The Precipitable Water Project:

Using Zenith Clear Sky Temperature to Approximate Precipitable Water in Areas without Nearby Measurements in the Western U.S.

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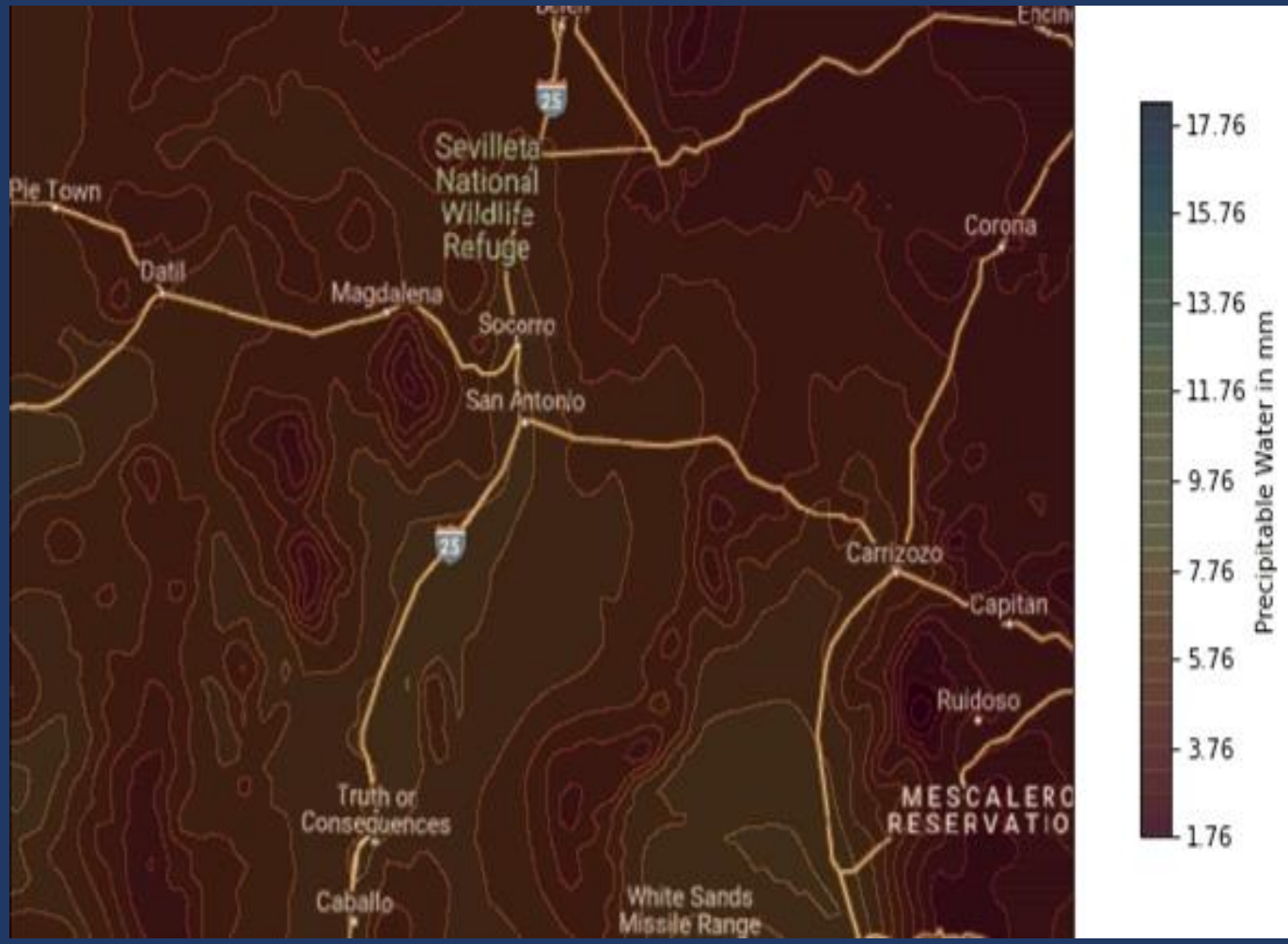
5th Texas Weather Conference



