SpecMo Workshop 2014
Dijon, Bourgogne
22 - 23.05.2014

Etudes multi-spectrales de l'O_3 pour l'amélioration des paramètres spectroscopiques (SMO_3) : mesures de laboratoire et atmosphériques

LERMA²

C Janssen, C Boursier, H Elandaloussi, P Jeseck, P Marie-Jeanne, C Rouillé, F Thibout, M Escudier, YV Té

Challenge of Atmospheric Composition Measurements by Remote Sensing

FTS-Paris

Té et al. *JAOT,* 2012

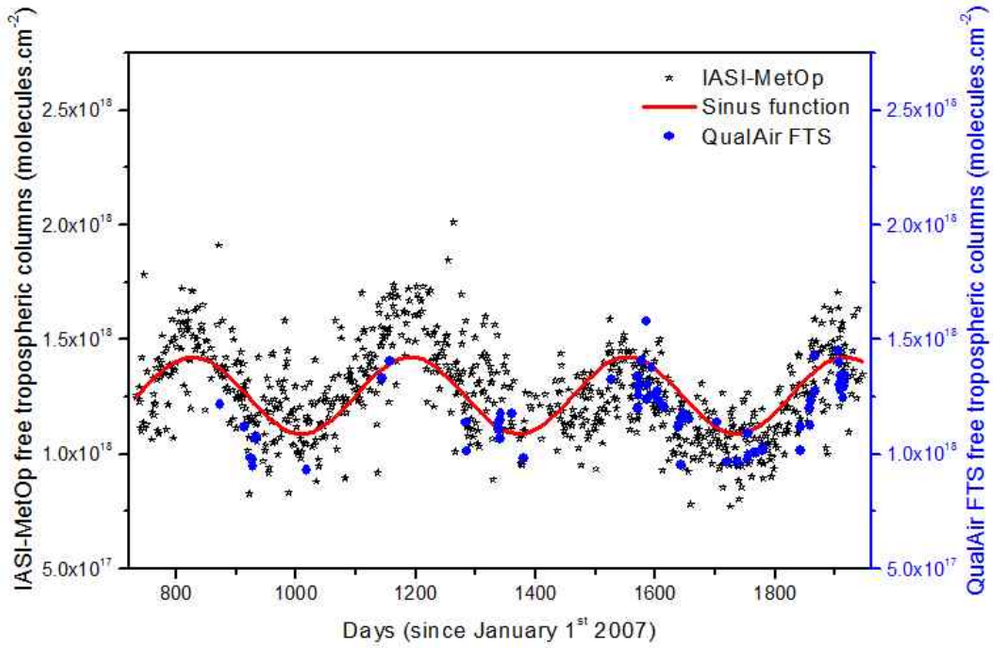
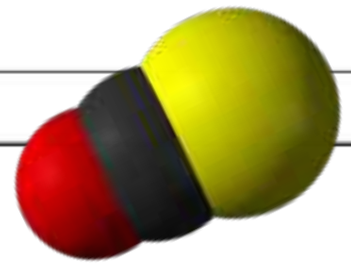


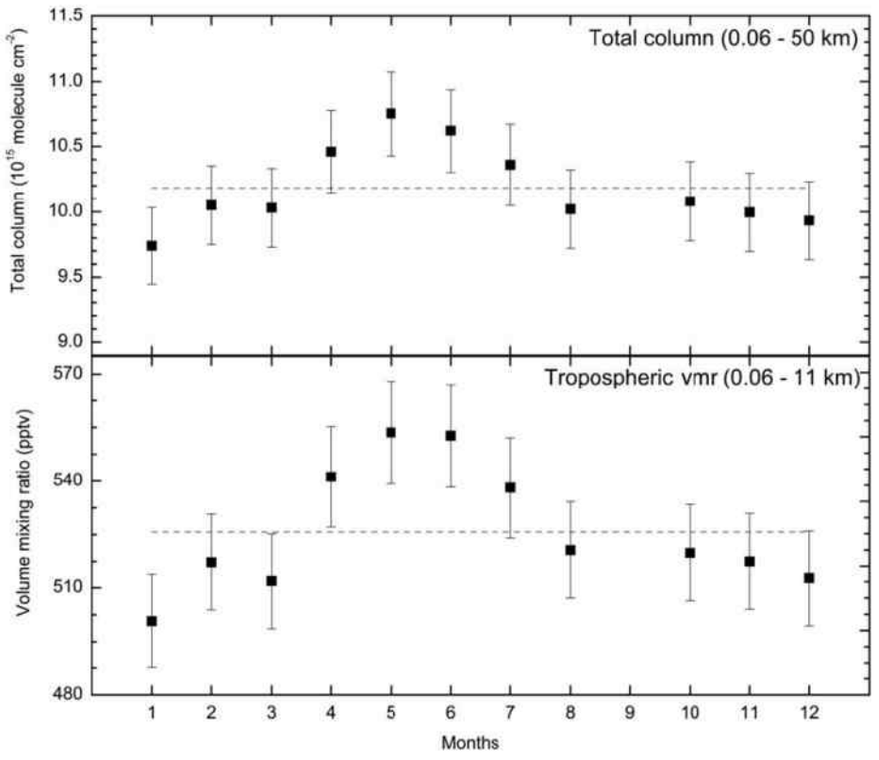
TABLE 1. CO retrieved total column uncertainties.

