Data processing description

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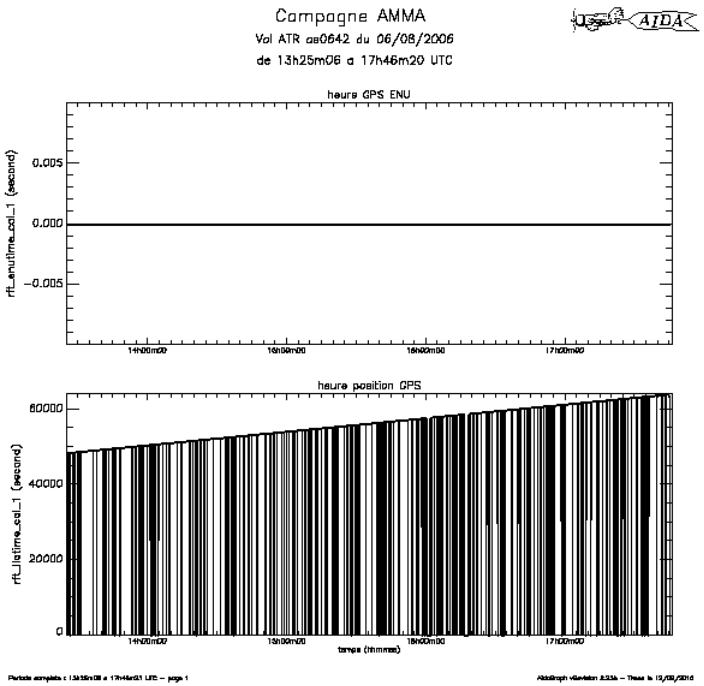
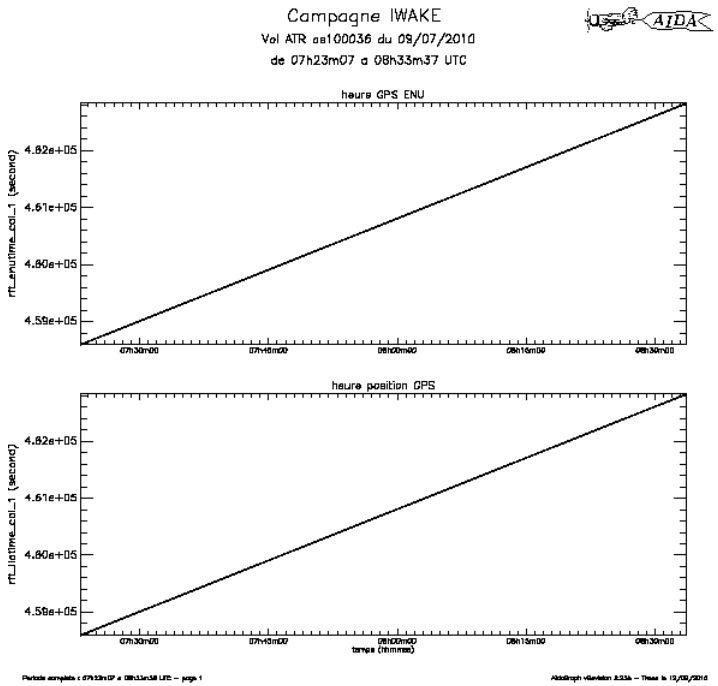
Introduction

What happened between the sensor and the file you get ?

