

Atmospheric Precipitable Water and its Correlation with Clear Sky Infrared Temperature Readings: Field Observations

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INTRODUCTION

- Precipitable water is the total amount of water vapor which is contained in a vertical column of air that stretches from the Earth's surface to the top of the atmosphere condensed into liquid form

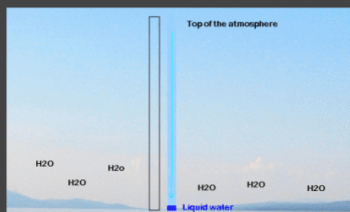


Figure 1: Schematic illustrating the concept of Precipitable Water. The left column contains air and water vapor, the right column contains dry air and condensed water vapor on the bottom of the column [1].

- Meteorologists need precipitable water measurements to help accurately forecast storm formation and strength
- Based on existing measurements, as Precipitable Water increases, zenith sky temperature increases. Multiple Models confirm this relationship [2].

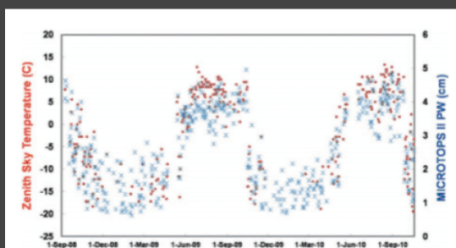


Figure 2: A 2-yr (8 Sep 2008–18 Oct 2010) time series of the apparent temperature of the cloud-free zenith sky (T_z , red) indicated by an IR thermometer and precipitable water (PW, blue) measured by a MICROTOS II sun photometer at Geronimo Creek Observatory. [3]

- This project demonstrates the ability to measure precipitable water with low cost tools in higher altitude arid climate zones similar to that found in the desert Southwest

REFERENCES

- [1] Mária, P. (n.d.). Product Tutorial on TPW Content Products.
- [2] Riley S, Kelsey V. Atmospheric Precipitable Water and its Correlation with Clear Sky Infrared Temperature Readings: Data Analysis. Poster presented at: PhysCon, 2019 Nov 13-16; Providence, RI.
- [3] Forrest M. Mims, Lin Hardtung Chambers, and David R. Brooks. Measuring total column water vapor by pointing an infrared thermometer at the sky. *Bulletin of the American Meteorological Society*, 92(10):1311-1320, 2011.

BACKGROUND

- Radiosondes and Ground-based GPS equipment is used for precipitable water measurements
- Most National Weather Service monitoring sites cannot collect precipitable water data due to the high equipment cost impacting forecast accuracy
- First responders need accurate weather forecasts to move resources to potential areas of need
- Atmospheric researchers need site specific precipitable water data for cloud formation research



Figure 3: Radiosonde launch at Langmuir Laboratory For Atmospheric Research



Figure 4: North American Radiosonde Launch Sites, compliments of the National Weather Service

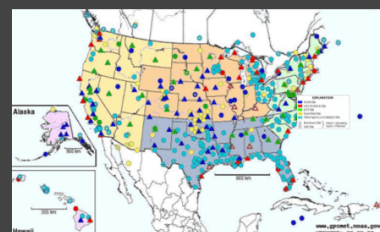


Figure 5: National Oceanic and Atmospheric Administration map of GPS precipitable water measurement sites

METHODOLOGY

- Use three different types of infrared thermometers to take daily ground and zenith air temperature readings



Figure 6: The three infrared thermometers used to collect data: (from left to right) 1610 TE, FLIR i3, and the AMES 12:1 Infrared Thermometer.

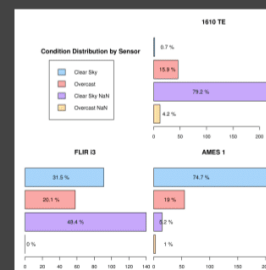


Figure 7: Condition distribution of Infrared Thermometers.

- Monitor and record the daily National Weather Service precipitable water measurements taken in Albuquerque and El Paso
- Show a correlation between zenith air temperature measurements and the amount of precipitable water over four seasons

RESULTS

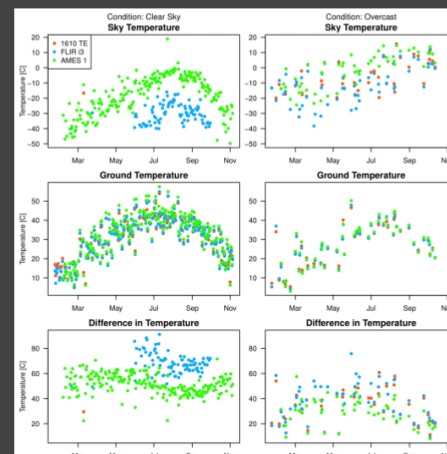


Figure 8: Infrared Temperature data collected

DISCUSSION

- Temperature data collected to date has shown a wider temperature range than previous work
- We now have almost a complete 4 season cycle dataset
- We have verified the exponential correlation between zenith clear sky temperature and precipitable water

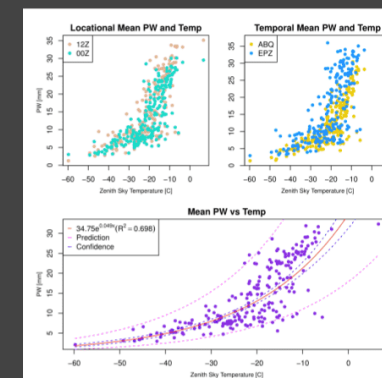


Figure 9: Correlation between infrared temperature and precipitable water.

- Sources of error: instruments measuring differing infrared bands and fluctuations in measurement times

FUTURE WORK

- Continue daily temperature measurements and precipitable water comparisons
- Look into ways to automate temperature readings to allow for additional collection sites in rural New Mexico
- Form partnerships to collect and analyse readings at other Universities and Public Service Offices
- Find more ways to distribute the data to enable accurate forecasting.

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