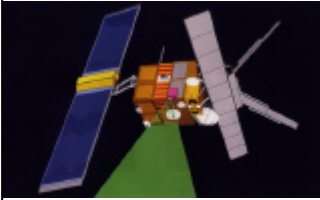
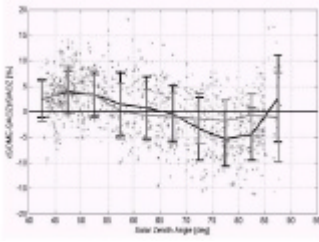





ERS-2/Envisat Atmospheric Data Quality

C. Zehner - ESA

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Presentation Overview

ERS-2/GOME Total Ozone Quality

ESA Approach on Validation/Calibration (Envisat)

Envisat Atmospheric Payload: Actual Validation/Calibration Status

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**ENVISAT:
 Europe's expanding capacity**

1991

ERS 1

→

1995

ERS 2

→


March 2002

ENVISAT

Oceans
 Sea Ice
 Cryosphere
 Land Surface
 Climatology

→

+ Global Ozone
 + enhanced ATSR





+ Ocean Colour

+ Atmospheric Constituents

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ERS-2: Global Ozone Monitoring Experiment (GOME):

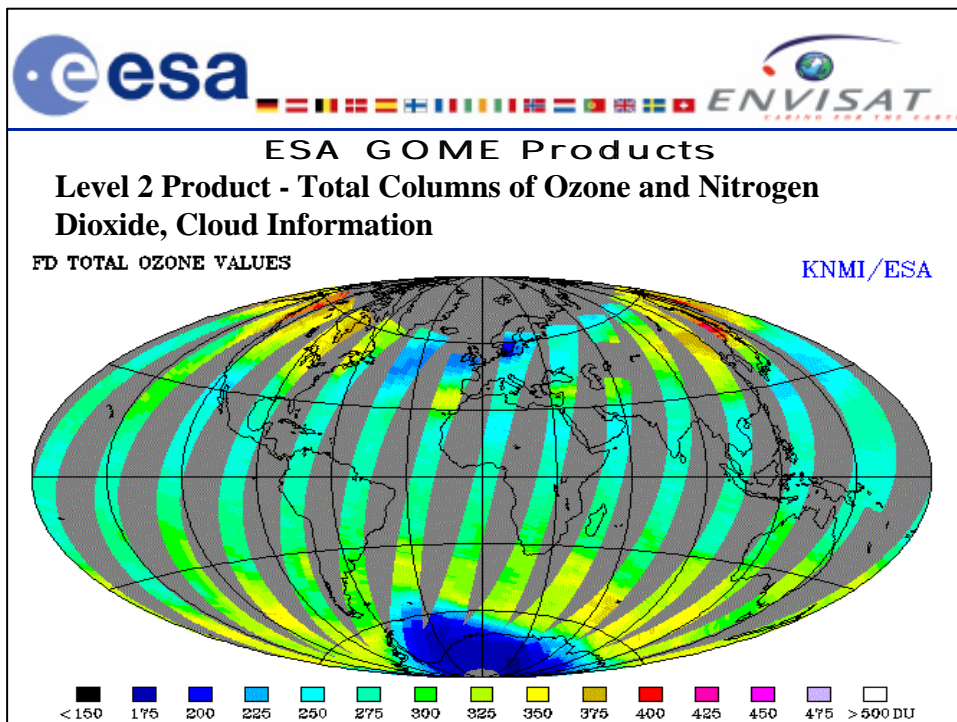
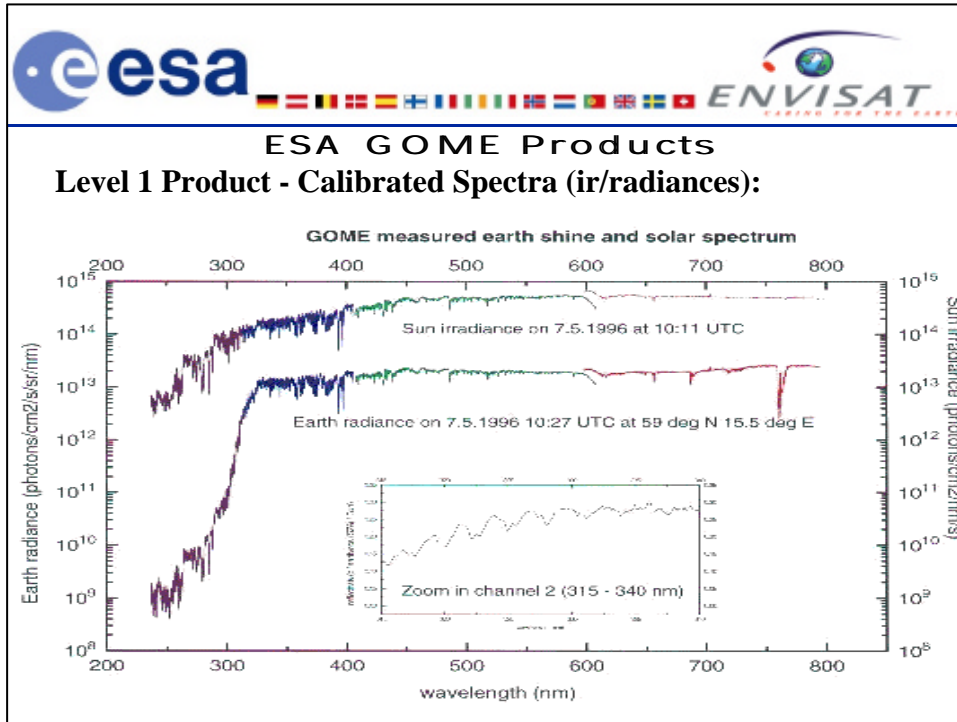
Operational on ERS-2 since April 95 (predecessor of **GOME** follow on Instruments on the operational **METOP** Series, GOME is a small version of **SCIAMACHY** on **ENVISAT**, **OMI** instrument on **EOS-AURA**) – problems on ERS-2 since June 22 2003 – covering 8 years of measurements (predicted lifetime of 3 years)



