ICOS-ATC Test Lab: from the lab evaluation to the field operation feedback

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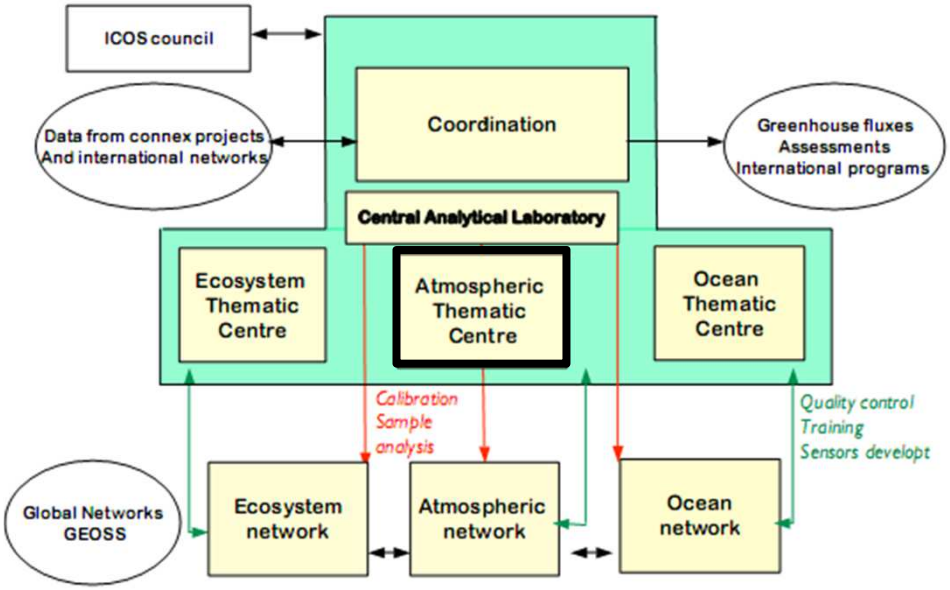
ICOS ATC – Test Lab: Presentation

ICOS Organisation



ICOS ATC

Why a Test Lab ?

Long term prospective: need to maintain the ICOS AS with high level instrumentation and methodology

ATC Test Lab to :

- ✓ Interact with Research Institutes and private companies
- ✓ Perform and document the tests of new sensors
- ✓ Provide recommandations for the update of the running AS
- ✓ Validate all instruments to be deployed within the ICOS network

ICOS ATC – Test Lab: Organisation

1/ Instrumentation

		CO_2	CH_4	N_2O	SF_6	CO	H_2O	$^{13}CO_2$
Loflo	NDIR	X						
Agilent HP6890	GC	X	X	X	X	X		
Finigan MAT252	MS							X
Ecotech	FTIR	X	X	X		X		X
Picarro G2301	CRDS	X	X				X	
Picarro G2401	CRDS	X	X			X	X	
LGR	ICOS	X	X				X	

2/ Methodology

- ❑ Standardized evaluation of the analyzers
- ❑ Collaboration with the French reference laboratory for Metrology (LNE)
- ❑ Moving towards an “operational” organization: quality insurance (ISO 17205 guidelines), traceability, documentation management, uncertainty management ..

3/ Manpower

2 people full time (4 expected)

ICOS ATC – Test Lab: State of the art

1st evaluation protocol established

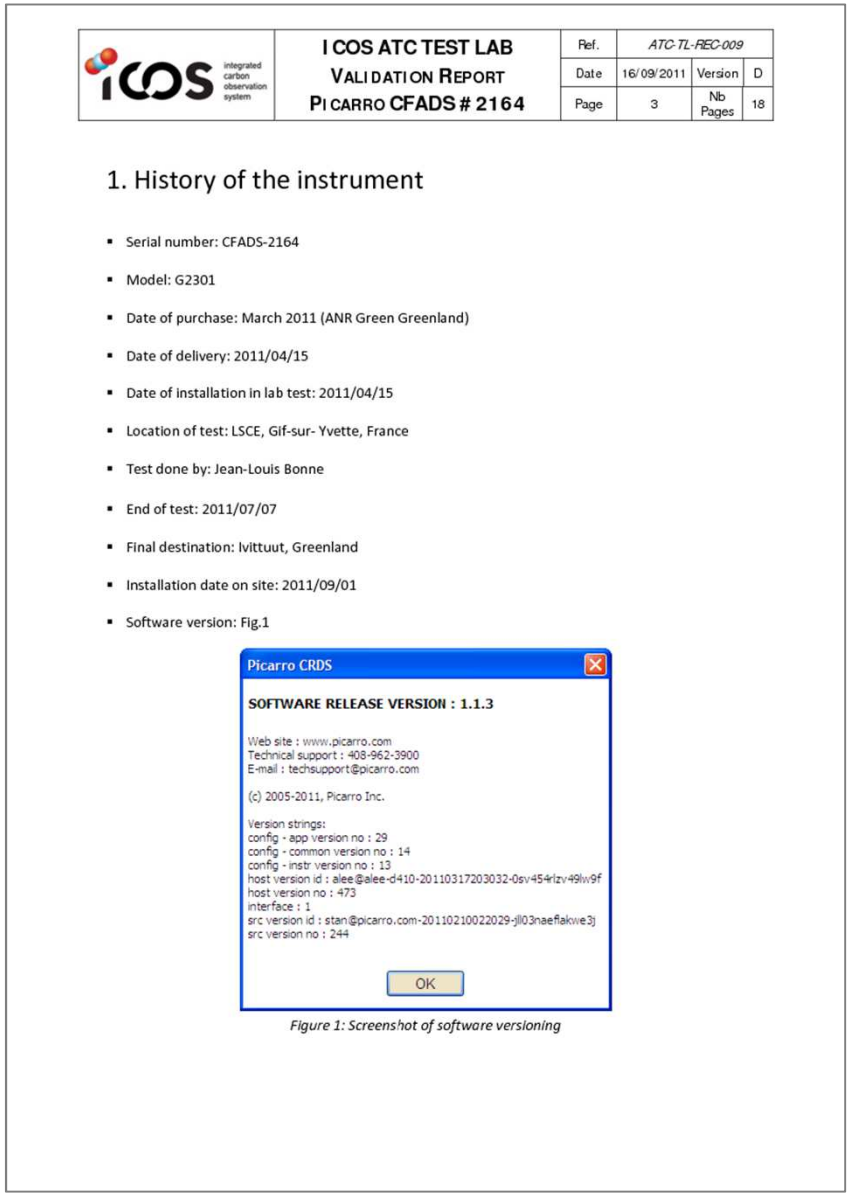
Standardized report for each instrument

(*will be publicly available*)

14 instruments evaluated since October 2010

Evaluation Protocol

1. Repeatability
2. Reproducibility
3. Linearity
4. Comparison with reference instrumentation
5. Water vapor influence



ICOS integrated carbon observation system	ICOS ATC TEST LAB VALIDATION REPORT PICARRO CFADS # 2164	Ref.	ATC-TL-REC-009		
		Date	16/09/2011	Version	D
		Page	3	Nb Pages	18

1. History of the instrument

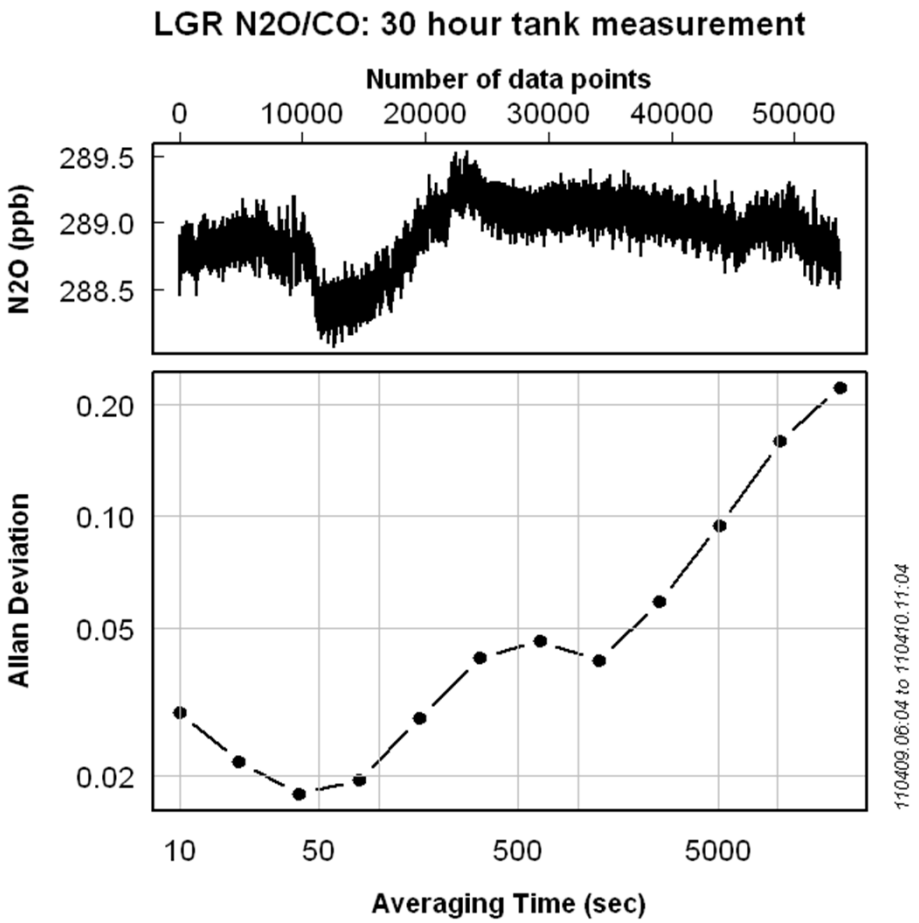
- Serial number: CFADS-2164
- Model: G2301
- Date of purchase: March 2011 (ANR Green Greenland)
- Date of delivery: 2011/04/15
- Date of installation in lab test: 2011/04/15
- Location of test: LSCE, Gif-sur- Yvette, France
- Test done by: Jean-Louis Bonne
- End of test: 2011/07/07
- Final destination: Ivittuut, Greenland
- Installation date on site: 2011/09/01
- Software version: Fig.1

