HITRAN Error Correlations
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This report compares the effect of two different assumptions regarding the treatment of error correlations in the HITRAN database:

1. Assume errors are uncorrelated between microwindows (as currently assumed in the MW/OM selection)
2. Assume errors are fully correlated for all microwindows

In reality, HITRAN errors would probably be correlated for particular vibration bands, which would be some intermediate regime between the above two cases.

The analysis is performed for the Jul01 delivery of nominal occupation matrices, so case (1) corresponds to the 'hitran' errors listed in the tables of the error analysis accompanying that database (issued 23rd August).

Tables 1–8 summarise the results for the individual retrievals, showing the total systematic error and the HITRAN component for the two cases. Also shown is the information content (bits) of the retrieval in each case, the first figure based on the full covariance matrix and the second figure based on just the diagonal elements. Note that for pT, the diagonal information content is larger due to the pointing correlations in the *a priori* being ignored in the diagonal case (information content is based on improvement over the *a priori* data, so if the *a priori* correlations are ignored the *a priori* appears worse). Entries in **bold** signify altitudes where the HITRAN error is the largest systematic error component.

Results:

1. Assuming full correlation generally increases the size of the HITRAN error component by up to 50%, although for N_2O the effect is marginal.
2. This adds a maximum of 5% to the total systematic error at certain altitudes, although 1–2% is a more typical value.
3. The increased systematic error leads to loss of information in the diagonal elements of the covariance of 1–2 bits typically, 4 bits for the pT retrieval.
4. However, the overall loss of information in the full retrieval covariance is generally small: a maximum of 0.2 bits (CH_4), more typically 0.1 bits and, for pT, actually an improvement of 1.3 bits. This suggests that the assumption of correlated HITRAN errors shifts information from the diagonal to the off-diagonal elements of the retrieval covariance but does not have much effect on the total information content of the retrieval.

Table 1: CH_4 error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km	52km	60km
Uncorrelated HITRAN errors (40.7/38.2 bits)														
Tot.Sys	10.2	11.1	11.8	13.4	16.7	16.7	18.0	14.7	11.9	10.0	9.1	8.2	8.5	14.1
hitran	5.5	4.1	5.9	6.0	5.8	4.7	6.9	4.0	5.1	3.3	3.6	3.2	3.9	6.6
Fully Correlated HITRAN errors (40.5/37.1 bits)														
Tot.Sys	11.7	12.1	14.1	15.1	18.3	17.2	18.0	14.9	12.6	10.3	9.1	8.7	8.8	14.3
hitran	**8.1**	**6.4**	**9.5**	**9.3**	9.0	6.3	6.3	4.5	6.0	4.0	3.7	4.2	4.2	5.7

Table 2: H_2O error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km	52km	60km
Uncorrelated HITRAN errors (41.0/36.9 bits)														
Tot.Sys	20.1	19.7	21.0	13.5	11.6	12.0	11.1	11.8	10.7	11.3	13.4	21.9	16.3	27.7
hitran	6.5	7.6	**16.0**	6.6	6.6	**8.5**	**7.8**	**9.2**	**7.9**	**8.6**	**9.6**	8.9	7.2	5.2
Fully Correlated HITRAN errors (40.9/34.2 bits)														
Tot.Sys	19.3	20.7	19.7	15.7	14.0	14.8	14.3	16.2	14.7	14.4	17.2	23.7	17.6	28.4
hitran	−5.6	2.0	7.6	**10.0**	**10.1**	**11.9**	**11.8**	**14.4**	**12.7**	**12.2**	**14.4**	12.5	**10.1**	6.4

Table 3: HNO_3 error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km
Uncorrelated HITRAN errors (34.9/33.3 bits)											
Tot.Sys	15.1	9.6	7.5	5.5	5.7	6.2	6.5	7.6	8.9	16.2	22.5
hitran	**15.1**	3.3	4.4	3.2	**4.1**	**5.2**	**5.9**	**6.4**	**6.6**	7.4	**12.1**
Fully Correlated HITRAN errors (34.8/31.0 bits)											
Tot.Sys	26.7	9.7	8.4	6.5	7.0	9.1	9.8	11.7	12.9	16.6	20.5
hitran	**20.0**	2.4	**5.3**	**4.4**	**5.6**	**8.3**	**9.3**	**11.3**	**10.9**	**8.9**	3.6

