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Report of the Fourth GCOS Reference Upper Air Network Implementation and Coordination Meeting (GRUAN ICM-4)

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1. Introduction

The fourth GRUAN Implementation and Coordination Meeting (ICM-4) was held 5 – 9 March 2012 in Tokyo, Japan. The meeting was generously hosted by the Japan Meteorological Agency (JMA) at their headquarters with support from the U.S. GCOS Programme Office at the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Centre (NCDC), the NOAA Climate Programme Office (CPO) and the GCOS Secretariat at the World Meteorological Organization (WMO). The meeting also included a site visit to the JMA GRUAN site at Tateno.

The annual GRUAN meetings afford an opportunity for the Working Group on GRUAN (WG-GRUAN, formerly the Working Group on Atmospheric Reference Observations (WG-ARO)), operating under the GCOS / World Climate Research Programme (WCRP) Atmospheric Observation Panel for Climate (AOPC), the GRUAN Lead Centre, and representatives from initial and prospective GRUAN sites and other stakeholders to review progress to date, highlight issues and exchange views.

The meeting's main goals were to update participants on GRUAN progress and to discuss new developments (for agenda see Appendix 2), with a focus on:

- Discussion of the progress on the GRUAN Manual and Guide to Operations;
- Establishing links with the scientific and meteorological community;
- Progress of the GRUAN Task and Analysis Teams;
- Review and progress of the work plans for the GRUAN Lead Centre, the WG-GRUAN, and GRUAN Task Teams.

As in the previous ICMs, the meeting included a site visit with a guided tour of the suite of instrumentation operating at the Tateno aerological observatory, one of the centres for upper-air observations of JMA. The aerological observatory at Tateno has a nearly 100 year history and plays an important role for upper-air observations undertaken by JMA. Participants regarded the site visit as very valuable, allowing deeper insight into how JMA addresses GRUAN-related issues. Participants in particular appreciated the local staff's hospitality and willingness to answer questions.

Rather than being a full record of the meeting, this report summarizes and synthesizes key discussions and outcomes. All documents prepared in support of ICM-4, and all meeting presentations, are available on the GRUAN website at http://www.gruan.org (under Meetings: Tokyo 2012: Documents).

2. Opening notes

The meeting was honored by having an opening presentation made by Kiichi Sasaki, head of the observations division of JMA. Mr Sasaki extended a warm and cordial welcome to the meeting delegates and expressed his appreciation to GCOS for selecting JMA as host. He pointed out that the Tateno observatory has been making observations for nearly 100 years and is a very valuable element in the observing system of JMA. Mr Sasaki referred to the earthquake and tsunami of 11 March 2011, which caused great loss and suffering for Japan. JMA has been making all efforts to restore lost facilities and reduce the impact of future natural disasters through early warning systems and learning from previous experiences. He expressed his hopes that participants recognize the efforts by the staff of JMA to make this meeting a positive experience for GRUAN and that GRUAN can provide valuable data for climate research.

Hironobu Yokota and Greg Bodeker of the organizing committee discussed the agenda for the week, and expressed the meeting's gratitude to the organizers from JMA both for the venue, the trip to Tateno later in the week, and for the excellent logistics provided.

The chairman of the GCOS atmospheric panel, Adrian Simmons, expressed his gratitude to JMA for hosting the meeting. He further expressed his appreciation for general support that JMA had provided to GCOS over the years, in particular through membership of the Steering Committee and AOPC, through acting as a monitoring and regional lead centre and through hosting the World Data Centre for Greenhouse Gases. Prof. Simmons became involved in GCOS in 2002 when he started contributing

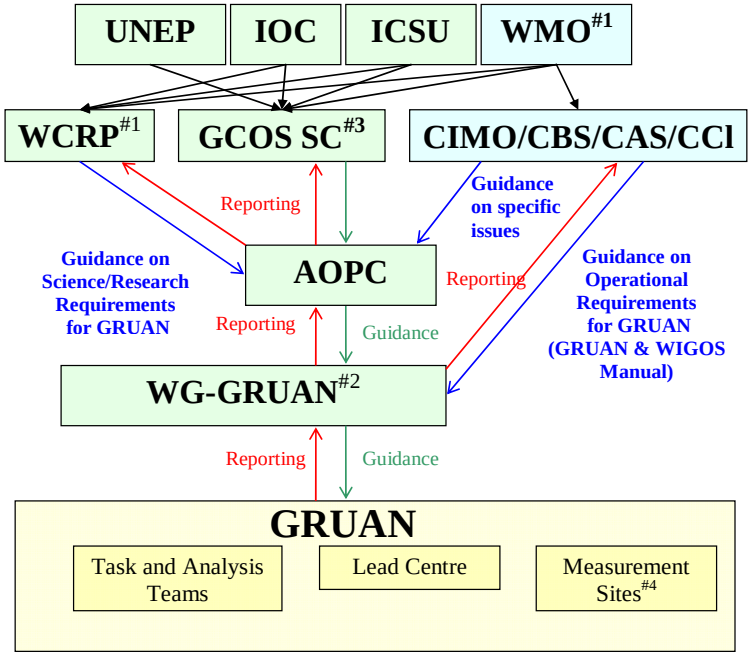
to the Second Adequacy Report (GCOS-48)[1]. In 2004, the first recommendation for the establishment of GRUAN was made. In 2006 he became chair of AOPC, at which time the WG-ARO, as it was known then, was formed. In 2007, it was decided to accept the offer of the German Meteorological Service, Deutscher Wetterdienst (DWD), to host the Lead Centre for GRUAN at the DWD observatory at Lindenberg. The President of the Commission for Instruments and Methods of Observations (CIMO) was then invited to be an ex-officio member of the WG-GRUAN. Tateno became a GRUAN site in 2009 and was the first new site beyond the initial set of sites selected. Prof. Simmons had been pleased to follow these developments of GRUAN, and congratulated all concerned. He noted that WG-GRUAN was a working group that really did work. In conclusion, he remarked that further expansion of GRUAN into unsampled regions such as South America and Africa was critically important, and remained a challenge.

3. Progress on advancing the GRUAN Implementation Plan

3.1. Review of the current management structure and linkage to WMO

The World Meteorological Organization (WMO) requested better representation of relevant WMO Technical Commissions within the GRUAN management structure. This topic was extensively discussed during the *WIGOS Expert Meeting on GRUAN Observing Practices and Governance* in January 2012 (GCOS-155)[2]. Benefits and potential drawbacks were evaluated and it was felt that the benefits of this change would outweigh the potential drawback of having an even larger WG-GRUAN. This opinion was shared at ICM-4 and the decision to expand the WG-GRUAN to include representatives from the WMO Technical Commissions was fully supported. Since the president of the Commission for Instruments and Measurements of Observations (CIMO) has been a member of WG-GRUAN from its inception, it was decided to also invite representatives from the Commission for Basic Systems (CBS), the Commission for Atmospheric Sciences (CAS) and the Commission for Climatology (CCL). The task of these representatives will be to provide guidance on operational requirements and other aspects, where WMO has extensive expertise and to report back to the relevant Technical Commissions on progress within GRUAN. This interface will allow a better flow of information between the GRUAN community and the Technical Commissions and strengthen the overall development of the global observing system.

This change is reflected in the updated management structure of GRUAN:



Notes

[1] GCOS-48: http://www.wmo.int/pages/prog/gcos/Publications/gcos-48.pdf
[2] GCOS-155: http://www.wmo.int/pages/prog/gcos/Publications/gcos-155.pdf

1. WCRP identifies scientific and research requirements for GRUAN, while WMO identifies operational requirements.
2. Composition of WG-GRUAN to be determined by the AOPC in consultation with WMO and should include:
   - one representative from each of CIMO, CBS, CAS and CCl; these representatives will be responsible for reporting back to their respective Technical Commission;
   - others (according to its Terms of Reference)
3. Global Climate Observing System Steering Committee.
4. GRUAN Measurement Sites are contributed by Members of WMO.

3.2. Status of implementation

The 2009-2013 GRUAN Implementation Plan (GCOS-134) was the guiding document for the progress achieved in the twelve-month period preceding ICM-4. The milestones and achievements were reviewed by Peter Thorne, co-Chair of WG-GRUAN, and discussed by the meeting attendees. Delays and changes to specific items in the Implementation Plan were noted; however, no significant deviations from the Implementation Plan were identified. It was stressed that maintaining the Implementation Plan is essential and that progress needs to be measured against the targets outlined in the Implementation Plan. The overall progress of action items decided upon during ICM-3 is summarized in Appendix 1.

A major modification of the GRUAN structure has been the introduction of a WG-GRUAN co-chair, which has been found to be effective. Communication between the co-chairs is efficient and keeps both co-chairs informed of the current status of GRUAN. The telephone conferences that are held every second month within the WG-GRUAN assure that the GRUAN community maintains its momentum and that important action items maintain the level of focus needed for completion.

The WG-GRUAN has grown significantly over the past twelve months and it is felt, by some, that the WG-GRUAN may be growing too large to be effective. Efforts will need to be taken to refine the purpose of the WG-GRUAN and the annual ICMs. However, it is important that WG-GRUAN members speak up and provide feedback, which is an essential element in keeping GRUAN focused.

The current Implementation Plan covers the period until 2013; however, it was recognized that the implementation of GRUAN will need to continue past this date. It was decided that the current Implementation Plan needs to be amended to cover the period until at least 2016 for GRUAN to become fully operational. This amendment will need to include action items that carry GRUAN through this transition period. The amendment to the Implementation Plan will need to be very specific and at the same time ensure that goals set are realistic. To avoid poorly posed action items, each task will need to have a responsible person or party (task team, analysis team or organization) identified up front and an expected completion date. Similar to the initial Implementation Plan it will be published as a formal GCOS document and is expected to be finished by October 2012, to be submitted to AOPC for formal consideration. As with the current Implementation Plan, it will be subject to evaluation and modification of tasks at ICMs, whereby progress and deviations will be documented in the meeting reports.

3.3. Lead Centre progress report

The Lead Centre reported on the recent developments within GRUAN from their perspective. The flow of data from Vaisala RS-92 radiosondes started in summer 2011 and is slowly increasing as more sites are being included in the data stream and data processing. This is expected to continue. New data streams from other instruments are also expected. The Lead Centre has worked with the representative of the site at Ny Alesund and supported the preparation of their formal site application. Communication with two additional potential applicant sites is ongoing.

The Lead Centre lost one member and has refilled this position. This transition has slowed operations. The small number of staff at the Lead Centre continues to be an impediment to the growth of GRUAN.

A number of software tools have been developed at the Lead Centre to support the monitoring of data flow and data availability as well as to improve the processing of the current Vaisala RS92 data product and to support the collection of lidar data products.

The Lead Centre is requesting feedback on the use of the data and the use of the public GRUAN material and is encouraging the use of the blog and the GRUAN web page for the sharing of

information. Voluntary user registration for GRUAN data has been introduced at the Lead Centre. Although not ideal, this tool will help to identify the user communities for GRUAN data. For details of the Lead Centre operations see Appendix 4.

4. Documentation

4.1. GRUAN Manual and Guide of Operations

The current draft version of the GRUAN Manual was extensively discussed and reviewed during the *WIGOS Expert Meeting on GRUAN Observing Practices and Governance* in January 2012 (see item 3 above). The overall structure and content found general acceptance; however, a significant number of changes were discussed and subsequently implemented. The most significant change was to separate the executive summary from the main text of the current draft. This executive summary now stands on its own as the GRUAN Manual and consists almost entirely of imperatives that parties to GRUAN 'shall' or 'will' do. The larger document is the GRUAN Guide of Operations and is somewhat less prescriptive in nature, reflecting that GRUAN will not consist of a set of identical sites taking absolutely identical measurements. The Manual and Guide were initially scheduled to be adopted at ICM-4. However, due to the changes agreed upon during the *WIGOS Expert Meeting,* formal adoption of the GRUAN Guide and Manual was delayed until a version including all modifications became available.

4.2. GRUAN documents

All GRUAN documents will be reviewed to assure high levels of standards within these publications. The reviews will be coordinated by the WG-GRUAN co-chairs with the assistance of a GRUAN document curator (Emma Scarlet at Bodeker Scientific). All documents, in particular those that regulate operations and procedures, and those that describe the current status of GRUAN processes, will need to be re-reviewed at some future date to avoid the information contained in these documents becoming obsolete. Each GRUAN document will therefore be assigned an expiration date at which time it will be re-reviewed and possibly revised. Only current versions of the documents will be served on the GRUAN web page. Older versions will be archived at the Lead Centre and will be made available on request.

The GRUAN Guide of Operations, which covers more specific regulations, will be reviewed/revised after 5 years. For the GRUAN Manual a review/revision will be required after 10 years. A number of additional trigger criteria were adopted by the WG-GRUAN and are documented in Appendix 12. The GRUAN document curator will maintain an inventory of all GRUAN documents including their required date of revision.

It was decided that in addition to GRUAN Technical Documents, there will be a series of GRUAN reports which will cover GRUAN related studies or research, that are of relevance or interest to the GRUAN community but will not be published in the general peer reviewed literature.

It is important that the authors of GRUAN documents are acknowledged since demonstrating involvement in, and contribution to, the writing of GRUAN documents may be necessary to justify authors' involvement to their superiors and to funding agencies.

It was stressed that the preferred route for GRUAN documentation remains the peer-reviewed literature, but it is recognized that not all documentation can or should appear in such a forum. Due consideration should always be given to the most appropriate form of documentation on a case-by-case basis.

4.3. Achieving operational status

GRUAN sites will collect high quality data which will be homogeneous over long time periods. These high-quality data will serve both the scientific and operational communities. One of GRUAN's strengths is the ability to reprocess historical measurements based on new knowledge which has been gained, to ensure the homogeneity of long-term time series. Here it is important to clearly distinguish GRUAN data from near-real-time data (see discussion below). GRUAN data include raw data and extensive metadata, which cannot be collected and processed in near-real-time. GRUAN processing also is

based on an instrument-specific central processing, which assures homogeneity in processing of all raw data across the network for each instrument type.

To make sure that GRUAN observations will be homogeneous over decades, operating procedures are required that guarantee that observations are being done consistently and repeatably. Any changes in instrumentation and operating procedures will have to be managed carefully. As has been documented in other reports, such changes could occur for logistical, technological or scientific reasons and GRUAN is not averse to change per se, particularly change that improves our ability to characterize the true state of the atmospheric column. But any changes do need to be planned, communicated and their effects clearly documented and adequately quantified.

Operational status also implies that a GRUAN station has a reasonable commitment to continue observations for decades. While no such commitment will be given in writing, strong institutional backing can be viewed as an indication that this can be achieved.

For GRUAN to be operational, a significant number of stations need to be operational and the coordination between sites has to be such as to assure that observations across the network are taken using nearly identical operating procedures. This will require capacity building and proper training to ensure that operators at sites perform their duties as required by the operating procedures.

