POLDER/Parasol Level-2 Product

Data Format and User Manual

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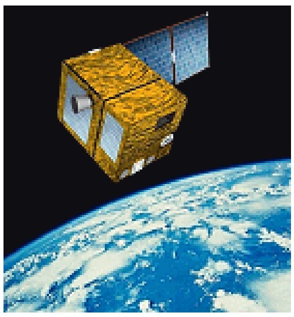

POLDER level-2 product

Data format and user manual

This document describes the content and format of the standard POLDER and Parasol products. The instrument that flew onboard the Parasol CNES platform was slightly different than that onboard the JAXA ADEOS platforms, which slightly impact the format. The present document is primarily for the POLDER/Parasol products, but it also applies to the POLDER/ADEOS products. Notes are provided when needed.

The concept of the POLDER instrument was imagined by several researchers from LERTS (Laboratoire d'Etudes et de Recherche en Télédétection Spatiale), CNES (Centre National d'Etudes Spatiales) and LOA (Laboratoire d'Optique Atmosphérique) during the late 80s'. The concept was then validated using an airborne version built and operated at LOA.

The spaceborne POLDER instrument has been developed by CNES in partnership with industrial contractors. It was flown on both ADEOS-I and ADEOS-II platforms. Unfortunately, the lifetime of both platforms was limited to less than a year following the failure of the solar paddle.
The Parasol instrument is similar to that of POLDER. It was launched in December 2004 to be part of the A-Train, flying is formation with Aqua, Calipso and Cloudsat. Significant changes concern:

- The orientation of the CCD matrix was changed. On ADEOS, the long axis of the matrix was cross-track. On Parasol, it is along track. This results in a lower daily coverage of the Earth, but a larger directional sampling for the pixel that are in the instrument swath (up to 16 from 14 on ADEOS).
- The shorter wavelength polarized channel is at 490 nm instead of 443 nm on POLDER.
- Onboard ADEOS, there were two channels at 443 nm (for optimized dynamic and signal to noise). There is a single one on Parasol, but with an additional channel at 1020 nm. This channel may be used for optimized synergy with the Calipso measurements at 1060 nm.

Scientific algorithms are defined and validated by the following science laboratories:

- Laboratoire d'Optique Atmosphérique (LOA)
- Laboratoire des Sciences du Climat et de l'Environnement (LSCE)
- Medias-France
- Laboratoire de Météorologie Dynamique (LMD)

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Introduction

The POLDER-1 instrument was launched onboard the ADEOS platform in August 1996. The instrument acquired data almost continuously from October 1996 to June 1997 when the platform solar panel failure doomed all instruments onboard. Another similar instrument, POLDER-2, was launched in December 2002 but the ADEOS-II platform died in June 2003. The Parasol instrument, very much like POLDER, was launched on a micro-satellite in December 2004. The satellite was part of the A-Train until December 2009. After this time, the mission continued until 2013 although with a slowly drifting orbit. All Parasol measurements are sent to CNES where they are processed. Level-1 consists of radiometric and geometric processing. It yields top-of-the-atmosphere geocoded radiances. The Parasol level-1 product is described in another document.

Level-2 processing generates geophysical parameters from individual Level-1 products that cover the fraction of the Earth observed during one ADEOS orbit with adequate illumination conditions. This document describes the content and format of Parasol Level-2 products and gives some information on the processing.

Level-3 processing performs a spatial and temporal synthesis of Level-2 products. The period of composition is either 10 days or one month, whereas the area is global. The content and format of Parasol Level-3 products is described in another document.

Level-2 processing is applied to all Level-1 products. It makes use of ancillary information such as:

- Atmospheric Ozone column amount derived from TOMS observations (for atmospheric absorption corrections).
- Global fields of Meteorological parameters: Surface pressure, surface wind speed, temperature and water vapor vertical profiles...
- A global, monthly estimate of the surface reflectance in clear conditions, derived from the analysis of POLDER-1 data.

Level-2 processing is separated in three "processing lines" referred to by L (for "Land Surfaces"), O (for "Ocean") and R (for "Radiation Budget").

"Land Surfaces" processing line

The "Land Surfaces" processing line analyzes the measurements acquired over Land Surfaces that are recognized as clear by the first step of the processing. It generates an estimate of the aerosol optical thickness and a "best fit" aerosol model, as well as directional surface reflectances corrected for atmospheric absorption, molecular scattering and aerosol scattering. The latter are limited to clear conditions (i.e. retrieved aerosol optical thickness smaller than a threshold).

The scientific rationale for the algorithm is described on the World Wide Web: http://smsc.cnes.fr/POLDER/SCIEPROD/ls_intro.htm

Two products are generated :

- "Atmospheric parameters" describes the result of aerosol inversion. The product is given on the Medium resolution grid (Appendix B-2) with a spatial resolution of approximately 19 km.
- "Surface (directional) parameters" gives an estimate of the surface directional reflectance for up to 14 observation geometries, after correction for atmospheric absorption, molecular scattering and aerosol scattering and absorption. This product is given at the original Level-1 spatial resolution (approximately 6 km), on the full resolution grid described in Appendix B-1.

"Ocean" processing line

The "Ocean" processing line analyzes the measurements acquired over water surfaces that are recognized as clear by the first step of the processing. It generates an estimate of the aerosol optical thickness and a "best fit" aerosol model.

The aerosol algorithm is described at http://smsc.cnes.fr/POLDER/SCIEPROD/ae_intro.htm

The "Aerosol parameters" product describes the result of the aerosol inversion over the ocean. An estimate of the aerosol optical thickness together with physical and optical properties of the retrieved model are given. Thanks to the analysis of the spectral, directional and polarization signatures of the reflectances, a very detailed description of the aerosol model is available. The product is generated on the Medium resolution grid (Appendix B-2) with a spatial resolution of approximately 19 km.

"Radiation Budget" processing line

The "Radiation Budget" processing line analyzes all measurements (clear and cloudy). It generates information on the cloud cover (amount, optical thickness, pressure, phase...), atmospheric water vapor, scene albedo, and some statistics on the spatial and directional variability of these parameters. The directional reflectances, for individual pixels that are recognized as clear and cloudy are also given. The product is given on the Medium resolution grid (Appendix B-2) with a spatial resolution of approximately 19 km.

The advanced algorithms are described on the web at
http://smsc.cnes.fr/POLDER/SCIEPROD/rb_intro.htm

The document first gives some general information on the data coding. It then describes in details the level-2 data format. The appendices provide more information for an in-depth use of the Parasol level-2 data. More information on the POLDER/Parasol instrument and the Level-1 processing can be found in Deschamps et al. (IEEE TGARS, 1994).

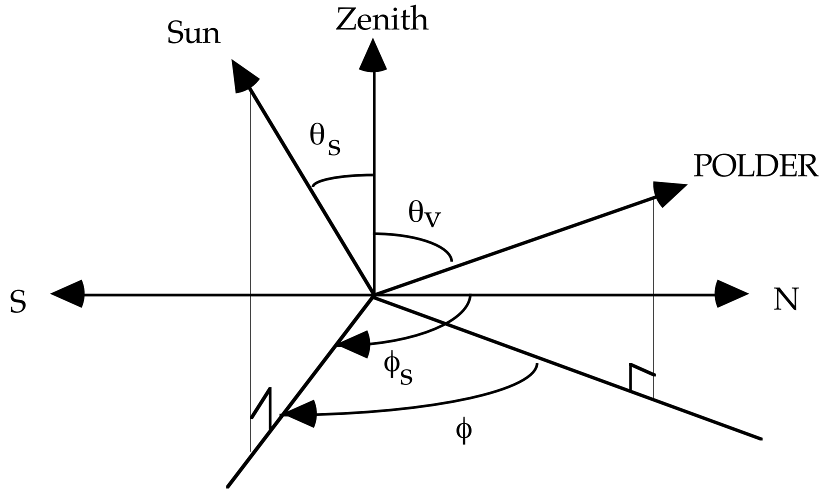
Definitions

POLDER/Parasol product identification

A POLDER standard product is composed of two files: A *leader* file and a *data* file. The *leader* file provides some information on the instrument and the data processing. The *data* file contains the geophysical parameters, together with ancillary data.

