GGG retrieval of EM27/SUN and intercomparisons against TCCON

EM27/SUN Telecon

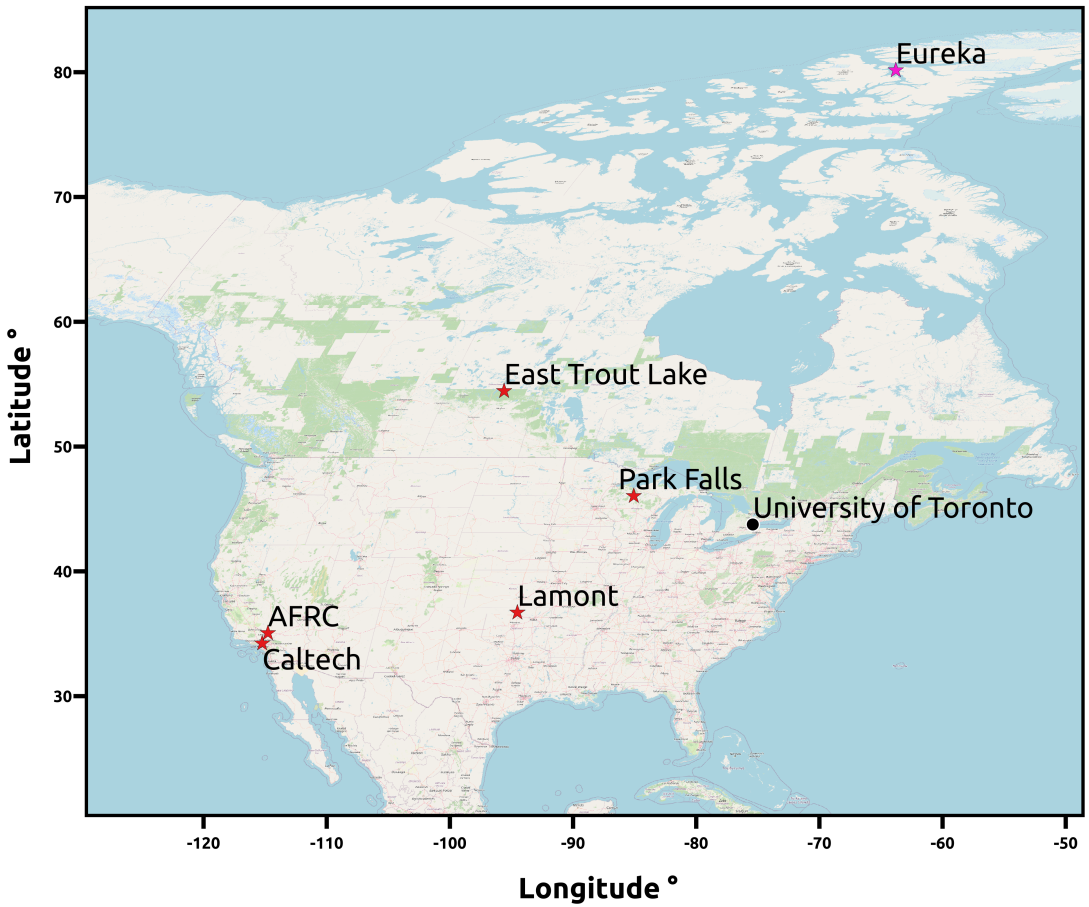
17 Jan 2023

EM27/SUNs for GHG Measurements in Toronto

Seven EM27/SUNs currently measuring in the GTA.
*Three have visited TCCON sites in North America.

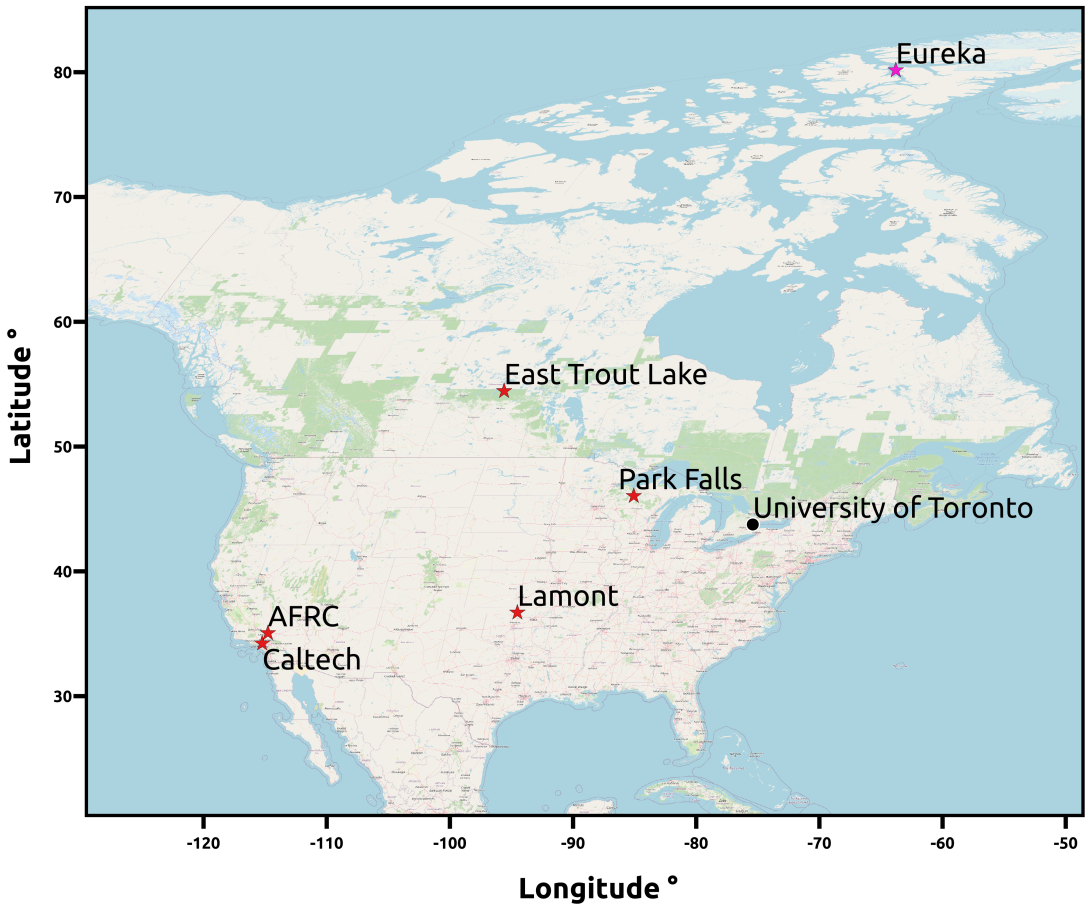
TCCON Road Trip

- Summer 2018 road trip campaign :
  - TCCON sites: Caltech (ci), AFRC (df), Lamont (oc), Park Falls (pa) and East Trout lake (et)
  - EM27/SUNs: Toronto (ta, tb, tc) and one EM27/SUN from Caltech (dn)
- Spring-Fall 2020: Eureka (eu), only of the instruments (tb)



TCCON Road Trip

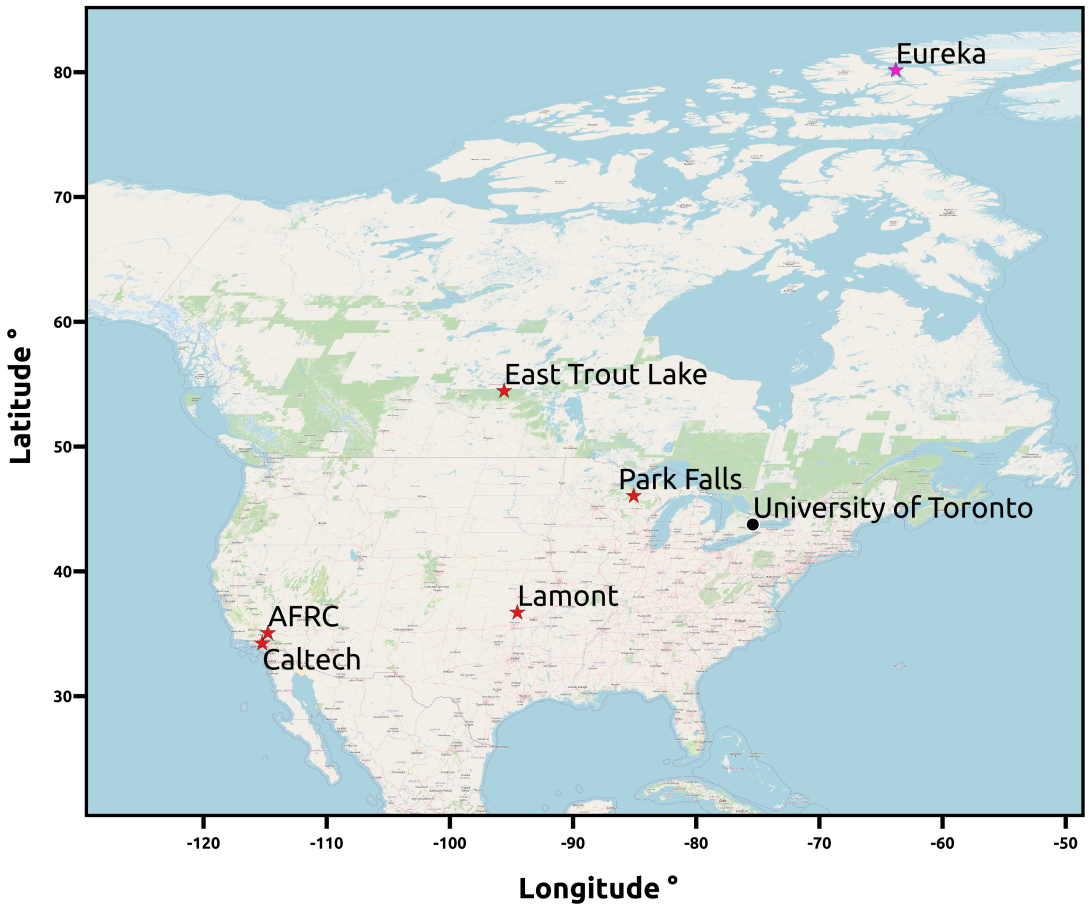
- Test the durability of EM27/SUNs when they are moving frequently
- Investigate the biases between the EM27/SUNs
- Investigate the biases between the EM27/SUNs and TCCON sites
- Indirectly Compare TCCON Stations to each other



