Vaisala RS92 Radiosondes offer a high level of GPS performance with a reliable telemetry link

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Vaisala RS92-SGP Radiosonde

PTU-sensors

- F-Thermocap thin wire temperature sensor
- Heated humidity sensors
- Silicon micro-machined pressure sensor

GPS wind finding

- Code correlating technology

Telemetry link

- Narrow band digital transmission fulfilling European Union ETSI EN 302 054-1 standard for digital radiosondes

ASIC based electronics (Application Specific Integrated Circuits)

Modular mechanical construction

RS92-SGP Radiosonde data transmission

Telemetry

- Transmitter type — Synthesized
- Frequency band — 400 MHz
- Output power — 60 mW min
- Channel spacing — 200 kHz
- Modulation — GFSK (Gaussian Frequency Shift Keying)
- Data rate — 2400 baud / 1 second frame

Error detection and correction

- Data frame is divided to several sub-blocks, each followed by a check sum
- Each data frame is also protected with Reed-Solomon check bytes that are used for error correction

Vaisala DigiCORA® Sounding System MW31

- Sounding Processing Subsystem SPS311
- PC with DigiCORA® software (version 3.12)
- Antennas

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MW31 / SPS311 - Software radio technology

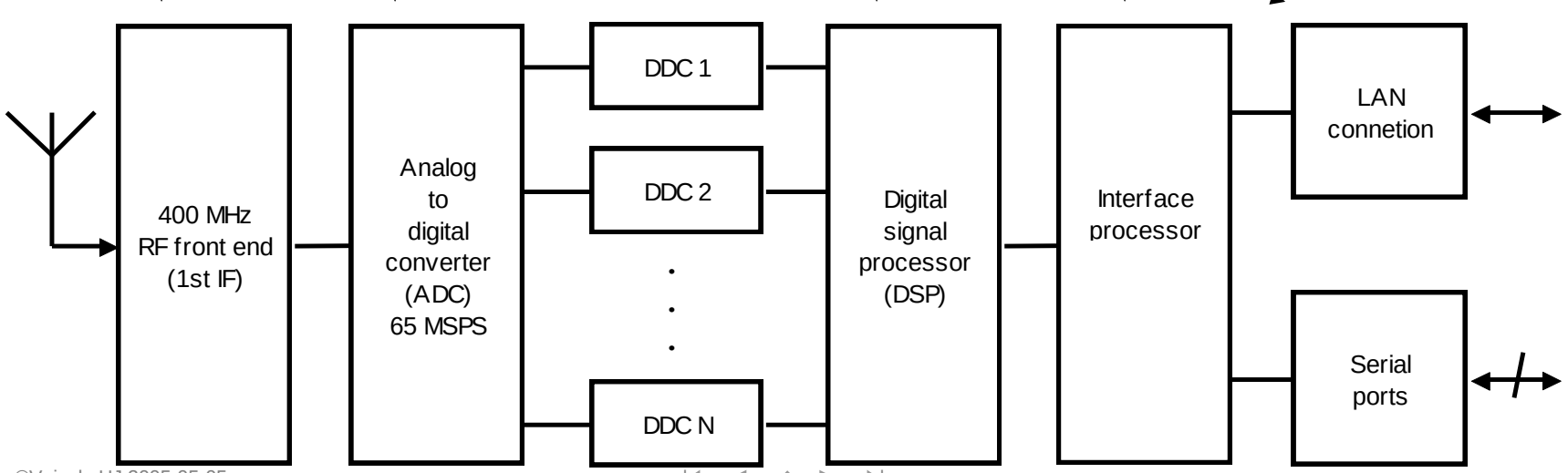
Down conversion of the meteorological band 400...406MHz to 16...22MHz (1st IF=intermediate frequency).

14bit Analog-to-Digital conversion with sampling rate of 64Msamples/s. The signal is now in digital form.

Digital filtering and down conversion to baseband

Digital Signal Processor: Automatic frequency control (AFC), demodulation, error detection and correction

Data delivery via LAN (TCP/IP).



