Presented by

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Prepared by

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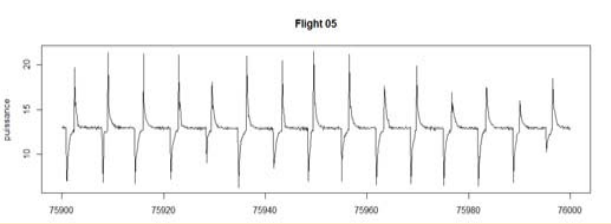
HAIC/HIWC Science Team Meeting 9/03/2015

ROBUST Probe Dataset

HAIC – High Altitude Ice Crystals
Brief reminder

Robust data processing	Conclusions from Paris meeting	Action
Power oscillation problem 	• Can be treated • 2 methods : cutting or filtering	**Analyse the different treatment methods and select the best one**
Calibration (removal of the dry term)	• There is a residual biais when using the initial calibration in dry air ➔ not applicable to all flights • A « local » calibration seems to reduce the biais	

HAIC – High Altitude Ice Crystals
Content

- Power oscillation removal
- Calibration
- Conclusions and way forward

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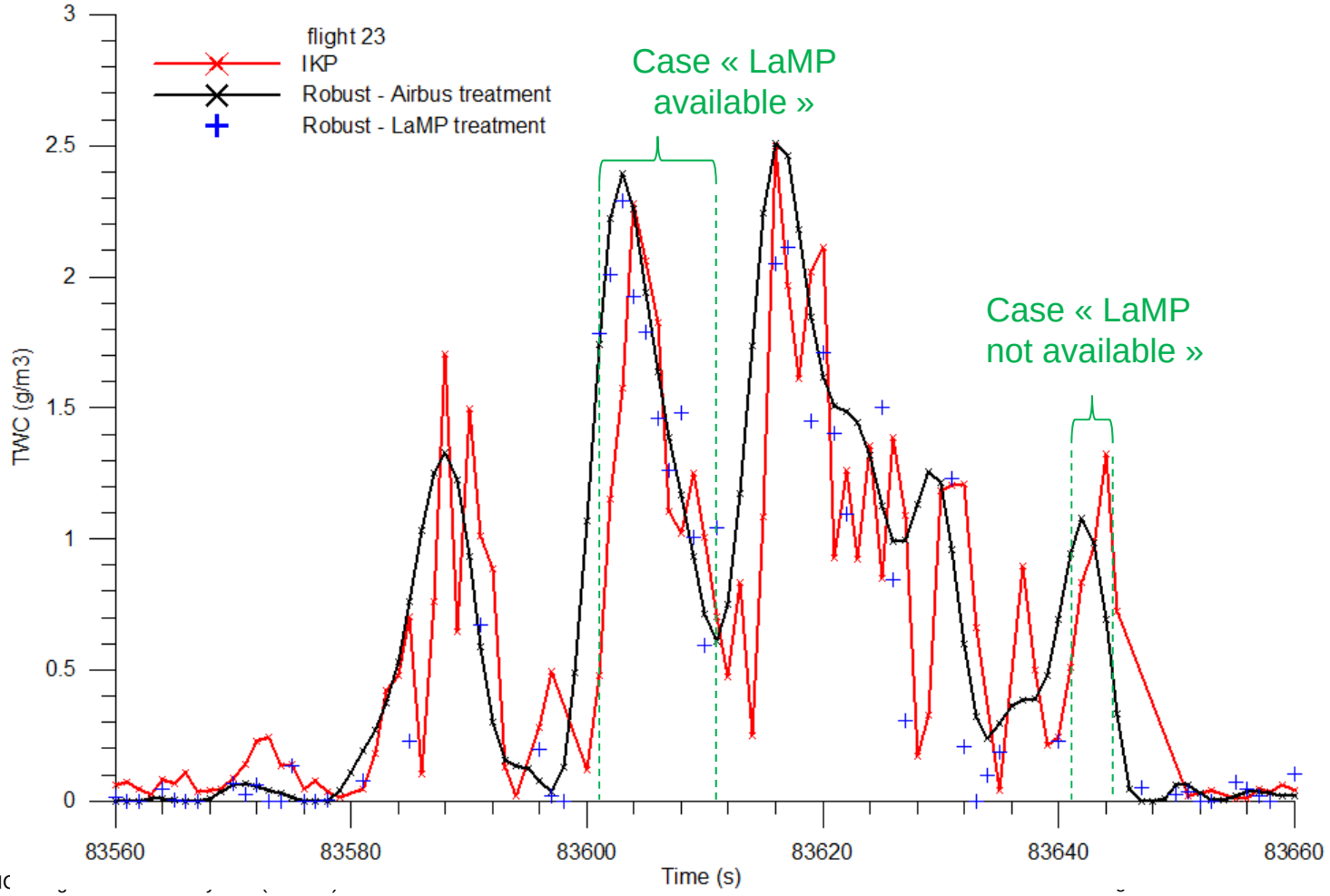
Power oscillation removal

2 different methods :

- Airbus : filtering
- LaMP : selection of data based on the temperature behaviour of sensor element

Evaluation : split the dataset in two parts depending on the rejections made by the LaMP treatment and compare with the IKP measurements