TCCON Road Trip

In addition we planned for:

- AirCore launches at 3 sites: Dryden, Lamont and Park Falls



Caltech

2018-07-06 to 2018-07-12

AFRC

2018-07-13 to 2018-07-19

Lamont

2018-07-21 to 2018-07-28

dn shipped back
to Caltech at the end

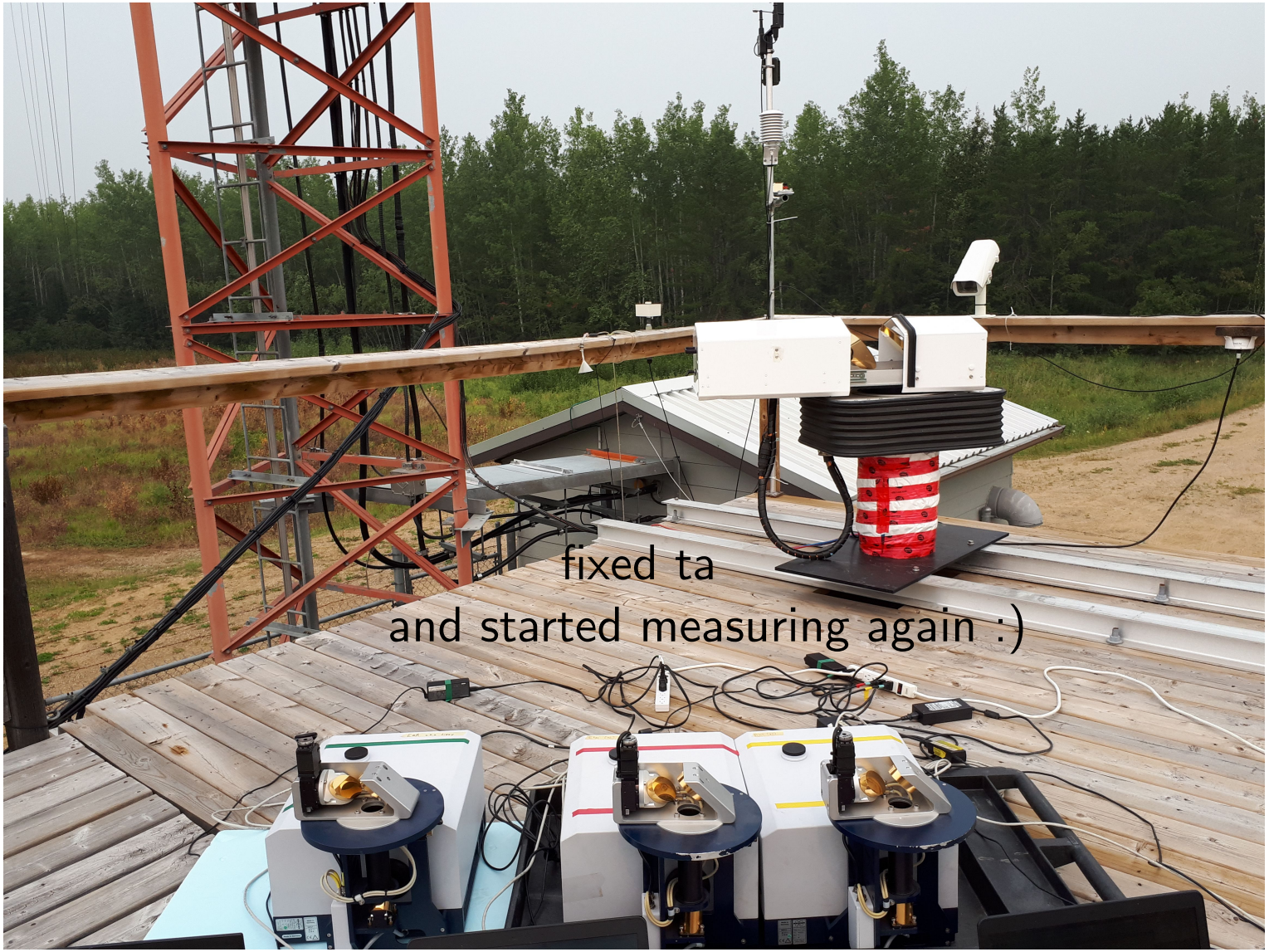
Park Falls

2018-07-30 to 2018-08-07

Many cloudy days
issues with ta's sun tracker
Measured with the two instruments tb & tc

