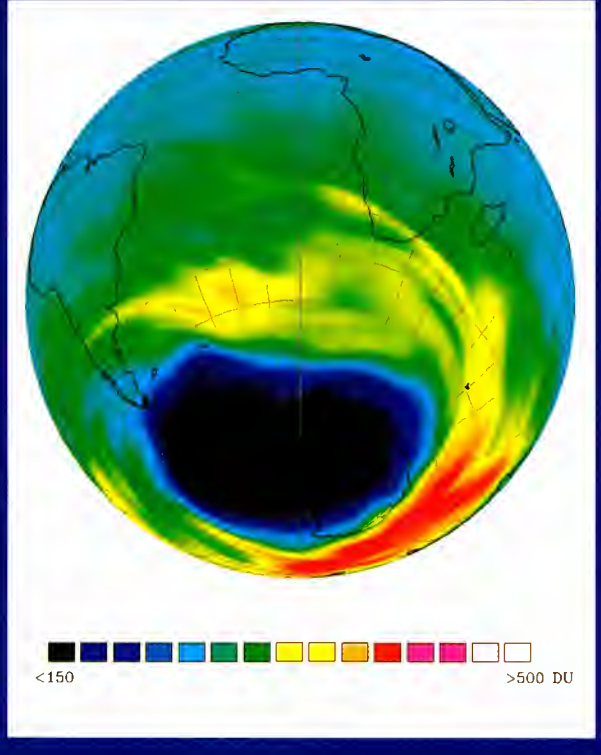
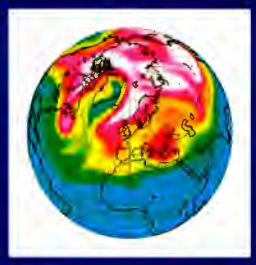
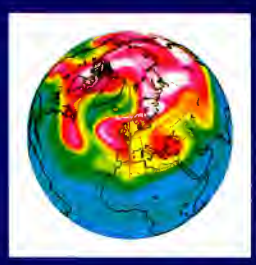
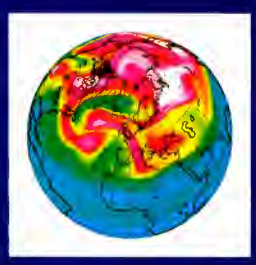
esa ESRIN

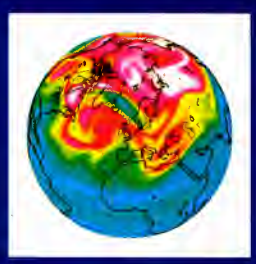
GOME Ozone Fast Delivery Service Product Guide

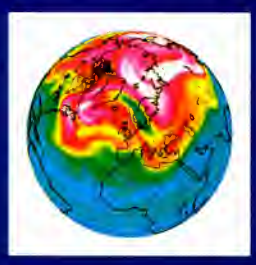












A Data User Programme Project

European Space Agency
Agence spatiale européenne

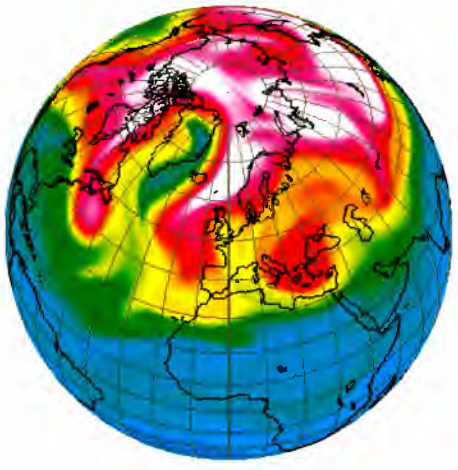
GOME16

Overview

A Fast Delivery Service is developed by the Royal Netherlands Meteorological Institute (KNMI) to provide to users the Global Ozone Monitoring Experiment (GOME, on board of ESA ERS-2 satellite) ozone products within 3 hours after observation (see figure 6). This Service meets the growing demand (by operational meteorology, laboratories, ..) for ozone products for purposes like:

- assimilation in numerical weather prediction models
- radiation forecasts
- planning of experiments related to atmospheric chemistry research

This Service provides to users GOME total ozone columns (level 2 products) and global assimilated ozone maps (level 4 products) via the World Wide Web in simple ASCII format and as images. This data can be directly used for research and education without specific knowledge on remote sensing.
By making maximum use of the existing ERS ground segment and European Internet links this project demonstrates the cost effective development and maintenance of an operational service and prepares applications for future atmospheric instruments to be flown on the ENVISAT and METOP satellites.
This work is performed within the frame of the Data User Programme (DUP).