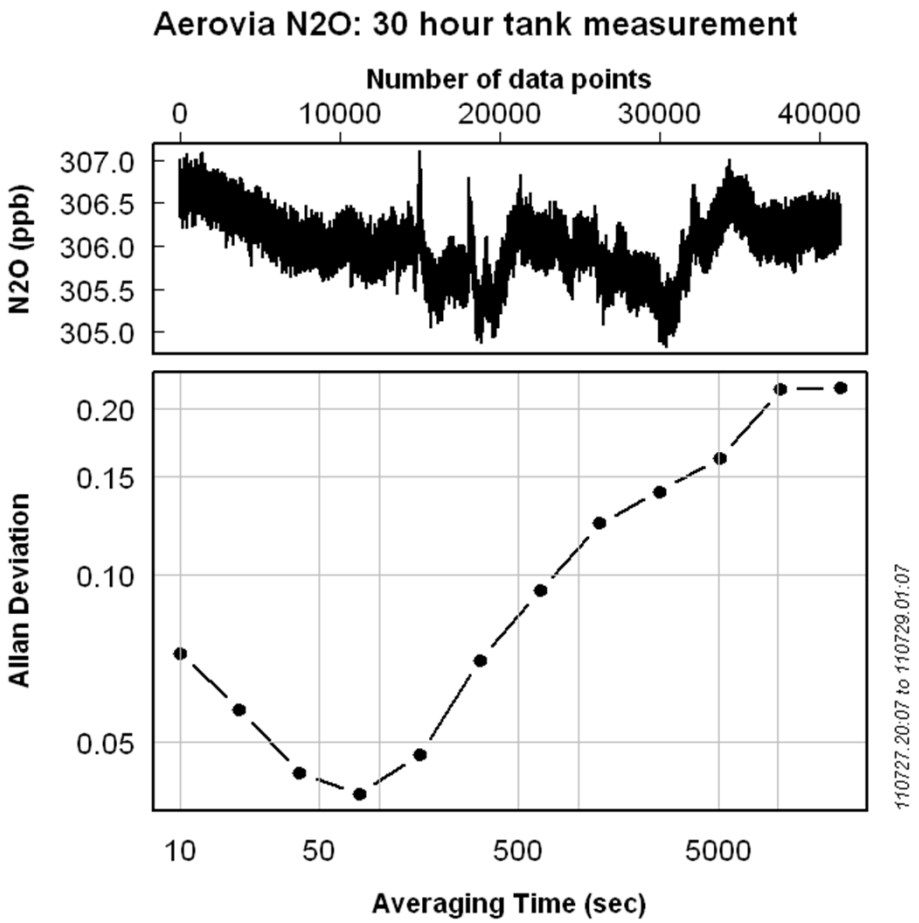
Figure 1: Screenshot of software versioning

ICOS ATC – Test Lab: State of the art

Repeatability Assessment

Minimum of 30 hour tank measurement, look at dispersion (1SD) for different averaging times.



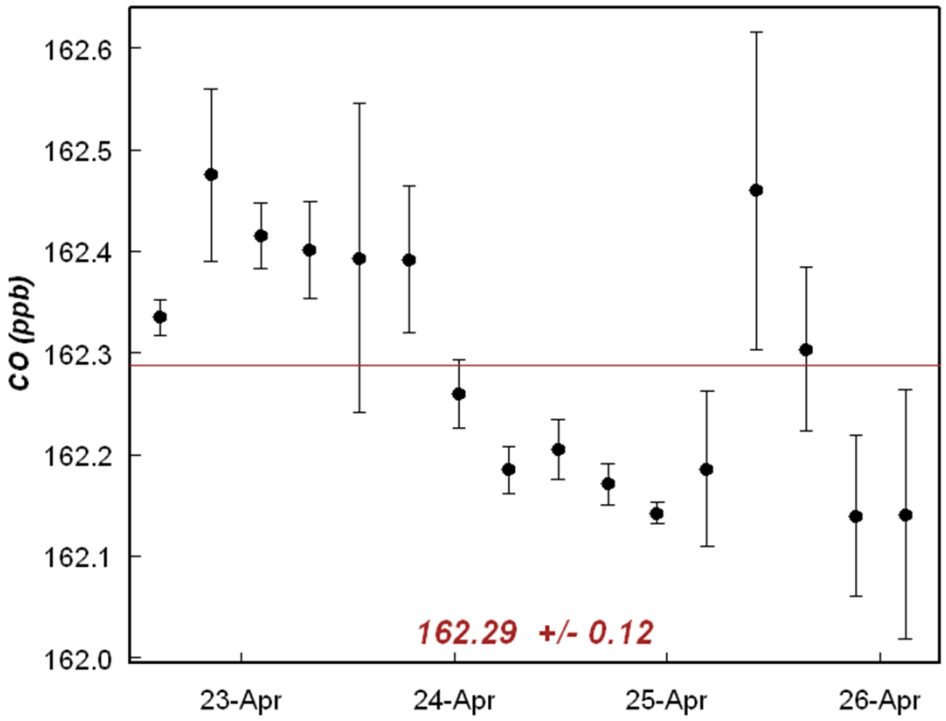


ICOS ATC – Test Lab: State of the art

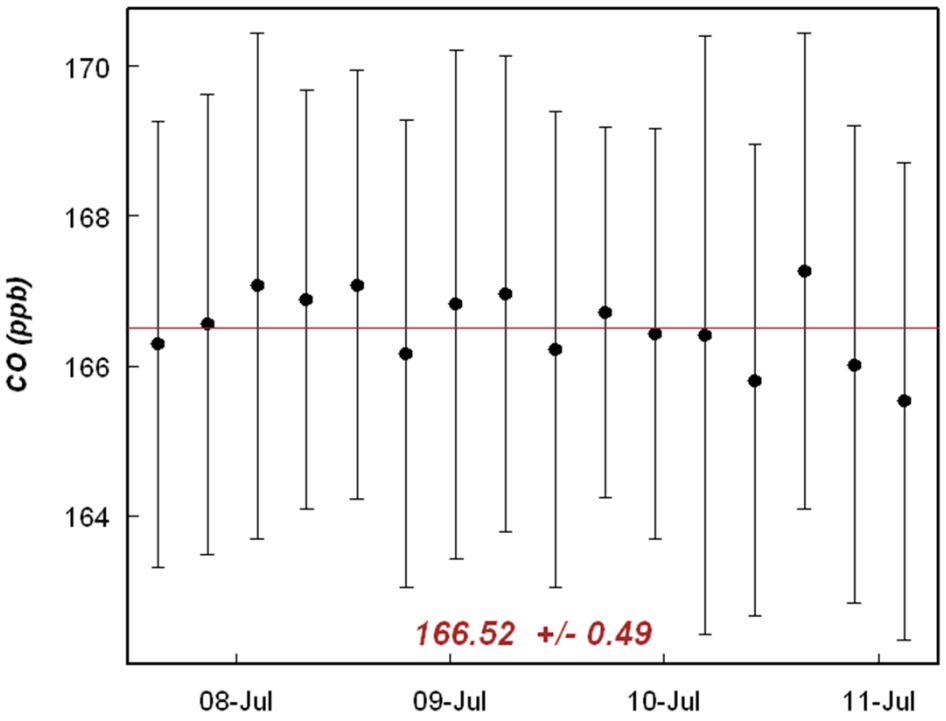
Reproducibility Assessment (1/2)

