IMLM v6.3 CH_4/CO product specification document

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1. Product description

This product is the result of the application of the SRON IMLM retrieval algorithm described in the algorithm description document (Schrijver and Gloudemans 2006) in a spectral window (in SCIAMACHY channel 8) where CH_4, CO, and H_2O can be retrieved.

2. Product format specification

The product is in ASCII format. It consists with a product header and data. The lines of the product header all start with a number sign (#). The data part has one record for each observation.

2..1 Header

The header contains the following information:

- The author and time of production.
- The version of the format of this product (1.0).
- The name of the level-1b product used for this product.
- The start and stop times of this level-1b product, as specified in the its header.
- The orbit number as specified in the level-1b product. Note: since some near real time level-1b files cover more than one orbit some or all results in the product may belong to the next orbit.
- The software version.
- The SCIAMACHY channel.
- The retrieval window in pixel numbers.
- The retrieval window in nanometers.
- The pixel mask version.
- The cloud mask version.

The header ends with a short description of the fields in the data records.

2..2 Data

Each data record consists of 31 fields, with the results for one observation.

Field	Description
1–2	Geographic longitude and latitude of the the corner point of the ground pixel which is first in time and flight direction, in degrees. Copied from the level-1b data.
3–4	The same for the corner point first in time and last in flight direction.
5–6	The same for the corner point last in time and first in flight direction.
7–8	The same for the corner point last in time and flight direction.
9–10	Geographic longitude and latitude of the centre of the ground pixel in degrees. Copied from the level-1b if available or computed.
11	Start time of the observation in days from 1 January 2000 0^h UT.
12	Integration time in seconds.
13	Solar zenith angle at the surface in degrees.
14	Line-of-sight angle at the surface in degrees.
15–18	Retrieved total vertical columns of H_2O, N_2O, CO, and CH_4 in cm^{-2}. Note: in this product there is no result for N_2O, value set to zero.
19–22	Estimated error in the columns of H_2O, N_2O, CO, and CH_4 in cm^{-2}. Error on N_2O set to zero.
23	Reduced χ^2 of fit (χ^2 divided by number of degrees of freedom).
24	Number of degrees of freedom (number of valid detector pixels minus number of fitted parameters).
25	Error flag: if not equal to zero, result to be discarded.
26	Retrieved surface albedo.
27	Cloud fraction from PMD cloud detection: fraction of PMD measurements detecting clouds.
28	Mean surface elevation for this ground pixel in meters.
29	Ordinal of state in the level-1b file (first state = 0).
30	Ordinal of observation within the state (first observation = 0).
31	Backscan indicator: if 1, this is a backscan. Backscans are normally not included in this product.

3. Software release history

Main features of version 6.3 are:

- Various calibrations (dark signal, orbital variation of dark signal, pixel-to-pixel gain) obtained from SRON calibration database.
- Dynamical pixel mask obtained from SRON database.
- Correction for ice layer dependent on mean detector signal level.
- Correction of pixel mask based on dark signal calibration.
- Correction of pixel mask based on fit residuals.
- Non-linearity correction from SRON database.
- ECMWF temperature and moisture profiles are used in the forward model.

- Spectroscopic data from the HITRAN 2004 database.
- Possibility to mask strong lines in the retrieval window.
- Cloud filter discriminates between clouds and ice/snow (Krijger et al. 2005).
- Computed albedo corrected for effects of ice layer.
- Air mass factor computed in spherical geometry.

Results using earlier versions have been published. Version 5.1 (with a slightly wrong correction for the orbital variation of the dark signal) was used in Gloudemans et al. 2004 and Straume et al. 2005. Version 5.5 was used in Gloudemans et al. 2005. The CO results from the current version 6.3 have been analyzed by de Laat et al. 2006. The current version differs from with 5.5 by the use of the HITRAN 2004 database, the masking of strong H_2O lines, and the use of ECMWF temperature and humidity profiles.

4. Implementation details

For this product the retrieval window is 2324.5–2337.9 nm. This is in SCIAMACHY channel 8, pixels 505–615 (counting pixels from 0–1023). Only pixels allowed by the dynamical dead and bad pixel map are included. Furthermore a number of pixels centred on strong water lines (around 2328.5, 2331.1, and 2335.2 nm) are excluded. The latter results in a good comparison between retrieved H_2O columns and water vapour columns from ECMWF data.

The SRON SCIAMACHY Data Monitoring Facility is used for dark signal calibrations (Kleipool 2003, 2004a) and dynamical dead and bad pixel maps (Kleipool 2004b). These are the same data that are distributed in the SRON patched level-1b files. The non-linearity data are taken from the SRON results (Kleipool 2003b); again the same data are in the SRON patched level-1b data.

Temperature and moisture profile data to be used in the forward model calculation are obtained from ECMWF in cooperation with KNMI. These data also implicitly contain surface elevation data through the pressure profiles. In particular, the a priori trace gas profiles in the forward model are cut off at the ECMWF surface pressure level.

The mean elevations of the ground pixels in the output are computed using the $5' \times 5'$ TerrainBase elevation database from the NOAA National Geophysical Data Center (NGDC). These elevations are not used in the retrievals.

The surface albedo is computed from the scaling polynomial applied to the forward model to match the detector signal level (see the Algorithm Description Document, Schrijver and Gloudemans 2006). It is corrected for the effects of the ice layer using the calibrated transmission in the window.

The backscan measurements are skipped. Only measurements with solar zenith angle less than 80° are processed.

5. List of known issues

CH_4 columns retrieved over tropical vegetated regions are generally lower than predicted by models. Also, they are lower (some 10%) than CH_4 results from SCIAMACHY channel 6. This can probably be

explained partly by undetected thin clouds and partly by aerosols over low-albedo surfaces.

Calibration of ice layer correction. This is calibrated by assuming model values over high-albedo regions like the Sahara. Different models lead to differences of a few percent in CH_4 and CO columns. For CO this is not significant (de Laat et al. 2006). The differences in CH_4 due to this calibration uncertainty are of course also visible when comparing with CH_4 results from channel 6 and are typically 1–2% for monthly averaged data.

CH_4 values over high-albedo regions (deserts) can be up to 5% too high in conditions of high aerosol load.

6. Data quality assessment

The quality of the CO results has been assessed by de Laat et al. 2006.

The quality of the CH_4 and CO results have been assessed by comparison with FTIR measurements by Dils et al. (2005).

The retrieved H_2O vapour columns compare reasonably well with the data from ECMWF.

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