It is important to emphasize that an integral part of GRUAN operations is the research that is being done at these sites. Therefore, research efforts are included in the definition of an operational GRUAN site and are part of the process of continuous improvements. The operational status of a site will be formally decided during the site certification process. This process, outlined in the Guide of Operations, recognizes that there can exist a range of GRUAN site capabilities but that certain minimum requirements do need to be met. Beyond that, the certification process is overseen by the WG-GRUAN and the guidance allows the WG-GRUAN to apply their expert judgment to the certification process.

5. The integration of GRUAN within the scientific and meteorological community

5.1. Involvement of instrument manufacturers

The cooperation with manufacturers of meteorological instrumentation is seen as essential in the development of GRUAN and communication with manufacturers is facilitated through the Association of Hydro-Meteorological Equipment Industry (HMEI) in cooperation with CIMO. HMEI had in discussions with the WG-GRUAN co-chairs identified that the TECO conferences are the most important trade fairs for manufacturers of hydro-meteorological instrumentation and it was recommended that CIMO, in cooperation with the Lead Centre, arrange for appropriate representation at the upcoming TECO conference in Brussels in October 2012. HMEI maintained that this would be more appropriate and get better attendance than the dedicated workshop idea that had been documented in the Implementation Plan. The aim of this involvement is to provide a forum for the GRUAN community to discuss GRUAN's long-term goals, needs, and activities with the manufacturers. Buy-in from the manufacturers is seen as essential for GRUAN and this forum is seen as an important step in this process. Attendance of some GRUAN representatives, however, will likely require identifying travel support to facilitate participation at that meeting.

5.2. Cooperation with other networks

GRUAN maintains close connections to a number of other networks, projects and activities, foremost the Network for the Detection of Atmospheric Composition Change (NDACC), to which close connections exist in a number of areas. The Microwave-Radiometer Network (MWRnet) is the leading partner in microwave observations. Traceability of observations to accepted standards is an essential component of GRUAN, and therefore, the cooperation with the metrology community in the framework of the Meteomet project is seen as vital. Furthermore, linkages to the reanalysis and satellite community have been established. It was recognized that building and maintaining links to other relevant programmes and activities was a process that needed to be constantly maintained, and that all ICM participants have a role to play as ambassadors and facilitators in such efforts.

5.3. Network design and expansion workshop

Following a decision at ICM-3, a workshop was planned to develop network design and expansion criteria. This workshop took place between 13 and 15 of June 2012 at Fürstenwalde, Germany. About 20 to 25 participants attended this workshop. Leading up to this workshop, white papers were prepared to formulate the needs and views of the scientific communities working on monitoring changes in climate, satellite calibration and validation, atmospheric process studies, and numerical weather prediction. The goal is to assess the needs of these communities in the expansion of the network and to provide strong arguments to approach potential new sites.

5.4. Links to the satellite community

The second overarching task of GRUAN is the validation of globally more comprehensive observing systems, in particular satellite systems. The Global Space-Based Inter-Calibration System (GSICS) provides fundamental satellite calibration through satellite-satellite methods. The Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) mechanism is interested in sustained development and intercomparison of satellite retrieved products. Both are potentially key partners. Predominant interests of the satellite community in GRUAN-like measurements are product (retrieval) validation and radiative transfer improvement through multiple high-quality measurements to estimate the atmospheric state at satellite overpasses. Approaches of this kind have already been tested in the context of Site Atmospheric State Best Estimates (SASBE). These methods consider the much longer ascent times of radiosondes compared to satellite overpasses as well as the drift of the radiosondes in space. Using ancillary measurements to interpolate in time and space may be helpful to overcome weaknesses. Descent data from radiosonde flights may also be useful in this regard.

5.5. Links to the metrology community

Andrea Merlone presented the efforts within the European MeteoMet consortium. This action by the metrology community aims to incorporate methods of traceability and standards within meteorological practices. One of the important activities is the development of cheap but traceable sensors. For water vapor the development of a low cost Tunable Diode Laser (TDL) hygrometer is envisioned. The cooperation with GRUAN is seen as important since the goals of MeteoMet and GRUAN are very similar. The meeting afforded the opportunity for the WG-GRUAN chairs and Meteomet to sign a formal agreement to further collaboration between the two organisations, and to formally accept Andrea Merlone's membership on the WG-GRUAN.

A key contribution from the Metrology community will be to ensure that GRUAN adopts the internationally accepted terminology for describing uncertainties in measurements as outlined in the *Guide to the Expression of Uncertainty in Measurement (GUM)*[3] of the International Bureau of Weights and Standards (BIPM). The presentation from the measurement scheduling Task Team emphasized that GRUAN should adopt the nomenclature of the GUM so that there is no conflict between GRUAN and other efforts such as standards of the International Organization for Standardization (ISO). The goals of the GUM are to a) describe the steps in the measurement progress and b) identify and quantify uncertainties. It is important that GRUAN does not attempt to re-define uncertainty. The GUM gives a very thorough framework of definitions that, when adopted, will put GRUAN on a solid foundation. Some efforts are needed to guarantee that the definitions being chosen are consistent within the GRUAN community.

A particular challenge in estimating uncertainties in atmospheric measurements is that repeated measurements of the measurand are nearly impossible to make. It is therefore important to give careful thought to what is actually being measured and that the output parameter will vary with the application of the data. Monthly means are commonly used for trend assessment; however, this does not allow looking at the scatter of individual results. In this regard, it is important not to confuse the variability of the measurements with the uncertainty of the monthly mean. The uncertainty expresses the range of values that describes the level of confidence. This level of confidence is associated with a statistical probability, which for GRUAN should be 95%.

[3] Guide to the expression of uncertainty in measurement, International Bureau of Weights and Measures, Working Group 1 of the Joint Committee for Guides in Metrology, 2008: http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf

5.6. User feedback

To make sure that GRUAN developments meet the needs of the users, feedback from users is seen as essential. An independent scientific advisory panel was proposed at the time of drafting the original GRUAN Implementation Plan. However, it was recognized that most of the experts capable of advising GRUAN are already engaged in the WG-GRUAN or one of the GRUAN Task Teams. Discussions suggested that GRUAN is more in need for an external review of data products, procedures and presentations and a user review might be more useful. This could be done through anonymous reviews or by asking colleagues from outside the GRUAN community. A review of selected aspects of GRUAN, such as the utility of the GRUAN data products was seen as more appropriate compared to a full review of GRUAN. This review could take place three years after data have started flowing. Early feedback from users, and potential users, of GRUAN data will ensure that GRUAN activities meet their target goals. The Lead Centre emphasized that any feedback provided to the Lead Centre is highly appreciated and that this will help keep GRUAN development focused on end-user needs.

5.7. Potential Surface Reference Network

Within GRUAN the need for reference surface observations has been expressed in previous meetings in an effort to tie upper air reference observations to reference observations at the surface and to understand the more globally complete surface component of the Global observing System (GOS). The GCOS Surface Network (GSN) is the equivalent to the GCOS Upper-Air Network (GUAN) and faces similar issues as GUAN in establishing long term reliable data sets. Howard Diamond gave an overview of the now decade old US operated Climate Reference Network (USCRN) and suggested that this could be viewed as a model for a surface reference network; noting potential challenges in expanding this type of operation to a global scale, considering the limited resources and the need for international coordination. There was unanimous agreement that a surface reference network is needed from a purely scientific perspective; however, it was also pointed out that establishing such a network would go far beyond the tasks of, and the resources available to, GRUAN. It was decided to defer a discussion on this topic to AOPC.

6. GRUAN research

Task Teams, in addition to the GRUAN Analysis Team on Network Design and Operations Research (GATNDOR) which had been formed at ICM-1, were formed at ICM-2 to support the development of GRUAN. The five existing Task Teams are: Radiosondes; Global Navigation Satellite System integrated Precipitable Water vapor (GNSS-PW); measurement scheduling and associated instrument-type requirements; ancillary measurements; and site representation. Each Task Team presented progress made since ICM-3 and discussed the planned activities for the upcoming year. There was unanimous agreement that the Task Teams are highly effective, that they do provide the essential support for the development of GRUAN and that they are the appropriate groups to address important issues within GRUAN. Nevertheless, cross-pollination between the different Task Teams should be strengthened to ensure that knowledge, skills and expertise developed within one Task Team, and where applicable in the work of other Task Teams, can be transferred to other Task Teams. This could be addressed at the time of ICMs and efforts should be taken to foster cooperation between Task Teams where common interests exist.

It was also expressed that the existing Task Teams are cooperating well with working groups of other networks focusing on similar topics. There does not appear to be any serious duplication of efforts and GRUAN Task Teams are effective in transferring experiences learned by other groups into GRUAN. At the same time, GRUAN Task Teams address deficiencies while cooperating with other working teams.

The suggestion was raised to form a new Task Team focused on metadata. This Task Team would ensure that metadata definitions and terminologies are uniform across GRUAN data products. Furthermore, this Task Team would address the problem of different metadata standards within different climate and forecasting communities. Finally, it was recognized that there are metadata which are not instrument specific but still important to capture in order to fully describe the site and understand the measurements and that these metadata need to be defined and the process of its collection clearly articulated. This Task Team should, at a minimum, include representatives from all other Task Teams. Cooperation with WMO is strongly recommended to support efforts to define metadata within the WMO Information System (WIS) and the WMO Integrated Observing System (WIGOS). It is imagined that this would initially be a strong Task Team to define metadata, but would

have a limited lifetime and cease to exist once uniform metadata collection and management had been effectively implemented across GRUAN. The establishment of such a Task Team however, was not decided upon at the meeting but deferred to WG-GRUAN for further consideration.

6.1. Task Team on radiosondes

Masatomo Fujiwara presented a progress report for the Task Team on radiosondes. Due to the departure of one of the Task Team co-chairs, the process to refill this position was discussed[4], but a decision was postponed until later. The status of several tasks was presented in greater detail.

- Review of the WMO Intercomparison Report:
  The review of this report was completed on time at the end of 2011. The 2010 WMO radiosonde intercomparison was a large scale intercomparison, with 72 multiple radiosonde launches and 102 people involved. The report made several recommendations which are repeated here.
  - To improve temperature measurements, evaporative cooling and heat contamination should be minimized by design improvements.
  - Both T and RH calibration should be carried down to -100°C and for RH, specific saturation vapour pressure equations should be used.
  - There are two common software temperature corrections applied as part of the post-processing, i.e. the solar radiation correction and the filtering of spurious heating pulses; the latter depends on the flight configuration and should be made transparent.
  - Recently, radiosonde manufacturers have started applying software corrections for RH measurements (for time-lag errors and solar heating errors), which in some cases may not be trustworthy. Some sonde manufacturers measure the temperature near the RH sensor, which is preferable and recommended; but further studies are still needed.
  - Wind measurement algorithms need to filter out the pendulum noise, which is an inherent limitation in the accuracy of horizontal wind measurements.
  - The LMS Multithermistor sonde uses an active solar radiation correction; however, it seems to exhibit a warm bias. The issue remains to convince Sippican to follow GRUAN standards.
  - During the campaign, ten systems used GPS to determine the vertical coordinate for all measurements while only one used a pressure sensor. Different manufacturers give different results due to a number of reasons. While the report concluded that there is no longer a need for a pressure sensor for operational GPS sondes, for GRUAN it is essential to have an independent pressure measurement, in particular, since pressure sensors provide better altitude registration at lower altitudes.
  - An important lesson for GRUAN was that uncertainty estimation standards require suitable vertical resolution requirements.

  Within the scientific instruments:
  - The LMS Multithermistor sonde showed a number of unexplained uncertainties.
  - The Meisei MTR temperature measurements showed a fast response, which could identify some rig contaminations.
  - In a number of soundings the Cryogenic Frostpoint Hygrometer (CFH) showed excessive controller instability and an unexplained wet bias at lower altitudes, which needs to be addressed.
- The radiosonde Task Team is preparing several reports and technical documents: RS-92 data product document (TD4), RS-92 pre-launch procedure (TD5, in preparation), RH time-lag corrections issues (in preparation), multi-payload configurations (in preparation), RS-92 auto-launcher influence (in preparation), chilled-mirror hygrometer data product document (in preparation).

Several issues were raised in the discussions of this team:

- It is recommended that the conversion of GPS height to geopotential height is incorporated into the CIMO guide.
- A discussion of the value and impacts of non-disclosure agreements in climate records showed that a balance has to be struck between the need for transparent documentation of climate records and the need for the protection of intellectual property of the manufacturers. Climate records must maintain the ability to be reprocessed, which requires long term accessible storage

[4] A process for assigning new Task Team co-chairs was agreed by WG-GRUAN in its meeting that preceded the ICM and is given in Appendix 13

of raw data, metadata and documentation. The communication with manufacturers through HMEI is key to continue this discussion.

- It was pointed out that redundant measurements are essential within GRUAN. This also includes the measurement of pressure on radiosondes. The availability of a pressure sensor in addition to GPS derived pressures is seen as key, in particular since possible gaps in GPS may have extreme impacts on the climate records.

See Appendix 5 for the full report of the GRUAN Task Team on radiosondes.

6.2. Task Team on GNSS-PW

June Wang presented the current progress of the GNSS- PW Task Team. The goal of this team is to develop explicit guidance on hardware, software, and data management practices to obtain GNSS PW measurements of consistent quality at all GRUAN sites. All 15 GRUAN sites now have GNSS equipment and the GRUAN requirements have been defined based on an international GNSS service document. The GRUAN GNSS site survey table has been updated; however, managing changes within this list of parameters is still being discussed. These requirements have been prepared and reviewed and are published as GRUAN Technical Document 6 (TD6). A draft of best practices making and verifying GNSS observations is currently being prepared. A draft of the guidelines for the GNSS-PW data and uncertainty analyses is underway. A GRUAN GNSS data and product table is currently being developed.

Tong Ning and Gunnar Elgered together with June Wang are developing an uncertainty analysis based on Immler et al. (2010) to quantify the uncertainty of the zenith total delay (ZTD), the uncertainty of zenith hydrostatic delay (ZHD), and the uncertainty of the conversion factor. These are the main contributing sources to the total uncertainty of the integrated water vapor. Here the total uncertainties of the ZTD and the ground pressure dominate the error budget of the PW uncertainty. All GRUAN sites need an independent surface pressure measurement with a well-known uncertainty and need to rely on one central processing. However, it is not clear which organization should take on the central processing. The Lead Centre was asked, but declined due to resource issues. There was no resolution of this issue at the meeting but WG-GRUAN co-chairs agreed to work with the Task Team towards resolving this important impediment to uniform processing of GNSS-PW measurements within GRUAN.

