APPLIED REMOTE SENSING CLUSTER

DLR

CHEOPS GOME

Multi-year global stratospheric ozone record by assimilating GOME ozone profile observations

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Abstract

8 years of ozone profile observations from the Global Ozone Monitoring Instrument (GOME) are assimilated in order to derive a consistent global ozone record for the stratosphere. This kind of data record allows the analysis of the evolution of the Antarctic ozone hole and further contributes to the evaluation of coupled-chemistry-climate models (CCMs). Ozone profiles from GOME spectra are gained by the Neural Network Ozone Retrieval System (NNORSY).

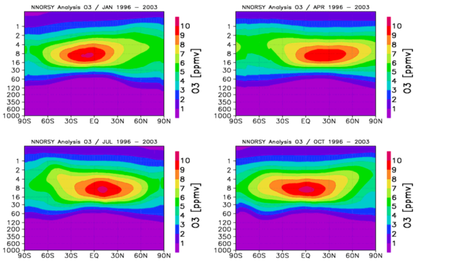

Figure 1: 2D zonal mean of ozone volume mixing ratios for the complete reanalysis period covering 1996 to 2003. The months Jan, Apr, Jul and Oct are depicted. The reanalysis is based on GOME/NNORSY ozone profiles v4.8 (preliminary).

Reanalysis and Quality Control

The data assimilation system has been developed within the ESA CHEOPS project (Climatology of Height-resolved Earth Ozone and Profiling Systems for GOME). CHEOPS aims at the derivation of a new ozone climatology based on GOME/NNORSY ozone profile retrievals (Müller et al., 2003).

The data assimilation system gains:

- -Global multi-year O3 reanalysis using all GOME/NNORSY profiles
- -Global 3D error statistics for quality control

Assimilation for Validation

Data assimilation has become an important tool for validation of trace gas retrievals. Within CHEOPS the system is applied to:

- -trace inconsistencies in the GOME ozone profile retrievals
- -control the quality of the ozone profiles by first guess of model
- -identify outliers and systematic errors
- -check the profiles in areas with known GOME problems (SAA)

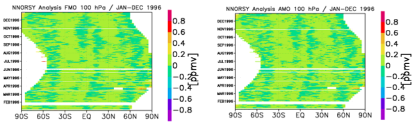

Figure 3: Daily zonal means of model first-guess minus GOME/NNORSY observation error (FMO) for 1996 at 100 hPa (left). The right plot shows the corresponding analysis minus observation error (AMO). The deviations mainly close to zero prove the overall consistency of the GOME/NNORSY data set. Some suspicious ozone profiles, however, could be identified end of March. These can easily be removed from the GOME-NNORSY ozone profile data set (preliminary).

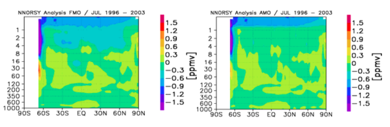

Figure 4: 2D zonal mean of FMO errors (first guess minus observation, left) and AMO errors (analysis minus observation, right) for the complete reanalysis covering 1996 to 2003. July is depicted for extreme solstice conditions. The quality of the GOME/NNORSY data is reflected by low errors. However, a bias above 4 hPa and at the terminator is evident (preliminary).

Validation

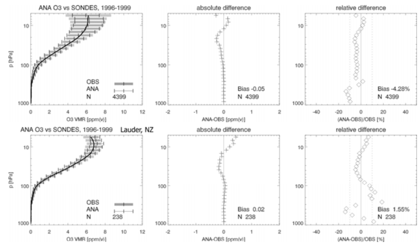

Figure 6: The ozone reanalysis is compared to correlative ozone sonde data. The comparison comprises all data of the World Ozone Data Center (top) and Lauder, NY only (bottom). Comparisons are shown for the period 1996 to 1999. Please note that all Lauder data is excluded from the GOME/NNORSY neural network training.

