

*GRUAN Workshop, Lindenberg, 27 February 2008*

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# **Radiosonde instrumentation: Issues and challenges**

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# Overview

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The straight forward task for GRUAN:

Pressure (or altitude)

Temperature

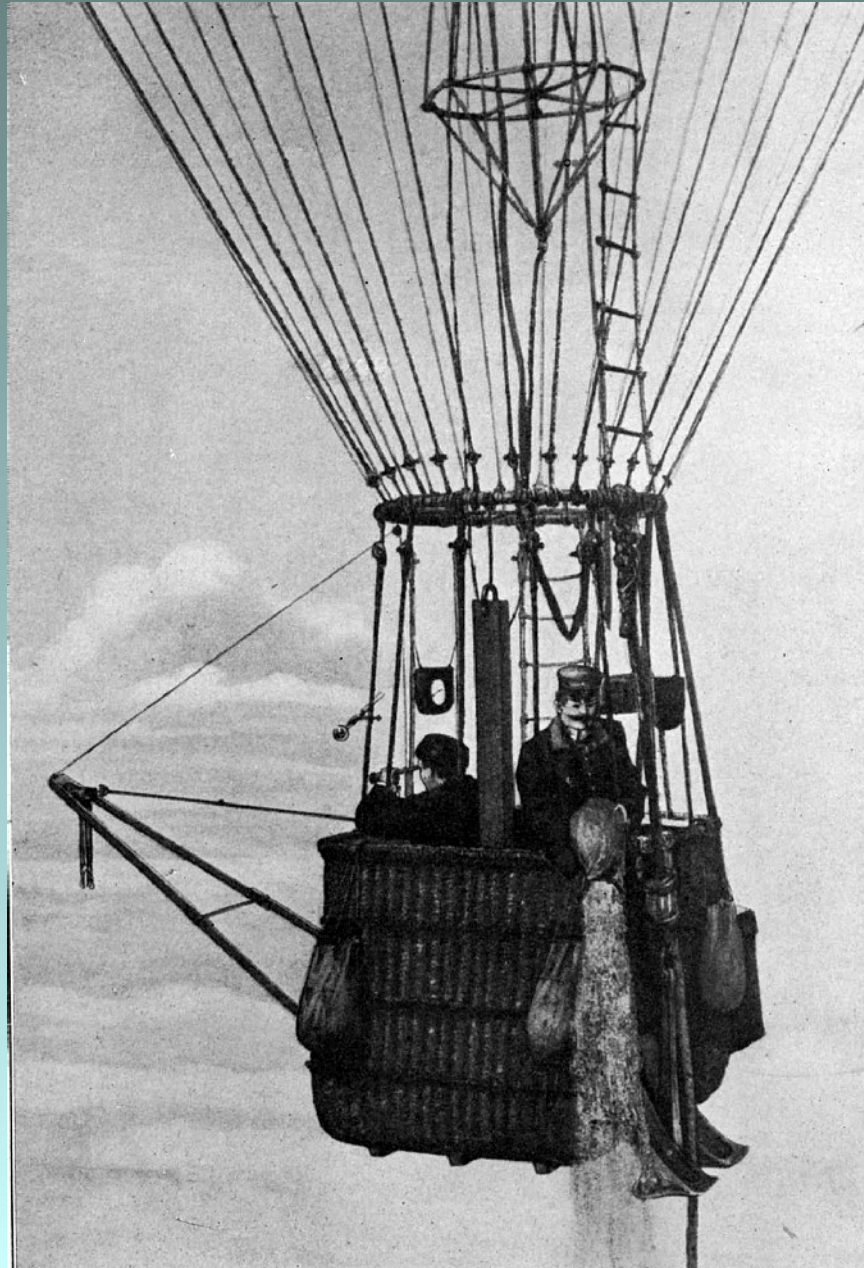
The GRUAN challenge:

Water vapor

The GRUAN free-bee:

Ozone

# *The straight forward measurements*



# *Pressure*

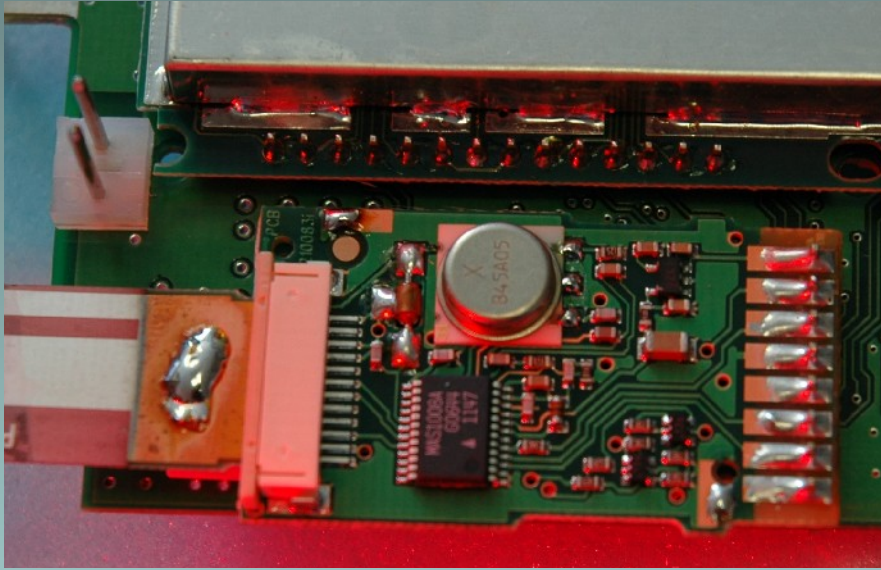
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Capacitive pressure sensor

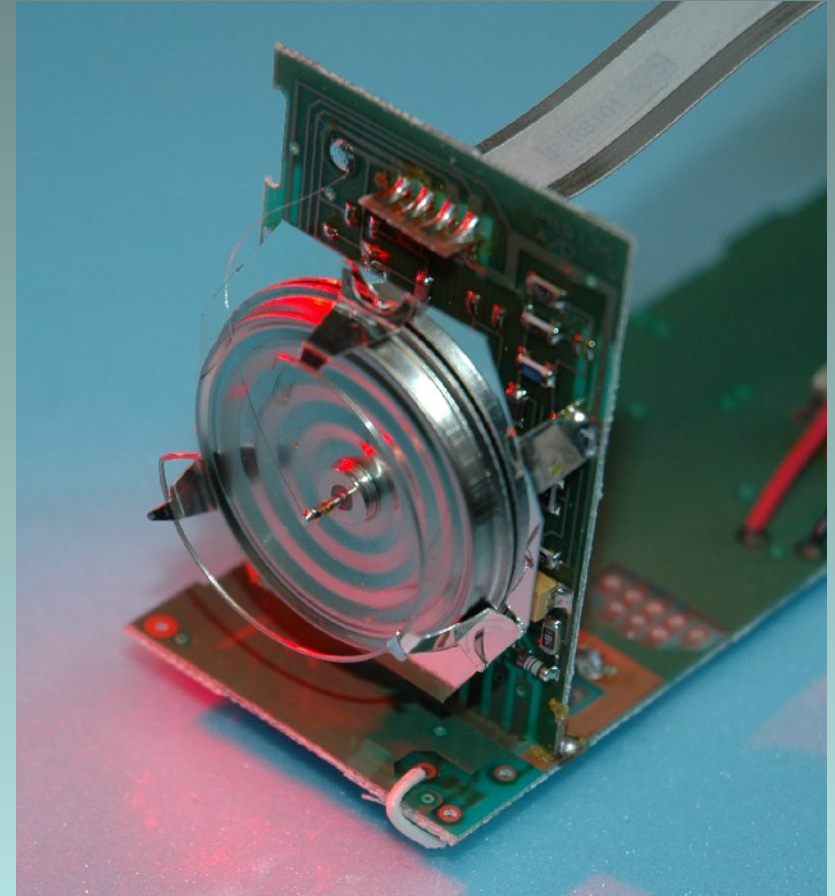
Hypsometer

GPS

# *Pressure: Capacitive pressure sensor*



**Vaisala  
RS92**



**Vaisala  
RS80**

# *Pressure: Capacitive pressure sensor*

Minor influence due to internal temperature measurement, lag on fast descent

Needs accurate ground reference  
(calibration check and offset correction)

But altitude error increases with height



# *Pressure: Hypsometer*



# *Pressure: Hypsometer*

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Temperature measurement only