Reprocessing monthly PW anomalies has a tremendous impact on the long-term trend and was shown to make the trend wetter. This shows the necessity of maintaining sufficient metadata to reprocess as new insights accrue in data in general and not just for GNSS-PW measurements.

A main challenge related to documentation is the question of who is responsible for maintaining documentation developed by a Task Team after the Task Team has been disbanded, as is envisaged once GNSS-PW measurements attain mature GRUAN measurement status. The meeting agreed that rather than having multiple documents that a site needs, it would be advantageous to maintain as few documents as possible. This should be done within a single GRUAN technical document along with a peer review article. The discussion pointed out the importance of bringing the work of the GRUAN GNSS Task Team into the official WMO documentation stream so that other meteorological operators and agencies could benefit from the lessons learnt. This applies generically to all that GRUAN does if it is to ultimately prove successful in part because lessons learnt and improved understanding of fundamental measurement characteristics from a successful GRUAN can act as a catalyst for broader, cost effective, improvements across the GOS.

It was briefly addressed what processing software is being used for ZTD and what timeline is used for processing. The Task Team documented what each site is using; however, the uncertainty analysis is still best done centrally. The expected time lag for the processing (also documented in the requirement table) is one month.

See 0 for the full report of the GRUAN Task Team on GNSS-PW.

6.3. Task Team on measurement scheduling and associated instrument-type requirements

Tom Gardiner presented the current progress of the Task Team on measurement scheduling and related activities. The overall objective of this Task Team is to develop defensible quantifiable scientifically-sound guidance for GRUAN sites on measurement scheduling in order to meet all GRUAN objectives including climate trend detection, satellite cal/val, and studies of local mesoscale processes. The goal is to quantify the contributing scheduling factors for the period required to reveal a trend, such as the size of the trend, the auto-correlation and the noise. It is important to note that water vapour, in particular, exhibits vastly different behavior between the UT and the LS. None of the work being done addresses gaps, drifts, or jumps in the time series. While such analysis is urgently required to define GRUAN scheduling requirements, there is currently no funding to support such analyses.

Current results indicate that in regions of high atmospheric variability such as in the upper troposphere, the natural variability makes trend determination less sensitive to random errors in measurements. In the stratosphere, on the other hand, the much lower variability of water vapor makes trend detection much more sensitive to random errors. However, the lower variability requires fewer measurements. One measurement per month in the lower stratosphere is as effective as 7 per month in the upper troposphere.

Removing systematic errors is essential and should include an attempt to randomize the uncertainties as much as possible. To do this it is important to define the intended scope / usage of the measurement, such as trend detection, satellite validation, or process studies.

In trend detection, the key uncertainty parameter is the long-term reproducibility. Statistical (type A) uncertainties, location and timing uncertainties are less important. Factors such as variability and autocorrelation of the measurements, the magnitude of the likely trend to be measured, and the vertical range should guide sampling requirements for trend detection. Studies of previous datasets, or model outputs will help.

In satellite validation, a decision has to be made whether to study the profile of the ECV or the radiance in space. In either eventuality, both datasets need to be mapped onto the same coordinate space, impacting the measurement uncertainty, the co-location of uncertainty, the spatial averaging, and the long-term reproducibility.

Process study requirements depend very much on the process being studied. For short term-process the unit will be individual profiles. High frequency sampling is often required; however, long-term reproducibility is often less important than low statistical uncertainty. Co-location uncertainties may be an issue.

Current discussion points of the Task Team include team membership, uncertainty term definitions, instrument specific scheduling, and future activities. Initial focus will be on the Manual and Guide but given limited resources the Task Team priorities for next year will have to be redefined. Open issues include a review for temperature and/or “priority 2” variables, assessing the benefit of weighting sampling according to natural variability, and which focus on one of the application areas would be of the most use to the sites recognizing that sites will be interested in different problems and have finite funding.

See 0 for the full report of the GRUAN Task Team on measurement schedules and associated instrument-type requirements.

6.4. Task Team on ancillary measurements

Thierry Leblanc and Tony Reale presented the progress of the Task Team on ancillary measurements. This Task Team defines requirements and operational procedures for observations from active and passive remote sensing instruments. Guidelines for lidar algorithms, microwave and FTIR observations are being developed in cooperation with other networks and outside activities, such as the International Space Science Institute (ISSI) Expert Team on Lidar Algorithms, MWRNet and NDACC.

Further activities within the Task Team include a discussion of Suomi-NPP validation activities, which focus on intensive campaigns at Atmospheric Radiation Measurement (ARM) sites (resources permitting) including special sonde launches at Suomi-NPP overpasses. The NOAA PROduct Validation System (NPROVS) is a satellite and radiosonde intercomparison tool, which incorporates the product data, not just the sensor data. NPROVS now also integrates GRUAN sondes.

A result of particular importance is that the comparison of the Vaisala RS92 operational temperature measurements with COSMIC operational temperatures indicates a warm bias of the Vaisala radiosondes in the stratosphere during (and only during) the northern summer night-time observations. This difference cannot currently be explained and requires further investigation.

SASBE, which is being developed in cooperation with ARM, was discussed as a potential direction that GRUAN might consider developing.

The question of distributed data processing was discussed and it was recommended to implement distributed data processing. Although centralized software is an important part of the process, distributing it is a separate challenge. Processing for lidar or microwave for example should not be done by the Lead Centre so that costs are distributed across GRUAN.

See 0 for the full report of the GRUAN Task Team ancillary measurements.

6.5. GATNDOR

Fabio Madonna presented an overview of the current status and results of the GRUAN Analysis Team for Network Design and Operations Research (GATNDOR). This team focuses on short-term research to address specific topics identified by the GRUAN science and management community. Three high priority topics were addressed within this team since ICM-3: Co-location of observations, management of change and quantifying the value of complementary observations. The topic of co-location involved the development of a toolbox for evaluating co-locations and the draft of a related manuscript.
The activities of this analysis team are coordinated through quarterly calls to keep track of the annual work plan. A close link with the Task Team on ancillary measurements is seen as important, since similar questions are addressed within this team. This team also contributed to several conferences (e.g., the WCRP Open Science Conference 2011).

Potentially new research topics may be the investigation of covariance matrices necessary or useful for vertically correlated uncertainties, the use of GRUAN data in radiosonde data reprocessing, and a metric for redundancy. Two aspects are important to consider here: independence and duplication. Redundant measurements are intended to verify their respective uncertainty, which can only be done if measurements are independent. A metric for redundancy needs to be developed, which may include correlation, factor analysis, time series and redundancy analysis. A significant number of redundant observations currently exist at different sites, which can be used to evaluate the usefulness of different combinations of redundant observations. Where sites are sufficiently similarly instrumented the question of geographical dependence in such considerations could be assessed.

Funding for addressing the research questions targeted by this Task Team is of particular concern since lack of funding is seriously impeding progress in answering these questions. Nevertheless, the current topics are envisaged to be completed by the end of 2013.

Change management was discussed both in the terms of homogenization of historic observations as well as how to ensure that future observational time series are not impacted by artificial jumps due to changes in observational practices or changes in instrumentation.

Co-location of observations remains an important subject in particular when considering different observational platforms. Sites may require strong advice on the statistical aspects of mismatches in co-location and GATNDOR may be able to help with this.

The ensuing discussion addressed several open issues. It was reiterated that a close cooperation between the task teams on scheduling and on ancillary measurements and GATNDOR may be required. In these efforts the use of the existing uncertainty estimates needs to be strengthened and a feedback needs to be developed that leads to an improvement of the observations.

6.6. The role of near-real-time data in GRUAN

The availability of near-real-time data from GRUAN sites was discussed in detail following the discussions at the *GCOS/WIGOS/CBS Expert Meeting* (see item 3 above). There was general understanding that generating high-quality GRUAN data products requires centralized processing, cross-validation using independent measurements, capture and archival of comprehensive metadata, and careful manual quality control. This is not conducive to near-real-time (< 2 hours) data submission. Nevertheless, the strongest benefit of near-real-time data submission was viewed as the buy-in by the hydrometeorological services and the potential support of numerical weather prediction (NWP), as well as the possibility of a quality feedback from the data-analysis centres. However, it was not at all clear that strengthening NWP would lead to increases in funding. The participants largely agreed that GRUAN sites should be required to provide data of operational quality in near-real-time wherever possible. There was consensus that at the present time near-real-time data submission would only be expected from operational radiosondes (partly because this was the only observation likely to be able to be consistently ingested by many operational data-assimilation schemes presently) and from GNSS, but not from any other instrument. It was also noted that non-compliance with this requirement would not automatically exclude a site from GRUAN participation.

Since near-real-time data are unlikely to have the same level of quality as GRUAN-processed data, operational quality data should be flagged as such prior to near-real-time transmission to avoid confusion with GRUAN-quality data processed later in non-real-time. In return for near-real-time data transmission, NWP centres are encouraged to feed back information on data quality to GRUAN processing centres. Further consideration on how best to achieve this is required and GRUAN will look to WMO to provide leadership on this matter. It was further noted that WMO training was available for sites to change their procedures to include near-real-time data submission, where this was not yet implemented.

It is also essential that GRUAN near-real-time observations must be flagged as data coming from GRUAN sites. In reanalysis efforts, GRUAN data may serve to validate observations, which can only be done if these observations were not used as a data source in the reanalysis. Therefore, reanalysis projects should exclude GRUAN observations from their data sources to be able to use these as validation data sets if they wish to perform such validation studies.

6.7. GRUAN trust fund

Funding to support the analyses required to define GRUAN's modus operandi remains a problem which then limits the development of GRUAN science and operations. At ICM-3, a proposal was made to establish a trust fund, which could then be used to address specific research questions that are relevant across the network as a whole. However, establishing a trust fund requires clear governance, clear terms of reference and terms of operation which makes finding an appropriate solution non-trivial.

It was agreed that the goals of a trust fund would have to be well defined; however, it is unlikely that a trust fund could support long-term observational programmes. It is more likely that a trust fund could support short-term programmes, or fill funding gaps, where it can be shown that continuing funding would later be guaranteed. The GCOS Cooperation Mechanism[5] (GCM) is an example, through which some countries have dedicated funds to support capacity development and renovation efforts. It will be essential to build on existing capabilities as GRUAN expands from its current 15 sites to 35-40 sites over the coming years. This will be of particularly importance for potential new sites in remote regions or in developing countries. One possibility is to make use of the GCM to collect and disburse funds specifically in support of GRUAN activities. The WG-GRUAN will continue exploring avenues to establish such a trust fund.

6.8. The use of descent data within GRUAN

Currently, GRUAN radiosonde launches are requested to also save descent data. However, the appropriate use and robust characterization of the properties of descent data have yet to be fully established. Stratospheric water-vapor observations on controlled balloon descent are superior to ascent data if valved balloons or dual balloon rigs are used. Descent measurements of stratospheric

[5] http://www.wmo.int/pages/prog/gcos/index.php?name=GCOSCooperationMechanism

water vapor do not suffer from outgassing by the balloon train and typically are advantageous at higher altitudes. However, stratospheric pressure measurements that factor into water-vapor mixing ratio calculations differ between ascent and descent, possibly because of lags in sensor temperature control. Ambient temperature measurements made on descent are impacted by contamination from the radiosonde package itself, since the radiosonde sensor arm is always oriented for contamination-free measurements on ascent. Furthermore, it is not clear how to map ascent pressure or temperature measurements onto descent water-vapor measurements, since mapping is typically done using time, pressure or geopotential-altitude coordinates. Since time stamps do not correlate ascent and descent observations, pressure differs between ascent and descent, and geopotential altitudes are usually determined from the pressure and temperature measurements themselves, there is currently no straightforward method to combine ascent pressure and temperature with descent water-vapor measurements. Poorly quantified response times of different sensors, in particular on fast parachute descents (balloon burst) are an additional complication in mapping ascent data onto descent profiles. Wind observations derived from GPS, in particular at tropospheric altitudes, may not be subject to balloon or payload contamination; so descent data may provide additional information. Considering these complications and their potential to significantly increase the uncertainties of descent measurements, it must be clarified whether there is added value for NWP if descent data are used. With the exception of stratospheric water vapor, it is currently not clear whether descent measurements add value to the goals of GRUAN and further investigation is warranted before a decision is made. The radiosonde Task Team is evaluating the utility of descent data.

6.9. New GRUAN data streams

One of the major challenges for GRUAN is that operational data streams do not satisfy GRUAN requirements. Most importantly, data streams from most operational instrumentation do not contain any information about the measurement uncertainties; they often do not have sufficient metadata, and are often poorly documented. To create data streams from instrumentation at GRUAN sties, these conditions must be met and the relevant teams need to cooperate to develop data streams, which are consistent across the GRUAN network.

The development of a water-vapor data product from frostpoint hygrometers was discussed in great detail. Most sources of measurement uncertainty are known and understood, but a vertically resolved estimate for the measurement uncertainty has not yet been developed. All currently available frostpoint measurements are considered absolute, i.e. no calibration or corrections are required. However, the estimate of the measurement uncertainty and the evaluation of contamination must be done consistently throughout these instruments.

A water vapor data product from Raman lidars was also discussed. Currently, observations from Raman lidars are made under a wide range of operational procedures and employ different data and analysis systems. This can be standardized to some extent without impacting the scientific freedom and creativity of the different principal investigators participating in GRUAN. First steps have been taken in defining the required data and metadata, which must be collected within GRUAN by the Task Team on ancillary measurements in association with the Lead Centre.

In addition to instruments from Vaisala; radiosondes from two other manufacturers are launched within GRUAN. The data from these manufacturers must be accompanied by an uncertainty estimate for all parameters as well as the relevant documentation. The Lead Centre was encouraged to work with the sites to advance this aim and to report at ICM-5 on progress to this end.

Precipitable-water data from GNSS receivers will need to be accompanied by an uncertainty estimate and the relevant documentation for this analysis, and the processing, needs to be developed. This work is currently being done within the GNSS Task Team (see 6.2). Questions remain to be addressed over the viability of a central processing from these measurements,

For all sites, documentation for the operating procedures needs to be provided and needs to be homogenized. This administrative effort is seen as key to assuring long-term stability of time series despite changes in operators, instrumentation and operating procedures. There was some discussion around the need for common metadata being not specific to a given instrument, such as regular site surveys and photographs and documentation about the relative locations of each instrument. This may be the prerogative of a Task Team on metadata but should not be forgotten.

7. Site reports

Currently 15 sites are contributing to GRUAN and no change in this composition occurred in 2011. All sites have embraced the need to quantify measurement uncertainties in an operational environment. Several sites have done dedicated experiments to study various aspects of the uncertainty within the vertical profile and investigate procedures to improve the correction of the systematic errors.

Three sites have expressed interest in joining GRUAN and gave presentations, which are briefly summarized below. Among these sites, Ny Alesund has formally applied to become a GRUAN station and at the time of ICM-4 this application was under very initial consideration.

