GRUAN Radiosonde Task Team's Task

Guidance for Multi-Payload Launches at GRUAN Sites

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GRUAN 5th Implementation and Coordination Meeting
De Bilt, Netherlands
25th February – 1 st March 2013

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Background and task objectives

- Background
  - For GRUAN observations, it is essential to control the data continuation at all times, including when there are any possible changes in the instruments
  - Data continuation is ensured by overlapping observations performed with dual/multi-sounding arrangement.
  - The currently measured parameters are temperature, water vapor, pressure, wind, and height, and the flight arrangement may have specific effects on the measurement of these parameters

- Objectives
  - From GCOS-149, 2011-12 GRUAN Work Plan: Develop best practice guidance for multi payload launches / Radiosonde Task Team
  - To adapt and take into use uniform methods for sonde-balloon rigging for GRUAN radiosonde observations.
    - GOAL 1: To agree on methods for sonde-balloon rigging for GRUAN radiosonde observations.
    - GOAL 2: To prepare instructions for sonde-balloon rigging
    - GOAL 3: To identify and to determine measurement uncertainty components on agreed rigging methods.

Goal: minimization of bias and deviation

Goal is to get the guidelines for dual (multiple) payload launches that

- 1) Minimize arrangement originated BIAS between the compared instruments
  - Data for the data continuity analysis should be valid
- 2) Reduce DEVIATION to level where less soundings would give statistical significant results
- 3) Minimize arrangement originated part of the measurement total uncertainty
  - Minimize ”Common mode BIAS” between the instruments and the ”truth”
  - Minimize ”Common mode BIAS” between the instruments and the other observation methods
  - This is important when the data is used also as official GRUAN data
- As a given - launces should be made safely and with high reliability in various weather conditions

Uncertainty components of multi-payload launches

- Balloon (size, type)
  - Ascent rate and balloon movements
    - May have an effect to ventilation -> bias/deviation
    - Effect to the wind measurement (deviation)
  - Thermal wake
    - Adiabatic cooling, IR-cooling and day time solar heating
    - Deviation and possibly bias against other observation methods or from the ”truth”
  - Moisture evaporation at high altitudes
  - Radiation effects?
- Main string
  - Used for extending an instrument from the balloon wake.
  - What is the sufficient string lenght with different balloon sizes and payloads?
  - String material moisture absorption properties (minor)

Uncertainty components of multi-payload launches, cont.

- Flight train
  - Parachute (size, type), train regulator/unwinder and radar reflector mutual order and distances may effect to the instruments movement and ventilation

- Rig
  - Material properties , dimensions and color
    - Thermal wake when instruments are hanging
    - Effect to ventilation when instruments are fixed to rig
    - Moisture absorption and collection at low altitudes and evaporation in the stratosphere?

- Instruments assembly to rig / flight train
  - Various effects to instrument ventilation
  - Effects of instruments mutual interference (horizontal distance)
  - etc.

Questionnaire sent to GRUAN stations

General Drawing

- "Big picture" of the whole rigging setup
- What are the components in the setup
- Order and distance between the components
- What type of connections are used between the components (knot, string, tape…)

General Information

- Site, instruments. Number of instruments
- Any general-level information about the setup, recommendations, limitations
- Viewpoints related to weather conditions

Detailed Description on Components

- Description on the components, if applicable:
  - Balloon, parachute, unwinder, radar reflector, other components
  - Main string length and type. Supporting strings arrangement
  - Rig dimensions and material
  - Radiosondes attachment to rig: freely hanging/taped/else

Received rigging information from the sites

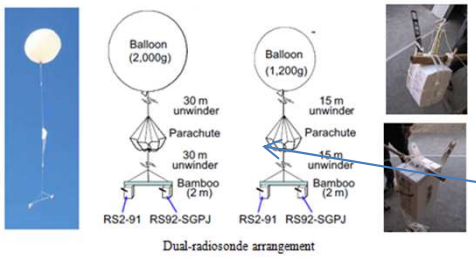
- Rigging information / comments received from several sites (Beltsville, Boulder, Lindenberg, Payerne, Tateno, Sodankylä), from WMO Radiosonde intercomparisons and from some manufacturers. There is use for more ....

