REC Analysis

- Automated the extraction of residuals from ESA L2 format (using IDL, with help from U.Leicester & RAL)

- L2 residuals represent average results from 1∼10 retrievals in time order throughout the orbit, with a common set of occupation matrices for all species.
  - So, for example, if the NO2 OM changes, this will also split the pT residual averages into two sets.

⇒ Too fragmented for REC analysis so further averaging is needed.

- In addition to extracting the L2 residuals, each set has been classified according to L2 residual according to
  - Occupation Matrix Label (not trivial!)
  - Day/Night
  - Ascending/Descending part of orbit
- These are the only classifications we can think of that might require separate REC analysis

⇒ We can now average according to any one or more classifications and perform REC analysis on result.

REC Analysis - Retrieved Species

- Table values are in units where ± 1 represents a fit climatological of $\pm 1\sigma$ variability signature

- Use of retrieved profiles should remove all signatures from residuals of other microwindows, so expect signatures $\simeq 0$.

Source	504	2081	2082	2083	K-All	K-Aug
o3	-0.21	-0.12	-0.09	-0.13	-0.18	-0.12
no2	0.06	0.05	0.05	0.05	0.11	0.05
hno3	-0.28	-0.16	-0.05	-0.07	-0.17	-0.08
ch4	0.06	-0.12	-0.09	-0.12	-0.26	-0.15
n2o	0.07	0.03	0.04	0.03	0.23	0.05
h2o_12	-0.10	0.00	0.06	-0.01	-0.23	-0.10
h2o_st	-0.23	0.02	0.10	0.04	1.86	-1.10

K-All = all data received from Kiruna 07 Jul 02 – 03 Aug 02

K-Aug = data from Kiruna for 02 Aug 02 – 03 Aug 02 only

$\Rightarrow$ ESTEC retrievals better than Kiruna

$\Rightarrow$ Orbit 2081–83 retrievals better than 504

$\Rightarrow$ Kiruna August retrievals better than July

REC Analysis - Contaminant Species

- Use of climatological profiles for these species should result in signatures $< \pm 1$.

Source	504	2081	2082	2083	K-All	K-Aug
so2	0.05	0.06	0.05	0.05	−0.14	0.04
nh3	−0.54	−0.50	−0.62	−0.70	−0.41	−0.67
hcn	0.07	0.17	0.06	0.13	−0.04	−0.19
n2o5	0.81	1.03	1.00	1.21	1.21	0.82
clono2	2.31	0.53	0.24	0.78	3.80	0.90
cof2	3.90	3.39	3.24	3.90	1.10	3.72
f12	6.17	8.88	13.96	15.97	−0.70	14.52
co2	−0.66	−3.44	−3.57	−3.11	12.28	−2.52
ccl4	11.37	6.97	3.99	8.99	3.09	6.25

$\Rightarrow$ Kiruna August results consistent with 2081–2083, so assume these are more meaningful

$\Rightarrow$ SO2 variability overestimated - allows for volcanic eruptions (none detected so far!)

$\Rightarrow$ Actual N2O5 appears to be at upper end of 1σ variability - climatology is day time mean when N2O5 is at a minimum

$\Rightarrow$ COF2 and CFC-12 climatologies significantly *underestimate* true atmospheric profile

$\Rightarrow$ CO2 climatology significantly *overestimates* true atmospheric profile.

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REC Analysis - Forward Model Errors

- These represent 'missing physics' from the forward model calculations, so expect signatures $\simeq +1$

Source	504	2081	2082	2083	K-All	K-Aug
co2mix	0.48	0.27	0.35	0.28	0.68	0.43
nonlte	0.22	-0.18	-0.11	-0.16	1.27	0.28

$\Rightarrow$ CO2 line mxing generally 25–50% anticipated effect

$\Rightarrow$ non-LTE effects much smaller, and often inverted! - partly due to averaging day and night profiles?

REC Analysis - Diurnal Variations

- Split residuals into day time and night time, defined by the solar zenith angle.

Source	504	2081	2082	2083	K-All	K-Aug
Day						
nonlte	0.33	−0.16	−0.10	−0.09	1.49	0.38
n2o5	0.81	0.70	0.86	0.89	1.29	0.78
Night						
nonlte	0.11	−0.19	−0.12	−0.27	0.98	0.09
n2o5	0.83	1.41	1.19	1.67	1.09	0.82

⇒ N2O5 still significantly underestimated in day-time

⇒ non-LTE signal still not resolved - problem with assumed modelling?

REC Analysis - Spectral derivatives

- In addition to forward model errors, also fit 0th, 1st and 2nd derivative spectra to each microwindow/sweep.

  Some initial findings:

$\Rightarrow$ 1st derivative shows consistent shift $\pm 0.001 \text{cm}^{-1}$ across spectrum, and similar shift from low altitude to high altitude

$\Rightarrow$ CH4_0021 (C-band back-up microwindow) shows large signatures in all derivatives - problem with this microwindow?

Summary

Still a lot more work to be done in analysing data using different averages (e.g., by occupation matrix for different latitude bands and nominal/non-nominal modes).

L2 Auxiliary Data

- Only change since launch has been to increase height margins in Occupation Matrices (as requested at the last CalVal meeting).

- Chiara has investigated Occupation Matrices actually used in operational data . . .