7.1. Existing sites

ARM: Doug Sisterson remotely provided an update. The Department of Energy (DOE) Atmospheric Radiation Measurement Program (ARM) is currently planning to install a new site at Graciosa Island, Azores as well as a new mobile site at Olikktok Point, Alaska. These sites might be of interest to GRUAN. A memorandum of understanding between DOE and NOAA to launch frostpoint hygrometers is in place.

Lindenberg: The results of the standard humidity chamber ground checks prove to be highly valuable in identifying production changes and unexpected sonde issues prior to launch. This ground check is seen as essential to establish traceability. This site has also started testing the sondes of a second manufacturer (Graw) in an effort to prove that the concepts learned with Vaisala can be applied to others suppliers of radiosondes.

Sodankylä: Twice daily observations are now being taken with an autosonde launcher. While these data are processed at the Lead Centre, problems relating to the autosonde launcher still need to be addressed. This station continues to test the Vaisala RR01 stratospheric water vapor sensor as well as Fluorescent Advanced Stratospheric Hygrometers (FLASH).

Tateno: Temperature differences between Meisei and Vaisala were found in the upper part of the profiles, but occasionally also in the troposphere under rainy and humid conditions. These are not well understood and require further study. In January 2011, this site modified its schedule to change the desiccant in the radiosonde preparation and now uses 1% correction as the threshold value to change the desiccant. An investigation of the temporal and spatial variabilities of precipitable water vapor indicated that a horizontal scale of 50 km has roughly the same variability as a 4 hour time period. JMA will increase the vertical resolution of its NWP model and raised the model ‘s upper boundary in an effort to improve the forecast accuracy. Radiosondes still play an essential role in forecasting, which is only rivaled by microwave profilers.

Since Japan is a densely populated country, falling radiosondes remains an operational hazard, requiring manufacturers to use padding around the radiosondes, biodegradable materials, and reducing the weight of the instruments.

The co-location of the ICM-4 meeting with the Tateno site permitted a site visit at which participants were shown around the site facilities and a dual-sonde launch was performed. Participants greatly appreciated the opportunity to see how the site was operated and address questions directly to the site operators. There was particular interest in the wind tunnel which was seen as unique. Following the site visit, further entertainment was graciously laid on by the JMA hosts and a visit was made to the National Institute of Environmental Studies (NIES), where Greg Bodeker provided a GRUAN overview and various researchers presented interesting seminars.

Payerne: Meteoswiss is now using the digital SRS-C34 radiosonde from Meteolabor. Dual soundings together with the Vaisala RS92 as well as the Snow White frostpoint hygrometer are conducted bi-weekly. Temperature differences between the SRS-C34 and the Vaisala RS92 are currently under investigation. For pressure, the hypsometer is no longer used, but rather pressure is derived from GPS altitudes. The Rotronic humidity sensor, however, only records data up to 200 hPa. Studies using dual temperature sensor sondes lead to some improvements in the solar radiation correction of the temperature measurements.

Cabauw: After the departure of the site representative Martin de Graaf, this position was taken over by Arnoud Apituley. The routine data from their daily soundings are flowing to the Lead Centre. Lidar observations are taken twice per week, weather permitting. The efforts within the microwave radiometer network are continuing. CABAUW is a super-site for the EUMETNET - E GVAP project and the reprocessing of the GNSS water-vapor data for climatology is pending. Reductions in the radiosonde launch frequency to once per day are pending and will be implemented shortly. Participants supported night-time ascents if the station goes to one launch a day and urged retention of a capability to launch more frequently if demanded by intensive field campaigns.

XilinHot: Dual flights between the Vaisala RS92 and the operational radiosonde are ongoing. The currently used operational radiosonde is not suitable for GRUAN and new developments hopefully will lead to a Chinese made radiosonde suitable for GRUAN. Initial results show good agreement for temperature and humidity in the lower troposphere. A ground check is being developed which would test the output of the radiosonde before launch. However, it is not yet clear how applicable this ground check is for the upper regions of the sounding. Cooperation between the sites, manufacturers and the Lead Centre is seen as important and the need for more detail guidance was expressed.

Lauder: Lauder is currently not explicitly funded for GRUAN operations, but continues to receive support from NOAA to make frost point hygrometer soundings on a monthly schedule. Further support is received in aligning relevant NDACC measurements to meet GRUAN specifications. Lauder launched 49 radiosondes including additional sensors (ozone and frostpoint) during 2011, and an additional 4 radiosondes in support of HIPPO aircraft overpasses. All Vaisala RS92 radiosondes are tested in a pressure chamber prior to launch. The ground system is scheduled to be updated pending funding. A new GNSS antenna has been obtained and is currently being installed. This receiver will be incorporated into the New Zealand GEOnet network. Lauder fully embraces the vision and goals of GRUAN, and recognizes the urgency of better balancing the hemispheric coverage. Unfortunately, the current funding situation in New Zealand makes increased or even stable resource support unlikely for now. However, together with the NZ Permanent Representative to WMO, exploration of every opportunity is continuing.

Boulder: Regular Vaisala RS92 soundings started in June 2011. The initial problem of not being able to receive the surface signal from the launch site at the distant ground station was overcome by using a small vacuum chamber to simulate launch for the radiosonde internal circuit. A dual frostpoint sounding shows the excellent repeatability of these instruments and helps validating uncertainty estimates. Stratospheric water-vapor observations with NOAA frost point hygrometers (FPHs) are typically done on both ascent and controlled descent using a valved balloon. The stratospheric ascent and descent profiles for each flight are carefully compared to remove contaminated ascent measurements. Radiosonde pressure measurement differences between ascent and descent exist and are being evaluated for their impacts on the quality of stratospheric water-vapor descent profiles (see discussion above). Additional soundings have been done testing a TDL hygrometer (Southwest Sciences) and a surface acoustic wave hygrometer (U. Cambridge). Comparison fights with the Vaisala RR01 sonde are ongoing.

Potenza: The autosonde system at the site has had some technical difficulties which were finally resolved. Nevertheless, the system will need an upgrade in order to use the dry-cell batteries, which are the only type now available for the autosonde systems. A new Trimble GPS system will be available by the end of 2012, as well as a new Doppler wind lidar and a dedicated water vapour Raman lidar. The update of the autolauncher system will be performed by the end of 2012 and the manual system will be repaired by the end of April. A first contact with GRAW has been established for purchasing a new radio-sounding system.

Beltsville: A total of 81 Vaisala RS92 soundings and 40 ozone soundings were launched in 2011. The RSLAUNCH client was setup and will soon commence data transmission. Periodic frostpoint hygrometer launches continue (WAVES-2011) and NOAA funding will be used exclusively for CFH sondes. The cooperation with the National Weather Service (NWS) is continuing with launches of the LMS radiosondes in comparison with the Vaisala RS92 and CFH in an effort to refine the “consensus reference”. An intensive campaign is scheduled for summer 2012. For Raman lidar observations the lamp calibration technique has been further studied and may improve both long-term and short-term stability of the overall system.

7.2. Candidate sites

Ny Alesund: Marion Maturili introduced the research site of Ny Alesund as a new candidate site for GRUAN. This site is located on the island of Spitsbergen in the Svalbard archipelago in the high Arctic ocean. It is an international centre for various Arctic research activities, such as glaciology, biology and atmospheric sciences. The site is operated by the Alfred Wegener Institute (Germany) and the Institut Polaire Français Paul Emile Victor (France). It provides regular observations for surface meteorology, upper air, radiation, and atmospheric composition. The site is a member of a number of other networks, such as the Baseline Surface Radiation Network (BSRN), NDACC, GAW and others. Sounding activities include daily radiosondes, weekly ozone-sondes and monthly soundings of stratospheric water vapor using FLASH sondes during the polar winter. This site uses the Standard Humidity Chamber (SHC) ground check for the Vaisala RS92 radiosondes. Data are submitted operationally to the Global Telecommunication System (GTS) through the Danish National Meteorological Institute (DNMI). In addition, tropospheric and stratospheric lidar measurements provide additional observations of upper-air temperature, water vapor and aerosol.
A formal site application was received by the WG-GRUAN just prior to the meeting and was under consideration using the procedures documented in the GRUAN Guide section, which had been approved as a separate stand-alone document.

Sirta and La Reunion: Martial Haeffelin introduced two research sites as possible candidates for GRUAN. The first site is the Institute Pierre-Simon Laplace Atmospheric Research Observatory at Sirta, together with the radiosonde station at Trappes on the outskirts of Paris France. This site implemented a strategy based on atmospheric observation services to monitor important climate variables. Parameters measured are, among others, temperature, water vapor, and wind in profiles from the surface to the middle stratosphere, as well as precipitation, greenhouse gases, aerosols, and radiation. This site contributes to several research networks (AERONET, BSRN, CLOUDNET, EARLINET, MWRNET, EG-VAP) and hosts regular field campaigns. Radiosondes are launched at Trappe and raw data are received at SIRTA, where they are processed automatically. Intercomparisons with other measurement sources (GPS, HATPRO MWR) are done routinely.
The second site is the Observatoire de Physique de l'Atmosphère located on the island of la Réunion in the subtropical Indian Ocean. This observatory operates measurement programmes to provide long-term series of atmospheric observations. It is part of several research networks (NDACC, SHADOZ, GAW, AERONET, WINPROF). Measurements are performed to explore atmospheric processes in the tropical troposphere and stratosphere to study stratosphere-troposphere dynamics, cyclones, climatologies and trends, transport of biomass burning emissions and others. Participants encouraged site applications when ready.

8. Next meeting

It was agreed that the next ICM meeting would be held near the GRUAN site at Cabauw, Netherlands, from 25-28 February 2013. The timing of the meeting should be similar to that for ICM-3, i.e. it should ideally precede the AOPC meeting by about 4 to 6 weeks to allow reporting on the outcome of this meeting at AOPC.

9. GRUAN Work Plan

The final session agreed on a specific GRUAN work plan for the forthcoming year based on the preceding discussions. These discussions showed that a few action items in the previous list of action items had been either ambiguous or far too detailed and that wording had not been sufficiently clear on who had to do what. Care needs to be taken to guarantee that the actions are properly described, documented and tracked.
To address this issue, only significant ICM-4 to ICM-5 actions are recorded in the following work plan. Minor action items are listed following the work plan, but will be documented and checked separately by the WG-GRUAN co-chairs.

9.1. 2012-13 GRUAN Work Plan

No	Action	Deadline	Who
1	Set up an online repository of all actions, whether they rise to work plans, within year report commitments or Implementation Plan items. Community owned. Managed by WG-GRUAN chairs.	May 2012	WG-GRUAN chairs (Bodeker)
2	Discuss with Task Team chairs and WG-GRUAN members how to proceed on creation of metadata task (metadata that is not necessarily instrument specific, but necessary for complete understanding; ensuring metadata consistency between data streams). Report via the blog.	Sep 2012	Lead Centre, WG-GRUAN chairs (Bodeker)
3	To process 4 or more sites with a focus on those who may benefit from early certification to undertake certification. Work with TT site representative co-chairs in this.	ICM-5	Lead Centre, WG-GRUAN, TT site representative co-chairs
4	RS-92 pre-launch documentation to be revised and submitted as a TD by the summer	Sep 2012	Lead Centre (Dirksen as lead) and the Radiosonde Task Team
5	Assessment of RS92 (and others?) time lag humidity corrections, comparing the GRUAN processing to other published approaches to be undertaken and submitted to a journal (R. Dirksen, M. Sommer, H. Vömel L. Miloshevich, A. Kats)	ICM-5	Lead Centre (Dirksen as lead) and the Radiosonde Task Team
6	Document detailing the issues surrounding multi-payload soundings to be drafted and submitted either to peer reviewed literature (first choice) or to WG-GRUAN for review	Sep 2012	Task Team Radiosondes (Jauhiainen lead)
7	Assessment of auto-sounder influence vs. manual launches to be written up and submitted to the peer reviewed literature	Sep 2012	Task Team Radiosondes (Kivi, Kizu lead)
8	Provide the theoretical basis for GRUAN uncertainty estimates for GNSS-PW. Submission to peer reviewed literature.	ICM-5	TT GNSS (co-chairs as lead)
9	Report on discussions with LC and others on starting the GNSS-PW data flow. Data collection client requirement? Central processing facility?	ICM-5	TT GNSS (co-chairs as lead)
10	Develop and publish online tools using the NPROVS system to visualize the GRUAN products (incl. uncertainty) and collocated satellite data (GPROVS?) and possibly SASBE products.	Dec 2012	TT Ancillary measurements (Reale, Vose, Tobin Dykema lead)

11	GRUAN Lidar Technical document (incl. all species) submitted for WG-GRUAN review.	Oct 2012	TT Ancillary measurements (Leblanc lead)
12	Complete the matrices of measurements started and try to be as detailed as possible taking into consideration new updates, changes, etc. available at the gruan.org web site.	May, 2012	TT Site representatives (Hurst lead, Demoz)
13	Collocation. Identify if the instruments at a site are collocated or distributed and details of the distribution (distance, ownership, etc). Include maps etc.	ICM-5	TT Site representatives (Demoz lead, Hurst)
14	Submission of a peer-reviewed paper about the topic "Quantify the value of complementary measurement"	ICM-5	GATNDOR (Madonna lead)
15	Peer-reviewed paper about the topic "Co-location of observations" with an emphasis of how to account for mismatches in quantifying and comparing uncertainties.	Submitted by ICM-5	GATNDOR (Fasso lead)
16	Development of initial frostpoint hygrometer product and associated technical document. Initial data and advanced draft of technical document available for consideration at ICM-5.	ICM-5	Vömel, Hurst
17	Post online monitoring reports, graphics etc. and link from the NCDC ftp area to make aspects more accessible to the end users. Also link to a (still under development) 'GPROVS' portal.	Oct 2012	Lead Centre (Sommer lead)
18	Work with sites not launching RS-92 to further development of the processing streams for their standard radiosondes. Report at ICM-5 on progress.	ICM-5	Lead Centre (Vömel lead)
19	Create a formal amendment to the Implementation Plan. To cover through 2016. To be submitted by September 1st to GCOS (AOPC) for consideration as a GCOS report. Owners: WG-GRUAN co-chairs.	ICM-5	WG-GRUAN co-chairs, Lead Centre, Task Team chairs
20	Create a draft technical document on surface meteorological measurement requirements (T, P, U) in support of in-situ and remote sensing activities at GRUAN sites to include aspects on frequency of reporting, calibration and upkeep. Lead: Peter Thorne. Draft submitted for consideration / discussion at ICM5	ICM-5	Peter Thorne, WG-GRUAN, LC, at least one member from each Task Team
21	Work with CIMO / HMEI to discuss how best to incorporate a GRUAN invited talk / talks / town hall / other as appropriate presence at the TECO meeting in Brussels in the autumn of 2012 to allow discussions with manufacturers. Report to WG-GRUAN. Holger / Bertrand/ WG-GRUAN chairs.	August 2012	Lead Centre, WG-GRUAN, Task Teams

