Fourth workshop on the GEWEX water vapor assessment

Workshop summary

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1. Overview

The GEWEX Data and Assessment Panel (GDAP) has initiated the GEWEX Water Vapor Assessment (G-VAP) in 2011. The major purpose G-VAP is to quantify the state of the art in water vapour products being constructed for climate applications, and by this supports the selection process of suitable water vapour products by GDAP for its production of globally consistent water and energy cycle products. Workshops are carried out on an annual basis to discuss recent findings, to further refine the plan and to draft and consolidate the assessment reports.The fourth workshop of the GEWEX water vapor assessment (G-VAP) was hosted by the Institute for Space Sciences at the Free University of Berlin (FUB) and took place in Berlin, Germany, on 9 and 10 October 2014. More than 30 participants from research institutes, universities and SME (Small and Medium-sized Enterprises, CNRS/LMD, CSU, FUB, Moog, MPI, U. Cologne, U. Leicester, U. Miami, U. Versailles/LATMOS, U. Wisconsin, Vanderbilt U.), from weather services (DWD, NOAA, SMHI), from the ground-based and in-situ measurement communities (DWD/GRUAN) as well as from space agencies (DLR, ESA, EUMETSAT) attended the workshop. A list of participants, their affiliations and email addresses are given in Appendix D. The presentations of the fourth G-VAP workshop are available at www.gewex-vap.org.

The main objectives of the 4th meeting were to

- Provide status on activities and present and discuss results achieved thus far,
- Decide on way forward: Refine on-going activities with the main objective to find explanations for observed discrepancies and limitations in long-term satellite data records of tropospheric water vapour,
- Discuss potential new contributions related to activities mentioned in the assessment plan,
- Discuss contents of G-VAP report and decide on lead authors of report sections.

An important constraint for the discussions was the fact that the WCRP report on G-VAP will be finalised in 2015 and will be submitted to GDAP for review in October 2015.

The workshop started with an overview presentation on GDAP and the GEWEX integrated product and was followed by a summary from last workshop and several presentations on data sets which are either already used within the assessment or on the candidate list. Additionally some data sets were introduced that were not considered so far but could possibly still be included. Furthermore, updates were given on G-VAP activities and related work, together with proposals on how to proceed in order to finalise the WCRP report on G-VAP in 2015. Also, presentations on the anthropogenically-driven increase in water vapour and the effect of atmospheric water vapour on cloud retrieval were given. The workshop finished with presenting and discussing the structure of the final G-VAP report and the organisation of the drafting of the report.

The main outcomes of the fourth workshop are summarized as follows:

- The time line for drafting the WCRP report on G-VAP, the latest data upload/download and the time line to finalise G-VAP have been confirmed by the workshop (see presentation by M. Schröder et al. on 09 October 2014 at 09:50).
- The structure of the WCRP report has been discussed, refined and agreed upon.
- Many participants have volunteered to become lead authors and/or contributing authors such that the majority of sections are covered. The terms for lead authors have been accepted.
- The nnHIRS profile data record will be considered as well. It is expected to be available by the end of 2014.
- Refinements and the next steps have been presented, discussed and agreed upon (see presentations, in particular by Lockhoff and Schröder and these minutes for details).

The following recommendations and needs have been compiled:

- ***Enhance evaluation of water vapour and temperature at the surface and in the boundary layer to strengthen the evaluation of energy fluxes (land and ocean) and the analysis of the planetary boundary layer.***
- ***Enhance quality analysis of profile data records over open ocean, in particular over high pressure areas/subsidence areas.***
- ***Explain differences and achieve consistency among reference observing systems (i.e., GRUAN versus IASI).***
- ***Provide long-term calibration uncertainty to enhance reliability of trend uncertainty analysis.***
- ***Provide water vapour transport product in order to analyse atmospheric dynamics and to evaluate the constancy of relative humidity (e.g., ocean to land transport).***
- ***Recommendation to GRUAN co-chairs: Include station over tropical land.***

Recommendations from previous workshops are recalled in Appendix B. Activities from last workshops are recalled in Appendix A – some of these activities are lacking an activity leader and the consolidation of profile evaluation is ongoing.

We recall that if no responsible person for an activity or for a WCRP report section can be found the activity will be left open for future analysis and the section will either be removed or moved into the Appendix.