A Level-2 product generated from POLDER measurements is identified by `PxL2TyGzcccooov` where x identifies the satellite mission (1 or 2 are for ADEOS 1 and 2 respectively, and 3 is for Parasol), `y` identifies the processing line (`L`, `O` or `R`), `z` identifies the product (`A`, `B`, or `C`), `ccc` is the orbit cycle number, `ooo` the orbit number in the cycle, and v identifies the reprocessing number (See Appendix A). The *leader file* and *data file* filenames are `pppL` and `pppD` respectively, where `ppp` is the 15 characters product identificator.

Geometry



Four angles are used in the level-2 products:

- The solar azimuth, ϕ_S, is relative to the local North direction. It may vary between 0 and 360°. The solar azimuth is 90° when the sun is East of the observed pixel.
- The solar zenith angle, θ_S, is relative to the local zenith. It may vary between 0° (sun at zenith) and approximately 80°.
- The view zenith angle, θ_V, is relative to the local zenith. It may vary between 0° (Parasol at zenith) and approximately 75°.
- The relative azimuth, ϕ, is the difference in azimuth between the sun and the satellite directions: $\phi=\phi_S-\phi_V$ where ϕ_V is defined, as ϕ_S, with respect to the North direction. ϕ may vary between 0° and 360°. ϕ is 0°/360° for backscattering measurements, and 180° for glitter observation.

Coding

Most parameters of the leader file are written as formatted ASCII characters, whereas the data file has a binary structure.

In what follows, we make use of the following coding types:

`Ax` : indicates an ASCII field of length x bytes.

`Fx.y` indicates a real written on `x` characters with `y` digits after the floating point (as in FORTRAN). Ex: `F10.4` for `-1234.5678`

`Ex.y` indicates a real written in exponential form on `x` characters with `y` digits after the floating point (as in FORTRAN). Ex: `E14.4` for `-1234.5678E-08`

`Bx` indicates a succession of bits (for quality flags). x is the number of bytes used.

`I4` indicates a four-bytes unsigned Integer (from 0 to 2^{32}-1)

`SI2` indicates a two-bytes signed integer (from -32768 to +32767)

`I2` indicates a two-bytes unsigned Integer (from 0 to +65535)

`SI1` indicates a one-byte signed integer (from -128 to +127)

`I1` indicates a one-byte unsigned integer (from 0 to +255)

In the format description below, the special character “$” is used to indicate the space character. Upper-case letters are used for fixed fields, whereas lower-case letters are used for variable fields.
Spare fields are filled with repetition of the “space” character.

For binary parameters, two values are reserved: “Non significant” and “Dummy”. The “Non significant” value characterizes out of range data. The “Dummy” value is used when the parameter was not estimated, for instance when less than 14 observation directions are available; in this case, all parameters for the unused directions are coded with “Dummy”.

	I1	I2
Dummy	255	65535
Non significant	254	65534

Leader File Format

General structure

The leader file is composed of 7 records of variable length. Its total length is 29520 Bytes :

Record Name	Record Length (Bytes)
Leader file descriptor	180
Header	360
Spatio-Temporal Characteristics	1620
Instrument setting parameters	180
Data processing parameters	720
Scaling factors	13140
Annotations	13320
Total	29520

Leader file descriptor

This record describes the data structure of the leader file.

Position	Type & Length	Content
1-4	I4	Record Number in the file : `1`
5-8	I4	Length of this record : `180`
9-20	A12	Reference Document Identification: `SPG9N122-316$ for PARASOL,` PAST33131CN$ for POLDER1 and P2ST33131CN for POLDER2
21-26	A6	Reference Document Version Number : `aa/bb$ for PARASOL, aa/bbb for POLDER1 and POLDER2`
27-32	A6	Software Version Number : `aabbcc.` aa, bb and cc correspond to different sections of the software
33-36	A4	File Number : `1$$$`
37-52	A16	File Name[1] : `PxL2TyGzcccooovL`
53-56	I4	Number of “header” records in the file : `1`
57-60	I4	Length of the “Header” record : `360`
61-64	I4	Number of “Spatio-Temporal Characteristics” records in the file : `1`
65-68	I4	Length of the “Spatio-Temporal Characteristics” record : `1620`
69-72	I4	Number of “Instrument setting parameters” records in the file : `1`
73-76	I4	Length of the “Instrument setting parameters” record : `180`
77-80	I4	Number of “Technological parameters” records in the file : `0`
81-84	I4	Length of the “Technological parameters” record : `0`

[1] See Annexe A for the POLDER/Parasol standard for filenames

85-88	I4	Number of "Data processing parameters" records in the file : `1`
89-92	I4	Length of the "Data processing parameters" record : `720`
93-96	I4	Number of "Scaling factors" records in the file : `1`
97-100	I4	Length of the "Scaling factors" record : `13140`
101-104	I4	Number of "Annotation" records in the file : `1`
105-108	I4	Length of the "Annotation" record : `13320`
109-180	A72	Spare

Header

The "header" record gives general information on the product and the models used for data registration.

Position	Type & Length	Content
1-4	I4	Record Number in the file : `2`
5-8	I4	Length of this record : `360`
9-24	A16	Information Point Phone Number
25-40	A16	Product identification : `PxL2TyGzcccooov$` See Appendix A
41-48	A8	Satellite identificator : `MYRIADE2 for PARASOL, ADEOS$1 for POLDER1 and ADEOS$2 for POLDER2.`
49-56	A8	Instrument identificator : `POLDER$1 or POLDER$2` or `PARASOL1`
57-72	A16	Spatial Coverage : `VIEWING$SEGMENT$`
73-80	A8	Pixel size of the POLDER/Parasol grid (km)
81-110	A30	Name of the ellipsoid used for the data registration : `GEODETIC$REFERENCE$SYSTEM$1980`
111-122	F12.4	Length of the ellipsoid minor axis (meter) : `6356752.3141`
123-134	F12.4	Length of the ellipsoid major axis (meter) : `6378137.0000`
135-164	A30	Name of the Digital Elevation Model (DEM) used for the data registration : `TERRAIN-BASE(NOAA)$$$$$$$$$$$$`
165-172	A8	Spatial resolution of the DEM along the latitudes (in degrees) : `aaa.aaa$`
173-180	A8	Spatial resolution of the DEM along the longitudes (in degrees) : `aaa.aaa$`
181-360	A180	Spare

Spatio-Temporal Characteristics

This records provides some information on the Earth temporal and spatial coverage for this viewing segment.

Position	Type & Length	Content
1-4	I4	Record Number in the file : `3`

5-8	I4	Length of this record : 1620
9-12	A4	Cycle Number : ccc$
13-16	A4	Orbit Number in the cycle : ooo$
17-20	A4	Sub satellite track number : ttt$
21-50	A30	Spare
51-58	A8	Ascending Node Longitude : ddd.ddd$ (0 – 360°)
59-74	A16	Ascending node date and UT time : yyyymmddhhmmsscc
75-100	A26	Spare
101-116	A16	Date and UT time of the first image acquisition for the viewing segment : yyyymmddhhmmsscc
117-132	A16	Date and UT time of the last image acquisition for the viewing segment : yyyymmddhhmmsscc
133-200	A68	Spare
201-204	A4	Number of sequences in the viewing segment (1≤Nseq≤130)
205-300	A96	Spare
301-304	A4	Line Number of the northern most pixel observed by Parasol in the viewing segment: nnnn (0000≤nnnn≤3240)[2]
305-308	A4	Line Number of the southern most pixel observed by Parasol in the viewing segment: nnnn (0000≤nnnn≤3240)
309-1620	A1312	Spare

Instrument setting parameters

This record describes the integration time sequencing (Short Integration Acquisition versus Long Integration Acquisition) used for this viewing segment, as well as the gain.