Example from Tateno site

MULTI-PAYLOAD RADIOSONDE SOUNDING EXAMPLE（Tateno, JAPAN）

General Information
Site / organization: Tateno / Japan Meteorological Agency (JMA)
System setup for dual-radiosonde arrangement
Multi-payload launches are carried out in case they can be presumed to fall at sea.

General Drawing
Balloon(2000g or 1200g) - Unwinder (string length 30 m or 15m) - Parachute - Unwinder - (string length 30 m or 15m) - knot - supporting strings for rig – rig(bamboo 2m) - radiosondes attached with strings or band to rig



Dual-radiosonde arrangement

Detailed Information:
Balloon type :JMA-B2000/JMA or JMA-B1200/JMA Nominal ascent rate 6 m/s.
Parachute: JMA-P170/JMA parachute 170, JMA-P120R/JMA parachute 120 for rain
Unwinder: UW-J15/15m JMA Unwinder
Main string: 60 m for 2000g balloon, 30m for 1200g balloon
Support strings: Triangle-shape string arrangemet for balancing the rig
Rod: Banboo rod (2 m for dual-radiosonde, 3m for triple-radiosondes).
Radiosondes' attachment: Directly bind to rig with string or plastic band

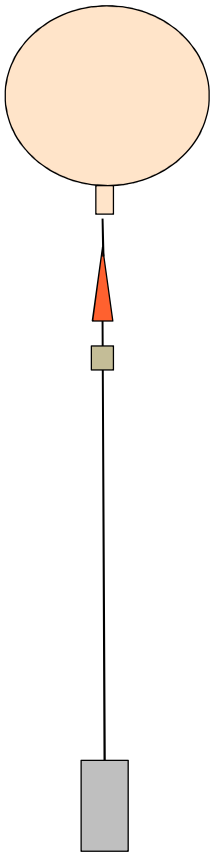
Descriptions
Drawings
Photos

are valuable information

Rigging alternatives review

- Following rigging alternatives describe some potential effects to the measurement performace, from theory basis, without analysis of the effect propability or severity
- Some effects are related to bias term, some may cause increased deviation for comparison data
- In many cases the effects can be small in practice

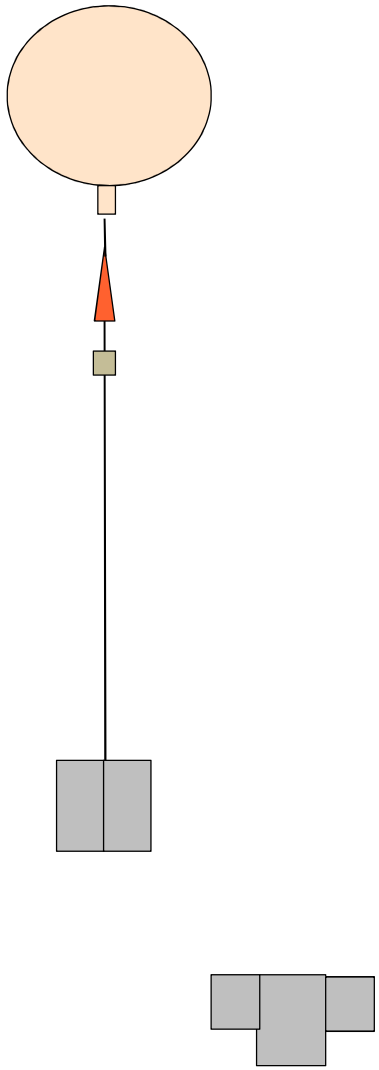
Single sounding, reference



PROPERTIES

- No elements close to an instrument affecting to the ventilation
- No elements close to an instrument collecting moisture or heat
- Instrument free rotation over the vertical axis
- All horizontal ventilation directions are evenly possible. Pendulum not affected by payload
- Due to small weight small balloon can be used

