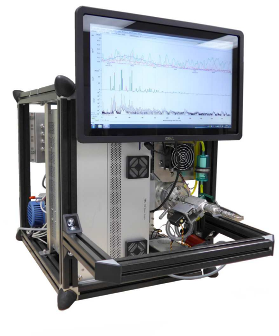


Bologna, Italy. October 2016

Preliminary results from the 2016 ACTRIS2 Q-ACSM intercomparison at the Aerosol Chemical Monitor Calibration Centre (ACMCC)

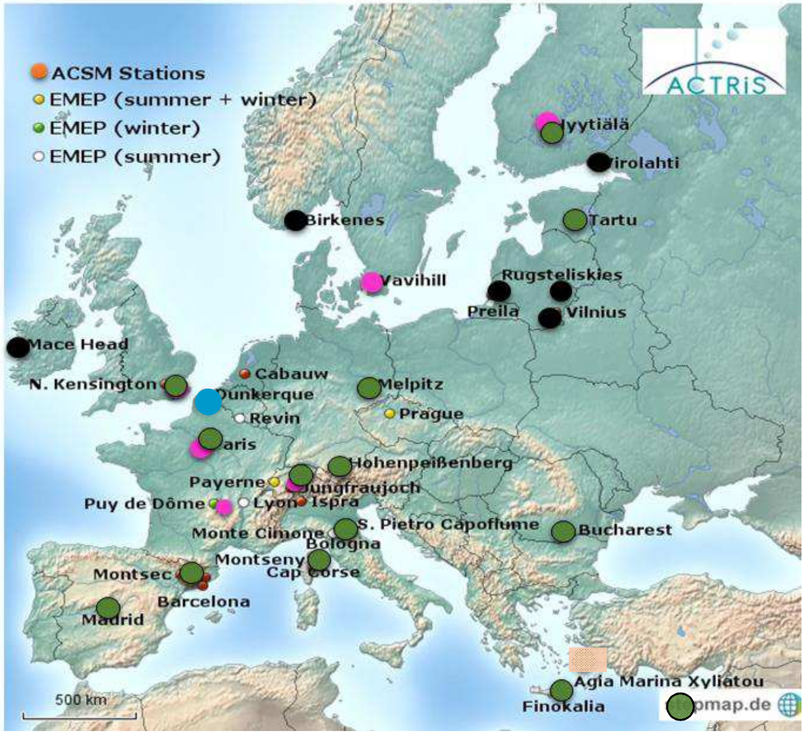
Olivier Favez, Evelyn Freney, Valérie Gros, Tanguy Amodeo, François Truong, Yunjiang Zhang, Jean Sciare
Phil Croteau, John Jayne

2016 ACTRIS-2 ACSM intercomparison exercice at the ACMCC

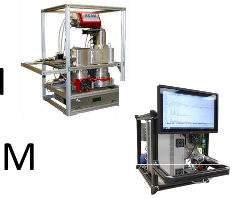
Goal: Homogenous quality-controlled ACSM datasets at a European scale

- ✓ Intercomparison campaign took place March/April 2016. A total of 21 instruments.
- ✓ In order to accommodate all applications to the intercomparison exercise, two separate calibration exercises were organized.

Participating stations:
Intercomparison Spring 2016



- Q-ACSM
- ToF-ACSM
- HR-AMS
- Did Not Attend

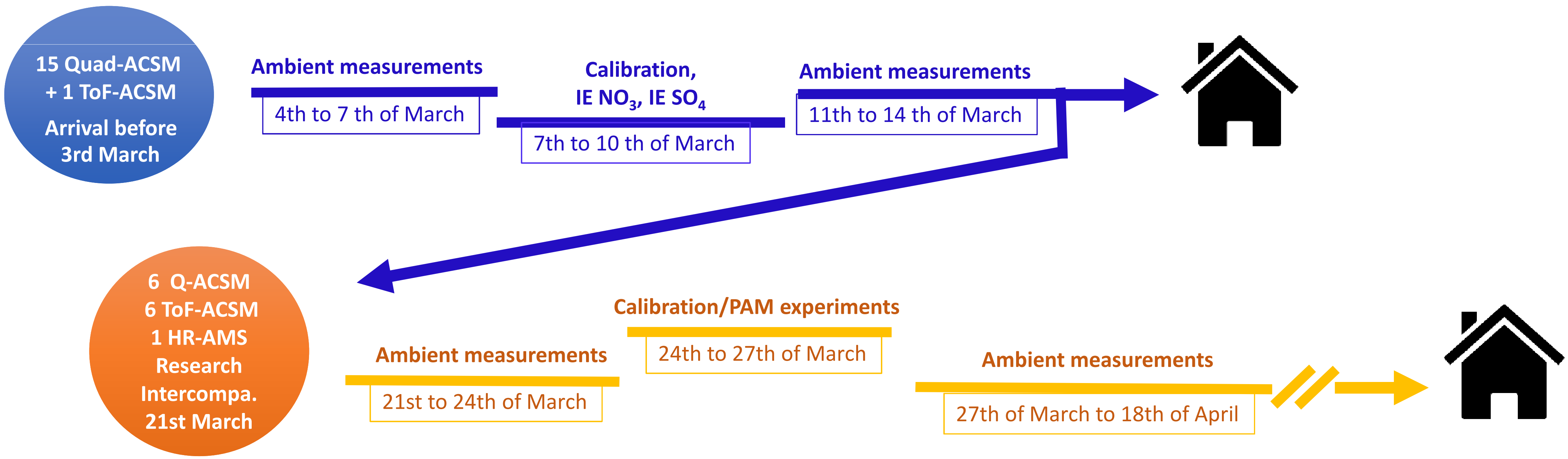


Site	Intercomparison Q-ACSM	ToF-ACSM
Hohenpeissenberg		
FMI –Hyytiala		
Cyprus		
Melpitz		
Finokalia		
London		
Bologna		
Madrid		
Vavihill		
SMEAR		
Zurich		
JFJ		
Bucharest		
Barcelona		
PUY		
SIRTA		
CapCorse		
Tartu		
ToFwerk		

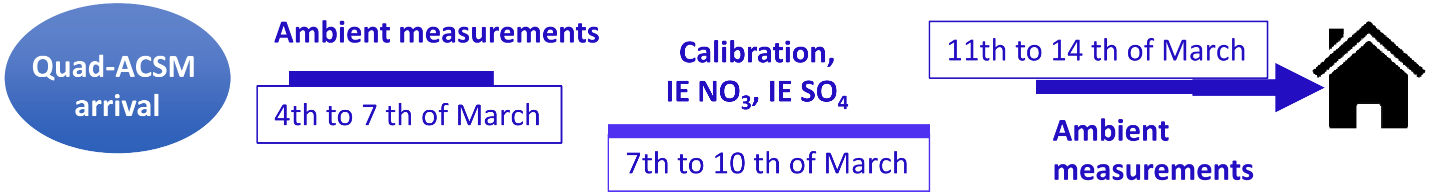
2016 ACTRIS-2 ACSM intercomparison exercice at the ACMCC

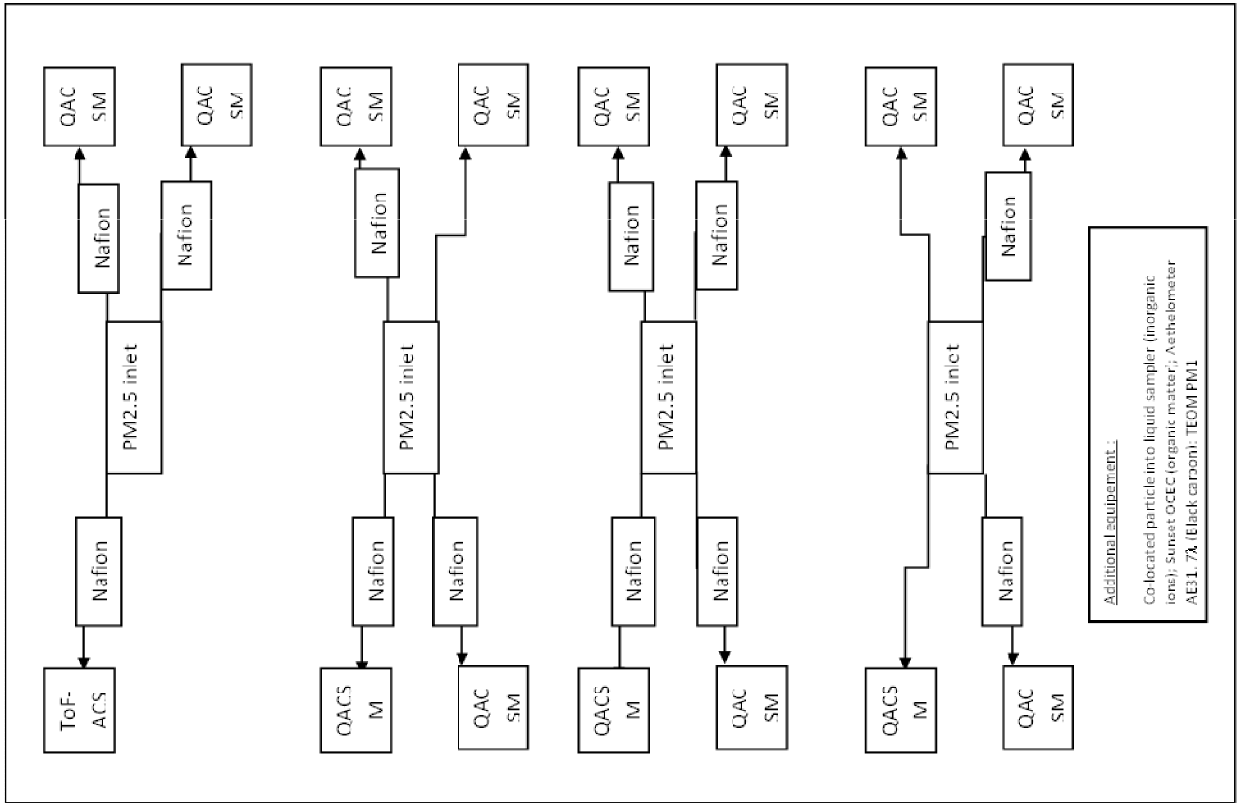
Organization:

1. Three to four days pre-calibration intercomparison.
2. Calibration using single and mixed inorganic solutions
3. Three to four days post-calibration intercomparison (extended for ToF-ACSM).