Software radio advantages

Accurate and flexible digital signal processing

- Software configurable receiver properties. Only software updates are needed to adapt to different data transmission formats

Efficient error detection and correction methods

- With selected error correction coding, 4.7% of the symbols can be erroneous without causing the system to lose data
- The relative coding gain is approximately 5 dB

Uniform unit-to-unit operation leading to better quality

With digital radiosondes narrow band drift free transmission link

RS92 Radiosonde - MW31 telemetry link performance test

Tested in Tenerife in November 2004 at the Izana Observatory of the Spanish National Institute of Meteorology

The station has characteristics which make it good for testing meteorological devices

(elevation 2360 m)

In addition to this, it is possible to expose the test systems to controllable levels of interference

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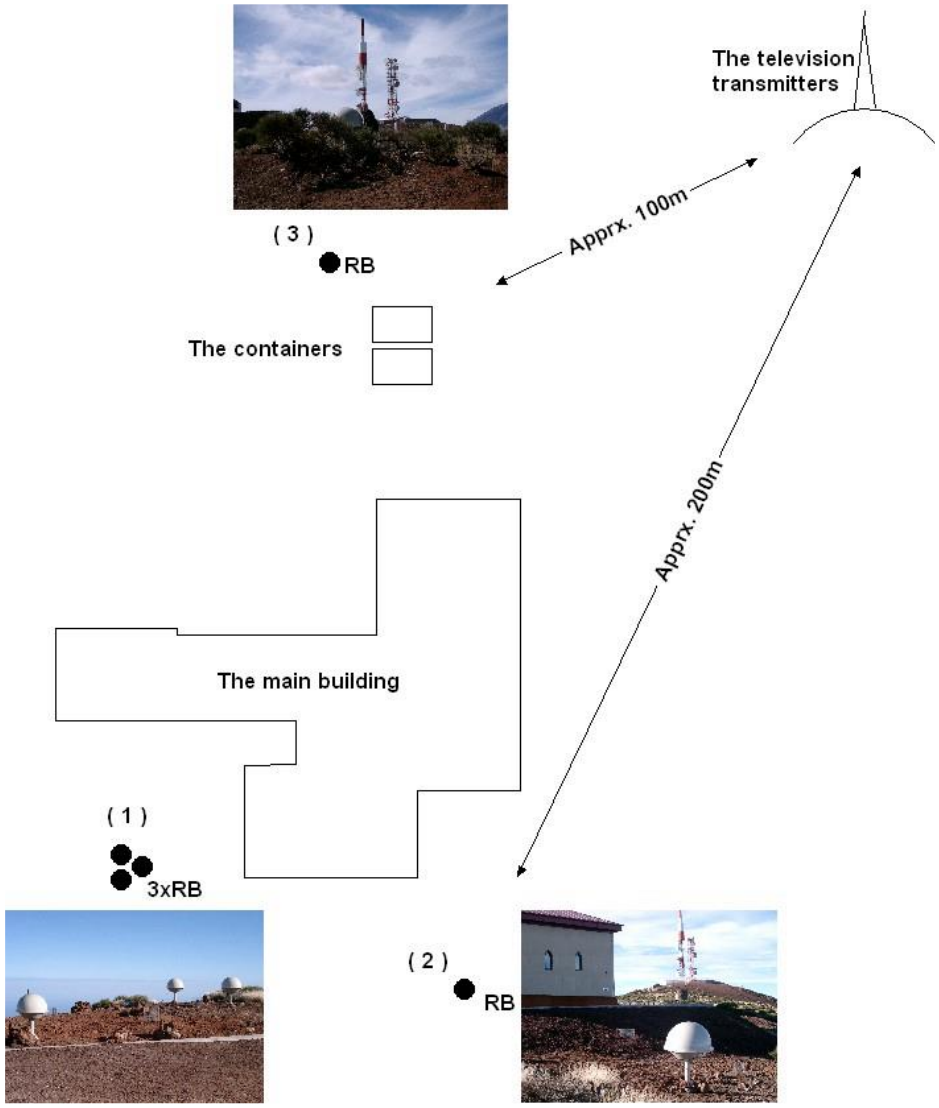
Test arrangement

