# INTERCOMPARISON DATA BETWEEN CONVENTIONAL INSTRUMENTS AND AUTOMATIC SENSORS

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## ABSTRACT

Automatic station located next to conventional stations. These are located at two natural regions, near the ocean (coast) and country side in the highland ("Andes Cordillera"). Nine places, four in coast and 5 in highland. All conventional instruments and sensor are calibrated and free of error. We only compare main daily observations (12Z – 18Z – 24Z). Conventional thermometer and pluviometer are considered like pattern. Inter comparison was made only on rainy months or season for precipitation. Appraised within ± 5% and ± 0.3 mm was the comparison range for precipitation. Total precipitation was different between records from conventional instruments and automatic sensors. In the case of temperature the sampling was for high, average and low temperatures. Appraised within ± 0.2°C and ± 5°C was the comparison range for temperatures. All the values that was "out of range" were qualified like "wrong". We made comparative and tendency graphs. Finally we had important differences between conventional instruments and automatic sensors.

## GEOGRAPHICAL LOCATION

The country is named as Ecuador, it is for "Equator Line" is located at:

- Northwest of South America
- Between Colombia and Peru, East of the Pacific Ocean
- Elevation from sea level to 20700 feet above sea level
- Three Natural regions
a) Coastal is Mostly plain
b) Highland is because "Andes Cordillera" through north to south of the country and neighbors countries.
c) Amazonia is a basin plain, and the main surface is cover by rain forest.



## 1. INTRODUCTION

Conventional instruments and automatic sensors were calibrated and free of error. We only made comparisons of three main daily observations 12z/18z/24z (07h00/13hoo/19h00 local time). The locations were we made the essay was in two regions highland and coast. All the automatic stations were next con conventional ones. Full study was in nine locations (Tomal{on, Innaquito, La Tola, Izobamba, Rumipamba, Milagro, Pichilingue, La Concordia, Guayaquil)

## 2. PARAMETERS AND PERIOD OF ANALYSIS

Pluviometer and normal thermometers were pattern. Rainfall and temperature were the inter comparison parameters. Automatic station was set up to register every one minute both parameters (1440 daily data) and transmit to central office at same time.

## 3. DATA PROCESSING

Because we had too many data from automatic station, we need to select data (every hour average) from automatic station, and then compare with each hour from conventional station. Both stations calculate:
- Total daily precipitation
- Temperature extreme values
- Temperature daily average

Graphics of:
- Rainfall
- Total rainfall
- Extreme and average temperatures

Then comparative table
Tendency
Standard deviation; and
Conclusions and recommendations

## 4. RAINFALL DATA

First we choice rainy season or months with the higher values. You have to, because if we have a few days with rainfall is difficult to compare results. When we analyze total daily rainfall data, conventional pluviometer almost always register a higher value than automatic sensor. Finally total daily and absolute values of rainfall were different between two stations. Appraised between values with ± 5% and ± 0.3 mm range for precipitation
(Graphic 1 and 2)

## 5. TEMPERATURE

Temperature parameter was analyzed with sampling maximum, average and minimum. Normal Thermometer most of data registered different temperature than temperature sensor. In order to compare we appraised with ± 0.2º C and ±0.5 ºC range for temperature. On the other hand for extreme temperatures only appraised with ± 0.5 ºC, and the results compare maximum temperature were very similar, but different with minimum.
(Graphic 3)

## 6. AUTOMATIC TOTAL DATA

Automatic sensor registered and store every one minute, is about 1440 data per day. We found to kind of error:
A) Less data than required, for example: two hundred (200) less during March 2012 at Pichilingue location.
B) More data than required, for example: two thousand (2000) during November 2010 at Izobamba location.
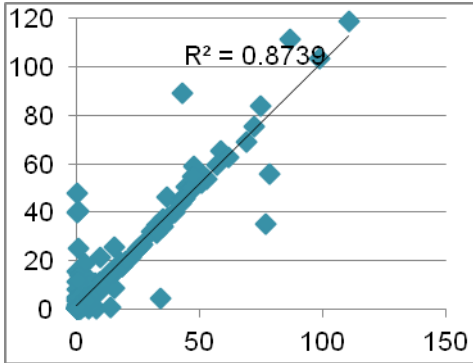(Graphic 4)