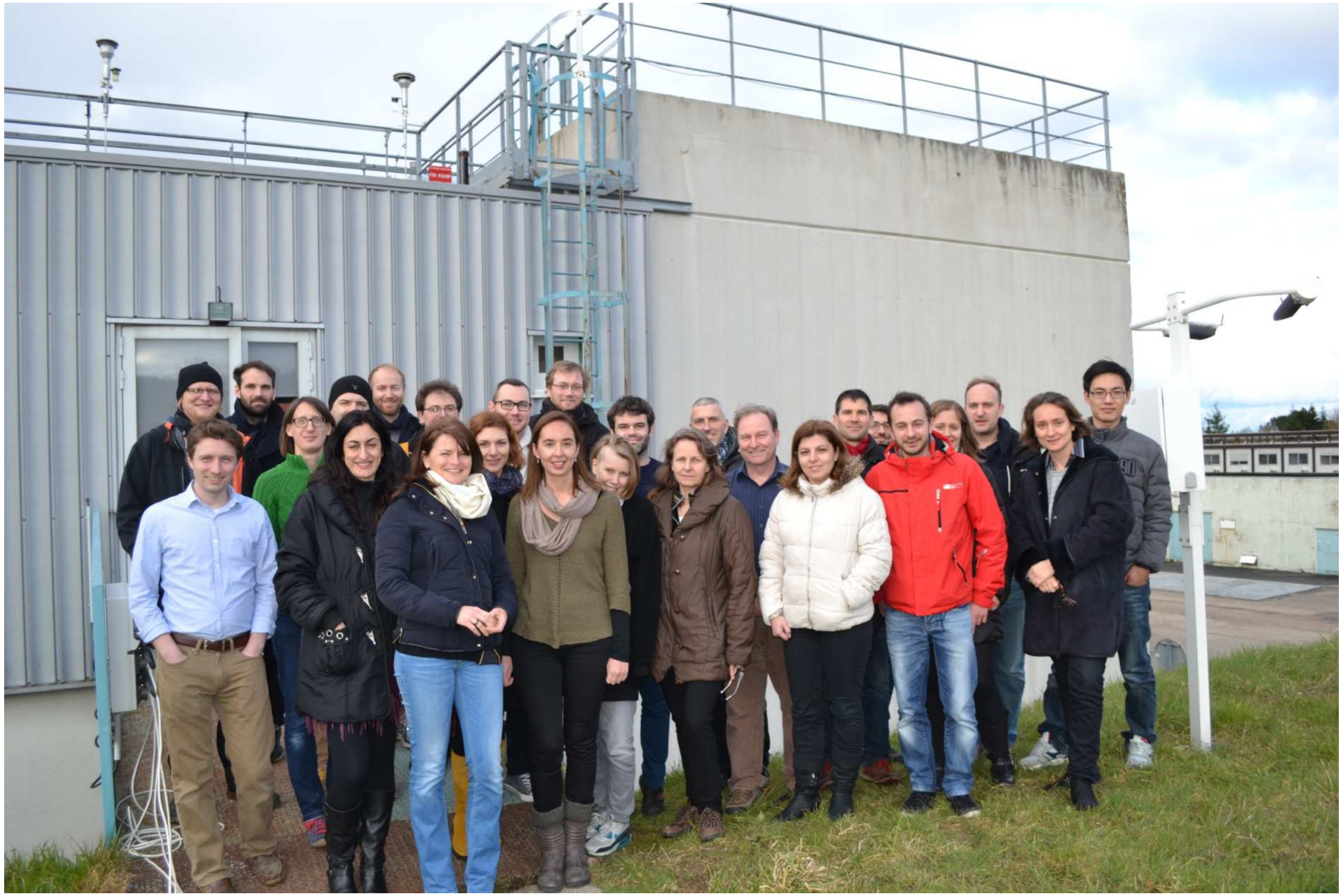


Q-ACSM intercomparison

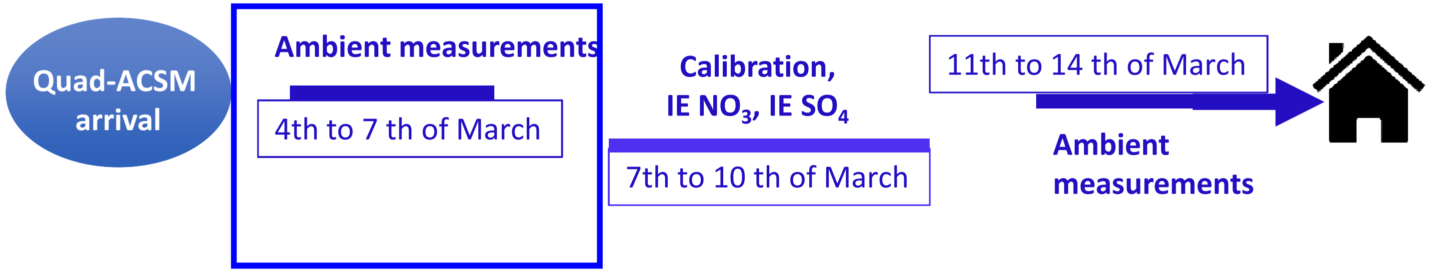


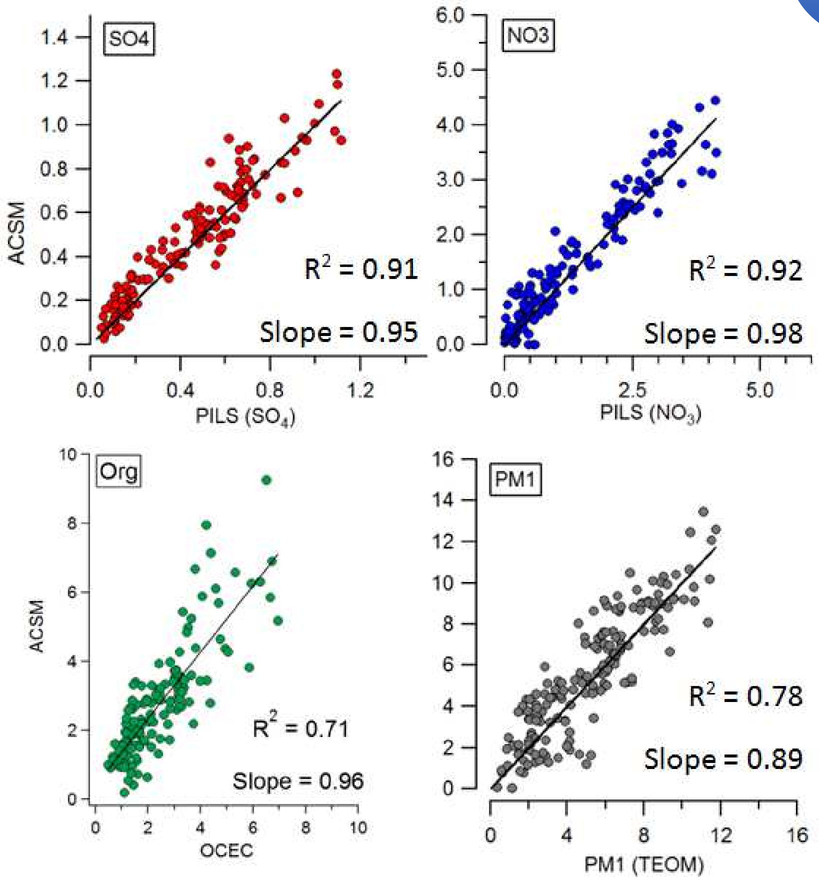


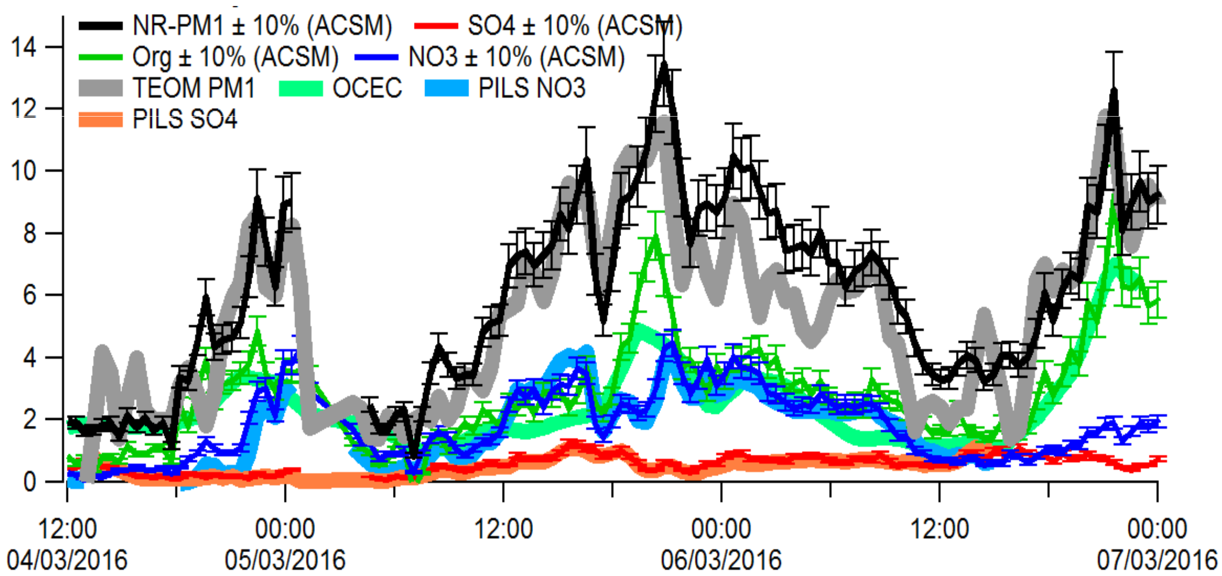
Q-ACSM intercomparison



Q-ACSM intercomparison







Q-ACSM intercomparison

Quad-ACSM arrival

Ambient measurements

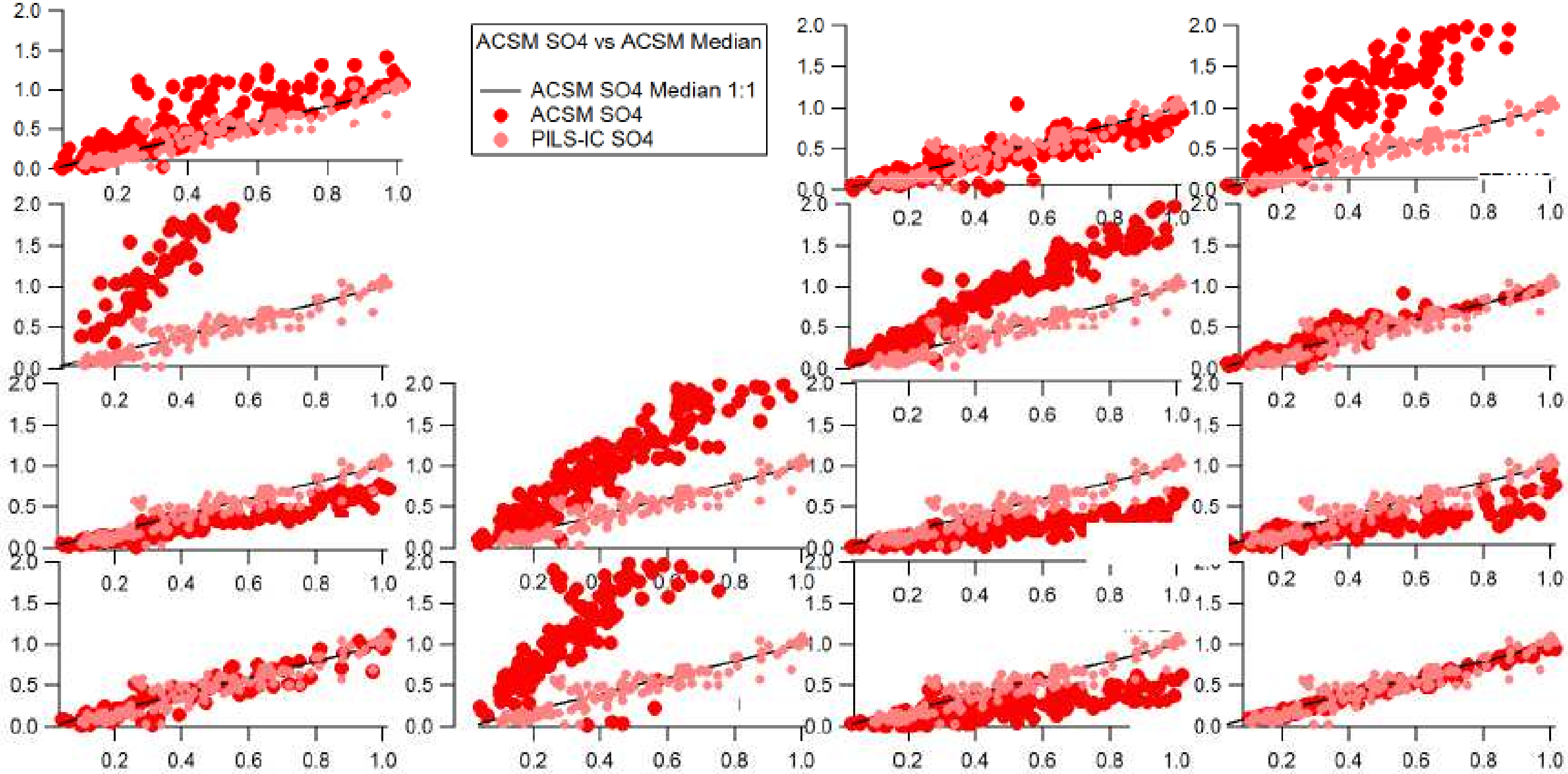
4th to 7 th of March

Calibration, IE NO_3, IE SO_4

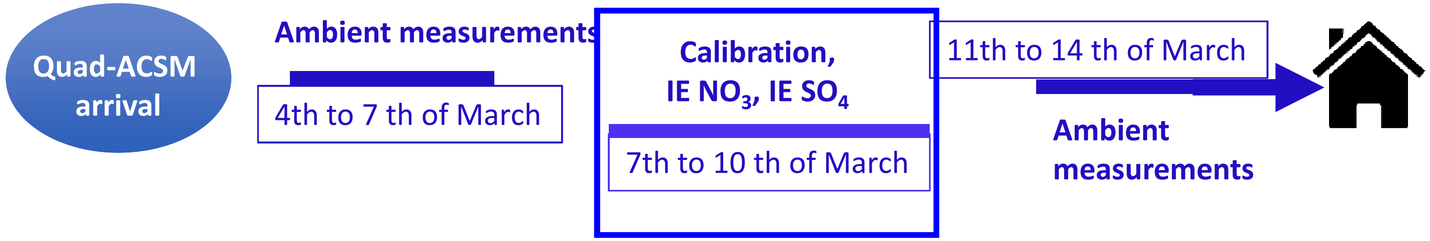
7th to 10 th of March

11th to 14 th of March

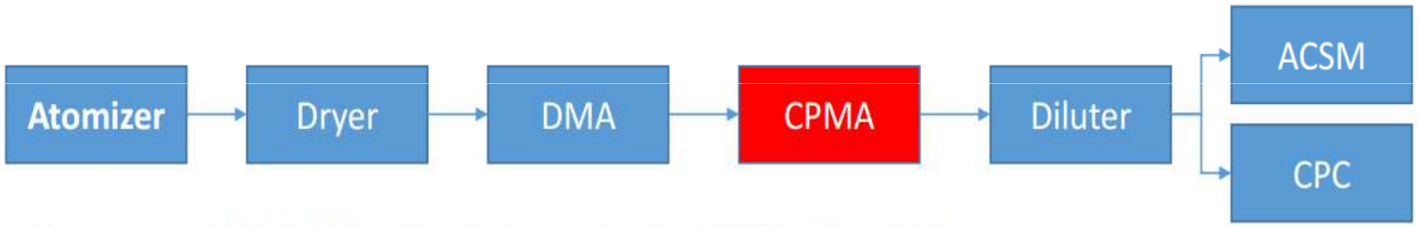
Ambient measurements



Q-ACSM calibrations

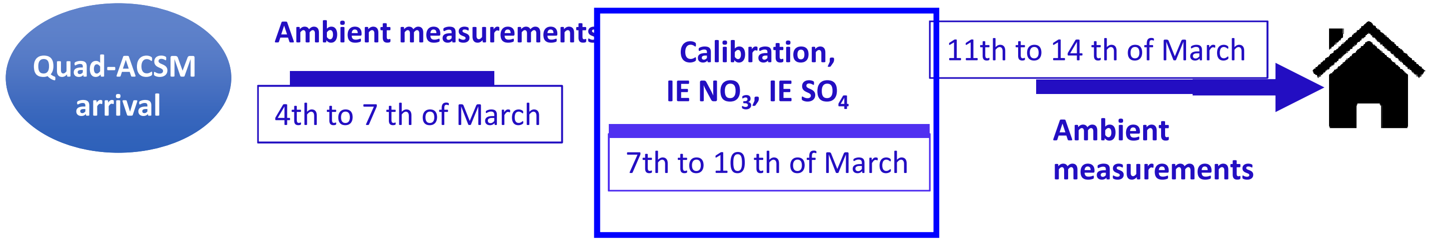


1. 'Standard' Calibration set-up

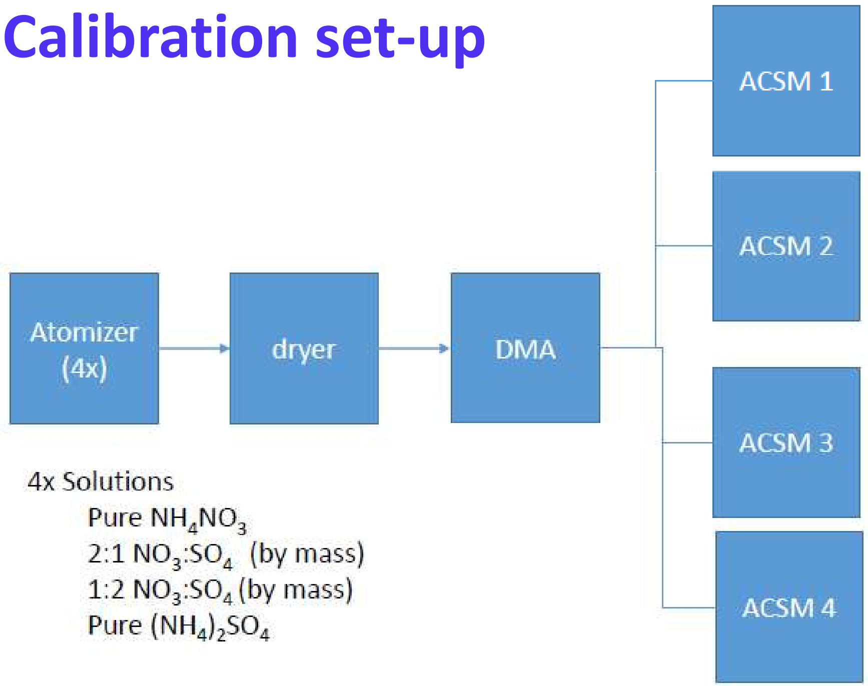


Like normal ACSM Calibration Setup but with CPMA after DMA
CPMA selects particles by Mass/Particle
Combined with DMA, this eliminates Q2s