GPS

Processing : nothing scientific
What to check : data loss

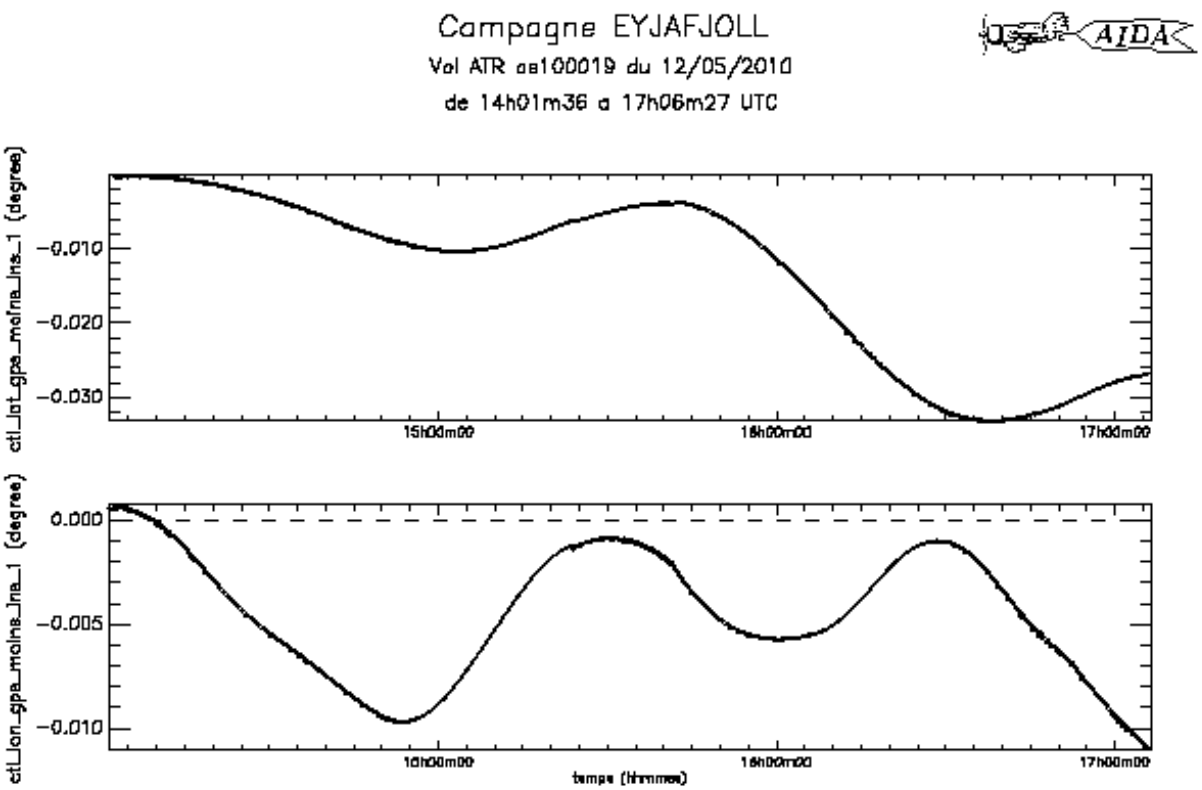




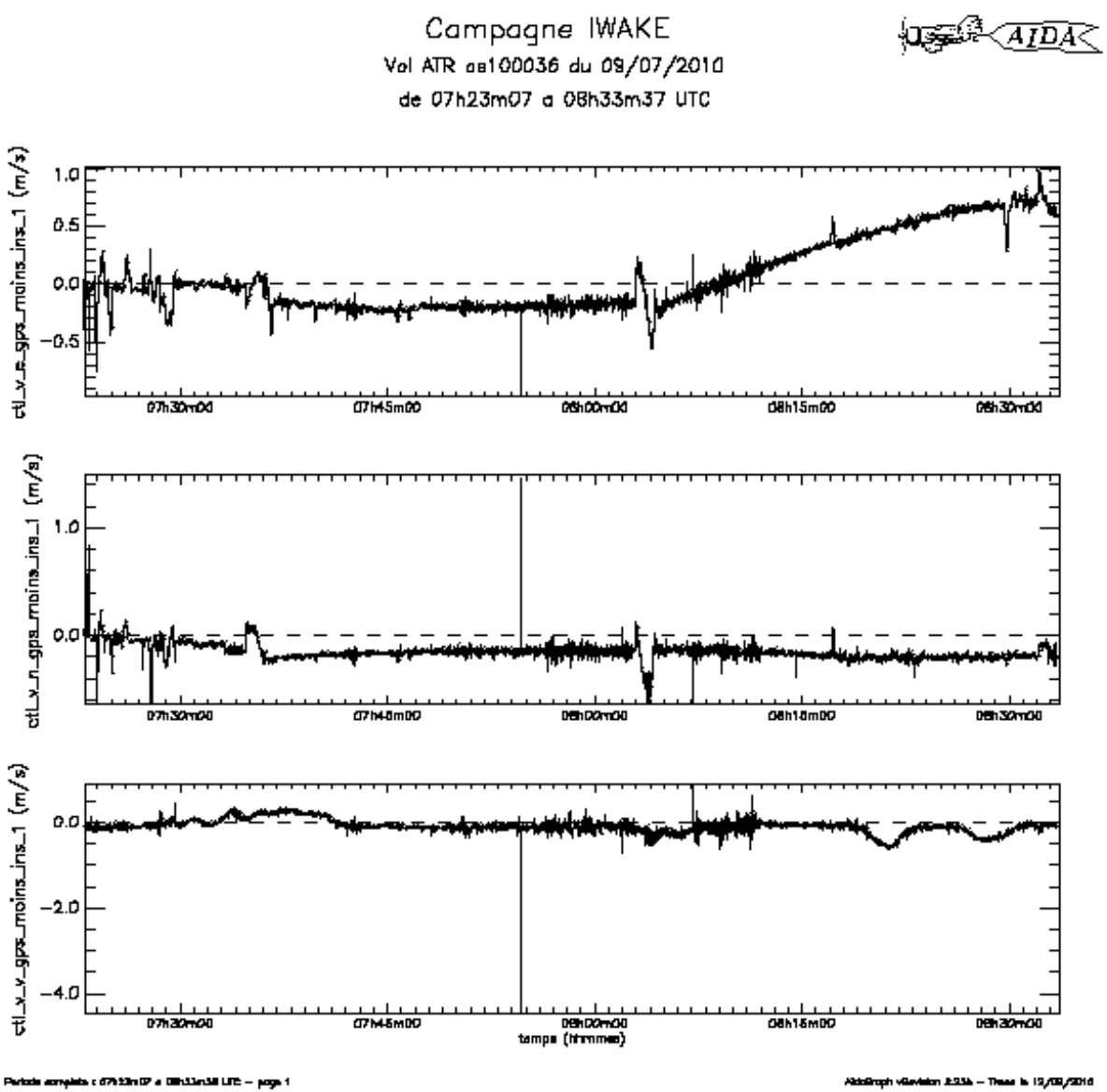
INS, for positions

Processing : nothing scientific

What to check : Drift, Schuler oscillation.



