National Aeronautics and Space Administration

Western Sonoran Desert

Water Resources

Evaluating Rock Pool Hydroperiod Fluctuation using Climate Variables to Inform Habitat Monitoring and Protection in the Western Sonoran Desert

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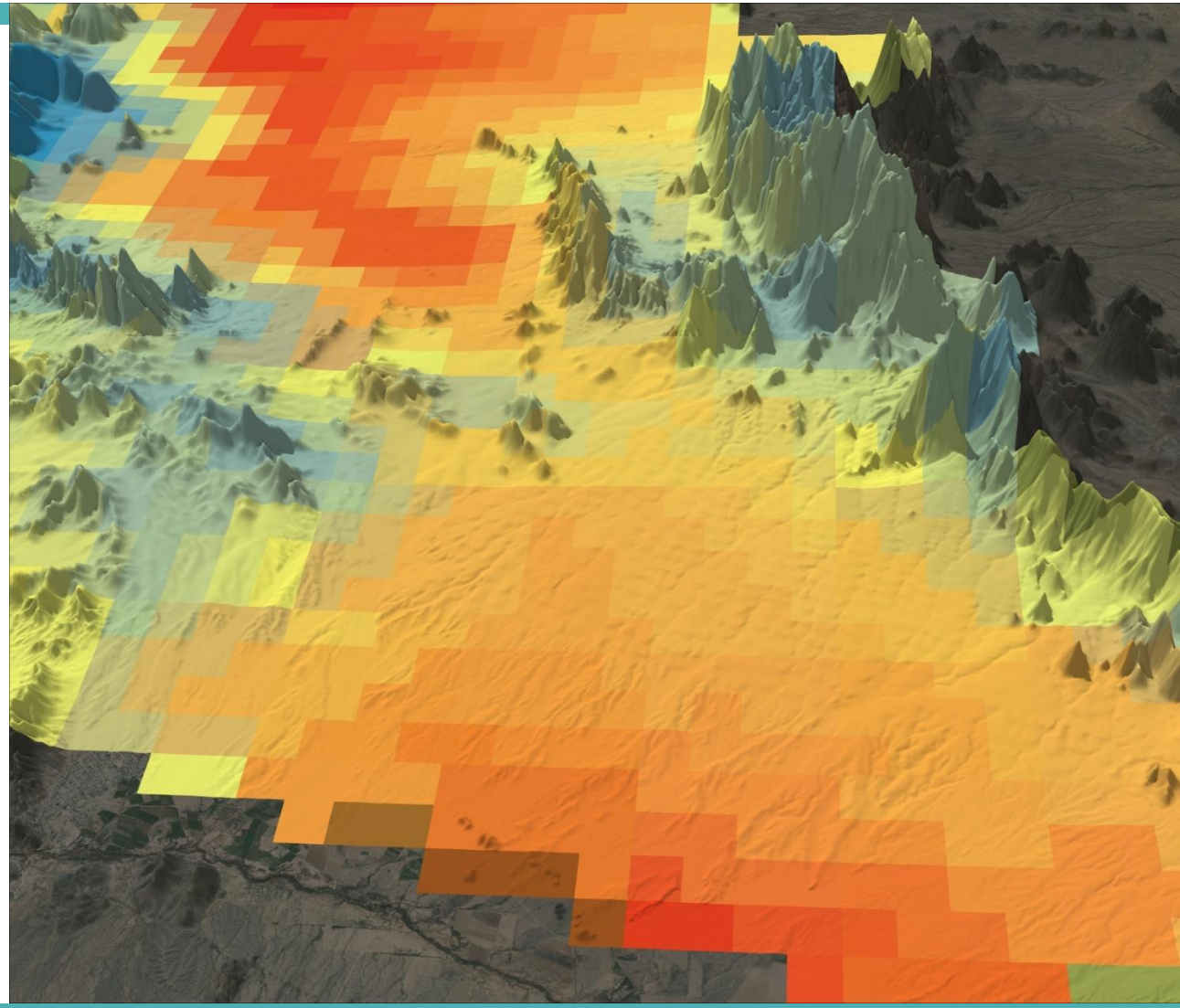
Charlie Nixon



THE TEAM

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OUTLINE

- Study Area
- Community Concerns
- Partners
- Objectives
- Study Period
- NASA Satellites & Ancillary Data
- Methodology
- Results
- Conclusions and End Use
- Limitations and Uncertainties
- Future Work
- Acknowledgments