PWAT: Drought to Deluge

This project shows how zenith clear sky temperatures can be used to approximate PWAT in higher elevation, arid and semi-arid regions of the west where data is not currently available for forecasting

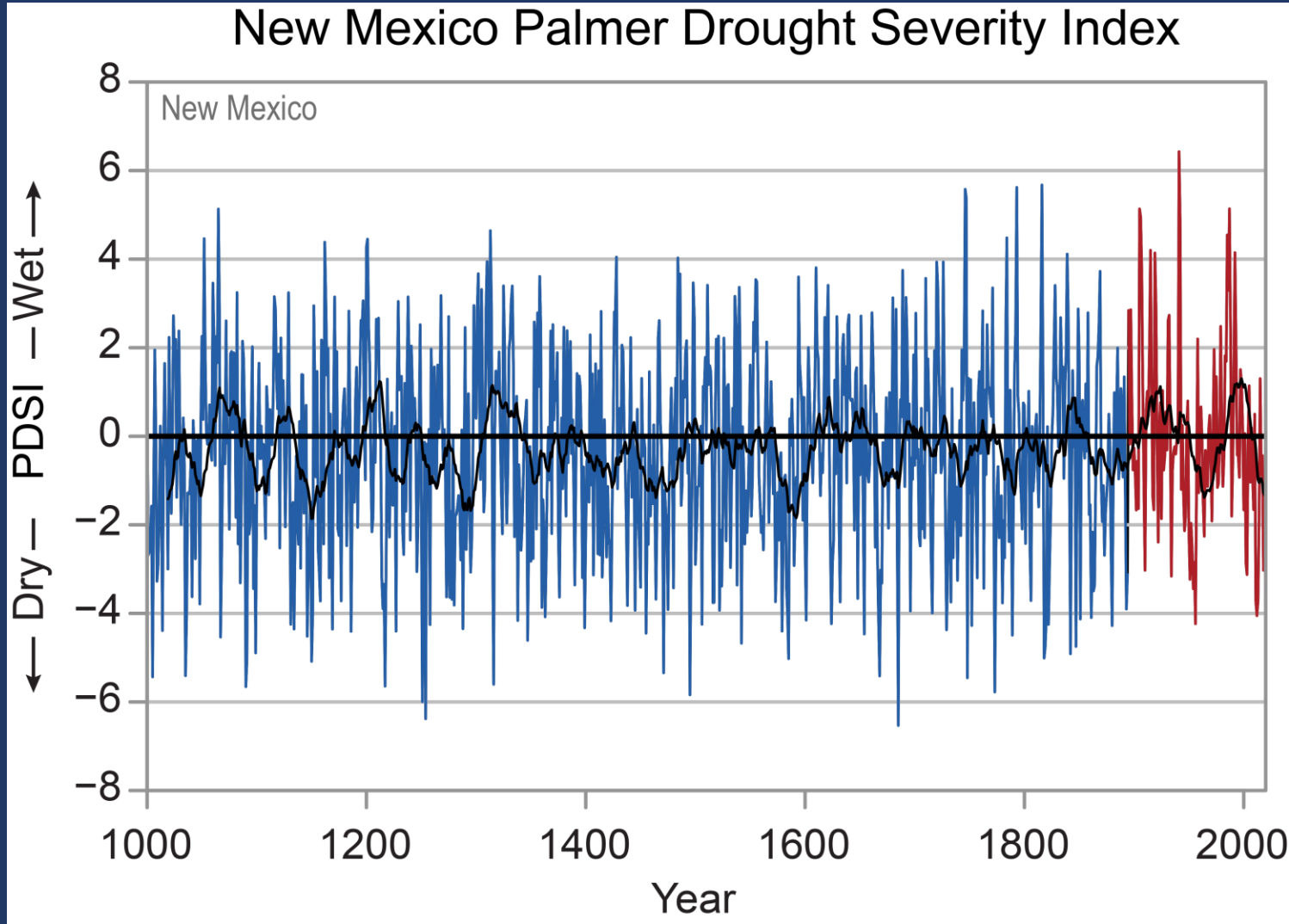


Image: https://statesummaries.ncics.org/chapter/nm/

PWAT Data Gaps

GOES-R limitations