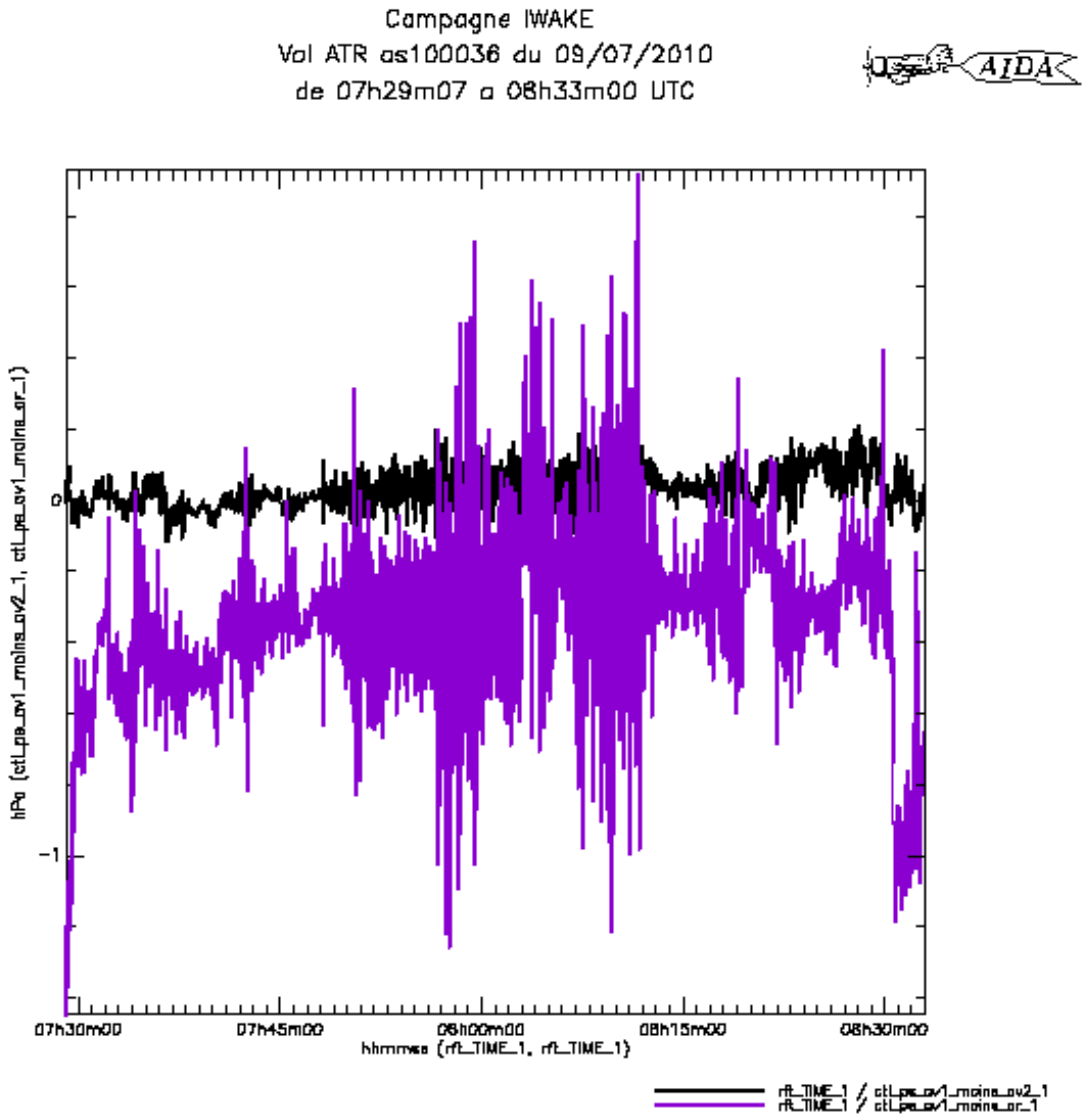
INS, for velocities



Pressure

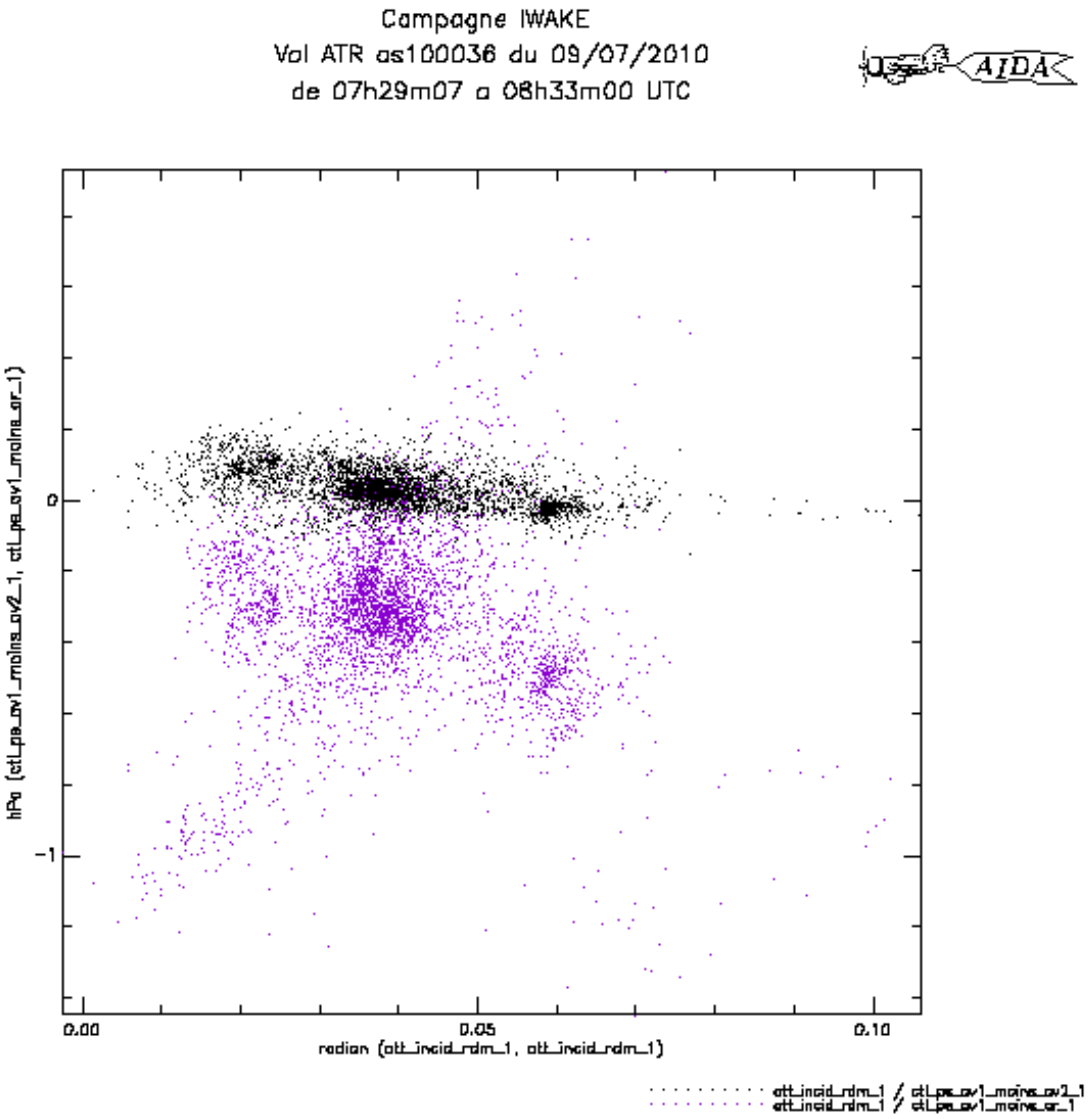
Processing : "static defect" removal

What to check : similarity of redundant measurements.