GOME is a spectrometer which collects light arriving from the sun illuminated earth's atmosphere/surface in nadir view.

- (Multi)Spectral coverage: 240 - 790 nm - 4 channels - 6 spectral bands
- Spectral resolution: 0.2 - 0.4 nm

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Release of GOME Products to Users during July 1996 (1 year after launch) – version 2.0: Total Ozone differed compared to ground based measurements (various Brewer, and Dobson stations and several DOAS sites) by 5% below 60 deg. SZA and by 10% below 90 deg. SZA

First Product Upgrade - mid 1998 – version 2.4: Total ozone accuracy within $\pm 2\%$ -5% at SZA lesser than 70 degrees, and 10% or better at larger SZA, except under special conditions, such as in wintertime polar regions where low ozone values could be overestimated by more than 15%

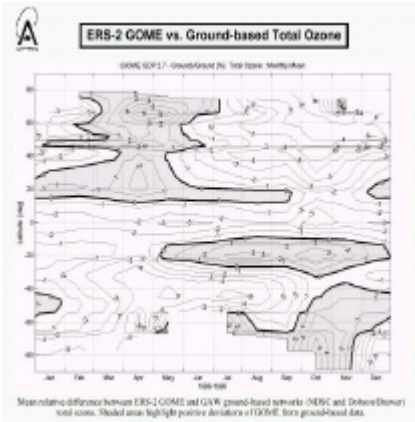
Second Product Upgrade - mid 1999- version 2.7: no significant improvement in total ozone (improvement of NO₂ instead) – possibility to reprocess all data with the same software version

Third Product Upgrade – mid 2002 – version 3.0: significant improvement in total ozone – reduced (50%) seasonal dependence - $\pm 2\%$ -3% agreement with ground-based measurements – ‘**Delta Validation (small team)**’

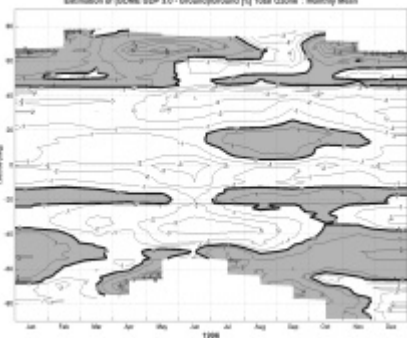
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Improvement of Seasonal Variation