Global Assimilated Ozone Map
1st of April 1999, at 12 GMT

The DUP (started in 1996 and is subscribed by Belgium, the Netherlands and Switzerland) is an optional ESA programme which is implemented, in phases of 5 years, via a range of projects.

The main objectives of the DUP are to:

- promote the usage of Earth observation data, primarily from ESA missions, and raise the awareness among potential users of the applicability in their daily operations;
- create an environment allowing for the development of user communities linked to applied research and institutional and commercial applications;
- support industry and user groups in establishing useful and cost effective services, based on applications already demonstrated in the frame-work of pilot projects;
- develop and validate technology/products in Europe and try to extend their usage also in developing countries.

How and Where

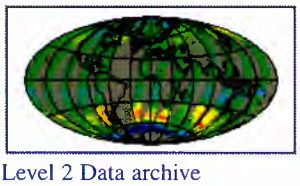
The GOME Fast Delivery service is developed and maintained by the KNMI Atmospheric Composition Research Division. The Division of Atmospheric Composition Research is one of the five research divisions of the Climate Research Department.

Its task is the study of the relationship between the (changing) composition of the atmosphere and the climate.

Products and Data Access

Total ozone columns (Level 2 product, Version 2.0)

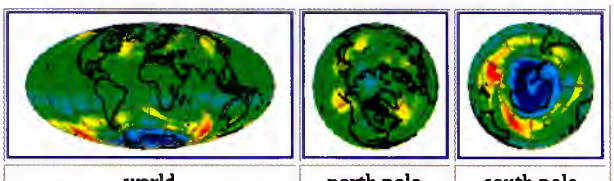
This image shows the most recent ozone column values (for the past 24 hours) derived from the Extracted GOME Instrument Header data (EGOI). The ozone columns are available in near-real time, i.e. within three hours after observation.



Level 2 Data archive

Assimilated ozone fields (Level 4 product)

This image shows the latest global total ozone fields calculated with the Assimilation Model KNMI (AMK). AMK is an advection model that assimilates total ozone columns and advects the ozone fields using ECMWF global wind fields.



world	north pole	south pole

Level 4 GIF Image Archive
Level 4 Data Archive

Fig. 1 Data Access via WWW

The division is involved in several satellite missions monitoring the atmospheric chemical composition (chair of the SCIAMACHY validation and interpretation subgroup, Principal Investigator of the Ozone Monitoring Instrument OMI and participant in the EUMETSAT ozone-SAF for the GOME2 instrument).

Activities funded within the DUP include the retrieval and assimilation of GOME ozone data in near real time.
Users can access the according GOME Fast Delivery Service at the following address:

http://ww.knmi.nl/neonet/atmo_chem/gome/fd/

Products

Level 2 Product Generation

Extracted GOME Instrument (EGOI - ten windows extracted out of the full data rate containing all instrument health parameters and parts of the measured spectrum) header products, disseminated via land-line from all ERS groundstations, are used for instrument monitoring purposes at ESA/ESRIN. The size and content of these products was changed (inclusion of the ozone retrieval window in the Ultra Violet (UV) part of the spectrum) to enable total ozone column retrieval and are provided to KNMI within three hours after observation.

