# GRUAN Implementation in Xilinhot and Round-trip drifting sounding system(RDSS)

Guo Qiyun、Zhang Xuefen、Dabu Xilatu、Luo Haowen

Meteorological Observation Center of CMA

feng_cloudy@163.com

Bern，Switzerland March 12, 2024

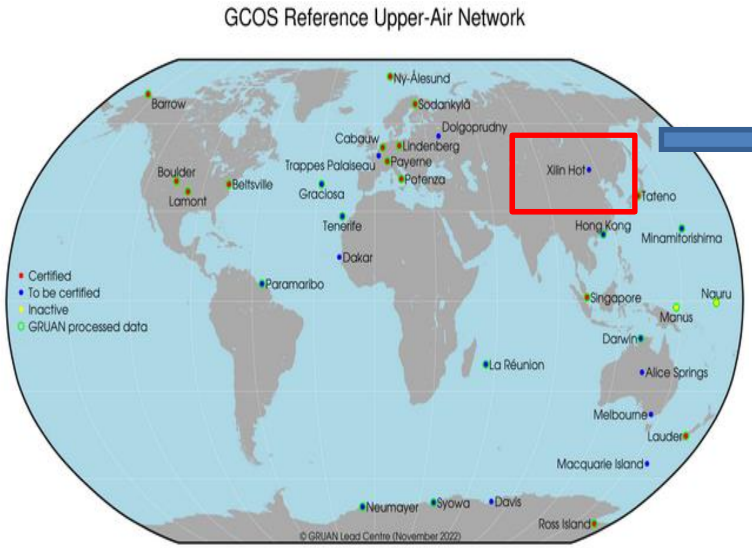
# Outline

一 GRUAN Implementation in Xilinhot（Xlh）

二 Round-trip drifting sounding system(RDSS)

# I.GRUAN Implementation in Xlh

## 1.1 Basic information of Xilinhot site




GRUAN

GRUAN Site Report for Xilinhot (XIL), 2023

Reported time range is Jan 2023 to Dec 2023
Created by the Lead Centre
Version from 2024-01-31

1 General GRUAN site information

| Object | Value |
|---|---|
| Station name | Xilinhot |
| Unique GRUAN ID | XIL |
| Geographical position | 43.9500 °N, 116.1200 °E, 1013.0 m |
| Operated by | IMWB \| Inner Mongolia Weather Bureau |
| Main contact | Luo, Hao Wen |
| WMO no./name | 54102 XILINHOT |
| Operators | currently 0, changes +0 / -0 |
| Sounding Site | 1 |
| GNSS | 1 |

- representativeness： mid-temperate semi-arid continental monsoon grassland climate in Asia
- metadata： submitted to LC-GRUAN yearly by CMA
- observation： participated actively in international comparison in 2022

  started GRUAN observation and exploitted GDP on March 2023

# I.GRUAN Implementation in Xlh

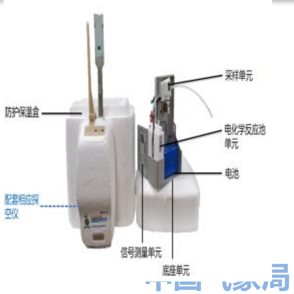
## 1.2 Building observation capacity

| no | GRUAN priority 1 and 2 ECVs | Observation equipments | Xilinhot Implement |
|---|---|---|---|
| 1 | Vertical profiles of temperature, pressure, water vapour, wind speed and direction, and ozone. | RS41 radiosonde as reference | The RS41 is compared with the GTH3 twice a week, Tuesday at 00 UTC, Saturday at 12 UTC |
| | | sounding | The GTH3 is launched once a day at 00,12UTC |
| | | Ozone sounding | CYT-1 ECC ozone sounding sensor was connected, releasing once a week on Wednesday or Thursday |
| | | Cryogenic Frost-point Hygrometer(CFH) | It has been played twice in November and December 2023, and once a month after June 2024, with RS41 and GTH3 |
| | | Surface weather station | The automatically operation is in good condition, the data is uploaded normally, and the GDP is to be formed. |
| | | GNSS/MET | |
| | | Microwave radiometer | |
| 2 | Other target variables of lower priority comprise vertical profiles of aerosol attributes including optical depth, total mass concentration, chemical mass concentration, scattering, and absorption; methane columns; surface net radiation, shortwave downward radiation, shortwave upward radiation, longwave downward radiation, longwave upward radiation, and radiances; cloud properties including cloud amount/frequency, base height, layer heights and thicknesses. | Vertical profiles of aerosol attributes | September 2024 |
| | | Surface net radiation | Yes |
| | | Cloud properties | Millimeter wave cloud radar |









# I.GRUAN Implementation in Xlh

## 1.3 Preparing for certification

- fulfils mandatory operating protocols in GCOS-171 Section 5.3
- submit GRUAN certification according to GRUAN-TN-5 as soon as possible
- get help from GCOS, WG-GRUAN and LC-GRUAN

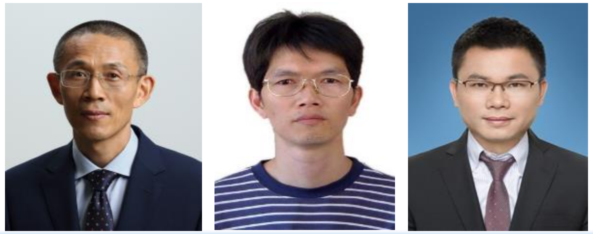
| Serial number | Specifics regarding site assessment and certification<br>Mandatory operating protocols | Xilinhot implementation |
|---|---|---|
| **1.Traceable** | 1.Calibration traceable to an SI unit or to an internationally accepted standard.<br>2.Provide traceable ground/instrument checks at the time of each profile measurement,independent of the manufacturer, for any instruments which provide vertical profiles extending from the surface. | 1. According to GRUAN-TD-5, the temperature and humidity traceability chain of GTH3 has been established to trace the source to international standards<br>2. Compare HP32 with 0%SHC and 100%SHC before each GTH3 and RS41 release |
| **2.Measurement uncertainty** | A comprehensive uncertainty analysis that includes all known sources of random error, has corrected for known systematic errors, and has documented those sources of uncertainty which could not be quantitatively accounted for. | 1. According to GRUAN-TN-13, the uncertainty of the temperature, humidity and wind pressure per second of the vertical profile of RS41 was established<br>2. According to the international comparison results of GRUAN-TD-5 and GTH3, the GTH3 uncertainty analysis method was initially established |
| **3.Peer-reviewed literature** | Readily accessible documentation of the measurement process and the derivation of the measurement uncertainty with a preference for publications in the peer-reviewed literature. | After the guidance of LC, confirm the rationality of the measurement uncertainty and then write the paper |
| **4.Processing chain** | Availability of complete metadata which provides sufficient information to fully describe the context of the measurement. This necessarily includes the raw data and sufficient details of the processing chain. | The raw data sets of RS41 and GTH3 have been established, and data exchange is to be established<br>Xilinhot metadata has been submitted to GRUAN LC by email |
| **5.Redundant observations** | Validation of the measurement and its uncertainty e.g. through intercomparisons with redundant observations. | The three kinds of ground uncertainty laboratory equipment will be learned in 2024<br>In real-time redundant measurement with ground-based vertical remote sensing equipment at the same site, it is necessary to learn quality constraints and uncertainty measurement transfer |
| **6.Annual reports** | Provide annual reports summarizing GRUAN operations at the site. | Submit Xilinhot annual report to GRUAN_LC every year |
| **7.Documented** | Conduct measurement programmes with an operational philosophy of continually striving to sustain the measurement quality at a given level. If improvements to measurement accuracy can be achieved, these need to be documented and their adoption agreed with the Lead Centre. | Actively record changes in measurement procedures |
| **8.Manage and Maintain** | 1.Manage changes in instrumentation, operating procedures, and processing algorithms proactively to avoid introducing spatial or temporal biases in GRUAN data products.<br>2.Maintain reference instruments and working standards for validating and, where possible, calibrating the measurement systems. | Manage changes and Maintain reference instruments |
| **9.Communication** | 1.Actively communicate with other GRUAN groups such as the Lead Centre, WG-GRUAN, task teams and/or other sites, (e.g. through participation in meetings, responding to communications, blog postings etc.).<br>2.Participate actively in the work of the task team of site representatives. Have a site representative on this task team and a reserve contact for GRUAN purposes | 1. Exchanged emails with GRUAN Lead Centre (Dr. Ruud Dirksen) for 23 times this year<br>2.A site representative on this task team is Guo Qiyun and Luo Haowen |

# I.GRUAN Implementation in Xlh

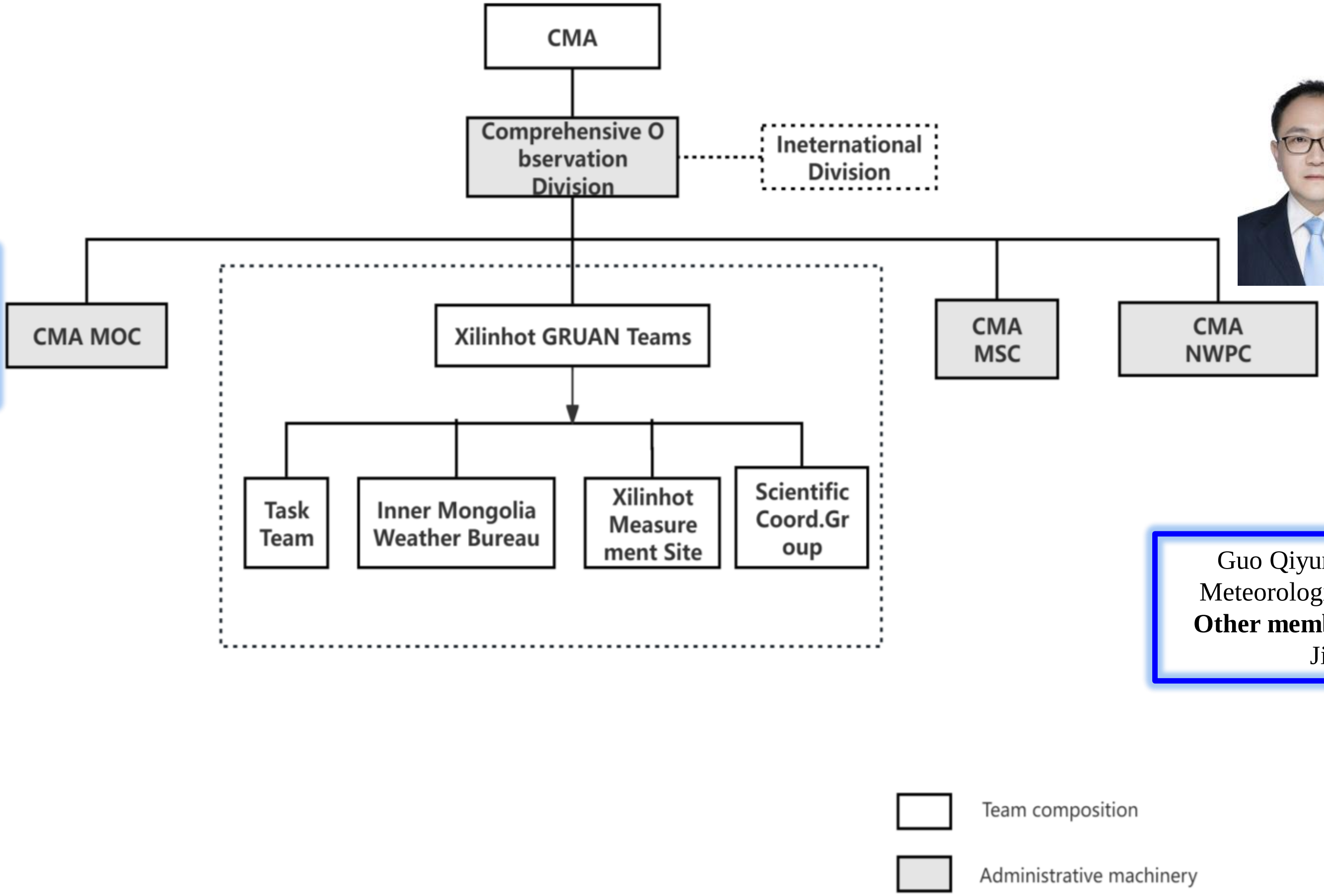
## 1.4 Attaching importance to team building