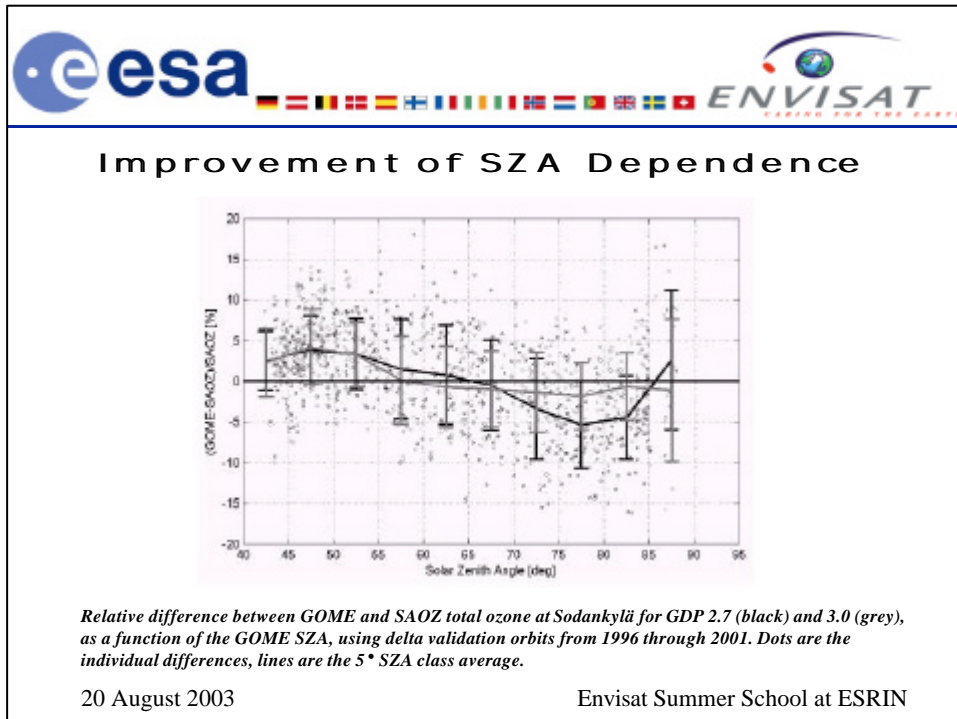
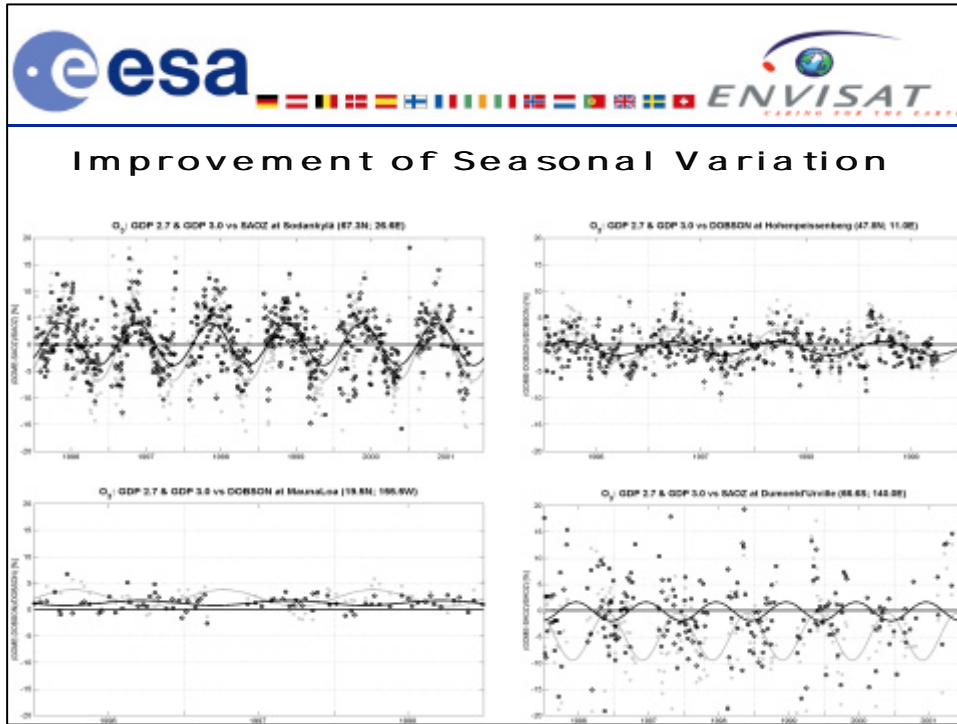




Mean relative difference between ERS-2 GOME and GIVW ground-based networks (NDSC and Dobson/Dobson) total ozone. Shaded areas highlight positive differences of GOME from ground-based data.



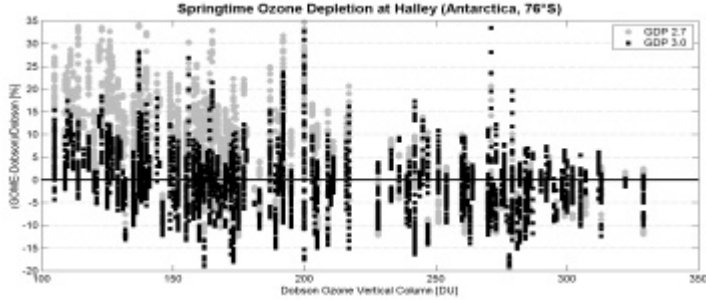
1998

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Improvement of Column Dependence



Column dependence of the GOME/Dobson total ozone difference at Halley (76°S) during the Antarctic ozone hole. The improvement with GDP 3.0 (black squares) appears clearly, compared to results with GDP 2.7 (grey circles). Data cover years from 1996 to 2001, from the 21st of August till the 21st of October.

