

Data processing description

Bruno Piguet

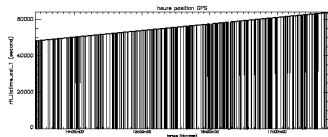
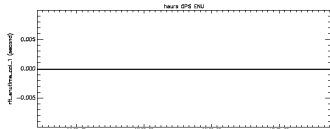
EU-FAR/TETRAD, 10-17 September 2010

What happened between the sensor and the file you get ?

Processing : nothing scientific

What to check : data loss

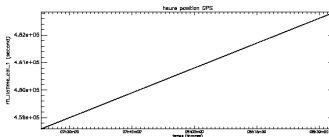
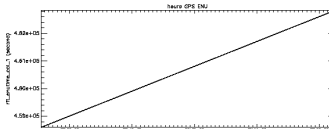
Campagne AMMA
Vol ATR 800642 du 06/09/2006
de 13h35m06 s à 17h46m20 UTC



Plotus samples : 1338028 à 1746202 UTC - page 1

Modèle de données AIDA - Time à 15/09/2010

Campagne IWAKE
Vol ATR 800636 du 09/07/2010
de 07h23m07 s à 09h33m37 UTC



Plotus samples : 0743007 à 0933037 UTC - page 1

Modèle de données AIDA - Time à 15/09/2010

Introduction

Positionning

Pressure

Relative wind

Temperature

Humidity

Dew point

Relative

Absolute

wind

LWC

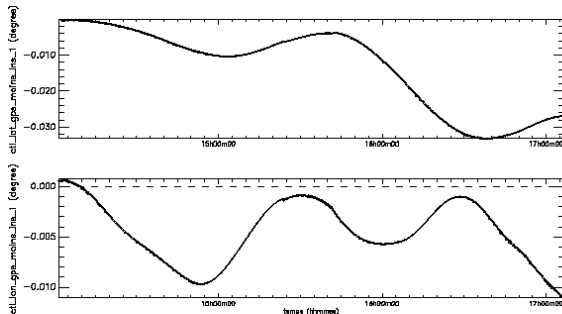
radiation

INS, for positions

Processing : nothing scientific

What to check : Drift, Schuler oscillation.

Campagne EYJAFJOLL
Vol ATR au100019 du 12/05/2010
de 14h01m36 a 17h06m27 UTC

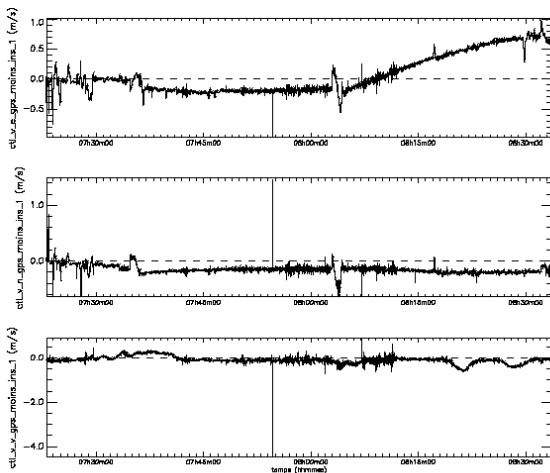


INS, for velocities

Processed Data

B. Piguet

Campagne IWAKE
Vol ATR a100036 du 09/07/2010
de 07h23m07 a 08h33m37 UTC



Période sélectionnée : 07h30m07 à 08h33m37 UTC - page 1

Altitude : 4500m - 233h - 10/07/2010

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LWC

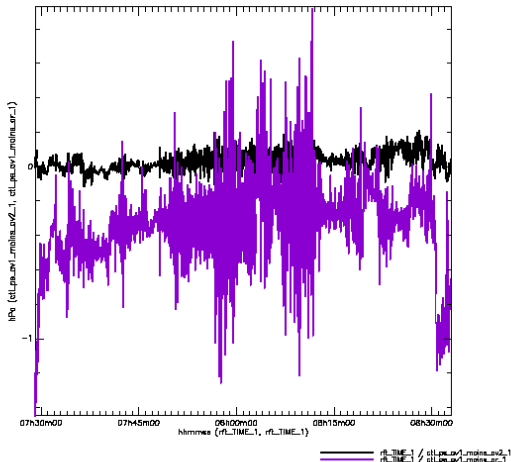
radiation

Pressure

Processing : "static defect" removal

What to check : similarity of redundant measurements.

