Multi-year changes in global Aura MLS stratospheric measurements and comparisons with ACE-FTS data

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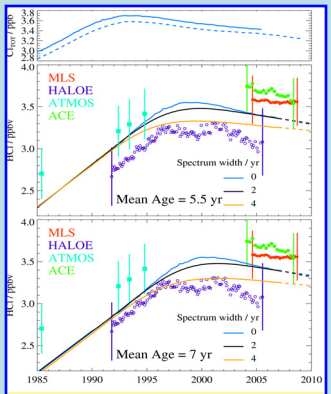
Long-term changes in upper stratospheric HCl (and total Cl)

- In the upper stratosphere/lower mesosphere (near 50 km), HCl makes up ~95% of total chlorine.

- A slow decrease in HCl is expected, reflecting the known (internationally agreed-to) decrease in industrial source gas (CFC) emissions (a major threat to the ozone layer).

- Updated plot from *Froidevaux et al.* [2006] (see also WMO, 2007) → global MLS HCl v2.2 data near 55 km versus other satellite datasets, including UARS HALOE and ACE-FTS (v2.2) data from the SciSat mission.



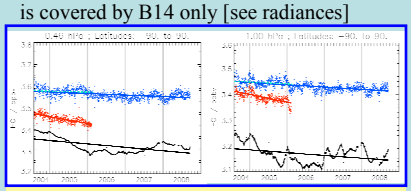
Update of *Froidevaux et al. [2006]*

Average HCl in past 4 years

- Daily continuous band 13 (B13) MLS data ceased in mid-Feb 2006 because of rapid degradation in B13 counts after Jan. 2006.
- MLS B14 covers most of B13 spectral region and is used to retrieve (v2.2) HCl.
- The MLS v2.2 HCl decrease is slower than the initial decrease (from 1.5 yr of data).
- The MLS HCl decrease is also slower than indicated by the ACE-FTS global HCl data [and slower than models/expectations].
- MLS radiance analyses reveal differences between the trends in radiance signals obtained from different MLS bands.

• MLS Level 2 retrievals

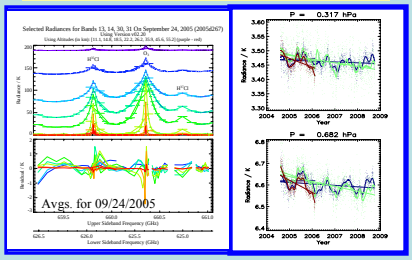
- v1.5 software used combination of B13 and B14 (covering ^{35}HCl and ^{37}HCl lines).
- v2.2 software uses B14 only (also covering ^{35}HCl & ^{37}HCl – but using different channels); a combined B13/B14 retrieval is also produced as a diagnostic.
- ^{37}HCl line (this isotope is 24% of total) is covered by B14 only [see radiances]



"Long-term" (4 yr) and short-term (1.5 yr) fits to MLS global HCl from band 14 & bands 13/14 retrievals. **Black points** = SLIMCAT model run.

• Radiances

MLS radiances from HCl emission (measured via Band 13 and Band 14)

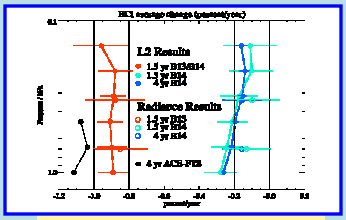


Radiances (top), residuals (bottom) | HCl radiances & linear fits.

Channels: **B14 = thick**, B13 = thin. | **B14 ^{35}HCl; B13 ^{35}HCl**; B14 ^{37}HCl

Short-term (1.5 yr) decrease using B13 radiances occurs at a faster rate than both short & long-term results from B14 signals

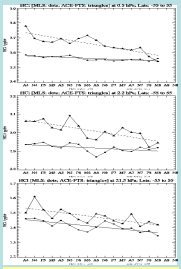
→ Level 2 algorithms are not the main issue.



HCl "trends" from different methods

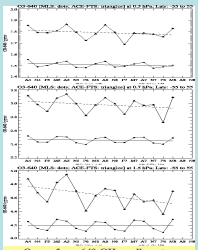
• MLS & ACE-FTS results

- Consider variations in various MLS and ACE-FTS (common) products; seasonal averages of near-global (60S-60N) results are shown below.



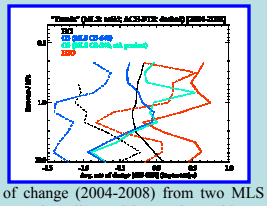
HCl

The differences between the rates of change for HCl are more pronounced in the upper stratosphere and lower mesosphere; better agreement is found in the lower stratosphere (although there is more variability there).



Ozone from 640 GHz radiometer (also used for HCl retrievals)

"Trend" differences (in US/LM) between ACE-FTS O_3 and O_3 retrieved from the 640 GHz radiometer data (same as used for HCl) do not shed a lot of light on HCl, as the level of agreement depends on pressure, and the variability (and error bars) are not small.



- Rates of change (2004-2008) from two MLS ozone products match well - and better than with ACE-FTS ozone "trend" results [see above]. Sampling and error bar issues have not been fully investigated (preliminary work).

• The MLS team continues to investigate this HCl trend issue between the two bands.
- Band 13 turn-on (with limited lifetime left) and other tests are being considered.

• Note, however, that this upper stratospheric issue does **not** impact lower to mid-stratospheric studies of much faster changes (e.g., vortex processing during winter).

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