increase of the radiative effect of clouds at Jungfraujoch. The very low water content and the snow and ice covered area cause major uncertainties in the long-wave and short-wave cloud-free calculations, which is one of the reasons for the large uncertainties in the retrieved cloud radiative forcing components.

For the upcoming year, we plan to deploy a hemispherical sky camera at Jungfraujoch to retrieve cloud information with high temporal resolution in order to improve and to reduce the uncertainties in the analysis of the radiative impact of clouds. Such sky cameras have been already installed at Payerne, Zimmerwald and Davos and an algorithm is currently being developed to classify the clouds into different cloud classes.

Key words:

Surface Radiation, Cloud Radiative forcing, Climate change

Collaborating partners/networks:

Meteoswiss

Scientific publications and public outreach 2011:

Refereed journal with internet access

Wacker, S., Gröbner, J., Hocke, K., Kämpfer, N., Vuilleumier, L., Bütikofer, R. Kovaltsov, G.A., Trend analysis of surface cloud-free downwelling long-wave radiation from four Swiss sites, Journal of Geophysical Research, DOI:10.1029/2010JD015343, **116**, 2011.

http://www.agu.org/pubs/crossref/2011/2010JD015343.shtml

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