Evaluation of AERONET precipitable water vapour versus microwave radiometry, GPS and balloon-borne radiosondes at ARM sites.

D. Pérez-Ramírez[1,2,3], A. Smirnov[4,5], H. Lyamani[2,3], D. Whiteman[1], B. Holben[4] and L. Alados-Arboledas[2,3]

[1] Mesoscale Atmospheric Processes Laboratory, NASA Goddard Space Flight Center, 20771, Greenbelt, Maryland, United States
[2] Andalusian Centre for Environmental Research, University of Granada, Granada, Andalucía, 18006, Spain
[3] Department of Applied Physics, University of Granada, Granada, Andalucía, 18071, Spain
[4] Biospheric Sciences Branch, NASA Goddard Space Flight Center, 20771, Greenbelt, Maryland, United States
[5] Sigma Space Corporation, 20771, Lanham, Maryland, United States

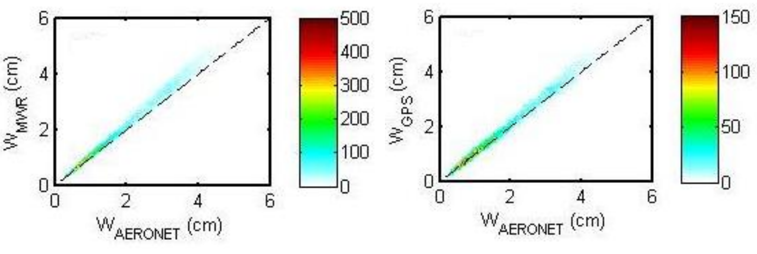
Presenting author email: alados@ugr.es

Measurements of the precipitable water vapour (*W*), defined as the total amount of water vapour in the atmospheric column, are being very important to characterize water vapour role in radiative forcing, hydrological cycle and climate. From several decades ago sun-photometry measurements at the water vapour absorption bands around 940 nm are being used to retrieve W. But it faced with problems related to an appropriate methodology and calibration. AERONET network addresses those problems and standardizes calibration and measurement protocols, as well as data quality [Smirnov et al., 2004]. But to date, evaluation of AERONET retrievals of W are sparse.

Balloon-borne radiosondes have been used as standard to retrieve W from decades ago, but faces with problems as the drift of the sonde, the 'dry' bias or the batch dependence [Milosevich et al., 2006]. Moreover, zenith wet delays measured by GPS allow the retrievals of W under almost all weather conditions. Similarly, W retrievals (and also atmospheric profiles of water vapour) can be obtained from sky brightness temperature measurements around 22.235 GHz water vapour absorption band by microwave radiometers. The uncertainties of these techniques to retrieve W stated in the bibliography are of ~5% for MWR and GPS and ~10-15% for balloon-borne.

The scope of this work is to evaluate AERONET retrievals of W versus those by MWRs, GPS and balloon borne. To this end, we use the large database of MWRs and balloon-borne measurements made at the three major sites of the U.S. Department of Energy Atmospheric Radiation Measurement (ARM), located at Southern Great Plains (36.61ºN, 97.49 ºW, 318 m a.s.l.), Nauru Islands (0.52 ºS, 166.92 ºE, 7 m a.s.l.) and Barrow (71.31 ºN, 156.67 ºW, 0 m a.s.l.). GPS retrievals of W at these sites are provided by SUOMINET network managed by the University Corporation for Atmospheric Research (UCAR).

For 10 years of correlative measurements between the different instrumentation at the Southern Great Plain, Figure 1 present number density plots of W obtained by MWRs, GPS and balloon-borne as function of those obtained by AERONET. The linear fits forced through zero revealed slopes of 1.10 ± 0.01, 1.05 ± 0.01 and 1.04 ± 0.01 for the evaluations versus MWR, GPS and balloon-borne. These values indicate underestimation of W retrieved by AERONET. The extended study, including also the other ARM sites, indicates underestimations by AERONET of ~7.8% versus MWR, ~3.8% versus GPS and ~4.8% versus balloon-borne radiosondes. But assuming an the uncertainty of AERONET retrievals of W is ~10%, the stated differences within the different instrumentation are within the error margins. Therefore, we conclude that within a 10% uncertainty there is no golden instrument to retrieve precipitable water vapour. The largest differences found between AERONET sun-photometers and MWRs can be explained by the differences in the spectral databases and radiative transfer models between sun-photometry and microwave radiometry. Actually, the strength of the water vapor absorption currently remains a subject of discussion in the scientific community [e.g. Alexandrov et al., 2009]. A better agreement between these two techniques should imply combined efforts to use the same spectral database with similar constraints.



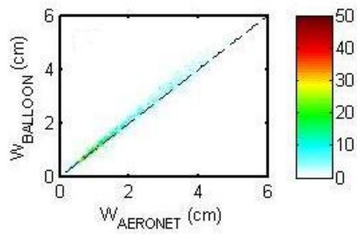


Figure 1: Number density plots of precipitable water vapor by MWR, GPS and balloon-borne as function of AERONET retrievals. Data were acquired at the Southern Great Plains.

Alexandrov, M.D., et al. (2010) *J. Geophys. Res.*, 114, doi:10.1029/2008.jd010543.

Miloshevich, L.M., et al., (2006) *J. Geophys. Res.*, 111, D09S10, doi:10.1029/2005JD006083.

Smirnov, A., et al., (2004) *Proceedings of AERONET workshop*, El Arenosillo, Spain.