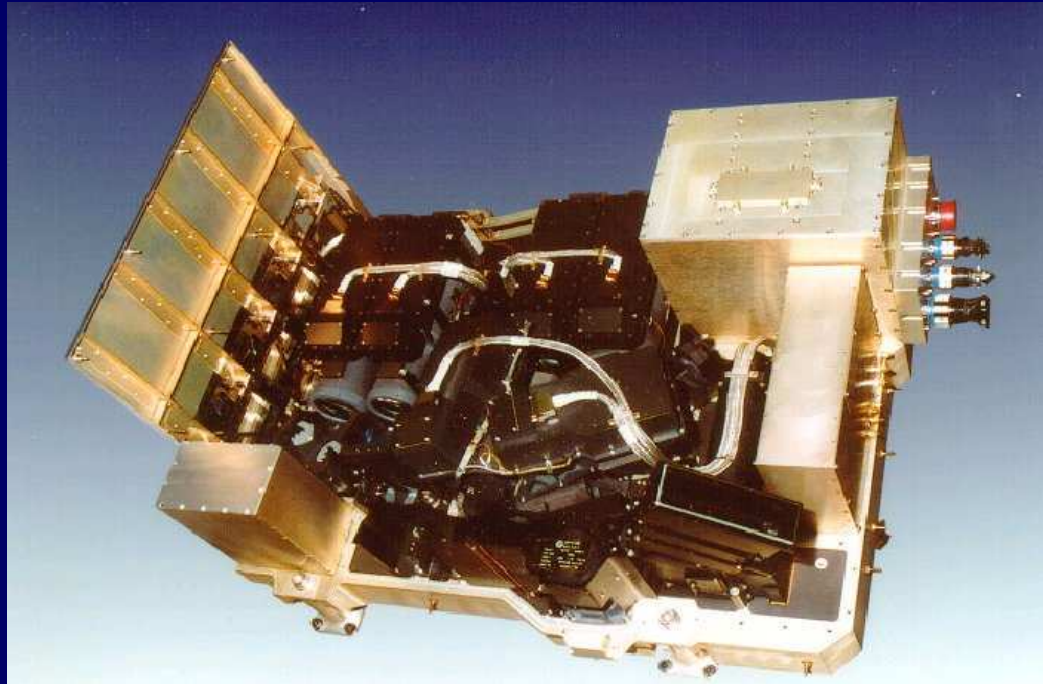


GOME-2 on MetOp



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(1) EUMETSAT (2) ESTEC

ESA Atmospheric Science Conference, ESA-ESRIN, Frascati, 8–12 May 2006

Overview

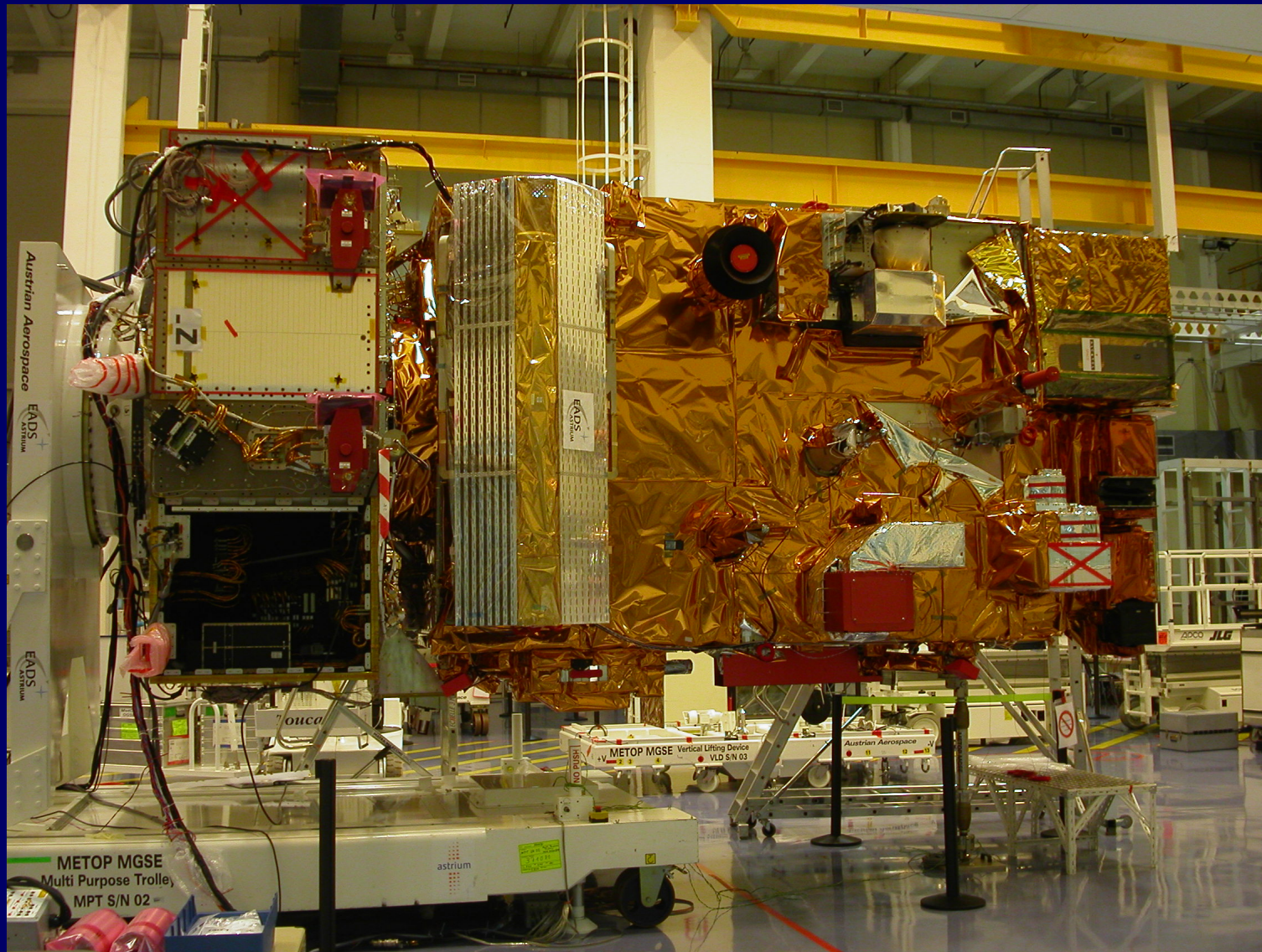
- Mission context
- Instrument
- Calibration
- Commissioning
- Data processing, products, dissemination

👉 Important changes GOME-2 wrt GOME-1 highlighted in yellow.

EPS/MetOp mission

- Series of three polar-orbiting satellites for operational meteorology and climate monitoring
- European element of EUM/NOAA Initial Joint Polar System
US: NOAA N/N'
- Orbit: sun-synchronous, 09:30h (descending node),
repeat cycle 412 orbits / 29 days
- ESA: Development of MetOp-1
EUMETSAT: Metop-2/3, launch, ground segment, operations
- Main instruments: IASI, ASCAT, GOME-2, GRAS,
AVHRR, ATOVS = HIRS + AMSU-A + MHS

MetOp during final assembly



EPS/MetOp calendar

1992	POEM mission separated into Envisat and MetOp
1998	MetOp phase C/D kickoff
March 2006	Last MetOp-A system test
	Baikonur Cosmodrome Readiness Review
	Launch & Operations Readiness Review
April 2006	MetOp-A shipment to Baikonur