Random errors	
Error source	CO error (%)
Temperature	1.8
Instrument noise	<1
Solar zenith angle	1.1
Interfering solar lines	<1
Total random error	2.4
Systematic errors	
Spectroscopic parameters	3–6.8
A priori profile	<1
Instrument line shape	<1
Total systematic error	3.1–6.9



Error source	OCS error (%)
Temperature	<0.5
Instrument noise	<0.5
Solar zenith angle	0.9
Interfering solar lines	<0.5
A priori profile	<0.5
Instrument line shape	1
Spectroscopic parameters	4.5 to 9.5
Total error	4.7 to 9.7

Krysztofiak et al., *A-O* 2014



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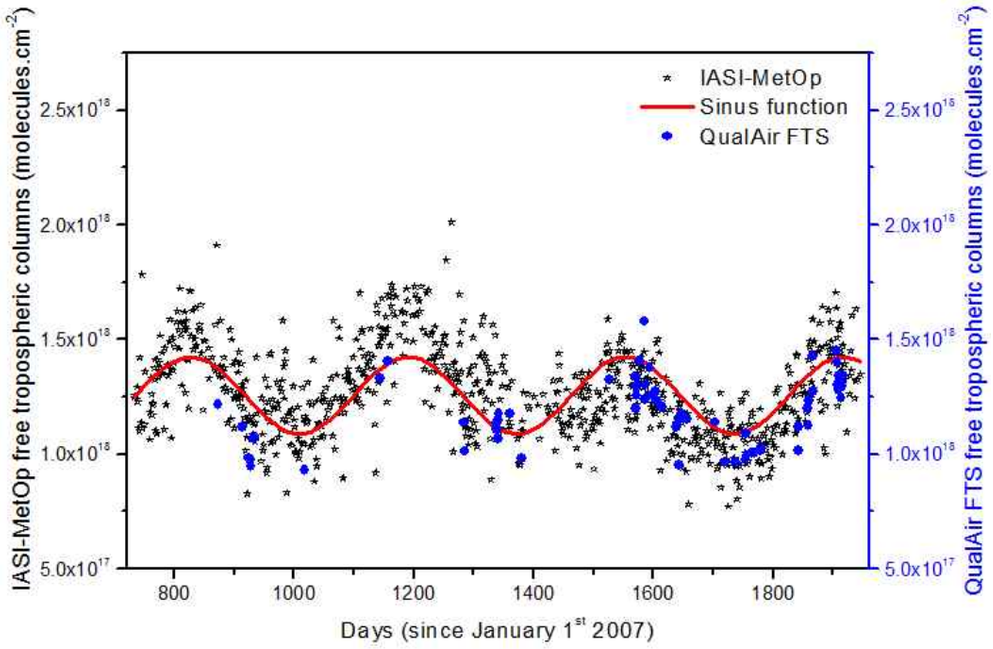

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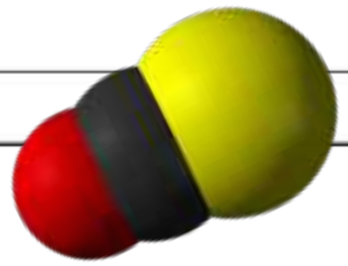

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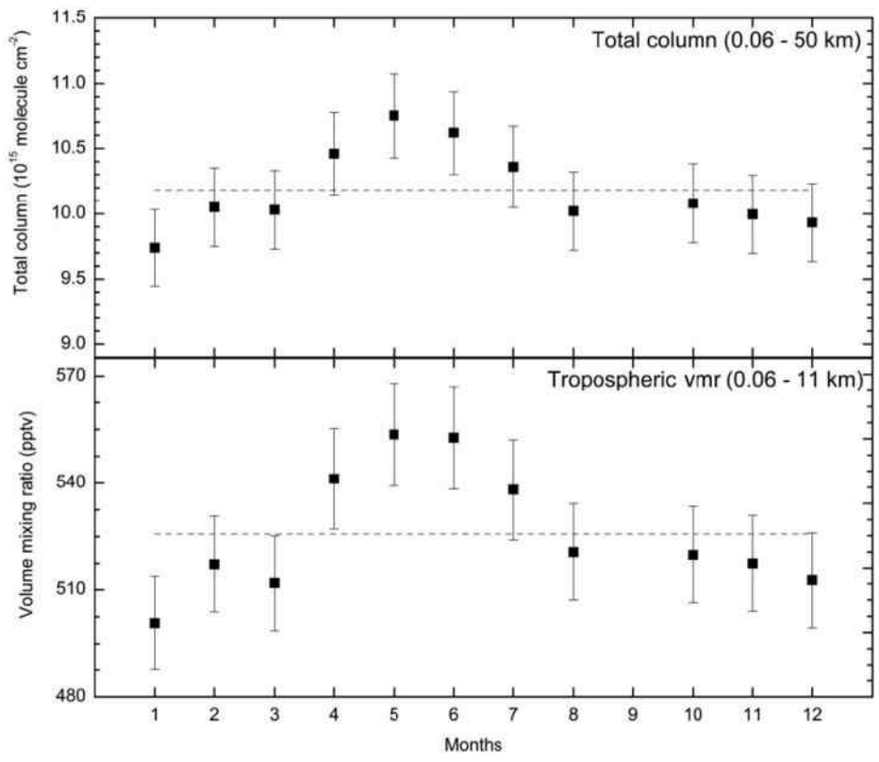