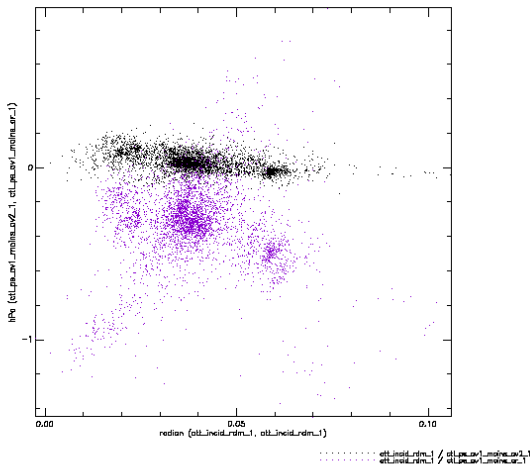
Campagne IWAKE
Vol ATR as100036 du 09/07/2010
de 07h29m07 a 08h33m00 UTC



Pressure (2)

Looking for a correlation of the error to a cause.

Campagne IWAKE
Vol ATR as100036 du 09/07/2010
de 07h29m07 a 08h33m00 UTC

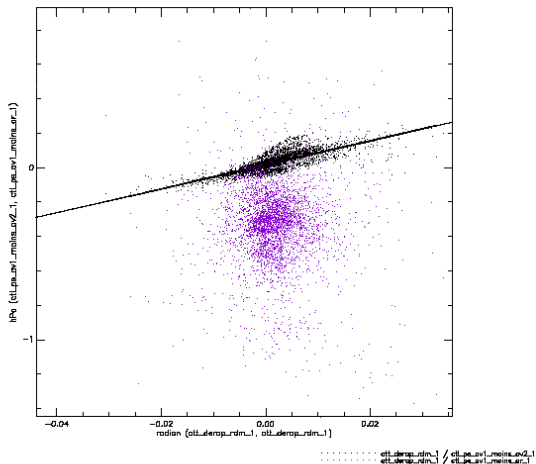


Aldighieri v. 254a - Trace le 12/08/2010

Pressure (3)

Looking for a correlation of the error to a cause.

Campagne IWAKE
Vol ATR as100036 du 09/07/2010
de 07h29m07 a 08h33m00 UTC



Regression lineaire : $Yr = 6.97885X + 0.0204981$, correlation : 0.788477

Aldighieri-Merloni 254a - Thèse le 12/09/2010

Processed Data

B. Piguet

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

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

What to check : similarity of redundant measurements.

Air flow direction

Processed Data

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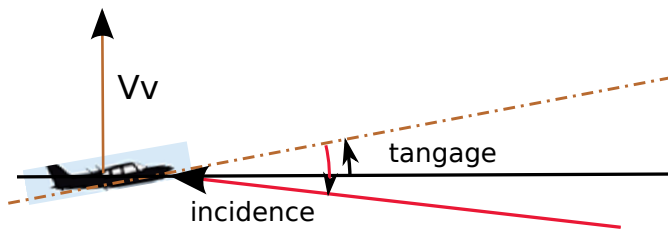
Processing : Conversion of differential pressure to angle (cf. theory and calibration)

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

For a Rosemount 858, $k = 12.8$ (in degrees).