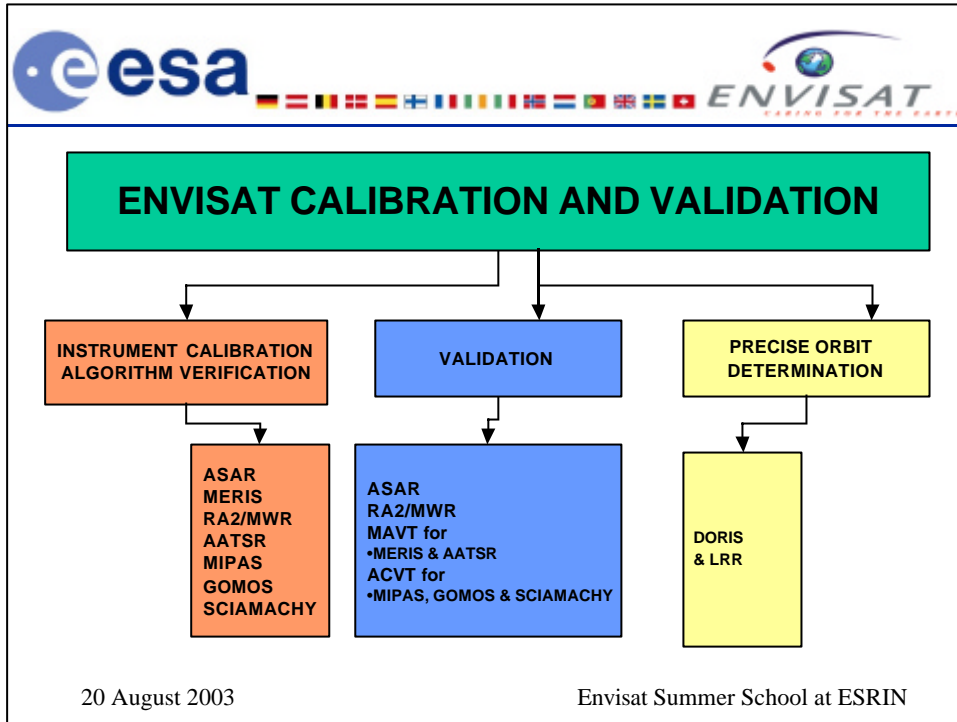
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Overview on GOME Data Processor Upgrade V3 Validation Results:

- Final GOME Delta Validation report available on-line:
http://earth.esrin.esa.it/pub/ESA_DOC/GOME/gdp3/
- The average deviation of GOME from ground-based data does not exceed $\pm 2-4\%$ for SZA below 70° . At lower sun elevation, the average error ranges from -8% to $+5\%$ depending on the season.
- Significant reduction of the total ozone column seasonal variation (e.g. winter/spring -8% to -4%) but the problem persists
- Significant improvement of total ozone solar zenith angle dependence except for autumn measurements in the Northern Hemisphere (problem persists)
- 3 studies running in parallel for further total ozone column improvement (for the purpose of total ozone monitoring)– final review Dec. 2003 at ESRIN

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-
- **Calibration Objectives**
 - Full in-flight calibration and re-characterisation of the instrument.
 - Complete verification of the L1b processor
 - First upgrade of the Level 1b ground processor by the end of the Commissioning Phase
 - Routine calibration operations by the end of the Commissioning Phase
 - **Validation Objectives**
 - Level 2 algorithm verification providing data products with consistent geophysical behaviour by the end of the Commissioning Phase
 - Data quality assessment at a Validation Workshop 9 months after launch based on a sufficiently large number of correlative measurements of sufficient quality covering large areas and a wide range of conditions under strict data quality control using established, well-defined techniques
 - Recommendations for long-term validation
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Atmospheric Chemistry Validation Team (ACVT)



- Ground-based Instruments

- Aircraft Measurements and
Dedicated Balloon Campaigns




- Model Assimilation and Satellite Intercomparison

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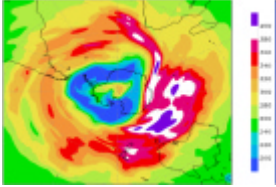
- Ground-based instruments
 - Ozone and radio soundings
 - Lidars
 - UV-VIS spectrometers
 - Fourier transform spectrometers and radiometers
 - Microwave radiometers
- Aircraft Measurements and
Dedicated Balloon Campaigns
 - ‘small’ and ‘large’ balloons
 - M55 ‘Geophysica’
 - DLR Falcon



