The GEWEX water vapor assessment (G-VAP) was initiated by the GEWEX Data and Analysis Panel (GDAP). The major purpose of G-VAP is to quantify the state of the art in water vapour products being constructed for climate applications, and by this support the selection process of suitable water vapour products by GDAP (see gewex-vap.org).

The assessment provides an overview of available data records (see gewex-vap.org—Data Records) and results based on consistent product inter-comparisons and comparisons to ground-based and in-situ observations. TCWV (total column water vapour), upper tropospheric humidity and profiles of specific humidity and temperature are considered.

A focus is on the assessment of temporal homogeneity and consistently computed trend estimates are also analysed. The inter-comparison results presented here consider eleven of the long-term TCWV and seven water vapour profile data records, namely ERA-20C, ERA-Interim, HOAPS, JRA55, MERRA, MERRA2, NCEP/CFSR, mHIRS, NVAP-M, NVAP-Ocean, REMSS.

Homogeneity and compliance with changes in observing system

Profile inter-comparison

Inter-comparison of full archive

The GEWEX water vapor assessment (G-VAP) is freely available. Differences in linear trends reveal distinct regions of the Arctic and Africa. The latter case the profile data records exhibit maximum spread at and above cloud top. An analysis of anomaly differences showed that the majority of data records are affected by break points and that regions of distinct trends usually exhibit break points. Most of the break points can be attributed to changes in the observing system.

Conclusions

G-VAP provides a recent overview of available water vapour data records at http://gewex-vap.org. Data records with a temporal coverage of more than 10 years have been utilised in G-VAP related analysis. The regridded data records comprise the G-VAP data archive which is freely available. Differences in linear trends reveal distinct areas at central South America, central Africa, the Sahara, the Arabian Peninsula, the poles and the stratoscumulus regions. In the latter case the profile data records exhibit maximum spread at and above cloud top. An analysis of anomaly differences showed that the majority of data records are affected by break points and that regions of distinct trends usually exhibit break points. Most of the break points can be attributed to changes in the observing system. The break points are a function of data record, region and parameter. Also, the trend estimates are typically significantly different and are not in line with theoretical expectation. Exceptions are HOAPS and REMSS. Finally, the spread in averaged TCWV data records as a function of predominant retrieval condition is largest in the clear-sky case.

The next G-VAP workshop will take place at DMI, Copenhagen, Denmark on two days in 5-9 October 2020.

Recommendations (subset):

- **CGMS, WMO, GRUAN**: Aim at the sustained generation and development of a stable, bias corrected multi-station radiosonde archive including reprocessing of historical data.
- **Space Agencies**: PIs, G-VAP: Enhance quality analysis of profile data records over open ocean, in particular over high pressure areas/subsidence areas and stratus.
- **GEWEX, Space agencies, G-VAP**: It is needed to assess options to merge the various observing systems to provide long-term, high resolution water vapour profile data.
- **CGMS, Space agencies**: It is important to ensure that developments around 5G telecommunication links do not impact microwave observations around 23 GHz via radio-frequency interference.

References


Data archive

- Regridded to common grid (2°x2°), regular, common vertical levels: 1000, 700, 500, 300 hPa, common period depending on parameter (e.g., 1988-2008 for TCWV),
- Freely available via doi-reference (10.5676/EUM_SAF_CM/VAP/V001),
- Results from intercomparison of full archive in Schröder et al. (2019), ESSD, 10.5194/essd-10-1099-2018

Trend estimation and regression

Figure 1: Graphical overview of G-VAP

Figure 2: Mean absolute relative difference in trend estimates (after Weatherhead et al., 1998, Marsich et al., 2014) for TCWV (left), specific humidity at 700 hPa (middle, here in relative units) and temperature at 700 hPa (right) from Schröder et al. (2019).

Figure 3: Trend estimates over global ice-free ocean (ocean,box) sorted in ascending order and results from regression analysis (Dessler and Davis, 2010, Mears et al., 2007). Bars give 1-sigma uncertainty estimate from trend estimation. Black dashed lines mark general theoretical expectation range. Also shown are regressions after homogenisation using output from homogeneity testing (Schröder et al., 2019).

Figure 4: Trend estimates over global ice-free ocean (ocean,box) sorted in ascending order and results from regression analysis (Dessler and Davis, 2010, Mears et al., 2007). Bars give 1-sigma uncertainty estimate from trend estimation. Black dashed lines mark general theoretical expectation range. Also shown are regressions after homogenisation using output from homogeneity testing (Schröder et al., 2019).

Figure 5: Trend estimates over global ice-free ocean (ocean,box) sorted in ascending order and results from regression analysis (Dessler and Davis, 2010, Mears et al., 2007). Bars give 1-sigma uncertainty estimate from trend estimation. Black dashed lines mark general theoretical expectation range. Also shown are regressions after homogenisation using output from homogeneity testing (Schröder et al., 2019).

Figure 6: Intercomparison of average specific humidity (left), relative specific humidity (middle, relative to ERA-Interim) and average temperature (right) over the Pacific stratocumulus region (see box in Figure 3) and southern hemispheric summer months. Dotted horizontal lines mark 1000, 700, 500, and 300 hPa (Schröder et al., 2018).

Figure 7: Time series (January 2005–December 2008) of TCWV for the tropics (520° N/S) over ocean for the predominate retrieval condition classes all sky, cloudy sky and clear sky. Partly the legends include unambiguous abbreviations of the data record names, with the following exceptions: AMSR-E JAXA (AMSR-E), AMSR-E REMSS (AMSR-E), and Merged Microwave REMSS (REMESS) (Schröder et al., 2016).

Figure 8: Time series (January 2005–December 2008) of TCWV for the tropics (520° N/S) over ocean for the predominate retrieval condition classes all sky, cloudy sky and clear sky. Partly the legends include unambiguous abbreviations of the data record names, with the following exceptions: AMSR-E JAXA (AMSR-E), AMSR-E REMSS (AMSR-E), and Merged Microwave REMSS (REMESS) (Schröder et al., 2016).

Figure 9: Time series (January 2005–December 2008) of TCWV for the tropics (520° N/S) over ocean for the predominate retrieval condition classes all sky, cloudy sky and clear sky. Partly the legends include unambiguous abbreviations of the data record names, with the following exceptions: AMSR-E JAXA (AMSR-E), AMSR-E REMSS (AMSR-E), and Merged Microwave REMSS (REMESS) (Schröder et al., 2016).