Challenge of Atmospheric Composition Measurements: LEFE-TCCON Paris

FTS-Paris

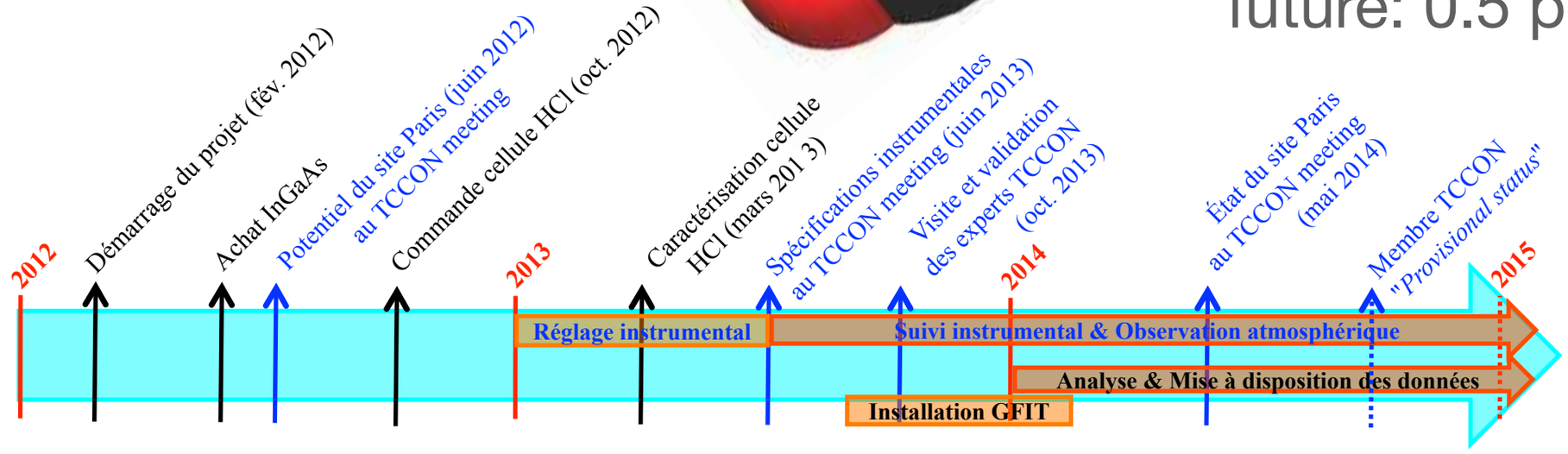
- 29 sites
- high-resolution
- GHG: CO_2, CH_4, N_2O, HF, CO, H_2O, HDO
- LEFE-TCCON

