

MIPAS/ENVISAT mission

Instrument and operational processing status and evolution

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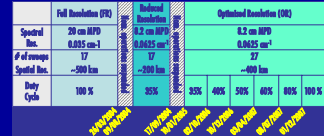
Mission overview

MIPAS, the Michelson Interferometer for Passive Atmospheric Sounding, is a high-resolution mid-IR FTS limb emission sounder on board the ENVISAT polar platform. MIPAS mission can be divided into two main phases

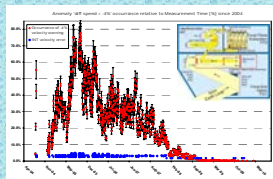
- **Full Resolution (FR)** : from launch (2002) until March 2004, when it was stopped due to the INT anomaly
- **Optimized Resolution (OR)** : started on Jan 2005, the spectral resolution was reduced to 41% of the original one, the spatial resolution was increased owing to the shorter slide movement.

Nowadays the MIPAS instrument is running in an excellent status and we expect to bring MIPAS up to 2014 with the ENVISAT mission extension.

Mission Timeline



Instrument status and expectations for extended mission



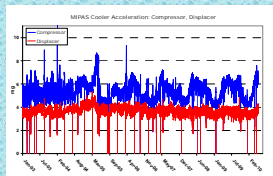
The Interferometer

The status of the MIPAS Interferometer (INT) was one of the main concern during the MIPAS mission. An increased number of INT velocity errors started to appear toward the end of 2003 and caused the mission interruption on 2004.

The anomaly investigation shows that the INT errors are related to Temperature, via the beam-splitter, to friction of the bearings and to the number of initialization. The mission scenario was tuned in order to minimize INT errors.

The usage of regular decontaminations and the avoidance of the automatic re-initialization of the slides allow to reduce progressively the occurrence of the INT velocity errors down to values even lower than beginning of mission.

INT performances are now even better than beginning of life (-4% warnings have disappeared, see Fig. on the left) !

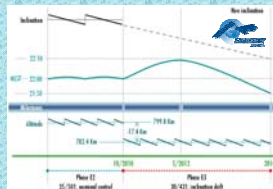


Life-limited items

The status of the life-limited items (a part from the INT) is the following:

- **Cooler** : the long term monitoring of the cooler vibration levels doesn't show any significant degradation a part from a seasonal increase of the acceleration in correspondence to the hottest period of the year, see figure on the left.
- **Laser** : the laser is still at 93% of its original output power and no degradation was observed so far.
- **ASU/ESU** : no indication of degradation was found so far on the ASU/ESU mechanism.

Overall there are no indications of significant degradation of any life-limited items !



Mission extension beyond 2010

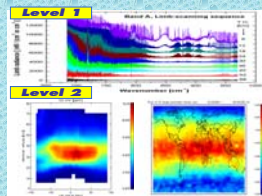
The ENVISAT orbit scenario will be changed in order to extend the mission beyond 2010 following the schema presented in the figure on the left. The orbit change will be performed **from 22 Oct to 2 Nov 2010** (restart of data distribution).

The new orbit scenario will be characterized by an altitude lowered by **17.4 km**, an **inclination drift** (going from 22:00 to 22:10 and then to 21:50) and a new repeating cycle of **30 days/431 orbits** (current is 35/501).

The impact of the orbit change on the MIPAS mission was carefully investigated. The only concern was on a potential illumination on the ASU mirror with a serious damage of the detectors. However the latest simulation results have shown that there will be no direct solar impact on mirror surface.

At the moment there are no showstoppers about the extension of the MIPAS mission beyond 2010.

Operational products availability: present and future



MIPAS products

Two types of ESA operational MIPAS products are delivered to the users:

- **Near Real Time (NRT)** : available at ftp ESRIN and Kiruna archives 3h after sensing time and removed after 10 days
 - **Off-line (OFFL)** : available 7–10 days after sensing time via D-PAC ftp server, permanently stored on the server.
- The ESA operational MIPAS products delivered to the users consist of:
- **Level 1** : geo-located, spectrally and radiometrically calibrated atmospheric spectra in the mid-IR from 4.1 – 14.6 μm
 - **Level 2** : vertical profiles of the geo-physical parameters retrieved from the atmospheric spectra: temperature, pressure and Volume Mixing Ratio (VMR) of six trace gases : H₂O, O₃, HNO₃, CH₄, N₂O and NO₂.

Processing status

10 Jun 2010 : restart of Level 2 NRT
21 Jun 2010 : restart of Level 2 OFFL

IPF	NRT	OFFL
Level 1	5.05	5.05
Level 2	5.05	5.05

Processors upgrades

The MIPAS Level 2 processing was stopped in the ESA Ground Segment since the start of the OR mission, while the processor was undergoing a delicate and complex development process in order to handle the new mission scenario.

The MIPAS Level 2 processing was restarted on June 2010 after a long interruption with the activation in NRT and OFFL processing centers of the latest processor version : IPF 5.05.

The processor v5.05 provides significant upgrades in both the format and content of the Level 1 and Level 2 products:

- **Level 1** : the 5.05 version is fully in-line with the previous processor version (5.02). In addition IPF 5.05 is compliant with the orbit lowering scenario of the extended ENVISAT mission.
- **Level 2** : the 5.05 version is able to handle the OR mission scenario via the implementation of a Tikhonov-like a posteriori regularization scheme (H₂O profiles are at the moment not regularized), in addition the processing of MIPAS special modes was implemented, and the Averaging Kernel Matrix is now provided within each Level 2 products.