Relative error constant with altitude

Quality of water and operational issue

Limited use on descent

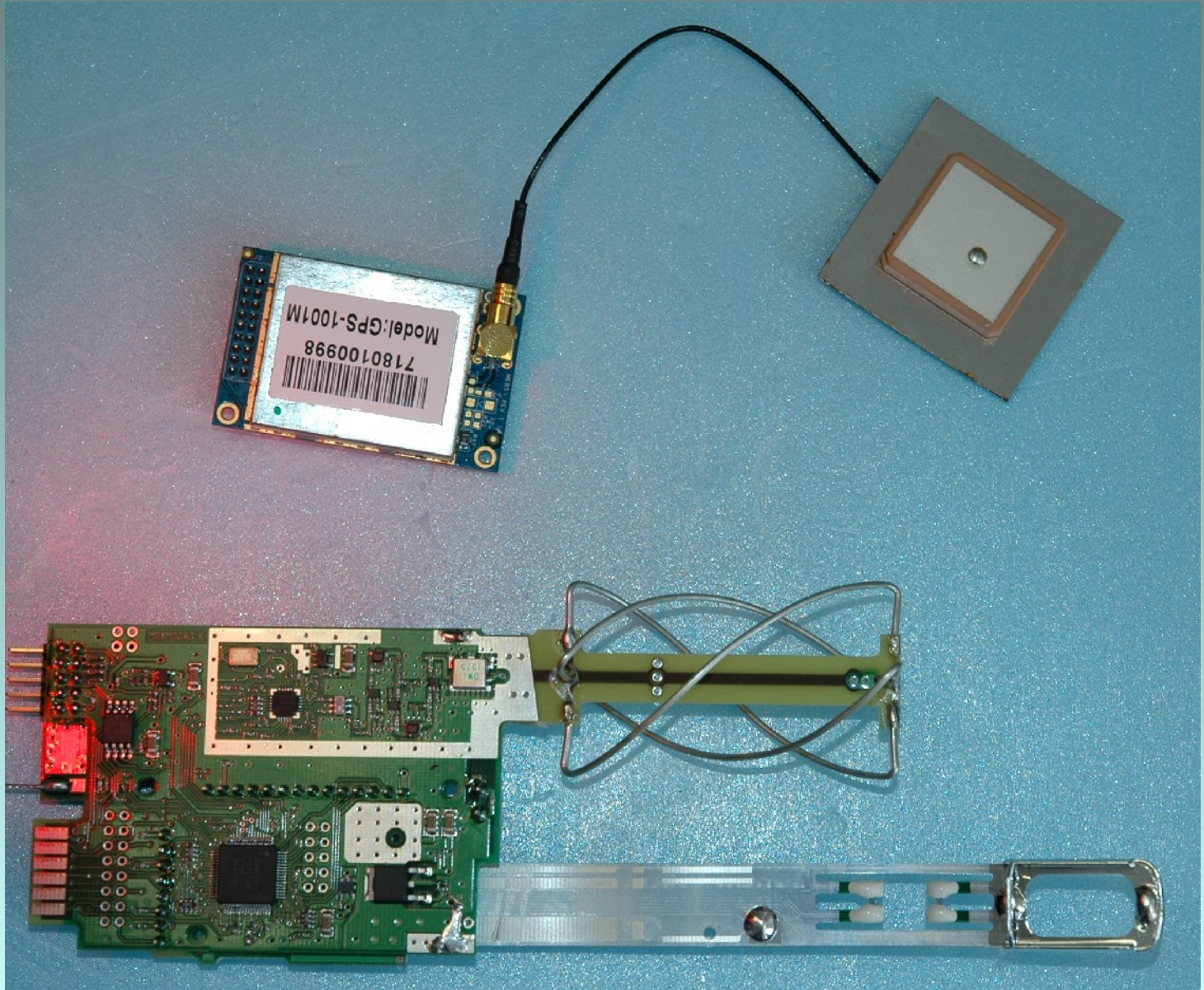
Needs accurate ground reference for check



# Pressure: GPS

Meisei  
&  
EnSci

Vaisala  
RS92



# *Pressure: GPS*

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Inverse of hypsometric equation

Limited by accuracy of air temperature measurement (and humidity measurement)

Algorithm has to be robust

Loss of signal means significant increase in derived pressure

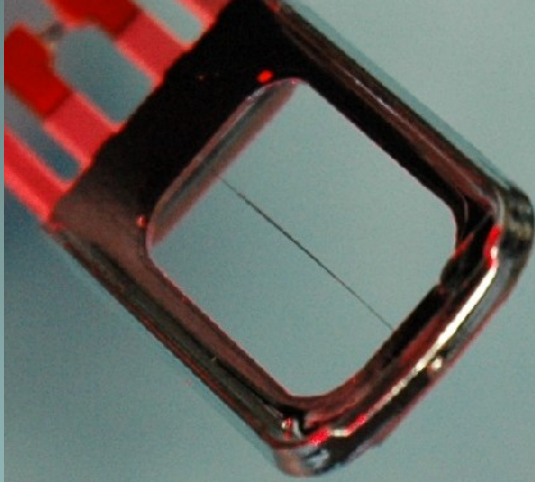
Needs accurate ground reference for initialization