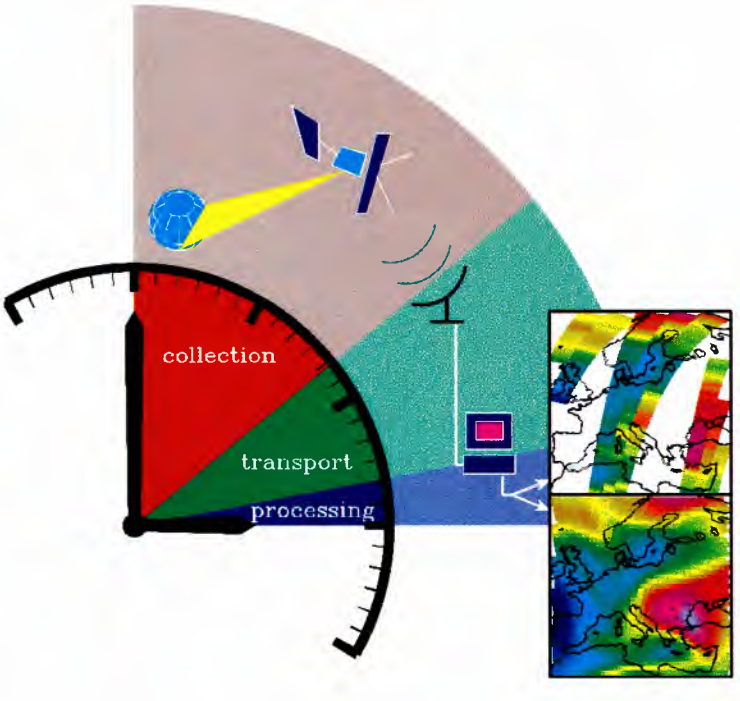


Fig. 2 System Overview

KNMI developed a simplified but very fast (~30 s/orbit on one processor) total ozone column retrieval algorithm for these EGOI products.
A simple calibration is performed on the raw data and, the so called Differential Optical Absorption Spectroscopy (DOAS) algorithm (which does not require absolute radiometric calibration), is used to derive the slant ozone column (amount of ozone along the light path). A Look-up table of pre-calculated Air Mass Factors is used to derive the vertical column density.

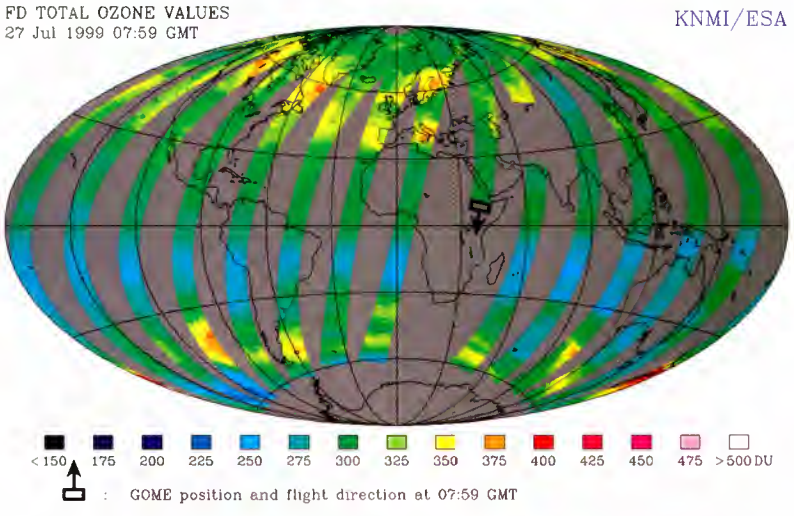


Fig. 3 GOME total ozone columns retrieved by KNMI, in near-real time, plotted on the World map. This plot is available on the World Wide Web and is updated every half hour showing GOME ozone measurements over the past 24 hours.

Level 2 Product Format

The GOME level 2 archive files contain the measured total ozone columns and the corresponding error estimate for one hour intervals.
Each row, in an ascii-archive file, contains the data of one GOME pixel measurement:

GOME pixel time (YYYYMMDDhhmmss)
Longitude of the four corner points of the pixel (1/100 degree)
Latitude of the four corner points of the pixel (1/100 degree)
Total ozone column (Dobson Units)
Pixel scan position (0=East, 1=Nadir, 2=West)
Error estimate of the total ozone column (Dobson Units)

The (FORTRAN) format is: (a14, 8i6, 3i3)

Level 2 Product Quality

The zonally averaged differences between the Fast-Delivery and TOMS (Total Ozone Mapping Spectrometer) ozone columns for each month of a year is smaller than 5 % for solar zenith angles less than 70 degrees.