Reprocessing status

Jun 2010 : Full mission re-processing to L1 completed with IPF 5.02
Sep 2010 : Planned mission re-processing to L2 with IPF 5.05

IPF	FR mission	OR mission
Level 1	5.02 / 5.05	5.05
Level 2	4.61 / 4.62	Sep 2010

Re-processing campaigns

Re-processing is performed when a processor upgrade brings a significant improvement in the data quality. The following MIPAS re-processing campaigns were performed so far or are envisaged for the near future:

- **FR mission** : the first FR mission re-processing was terminated with the IPF 4 baseline. The generated products were extensively analyzed by the scientists for validation purposes.
 - **Full mission (Level1)** : the full MIPAS mission was re-processed to Level 1 during the first quarter of 2010 with the IPF 5.02/05. The re-processed data have improved quality, in particular with respect to the engineering pointing information.
 - **Planned full mission (Level2)** : a significant data gap is currently present in the MIPAS archives, since no Level 2 products are available for the OR mission up to the recent switch of IPF 5.05. As soon as the scientific quality of the IPF 5.05 processor will be validated, the full mission reprocessing to Level 2 will start with this IPF.
- Full mission reprocessing to Level 2 with IPF 5.05 will start around Sep 2010, priority will be given to the OR mission.**

Validation status

May 2010 : New Level 2 validation campaign of O₃ mission presented with 20% of O₃ mission (aligned with IPF 5.05 baseline)

Level 2	IPF	Status
FR mission	4.61 / 4.62	Done
OR mission	ORRM (aligned with IPF 5.05)	Validation Go-gating

Validation Results

The validation of the operational processor against correlative measurements is an essential step in order to certify the scientific validity of the geophysical parameters before delivery to the user community.

MIPAS Level 2 geo-physical products have undergone the following validation exercises:

- **FR mission** : the re-processed products generated with IPF 4.61/62 were extensively analyzed by several validation teams and the geophysical parameters were compared against correlative data taken from ground based, airborne or satellite based instruments. A full picture of the results has been collected in the **ACP MIPAS Special Issue**.
- **OR mission** : the long unavailability of ESA operational MIPAS Level 2 products caused of a significant delay in the validation of the geo-physical parameters of the OR mission. The latest Level 2 dataset for the OR mission was processed using the **scientific baseline algorithm (OIRM)**. This dataset was recently delivered to the validation teams.

Some preliminary results on the L2 ORRM based on network of ground based sondes, FTIR and Lidar (EQUAL and VALID teams) raised some questions on the validity of O₃ and Temp profiles below 20km. Investigation are on-going.

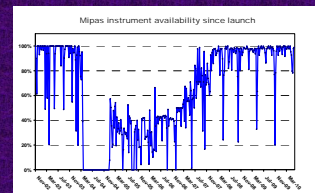
Long term performances monitoring

The long term monitoring of the MIPAS instrument performances allows to prevent instrument damaging and to avoid degradation of the products quality.

Instrument availability

The MIPAS mission is an example on how the corrective actions undertaken after the occurrence of an important anomaly (INT velocity errors) were successful in bringing the instrument back to its original performances status.

The recovery of the MIPAS instrument can be clearly seen in the plot below, where the availability of the instrument is reported, showing the mission interruption in 2004 and the progressively improvement of the INT performances that allows to bring the duty cycle back to 100%.



Ice contamination monitoring

The MIPAS focal plane (cooled to 70K) is affected by ice contamination.

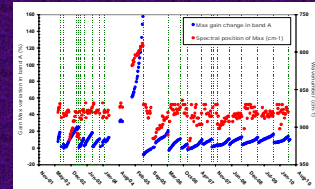
The ice is formed after outgassing of some materials which are part of the instrument itself or of external modules (platform, other instruments).

The ice accumulates on optics with loss of signal at the detectors. The loss of signal is compensated via the increase of gain.

Warm up of focal plane with switch-off of the cooler (decontamination) allows to release ice with subsequent decrease of the gain.

Ice contamination impacts the quality of Level 2 products via the increase of NESR that translates directly in increased ESD of the retrieval products.

The evolution of gain factor at its maximum is reported in the figure below for band A, which is the most affected by ice.



The lessons learned from this investigation are the following:

- Periodic decontaminations (at least twice per year) are essential in order to optimize IR instrument in-flight operations.
- The most critical part of the mission was the first year, when very strong contamination was seen in all ENVISAT IR sensors (e.g.: AATSR, SCIAMACHY), due to contaminants carried on board the spacecraft.
- In the last three years of MIPAS operations we can observe an instrument more and more free of contaminants and operations are more stable.
- We could determine the detector sensitivity degradation via the fit of the gain factor just after a decontamination, for channel A it is 0.02%/month.

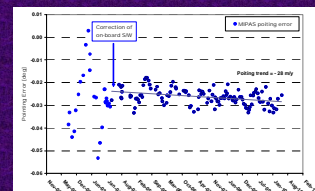
Pointing error monitoring

The pointing error is a crucial parameter for a limb sounding experiment.

The MIPAS mispointing is derived from the special LOS measurements, when the instrument is used as a radiometer (fixed slides) pointing at stars. The pointing error is estimated from the observed time delay (expected-observed) of a given star when passing the FOV.

The evolution of the mispointing along the mission can be seen in the plot below. After the correction of the on-board S/W the mispointing is stable around a value of -25mdeg. The spreading of the points is due to increased noise in the channel D2 used for LOS measurement.

We estimated a pointing trend of -28m/y, instrument looking higher and higher.



Useful Information

Daily and monthly monitoring of the instrument performances are generated and published on-line on the **pag web page**, refer to the link below:

<http://earth.esa.esa.int/ftp/earth/mipass/reports/>

For any queries regarding MIPAS data send a mail to the **ESA EOWhelp**:

eowhelp@esa.esa.int