- in conjunction with universities, research institutes ...
- 2 managers, 3 scientists and 5 engineers are responsible for implementation, certification and research

Zhang Xuefen/Dabu xilatu,
Lead team management and construction
Meteorological Observation Centre of CMA/Inner Mongolia Meteorological Administration



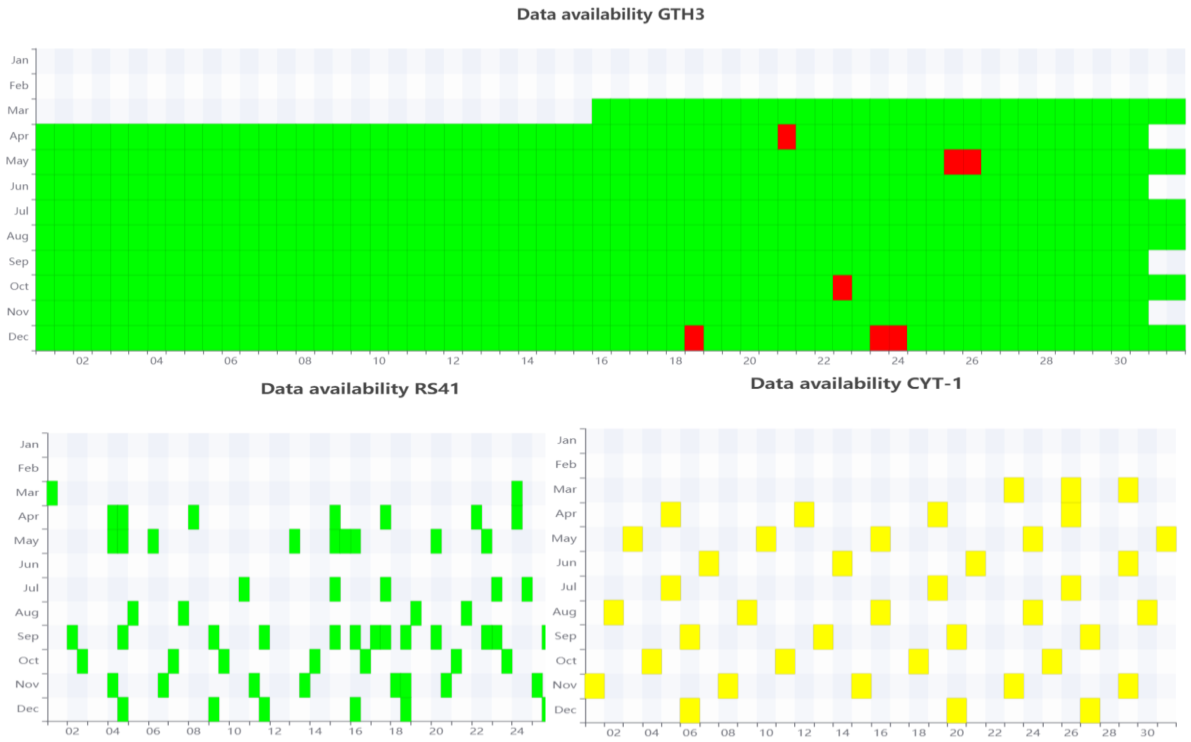
Bian Jianchun, led the scientific research
Institute of Atmospheric Physics, Chinese Academy of Sciences
**Other members:** Xia Xiangao, Huang Zhongwei




Guo Qiyun, lead the task implementation
Meteorological Observation Centre of CMA
**Other members:** Li Yan, Luo Haowen, Yang Jiachun, Huang Xiaojie

# I.GRUAN Implementation in Xlh

## 1.5 Starting fixed sounding observation




RS41, GTH3, ozone(CYT-1) radiosonde data statistics (by December 31, 2023)

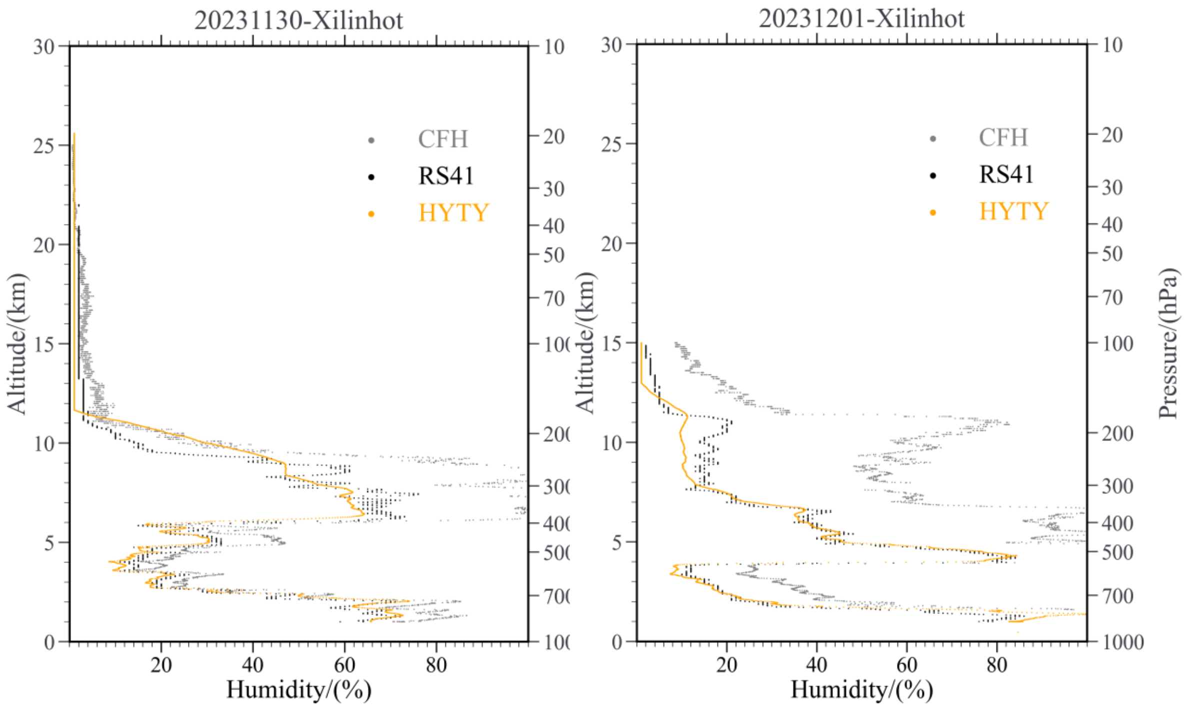
Ozone sounding and intercomparison of GTH3, CFH and RS41

- start time: March 16, 2023
- observation frequency: GTH3 twice a day， RS41 twice a week, and ozone once a week
- samples: GTH3(720)， RS41(86)， and ozone(50), *up to March 12,2024*

# I.GRUAN Implementation in Xlh

## 1.6 Comparison to CFH(and RS41)

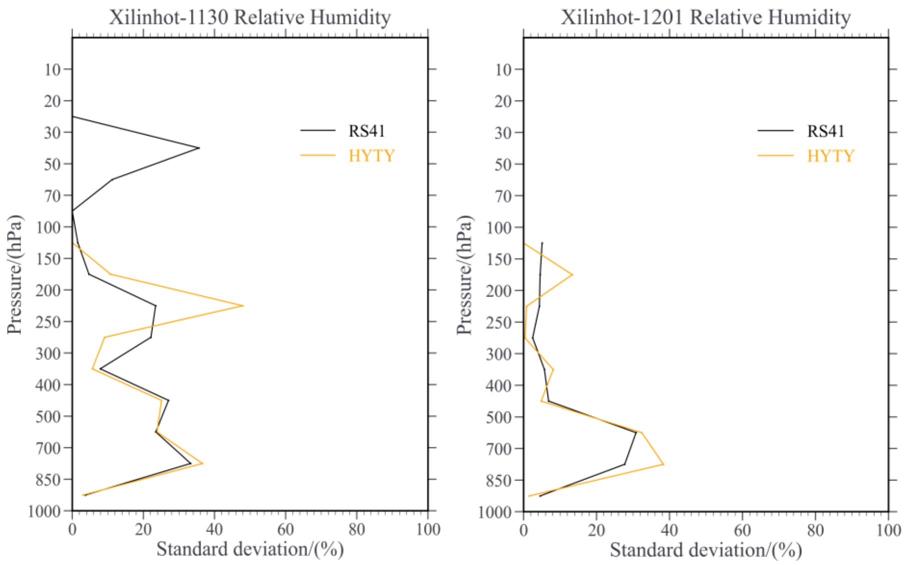
- times: respectively once in November and December 2023
- consistency: the performance of GTH3 is consistent with CFH and RS41 below 15km
- follow-up arrangement: once comparison every month from June 2024




The intercomparison of CFH, RS41 and GTH3 water vapor profile

$$y_i = \frac{X_{ai} - X_{bi}}{X_{bi}} \qquad \overline{Y_{ab}} = \frac{1}{n}\sum_{i=1}^{n} y_i \qquad S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(y_i - \overline{Y_{ab}})^2}$$

Xa represents the measurement results of the test meteorosonde, Xb represents the measurement results of CFH low temperature frost point hygrometer, and n represents the total amount of detected data



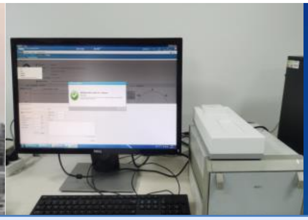

The intercomparison of CFH, RS41 and GTH3 water vapor profile (standard deviation)

# I.GRUAN Implementation in Xlh

## 1.7 Comparison to RS41

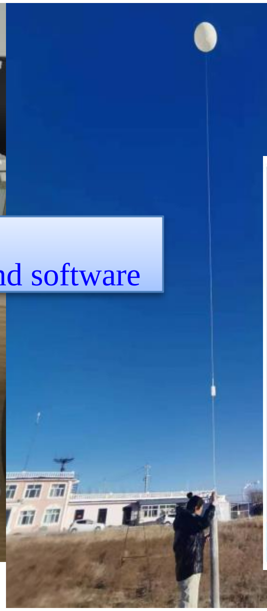
- times: twice a week, every Tuesday 00UTC and Saturday 12UTC
- GDP: about 65 sets according to the GRUAN RsLaunch Client

