



## R23 and its replacement

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2.2. A fully equipped GRUAN site shall make at least double, and preferably triple, redundant measurements of all GRUAN priority 1 and 2 ECVs<sup>3</sup> and, specifically:

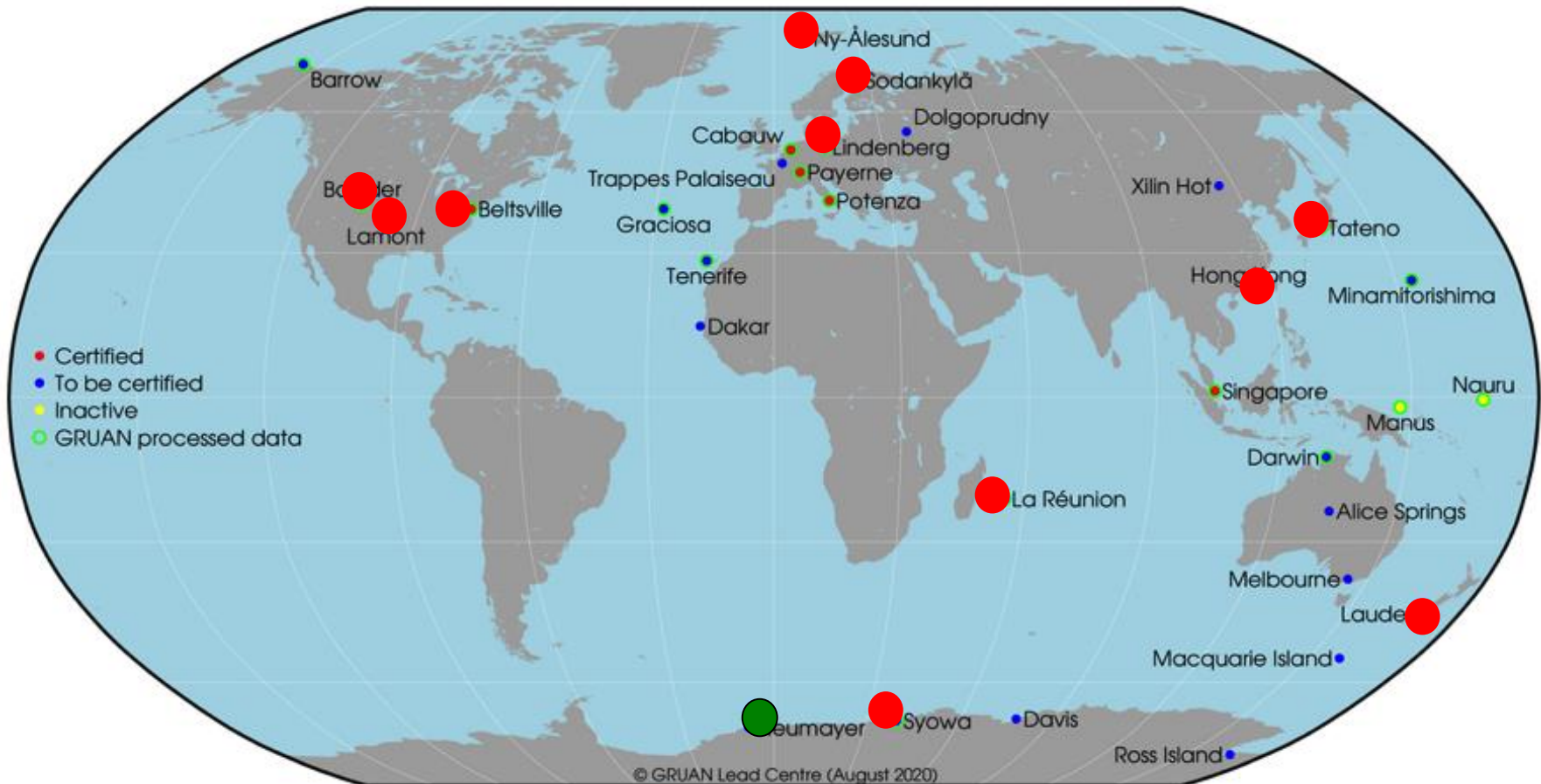
- i) Four times daily radiosonde measurements of temperature and pressure to 30 km, and water vapour in the troposphere, also submitted in NRT to the WMO Information System (WIS);
- ii) Weekly ozone profile measurements;
- iii) Monthly water vapour profile measurements to ~30 km; and
- iv) Hourly observations of integrated precipitable water vapour.