STUDY AREA

Tinaja located in OPCNM

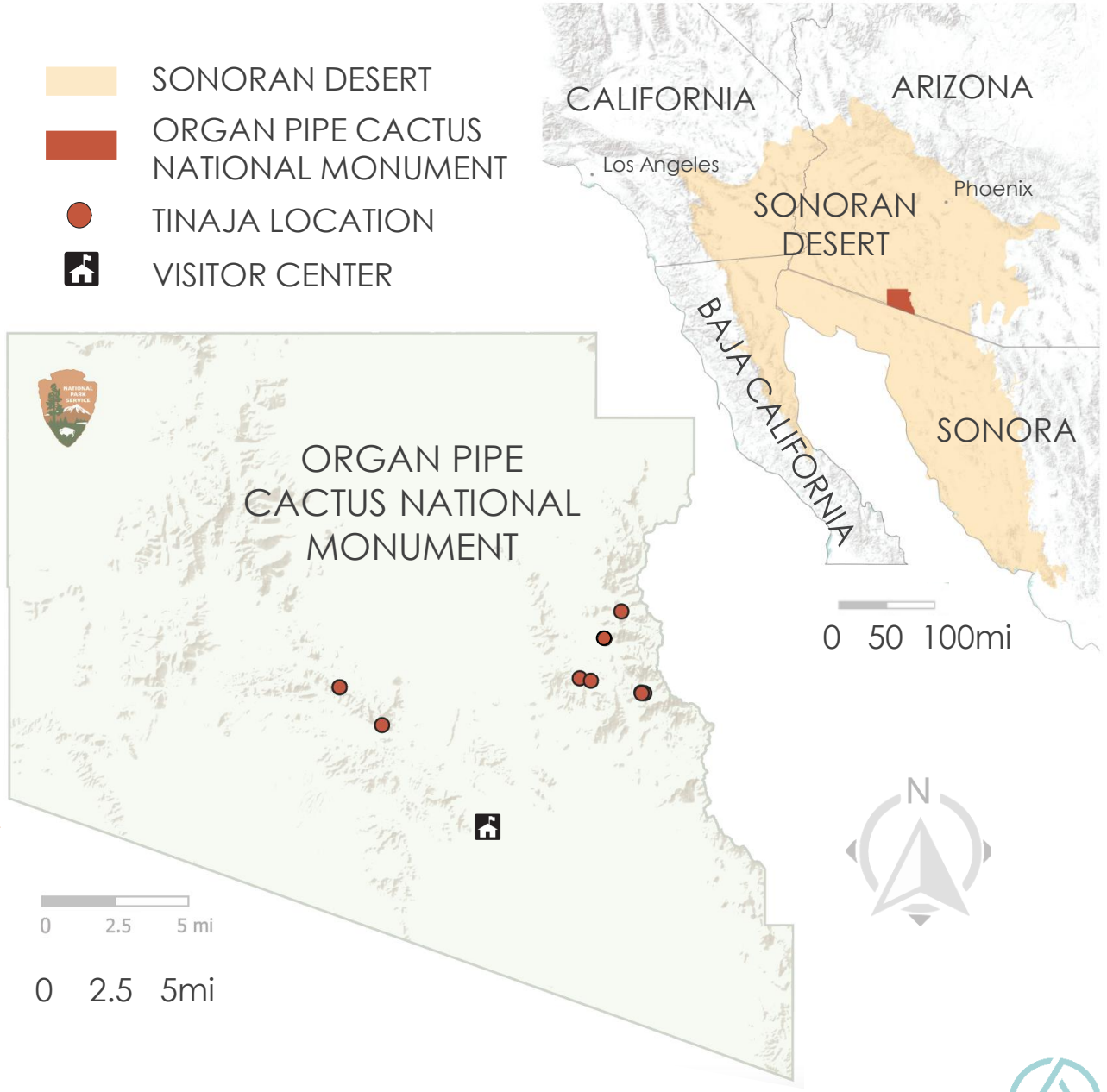
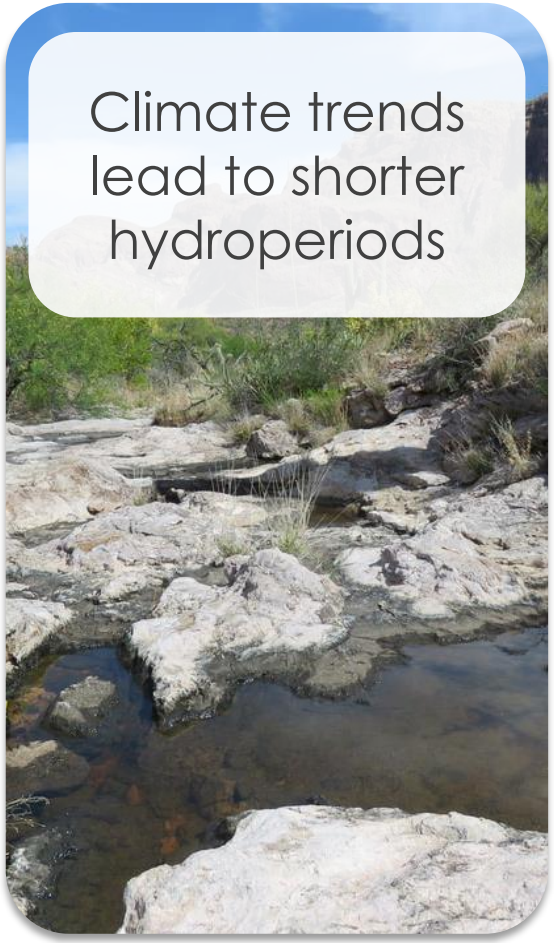


Image Credit: Susan Washko; Base map: ESRI World Terrain Base

COMMUNITY CONCERNS



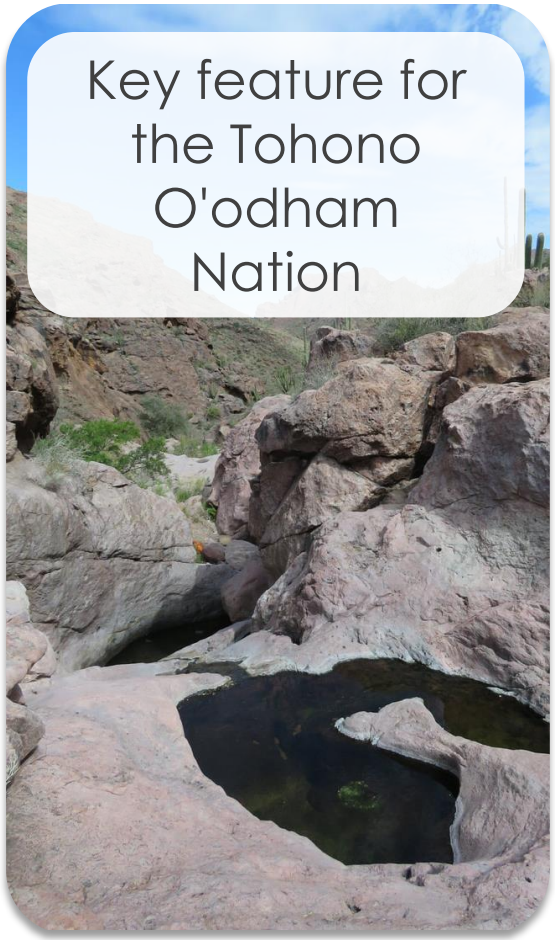


Image Credit: Susan Washko; NPS (right)

PARTNERS

National Park Service, Organ Pipe Cactus National Monument

Ami Pate, Geographer | *End User*

The University of Arizona

Susan Washko, Ph.D. Candidate | *Collaborator*

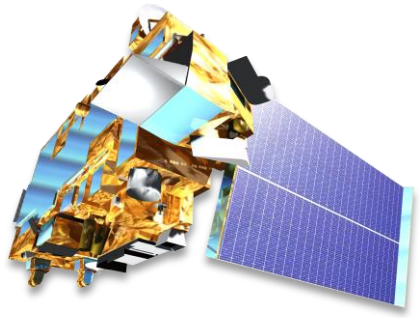
Image Credit: NPS

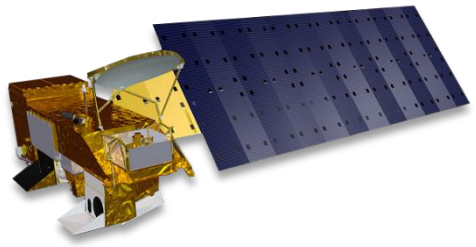
OBJECTIVES

- Generate **climatology time series** for Organ Pipe Cactus National Monument to support conservation
- Produce **climatology maps** and analyze climate patterns to identify areas most susceptible to change
- Quantify wet and dry periods in study area through a **hydroperiod trend analysis**