Vaisala Sounding antenna

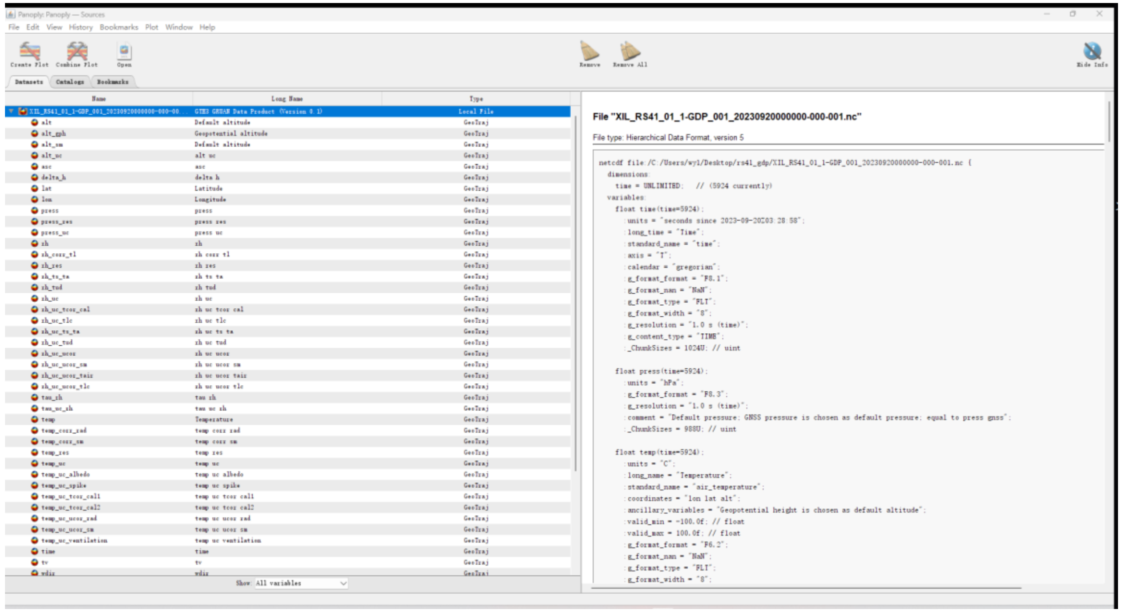


Vaisala Radiosonde receiver and software











Vaisala RS41-SG radiosonde

Vaisala base box

intercomparison of RS41and GTH3

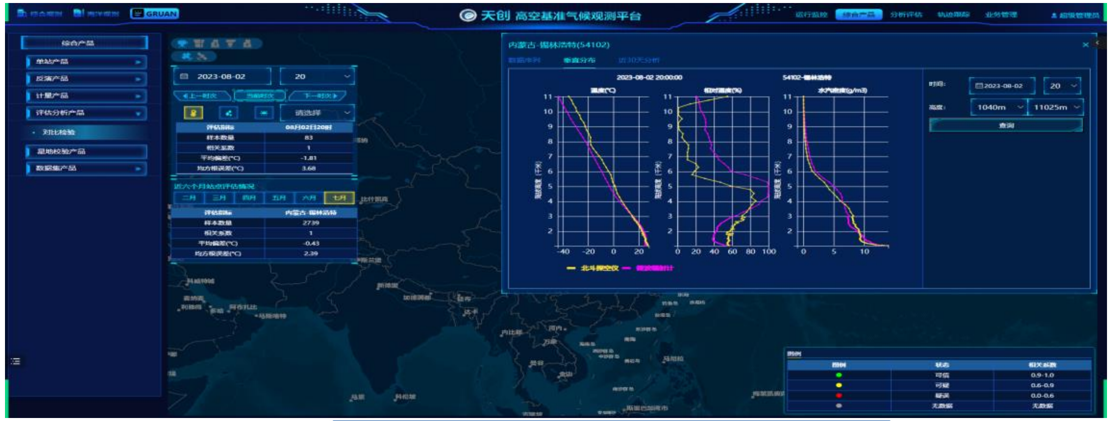
The GDP file of 65 sets of RS41 has been completed in 2023

# I.GRUAN Implementation in Xlh

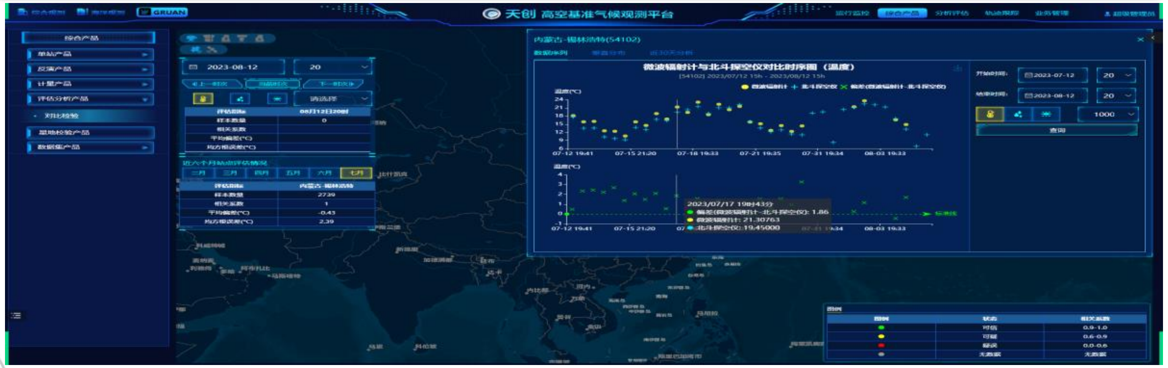
## 1.8 Preprocessing GRUAN data

- quality control： rawdata of GTH3 radiosondes was carried out
- comparison: GTH3 with ground-based microwave radiometer and FY-3 satellite was carried out

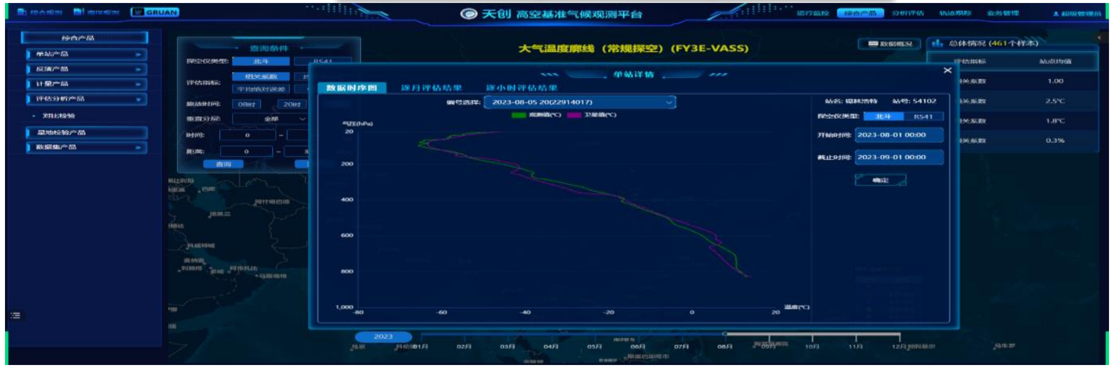
Comparative analysis of microwave radiometer and RS41-SG radiosonde



Vertical profile comparison



Test for comparative evaluation



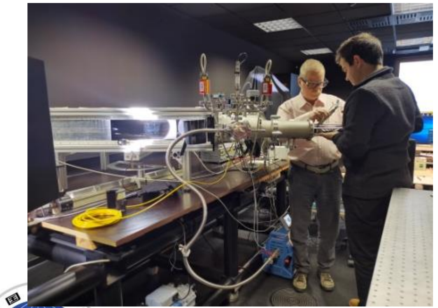
The temperature authenticity of RS41 and FY-3 satellites (R=0.99)

# I.GRUAN Implementation in Xlh

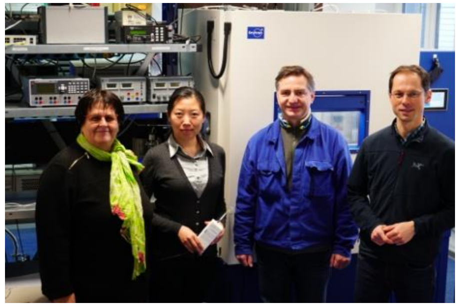
## 1.9 Developing GTH3 GDP progress-UAII2022

- GTH3 represented operational sounding to participate in international comparison (nonoperational： CF-06-AH)
- It was assessed to be suitable for applications in aeronautic meteorology, near/ultra-short term forecasting, global numerical weather forecasting and real-time monitoring applications

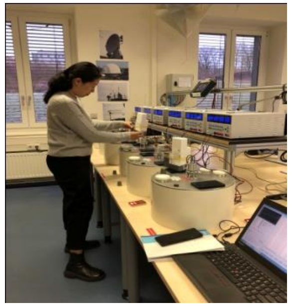




Radiation sensitivity of air temperature measurement



Humidity and temperature sensor performance at low temperature



Humidity sensor performance at room conditions

**atmospheric temperature and relative humidity measurements $\Lambda^{\delta}_{\sigma(\delta)\pm\epsilon}$**

| | | Atmospheric temperatue [K] | | | | Relative humidity [%RH] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PBL | FT | UTLS | MUS | PBL | FT | UTLS | MUS |
| GTH3 | Day | $0.18^{-0.05}_{0.17}\pm0.03$ | $0.12^{+0.05}_{0.11}\pm0.04$ | $0.09^{+0.01}_{0.08}\pm0.02$ | $0.27^{-0.22}_{0.16}\pm0.10$ | $7.00^{-5.43}_{4.41}\pm0.74$ | $8.75^{-3.50}_{8.02}\pm0.60$ | $7.73^{-1.55}_{7.58}\pm0.40$ | $1.69^{+1.48}_{0.82}\pm0.46$ |
| | Night | $0.38^{-0.18}_{0.34}\pm0.05$ | $0.15^{+0.02}_{0.15}\pm0.02$ | $0.12^{+0.06}_{0.10}\pm0.05$ | $0.10^{-0.03}_{0.10}\pm0.02$ | $4.72^{+0.74}_{4.66}\pm0.15$ | $6.41^{+2.16}_{6.03}\pm0.11$ | $6.82^{+3.70}_{5.74}\pm0.26$ | $1.71^{+1.54}_{0.74}\pm0.28$ |

The night valuer of the GTH3 s slightly larger than that of the day, and the temperature value is smaller than that of other radiosondes, so the GTH3 has better temperature detection performance

| | | Geopotential height [m] | | | | Pressure [hPa] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PBL | FT | UTLS | MUS | PBL | FT | UTLS | MUS |
| GTH3 | Day | × | $5.9^{+2.0}_{5.5}\pm1.8$ | $13.2^{+10.0}_{8.6}\pm3.8$ | $29.5^{+23.4}_{17.9}\pm4.2$ | × | $0.4^{-0.0}_{0.4}\pm0.1$ | $0.4^{-0.3}_{0.2}\pm0.1$ | $0.3^{-0.2}_{0.1}\pm0.0$ |
| | Night | × | $5.8^{+0.4}_{5.8}\pm0.4$ | $11.5^{+7.7}_{8.6}\pm3.4$ | $26.7^{+20.7}_{16.8}\pm4.2$ | × | $0.5^{+0.1}_{0.5}\pm0.2$ | $0.3^{-0.1}_{0.2}\pm0.1$ | $0.1^{-0.1}_{0.1}\pm0.0$ |

The geopotential height and the pressure measurement error is small and at the average level

| | | Wind (horizontal) direction [°] | | | | Wind (horizontal) speed [m s$^{-1}$] | | | | Wind (horizontal) vector [m s$^{-1}$] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PBL | FT | UTLS | MUS | PBL | FT | UTLS | MUS | PBL | FT | UTLS | MUS |
| GTH3 | Day | × | $3.6^{-0.4}_{3.6}\pm0.2$ | $2.5^{-0.2}_{2.5}\pm0.3$ | $6.1^{-0.4}_{6.1}\pm0.2$ | × | $0.2^{-0.0}_{0.2}\pm0.0$ | $0.2^{-0.0}_{0.2}\pm0.0$ | $1.3^{-0.0}_{1.3}\pm0.0$ | × | $0.3^{+0.2}_{0.1}\pm0.0$ | $0.3^{+0.2}_{0.2}\pm0.0$ | $1.5^{+0.3}_{1.5}\pm0.0$ |
| | Night | × | $2.6^{-0.2}_{2.6}\pm0.2$ | $2.4^{-0.1}_{2.4}\pm0.1$ | $4.5^{-0.6}_{4.4}\pm0.2$ | × | $0.2^{-0.0}_{0.2}\pm0.0$ | $0.2^{+0.0}_{0.2}\pm0.0$ | $0.2^{-0.0}_{0.2}\pm0.0$ | × | $0.2^{+0.2}_{0.1}\pm0.0$ | $0.2^{+0.2}_{0.1}\pm0.0$ | $0.4^{+0.3}_{0.3}\pm0.0$ |