2012-2013: HCl gas cell + InGaS detector

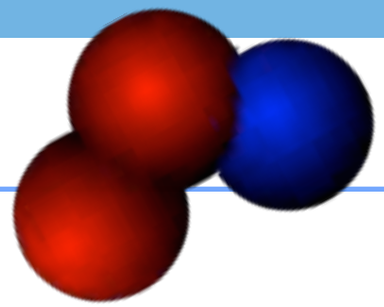
- required precision

right now: 1 ppm → 0.25 %

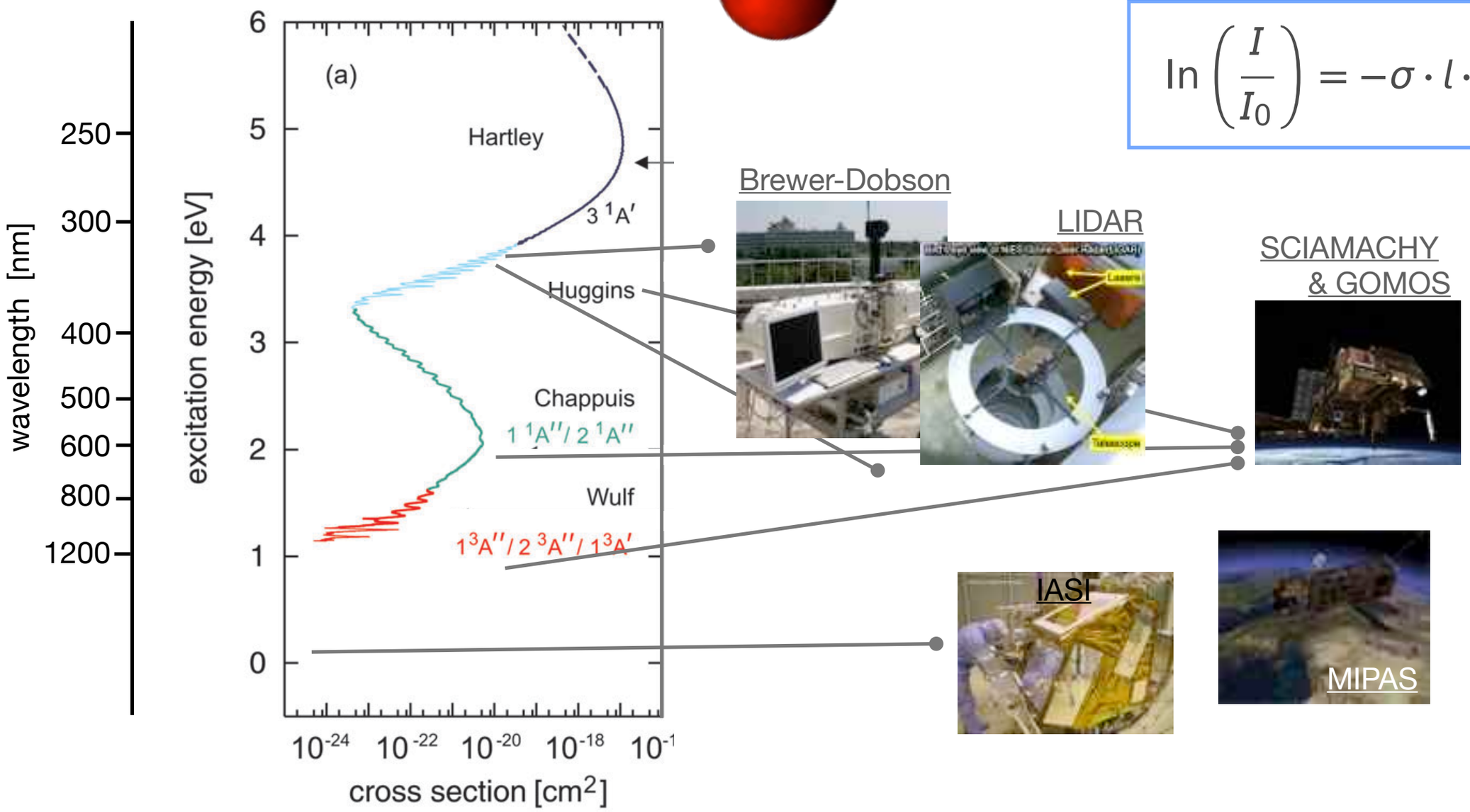
future: 0.5 ppm → 0.125 %



Spectrometry of Atmospheric O_3



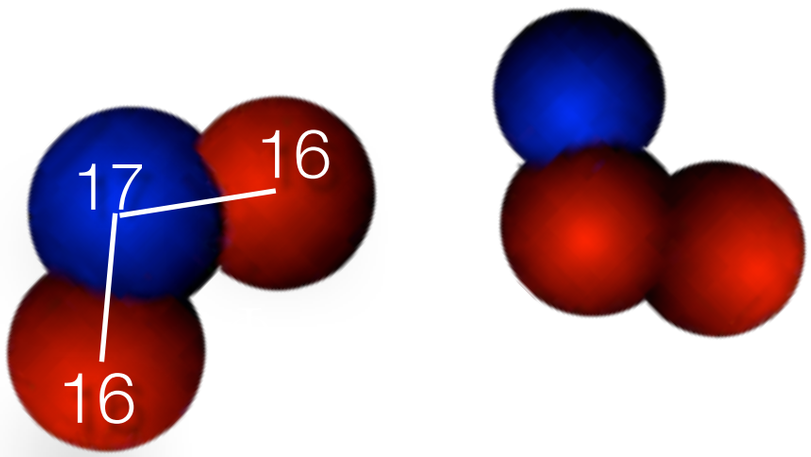
$$\ln\left(\frac{I}{I_0}\right) = -\sigma \cdot l \cdot n$$



cross section from: S. Y. Grebenshchikov, Z. W. Qu, H. Zhu, and R. Schinke, Phys. Chem. Chem. Phys. 9(17), 2044–2064 (2007)

O_3 as Metrological Challenge

- Reactive molecule (E_0 = 1 eV)
- Fragile, decomposes on surfaces
- Ozone is a key atmospheric compound
  - climate & composition change
  - air quality
- Large isotope anomaly, *i.e.* interesting tracer
- Use in industry & technology
  - *i.e.* water purification & plasma etching
- Health effects



2 recommended reference standards (BIPM)