2. Background

This year's 4th G-VAP workshop builds upon three previous workshops held in 2011, 2012, and 2013. The 1st workshop was hosted by the European Space Agency's European Space Research Institute (ESA-ESRIN) with support from the ESA DUE GlobVapour project in March 2011. This workshop set the general framework for the assessment by agreeing on variables, data records and general procedures to be considered. The workshop summary was published in the GEWEX Newsletter[1]. The 2nd workshop, hosted by Deutscher Wetterdienst and EUMETSAT's Satellite Application Facility on Climate Monitoring (CM SAF) in September 2012 aimed at the consolidation of the G-VAP strategy and the technical

[1] http://www.gewex.org/gewexnews/May2011.pdf

implementation. The results of the 2nd GVAP workshop were presented to the first GDAP meeting in Paris, October 2012, where further recommendations were received. The major outcomes of the 2nd workshop and feedback from the first GDAP meeting have also been summarized in the GEWEX Newsletter[2]. Results from the previous G-VAP workshops and feedback from GDAP were used for setting up the G-VAP assessment plan. The consolidated and final G-VAP assessment plan is available at the G-VAP webpage (www.gewex-vap.org). The main outcome of the 3rd Workshop was the consensus about the way forward: finalization of the intercomparison, of the comparison to ground-based and in-situ observations, of the homogeneity, trend and stability analysis using gridded data and of the identification of strengths and reasons for inconsistencies. Additionally, several refinements were suggested in particular the analysis of PDFs using instantaneous data. The major outcomes of the 3rd workshop were summarized in the GEWEX Newsletter[3].

3. Major results

In his talk J. Schulz gave an overview on GEWEX (Global Energy and Water Cycle Exchanges) Projects, its organizational structure and research foci in general and in particular on the GEWEX Data and Assessments Panel (GDAP) and GEWEX Integrated Product. He recalled the objectives of G-VAP and associated GEWEX needs. Specific humidity at the surface is an essential input parameter for the analysis of the Earth's energy budget. An assessment of the current state of the art is needed and would be highly appreciated. DWD is internally looking for funds to carry out this activity. Finally, J. Schulz pointed out the importance of being able to easily provide updates of the assessment results (e.g. when new datasets are available) or of providing data and tools for external evaluation of datasets. L. Schüller commented that in principle CM SAF offers the opportunity to provide the service of updating assessment results due to the sustained funding scheme via EUMETSAT.

M. Schröder gave an overview on G-VAP and its scope and objectives. He largely cited the assessment plan which is available online at www.gewex-vap.org. He recalled that the general goal is to inform the user community on the advantages and limitations of currently available long-term water vapour satellite data records and that the specific goal is to support GDAP in its selection process of a suitable water vapour data record as input to GEWEX products. The time line for data provision was recalled (until fall 2014) and extended by a time line for WCRP report drafting: first draft reports from activity leaders available in April 2015, final reports available in July 2015, first WCRP report draft ready in October 2015 and final WCRP report submitted to WCRP at the end of 2015. In the second half of his presentation he provided a summary on the outcomes of the last workshop which took place at CIRA, CSU in Fort Collins, CO, USA on 30 September – 02 October 2013. The intense and valuable discussions led to a series of actions and recommendations which are recalled in the Appendices A and B. These have been slightly adapted following this presentation and subsequent discussions.

[2] http://www.gewex.org/gewexnews/Nov2012.pdf
[3] http://www.gewex.org/gewexnews/Nov2013.pdf

F. Fell shortly introduced the G-VAP webpage (www.gewex-vap.org). He especially highlighted the online available data fact sheets which provide details on available satellite-based water vapour data sets.