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 **MOPITT** 

- **Satellite Measurements**
 - ATSR2, GOME, HALOE, HIRLDS,
 - METEOSAT, MOPITT, OMI, OSIRIS, POAM III, POLDER,
 - SABER, SAGE II, SAGE III, SBUV, SMR, SUSIM, SOLSPEC, TOMS
- **Model Assimilation**
 - assimilation into transport/dynamic models & meteorological models
 - provision of synoptic global maps (2-3 D), total columns and profiles at certain times and locations (ground-based sites)
 - algorithm consistency checks



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Supporting Activities

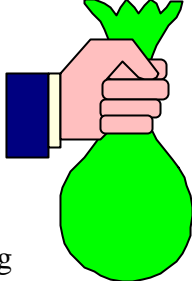
- **Data storage facility at NILU in Norway**
 - Provision of data storage / data access for correlative measurements
 - Access for all calibration and validation participants
- **ECMWF**
 - provision of meteorological data for Envisat data product generation

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Funding Approach

- Combination of ESA contracts and Announcement of Opportunity(AO) Contributions
- AO PIs have Free Access to Data, no ESA Funding
- Engineering Calibration Primarily under ESA contract with Additional Support by AO PIs
- Geophysical Validation Primarily by AO PIs but for Cal/Val co-funding Negotiated with ESA Member States



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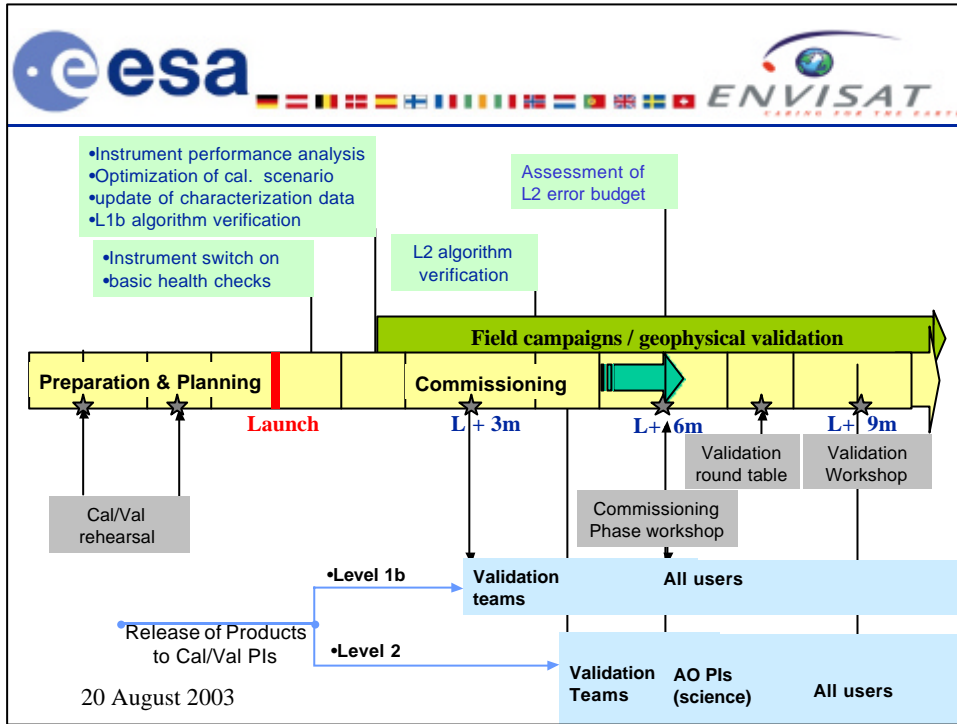



Access to Scientific ESA Data – Category I Project - <http://eopi.esa.int/>



2003-02-21 Exploitation Results & News	Principal Investigator ** Results **	Evaluator **	Correspondent **	Open AOs
Results News Search Submission Cat-1 & Open AOs Previous AOs Reporting Services About this site ESA Data Policy Links HOME Contact us	 Preliminary validation of ASAR Wave mode Level 2	 The breathing of Etna	  Evidence of Nonlinear Elasticity...	 AO for WMIQ  AO for Greece  Category-1
	 Space-borne Radar interferometric mapping...	 Envisat's ASAR reveals extent of massive oil spill off Spanish coast	 Sulphur dioxide levels fall sharply near Etna	<div style="text-align: center;">  Search the EO Projects </div>
	<div style="text-align: center;">  <input type="text"/> ID <input type="password"/> password <input type="button" value="Start"/> </div>			



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Envisat Calibration/Validation:

- **Envisat Calibration Review Workshop - 9-13 September 2002**
 ESTEC -The Netherlands -
<http://www.envisat.esa.int/calval/workshop/>
- **Envisat Validation Workshop - 9-13 December 2002**
 ESRIN – Italy
http://www.envisat.esa.int/workshops/validation_12_02/presentations.html