Position	Type & Length	Content
1-4	I4	Record Number in the file : 4
5-8	I4	Length of this record : 180
9-16	A8	Short Integration Acquisition (SIA) duration (ms) : mmm.mmm$
17-24	A8	Long Integration Acquisition (LIA) duration (ms) : mmm.mmm$
25-40	A16	Integration Time definition for sequence type A : tttttttttttttttt with t=S (SIA duration) or t=L (LIA duration). The 16 characters correspond to the 16 Parasol filters in the following order : Dark , 490P1, 490P2, 490P3, 443NP, 1020NP,

[2] If only a given geographical area is ordered from the POLDER processing center, this field and the next one are automatically updated in agreement with the area selection. If no pixel was found during the extraction, this parameter is set to 0.

		565NP, 670P1, 670P2, 670P3, 763NP, 765NP, 910NP, 865P1, 865P2, 865P3
41-56	A16	Integration Time definition for sequence type B : tttttttttttttttt with t=S (SIA duration) or t=L (LIA duration). Same as above
57-72	B16	Sequence type (A or B) for the 128 first sequences of the orbit (for a total maximum of 130). The 16 bytes include 128 bits. Each bit is for one sequence Bit=0 : Sequence type A Bit=1 : Sequence type B
73-74	A2	Analogic gain number : g$ (1≤g≤7)
75-180	A106	Spare

Data processing parameters

This record provides information on the input data and the software version used to generate the Level-1 and Level-2 Parasol data.

Position	Type & Length	Content
1-4	I4	Record Number in the file : 5
5-8	I4	Length of this record : 720
9-16	A8	Level-0 data creation country : FRANCE$$ for PARASOL, JAPAN$$$ for POLDER1 and POLDER2
17-24	A8	Level-0 data creation agency : CNES$$$$ for PARASOL, NASDA$$$ for POLDER1 and POLDER2
25-40	A16	Level-0 data creation facility : CMSN1-PARASOL$$$ for PARASOL, HEOC-ADEOS$-HREC for POLDER1 and HEOC-ADEOS2-HREC for POLDER2
41-56	A16	Level-0 data creation date and UT time yyyymmddhhmmss$$
57-64	A8	Level-0 processing software version : e.r$$$$$ for PARASOL and ee.rr$$$ for POLDER1 and POLDER2
65-200	A136	Spare
201-208	A8	Level-1 data creation country : FRANCE$$
209-216	A8	Level-1 data creation agency : CNES$$$$
217-232	A16	Level-1 data creation facility : CST-PGS$$$$$$$$$
233-248	A16	Level-1 data creation date and UT time yyyymmddhhmmss$$
249-256	A8	Level-1 processing software version : aa.bb$$$
257-272	A16	Identificator of the PARASOL Level-0 data used as input : aaaaaaaaaaaaaaaa
273-280	A8	Version of the data used for radiometric calibration: ee.rr$$$

281-296	A16	Date and UT time of creation of the radiometric calibration input file : yyyymmddhhmmss$$
297-312	A16	Date and UT time of the beginning of applicability of the radiometric calibration: yyyymmddhhmmss$$
313-320	A8	Version of the data used for geometric processing : ee.rr$$$
321-336	A16	Date and UT time of creation of the geometric data input file : yyyymmddhhmmss$$
337-352	A16	Date and UT time of the beginning of applicability of the geometric data : yyyymmddhhmmss$$
353-356	B4	Product Confidence Data. This field contains several indicators on the product quality for internal use.
357-360	A4	Spare
361-368	A8	Level-2 data creation country : FRANCE$$
369-376	A8	Level-2 data creation agency : CNES$$$$
377-392	A16	Level-2 data creation facility : CST-PGS$$$$$$$$$
393-408	A16	Level-2 data creation date and UT time yyyymmddhhmmss$$
409-424	A16	Processing line identification: either LAND$SURFACES$$$ or OCEAN$COLOUR$$$$ or RADIATION$CLOUDS
425-456	A32	Product thematic identification. either DIRECTIONAL$PARAMETERS or NON$DIRECTIONAL$PARAMETERS or AEROSOL$PARAMETERS or WATER$VAPOUR$AND$AEROSOLS or Spare
457-464	A8	Level-2 processing software version : aabbcc$$
465-480	A16	Identificator of the input Level-1 product : PxL1TBG1cccooov$
481-496	A16	Identificator of the first input Level-3 product[3] : PxL3TLGAyymmddv$
497-512	A16	Identificator of the second input Level-3 product (if any)
513-528	A16	Identificator of the third input Level-3 product (if any)
529-560	A32	Identificator of the first input Meteorological data file
561-592	A32	Identificator of the second input Meteorological data file
593-624	A32	Identificator of the third input Meteorological data file (if any)
625-656	A32	Identificator of the first input TOMS data file
657-688	A32	Identificator of the second input TOMS data file (if any)
689-692	B4	Product Confidence Data (PCD). For internal use
693-720	A28	Spare

[3] For "Radiation Budget" processing line only. This line makes use of -up to three- clear surface reflectance synthesis generated from the Level-2 and Level-3 processing of the "Land Surfaces" line. The field is "spare" for the other processing lines.

Scaling factors

This record describes the coding of the parameters in the data file. Most parameters are given using integer binary coding with either 1 or 2 bytes. The physical values (PV) can be computed from the Binary Values (BV) through :

$$PV = Slope \times BV + Offset$$

The Slope and the Offset are given for each parameter in this record.

Position	Type & Length	Content
1-4	I4	Record Number in the file : `6`
5-8	I4	Length of this record : `13140`
9-16	A8	Interleaving indicator : `BIP$$$$$`
17-32	A16	Byte ordering standard (`BIG ENDIAN` or `LITTLE ENDIAN`): `BIG$ENDIAN$$$$$$` (as on IBM mainframes)
33-36	A4	Number of parameters per pixel : `Npar`
37-44	A8	Number of bytes per pixel : `Nbytes`[4]
26 ip + 19[5] 26 ip + 20	A2	Number of bytes for parameter `#ip : nn`
26 ip + 21 26 ip + 32	E12.5	Slope for the computation of physical value for parameter `#ip : ±s.sssssE±bb`
26 ip + 33 26 ip + 44	E12.5	Offset for the computation of physical value for parameter `#ip : ±o.oooooE±cc`
26 `Npar` + 45 13140	A	Spare

Annotations

This record gives some statistical information on the results of the level-2 processing. The percentages of "land", "water" and "mixed" pixels in the viewing segment are given. The percentage of cloud contaminated pixels (recognized as such by the algorithm) for each 10° latitude band (first : 90N-80N, last : 80S-90S) is given. This percentage is computed on the pixels of the Level-1 product which are used in the processing line (land pixel for LS, water pixels for OC). Finally, this record gives the number of pixels in the product for each line of the POLDER/Parasol grid used.

Position	Type	Content
1-4	I4	Record Number in the file : `7`
5-8	I4	Length of this record : `13320`
9-12	A4	Percentage of Dummy data in level-2 product: `ppp$ (0≤ppp≤100)`
13-16	A4	Percentage of "non significant" data in level-2 product : `ppp$`

[4] `Npar` and `Nbytes` vary with the thematic and product type.