Updates on candidate satellite data records were given by R. Kursinski (GPS-RO), N. Docter (MERIS), B. Bojkov (various ESA products), M. Grossi (GOME-2), H. Diedrich (MODIS), and J. Forsythe (NVAP-M, NASA Water Vapor Project-MEaSUREs). R. Kursinski showed updated results from his presentation at the last workshop. An analysis of the moisture exchange mixture between the planetary boundary layer and middle troposphere revealed that limited observational constraints are available for such an analysis. N. Docter showed the high quality of the fully reprocessed MERIS archive and mentioned plans to extend the record with MODIS and OLCI observations. B. Bojkov introduced water vapour records which are and will be available from ESA: homogenised GOME/SCIAMACHY/GOME-2- time series, a combined SSM/I+MERIS data record (both from the ESA DUE GlobVapour project, www.globvapour.info), a GOME data record from the GOME Evolution project, a MWR-based water vapor time series generated within the EMiR project and a (A)ATSR data set covering the years 1991-2012. All products with the exception of the GlobVapour products will presumably be released during 2015. Although it will likely not be possible to include all final data sets within the G-VAP assessment, it was agreed to provide information on "reference years" which will be considered in the PDF analysis. M. Grossi presented results from intense evaluation of GOME-2 products and H. Diedrich introduced a new retrieval for MODIS, mentioning the aim to have a single retrieval for MERIS, MODIS and OLCI. Finally, J. Forsythe introduced the various product types of the integrated NVAP-M and analysed the temporal sampling impact on the NVAP-M climatology.

G-VAP results were presented by M. Schröder, M. Lockhoff and L. Shi. M. Schröder presented results on using trend analysis as a tool to compare TCWV and water vapour profiles. On global scales the TCWV trends were found to be significantly different. The regions showing distinct differences in the trend estimates were consistently observed in the intercomparison results presented by M. Lockhoff. Among these regions are tropical land regions. This led to the recommendation reported to the GRUAN co-chairs to consider a tropical land surface station during GRUAN network expansion (www.gruan.org, then GRUAN-RP-4). Using homogeneity tests these differences in TCWV were found to be caused by break points which temporally coincide in almost all cases with changes in the observing system. The breakpoints are not evident when comparisons to the homogenised IGRA data record were carried out. One reason is that areas with distinct differences are not covered with stations. M. Lockhoff presented also first results from the intercomparison of short-term data records and PDF analysis. This first analysis included the nnHIRS product which is input to the GEWEX Integrated Product. Largest differences were found for the satellite-based data sets, especially over high pressure areas over the ocean. In each presentation the next steps in terms of activities and in terms of data records were presented. Among the next steps is the proposal on how to proceed with the PDF analysis and to discuss the degree of stability when applying various metrices to the HOAPS and RSS data records.

After N. Scott introduced the ARSA radiosonde archive, its evaluation and first results from comparisons to the homogenised IGRA radiosonde archive, T. Trent compared TCWV from

these two radiosonde archives to TCWV from HIRS to assess stability. Different conclusions may be drawn when looking at the change in bias or in scatter over time. R. Bennartz assessed the correlation of the >20yrs TCWV data records to major climate indices. The response to Nino34 and PDO are very robust and similar in all datasets while there is strongest disagreement for AO and NAO. These presentations also included next steps.

After an introduction to the GRUAN scope and products by R. Dirksen, X. Calbet, A. Gambacorta and B. Sun showed validation results for the EUMETSAT IASI product and for the NOAA's hyperspectral retrieval algorithm for climate applications as well as results from the NPROVS+ validation system, respectively. The value of the NPROVS+ and K-metric approach were again emphasized. B. Sun also showed evaluation results over the open ocean. In view of results shown by M. Lockhoff it would be valuable to further pursue this analysis. X. Calbet found an inconsistency when comparing IASI with GRUAN data using lbl radiative transfer model and when considering the IASI noise level (3 sigma) as significance level. A. Gambacorta explained the importance of using area weighted statistics during evaluation exercises. All three expressed their interest in supporting G-VAP. In their presentations and also in the presentations of J. Kinzel and S. Eikenberg the collocation aspect and associated uncertainty was discussed. A general increase of collocation uncertainty with increase in spatio-temporal distance was shown. J. Kinzel presented a new and unique method on how to determine the retrieval uncertainty and collocation errors by using multiple independent data records. X. Calbet introduced the new 3G joint community effort to estimate the collocation uncertainty.

B. Soden, L. Shi, M. Schröder, L Picon and H. Brogniez presented results from diverse analyses of upper tropospheric humidity data. By analysing differences between HIRS/2 and MSU observations (proportional to upper tropospheric water vapour) B. Soden demonstrated that an increase in this difference can only be explained by human-induced warming. Temporal variability on scales between inter-annual and decadal scales as well as long-term trends in upper tropospheric humidity from Meteosat were analysed by M. Schröder. A decrease of UTH in dry areas can be observed. However, the decrease is not statistically significant due to large interannual variability. Next steps were presented as well and include the extension of this analysis to other UTH data records. L. Shi compared the correlation between UTH and the El Nino 3.4 indices and found that the correlation is very small on global scale and can differ from correlation between TCWV and the El Nino 3.4 index on regional scales. L. Picon analysed the sensitivity of OLR to FTH and how it is presented in climate models. H. Brogniez analysed the uncertainties contributing to the retrieval of UTH and also found differences between corrected radiosonde data and microwave sounder observations which might be a spectroscopy-related difference.

