

# The extension of the ENVISAT Atmospheric-Chemistry missions beyond 2010: status and perspectives

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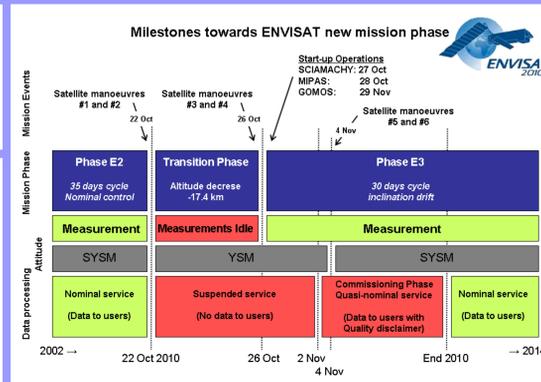
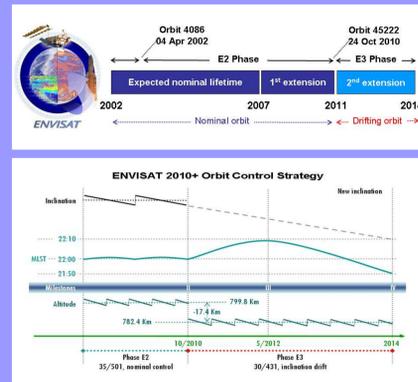
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## ENVISAT extension beyond 2010

On October 2010, on the basis of the high demand for long term series of geophysical parameters combined with the overall excellent status of the satellite, ENVISAT operational lifetime was further extended. ENVISAT was moved to a new orbit and a new mission phase (E3) was initiated, allowing to operate all payloads up to mid 2014, far beyond the nominal lifetime originally set to five years (from 2002 until 2007).

- Key strategy to minimize fuel consumption was interrupting the orbital inclination control manoeuvres inducing a drifting Mean Local Solar Time (MLST) varying in the +/- 10 min range from the initial +/- 5 min range.
- The extension orbit is characterized by an altitude decrease of 17.4 km and by a different repeating cycle (from 35/501 to 30/431 days/orbits).
- ENVISAT new orbit represents the start of a "new" extension phase for all payloads owing to the number of changes involved.
- A re-characterization of each subsystem (Mini-Commissioning Phase) was carried out to assess instrument performances and data quality.
- The three ENVISAT Atmospheric-Chemistry sensors restarted gradually operations and are fully operational in the new mission phase.



## Mission status

- ENVISAT orbit change project has been successful.
- The intensive checks run by many different teams have demonstrated nominal behavior of all instruments.
- The orbit change has not revealed any significant impact on operations and data processing. Performances are of the same level as before the orbit lowering.
- No showstoppers found to the continuation of mission lifetime until the expected ENVISAT end-of-life.
- MIPAS, GOMOS and SCIA will continue providing the scientific community with invaluable data for the next 3 years.
- Limb data from 27 Oct to 02 Nov should be considered with caution due to degraded pointing accuracy.

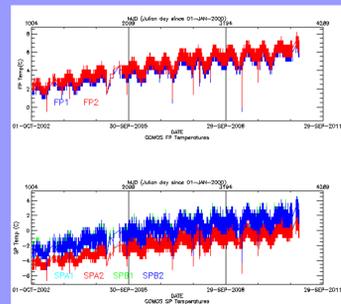
	GOMOS	MIPAS	SCIAMACHY
Operation resumption	29 Nov 2010 08:27:36 UTC	28 Oct 2010 09:46:48 UTC	27 Oct 2010 01:43:53 UTC
Data gap (orbits)	45189 - 45740	45189 - 45280	45189 - 45261
Processor upgrade	usage of CF 5.8.1 to correctly propagate the orbit vector for the new scenario.		
Measurement baseline		Nominal	
Calibration concept		Unchanged	
Data processing		Nominal	
Life Limited Items		No criticalities identified	

## GOMOS

Anomaly	Period	Corrective action	Impact on the data	
Instrument planning	Transient: Planning Tool unavailability	21/10/2010 – 29/11/2010	Bug fixing	Missing measurements between orbit 45189 and 45740

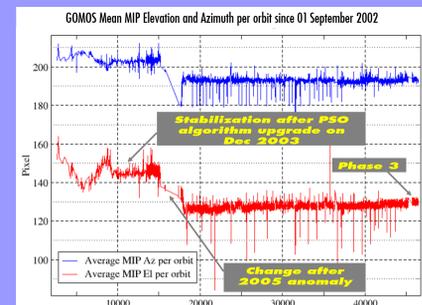
### Thermal performance

CCD temperatures show no changed trend after the orbit lowering. The global increase is due to the expected radiator ageing.



