Task Team Radiosonde

- Progress Report for April 2011-March 2012 -

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ICM-4, Tokyo, March 2012

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1. Introduction: Task Team Radiosonde

- Provide guidelines for the GRUAN on how to obtain the best possible, reference quality data from radiosoundings

- Evaluate radiosonde data products on the basis of the GRUAN specifications

- Survey radiosondes and sensors (in particular considering their performance in intercomparisons)
- Review the uncertainty analyses and correction algorithms
- Recommend radiosonde launch procedures and metadata to be collected
- Draw conclusions on the suitability of radiosondes, specific sensors, procedures, and algorithms for the network

- Promote scientific efforts for assessing and improving radiosondes
- Recommend measures for ensuring long-term stability of radiosonde records.
- Provide input to the GRUAN manual by defining launch procedures and pre-launch checks that need to be followed by the sites

2. Membership & co-chiar issue

Name	Affiliation	Status
Masatomo Fujiwara	Faculty of Environmental Earth Science, Hokkaido University, Japan	co-chair, member of WG-ARO
Franz Immler	GRUAN lead centre, Deutscher Wetterdienst, Lindenberg Meteorological Observatory, Germany	co-chair
Rolf Phillipona	MeteoSuisse, Switzerland	
Joseph Facundo	Observing Systems Branch, NOAA, USA	
Carl Bower	Office of Climate, Water and Weather Services, NOAA, USA	
Frank Schmidlin	NASA/GSFC/WALLOPS Flight Facility, USA	
Alexander Kats	Central Aerological Observatory/KOMET, Russia	
Hannu Jauhiainen	The Association of Hydro-Meteorological Equipment Industry, Finland	HMEI representative
Michael Hicks	Howard University, USA	
Larry Miloshevich	MILO-Scientific, USA	
Rigel Kivi	Finnish Meteorological Institute, Finland	
Nobuhiko Kizu	Japan Meteorological Agency, Japan	
LI Wei	China Meteorological Administration, China	

- Selection process of a new co-chiar was discussed within the WG-ARO
- In short. . .
  - A new co-chair will be elected from the task team members
  - The WG-ARO co-chairs make the final selection

3. Updates for the Tasks

1. Review of the WMO Intercomparison report
2. RS92 data product document (TD4)
3. RS92 pre-launch procedure (TD5)
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3-1. Review of the WMO Intercomparison report

- **Milestone:** *Lessons from the WMO report are summarized, and review is made from the GRUAN viewpoints*
- **Main Contact:** *Miloshevich and Philipona*
- **Due Date:** *End of 2011*
- **Status:** *Document done*

- **Progress:** *Review document is created; will ask the whole GRUAN community for comments/reviews just after the ICM-4*
- **Issues/comments:**
  - *After the reviews, this will be a GRUAN Special Report (SR) (not a TD)*

WMO INTERCOMPARISON OF HIGH QUALITY RADIOSONDE SYSTEMS

Yangjiang, China, 12 July - 3 August 2010

J. Nash (United Kingdom)
T. Oakley (United Kingdom)
H. Vömel (Germany)
LI Wei (China)

WMO INTERCOMPARISON OF HIGH QUALITY RADIOSONDE SYSTEMS
YANGJIANG, CHINA,
12th July to 3rd August 2010

Published in May 2011

Instruments and Observing Methods Report No. 107, WMO/TD-No. 1580, **238 pp. (with many many figures . . .)**

13 "latest" radiosonde types participated in the intercomparison

72 successful multiple radiosonde soundings were performed over the three weeks
(60 QRS and 12 SSI soundings)

A total of **102** people were involved.

The Report discusses:

- Description of the systems tested
- Procedures – radio-frequency, preparation and launch, balloon performance
- Data collection, processing and editing

- Comparison of simultaneous temperature measurements
- humidity measurements
- geopotential height measurements
- pressure measurements
- wind measurements
- Conclusions & Recommendations

GRUAN Radiosonde Task Team
Review Report on the WMO Instruments and Observing Methods, Report No. 107, WMO/TD-No. 1580, 2011

- This review report (only 15 pages) summarizes lessons from the WMO report (238 pages) that are relevant to GRUAN and its goals.

- The review report is organized into the following sections:
  - (1) Recommendations for improving radiosonde T and RH measurements.
  - (2) T and RH corrections used by manufacturers in their standard data products.
  - (3) Other radiosonde measurements (GPS, pressure, altitude, winds).
  - (4) Evaluation of the "scientific" (reference) sensors.
  - (5) Other lessons and recommendations concerning the WMO intercomparison and report.

