Retrieval of Minor Species from MIPAS

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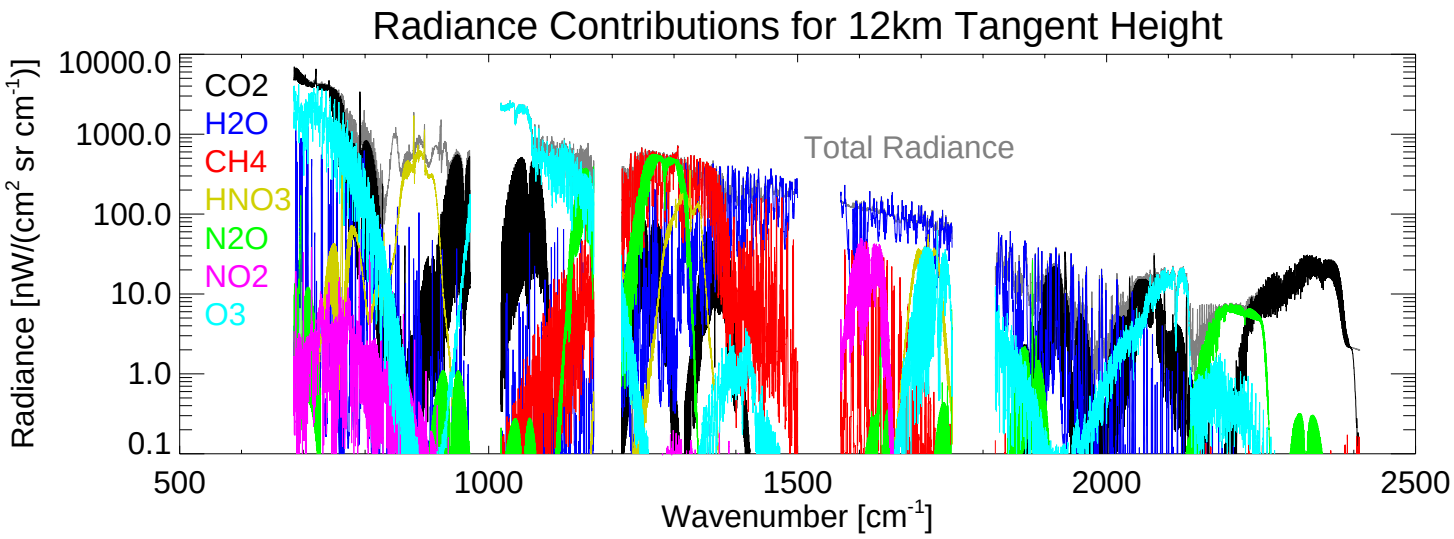
Background

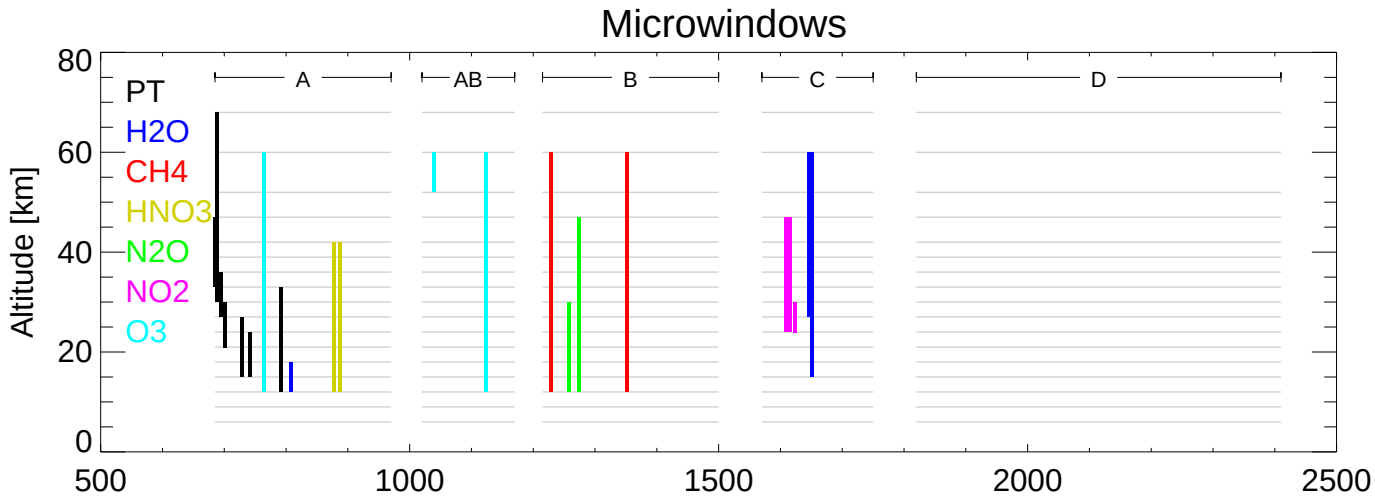
ESA's operational processing for MIPAS retrieves profiles of pressure, temperature, H2O, O3, HNO3, CH4, N2O and NO2

