

Estimation of precipitable water using thermal infra-red images

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Objective

This study investigates the link between precipitable water (PW) and zenith-point temperature (T_b) retrieved via thermal images from a high-cost thermal camera under clear sky conditions.

Data & Methodology

Measurement site:

Laboratory of Atmospheric Physics, University of Patras, Greece

PW measuring instrument:

Portable Microtops II (MII) sun-photometer

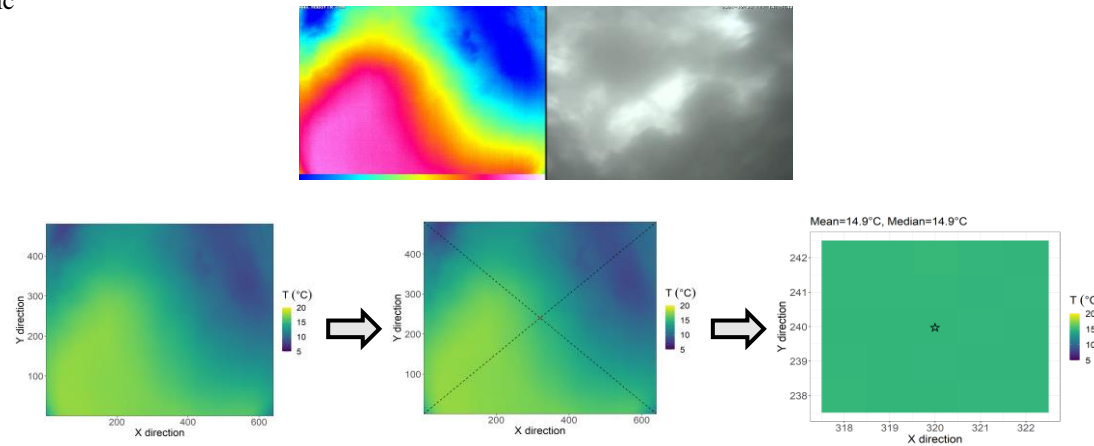
Thermal infra-red camera:

Mobotix #73 (M73)

Data Coverage:

02/2022 – 09/2022

Extraction of zenith-point temperature (T_b) from thermal infra-red images:



Temporal synchronization

(PW, T_b) pairs considering M73 images (t_{M73}) within a ± 60 min window centered around the MII timestamps (t_{MII}).

$$\Delta t_{ij} = |t_{MII,i} - t_{M73,j}|, i = 1, \dots, t_{MII,i} \text{ \& } j = 1, \dots, t_{M73}$$

Non-linear modelling

$$PW = f(T_b) = ae^{bT_b}$$

The coefficients a , b are estimated through the Levenberg-Marquardt minimization method.

Results

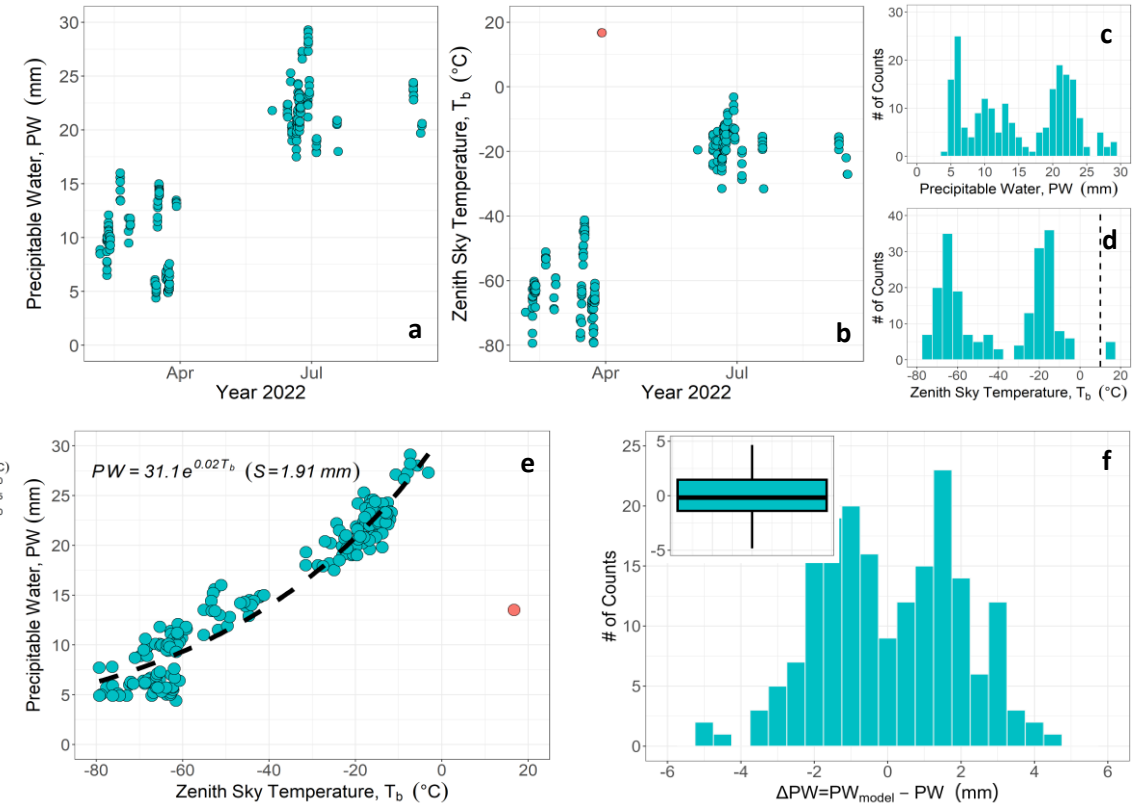


Figure 1: Time series of (a) PW and (b) T_b . Frequency histograms of (c) PW and (d) T_b . (e) PW versus T_b . The dashed exponential curve describes the non-linear relationship between PW and T_b , (f) Frequency histogram and boxplot (inset) of the PW differences ($\Delta PW = PW_{\text{model}} - PW$).

- ✓ PW and T_b exhibit similar temporal patterns and they are highly correlated. PW ranges from 4.4 to 29.1 mm, with an average of 14.9 mm. T_b ranges from -79.3 to -3.1 °C with an average of -42 °C.
- ✓ The systematic error is 0.04 mm, the dispersion error is 1.91 mm (12.8%) between the modeled and observed values.
- ✓ ΔPW is described by two near-normal statistical distributions (central tendencies at ~ -1 and 1.5 cm)

Acknowledgments

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