Name of research institute or organization:

Physikalisch-Meteorologisches Observatorium Davos,
World Radiation Center (PMOD/WRC)

Title of project:

Comprehensive Radiation Flux Assessment (CRUX)

Part of this programme:

GAW-CH

Project leader and team:

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Project description:

The project CRUX (Comprehensive Radiation Flux Assessment) aims to study the role of the clouds on the surface radiation budget of the Earth and on the climate system. It combines observations of different atmospheric parameters and radiative transfer models. The analyses are performed for different stations in Switzerland (Jungfraujoch 3471 m asl, Davos 1594 m asl and Payerne 490 m asl). CRUX is financed by the Swiss contribution to the Global Atmosphere Watch Programme (GAW-CH) of the WMO.

Climatologies of the cloud radiative effect (CRE), cloud fraction and cloud types have been calculated for the two stations Davos and Payerne. The CRE is defined as a radiation flux measurement (under cloudy conditions) minus a modelled clear sky value. The CRE is calculated for shortwave (0.3 – 3 µm) and longwave (3 – 100 µm) radiation separately. The radiation flux measurements are retrieved from pyranometers and pyrgeometers. Information about the integrated water vapour (IWV) are retrieved from GPS measurements. Cloud fraction calculations and cloud type determinations are based on visible all-sky cameras that are installed at the aforementioned three stations.

The analyses in Davos and Payerne have shown that different (atmospheric) parameters, such as fractional cloud coverage, cloud base height and IWV, have an influence on the magnitude of the longwave cloud radiative effect (LCE) and the shortwave cloud radiative effect (SCE). Additionally, for the magnitude of the SCE it is of importance whether the sun is covered by a cloud or not. Slight differences in the LCE and SCE for the different cloud coverages and cloud types have been observed between the two stations Davos and Payerne.

It is of interest to calculate the SCE and LCE for the high-altitude station Jungfraujoch as well in order to analyse whether the altitude of the station influences the magnitude of the LCE and SCE significantly. At Jungfraujoch we already have access to shortwave and longwave radiation as well as to IWV data. Also a visible all-sky camera is already installed since July 2012 at Jungfraujoch.

The algorithms to calculate the fractional cloud coverage and to determine the cloud type on the basis of images taken by the visible all-sky camera automatically are already available. The cloud types are classified on the basis of the knn (k-nearest-neighbour) method. This is a supervised method, which means that the algorithm is learning through a training set. However, for each station another training set of cloud camera images is needed in order to train the algorithm. The different training sets are needed because of different camera systems and settings, and because local atmospheric conditions might affect the knn parameters differently at each site. Not yet available is the training set for the station Jungfraujoch, but it is expected to be ready in the first quarter of 2017.

The plan is to distinguish automatically between the five cloud classes cirrus-cirrostratus, cirrocumulus-altocumulus, cumulus, altostratus and fog as well as clear sky situations (all shown in Figure 1).

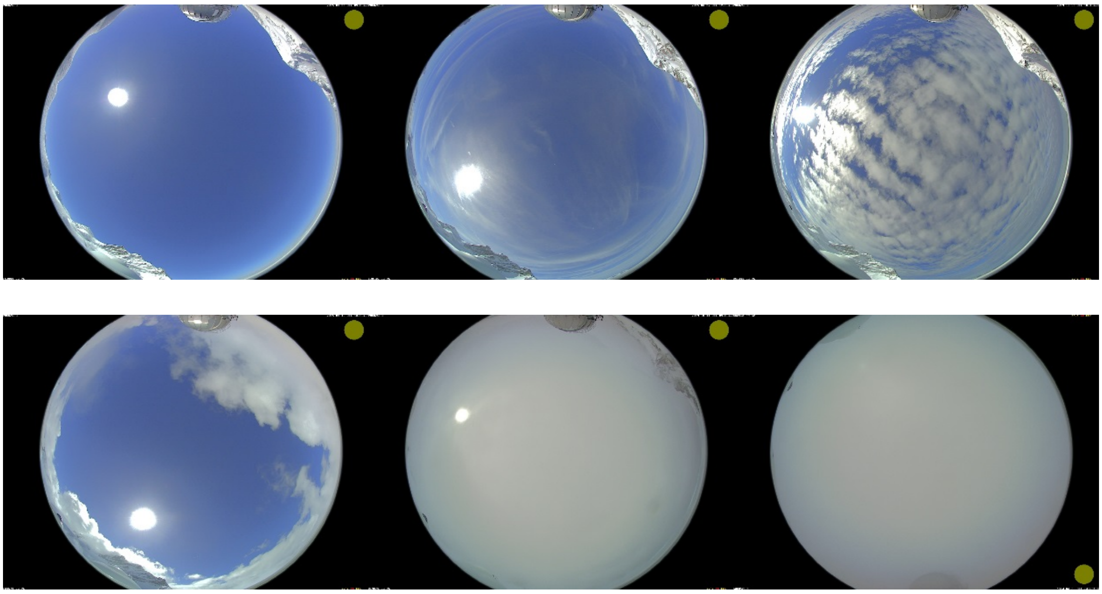

Figure 1. Examples of the training set images from the visible all-sky camera on Jungfraujoch. 1: clear sky, 2: cirrus-cirrostratus, 3: cirrocumulus-altocumulus, 4: cumulus, 5: altostratus and 6: fog (from top left to bottom right).

The training set consists of around 200 example images per cloud class. On the example images only one of the cloud types is present. Due to the fact that the cloud class determination algorithm is working with spectral and textural information, the example images should be as diverse as possible in terms of size and shape of the clouds, cloud position, solar zenith angle, time of the day and the season.

For all the six cloud classes more than 200 images have been carefully chosen and manually classified by different persons separately. One of the challenges at Jungfraujoch is that the cloud camera is not shaded. This unshaded situation leads to the problem of many overexposed images due to the sun brightness. On these overexposed images, the color and textural features of the clouds cannot be calculated and it is almost impossible to determine the cloud class. Thus it is planned to select these overexposed images automatically and exclude them from the cloud type determination process.

The next steps will be to calculate the different textural and spectral features on the basis of the training set for Jungfraujoch. Afterwards the trained algorithm will be applied on a sample data set and the classification will be verified. As soon as the results of the automatic classification are satisfactory, the cloud type determination algorithm can be applied on several years of data collected with the visible all-sky camera at Jungfraujoch. In a final step the LCE and the SCE can also be calculated for the high-altitude station Jungfraujoch and compared with the values from Davos and Payerne.

Key words:

Climate change, radiation, cloud fraction, cloud type classification, hemispherical sky camera

Internet data bases:

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

Collaborating partners/networks:

MeteoSwiss

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