Comparison of Precipitable Water Measured by Sun Photometer and that Estimated from Surface Meteorological Parameters

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Introduction

Water vapor is an important link connecting the various components of the hydrological cycle and hence an understanding of its role in the hydrological climate system and its variability on all spatial and time scales is very essential. Meteorologists are currently not just interested in dewpoint or humidity at the surface, but in the moisture content in the entire atmosphere. An important water vapor parameter is Precipitable Water (PW) which is a measure of the total water vapor contained a small vertical column extending from surface to the top of the atmosphere. However, the majority of moisture in the atmosphere is contained roughly within the lowest 10,000 feet. Climate models have shown significant increases in water vapor in response to global warming. Precipitable water climatologies on long-term scale are necessary to verify these model results. Distribution of PW is a good indicator of the dynamics of the circulation systems in the atmosphere. Latitudinally, there is a decrease of precipitable water from equatorial regions, where it attains the highest values, to the north and south poles.

Water vapor absorption of solar radiation has been studied for several decades and several researchers have used the optical technique (sun photometer) to determine precipitable water in the atmosphere (for eg. Volz, 1974; Michalsky et al., 1995; Morys et al., 2001; Ernest Raj et al., 2004). Sun photometer derived precipitable water at a midlatitude station (Luxemburg) over a six year period (1998-2003) has been used in the present study to examine seasonal variations and also to compare with the estimations made from surface meteorological parameters and satellite derived data.

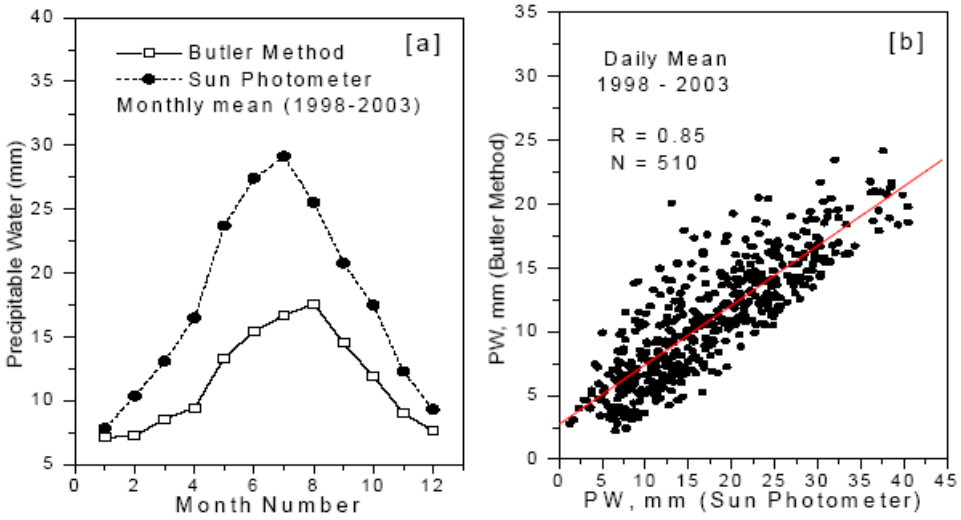
Data

Observations made at Diekirch, Luxemburg (49.848$^{?}$ N, 6.332$^{?}$ E), a midlatitude station using a five-channel sun photometer (Microtops-II, Solar Light Inc., USA) for the 6 year period 1998-2003 have been used in the study. PW retrieval is based on measurements in the 940 and 1020 nm channels. Surface temperature and R.H. for the same station available at 30 minute interval have also been collected from the web site and used to estimate PW using Butler method. For comparison with sun photometer data daily and monthly means have been computed. MODIS satellite retrievals of PW in the 'clear sky NIR' and 'IR' channels have been obtained for the above station location for further comparisons. The results are presented and discussed.

Results and Discussion

The overall six year monthly mean precipitable water obtained from sun photometer measurements and estimated from surface meteorological parameters for Luxemburg is shown plotted in Figure 1(a). The seasonal variation is identical in both the data sets, but sun photometer values are higher by almost 15 mm during the summer months of June to September.

Figure 1(b) shows the scatter plot of daily mean PW data by the two techniques. On daily scale also there is a very good agreement with a correlation coefficient of 0.85. On 75% of the days the agreement is within ± 10 mm. The deviation in summer season is mainly



due to the fact that ground-based sun photometer measures the total moisture content including the water vapor content at upper tropospheric layers. The Butler method of estimation assumes some sort of an exponential decrease of temperature with height and does not account for the upper level moisture influx. PW values by the two techniques have been examined for different months separately and the agreements were good except for the month of April. MODIS satellite derived PW by clear sky NIR and IR methods for the same latitude-longitude position have been collected and compared with the above observations and estimations. Variations on monthly mean scale have been found to be very consistent. Results of the study will be presented and discussed.

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