TGT tank measured every 5 hours for 30 minutes alternatively with ambient air.
Averages calculated for each measurement period by excluding the first 20 minutes.
Look at the dispersion (1σ) of the data sets

Los Gatos



Picarro G2401

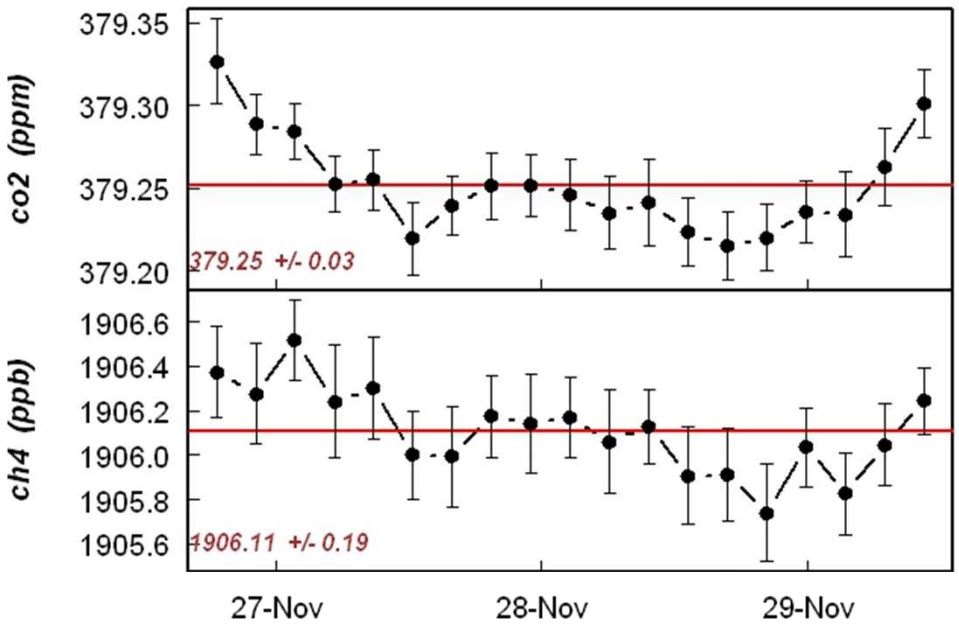


ICOS ATC – Test Lab: State of the art

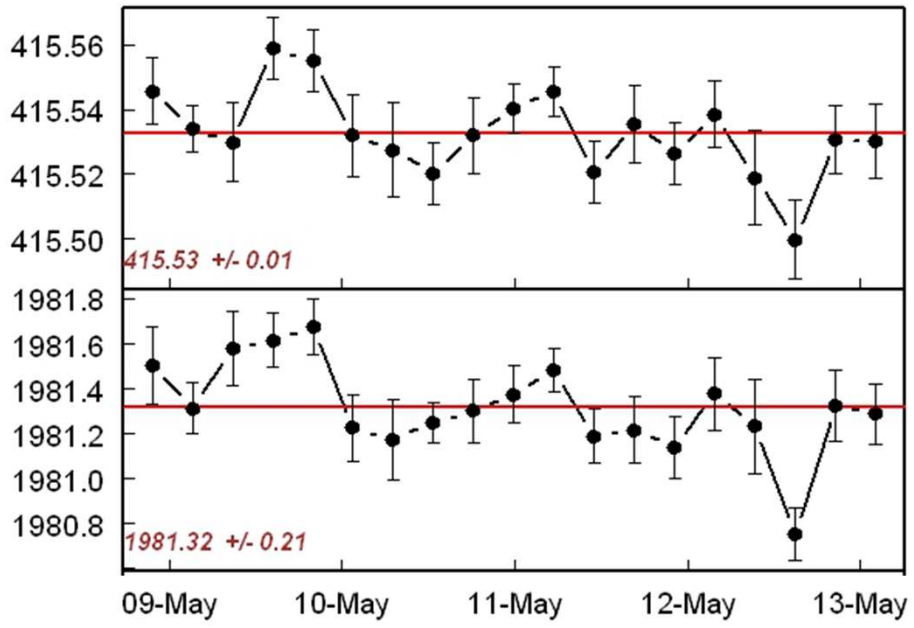
Reproducibility Assessment (2/2)

TGT tank measured every 5 hours for 30 minutes alternatively with ambient air.
Averages calculated for each measurement period by excluding the first 15 minutes.
Look at the dispersion (1σ) of the data sets