- Angle of incidence
- Topography

POES limitations

- Orbits
- Frequency

GPS measurements and Ground based monitoring equipment

- Few measurement sites
- Funding
- Elevation

Radiosondes

- Large WFO areas
- Large distances between sites

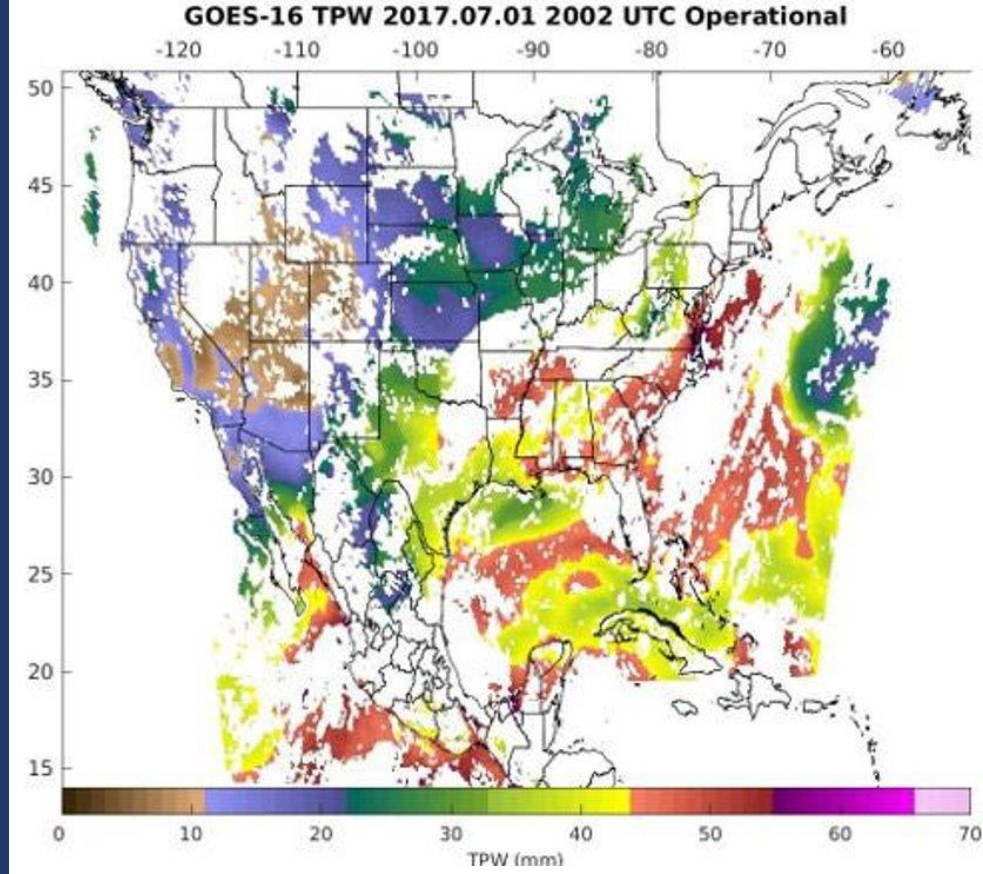


image from: https://www.goes-r.gov/products/baseline-total-precipitable-water.html

