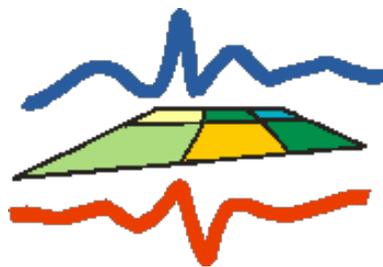


Transregio SFB 32
Subproject D2
Cloudcover from total sky imager



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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 $50^{\circ}54' 30.02''\text{N}$ $6^{\circ}24'47.13''\text{E}$. The instrument consist of a small electronical 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 generates a

mask to exclude sun shade tape, camera boom, camera housing and pixels lower than 3° above the horizon. Remaining pixels are classified and a mask is generated, classified pixels 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° above the horizon. The presence of glint on the sun shade tape is used to detect the visibility of the sun.

A script transferred every 20 seconds sky image, cloud mask, cloud coverages 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. From every image and cloudmask two scan circles at 30° and 45° are extracted and relative amounts of cloud classes are determined. The classification and red, green, blue values are stored in a netcdf file together with the cloud amounts on the scan circle. The `t-azi` images in fig.2 represent the content of the netcdf file.

Images can be found in our data browser <http://gop.meteo.uni-koeln.de/Hatpro/dataBrowser/>.