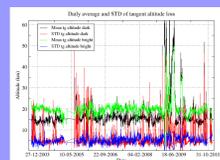
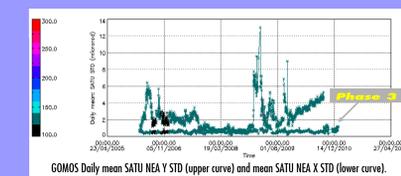
### Acquisition and detection performance

The Most Illuminated Pixel (star position on the SATU CCD in detection mode) shows no new trend during the first stages of new mission scenario.



### Tracking performance

The Star Acquisition and Tracking Unit noise equivalent angle (SATU NEA) is the statistical angular variation of the SATU data above the atmosphere at the beginning of the star tracking. The mean of the standard deviation above 105 km are computed for every occultation; the daily mean value is monitored in order to assess instrument performance in terms of star pointing. No new trend has been detected during the first stages of the new mission phase (E3).

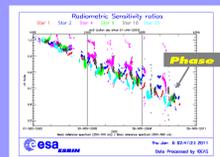


The monitoring of the tangent altitude at which the star is lost (Last Tangent Altitude) is an indicator of the pointing performance: no new trends of these parameters have been detected.

### Radiometric performance

The radiometric sensitivity of each of the four CCDs (UV, Visible, IR1 and IR2) and for the two photometers has been monitored by computing the ratio between parts of the reference spectrum using specific stars. For SPA1 detector (UV), the ratio has decreased around 40% over the mission.

This variation is due to the expected ageing of the contamination on the telescope optics which affects mainly the UV wavelengths. After the orbit lowering no changes in the trend are visible.

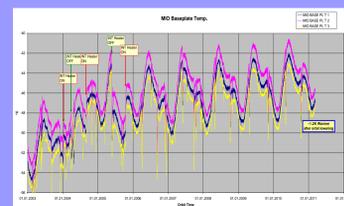


## MIPAS

Anomaly	Degraded mission period	Corrective action	Impact on the data	
Instrument planning	Transient: re-init every 3 orbits	28/10/2010 – 02/11/2010	Upload of corrected CTI	Re-initialization was planned every three orbits. No impact on data quality, but small data gap around -40 deg lat.
	Transient: unwanted altitude scan pattern	28/10/2010 – 30/11/2010	S/W patch for RGT tool	Scan pattern tangent altitudes slightly deviates from baseline. No impact on data quality.
Cooler performances	Transient: displacer spikes	28/10/2010	None	The cooler spikes could not be correlated to any other parameters, they are considered as SEU.
Pointing performances	Transient: ENVISAT YSM	28/10/2010 – 02/11/2010	Switch to ENVISAT SYSM	Degraded pointing accuracy when ENVISAT was working on Yaw Steering Mode (YSM).

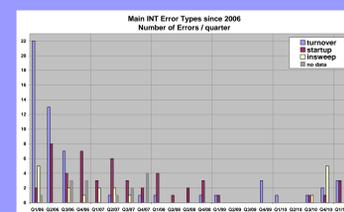
### Thermal performances

The MIO temperatures along the mission are presented in the plot below. After the orbit lowering we observed a slight increase of the overall instrument temperature (1.2K) that was also seen in other ENVISAT sensors.

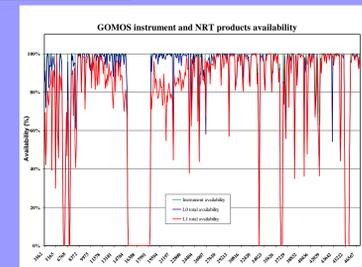


### Interferometer performances

The increase of IDU errors detected with the restart of the mission in the Phase 3 (see plot below), was explained with a temporary degradation of the motor currents performances. The situation is far to be critical and it will be monitored closely in the next months. It may be that the increased temperature have influenced somehow the INT, but this has to be demonstrated.

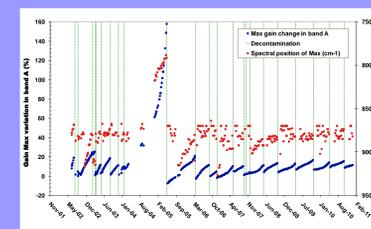


## GOMOS



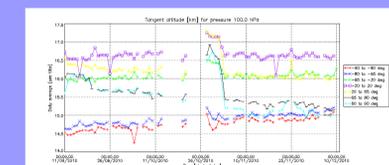
### Radiometric performances

The detector radiometric performances are still very good. The plot below shows the detector ice contamination in channel A along the mission. After the critical period at the start of the mission and during 2005 the ice contamination is very stable and it was not impacted by the orbit extension.



### Pointing performances

The monitoring of the tangent altitude at a given pressure level (see plot below) can highlight problems with pointing accuracy. The plot shows clearly that the ENVISAT accuracy was strongly impacted by the usage of the YSM from 28 Oct to 2 Nov 2010. The accuracy of the MIPAS pointing is back to nominal level since we switch to the nominal ENVISAT SYSM.