Instruments connected together, no rig

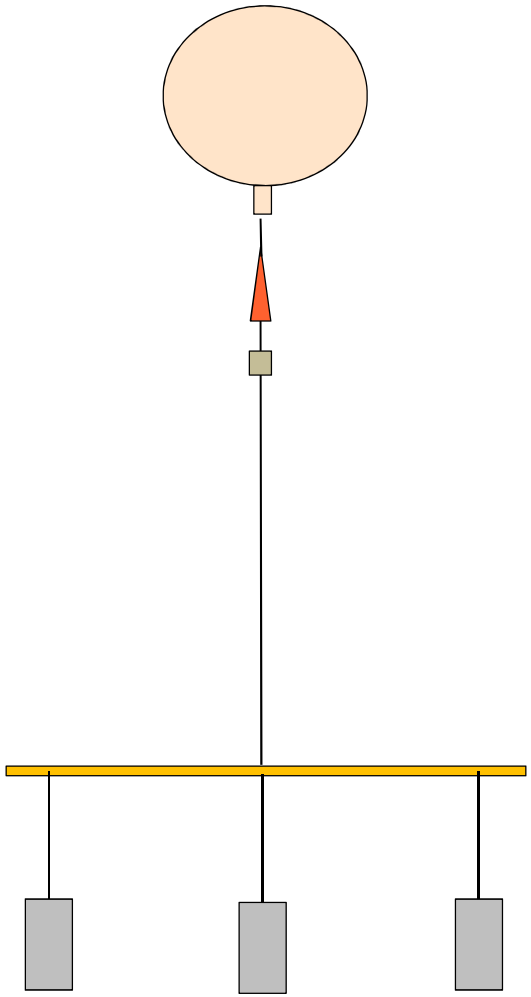


POSSIBLE EFFECTS, IN THEORY (*

- Larger top cross section and larger volume may reduce sensors ventilation
- Larger top cross section and larger volume may collect moisture or heat
- Combined package may have an effect to the radiation properties
- Slightly reduced rotation over the vertical axis due to increased momentum
- Non-symmetric package shape may have an effect to the horizontal flight direction (pendulum)

(* In addition to single flights

Instruments connected to rig, hanging

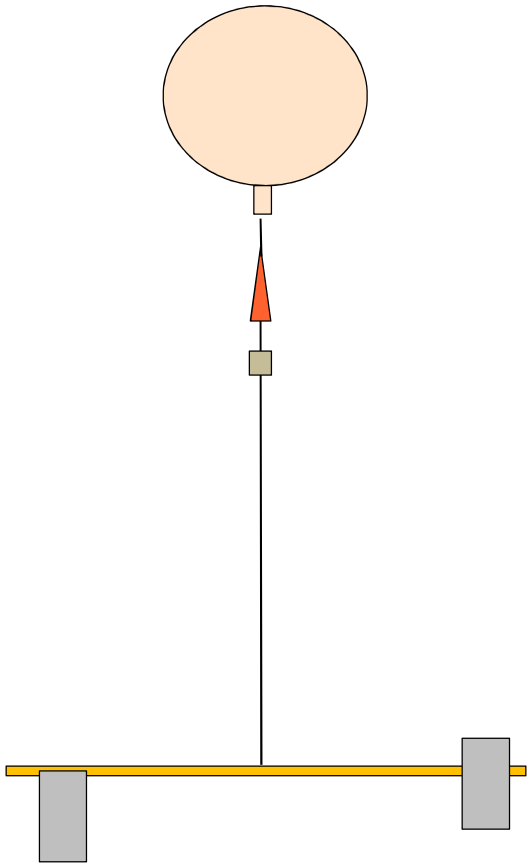


POSSIBLE EFFECTS, IN THEORY (*

- Slightly reduced rotation over the vertical axis due to short string between an instrument and a rig
- Rig may have an effect to the ventilation
- Rig may heat/cool the air flowing to the instruments
- Rig may moisten the air flowing to the instruments