J. Roman assessed measurement requirements in a changing climate and demonstrated the increasing demands on quality when focusing on changes in extremes. C. Stubenrauch discussed various links between atmospheric profiles and clouds. Among others she discussed supersaturation and its relevance for contrail formation.

M. Schröder presented results on behalf of B. Ho on an initial comparison of SSM/I and COSMIC TCWV data, also with the aim to describe differences in presence of strong precipitation.

The main objective of the last presentation was to present the structure of the WCRP report on G-VAP and to find responsible persons who take the lead in drafting sections of this report, together with other volunteers who provide support. It was recalled from the 3rd workshop that some sections maybe be based on subsets of data records and may have an exemplary, descriptive character which ideally leads to a recommendation on future activities, data record improvements or data usage. The time line was recalled and during the presentation and in bilaterals the terms for lead authors were given, namely: to take over responsibility for writing the complete section including a summary of own work, to coordinate and implement the input from contributing authors, to answer and implement feedback from reviewers, to support the drafting of a publication, and to adhere to the time line and scope of G-VAP. Table 1 provides an overview of lead authors and contributing authors.

Table 1: WCRP report on G-VAP: Sections, lead authors and contributing authors. We propose that each lead author includes the author, parameter and data record list per section.

Section	Lead author	Contributing author
1. Summary	M. Schröder	L. Shi, lead authors
2. Introduction		
2.1 Scope	M. Schröder	L. Shi
2.2 Questions	M. Schröder	L. Shi
2.3 Definitions	M. Lockhoff	Lead authors
2.4 Information and avk	T. August (tbc), T. Trent (tbc)	
3. Data records		
3.1 Overview (satellite sensors, pros/cons per type)	J. Forsythe	A. Gambacorta, R. Kursinski,...
3.2 Uncertainties	A. Gambacorta	H. Brogniez,...
3.3 Inventory (overview tables here with link to DFS, summaries from DFS in Appendix)	F. Fell	M. Schröder
3.4 Overview and quality of reference observations	NN	NN
4. Analysis of gridded data		
4.1 Intercomparison	M. Lockhoff (TCWV, WV), L. Shi (UTH)	M. Schröder
4.2 Variability	R. Bennartz (TCWV), L. Shi	A. Walther, F. Fell, M. Schröder

	(UTH)	
4.3 Trend	M. Schröder	M. Lockhoff, J. Roman, L. Shi
4.4 Homogeneity	M. Lockhoff	
4.5 Stability	T. Trent	M. Lockhoff
4.6 Consistency	L. Shi	M. Schröder, M. Lockhoff
4.7 Summary	M. Schröder (TCWV, WV), L. Shi (UTH)	Lead authors
5. Analysis of instantaneous data		
5.1 PDF	R. Kursinski	M. Lockhoff
5.2 Sampling	B. Ho	J. Forsythe, M. Lockhoff, M. Schröder
5.3 Collocation	X. Calbet	S. Eikenberg, J. Kinzel, B. Sun, T. Trent
5.4 Intercomparison	NN	T. August, A. Gambacorta, T. Reale, B. Sun, T. Trent
5.5 Summary	M. Schröder	Lead authors
6 Conclusions	M. Schröder	L. Shi, lead authors

Finally, the activities list in Table 2 was agreed upon.

Table 2: List of new activities.