- In the following, we pick up some of the key points of the review report

(1) Recommendations for improving radiosonde T and RH measurements

- Manufacturers make software interpolations for missing/unreliable measurement points
- → should flag out the data and not report anything

- For temperature sensors:
- Evaporative cooling errors occur after passing through low clouds (inversion structures not easy to measure!) → hydrophobic coating minimizes these errors
- Heat contamination from own sensor support and payload and/or from the rig (→ task on the multi sounding configuration)

- Both T and RH sensor, calibrations should be carried out down to -100C to avoid calibration bias in the tropics (e.g., -100C for Meteolabor T, -90C for Vaisala T and RH, etc.)
- The choice of equation for saturation vapor pressure over liquid water is a critical concern for RH calibrations at low temperatures (the equations only by Wexler (1977), Hyland and Wexler (1983), or Sonntag (1994) are recommended)

(2) T and RH corrections used by manufacturers in their standard data products **(for T)**

- There are two common software temperature corrections:
- (1) solar radiation correction (vary from 0.6C to 2.3C at 10 hPa)
- (2) filtering of spurious heating pulses from sensor supports and/or radiosonde body heated by the Sun

- This filtering should depend on the flight configuration/condition → may create additional uncertainty in the daytime

- Lockheed-Martin Sippican (LMS) Multithermistor uses an "active correction" based on solving equations for sensors of different emissivity/absorptivity, to consider different cloud and radiation environments
- But, a warm bias is indicated
- → needs further study & documentation of the calculation method and uncertainty evaluation to be a "reference"
- (What/how should we do to convince LMS to follow the GRUAN concept?)

(2) T and RH corrections used by manufacturers in their standard data products **(for RH)**

- Manufacturers have only recently begun to apply software corrections to RH measurements for:
- (1) slow sensor response time ("time-lag error")
- (2) solar radiation dry-bias error (solar heating on the RH sensor)

(1)

- Some sensors are very slow, and corrections are very large and probably not trustworthy; some methods can amplify noise
- WMO report says, “the result looked reasonable in 65% of the cases, and quite wrong in 35%”

(2)

- Some manufacturers directly measure the temperature “near” the RH sensor using a dedicated temperature sensor → preferable and recommended, but still needs further study
- Other manufacturers use a software correction where the actual temperature of the RH sensor is estimated or an RH adjustment is applied

- In general, software corrections may not work in different locations/seasons with different cloud/radiation characteristics → solutions on the hardware desirable

(3) Other radiosonde measurements (GPS, pressure, altitude, winds)

- 10 operational radiosonde systems used GPS; only 1 used pressure sensor
- The same GPS method by different manufacturers gives different results due to:
  - Wrong surface altitude
  - Bugs/misunderstanding in the equations
  - Different algorithms to detect the launch time (1 sec diff. → 0.6 hPa diff. at surface)
  - Different algorithms to treat the first few minutes after the launch when the GPS signal reception is rather unstable
  - Different algorithms for horizontal winds to filter out and smooth the oscillations due to rotating pendulum motions of the payload

- WMO report concludes that "there is no need of a pressure sensor anymore for operational GPS radiosondes"
- At upper levels, GPS-derived height and pressure (+/-0.1~0.2 hPa in the stratosphere) have superior reproducibility and lower random error
- However, CIMO accuracy guidelines for pressure must be relaxed to 1.5 hPa near the surface (currently 0.5 hPa throughout, but this is not achievable by GPS)
- Therefore, it may still be desirable to retain an independent pressure measurement

- For winds: Algorithms filtering out the influence of pendulum motions are used
- → but, different flight configurations create oscillations with different freq. and amp.
- → thus, the algorithms currently applied may not work for different situations

(4) Evaluation of the "scientific" (reference) sensors

- LMS Multithermistor:
- “Full documentation about the uncertainties of the Multithermistor instrument is necessary before it could usefully be used for temperature measurements in GRUAN”

- Meisei MTR (tungsten-wire temperature sensor) :
- This very fast-response, 6 Hz temperature sensor reveals transient effects, namely, positive and negative pulses probably mainly result from the bamboo rig → consideration is needed for multi sounding configuration

- Cryogenic Frostpoint Hygrometer (CFH):
- “Excessive controller instability” was found; this is probably due to the manufacturer change . . . we should watch for any quality changes
- There is an unexplained wet bias of the CFH in the lower troposphere, possibly associated with the region where the dewpoint rather than the frostpoint is measured
- Determining the altitude where contamination becomes significant seems somewhat subjective
- Note: Using CFH for RH (MR) requires accurate T and P (P) measurements, and it would be good if better T and P sensors could be used

(5) Other lessons and recommendations concerning the WMO intercomparison and report

- GRUAN uncertainty estimation standards need suitable vertical resolution requirements
- For instance, what vertical resolution is required for RH, 250 m, 500 m, 1 km?