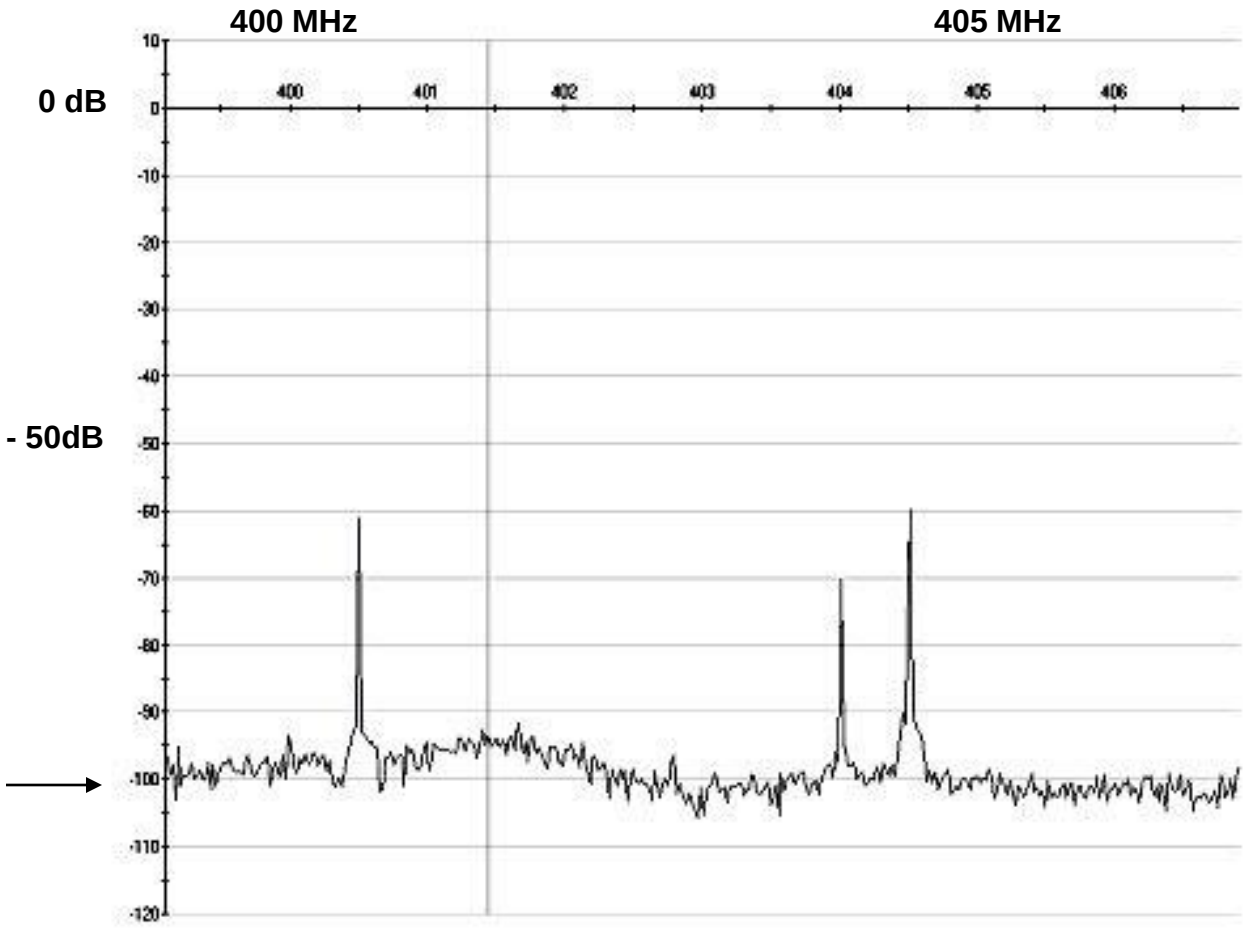


Spectrum measured in Location 1

No line of sight to noise source

The noise level is normal, -100dB

Normal noise level conditions



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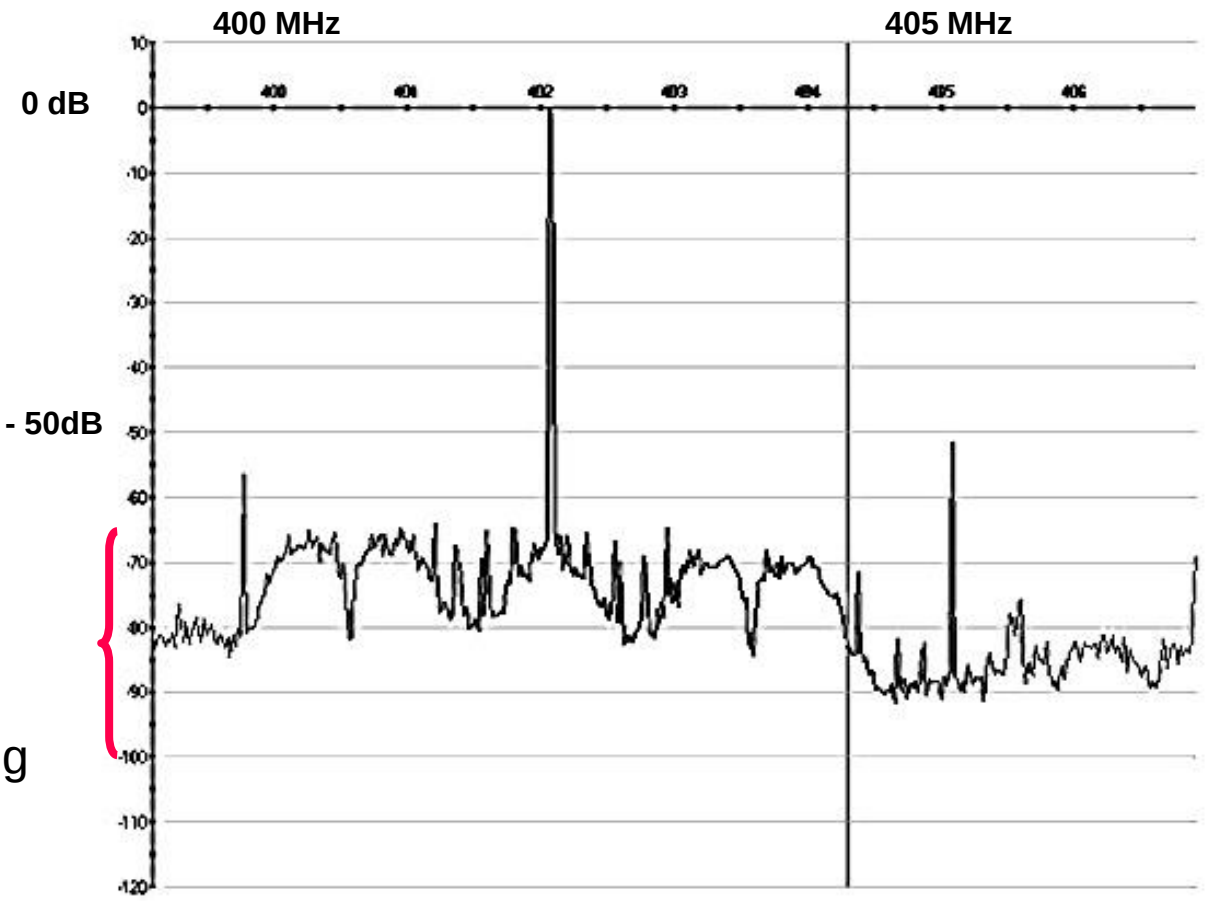
Spectrum measured in Location 3

Direct 100 m line of sight to noise source

Severe disturbance



Generally the noise level is up in the whole band from 10 to 35 dB

There are also strong peak disturbances.

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Performance comparison: SPS311 with Software Defined Radio vs. SPS220 with analog receiver

Test was made in the presence of severe telemetry link disturbance

	Type	Channeling Ratio [%]	Valid Raw Wind [%]	FER [%]	Range [km]	Height [km]
1	RS92-SGP / SPS311 SW-radio	100	100	0.1	127	31
2	RS92-SGP / SPS311 SW-radio	100	99	0.4	55	30
3	RS92-SGP / SPS311 SW-radio	100	100	0	109	28
4	RS92-SGP / SPS311 SW-radio	100	100	0	89	30
5	RS92-SGP / SPS220 radio	94	89	NA	61	33
6	RS92-SGP / SPS220 radio	98	96	NA	70	32

The **Channeling Ratio [%]** is a measure of the PTU data availability as reported by the DigiCORA MW31 Sounding System

The **Valid Raw Wind [%]** is reported by DigiCORA

RS92-GPS wind finding performance

Due to the lack of a good reference, the absolute accuracy of wind measurement in the test soundings cannot be determined