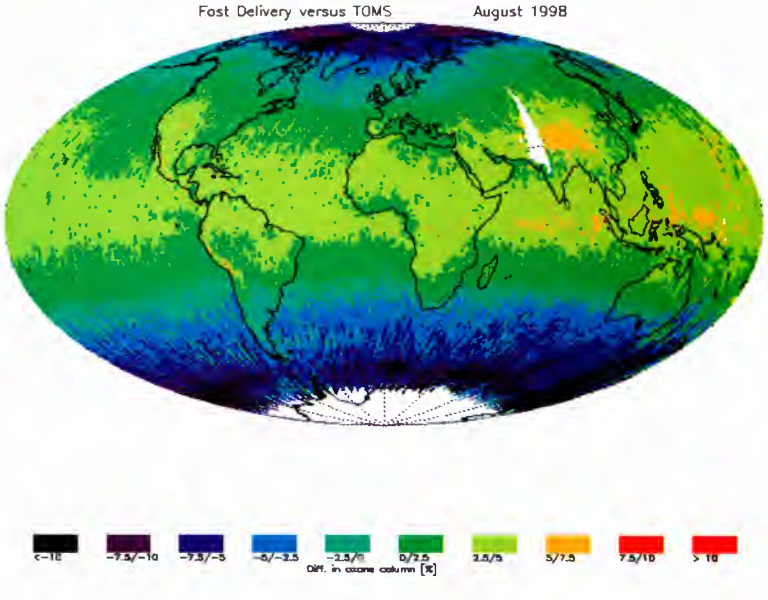
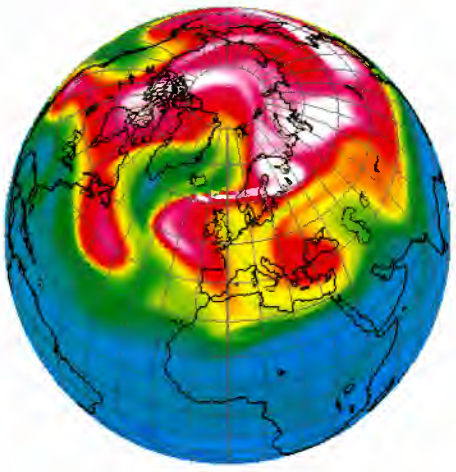


Fig. 4 Global map showing the monthly averaged relative difference between the GOME Fast Delivery ozone columns and TOMS measurements for the whole August 1998.

Level 4 Product Generation

The level-2 processing produces a list of GOME total ozone observations at different times and at different geographical locations. A collection of 24 hours of GOME measurements is shown in figure 3.



Global Assimilated Ozone Map 2nd of April 1999, at 12 GMT

Most of the features in the ozone field result from differences in the concentration in the lower stratosphere. At these altitudes the chemical lifetime of ozone is long, and the distribution of ozone is governed mainly by the actual wind field. Since this transport can be thousands of kilometers in 24 hours, the entire global ozone distribution is changing considerably during a single day. For creating global ozone maps based on GOME observations it is important to account for this conveyance effect.

The data assimilation software has been incorporated in the automatic GOME Fast Delivery processing. Within three hours data is acquired, calibrated, total ozone columns are retrieved and these observations are assimilated to provide global maps of ozone (level-4 products) based on the GOME observations.

In the data assimilation approach a transport model describes the atmospheric flow of ozone. The model is driven by wind fields provided by the European Centre for Medium-Range Weather Forecasts. The variational data assimilation technique (called 4D-Var) is used to adjust the model ozone field such that it is consistent with the available ozone observations provided by GOME.