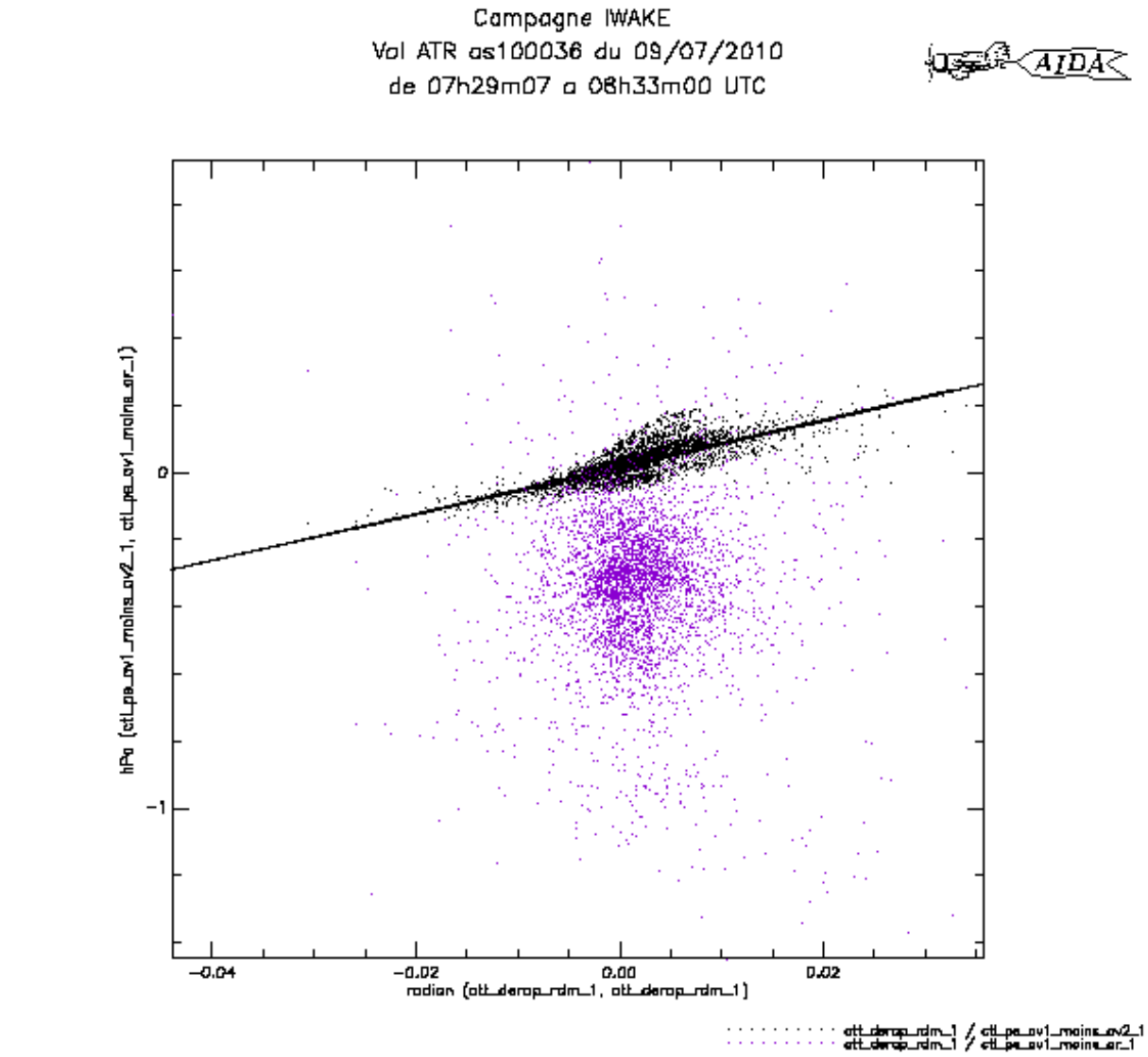
Pressure (2)

Looking for a correlation of the error to a cause.



Pressure (3)

Looking for a correlation of the error to a cause.



Air speed

Processing : "static defect" removal, then pressure to speed conversion :

$$V_p^2 = 2.c_{pa}.T_s.\left[\left(1+\frac{\Delta P}{P_s}\right)^{R_a/c_{pa}} - 1\right]$$

What to check : similarity of redundant measurements.

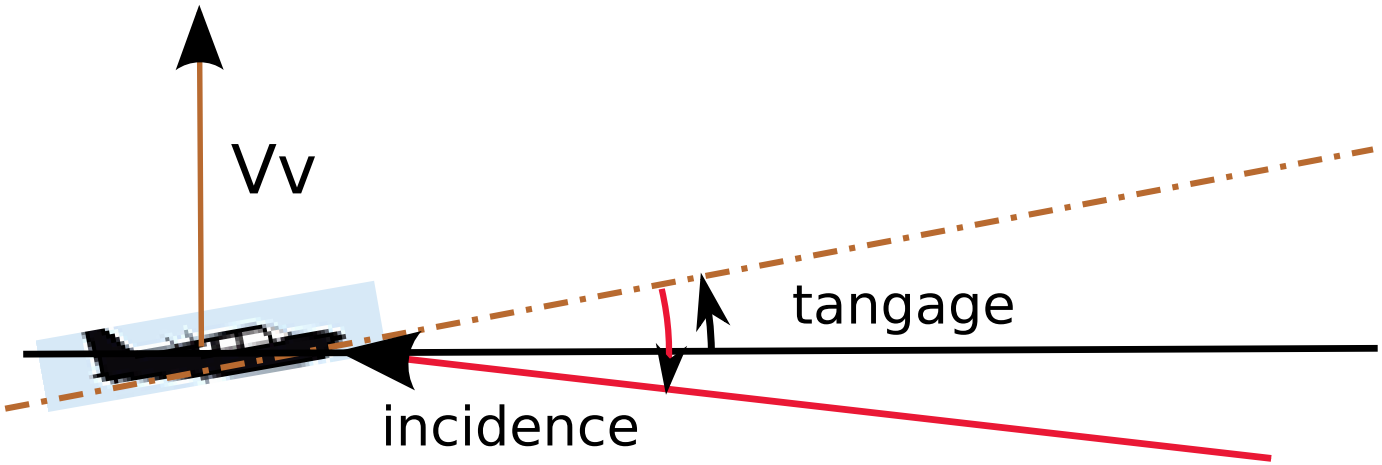
Air flow direction

Processing : Conversion of differential pressure to angle (*cf.* theory and calibration)

$$\alpha = \alpha_0 + k\frac{\Delta P\_\alpha}{\Delta P}$$

For a Rosemount 858, $k = 12.8$ (in degrees).
What to check : Icing

A simple qualitative radôme icing test



If $\omega \ll Vv$, $(pitch - attack) * Vp \approx Vv$
Vv can comme from various sources : INS, GPS, dP/dt
Most of the time, discrepancy come from *attack*