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ACVT Validation Results - SCIAMACHY:



Level 1 product: problems in radiometric calibration identified

- polarisation correction
- 10-15% offset in the sun spectra as compared to reference data

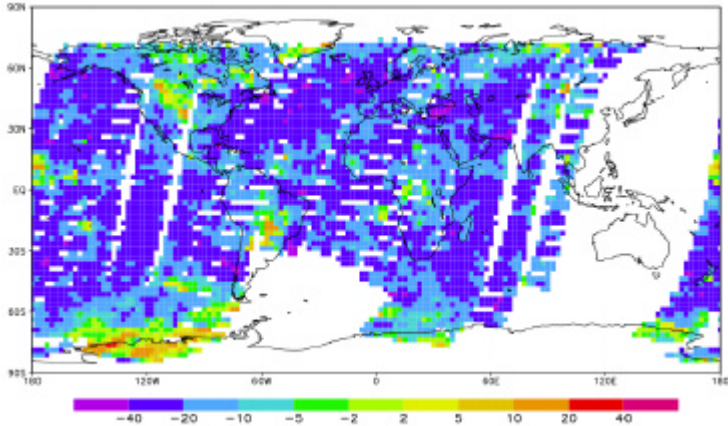
Level 2 product - total ozone column:

- A negative bias was found in SCIAMACHY total ozone of about 10% as compared to GOME, TOMS and SBUV measurements and model output.
- SCIAMACHY total ozone RMS (noise) is very promising and is comparable to/shows a better sensitivity than GOME measurements

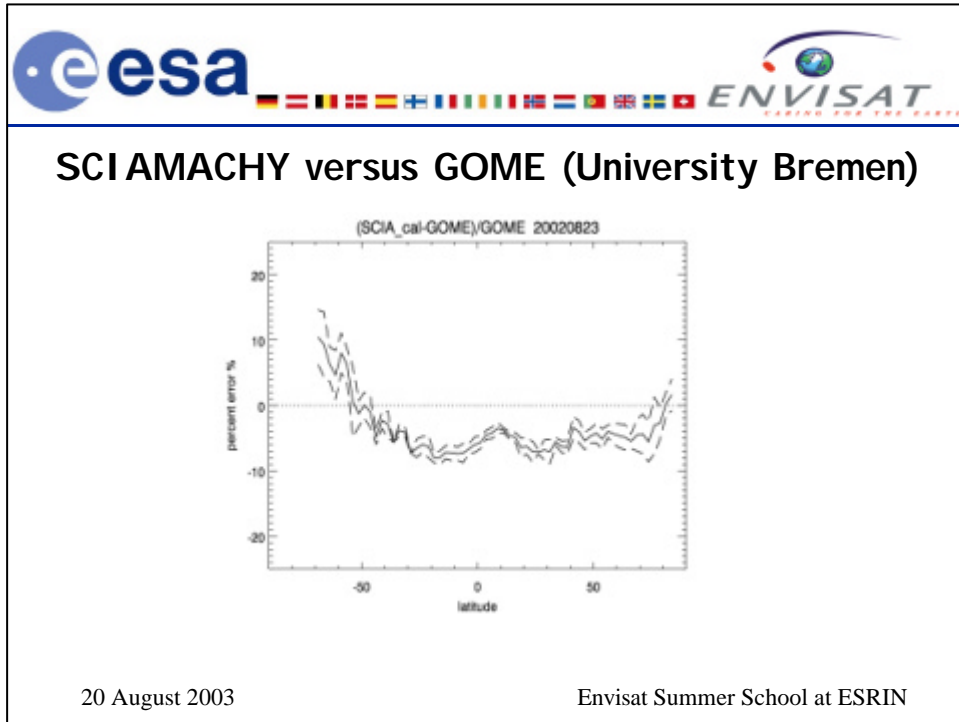
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SCIAMACHY versus assimilated GOME (KNMI)



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ACVT Validation Results - GOMOS:

