CORE SITE GILCHING (GERMANY) - PI ACTIVITIES IN 2003 AND AIMS FOR 2004

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ABSTRACT

The CHRIS core site Gilching is located in the Bavarian Alpine foothills, 25 km south-west of Munich. The activities in this area are coordinated by the University of Munich – chair for geography and geographical remote sensing together with the gtco (Ground Truth Center Oberbayern).

In 2003, four CHRIS images were acquired. Airborne and field based hyperspectral measurements were also conducted during the vegetation period of that year. Also, four airborne data sets were acquired using AVIS-2 (Airborne Visible / near Infrared imaging Spectrometer) and three sets of GVIS (Ground based Visible and near Infrared imaging Spectrometer) measurements were acquired.

Besides the discussion of the acquired data, problems that occurred during the campaign in 2003 will be addressed.

For 2004, a more intensive field campaign is planned. The field measurements will be carried out at weekly intervals, AVIS and GVIS measurements are planned as often as possible, depending on the weather conditions. A list of planned activities provides a basis for the discussion and coordination of desired CHRIS acquisition dates in the test site Gilching.

1. INTRODUCTION

The core site “Gilching” is located in the Bavarian Alpine foothills, 25km south-west of Munich. This area is a test site for several research projects providing various measurements, both from the ground and remotely sensed. The main research topics in this area are the retrieval of biophysical parameters (biomass, chlorophyll, nitrogen) using optical remote sensing as well as retrieval of soil moisture using radar. These parameters serve as input and validation for hydrological and vegetation modelling approaches.

The optical remote sensing activities are conducted at various scales. To achieve this, various optical sensors (field spectrometer (GVIS), airborne (AVIS-2) and satellite based (CHRIS) sensors) are used to investigate scaling issues between different spatial resolutions.

2. TEST SITE

Within the test site Gilching (48°6’ N, 11° 17’ S), one field with silage maize (Zeas may L.), one with rape (Brassica napus L.), one with triticale (X Triticosecale Wittmack) and one with winter wheat (Triticum aestivum L.) were chosen as test fields for 2003.

Most of the farmers are under contract to the local office for water management. This enables access to detailed field management data including information about crop rotation, cultivars, dates of sowing and harvest, the application of fertiliser, herbicides and fungicides and the quantity applied.

A weather station of the Bavarian network of agrometeorological stations enables access to local weather monitoring. Station No. 72 (Gut Hüll), located at the north-eastern edge of the test site, provides meteorological data such as precipitation, soil and air temperature, total radiation and air humidity. An eddy covariance flux station and a permanent soil moisture station were installed on the rape field to obtain data at hourly intervals.

A biweekly field campaign was conducted, where plant parameters such as wet/dry biomass, height, phenological stage, leaf chlorophyll and nitrogen content were measured.

3. INSTRUMENTATION

Figure 1 presents the remotely sensed data that was collected for Gilching in 2003.

![Figure 1: Available remotely sensed data from 2003 (top = CHRIS; centre = AVIS-2; bottom = GVIS). The number of rays indicates the number of acquired angles)](image)
conducted during that year’s vegetation period; four airborne data sets (April 14 and 16, May 16 and 24) were acquired using AVIS-2 and three GVIS (Ground based Visible and near Infrared imaging Spectrometer) measurements were acquired (May 16 and 24, June 4).

3.1 CHRIS

Four CHRIS data sets are available for 2003; these are shown in Figure 2.

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 24</td>
<td>1 image (quasi nadir)</td>
<td>1</td>
</tr>
<tr>
<td>July 26</td>
<td>5 angles</td>
<td>5</td>
</tr>
<tr>
<td>August 2</td>
<td>4 angles</td>
<td>4</td>
</tr>
<tr>
<td>September 17</td>
<td>5 angles</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 2: CHRIS images acquired in 2003 in Gilching

The CHRIS data is dark current corrected using the mean value of the masked pixels for each line. After dark current correction the images have been destriped using a multiplicative approach, where the pixels of a column were aligned to their adjacent pixels.

The atmospheric correction and reflectance calibration was conducted using PAAK [1], which is based on the radiation transfer model RSTAR. Although Lidar measurements are available, the cloudy or dusty weather hampered a correct atmospheric correction, as presented in section 4.1.

The geometric pre-processing was carried out using ground control points.

3.2 AVIS-2

AVIS-2 is a pushbroom imaging spectrometer that operates with 64 spectral bands in the visible/near infrared domain (400-850nm). The sensor AVIS was built at the University of Munich, chair for geography and remote sensing in 1998 [2, 3, 4]. The second generation – AVIS-2 – offers the possibility of along-track pointing [5]. Its specifications are as follows:

- Spectral Coverage: 400 - 850 nm
- Data Acquisition: digital B/W camera
- 640x64 pixels, 16 bit
- Spectral Resolution: 7 nm, 64 bands

Figure 3: AVIS image stripe in real colour composite (left image, BGR = 447, 557, 681 nm) and false colour composite (right image, BGR = 557, 681, 734 nm), acquired on May 24
IFOV: 2.2 mrad, 640 pixels per scan line
Along-track pointing: ± 55°, 7 angles selectable

An example for an AVIS-2 image stripe, which was acquired on May 24, is presented in Figure 3. Angular data sets were collected on both May 16 and 24 and will be described in more detail in section 4.2.

All data was dark current and flat field corrected. Atmospheric correction and reflectance calibration was conducted using PAAK [1]. Geometric processing was carried out using the GPS and INS data recorded in the header of each image line.