Image Credit: Susan Washko (top); NPS

NASA SATELLITES & ANCILLARY DATA





Terra **MODIS**	Evapotranspiration
Aqua **MODIS**	Temperature
GridMET	Wind Air Temperature Precipitation Solar Radiation
OpenET	Evapotranspiration
University of Arizona Camera Footage Timeseries	*In situ* Tinaja Observations

Image Credit: NASA Earth Observatory

STUDY PERIODS

Climatology Maps and Timeseries

1979 → 2022

gridMET

2002 → 2022

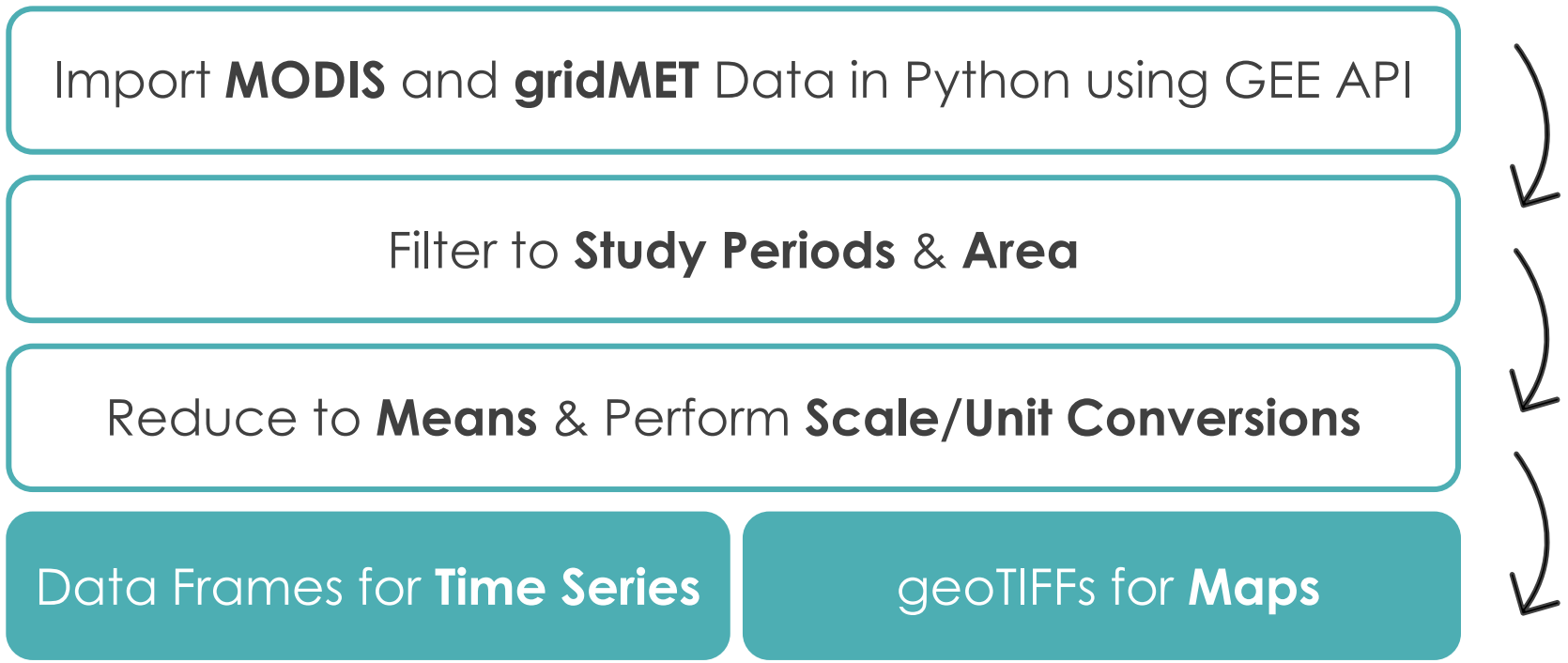
MODIS

Hydroperiod Trend Analysis

2019 → 2022

in situ data & OpenET

METHODOLOGY: LONG-TERM CLIMATOLOGY

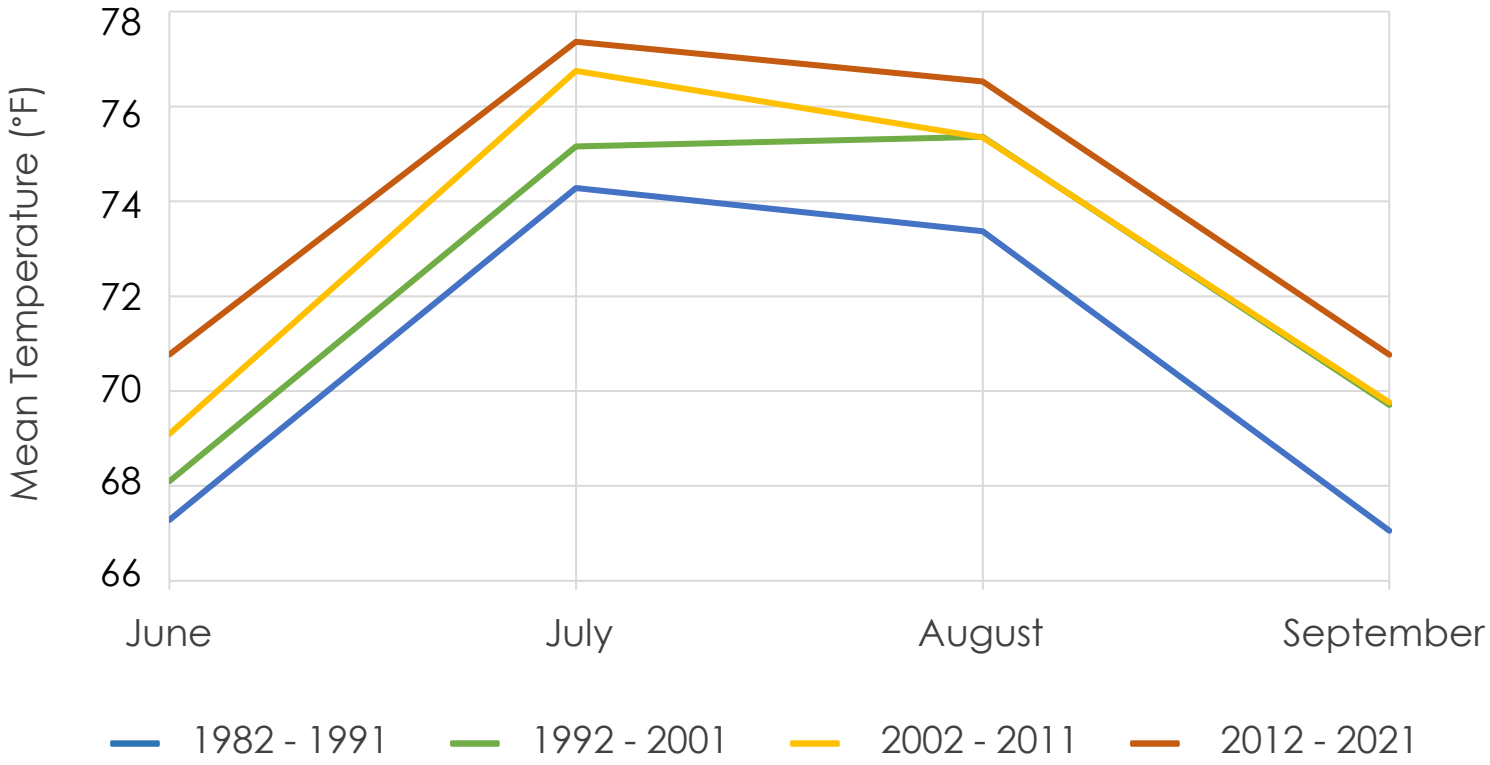


RESULTS: CLIMATOLOGY TIME SERIES

+3°F increase between 1979-2021

+2°F increase between 2002-2021

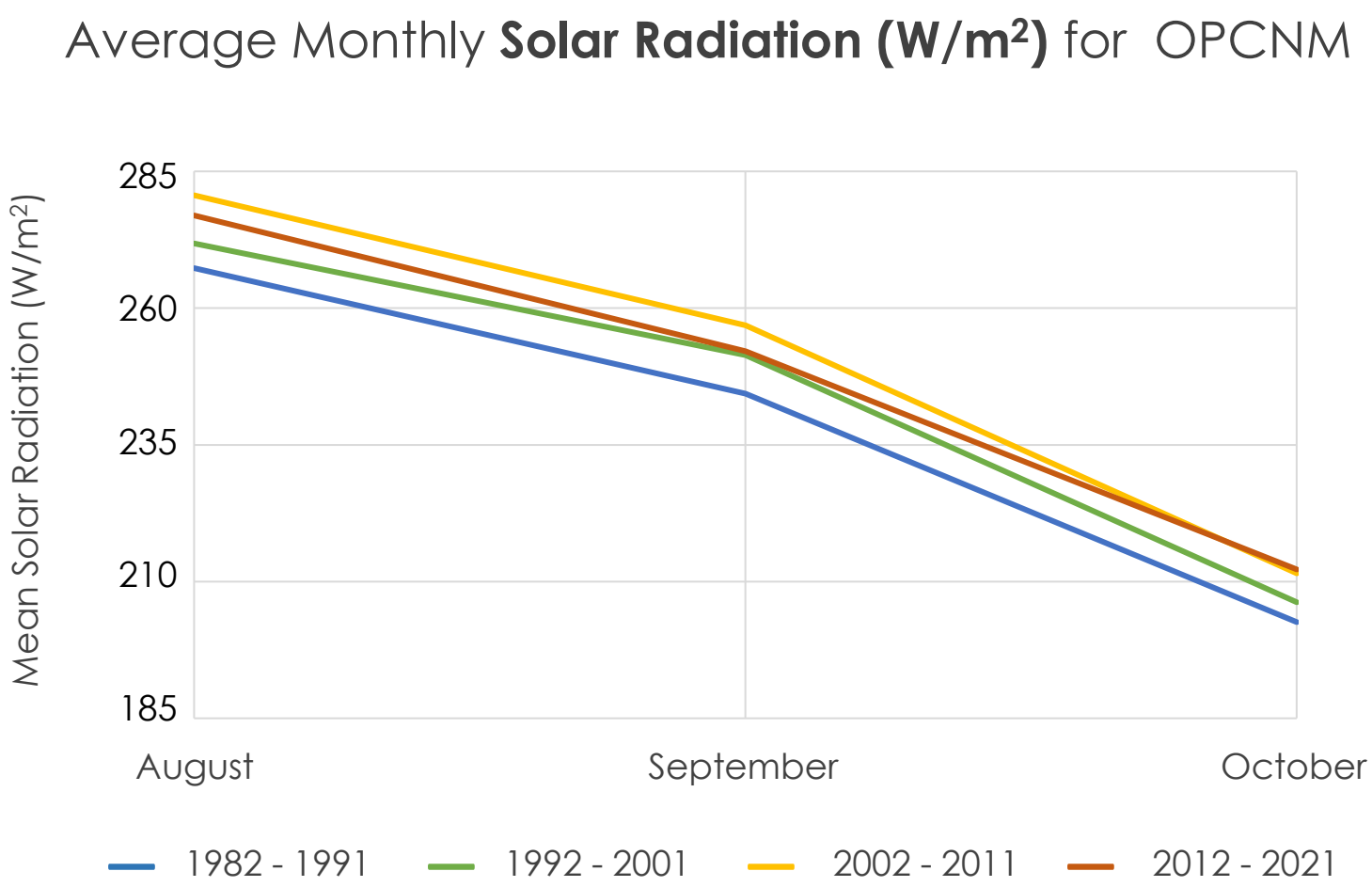
Average Monthly **Minimum Temperature (°F)** for OPCNM



