Transregio SFB 32
Subproject D2
Cloudcover from total sky imager

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Figure 1: Setup of the total sky imager (TSI) on roof of institute ICG2 in the research center Jülich in front of the 120 m meteorological tower.

1 Instrument

Cloud coverage data described here come from a total sky imager (TSI) from Yankee environmental systems (YES, USA). It is installed on roof of the institute ICG-2 at the research center Jülich at 50^{o}54’ 30.02”N 6^{o}24’47.13”E. The instrument consist of a small electronic camera which looks overhead onto a spherical chrome plated mirror (see fig. 1) and a build in Linux machine which controls the camera, the mirror (see below) and performs analysis of the images. To block the sun from images a black tape is fixed radially on the mirror and the mirror is positioned according to the actual sun position. The instrument uses a proprietary secret algorithm of YES to discriminate between sky, thin cloud and opaque cloud pixels. The algorithm is probably based on the ratio of the blue and the red channel of every pixel and certain thresholds. These are not absolute fix but probably depend slightly on total intensity of the individual pixel and position relative to horizon and sun. Base values of these thresholds can be adjusted by the user. The instrument

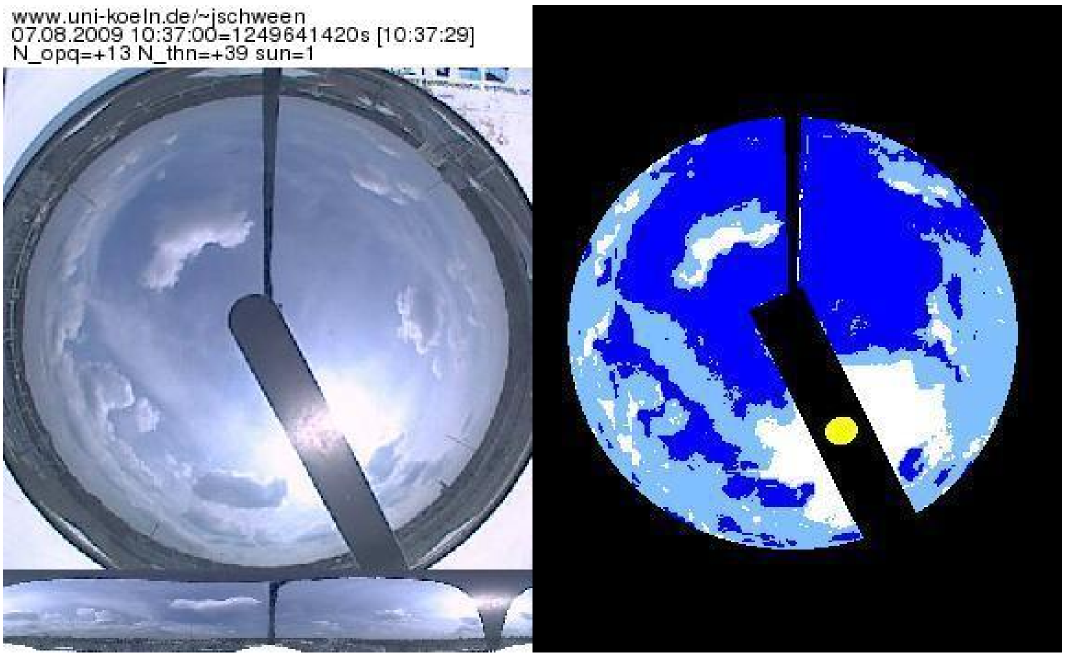

Figure 2: Examplary sky image (left) together with cloud classification mask (right), time stamp, derived percentages of opaque and thin clouds and a flag indicating whether the sun is visible (top left). Colors in the cloud mask indicate sky (dark blue), thin clouds (light blue) and clouds (white). The yellow dot in the cloud mask at the sun position indicates that the sun is visible.

Table 1: Data avaiability.

date	remarks
10.9.2008	first installation
25.9.2008 - 22.10.2008	no data due to problems with instrument software
6.5.2009 - 12.5.2009	no data due to problems with instrument software
10.6.2009 - 24.6.2009	data biased due to rusty mirror
1.10.2009 - 15.10.2009	data biased due to rusty mirror
1.11.2009 - 5.11.2009	data biased due to rusty mirror
14.1.2010 - 28.1.2010	data biased due to rusty mirror
9.3.2010 - 15.6.2010	no data due to new chrome plating of the mirror

generates a mask to exclude sun shade tape, camera boom, camera housing and pixels lower than 3^oabove the horizon. Remaining pixel are classified and a mask ist generated, classified pixel are counted and percentages of the respective class in the images are provided. No weighting according to position in the image, distance to zenith or horizon is applied. The instrument delivers no data when the sun is less than 3^oabove the horizon. The presence of glint on the sun shade tape is used to detect the visibility of the sun.

A script has been written to transfer every 20 seconds sky image, cloud mask, cloud coverage and instrument configuration data via hypertext transfer protocol (http) to cologne. Sky image and cloud mask are mounted side by side together into one image, cloud cover data are written as text and jpeg comment into the image (see fig.2). Cloud cover and instrument data are written into text files. Actual images can be seen at `http://www.uni-koeln.de/~jschween/tsi/`.