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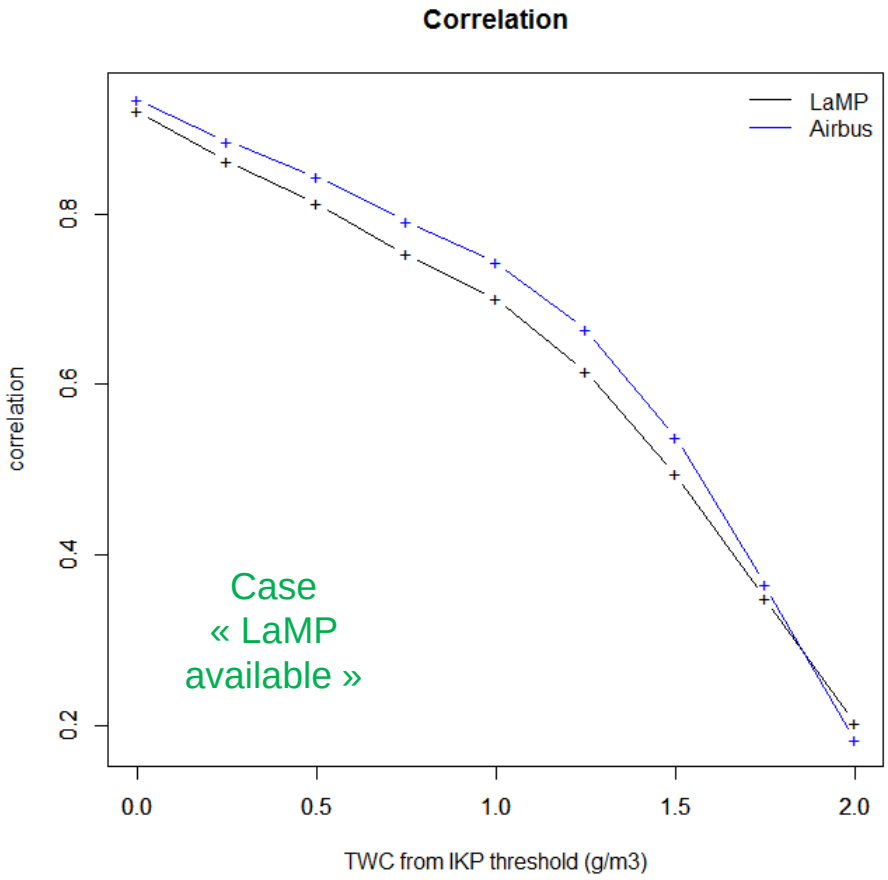
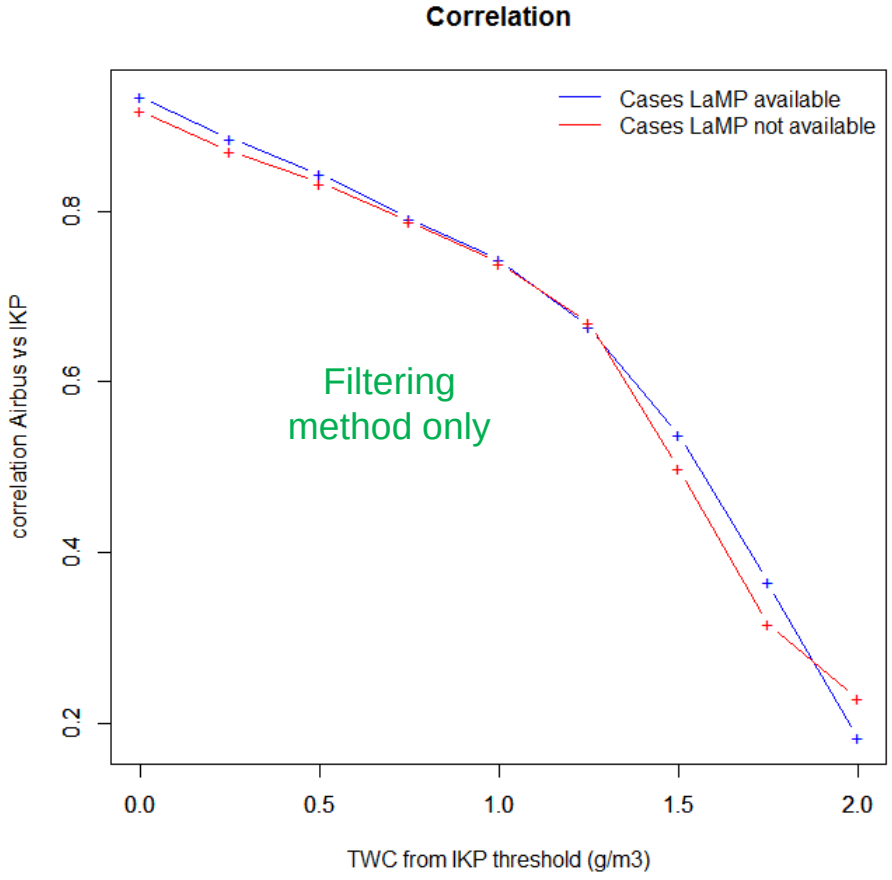
Power oscillation removal

Correlation coefficients with the IKP TWC for different thresholds :
0.25 - 0.5 - 0.75 – 1 – 1.25 – 1.5 – 1.75 – 2 g/m3





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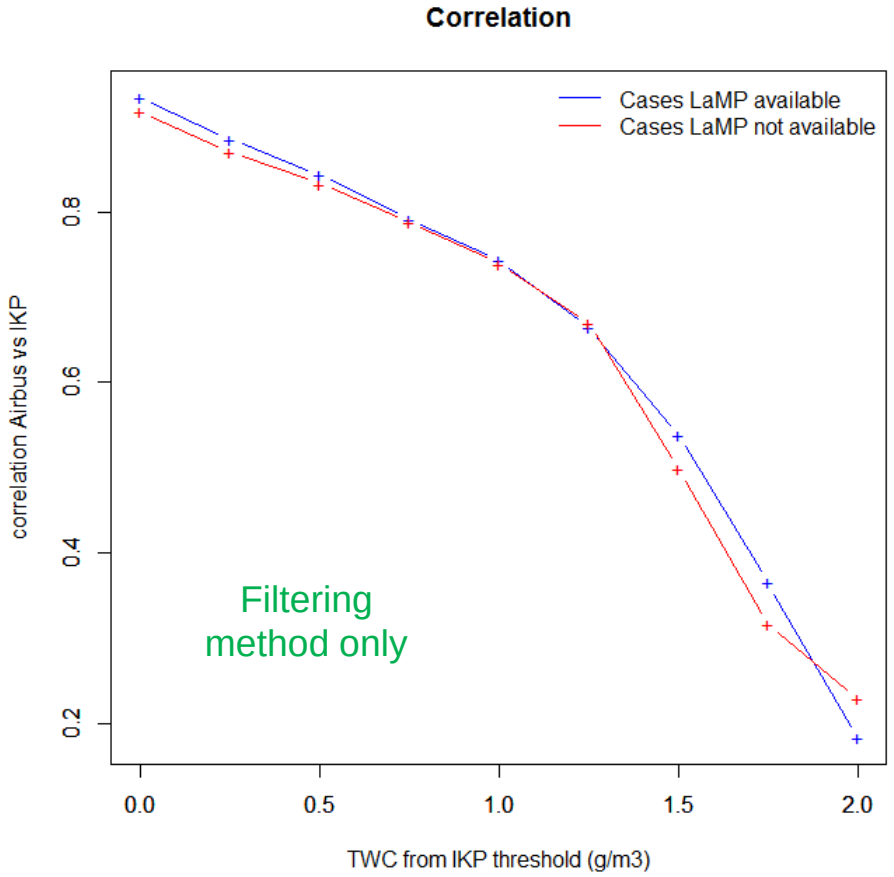
Power oscillation removal

Conclusions :

- The filtering method gives a good agreement with the IKP even where the raw data from the Robust were rejected by the LaMP criteria

- The filtering method produces a continuous dataset in contrastto the LaMP treatment.

➔ Final dataset to be released = 1Hz filtered data



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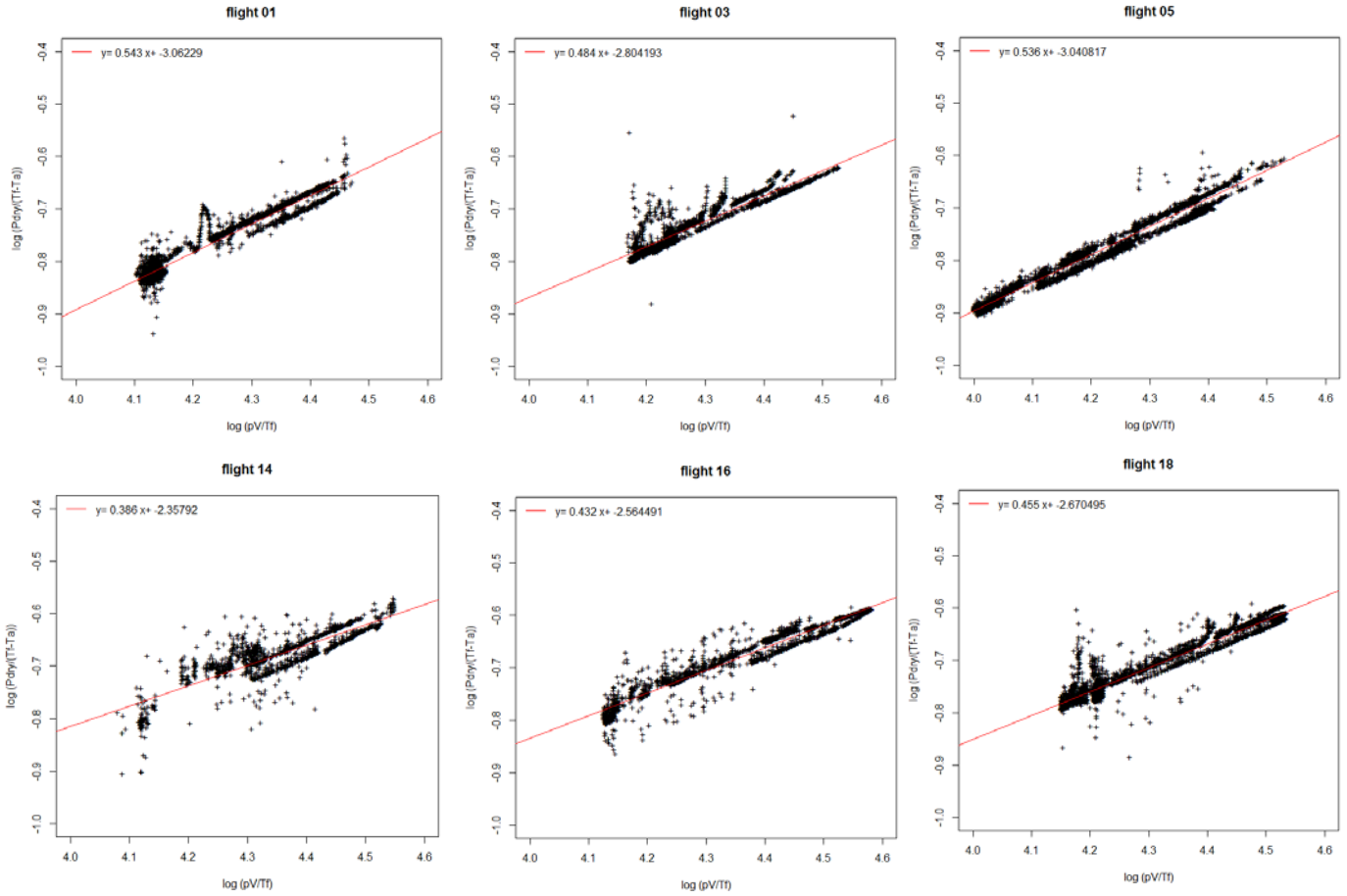
HAIC – High Altitude Ice Crystals
Calibration