Wind information is free

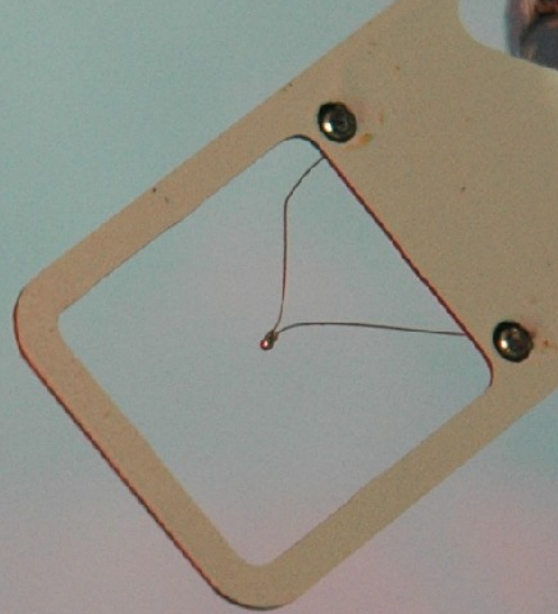


# Temperature

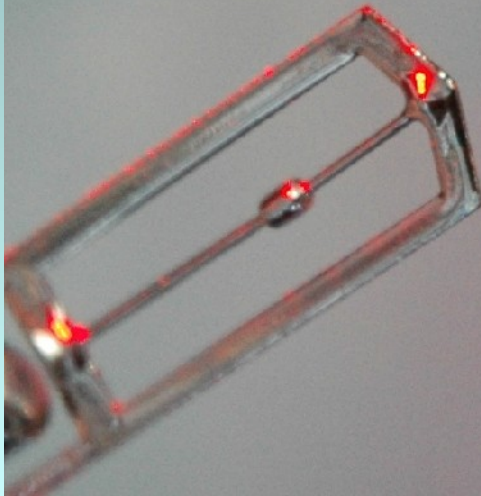
Vaisala  
RS92



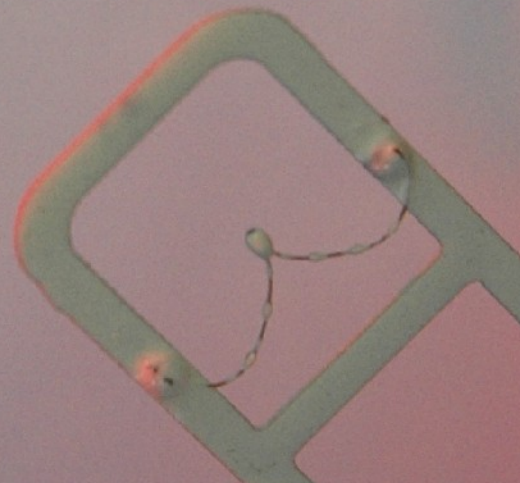
Meisei  
RS-06



Vaisala  
RS80



Modem  
M2K2



# *Temperature*

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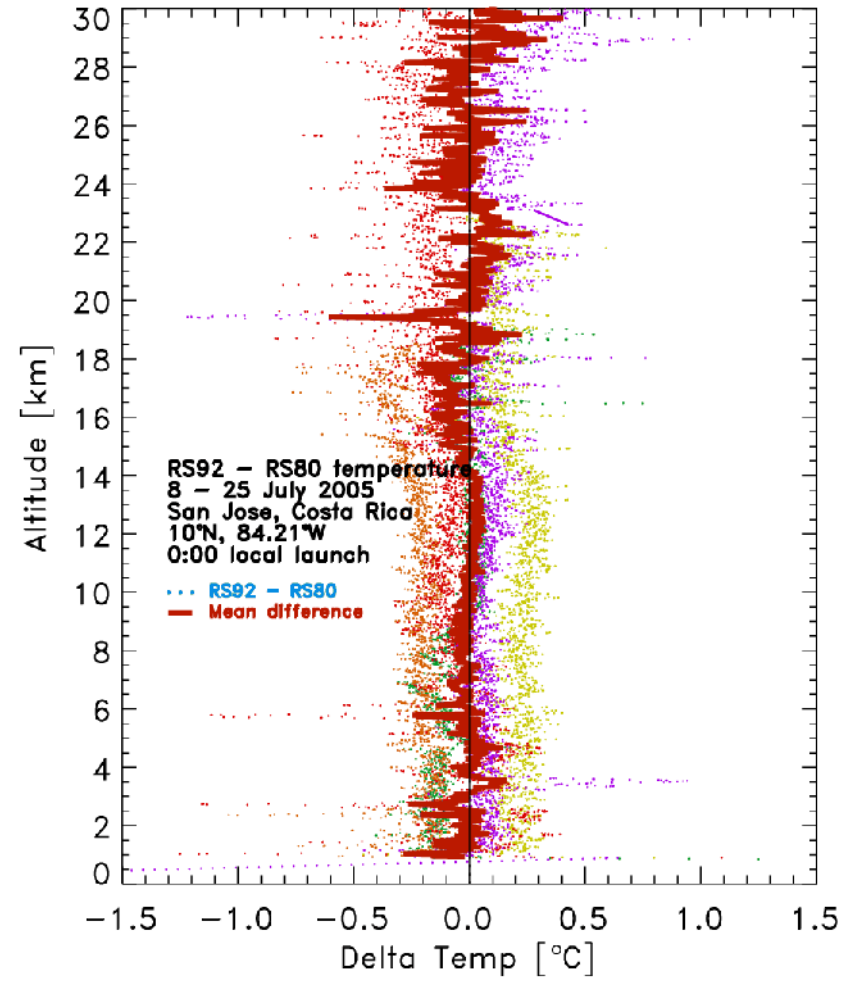
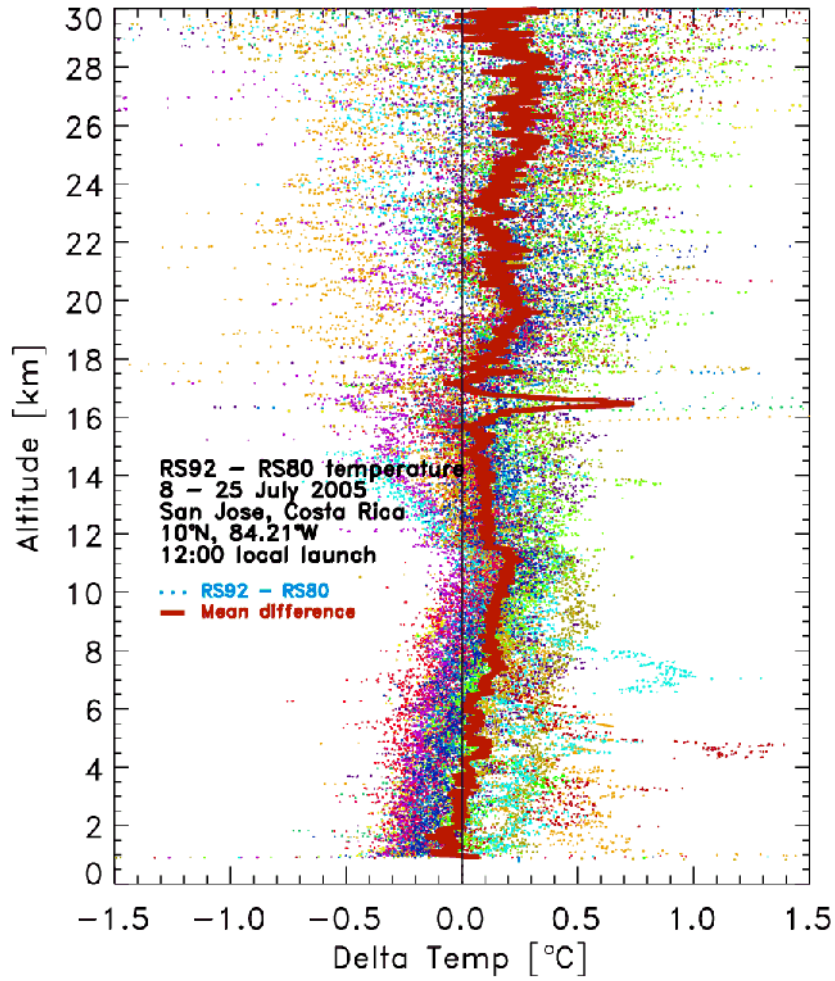
Need accurate evaluation of radiation error !!!  
(sensor size)

Time response (sensor size)

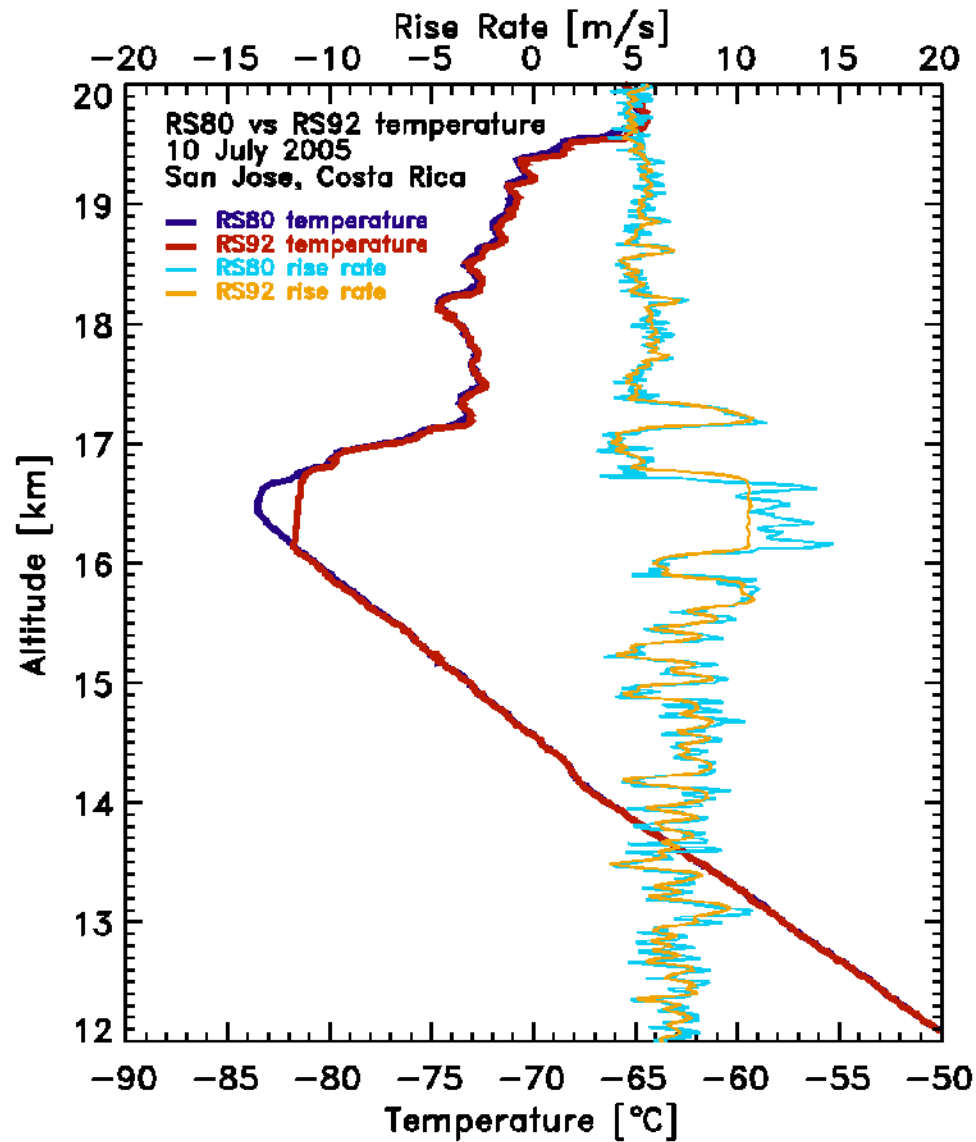
Cloud penetration (sensor size)