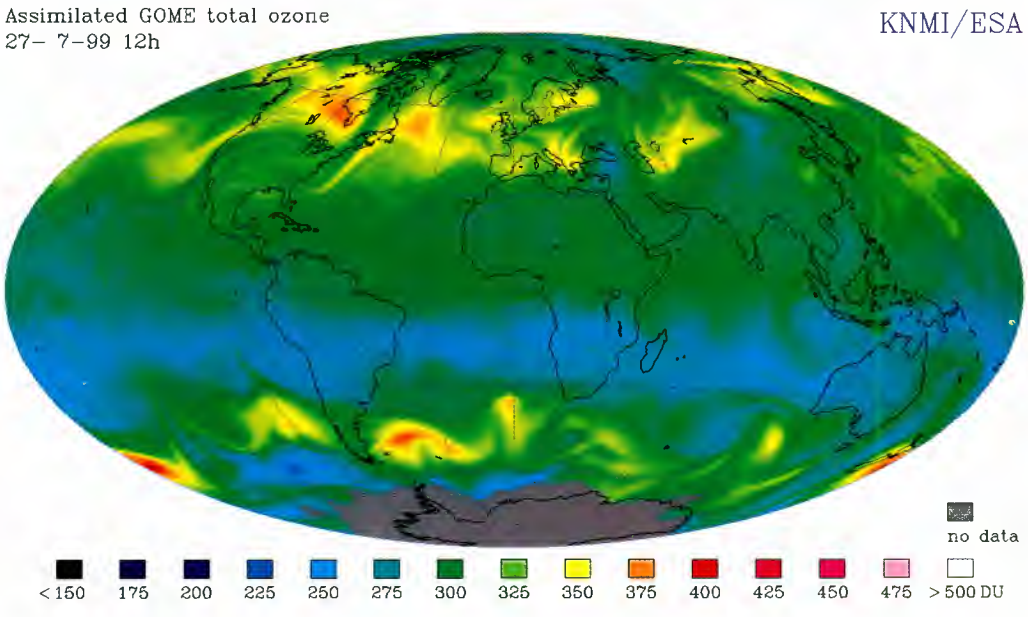


Fig. 5 Global assimilated Ozone Map for 12 GMT 27 July 1999

The analysis accounts for estimated observation and retrieval errors, the model forecast uncertainty and the estimated spatial correlation between model forecast errors. An example of a global synoptic (a global field for one specific time, in our case 12 GMT) ozone distribution, based on GOME measurements of that day and preceding days, is shown in figure 5. Apart from synoptic ozone maps, the procedure provides a detailed estimate of the quality of the analyzed ozone distribution.

Level 4 Product Format

Global assimilated ozone maps are provided either as pictures in GIF Format or as ASCII files following the TOMS level 3 data format for global ozone maps:

The data are gridded into 1 degree latitude and 1.25 degree longitude zones. Latitudes cover the range from -90 degrees (South Pole) to 0 degrees (Equator) to +90 degrees (North Pole). The first zone extends from -90 to -89 (the grid cell is considered to be centered on -89.5). Similarly, longitudes cover the range from -180 (West longitude) to 0 (Greenwich, England) to +180 (East longitude). The first longitude zone extends from -180 to -178.75 (the grid cell is considered to be centered on -179.375).

The first three lines are header information which include the date of the measurement, the type of data and the generation date.

The next lines contain the 288 longitude values for one latitude zone, centered at -89.5. The following 288 longitude values are given for the latitude zone centered at -88.5, and so on. All measurements are given in Dobson Units and are integers with 3 significant digits.

As an example, the first few lines of the data file for May 19, 1998 are given:

Day: 139 May 19, 1998 Assimilated GOME total O3 (KNMI/ESA) 9805194; T= 12:00
Longitudes: 288 bins centered on 179.375 W to 179.375 E (1.25 degrees steps)
Latitudes: 180 bins centered on 89.5 S to 89.5 N (1.00 degree steps)

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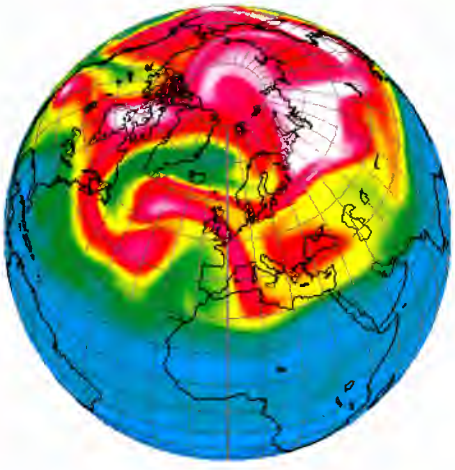
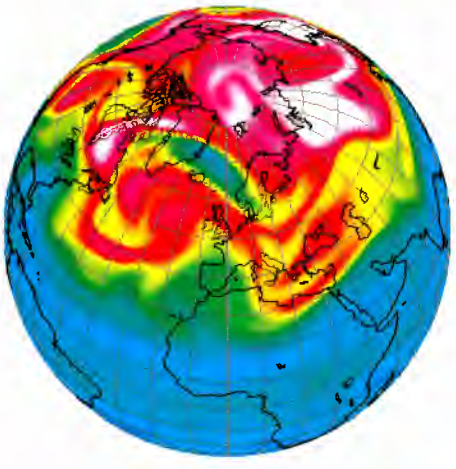
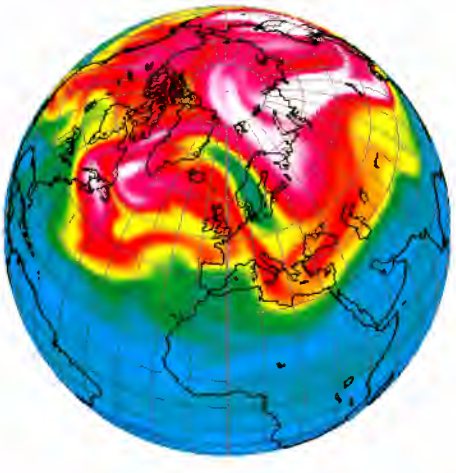