During many flights, the regression curve for the dry power term shows a systematic evolution of the slope with flight time.

This is possibly due to the decrease of the A/C mass (fuel consumption) and it's impact on the balance of the A/C, including flow field around aircraft

<u>Assumption</u> : for the same TAS, the airflow under the wing is slower when the A/C is lighter: Consequently the dry power term decreases slightly with flight time.

Dry convective heat loss computation

A. Commonly used regression formula for dry power calculation of Robust probe:

$$\log (P_{dry}/(T_f-T_a)) = a + b*\log(p.V/T_f)$$

B. Test: Replace above regression equation by:

$$\log (P_{dry}/(T_f-T_a)) = a + b*\log(p.V.\ f(t)/T_f)$$

where f(t) is a function of flight time

$$f(t) = 1- K.\ time\_from\_departure$$

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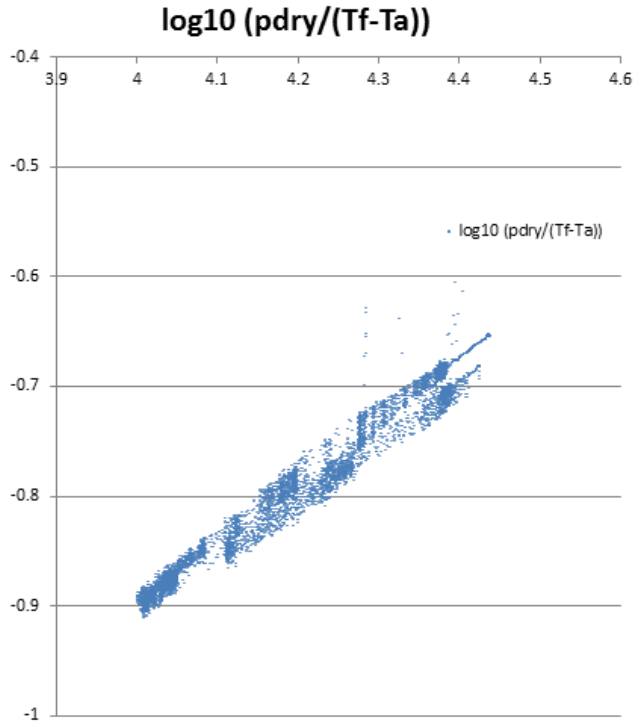
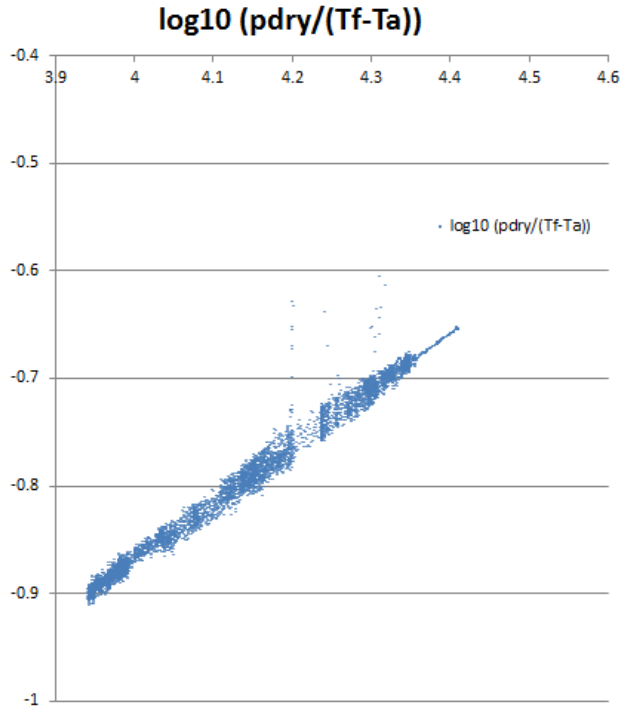
Calibration

- K is chosen in order to minimize the spreading of the regression curve
- Data selection : TAS >100Kt and CDP_Count < 0.01 and alt >7000ft