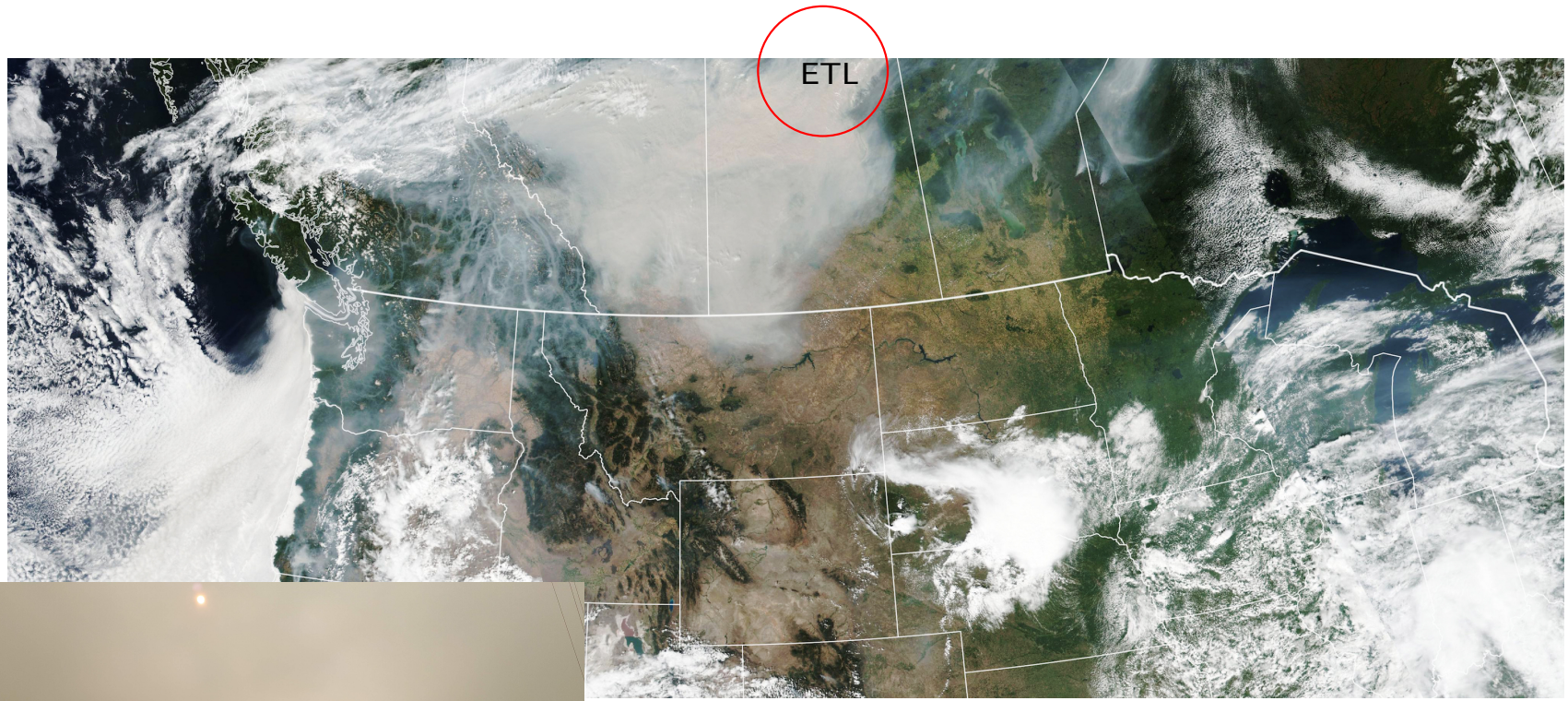
East Trout Lake

2018-08-10 to 2018-08-19



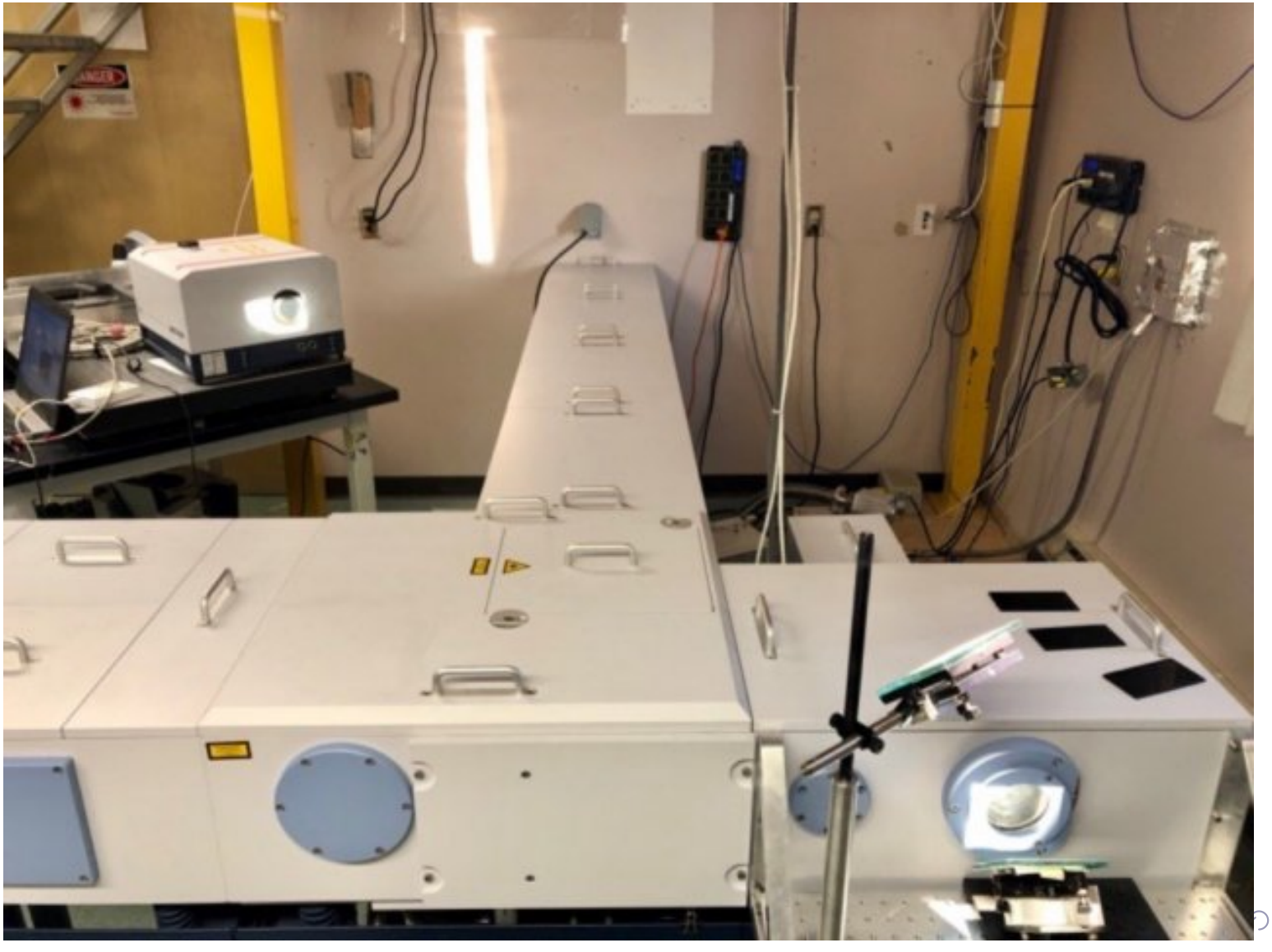
East Trout Lake

Forest Fires



* MODIS image

TCCON Laser failure on July 6th



Overview of the trip

Site	Dates	# days	EM27/SUNs	# EM27/SUN ifgs	# TCCON ifgs	AirCore
Caltech	2018-07-06 – 2018-07-12	7	ta,tb,tc,dn	21356	1541	-
Dryden	2018-07-13 – 2018-07-19	7	ta,tb,tc,dn	16522	3775	6
Lamont	2018-07-21 – 2018-07-19	5	ta,tb,tc,dn	12942	872	9
Park Falls	2018-07-31 – 2018-08-07	4	(ta),tb,tc	3324	406	4
East Trout Lake	2018-08-09 – 2018-08-18	6	ta,tb,tc	10665	861	-
Eureka	2020-03-04 – 2020-09-25	61	tb	132279	5166	-

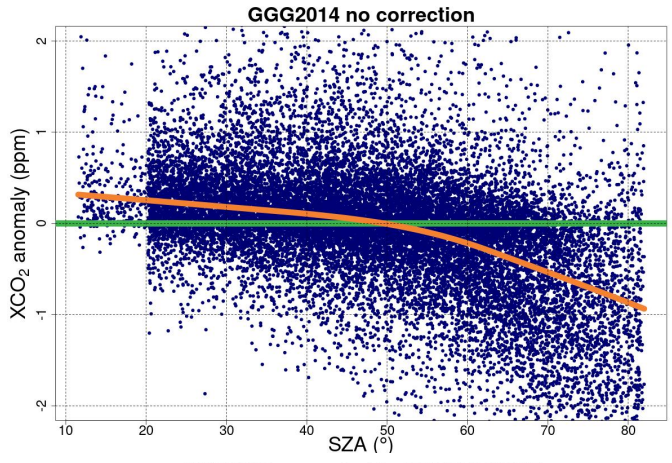
Retrieval Procedure

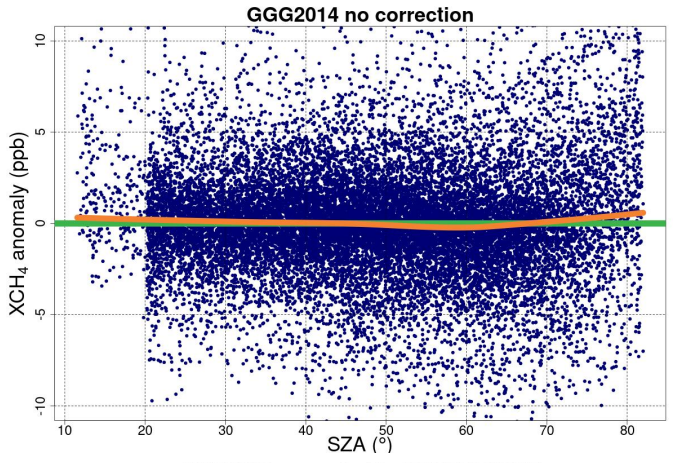
- Software: EGI/GGG2014 and EGI/GGG2020
- Data were processed with identical pressure data taken from TCCON and a priori profiles
- Revised Post-Processing steps for the EM27/SUNs:
  - Calculated Airmass Dependant Correction Factors (ADCFs) $\rightarrow$will go to EGI
  - Calculated an additive instrument-to-instrument bias $\rightarrow$using ghost correction feature in GGG (will need to change the name at some point)
  - Calculated Airmass Inependant Correction Factors (AICFs) using coincident AirCore measurements $\rightarrow$will go to EGI
- Added truncated low resolution 125HR spectra to match EM27/SUN resolution