Picarro G2301 CFADS-2122



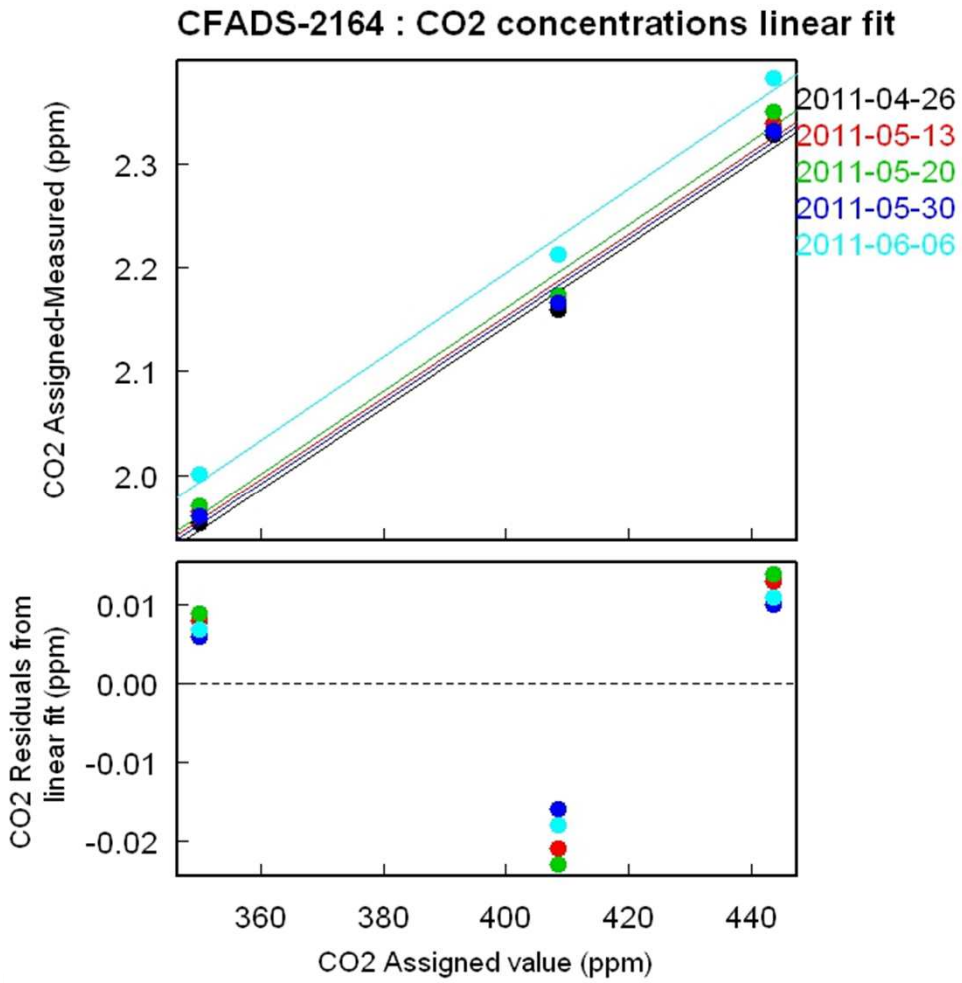
Picarro G2301 CFADS-2164

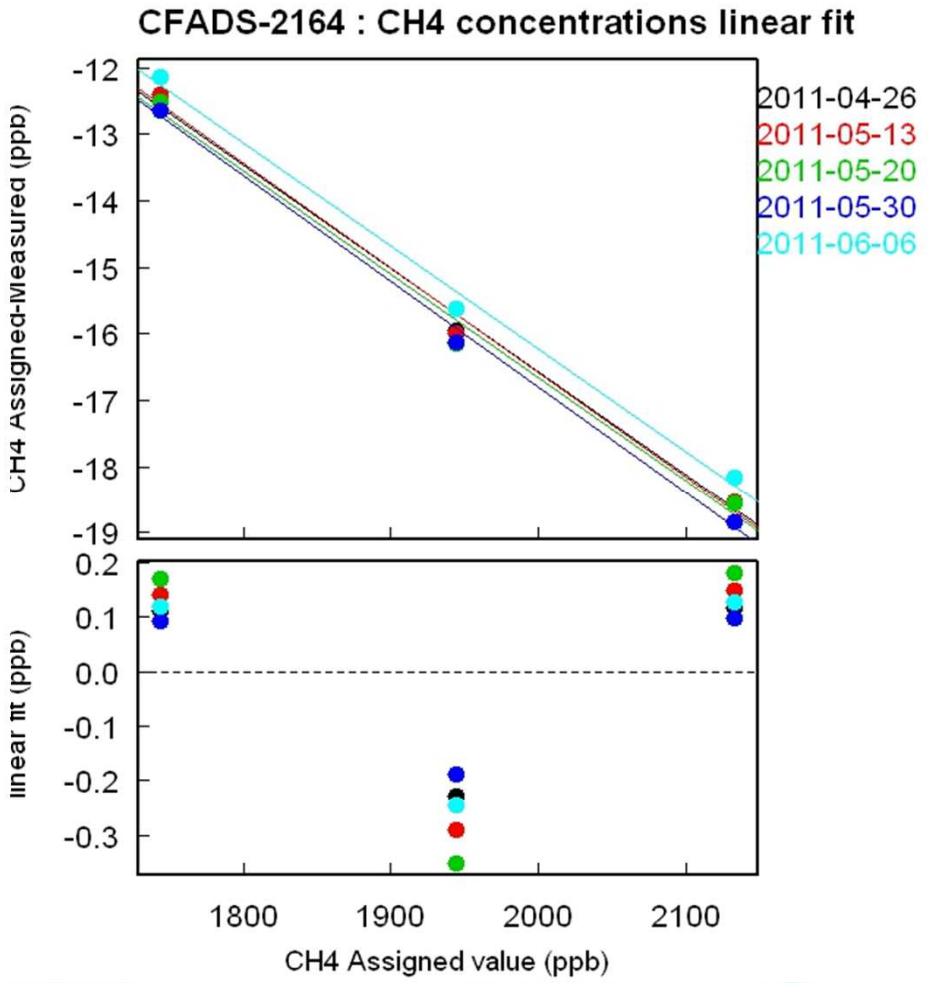


ICOS ATC – Test Lab: State of the art

Linearity Assessment

Instruments calibrated with 3 standards (GC assigned values)
Will be extended to 5 standards.

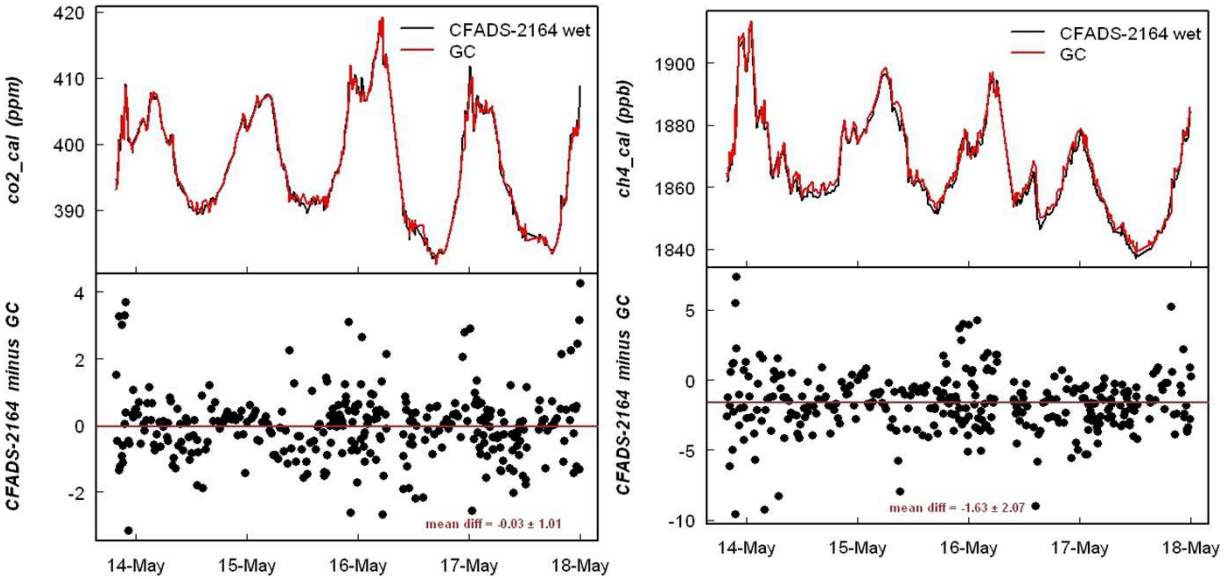




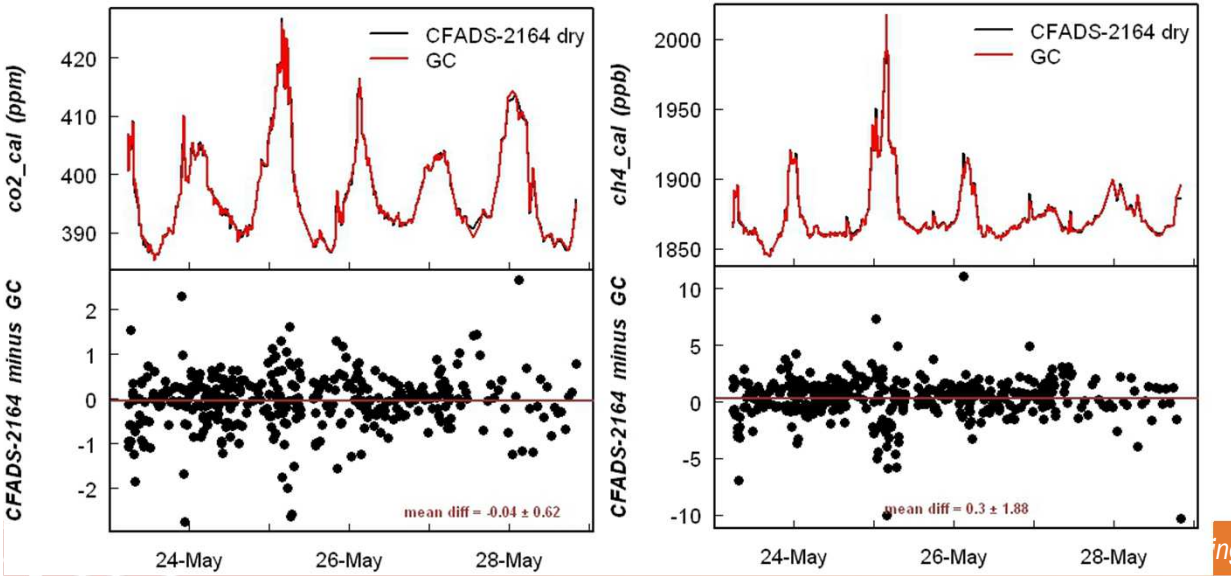
ICOS ATC – Test Lab: State of the art

Intralab comparison

Ambient air comparison with and without drying unit



	CO2 (ppm)	CH4 (ppb)
Picarro (wet) minus GC	-0.03 ± 1.01	-1.63 ± 2.07

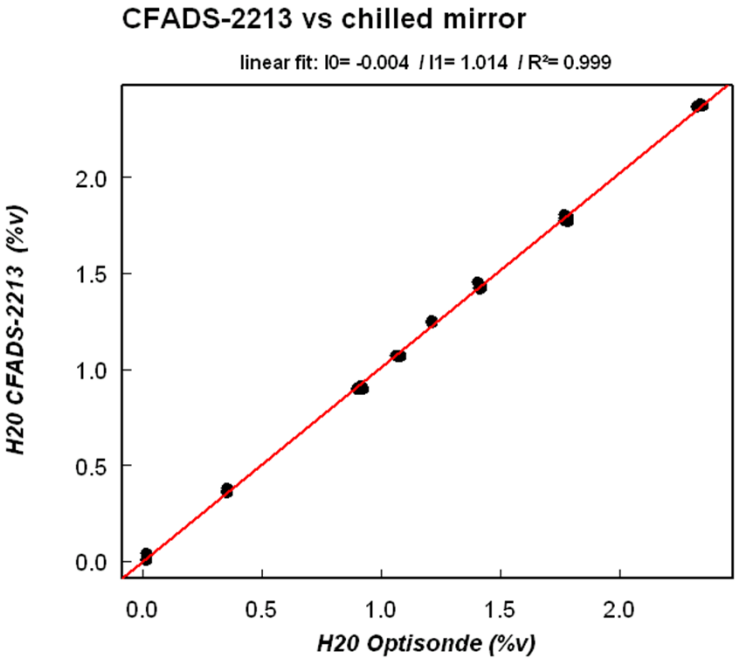


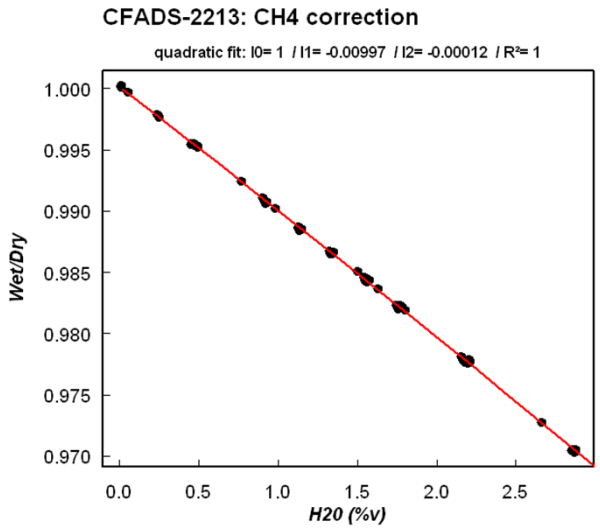
	CO2 (ppm)	CH4 (ppb)
Picarro (dry) minus GC	-0.04 ± 0.62	-0.3 ± 1.88