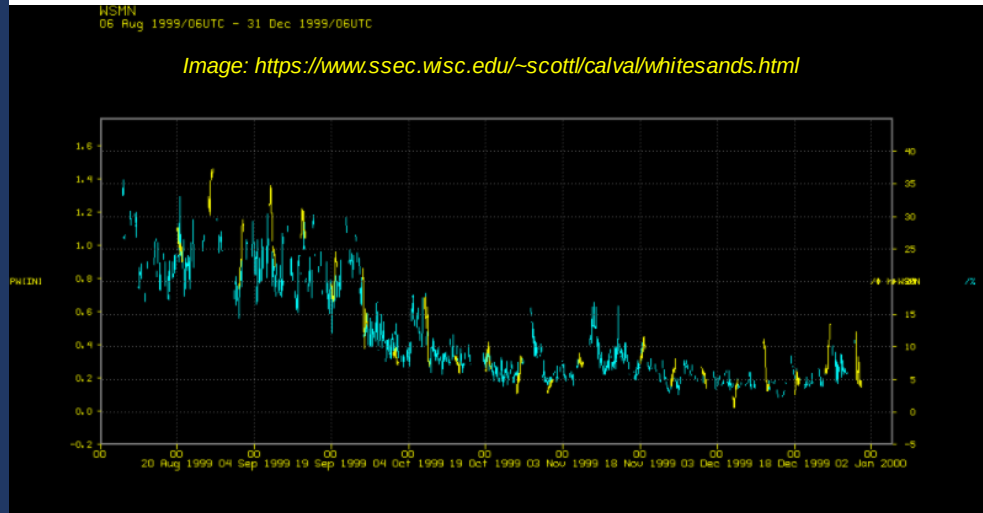


Image: https://www.ssec.wisc.edu/~scottl/calval/whitesands.html

Previous Works

Smith and Toumi. 2008
London, UK

Maghrabi and Clay. 2009
Coastal South Australia

Mims et al. 2011
Seguin, Texas

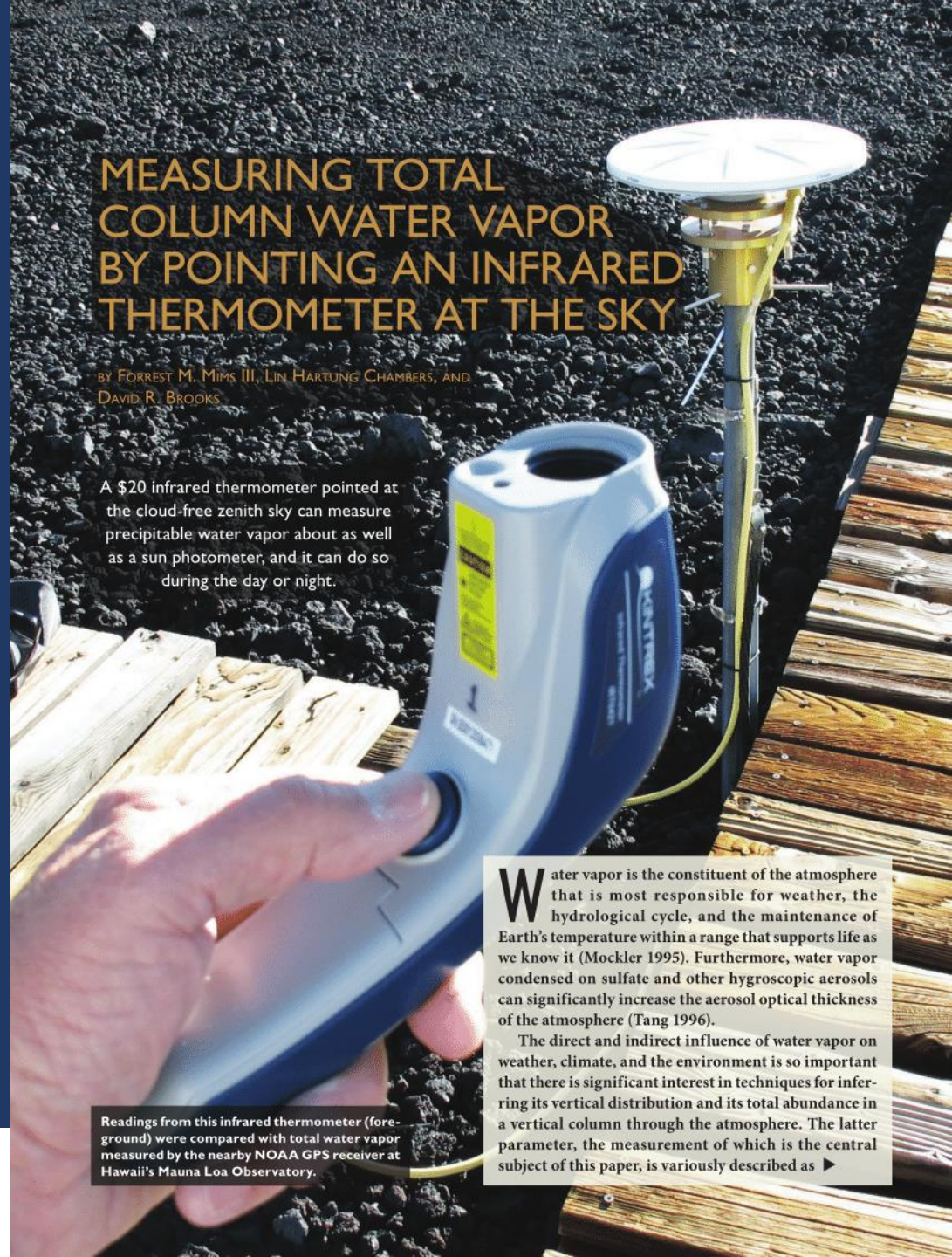


Image: Bulletin of the American Meteorological Society, 92(10), 1311-1320. https://journals.ametsoc.org/view/journals/bams/92/10/2011bams3215_1.xml

Instrumentation

TE 1610
Field of view: 4.8° Cone
low temperature limit: -20°C
Target emissivity: 0.95

FLIR i3
Field of view: 12.5° x 12.5° Rectangle
Low temperature limit: -40°C
Target emissivity: 0.95

AMES 12:1