RESULTS: CLIMATOLOGY TIME SERIES

+8 W/m^2 increase between 1979-2021

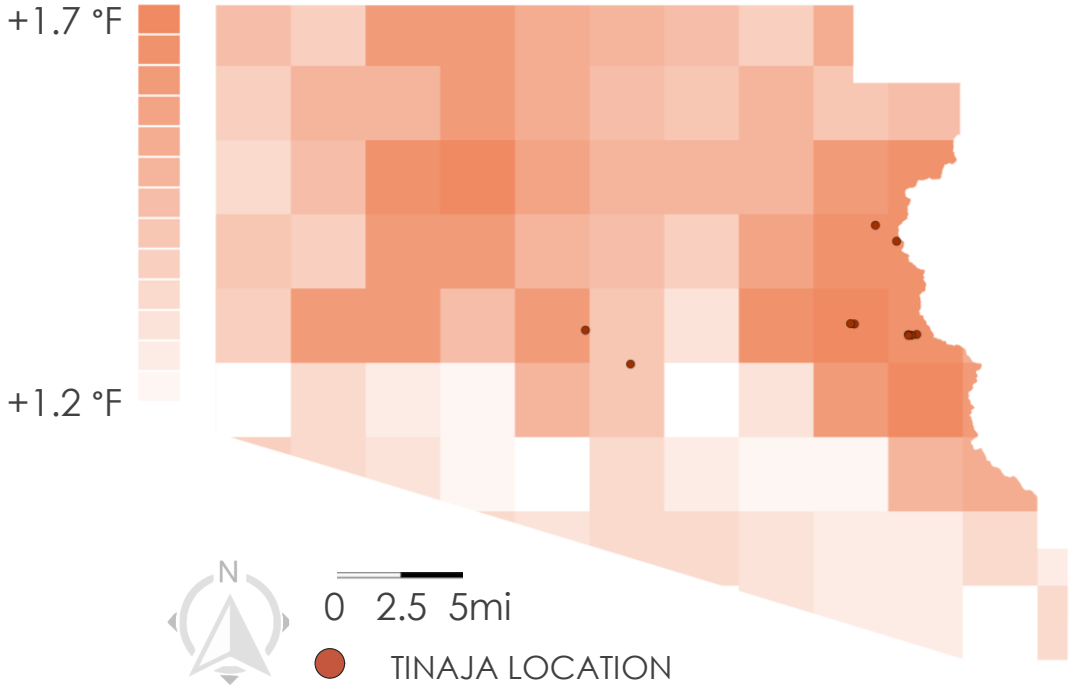
Elevated rate of increase **Aug - Oct**



RESULTS: CLIMATOLOGY MAPS

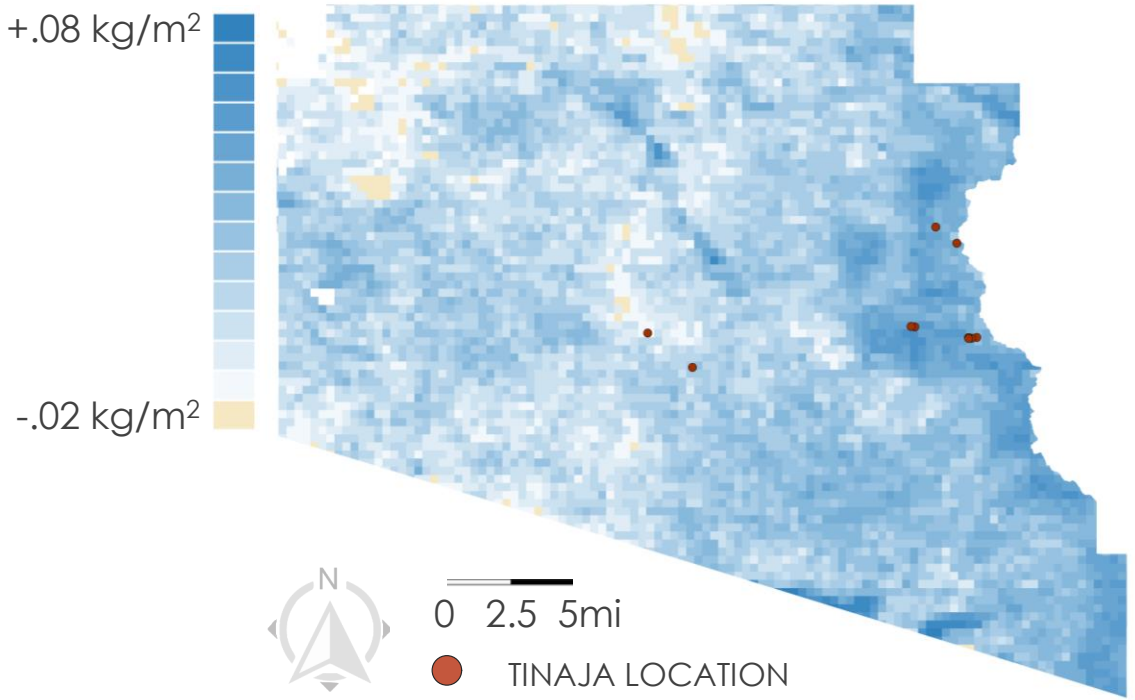
Average Minimum Air Temperature Change (°F)

Period = 2012-2021 minus 2002-2011

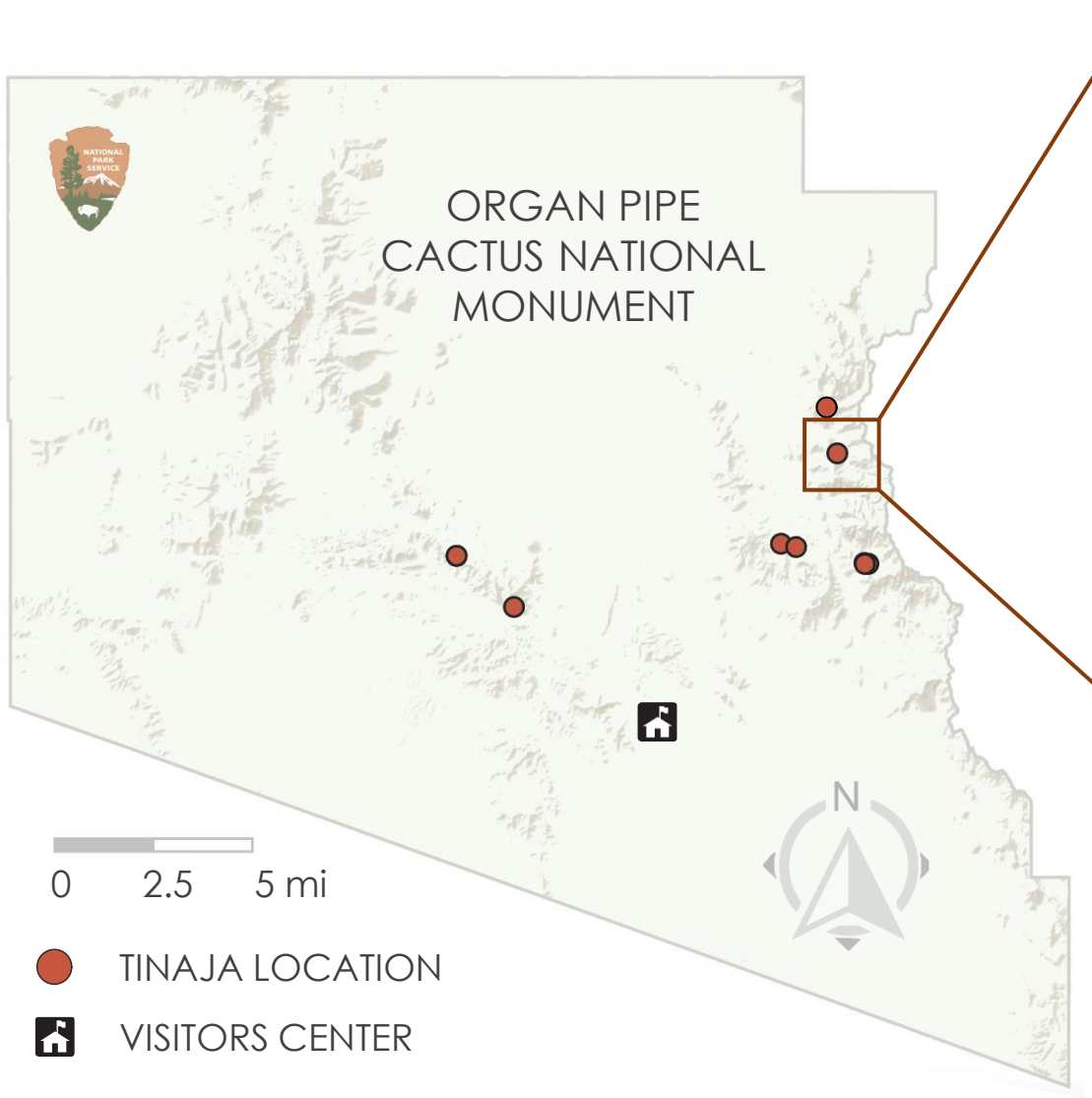


Average ET Change (kg/m^2)