The aim here is to investigate which additional species could be retrieved using substantially the same retrieval algorithm

Operational Algorithm

- Nominal scan pattern 6-68km
- Finite number of microwindows, max 3 cm^{-1} width
- Simultaneous retrieval of continuum in each microwindow
- Generate one independent profile per limb scan
- Local thermodynamic equilibrium


Radiance Contributions for 12km Tangent Height
Radiance [nW/(cm2 sr cm-1)]
10000.0
1000.0
100.0
10.0
1.0
0.1
CO2
H2O
CH4
HNO3
N2O
NO2
O3
Total Radiance
500
1000
1500
2000
2500
Wavenumber [cm-1]


Microwindows
Altitude [km]
80
60
40
20
0
PT
H2O
CH4
HNO3
N2O
NO2
O3
A
AB
B
C
D
500
1000
1500
2000
2500

Approach

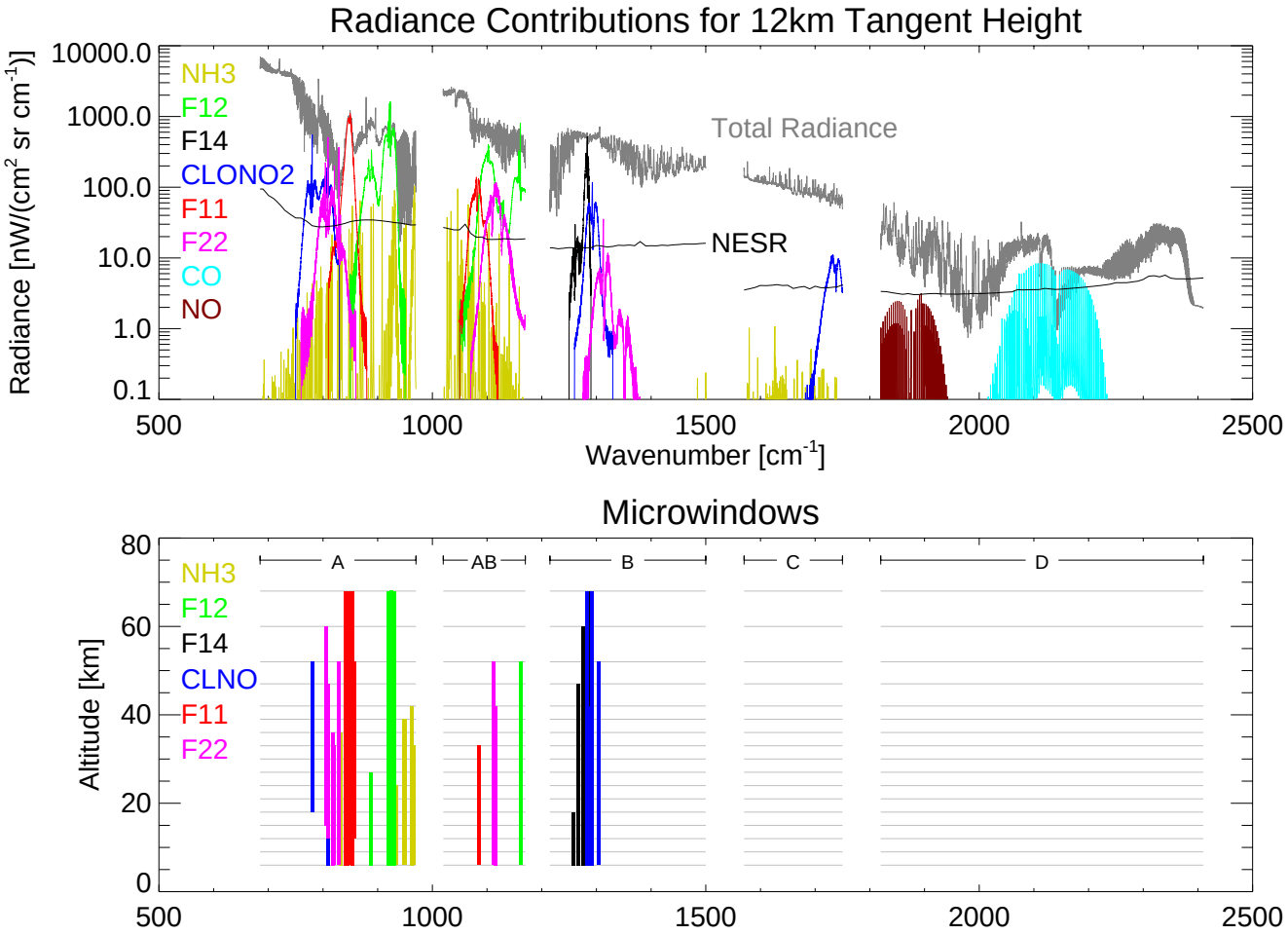
Microwindows are selected to

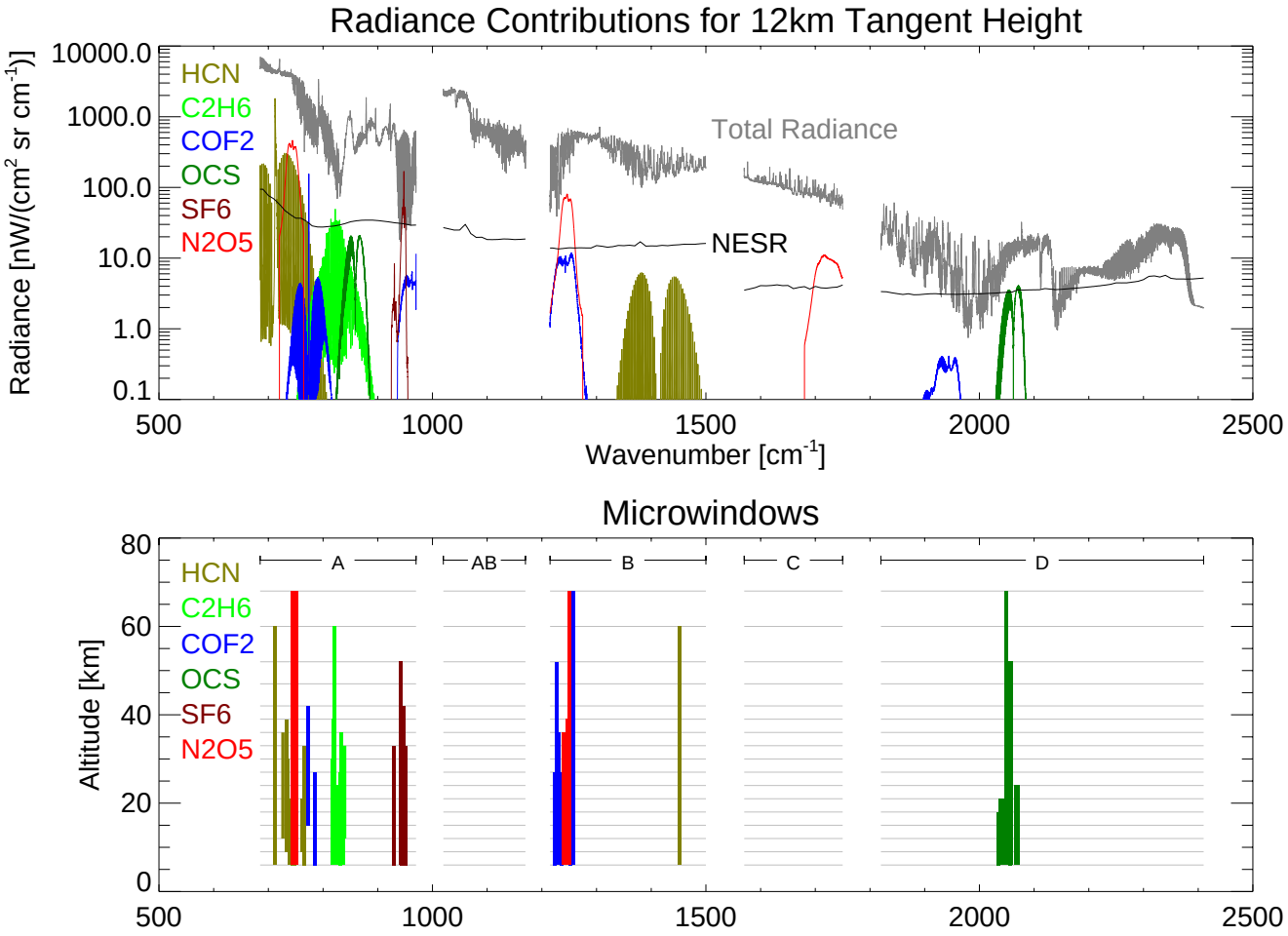
- Maximise information from target species (S/N)
- Minimise systematic error contribution (eg other gases)

