

ENVISAT Post-Launch Sample Products

Product Information Note

- MIPAS -

Update of note, to be included in Enviview Release v. 5

MIPAS Simulated Products

Introduction

MIPAS will sense the Earth atmosphere's limb emission in the thermal infrared, covering a spectral range of 685 - 2,410 wavenumbers. Due to its high radiometric sensitivity and spectral resolution it will allow to analyse a large number of middle atmospheric constituents. The ENVISAT Payload Data Segment will routinely generate and disseminate MIPAS data products, covering both calibrated, geo-located limb radiance data (Level 1B) and vertical profiles of atmospheric pressure, temperature and volume-mixing-ratios of the primary target species O₃, H₂O, CH₄, N₂O, NO₂ and HNO₃ (Level 2).

MIPAS will periodically acquire atmospheric limb emission spectra by scanning the instrument's line-of-sight in discrete steps, covering a typical tangent height range from the upper Troposphere up to the lower Mesosphere (approx. 6 km ... 68 km). At the beginning of each elevation scan the azimuth angle is adjusted in a range $-20^{\circ} / +10^{\circ}$ about the nominal (rearward) direction, to compensate for the orbit inclination (98.55°) and thus allowing to view the polar areas. A single interferometer stroke is performed at each altitude whilst interferograms are recorded in a total of 8 detector channels (A1, A2, ..., D1, D2). Assuming 17 tangent heights per elevation scan, a measurement time of 4.45 s per stroke (high resolution) and taking into account periodic radiometric calibrations then about 75 complete scans will be acquired in each orbit (period = 100.6 min).

A description of the instrument as well as a summary of primary characteristics has been given at the ESAMS '99 workshop (*MIPAS Instrument Concept and Performance*, by M. Endemann). An outline of the early in-orbit operation of MIPAS has been presented at IGARSS 2002 (*ENVISAT-MIPAS: Instrument Commissioning & Early Results*, by H. Nett and G. Perron). Electronic copies of both paper is included on the CD-ROM / MIPAS.

The MIPAS sample products contained on the CD cover a typical measurement sequence acquired in the so-called background mission scenario. They comprise both Level 1 B and Level 2 data as well as a consistent set of auxiliary input data required by the on-ground processing chain.

Overview of MIPAS Products

Raw MIPAS data will be recorded on board ENVISAT and downlinked typically once per orbit, according to visibility of a receiving ground station. Each downlinked sequence will be converted into a so-called Level 0 product that will form the basis for all further processing. The Level 1 B stage of the Instrument Processing Facility (IPF) performs the conversion of instrument raw data (scene, blackbody and deep space) and various auxiliary input data into fully calibrated, geo-located radiance spectra. A number of supplementary parameters are computed and included in the Level 1B product, to support the correct interpretation the further processing in the Level 2 component.

The Level 2 processing is based on the analysis of emission features of selected target gases from the Level 1B input data and is performed in two stages, (1) retrieval of p, T profiles and (2) sequential retrieval of VMR profiles for the six target species, using pressure, temperature information retrieved in the first stage. Several auxiliary data are required that control, e.g., the extraction / pre-processing of the Level 1B input data or provide atmospheric state parameters as used by the iterative profile fit algorithm. **Tables 1 & 2** provide an overview of MIPAS data products and list some relevant performance parameters.

TABLE 1. MIPAS Level 1B product summary sheet

PRODUCT ID	MIP_NL_1P
NAME	Geo-located, fully calibrated MIPAS limb emission spectra
DESCRIPTION	<p><i>Measurement data:</i></p> <p>Geolocated, spectrally and radiometrically calibrated limb emission spectra in the 685 cm⁻¹ - 2,410 cm⁻¹ wavenumber range (5 bands: A: 685 - 970 cm⁻¹, AB: 1,020 - 1,170 cm⁻¹, B: 1,215 - 1,500 cm⁻¹, C: 1,570 - 1,750 cm⁻¹, D: 1,820 - 2,410 cm⁻¹)</p> <p><i>Annotation data:</i></p> <p>Geolocation data, product confidence data, processing parameters, NESR data, offset calibration data</p>
COVERAGE	<p>Tangent height range: 6 km ... 68 km (typ.)</p> <p>Pointing range: (Azimuth pointing range relative to S/C velocity vector):</p> <p style="text-align: right;">160⁰ - 190⁰ (rearward looking) 75⁰ - 110⁰ (sideward looking)</p>
THROUGHPUT	Average: 420 kbits per second
ACQUISITION TIME	<p>duration of an interferometer stroke ('sweep'):</p> <p style="text-align: right;">~ 4.45 s at high resolution (MPD = 20 cm) ~ 0.85 s at low resolution (MPD = 2 cm)</p>
GEOMETRIC RESOLUTION	<p>Instantaneous field of view (IFOV): 0.0523⁰ (elevation) * 0.523⁰ (azimuth)</p> <p>At line-of-sight (LOS) tangent point (effective):</p> <p style="text-align: right;">3 km (vertical) * 30 km (horizontal) (rearward looking) 3 km (vertical) * 60 km (horizontal) (sideward looking)</p> <p>Length of measurement cell for an individual height step:</p> <p style="text-align: right;">approx. 300 km ... 500 km (dependent on tangent height and optical properties of the atmosphere)</p>
SIZE	approx. 290 Mbytes per orbit
SPECTRAL RESOLUTION	0.031 cm ⁻¹ ... 0.035 cm ⁻¹ (for high resolution setting; max. path difference: 20 cm)
RADIOMETRIC ACCURACY	<p>685 - 1,500 cm⁻¹: 2 * NESR_T^a + 5 % [true source spectral radiance]</p> <p>1,570 - 2,410 cm⁻¹: 2 * NESR_T + X % of [true source spectral radiance], (X to be linearly interpolated between 2 at 1,570 cm⁻¹ and 3 at 2,410 cm⁻¹)</p>
AUXILIARY DATA	Instrument characterisation data, LOS calibration data, parameters controlling spectral calibration & instrument lineshape retrieval, orbit state vector & attitude information, others.

