

Multi-Target Retrieval (MTR): the simultaneous retrieval of pressure, temperature and Volume Mixing Ratio profiles from limb-scanning atmospheric measurements

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INSTRUMENT

MIPAS (Michelson Interferometer for Passive Atmospheric Sounding)
on board of the ESA satellite ENVISAT

- Fourier Transform Interferometer
- Spectral resolution: 0.033 cm⁻¹ (unapodized)
- Limb emission measurements: 5 bands in the range 685 - 2410 cm⁻¹
- 17 Nominal altitudes : 6 – 42 km at 3 Km step, 47, 52, 60, 68 km

ESA Level 2 Near Real Time Processor: Optimized Retrieval Model (ORM)⁽¹⁾

- Retrieves tangent pressures and vertical profiles of temperature and volume mixing ratios (VMR) of high priority species (H₂O, O₃, HNO₃, CH₄, N₂O, NO₂)
- Sequential analysis of each limb-scanning sequence:
 - First Pressure+Temperature are retrieved then the VMR of the high priority species are retrieved sequentially for each scan. The result of each step is used as an input into the subsequent retrievals.
- Retrievals are performed on narrow spectral intervals called "microwindows" (MWs)⁽²⁾
- The uncertainty of the retrieved quantities acts as a systematic error source on the subsequent retrievals. This error is reduced by properly selecting both the MWs and the retrieval sequence.

p+T → H₂O → O₃ → HNO₃ → CH₄ → N₂O → NO₂

AFFILIATIONS

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Multi-Target Retrieval (MTR)⁽³⁾

- Performs the simultaneous retrieval of the altitude distributions of tangent pressures, temperature and the VMR of all target species
- In this way the error propagation that affects the sequential retrieval of the target quantities is avoided.
- Moreover the cross talk between different target quantities is properly represented by the Covariance Matrix (CM) of the retrieved parameters: it can be evaluated through the correlation coefficients and contributes to the random error via the diagonal elements of this matrix.

COMPARISON MTR - ORM

- Real data : orbit 2081, 24th July 2002
- Same set of MWs (optimized for ORM)
- Same atmospheric profiles as initial guess
- The quality of the retrieval is assessed from
 - χ -test value → it must approach unity
 - Number of iterations for GN convergence

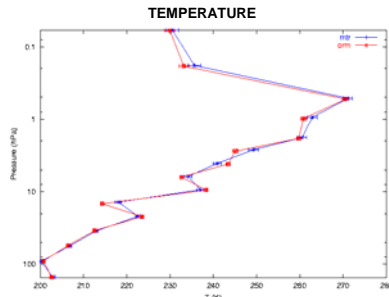
RESULTS are shown for the scans where ORM shows instability

MTR advantages

- the uncertainty on the initial guess of the quantities that are going to be simultaneously retrieved does not act as a source of systematic errors
- the error due to the cross-talk between different target quantities is properly represented by the variance-covariance matrix of the retrieved parameters.
- the selection of the spectral intervals to be used in the analysis is no longer dominated by the need to reduce the interferences among target species
- the efficiency of the analysis process increases if the analyzed spectral intervals include spectral features due to as many as possible target quantities.
- the information on pressure and temperature can be gathered from the spectral features of all target species.
- in the iterative procedure the risk of a lack of convergence is reduced.

SPECIES	SCAN 20		SCAN 23	
	GN iter	Final χ^2	GN iter	Final χ^2
P+T	6	2.062	9	1.927
H2O	1	0.893	1	0.894
O3	2	1.230	1	1.136
HNO3	1	1.006	1	1.032
CH4	1	1.015	1	1.062
N2O	1	0.932	1	1.007
NO2	1	1.029	1	1.064
MTR	3	1.050	3	1.086

SCAN 23 Lat 10.57S – Long 27.24 W



SPECIES	SCAN 35		SCAN 36	
	GN iter	Final χ^2	GN iter	Final χ^2
P+T	5	2.731	6	2.118
H2O	1	0.893	1	0.969
O3	1	1.330	1	1.362
HNO3	1	1.063	2	1.002
CH4	1	1.024	1	1.033
N2O	2	1.027	1	1.070
NO2	2	1.142	1	1.343
MTR	3	1.148	2	1.169

H₂O

O₃

HNO₃

CH₄

N₂O

NO₂

CONCLUSIONS

- Although MTR has been operated on the MWs optimized for the sequential retrieval, it has shown a **higher stability** for the analyzed orbit.
- In general the final χ -test value reached by MTR is **lower** than the average of the values obtained by ORM
- Random errors affecting the retrievals are sometimes larger: this is due to the proper representation of the error propagation that is hidden in ORM results.