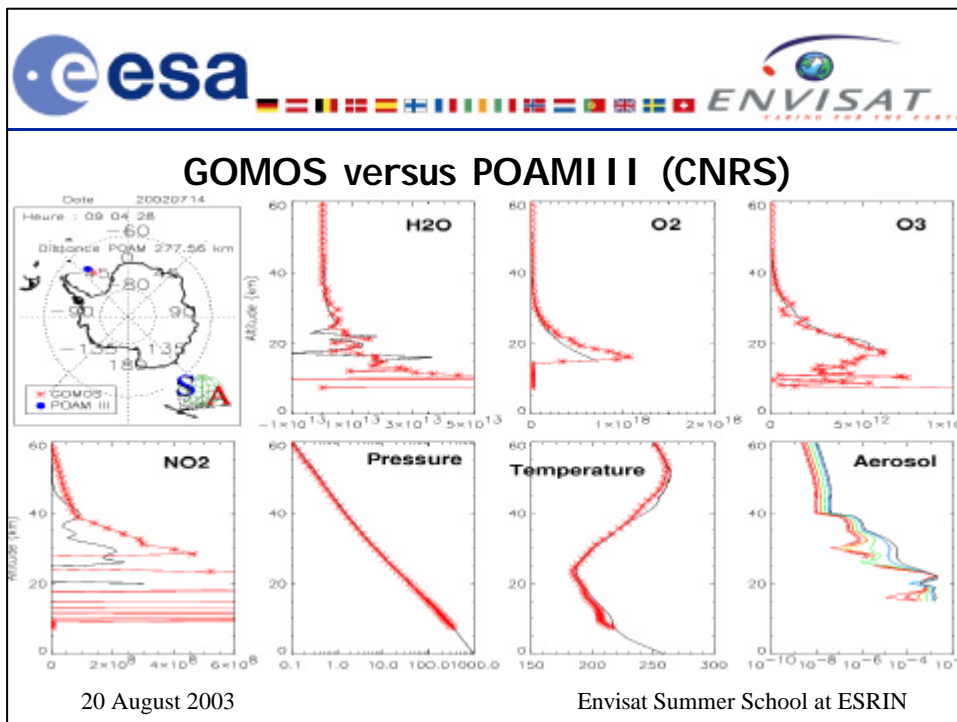
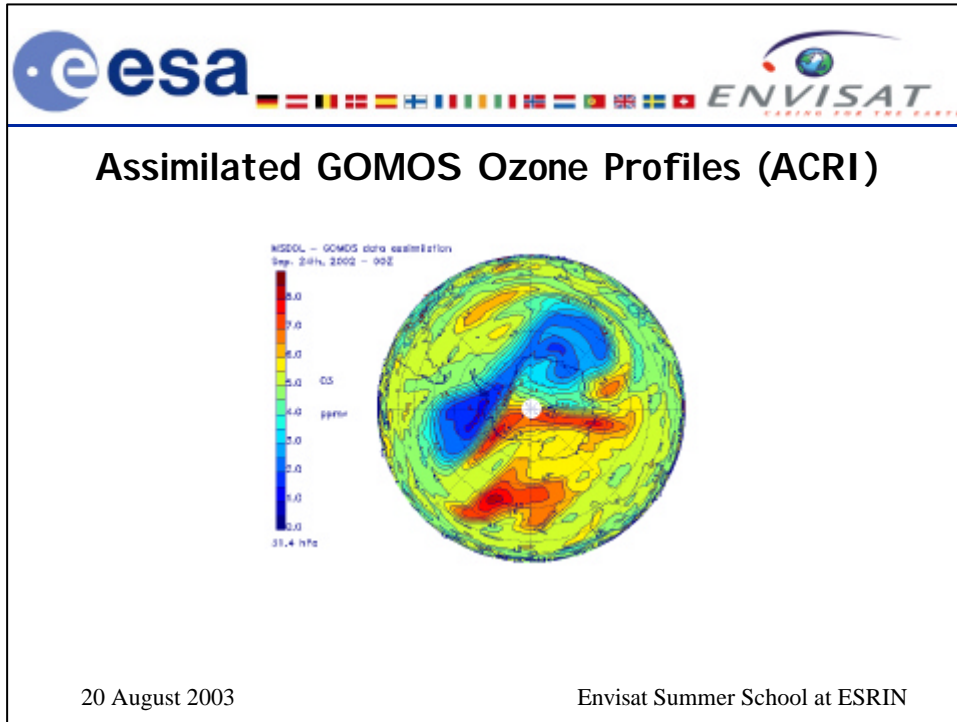
Level 1 product: instrumental problems for the detector dark current correction (significant impact on minor trace gas retrieval)



- Development of new correction algorithm

Level 2 product - ozone profiles:

- Scintillations correction more complex than expected
- GOMOS profiles exhibit large oscillations
- Error bars in GOMOS products are unreliable

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A CVT Validation Results - MIPAS:



Level 1 product: no major problems identified

Level 2 product - ozone profiles:

- MIPAS level 2 products were already successful assimilated (consistent with models).
- MIPAS ozone profiles compare well with co-located ground-based balloon, ground-based and satellite measurements measurements.