9.2. Other items

Minor action items, which are being tracked elsewhere:

- Propose revisions to terms of reference and membership of WG-GRUAN to AOPC members prior to their late April meeting. WG-GRUAN chairs.
- Formally instigate and manage GRUAN Technical Documents review protocol as documented in the WG-GRUAN meeting outcomes.
- Assess the site application currently under consideration and others received as detailed in the site assessment and certification document.
- Manual and Guide finalized and signed off, formally adopted and published. (Bodeker)
    - Remove 'intermediate station' from guide section 5
    - Change name of 'fully compliant station' (work with sites Task Team to find acceptable terminology)
    - Tom Gardiner and Andrea Merlone to work with Greg on uncertainty language throughout.
    - Remove seasonally variant scheduling language from guide but retain language that this might be important later.
- Radiosonde Task Team to resolve second co-chair issue along agreed WG-GRUAN procedures.
- The radiosonde Task Team will circulate their CIMO intercomparison summary for wide review and then submit to formal review as a GRUAN report by WG-GRUAN by the summer.
- Further efforts will be made to assess controlled descent mechanisms for balloon payloads. A paper will be prepared on the Payerne solution. Topic to be discussed further at ICM-5. (Hurst, Philipona, Fujiwara)
- Develop guidance on GNSS-PW data through a GRUAN GNSS data and product table. September 2012. (TT GNSS members)
- Identify best practices in making and verifying GNSS observations. Report at ICM-5. (TT GNSS members.)
- Recommend practices on managing change in GNSS-PW measurements. Presentation at ICM-5. (TT GNSS co-chairs.)
- Review of temperature scheduling requirements (as already done for water vapour in the Guide) for scheduling decision support. Presentation at ICM-5. (TT co-chairs.)
- Retention of collocated satellite radiances within or linked from the GRUAN data archive to facilitate intercomparisons. Report at ICM-5. (Reale, Sommer)
- Investigate use of satellite collocation data as an additional QC/QA tool on GRUAN products over the coming year and report at ICM-5. (Reale, Sommer)
- Report on progress towards gaining a lidar data stream including run clients and uncertainty estimation. Presentation at ICM-5. (Leblanc)
- First draft of Technical Document on bringing microwave radiometer measurements into GRUAN, leveraging MWRnet expertise. Summer 2012 circulated to TT AM members. (N. Cimini and N. Kämpfer.)
- First draft of GRUAN FTIR Technical Document, leveraging MUSICA, made available to TT AM members for comment. Summer 2012. (Schneider, Hannigan)
- Inventory of AERI instruments to be compiled for TT AM consideration and report to GRUAN community on viability to bring AERI into GRUAN. By ICM-5. (Schneider, Hannigan)
- Inquire to EARLINET colleagues on the status of their Centralized Data processing Algorithm and study possible synergy between EARLINET and GRUAN. Report at ICM-5. (Apituley, Leblanc)
- Investigate essential "recipe" of GRUAN ancillary and sonde measurements (including uncertainties) to calculate SASBE with focus on atmospheric temperature and moisture for NPP satellite hyper-spectral products validation. Report to TT AM by ICM-5. (Tobin.)
- GATNDOR workplan published for coming year. To be published on the blog. (Madonna)
- Circulation of a Phd position for working on a new GATNDOR topic: "Assessment of the impact of comparison model error: use of GRUAN uncertainty covariance matrix and assessment of best vertical resolution to use in RTM modeling for improving satellite validation".

- Extend trend sensitivity studies analysis to stratospheric water vapour and submit the resulting analysis to the peer reviewed literature. Until Dec 2012, dependent upon funding. (TT Measurement Scheduling, Whiteman lead)

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Appendix 1 Review of actions from ICM-3 (GCOS-149)

No	Action	Deadline	Status
1	WG-GRUAN to update its terms of reference to include the role for assessment and certification as well as the new co-chair structure.	Jul 2011	Done
2	Formulate recommendations on ground check for radiosondes as GRUAN technical document.	Jul 2011	In review
3	Prepare generic poster and PowerPoint presentation to be used in promoting GRUAN within the scientific community. This material is to be posted on www.gruan.org.	Jul 2011	Done
4	Consult with the satellite community (GSICS EP, SCOPE-CM EP, CGMS Working Groups) on better linkage to GRUAN.	Sep 2011	Not started:
5	The site representation team will collect acknowledgement requirements from sites. Agree and implement data usage acknowledgement protocol.	Sep 2011	Done
6	NCDC should consider the role of repository for raw data and data not yet congruent with GRUAN standards in addition to GRUAN data products. Lead Centre will advise NCDC on needs.	Sep 2011	Done. Lead Centre will contact NCDC when need arises.
7	Update the inventory of GRUAN site instrumentation in form of a matrix of current site capabilities	Sep 2011	In progress (current workplan item 13.)
8	NCDC to consider a graphical user interface to RS92 GRUAN data. Report to WG-GRUAN by October 2011.	Oct 2011	To be started. Lack of resources prevent action.
9	NCDC to consider viability to place a voluntary user registration on data usage making clear the benefits of being made aware of periodic reprocessing and likely impacts. Report to WG-GRUAN by October 2011.	Oct 2011	Done. Lead Centre implemented voluntary user registration.
10	Develop a collection of material, which may be used in proposals by sites to get funding. This collection of material is to be started on the GRUAN blog.	Oct 2011	To be started. Ethical issues were raised. Priority seen as low.
11	Work with HMEI to scope possible workshop aims and requirements and discuss whether CIMO involvement etc. makes this redundant. Possibility of meeting manufacturers at AMS.	Oct 2011	Done. Meeting proposed to take place at TECO 2012. (current work plan item 23.)
12	Integrate GRUAN observations in the NOAA Products Validation System (NPROVS.)	Oct 2011	Done
13	Explore possible avenues to set up a trust fund in support of targeted GRUAN activities.	Dec 2011	Initial discussions have taken place. Priority seen as low.
14	Circulate relevant documents to communities likely to be users of GRUAN products to ascertain whether these data products meet their needs.	Dec 2011	Not done. Scope unclear and action removed.
15	Complete measurement guidance for GNSS-IWV as technical document.	Dec 2011	Done
16	Complete the GRUAN Manual of Operations in liaison with Task Teams; final version to be approved by WG-GRUAN, Lead Centre and 2/3s of all sites.	Jan 2012	In progress. Revisions necessary after CBS/CIMO meeting in Jan 2012.

17	Develop definition for optimal GRUAN site to decide on future sites (optimal location/climate zone, institution etc.). Form an organizing committee to make initial steps towards a workshop (possibly ISSI hosted), to be held shortly after ICM-4. Initial steps are to develop an agenda, draft an invitee list, plan for workshop.	Jan 2012	Not done. Action superseded by Network Expansion Workshop.
18	Assessment and certification criteria to be fleshed out by WG-GRUAN, Lead Centre, in consultation with sites representatives. Draft for adoption in time for ICM-4.	Jan 2012	Done
19	Protocol for acceptable instrument change-over as section in manual to cover generic change criteria.	Jan 2012	In progress as part of the manual
20	Include a section in the manual on how to move from priority one to priority two climate variables.	Jan 2012	In progress as part of the manual
21	Complete measurement guidance for lidar as technical document.	ICM-4	In preparation (current work plan item 12.)
22	Radiosonde Task Team to prepare a report on the issues of descent temperature measurements and the use of controlled descent measurements.	ICM-4	Discussions have started. Priority is low.
23	Formulate requirements on surface observations in support of upper-air observations.	ICM-4	To be started (current work plan item 22.)
24	Develop best practice guidance for multi payload launches.	ICM-4	In preparation (current work plan item 6.)
25	Assessment of the value and utility of satellite coincident *in-situ* and remote sensing measurements vis-à-vis standard times for satellite cal/val.	ICM-4	To be started. Priority is low.
26	Initial set of temporal sampling guidance for *in-situ* and remote sensing instrumentation based upon a quantitative assessment prior to network expansion, including superseding of GCOS-121 documentation for *in-situ* measurements.	ICM-4	Limited progress in parts due to very broad focus.
27	Formulate generic guidance on collocation based upon quantitative evidence wherever available, for priority one variables. Includes a toolbox and paper for submission.	ICM-4	In preparation (current work plan item 16.).
28	Investigate and design a system to report and resolve problems in data quality and instrument issues.	ICM-4	In progress (current work plan item 18.)
29	Implement final version of the GRUAN data dissemination structure.	ICM-4	Done

Appendix 2 Meeting agenda

Fourth GRUAN Implementation and Coordination Meeting, Japan Meteorological Agency, Tokyo, Japan, 5th through 9th March 2012

Location: JMA Headquarters, Conference Room

Monday 5th March

08:30 - 12:00 Closed meeting of WG-GRUAN membership [Coffee break, 10:00 - 10:30]

12:00 - 13:30 Lunch

13:30 - 14:00 Participant registration

Session 1:

Update on specific progress since ICM-3

Chair: Greg Bodeker; Rapporteur: Fabio Madonna and June Wang

14:00 - 14:10 Local organizers to outline logistics, emergency procedures etc.

14:10 - 14:30 Welcome from the organizers – *Akihide Segami*, Director-General of the Observations Department of JMA and GRUAN co-chairs.

14:30 - 14:45 Opening remarks from Adrian Simmons chair of AOPC and chair of GCOS steering committee – *Adrian Simmons*

14:45 - 15:10 GRUAN governance and outcomes of CBS expert team review – *Greg Bodeker / Adrian Simmons*

15:10 - 15:30 What does it mean for the GRUAN network to become 'operational'? – *Holger Vömel*

15:30 - 16:00 Coffee

16:00 - 16:45 Lead Centre progress report (incl. status of reference humidity profile measurements) – *Holger Vömel*

16:45 - 17:30 Update from WG-GRUAN and check on progress against agreed tasks to be completed by ICM-4 as agreed at ICM-3 – *Peter Thorne*

17:30 - 18:00 Discussion

18:30 - 20:30 Workshop Dinner hosted by JMA

Tuesday 6th March

Session 2: Task Team Updates

Chair: Holger Vömel, Rapporteur: Howard Diamond

08:30 - 09:00 Radiosondes – *Masatomo Fujiwara*

09:00 - 09:30 GPS-PW – *June Wang / Kalev Rannat*

09:30 - 10:00 Sites Task Team overview – *Belay Demoz / Dale Hurst*

10:00 - 10:30 Coffee

10:30 - 11:00 Ancillary measurements – *Thierry Leblanc / Tony Reale*

11:00 - 11:45 Scheduling – *Tom Gardiner / Dave Whiteman*

11:45 - 12:15 GATNDOR status – *Fabio Madonna*

12:15 - 12:30 General discussion about how Task Team are operating, outlook for the future, any new Task Teams required?

12:30 - 14:00 Lunch

Session 3: Reporting

Chair: Holger Vömel, Rapporteur: Karin Kreher and Thierry Leblanc

14:00 - 15:30 Discussion of changes to GRUAN manual following CBS expert team review – *Greg Bodeker*

15:30 - 16:00 Coffee

16:00 - 16:30 Status of data flow – *Michael Sommer*

16:30 - 16:45 Recap of implementation plan ICM-4 to ICM-5 actions – *Greg Bodeker*

Session 4: Reporting on contacts with the external community

Chair: Holger Vömel, Rapporteur: Karin Kreher and Thierry Leblanc

16:45 - 17:15 Outcomes of WCRP open science conference, NDACC steering committee meeting and GRUAN represenation at forthcoming meetings - *Peter Throne and Holger Vömel*

17:15 - 17:45 GRUAN connection to Meteomet community and the development of a roadmap for future collaboration - *Andrea Merlone*

17:45 - 18:00 Network expansion workshop - *Greg Bodeker*

Possible **voluntary** evening break out session to discuss GRUAN manual if required

Wednesday 7th March

Session 5: Site updates

Chair: Peter Thorne; Rapporteur: Belay Demoz and Dale Hurst

08:30 - 08:45 ARM Sites - *Doug Sisterson* by webex (reserve: P. Thorne / H. Diamond)

08:45 - 09:00 Lindenberg - *Ruud Dirksen*

09:00 - 09:15 Sodankylä – *Rigel Kivi*

09:15 - 09:30 Tateno – *Hironobu Yokota*

09:30 - 09:45 Payerne – *Rolf Philipona*

09:45 - 10:00 Cabauw – *Arnoud Apituley*

10:00 - 10:30 Coffee

10:30 - 10:45 Xilinhot – *Li Wei*

10:45 - 11:00 Lauder – *Karin Kreher*

11:00 - 11:15 Boulder – *Dale Hurst*

11:15 - 11:30 Potenza – *Fabio Madonna*

11:30 - 11:45 Beltsville – *Belay Demoz*

11:45 - 12:30 Issues arising from site reports discussion – *Peter Thorne* lead

12:30 - 14:00 Lunch

14:00 - 14:20 Spitzbergen - *Marion Maturili*

14:20 - 14:40 Sirta and La Reunion - *Martial Haeffelin*

14:40 - 15:00 Bringing priority 2 variables into GRUAN - *Greg Bodeker*

15:00 - 15:30 Coffee

Session 6: GRUAN data from other instruments

Chair: Peter Thorne; Rapporteur: Arnoud Apituley

15:30 - 16:00 A case study: Bringing lidar data online as a GRUAN data product - *Thierry Leblanc*

16:00 - 16:20 Bringing GPS integrated precipitable water as data stream into GRUAN - *Kalev Rannat*

16:20 - 16:40 Bringing other radiosonde types online as GRUAN data products - *Rolf Philipona / Li Wei*

16:40 - 17:00 Bringing frostpoint soundings online as GRUAN data products - *Dale Hurst and Holger Vömel*

17:00 - 17:20 Defining GRUAN operations and GRUAN protocols - *Holger Vömel*

17:20 - 18:00 Discussion

Voluntary evening breakout session to discuss the requirements for traditional surface observations.