2 time table

Times of installation are summarized in table 1. As the instrument mirror is thought for surveillance indoor its chrome plating suffers from environmental influence. In November 2008 first rust spots appeared on the mirror. As cloud detection is based on the red to blue ratio of single pixels, rust leads to an overestimation of cloudy pixels. Even regular cleaning and waxing of the mirror could not stop an increasing faster development of rusty spots. Beginning of 2009 we got the hint that a new thicker chrome plating would be a better solution than purchasing a new insufficient mirror. In March the mirror was given to a Dutch chrome plating shop. Problems with money transfer led to several delays and a reinstallation only 3 month later.

Table 2: Basic structure of the zip files in the database: every zip file contains one month of data in a single subdirectory with `<YYYYMM>` the year and month of the file.

```
cloud_data_<YYYYMM>.zip
  <YYYYMM>/
    <YYMMDD>.log
    <YYMMDD>.png
    ...
```

3 data files

Cloud coverage, sun visibility and further instrument parameters are read from the instrument every 20 seconds and stored in an ASCII file with name `<YYMMDD>.log`. One month of data is grouped in one zip file (see table 2). Data files are ASCII files containing data in columns separated by white spaces (see fig. 3). When the sun is less than 3°above the horizon variables `opq` and `thn` have the value -9999. Variable `t_raw_ms` may have the value `+-1`. The cloud coverage data give an estimate of the cloud coverage but suffer from some problems: Close to the horizon and around the sun light scattered by aerosol lead to a shift of color to white and are interpreted as clouds. Thus derived cloud coverage tends to overestimate cloud coverage. The delivered sun flag may be used to derive sun shine duration. Additionally to the data files daily quick looks are provided (see fig. 3).

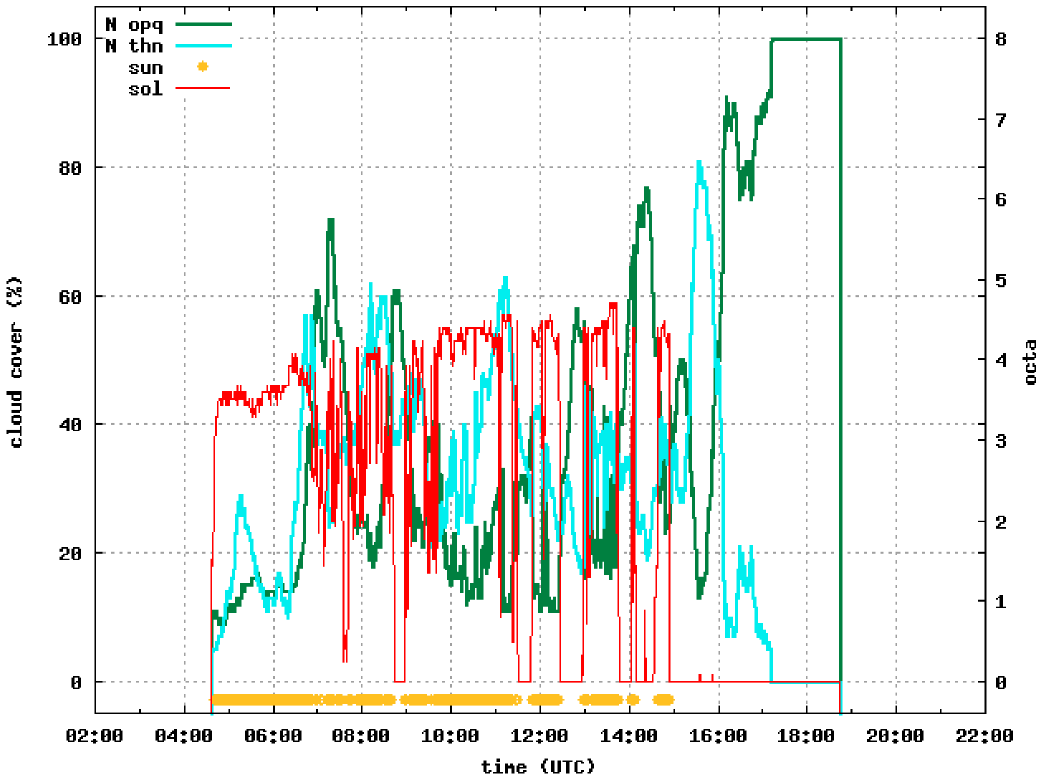

Figure 3: Exemplary quicklook from 7.8.2008 with `N opq` the percentage of opaque cloud pixels, `N thn` the percentage of thin cloud pixels and `sol` what the manufacturer calls 'solar strength'. Variable `sun` shows the sun visibility flag as an orange circle below the zero line when the sun is visible.

Table 3: Basic structure of the data files.

column	name	content
1	date	dd.mm.yyyy
2	time	hh:mm:ss
3	t_raw_ms	milliseconds since January 1,1970
4	opq	percentage of opaque cloud pixels
5	thn	percentage of thin cloud pixels
6	sun_flag	sun visibility: 0=not visible, 1=visible
7	cx	x-position of mirror center in pixel
8	cy	y-position of mirror center in pixel
9	rad	distance between mirror top and camera in inch
10	opq_ts	threshold for opaque cloud
11	thn_ts	threshold for thin cloud
12	sun_ts	threshold for sun visibility
13	sol_azi	sun azimuth angle in degrees
14	sol_ele	solar elevation angle in degrees
15	sol_str	'solar strength' in ?