a. Noise equivalent spectral radiance when the instrument is viewing a blackbody source at temperature T.

TABLE 2. MIPAS Level 2 product summary sheet

PRODUCT ID	MIP_NL__2P (full Level 2 product)
NAME	Atmospheric pressure, temperature data, constituents profiles of primary MIPAS target species
DESCRIPTION	<p><i>Measurement data:</i></p> <p>Geolocated, vertical profiles of p, T, O₃, H₂O, CH₄, N₂O, NO₂, HNO₃, profile variance/covariance data, height correction data, fitted continuum/radiometric offset parameters</p> <p><i>Annotation data:</i></p> <p>Product confidence data, residual spectra, microwindow&occupation matrix data, processing parameters</p>
COVERAGE	Global coverage, i.e. mapping of the Earth's upper Troposphere and Stratosphere at all latitudes and longitudes
THROUGHPUT	approx. 9 kbits per second
GEOMETRIC RESOLUTION	<p>Vertical resolution of p, T and VMR profiles: ~ 3 km</p> <p>Horizontal resolution of p, T and VMR profiles: approx. 300 km ... 500 km along track (depending on tangent height range and optical properties of the atmosphere)</p>
PRODUCT SIZE	6.8 Mbytes
AUXILIARY DATA	Spectroscopic data, pre-tabulated cross-sections, microwindows & occupation matrix data, validation thresholds, initial guess p, T and trace gas VMR profiles, a priori pointing information, processing setup / configuration parameters
PRODUCT ID	MIP_NLE_2P (Meteo product)
NAME	Atmospheric pressure, temperature data, H ₂ O, O ₃ abundancy profiles
DESCRIPTION	<p><i>Measurement data:</i></p> <p>Geolocated, vertical profiles of p, T, O₃, H₂O profile variance/covariance data, height correction data, fitted continuum/radiometric offset parameters</p> <p><i>Annotation data:</i></p> <p>Product confidence data, microwindow&occupation matrix data, processing parameters</p>
COVERAGE	same as MIP_NL__2P
THROUGHPUT	approx. 1.1 kbits per second
GEOMETRIC RESOLUTION	same as MIP_NL__2P
PRODUCT SIZE	0.85 Mbytes
AUXILIARY DATA	same as MIP_NL__2P

Overview of MIPAS Simulated Data Products

The MIPAS product files contained on the CD-ROM / MIPAS correspond to the output of the MIPAS IPF for a nominal full orbit measurement sequence. In the actual scenario a series of nominal limb scan measurements with 17 limb tangent heights (68 km down to 6 km, in variable steps between 8 and 3 km) were acquired, with the instrument set to high spectral resolution (MPD = 20 cm). A deep space (DS) calibration measurement is performed after each block of four elevation scans which is in line with the current baseline calibration strategy. The acquisition window spans the period

24-JUL-2002 11:21:32 UTC (zero path difference (zpd) time of first interferometer stroke)

24-JUL-2002 12:59:08 UTC (zpd time of last interferometer stroke)

The geolocation of the acquired elevation scans (defined as the - refraction corrected - geolocation of the line-of-sight tangent point for an interferometer stroke near the center of the scan, in an Earth-fixed coordinate system) will follow a ground track that passes near the poles, with the position of first and last scan located at

- 25.98⁰ Latitude / +148.76⁰ Longitude (first scan in product)

and

- 28.83⁰ Latitude / +123.96⁰ Longitude (last scan in product),

respectively.

Table 3 summarises the product files contained on the CD-ROM/MIPAS.