Q-ACSM calibrations



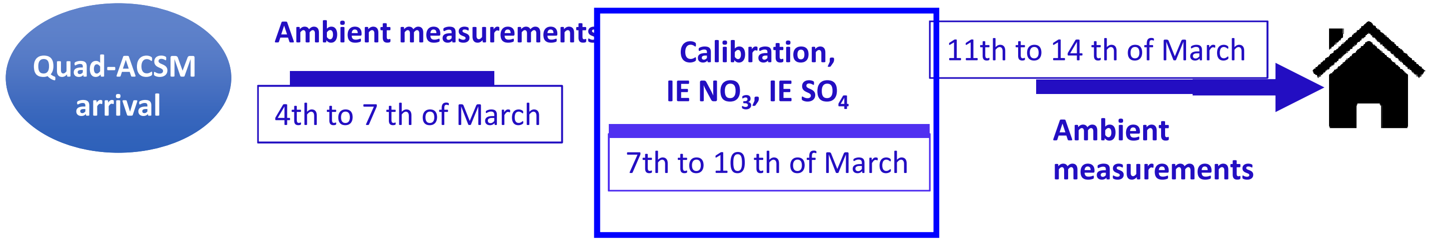
2. Mixture Calibration set-up

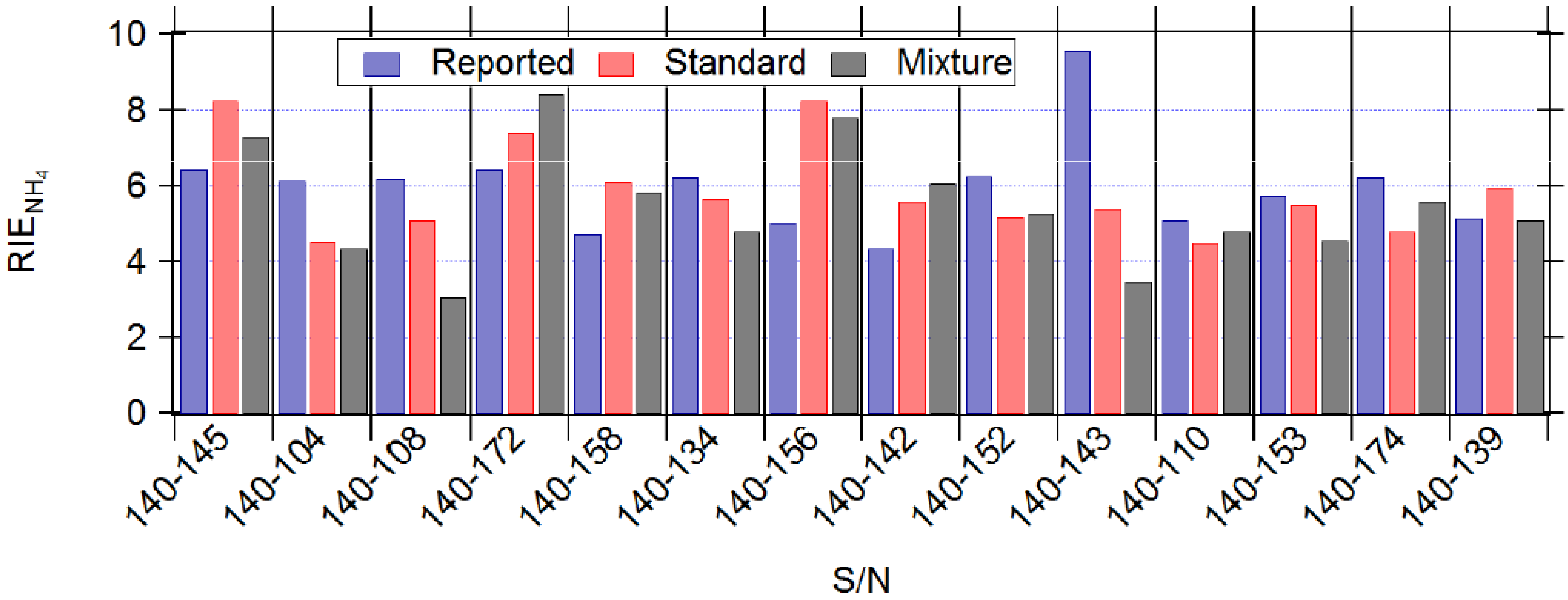


Run normal ACSM single scan mode, 1 set

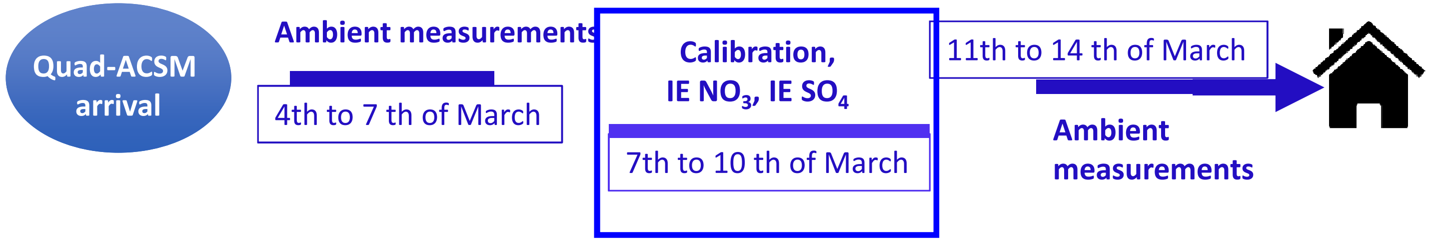
ACSM sample flow 0.5LPM/ACSM

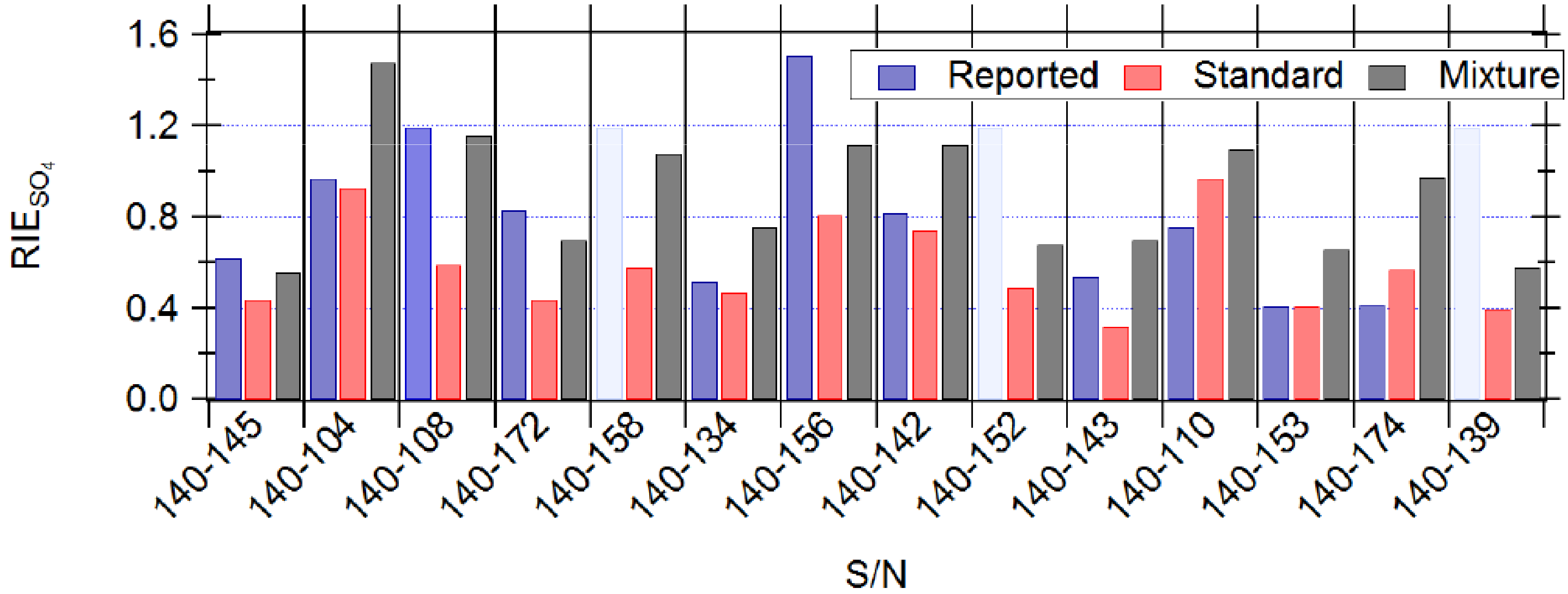
Q-ACSM calibrations





Q-ACSM calibrations



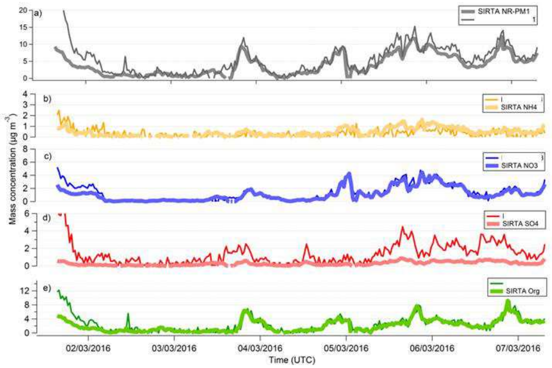


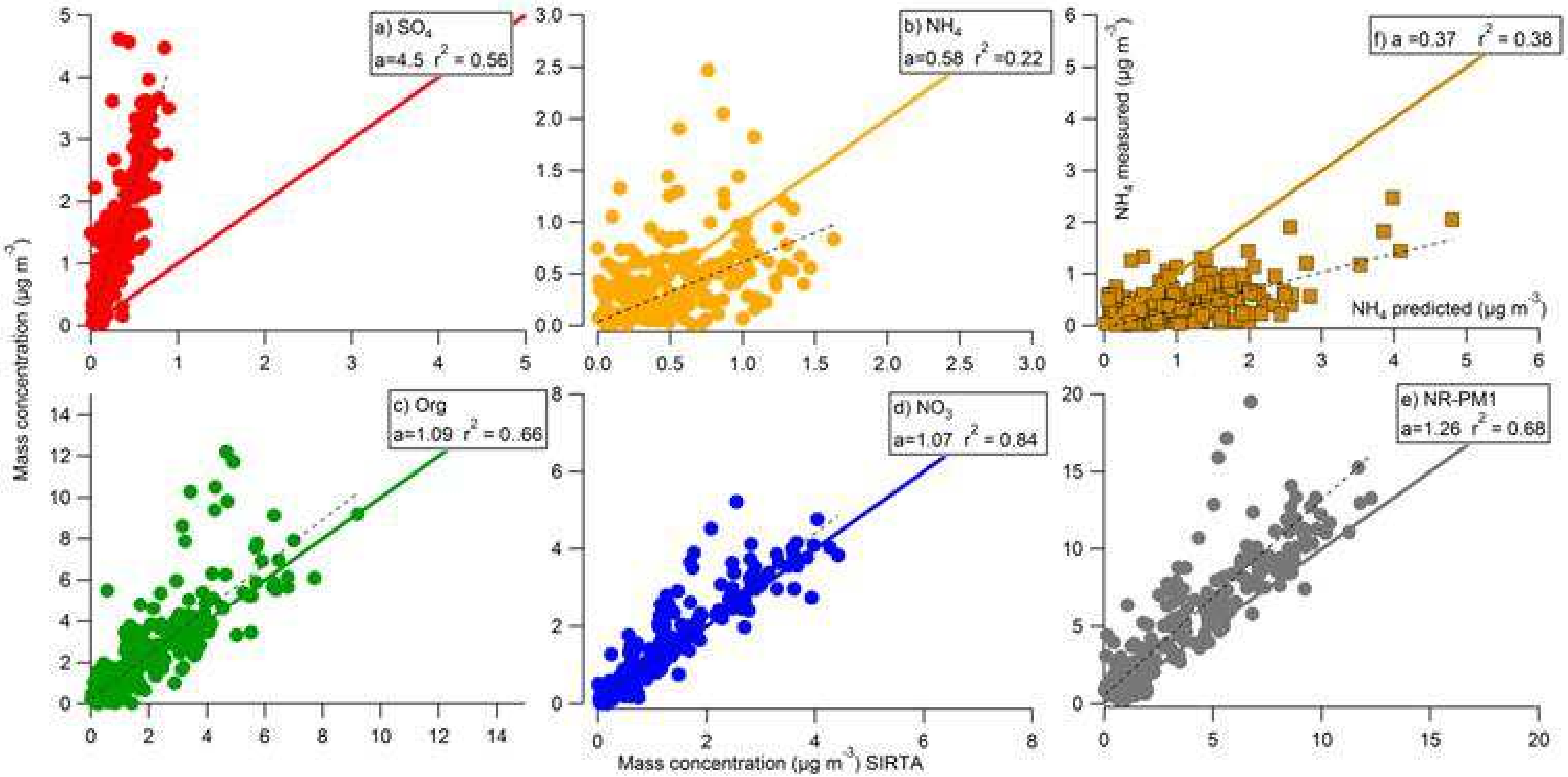
Q-ACSM intercomparison

Some examples of individual instrument comparisons

Comparison with reference instrument