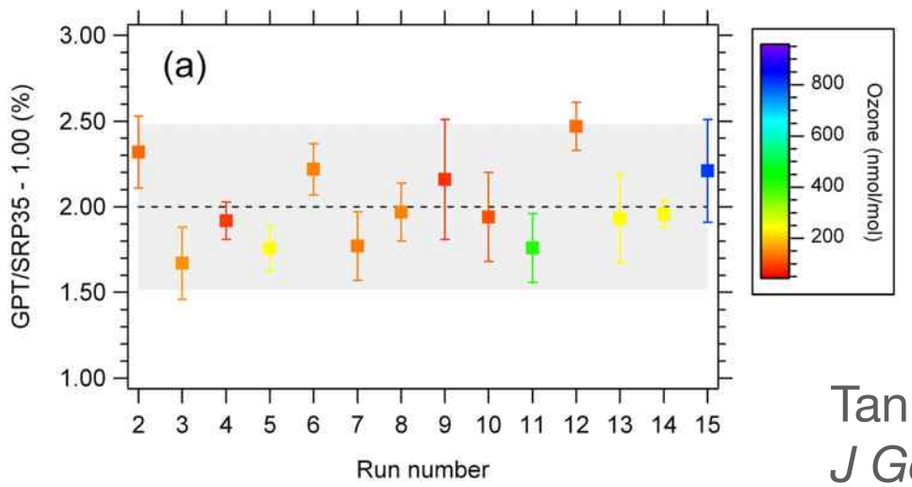
- *1. Gas Phase Titration (GPT)*

  $O_3 + NO \rightarrow NO_2 + O_2$

- *2. Absorption photometry (AP) at 253.65 nm (Hg)*

  spectroscopic, ozone, based on σ_{UV}

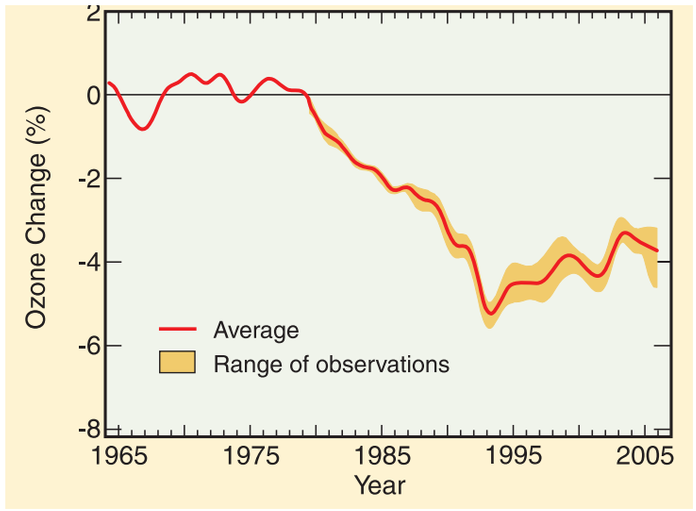
Problem : current methods don't fit
GPT ~ AP + 2%



Tanimoto *et al.*, *J Geophys Res*, *D16313, 2006*

Ozone Spectroscopic Data Quality

- target uncertainty : < 1%



Scientific Assessment of Ozone Depletion 2010, WMO

- Inconsistencies in atmospheric & laboratory data (+ data bases)
  - Lab: IR (10 µm / 1000 cm^{-1}) - UV (300 nm):
    - 5.5 % (Picquet-Varrault et al., 2005) &
    - 4.0 (± 0.1)% (Gratien et al., 2010)
  - Column-O_3: FTIR (962 -1044 cm^{-1}) - Brewer (303.2 - 320.1 nm) @ Izaña:
    - 4.2 ± 0.7 % (*e.g.* Viatte et al., *Atmos. Meas. Tech*. **4**, 2011)

Atmos. Meas. Tech. Discuss., 7, 2071–2106, 2014
www.atmos-meas-tech-discuss.net/7/2071/2014/
doi:10.5194/amtd-7-2071-2014

Atmospheric Measurement Techniques Discussions

Quality assessment of ozone total column amounts as monitored by ground-based solar absorption spectrometry in the near infrared (> 3000 cm^{-1})

O. E. García[1], M. Schneider[1,2], F. Hase[2], T. Blumenstock[2], E. Sepúlveda[1,3], and Y. González[1]

Rel. retrieval bias using recommended data

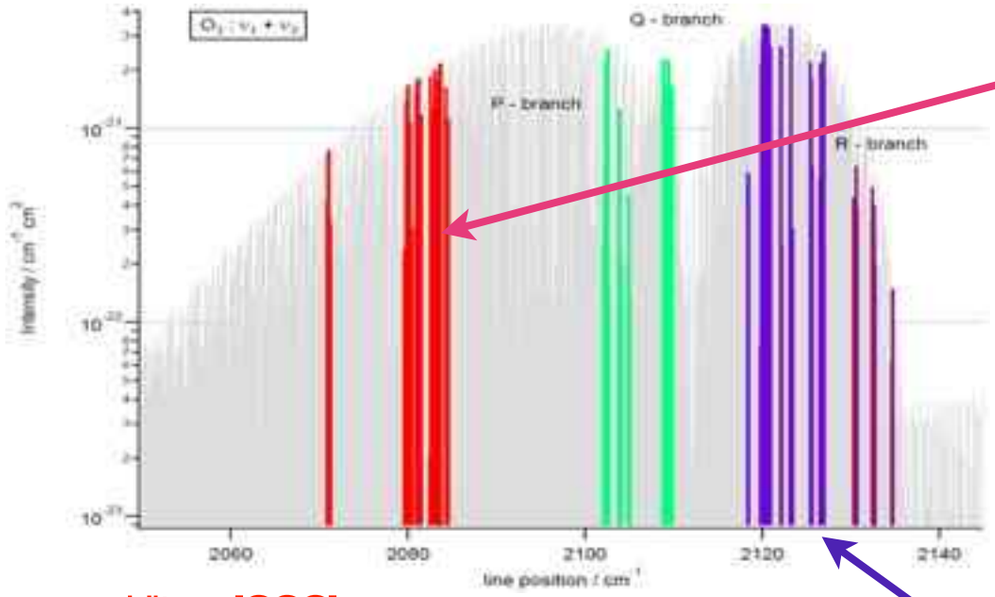
	UV	VIS	3 µm	5 µm	10 µm	14 µm
UV					-4 %	
VIS				0 ?		
3 µm						
5 µm		0 ?			?	
10 µm	4 %		-7 %	?		?
14 µm					?	