17 July 2006 MetOp-A launch!

December 2010 MetOp-B launch

June 2015 MetOp-C launch

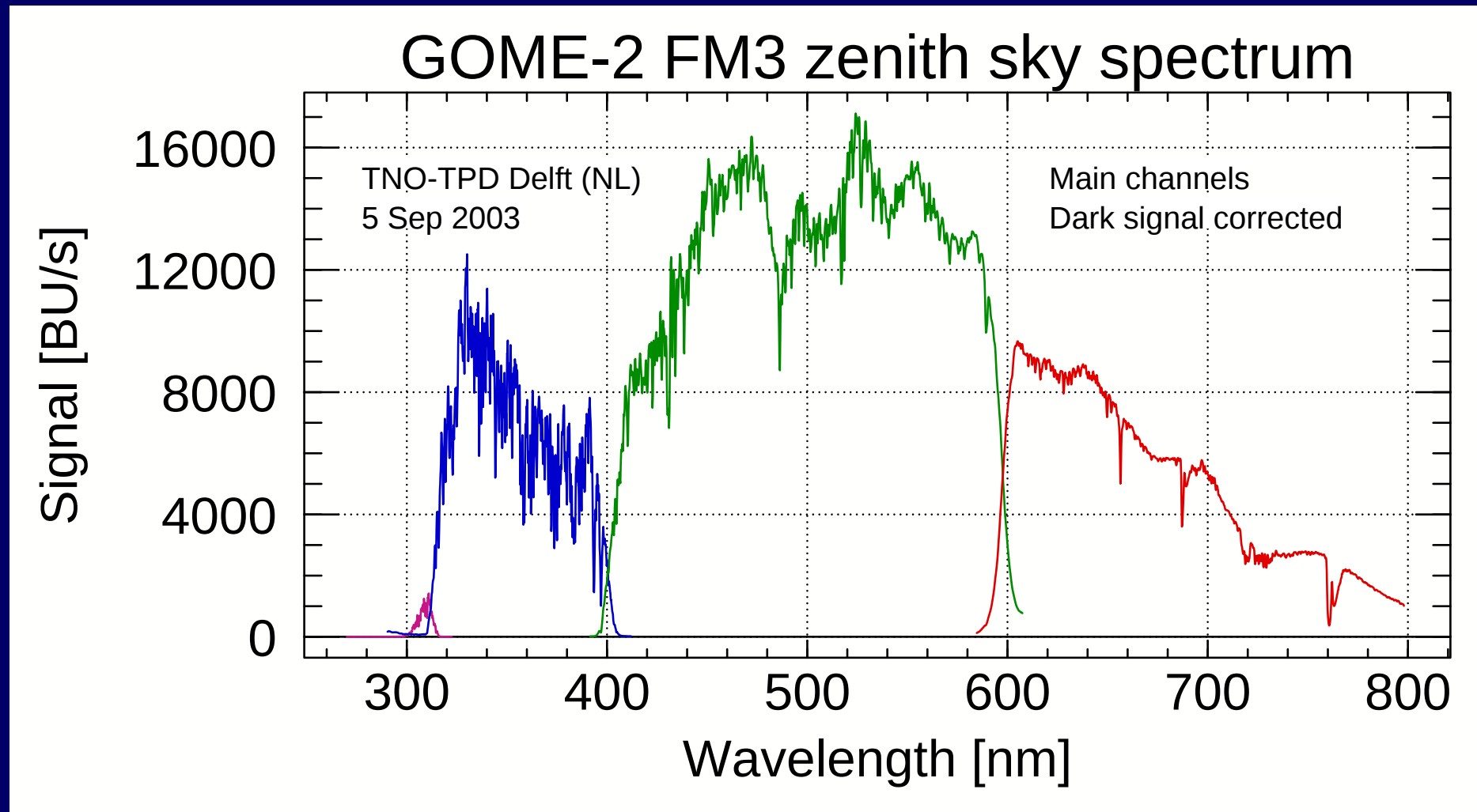
Soyuz - the MetOp launcher is ready



GOME-2 instrument overview

Principle	nadir-scanning UV/VIS grating spectrometer
Wavelength range	240–790 nm in 4 main channels 300–800 nm in 2 polarisation channels (s/p)
Detectors	1024-element Reticon linear diode arrays
Readout time	46.875 ms (complete array) (/2)
Spectral sampling	0.12–0.21 nm (main channels)
Spectral resolution	FWHM 0.26–0.51 nm (main channels)
Swath width	Default 1920 km (*2)
Swath type	Earth-curvature compensating
Min effective IT	187.5 ms (/8)
Spatial resolution	Default 80 x 40 km ² (/4)
Internal calibration	LED, Spectral lamp (PtCrNeAr), White lamp
Sun diffuser	Quartz quasi-volume (DOAS!)
Data rate	400 kbit/s or 300 MB/orbit (*10)

GOME-2 zenith sky spectrum



GOME-2 instrument: other improvements

- Polarisation measured in 15 programmable spectral bands per channel, default IT 23.4 ms (16 per main channel readout)
- Reduced polarisation sensitivity η
- Reduced straylight levels
- Dichroic filter in channels 3/4: η spectral structures reduced, coating hardened for improved stability
- Analog to Digital conversion close to detectors: cross-talk gone
- Reduced sensitivity to Single Event Upsets (automatic memory refresh)

GOME-2 on-ground calibration

- Mostly flight-representative conditions:
thermal vacuum, optical bench temperatures -5, +5, +15°C.
Exception: angular dependencies in ambient
- Key parameters:
 - Absolute (ir)radiance response
 - Polarisation sensitivity
 - Straylight characteristics
 - Ozone/NO₂ absorption cross sections (U Bremen CATGAS)
 - Instrument slit function (evaluated by RAL)