BEFORE





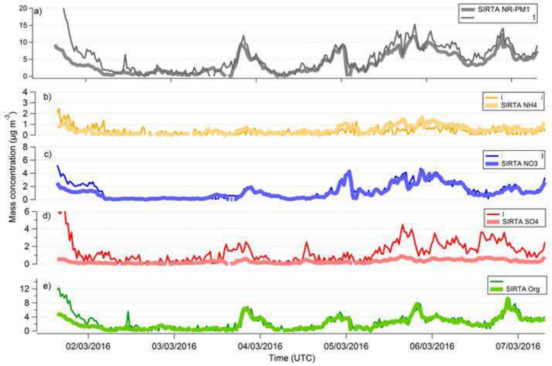
Q-ACSM intercomparison

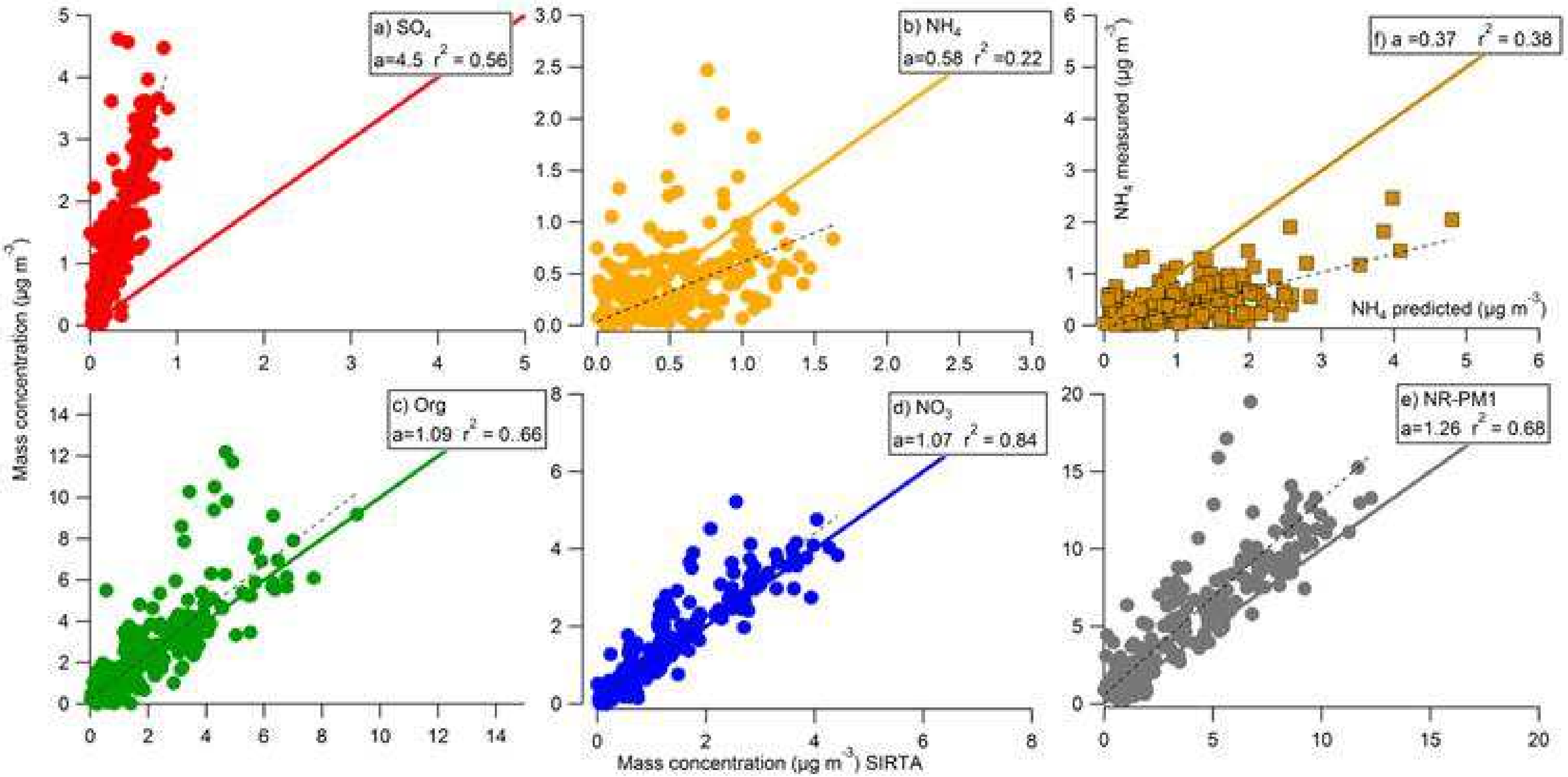
Some examples of individual instrument comparisons

Comparison with reference instrument

	RIENH4 STD	RIESO4 STD	RIESO4 MIX	RIENH4 MIX
Original	**6.23**	**0.42**	-	-
Calibrated	4.81	0.32	0.98	5.54

BEFORE





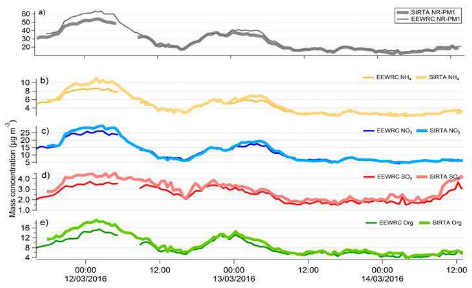
Q-ACSM after-calibration intercomparison

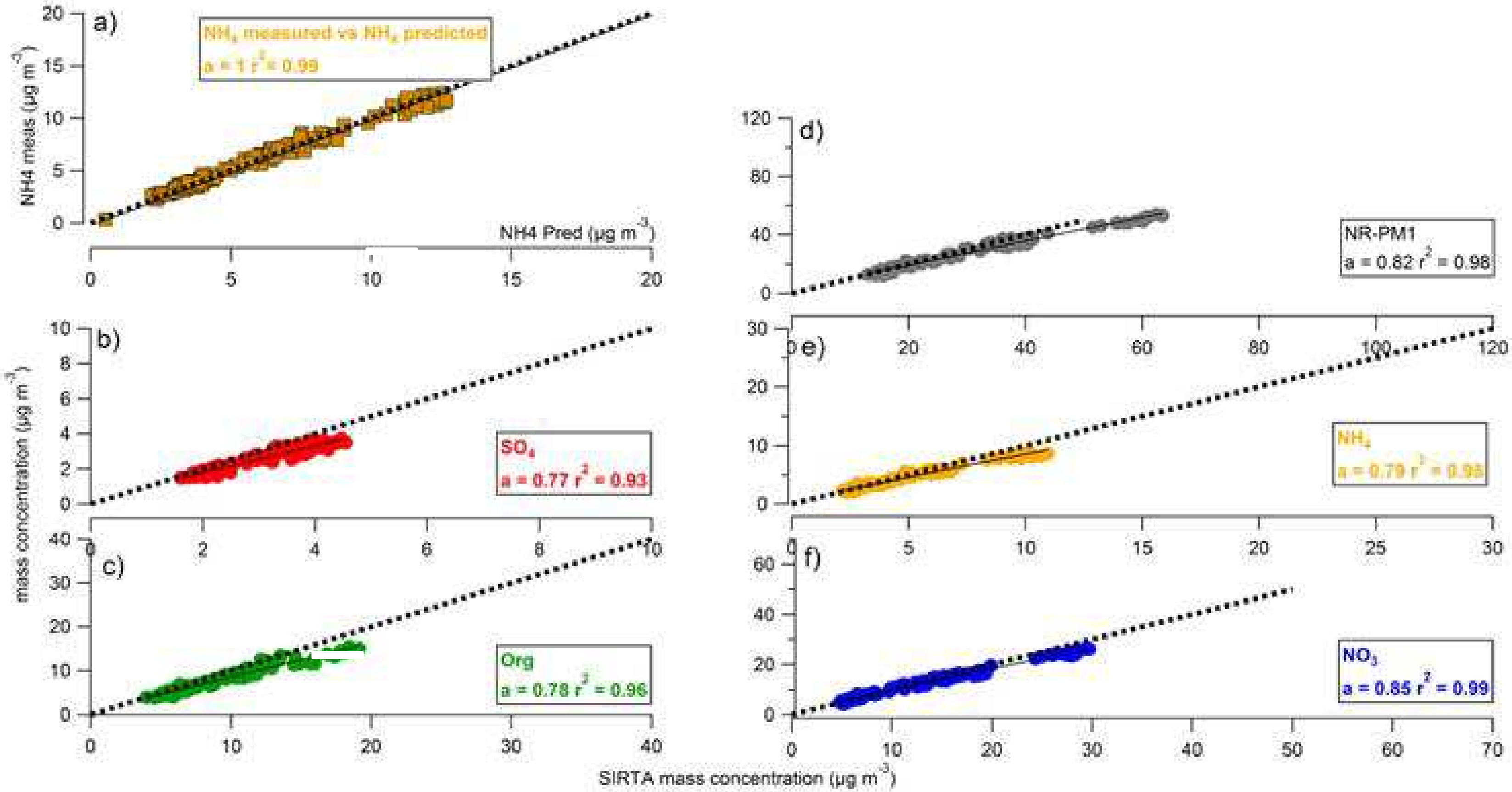
Some examples of individual instrument comparisons