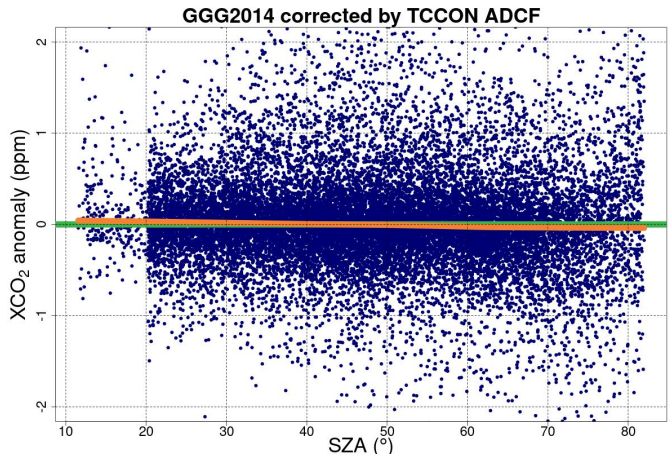
ADCF calculation

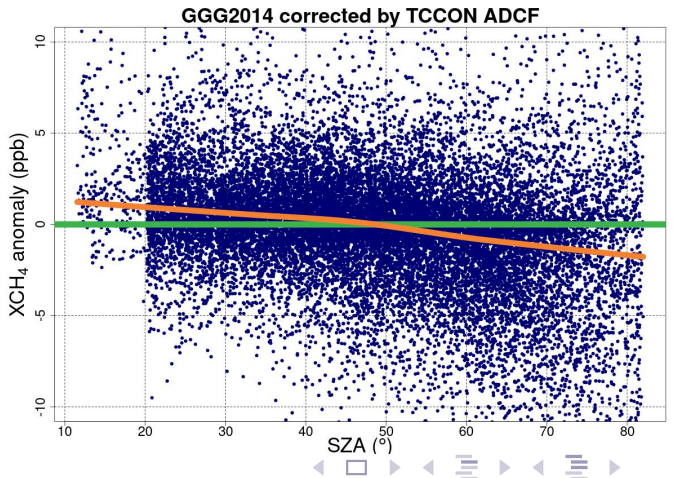
GGG2014

	TCCON GGG2014 ADCF	EM27/SUN GGG2014 ADCF
XCO_2	-0.0068	-0.0068
XCH_4	0.0053	0
XCO	-0.0483	0





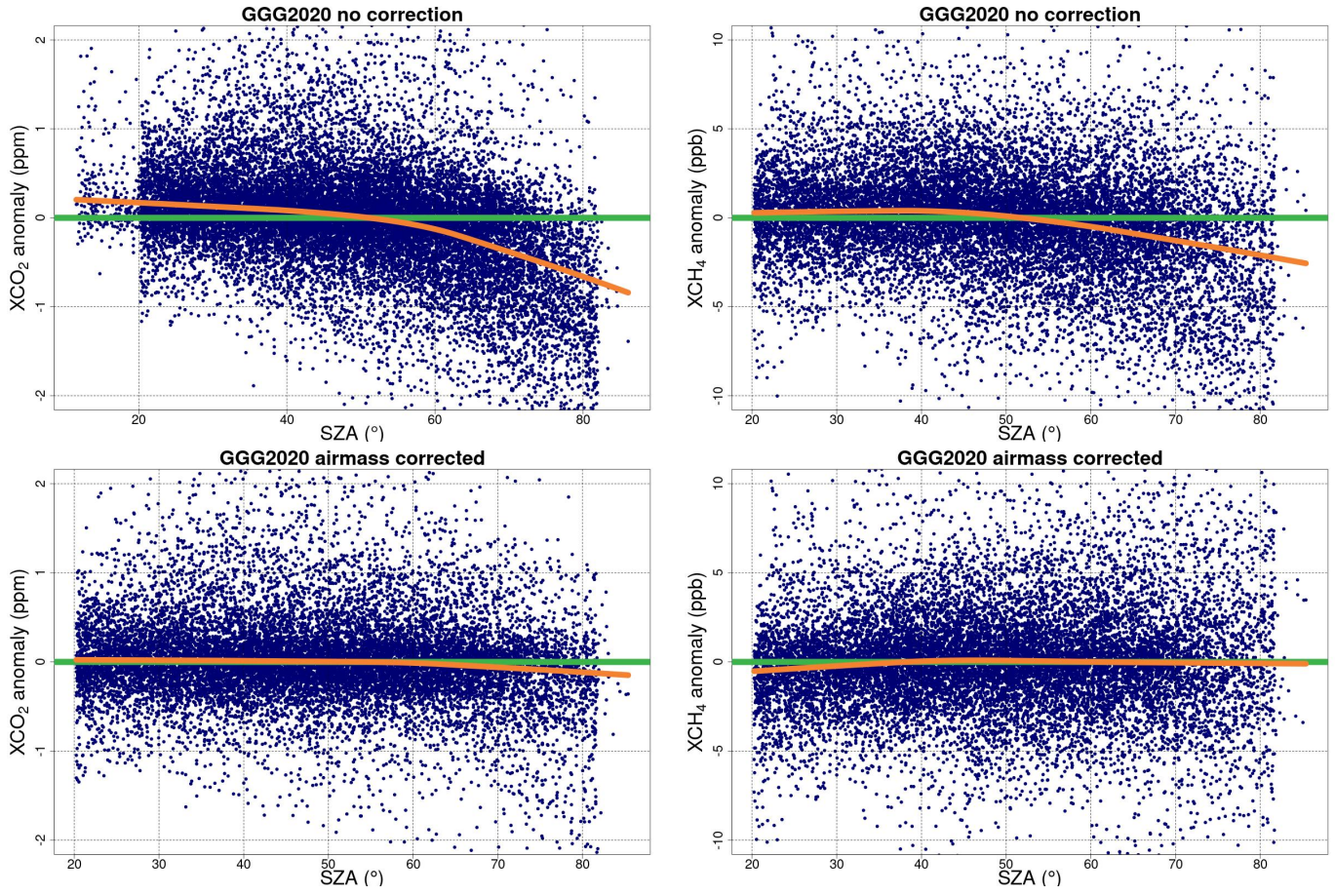




ADCF calculation

GGG2020

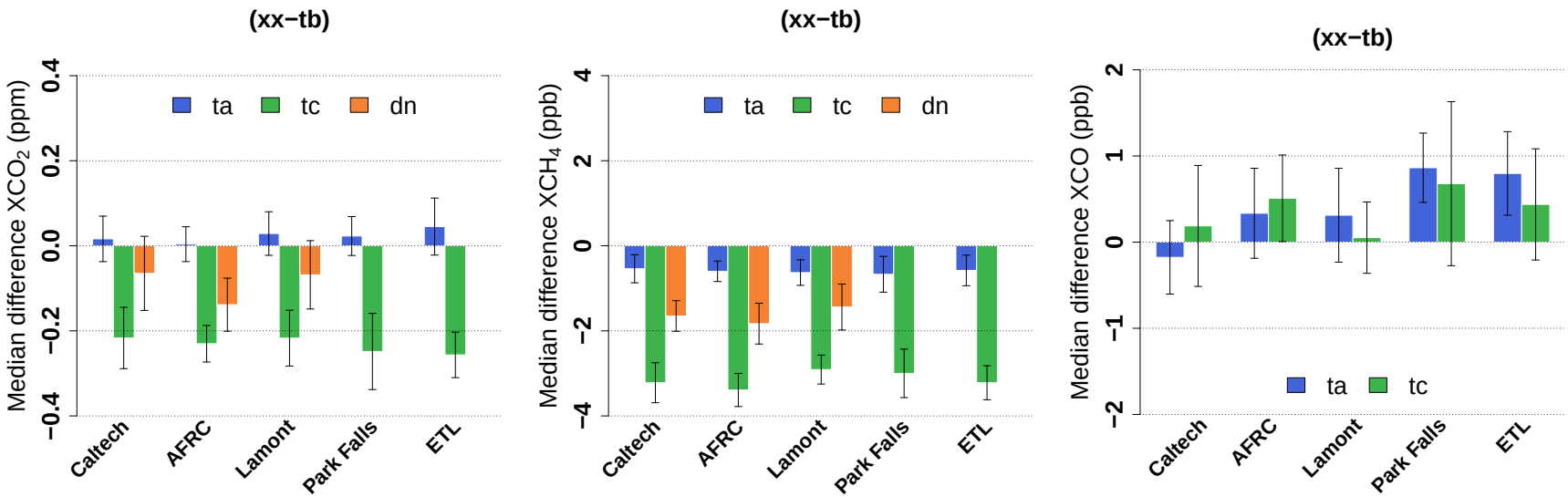
	TCCON GGG2020 ADCF	EM27/SUN GGG2020 ADCF
Xluft	0.00053	0.0027
XCO_2	–	-0.0049
XCH_4	–	-0.0045
XCO	0	0



Comparison of EM27/SUNs

GGG2014

Consistent bias between the EM27/SUNs throughout the road trip.