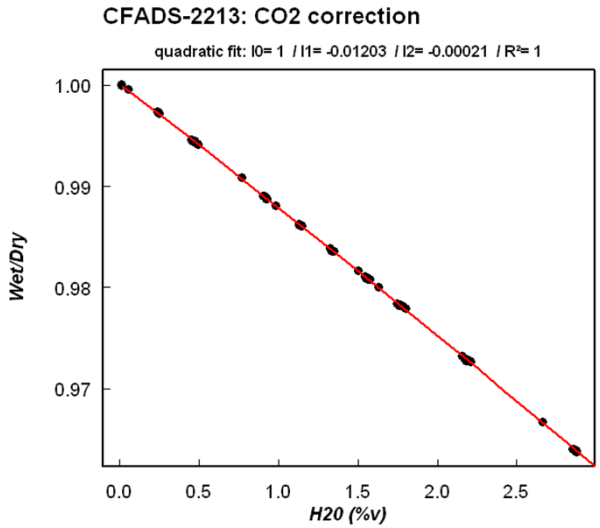
ICOS ATC – Test Lab: State of the art

Water vapor Influence

Humidifier coupled to a chilled mirror for independent water vapor measurement and correction functions assesment



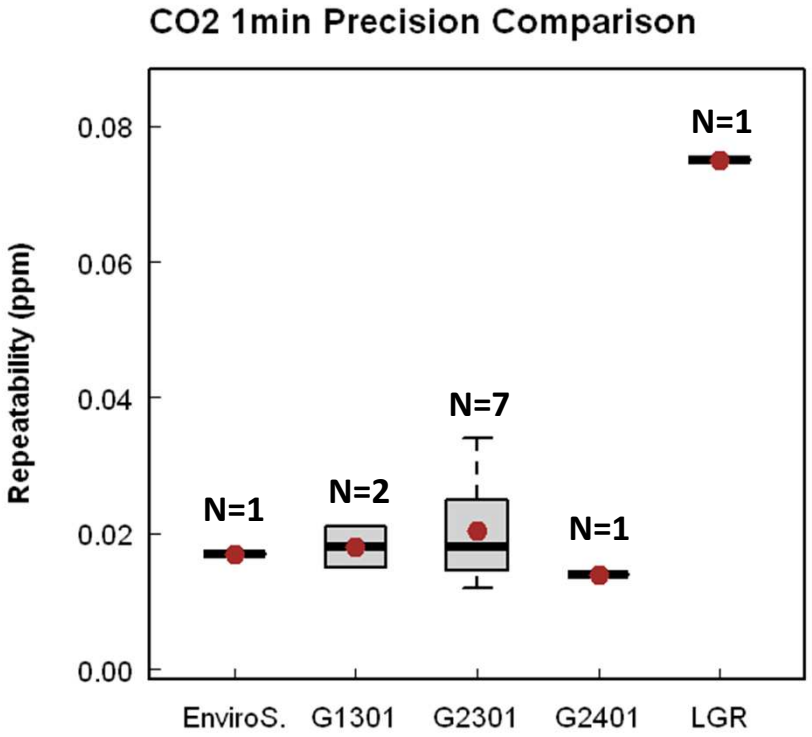


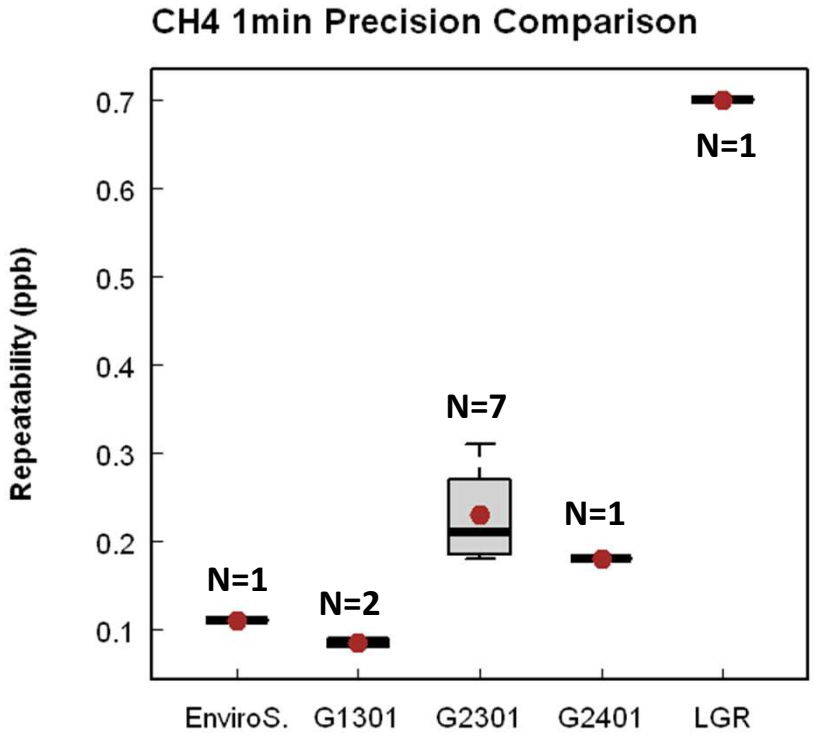


ICOS ATC – Test Lab: State of the art

Summary of evaluations

- ✓ 10 Picarro G1301/G2301 $CO_2/CH_4/H_2O$ (French network)
- ✓ 1 Picarro G2401 $CO_2/CH_4/CO/H_2O$ (lending from EMPA)
- ✓ 1 LGR N_2O/CO (French network)
- ✓ 1 LGR CO_2/CH_4 (lending from LGR)
- ✓ 1 Aerovia N_2O (lending from Reims University)