TABLE 3. Summary of MIPAS simulated products

Product ID	Filename on CD-ROM	File Size [Bytes]	Remarks
<i>Products related to Level 1B processing stage</i>			
MIP_NL__1P	MIP_NL__1P020724_112130_M1_2081_020801	289,829,711	full orbit Level 1 B data product
<i>Auxiliary products</i>			
MIP_CA1_AX	MIP_CA1_AXT__20020717_111609_20020719_111609_20070717_111609	15,020	Characterisation data
MIP_CG1_AX	MIP_CG1_AXTPDH20020724_121513_20020724_121513_20070724_121513	1,055,445	Gain calibration data
MIP_CL1_AX	MIP_CL1_AXTPDH20020614_150000_20020615_060000_20501231_235959	2,920	LOS calibration data
MIP_CO1_AX	MIP_CO1_AXTPDH20020730_164037_20020730_164037_20070730_164037	218,525	Default offset calibration & validation data
MIP_CS1_AX	MIP_CS1_AXTPDH20020614_150000_20020615_060000_20501231_235959	3,052	Spectral calibration and instrument lineshape (ILS) data
MIP_MW1_AX	MIP_MW1_AXTPDH20020614_150000_20020615_060000_20501231_235959	2,707	Microwindows dictionary for spectral calibration and ILS retrieval

TABLE 3. Summary of MIPAS simulated products

Product ID	Filename on CD-ROM	File Size [Bytes]	Remarks
<i>(continued)</i>			
MIP_PS1_AX	MIP_PS1_AXT___20020730_163958_20020730_163958_20070730_163958	527,847	Level 1B processing & setup parameters
<i>Products related to Level 2 processing stage</i>			
MIP_NL__2P ^a	MIP_NL__2PNPDK20020724_112132_000058572008_00023_02081_0044.N1	6,381,154	full orbit Level 2 data product
MIP_NLE_2P ^a	MIP_NLE_2PNPDK20020724_112132_000058572008_00023_02081_0044.N1	785,572	Level 2 Meteo product
<i>Auxiliary products</i>			
MIP_CS2_AX	MIP_CS2_AXV___20000101_000000_20000101_000000_20060101_000000	134,806,917	pre-tabulated absorption cross section data
MIP_IG2_AX	MIP_IG2_AXTPDH20020730_170000_20020730_170000_20060730_000000	425,513	Initial guess profile & contaminants profile data
MIP_MW2_AX	MIP_MW2_AXTPDH20020614_150000_20020615_060000_20501231_235959	153,542	retrieval microwindow (MW) data for pT and VMR target species processing
MIP_OM2_AX	MIP_OM2_AXTPDH20020614_150000_20020615_060000_20501231_235959	513,819	MW occupation matrices for pT and VMR retrievals and pT error propagation data
MIP_PI2_AX	MIP_PI2_AXV___20000101_000000_20000101_000000_20060101_000000	166,539	a priori pointing error information
MIP_PS2_AX	MIP_PS2_AXTPDH20020719_120000_20020719_180000_20501231_235959	11,915	Level 2 processing & setup parameters
MIP_SP2_AX	MIP_SP2_AXV___20000101_000000_20000101_000000_20060101_000000	12,992,534	spectroscopic line data

a. It should be noted that the two Level 2 data products contain identical measurement data sets for geophysical parameters p, T and abundance profiles of O₃, H₂O.

Origin of Data

Instrument data

The instrument source packet data have been acquired at the Kiruna payload data handling station (PDHS-K) via X-band on 24 July 2002.

Level 1B auxiliary data and product

The Level 1B related auxiliary data and the Level 1B product file have been generated using the MIPAS Level 1B algorithm prototype code (MIGSP ver. 2.4a) and a suit of supporting tools developed by ABB BOMEM Inc.. The underlying algorithms are described in detail in the *Level 1B Algorithm Technical Baseline Document/ATBD* (PO-TN-BOM-GS-0012), that is contained on the CD-ROM / MIPAS in electronic form.

Level 2 auxiliary data and product

The Level 2 related auxiliary data and the Level 2 product file have been generated using the MIPAS Level 2 algorithm prototype code (ML2PP, ver. 3.1) and a suit of supporting tools developed by Astrium GmbH, in the frame of an ESA contract (no. 11708/95/NL/CN). The underlying retrieval algorithm, the so-called Optimised Retrieval Model, ORM, has been developed and implemented in a scientific prototype code in a parallel activity involving IROE-CNR (I), FMA (I), U. of Bologna (I), ISM-CNR (I), FZ-IMK (D) and LPM (F), under the lead of IROE-CNR (ESA contract 11717/95/NL/CN). A comprehensive description of the ORM algorithm is provided in document *High Level Definition and Physical and Mathematical Optimisations* (TN-IROE-RSA9601), contained on the CD-ROM / MIPAS in electronic form.

The auxiliary files are identical to data used during development and acceptance testing of the operational MIPAS ground processing software (MIPAS IPF), with the exception of the L 2 processing parameter file, MIP_PS2_AX. They were generated on the basis of results produced under 11866/96/NL/GS (MW2 and OM2 data) and 11708/95/NL/CN (other data).

Limitations

The MIPAS sample products have been generated on a SUN Sparc workstation installed at ESTEC using the Level 1B and Level 2 prototype software codes. Both, input/output data formats and algorithm settings have been configured such as to ensure full compatibility with the MIPAS Instrument Processing Facility (IPF) installed in the Envisat Payload Data Segment. The auxiliary data used for the processing are identical to those activate in the IPF at the time of the data acquisition.