## 7. CONCLUSIONS AND RECOMMENDATIONS

- Significant differences analyzed data by data
- Rain analysis: difference is between 5 and 17%  (volume) error with automatic sensor

- Total rainfall is different between 6 and ???% when record and "GPR" transmission had problems in automatic station (like this value 746383.4 mm)
- Temperature analysis: error is lower  when consider $\pm 5^{\circ}$ than $2^{\circ}C$
- Extreme temperature: coefficient of correlation between 0.23/0.84, maybe automatic sensor record many times $0^{\circ}$ C (too low temperatures are not possible in these months)
- A bigger period of time would be convenient in order to find similar o different variations.
- Set up automatic station to register every 5 minutes for rainfall and every hour for temperature would help to improve the data treatment and comparison (instead of every one minute)
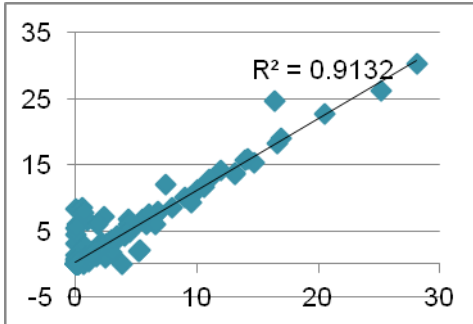
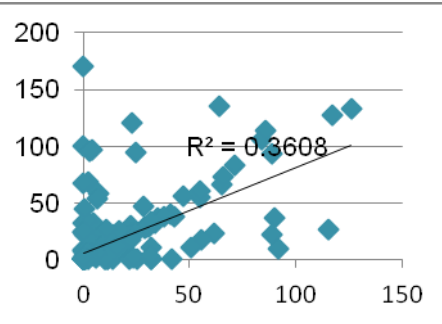**GRAPHIC 1 - CORRELATION BETWEEN DATA**