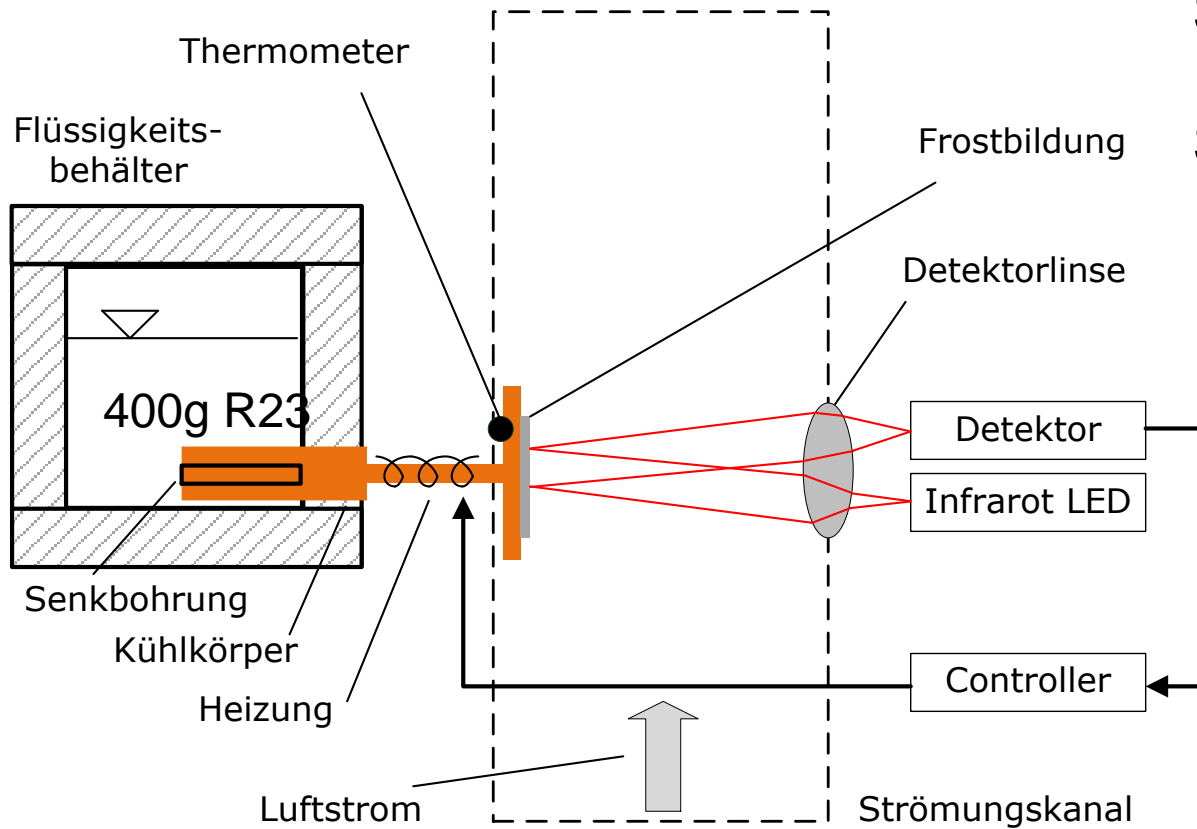
2.3. Minimum requirements for a GRUAN site include:

- i) Weekly radiosonde measurements of temperature and pressure to 30 km and humidity in the troposphere; and
- ii) Monthly water vapour profile measurements to ~30 km. Where several GRUAN sites are located sufficiently close to each other, where the sufficiency shall be guided by scientific studies, individual site flight schedules should be coordinated to share the burden of making these measurements.
- iii) At least twice daily observations of integrated precipitable water vapour.

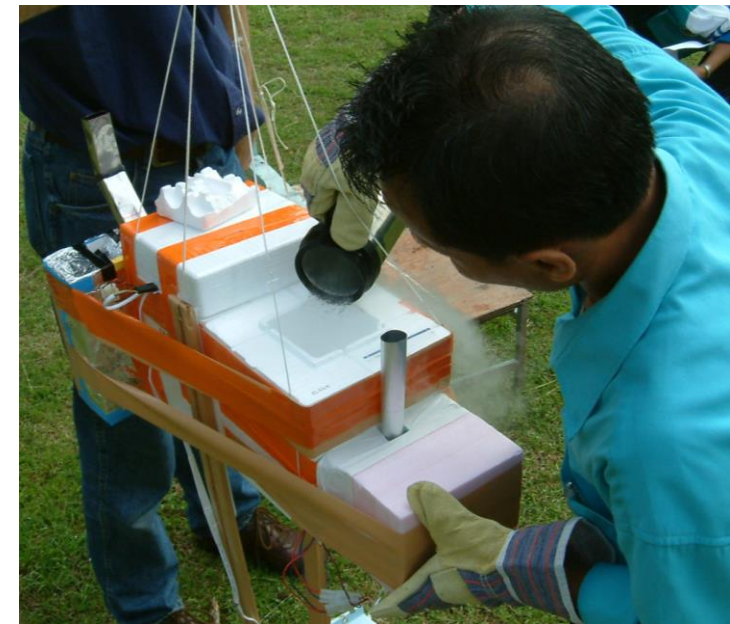
## GRUAN Manual (GCOS-170)

# 11 Sites with stratospheric hygrometer soundings





Frostpoint: H<sub>2</sub>O partial pressure  
Sensitivity 1-10<sup>5</sup> ppmv  
Response time ~20s (strat.)  
Sophisticated controller