Period = 2012-2021 minus 2002-2011



METHODOLOGY: HYDROPERIOD TRENDS

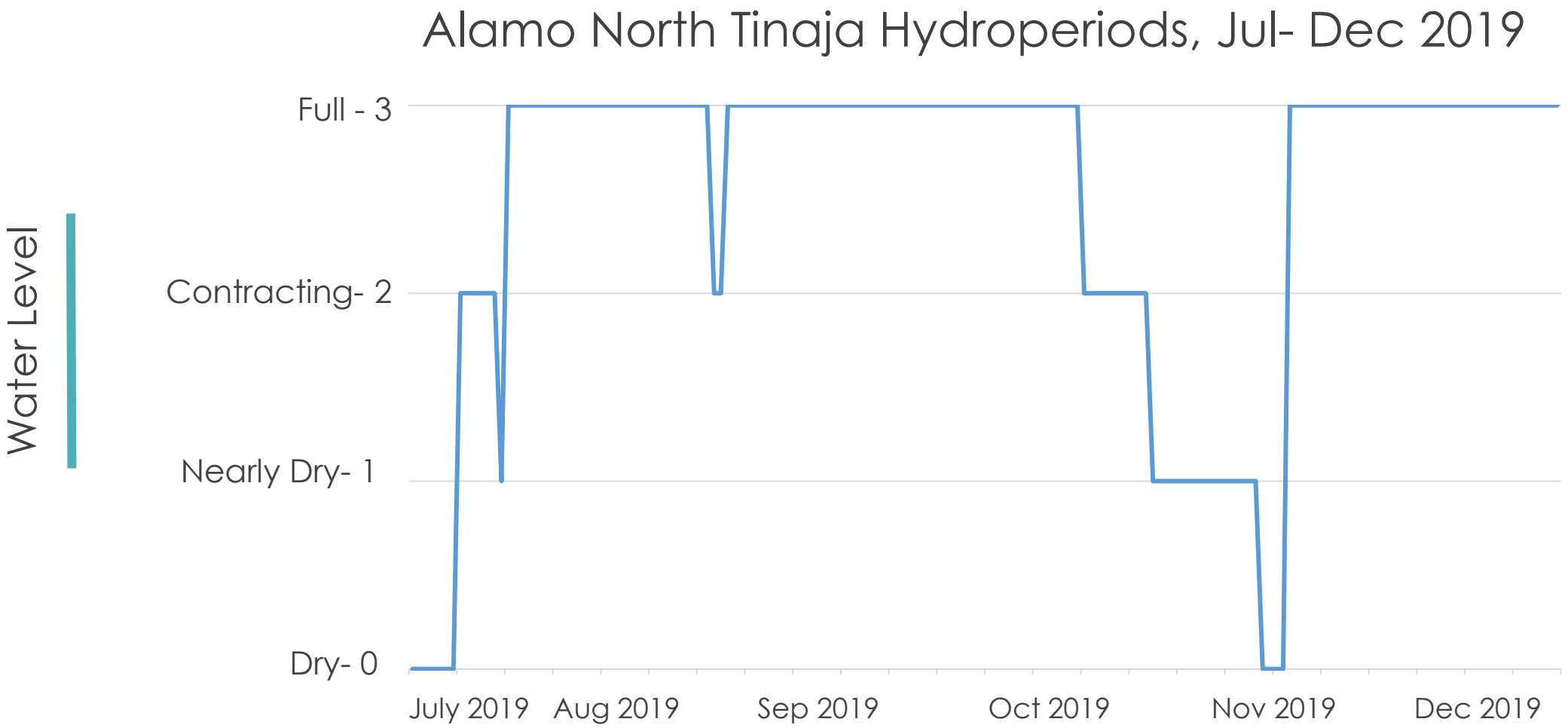


Alamo South Tinaja in OPCNM

Image Credit: Susan Washko

Base map: ESRI World Terrain Base, Google Satellite

METHODOLOGY: HYDROPERIOD TRENDS



METHODOLOGY: HYDROPERIOD TRENDS

Frequency & Duration of Hydroperiods