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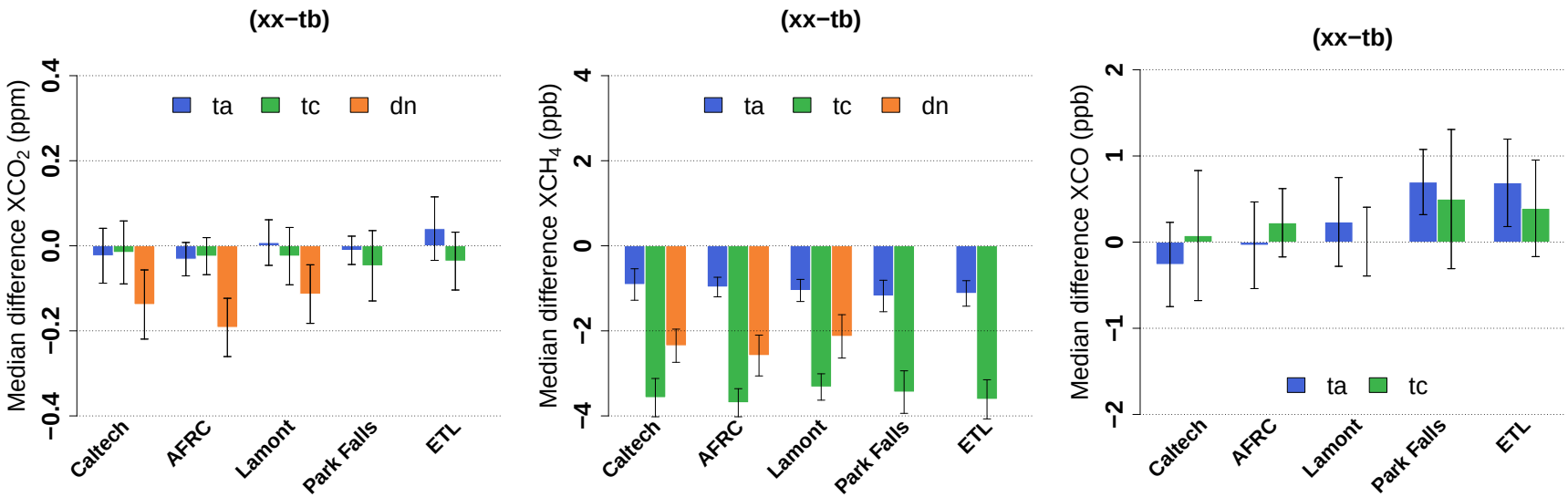
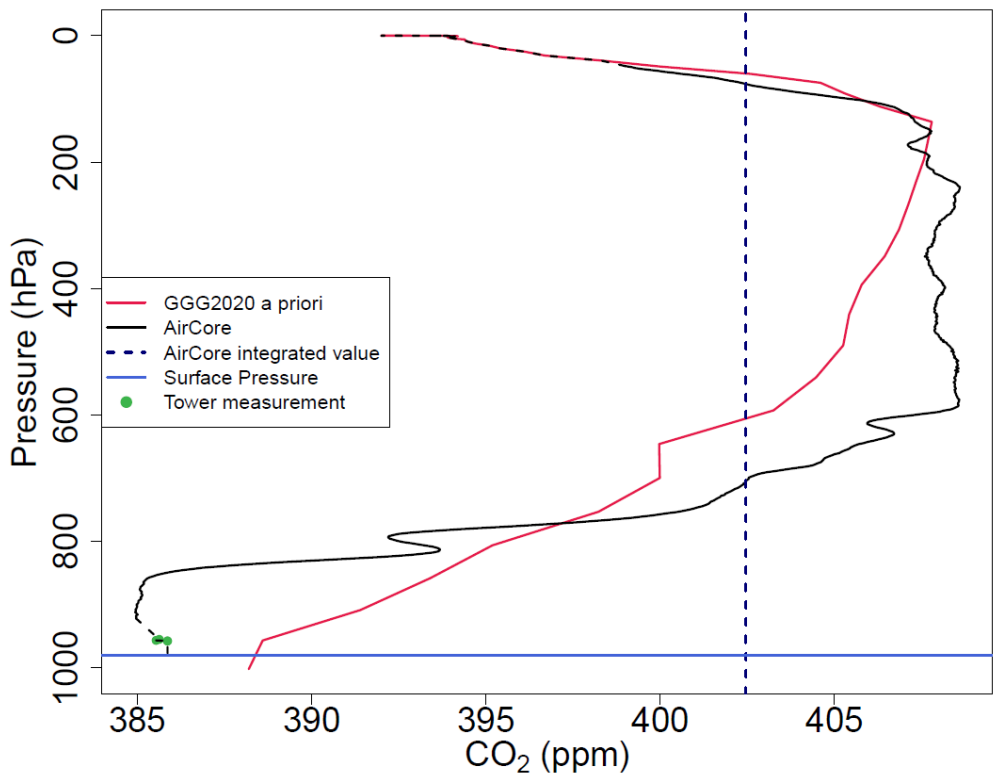


Coincident AirCore Measurements

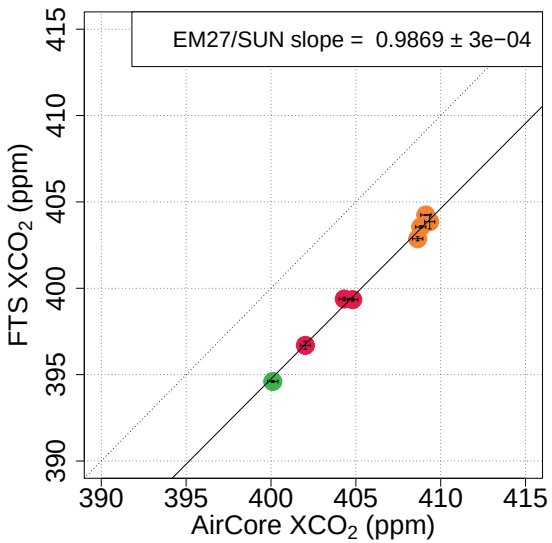
Site	Date	Launch time (UTC)	Number of launches	Collocated EM27/SUN(s)
AFRC remote site	2018-07-16	21:30	2	ta
	2018-07-17	14:00	1	ta
	2018-07-17	21:30	1	ta
	2018-07-18	18:00	2	ta
Lamont	2018-07-23	17:00	2	ta,tb,tc,dn
	2018-07-25	17:00	4	ta,tb,tc,dn
	2018-07-27	17:00	3	ta,tb,tc,dn
Park Falls	2018-07-31	17:00	2	tb,tc
	2018-08-03	17:00	2	–

