Cloud fraction determination with hemispherical sky cameras at Jungfraujoch

Christine Aebi[1,2], Stephan Nyeki[1], Julian Gröbner[1]

[1] Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center (PMOD/WRC), Davos Dorf, Switzerland
[2] Oeschger Center for Climate Change Research and Institute of Applied Physics, University of Bern, Bern, Switzerland

christine.aebi@pmodwrc.ch

Part of this programme: Comprehensive Radiation Flux Assessment (CRUX) in the GAW-CH programme

Keywords: Hemispherical cloud camera; cloud detection; cloud fraction; cloud type; climate

1. Project description

The Comprehensive Radiation Flux Assessment (CRUX) project aims to study the role of clouds on the climate system in general and on the surface radiation budget in particular. Within the project, observational data of different atmospheric parameters are combined with radiative transfer model calculations. Cloud analyses are performed for the three Swiss stations Jungfraujoch (3471 m asl), Davos (1594 m asl) and Payerne (490 m asl). Additionally, a trend analysis of the shortwave and longwave radiation and of other atmospheric parameters is performed for the three aforementioned stations and additionally also for Locarno-Monti (367 m asl) over a time period of 20 years. CRUX is financed by the Swiss contribution to the Global Atmosphere Watch Programme (GAW-CH) of the WMO.

Figure 1. Visible all-sky camera (Mobotix) installed at Jungfraujoch.

There are several studies showing the opposing effect of clouds on the surface radiation. On one hand, the shortwave radiation can be reflected at clouds back to space before reaching the Earth's surface and on the other hand an overcast sky emits a larger fraction of thermal radiation than a cloud-free sky. To better understand the influence of clouds on the surface radiation budget there is a need of cloud detection in a high temporal and spatial resolution. Therefore, we installed visible all-sky cloud cameras at three stations in Switzerland in 2010. The cameras have been measuring continuously during daytime with a temporal resolution of one to five minutes. The visible all-sky camera at Jungfraujoch is shown in Figure 1.

The cloud camera data are used to calculate the cloud fraction as well as to determine the cloud type automatically for every single image. The cloud fraction is determined by considering the red-green-blue information of the images (Wacker et al., 2015). The cloud type is determined by calculating twelve spectral, textural and radiative features (Wacker et al., 2015).

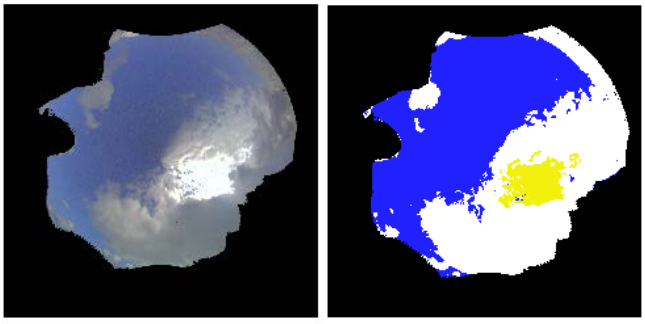

Figure 2. Cloud situation at Jungfraujoch on September 19, 2018 at 14:32 UTC (left) and the corresponding classification in clouds (white), no-clouds (blue) and sun pixels (yellow) (right).

Figure 2 shows on the left the cloud situation at Jungfraujoch on September 19, 2018 at 14:32 UTC and on the right the corresponding classification in clouds (white), no-clouds (blue) and

the sun pixels (yellow). The calculated cloud fraction of this situation is 48 %.

These cloud fraction and cloud type information can be used to calculate the cloud radiative effect (CRE). The CRE is defined as a radiation flux measurement (under all-sky conditions) minus a modelled clear-sky radiation value. Such CRE have been performed for a four to five years' period for the two stations Davos and Payerne (Aebi et al., 2017). As a future project the CRE could be also calculated for the high-altitude station Jungfraujoch.

The cloud information from cloud cameras can also be used to perform the trend analysis of shortwave and longwave radiation under different cloud conditions (Nyeki et al., subm). Additionally, these data can be used to interpret the calculated trends.

References

Aebi, Ch., Gröbner, J., Kämpfer, N., and Vuilleumier, L.: Cloud radiative effect, cloud fraction and cloud type at two stations in Switzerland using hemispherical sky cameras. Atm. Meas. Tech., 10, 4587–4600, https://doi.org/10.5194/amt-10-4587-2017, 2017.

Nyeki, S., Wacker, S., Aebi, Ch., Gröbner, J., Martucci, G., and Vuilleumier, L.: Trends in surface radiation and cloud radiative effect at four Swiss sites for the 1996 – 2015 period, submitted to ACP.

Wacker, S., Gröbner, J., Zysset, C., Diener, L., Tzoumanikas, P., Kazantzidis, A., Vuilleumier, L., Stoeckli, R., Nyeki, S., and Kämpfer, N.: Cloud observations in switzerland using hemispherical sky cameras, J. Geophys. Res., 120, 695–707, https://doi.org/10.1002/2014JD022643, 2015.

Internet data bases

ftp://ftp.pmodwrc.ch/stealth/002_payerne/liras/cloudcam/jf/

Collaborating partners / networks

MeteoSwiss

Scientific publications and public outreach 2018

Refereed journal articles and their internet access

Nyeki, S., S. Wacker, Ch. Aebi, J. Gröbner, G. Martucci, and L. Vuilleumier, Trends in surface radiation and cloud radiative effect at four Swiss sites for the 1996 – 2015 period, submitted to ACP.
https://www.atmos-chem-phys-discuss.net/acp-2018-1096/

Address

PMOD/WRC
Dorfstrasse 33
CH-7260 Davos Dorf
Switzerland

Contacts

Christine Aebi
e-mail: christine.aebi@pmodwrc.ch

Dr. Julian Gröbner
Tel.: +41 58 467 5157
e-mail: julian.groebner@pmodwrc.ch