Field of view: 4.8° Cone
Low temperature limit: -50°C
Target emissivity: 0.95

Image taken by Spencer Riley

Methodology

Daily zenith sky temperature measurements

- Started January 2019, Socorro, NM
- 1700-1800 UTC or 2300-2400 UTC
- Designation of either cloudy or clear sky
- Ground Temperature measurements taken to check for calibration and drift

Compare zenith clear sky temperatures with PWAT measurements

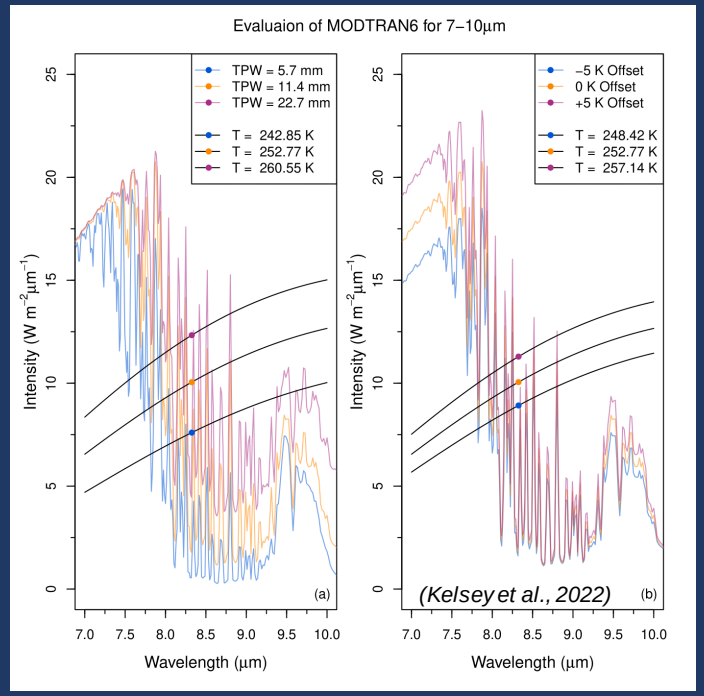
- Radiosondes from ABQ and EPZ WFOs
- SuomiNet data (when available)
- AERONET data (when available)

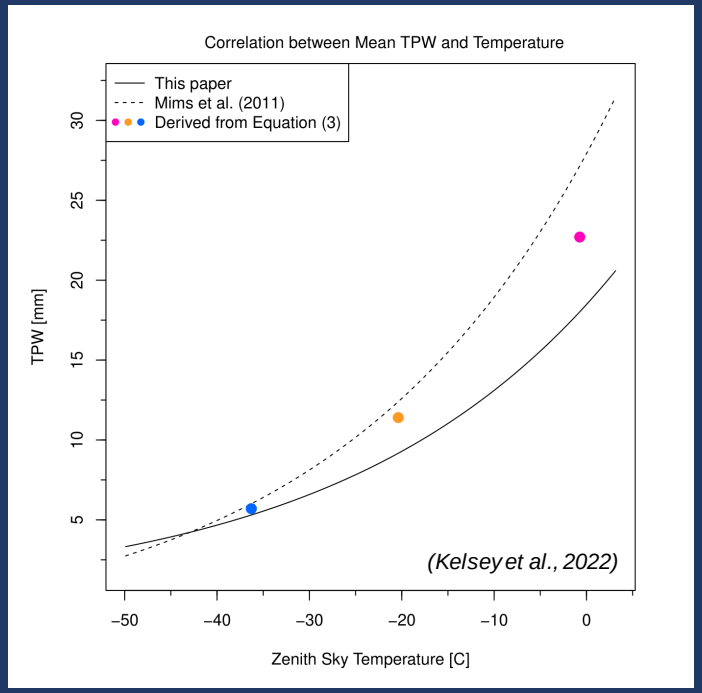
Checking our data against MODTRAN6 and Mims et al.