Comparison with reference instrument

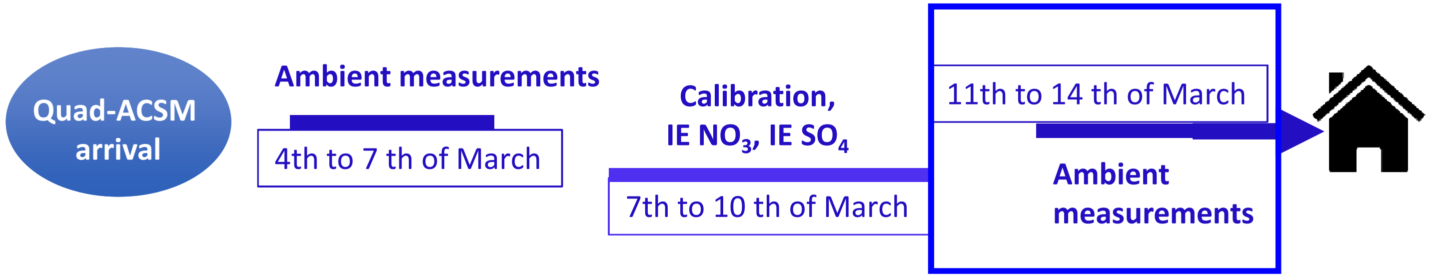
AFTER

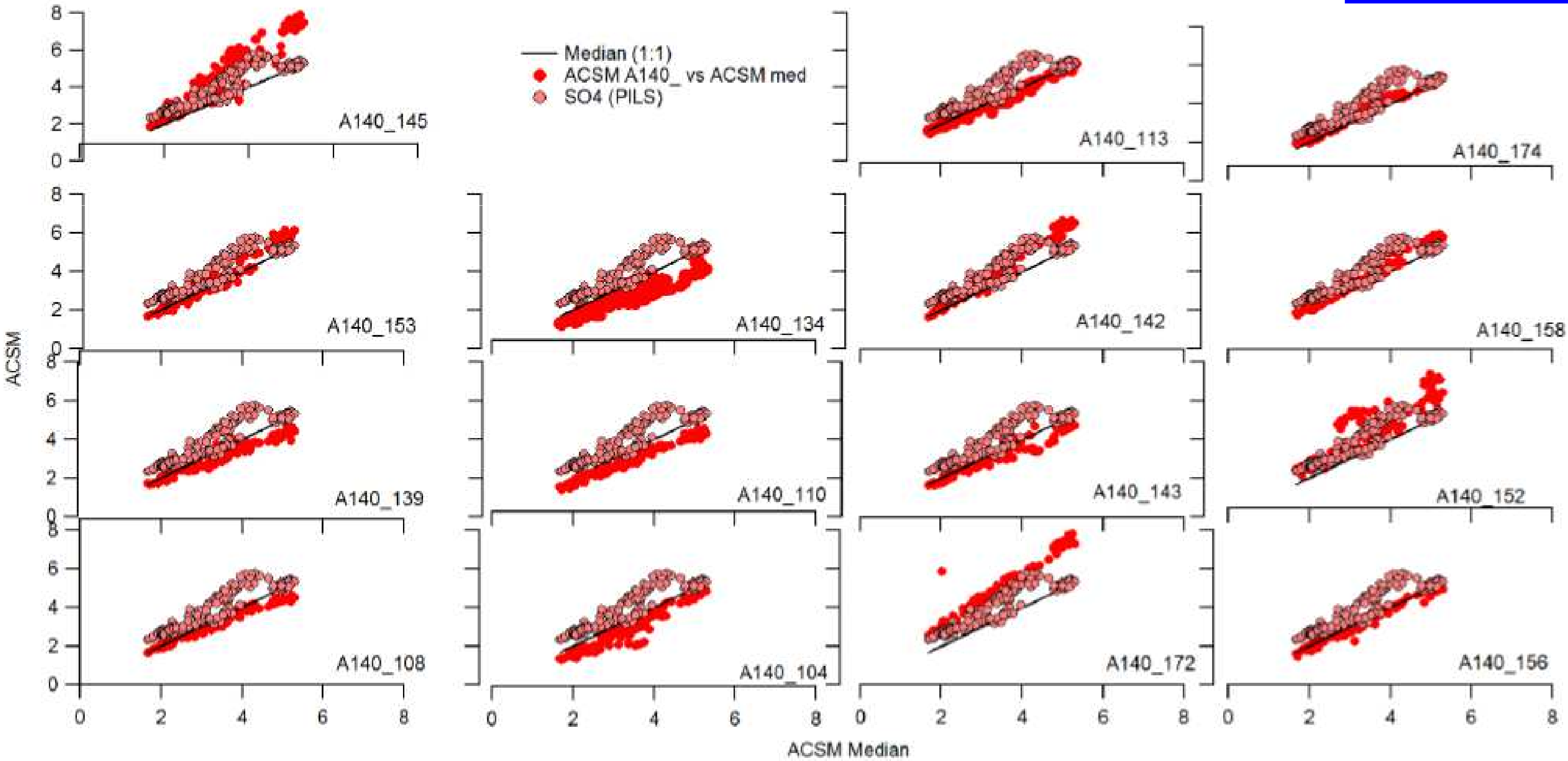
	RIENH4 STD	RIESO4 STD	RIESO4 MIX	RIENH4 MIX
Original	6.23	0.42	-	-
Calibrated	4.81	0.32	0.98	5.54



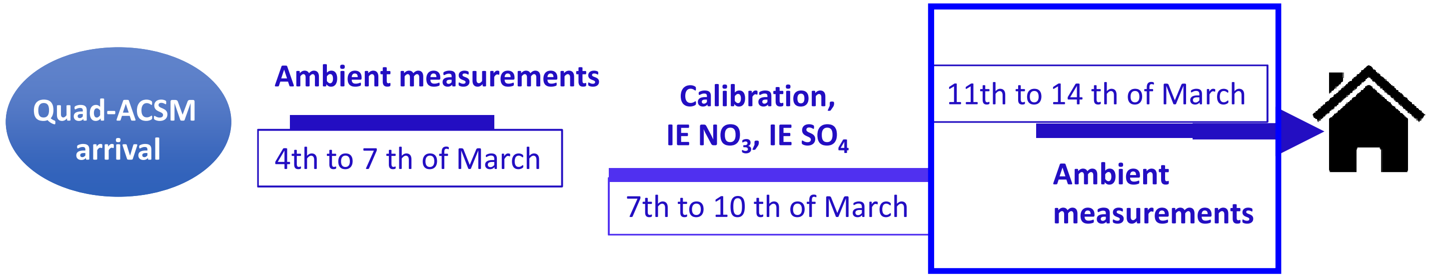


Q-ACSM after-calibration intercomparison

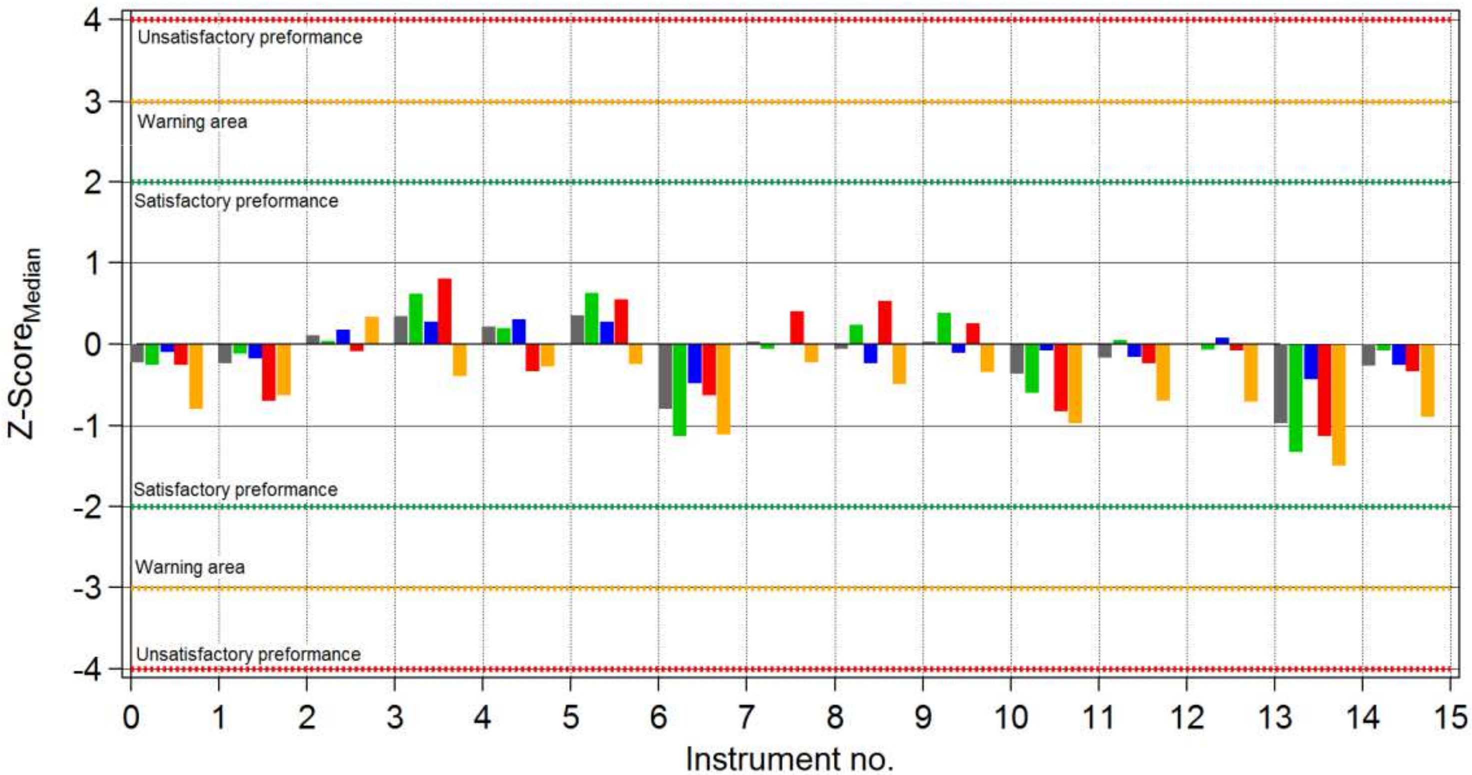




Q-ACSM after-calibration intercomparison

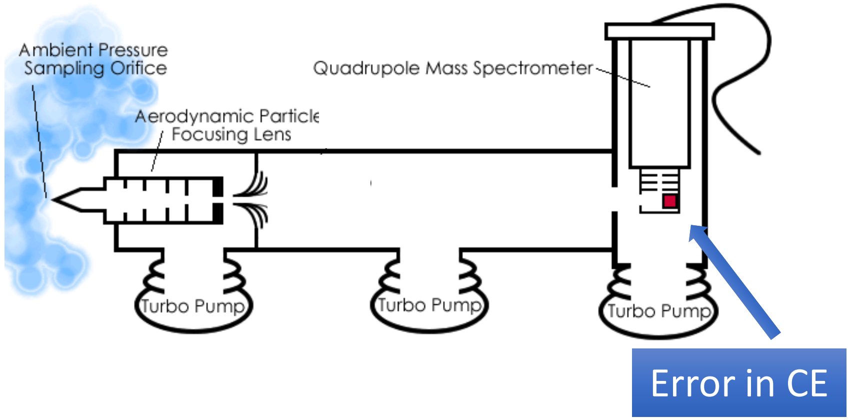


Instrument performance evaluated against the Median using the Z-score method



Collection vs. transmission efficiency

Evalulation criteria (Error associated with instrument transmission and collection)



CE: Correction for collection efficiency of indiviual instruments depends on composition and phase

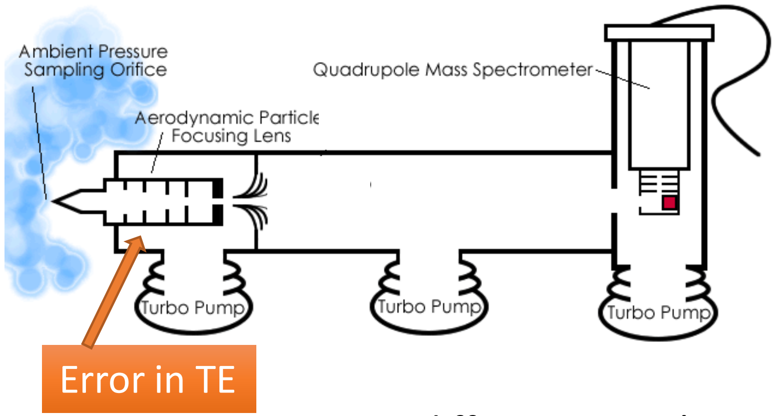
Instruments are then corrected using a chemical dependant collection efficiency (CDCE).