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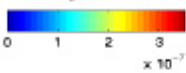



MIPAS Measurements used for Forecasting (BIRA/IASB)

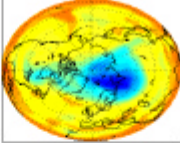
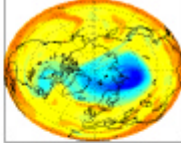
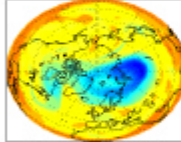
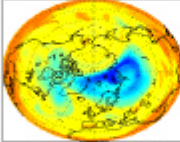
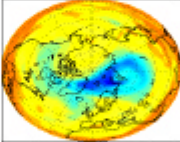
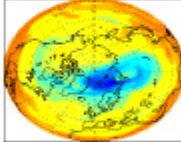
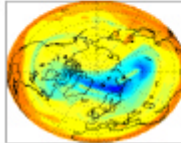
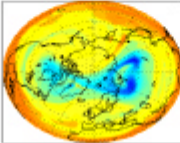
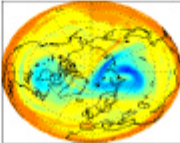
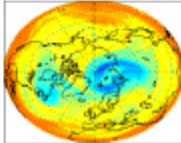
BASCOE v1H02 4D-VAR MIPAS assimilation
 Forecast from 03 mar 2003 00h00 at 475 K



N_2O (v.m.r.)

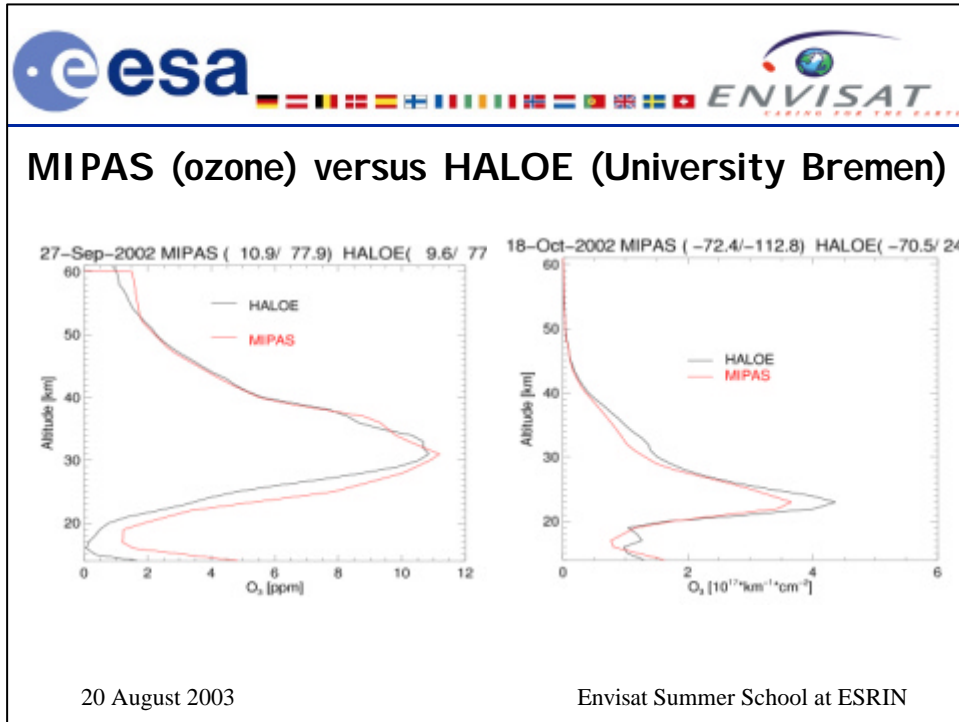


$\times 10^{-7}$

	03 mar 2003 12h00	04 mar 2003 12h00	
			
05 mar 2003 12h00	06 mar 2003 12h00	07 mar 2003 12h00	08 mar 2003 12h00
			
09 mar 2003 12h00	10 mar 2003 12h00	11 mar 2003 12h00	12 mar 2003 12h00
			

20 August 2003



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ACVT Validation – still ongoing:

- Envisat Ground-segment is being updated to fix known problems
- Data Delivery to the scientific user community (beyond Cal/Val activities) is planned during autumn 2003 - <http://envisat.esa.int/dataproducts/availability/>
- Next Validation Workshop is planned during November 2003

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Conclusions

- Big effort necessary to establish first confidence levels for products derived from a new atmospheric space sensor (1 year for GOME, 4 years for TOMS)

- Maturation of retrieval algorithms for atmospheric sensors is an iterative process (e.g. operational processor upgrade every second year)

- 3 ESA studies running in parallel on the development of a GOME total ozone algorithm to be suitable for trend monitoring – 1% relative accuracy over 10 years (to be finalised by Nov. 2003)

- about 8.5 years after launch - GOME total ozone product for the application of trend monitoring

- **planned** release of Envisat atmospheric products to all users – autumn 2003 (1.5 years after launch)

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