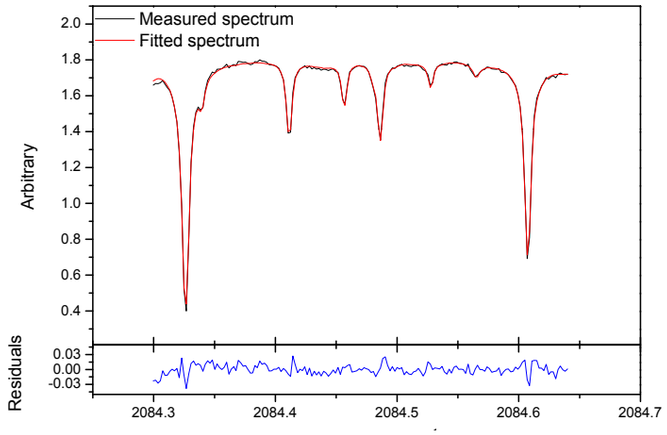
O_3 Multispectral Study

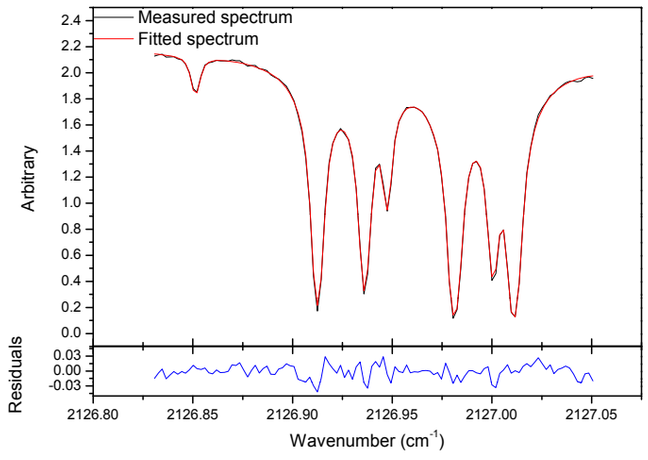
FTS-Paris

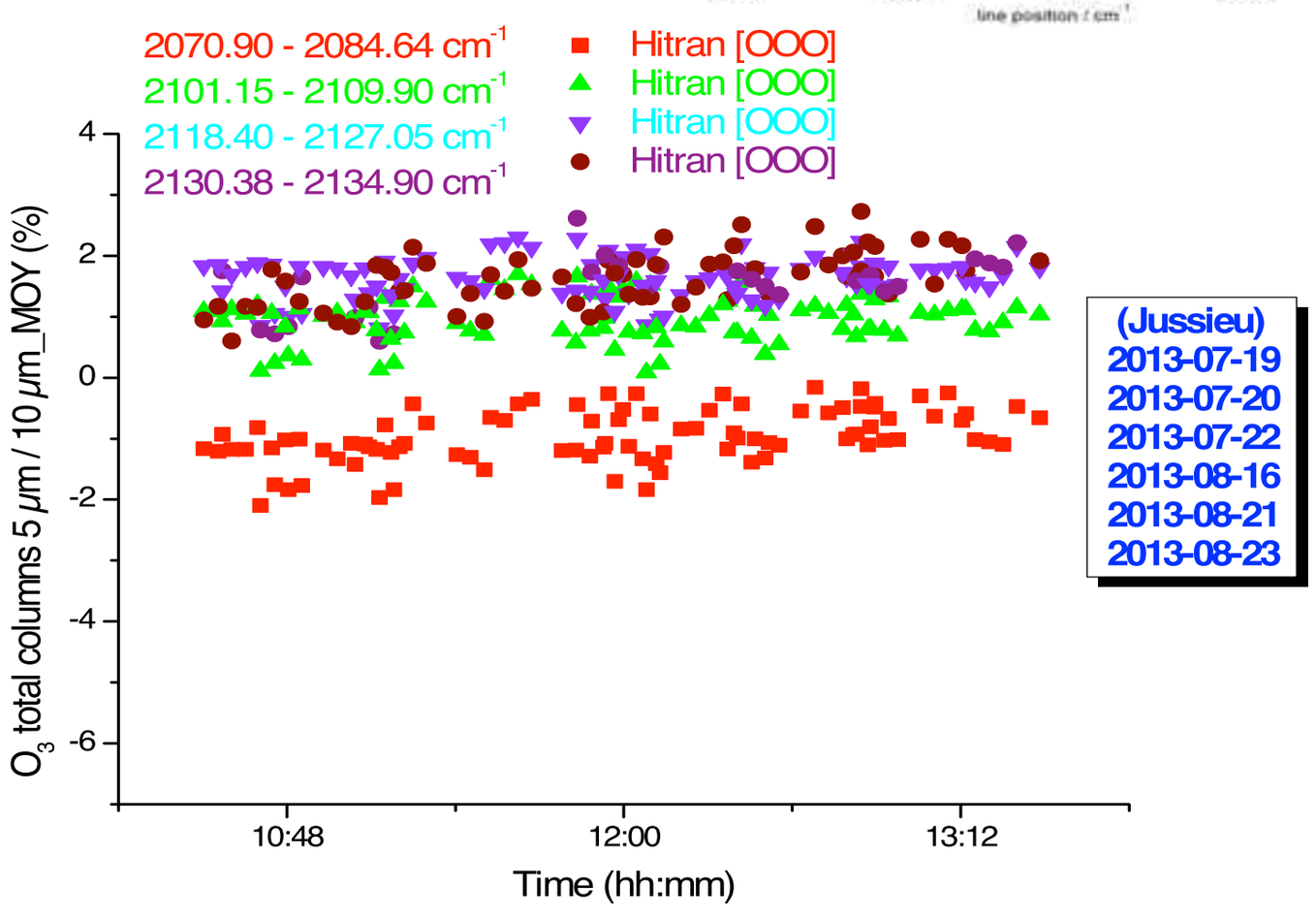
Good agreement (< 2%) between 5 and 10 µm (Thomas et al. *JQSRT* **111**, 2010)