Processing algorithms

# Temperature



# Temperature







**Water vapor**

# *The hard measurement*



*Henry Coxwell and James Glaisher  
5 September 1862*

# *Water vapor*

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## **GRUAN challenge:**

**Currently there exists no commercial sounding instrument that comes close to meeting the GRUAN specifications!**

# *Water vapor*

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**BUT**

**There may be a few research instruments  
that might fill the void**

# Water vapor: Sensors

## Polymer capacitive sensor:

Vaisala RS92

Graw  
Internet  
Meisei  
Modem  
Sippican

FN

## Chilled mirror Frostpoint sensor:

Meteolabor

CFH

## Research Instruments:

FLASH

TDL

a few others

## Carbon resistive sensor:

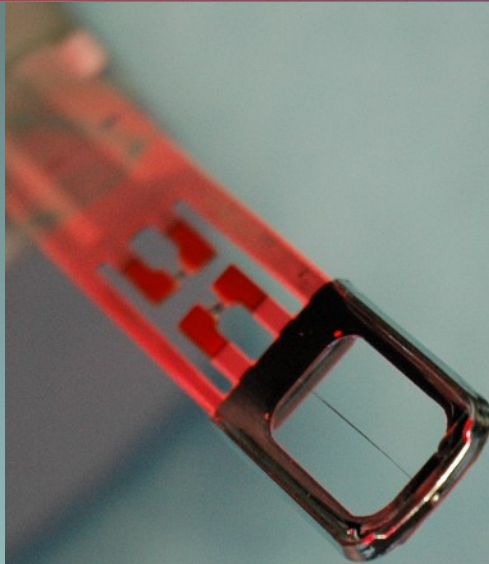
Sippican

Meteolabor

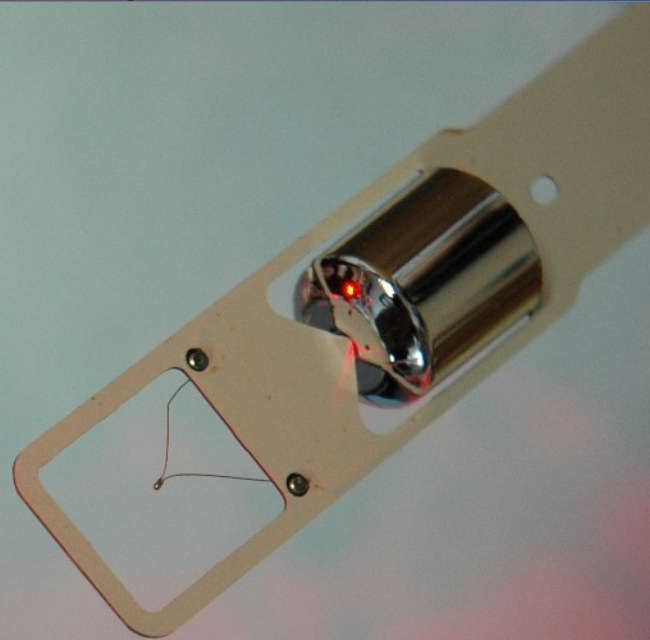