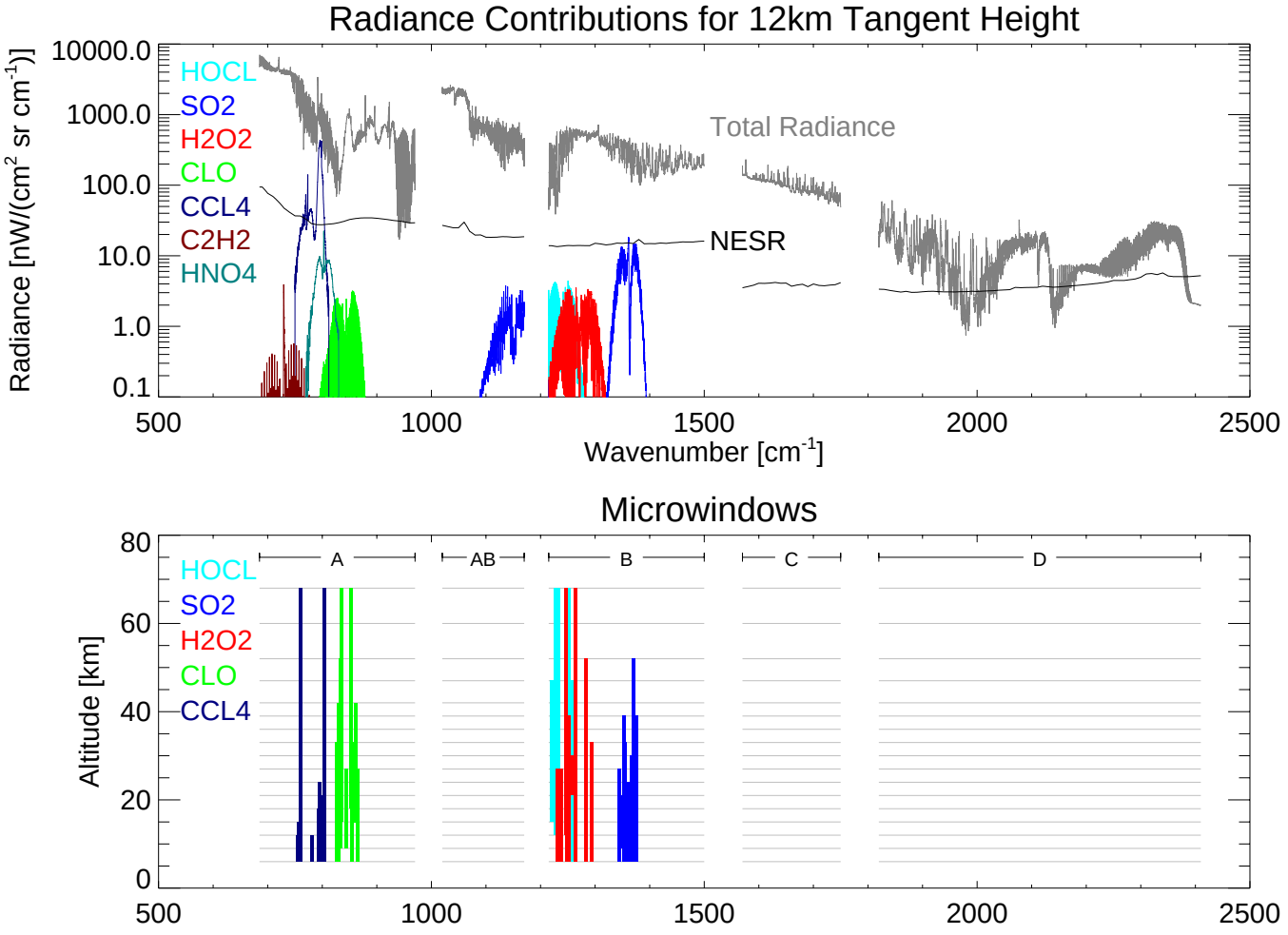
Typically 2-3 microwindows or 2000 measurements per species for the operational products