Classical regression approach



Adding correction term:
K = 1 – **2.345E-5** . t : Only one slope

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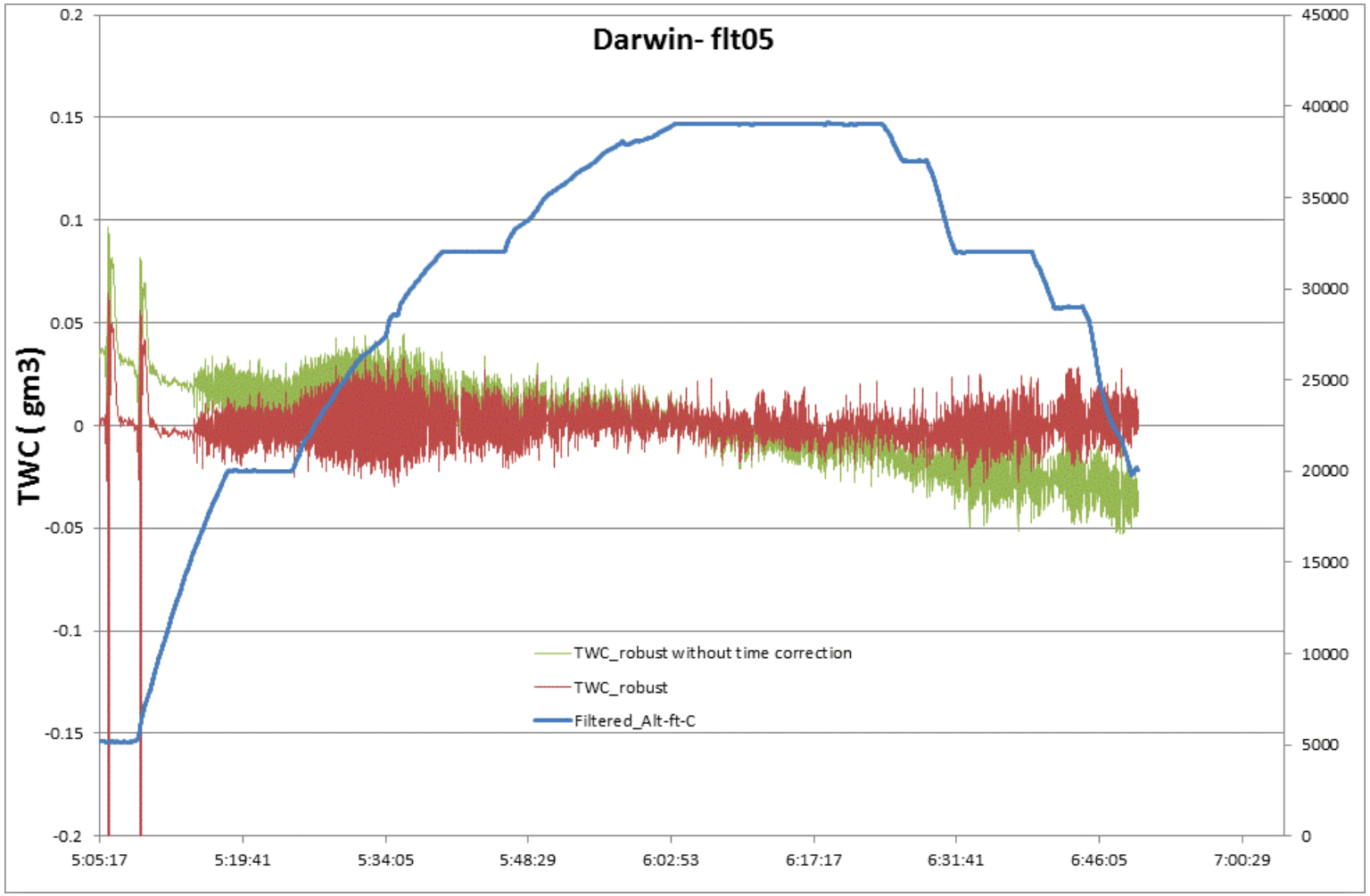
Calibration



The bias of the TWC measurement in dry air (Robust probe calibration flight 5) disappears

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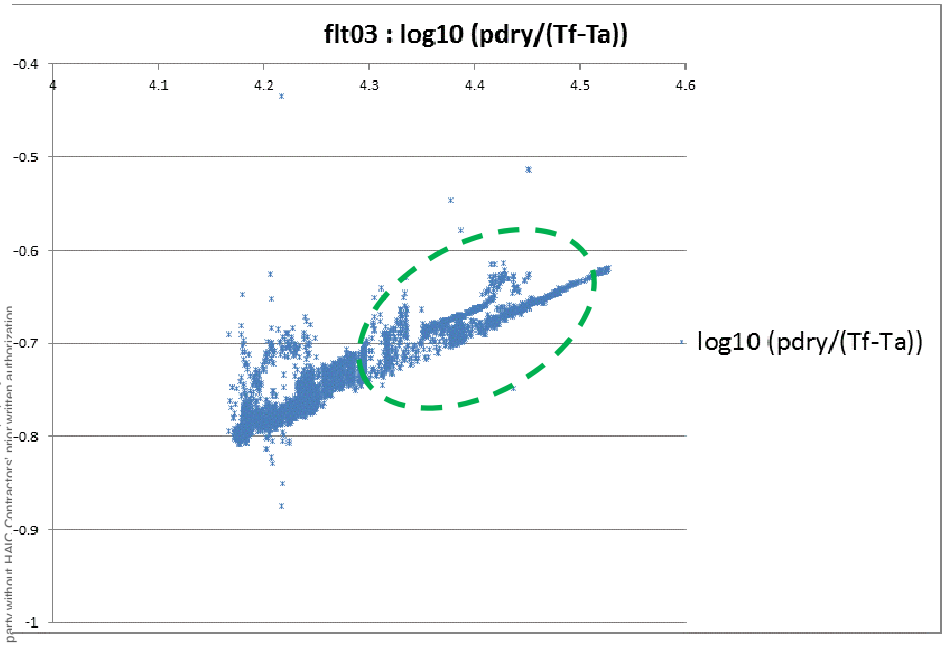
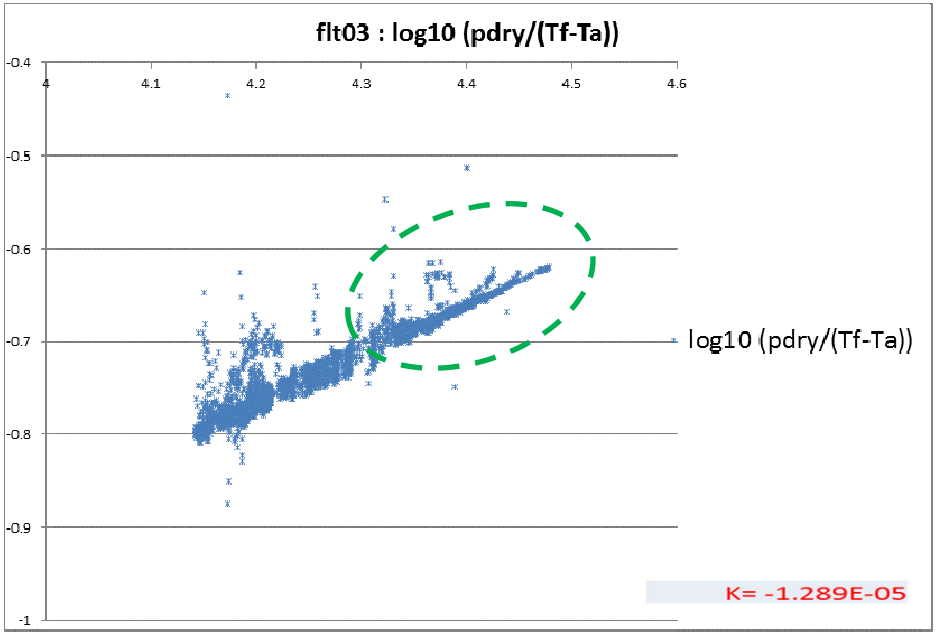
Calibration

Flight 3 analysis (in view of Walter's proposition of manual offset estimation)

- As for flight 5, the tentative is to reduce the scattering of the NU/RE regression curve (measurement with CDP_cnc= 0)



before



after

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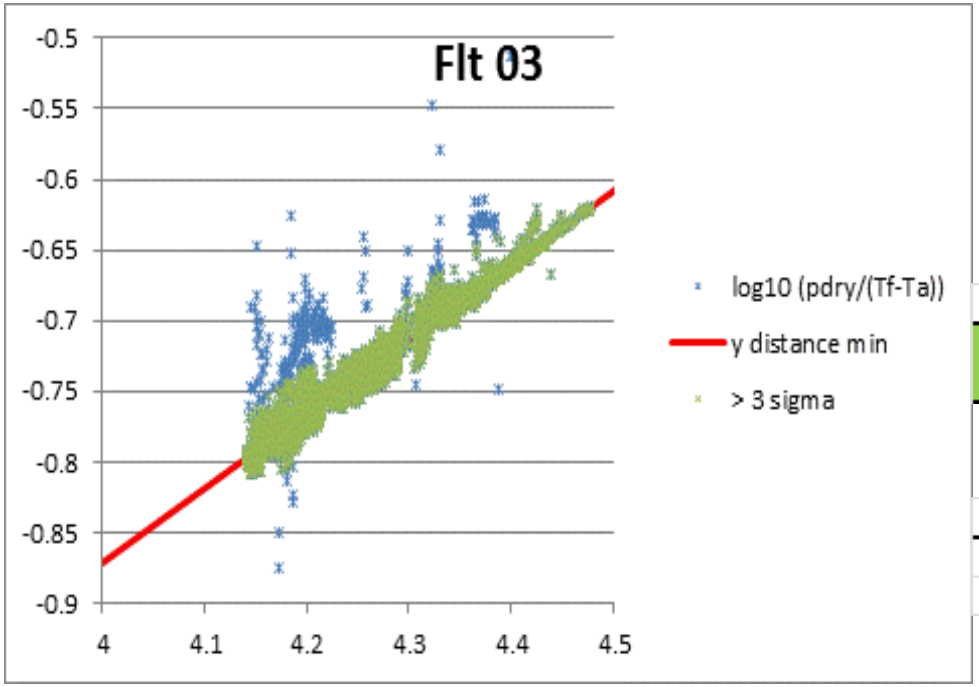
- We can notice that the **scattering is not symmetrical**
- Visible blue dots in the upper part of the chart correspond to particles detected by robust probe, but not by CDP (too large to be classified).
- When computing a regression line (min square distance) these dots introduce an error. We propose to take into account only data points with distance to the regression line <3 sigma (iterative optimization).