Zenith Sky Temperature matches Brightness Temperature data from MODTRAN6

Planck function evaluated

Our fit more in line with MODTRAN6 points than Mims et al. achieved





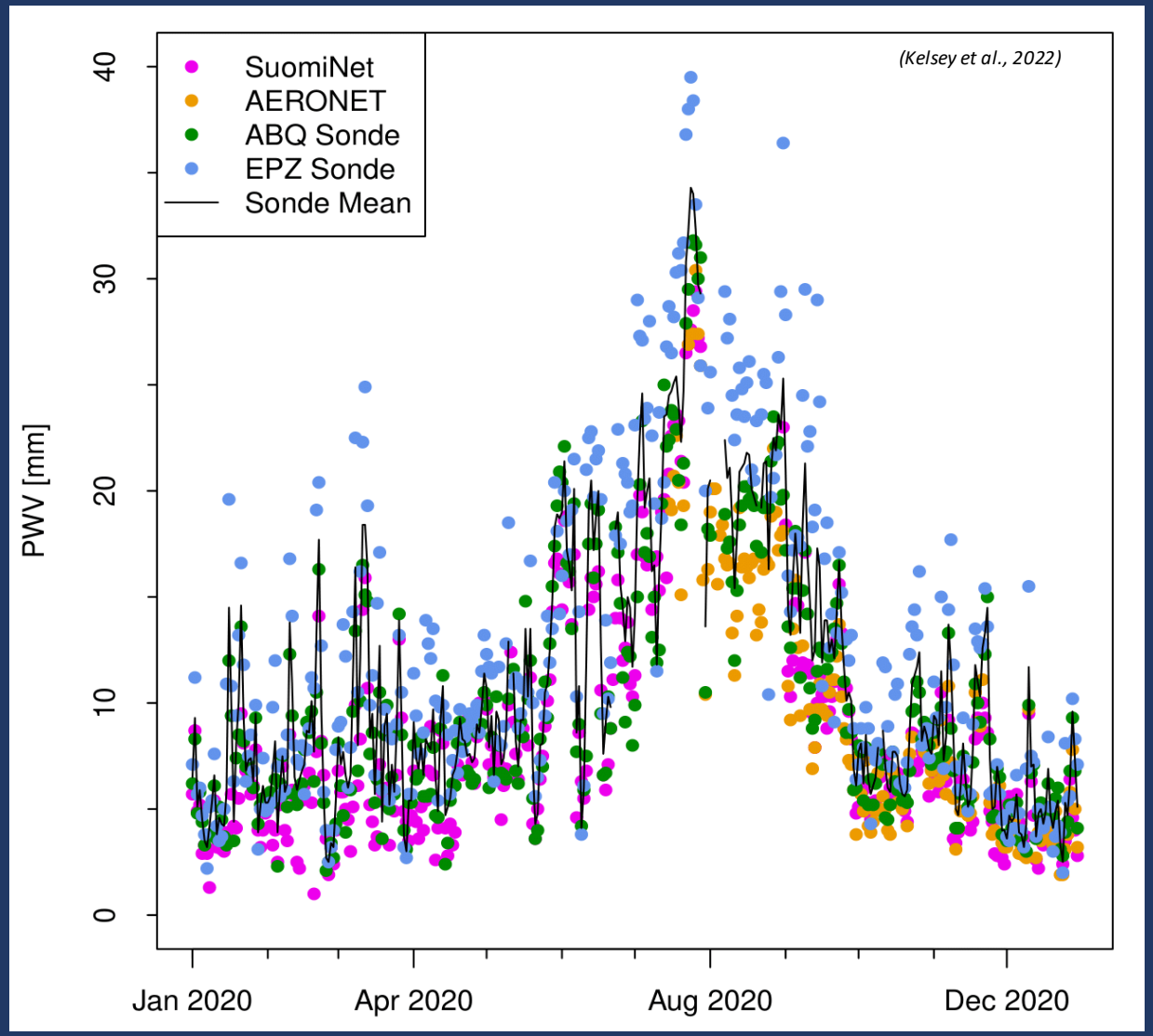
Local PWAT measurement comparisons

SC01 SuomiNet

- On M Mountain
- Satellite GPS
- ~2600 ft difference in elevation
- Not online ~50% of the time since Jan 2019

AERONET