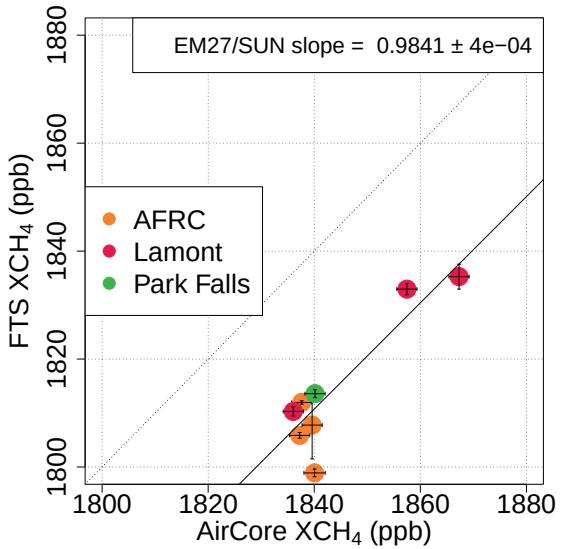


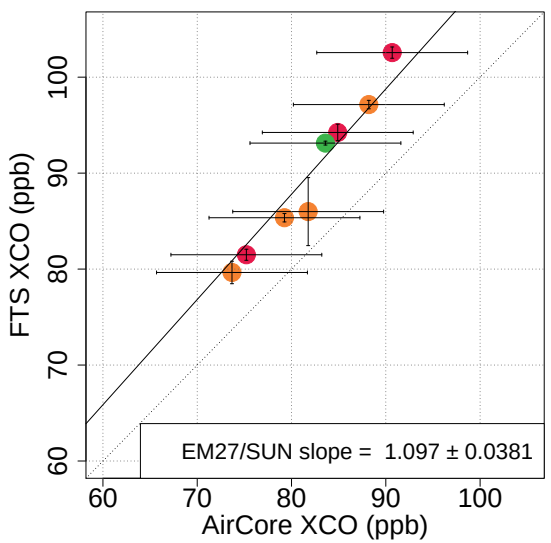
AICF Calculation

GGG2014

	TCCON GGG2014 AICF	EM27/SUN GGG2014 AICF
XCO_2	0.9898	0.9869
XCH_4	0.9765	0.9840
XCO	1.0672	1.0965



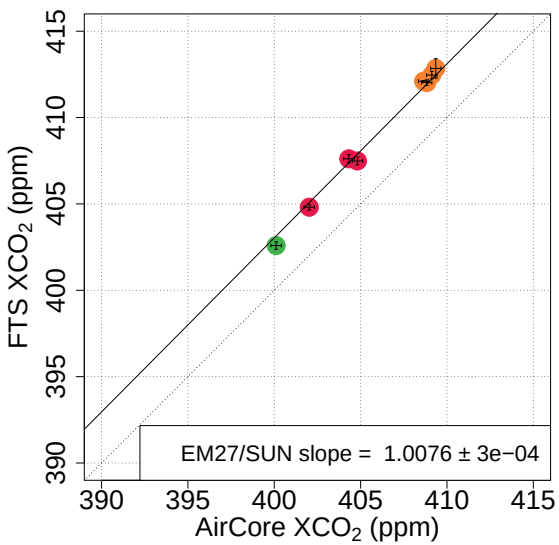


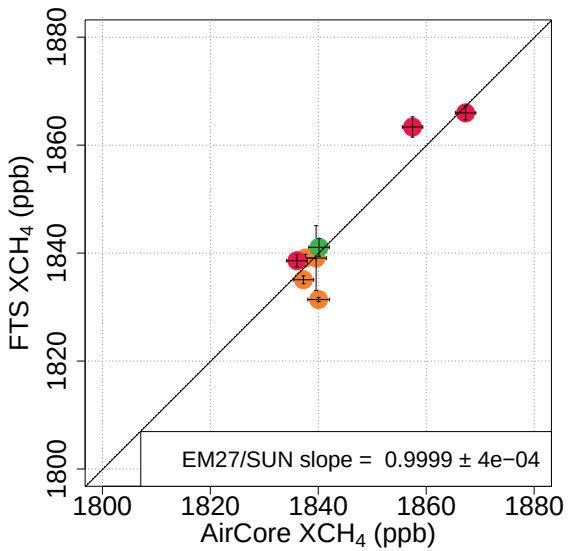


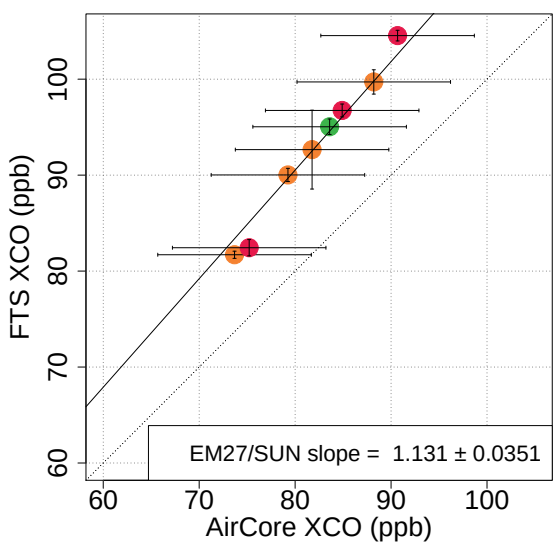
AICF Calculation

GGG2020

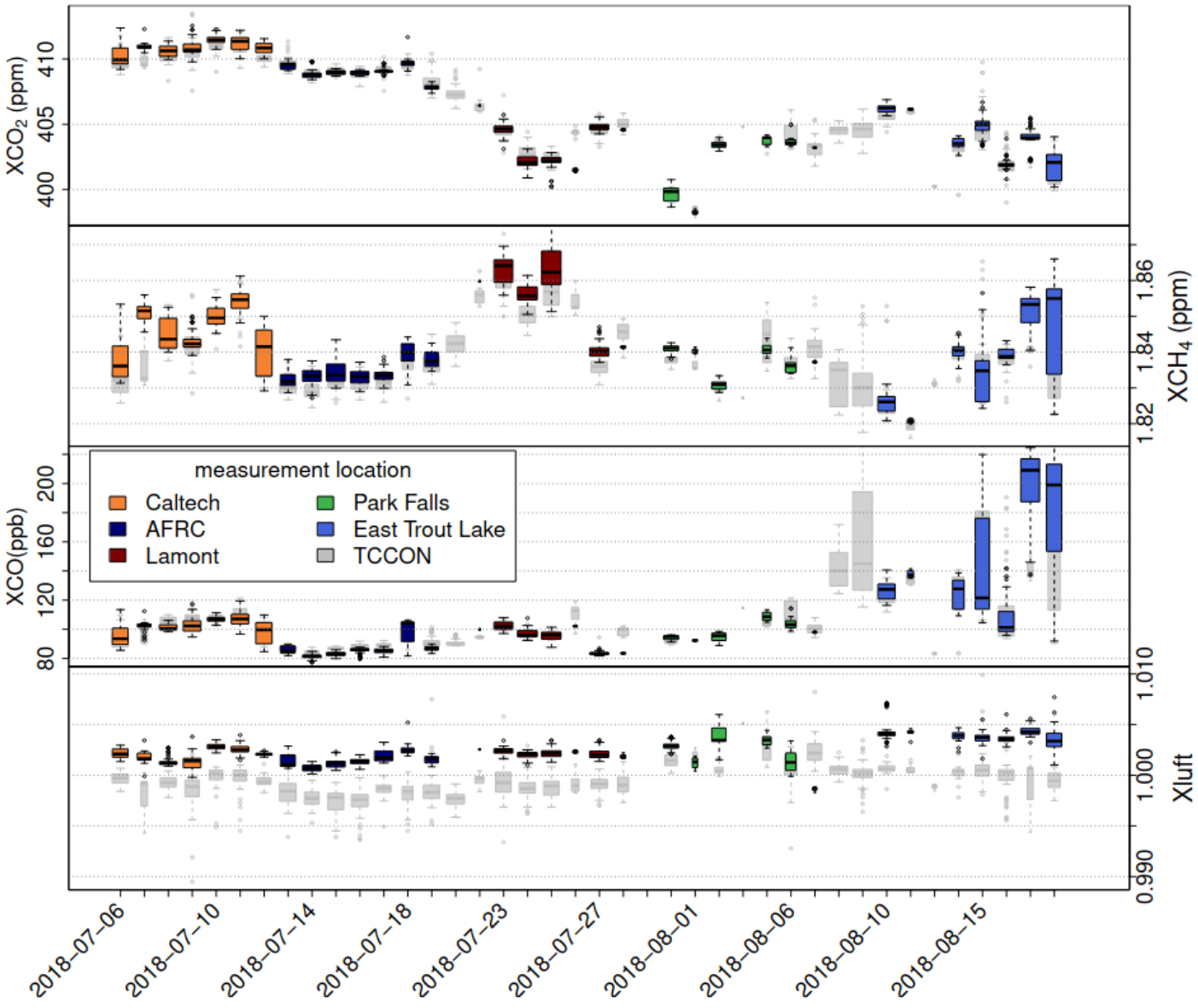
	TCCON GGG2020 AICF	EM27/SUN GGG2020 AICF
XCO_2	1.0101	1.0076
XCH_4	1.0031	0.9999
XCO	1.0	1.0