Problem with evaluation of (ACE) satellite data (Walker et al. 2007)

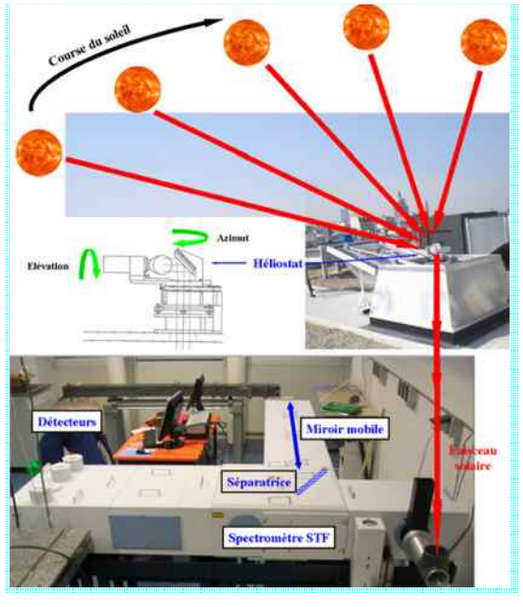








(Jussieu)
2013-07-19
2013-07-20
2013-07-22
2013-08-16
2013-08-21
2013-08-23

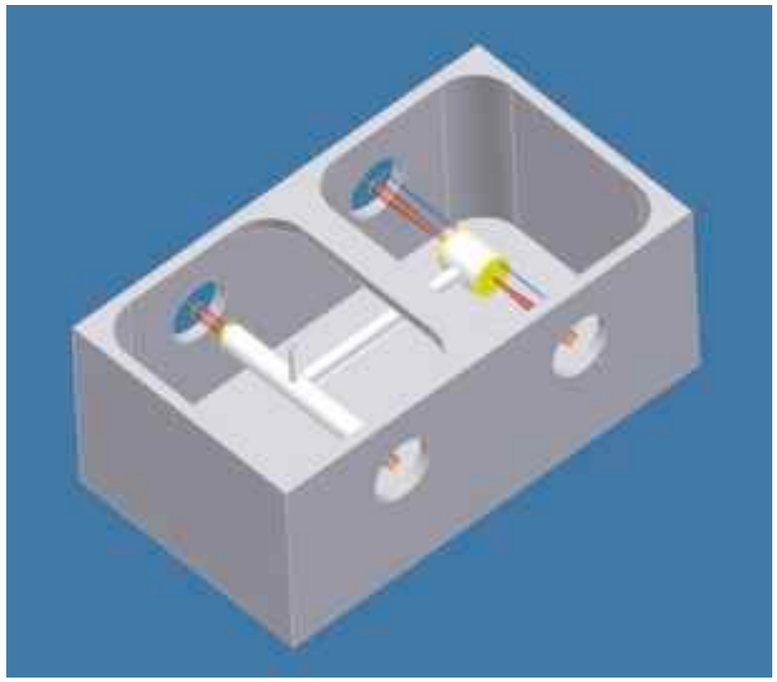


O_3 Multispectral Study : Cell

FTS-Paris

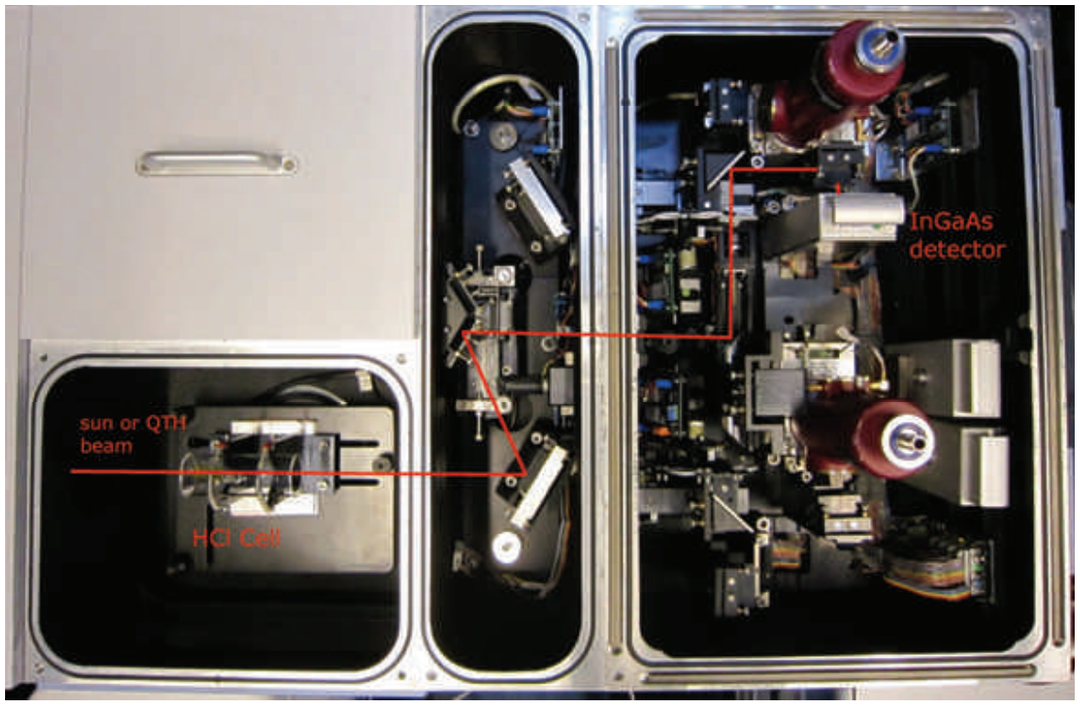
- All pyrex, BaF_2, KBr, teflon
- ozone decomposition :