[5] `ip` is the parameter number. `1 ≤ ip ≤ Npar.`

17-20	A4	Percentage of "land" pixels in the level-2 product : ppp$ (0≤ppp≤100)
21-24	A4	Percentage of "ocean" pixels in the level-2 product : ppp$ (0≤ppp≤100)
25-28	A4	Percentage of "coast" pixels in the level-2 product : ppp$ (0≤ppp≤100)
4 ib + 25[6] 4 ib + 28	A4	Percentage of pixels recognised as "cloudy" in the 10° latitude band #ib : ppp$ (0≤ppp≤100)
101-200	A100	Spare
201-204	A4	Number of lines in the POLDER grid for which at least one pixel is present in the data file[7]: nnnn
4 il + 201[8] 4 il + 204	A4	Number of pixels (or records) in the data file for line #il (1≤il≤Nlin[9], from North to South) : nnnn (0≤nnnn≤6480)
205 + 4 Nlin 13320	A156	Spare

[6] ib is the 10° latitude band number (from North to South). 1 ≤ ib ≤ 18

[7] If only a given geographical area is ordered from the POLDER processing center, this field and the next one are automatically updated in agreement with the area selection.

[8] il is the line number in the POLDER reference grid. 1 ≤ il ≤ Nlin

[9] Nlin is the number of lines in the POLDER grid used for the product. It is either 3240 (full resolution grid) or 1080 (medium resolution grid).

Data File Format

The Data file is composed of a first record of length 180 bytes, and a variable number of records equal to the number of pixels in the product (Npixels).

Record Name	Number of records	Record Length (Bytes)
Data file descriptor	1	180
Data record	Npixels	Nbytes

Data file descriptor

This record describes the data structure of the data file.

Position	Type & Length	Content
1-4	I4	Record Number in the file : 1
5-8	I4	Length of this record : 180
9-20	A12	Reference Document Identification : SPG9N122-316$
21-26	A6	Reference Document Version Number : aa/bb$
27-32	A6	Software Version Number : aabbcc. aa, bb and cc correspond to different sections of the software
33-36	A4	File Number : 2$$$
37-52	A16	File Name[10] : PxL2TyGzcccooovD
53-56	I4	Number of "data" records in the file : ($0 \leq$ Npixels $\leq 1.2\ 10^6$)
57-60	I4	Length of one "data" record : Nbytes
61-100	A40	Spare
101-104	I4	Length of the prefix in the "data" record (bytes) : 7
105-108	I4	Length of data in the "data" record[11] : nnnn
109-112	I4	Length of the suffix in the "data" record (bytes) : 0
113-180	A68	Spare

[10] See Annexe A for the POLDER/Parasol standard for filenames

[11] The data record length is nnnn+13. 13 bytes are kept for record number, record length and prefix.

Data record. Generalities

There are 4 different level-2 products. The "aerosol" products provide parameters that are independent on the viewing geometry. Other products provide parameters for each direction available in the corresponding level-1 product. In the later case, room is allocated for 16 sets of parameters (14 for POLDER onboard ADEOS missions), as this is the maximum number of observations for a given surface pixel during the Parasol overpass. In the data record, if less than 16 directions are available (Ndir<16), the available directions are stacked first, and the end of the record is filled with Dummy values. Note that the `Ndir` sets of measurements do not necessarily correspond to consecutive observation sequences.

In the tables below, the parameter number is the number used in the "scaling factor" record of the leader file. The Offset and Slope to be used for the conversion to physical values are given as of May 2005. At this time, there is no plan to change these values; nevertheless a careful user should verify that they agree with the values given in the leader file (scaling factors record). The offset is only given (in parenthesis) when different than 0.

Data record. LS processing line, Surface (Directional) parameters

The reflectances that are given in this product are corrected for gaseous absorption, molecular scattering and aerosol scattering (rough correction). This data is generated on the POLDER/Parasol full resolution grid (Appendix B-1).

The table below describes the product for the Parasol mission. For POLDER on ADEOS, there are only 14 view directions (rather than 16) so that the product is smaller (length of a record is 291 bytes).

Position	Param #	Type & Length	Slope & (Interc.)	Content
1-4		I4		Record Number in the file : `2≤RecNum≤Nrec+1`
5-6		I2		Length of this record (bytes): `329`
7-8		I2		Line Number of the pixel in the POLDER grid
9-10		I2		Column Number of the pixel in the POLDER grid
11-12		SI2		Pixel altitude from the DEM (meters)
13		I1		Land (100), Water (0) or Mixed (50) indicator: `100`
14-21	1	B 8	1	Pixel Confidence Data. See Appendix C
22-23	2	I2	0.1	Solar Zenith Angle [°]
24	3	I1	1.42	Solar Azimuth Angle [°]
25	4	I1	1	Number of available viewing directions : `Ndir` In the following `0 ≤ id ≤ Ndir-1`
Directional Parameters				
19 id + 26	9 id + 5	I1	1	Sequence Number : `ssss (1 ≤ ssss ≤ 130)`
19 id + 27	9 id + 6	I2	0.1	View Zenith Angle [°]
19 id + 29	9 id + 7	I2	0.1	Relative Azimuth Angle [°]
19 id + 31	9 id + 8	I2	10^{-3}	Surface Reflectance 443 nm
19 id + 33	9 id + 9	I2	10^{-3}	Surface Reflectance 565 nm
19 id + 35	9 id + 10	I2	10^{-3}	Surface Reflectance 670 nm
19 id + 37	9 id + 11	I2	10^{-3}	Surface Reflectance 765 nm
19 id + 39	9 id + 12	I2	10^{-3}	Surface Reflectance 865 nm
19 id + 41	9 id + 12	I2	10^{-3}	Surface Reflectance 1020 nm
19 id + 43	9 id + 13	I2	10^{-4}(-1)	Surface Polarized Reflectance 865 nm
19 id + 45 329				Dummy values (If `Ndir < 16`)

Data record. LS processing line, Aerosols Parameters

This data is generated on the POLDER/Parasol medium resolution grid (Appendix B-2). Line and column numbers for the pixel refer to this grid.

The full aerosol inversion is based on a set of models. The algorithm seeks the model and optical thickness that fits the measurements the best. The product gives the result of this inversion (optical thickness, refractive index, Angstrom coefficient). The aerosol index is the product of the optical thickness and the Angstrom coefficient. It is an efficient indicator of the presence of small particles. Finally, another optical thickness inversion is performed with a single "fixed" model. The product also gives this parameter.

Note that the aerosol retrieval over land is based on the polarized radiance. Coarse mode aerosols polarize very little. As a consequence, the retrieved aerosol optical thickness is representative of the fine mode only.

Position	Param #	Type & Length	Slope & (Interc.)	Content
1-4		I4		Record Number in the file : `2≤RecNum≤Nrec+1`
5-6		I2		Length of this record (bytes): `32`
7-8		I2		Line Number of the pixel in the POLDER grid
9-10		I2		Column Number of the pixel in the POLDER grid
11-12		SI2		Pixel altitude from the DEM (meters)
13		I1		Land (100), Water (0) or Mixed (50) indicator: `100`
14-17	1	B 4	1	Pixel Confidence Data. See Appendix D
18-19	2	I2	$2\ 10^{-3}$	Aerosol Optical thickness at 865 nm.
20	3	I1	10^{-2}	Aerosol model refractive index (Real part)
21	4	I1	0.014	Aerosol model Angström Coefficient
22-23	5	I2	$2\ 10^{-3}$	Aerosol Index
24-25	6	I2	$2\ 10^{-3}$	Fixed model Optical Thickness at 865 nm.
26-27	7	I2	$2\ 10^{-3}$	Aerosol altitude above ground level (km)
28-29	8	I2	10^{-2}	Quality index for polarized reflectance fit (0: bad; 1:Excellent)
30	9	I1	10^{-2}	Quality index for viewing geometry conditions (0: bad; 1:Excellent)
31-32	10	I2	10^{-2}	quality index for aerosol altitude above ground level retrieval (0: bad; 1:Excellent)

Data record. OC processing line, Aerosol Parameters

This data is generated on the POLDER medium resolution grid (Appendix B-2). Line and column numbers for the pixel refer to this grid. Identification of the aerosol model depends on the viewing geometry. A full model inversion is possible only when large scattering angles are observed. For such geometries, all parameters are given in the product. When the viewing geometry is not optimal, a reduced set of parameters is inverted. Other parameters are set to the Dummy value.