Assuming that when particles contain a high fraction of ammonium nitrate that they are more efficiency sampled (more liquid)

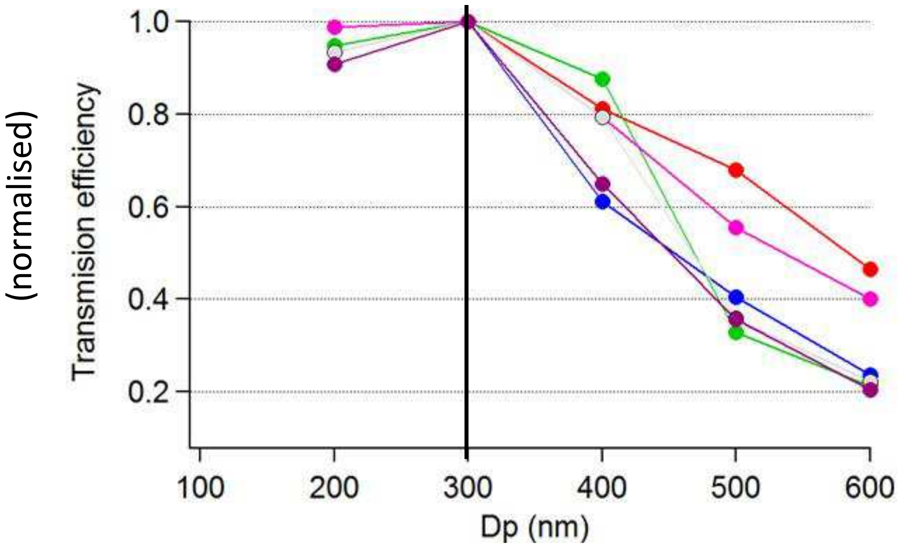
The instrument to instrument variation in the CDCE =5%

Collection vs. transmission efficiency

Evalulation criteria (Error associated with instrument transmission and collection)



5 different ACSM'S



Lens transmission efficiency

- For this exercise, standard AN calibrations were performed at various size of (relatively large particles) on different instruments
- The lens transmission efficiency (E_L) is calculated as the ratio between RFNO3 obtained for a given size and RFNO3 obtained at 300 nm

If 50% of the mass > 400 nm ⇒ tot. mass may be off by up to 20%

⇒ May induce much more bias than CDCE calculations

Evaluation criteria (Conclusion)

Error1

Calibration repeatability : Variation in calibration value (3 to 4 calibrations were performed on each instrument)
Max. Error of 15%

Error2

TE: Transmission efficiency error.. Depending on the particle size measured the lens TE varies..
Max. Error of 25%

Error3

CE: Collection efficiency correction.
Depending on the particle chemical composition and morphology..
Error in CDCE based on chemical composition
Max. Error of 5%

Propagation of errors

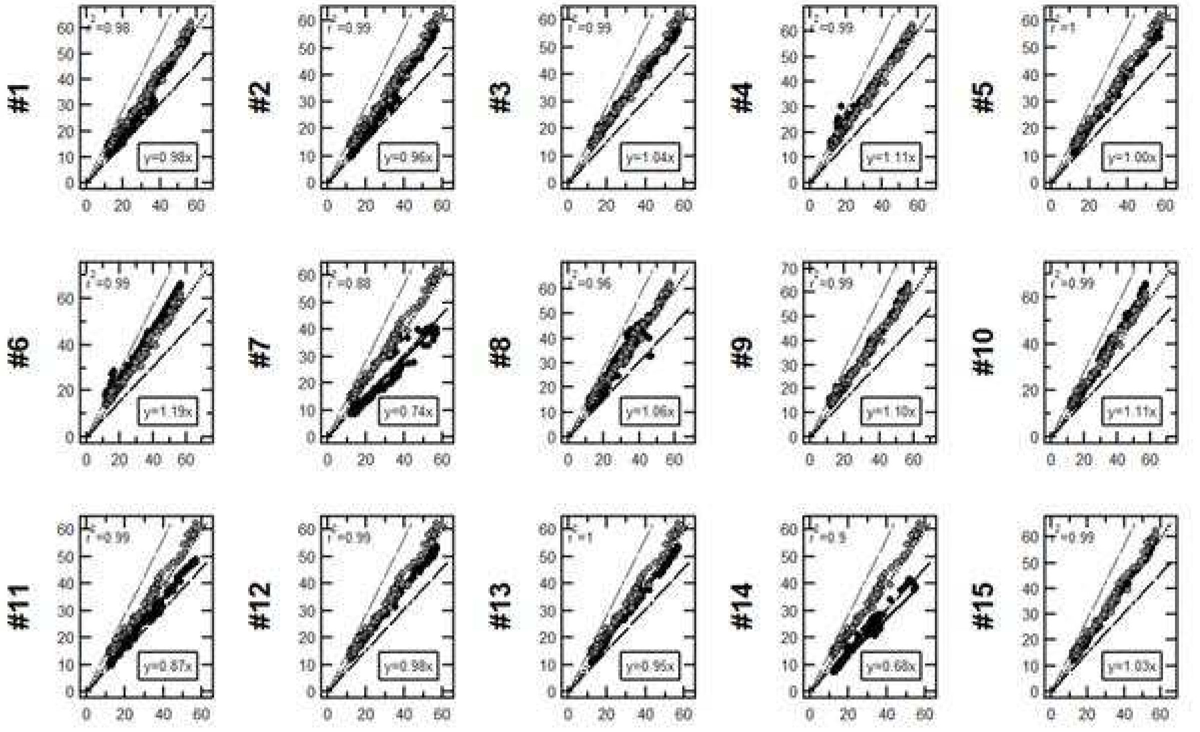
$$\sqrt{\sum Error1^2 + Error2^2 + Error3^2}$$

= **30% at max.**

Instrument falls within ± 30% of the « reference » instruments

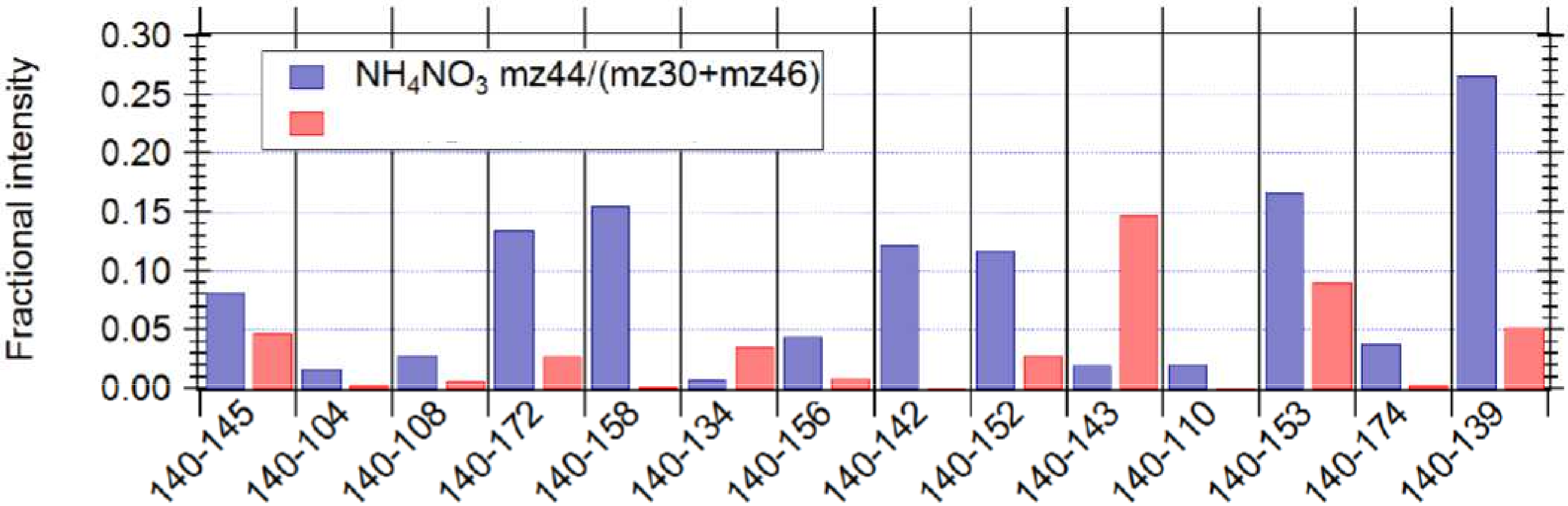
PM1 of all instrument compared with PM1 of SIRTA instruments. Dotted line indicates ± 30% error

light points represent TEOM-FDMS, black points represent ACSM data

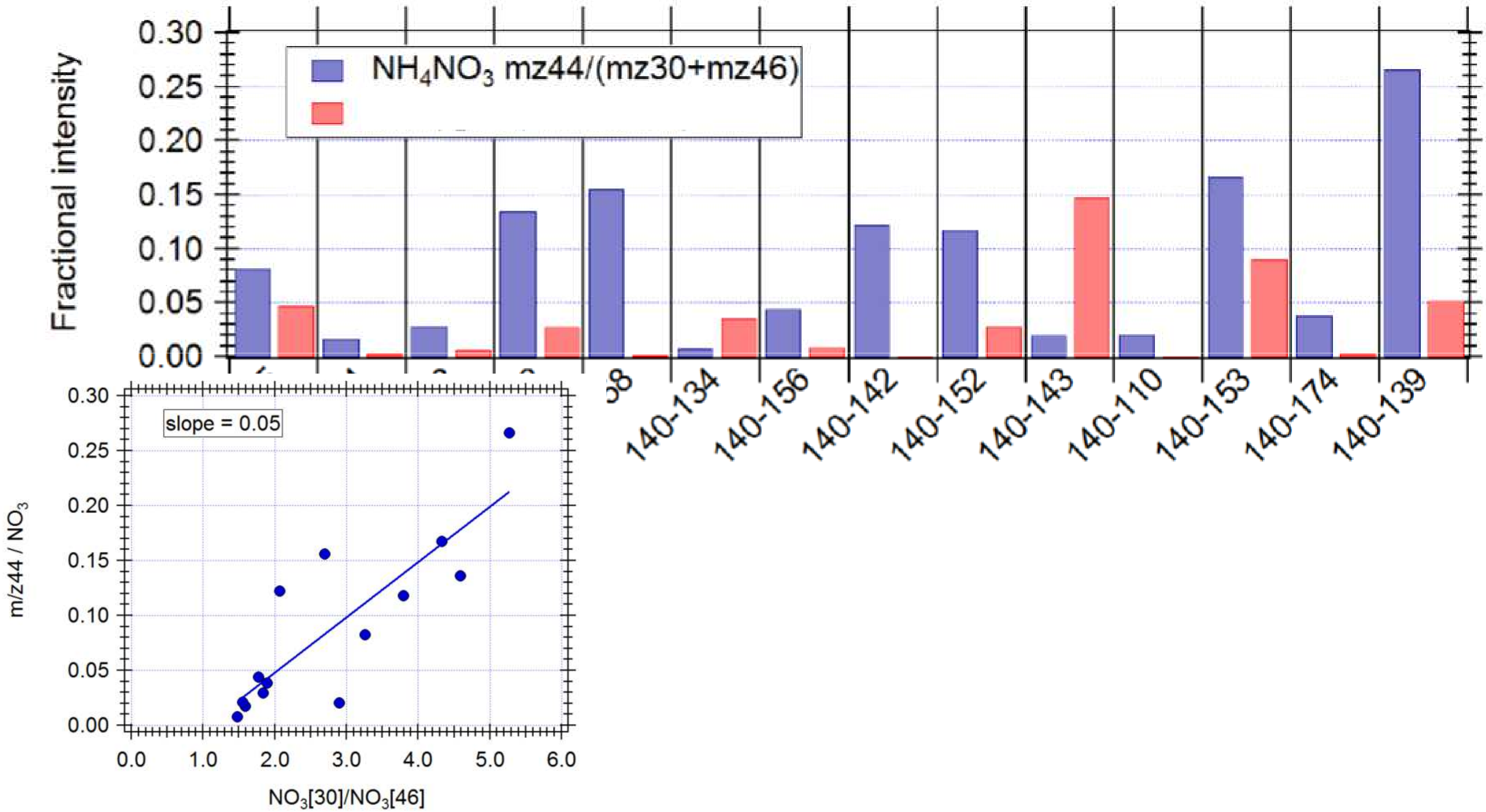


PM1 SIRTA (REF)