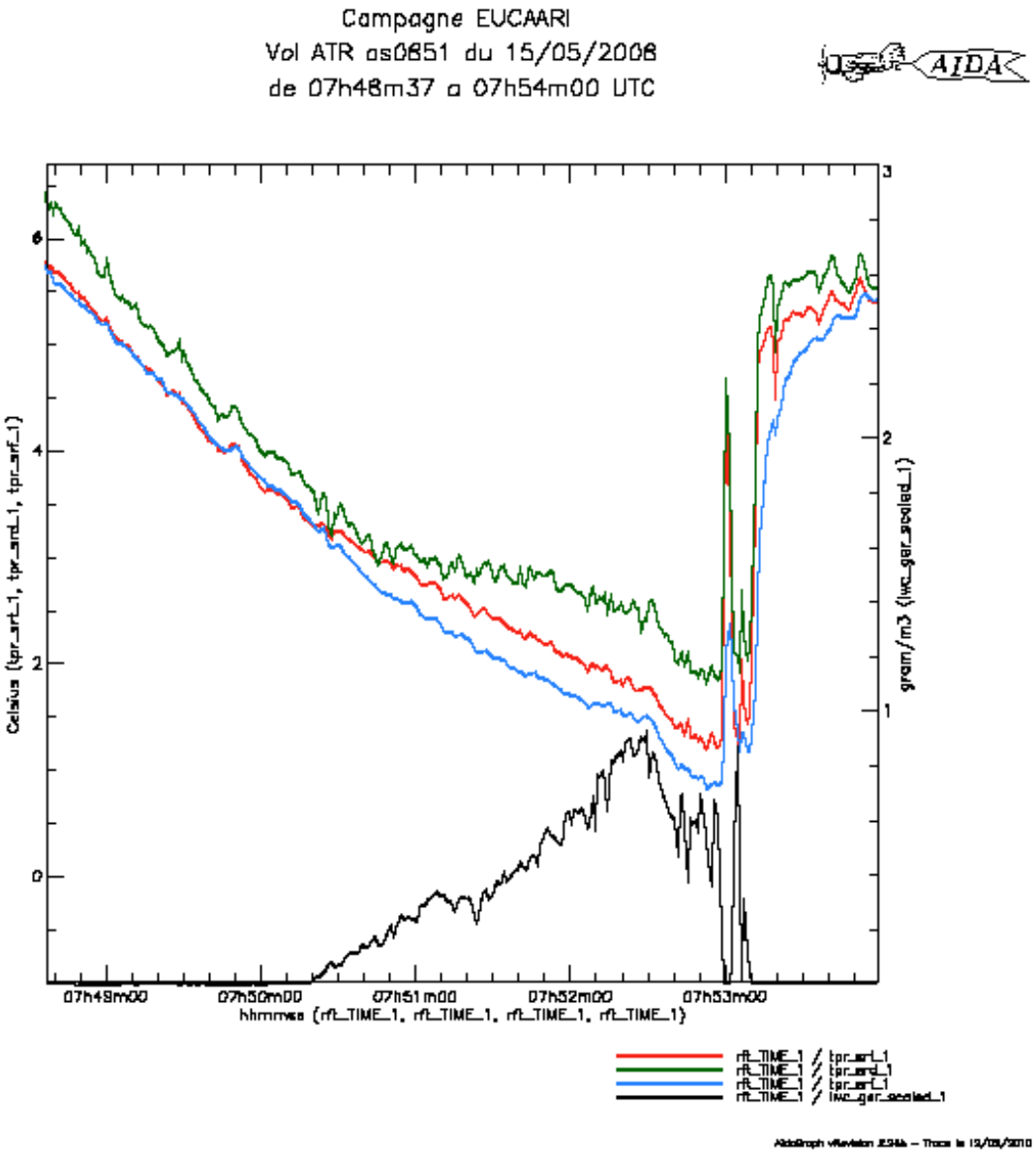
Temperature

Processing :

$$T_s = \frac{T_t}{1 + r_f \times \left(\left(1 + \frac{\Delta P}{P_s} \right)^{R_a / c_{pa}} - 1 \right)}$$

What to check : similarity of redundant measurements. Series of differences, correlation of differences to a plausible cause.