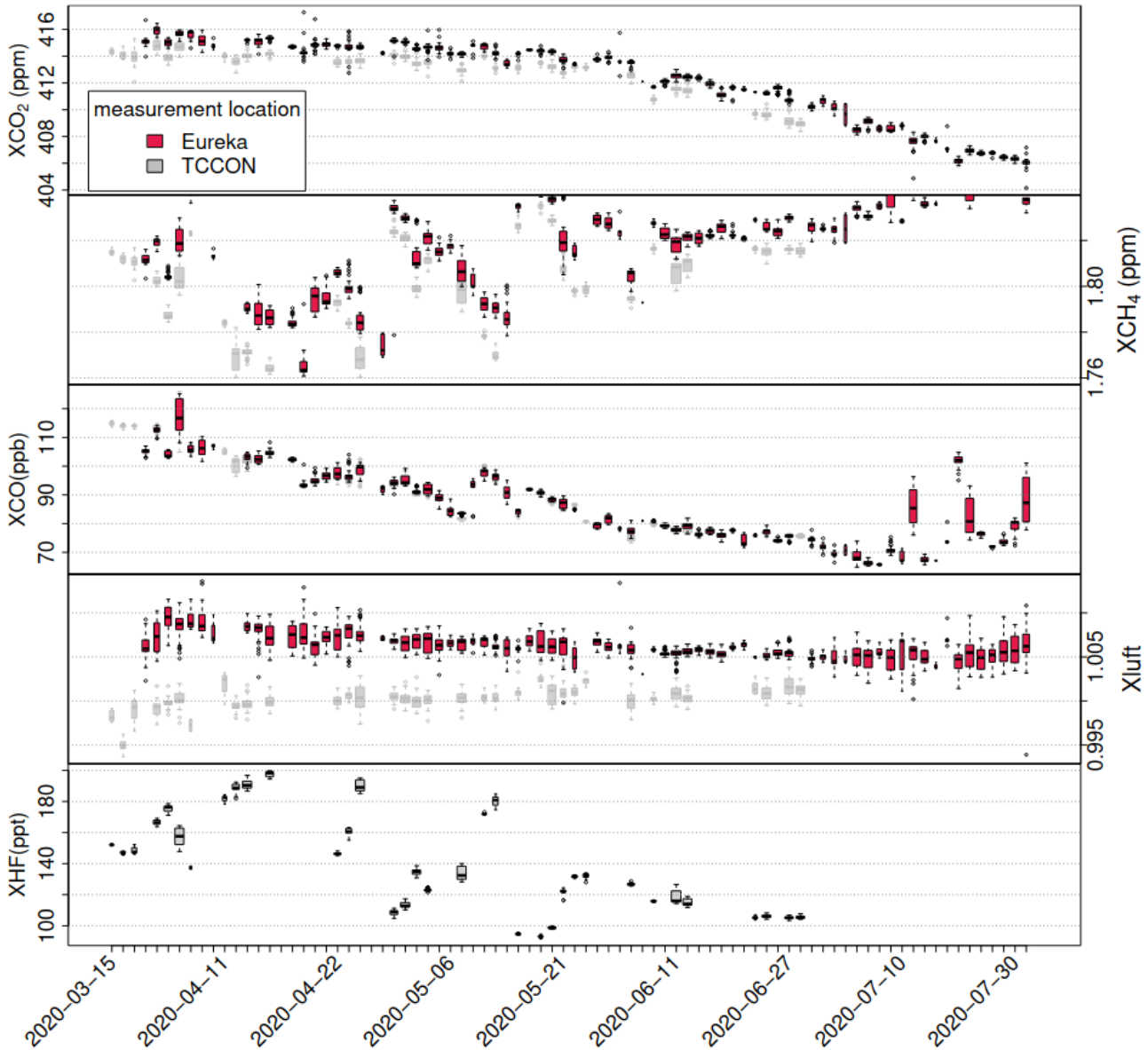




Timeseries from Road Trip 2018



Timeseries from Eureka 2020

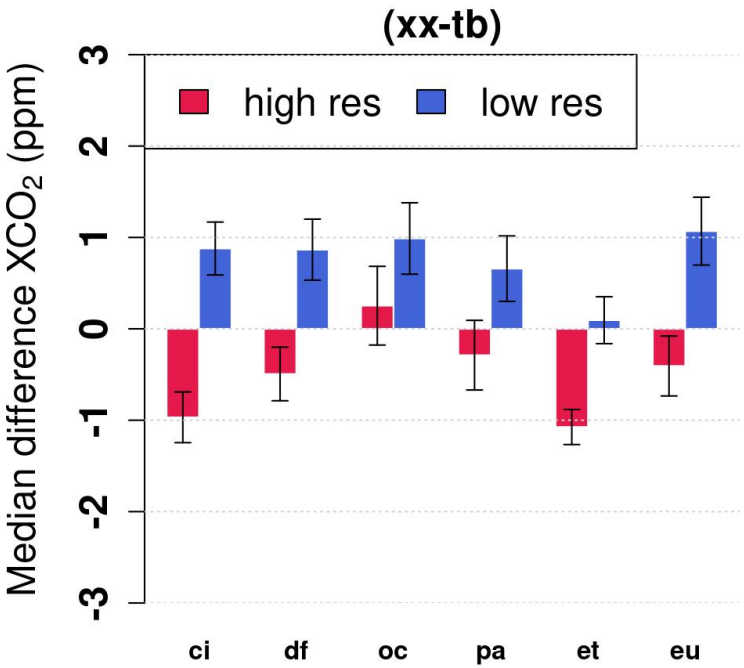


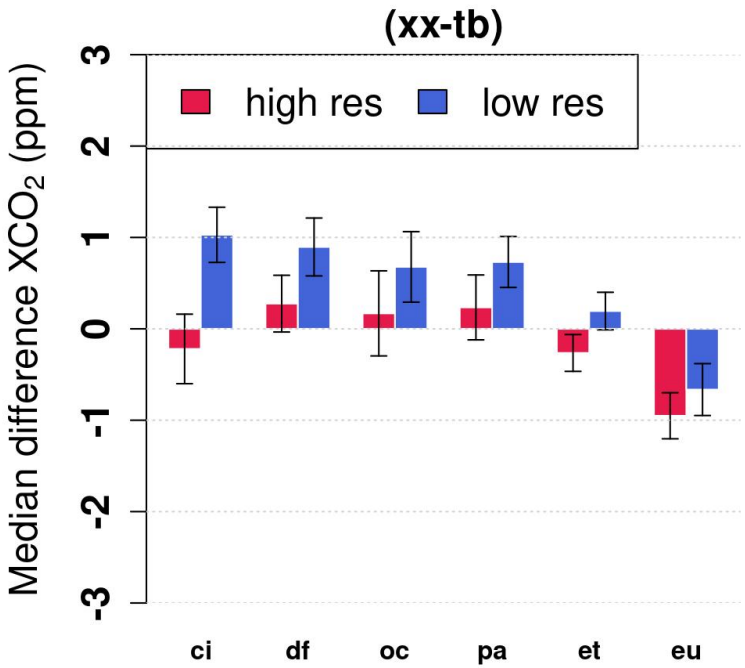
Comparison of EM27/SUNs with TCCON

XCO_2

GGG2014
Maximum difference:
High resolution= 1.33 ppm
Low resolution= 0.89 ppm

GGG2020
Maximum difference:
High resolution= 0.53 ppm
Low resolution= 0.83 ppm



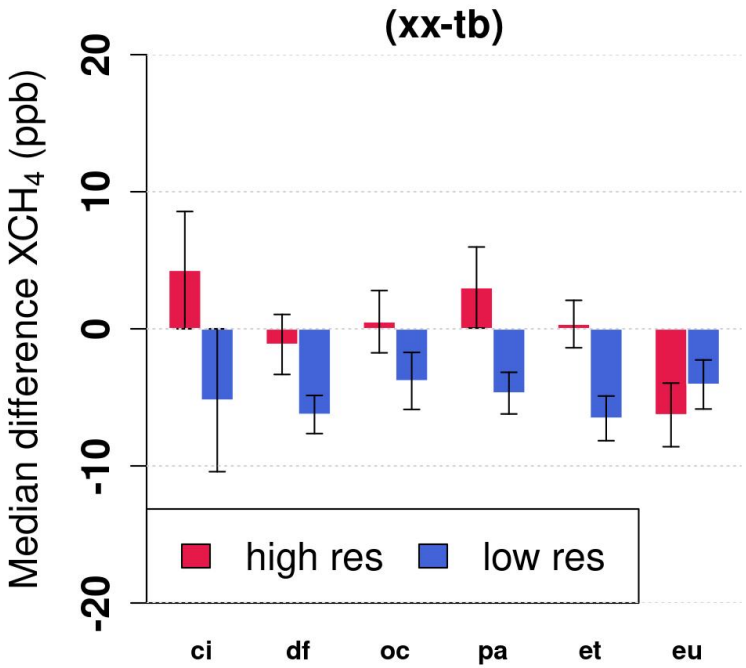


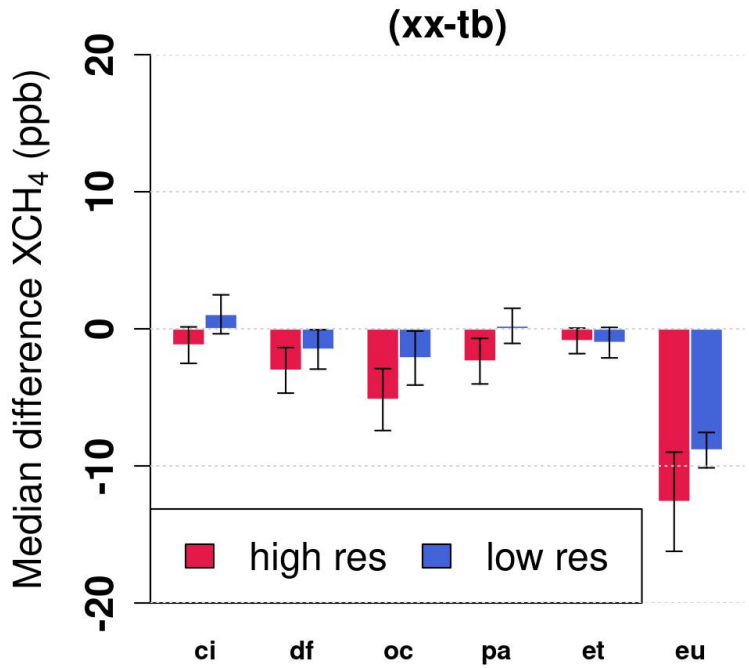
Comparison of EM27/SUNs with TCCON

XCH_4

GGG2014
Maximum difference:
High resolution= 5.4 ppb
Low resolution= 2.7 ppb

GGG2020
Maximum difference:
High resolution= 4.3 ppb
Low resolution= 3.2 ppb

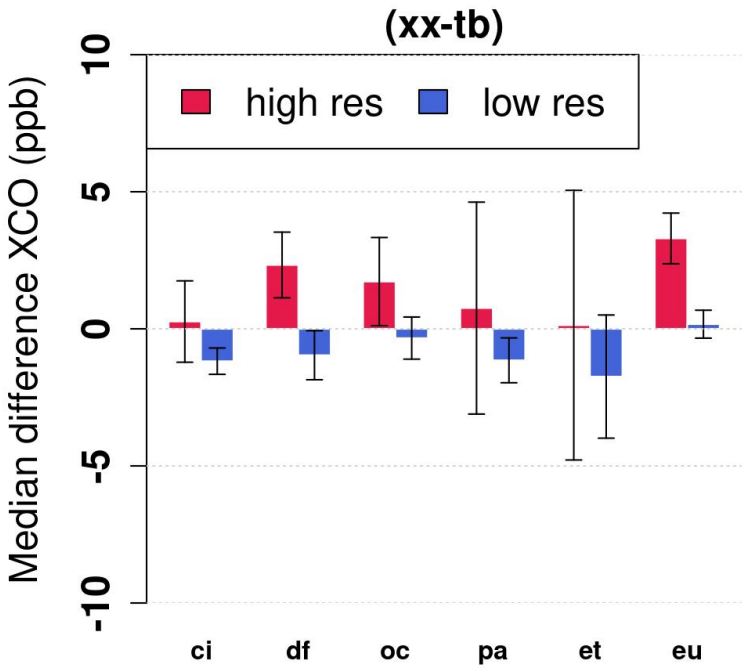




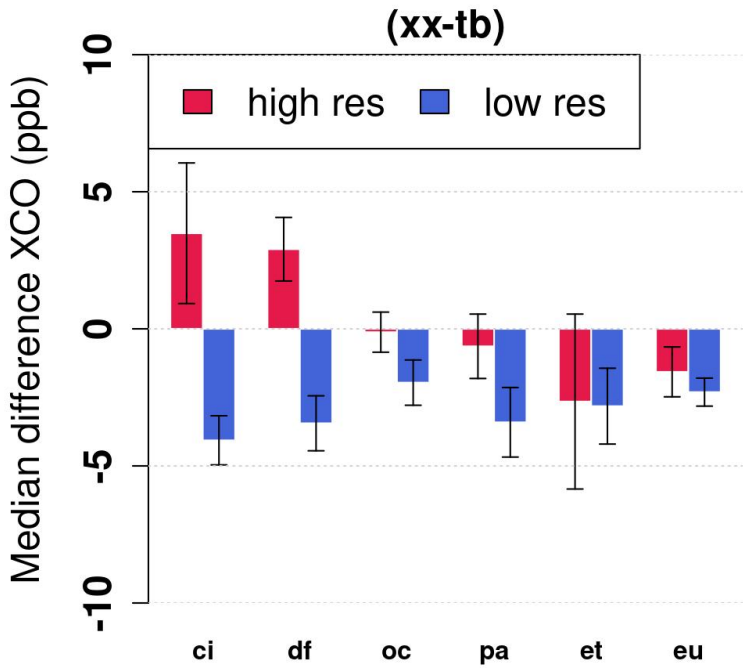
Comparison of EM27/SUNs with TCCON

XCO

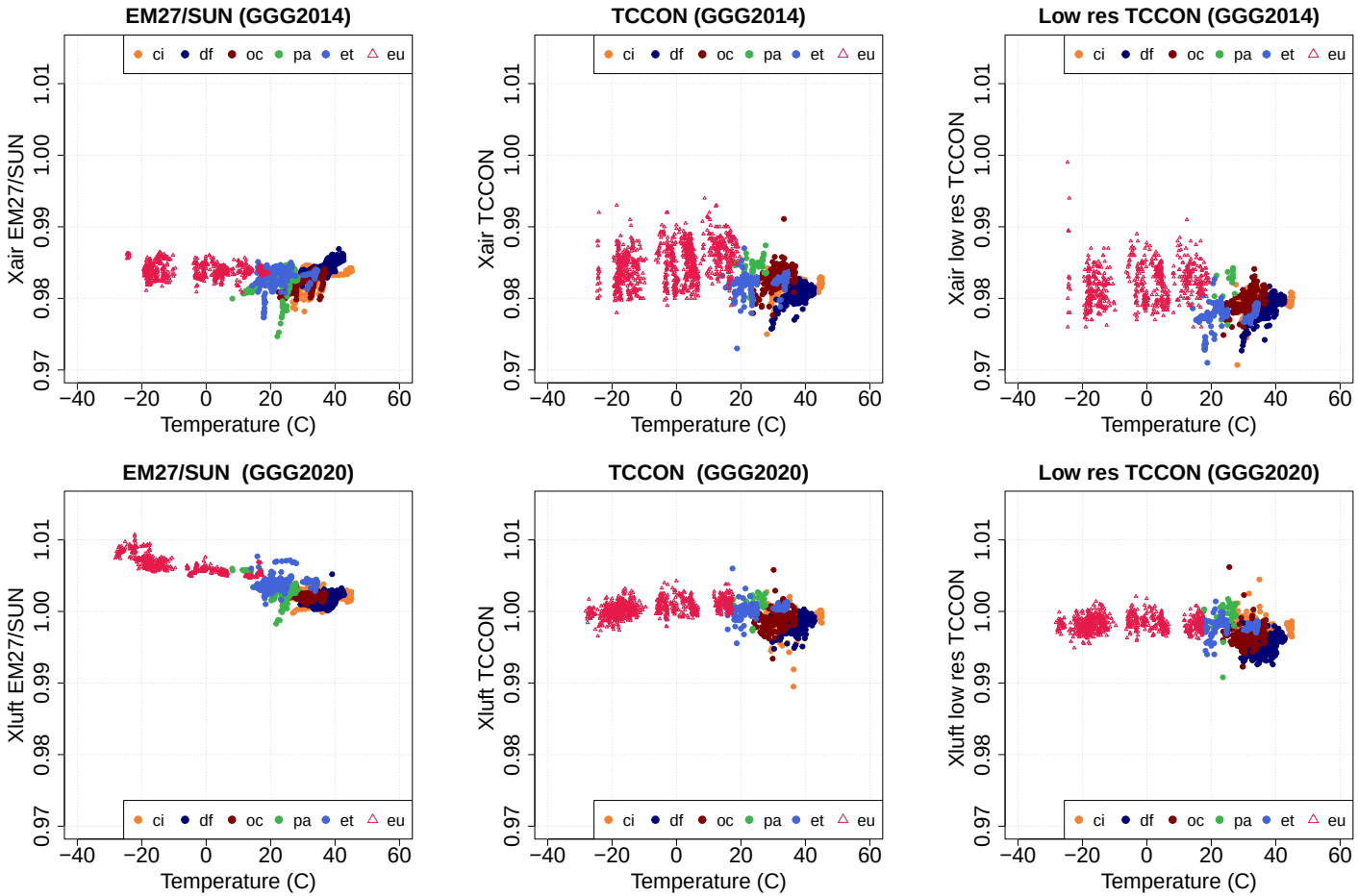
GGG2014
Maximum difference:
High resolution= 2.2 ppb
Low resolution= 1.4 ppb



GGG2020
Maximum difference:
High resolution= 6.1 ppb