# Water vapor: Polymer sensors

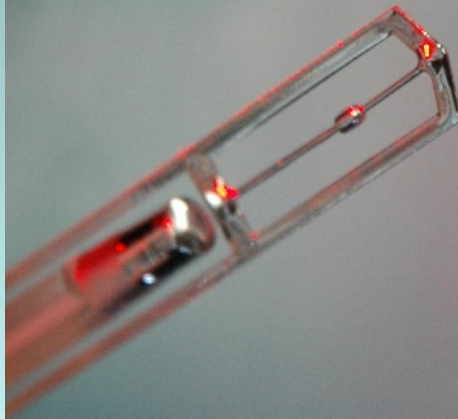
Vaisala  
RS92



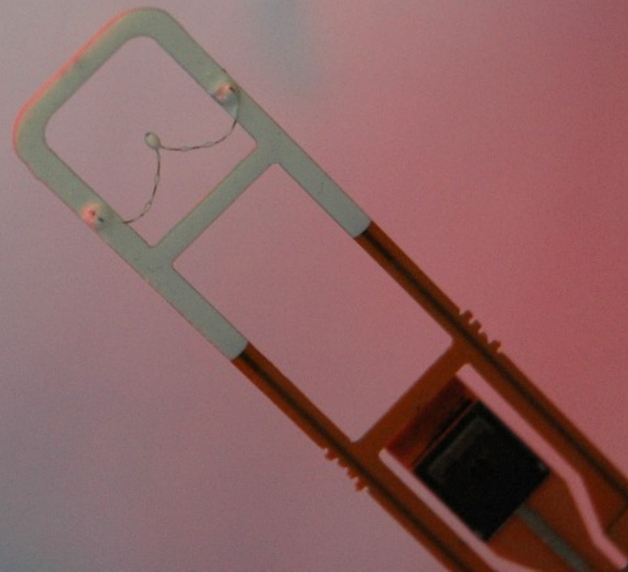
Meisei  
RS-06



Vaisala  
RS80



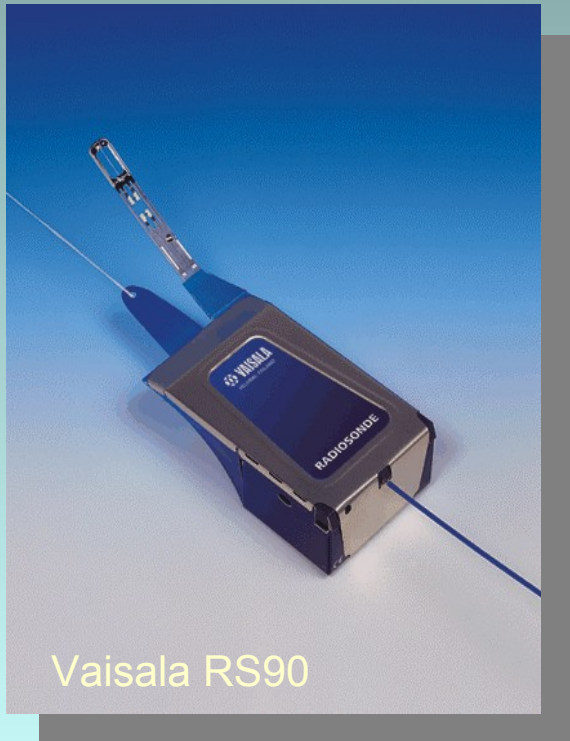
Modem  
M2K2



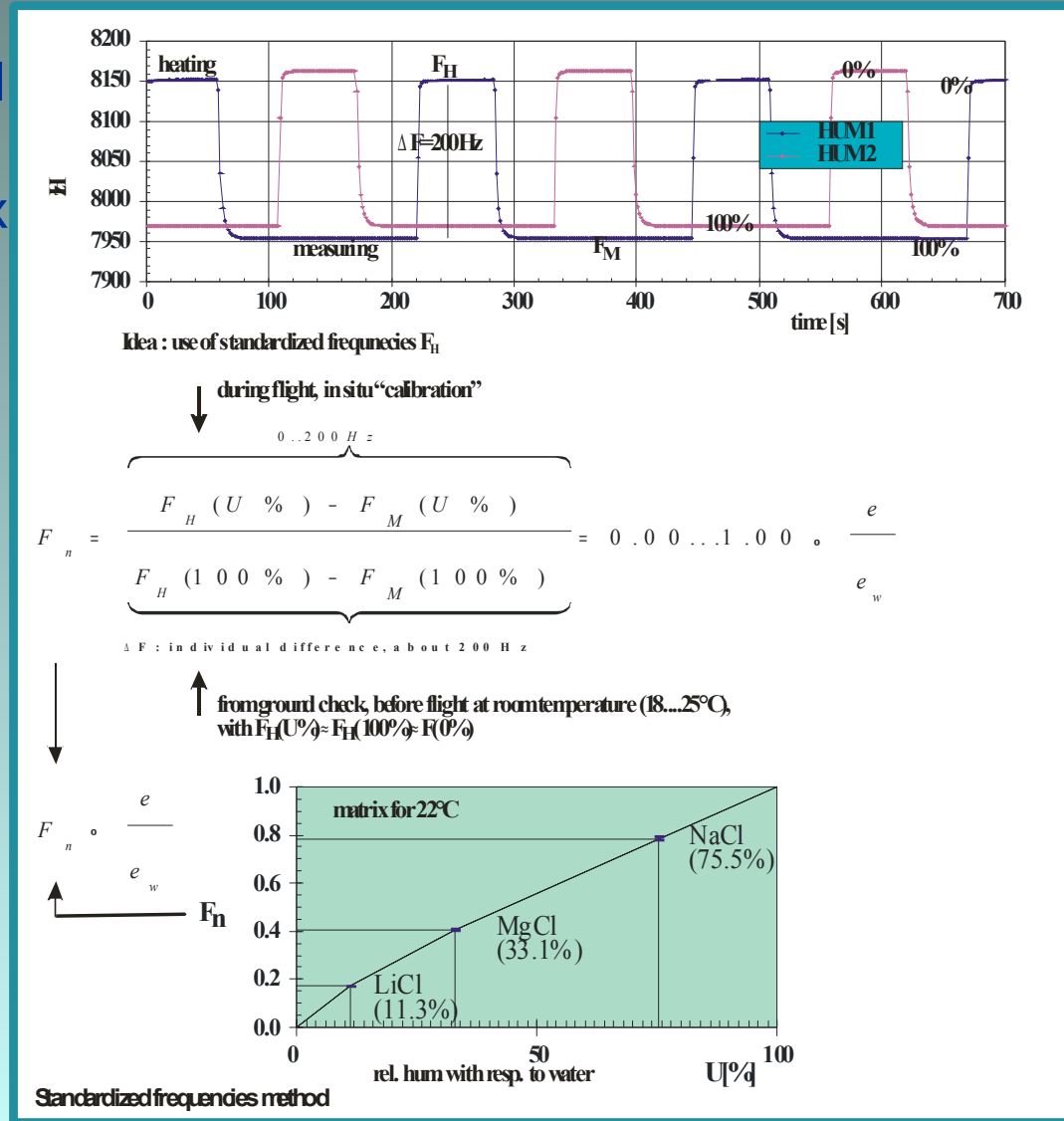


# Water vapor: Polymer sensors FN method

In dual sensor sonde (RS92)  
 make use of heated sensor signal  
 as baseline measurement  
 → Relate this to calibration matrix



Vaisala RS90



# Water vapor: Polymer sensors FN method

Calibration at different RH values:

0%RH: Molecular sieve

11%RH: LiCl

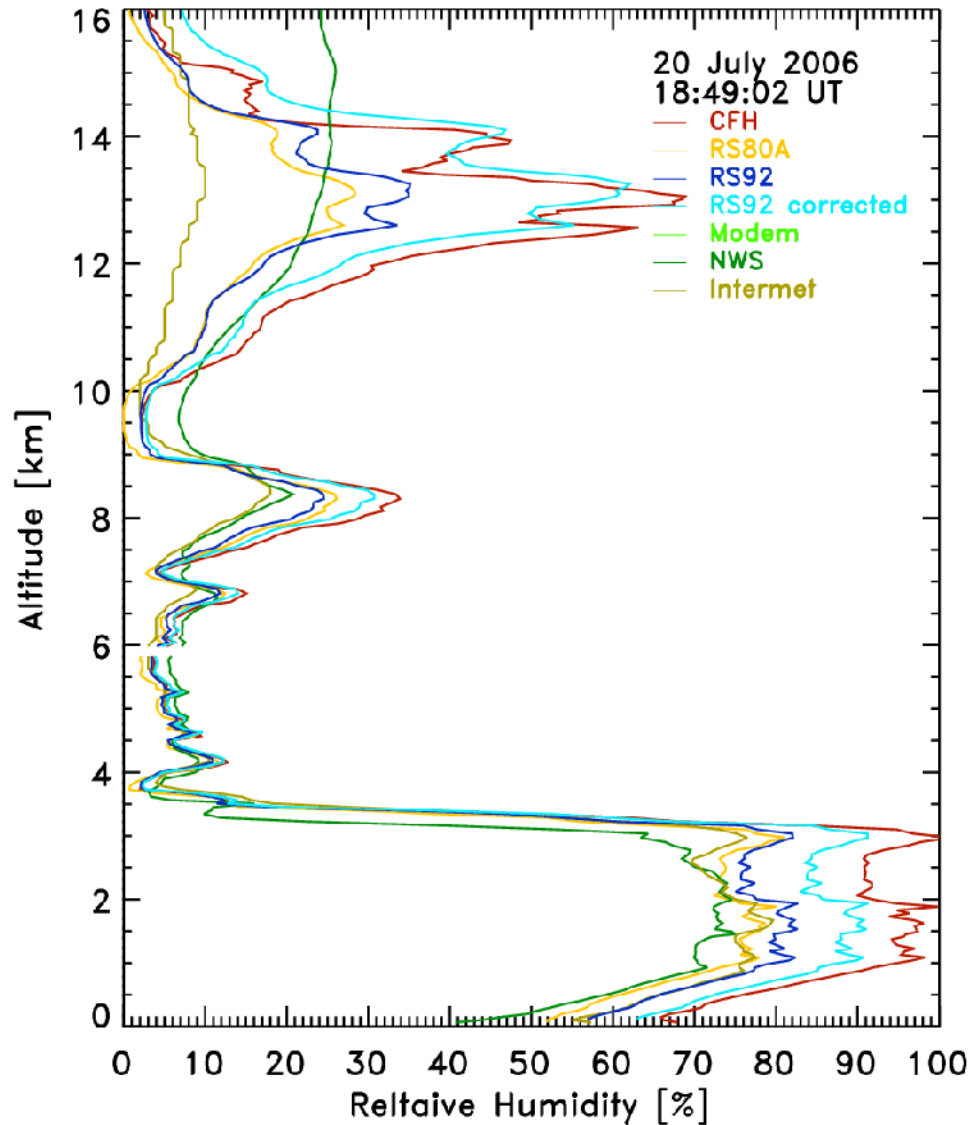
33%RH:  $\text{MgCl}_2$

75%RH: NaCl

100% RH: double distilled  
Water

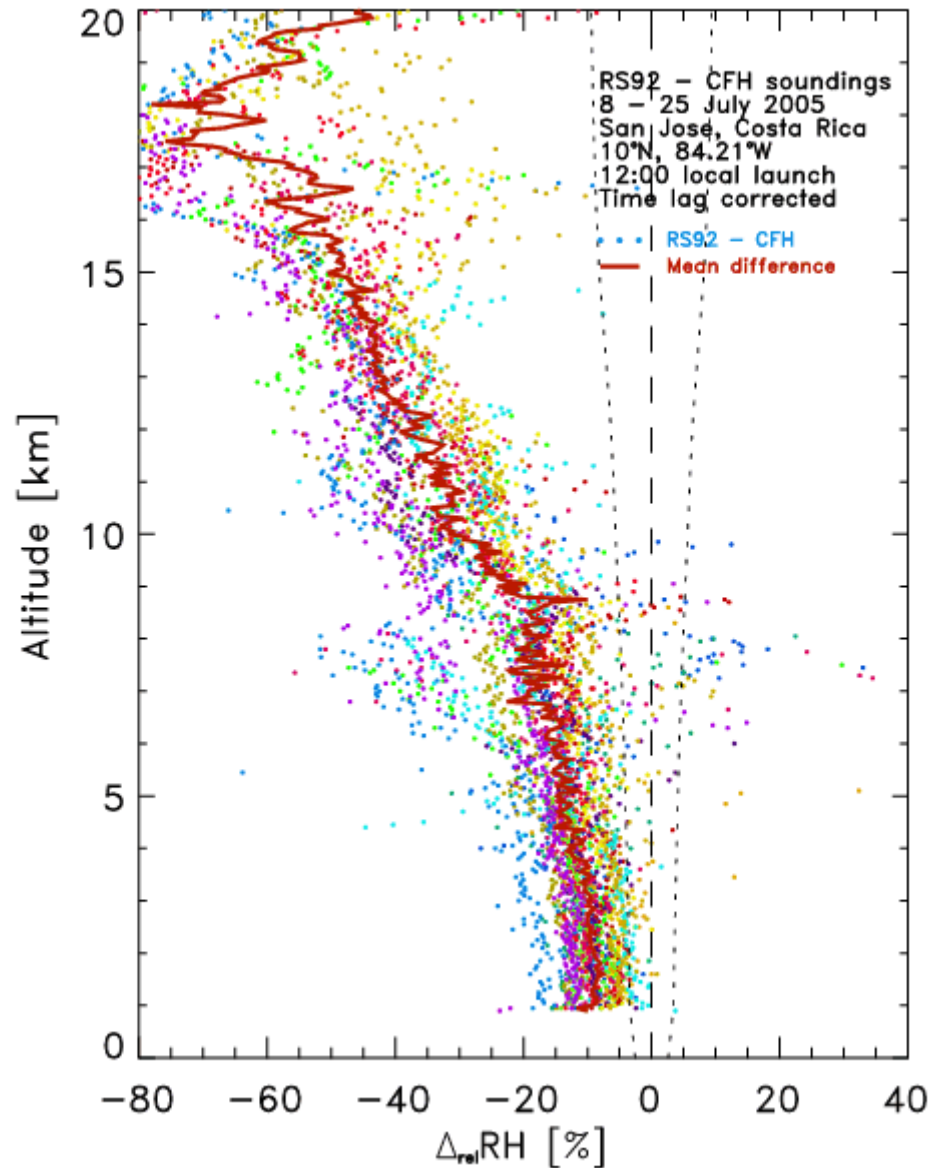


# Water vapor: Polymer sensors



WAVES 2006  
Howard University  
Beltsville, MD

# Water vapor: Polymer sensors



Vaisala RS92  
Radiation error:

# *Water vapor: Frost point*

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CFH is reference instrument

Snow White is useful, but difficult to interpret



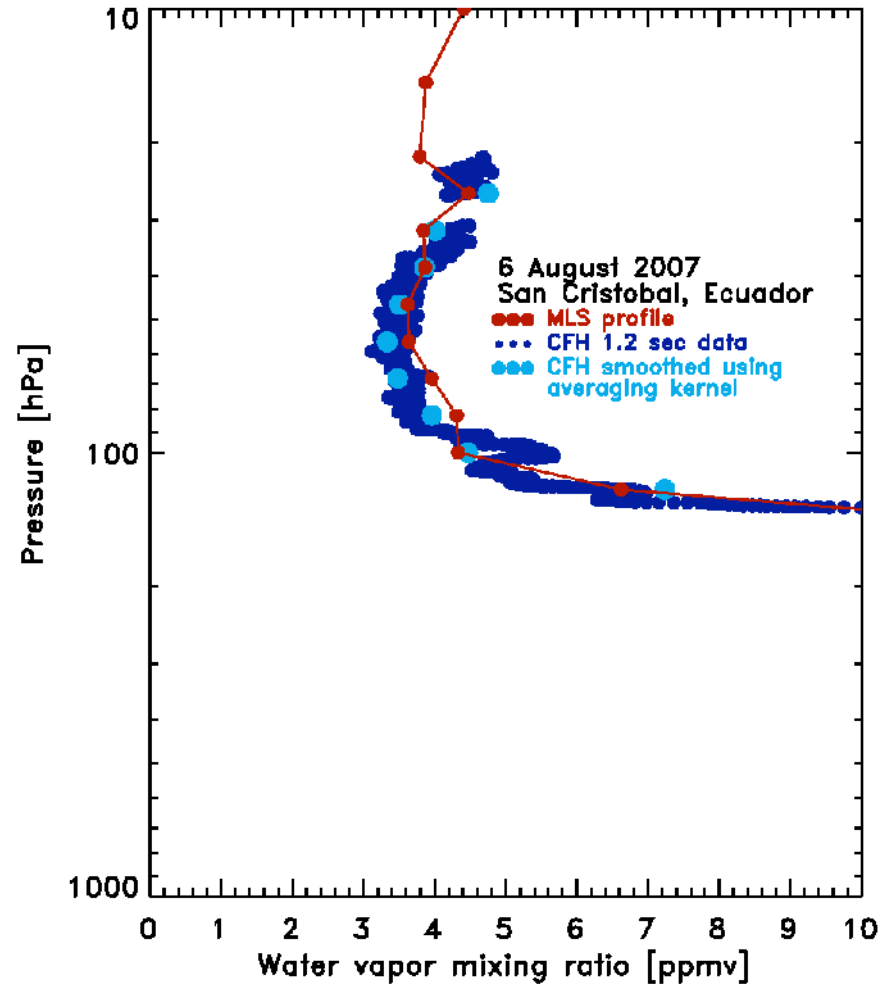
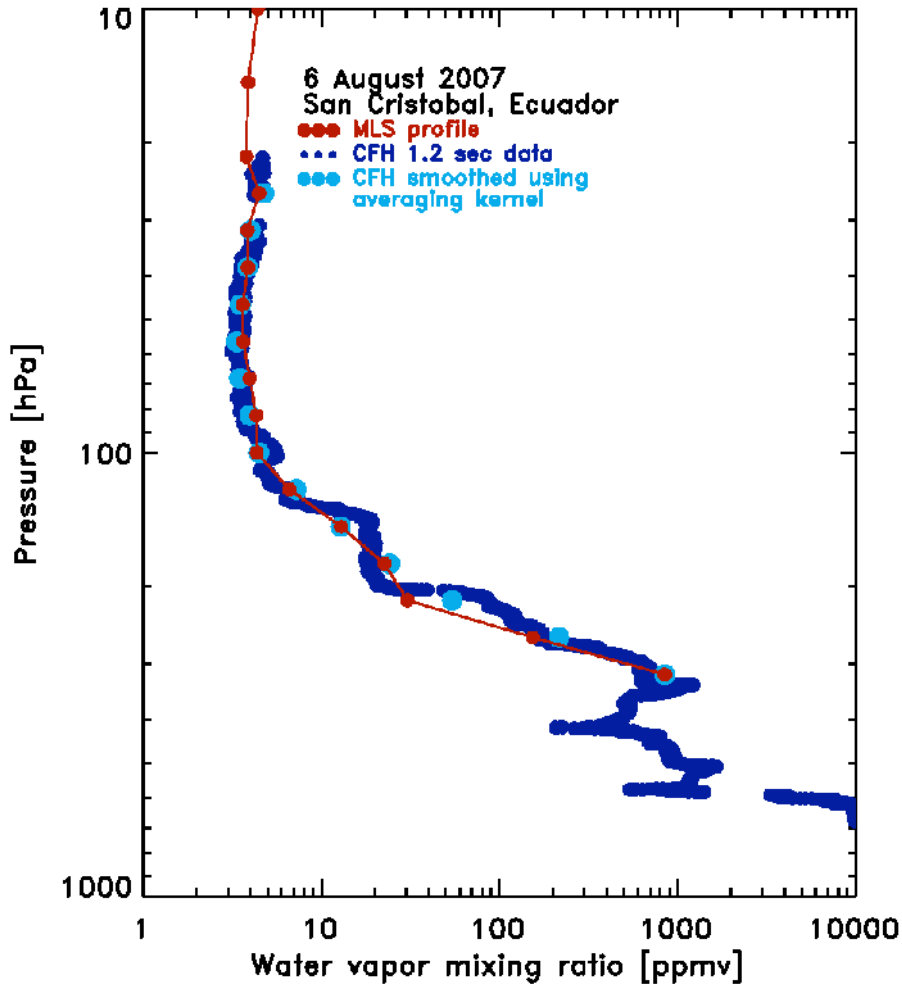
# *Water vapor: Frost point*