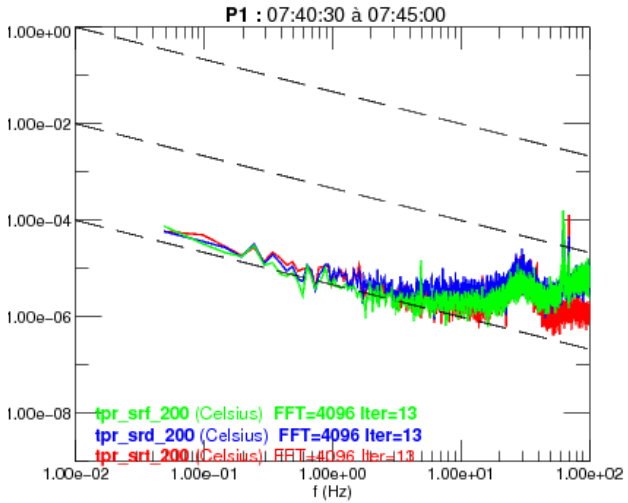
Temperature - comparison

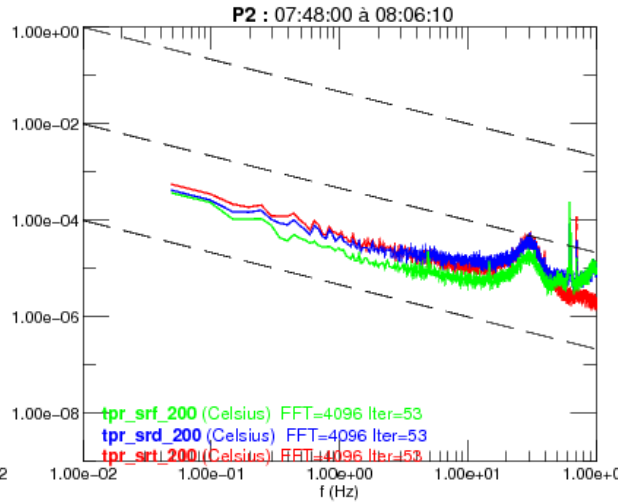


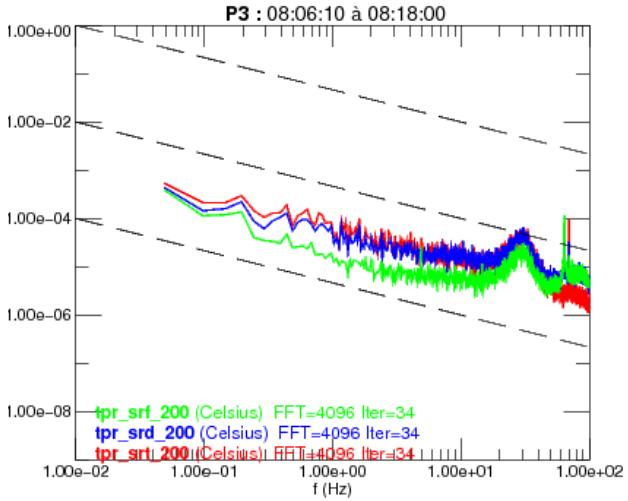
Temperature - spectra

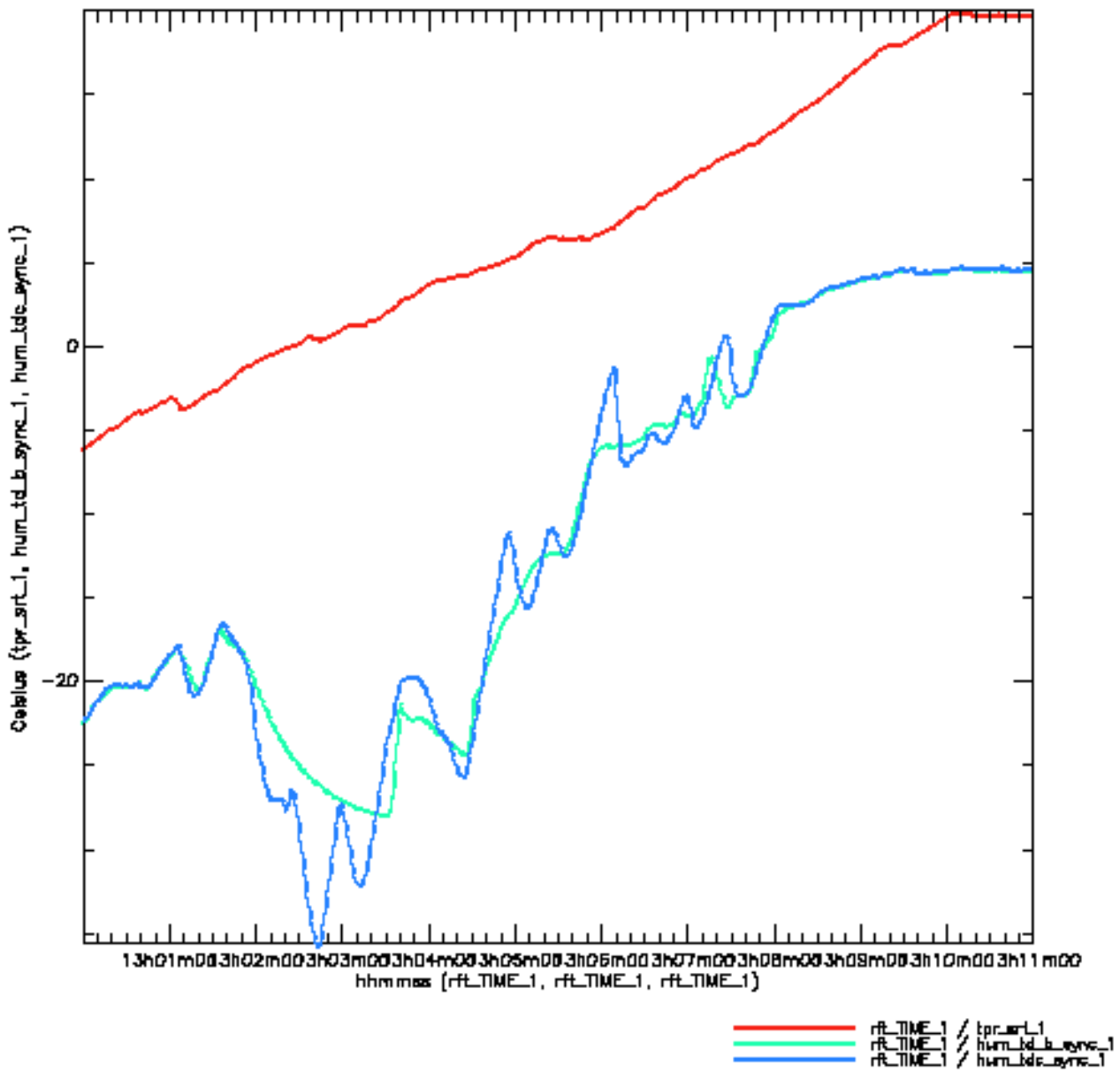
Densité Spectrale de Puissance * Freq

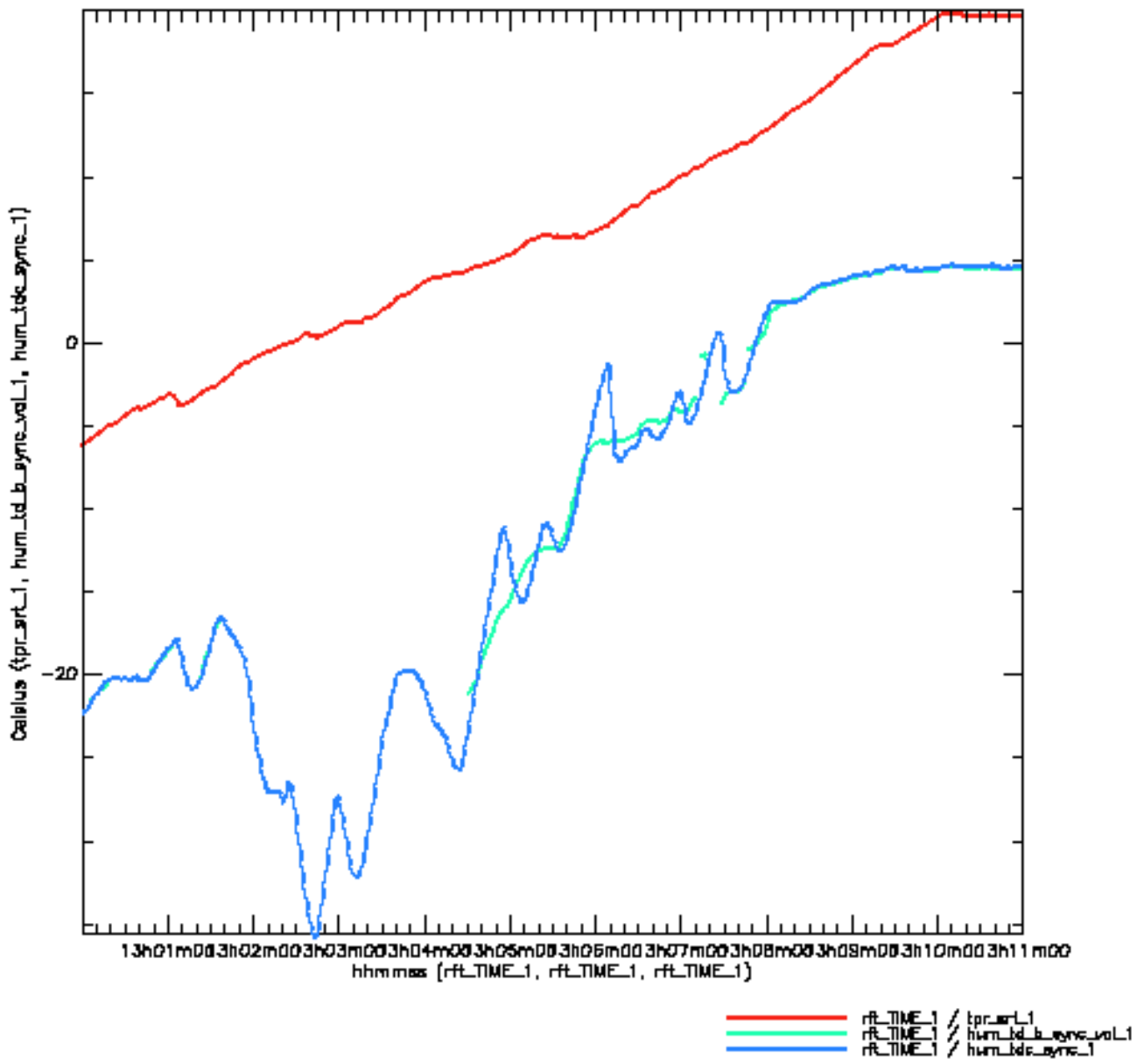