Activity	**Responsible**	**Comment**	**Until**
Provide template of WCRP report sections and structure of report to lead and contributing authors	Co-chairs		7 Dec 2014
Draft first/final section of WCRP report and provide the draft to co-chairs	Lead authors	With support from contributing authors	April/July 2015
Draft WCRP report on G-VAP and provide the draft to GDAP chair	Co-chairs	With support from lead and contributing authors	October 2015
Extend long-term (>20yrs) analysis with JRA55 and nnHIRS (expected to be available in October 2014)	Maarit Lockhoff, Marc Schröder		July 2015
Include presentations of previous G-VAP workshops on G-VAP webpage	Frank Fell, Marc Schröder		January 2015
Identify periods for consideration in PDF analysis and provide this information to workshop participants	Maarit Lockhoff		January 2015

4. Conclusions

The 4th G-VAP workshop was hosted by the Institute of Space Sciences at FU Berlin, Berlin, Germany on 09+10 October 2014. More than 30 scientists from all over the world participated and nearly everybody contributed with a presentation. The presentations were very interesting and relevant to G-VAP and triggered intense, valuable and constructive

discussions. In particular the willingness of the participants to take over responsibility in WCRP report drafting is noteworthy and highly acknowledged.

Several presentations contained an outline of the next steps in order to ensure a timely finalisation of G-VAP. The presentations are available online at www.gewex-vap.org. The next steps were uncontroversial. The structure of the WCRP report and the time line for WCRP report drafting were also outlined and agreed upon.

Finally, the discussions led to a series of refinements (see Table 2) and recommendations. The recommendations are:

- Enhance evaluation of water vapour and temperature at the surface and in the boundary layer to strengthen the evaluation of energy fluxes (land and ocean) and of the planetary boundary layer.
- Enhance quality analysis of profile data records over open ocean, in particular over high pressure areas/subsidence areas.
- Explain differences and achieve consistency among observing systems (e.g., GRUAN versus IASI).
- Provide long-term calibration uncertainty to enhance reliability of trend uncertainty analysis.
- Recommendation to GRUAN co-chairs: Include station over tropical land.
- Provide water vapour transport product in order to analyse atmospheric dynamics and to evaluate the constancy of relative humidity (e.g., ocean to land transport).

The next workshop will take place end October / beginning November 2015.

Appendix A List of activities from previous workshops

The list has been updated according to decisions from G-VAP workshops.

Activity	Responsible	Comment	Status
Compare breakpoint positions to changes in observing system and gradients in major climate indices, relate breakpoint strength to variance before and after breakpoint time and inform PIs	Maarit Lockhoff	Continuous	open
Analyse trend as function of temporal coverage for exemplary data record (e.g., HOAPS)	Marc Schröder	December 2013	closed
Set-up password protected ftp server	Maarit Lockhoff, Marc Schröder	Server has limited space	closed
Contact PIs to get information on long-term calibration uncertainty and number of valid observations per month for full record length	Marc Schröder	Will be formulated as recommendation	closed
Analyse consistency between temperature and absolute humidity as well as relative humidity using satellite data records of more than 10 years temporal coverage	Lei Shi	July 2015	open
Draft summary report on information content description, value averaging kernels and collocation uncertainty	Thomas August, Tim Trent	April 2015	open
Analyse differences in climatologies per weather type (clear, cloudy, all-sky)	Maarit Lockhoff	Next workshop	open
Intercompare differences between PDFs from different orbits using multi-platform data records (subset from long-term candidate satellite data records)	Maarit Lockhoff	Looking for activity lead on TCWV PDF analysis	open
Address diurnal sampling issues using GNSS data	NN		Activity lead open
Consolidate details of profile evaluation	Marc Schröder, Tony Reale, Antonia Gambacorta	As soon as possible	open
Exchange information on metrics, data records and general approaches and include B. Read (L. Shi and M. Schröder) in activity on UTH analysis (UTLS analysis) – joint SPARC and G-VAP activity	Lei Shi, Marc Schröder	Shifted to February 2015	open
Summarize recommendations and needs as input to a GEWEX letter to agencies	Jörg Schulz, Marc Schröder	Shifted to early 2016	open
Draft assessment plan	Co-chairs	Available online	closed
Clarify framework of potential cooperation with ICARE	Co-chairs		open

Establish formal communication link to SPARC	Co-chairs	See summary from 3rd workshop	closed
Establish group to initiate technical implementation	Co-chairs	IDL-based G-VAP tool was set up by A. Walter and R. Bennartz	closed
Prioritise data records	Co-chairs	See assessment plan and minutes of 3rd and 4th workshop	closed
Update data fact sheets according to workshop discussions	F. Fell with support from co-chairs	Updated	closed
Set-up G-VAP webpage	Co-chairs	www.gewex-vap.org	closed
Establish group to advise long-term analysis	M. Schröder, R. Bennartz	Covered by discussion letters in future	closed
Draft data policy	M. Schröder, R. Bennartz	See assessment plan	closed
Contact data providers to join effort (continuous activity)	Co-chairs		ongoing