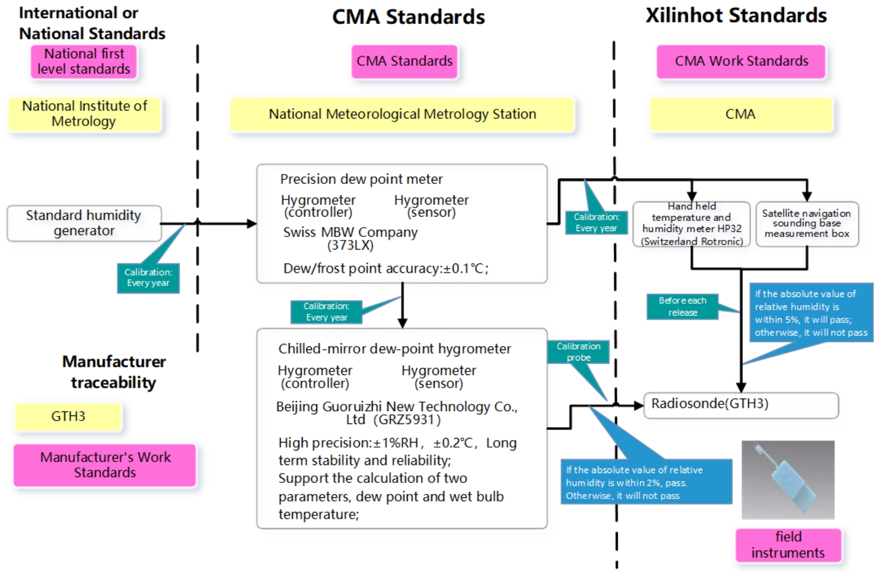
The GTH3 wind accuracy is high and stable

# I.GRUAN Implementation in Xlh

## 1.9 Developing GTH3 GDP progress-calibration traceable

- **manufacturer traceability:** Before ex-factory, the manufacturer is required to calibrate T, U and P sensors
- **site traceability:** Site technicians compare GTH3 with the HC2A-S probe of Rotronic HP32 in 0% and 100% standard humidity room check (SHC) for 10 mins before releasing GTH3 and RS41
- **instrument traceability:** The HC2A-S probe of Rotronic HP32 are calibration traceable to an SI unit every year

**Thanks MEISEI radiosonde for referring to traceability method**



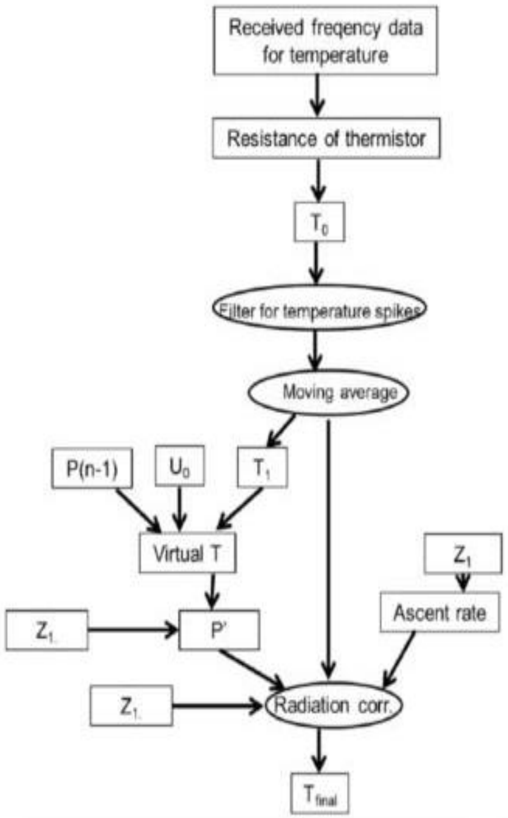

The calibration traceable process of GTH3 was established with reference to MEISEI radiosondes

The HC2A-S probe of Rotronic HP32

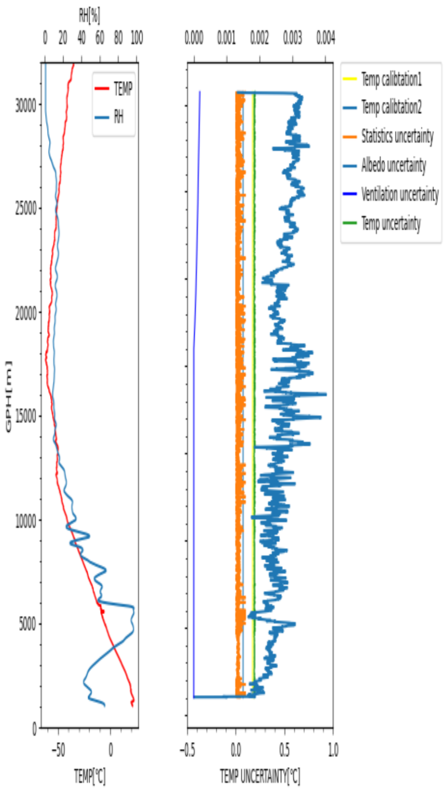

SHC

# I.GRUAN Implementation in Xlh

## 1.9 developing GTH3 GDP progress-temperature




The temperature processing steps and correction algorithms for the GTH3



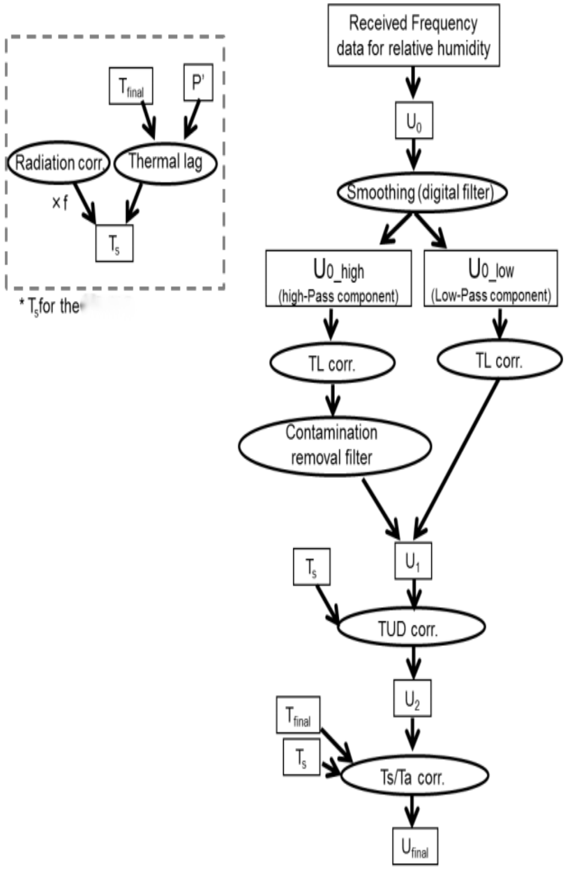

July 18, 2023 00UTC example of the temperature uncertainty profile for the GTH3

- due to the lack of radiation sensitivity of temperature measurement, based on the GRUAN-TD-5, the Meisei RS-11G and iMS-100 uncertainty sources, and the UAII2022 Lindenberg results, the uncertainty sources and values for GTH3 temperature processing steps was studied and established (thanks to WMO, GCOS, GRUAN and JMA, etc.)

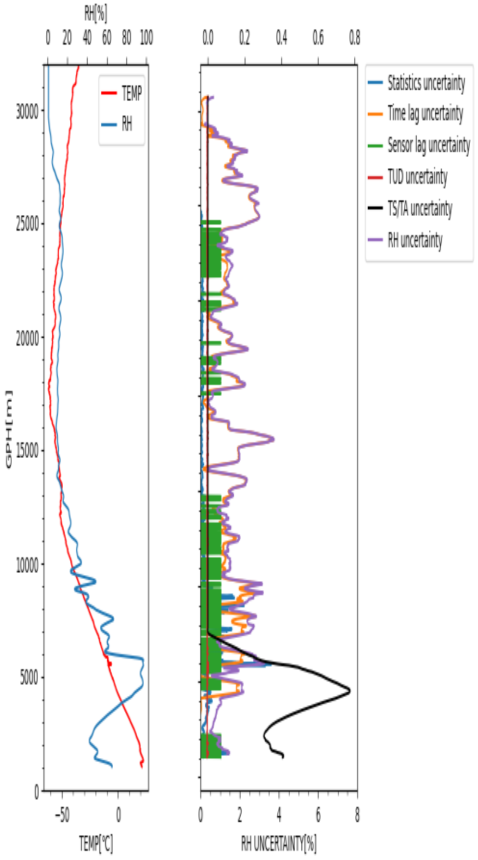
| Components | Value [K] | Reference |
|---|---|---|
| Solar radiation (albedo) | $\|I_{clear} - I_{cloudy}\|/(2\sqrt{3})$ | The albedo is corrected by 0.1 (e.g., sea surface), 0.2 (assumed in the actual correction algorithm), and 0.6 (e.g., under cloudy conditions) at 100 hPa and 10 hPa pressures, respectively. |
| Solar radiation (ventilation) | $\Delta T(\text{Ascent rate} + 3\text{m/s})/\sqrt{3}$ | With reference to Meisii's correction of 6 m/s and 9 m/s for balloon ascent/ventilation at 100 hPa and 10 hPa pressure, the final temperature will have a thermal deviation of ~0.5 K in the stratosphere when highly reflective clouds are present. |
| Thermistor calibration | 0.173 | Calibrate the variability of the thermistor and record the calibration values of 35 ° C, 0 ° C, -40 ° C and -80 ° C for six months. The annual variation range must be within 0.3K |
| Variability in the calibration chamber | 0.075 | At the same time, 10 sensors are calibrated, and the spatial variability of the calibration chamber is between -85°C and +40°C |
| Heat spike | 0 | A 600g balloon with a 10-meter rope length is used, and the typical uncertainty value of thermal peak filtering is 0.1 to 0.2K. Xilinhot 30m rope length can uncorrected |
| Evaporative cooling | - | The uncertainty generated by thermistor after passing through the supercooled droplet cloud. Uncorrected. |

# I.GRUAN Implementation in Xlh

## 1.9 developing GTH3 GDP progress-relative humidity




**The relative humidity processing steps and correction algorithms for the GTH3**



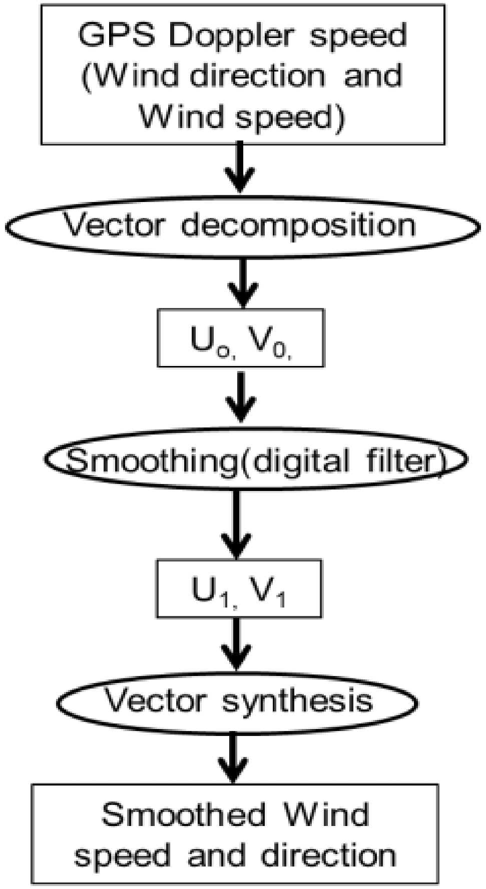

**July 18, 2023 00UTC example of the relative humidity uncertainty profile for the GTH3**

- based on the GRUAN-TD-5, the Meisei RS-11G and iMS-100 uncertainty sources, and the UAII2022 Lindenberg results, the uncertainty sources and values for GTH3 relative humidity processing steps was studied and established (thanks to WMO, GCOS, GRUAN and JMA, etc.)