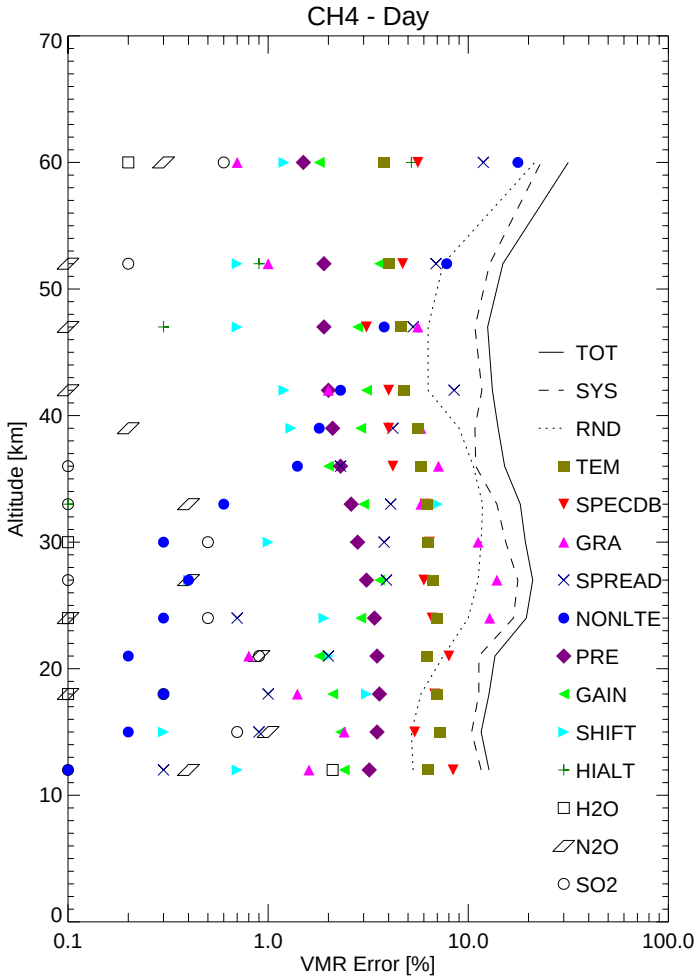
Use the same microwindow selection algorithm but extend to 10 microwindows or 10000 measurements