GOME-2 in-orbit verification

In-orbit verification (ESA) – first 8 weeks after launch

- Verify compliance to requirements (functional/performance)
- Compare pre-flight/in-flight performance
- IOV specific operations

GOME-2 in-flight calibration

- Daily calibration
 - sun calibration
 - spectral calibration
 - dark signal characterisation
 - white light source characterisation
- Monthly calibration
 - spectral calibration
 - diffuser monitoring
 - engineering parameters
- Moon calibration

GOME-2 routine operations

- On-board timelines controlling sequence of instrument modes
- One timeline per orbit
- < 10 different timelines needed for routine operations
- Similar to GOME-1 operations, including polar and narrow swaths, and lunar “calibrations”
- Timelines synchronised with orbit repeat cycle

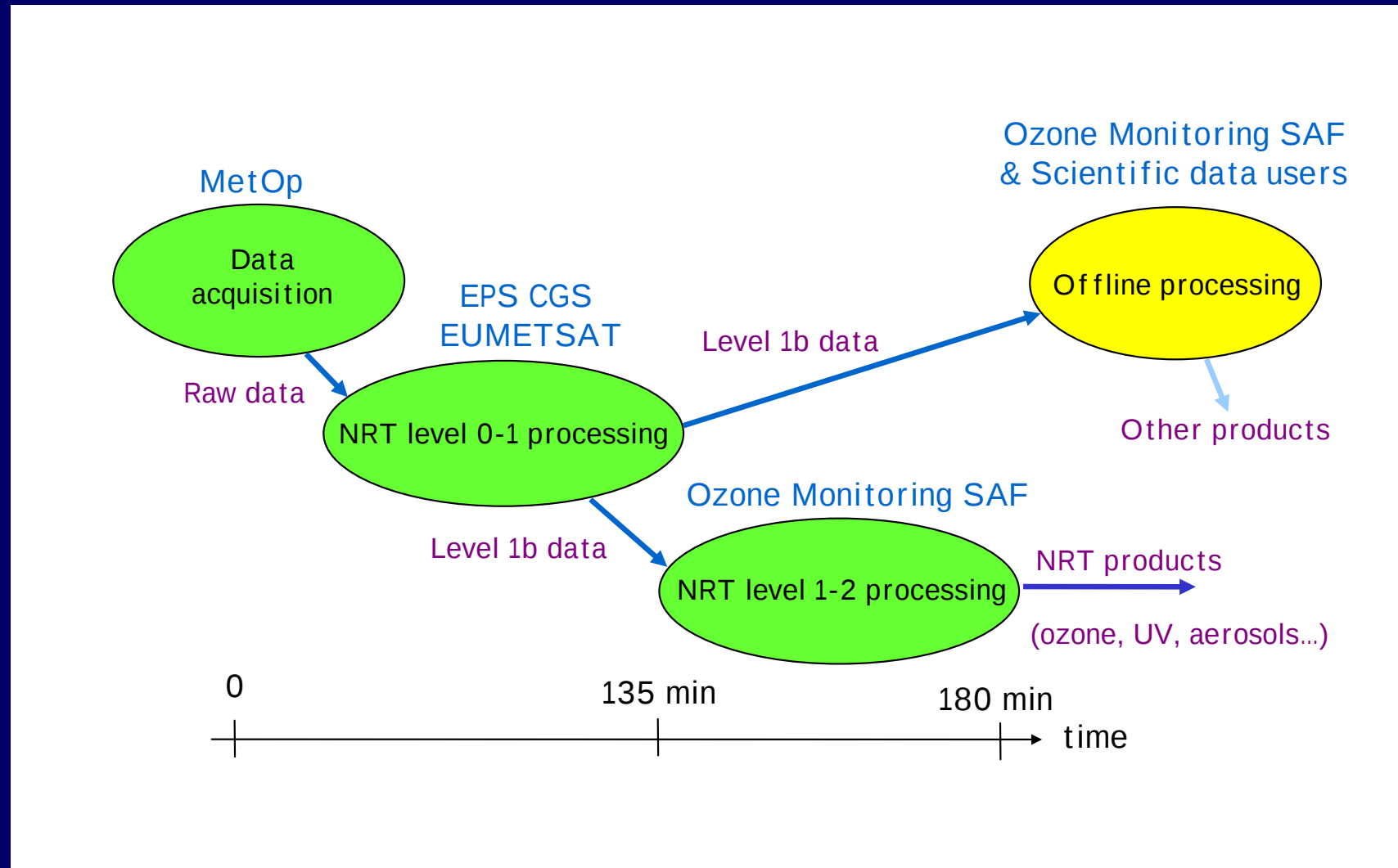
GOME-2 timelines pattern

GOME-2 timeline planning per 412/29 repeat cycle. Version 1.0, 1 March 2005

day	orbit offset	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	D	P/X	S	P/X	S	P/X	M	P/X	X	P/X	X	P/X	X	P/X	X
2	15	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
3	29	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
4	43	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
5	57	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N
6	72	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
7	86	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
8	100	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
9	114	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
10	128	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X
11	143	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
12	157	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
13	171	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
14	185	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
15	199	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N
16	214	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
17	228	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
18	242	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
19	256	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
20	270	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X
21	285	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
22	299	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
23	313	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
24	327	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
25	341	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N
26	356	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
27	370	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
28	384	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	
29	398	D	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	X	P/X	

D Daily calibration (incl. Sun mode)
M Monthly calibration (incl. LED, WLS, SLS, SLS over diffuser modes)
N Narrow swath (320 km)
P Polar (north/south, overrides nominal swath if used)
S Nadir static
X Nominal swath (1920 km)