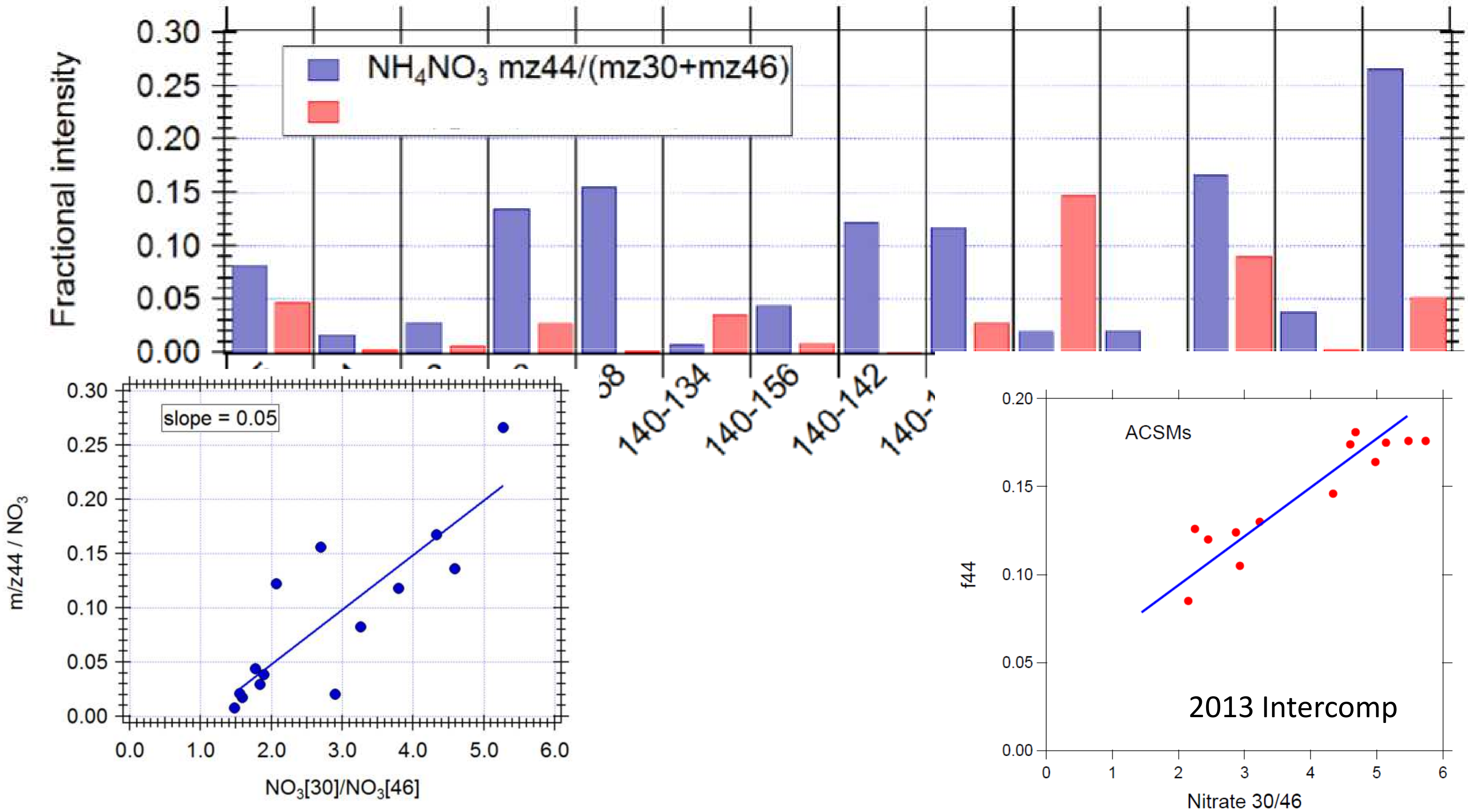
‘Pieber effects’



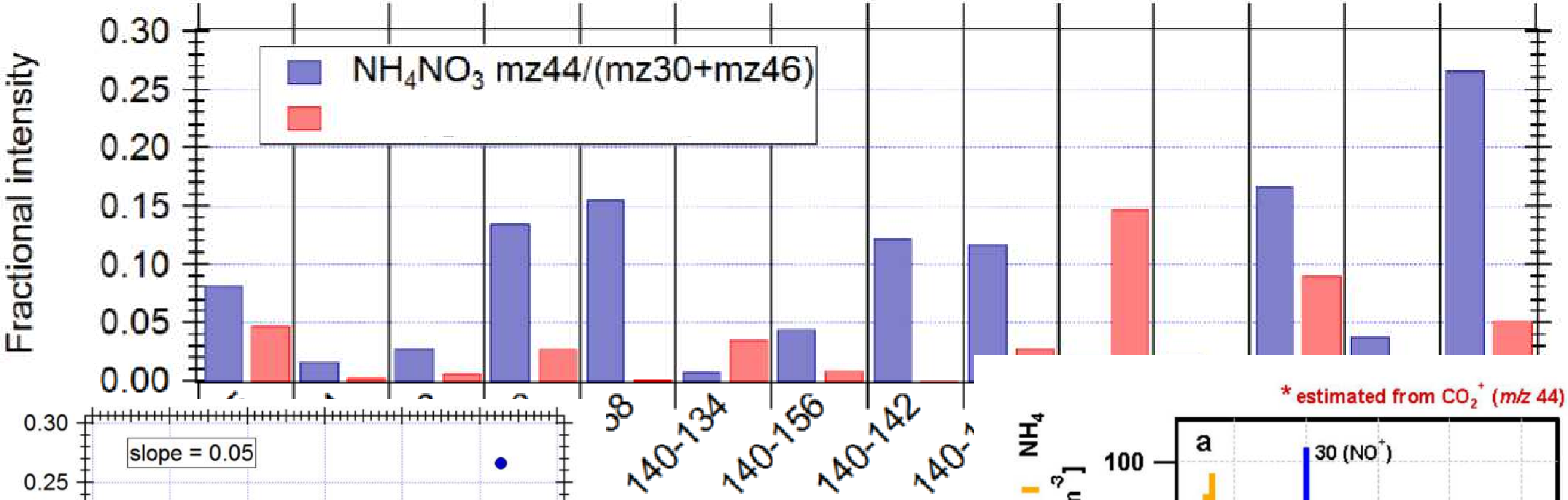
'Pieber effects'

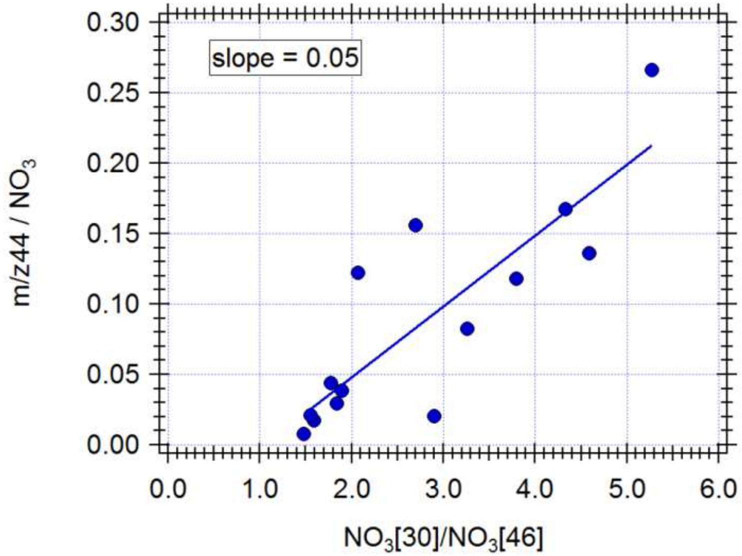


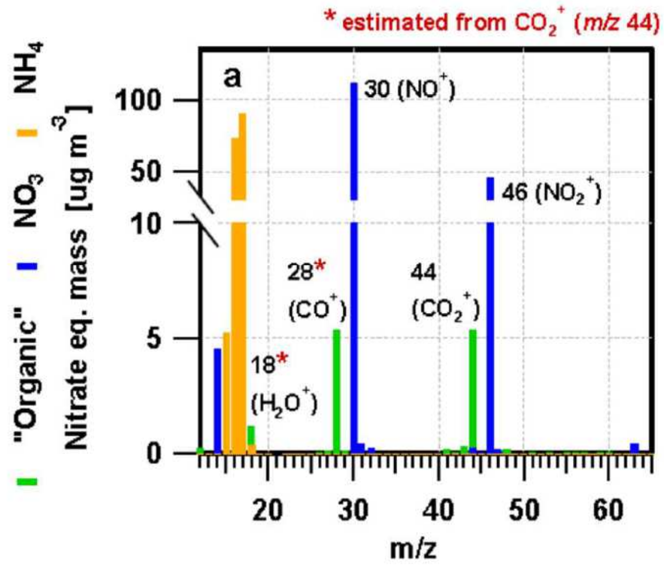
‘Pieber effects’



‘Pieber effects’

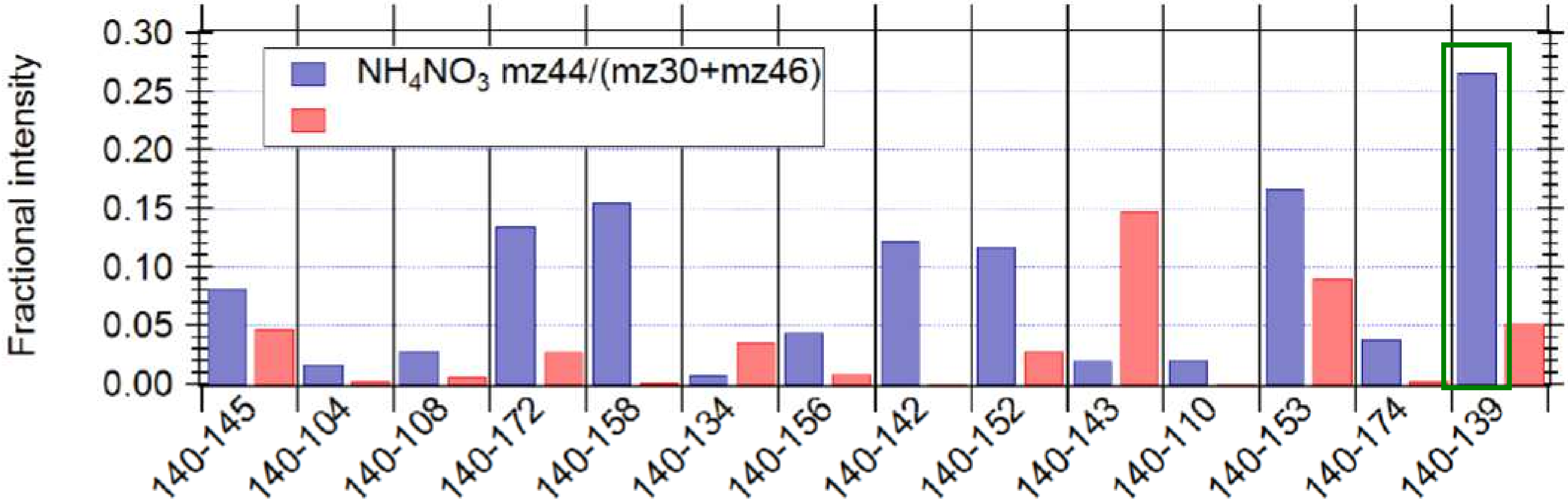




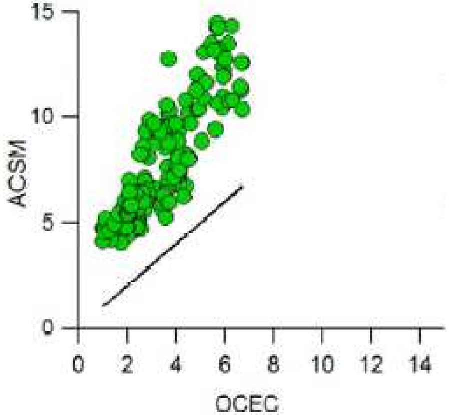


Pieber et al., 2016

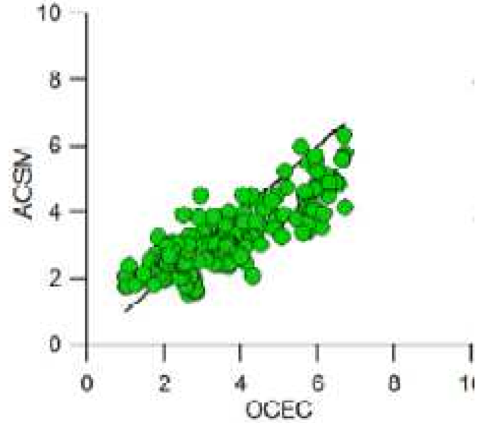
‘Pieber effects’