Thursday 8th March

Tateno Site Visit

(or see local logistics for more detail)

Friday 9th March

Session 7: Science issues

Chair: Greg Bodeker; Rapporteur: Bertrand Calpini and Arnoud Apituley

08:30 - 09:00 AOPC discussion of surface reference network - *Adrian Simmons / Howard Diamond*

09:00 - 09:45 Measurement scheduling discussion - *Tom Gardiner /* Dave Whiteman

09:45 - 10:00 Meeting the needs of the reanalysis community - *David Tan*

10:00 - 10:30 Coffee break

10:30 - 10:55 Change management - *June Wang*

10:55 - 11:20 Collocation of GRUAN measurements - *Allesandro Fasso*

11:20 - 11:45 Managing distributed sites discussion - *Arnoud Apituley / Belay Demoz*

11:45 - 12:00 JAXA Earth observation satellites and the validation – *Keiji Imaoka*, EORC/JAXA

12:00 - 12:15 Better linking GRUAN to satellite communities - *John Dykema*

12:15 - 13:30 Lunch

Session 8: Final discussions

Chair: Holger Vömel; Rapporteur: Masatomo Fujiwara and David Tan

13:30 - 14:30 Review of the GRUAN implementation plan - any amendments - *Greg Bodeker*

14:30 - 15:15 Recap of tasks and responsibilities for upcoming year - sign off by all - *Peter Thorne* lead

15:15 - 15:30 Meeting close

15:30 - 16:00 Coffee

16:00 - 18:00 Closed meeting of WG-GRUAN membership

Appendix 3 List of participants

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4th GCOS Reference Upper Air Network
Implementation and Coordination Meeting
GRUAN
5-9 March 2012
Tokyo, Japan

Appendix 4 Lead Centre Report 08/2011 to 02/2012

GRUAN Lead Centre progress report 01/2012

covering the period 08/2011 to 02/2012

Author

Holger Vömel
GRUAN Lead Centre
Lindenberg Meteorological Observatory – Richard Assmann Observatory
German Meteorological Service (DWD)

Summary

The data of the ARM sites are incrementally included into the data processing stream.

The lead Centre had one change in personnel.

Several new software tools and upgrades have been developed.

The application process for three new sites is being actively supported.

The GRUAN lead Centre has participated in several conferences and workshops.

Preparation of ICM-4 as well as the upcoming network design workshop.

Health of network

The amount of data is slowly increasing and a continuation of this increase is to be expected. For long term operations the amount of documentation has to increase as well.

Progress against stated objectives

Open items	**Summary of progress**
3. Prepare generic poster and PowerPoint presentation to be used in promoting GRUAN within the scientific community.	Done. This material has been posted on www.gruan.org.
5. The site representation team will collect acknowledgement requirements from sites. Agree and implement data usage acknowledgement protocol. (Sep 2011)	In progress. Request for requirements was sent out and replies are being collected by Greg Bodeker.
6. NCDC should consider the role of repository for raw data and data not yet congruent with GRUAN standards in addition to GRUAN data products. Lead Centre will advise NCDC on needs. (Oct 2011)	For the existing GRUAN data stream there is not yet any need to store raw data at NCDC. For sonde related data streams that may come online in the near future no storage issue is expected. For other systems, the definition of raw data has yet to be completed.
7. Update the inventory of GRUAN site instrumentation in form of a matrix of current site capabilities. (Oct 2011)	Requests for information had been sent out to the sites and replies have been collected at the Lead Centre. A suitable matrix is currently being compiled and will be distributed through the GRUAN web site.
9. NCDC to consider viability to place a voluntary user registration on data usage making clear the benefits of being made aware of periodic reprocessing and likely impacts. Report to WG-GRUAN by October 2011.	Included on the GRUAN Lead Centre website at www.gruan.org

10. Develop a collection of material, which may be used in proposals by sites to get funding. This collection of material is to be started on the GRUAN blog. (Oct 2011)	To be started.
11. Work with HMEI to scope possible workshop aims and requirements and discuss whether CIMO involvement etc. makes this redundant. Possibility of meeting manufacturers at AMS. (Oct 2011)	Initial discussions have happened. A more detailed discussion has to occur at ICM4.
12. Integrate GRUAN observations in the NOAA Products Validation System (NPROVS.) (Oct 2011)	GRUAN data have been tested in NPROVS on testing basis. Routine inclusion is currently in preparation.
13. Explore possible avenues to set up a trust fund in support of targeted GRUAN activities. (Dec 2011)	Not yet started.
14. Circulate relevant documents to communities likely to be users of GRUAN products to ascertain whether these data products meet their needs. (Dec 2011)	Relevant documents do not yet exist and have to be written. Experiences with the use of GRUAN data are currently assessed within the GRUAN community. Further discussions of the needs of GRUAN data users should happen within the frame of the scheduled network expansion workshop.
16. Complete the GRUAN Manual of Operations in liaison with Task Team; final version to be approved by WG-GRUAN, Lead Centre and 2/3s of all sites.	In progress. Contract to complete the manual is in place.
17. Assessment and certification criteria to be fleshed out by WG-GRUAN, Lead Centre, in consultation with sites representatives. Draft for adoption in time for ICM-4.	Completed.
19. Protocol for acceptable instrument change-over as section in manual to cover generic change criteria.	In progress. To be discussed at ICM4.
20. Include a section in the manual on how to move from priority one to priority two climate variables.	In progress. To be discussed at ICM4.
23. Formulate requirements on surface observations in support of upper-air observations.	To be started
27. Formulate generic guidance on collocation based upon quantitative evidence wherever available, for priority one variables. Includes a toolbox and paper for submission.	Open
28. Investigate and design a system to report and resolve problems in data quality and instrument issues.	A first tool for reporting and detecting data quality issues has been designed at the lead Centre.
29. Implement final version of the GRUAN data dissemination structure.	The GRUAN data dissemination structure has been decided on and has been implemented.

Achievements

- Data from four ARM sites are currently being included into the data processing stream. These data include a number of changes and updates and are therefore made available as beta version 2 on a local DWD site. Once all sites are being switched over to version 2 processing, the ARM data will become part of the regular data stream. ARM data from Nauru and Manus for the year 2011 have already been processed and processing of these data is ongoing. The data from Darwin currently do not include raw data and therefore these observations cannot currently be processed using the GRUAN procedures.

- The WMO World Climate Research Programme Open Science Conference, which was held in Denver, CO, from 24 through 28 Oct 2011, included a GRUAN poster cluster, in which 12 different studies and projects directly related to GRUAN were presented. This poster cluster was coordinated by the lead Centre.
- After the presentation of GRUAN at the NDACC symposium the NDACC steering committee requests a GRUAN representative to be member of the NDACC steering committee.

Lead Centre operations

- One member of the lead Centre has left DWD at the end of September 2011. This position was refilled by 2 January 2012. Lead Centre operations have been severely slowed down due to this transition, but are slowly recovering to normal speed.
- A new version 0.4 of the RSlaunch client has been released and has been distributed to all the sites in January 2012.
- A reporting tool, which provides an overview of all data received at the lead Centre has been developed and is currently been tested. Sites providing data will receive summaries of their submissions by ICM4.
- The site at Ny Alesund, which is managed by the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany, in cooperation with the French Polar Institute Paul Emile Victor (IPEV) has expressed interest in joining GRUAN. Negotiations with this site have been completed and a site application has been received. This site is being recommended as new site in GRUAN.
- The sites at Sirta and La Reunion Island, France are being proposed as new sites for GRUAN. Negotiations are ongoing. A representative for these sites has been invited to attend ICM4 and to present the status and plans for these two sites.
- Presentation of GRUAN at the NDACC symposium at La Reunion from 6 through 10 Nov 2011
- The lead Centre has participated in the GCOS/WIGOS/CBS Expert Meeting on GRUAN Observing Practices and Governance and provided input from the lead Centre perspective.
- The lead Centre actively cooperated with the ancillary measurements Task Team and supports their activities in the preparation of the lidar client, which is designed to standardize and collect Raman lidar data for water vapor vertical profile observations.
- The lead Centre has participated in the preparation of ICM-4.
- The lead Centre has prepared the local logistics for the network expansion workshop, which is scheduled to take place at Fürstenwalde between14-16 June 2012.

Work plan for next six months

- Writing the report for ICM-4
- Preparing for the network design workshop at Fürstenwalde
- Preparing for the 9th International Temperature Symposium
- Supporting candidate sites in their process to become GRUAN stations
- Developing of new data products

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Appendix 5 Task Team reports

5.1 Task Team radiosondes

Prepared by Masatomo Fujiwara
Status as of January 2012

SUMMARY

Review of the WMO Intercomparison report has been completed. Some other tasks were in progress. One of the two co-chair positions is still vacant; a new person came to the Lead Centre in January 2012 as the replacement of Franz Immler, and at ICM4 we will ask him to participate in the Task Team (the WG-GRUAN co-chairs suggested us to proceed slowly).

PROGRESS ON TASKS REPORTED ON THE PREVIOUS REPORT

Task (1): Review of the WMO Intercomparison report

Main Contact: Miloshevich, Philipona **Due Date:** End of 2011 **Status:**Document done
Milestone: Lessons from the WMO report are summarized, and review is made from the GRUAN viewpoints
Progress: Review document is created; will ask WG-GRUAN etc. for comments
Issues: Will this be a GRUAN Technical Document (TD)?

Task (2): RS92 pre-launch procedure

Main Contact: Fujiwara **Due Date:** ICM-4 **Status:** under work
Milestone: Review of the pre-launch ground-check/ground-calibration procedures
Progress: Immler and Miloshevich prepared a document as TD5; review will be made within the Task Team soon.
Issues: Missing perspective in TD5 is to gather information from all relevant GRUAN sites. This task will be relevant to the issue on the GRUAN surface observation requirement.

Task (3): RS92 data product document

Main Contact: **(**Fujiwara) **Due Date: --- Status:** partly done?
Milestone: Lead Centre prepares a document, TD4
Progress: TD4 had been prepared, and review was made by some WG-GRUAN members
Issues: 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 these projects, and our Task Team will review them or even participate in them.

Task (4): Use of descent data and control descent

Main Contact: Philopona, Hurst, **Due Date:** ICM4 **Status:** Under work
Milestone: The use of descent data and controlled descent for GRUAN sounding is discussed in a document
Progress: Regular descent sounding is made at Boulder and Lauder. Some experiments were made at Lindenberg, Payerne, NCAR (and under a tropical project named SOWER).
Issues: Still in the experimental phase. Brief report and offline discussion will be made at ICM4

Task (5): Multi sounding configuration

Main Contact: Jauhiainen **Due Date:** ICM4 **Status:** Under work

Milestone: Recommendation for the multi sounding configuration is made for GRUAN
Progress: A questionnaire will be sent to several researchers/engineers very soon to gather the information on their multi- sounding experiences
Issues: Need more time to prepare a document and to review it within the team

Task (6): RS92 auto-launcher influence
Main Contact: Kivi et al. **Due Date:** ICM4 **Status:** Under work
Milestone: Influence/effects of using the auto-launcher system is documented
Progress: Information is being summarized at Sodankyla (Kivi), Potenza (Madonna), and Tateno (Kizu)
Issues: Report will be made at ICM4 in the site report session; offline discussion will be made for a summary document.

Task (7): Chilled-mirror hygrometer data product document
Main Contact: Vömel, Hurst, Philipona, Fujiwara **Due Date:** End of 2011, **Status:** Under work
Milestone: A GRUAN Technical Document is prepared, which include the information on the uncertainty estimation method
Progress: A document is being prepared.
Issues: Hurst will have a time slot for presentation at ICM4; offline discussion will be made at ICM4.

Task (8): Time-lag correction issues (including intercomparisons) for RS92 RH measurements
Main Contact: (Fujiwara), Kats, Miloshevich **Due Date:** End of 2011 **Status:** Not yet started
Milestone: Various time-lag correction schemes will be compared to create the best correction scheme for GRUAN
Progress: Not yet started
Issues: This task is considered to be included/merged in the task on RS92 data product document (see Task (3)). We also need representatives for the GRUAN correction and the Vaisala correction 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.)

5.2 GRUAN Task Team GNSS-PW

Submitted by Kalev Rannat and June Wang
Status as of January 2012

SUMMARY
Besides working on the tasks listed below, the GNSS-PW Task Team has also been involved in the following activities:

1. Gfg2 workshop, Oslo (Oct. 12-13) on GNSS applications for Global Environmental Earth Observation to represent GCOS. Kalev Rannat participated with a presentation ("GCOS + GRUAN").
2. The TT helped the Lauder observatory to set-up their GPS receiver and provided advices on surface met sensors.
3. John Braun, Galina Dick, Seth Gutman and June Wang from our Task Team all joined the IGS Troposphere Working Group. We hope to make connections with IGS through this working group.
4. The Task Team is discussing the connections between Global Geodetic Observing System (GGOS) Core Network Sites and GRUAN. A few of us felt that it is a good idea to establish such connections. We will discuss this at next Conference call (Feb. 2012).
5. The new GRUAN GNSS installation at Sodankylä is finished, initially tested, but has still problems with data flow. Therefore, it is still not in routine service. The problems should get overcome for spring, 2012.
6 The local experiments at Sodankylä (according to the tasks #5-6 from previous plans and report) are put on hold until the problems with data flow get finally resolved.

PROGRESS ON TASKS REPORTED ON THE PREVIOUS REPORT

Task#1: To define GRUAN requirements
Main Contact: G. Elgered/J. Wang **Due Date: 8/31/2011 Status:** finished**.**
Milestone: A document
Progress: A document was produced to summarize the requirements and how they were derived.
Issues: none

Task#2: To document and review current status of GNSS apparatus and setup at the sites
Main Contact: K. Rannat **Due Date:** 12/31/2011 **Status:** finished.
Milestone: A table (excel file)
Progress: The file was last updated in January, 2012. The altitude of GPS sites and RADOME usage are clarified. The table should coincide with requirements in the guidelines. The table will be sent to LC
Issues: The TT keeps hands on the updates as the status and set-ups of stations changes when it is still active and then the LC afterwards. Some data about the antenna height from MSL is still missing.

Task#3: To prepare "GRUAN GNSS Site Guidelines"
Main Contact: J. Wang **Due Date:** 12/31/2011 **Status:** Almost finished
Milestone: A GRUAN TD
Progress: The first version of "GRUAN Ground-based GNSS Site Guidelines" was completed, reviewed by three WG-GRUAN members and revised based on the reviewers' comments. The TT is waiting for the reviews of the revised version. The guidelines have been sent to Lauder for their new site set-up.
Issues: The LC with the help from the Task Team should maintain it. The site log defined here should be separated from the table in #2 but be consistent. Could LC make this consistency check automatic?

New tasks and progress to date

Task#4: To work on Tasks #4-7 listed in ToR
Main Contact: J. Wang/K. Rannat **Due Date:** 12/31/2012 **Status:** started.

Milestone: Each task will produce a document.

Progress: A plan for working on Task #4-7 was finalized including assigning subtask teams to each task and discussions on each task (available upon request). The subtask teams started to work on it. The progresses will be updated at ICM4.

Issues: Some of these tasks are huge undertakes. Any assistance (both man power and resources) are needed to accomplish them.

5.3 Task Team scheduling

Prepared by Tom Gardiner
Status as of January 2012

SUMMARY
The primary objective for the Task Team is to develop defensible, quantifiable, scientifically-sound guidance for GRUAN sites on measurement schedules and associated site requirements, in order to meet the GRUAN objectives.