Calculate hydroperiod patterns

Seasonal and monthly time series analysis

Climatology Variable Analysis

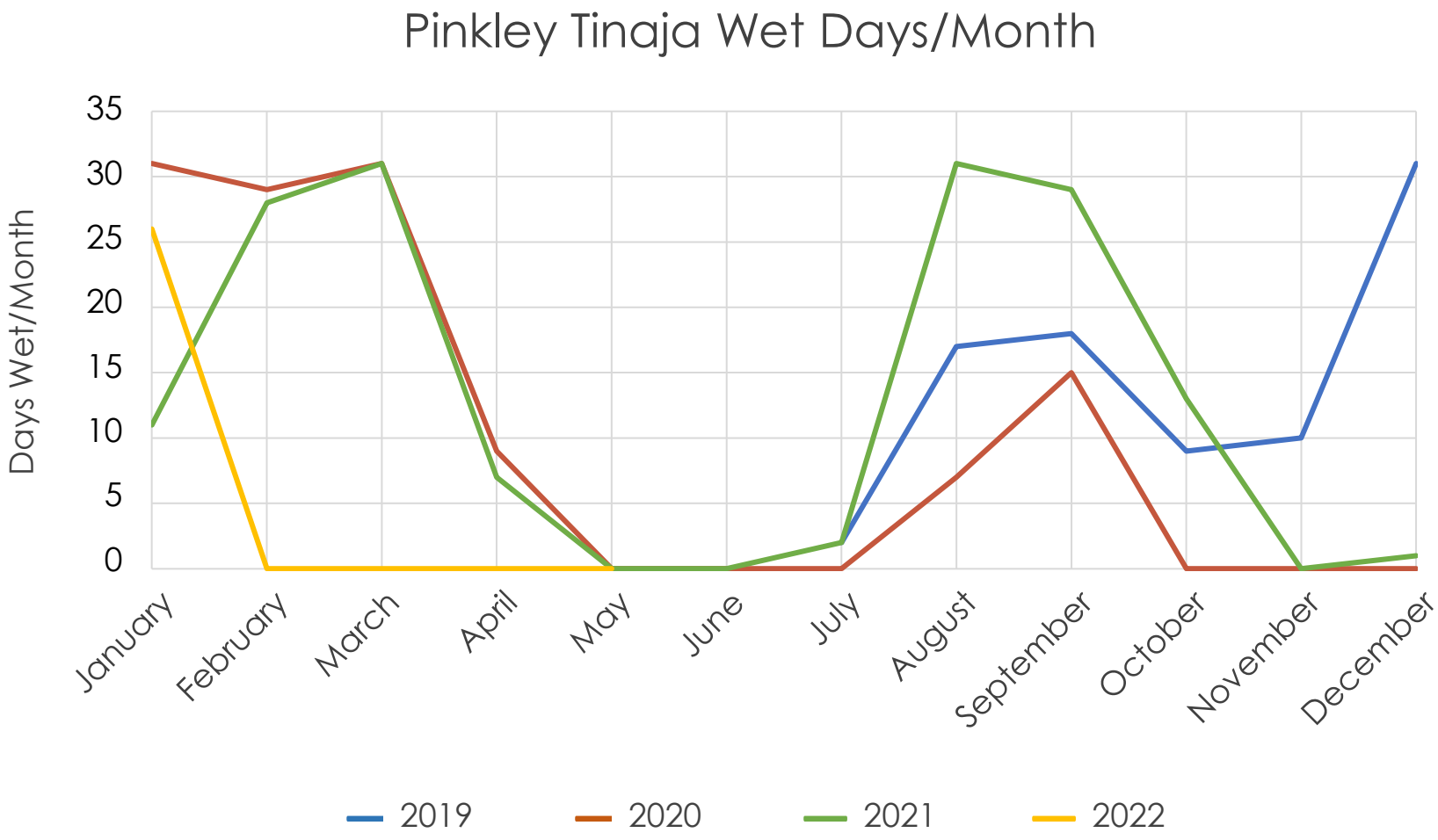
Plot climate variables over time with *in situ* data

Nonparametric trend analysis

RESULTS: HYDROPERIOD TREND ANALYSIS

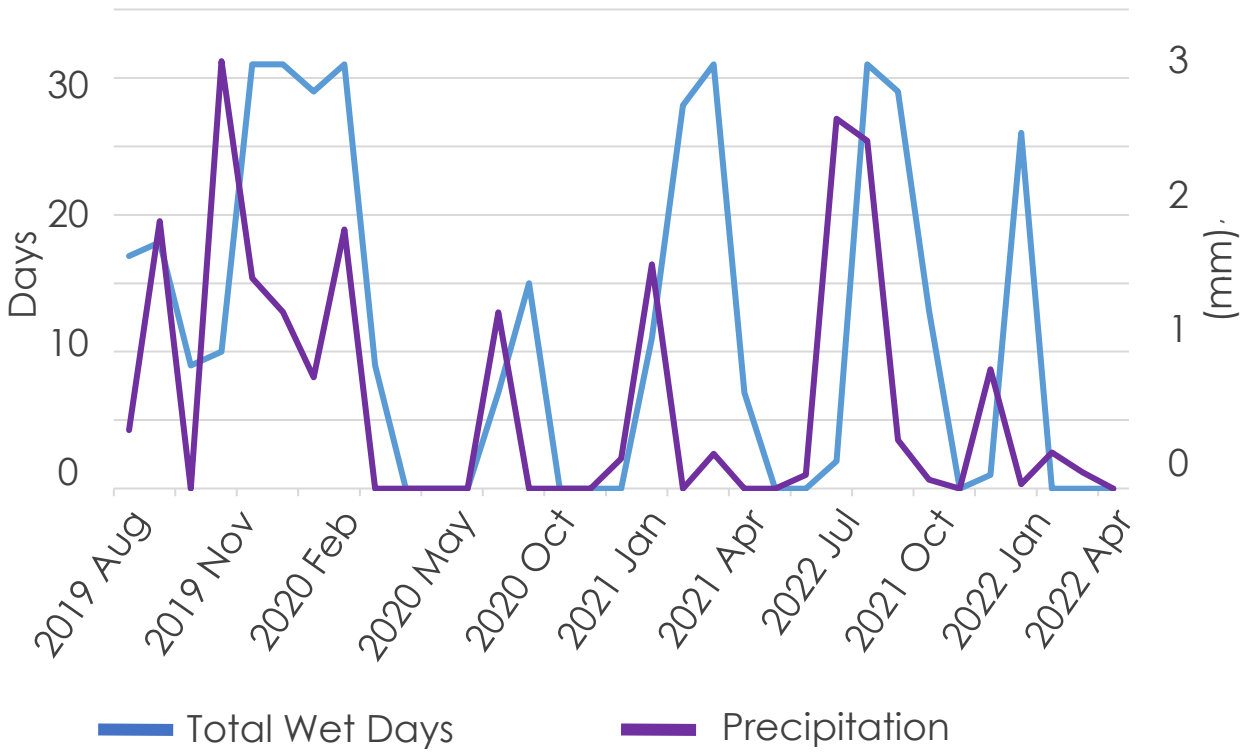
Wet Season
January - March
August - October