The blue dots are eliminated for computation, because they are probably in-cloud data



flight 03	
a	-2.9762892
b	0.52630856

flight 03 (previously)	
a	-3.078000
b	0.544600

- Dry term is computed with new a and b values

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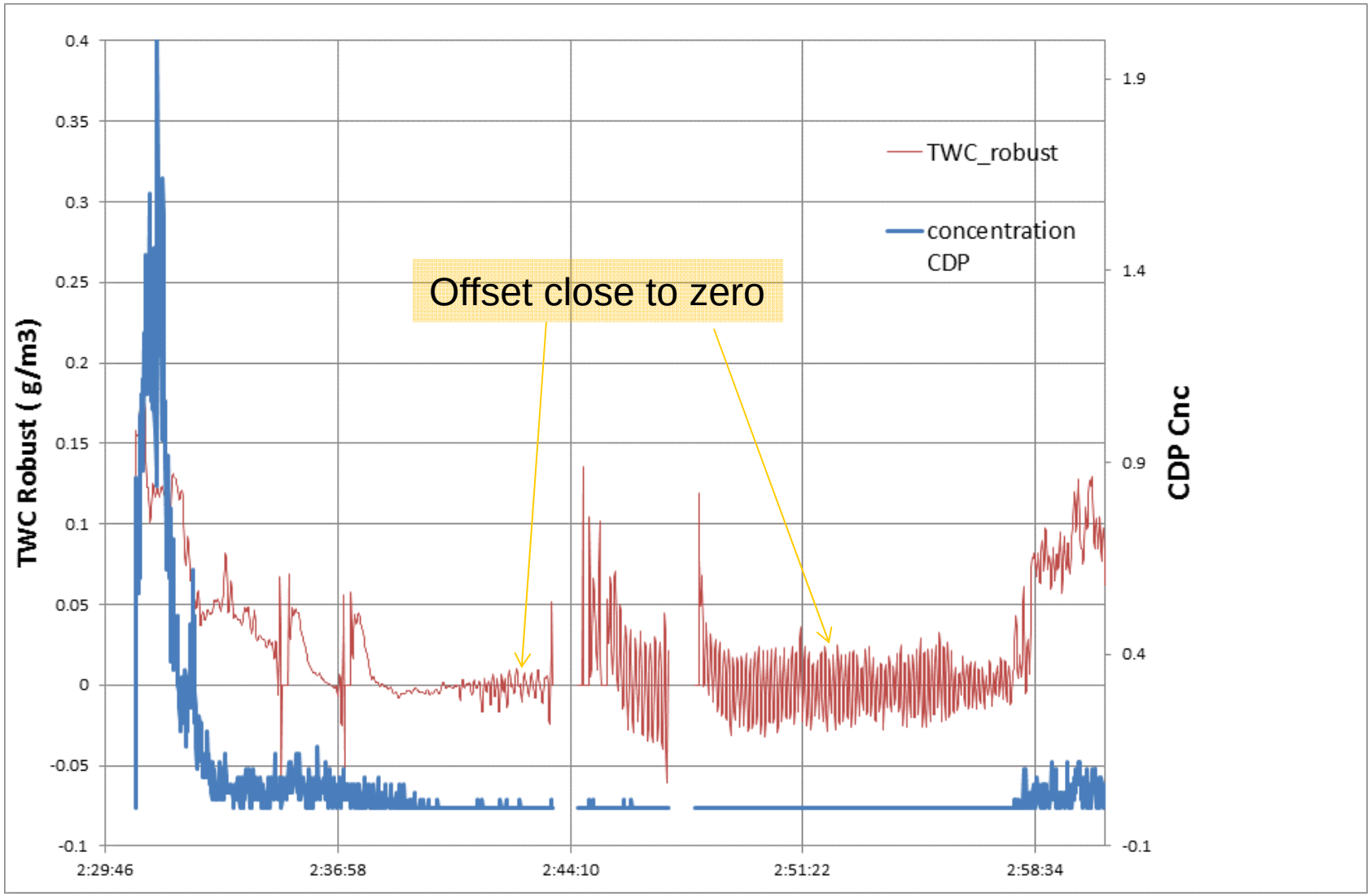
Calibration

Flight 3 (dry power correction term applied), first part (30 min)



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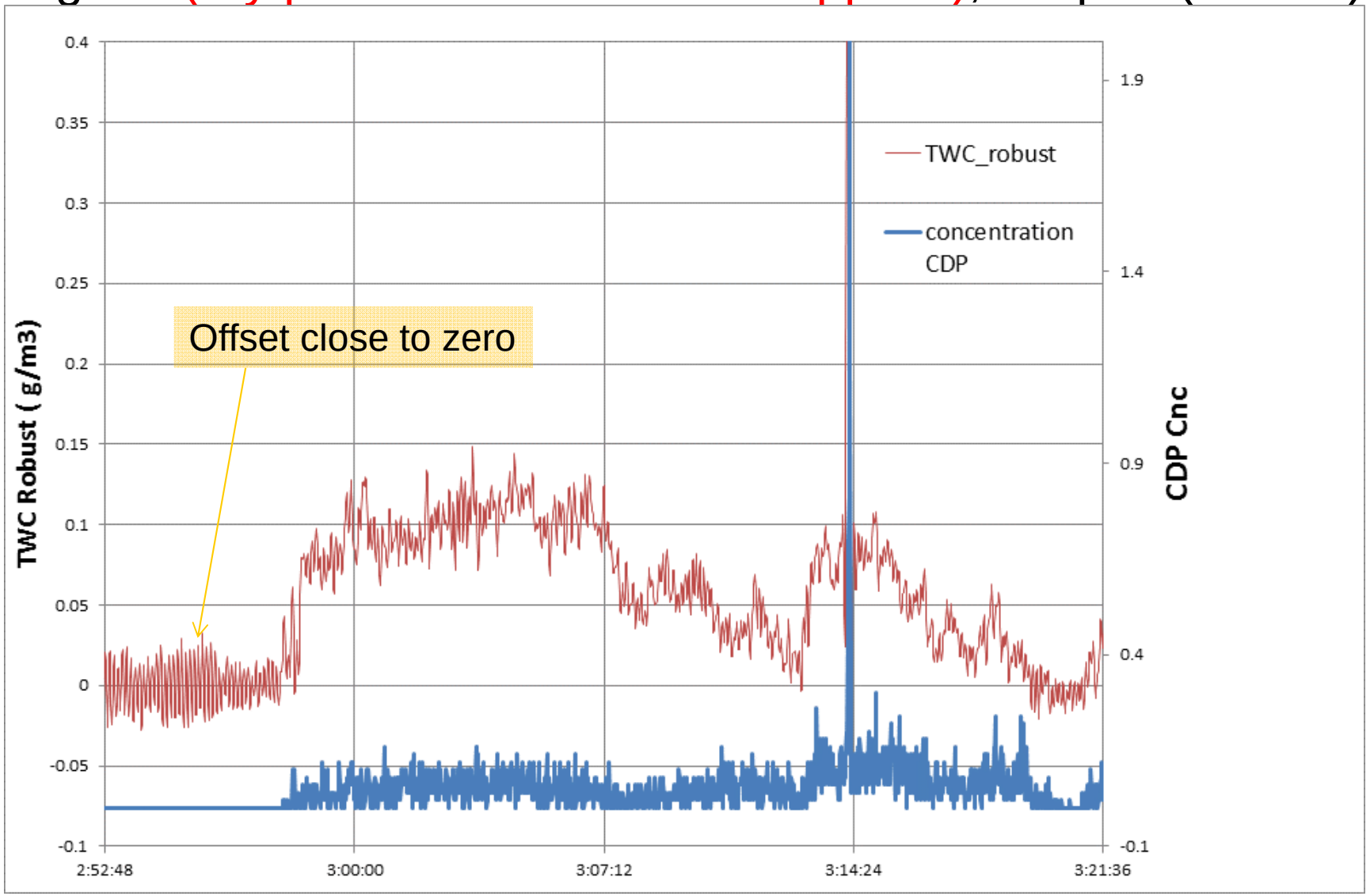
Flight 3 (dry power correction term applied), 2nd part (30 min)