Earlier we have reported (CIMO UASI-1/IOC-1 meeting on March 3, 2004)

- Wind direction measurement reproducibility (1-σ stdev)
  - generally better than 2 degrees
  - in fast changing layers over a shorter period, better than 6 degrees
- The reproducibility for wind speed measurement is better than 0.2 m/s

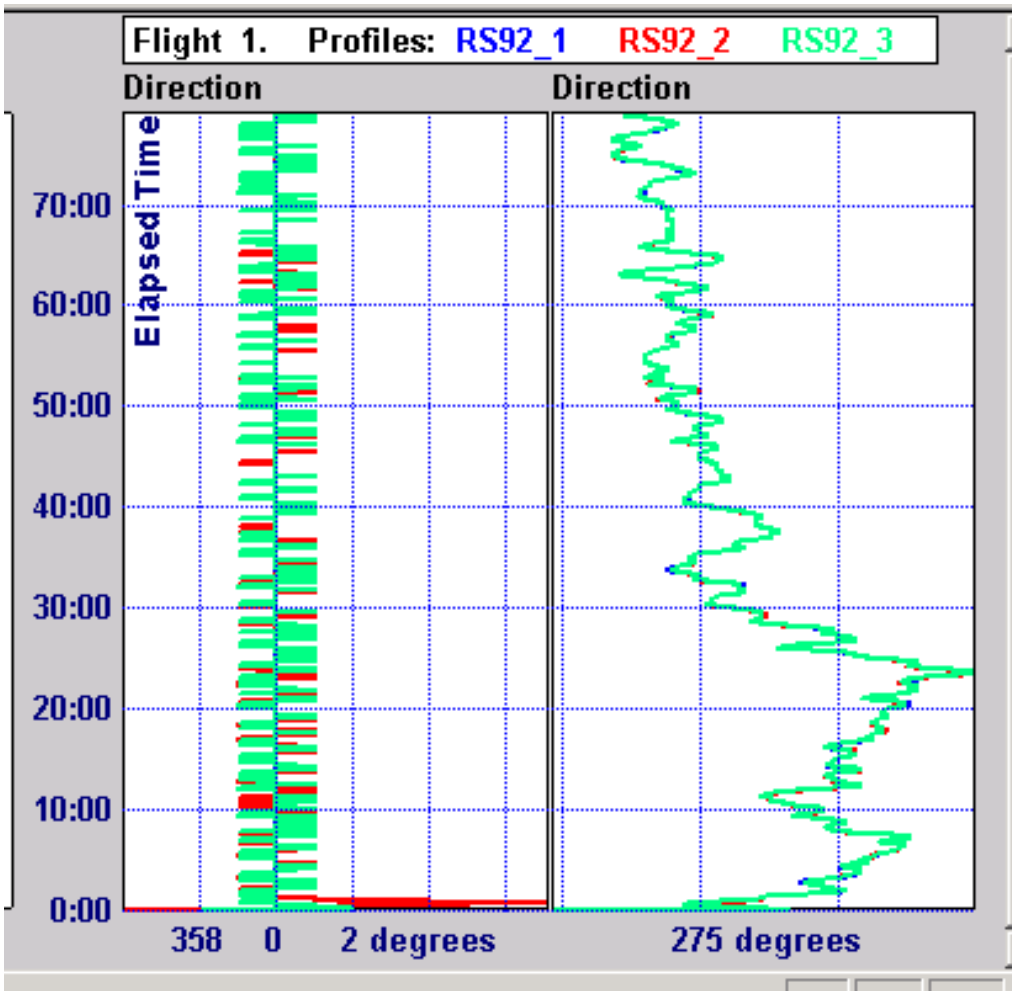
More recent test data show a similar level of windfinding performance