| Components | Value[%RH] | Reference |
|---|---|---|
| Sensor calibration | 1.15 | At 25℃, 15%RH, 30%RH, 50%RH, 70%RH, 90%RH and 95%RH were calibrated for each batch of sonde humidity sensors, and 1.15 was obtained after 6 months of statistics |
| SHC 100 %RH check | 1.23 | HP32 Calibration uncertainty at 0% and 100% humidity |
| GC check | 0.173 | Reference to the uncertainty of calibration of Beidou sounding base test box |
| Time-lag correction | $U(u_\tau)$ $u_\tau=\tau\times0.25$ $\tau$=1.5692EXP(-0.078T) | The uncertainty of the reference delay correction (the lower the temperature, the larger the delay correction) mainly comes from the uncertainty of the response time constant of the humidity-sensitive capacitor. |
| TUD correction | 1.2 | The reference temperature compensation value is 1.2, and temperature compensation is performed for the relative humidity deviation under the condition of -80-40 degrees |
| Ts/Ta correction | U(△T) where△T 0.3K/√3 | According to the formula, the thermal lag and solar radiation heating above 600hPa are significant, and the E+E humidity sensor has no temperature resistance, so it is necessary to develop humidity sensor for heating temperature measurement |
| Hysteresis | 1.8 | The reference value is 1.8. |
| Contamination | - | Correction amount itself (depending on weather conditions) |

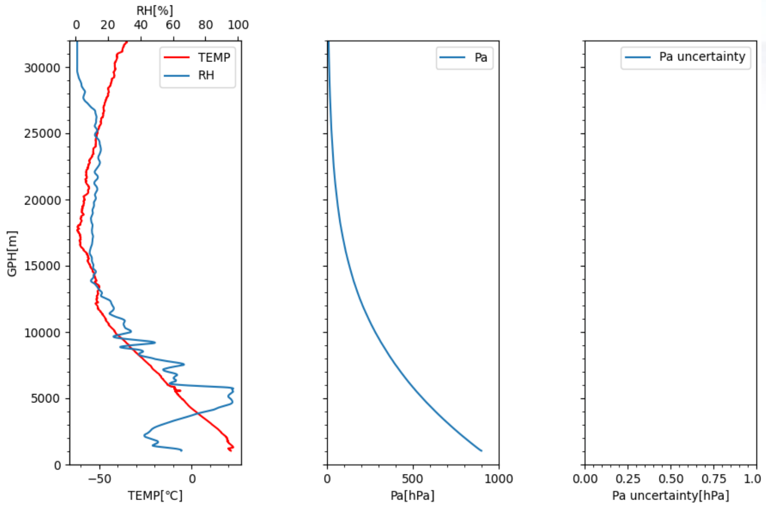
# I.GRUAN Implementation in Xlh

## 1.9 developing GTH3 GDP progress-pressure and wind

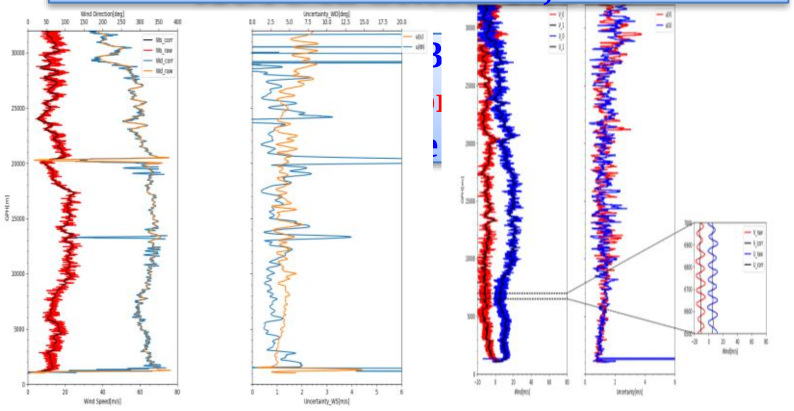



The horizontal wind processing steps and correction algorithms for the GTH3

| ECVs | Parameter | Value | Reference |
|---|---|---|---|
| **air pressure** | Uncertainty of the surface pressure gauge | 0.06 ( hPa) @surface<br>0.01 ( hPa) @100 hPa<br>0.001 ( hPa) @10 hPa | ➢ The uncertainty of ground station pressure also affects the pressure<br>➢ Barometric uncertainty comes from temperature, humidity and altitude<br>➢ GPS/ Beidou geopotential height measurement is the main source of uncertainty at low altitudes, while temperature measurement is the main source of uncertainty at high altitudes |
| | Uncertainty from temperature measurements | 0 ( hPa) @surface<br>0.5 ( hPa) @100 hPa<br>0.12 ( hPa) @10 hPa | |
| | Uncertainty from RH measurements | 0 ( hPa) @surface<br>0.01 ( hPa) @100 hPa<br>0.002 ( hPa) @10 hPa | |
| **horizontal wind** | the stability of the Beidou Doppler speed data | / | The variability (1σ) is less than 0.01 m/s |
| | the low-pass filtering process to remove the pendulum-motion and noise components | The uncertainty value of wind speed is 2-4 m/s, and the uncertainty value of wind direction is mostly less than 2°, except 25-30km | Using a low-pass digital filter with Kaiser window (Kuo and Kaiser, 1966) to remove noise from wind measurements, the U and V components and uncertainties are calculated |




Vertical profile of the pressure and their uncertainty taken at Xlh for GTH3 at 12UTC on October 21, 2023

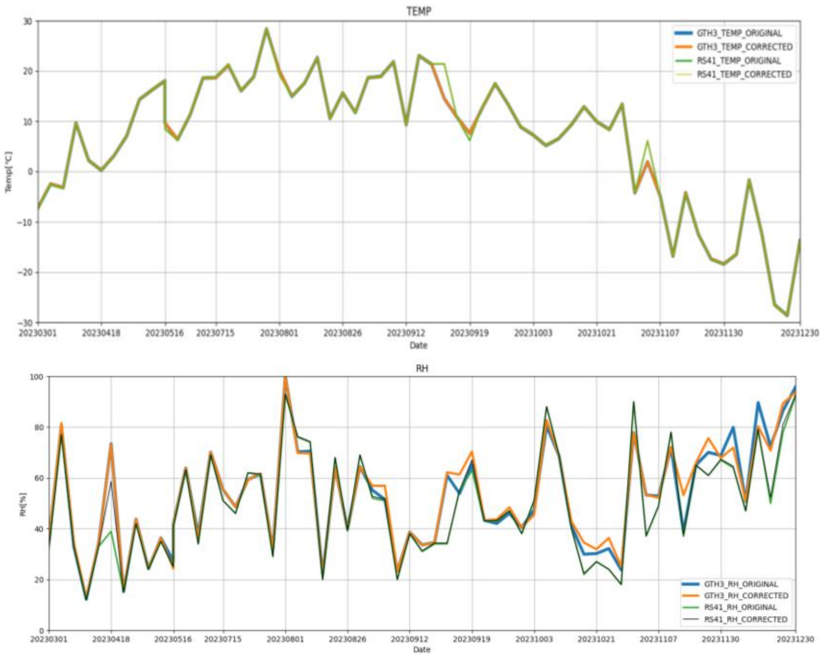


Vertical profile of the wind speed and direction and their uncertainty (left) horizontal winds and their uncertainty (right) taken at Xlh for GTH3 at 12UTC on October 21, 2023

# I.GRUAN Implementation in Xlh

## 1.9 developing GTH3 GDP progress-overall performance

raw and corrected value of 850hPa temperature and humidity




GRUAN Observation Index requirements (GCOS-134)

| Variables | Temperature | Water vapour | Pressure | Wind speed | Wind direction |
|---|---|---|---|---|---|
| ECVs | Priority 1 | | | | |
| Measurement range | 170-350 K | 0.1-90000 ppmv | 1-1100 hPa | 0 – 200 m/s | 0-360° |
| Vertical range | 0-40 km | 0-40 km | 0-40 km,0-30 km is routinely achievable with radiosondes | 0-40 km | 0-40 km |
| Vertical resolution | 0.1km (≤30km)<br>0.5km (＞30km) | 0.05km (≤5km)<br>0.1km (5~30km) | 0.1 hPa | 0.05km (troposphere)<br>0.25km (stratosphere) | 0.05km (troposphere)<br>0.25km (stratosphere) |
| Random error | 0.2 K | 2% (troposphere)<br>5% (stratosphere) | 0.01 hPa or WMO CIMO 8 | 0.5 m/s (troposphere)<br>1.0 m/s (stratosphere) | 1° (troposphere)<br>5° (stratosphere) |
| Systematic error (bias) | 0.1K (troposphere)<br>0.2K (stratosphere) | 2% (troposphere and stratosphere) WMO-No. 8 recommends 5% | 0.1 hPa or WMO-No. 8 | 0.5 m/s | 5° |
| Stability | 0.05 K | 1% (0.3%/ten years) | Better than a quarter of the random error quoted above, per decade | 0.1 m/s (troposphere)<br>0.5 m/s (stratosphere) | 1° (troposphere)<br>5° (stratosphere) |

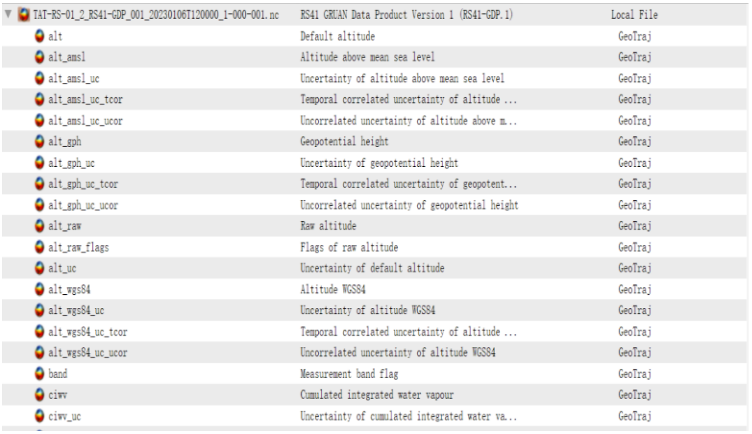
- GRUAN uncertainty analysis technique was applied to 65 sets of RS41 and GTH3 from March to December in 2023
- Temperature uncertainty of GTH3 was 0.19℃, relative humidity (WV) uncertainty was 1.38%RH, wind speed uncertainty was 0.31m/s, and wind direction uncertainty was 1.51°