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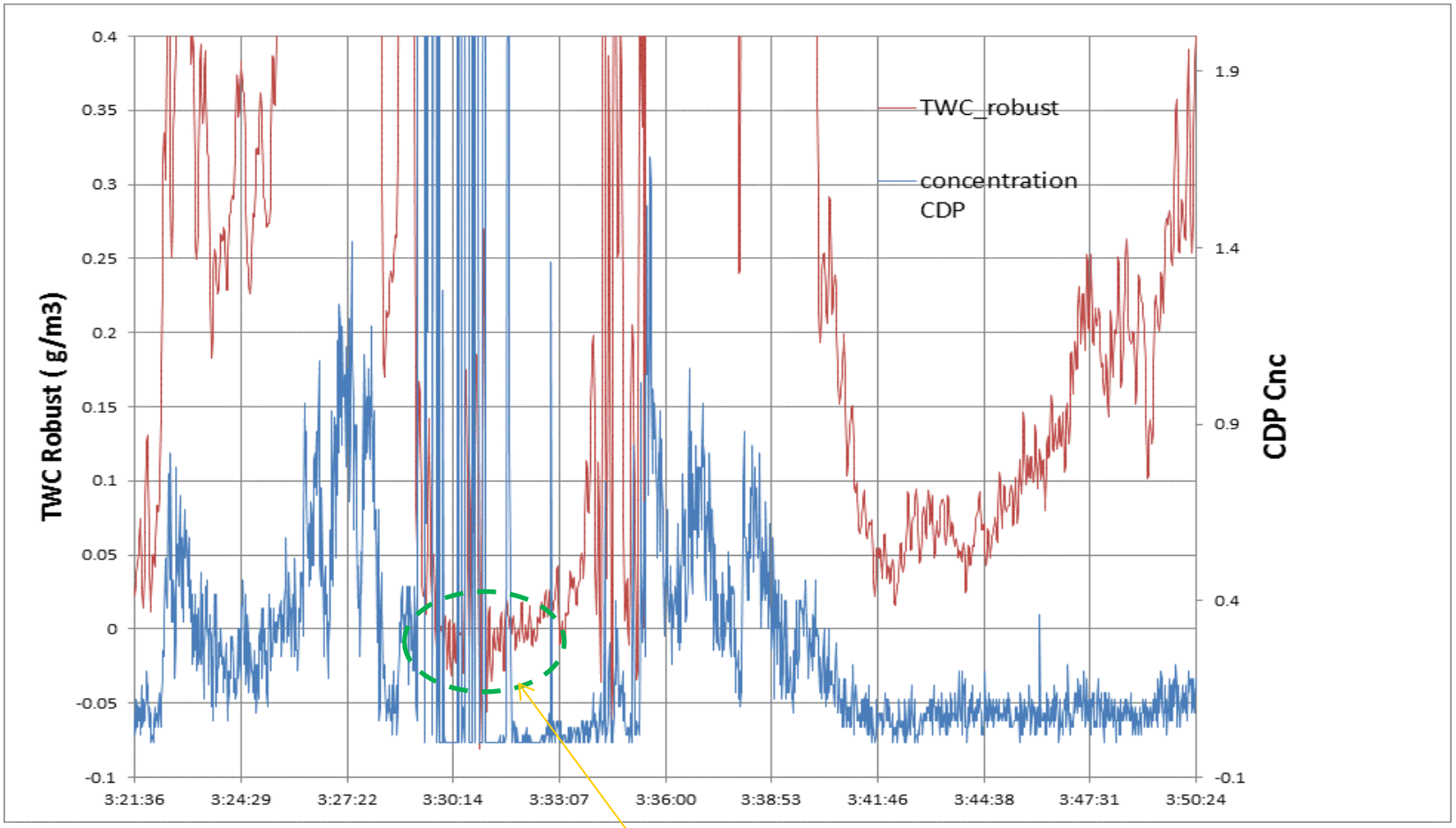
Flight 3 (dry power correction term applied), 3rd part (30 min)



YES, negative offset of TWC robust, but probably not enough zero CDP_cnc to fix something

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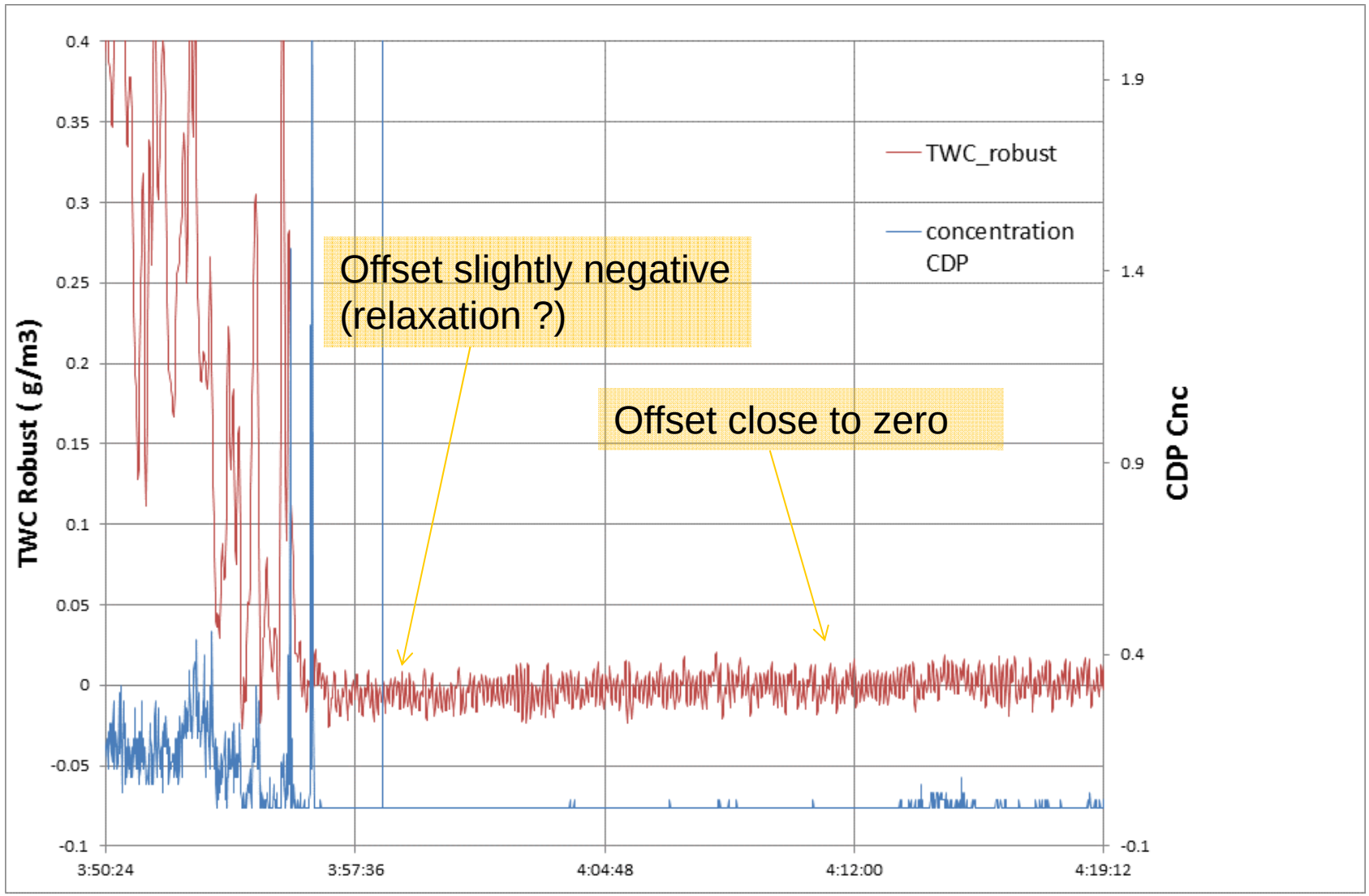
Calibration