iwake **Acquisition : as100036 du 09/07/2010**









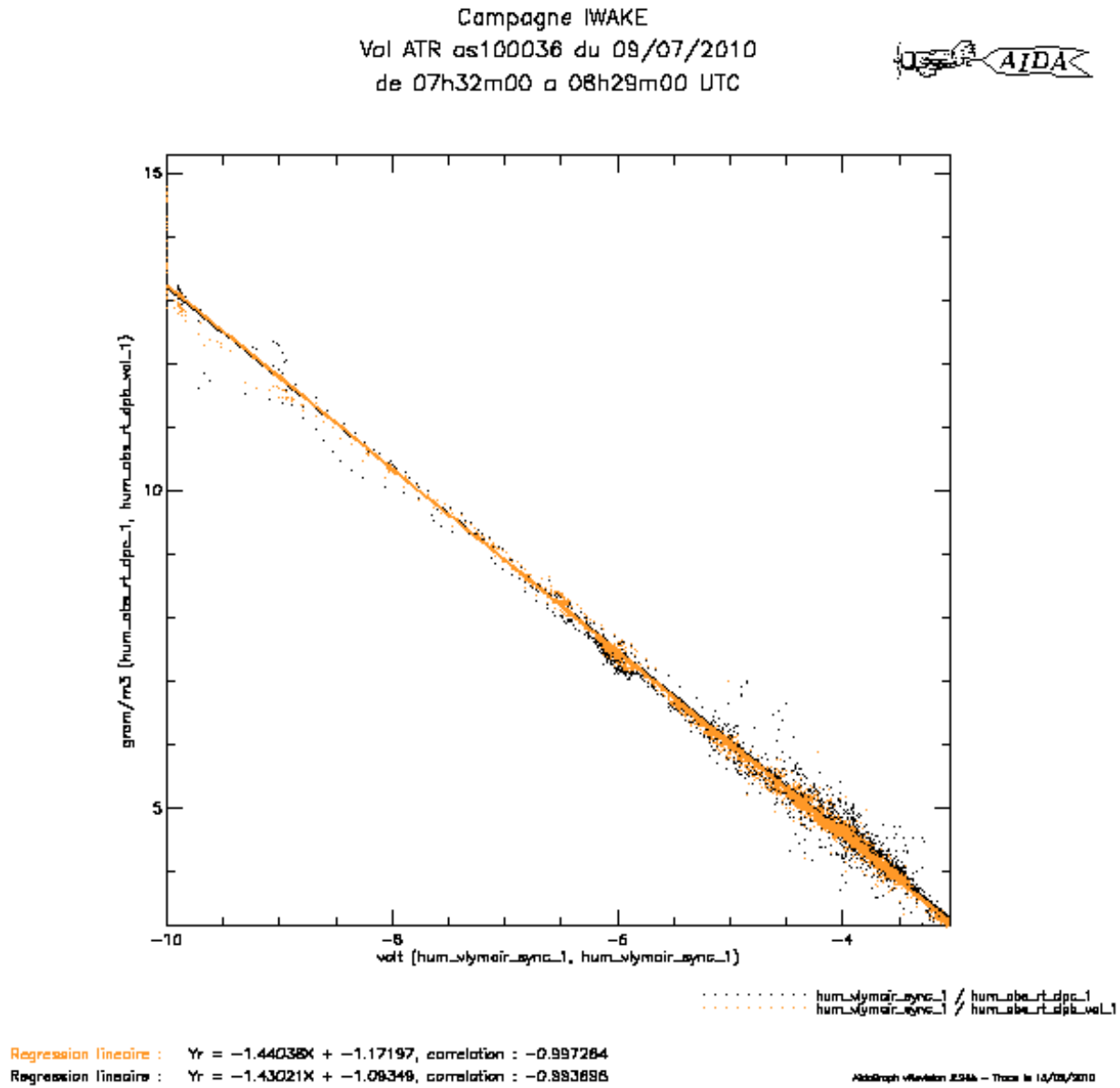


Capacitive probe : relative humidity sensor

Processing :
Correction of the two effects of fast air flow stopping on the sensor : change of pressure and temperature.
Empirical calibration with a reference computed from dew point hygrometers.