RS92-GPS wind finding performance, wind direction

Test was performed in Tenerife in November 2004 at Izana Observatory

Three RS92 radiosondes were flown on the same rig

Reproducibility of wind direction



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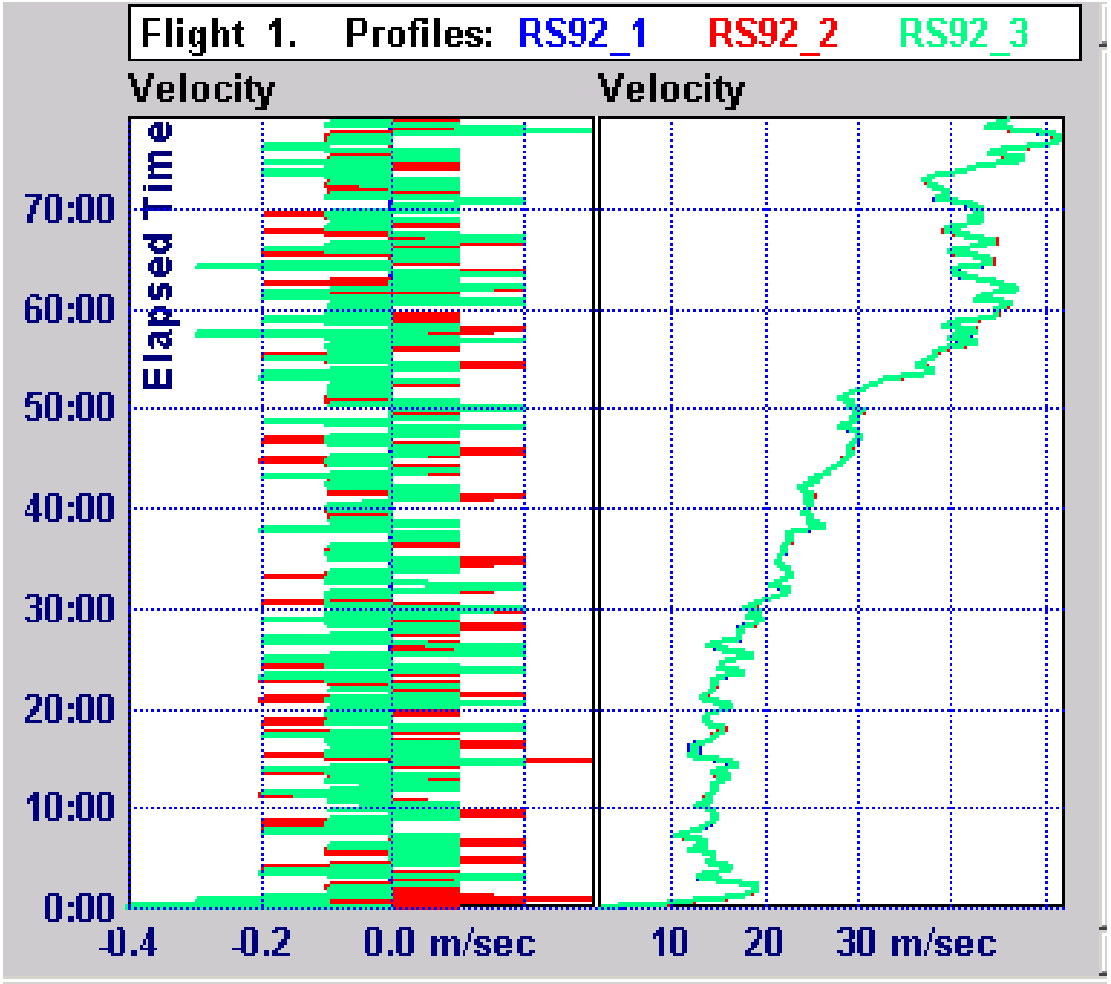
RS92-GPS wind finding performance, velocity

Reproducibility of wind velocity



Wind data availability in operational use

Analysis of all synoptic observations in 2004 with RS92-GPS radiosondes in the WMO Region VI Europe.

Missing winds to PTU top (%) =

sum of missing wind meters / sum of total reported wind meters to PTU Top

TEMP messages, Region VI Europe, Year 2004 **Vaisala RS92 GPS sondes**			
Month	**Missing winds to PTU top (%)**	**Month**	**Missing winds to PTU top (%)**
Jan	1.8	July	0.6
Feb	0.1	August	0.3
March	0.3	September	0.7
April	0.1	October	0.4
May	0.2	November	0.2
June	0.1	December	0.1

Considerable improvement is seen when compared to the results achieved with codeless GPS technology

Vaisala DigiCORA® MW31 GPS height calculation

DigiCORA® sounding software uses only autonomous radiosonde GPS signal for navigation, but it can also use the local GPS receiver as differential base station

Differential GPS calculation provides better accuracy when GPS positioning is used to calculate the GPS geopotential height

Calculation algorithms are based on WGS84 specifications

Differential GPS calculation will be available in the next DigiCORA software release

Difference of PTU-based and GPS-based geopotential heights

Figure A shows an example of the difference between PTU-height and GPS-height measurement

Figure B shows the result with a simulated -0.1 hPa constant pressure offset.