RUMIPAMBA



R² = 0.8739

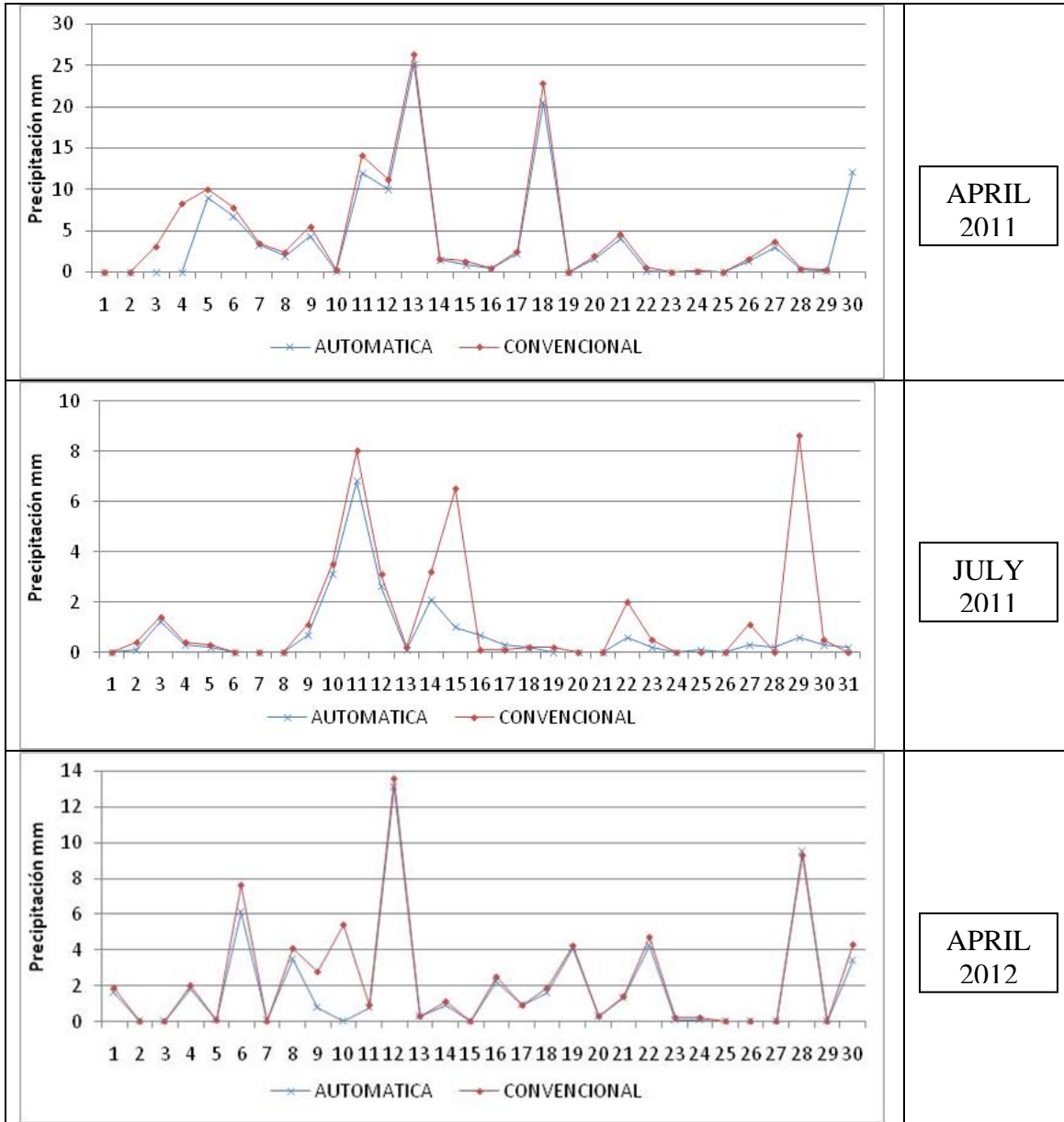LA CONCORDIA



R² = 0.1934

PICHILINGUE



R² = 0.9132

MILAGRO



R² = 0.3608
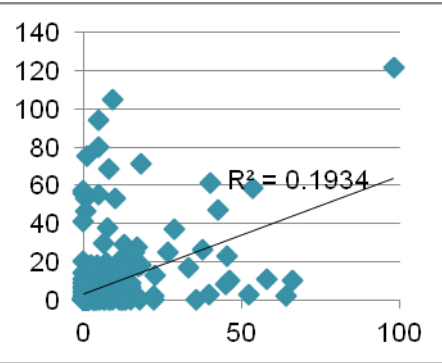
| | |
|---|---|
| La Tola | 0.86 |
| Izobamba | 0.98 |
| Rumipamba | 0.96 |
| Pichilingue | 0.6 |
| La Concordia | 0.93 |
| Milagro | 0.44 |

**GRAPHIC 2 - RAINFALL ANALYZIS**

ESTACION RUMIPAMBA



| APRIL 2011 |
| JULY 2011 |
| APRIL 2012 |

## Summary

| Abr-11 | | Jul-11 | | Abr-12 | |
|---|---|---|---|---|---|
| automat. | convenc. | Automat. | Convenc. | Automat. | Convenc. |
| 121.5 | 134.5 | 21.9 | 41.4 | 56.8 | 69.7 |

RR period
A = 509.6
C = 607.1

**GRAPHIC 3 - TEMPERATURE ANALYZIS**

# IZOBAMBA WEATHER STATION
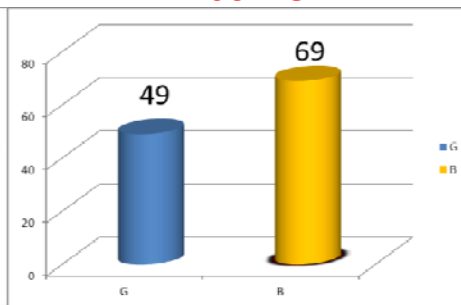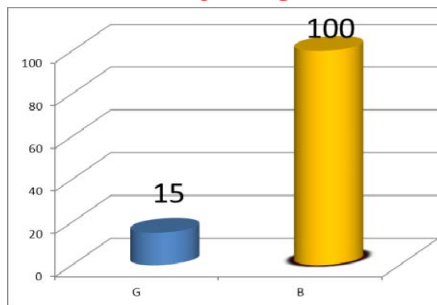# PERIOD: AUGUST TO NOVEMBER 2011