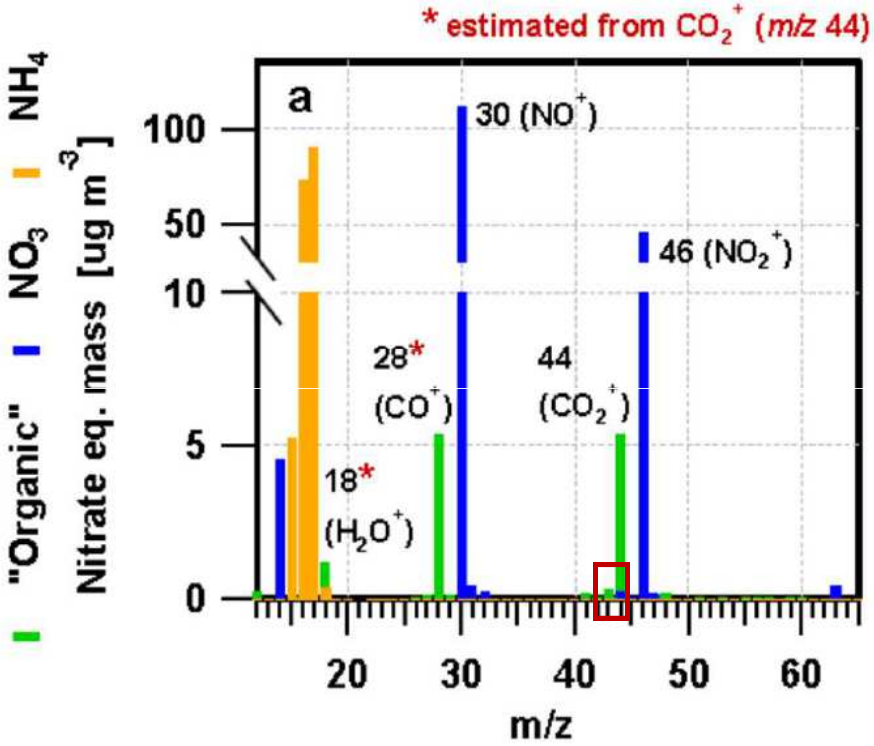
Total OA conc.:



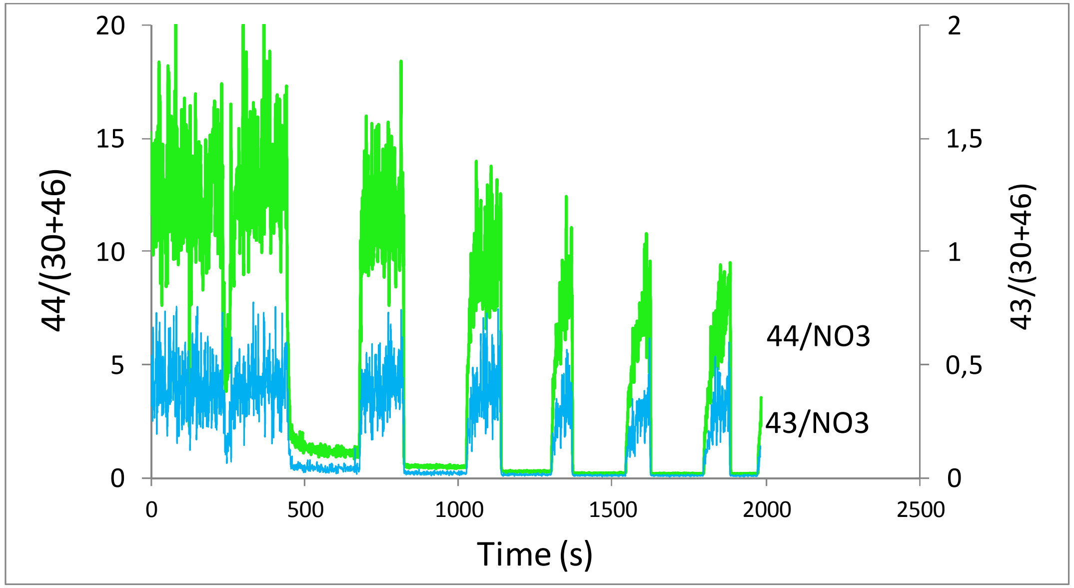
‘Pieber corrections’



‘Pieber effects’



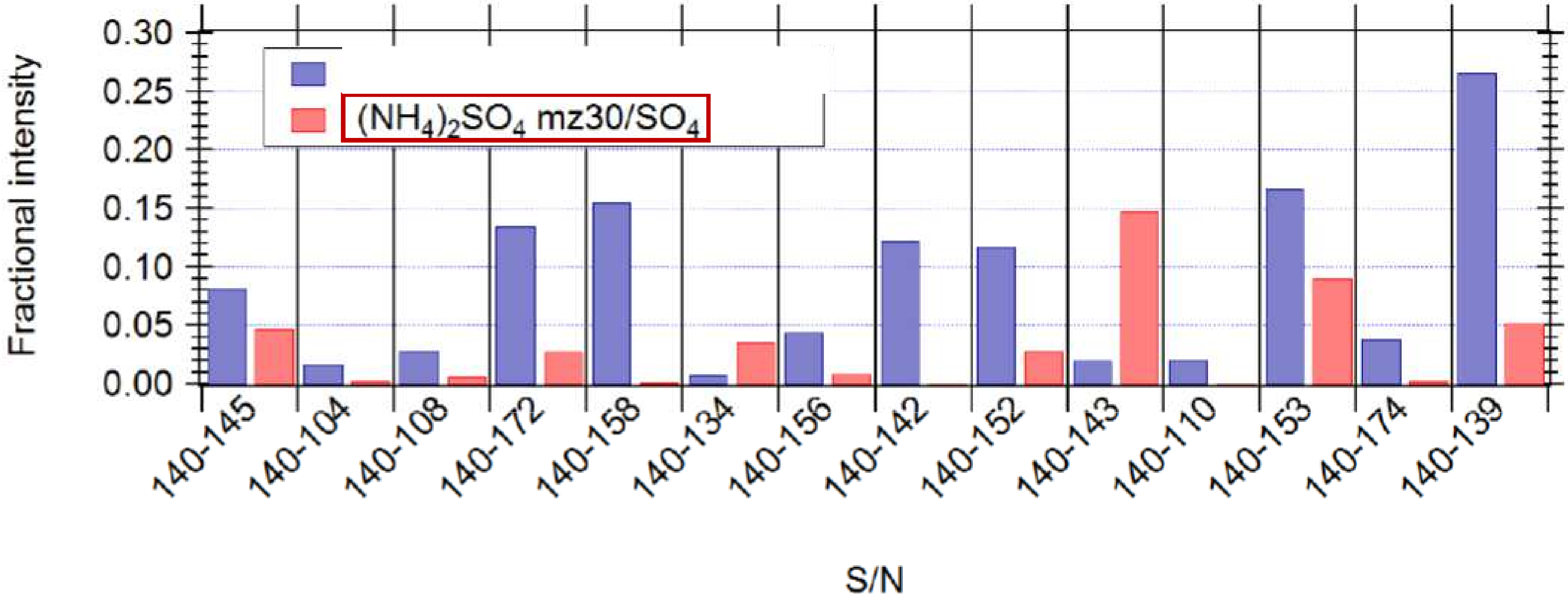
Pieber et al., 2016



ToF-ACSM calibration data

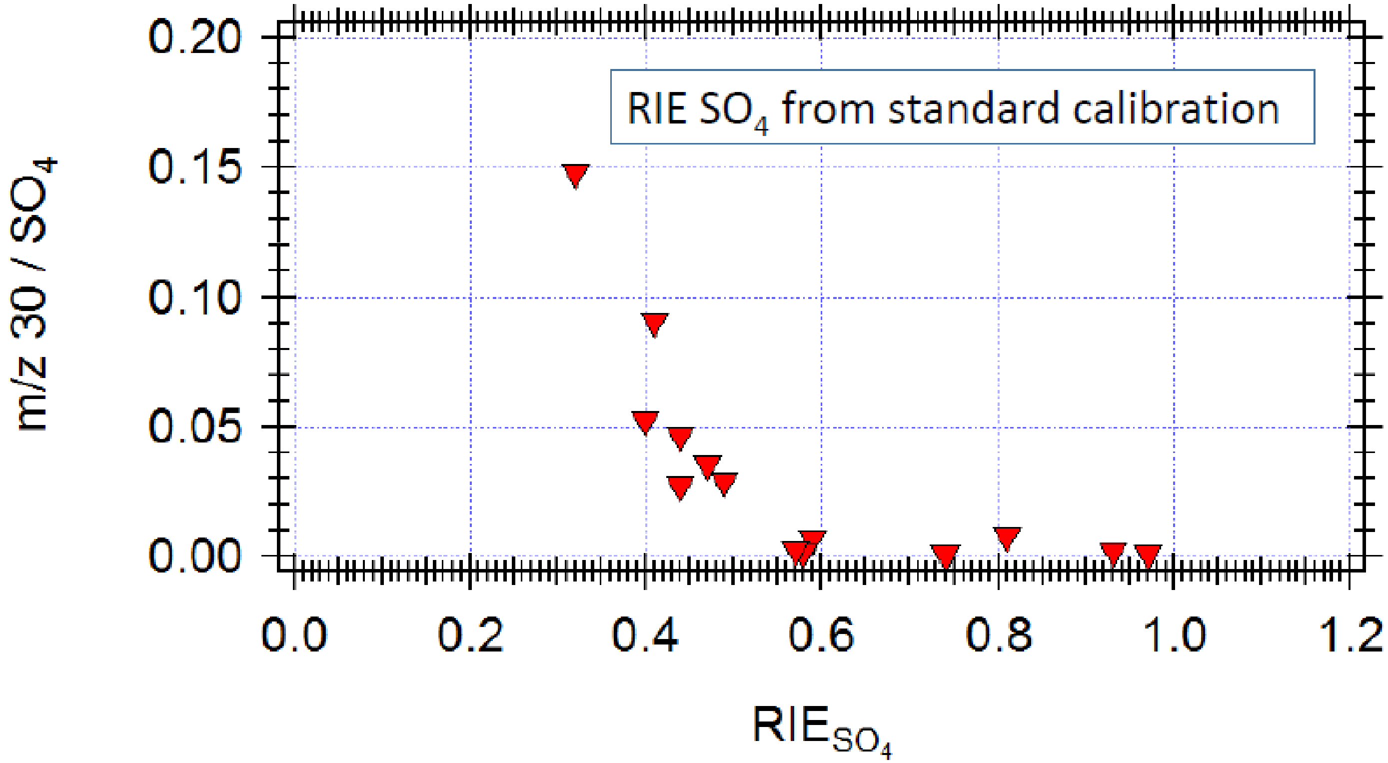
Might be worthy to check if m/z43 - related corrections could be needed in some cases

‘Pieber effects’



‘Pieber effects’

m/z 30 from pure $(NH_4)_2SO_4$



Conclusions

- The ACSM is still a research instrument on which we have to keep performing research activities
- The data acquired during the ACMCC intercomparison exercises will be used to further determine robust uncertainties for these instruments
- Calibrations in acquisition mode (‘mixture calibrations’) significantly improved the accuracy of SO4 measurements
- Tunning of ACSM (AMS) Analog Input used for CPC reading has to be checked
- Encourage users to check for size dependent lens transmission efficiency of each individual instrument
- Some more ‘Pieber effects’ to come .. (→ some more optimisation of the frag table ?)