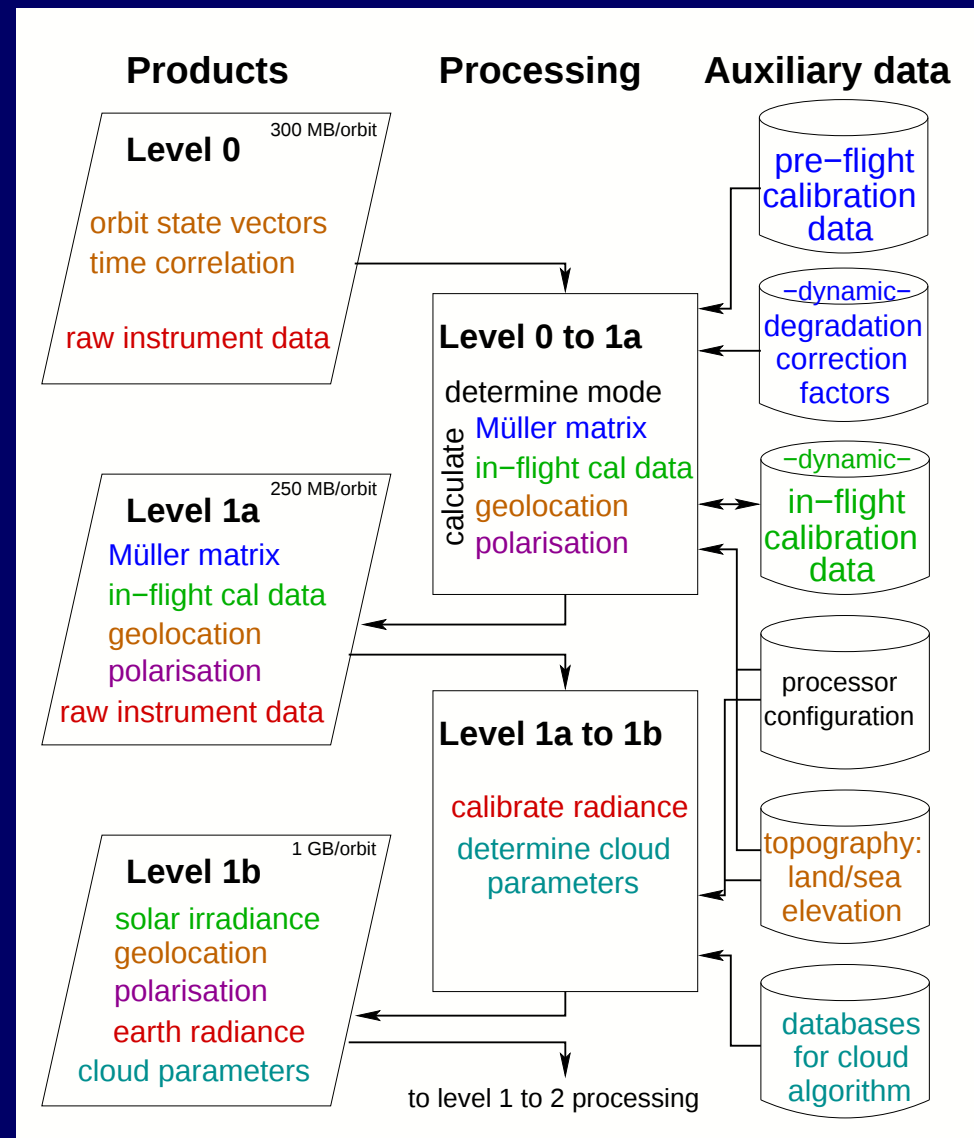
GOME-2 data processing



GOME-2 operational processing overview

Data reception	EPS ground station in Longyearbyen, Svalbard
Level 0 to 1	Near-real time (NRT) processing, dissemination, archiving at EPS Core Ground Segment at EUM
Level 1 to 2	NRT and offline processing at Ozone SAF institutes. Dissemination and archiving at EUM
Timeliness	2h 15min from sensing for level 1 products 3h from sensing for level 2 products
Data formats	Generic EPS binary format for level 1 products (converter to HDF5 available) HDF5 for level 2 products

GOME-2 level 0/1 processing & products



GOME-2 level 2 SAF operational products

- Ozone profiles (KNMI) (NRT & offline)
- Ozone and trace gas total columns (DLR) (NRT & offline)
Continuity with GOME-1 time series
- Aerosol optical depth and Absorbing aerosol index (KNMI) (NRT)
- Clear-sky UV (DMI) (NRT)
- UV with clouds (FMI) (offline)

GOME-2 calibration & validation

- Ensure products satisfy EPS end user requirements and continuously improve their quality
- Instrument & data product long-term monitoring
- Level 1 verification, confidence checking & validation
- Feedback from level 2 required for full level 1 validation
- O3MSAF responsible for validation of operational level 2 products
- Nominal operations

GOME-2 calibration & validation milestones

- Launch 17th July 2006
- Release from GOME-2 IOV mid-September 2006
- Verified level 1b product mid-November 2006
- Commissioning hand-over review mid-January 2007
- Validation continues for the lifetime

GOME-2 instrument monitoring

- House-keeping data
 - usage statistics, thermal performance, electrical performance, scanner performance
- Internal calibration sources
 - internal light sources, diffuser reflectivity
- In-flight calibration parameters
 - dark signals, PPG, spectral stability, etalon, throughput (solar)
- Radiance & polarisation
 - throughput (earthshine)