**± 0.2 ºC**

| | 12Z | 18Z | 24Z |
|---|---|---|---|
| Good | 15 | 20 | 55 |
| Bad | 100 | 98 | 64 |
| Data | 115 | 118 | 119 |
| Coef. | 0.7931 | 0.8324 | 0.8255 |
| % error | 5.4 | 4.0 | 7.7 |

**± 0.5 ºC**

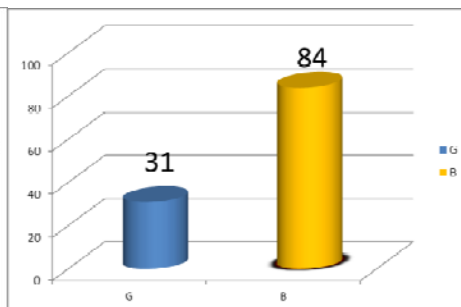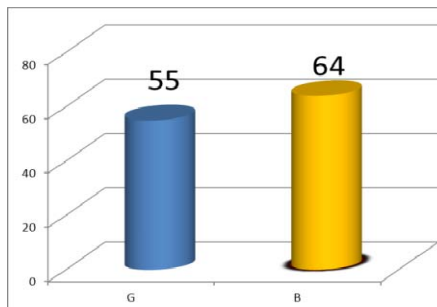| | 12Z | 18Z | 24Z |
|---|---|---|---|
| Good | 31 | 49 | 80 |
| Bad | 84 | 69 | 39 |
| Data | 115 | 118 | 119 |
| Coef. | 0.7931 | 0.8324 | 0.8255 |
| % error | 13.5 | 9.9 | 19.2 |

**± 0.2 ºC**

**± 05. ºC**



12Z
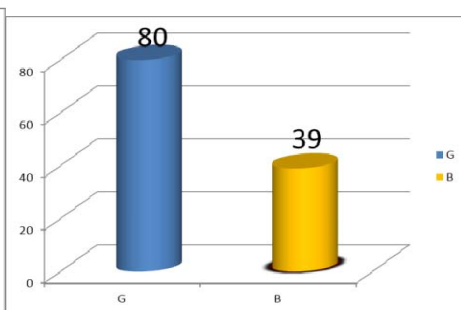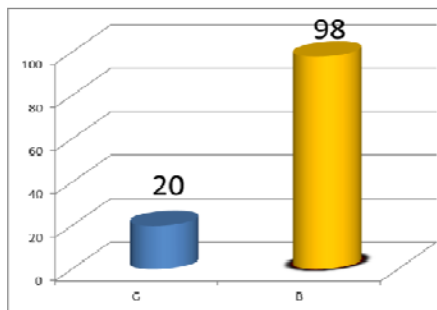
18Z

24Z

EXTREME TEMPERATURE
APPRAISED WITH ± 0.5 ºC FOR HIGH AND LOW TEMPERATURE

FINDINGS

IZOBAMBA
148 Data

|        | Max.   | Min.  |
|--------|--------|-------|
| Good   | 111    | 51    |
| Bad    | 37     | 97    |
| Data   | 148    | 148   |
| C.C.   | 0.8188 | 0.262 |

PICHILINGUE
602 Data

|        | Max.   | Min.   |
|--------|--------|--------|
| Good   | 461    | 248    |
| Bad    | 141    | 354    |
| Data   | 602    | 602    |
| C.C.   | 0.8162 | -0.171 |

LA CONCORDIA
610 Data

|        | Max    | Min    |
|--------|--------|--------|
| Good   | 355    | 124    |
| Bad    | 112    | 345    |
| Data   | 467    | 469    |
| C.C.   | 0.4701 | 0.0254 |

# GRAPHIC 4 - AUTOMATIC TOTAL DATA RECORD

Every minute  =1440 data per day

IZOBAMBA
NOV – 2010





PICHILINGUE (MARCH 2012)