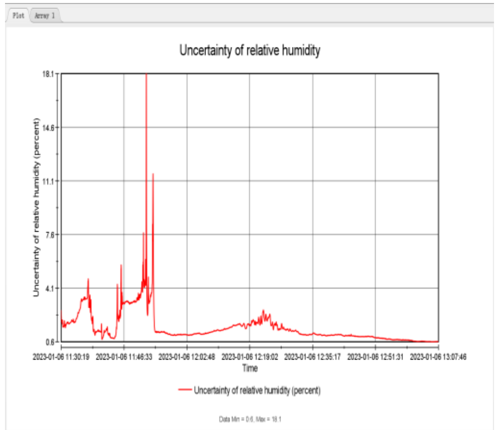
# I.GRUAN Implementation in Xlh

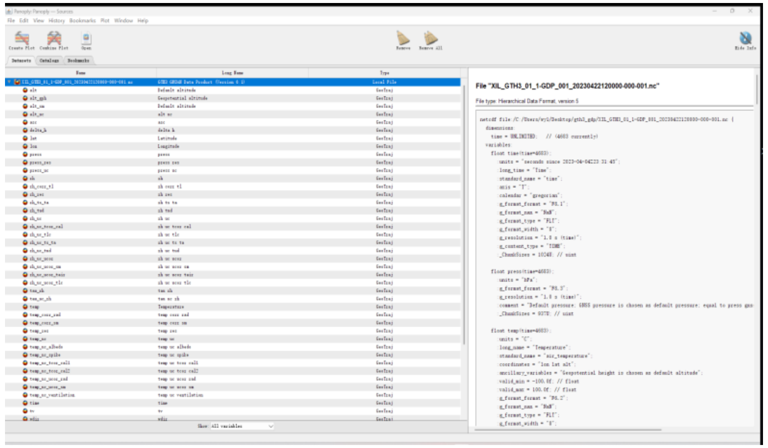
## 1.9 developing GTH3 GDP progress- data flow

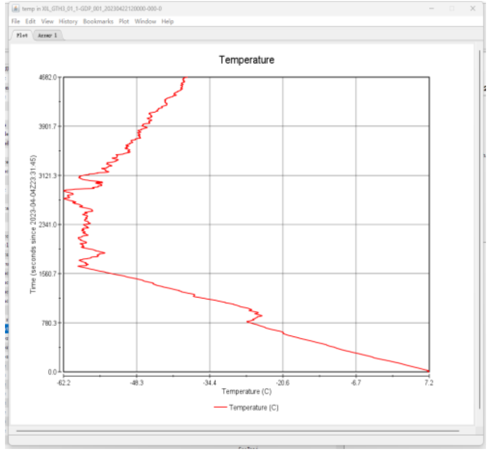
- According to NetCDF Data format of GDP, 65 sets of GTH3 and RS41 have been formed
- GDP will be submitted to the LC-GRUAN by May 2024, and start certification of Xlh and GTH3

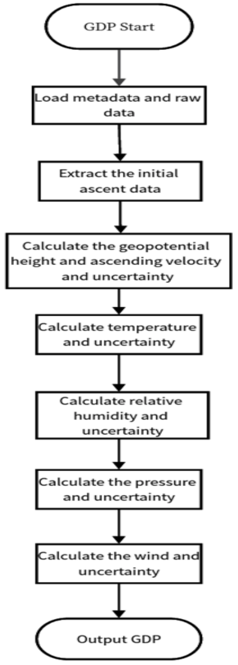
Observation elements: geopotential height, temperature, relative humidity, temperature uncertainty, humidity uncertainty, calibration temperature, other inversion products...






GRUAN data product (GDP) algorithm

# I.GRUAN Implementation in Xlh

## 1.10 Next work and suggestions

- Before **May 2024,** CMA will submit GDP of intercomparison of 65 sets of GTH3 and RS41 in 2023 to LC-GRUAN for certification
- From **June 2024**, Xlt will strat CFH intercomparison and stratospheric weather balloon observation (≥40km) once per month
- Before **December 2024**, three sets of sounding ground laboratory, including investigations of humidity and temperature sensor at low temperatures, six of relative humidity calibration checks (SHCs), and wind tunnel setup for radiation experiments, will be built in Inner Mongolia Meteorological Bureau to support GRUAN uncertainty analysis and certification
- **By 2025**, CMA will complete certification of the GTH3 and Xlh, and start the certification of remote sensing and other observation GDP

# I.GRUAN Implementation in Xlh

## 1.10 Next work and suggestions

- It is suggested that GCOS， WG-GRUAN and LC-GRUAN can arrange technical experts come to China help Xlh in 2024, and conduct in-depth technical guidance with certification.
- CMA will do his best to achieve certification of Xlh site and GTH3 radiosonde by 2025， and will send someone to Lindenberg for studying between 2024 and 2025.

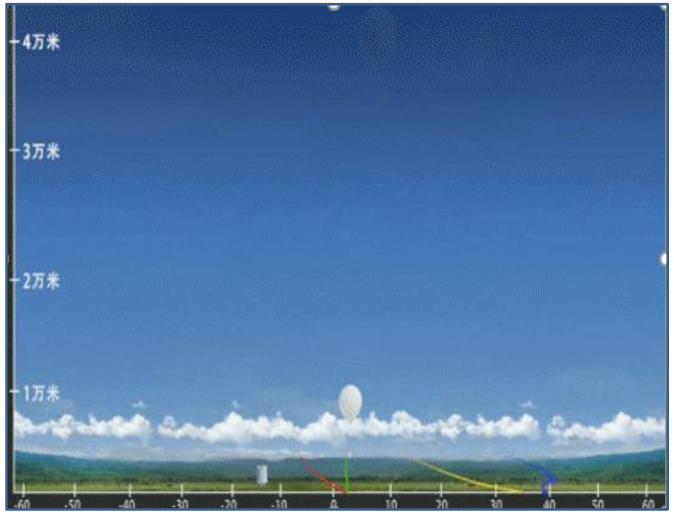
# 目录

# II.Round-trip drifting sounding system(RDSS)

# II.Round-trip drifting sounding system(RDSS)

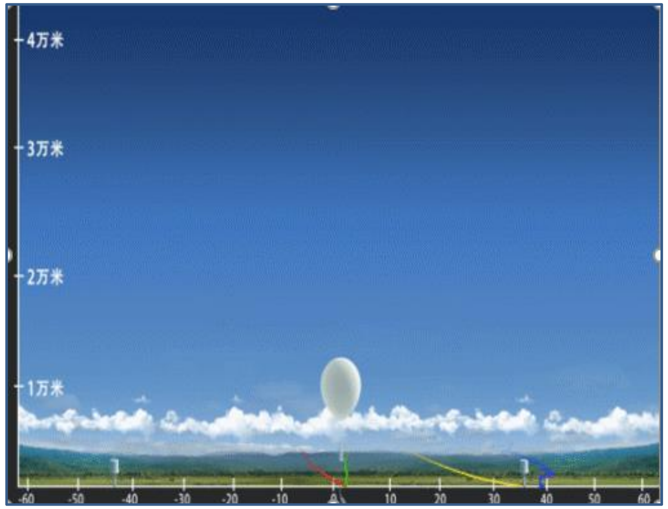
## 2.1 Comparison of sounding mode

Single ballon radiosonde observation




- wind measurement of radar tracking and positioning
- single point balloon release - single point semi-automatic tracking radiosonde
- one profile data was obtained from one observation
- 26-28km altitude, 1 hour ascent observation

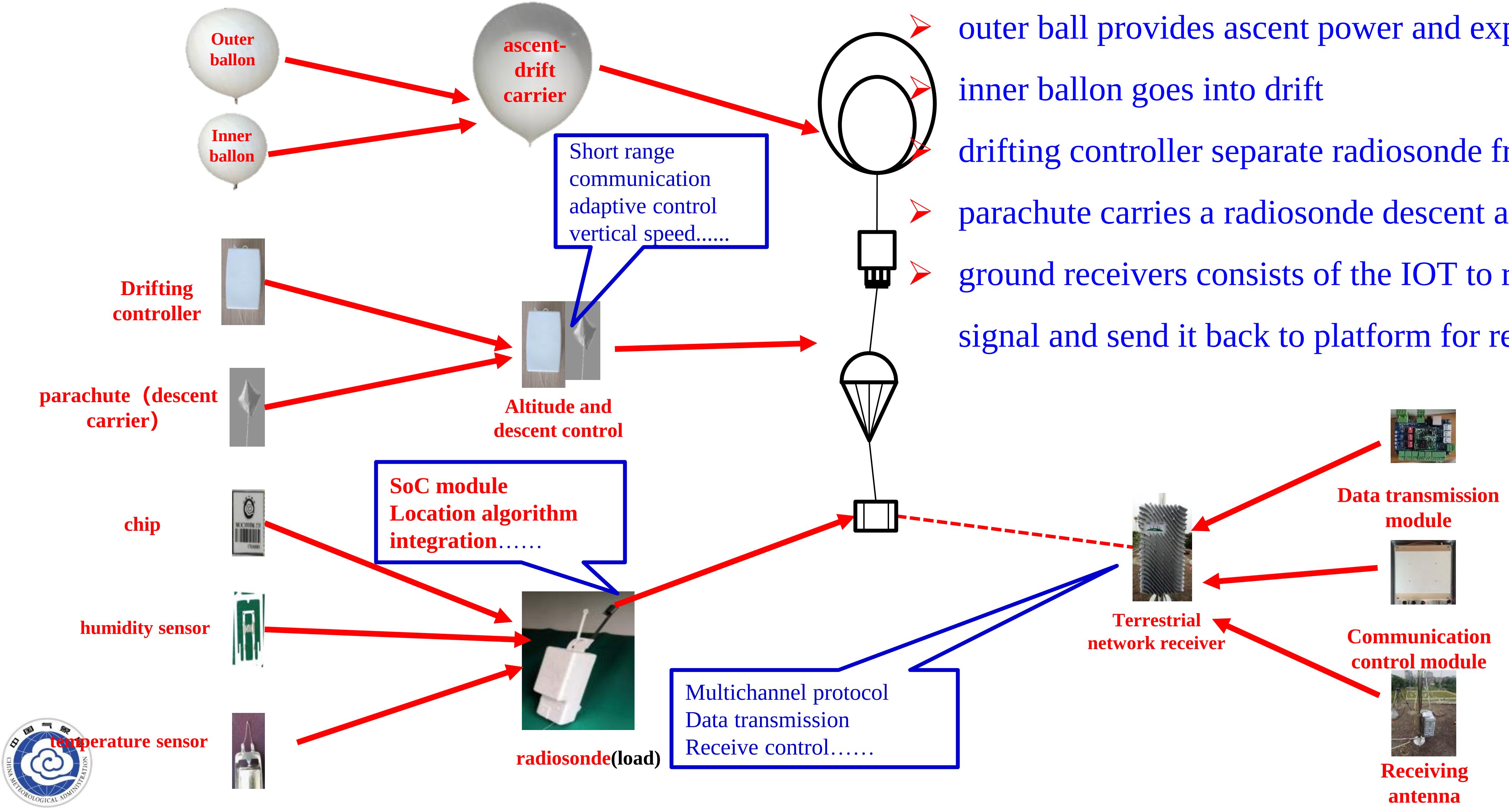
Round-trip drifting sounding system




- navigation positioning wind measurement
- single point balloon release - Ground to upper air Iot reception multi-station network automatic tracking radiosonde
- 2 profiles (ascent - descent) +1 drift section data were obtained in one observation
- 24-28km altitude, 4 hours drift observation and 1hour descent observation

