Mesospheric Retrievals with MIPAS

L. F. Millán-Valle and A. Dudhia
Atmospheric, Oceanic and Planetary Physics, University of Oxford

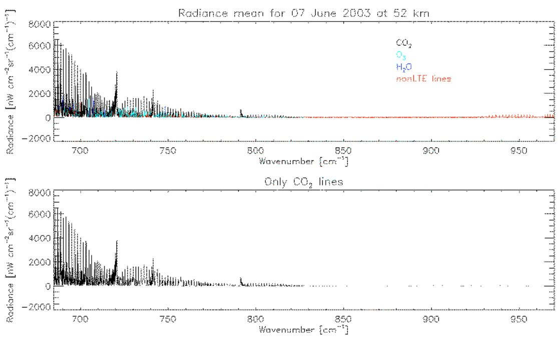
Introduction

MIPAS normally scans from 6 to 68 km but, under special viewing modes, its altitude coverage can be extended to tangent heights above 100 km, capturing the entire mesosphere. Currently, the middle atmosphere mode, which covers the altitudes from 18 to 102 km in 29 steps, is used every ten days.
The operational MIPAS L2 retrieval uses an iterative microwindow approach which implies re-running the radiative transfer model. When trying to extend this into the mesosphere, the low signal to noise ratio requires many more spectral points to be used and hence a much longer processing time.
A linear algorithm has been developed to retrieve temperature, pressure and volume mixing ration at lower mesospheric altitudes. The retrieval exploits the linearity of an optically thin path and uses pre-computed spectra.

Pressure - Temperature (pT) retrieval

1. Spectral range from 685-970 cm^{-1} (A band)

2. Screen out lines affected by non-LTE effects and lines from other gases rather than CO_2.



3. Retrieve temperature and pressure by a linear least squares fit of the form:

$$x = x_o + \left(K^T K\right)^{-1} K^T \left(y - f(x_o)\right)$$

y: measurement vector (limb radiances)
x: state vector (parameters to retrieve)

$f(x_o)$: precomputed reference spectra (the result of the radiative transfer model using x_o)
K: precomputed Jacobian $K_{ij} = \frac{\partial y_i}{\partial x_j}$

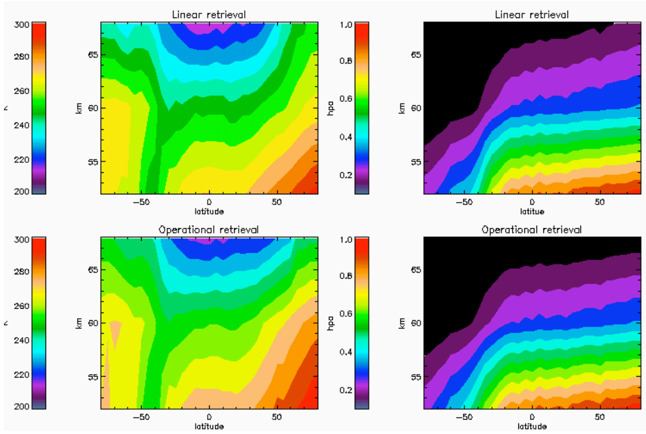
More linearity is obtained retrieving linear pressure rather than log(pressure) and retrieving Planck function (at a fixed wavenumber) rather than temperature.
After the retrieval, the Planck function is converted into temperature.

Three initial guesses are used to improve the retrieval accuracy.

- Mid latitude day
- Polar summer
- Polar winter

In the three cases, the retrieval scheme is carried out and the one that most closely predicts the observed spectra is used.

4. Add the hydrostatic balance constraint (using the standard optimal estimation approach described by Rodgers 2000)



Zonal average temperature and pressure retrieved for 07 June 2003

Gas concentration retrieval

1. Chose a spectral range where most lines from the molecule to retrieve are found

Molecule	Spectral range
O_3	1020-1170 cm^{-1} (AB)
H_2O	1215-1500 cm^{-1} (B)

2. Again, screen out lines affected by non-LTE effects and lines from other gases rather than the gas to retrieve.

3. Assuming the measured radiance is,

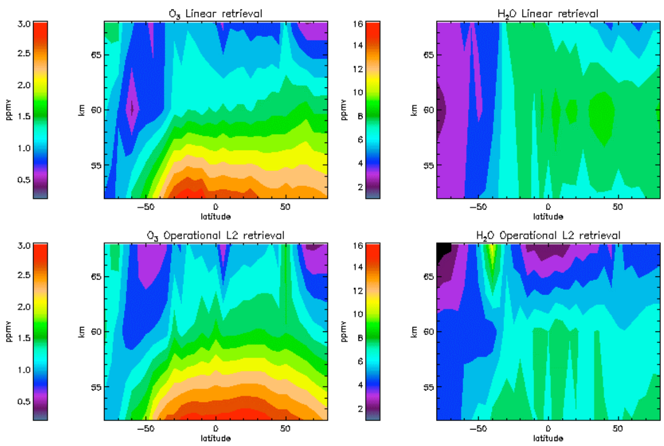
$$y = y_o + K_B(B - B_o) + K_p(p - p_o) + K_v(v - v_o)$$

the volume mixing ratio can be retrieved following,

$$v = v_o + \left(K_v^T K_v\right)^{-1} K_v^T \left[y - y_o - K_B(B - B_o) - K_p(p - p_o)\right]$$

B: correspondent Planck function (at a fixed wavenumber) for the temperature retrieved
p: pressure retrieved

B_o, p_o, v_o: Planck function, pressure and volume mixing ratio values of the initial guess.
K_B, K_V, K_T: Planck function, vmr and pressure Jacobian



Zonal average O_3 and H_2O retrieved for 07 June 2003

Future work

The retrieval will be extended to higher altitudes and more gases will be retrieved with the same approach: using the whole signature of the molecule rather than just microwindows.

References

Rodgers, Inverse Methods for Atmospheric Sounding: Theory and Practice, world Scientific, 2000

Email: millanvalle@atm.ox.ac.uk