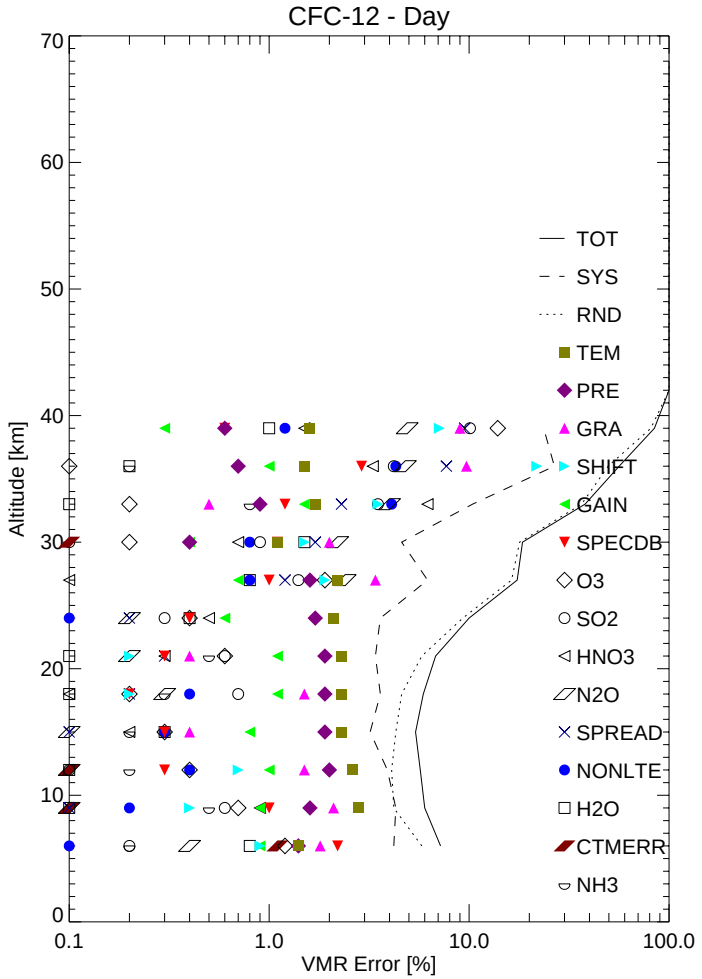
Also assume retrieval extends down to 6km


Radiance Contributions for 12km Tangent Height
Radiance [nW/(cm^2 sr cm^{-1})]
10000.0
1000.0
100.0
10.0
1.0
0.1
NH3
F12
F14
CLONO2
F11
F22
CO
NO
Total Radiance
NESR
500
1000
1500
2000
2500
Wavenumber [cm^{-1}]
Microwindows
Altitude [km]
80
60
40
20
0
A
AB
B
C
D
NH3
F12
F14
CLNO
F11
F22
500
1000
1500
2000
2500


Radiance Contributions for 12km Tangent Height
Radiance [nW/(cm^2 sr cm^{-1})]
10000.0
1000.0
100.0
10.0
1.0
0.1
HCN
C2H6
COF2
OCS
SF6
N2O5
Total Radiance
NESR
500
1000
1500
2000
2500
Wavenumber [cm^{-1}]
Microwindows
Altitude [km]
80
60
40
20
0
A
AB
B
C
D
HCN
C2H6
COF2
OCS
SF6
N2O5
500
1000
1500
2000
2500


Radiance Contributions for 12km Tangent Height
Radiance [nW/(cm2 sr cm-1)]
10000.0
1000.0
100.0
10.0
1.0
0.1
HOCL
SO2
H2O2
CLO
CCL4
C2H2
HNO4
Total Radiance
NESR
500
1000
1500
2000
2500
Wavenumber [cm-1]
Microwindows
Altitude [km]
80
60
40
20
0
A
AB
B
C
D
HOCL
SO2
H2O2
CLO
CCL4
500
1000
1500
2000
2500


CH4 - Day
Altitude [km]
VMR Error [%]
0.1
1.0
10.0
100.0
0
10
20
30
40
50
60
70
TOT
SYS
RND
TEM
SPECDB
GRA
SPREAD
NONLTE
PRE
GAIN
SHIFT
HIALT
H2O
N2O
SO2


CFC-12 - Day
Altitude [km]
VMR Error [%]
0.1
1.0
10.0
100.0
0
10
20
30
40
50
60
70
TOT
SYS
RND
TEM
PRE
GRA
SHIFT
GAIN
SPECDB
O3
SO2
HNO3
N2O
SPREAD
NONLTE
H2O
CTMERR
NH3