Flight 3 (dry power correction term applied), 4th part (30 min)



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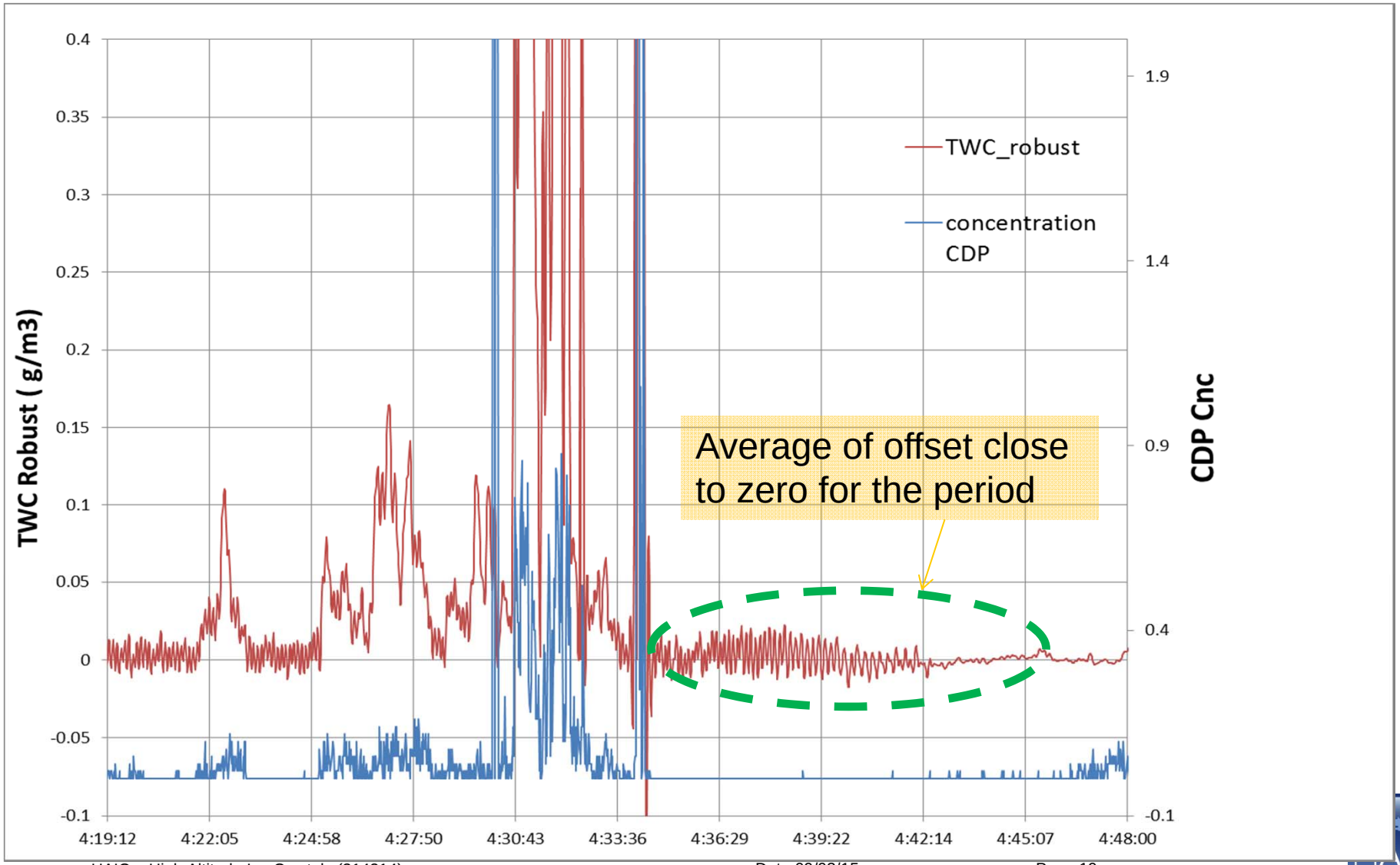
Calibration

Flight 3 (dry power correction term applied), 5th part (30 min)