# II.Round-trip drifting sounding system(RDSS)

## 2.2 System composition and theory

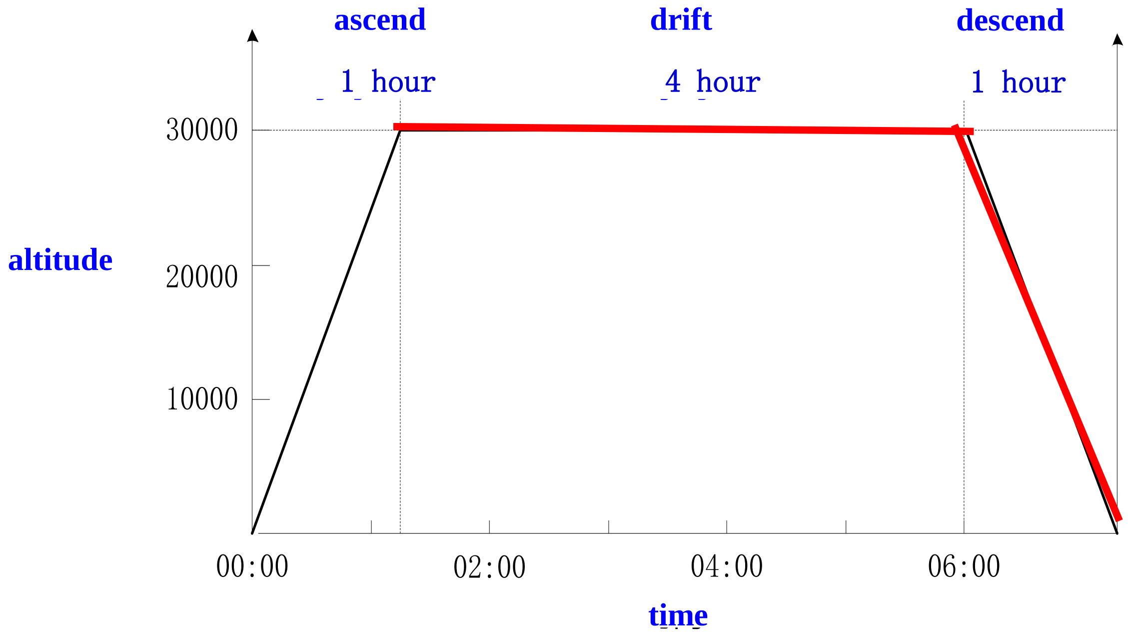


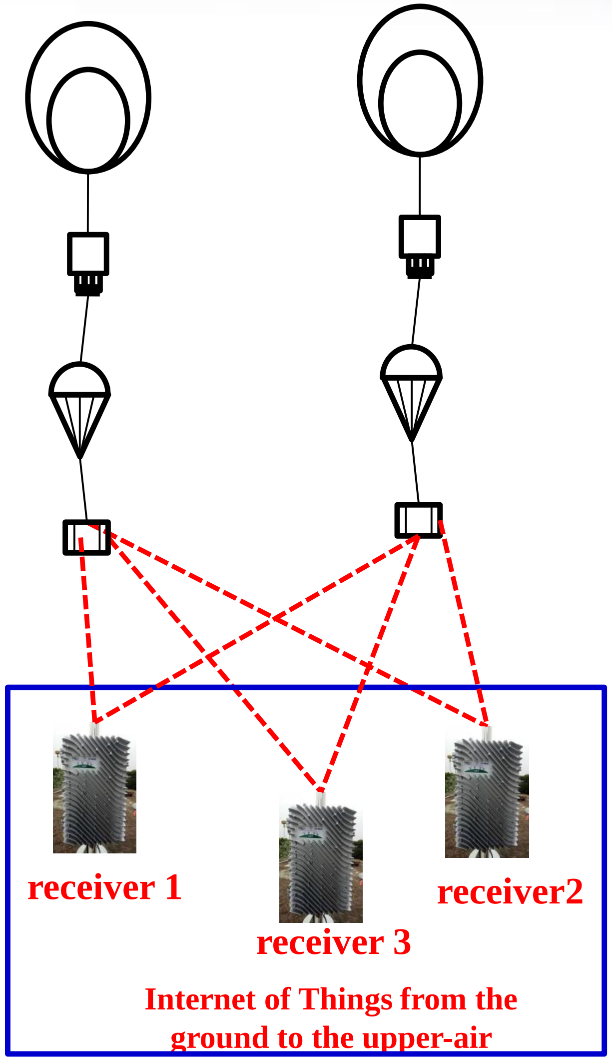

## ◆Observation theory steps

- ➢ outer ball provides ascent power and explods at a fixed height
- ➢ inner ballon goes into drift
- ➢ drifting controller separate radiosonde from inner ballon
- ➢ parachute carries a radiosonde descent at low speed
- ➢ ground receivers consists of the IOT to receive radiosonde signal and send it back to platform for real-time processing

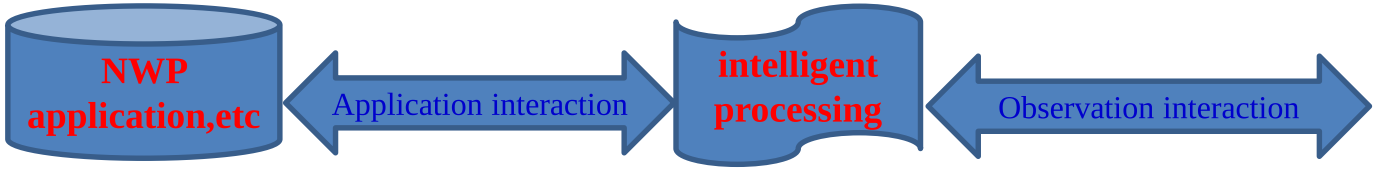
# II.Beidou Round-trip drifting sounding system(RDSS)

## 2.3 Observation process




- based on the first ascent sounding, the drift and descent observation have been expanded
- it promote development of numerical weather prediction model such as GRAPES （operational numerical forecast model of CMA）.



# II.Round-trip drifting sounding system(RDSS)

## 2.4 Early technology development

**2017** A round-trip drifting sounding system with three observation stages of ascent-drift- descent is developed

**2018** In the middle and lower reaches of the Yangtze River, the RDSS observation experiment has been carried out, and the key technology has been overcome

**2020 -2023** Guangdong has successfully carried out phased pilot operational and data application.

The observation, data and application departments of the China Meteorological Administration have worked together to establish a full business process for data collection, transmission and application

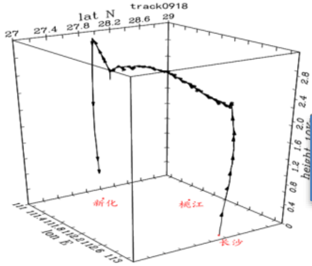
- **more than 7,000 tests was carried out in the middle and lower reaches of the Yangtze River, Guangdong and Inner Mongolia**
- **operation of hardware and software, data processing ,and assimilation of RDSS have been comprehensively tested**
- **CMA will actively carry out joint applications with other countries to promote the in-depth application of data of RDSS**

# II.Round-trip drifting sounding system(RDSS)

## 2.5 Typical regional observation and assimilation

Single station release, the first time to achieve the ascent more than 4 hours of drifting - fall process

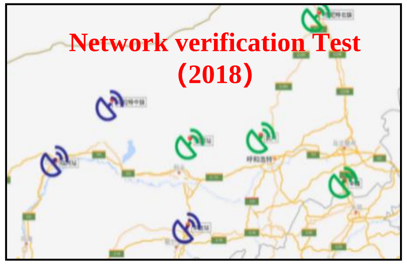
Prototype verification test（2018）

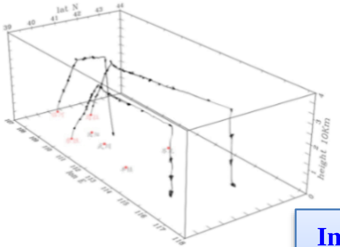



Observation test result

It was deployed in three stations in Inner Mon-golia, and a small scale networking test was carried out for the first time

Network verification Test（2018）

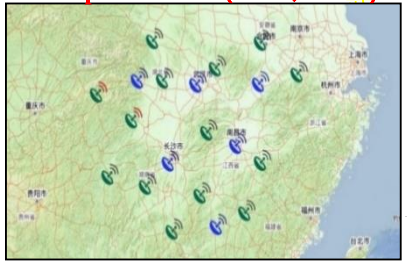


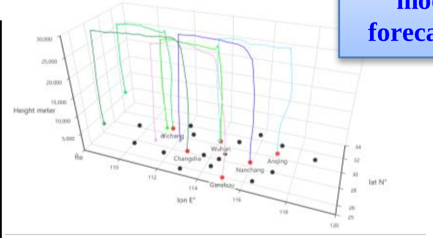



Implications for regional model forecasting

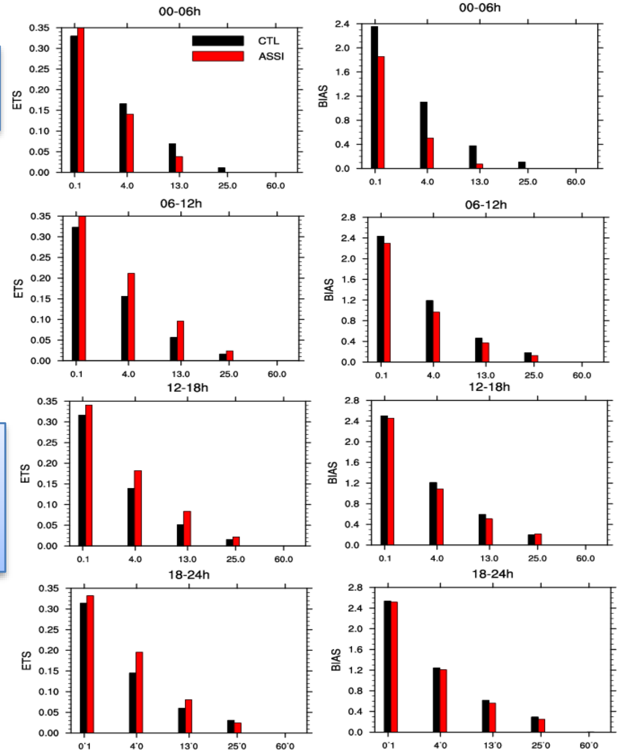
Regional networ-king experiment in the middle and lower reaches of the Yangtze River (over 600000 km², 13 months)

Interactive test of observation and prediction （2019、2021）






Development and influence of Round-trip Drifting Sounding System assimilation technology



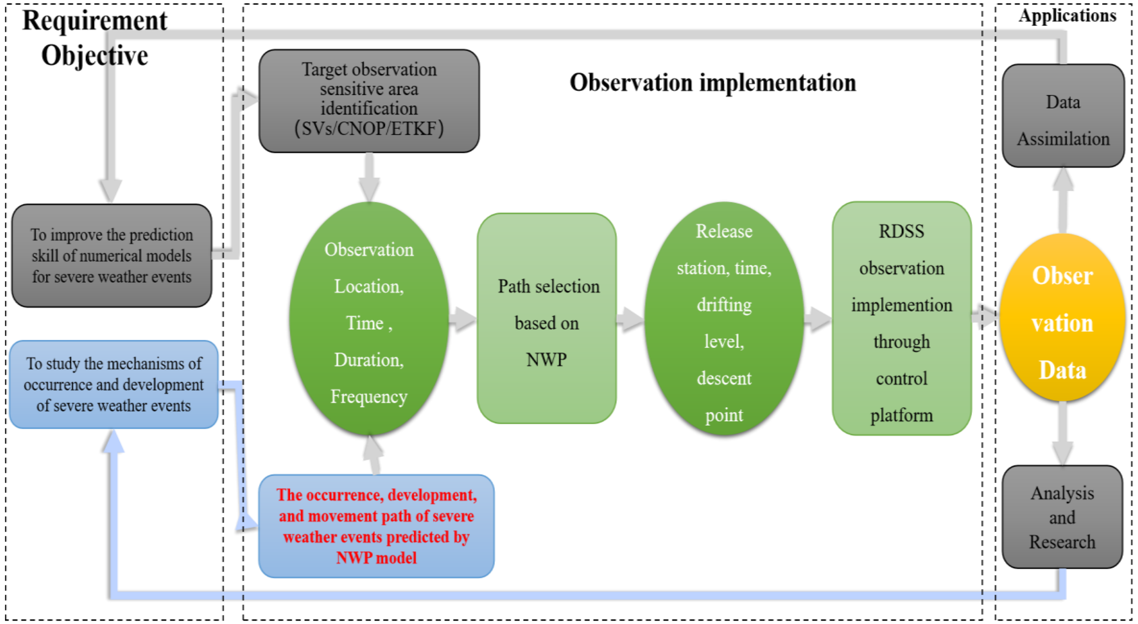

**Result benefit**：

- in the middle and lower reaches of the Yangtze River, an interactive experiment of sounding network observation and prediction has been carried out for 13 months in an area of more than 600,000 km²
- after assimilating, error of analysis field in the middle and lower reaches of the Yangtze River reduced 2% and the precipitation forecasting technique improved 1%