Appendix B List of recommendations and needs from previous workshops

- ***Develop and provide PDF based climatology of satellite-based radio-occultation data.***
- ***Analyse differences between observations under all-sky as well as cloudy and clear sky conditions.***
- ***Need for continental high quality satellite data records.***
- ***Need for inter-calibrated radiance/brightness temperature data records and homogeneously reprocessed instantaneous satellite data records.***

Appendix C Workshop Agenda

G-VAP – Workshop

09 - 10 October 2014

Agenda

Venue:

Institute for Space Sciences

Free University of Berlin

Berlin, Germany

Version 1.3

09 October 2014

Thursday, 9th Oct 2014

09:00 – 09:10	Welcome *Fischer*
09:10 – 09:20	Aims of meeting and logistics *Schröder, Shi*
09:20 – 09:50	G-VAP and the GEWEX integrated product *Schulz*
09:50 – 10:05	*Overview and s*ummary from last workshop *Schröder*
10:05 – 10:20	Extreme values, their uncertainties and the intercomparison of PDFs *Kursinski*
10:20 – 10:30	G-VAP webpage *Fell*
10:30 – 11:00	Coffee break
11:00 – 12:00 (15 minutes each)	Spatially high resolution retrievals of TCWV over land surfaces using MERIS *Docter* New water vapour data records from ESA *Bojkov, Casadio*
(30 min)	Discussion
12:00 – 13:30	Lunch break
(15 min each)	Water vapour column density product from GOME-2 Metop-A and GOME-2 Metop-B *Grossi* A new MODIS TCWV retrieval and a bridge to OLCI *Diedrich* NASA Water Vapor Project-MEaSUREs (NVAP-M) global water vapor dataset: Latest results *Forsythe* Trend analysis as a tool: Application to TCWV and water vapour profiles *Schröder*

	Results from inter-comparisons: An update *Lockhoff*
(15 min)	Discussion
15:30 – 16:00	Coffee break
16:00 – 18:00 (15 min each)	Assessing homogeneity *Lockhoff*
	Quality assessment of satellite and radiosonde data *Scott (remote)*
	Assessing stability through intercomparison of HIRS and ARSA data *Trent*
	Analysis of anomalies and temporal variability in water vapour CDRs and climate model simulations *Bennartz*
	Water vapour profile validation using NPROVS+ *Sun*
	Intercomparison of 10 year data records and PDF analysis: first results *Lockhoff*
(30 min)	Discussion
18:00	Adjourn

Friday, 10th Oct 2014

09:00 – 09:15	An overview on GRUAN *Dirksen*
09:15 – 09:30	A brief review of collocation uncertainties and results from comparison of GRUAN and IASI data *Calbet*
09:30 – 09:45	Development of a climate quality hyper spectral retrieval algorithm and its validation *Gambacorta*

09:45 – 10:00	Statistical uncertainty separation through intercomparison of independent data sources *Kinzel*
10:00 – 10:30	Detecting anthropogenically-driven increases in upper tropospheric water vapor using satellite observations *Soden*
10:30 – 11:00	Coffee break
11:00 – 12:30 (15 min each)	Intercomparison of UTH data records: An update *Shi*
	Trends in UTH data records: An update *Schröder*
	Consistency between TCWV and UTH: first results *Shi*
	Comparisons of observed inter-tropical FTH fields and their radiative impacts against climate model outputs *Picon*
	Evaluation of the atmospheric humidity as seen by SAPHIR/ Megha-Tropiques: accounting for uncertainties *Brogniez*
(15 min)	Discussion
12:30 – 14:00	Lunch break
14:00 – 15:00 (15 min each)	Measurement and sampling requirements for satellite remote sensing of precipitable water vapor in a changing climate *Roman*
	Effects of atmospheric profiles on cloud retrieval *Stubenrauch*
	Intercomparison of various water vapour observations and simulations with focus on small scale variability *Eikenberg*
(15 min)	Discussion
15:00 – 16:00	The G-VAP report: Sections and lead authors *Schröder, Shi, all*

16:00 – 16:30	Coffee break
16:30 – 17:00	Wrap-up, next meeting
17:00 – 17:30	AoB
17:30	Expected end

Appendix D List of participants

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