Global Assimilated Ozone Map
3rd of April 1999, at 12 GMT



Global Assimilated Ozone Map
4th of April 1999, at 12 GMT



Global Assimilated Ozone Map
5th of April 1999, at 12 GMT

Service Performance Statistics

This graph (updated every three hours on the KNMI web page) shows the time delay between the GOME observations and the Fast Delivery retrieval of the total ozone column, averaged over the last month. The histogram shows the average percentage of the data which is retrieved within the indicated time interval. The dashed line shows the cumulative distribution.

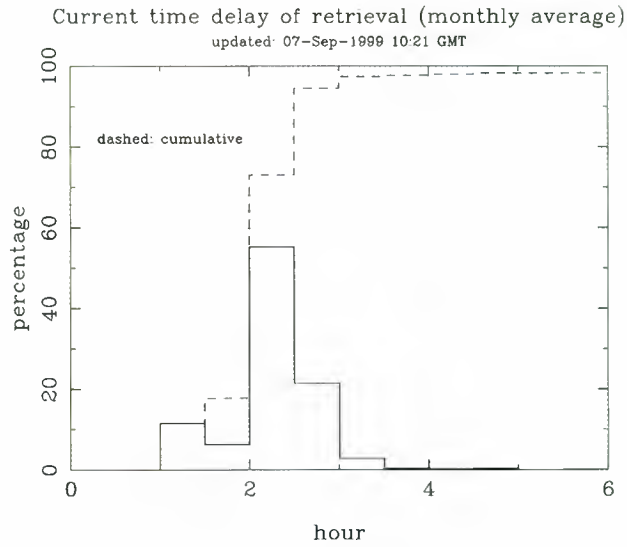


Fig. 6 Delivery Statistics

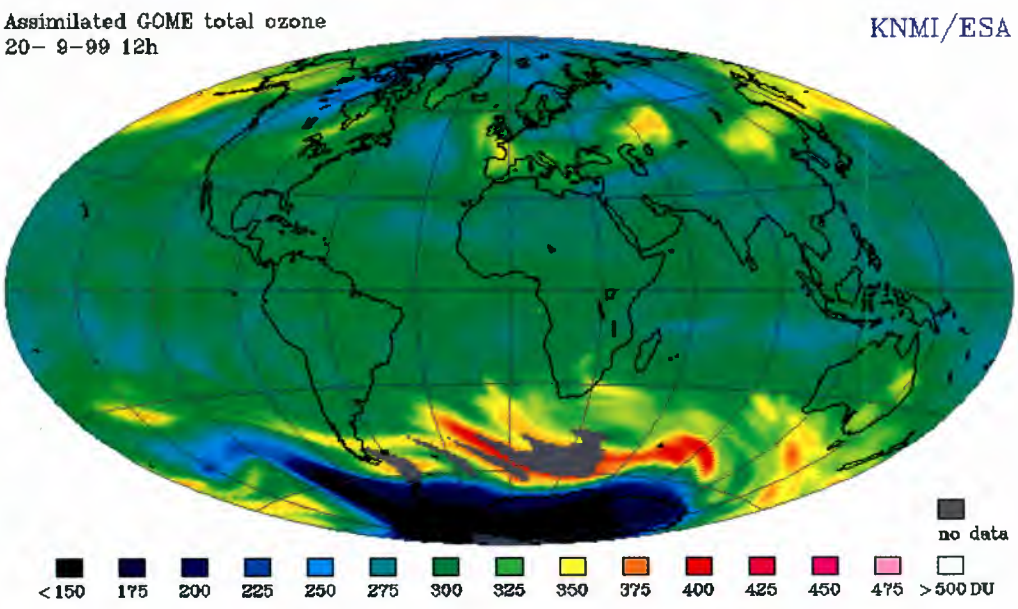


Fig. 7 Global assimilated Ozone Map for 12 GMT 20 Sept. 1999

Future Planning

At present the software version 2.0 is operated to generate total ozone columns in near-real time. Future upgrades are planned to improve the product quality of the total ozone columns (e.g. usage of better reference spectra, inclusion of polarization correction etc.).