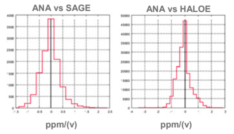

Figure 7: The ozone reanalysis is compared to correlative SAGE (left) and UARS/HALOE data (right) for 1996.

	bias	rms	mean
ANA vs SAGE	0.08	0.42	3.21 ppm(v)
ANA vs HALOE	-0,12	0.53	3.55 ppm(v)

Error Analysis

The assimilation scheme comprises a sequential assimilation approach using optimum interpolation with error propagation and the chemistry-transport model ROSE/DLR. Analysed background errors constitute an important diagnostic. The quality of the ozone profile retrievals is controlled using first-guess/analysis minus observation error (FMO/AMO) statistics. The ozone reanalysis is compared to UARS/HALOE, SAGE, ozone sonde data and a transient run of the CCM E39/C.

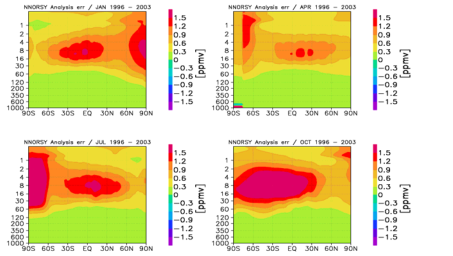

Figure 2: 2D zonal mean of the analysed error (B') for the complete reanalysis period covering 1996 to 2003. The months Jan, Apr, Jul and Oct are depicted. The reanalysis is based on GOME/NNORSY ozone profiles v4.8 including error estimates (preliminary).

Assimilation Scheme

Instead of fixed background error an error propagation scheme is applied. The final analysis is improved by using the analysis error for next time step (Menard and Chang, 1999). The analyzed variances B' are propagated forward as additional quasi-tracers and corrected for chemistry (see Figure 2)

No averaging kernels can be delivered by the GOME/NNORSY neural network retrieval approach (Mejer et al. , 2006). Since the NNORSY data is vertically dense compared to model vertical grid (60 to 43 levels) we follow a horizontal optimal interpolation scheme.

Set up and initialization of CTM ROSE/DLR follows Baier et al.

Met. analysis	UK Met Office	**Gas chemistry**	non-family concept
Discretisation	43 layer, 0-56 km 3.75°x2.5° lon-lat grid	*solver*	*Gauss-Seidel, Newton-Raphson*
Advection	Lin and Rood	*reaction rates*	*JPL2002*
Troposphere	Convection O3 relax. to climat. Mean	*photolysis rates*	*Stamnes, 2003*
Het. chemistry	ICE, NAT, STS	*source gases*	*CFC11, CFC12, CH3Br*

Comparison to CCM

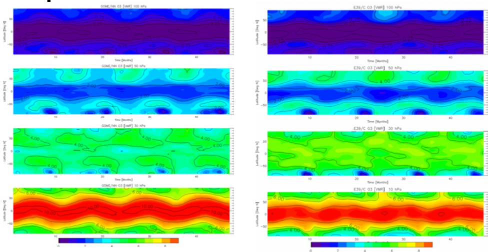

Figure 5: Monthly mean ozone mixing ratios from assimilated GOME/NNORSY data (left) and as calculated by the CCM E39/C (right) from 1996 to 1999 for 100 hPa, 50 hPa, 30 hPa and 10 hPa (from top) (Dameris et al., 2005). E39/C captures the variability mainly well. Differences occur at high latitudes e.g. the inter-annual variation of the ozone hole is underestimated. On the contrary, E39/C shows too strong a variability in northern high latitudes (Erbertseder et al. 2006) [Acknowledgement: Martin Dameris and Veronika Eyring for E39/C data].

Conclusion and Outlook

A global multi-year stratospheric ozone reanalysis was derived by assimilating GOME/NNORSY ozone profile retrievals. The reanalysis additionally gained a global error statistics including analyzed errors, FMO and AMO errors.

The assimilation scheme was used to identify outliers and inconsistencies in the GOME/NNORSY retrievals. It constitutes a valuable validation tool for GOME/NNORSY data. This step is a prerequisite since CHEOPS aims at the compilation of a new standard ozone climatology.

The results are based on preliminary GOME/NNORSY data. Based on the upcoming final version we will focus on validation. A further focus will be on the derivation and validation of tropospheric ozone levels.

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