ICOS ATC – Test Lab: Field Operation Feedback

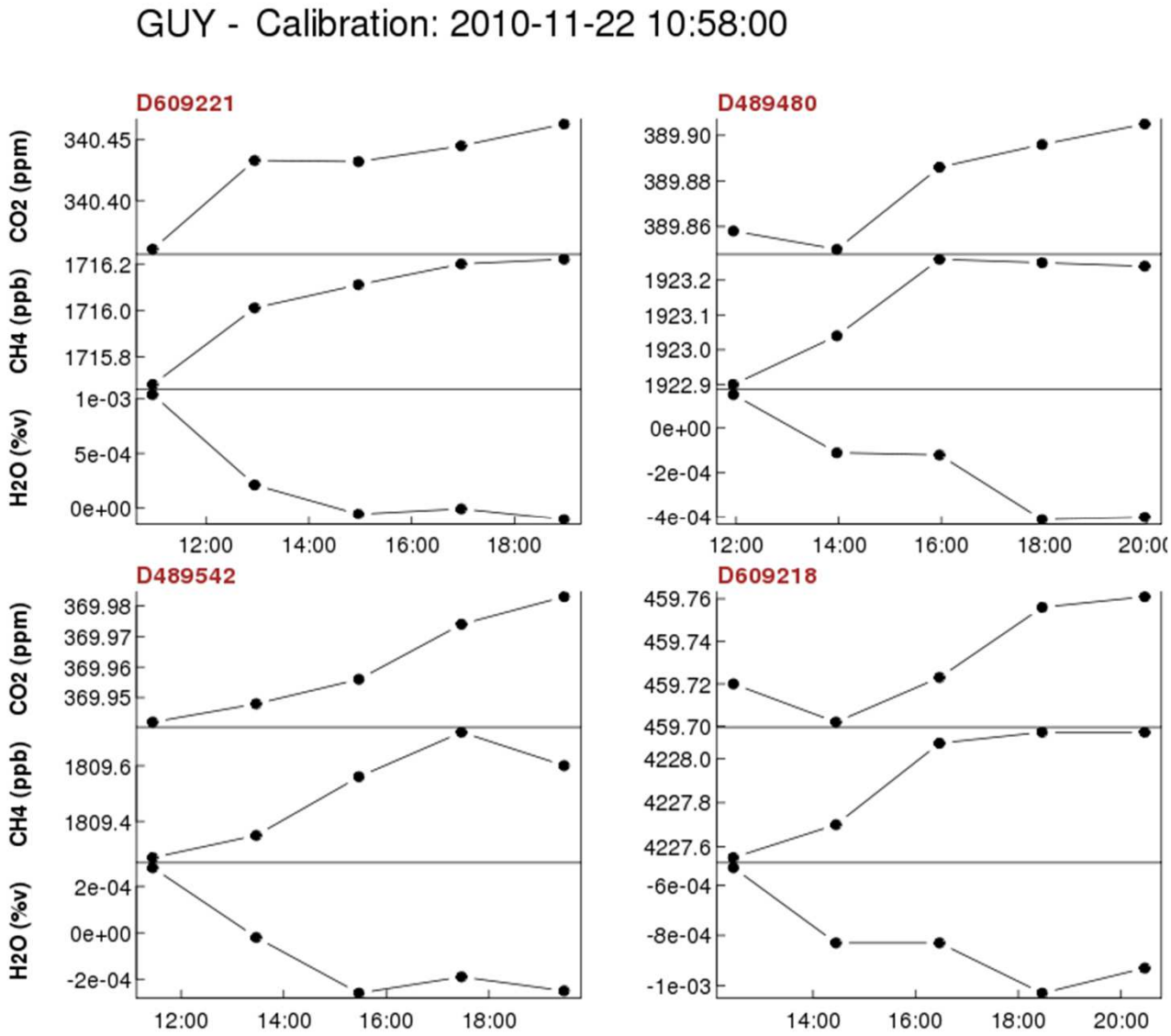
9 Picarro CRDS analyzers $CO_2/CH_4/H_2O$ installed at stations (2008-2011)
First one installed in August 2008 in Ivory Coast

Picarro Model	Instru. ID	Site. ID	Installation Date	Drying
EnviroSense	CFCDS-02	LTO (Ivory Coast)	Aug 08 - …	Yes
EnviroSense	CFCDS-14	BIS (France)	Jul 09 - Mar 10	Yes
G1301	CFADS-45	BIS (France)	May 10 - …	Yes
G1301	CFADS-44	GUY (French Guiana)	Sept 09 - …	No
G2301	CFADS-2122	MHD (Ireland)	Mar 11 - …	Yes
G1301	CFADS-95	PUY (France)	Apr 11 - …	Yes
G2301	CFADS- 2142	OPE (France)	Apr 11 - …	Yes
G1301	CFADS-74	OPE (France)	Jul 11 - …	No
G2301	CFADS-2164	IVI (France)	Sept 11 - …	Yes

ICOS ATC – Test Lab: Field Operational Feedback

Calibration typical profile

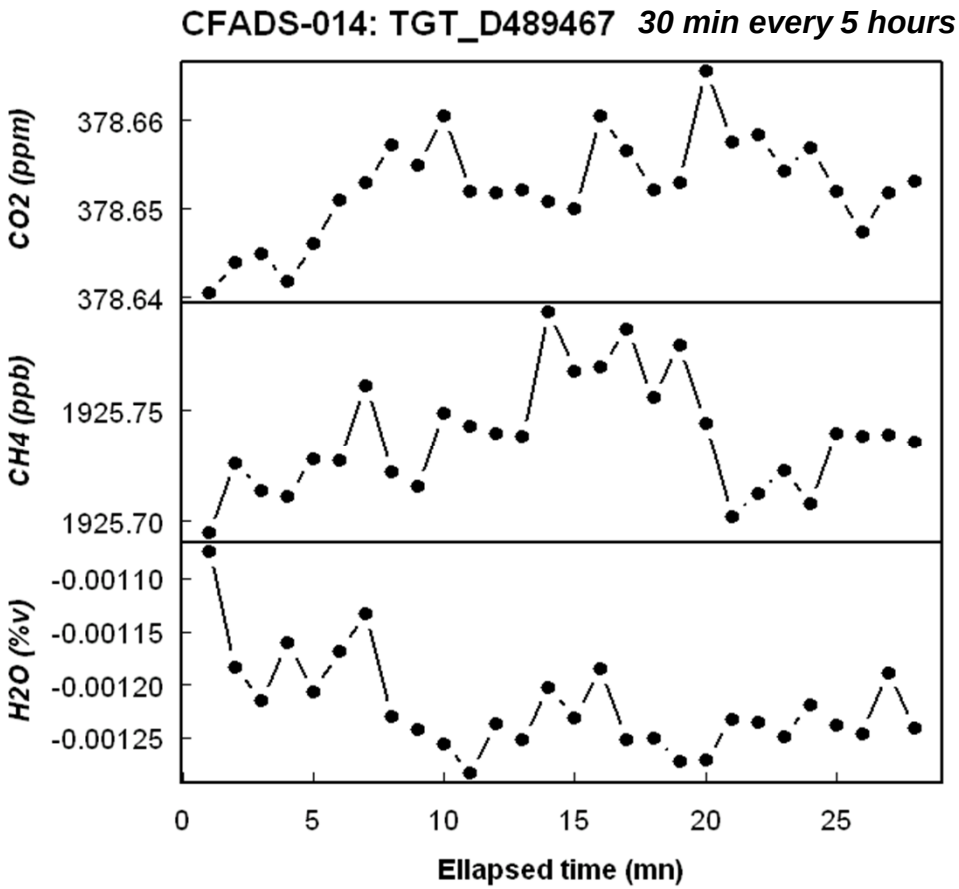
- *Calibration every 2 weeks till early 2011*
- *4 standards measured 5 times for 30 minutes*
- *2 first cycles excluded for mean calculations*



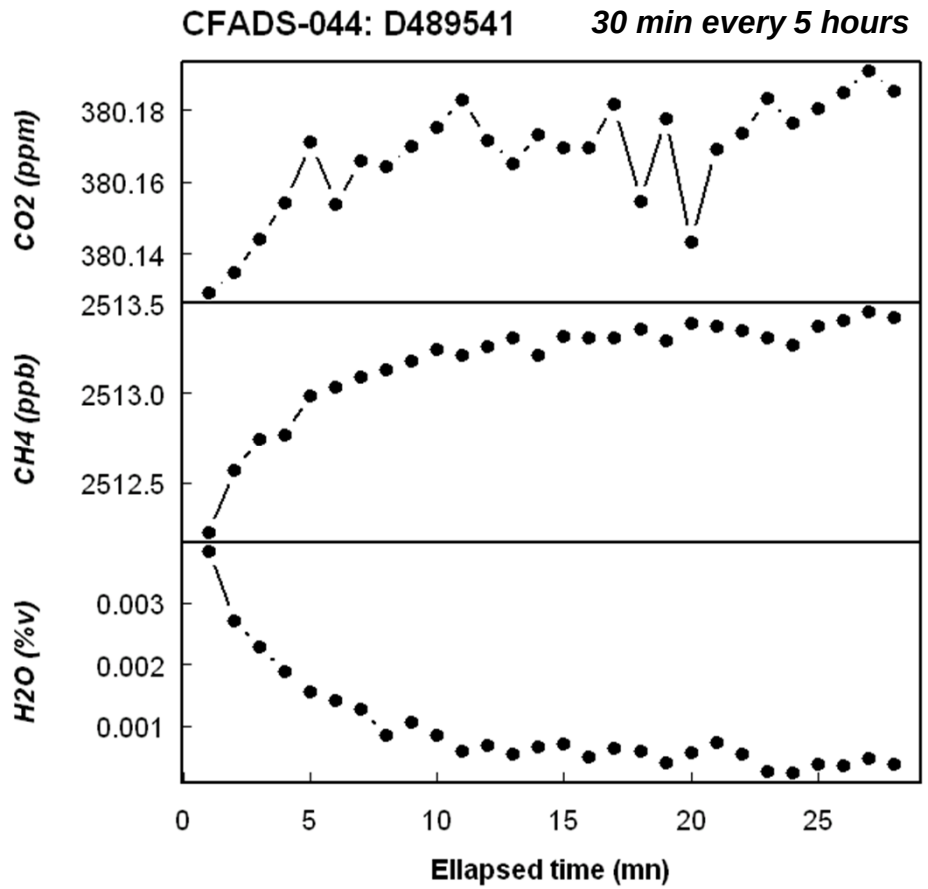
ICOS ATC – Test Lab: Field Operational Feedback