The retrieval of height-resolved ozone information, from the EGOI's data, is currently under development. The UV part of the spectrum contains information on the vertical ozone distribution. However, GOME ozone profiles are presently not derived on an operational basis. Numerical weather prediction can benefit from assimilation of stratospheric ozone profiles, if they are retrieved within 3 to 6 hours after observation.
An existing off-line profile retrieval algorithm is being adapted to produce reliable stratospheric profiles, within this strict time constraint, with a spatial resolution sufficient for numerical weather predictions.

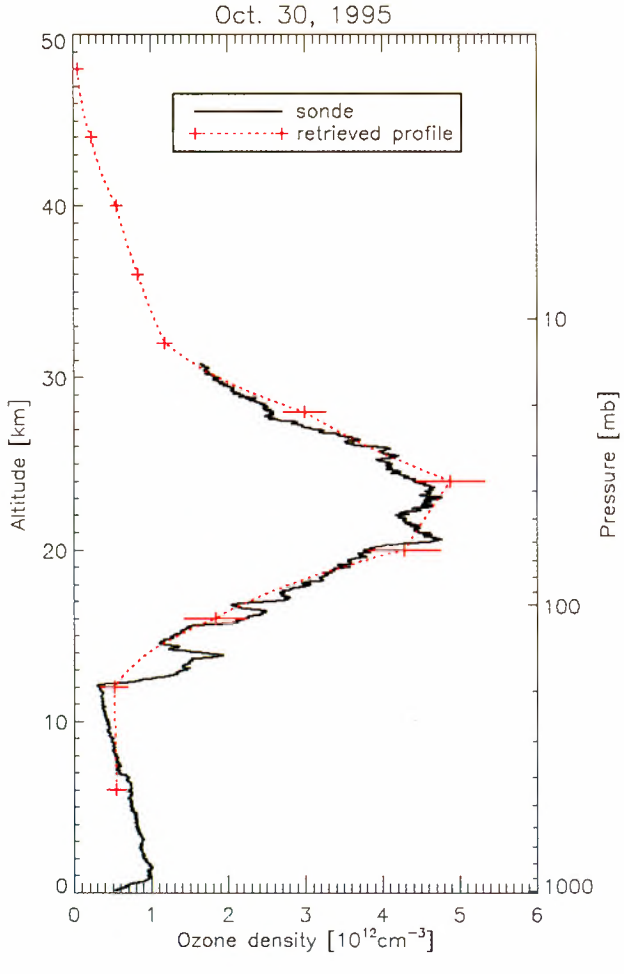


Fig.8 An example of an Ozone Profile (red line) retrieved with the off-line algorithm from GOME observations on 30 October 1995, above Aberystwyth, Wales. The black line shows an Ozone profile measurement performed by an ozone sonde released at Aberystwyth on the same day.

Contact Points and Documentation

GOME Ozone Fast Delivery Service:

Web pages: http://www.knmi.nl/neonet/atmo_chem/gome/fd/

Documentation available on-line at the above address:

· The Fast Delivery System
· Algorithm Specifications (Software version 2.0, also in postscript format)
· Level 2 and 4 product specifications (also in postscript format)
· Variational data-assimilation

Users contact:

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Ankie Piters (piters@knmi.nl)
Pieter Valks (valks@knmi.nl)

Data User Programme:

Web pages: http://styx.esrin.esa.it:5000/DUP/

Project Responsible: Claus Zehner (claus.zehner@esrin.esa.it)
DUP Responsible: Giancarlo Pittella (gpittell@esrin.esa.it)

Further support or information can also be forwarded to:

EOHelp
The ESA Earth Observation Missions
Help Desk Team
Via Galileo Galilei
00044 Frascati (Rome) - Italy

Tel. no.: +39 06 94180 777
Fax no.: +39 06 94180 272
E-mail: eohelp@esrin.esa.it
Web pages: http://earthnet.esrin.esa.it

ESRIN/APP-AEU/DUP/GOME/BR-1

Front Cover:
The main picture shows the Antarctic ozone hole of October 1998, as seen by the GOME instrument. The black and blue colors indicate low ozone values, while high values are represented by red and white.
The time series of the five small pictures (daily ozone maps for 01-05 April 1999) show the entrapment of tropical air in Northern regions causing an occurrence of low ozone concentrations over Europe.

Image processed by KNMI - ESA/ESRIN