Latitude-Dependence of MIPAS Microwindow Selection
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1 Introduction

Different studies have shown that microwindows selected for mid-latitude conditions do not perform well in polar winter atmosphere

- A. Dudhia, report presented at 33rd SAG.
- N. Glatthor *et al.*, submitted to *J. Geophys. Res.*

So, for MIPAS operational processing, the options are

1. Determine sets of microwindows optimised for each latitude/season.
2. Determine a single set of globally-optimised microwindows.

Option 1, using dedicated sets of microwindows for each latitude/season, should achieve the greatest accuracy in retrieved profiles. The disadvantages are that it is also necessary to define a set of latitude/season conditions covering all expected cases for the real atmosphere, and that the error characteristics of the retrieval will change around the orbit as different microwindows are used. Option 2 would be expected to give less accurate retrievals in any one location, but the advantages are that only a 'representative' set of latitude/seasonal conditions is required to cover the expected global variability, and the error characteristics of the retrieval only vary with atmospheric conditions around the orbit. Clearly Option 2 is preferable from a practical point of view, so the key question is:

> How much accuracy is lost by applying a global set ?

2 Atmospheric Profiles

Microwindow selection is based on precomputed spectra representing

- Jacobians for the retrieved species
- 1σ perturbations of all known error sources

These are stored as differences relative to nominal spectra computed for some fixed atmospheric profile.

Previously these spectra have only been computed for mid-latitude, day-time conditions. Four other scenarios have now been added, giving

`day` Mid-Latitude day-time (as previously)

`ngt` Mid-Latitude night-time

`sum` Polar summer

`win` Polar winter

`equ` Equatorial day-time

The first four cases correspond to the profiles defined in the 12054 Study (Clarmann *et al.*, 1998). The `equ` case is the same as the `day` case, except with the FASCODE equatorial profiles of T, p and H_2O.

3 Figures of Merit

Retrieval accuracy for a microwindow selection applied to a particular atmosphere can be defined in terms of a Figure of Merit

$$H^{\mathrm{atm}} = -\log_2(F^{\mathrm{rtv}}/F^{\mathrm{apr}}) \tag{1}$$

where the covariance function F is given by:

$$F = \prod_{i=1}^{16} \left(\frac{1}{2} S_{ii}^{\mathrm{rnd}} + \frac{3}{2} S_{ii}^{\mathrm{sys}} \right) \tag{2}$$

which is the product of the diagonal terms of the sum of the the random and systematic covariances, with additional weight (penalty) applied to the systematic error component. i refers to each retrieval level in a profile, taken as 8, 11, ... 53 km in this case.

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Figure 1: Temperature profiles

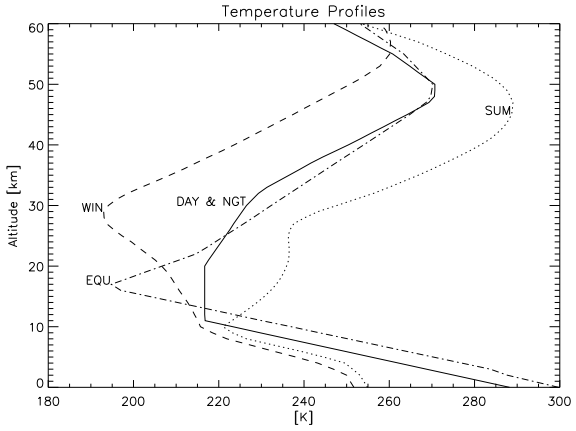
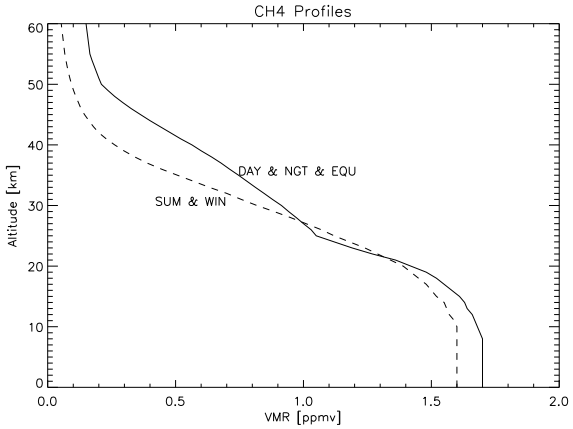


Figure 2: CH_4 profiles



A 'Global' Figure of Merit, representing quality of microwindow selection when applied globally, is simply:

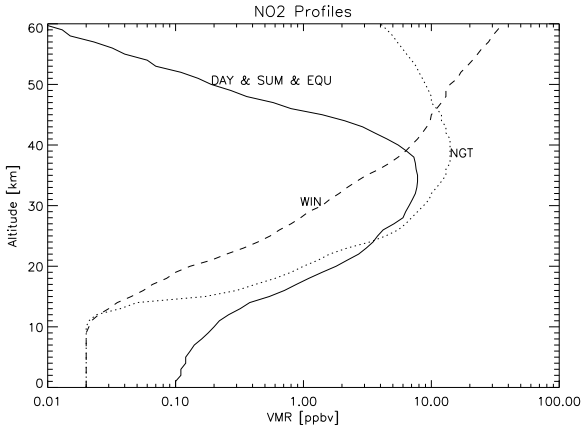
$$H^{\mathrm{glo}} = \frac{1}{5}\left(H^{\mathrm{day}} + H^{\mathrm{ngt}} + H^{\mathrm{sum}} + H^{\mathrm{win}} + H^{\mathrm{equ}}\right) \tag{3}$$

Also, we can define a polar-winter weighted Global Figure of Merit

$$H^{\mathrm{glw}} = \frac{5}{6}H^{\mathrm{glo}} + \frac{1}{6}H^{\mathrm{win}} \tag{4}$$

The justification for adding this last case is that the polar winter atmospheres is the most distinct of the five cases, and, scientifically speaking, probably the most important.