Position	Param #	Type & Length	Slope & (Interc.)	Content
1-4		I4		Record Number in the file : `2≤RecNum≤Nrec+1`
5-6		I2		Length of this record (bytes): `50`
7-8		I2		Line Number of the pixel in the POLDER grid
9-10		I2		Column Number of the pixel in the POLDER grid
11-12		SI2		Pixel altitude from the DEM [meters]
13		I1		Water indicator : `0`
14-17	1	B 4	1	Pixel Confidence Data. See Appendix F
18	2	I1	0.01	Quality of the fit[12]: $IQ=(1-\sigma_{lum}/2\ 10^{-3})>0$
19-20	3	I2	10^{-1}	Solar Zenith Angle [°]
21-22	4	I2	$2\ 10^{-3}$	Aerosol Optical Thickness 865 nm
23-24	5	I2	$2\ 10^{-3}$	Aerosol Optical Thickness 670 nm
25-26	6	I2	10^{-2} (-0.5)	Aerosol Angstrom Coefficient
27	7	I1	$5\ 10^{-4}$	Uncertainty of aerosol optical thickness at 865 nm
28	8	I1	$5\ 10^{-3}$	Aerosol scattering asymmetry factor
29-30	9	I2	$2\ 10^{-3}$	Aerosol Index
31	10	I1	$5\ 10^{-2}$	Aerosol Effective radius [μm]
32	11	I1	$5\ 10^{-3}$	Fine mode effective radius [μm]
33	12	I1	$5\ 10^{-2}$	Large mode effective radius [μm]
34–35	13	I2	$2\ 10^{-3}$	Fine mode Optical thickness 865 nm: $\tau_{ap}865$
36–37	14	I2	$2\ 10^{-3}$	Fine mode Optical thickness 670 nm
38-39	15	I2	10^{-2} (-0.5)	Fine mode Angstrom exponent

[12] The quality of the fit is based on the RMS difference between the observed and modeled radiance, at 670 and 865 nm, both in total and polarized light. It is 1 for null difference and 0 for RMS differences greater than $2\ 10^{-3}$.

Parameters limited to favourable viewing geometries (large range of scattering angles)				
40-41	16	I2	$2\ 10^{-3}$	Optical Thickness of spherical coarse mode at 865 nm
42-43	17	I2	$2\ 10^{-3}$	Optical Thickness of non-spherical coarse mode at 865 nm
44	18	I1	$5\ 10^{-3}$	Relative contrib. of non spherical particles in coarse mode
45	19	I1	10^{-2} (1)	Refractive Index of fine mode, only for $\tau_{ap}865>0.02$
46	20	I1	10^{-2} (1)	Refractive Index of coarse mode, only for $\tau_{ags}865>0.02$
47-48	21	I2	$5\ 10^{-3}$	Logarithm of the backscattering coefficient at 565 nm
49-50	22	I2	$5\ 10^{-3}$	Logarithm of the backscattering coefficient at 1020 nm

Data record. RB processing line

The data record for the RB processing line corresponds to the Medium Resolution Grid, described in Appendix B-2. The spatial resolution is about 19 km, i.e. approximately 3x3 POLDER pixels. The quality indices are described in Appendix G. This product includes ancillary meteorological parameters, which have been spatially and temporally interpolated from ECMWF fields.

The table below describes the product for the Parasol mission. For POLDER on ADEOS, there are only 14 view directions (rather than 16) so that the product is smaller (length of a record is 279 bytes).

Position	Param #	Type & Length	Slope & (Interc.)	Content
1-4		I4		Record Number in the file: `2≤RecNum≤Nrec+1`
5-6		I2		Length of this record (bytes): `307`
7-8		I2		Line Number of the pixel in POLDER grid
9-10		I2		Column Number of the pixel in POLDER grid
11-12		SI2		Mean pixel altitude from the DEM in the pixel [m]
13		I1		Surface Type Indicator[13]
14-15	1	B 2	1	Pixel Confidence Data. (See appendix G)
16	2	I1	1	Observation UT time: hours
17	3	I1	1	Observation UT time: minutes
18	4	I1	1	Number of available viewing directions: `Ni`
19	5	I1	1	Number of directions used for Rayleigh pressure estimate (N_R) & Number of Parasol pixels in the super-pixel (N_P). On 4 bits each (the one byte value is 16 $N_R + N_P$)
20	6	I1	1	Indices of the first and last direction contaminated by the glint. On 4 bit each (One byte value is 16 $I_{first} + I_{last}$)
21	7	I1	$4\ 10^{-3}$ (0.2)	Cosine of the Solar Zenith Angle for central pixel
22-23	8	I2	10^{-4}	Narrowband albedo at 670 nm [land] or 865 nm [ocean]. Averaged over the N_P pixels, and weighted over the N_i directions.
24	9	I1	0.2	Relative spatial standard deviation of the albedos (based on the direction-means) [%]
25	10	I1	0.2	Relative angular standard deviation of the albedos (based on the spatial-means) [%]
26	11	I1	$4\ 10^{-3}$	Albedo quality index (0: bad; 1: Excellent) based on the comparison of measured and assumed directional

[13] [0]: 100% water, [10]: >90% water, [50]: mixed, [90]: >90% Land, [100]: 100% Land

				signatures of the reflectances.
27-28	12	I2	10^{-4}	Scene Albedo (derived from the 3x3 pixel spatial averages) at 670 nm [land] and 865 nm [ocean]
29	13	I1	0.2	Relative angular standard deviation of the Scene Alb [%]
30	14	I1	$4\ 10^{-3}$	Clear Albedo (modelled, independent of Parasol measurements) at 670 nm [land] or 865 nm [ocean]
31-32	15	I2	10^{-4}	Shortwave Albedo derived from the 443, 670 and 865 nm albedos
33	16	I1	$4\ 10^{-3}$	Clear Shortwave Albedo (modelled, independent of Parasol measurements)
34	17	I1	$5\ 10^{-3}$	Cloud Cover (number of cloudy pixels divided by Np)
35	18	I1	1/15.	CN_+: Fraction of obs classif. from “uncertain” to “cloud” CN_-: Fraction of obs. classified from “uncertain” to “clear” Four bit each: One byte contains 16 CN_+ + CN_-
36	19	I1	10^{-2}	Cloud Cover quality index (O: bad; 1: Excellent)
37	20	I1	$3\ 10^{-2}$	Water vapor column [g cm^{-2}] (based on clear pixel measurements)
38	21	I1	10^{-2}	Standard deviation of water vapor estimates [g cm^{-2}]
39	22	I1	5	Cloud Pressure, derived from the Oxygen channels [hPa]. Proxy of the cloud middle pressure
40	23	I1	2.5	Angular standard deviation of the cloud O_2 pressure [hPa]
41	24	I1	5	Cloud Pressure, derived from polarized reflectances (Rayleigh method) [hPa]. Proxy of the cloud top pressure
42	25	I1	2.5	Angular standard deviation of the Rayleigh pressure [hPa]
43-44	26	I2	10^{-2}	Cloud Optical Thickness (linear mean), based on 670 nm [land] and 865 nm [ocean] measurements
45	27	I1	0.4	Relative spatial standard deviation of optical thickness [%]
46	28	I1	$2\ 10^{-3}$	Homogeneity coefficient of the optical thickness: τ^* / τ where τ is the scene mean optical thickness, and τ^* is the optical thickness derived from the scene mean reflectance.
47	29	I1	$4\ 10^{-3}$	Cloud Spherical Albedo at 670 [land] or 865 nm [ocean]
48	30	I1	1	Cloud Phase[14]

[14] The cloud phase index is derived using various tests that can be applied depending on accessible geometry and number of available direction. Hence the confidence in the retrieved index may vary and this confidence is translated in the index with the following convention : The index is coded with values ranging from 0 to 255. Values from 0 to 99 indicate LIQUID phase; 100 to 199 indicate ICE phase; 200 to 229 indicate MIXED phase; 230 to 239 indicate UNCERTAIN (no decision made); 240 is for CLEAR sky; 255 is for NO observation. Within each class, lower index value indicates higher confidence.