- Sevilleta National Wildlife Refuge
- Sun Photometer
- 22 miles north
- similar elevation
- online 5 months/year



Approximation based on Correlation

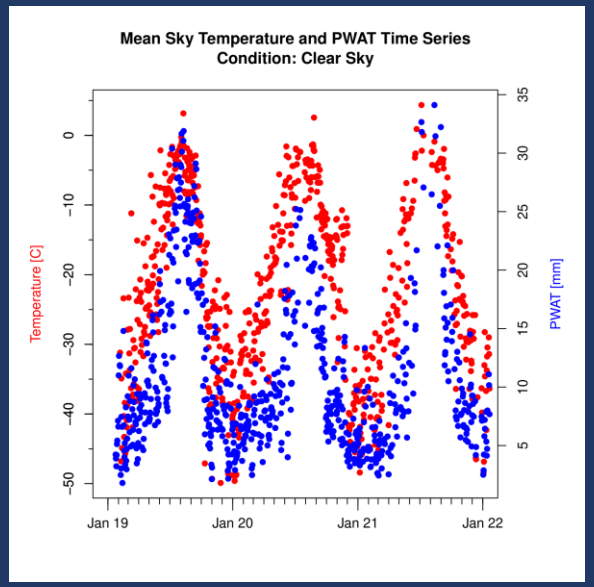
Seasonal Trends

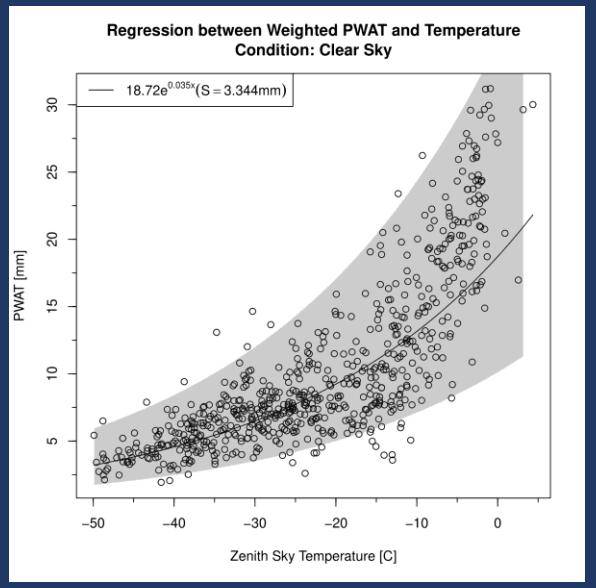
Spatiotemporal average with best-fit line

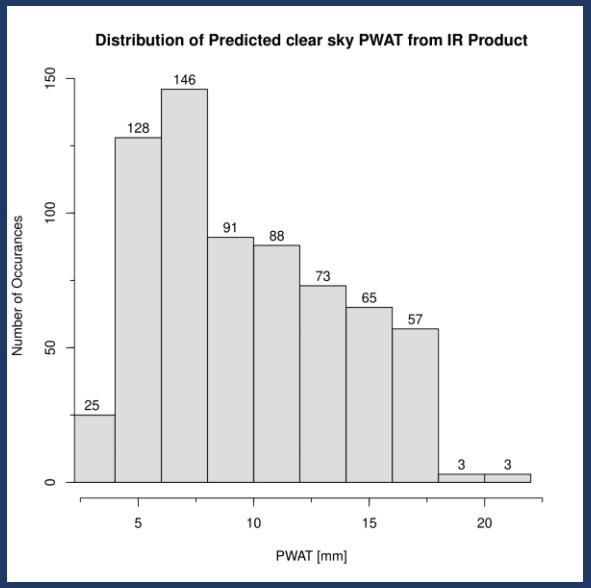
Correlation proved first, then PWAT values approximated