Target Tank typical profile

Biscarosse Site (Fr) / Drying



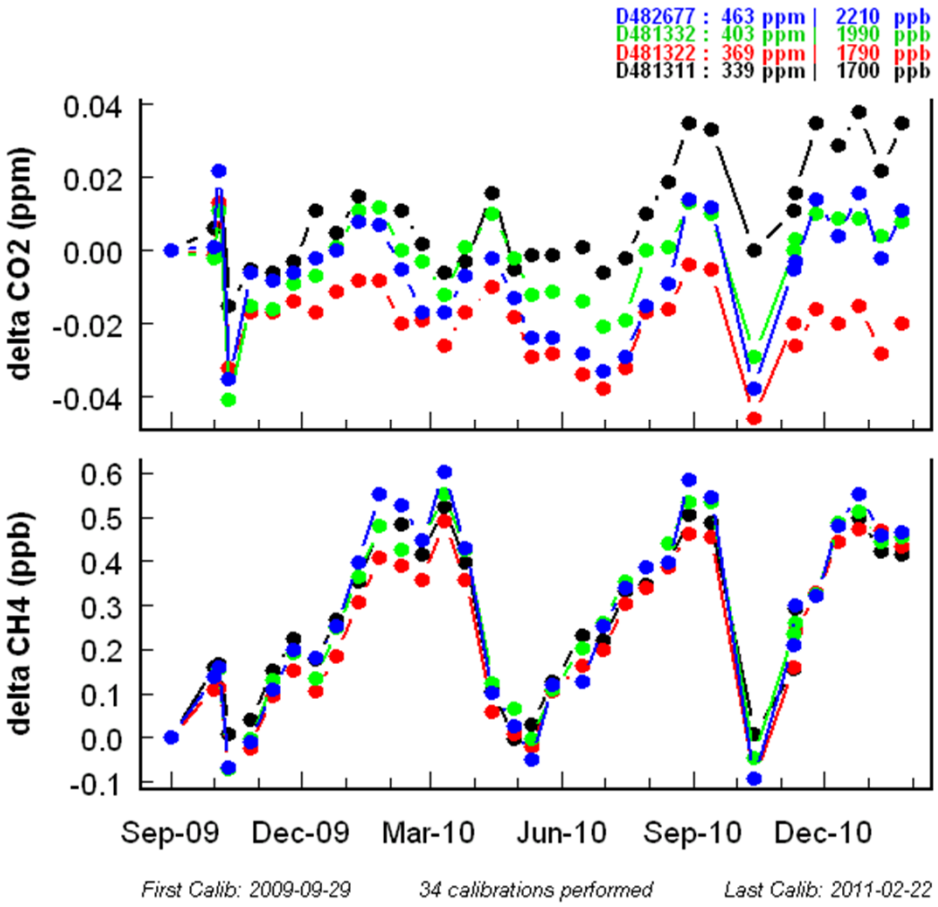
Kourou Site (French Guiana) / No drying



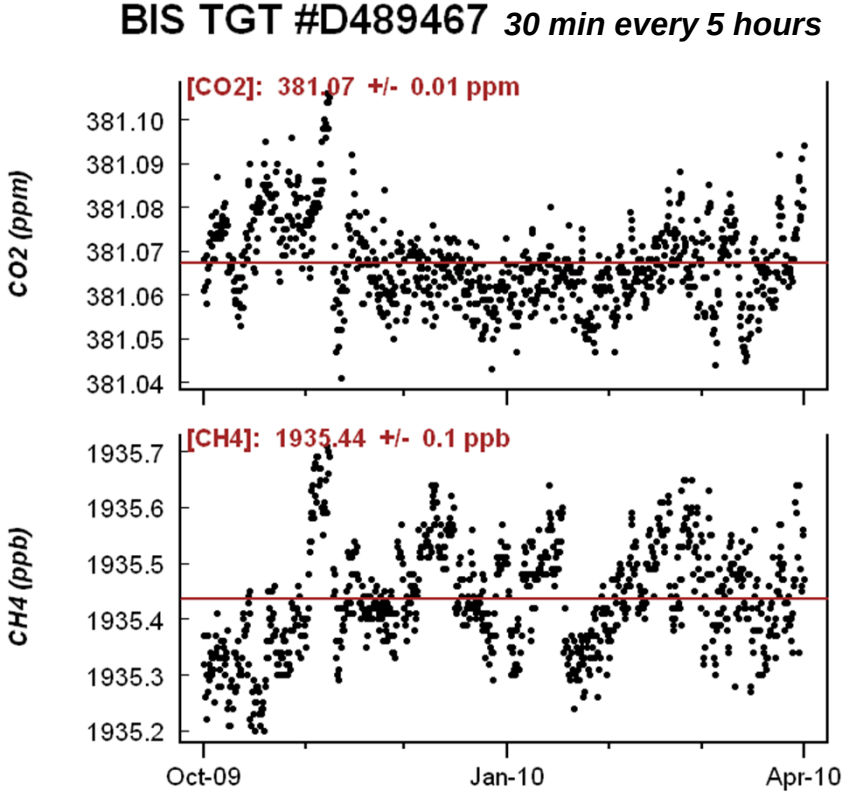
ICOS ATC – Test Lab: Field Operational Feedback

Drift (1/2)