49	31	I1	1	Ice crystal shape index [for further versions]
50	32	I2	1	Cloud top pressure, derived from oxygen band measurements [hPa]
52	33	I2	1	Cloud middle pressure, derived from oxygen band measurements [hPa]
54	34	I2	1	Cloud geometrical extension from angular standard deviation of the cloud oxygen pressure (only on liquid clouds) [m]
56	35	I2	1	Cloud geometrical extension estimated from cloud top oxygen pressure and cloud middle oxygen pressure [m]
58	36	I1	1	Cloud multi-layer flag [%]
Additional Information on atmospheric profile (not derived from Parasol)				
59	37	I1	10^{-3}	Stratospheric Aerosol Optical Thickness
60	38	I1	0.002 (0.1)	Ozone Total Column [cm atm]
61	39	I1	0.5	Surface wind Speed (derived from ECMWF) [m s^{-1}]
62	40	I1	1.5	Surface Wind direction [°]
63	41	I1	4 (100)	Surface Pressure (derived from ECMWF) [hPa]
64-73	42-51	10 I1	1 (150)	Temperature Profile[15] [K]
74-83	52-61	10 I1	0.03	Water vapor profile [g cm^{-2}]. Integrated content between the surface and level.
Directional Parameters				
14 id + 84[16]	10 id+62	I1	0.5	View Zenith Angle (°) for central pixel
14 id + 85	10 id+63	I1	1.5 (-180)	Relative Azimuth Angle (°) for central pixel
14 id + 86 14 id + 87	10 id+64	I2	10^{-4}	Reflectance corrected for gas absorption at 865 nm [ocean] or 670 nm [land]
14 id + 88 14 id + 89	10 id+65	I2	10^{-4}	Narrowband albedo (estimated from the above reflectance)
14 id + 90 14 id + 91	10 id+66	I2	10^{-4}	Shortwave reflectance estimated from narrowband reflectances
14 id + 92 14 id + 93	10 id+67	I2	10^{-4}	Shortwave albedo (estimated from the above narrowband albedo)
14 id + 94	10 id+68	I1	8 10^{-4} (-0.05)	Polarized normalized radiance at 865 nm, corrected for the observation geometry (multiplied by $1+\cos(\theta_v)/\cos(\theta_s)$).

[15] The pressure levels for the temperature and water vapor profiles are 1000, 925, 850, 700, 500, 400, 300, 250, 200, 150.

[16] $0 \leq id \leq Ni-1$

14 id + 95	10 id+69	I1	1 1	Number of Cloudy pixels Number of Clear Pixels. Note: some pixels are “uncertain”
14 id + 96	10 id+70	I1	0.005	Directional apparent cloud cover
14 id + 97	10 id+71	I1	0.004	Spherical cloud albedo (mean on cloudy pixels) at 865 nm [ocean] or 670 nm [land]
279 / 307				Filler for POLDER et PARASOL Length_Record = 279 bytes for POLDER and 307 bytes for PARASOL

Acronymes

ADEOS	Advanced Earth Observing Satellite
CCD	Charge Coupled Device
CNES	Centre National d'Etudes Spatiales
DEM	Digital Elevation Model
ECMWF	European Center for Medium Range Weather Forecast
ERBE	Earth Radiation Budget Experiment
ISCCP	International Satellite Cloud Climatology Project
LERTS	Laboratoire d'Etudes et de Recherche en Télédétection Spatiale
LIA	Long Integration Acquisition
LOA	Laboratoire d'Optique Atmosphérique
LSCE	Laboratoire des Sciences du Climat et de l'Environnement
LMD	Laboratoire de Météorologie Dynamique
LPCM	Laboratoire de Physique et Chimie Marines
NDVI	Normalized Difference Vegetation Index
NRE	Normalized Radiant Exitence
NWM	Numerical Weather Model
NASDA	National Space Development Agency of Japan
POLDER	Polarization and Directionality of the Earth Reflectances
SIA	Short Integration Acquisition
TOA	Top of the Atmosphere
TOMS	Total Ozone Mapping Spectrometer
UT	Universal Time

Appendix A : Product identification

This Appendix describes the POLDER/Parasol standard for product identification.

A standard POLDER/Parasol product identificator (15 characters) takes the form :

`PwLxTyGzcccooov` (Browse, level 1 or level 2)

`PwLxTyGzaammddv` (level 3)

where `w` is the instrument number (1 for POLDER-1 on ADEOS-1, 2 for POLDER-2 on ADEOS-2, 3 for Parasol)

`x` indicates the product level (1, 2, 3, or 1 for the Browse product)

`y` indicates the product thematic (B (as Basic) for level 1 and Browse products, R (as Radiation and clouds) L (as Land surfaces) or O (as Ocean Color) for Level 2 and 3 products)

`z` is a code for product type (see table below)

`ccc` is the ADEOS cycle number (1 ≤ ccc ≤ 999)

`ooo` is the orbit number in the cycle(1 ≤ ooo ≤ 585 for POLDER-1; 057 for POLDER-2, 233 for Parasol)

`aammdd` is the reference date for the temporal synthesis (year-month-day)

`v` indicates the reprocessing number (from `A` to `Z`)

Level	Thematic	Product Type	x	y	z	Grid
Browse			1	B	B	
1			1	B	1	Full
2	Clouds & Rad. Budget		2	R	B	Medium
	Ocean & Atm.	Directional parameters (surface)	2	O	A	Full
		Non-Directional param. (surface)	2	O	B	Full
		Aerosols parameters	2	O	C	Medium
	Land & Atm.	Directional parameters (surface)	2	L	A	Full
		Aerosols parameters	2	L	C	Medium
3	Clouds & Rad. Budget	Synthesis	3	R	B	Medium
	Ocean & Atm.	Marine parameters	3	O	B	Full
		Aerosol parameters	3	O	C	Medium
	Land & Atm.	Directional signature param (surf.)	3	L	A	Full
		Albedo & Vegetation parameters	3	L	B	Full
		Atmospheric parameters	3	L	C	Medium