- For GRUAN RS92 data product, a documentation is needed for, e.g.:
  - all applied corrections
  - general treatment of outliers
  - filtering of spurious heating pulses/oscillations
  - factors related to geopotential height, pressure, and winds from GPS
- . . . because all details of the data processing matter

3. Updates for the Tasks

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3-2. RS92 data product document (TD4)

- **Milestone:** *GRUAN RS92 data product is documented*
- **Main Contact:** *(Fujiwara)*
- **Due Date:** ---
- **Status:** *partly done?*

- **Progress: "***TD4" had been prepared by the Lead Centre, and review was made by some WG-ARO members*
- **Issues/comments:**
  - *TD4 is a simple documentation on the file format, information content, etc.*
  - *We need another document to describe the detailed information how the "GRUAN RS92 data product" is created and to explain the uncertainty estimation method for this product.*
  - *For this purpose, we will also need a project to intercompare Vaisala RS92 data product and GRUAN product or even to validate the GRUAN product.*
  - *Lead Centre will lead this project, and our task team will help them (by reviewing or even participating the project)*

3-3. RS92 pre-launch procedure (TD5)

- **Milestone:** *Review of the pre-launch ground-check/ground-calibration procedures & suggestion for the actual procedures at GRUAN sites*
- **Main Contact:** *Immler → . . . → a new person will be assigned*
- **Due Date:** *ICM-4*
- **Status:** *under work*

- **Progress:** *Immler and Miloshevich prepared a document as TD5; review is being made within the task team.*
- **Issues/comments:**
  - *Current version only explains Vaisala procedure, Lead Centre procedure, and Milo-Scientific procedure.*
  - *Missing perspective in TD5 is to gather the current status information from all the GRUAN sites (what they are actually doing as the laboratory checks).* (by communicating with Task Team Site)
  - *This task might be related to the GRUAN surface observation requirement (for launch condition data acquisition)*

3-4. RH time-lag correction issues

- **Milestone:** *Various time-lag correction schemes will be compared to create the best correction scheme for GRUAN*
- **Main Contact:** *Immler, Kats, Miloshevich*
- **Due Date:** *End of 2011*
- **Status:** *Not yet started*

- **Progress:** *Not yet started*
- **Issues/comments:**
  - *This task is considered to be included/merged in the task on RS92 data product (and uncertainty evaluation) document.*
  - *We also need representatives for the GRUAN correction and the Vaisala correction (and NOAA NWS correction as well?) to make the RH intercomparison to be complete.*
  - *(Note: For future reference, the comparison method will need to consider whether the time-lag correction is done before or after other corrections such as T and RH radiation corrections.)*

3-5. Multi sounding configuration

- **Milestone:** *Recommendation for the multi sounding configuration is made for GRUAN*
- **Main Contact:** *Jauhiainen*
- **Due Date:** *ICM4*
- **Status:** *Under work*

- **Progress:** *A questionnaire has been sent to the GRUAN community (including HMEI) to gather the information on their multi-sounding experiences*
- **Issues/comments:**
  - *Need more time to get the response and to prepare a document*
  - *(→ filtering algorithms for temperature and winds)*

3-6. Use of descent data and control descent

- **Milestone:** *The use of descent data and controlled descent for GRUAN sounding is discussed in a document*
- **Main Contact:** *Philopona, Hurst et al.*
- **Due Date:** *ICM4*
- **Status:** *Under work*

- **Progress:** *Regular descent sounding is made at Boulder and Lauder. Some experiments were made at Lindenberg, Payerne, NCAR, and in some other research projects*
- **Issues/comments:**
  - *Still in the experimental phase.*
  - *Brief report will be made during the site report session*

3-7. RS92 auto-launcher influence

- **Milestone:** *Influence/effects of using the auto-launcher system is documented*
- **Main Contact:** *Kivi et al.*
- **Due Date:** *ICM4*
- **Status:** *Under work*

- **Progress:** *Information is being summarized at Sodankyla (Kivi), Potenza (Madonna), and Tateno (Kizu)*
- **Issues/comments:**
  - *Brief report will be made during the site report session*
  - *offline discussion will be made for a summary document*

3-8. Chilled-mirror hygrometer data product document

- **Milestone:** *A GRUAN Technical Document is prepared, which include the information on the uncertainty estimation method*
- **Main Contact:** *Voemel, Hurst, Philipona, Fujiwara*
- **Due Date:** *End of 2011*
- **Status:** *Under work*

- **Progress:** *A preliminary document is being prepared as a start.*
- **Issues/comments:**
  - *Hurst and Voemel have a time slot for relevant presentation tomorrow*

Summary

1. Introduction
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3. Updates for the Tasks
    1. Review of the WMO Intercomparison report (→review)
    2. RS92 data product document (TD4)
    3. RS92 pre-launch procedure (TD5) (→substantial additions?)
    4. RH time-lag correction issues (→RS92 product publication by LC)
    5. Multi sounding configuration
    6. Use of descent data and control descent (→still in experimental phase)
    7. RS92 auto-launcher influence
    8. Chilled-mirror hygrometer data product document