What to check : Icing

A simple qualitative radôme icing test



If $\omega \ll V_v$, $(pitch - attack) * V_p \approx V_v$

V_v can come from various sources : INS, GPS, dP/dt

Most of the time, discrepancy comes from *attack*

Processed Data

B. Piguet

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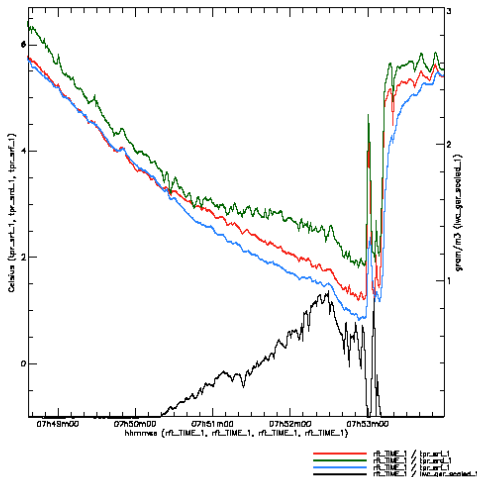
Processing :

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

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

Temperature - comparison

Campagne EUCAARI
Vol ATR as0851 du 15/05/2008
de 07h48m37 a 07h54m00 UTC



AirData - Version 2.54a - Trace 15 (15/05/2008)

Processed Data

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Temperature - spectra

Processed Data

B. Piguet

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Relative

Absolute

wind

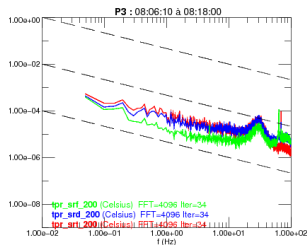
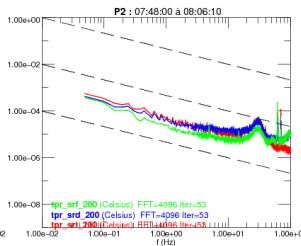
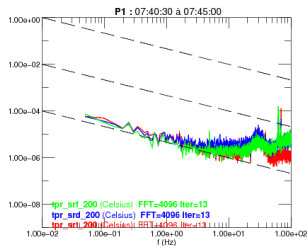
LWC