2 data files

Table 1 shows the header of a netcdf file

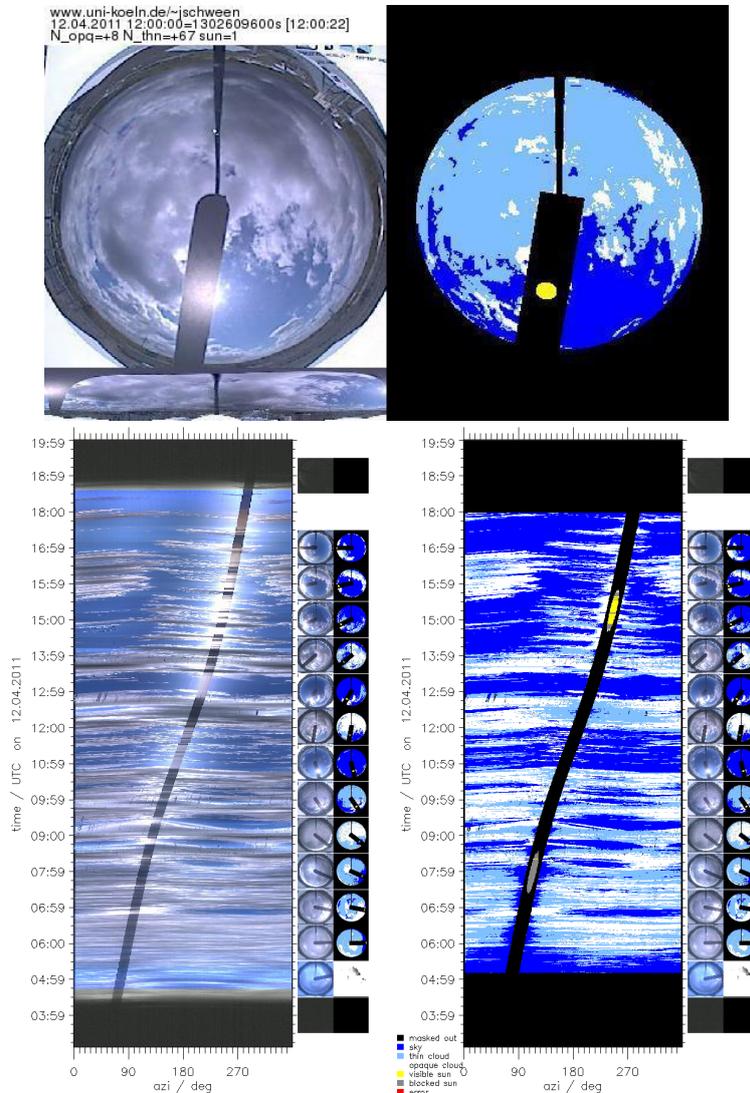


Figure 2: Top: Exemplary sky image from April 12, 2011 (left) together with cloud classification mask (right), time stamp, derived percentages of opaque and thin clouds and a flag indicating whether the sun is visible (top left). Colors in the cloud mask indicate sky (dark blue), thin clouds (light blue) and clouds (white). The yellow dot in the cloud mask at the sun position indicates that the sun is visible. Bottom: "t-azi" composit from image (left) and cloud mask (right). Every line depicts one scan circle at 30° elevation with azimuth running from left to right and time from bottom to top.

Table 1: Basic structure of the netcdf files in the database:

```

netcdf tsi_scan_120502 {
dimensions:
  time = UNLIMITED ; // (3028 currently)
  rgb = 3 ;
  azi = 360 ;
  ele = 2 ;
  corner = 4 ;
variables:
  double time(time) ;
    time:units = "julian date" ;
    time:long_name = "julian date i.e. days since 1 Jan 4716 B.C. 12UTC" ;
  int tunix(time) ;
    tunix:units = "unix epoch" ;
    tunix:long_name = "unix epoch i.e. seconds since 1 Jan 1970 00:00" ;
  float azi(azi) ;
    azi:units = "degree" ;
    azi:long_name = "azimuth angle" ;
  float ele(ele) ;
    ele:units = "degree" ;
    ele:long_name = "elevation angle" ;
  byte scan(time, ele, azi, rgb) ;
    scan:units = "rgb value" ;
    scan:long_name = "rgb values [0..255] of respective pixel in tsi image" ;
  byte cloudmask(time, ele, azi) ;
    cloudmask:units = "cloud mask values (0..5)" ;
    cloudmask:long_name = "cloud mask values: 0=black, 1=sun, 2=thin cloud, 3=opaque cloud, 4=sun(visible), 5=sun(blocked)" ;
  byte N_thn_scan(time, ele) ;
    N_thn_scan:units = "percent" ;
    N_thn_scan:long_name = "percentage of thin cloud pixels in scans" ;
  byte N_opq_scan(time, ele) ;
    N_opq_scan:units = "percent" ;
    N_opq_scan:long_name = "percentage of opaque cloud pixels in scans" ;
  byte N_thn(time) ;
    N_thn:units = "percent" ;
    N_thn:long_name = "percentage of thin cloud pixels in image" ;
  byte N_opq(time) ;
    N_opq:units = "percent" ;
    N_opq:long_name = "percentage of opaque cloud pixels in image" ;
  byte sun_flag(time) ;
    sun_flag:units = "0 | 1" ;
    sun_flag:long_name = "sun flag: 0=sun blocked, 1=sun visible" ;
  float sol_azi(time) ;
    sol_azi:units = "degree" ;
    sol_azi:long_name = "azimuth of sun" ;
  float sol_ele(time) ;
    sol_ele:units = "degree" ;
    sol_ele:long_name = "elevation of sun above horizon" ;
  byte rgb_corner(time, corner, rgb) ;
    rgb_corner:units = "rgb value" ;
    rgb_corner:long_name = "rgb values [0..255] of NW,NE,SW,SE corners in tsi image" ;

// global attributes:
  :Date_of_file_generation = "Wed May 2 03:08:24 2012" ;
  :Conventions = "scan rings from TSI IGMK Cologne" ;
  :location = "FZ-Juelich 5054\ '30.02\ '\ 'N 624\ '47.13\ '\ 'E" ;
  :system = "TSI-880#142 of University of Cologne" ;
  :day = 2 ;
  :month = 5 ;
  :year = 2012 ;
  :institution = "Data processed by University of Cologne; contact: jschween@uni-koeln.de" ;
  :sample_int = "20 seconds" ;
}

```