  ~ 2 or -4‰ / h (UV off/on)
- Pt100 sensors



- 2 parallel beams
- short (50 mm):
  UV + 10 µm
- long (~200 mm):
  5 or 14 µm
- Pt100 sensors
- connect to high purity O_3 production system

crossed beam cell



Bruker 125 HR of FTS Paris

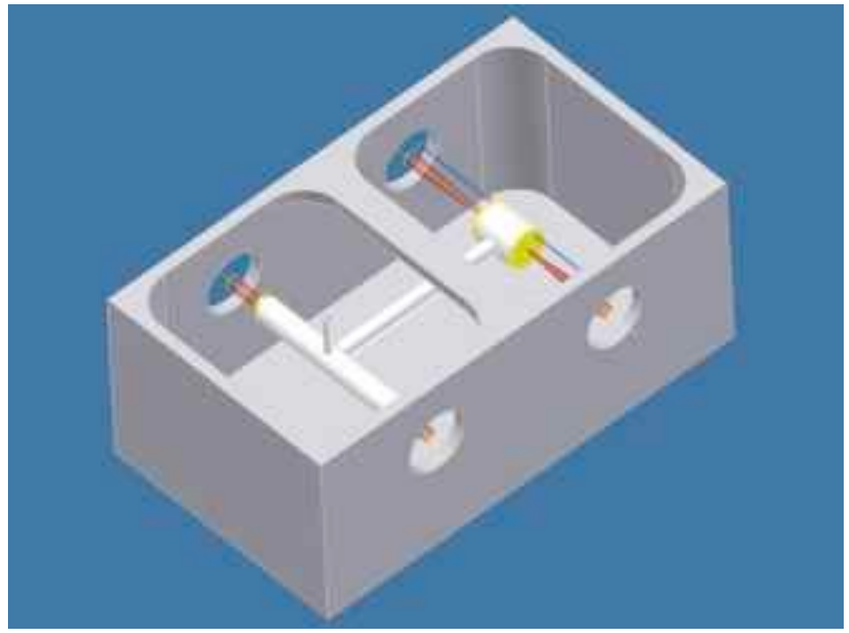
O_3 Multispectral Study : Double Cell

FTS-Paris

2014

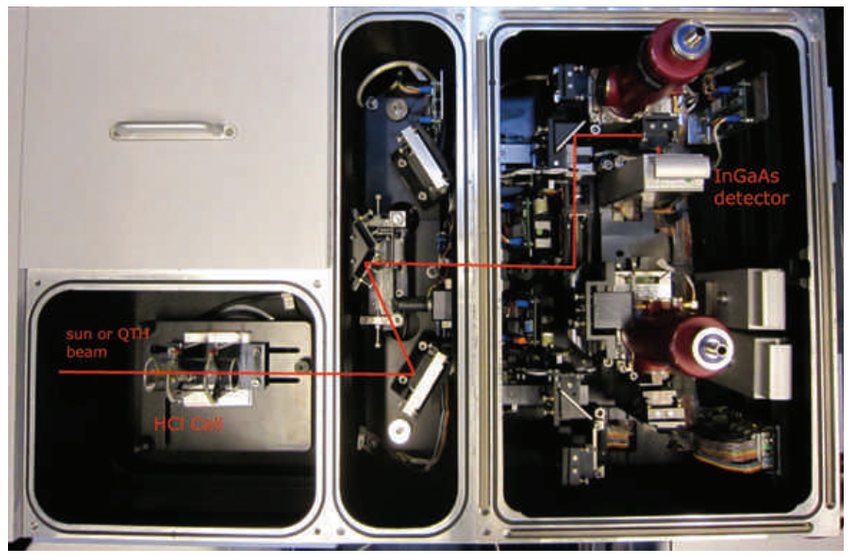
cell is being built in house with support from

F. Thibout (LKB) &
M. Escudier (INSP)



2014 - 2015

first cell measurements in winter period



O_3 Multispectral Study

- Quasi-simultaneous mesurements in different bands
  - in cell @ UV, 5 µm, 10 µm, and 14 µm
- Comparison with theory (GSMA / Reims)
- Atmospheric validation (compare with other TCCON partners, eg Karlsruhe, Izana and Orléans/Trainou

AO LEFE-CHAT 2014