WAVAS-II Annual Meeting

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DATES:
30 November – 2 December 2016

ORGANISER:
Gabriele Stiller, Karlsruhe Institute of Technology (KIT)

HOST INSTITUTION:
KIT, Karlsruhe, Germany

NUMBER OF PARTICIPANTS: 11

SPONSORS:

Karlsruher Institut für Technologie

BACKGROUND:
Following phase I of the Water Vapour (WAVAS) activity, which analysed and assessed long-term changes of Upper Tropospheric and Stratospheric (UTS) water vapour from *in situ* datasets from hygrometers and remote sensing instruments, the WAVAS-II activity aims to assess the value and accuracy of recent satellite measurements and to give new recommendations and guidelines for future research on UTS water vapour.

ACTIVITY WEBSITE:
www.sparc-climate.org/activities/water-vapour

In 2000 SPARC published its Assessment of Upper Tropospheric and Stratospheric (UTS) Water Vapour (SPARC Report No. 2, available at **www.sparc-climate.org/publications/sparc-reports/sparc-report-no2**), which was coordinated and edited by Dieter Kley, James M. Russell III, and Celine Phillips. The key topic addressed in this report was the analysis and assessment of long-term changes of UTS water vapour, with an emphasis on the observed increase of water vapour in the stratosphere. The report had a strong focus on describing and comparing relevant datasets using *in situ* hygrometers and remote sensing instruments from laboratories around the world to create a suitable long-term dataset, including historical data back to the 1940s.

In the years since, climatological measurement programmes have continued, new campaigns to investigate UTS water vapour have been carried out, new satellite observation programmes have been launched, and many model and laboratory studies have explained the observations and identified previously unknown processes. Detection of trends has become an important climate issue and for such analyses it is critical to have well verified estimates of possible instrument drifts. To understand microphysical processes related to water vapour, knowing the absolute accuracy and not simply the relative discrepancies between different sensors is important. The primary goal of the WAVAS-II activity is to assess the value and accuracy of recent satellite measurements and to give new recommendations and guidelines for future research on UTS water vapour.

The objectives of WAVAS-II are to:

1. Provide a quality assessment of upper tropospheric to lower mesospheric satellite records since 2000;
2. Provide, as far as possible, absolute validation against ground-truth instruments;
3. Assess inter-instrument biases, depending on altitude, location, and season;
4. Assess representation of temporal variations on various scales;
5. Include data records on isotopologues;
6. Provide recommendations for use of available data records and for future observation systems.

This is the first effort to compare all available stratospheric

satellite water vapour profiles with research-quality balloon- and ground-based measurements of water vapour. The results are being prepared for publication in a special issue of ACP/AMT/ESSD (**www.atmos-chem-phys.net/special_issue830.html**) where WAVAS-II and related independent papers will be published.

The core author team of the WAVAS-II satellite comparison activity met at the Institute of Meteorology and Climate Research of the Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, for a three-day working session to advance the papers on the assessment of the quality of water vapour records from satellite instruments. During the meeting, results from the planned papers were presented and open issues related to consistency amongst the papers were discussed.. On the last day, Maarit Lockhoff from the GEWEX G-VAP activity joined the group to exchange details about the assessment methods used and to discuss future opportunities for joint activities between GEWEX and SPARC.

Presentations were given for each major component of the report, each of which will be submitted as a paper to the journal special issue.

Discussions started with the characterisation paper (**Kaley Walker** and **Gabriele Stiller**), which will describe all measurements used in the WAVAS-II activity. This will include descriptions of the techniques used as well as information on temporal/spatial coverage, vertical resolution, precision, systematic errors, and recommended data filtering. The satellite instruments and periods for which they were or will continue to be active are shown in **Figure 13**.

The second paper will compare all available frost point hygrometer profiles with satellite profiles. **Michael Kiefer** and **Dale Hurst** presented statistics for profile-to-profile comparisons between seven frost point stations and 15 satellites. Dale also discussed the method he used to determine drifts between satellite data records and the time series' from frost point hygrometer stations. This method is to be applied to all satellite instruments and stations with long enough data records.