Table 4: N_2O error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km
Uncorrelated HITRAN errors (35.6/34.0 bits)												
Tot.Sys	7.8	9.0	9.9	8.2	8.6	10.2	10.2	11.7	11.2	9.8	8.0	16.2
hitran	1.7	2.0	1.4	2.5	3.4	5.1	5.7	**5.8**	**5.6**	**5.6**	**5.6**	5.4
Fully Correlated HITRAN errors (35.6/34.0 bits)												
Tot.Sys	7.7	9.0	10.0	8.8	8.4	9.9	10.5	11.2	11.0	9.5	8.8	15.5
hitran	0.8	−1.7	0.3	3.9	3.2	4.8	5.6	**5.5**	**5.8**	**5.1**	**5.4**	5.0

Table 5: NO_2 error contributions [%].

Alt	24km	27km	30km	33km	36km	39km	42km	47km
Uncorrelated HITRAN errors (25.0/24.5 bits)								
Tot.Sys	13.1	9.2	7.6	6.8	5.8	5.0	6.5	7.7
hitran	2.9	2.3	1.1	0.7	1.9	1.9	**4.8**	**6.3**
Fully Correlated HITRAN errors (24.9/24.1 bits)								
Tot.Sys	13.4	9.5	7.6	6.8	6.2	5.4	6.5	12.6
hitran	−2.7	−2.6	0.5	0.4	2.7	2.7	**3.1**	**8.1**

Table 6: O_3 error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km	52km	60km
Uncorrelated HITRAN errors (49.6/47.7 bits)														
Tot.Sys	16.8	17.7	17.1	7.6	6.9	6.5	6.9	6.5	5.2	4.5	3.8	6.8	6.2	12.8
hitran	4.2	**8.0**	1.8	1.6	**4.3**	2.8	**4.4**	3.2	1.8	1.8	1.8	2.1	2.0	4.3
Fully Correlated HITRAN errors (49.5/46.9 bits)														
Tot.Sys	16.7	18.4	17.1	7.9	6.8	7.4	7.3	7.1	5.7	5.0	4.5	7.1	6.8	12.1
hitran	4.0	3.9	0.5	2.4	3.5	**4.5**	**4.8**	**4.4**	2.8	2.8	**2.9**	3.1	**3.4**	0.8

Table 7: Pressure error contributions [%].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km	52km	60km	68km
Uncorrelated HITRAN errors (44.5/59.4 bits)															
Tot.Sys	6.3	6.4	6.7	6.9	6.4	5.2	3.8	2.6	2.5	2.9	3.4	3.5	3.6	4.0	4.1
hitran	2.6	2.7	2.7	2.6	2.5	2.3	1.9	**1.8**	**2.2**	**2.6**	**3.1**	**3.2**	**3.0**	**3.0**	**2.9**
Fully Correlated HITRAN errors (45.8/55.2 bits)															
Tot.Sys	7.4	7.4	7.6	7.7	7.2	6.2	5.0	4.0	3.7	3.9	4.1	4.3	4.3	4.7	4.8
hitran	**4.5**	**4.5**	4.4	4.2	4.1	**3.9**	**3.6**	**3.2**	**3.3**	**3.5**	**3.9**	**4.0**	**3.8**	**3.7**	**3.7**

Table 8: Temperature error contributions [K].

Alt	12km	15km	18km	21km	24km	27km	30km	33km	36km	39km	42km	47km	52km	60km	68km
Uncorrelated HITRAN errors (44.5/59.4 bits)															
Tot.Sys	2.36	2.33	1.91	1.79	2.27	2.27	2.60	1.67	1.55	1.31	1.18	1.60	0.85	2.63	4.02
hitran	0.37	0.84	0.56	**1.01**	0.64	0.36	0.65	0.65	0.47	0.59	0.27	**0.79**	0.21	0.28	0.30
Fully Correlated HITRAN errors (45.8/55.2 bits)															
Tot.Sys	2.44	2.38	1.96	1.85	2.30	2.33	2.66	1.86	1.54	1.34	1.16	1.45	0.84	2.63	3.99
hitran	−0.70	−0.98	−0.69	**−1.00**	−0.68	−0.60	−0.73	−0.94	−0.40	−0.46	−0.02	−0.65	−0.19	−0.22	0.13