In terms of scientific outputs from the Task Team, while the activities of the team remain a voluntary one without specific funding, the main information sources are from the peer-reviewed literature, GRUAN documentation, and currently unpublished studies of which the group is aware. Some limited new analyses are being undertaken by team members using existing data sets to start to address areas where critical gaps exist that prohibit scientifically defensible choices.

The main activity has been work on the scheduling section of the GRUAN Manual, and a new version has been produced for discussion at the ICM.

Progress on tasks reported on in previous report

Task	Due Date	Milestone	Progress	Issues
Complete Trend Paper	June 2011	Submission of paper lead by Dave Whiteman on 'The relative importance of accuracy and observation frequency in detecting trends in upper tropospheric water vapor'	Revised paper accepted by JGR.	
TT membership	May 2011	Confirmed list of at least 5 TT members.	TT now quorate with 6 members	Still no site representation on TT
TT telecon	Sept 2011	Telecon to discuss TT issues and review objectives and tasks	Doodlepoll TT membership	No suitable date identified. TT discussions carried out by email.
Bibliography of relevant information sources	Nov 2011	Prepare a document that identifies and briefly summarises the sources of information (papers, reports, etc) relevant to the scheduling issues.	Information for document still being gathered. Aiming for release in May 2012.	Keep document updated after initial release.
Paper for ITS	Dec 2011	Prepare paper (Tom Gardiner lead) for GRUAN session at the 9th International Temperature Symposium	Paper submitted to ITS.	
Resolve differences in times to determine trends	June 2012	Review the reasons for the difference in the time to detect WV trends in Boers and Whiteman papers.	Not started	No funding.
Extend trend studies into LS	Dec 2012	Submission of paper (Dave Whiteman lead)	Currently studying MLS and aircraft in-situ measurements with goal of assessing noise and autocorrelation in LS water vapor	No funding.
Scheduling summary document	Mar 2012	Prepare guidance on scheduling issues for inclusion in GRUAN manual	New version available for comments.	Need to clarify the required contents, including instrument specific details

5.4 Task Team ancillary measurements

Prepared by Thierry Leblanc
Status as of February 2012

SUMMARY

The Task Team on ancillary measurements (TT5) met in what was their first team-wide teleconference on February 2, 2012. Besides the usual updates on ongoing tasks, live discussions triggered a number of new tasks, as itemized below. Several projects parallel to GRUAN have reached significant maturity, allowing unprecedented leverage to the benefit of GRUAN:
1) key information on microwave measurements gathered in the framework of MWRnet will be compiled in the upcoming GRUAN Microwave Guidelines (Aug 2012);
2) the potential use of consistent FTIR retrievals from the MUSICA project; 3) the coordination of ancillary measurements leading to site atmospheric state best estimate (SASBE) parameters.
A first draft of the GRUAN Lidar Guidelines was made available in January. A revised version will be available within a few weeks. A similar document will be initiated for microwave and FTIR (first draft due Aug 2012). Additional details on the above topics as well as other topics covered by TT5 can be found under each individual task listed below.

PROGRESS ON TASKS REPORTED ON THE PREVIOUS REPORT: Completed tasks

Task: MWRNet Update, including tasks pertaining to all TT5 Terms of Reference

Main Contact: N. Cimini **Due Date:** None **Status: Completed**
Milestone: 14-16 march 2011: Second Meeting in Koln (EG-CLIMET)
Progress: 13 actions and 19 recommendations. Reports available to MWRnet members at: (http://cetemps.aquila.infn.it/mwrnet/main_files/reports.html). Inventory of registered instruments and contacts: http://cetemps.aquila.infn.it/mwrnet/
Issues: None

Task: Validation Strategies and Results (lidar, microwave, FTIR, Sonde): New Publications

Main Contact: T. Leblanc **Due Date:** Recurring **Status: Completed**
Milestone: Dec. 2011, Jan 2012: AMT Special Issue on MOHAVE-2009
Progress: 4 papers published in AMT: Stiller et al (MIPAS), Hurst et al. (FPH+radiosonde), Leblanc et al. (MOHAVE Overview), Leblanc et al. (TMF lidar).
Issues: None

Task: Validation Strategies and Results (microwave): New Publication

Main Contact: A. Haefele **Due Date:** Recurring **Status: Completed**
Milestone: Sept. 2011: AMT paper on ARIS Campaign (microwave)
Progress: Straub, C., et al.: ARIS-Campaign: intercomparison of three ground based 22 GHz radiometers for middle atmospheric water vapor at the Zugspitze in winter 2009, Atmos. Meas. Tech., 4, 1979-1994, doi:10.5194/amt-4-1979-2011, 2011
Issues: None

Task: Consistent ground-based FTIR Retrievals: H2O and HDO/H2O

Main Contact: M. Schneider **Due Date:** None **Status: Completed**
Milestone: Feb. 2011: start of MUSICA (http://www.imk-asf.kit.edu/english/musica)
Progress: Consistent H2O and HDO/H2O data are now available for the ten ground-based FTIR sites of MUSICA.
Issues: Still missing is a detailed characterization of the products for each individual site and observation: averaging kernels and error budgets.

Task: Suitability of Deployed Equipment: Best Measurement Practices (microwave)

Main Contact: N. Cimini **Due Date:** Recurring **Status: Completed**
Milestone: 14-16 march 2011: Second Meeting in Koln (EG-CLIMET)
Progress: Best Measurement Practices discussed and reported within MWRnet will be transferred into the GRUAN microwave radiometer guidelines (see new task below)
Issues: None

PROGRESS ON TASKS REPORTED ON THE PREVIOUS REPORT: Ongoing tasks

Task 1: Inventories of Retrievals and Products from satellites
Main Contact: T. Reale **Due Date:** ICM-4 **Status:** Ongoing
Milestone: ICM-4
Progress: Identify available derived satellite products and associated (metadata) for atmospheric temperature and moisture profiling suitable for validation exercises at GRUAN sites
Issues: None

Task 2: Validation Strategies and Results (Satellite): Coordination with JPSS
Main Contact: T. Reale **Due Date:** ICM-4 **Status:** Ongoing
Milestone: April 2011: Sounding Operational Algorithm Team (SOAT)
Progress: Provided briefs to JPSS cal/val team on routine validation of NPP Environmental Data Record (EDR) for atmospheric temperature and moisture soundings and opportunities for special validation exercises at GRUAN sites. Focus of intensive validation at ARM sites (resource permitting) for special sonde launch(s) at NPP overpass during 2012
Issues: Delay in resource allocation and planning for special sonde launches

Task 3: Validation Strategies and Results (Satellite): Satellite Products Cal/Val (NPROVS)
Main Contact: T. Reale **Due Date:** ICM-4 **Status:** Ongoing
Milestone: October 2011
Progress: Developed initial NOAA Products Validation System (NPROVS) interface to integrate, display and analyze GRUAN (radiosonde) observations accessed from NCDC using NPROVS
Issues: Still need to integrate GRUAN sondes with historical NPROVS satellite collocation data (2011, Lindenberg, Tateno) and incorporate “uncertainty” in analysis

Task 4: Consistent FTIR and IASI Retrievals and Products: H2O and HDO/H2O
Main Contact: M. Schneider **Due Date:** 2016 **Status:** Ongoing
Milestone: Feb. 2011: start of MUSICA (http://www.imk-asf.kit.edu/english/musica)
Progress: First paper on consistency of MUSICA’s ground- and space-based H2O and HDO/H2O remote sensing products for a subtropical ocean scene; Schneider and Hase, ACP, 11, 11207–11220, 2011,
Issues: Next steps: Examine long-term consistency (the whole IASI period: 2007-2012) and develop IASI land scene retrievals

Task 5: Products and Uncertainty Budgets (lidar): ISSI Team on NDACC lidar algorithms
Main Contact: T. Leblanc **Due Date:** Summer 2012 **Status:** Ongoing
Milestone: August 2011: Standardization Tools for Vertical Resolution Validated
Next milestone: Sept. 2012 with Meeting # 3 (final)
Progress: Vertical resolution: Tools available, Manual being written, due May 2012. Results posted here: http://www.issibern.ch/teams/ndacc/private/NDACC_Tools_Vertical_Resolution.htm (currently, login needed, but eventually will become public). Tools for “NDACC-standardized” reporting of uncertainties to be developed in the spring of 2012.
Issues: 4-month delay for uncertainties, Meeting # 3 planned for Sept. 2012

Task 6: Products and Uncertainty Budgets (satellite): GEWEX

Main Contact: M. Schröder **Due Date:** Post 2013 **Status:** Ongoing

Milestone: Second workshop on the GEWEX water vapour and temperature profile assessment announced: DWD, Offenbach, Germany, Sept. 2012

Progress: The workshop preparation is well advanced, the first circular has been distributed, and first participants/experts already registered. The assessment will be introduced at the upcoming International TOVS Science Conference in Toulouse, France. The assessment plan is based on the GEWEX News from May 2011 on the first workshop and has been largely extended. A first distribution is planned for March 2012. First proposals in support to the assessment are planned and a few have already been submitted to appropriate funding agencies

Issues: None

Task 7: Inventories of Potential Instruments (microwave)

Main Contact: N. Cimini **Due Date:** Recurring **Status:** Ongoing

Milestone: Last: 2nd Workshop, March 2011; Next: TBA

Progress: 3 new units have joined MWRnet: 2 in Germany, 1 in USA

Issues: None

Task 8: Validation Strategies and Results (Microwave)

Main Contact: N. Cimini **Due Date:** Recurring **Status:** Ongoing

Milestone: 14-16 march 2011: Second Meeting in Köln (EG-CLIMET)

Progress: Validation statistics available for some GRUAN sites will be made available and reported on GRUAN microwave radiometer guidelines

Issues: **None**

Task 9: Validation Strategies and Results (lidar, microwave, FTIR, Sonde): New Publications

Main Contact: T. Leblanc **Due Date:** Recurring **Status:** Ongoing

Milestone: Jan 2012: AMT Special Issue on MOHAVE-2009

Progress: 1 paper in AMT-Discussions: Whiteman et al. (ALVICE lidar), Two more papers to be submitted soon: McGee (STROZ lidar), and Toon et al. (FTIR).

Issues: TBA

Task 10: Validation Strategies and Results (microwave): New Publication

Main Contact: A. Haefele **Due Date:** Recurring **Status:** Ongoing

Milestone: Fall 2011: AMT-Discussion paper on suitability of microwave for NWS

Progress: Löhnert, U. and Maier, O.: Assessing the potential of passive microwave radiometers for continuous temperature profile retrieval using a three year data set from Payerne, Atmos. Meas. Tech. Discuss., 4, 7435-7469, doi:10.5194/amtd-4-7435-2011, 2011

Issues: None

Task 11: Metadata (Microwave)

Main Contact: N. Cimini **Due Date:** None **Status:** Ongoing

Milestone: TBA

Progress: MWR data from most common units have been collected to start the activities on data and metadata format harmonization

Issues: None

Task 12: Suitability of Equipment: Best Measurement Practices (lidar guidelines)

Main Contact: T. Leblanc **Due Date:** ICM-4 **Status:** Ongoing

Milestone: January 2012: Draft version 0.1 released

Progress: First draft of the GRUAN Lidar Guidelines released and submitted for review to TT5 members as well as other GRUAN collaborators. Guidelines propose an overall structure that would allow full traceability of instrument and data processing changes. The structure includes the use of a so-called “IGLIMP” document fully describing each GRUAN lidar programme (instrumentation and SOP), an interface utility (“Lidar RunClient”) uploading all necessary data

and meta-data, and a centralized processing software ("GLASS"). The draft is now being reviewed. A revised version will be available at ICM-4.

Issues: TBA.

NEW TASKS AND PROGRESS TO DATE

Task 13: GRUAN Manual Add-ons by TT5 in Secs. 6.4.2 and 7.1.4

Main Contact: All TT5 **Due Date:** ICM-4 **Status:** New

Milestone: Feb 2012: TT5 input returned

Progress: "Scheduling" and "Remote sensing instruments" add-ons by TT5 now being finalized (to G. Bodeker)

Issues: None

Task 14: Suitability of Equipment: Best Measurement Practices (Microwave Guidelines)

Main Contact: N. Cimini **Due Date:** ICM-5 **Status:** New

Milestone: Aug 2012: First draft due

Progress: Large amount of material collected from MWRnet activities, and to be compiled for use in the GRUAN Microwave guidelines

Issues: None

Task 15: Suitability of Equipment: Best Measurement Practices (FTIR Guidelines)

Main Contact: M. Schneider **Due Date:** ICM-5 **Status:** New

Milestone: Jul 2012: First draft due

Progress: TT5 FTIR experts will work on a first draft following principles applied in Lidar Guidelines doc.

Issues: None

Task 16: Interface with other expert teams: EARLINET Centralized Algorithm (lidar)

Main Contact: A. Apituley **Due Date:** TBA **Status:** New

Milestone: Aug 2012: First report due

Progress: A. Apituley and T. Leblanc will inquire to EARLINET colleagues on the status of their Centralized Data processing Algorithm and study the potential synergy between EARLINET and GRUAN

Issues: None

Task 17: Suitability of Equipment: AERI as a potential GRUAN FTIR instrument (FTIR)

Main Contact: J. Hannigan **Due Date:** TBA **Status:** New

Milestone: Aug 2012: First report due

Progress: J. Hannigan and M. Schneider, together with D. Tobin, will investigate on the possibility to bring AERI instrument into GRUAN.

Issues: None

Task 18: Suitability of Deployed Equipment: Site Atmospheric State Best Estimate (SASBE)

Main Contact: Tobin/Reale **Due Date:** TBA **Status:** New

Milestone: September 2102

Progress: D. Tobin with J Dykema to investigate essential "recipe" of GRUAN ancillary and sonde measurements (including uncertainties) to calculate SASBE with focus on atmospheric temperature and moisture for NPP satellite hyperspectral products validation

Issues: None

5.5 Task Team site representatives

Prepared by Dale Hurst, Belay Demoz
Status as of January 2012

SUMMARY

The Task Team of site representatives continues to serve as the conduit through which information and requests from the Lead Centre and WG-GRUAN are disseminated to the GRUAN measurements sites. During the last six months, most of the information and requests centered around the GRUAN manual, data policy, and site assessment and certification document. The composition of the Task Team has changed:

Martin deGraaf departed, leaving **Arnoud Apituley** as lone site representative (Cabauw)

Hakaru Mizuno departed and was replaced by **Hironobu Yokota** (Tateno)

Karin Kreher joined **Paul Johnston** as co-representative (Lauder).