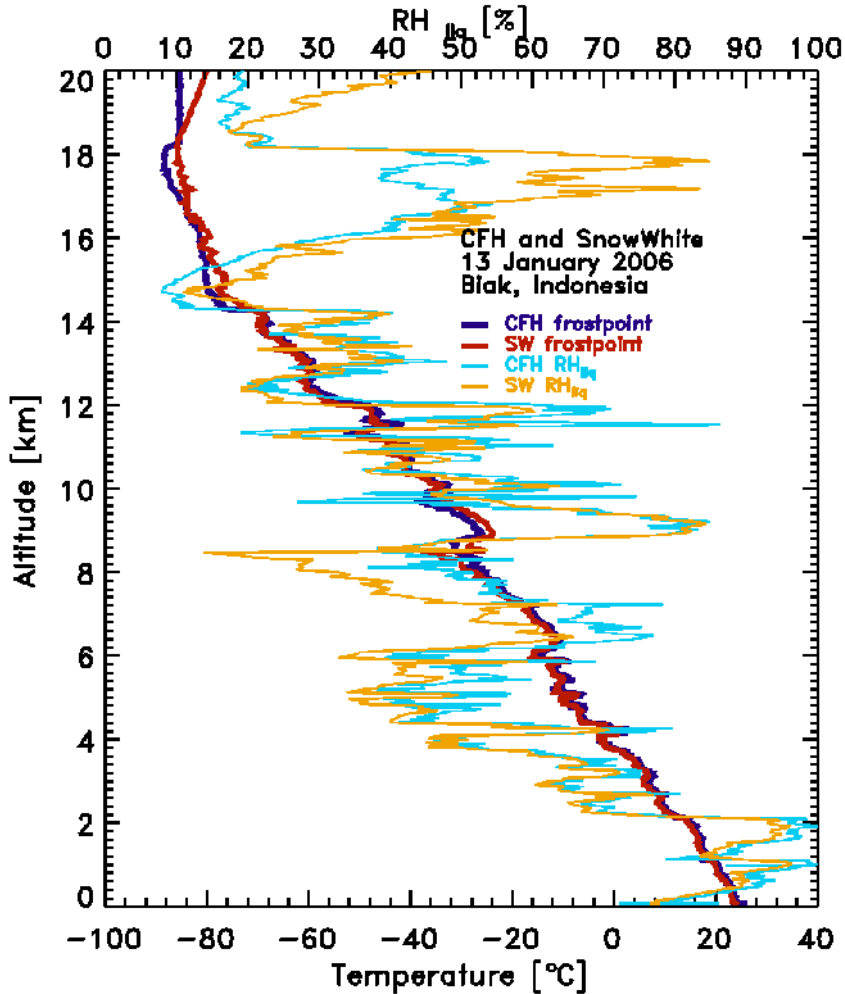


# Water vapor: Frost point

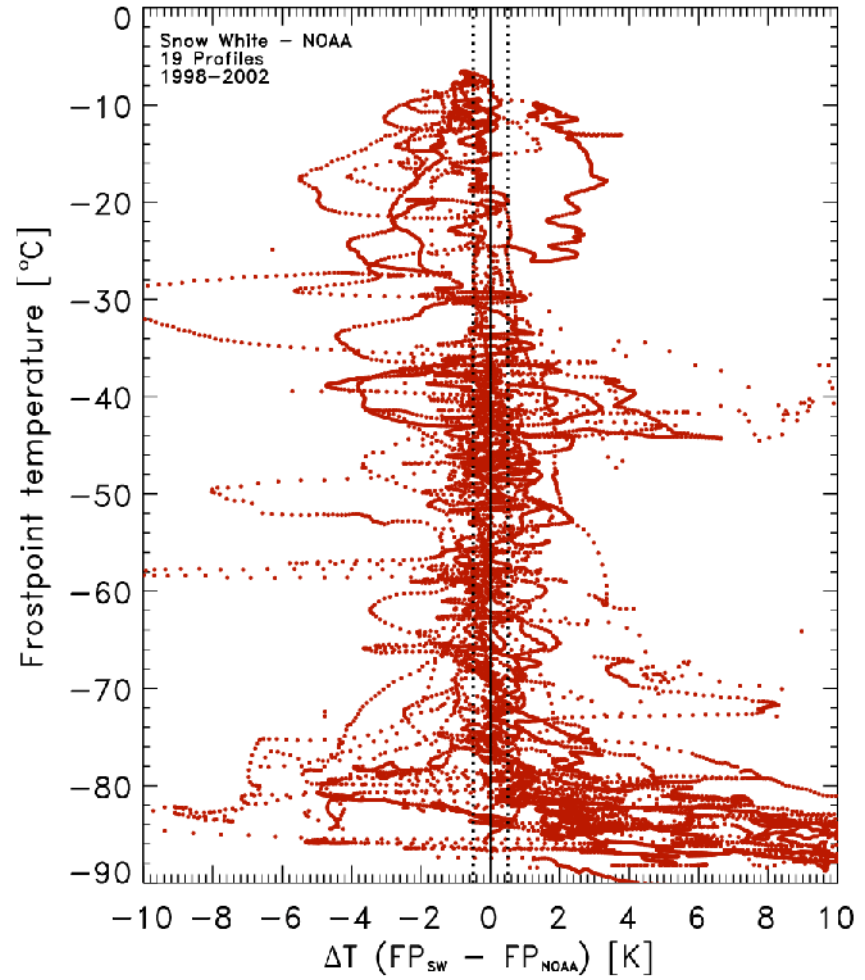
## Comparison with AURA/MLS



# Water vapor: Frost point

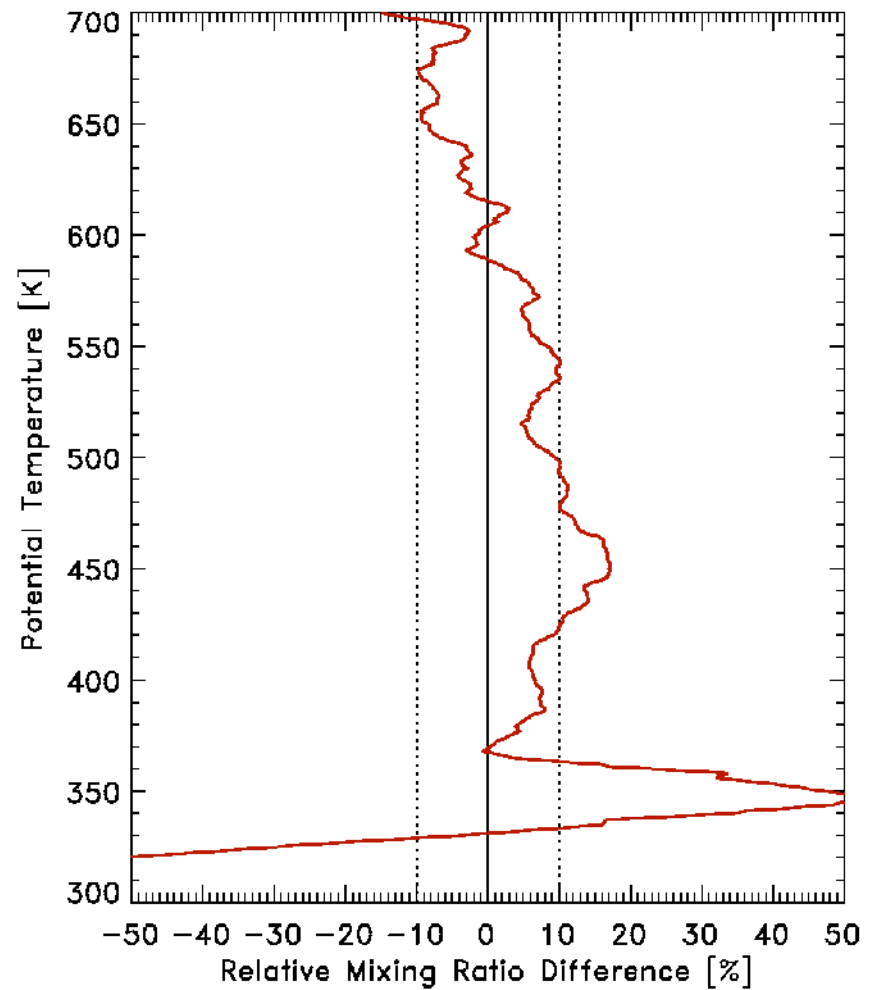
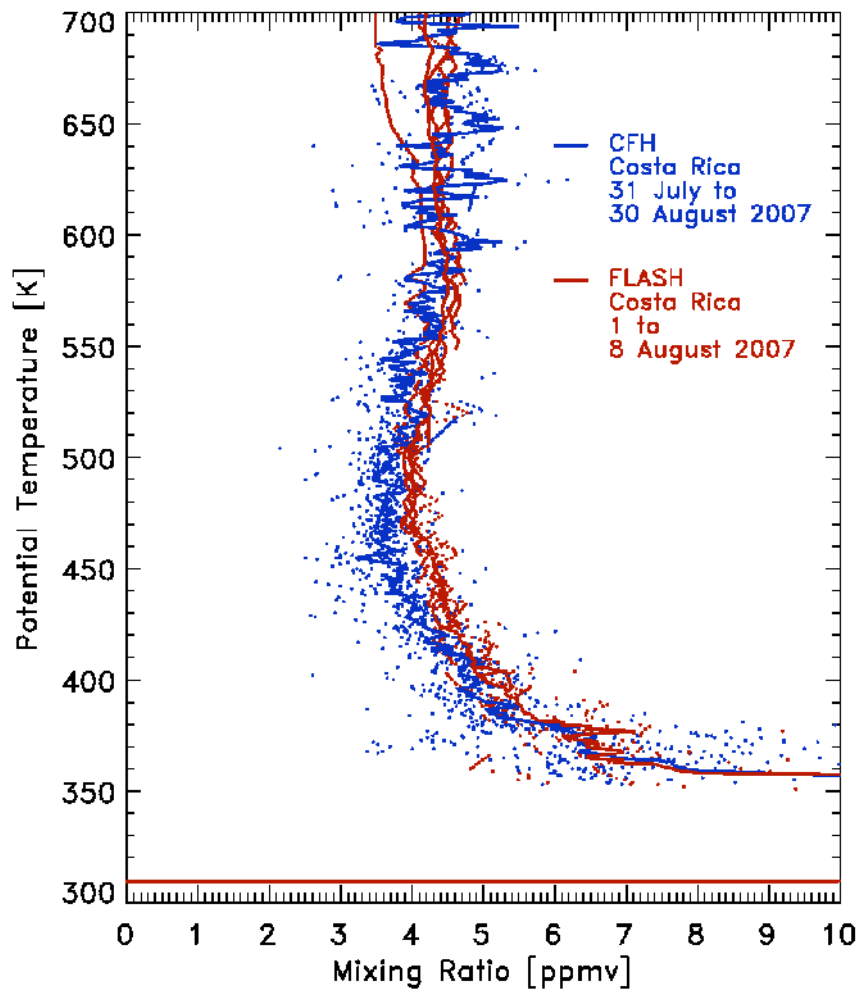