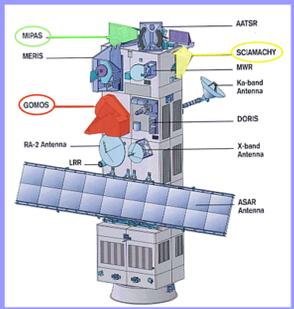


## Atmospheric-Chemistry instruments

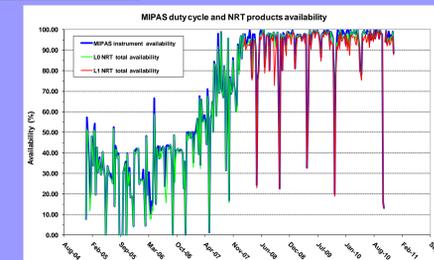
**GOMOS** Global Ozone Monitoring by Occultation of Stars, is a spectrometer that works in the UV, visible and near infrared wavelength ranges from the upper troposphere to the mesosphere. GOMOS uses the stellar occultation technique which consists of measuring a reference star spectrum above the atmosphere and subsequently the spectra of the same star as it sets through the atmosphere.

**MIPAS** Michelson Interferometer for Passive Atmospheric Sounding, is a Fourier transform spectrometer that measures the atmospheric limb emission in the mid-IR (4.15 - 14.5 µm). It can perform elevation scan sequences through different sections of the atmosphere, from the upper troposphere to the mesosphere. MIPAS can scan in the anti-flight direction and in the perpendicular direction.

**SCIAMACHY** Scanning Imaging Absorption spectroMeter for Atmospheric Cartography, is a passive remote sensing spectrometer observing backscattered, reflected, transmitted or emitted radiation from the atmosphere and Earth's surface, in the wavelength range between 240 and 2380 nm. The three different viewing geometries (nadir, limb, and sun/moon occultations) yields to have total column values as well as distribution profiles in the stratosphere and, in some cases, the troposphere and mesosphere for trace gases and aerosols.



## MIPAS

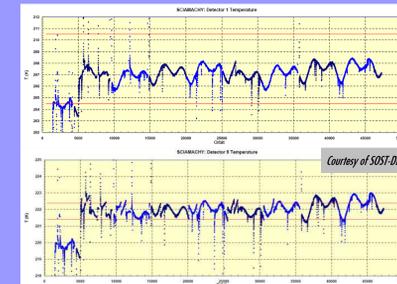


## SCIAMACHY

Anomaly	Degraded mission period	Corrective action	Impact on the data	
Instrument planning	Transient: discrepancy between specified and executed limb tangent heights	27/10/2010 – 10/01/2011	Upload of modified ESM Basic Scan Profile parameters (OCR 50)	Between orbits 45262 and 46340, start/stop tangent heights for limb-type measurements resulted different by several kilometres from the specified values with top most height (90 km) missing in the Level 2 products.
Thermal performances	Transient: SCIAMACHY detector temperatures resulted higher by about 0.3-0.5K.	27/10/2010 – 31/12/2010	None	Temperatures for channels 1-3 and 6-8 remained within nominal operational ranges, while temperatures of detectors 4 and 5 were above the upper limit, even more than usually tolerated.
Pointing performances	Transient: ENVISAT YSM	28/10/2010 – 02/11/2010	Switch to ENVISAT SYSM	Degraded pointing accuracy when ENVISAT was working on Yaw Steering Mode (YSM). Throughput monitoring data during this period are more variable and may also contain slight offsets.

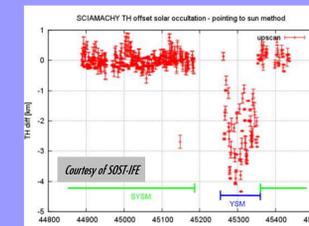
### Thermal performances

Increased detector temperatures persisted during Oct/Nov 2010; temperatures started to stabilize returning to the specified ranges by the end of the year.



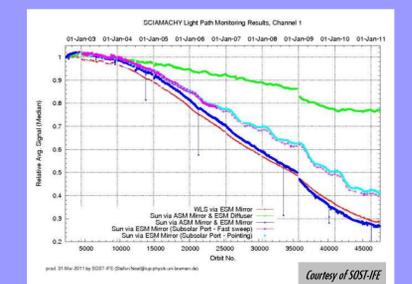
### Pointing performances

Degraded pointing accuracy during YSM. Back to previous with SYSM.



### Spectral Light Path monitoring

Long-term analysis of measurements of SCIAMACHY light paths for different viewing geometries did not highlight major impact on throughput following the orbit change.



### Bad and dead Pixel Mask

The orbit manoeuvre was suspected to cause potential contamination of the optical surfaces (mirrors, detector array) for the exhaust emissions of the thrusters, located in close vicinity of SCIAMACHY. SWIR detector degradation monitored at SRON by the total number of dead pixels hasn't significantly increased indicating no signs of induced contamination.

Instrument status