If GPS based satellite readings or POES data is available, it should be used

Approximation provides insight where there are no PWAT measurements available







Next steps

Automation

- Have measurements taken on an hourly basis to be useful to NWS

Citizen Science / GLOBE Project

- Manual measurements at rural locations

Data

- Automated Surface Observing System (ASOS)
- Advanced Weather Interactive Processing System (AWIPS)

Continued development of PMAT

- Open source software
- Full access to our dataset

https://docs.pmat.app/

Any Questions?

Thanks for coming and hearing about the Precipitable Water Project today!

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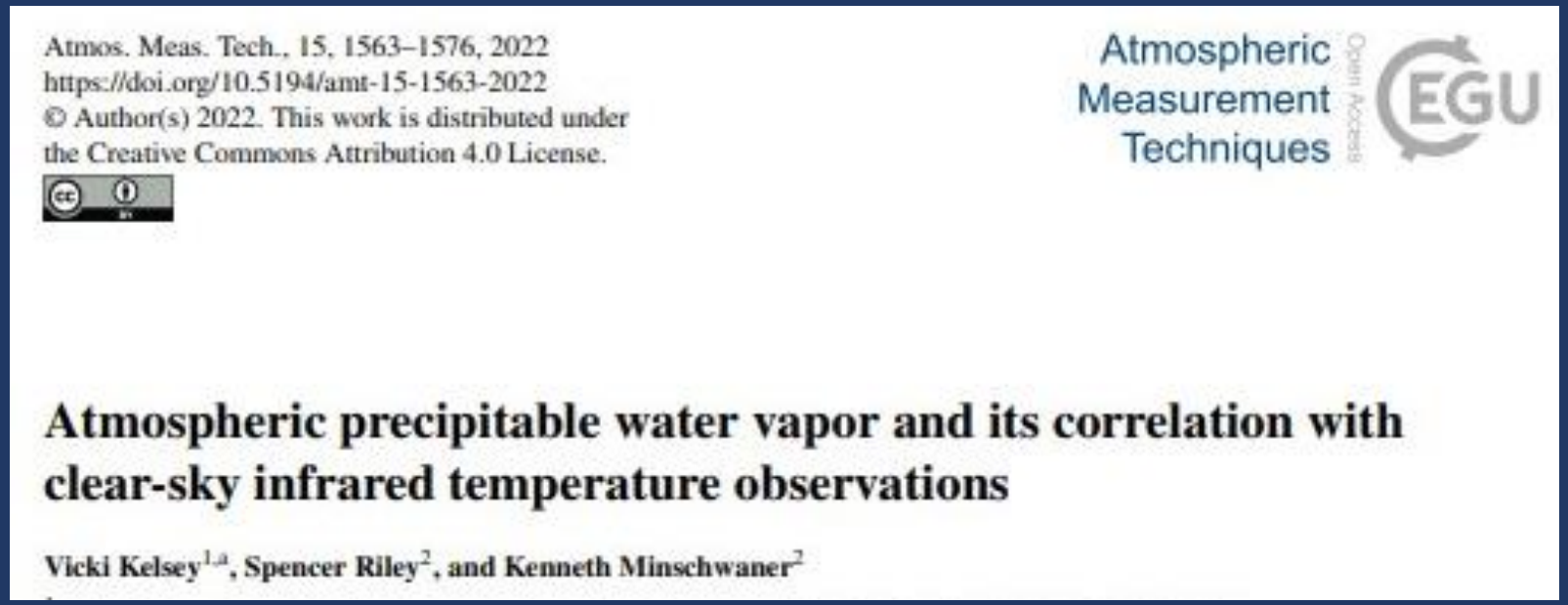
For more info, please see our paper (published 18 March 2022)



Atmos. Meas. Tech., 15, 1563–1576, 2022
https://doi.org/10.5194/amt-15-1563-2022

Atmospheric Measurement Techniques

Atmospheric precipitable water vapor and its correlation with clear-sky infrared temperature observations

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