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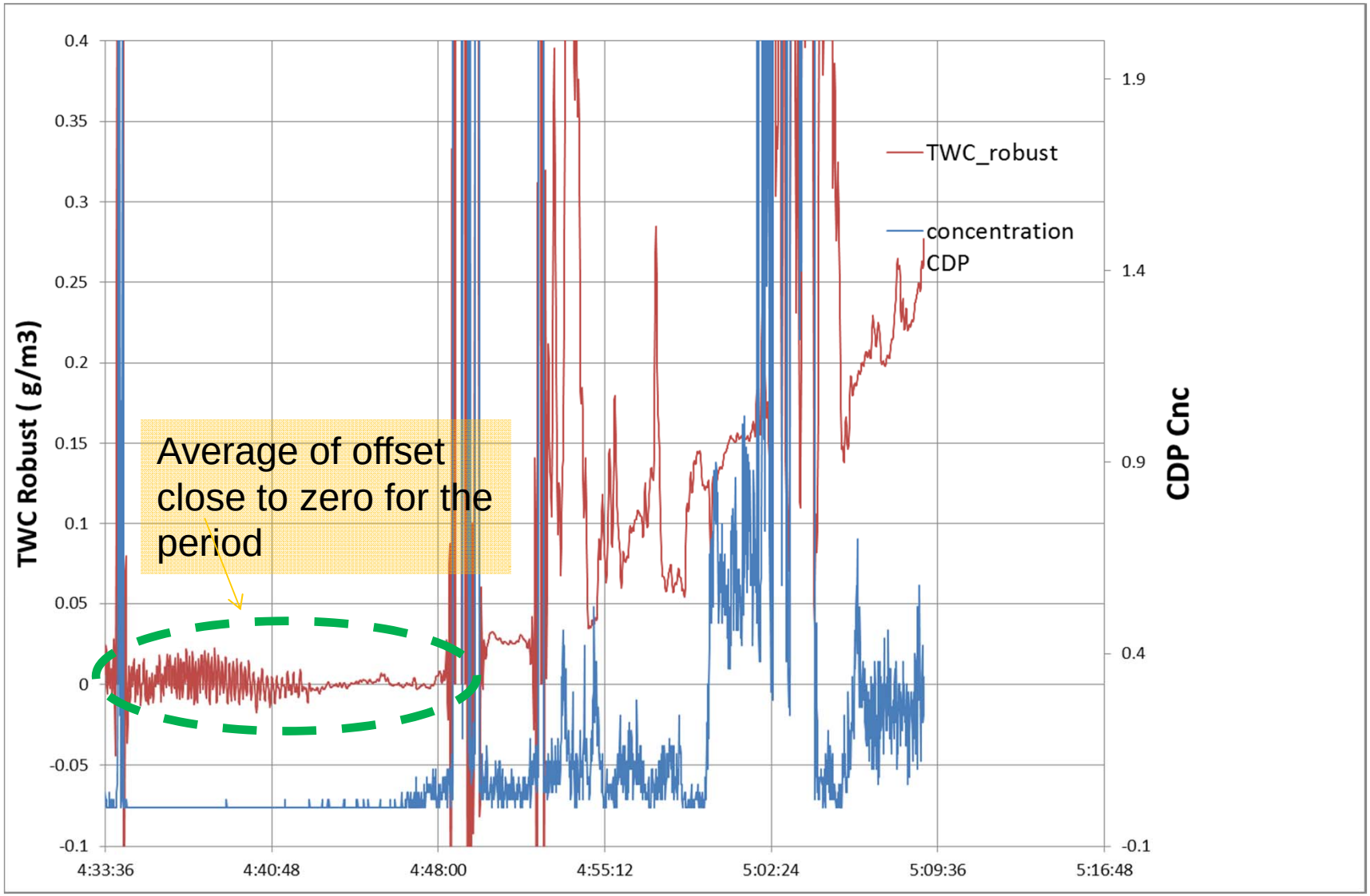
Calibration

Flight 3 (dry power correction term applied), 5th part (30 min)



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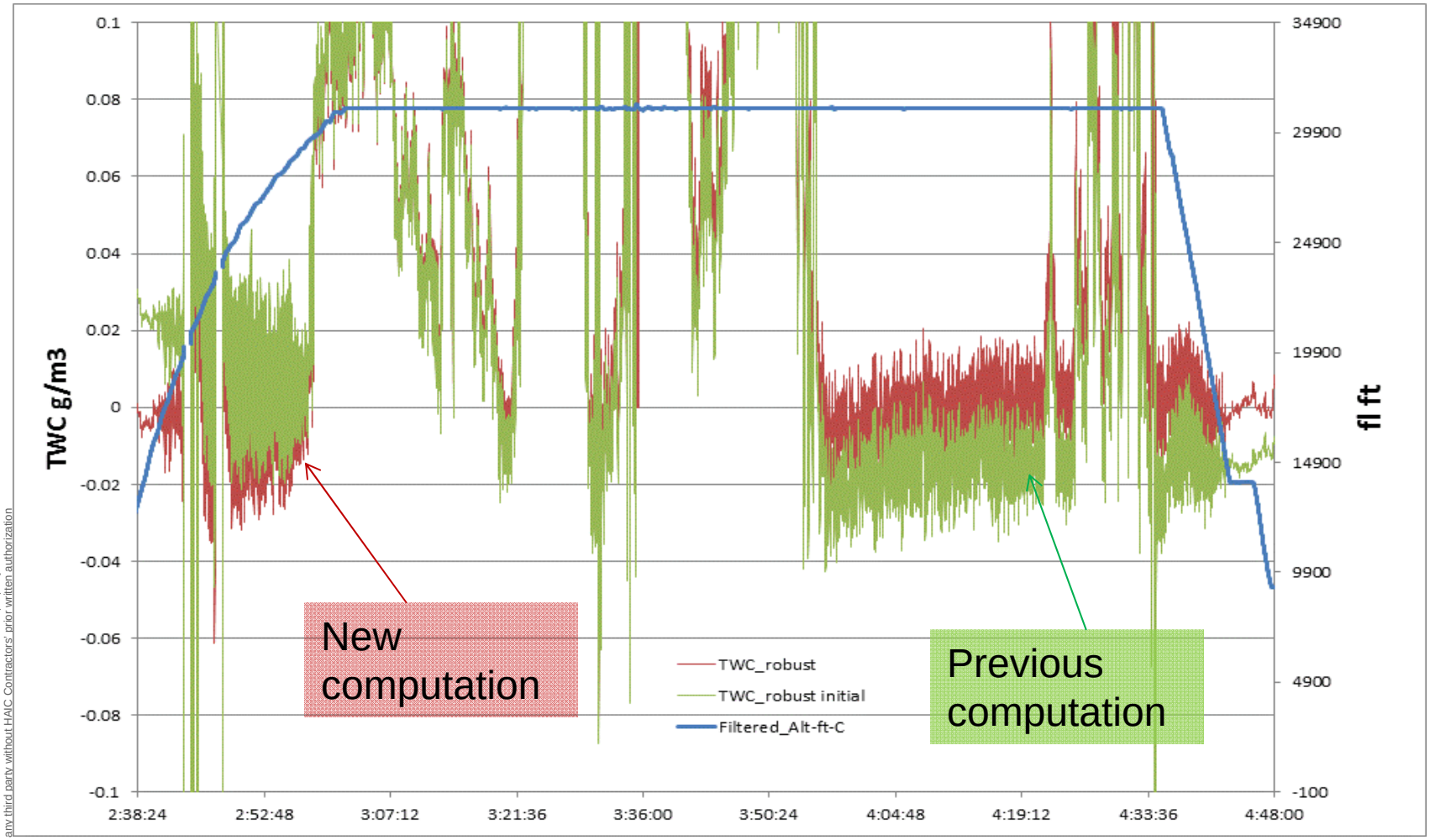
Calibration

Flight 3 (dry power correction term applied), whole flight



Previous computation biased; new computation improves dataset!

Conclusions

- The airspeed at Robust probe sensor element (related to TAS) depends probably on weight and balance of the A/C
- A simple improvement of the model gives better results (specially reduce the non-expected offsets)
- The zero CDP_cnc must be taken into account carefully because some particles are probably discarded by CDP (transfer time or other, signal too large for classification in CDP size bins)
- Some negative values are still found for TWC robust just after high TWC measurement (observed twice). Is there a kind of relaxation effect ?
- Manuel adjustment can be useful, but should be used only as ultimate alternative, when no other analytic processing is possible. Start and end of flight difficult to use for this adjustment.

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Conclusions and way forward

Robust data processing	Conclusions	Action
Power oscillation problem	Apply filtering method	**Produce and release the final data set (Airbus)** **Availability : End of march 2015**
Calibration (removal of the dry term)	• Local calibration (i.e. for each flight) • Introduce the linear reduction of airspeed as a function of time in the Re/Nu regression • Select zero CDP concentration cases carefully • Fixture correction	

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Conclusions and way forward

Dissemination :

- Robust efficiency study in ice conditions as a function of TWC (from IKP), MMD, Temperature,… CNRS+SEA+Walter

Datasets :

- Robust dataset
- IKP version 4
- PSD (MMD) dataset

Useful references :

- IKP : tunnel experiments and validation ? Probe efficiency and data treatment (background humidity removal)

Idea Lyle:

- Use of new porous sensor element for few Cayenne flights: higher efficiency

High Altitude Ice Crystals (HAIC, 314314)

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