Gerald Nedoluha and **Michael Kiefer** presented their work on the comparison of upper stratospheric and mesospheric water vapour profiles between satellite records and ground-based microwave radiometer data (Nedoluha *et al.*, 2017). Both biases and drifts were presented. **Stefan Lossow** discussed results that will be covered in two WAVAS-II papers. One paper will present satellite-to-satellite comparisons, both on the basis of co-incident profiles and for zonal means. Another paper, which has subsequently been published in the WAVAS-II special issue (Lossow *et al.*, 2017), presents an analysis of the available time series using multivariate linear regression and compares several derived quantities such as the amplitude and phase of the seasonal cycle as well as other oscillations among the various datasets.

The sixth paper under preparation, presented by **Farah Khosrawi**, will cover the biases and drifts between the various satellite datasets, and the ability of the satellite data records to reproduce intra- and inter-annual variability. The latter will be done on the basis of correlation analyses among the time series.

A seventh paper, presented by **William Read**, will focus on upper tropospheric humidity (measurements taken below the local tropopause). He showed results comparing satellite profiles with frost point hygrometer and radiosonde data. Additionally, he showed a correlation analysis with profiles from meteorological sounders (AIRS and TES) and compared gridded satellite data on pressure levels.

Two further papers under preparation, presented by **Kaley Walker** and **Stefan Lossow** respectively , will show comparisons of data records of minor water vapour isotopologues HDO, $H_2{}^{18}O$, and $H_2{}^{17}O$ that are measured by ACE-FTS, SMR, and MIPAS (only HDO from MIPAS). Comparisons of the related isotopic ratios δD-H_2O, δ^{18}O-H_2O, and δ^{17}O-H_2O will also be included.

The final discussion, led by **Karen Rosenlof** and **John Gille**, covered what will go into the summary and recommendations paper that will be prepared after completion of the comparison papers mentioned above.

A follow-up meeting took place in June 2017 at the University of Toronto, hosted by Kaley Walker. This was hopefully the last meeting before finalising this activity. This will effectively close the WAVAS circle, as the first WAVAS-II meeting also took place in Toronto, in March 2009.

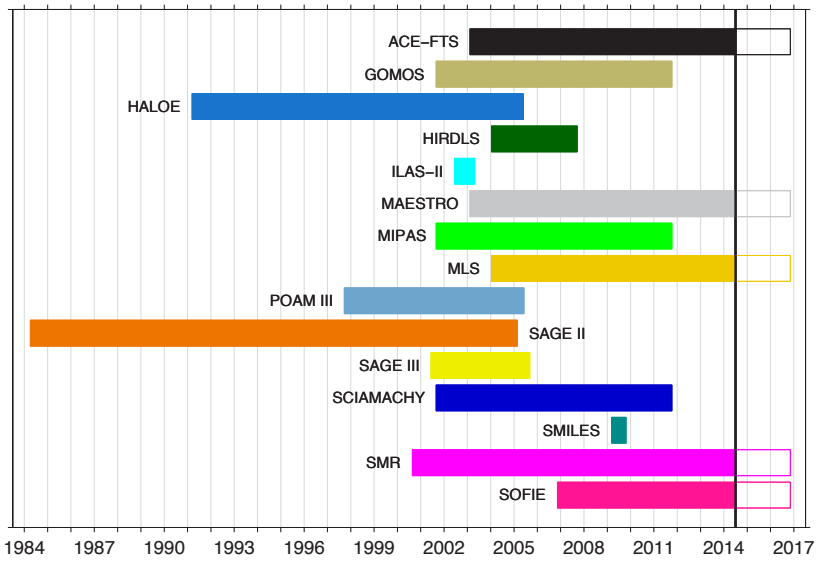

***Figure 13**: Satellite measurements considered in the stratospheric comparisons of the WAVAS-II activity. Tropospheric comparisons will include additional satellite measurements from TOVS, AIRS, IASI, and TES.*

References

Lossow *et al.*, 2017: The SPARC water vapour assessment II: comparison of annual, semi-annual and quasi-biennial variations in stratospheric and lower mesospheric water vapour observed from satellites. *Atmos. Meas. Tech.*, **10**, 1111-1137, doi:10.5194/amt-10-1111-2017.

Nedoluha, *et al.*:, 2017: The SPARC water vapor assessment II: intercomparison of satellite and ground-based microwave measurements. *Atmos. Chem. Phys.* Discuss., doi:10.5194/acp-2017-578.

***Figure 15**: WAVAS-II core author team during the working group meeting held from 30 November to 2 December 2016 at KIT, Karlsruhe, Germany.*