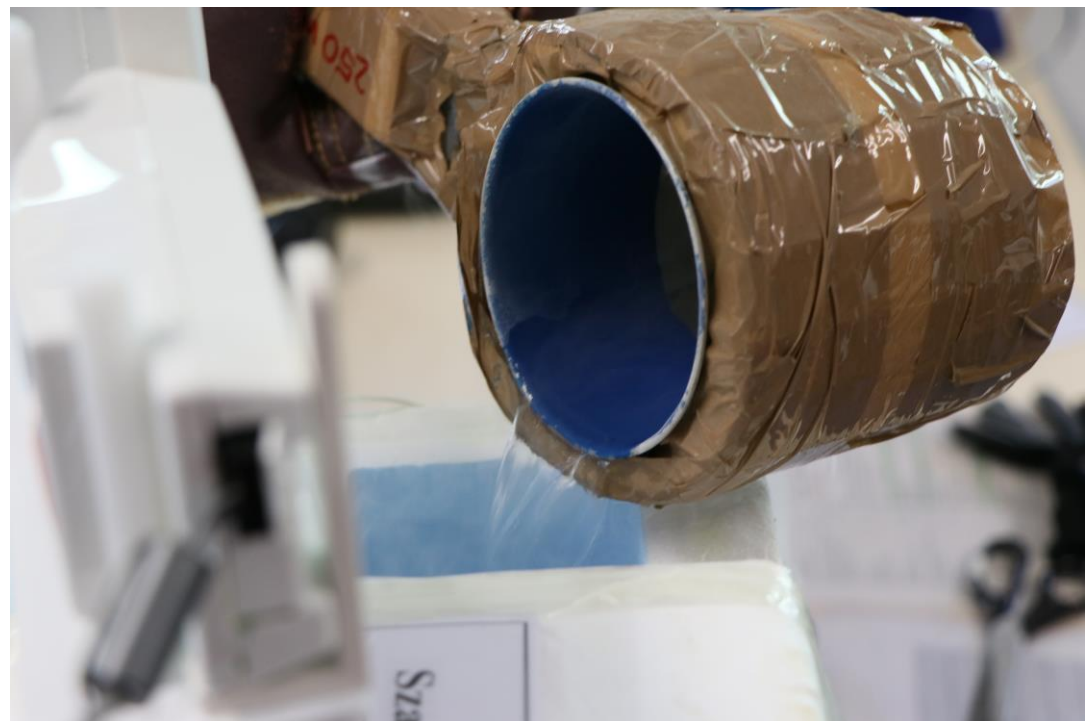


FPH NOAA  
CFH EnSci



Employed within GRUAN (since beginning)

- CFH – EnSci
- FPH – NOAA
- R23 cryogen ( $\text{CF}_3$ )



- Ideal thermodynamic properties for CFH/FPH application
- GWP  $\approx$  14,000
- EU regulation 517/2014, reduction of f-gases
  - Ban on R23 starting 2020
- Reduced availability
  - sales ban EU & Japan
  - Import restrictions
- Transition to another cooling method necessary

Employed within GRUAN (since beginning)

- CFH – EnSci
- FPH – NOAA
- R23 cryogen ( $\text{CF}_3$ )

Peltier-based

- Skydew, P-CFH

## ➤ Alternative cryogen

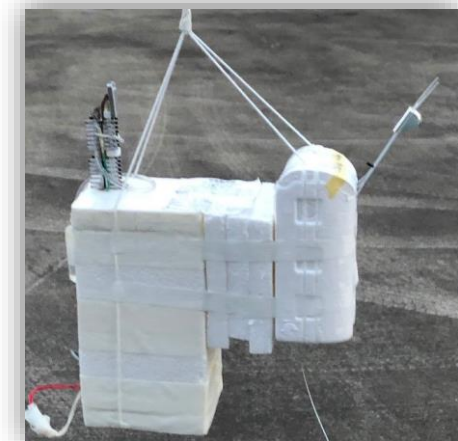
- LC – TU Dresden cooperation: cold Ethanol [ICM-12]
- FZJ: Dry ice/ethanol
  - LC, BOU (pres. Emrys Hall)
- LC - FZJ: Liquid N<sub>2</sub> (pres. by C. Rolf)



## ➤ Alternative instruments

- Skydew, commercially available. (pres. Takuji Sugidachi)
- PCFH, in development (pres. F. Wienhold)
- FLASH-B (tested at LC)

PCFH



Skydew



- European sites
  - LIN 1/month no availability issue
  - NYA 6 CFH left, program on hold.
  - SOD 2 bottles left (8-10 launches)
  - REU 8 launches
  
- US-sites: no availability issues. 25% price increase
  - BEL in stock: 5-6 launches
  - BOU 1/month no availability issues
  - LAU 1/month no availability issues
  - SGP ~10 launches
  
- HKO CFH: 1/month no availability issues

- Dry ice/ethanol tests with FPH [Emrys Hall/Ruud Dirksen]
- Liquid nitrogen container for CFH [Christian Rolf]
- Skydew [Takui Sugidachi]
- PCFH [Frank Wienhold]
- Discussion

## CFH/FPH:

- Ethanol/dry ice and LN2 cooling seem to work
- Optimize heat transfer, PID settings.
- Performance at e.g. tropical sites?

## Skydew & PCFH

- Performance daytime/nighttime