Low resolution= 2.1 ppb



GGG2020 Temperature correction issue



Summary

- We have developed post processing steps specific to EM27/SUNs to be followed by all GGG users
- We have shown that EM27/SUNs are stable enough when moving frequently
- GGG2014: Comparisons between EM27/SUN and TCCON retrievals show some variations from site to site which improves using the low resolution spectra
- GGG2020: There are some improvements in site-to-site biases except for XCO, using low resolution doesn't improve the site-to-site biases as expected
- We see some temperature dependence in Xluft which could cause additional biases in Eureka
- More investigation needs to be performed on GGG2020 low resolution TCCON retrievals
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- Tazeen Ajmari

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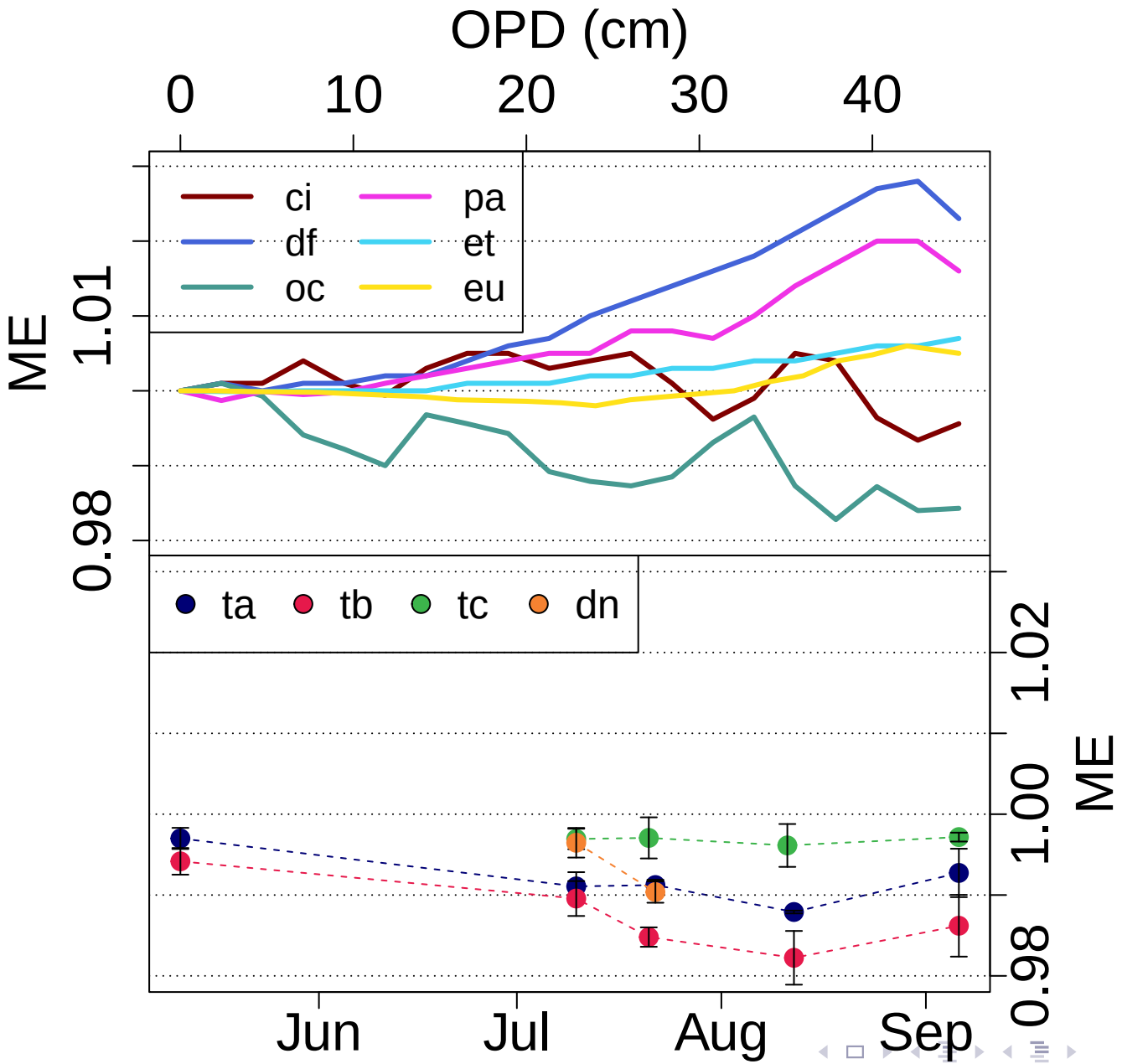
NSERC

ILS


OPD (cm)
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