PROGRESS ON TASKS IN THE PREVIOUS REPORT

Task: Request and compile comments on the GRUAN data policy
Main Contact: Greg Bodeker **Due Date:** Sep 2011 **Status:** Completed
Milestone: Obtain feedback from site representatives on the GRUAN data policy
Progress: No comments were received
Issues:

Task: Request sign-offs of the GRUAN site assessment and certification document
Main Contact: Greg Bodeker **Due Date:** 1 Jan 2012 **Status:** Completed
Milestone: 12 of 15 sites approved the document by the due date
Progress: Completed
Issues:

Task: Request reviews and comments on the most current version of the GRUAN manual
Main Contact: Greg Bodeker **Due Date:** 15 Jan 2012 **Status:** Completed
Milestone: Obtain feedback from site representatives on the GRUAN manual
Progress: Completed
Issues:

NEW TASKS AND PROGRESS TO DATE

Task: Find a site representative willing to serve as a member of TT3 (scheduling)
Main Contact: TT3 co-chairs, Dave Whiteman and Tom Gardiner **Due Date:** ASAP
Status: Ongoing
Milestone:
Progress: None to date
Issues:

Task: Assist in the formulation of instrument capability list
Main Contact: Lead Centre **Due Date:** Open **Status:** Ongoing
Milestone:
Progress: First draft list completed and being refined
Issues:

Appendix 6 Meeting of the WG-GRUAN

WG-GRUAN Meeting, Tokyo, Japan, 5 and 9 March 2012

Attendees:
Arnould Apituley, Franz Berger, Greg Bodeker, Bertrand Calpini, Belay Demoz, Howard Diamond, John Dykema, Allessandra Fasso , Masatomo Fujiwara, Tom Gardiner, Dale Hurst, Karin Kreher, Thierry Leblanc, Fabio Madonna, Andrea Merlone, Kalev Rannat, Tony Reale, Masato Shiotani, Adrian Simmons, David Tan, Peter Thorne, Holger Vömel, June Wang

The WG-GRUAN met in advance of the main meeting to discuss progress generally and specific governance issues. The WG-GRUAN met again after the closing of main meeting to review the meeting and address remaining open issues. The summary presented here reflects the discussions of both sessions of the WG-GRUAN meeting

The WG-GRUAN places on the record its appreciation to DWD for the continued support for the GRUAN Lead Centre at Lindenberg. The Lead Centre has been instrumental in advancing the GRUAN effort since its instigation. It is absolutely imperative that reference networks be pro-actively managed on a day-to-day basis if they are to be a success. As such, the Lead Centre staff have been and continue to be, key participants in the success of the GRUAN endeavor.

More specifically, the Lead Centre has achieved a substantial number of accomplishments in the initial period of operations, viz.:
- GRUAN data flow
- Capturing requirements of data and metadata and propagating such standards across the network
- Involvement in substantial intercomparison campaigns to improve our fundamental knowledge of instrumentation characteristics
- GRUAN web portal and blog
- Significant process documentation

DWD has expressed its ongoing commitment to the operation of the Lead Centre, which is received with pleasure. As the WG-GRUAN looks to continue to expand the network and its operations it continues to see the Lead Centre as playing a truly central role in the success of GRUAN. The WG-GRUAN agreed on a document to be submitted to AOPC for their consideration to this effect.

WG-GRUAN members were in agreement that the new co-chair solution and the extra resource that Greg Bodeker had bought had served to significantly strengthen the WG-GRUAN activities over the past year.

The outcomes from the meeting in Geneva in January held under the auspices of WIGOS / GCOS / CBS in terms of WG-GRUAN membership and governance were discussed. WG-GRUAN members welcomed the stronger potential involvement of the WMO Technical Commissions but reaffirmed their opinion that AOPC and GCOS were the appropriate immediate governing parties.

The application from the AWI for the site at Ny Alesund sparked a lengthy debate about how to implement the site certification process in practice. Although the site assessment and certification document has been formally adopted and the criteria have been well described the discussion focused on how to proceed with this application in detail. It was decided that the co-chairs prepare a set of questions, which would guide the evaluation by the WG-GRUAN members. Each member was strongly urged to study the site application and the formulate questions back to the site. It was decided that this set of questions would be collected by the Lead Centre and then sent to the site. Most of the debate centred around whether a formal scoring system be involved and if so what the ‘pass mark’ should be. There were wildly varying opinions presented upon the issue. The eventual majority decision was to include a scoring system on the first attempt and if necessary reassess thereafter based upon how well it worked and any WG-GRUAN member feedback to the co-chairs.

The number of tasks to be completed by participants within GRUAN continues to grow. Tracking the progress of these tasks presents itself as a challenge. This is currently being addressed by a web based document that provides an overview of all active and completed tasks. This document is

intended to be a document for the internal use of the WG-GRUAN and not intended to be a public document.

Representation of GRUAN within NDACC was discussed. In a discussion following ICM-4 it was decided that Holger Vömel, head of the GRUAN Lead Centre would represent GRUAN within the NDACC Steering Committee and that Greg Bodeker and Peter Thorne would act as co-representative in case of time or scheduling conflicts.

Three Technical resolutions were discussed and adopted that related to:

- the protocols for GRUAN literature (Appendix 11);
- Manual and Guide Revision protocols (Appendix 12); and
- Task Team co-chair replacement (Appendix 13)

These were adopted my majority consent of the WG-GRUAN members present.

ICM-5

Without discussion, KNMI was invited to host the ICM-5 meeting in 2013 and KNMI has expressed preliminary interest in doing so (see section 8).

Appendix 7 GRUAN literature protocols

GRUAN literature review and adoption protocols

The GRUAN Technical Documents series contains information necessary to undertake GRUAN-congruent measurements and understand the rationale behind these measurements. Being a science driven network the first preference is to publish within the peer-reviewed literature whenever possible. High level documentation such as the Manual, Guide, Implementation Plans and summaries of significant GRUAN meetings are published as GCOS reports. Documents that do not fall into these first two categories constitute the GRUAN documents series.

Classes of GRUAN documentation

Technical documents
Technical documents shall relate entirely to technical aspects of GRUAN operations, including but not necessarily being limited to standard operating procedures for instruments, and procedures for data collection, transmission and storage. They will include all necessary process metadata required to understand these aspects.

GRUAN reports
GRUAN reports shall be less technical and / or specific in nature and relate to issues such as lessons learned or operational ethos. Most reports that cannot be categorized as Technical Documents shall be filed under this class but WG-GRUAN and the Lead Centre reserve the rights to add additional classes in future.

Document review process

Formal document review before adoption as GRUAN literature is mandatory. The WG-GRUAN chairs will task three reviewers selected from WG-GRUAN, Task Teams, and other volunteer experts with this review. The WG-GRUAN aims to elect a curator of GRUAN documentation, who will manage the process of GRUAN document review once reviewers have been selected. Reviewers will be selected based upon expertise and / or perspective. Every effort will be made to ensure that reviewer tasks are spread appropriately across WG-GRUAN membership so as not to be overly onerous on any individual. WG-GRUAN chairs will act as editors and based upon reviewer comments make a decision regarding adoption or revision and whether re-review is necessary.

Document adoption and publication

The document will be officially endorsed once WG-GRUAN chairs are satisfied that reviews have been adequately taken into account and the report is deemed acceptable. At such a time the report will be published on the GRUAN website and catalogued. Authorship of the document should be clearly documented.

Document lifecycle

All GRUAN *Technical Documents* shall be assigned a re-review lifecycle of not greater than 5 years (to be managed by the GRUAN document curator). WG-GRUAN chairs will have discretion in setting this cycle length based upon reasonable expectations of the likely timescale of the dating of contents. GRUAN *reports* shall not have an expiry date assigned unless the WG-GRUAN chairs believe such a mandatory re-review is required given the report contents. The WG-GRUAN chairs or a designate shall manage this process.

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Appendix 8 Manual and Guide revision

Manual / Guide revision protocols

As stated in the ICM-3 report, significant regulatory material will be approved by unanimous WG-GRUAN consent and 2/3 sites sign off. This will continue to be the case and this document does not supersede this former directive. Rather it is intended to document criteria to be met which would warrant re-opening for revision and re-acceptance protocols.

The Manual or Guide will be revised upon any of the following threshold criteria being met:

1. A direct request to revise from GCOS AOPC
2. A request to revise from more than 50% of WG-GRUAN members or more than 33% of WG-GRUAN and the Lead Centre.
3. A request to revise from two or more WMO Technical Commissions associated with GRUAN
4. More than five years since last revision for the Guide and ten years for the Manual.

If the revision arose from a direct request (1-3), WG-GRUAN by majority decision will decide whether the requested changes constitute minor or major revisions. A five / ten year review will always constitute major revisions.

In the event that revisions are minor in nature:

- WG-GRUAN chairs in consultation with the Lead Centre will revise the Manual and / or Guide accordingly in liaison with the requestors
- The revised version(s) once WG-GRUAN chairs, LC and requestor are satisfied will be put to a simple majority acceptance vote by WG-GRUAN and for consent by the Task Team on site representative chairs.
- Upon acceptance the third decimal version point will be incremented by a single integer, the previous version archived and the new version posted in its stead.

In the event that revisions are major in nature:

- Resource will be sought to undertake the necessary re-evaluation and revisions under a consultant role by a nominated party.
- The revised version will be put to the same unanimity of WG-GRUAN and 2/3 of sites criteria as the initial version.
- Upon acceptance the second decimal place version point will be incremented by a single integer, the third decimal integer reset to zero, the previous version archived and the new version posted in its stead.

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Appendix 9 Guidelines for selection of Task Team co-chairs

In the event of a new task team being constituted

- An initial list of task team members will be solicited by the WG-GRUAN co-chairs from the GRUAN community at large, AOPC, GCOS Secretariat, WCRP, CBS, CIMO, CAS, CCL, HMEI or any other external body with an interest in GRUAN.
- All members of the incipient task team will, by default, be eligible for election as co-chair unless they specifically request not to be.
- The WG-GRUAN co-chairs will arrange a closed election amongst the task team members, taking votes by email, and then select two co-chairs. These need not necessarily be the task team members receiving the greatest number of votes.
- The WG-GRUAN co-chairs will announce the selection by email.

In the event of an existing co-chair position becoming available

This may occur either as a result of a co-chair leaving the GRUAN community or electing to no longer function in the role of a task team co-chair. In either case:

- All members in the task team will, by default, be eligible for election as co-chair unless they specifically request not to be.
- The incumbent co-chair will, through an open and transparent process, generate a list of up to, but not exceeding, 3 nominees for the position. The process could be through an election, but need not necessarily be.
- The incumbent co-chair will then, in private, order that list according to their preference and pass that list on to the WG-GRUAN co-chairs.
- The WG-GRUAN co-chairs will then make the final selection, confer with the incumbent task team co-chair, and announce the selection, by email, to the task team.

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Appendix 10 List of acronyms

AOPC	Atmospheric Observation Panel for Climate (GCOS)
ACRF	ARM Climate Research Facility
AMS	American Meteorological Society
ARM	Atmospheric Radiation Measurement Program (DOI)
ATM	Accurate Temperature Measuring radiosonde (NASA reference radiosonde)
BIPM	International Bureau of Weights and Measures
BSRN	Baseline Surface Radiation Network
CBS	Commission for Basic Systems (WMO)
CEOS	Committee on Earth Observation Satellites
CFH	Cryogenic Frostpoint Hygrometer
CGMS	Coordination Group of Meteorological Satellites
CIMO	Commission for Instruments and Methods of Observation (WMO)
CMA	China Meteorological Administration
CM-SAF	Satellite Application Facility on Climate Monitoring
CPO	Climate Program Office (NOAA)
DOE	Department of Energy (USA)
DWD	German Meteorological Service (Deutscher Wetterdienst)
EARLYNET	European Aerosol Research Lidar Network
ECMWF	European Centre for Medium-Range Weather Forecasts
EDGE	Enhanced Data Rates for GSM Evolution
EG-CLIMET WG/MC	European Ground-based Observations of Essential Variables for Climate and Operational Meteorology Working Group/ Management Committee
EMRP	European Metrology Research Project
FTIR	Fourier Transform Infrared Spectrometer
FTS	Fourier Transform Spectrometer
GATNDOR	GRUAN Analysis Team for Network Design and Operations Research
GAW	Global Atmospheric Watch (WMO)
GCOS	Global Climate Observing System
GEOMS	Generic Earth Observation Metadata Standard
GEOS	Geostationary Operational Satellites
GEWEX	Global Energy and Water Cycle Experiment
GNSS	Global Navigation Satellite System
GOS	Global Observing System (WMO)
GOSIC	Global Observing System Information Centre (at NCDC)
GPS	Global Positioning System
GNSS-PW	Global Positioning System Precipitable Water
GRUAN	GCOS Reference Upper Air Network
GSICS	Global Space-Based Inter-Calibration System
GSN	GCOS Surface Network
GTS	Global Telecommunication System
GUAN	GCOS Upper Air Network
HMEI	Association of Hydro-Meteorological Equipment Industry
ICM	Implementation - Coordination Meeting (GRUAN)
IGRA	Integrated Global Radiosonde Archive
IPW	Integrated Precipitable Water
ISCCP	International Satellite Cloud Climatology Project
ISSI	International Space Science Institute
IWV	Integrated Water Vapour
JGR	Journal of Geophysical Research
JPL	Jet Propulsion Laboratory (NASA)
JPSS	Joint Polar Satellite System
KNMI	Royal Netherlands Meteorological Institute
LIDAR	Light Detection and Ranging (optical remote sensing)
LUAMI	Lindenberg Upper-Air Methods Intercomparison Campaign
MOL	Lindenberg Meteorological Observatory
MTR	Meisei Temperature Reference
MWRnet	Microwave-Radiometer Network
NASA	National Aeronautics and Space Administration (USA)

NCAR	National Centre for Atmospheric Research (USA)
NCDC	National Climatic Data Centre (NOAA)
NDACC	Network for the Detection of Atmospheric Composition Change
NetCDF	Network Common Data Form
NILU	Norwegian Institute for Air Research
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOAA FPH	NOAA Frost Point Hygrometer
NOAA/NWS	NOAA National Weather Service
NPROVS	NOAA Products Validation System
NWP	Numerical Weather Prediction
NWP SAF	Satellite Application Facility for Numerical Weather Prediction
PW	Precipitable Water
SCOPE-CM	Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring
SGP	Southern Great Plains Site (ACRF)
SI	International System of Units
SSI	Scientific Sounding Instruments
STAR	Centre for Satellite Applications and Research
TECO	Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (WMO)
UKMO	UK MetOffice
UT/LS	Upper Troposphere and Lower Stratosphere
WCRP	World Climate Research Programme
WG-GRUAN	Working Group on GRUAN
WIGOS	WMO Integrated Global Observing Systems
WIS	WMO Information System
WMO	World Meteorological Organization

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