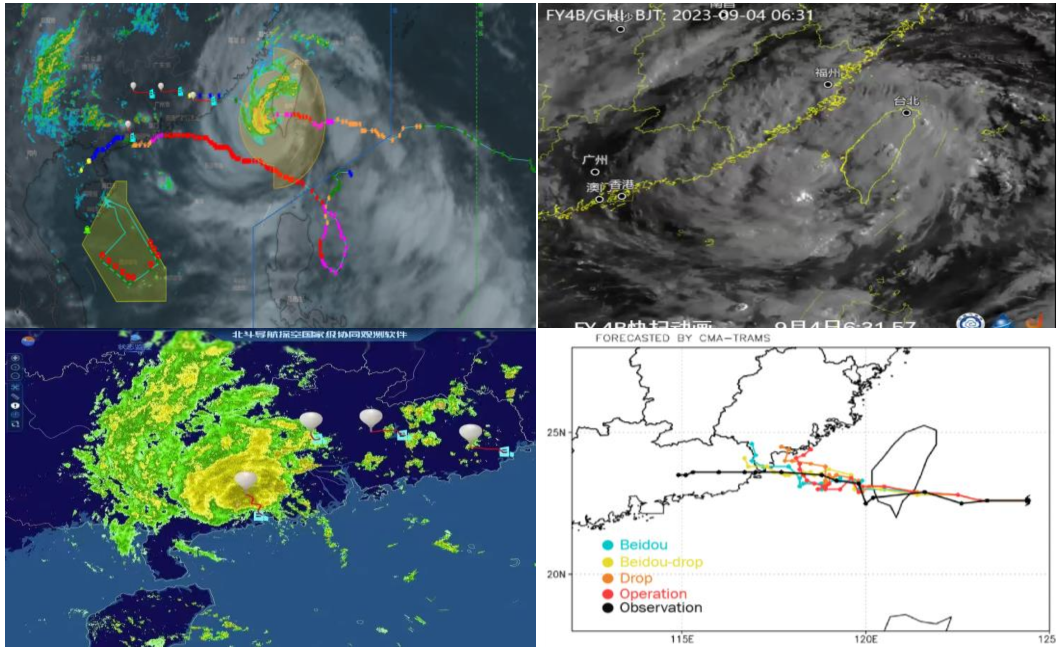
# II.Round-trip drifting sounding system(RDSS)

## 2.6 Typical target observation and assimilation applications

- drift-descent observation can achieve  intensive scientific sounding and collaborative observation
- Radiosondes can be controlled to implement target observation in a specific area, to achieve observation and NWP linkage.




RDSS interactive process of observation and NWP

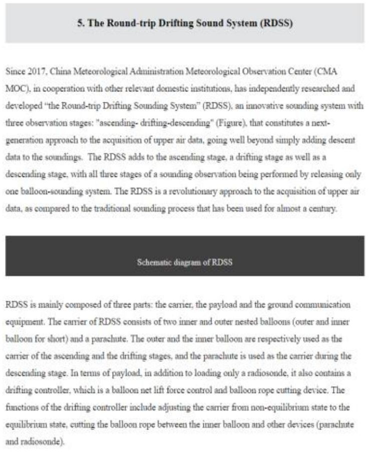


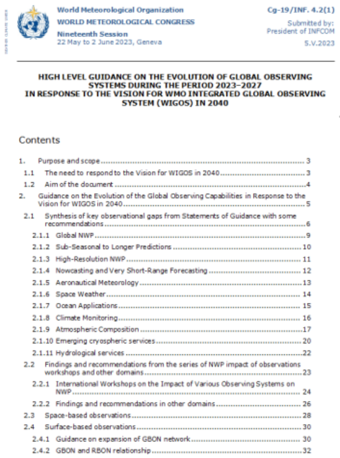

At 12:00 UTC on September 3, Affected by Typhoon "Haikui" carried out the Beidou RDSS observation in the Guangdong 4 upper-air sounding stations.and the 60-90 hour track forecast is improved, and the 72 hour and 90 hour track errors are reduced by 66.8km and 82.4km, respectively

# II.Round-trip drifting sounding system(RDSS)

## 2.6 Technology promotion and sharing

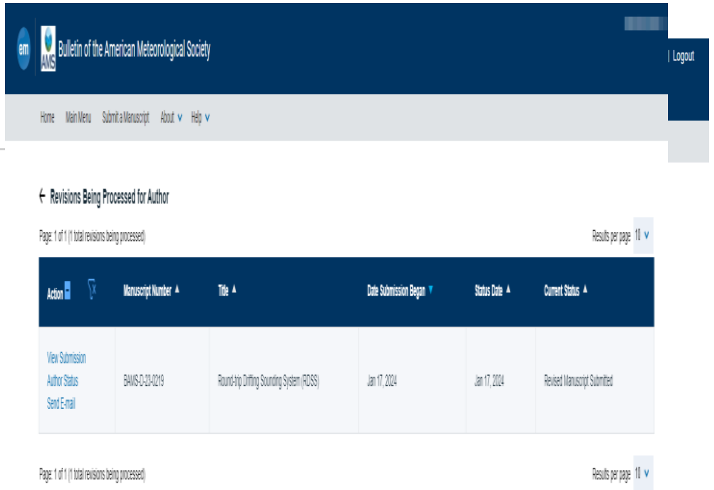
- RDSS was presented to WMO Secretariat in October 2022, published in wigos Newsletter Vol.9 No.1 in January 2023
- In March 2023, it was written into the WIGOS 2040 high-level guidance document to emphasize new technologies
- RDSS review paper has been submitted to BAMS journal, hoping to further promote the application and promotion
- CMA will actively contribute experts to promote and demonstrate use of RDSS in WMO specifications and guidelines


Cg-19/INF. 4.2(1), p. 49

| Recommendations to Members on the Evolution of Observing Systems 2023–2027 | | |
|---|---|---|
| Action No. | | Performance monitoring |
| 2.11 | Develop innovative in situ profiling techniques that can provide cost-effective and extended upper-air measurements | Application of innovative measurement techniques, such as Round-trip Drifting Sounding System |




WIGOS Newsletter 2023:Vol.9 No.1

Cg-19 4.2(1):HIGH LEVEL GUIDANCE ON THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS DURING THE PERIOD 2023–2027

BAMS journal website submission

# That's all. Thanks again

*We need help from GCOS，WG-GRUAN and LC-GRUAN...*

*guide to certification of XLH site and GTH3 radiosonde.*

***Contacts:***

***Organization management: Zhang Xuefen(Sophyzxf@163.com)、Dabu Xilatu(24893403@qq.com)***

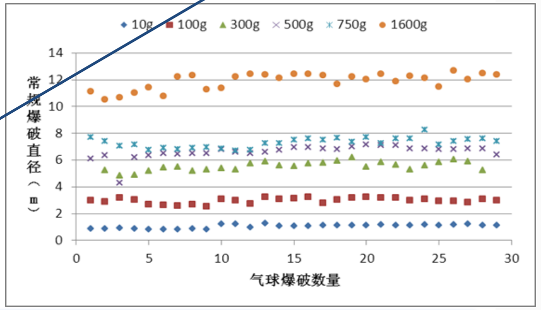
***Project implementation: Guo Qinyun(feng_cloudy@163.com)、Luo Haowen(luohw_1@163.com)***

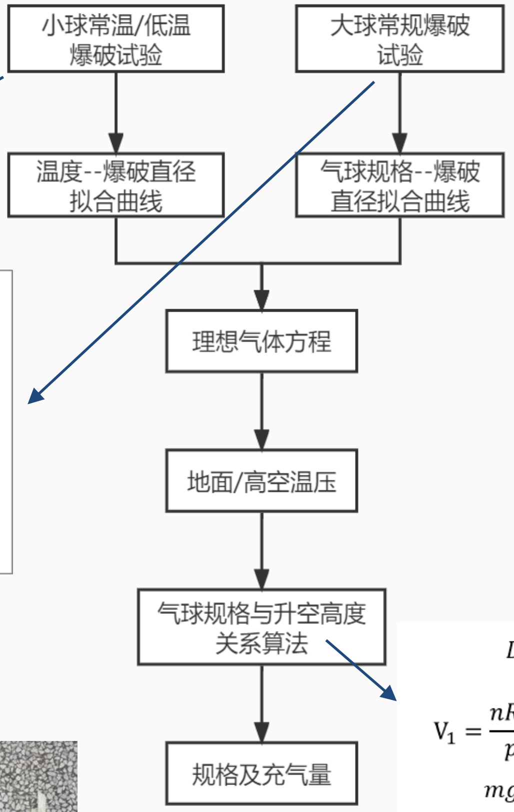
***Scientific research: Bian Jianchun(bjc@mail.iap.ac.cn)***

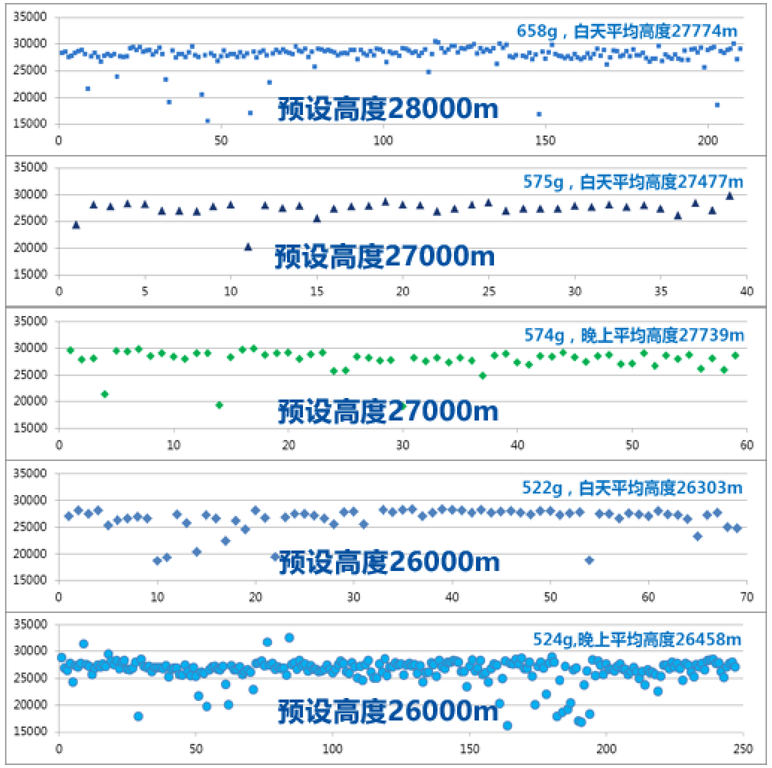
➢On the basis of the relationship between balloon size and explosion diameter, an algorithm of the relationship between balloon size and take-off height is established by introducing temperature coefficient.

低温爆破试验及曲线拟合

常规爆破试验及曲线拟合




**control of Ball handle**

控制前

控制后

$$D_1 = \omega D$$

$$V_1 = \frac{nRT_1}{p_1} = \frac{4\pi\left(\frac{D_1}{2}\right)^3}{3}$$

$$mg = \rho_H g V_0$$

$$n = \frac{p_0 V_0}{RT_0}$$

气球规格与升空高度算法

$$0.371M^{0.464}(-6.833*10^{-5}t^2-0.002t+0.991)=2\sqrt[3]{\frac{3mp_0T_1}{4\pi\rho_H T_0 p_1}}$$

**引入气球爆破体积在低温下的下降系数ω**