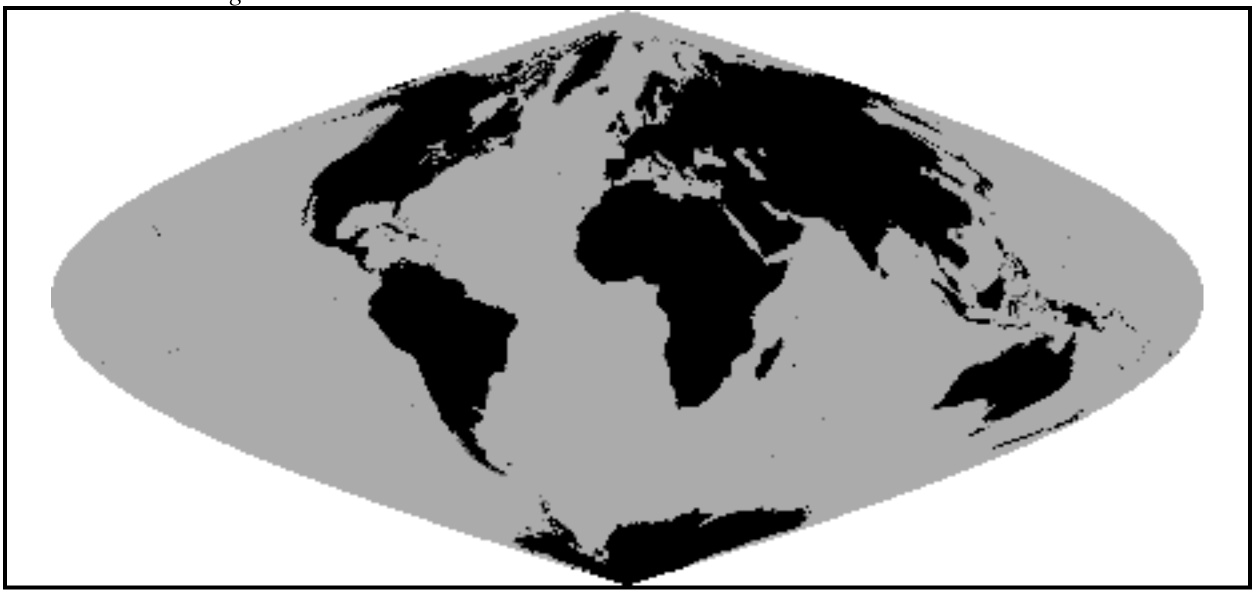
A product consists of two files. A *leader file* and a *data file*. The *leader file* filename takes the form aaaL where aaa is the product identificator (15 characters). Similarly, the *data file* filename is aaaD.

In the table above, the last column indicates the resolution of the grid used for the corresponding product (See the following appendices).

Appendix B : POLDER/Parasol Full resolution reference grid

The POLDER/Parasol Full resolution grid is used for level 1 products as well as surface parameters of the level 2 and 3 products.

The POLDER/Parasol reference grid is based on the sinusoidal equal area projection (Sanson-Flamsted). The step is constant along a meridian with a resolution of 1/18 degrees. Thus, there are 180x18 = 3240 lines from pole to pole. Along a parallel, the step is chosen in order to have a resolution as constant as possible. The number of pixels from 180 W to 180 E is chosen equal to 2 x NINT[3240 cos(latitude)] where NINT stands for *nearest integer*.



`lin` is 1 to 3240 from top to bottom

`col` is 1 to 6480 from left to right

Note that, in the real world, the coordinates of the neighbours of a given pixel (*lin* , *col*) are ***not*** necessarily given by (*lin* ± 1 , *col* ± 1). It is necessary to account for the deformation of the projection with the longitude.

The following equations yield the latitude and longitude of a pixel given by its (lin,col) coordinates in the POLDER reference grid :

$$lat = 90 - \frac{lin - 0.5}{18}$$

$$N_i = \mathrm{NINT}[3240 \cos(lat)]$$

$$lon = \frac{180}{N_i}(col - 3240.5)$$

The following equations yield the (lin,col) coordinates in the POLDER reference grid for a pixel of given latitude and longitude :

$$lin = \mathrm{NINT}[18(90 - lat) + 0.5]$$

$$N_i = \mathrm{NINT}[3240 \sin(\frac{lin - 0.5}{18})]$$
$$col = \mathrm{NINT}[3240.5 + \frac{N_i}{180} lon]$$

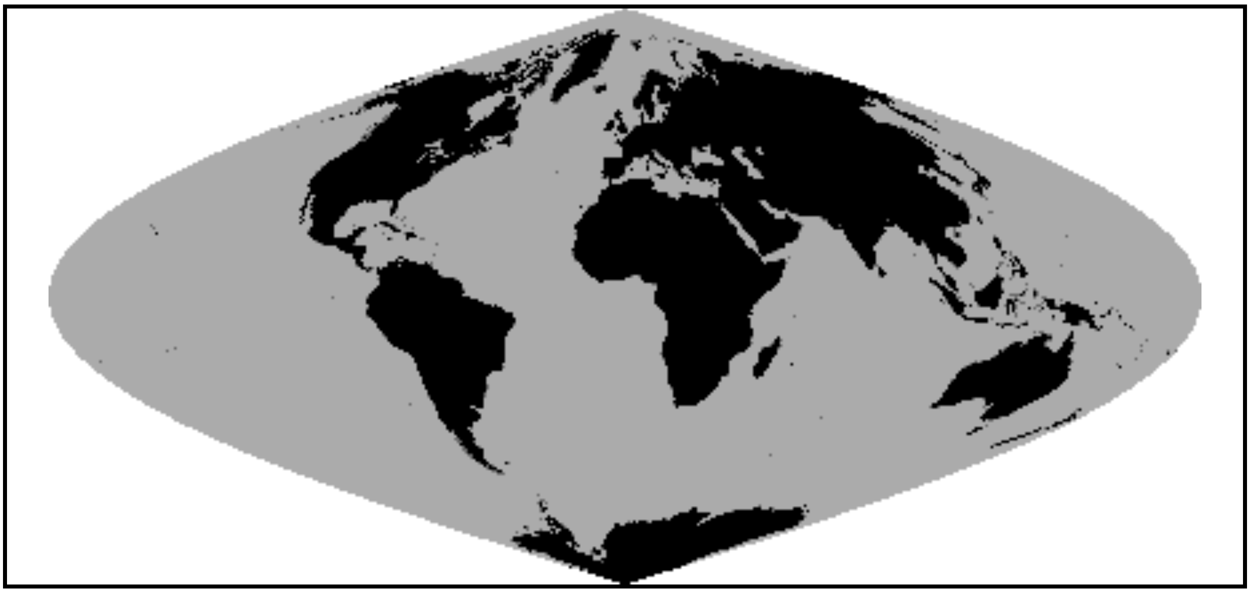
This POLDER reference grid is centered on the Greenwich meridian. For the extraction and visualisation of POLDER data close to the 180° longitude line, it may be easier to work with a similar grid centered on this meridian. A simple formula allows to switch from one (lin,col) coordinate system to the other (lin',col') :

$$lin' = lin$$
$$N_i = \mathrm{NINT}[3240 \sin(\frac{lin - 0.5}{18})]$$
$$col' = 3241 - N_i + \mathrm{MOD}_{2N_i}(col + 2N_i - 3241)$$

where MOD_{2N_i} returns the remainder of the integer division by $2N_i$.

Appendix B-2 : POLDER/Parasol Medium resolution reference grid

The POLDER/Parasol Medium resolution grid is used for level 2 and 3 atmospheric products such as aerosol and water vapor. It is similar to the Full resolution grid, albeit with a resolution reduced by a factor of 3.



`lin` is 1 to 1080 from top to bottom

`col` is 1 to 2160 from left to right

The following equations yield the latitude and longitude of a pixel given by its (lin,col) coordinates in the POLDER reference grid :

$$lat = 90 - \frac{lin - 0.5}{6}$$

$$N_i = \mathrm{NINT}[1080 \cos(lat)]$$

$$lon = \frac{180}{N_i}(col - 1080.5)$$

The following equations yield the (lin,col) coordinates in the POLDER reference grid for a pixel of given latitude and longitude :

$$lin = \mathrm{NINT}[6 * (90 - lat) + 0.5]$$

$$N_i = \mathrm{NINT}[1080 \sin(\frac{lin - 0.5}{6})]$$

$$col = \mathrm{NINT}[1080.5 + \frac{N_i}{180} lon]$$

Appendix C : Pixel Confidence Data. Level-2 “Land” Surface products

64 bits are used for this Data Quality Index. In the table below, bit 1 is the least significative, and bit 64 is the most significative. The bit value is 1 if the condition is true.