BIS - Cal. Tanks raw values since 1st calibration



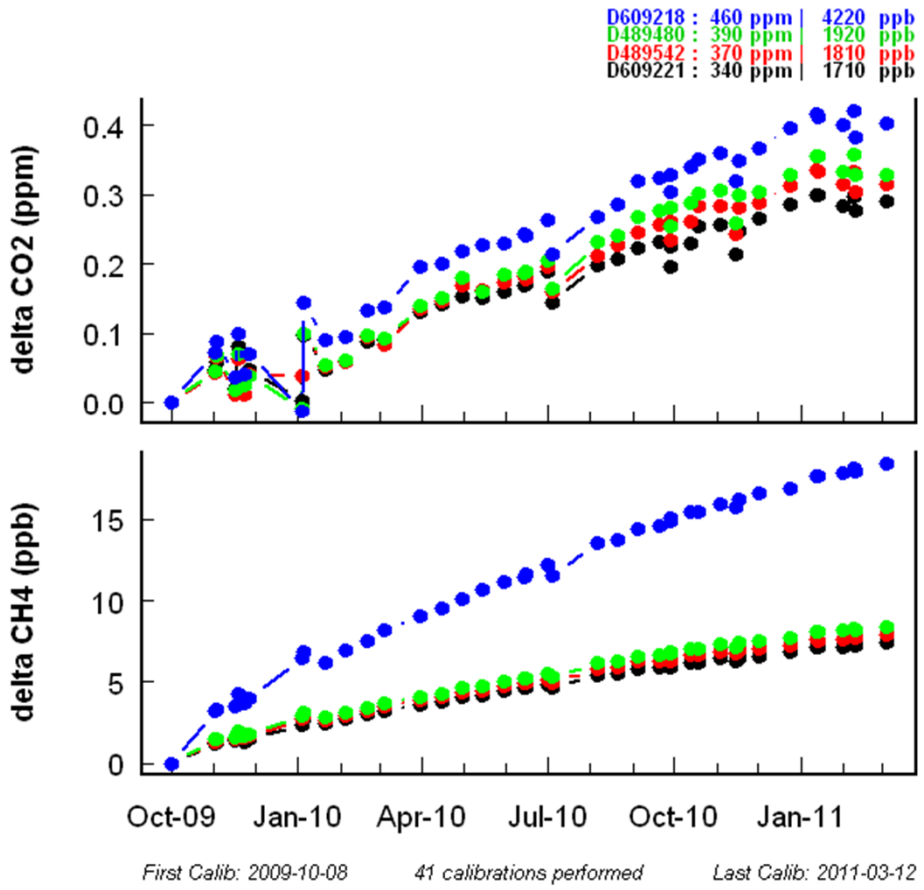
BIS - Target tank corrected values



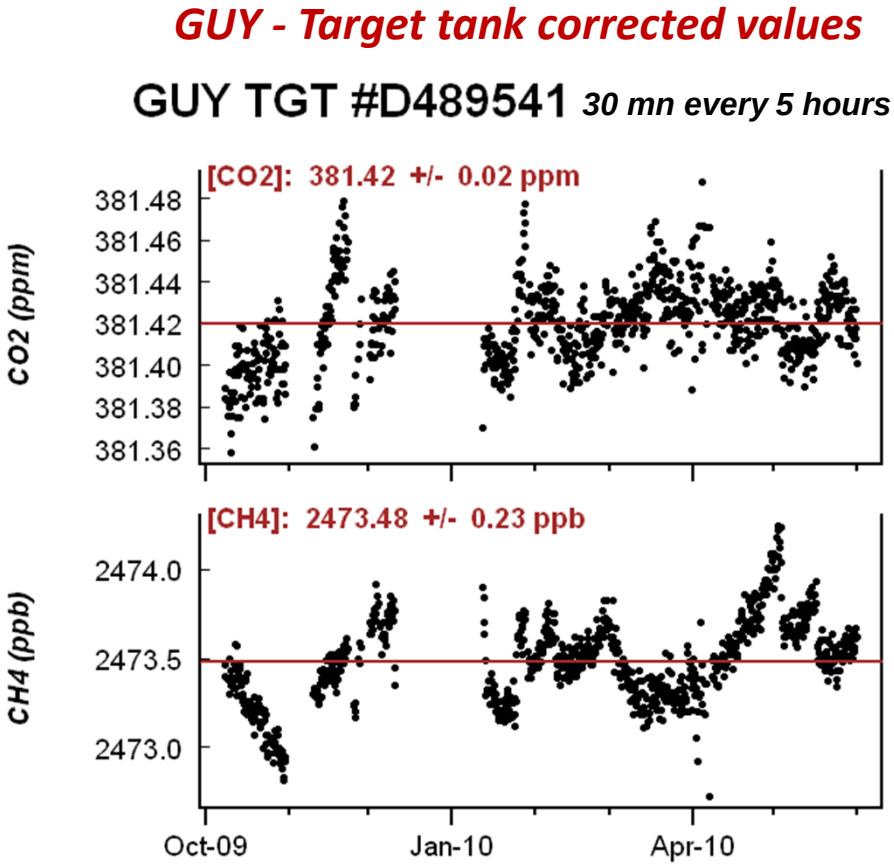
ICOS ATC – Test Lab: Field Operational Feedback

Drift (2/3)

GUY - Cal. Tanks raw values since 1st calibration



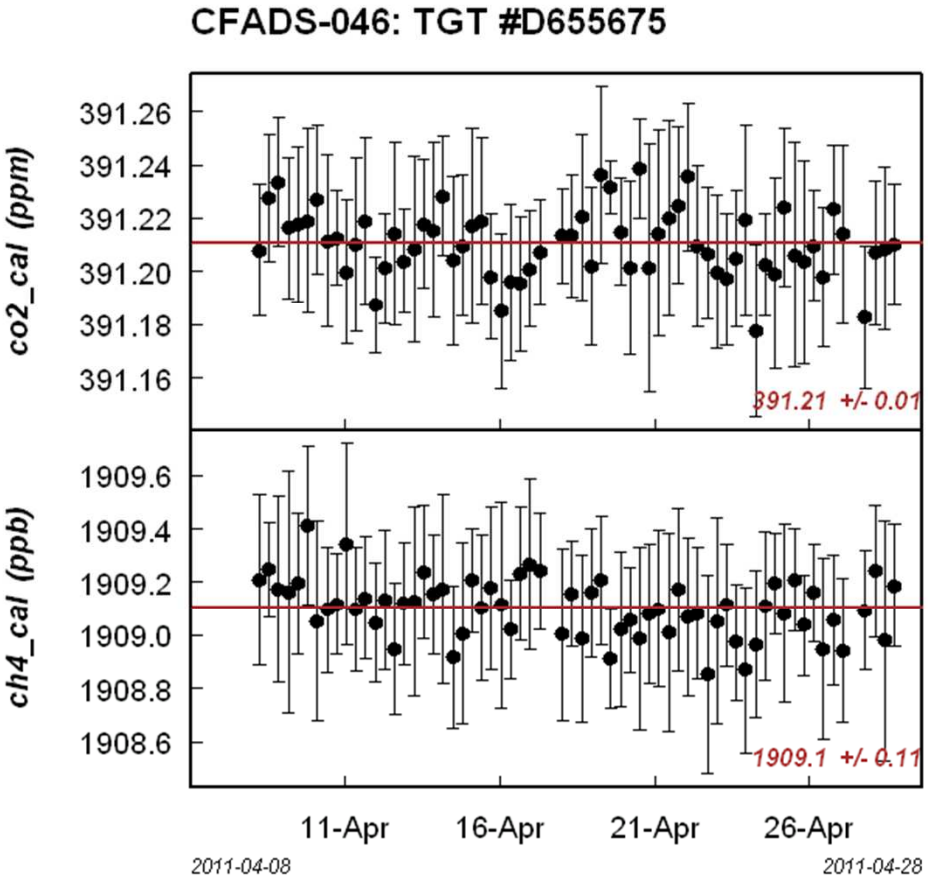
GUY - Target tank corrected values



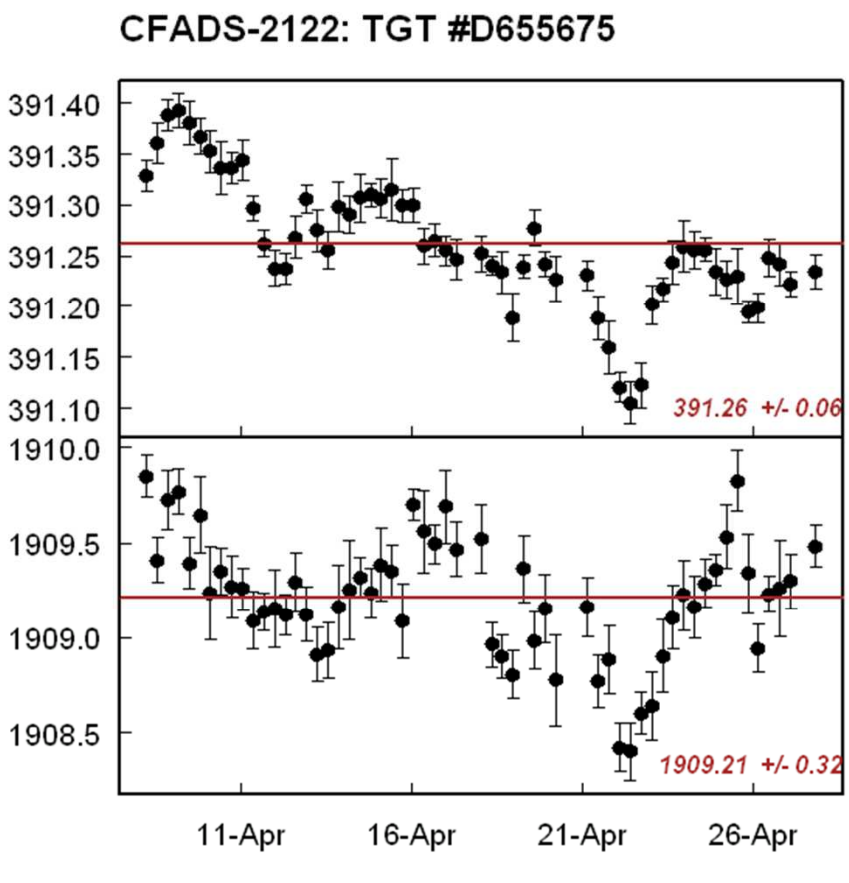
ICOS ATC – Test Lab: Field Operational Feedback

Drift (3/3)

Mace Head – G1301
Target tank corrected values



Mace Head – G2301
Target tank corrected values



ICOS ATC – Test Lab: Field Operational Feedback

Summary of breakdowns:

Picarro Model	Installation Date	Breakdown	Action
EnviroS. CFADS14	Jul.09 (BIS)	Mar.10: noise is 10x higher than the specification after power breakdown	Back to Picarro. Cavity Replacement
EnviroS. CFCDS02	Aug.08 (LTO)	Nov.10: thermoregulation issue	Back to Picarro Fans replacement. Repaired damaged electronics
G1301 CFADS44	Sep.09 (GUY)	Jun.11: Internal communication issue after power breakdown	Back to Picarro: Main board and power supply replaced. Cavity replacement proposed, precision has gotten worse by 2.
G1301 CFADS95	Apr.11 (PUY)	Sep.11: Liquid water goes through the cavity	Back to Picarro: Cavity Replacement
G2301 CFADS2122	Mar.11 (MHD)	Drift too high in CO2 and CH4	Cavity Replacement proposed

4 (+1) instruments shipped back to factory.
Cavity replacement: periodic problem

Summary

ATC Test Lab:

- First evaluation protocol established, 14 instruments tested
- Need to extend the test protocol (cross sensitivities, …)
- First step in the evaluation of an instrument. Need to be completed with field operation feedback

Picarro field operation feedback:

- Instrument dependent strategy in terms of calibration frequency, tank stabilization times
- Low maintenance (pumps, laser adjustments, …)
- Main problems after powerfailures