(* In addition to single flights

Instruments fixed to a rig

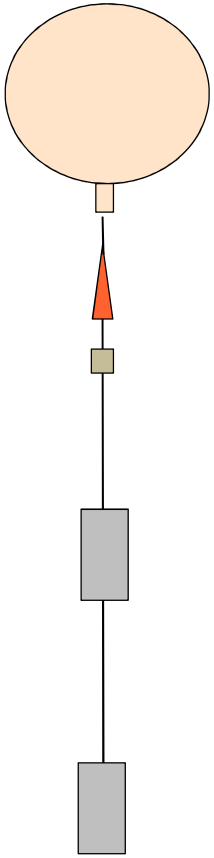


POSSIBLE EFFECTS, IN THEORY (*

- Reduced rotation over the vertical axis due to increased momentum
- May reduce instrument small scale movements and ventilation
- Rig may heat/cool or moisten the air flowing to the instruments, depending on the assembly

(* In addition to single flights

Instruments connected to string vertically

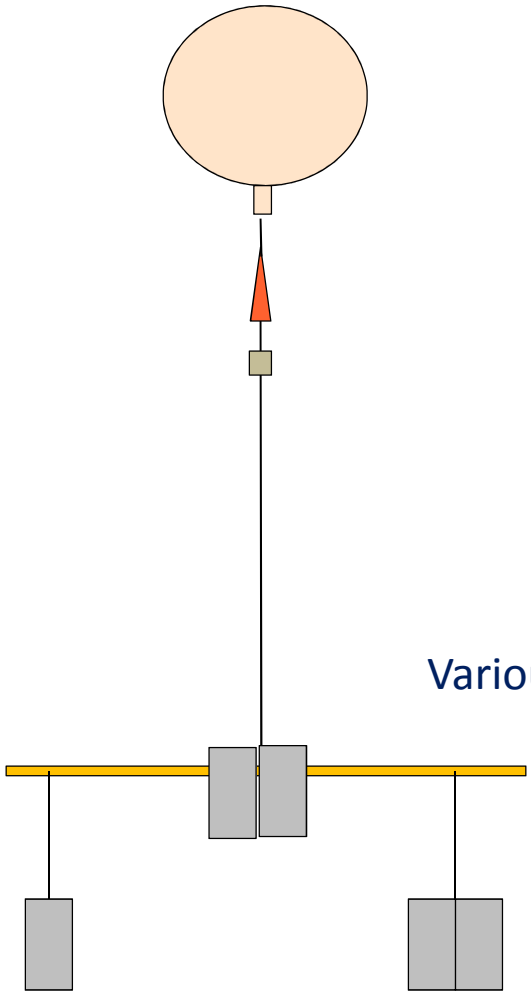


POSSIBLE EFFECTS, IN THEORY (*

- Higher instrument may cause thermal wake and effect to lower instrument measurement
- Higher instrument may reduce ventilation of the lower instrument
- Slightly reduced rotation over the vertical axis
- Some challenge in data synchronization on timely basis

(* In addition to single flights

Combined assembly



Various combinations

POSSIBLE EFFECTS, IN THEORY (*

- Features as in lighter assembly solutions. However heavier payload and more rigid fixing may enforce the effects

(* In addition to single flights

Next steps

Specified in the GRUAN Implementation Plan 2013-2017

- (D3) A document detailing the operational challenges related to multi-payload soundings submitted either to peer reviewed literature (first choice) or to WG-GRUAN for review as a TD. D3: Drafted August 2013

Actions

- Continue collecting information on used rigging methods. In addition collect data and understanding why different methods are favoured or not. Collect information on specific requirements of instruments
- Review the existing literature
- Evaluate magnitude of measurement uncertainty components for various potential rigging methods (qualitative if not quantitative). This would also require flow and thermal analysis at some extent.
- Identify rigging methods that enable low measurement bias between instruments in comparison
- If needed, clarify the goals of this task and consider getting some more volunteers for this task either within or outside the TT1.

Thank you for your attention!