HOW TO EXTRACT THE GEOLOCATION OF SCIAMACHY NADIR PIXELS FROM THE LEVEL-2 DATA FILES

V. Soebijanta[(1)]**, J.-C. Lambert**[(1)]**, J. F. Meirink**[(2)]**, and A. Piters**[(2)]

[(1)]*Institut d'Aéronomie Spatiale de Belgique (IASB-BIRA),* Brussels, Belgium
[(2)]*Royal Netherlands Meteorological Institute (KNMI)*, De Bilt, The Netherlands

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1   Introduction

The procedure to extract geolocation information belonging to a certain product from a SCIAMACHY level-2 data file is not completely trivial. During the Envisat commissioning phase several validation teams and product deliverers made an erroneous interpretation of the geolocation information. This document shows the effect of an erroneous extraction and provides a brief description and methodology of how geolocation information has to be extracted.

2   Integration time dependence of the geolocation information

In order to optimise the ground pixel resolution, SCIAMACHY uses integration times (IT) varying with solar elevation and the considered spectral region. Variable integration times result in variable ground pixel sizes, the effective geolocation (pixel corners and centre) depending on the molecule's fitting window and on the solar elevation. The SCIAMACHY level-2 data product contains the geolocations of 'subpixels' corresponding to the shortest IT in the state (= a block of consecutive nadir measurements, usually about 960 x 400 km²). The level-2 product does not contain the effective geolocation for species with larger ITs. By using the appropriate start time of the data set record (DSR time) and the IT provided in the level-2 data file, the user is able to compute the effective pixel coordinates of the retrieval by co-adding the component subpixels. Unfortunately, computing is the only manner to get the effective coordinates, SZA value and cloud parameters of the SCIAMACHY product.

As an illustration, Fig. 1a shows what SCIAMACHY O_3 forward pixels retrieved in the UV band look like when the extraction of the geolocation information is made without considering the molecule IT. In this particular case, the effective pixel contains two subpixels and only the first of them is plotted. Fig. 1b illustrates the real location of the pixels, which are two times larger than when using the erroneous reading method.

Fig. 1 illustrates the effect of the geolocation misinterpretation. With the purpose of selecting pixels within a distance of 300 km around a target point (corresponding e.g. to a correlative measurement or to modelling/assimilation results), the selected pixels will be different when the geolocation is correctly extracted or not.

The mistake described here above has been made by some validation teams and even by the official product deliverer during the commissioning phase. For instance, the total ozone columns in the SCIAMACHY level-2 BUFR product have unfortunately wrong geolocation coordinates due to the erroneous extraction method as illustrated in Figure 1. Enviview and other official conversion tools such as Pds2Ascii and Pds2Hdf are presently unable to provide the correct geolocation coordinates of the SCIAMACHY retrieved species.
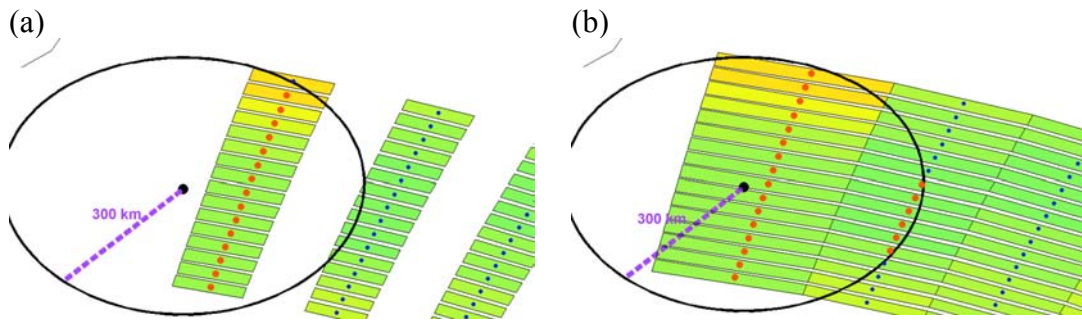

Correspondence to : V. Soebijanta (vincent.soebijanta@iasb.be)

Figure 1 : *Extraction of the pixel coordinates belonging to a SCIAMACHY measurement (e.g., the total ozone column): (a) erroneous extraction, only first of a total of two 'subpixels' (rectangles) is selected; (b) correct extraction, both subpixels are selected leading to the effective ozone pixels given by rectangles. Red dots are subpixel centres which are included in a radius of 300 km around a data target (black dot).*

3   Geolocation extraction procedure

Suppose one wants to extract the 'Geolocation of the ground pixel' in the annotation data set (ADS) belonging to any retrieved molecule in the measurement data set (MDS) (e.g. DOAS_0_O3). Then the following methodology has to be strictly respected:

1) Find *ADS subpixel* with *DSR time* equal to that *MDS pixel*;
2) For selected pixels and subpixels, compare integration times (*integr_time*) in both data sets:
-   if *MDS integr_time = ADS integr_time*, then the *MDS geolocation = ADS geolocation* and no further computing is needed;
-   else if *MDS integr_time > ADS integr_time*, then continue by :
3) Get the following (N –1) subpixels from *ADS* with N=(*MDS IT*)/(*ADS IT*) to have the required number of subpixels (N);
4) Merge *N ADS subpixels* into one pixel by applying the following computation for the different parameters:
    a) <u>centre :</u> take the geographic average of *cor_coor_nad[2]* and *cor_coor_nad[3]* from the $(N/2)^{th}$ *ADS subpixel*
    b) <u>corners:</u>
       -   take first corner as *cor_coor_nad[0]* from the 1st *ADS subpixel*
       -   take second corner as *cor_coor_nad[1]* from the 1st *ADS subpixel*
       -   take third corner as *cor_coor_nad[2]* from the Nth *ADS subpixel*
       -   take fourth corner as *cor_coor_nad[3]* from the Nth *ADS subpixel*
    c) <u>earth radius :</u> take the average of the *N ADS earth_rad*
    d) <u>satellite geodetic height :</u> take the average of the *N ADS sat_geod_ht*
    e) <u>solar zenith angle :</u>
       -   take first element as *sol_zen_angle_toa[0]* from the 1st *ADS* subpixel
       -   take second element as *sol_zen_angle_toa[2]* from the $(N/2)^{th}$ *ADS* subpixel
       -   take third element as *sol_zen_angle_toa[2]* from the Nth *ADS* subpixel
    f) <u>relative azimuth angle :</u> as solar zenith angle
    g) <u>line-of-sight relative angle :</u> as solar zenith angle

Remarks:
1) Variable names in italic can be seen when reading PDS files with Enviview.
2) A similar extraction procedure is needed to get the cloud and aerosols information belonging to any retrieved molecule in the measurement data set (MDS)

4   References

Meirink, J.F., V. Soebijanta, A. Piters, H. Eskes, R. Van der A, M. Allaart, M. de Graaf, and J-C. Lambert, Verification of SCIAMACHY near-real-time and meteo level-2 products: O₃ and NO₂ columns, clouds, aerosols, and geolocation, in *Proc. of ENVISAT Validation Workshop, Frascati, Italy, 9-13 Dec. 2002*, ESA SP-531, 2003