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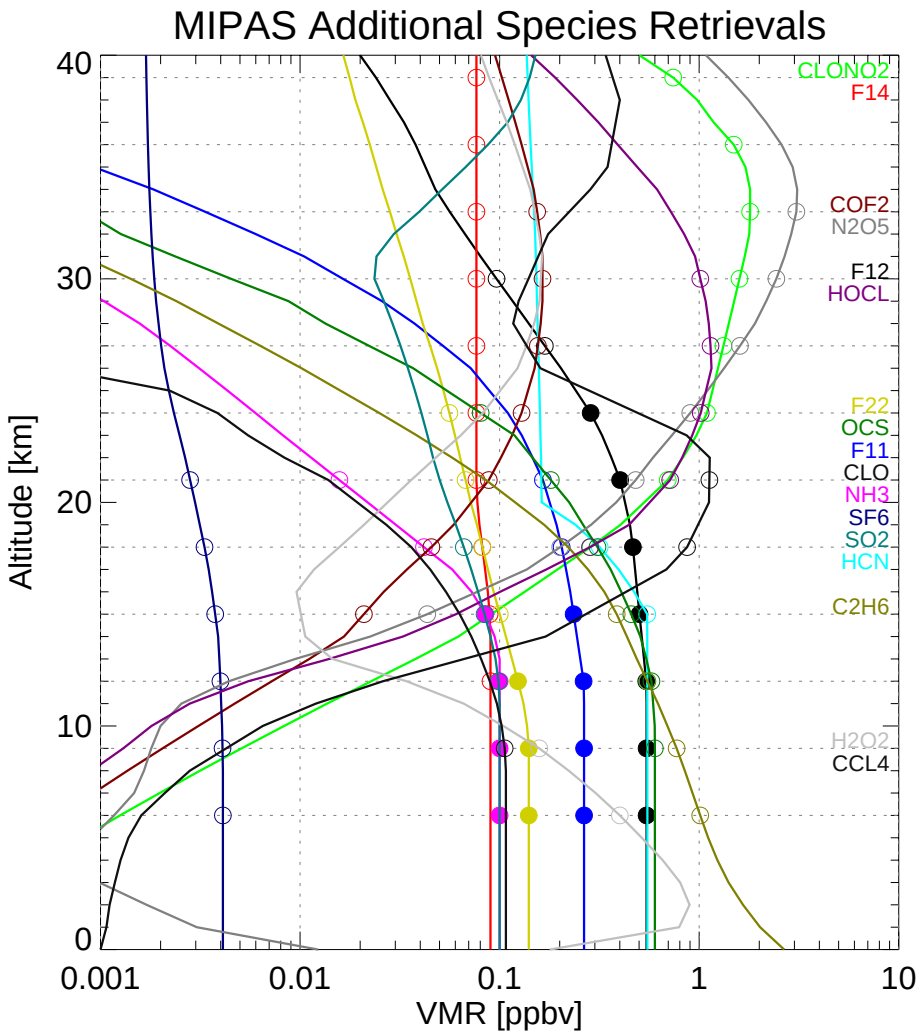

Results

Plot shows assumed profile for each species in this analysis

Open circles where random Error is less than 30%

Filled circles where random Error is less than 10%

MOLECULE	ALT RANGE	INFO
CFC-12	6 – 30 KM	36.2
CFC-14	12 – 52 ? KM	33.1
ClONO2	18 – 39 KM	25.0
CFC-11	6 – 21 KM	23.7
HCFC-22	6 – 24 KM	23.6
NH3	6 – 21 KM	20.2
HCN	12 – 18 KM	19.2
COF2	15 – 33 KM	18.7
OCS	9 – 12 KM	15.2
SF6	6 – 21 KM	15.0
N2O5	15 – 33 KM	13.5
C2H6	6 – 15 KM	13.3
HOCl	18 – 30 KM	12.6

Priority List

Assuming that we start with a priori uncertainty of 100% at 17 profile levels, define information content as 1 bit for every factor 2 improvement at one level.

Table shows top 13 new species in terms of retrieval accuracy, and probable altitude range

Summary

- Potential additions to the list of operationally retrieved MIPAS species have been identified on the basis of expected accuracy
- 'Scientific' priorities have not been considered (yet)
- This analysis depends on assumed profile
- Other species may be retrievable in enhanced conditions, or with different retrieval algorithms