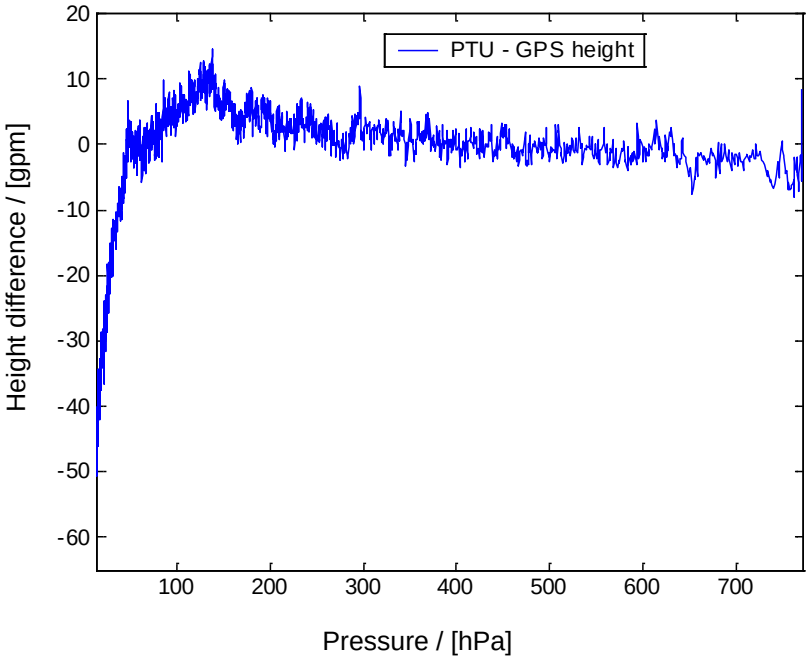


Fig. A

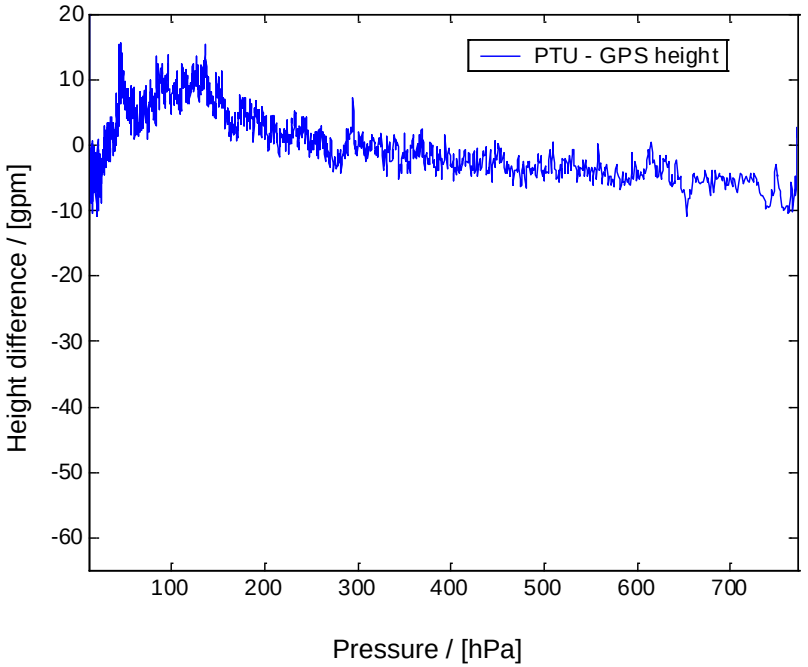


Fig. B

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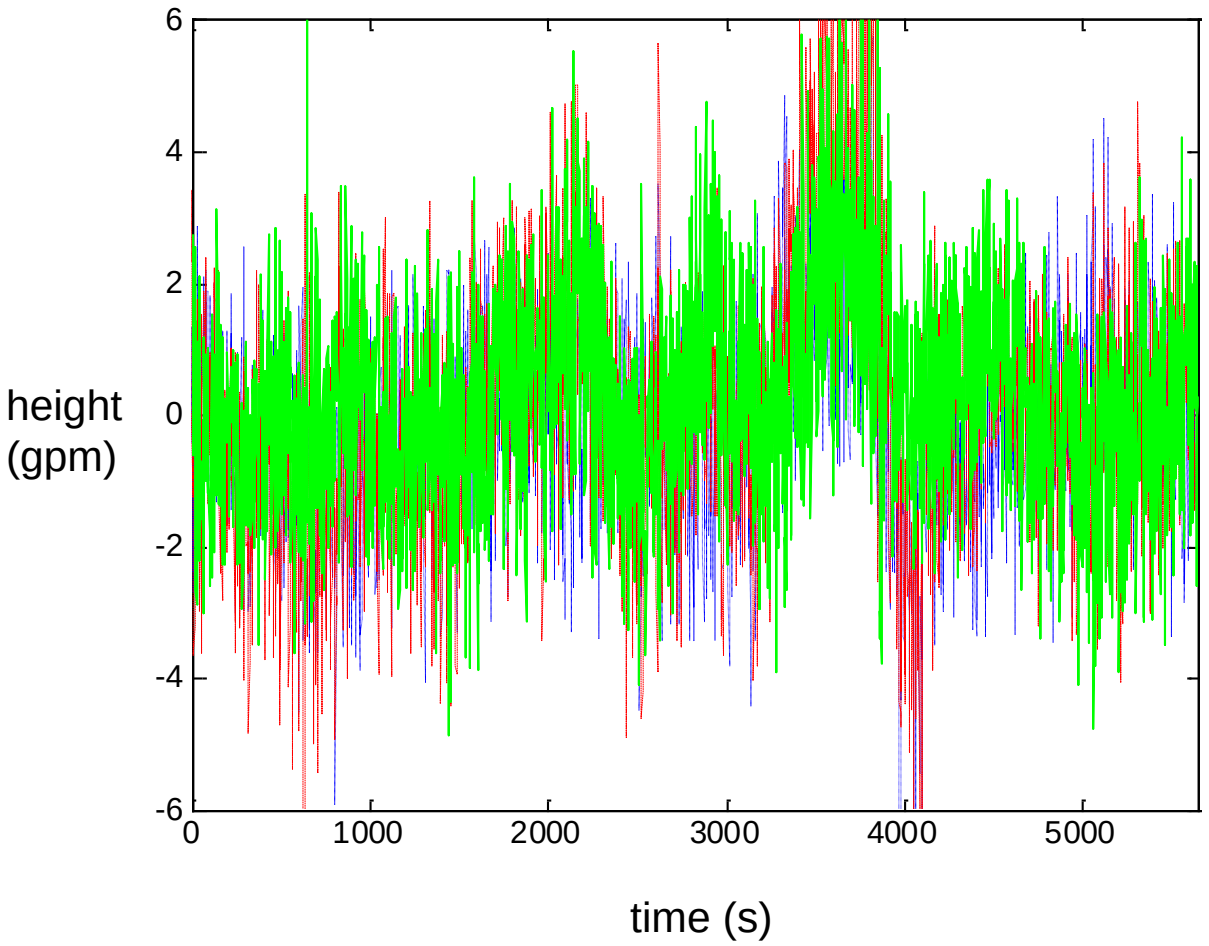
RS92-GPS geopotential height calculation reproducibility

Typical performance of three RS92 radiosondes measuring the same height

Pair differencies

A - B, A - C, B - C



Conclusions

Vaisala RS92-SGP radiosonde and DigiCORA® Sounding System MW31, featuring modern software defined radio technology and calculation algorithms, provide

- Overall excellent telemetry performance
- Reliable and very accurate wind speed and direction data
- Cabability to accurately calculate GPS-based height with good reproducibility

The system was used succesfully in Mauritius WMO Radiosonde Intercomparison

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Vaisala thanks

Spanish National Institute of Meteorology, Tenerife Izana Observatory

for their kind help in facilitating our tests

Thank you !

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