Example profiles



Statistical comparison

# Water vapor: FLASH



# *Water vapor: Options*

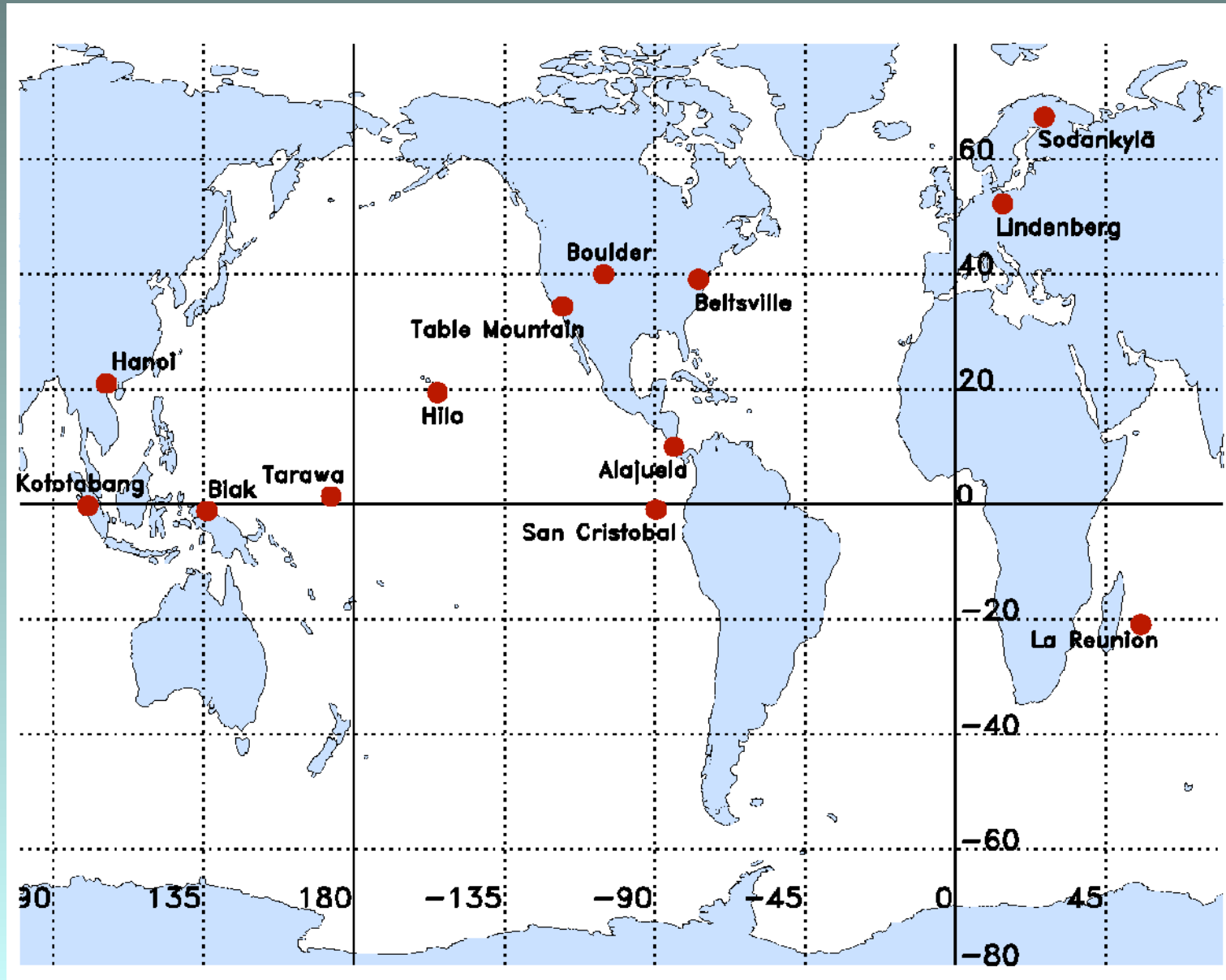
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Which sensor(s) to use?

Vaisala has the highest quality polymer sensor  
But only good for tropospheric measurements  
And it needs corrections (big drawback for  
climate studies)

CFH is only stable instrument for tropospheric and  
stratospheric work  
But needs to be commercialized to increase  
availability and reduce cost

# *Water vapor: Sites with CFH capabilities*



# *Sensor task list*

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## Pressure:

- Need to establish and document the accuracy of the sensors used

## Temperature:

- Need to establish and document the accuracy of the sensors used
- GRUAN must establish and document the radiation correction for the sensors used

## Water vapor:

- Need to deal with large number of low quality soundings interspersed with small number of high quality soundings.
- Need to support the development of high quality operational instrument(s)
- Need to establish and document required correction schemes for low cost sensors



# *Sensor task list*

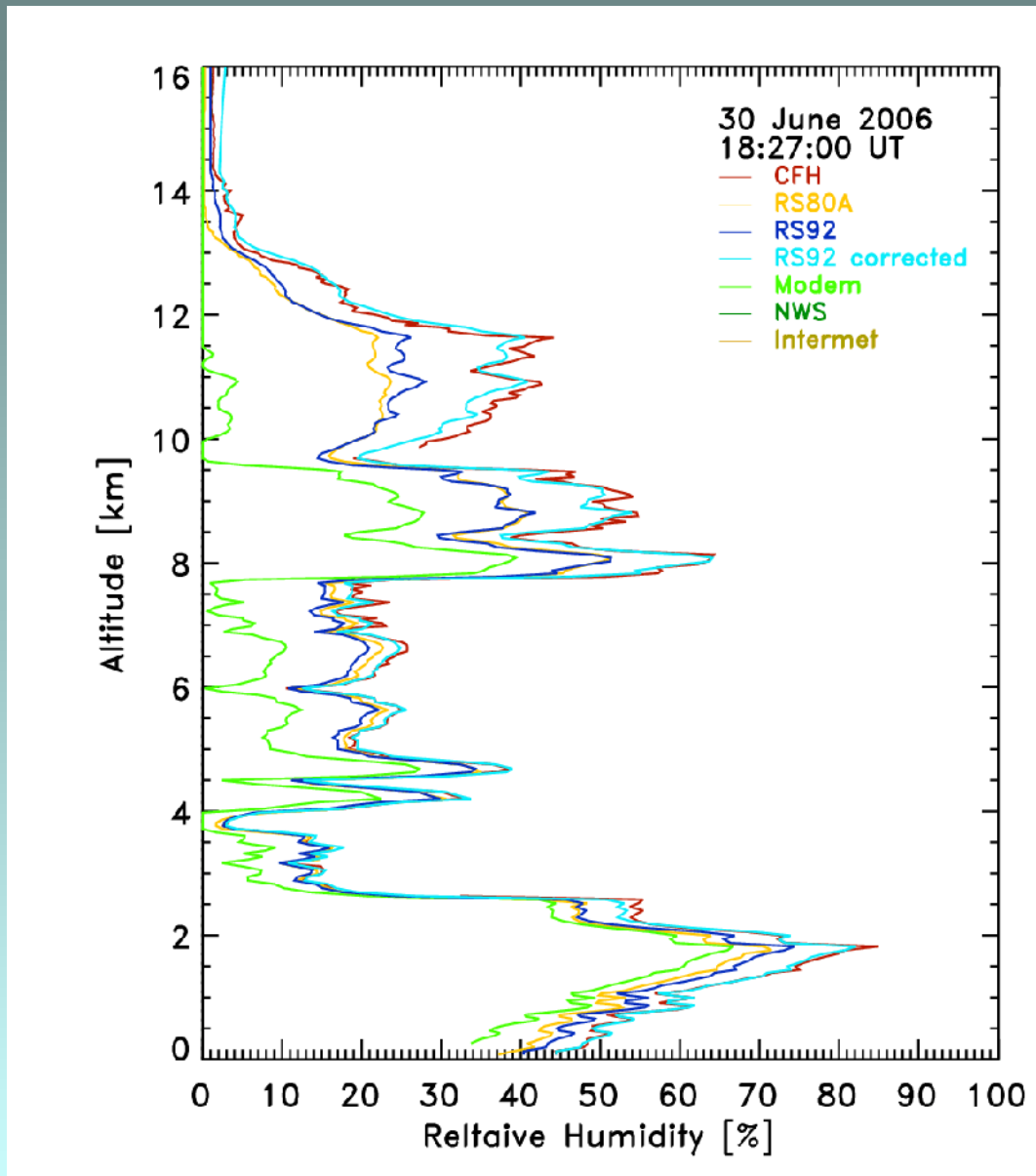
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All:

- Need to have full understanding of processing algorithms
- Use cross checks of various sensors
  
- Should to use descent data as well  
(For verification and reality check. These data are free!)



# Water vapor: Polymer sensors



WAVES 2006  
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