Figure 3: NO_2 profiles



4 Experiments

Tests were performed for three target species:

pT most important since it affects all other retrievals

CH_4 easiest since it is the most uniformly distributed species

NO_2 most difficult since it has the largest variation

Profiles for these species for the different atmospheres are shown in Figs. 1–3

Microwindows were selected for each retrieval to maximise either the Figure of Merit for one particular atmosphere, or one of the two global cases (Eqs. 3 or 4). The selection was stopped once 5000 measurements or 10 microwindows had been reached.

5 Results

Results for the 3 species are shown in Tables 1–3. Each row represents a set of microwindows selected to maximise a particular Figure of Merit, each column represents the actual Figure of Merit achieved by each set. The asterisks indicate the highest value achieved for a particular atmosphere.

As an example of the actual error profiles, the total and random temperature errors for the winter atmosphere are shown in Figs. 4 and 5 (representing the H^{win} column in Table 1).

6 Conclusions

The results indicate that the 'global' microwindows performance for a particular atmosphere is similar to that of microwindows selected specifically for that atmosphere (in the case of the pT retrieval, the global selections actually perform better, although this is probably just due to chance in finding a particularly good microwindow).

The recommendation, therefore, is to use the polar-winter weighted global microwindow selection for ini-

Table 1: pT MW comparisons.

Select.	H^{day}	H^{ngt}	H^{sum}	H^{win}	H^{equ}	H^{glo}	H^{glw}
day	48.9	43.8	39.9	16.3	44.4	38.7	34.9
ngt	45.6	46.6	32.3	29.0	39.3	38.6	37.0
sum	34.6	32.4	45.1	15.1	33.0	32.0	29.2
win	32.3	33.4	27.3	42.7	29.2	33.0	34.6
equ	42.8	39.0	38.1	18.5	43.9	36.5	33.5
glo	48.3	44.2	46.4	34.2	47.4	44.1	42.5
glw	53.4*	54.1*	54.1*	54.8*	52.9*	53.8*	54.0*

Table 2: CH_4 MW comparisons.

Select.	H^{day}	H^{ngt}	H^{sum}	H^{win}	H^{equ}	H^{glo}	H^{glw}
day	40.3	39.8	41.4	27.4	38.6	37.5	35.8
ngt	40.8	41.9*	39.3	26.7	38.6	37.5	35.7
sum	39.0	39.6	44.6*	29.1	36.4	37.7	36.3
win	28.9	30.5	33.1	33.3*	25.7	30.3	30.8
equ	39.0	38.6	38.6	24.1	41.0*	36.3	34.2
glo	41.0*	41.6	43.5	32.2	38.7	39.4	38.2
glw	40.6	41.2	43.9	32.8	39.4	39.6*	38.4*

tial processing of the MIPAS flight data.

Table 3: NO_2 MW comparisons.

Select.	H^{day}	H^{ngt}	H^{sum}	H^{win}	H^{equ}	H^{glo}	H^{glw}
day	30.8*	29.8	28.7	11.4	26.5	25.4	23.1
ngt	26.0	32.4*	27.2	10.0	22.2	23.2	21.0
sum	24.8	23.8	32.6*	6.0	19.9	21.4	18.9
win	24.5	30.5	24.3	23.1*	22.3	24.9	24.6
equ	23.4	26.9	27.1	5.6	29.2*	22.5	19.6
glo	26.6	31.7	29.2	18.7	23.7	26.0	24.8
glw	27.0	31.3	30.3	17.6	25.1	26.3*	25.0*

Figure 4: Temperature Total error, winter profile

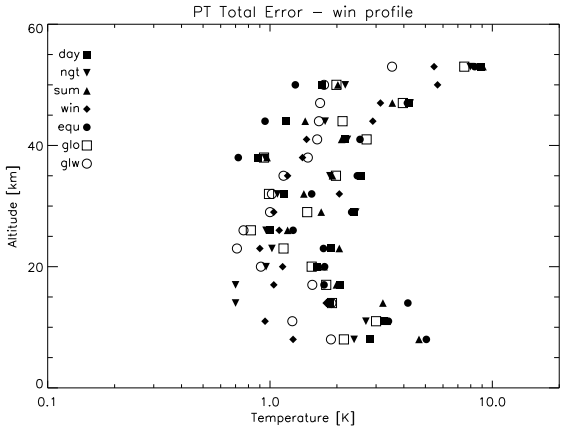


Figure 5: Temperature Random error, winter profile