stokes fractions (solar, special earth viewing)
earthshine scanning, FPA and PMD consistency

GOME-2 product quality monitoring

- Basic quality information
- Quality flags related to geolocation
 - SAA, sun-glint, rainbow
- Counts of non-nominal temperatures
 - detector, pre-disperser, radiator
- In-flight calibration data quality
 - missing data, threshold checks, back-up algorithms
fitting checks, missing/bad Stokes fractions
- Quick-look parameters
 - PMD false colour images, ozone line ratios etc

GOME-2 level 1 verification, confidence checking & validation

- Geolocation
 - simple checks, PMD false colour images
- Wavelength calibration
 - alternative algorithm using Fraunhofer lines
- Stokes fractions
 - vector RTM
- Cloud parameters
 - ISCCP and AVHRR data
- Sun Mean Reference Spectrum
 - other reference spectra, other satellite measurements
- Earthshine spectra & albedo
 - confidence checking, other satellite measurements, RTM simulations

GOME-2 data availability

EPS global near-real time (NRT) products (level 1b, level 2)
distributed via EUMETCAST (telecom satellite link)

Required: PC + Digital Video Broadcast (DVB) card connected to a satellite antenna + client software obtainable from EUMETSAT user services.

Archived products from the EUMETSAT Unified Meteorological Archive and Retrieval Facility (UMARF) available on request (various delivery media).

NRT and archived data free of charge for PIs of EPS/MetOp Research Announcement of Opportunity.

Check EUMETSAT web page for **useful tools and libraries**.

Further reading

EUMETSAT homepage: www.eumetsat.int

What we do – Satellites – EUMETSAT Polar System – EPS Prelaunch User Information – EPS Technical Documentation/EPS Product Guides

- GOME-2 Products Guide (high-level introduction)
- GOME-2 Level 1 Product Generation Specification
- GOME-2 Level 1 Product Format Specification

Ozone/Atmospheric Chemistry SAF documentation