3.3 GVIS

GVIS is a tractor-mounted version of AVIS using 16 optical fibres, installed on a cantilever arm, instead of a lens. The movement of the tractor offers the possibility of two-dimensional ground measurements at a spatial scale below 1m. The specification of GVIS is as follows:

- Spectral Coverage: 530 - 1020 nm
- Data Acquisition: digital B/W camera 512x120 pixels, 16 bit
- Spectral Resolution: 6 nm, 119 bands
- FOV/Fibre: 0.44 rad
- FOV Total: 12 m

The GVIS data was dark current and flat field corrected. The reflectance calibration was conducted using both measurements of reference panels and diffuse skylight.

Geometric pre-processing is conducted using the GPS data stored in the header of each image line.

4. ANGULAR MEASUREMENTS

A direct comparison of angular measurements of AVIS-2 and CHRIS is not possible for 2003 because of the different acquisition dates (see also Figure 1). Therefore CHRIS angular acquisitions of September 17 will be described in more detail. AVIS-2 angles will be discussed on the basis of measurements conducted on May 24.

4.1 CHRIS

Figure 5 provides five CHRIS angular images acquired on September 17 in a false colour composite. The data was pre-processed as described in section 3.1. The sun azimuth angle is 145°.

At this time of the year, crops such as wheat, triticale or rape are harvested. Maize plants begin to wither. Therefore the angular reflectances of two meadows will be discussed: the reflectance spectra represent mean field spectra of permanent grassland sites in Gilching. The reflectance shapes of the different observation angles are very similar, but the levels vary. For both
sites, the highest reflectance levels occur at the backward-looking \(-35^\circ\) angle. The reflectance level decreases at higher or lower angles. Therefore the \(-35^\circ\) angle appears to be the measurement nearest the hot spot. The lowest reflectance level can be observed at the forward-looking \(+35^\circ\) angle in the VIS, in the NIR at the forward-looking \(+55^\circ\).

A problem occurred in the VIS, where the reflectances of all angles (12 to 28 \%) are far too high. This is caused by the mist that can be observed in large parts of the CHRIS image from that day. Although Lidar measurements were carried out on that day, the partial coverage prohibited a correct atmospheric correction.

The reflectance spectra in Figure 5 also display a strong decrease at wavelengths above 800nm. This is due to the decreasing sensitivity of CHRIS in the NIR. A recalibration could not be conducted because of the existing problems with the atmospheric correction of this data set.

### 4.2 AVIS-2

AVIS-2 angular measurements were conducted on May 24, which are shown in Figure 6. The data was pre-processed as described in section 3.1.

The reflectance levels of the different observation angles show behaviour similar to those of CHRIS that are presented in Figure 5. The near hot spot observation can be observed at the backward \(-45^\circ\) angle. The forward \(+45^\circ\) angle shows the lowest level in the VIS while the nadir angle is the lowest in the NIR part of the spectrum.

### 5. SENSOR COMPARISON

A major issue in the test site Gilching is the comparison of hyperspectral data acquired with different sensors at different spatial scales. Simultaneous measurements of CHRIS, AVIS-2 and GVIS could only be conducted on May 24. Unfortunately, the CHRIS image does not cover the test fields that were measured with GVIS. Therefore a direct comparison of all sensors is not possible. A comparison of GVIS to AVIS-2 on the one hand and AVIS-2 to CHRIS on the other hand will be presented instead.

#### 5.1 AVIS-2 and GVIS

An AVIS-2 image stripe acquired on May 24 is shown in Figure 7. In its northern part the flight stripe covers a field of triticale, where GVIS measurements were carried out simultaneously to the AVIS-2 acquisition. The data was pre-processed as describe in section 3.1.

Although the GVIS image illustrates the heterogeneity within the field much better that the AVIS-2 image does, the mean field spectra of AVIS-2 and GVIS are quite similar; slight differences can be observed in the RED and NIR part of the spectra (680-720nm and >770nm).

#### 5.2 AVIS-2 and CHRIS

When comparing the mean field spectra of a meadow and a forest site of CHRIS and AVIS-2, there appear to
be many more differences than when comparing AVIS-2 to GVIS. This is caused by difficulties with the atmospheric correction of the CHRIS image. The weather conditions are comparable to those described in section 4.1 for the September acquisition. A layer of mist covers parts of the CHRIS image leading to problems with an accurate atmospheric correction. As a result the reflectances in the VIS are too high for both sites that were observed. A recalibration to eliminate the decrease of CHRIS sensitivity in the NIR could not be carried out. Therefore the reflectance spectra cannot be compared.

5. AIMS FOR 2004

For 2004, an intensive field campaign is carried out with weekly ground sampling intervals.

Hyperspectral measurements using GVIS and AVIS-2 are planned to be carried out in a weekly or biweekly time interval (depending on the weather conditions). In addition, plant parameters will be measured simultaneously to CHRIS, AVBIS-2 and GVIS acquisitions as often as possible.

To enhance the possibility of comparison between the sensors the CHRIS mode should be changed from mode 3 (land mode, 18 bands, full swath) to mode 5 (land mode, 37 bands, half swath). This leads to new centre coordinates for the test site Gilching, which are given in Table 1.

Table 1: New centre coordinates the test site Gilching for 2004

<table>
<thead>
<tr>
<th>New Centre Coordinates</th>
<th>Geogr. (WGS 84)</th>
<th>UTM (WGS 84)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.0587 N 11.3079 E</td>
<td>48.0587 N</td>
<td>32 5325859 N</td>
</tr>
<tr>
<td>580m</td>
<td>11.3079 E</td>
<td>671982 E</td>
</tr>
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</table>

6. REFERENCES