What to check : aging, change of behaviour after wetting.

Lyman-α : Absolute humidity sensor



Wind - computation (1)

If the velocity of the aircraft with respect to ground, is expressed in the aircraft frame :

Velocities sum in the aircraft frame :

$$V_{air/ground} = V_{air/rad} + \Omega_{(av/\text{ground})} \wedge X_{rad} + V_{aircraft/ground}$$

Rotation to the local geographic frame :

$$\text{Wind} = V_{air/ground(\text{geo})} = \left[M_{\text{att}}\right] \left[V_{air/ground(\text{aircraft})}\right]$$

Where :

X_{rad} : coordinates of the radome in the frame of the velocity measurement system

$\left[M_{\text{att}}\right]$: rotation matrix corresponding to attitude angles.

Wind - computation (2)

If the velocity of the aircraft with respect to ground is expressed in the geographic frame :

Computation of $V_{air/aircraft}$ at the location of velocity measurements, in the aircraft frame

$$V_{air/aircraft} = V_{air/rad} + \Omega_{(av/\text{ground})} \wedge X_{rad}$$

Rotation to the local geographic frame :

$$V_{air/aircraft(\text{geo})} = \left[M_{\text{att}}\right] \left[V_{air/aircraft(\text{aircraft})}\right]$$

Simple sum at the end, in the local geographic frame :

$$\text{Wind} = V_{air/aircraft} + V_{aircraft/ground}$$

Statistical empirical corrections

Under the hypothesis of uniform wind, two back-and-forth legs allow to compute biases.
This can be generalized to any angle (Maurel 1995), and it gives you a statistics of corrective terms along a campaign.

King-Probe

Processing :

$$LWC = \frac{P_w - A(T_w - T_s).(\rho.V_p)^{\chi}}{I.d.V_p.[L + c.(T_{wh} - T_s)]}$$

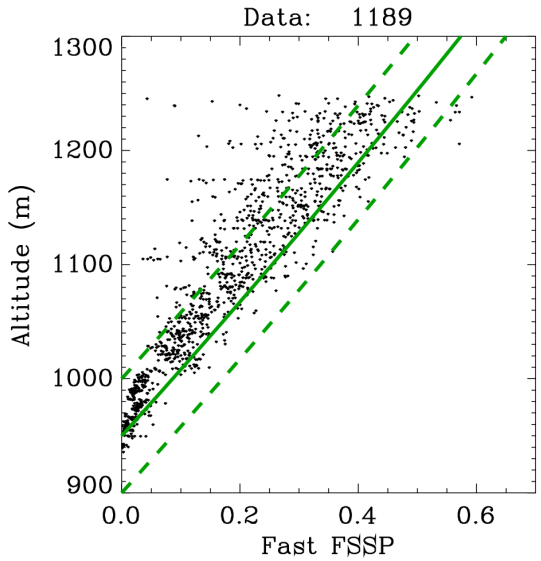
where $L = 2.264.10^6 J.kg^{-1}$ (Water latent heat at $100°C$)
and $c = 4218 J.kg^{-1}$ (Specific water heat)
What to check :

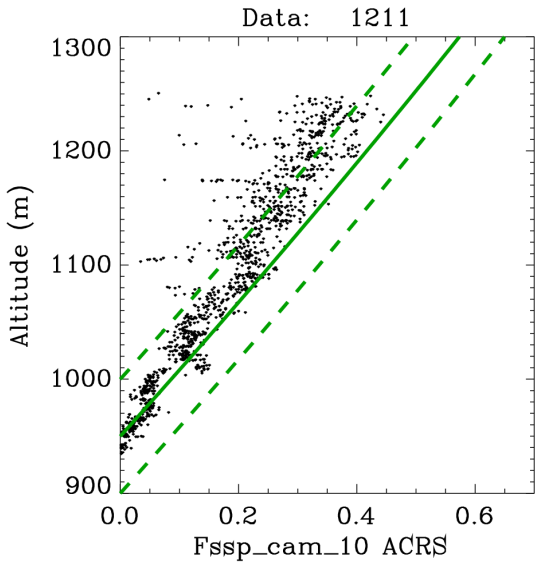
- Dry air term.
- Physical plausibility (compare to adiabatic vertical profile)

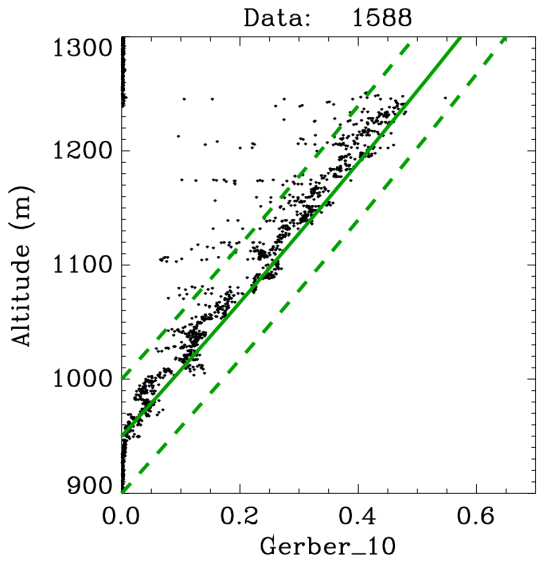
EUCAARI as0852 – at0809

VERTICAL PROFILES
of LWC ($g*m^{-3}$)
at: 114950.3

Base parameters:
Z = 950. (m)
P = 908.0 (hPa)
T = 2.3 (C)







radiation

Processing :
Long-wave thermal equilibrium :

$$Flx = a.V_{th} + \sigma.T_b^4 + K.\sigma.(T_b^4 - T_c^4)$$

Short-wave :
We **don't** do any attitude correction.
What to check :
comparisons to :

- other measurements
- physically plausible estimates

Comparaison to sea temperature