Input Level-1 data : Byte #8	
01	no (670 nm, 865 nm) couple
02	no (763 nm, 765 nm) couple
03	no (865 nm, 910 nm) couple
04	at least one no significant data (nsd)
05	insufficient number of valid viewing directions
06	Central pixel of the 3x3 super-pixel is unavailable
07	Dense vegetation detected: Pixel re-classified as clear
08	Snow cover detected: Pixel re-classified as clear
Atmospheric Corrections and Clouds Detection : Byte #7	
01-02	=11 : no Ozone correction =01 : Ozone absorption correction using TOMS data =10 : Ozone absorption correction using ECMWF data
03	Stratospheric aerosol correction uncertain (optical thickness larger than a threshold)
04	Imprecise stratospheric aerosol correction (optical thickness larger than a threshold)
05	No information on surface snow cover (some cloud tests cannot be applied)
06	Presence of snow cover
07	No polarization-based cloud detection test (observation geometry unsuited)
08	Blue channel test indicates Cloud or aerosol presence in the pixel
Cloud Detection Indicators: Byte #6	
01-08	0 (because cloudy pixels are not included in the product)
Associated 3x3 super-pixel and hot spot distance : Byte #5	
01-04	number of clear pixels in the associated super-pixel
05	insufficient number of valid viewing directions for at least one wavelength, or insufficient number of clear pixels, or no (865 nm, 910 nm) couple
06-08	hot spot distance
Land-Aerosol coupling: Byte #4	
01-08	Quality index for aerosol inversion dedicated to atmospheric corrections. 0 (bad) – 100 (Very good)
Tropospheric Aerosols Inversion : Byte #3	
01	No inversion because minimum scattering angle larger than a threshold or maximum scattering angle smaller than a threshold

02	Aerosol optical thickness larger than a threshold. No surface reflectance estimate.
03	Pixel is not recognized as “Dark Dense Vegetation”. The comparison between modeled and measured 443 nm reflectance was not attempted.
04	Large difference between measured and modeled reflectance at 443 nm.
05-08	Spare
Rayleigh + Aerosol correction: Byte #2	
01	Lack of input data for aerosol correction
02-03	Index of BRDF used for atmospheric correction (surface atmosphere coupling)
04-08	Quantifies the difference between the a-priori and the observed BRDF
Surface Reflectances Quality: Byte #1	
01	The 490 nm signal is weak by comparison to the tropospheric aerosol signal
02	The 670 nm signal is weak by comparison to the tropospheric aerosol signal
03	The 865 nm signal is weak by comparison to the tropospheric aerosol signal
04	Spare (0)
05-08	Intensity of the tropospheric aerosol signal (ranges from 0 - high - to 15 - weak)

Appendix D : Pixel Confidence Data. Level-2 "Land" Aerosol products

32 bits are used for this Data Quality Index. In the table below, bit 1 is the least significative, and bit 32 is the most significative. The bit value is 1 if the condition is true.

Cloud Detection (5 bits)	
01	At least one of the cloud detection tests could not be applied
02-05	Number of clear pixels in the 3x3 super pixel
06	Central pixel of the 3x3 super-pixel is unavailable
07	Snow identified in the central pixel (pixel reclassified as clear)
08	Spare (000)
Data Couples and Atmospheric Corrections (8 bits)	
09	Insufficient number of (865,910) couples
10	Insufficient number of (Q443,U443) couples
11	Insufficient number of (Q670,U670) couples
12	Insufficient number of (Q865,U865) couples
13-14	=11 : no Ozone correction =01 : Ozone absorption correction using TOMS data =10 : Ozone absorption correction using ECMWF data
15	Stratospheric aerosol correction uncertain (optical thickness larger than a threshold)
16	Imprecise stratospheric aerosol correction (optical thickness larger than a threshold)
Tropospheric Aerosols Inversion (8 bits)	
17	No inversion because minimum scattering angle larger than a threshold or maximum scattering angle smaller than a threshold
18	Aerosol optical thickness larger than a threshold. No surface reflectance estimate.
19	Pixel is not recognized as "Dark Dense Vegetation". The comparison between modeled and measured 443 nm reflectance was not attempted.
20	Large difference between measured and modeled reflectance at 443 nm.
21	Too large differences between measured and modeled reflectance (risk of glitter)
22	Meteorological data indicate the presence of snow at ground level
23	Not enough information to retrieve aerosol model : A-priori model used
23-24	Spare
25-32	Quality index for aerosol inversion dedicated to atmospheric corrections. 0 (bad) – 100 (Very good)

Appendix F: Pixel Confidence Data. Level-2 "Ocean-Aerosol" products

32 bits are used for this Data Quality Index. In the table below, bit 1 is the least significative, and bit 32 is the most significative. The bit value is 1 if the condition is true.

pos.	Condition
01	Error on oxygen absorption correction (R_{763}>R_{765})
02	Error on water vapor absorption correction (R_{910}>R_{865})
03	Error on Oxygen transmission (R_{763}>R_{765}) after water-vapor correction
04	Some of the inverted parameters are out of range. Pixel should not be used for further processing
05	Very small aerosol optical thickness. Set to zero
06	Small aerosol optical thickness. No aerosol model inversion
07	Significant aerosol optical thickness. Full inversion
08	Case 1: small range of scattering angles, with rather low values
09	Case 2: small range of scattering angles, with rather large values
10	Case 3: large range of scattering angles, with rather low values
11	Case 4: small range of scattering angles, with rather large values
12	Scattering angles unsuited for phase function inversion
13	Only one or two directions available for aerosol inversion
14-20	Spare (0)
21	Error on stratospheric aerosol correction (corrected reflectance lower than 0)
22	Stratospheric aerosol correction uncertain (optical thickness larger than a threshold)
23	Surface pressure correction larger than a threshold
24	Cloud detected: Polarized reflectance at 140° (always 0 since only clear pixels are in the product)
25	Cloud detected: Threshold on 865 nm reflectance (always 0 since only clear pixels are in the product)
26	Cloud detected: Spatial variability of measured reflectances (always 0 since only clear pixels are in the product)
27	Cloud detected: Neighbors contaminated (always 0 since only clear pixels are in the product)
28	Ozone data origin (0:TOMS; 1: ECMWF)
29	Variable origin of ozone data in the 3x3 super pixel
30-31	Surface wind speed range. [00]: $u \leq 8$ m s^{-1}; [01]: $8 < u \leq 12$ m s^{-1}; [10]: $12 < u \leq 15$ m s^{-1}; [00]: $u > 15$ m s^{-1}.
32	Inhomogeneous wind speed within the 3x3 super-pixel.

Appendix G: Pixel Confidence Data. Level-2 "Radiation Budget" products

In the tables below, bit 1 is the least significative, and bit 32 is the most significative. The bit value is **1** if the condition is **true**.

	Statistics on pixel quality (11 bits)
01	Valid *Water Vapor* parameter in product
02	Valid *Cloud pressure* parameter in product
03	Valid *Rayleigh Cloud pressure* parameter in product
04	Liquid cloud phase detected
05	Ice cloud phase detected
06	Mixed cloud phase detected
07	Valid *Cloud optical Thickness* parameter in product
08	Possibility for snow or Ice cover in pixel
09	No glint contamination
10	Clear pixel
11	Cloudy pixel
12	Surface reflectance parameters used in algorithm are in good temporal coincidence
13	Surface reflectance parameters used in algorithm have a good spatial homogeneity
14	Valid *Visible Albedo* parameter in product
15	Valid *Shortwave Albedo* parameter in product
16	Spare