radiation

Densité Spectrale de Puissance * Freq

iwake

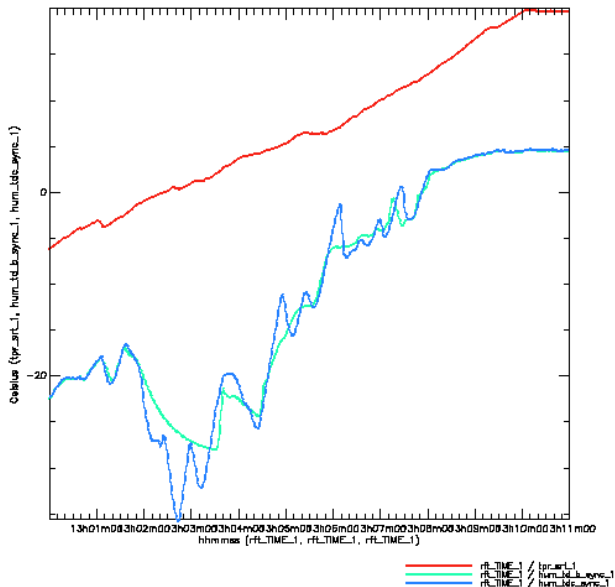
Acquisition : as100036 du 09/07/2010



Campagne TETRAD
 ATR42 as100050 du 10/09/2010
 de 13h00m00 à 13h11m00 UTC

Processed Data

B. Piguet



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Positionning

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Relative wind

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Humidity

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Relative

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wind

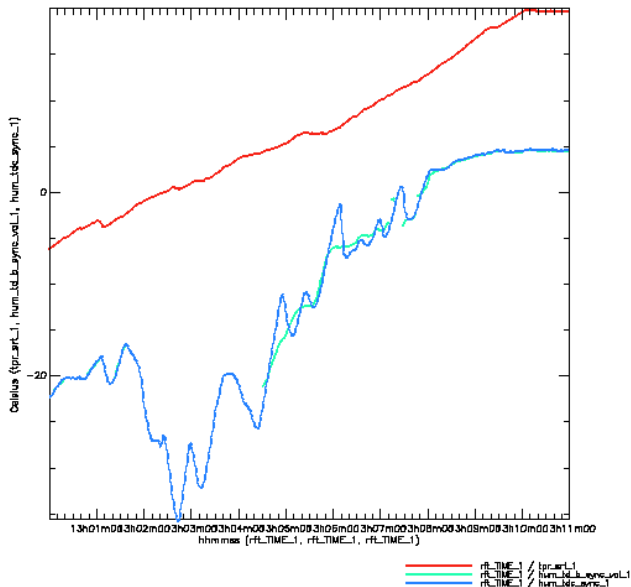
LWC

radiation

Campagne TETRAD
 ATR42 as100050 du 10/09/2010
 de 13h00m00 à 13h11m00 UTC

Processed Data

B. Piguet



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Capacitive probe : relative humidity sensor

Processed Data

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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.

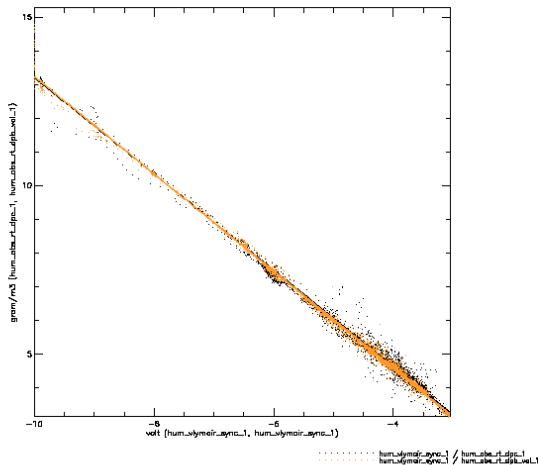
What to check : aging, change of behaviour after wetting.

Lyman- α : Absolute humidity sensor

Processed Data

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Campagne IWAKE
Vol ATR as100036 du 09/07/2010
de 07h32m00 à 08h29m00 UTC



Regression linéaire : $Yr = -1.44038X + -1.17197$, correlation : -0.997264
Regression linéaire : $Yr = -1.43021X + -1.09349$, correlation : -0.993696

Absoluph v4.0.0.0 - 254h - Trace le 14/08/2010

Introduction
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Relative
Absolute
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LWC
radiation

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 :

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

Rotation to the local geographic frame :

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

Where :

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

$[M_{att}]$: rotation matrix corresponding to attitude angles.

Processed Data

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Statistical empirical corrections

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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.

Processing :

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

where $L = 2.264 \cdot 10^6 J \cdot kg^{-1}$ (Water latent heat at $100^\circ C$)
and $c = 4218 J \cdot kg^{-1}$ (Specific water heat)

What to check :

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

EUCAARI as0852 - at0809

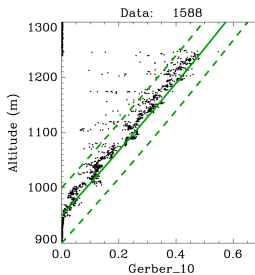
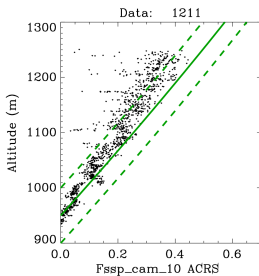
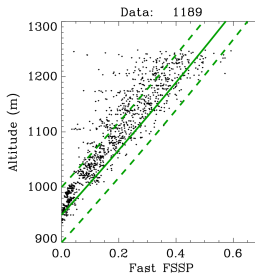
VERTICAL PROFILES
of LWC ($\text{g}\cdot\text{m}^{-3}$)
at: 114950.3

Base parameters:

Z = 950. (m)

P = 908.0 (hPa)

T = 2.3 (C)



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Processing :

Long-wave thermal equilibrium :

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

Short-wave :

We **don't** do any attitude correction.

What to check :

comparisons to :

- ▶ other measurements
- ▶ physically plausible estimates

Comparaison to sea temperature

Processed Data

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