Dry Season
April - July

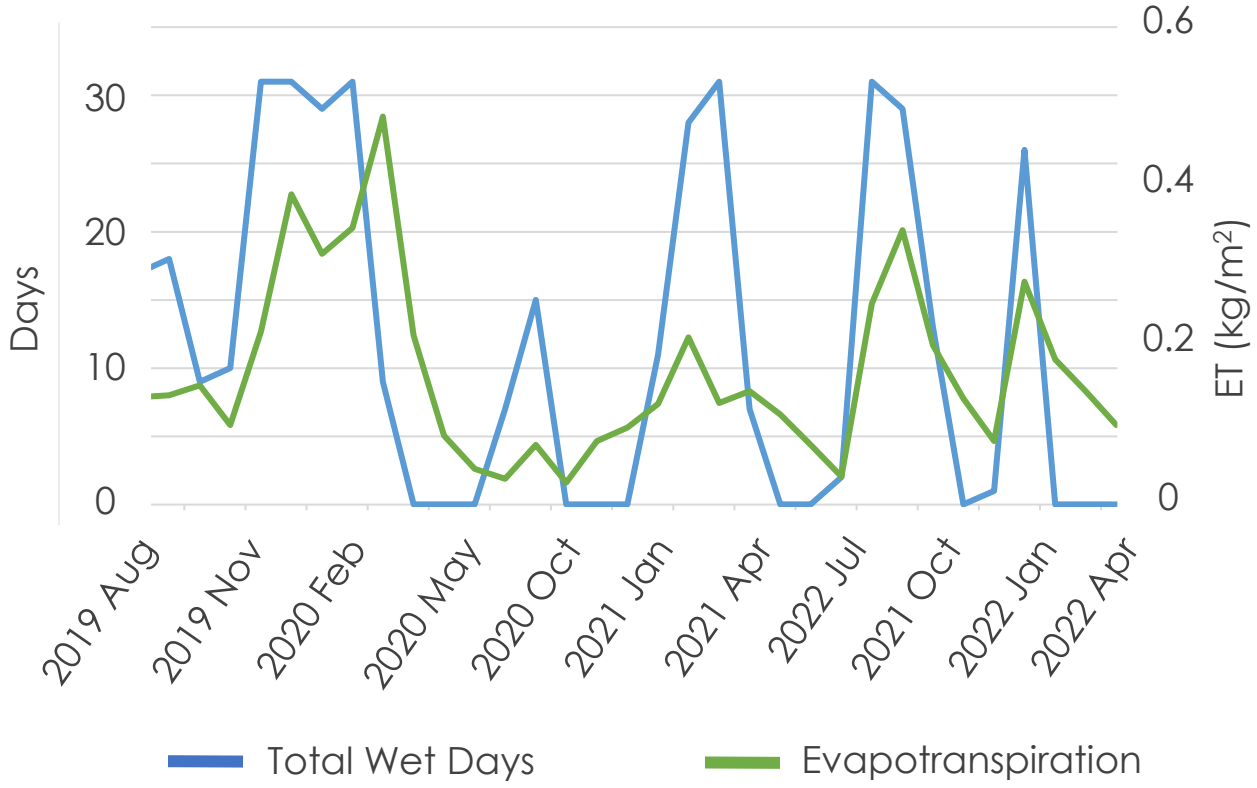


RESULTS: HYDROPERIOD TREND ANALYSIS

Pinkley: Total Wet Days/ Month and Average Precipitation (mm)



Pinkley: Total Wet Days/ Month and Average Evapotranspiration (kg/m^2)

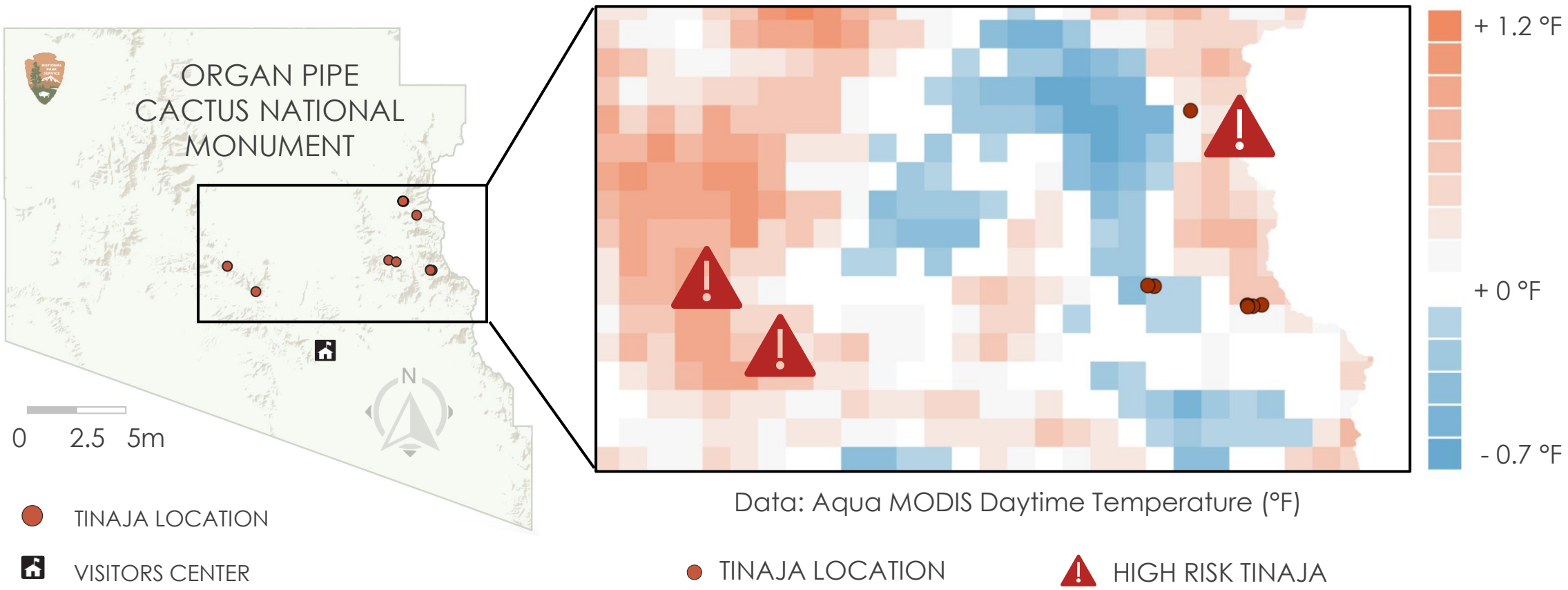


The number of days a tinaja was wet/month had the strongest correlations with **monthly averages of evapotranspiration and precipitation.**

RESULTS: HYDROPERIOD TREND ANALYSIS

Tinajas at High Risk due to Increasing **Daytime Temperatures (°F)**

Period = 2012-2021 minus 2002-2011



Base map: ESRI World Terrain Base

CONCLUSIONS & END USE

CLIMATOLOGY

Rates of warming and drying are increasing rapidly in the Sonoran Desert

HYDROPERIODS

Feasible to correlate hydroperiods with ET and precipitation data

MANAGEMENT

In situ data combined with EOs can inform tinaja management priorities

Image Credit: Susan Washko

LIMITATIONS AND UNCERTAINTIES

- **Short temporal resolution** of *in situ* data and some climate variables
- **Small geographic scope** within OPCNM
- Other **contributing variables** not considered

Image Credit: NPS

FUTURE WORK

- Expand **study area** to consider regional geographic diversity
- Include **additional variables** in analyses
- Model **future hydroperiods**

Image Credit: Susan Washko

ACKNOWLEDGEMENTS

Partners

- Ami Pate (National Park Service, Organ Pipe Cactus National Monument)
- Susan Washko (The University of Arizona)

Science Advisors

- Molly Woloszyn (NOAA National Centers for Environmental Information, National Integrated Drought Information System)
- Dr. Douglas Rao (NOAA National Centers for Environmental Information, North Carolina Institute for Climate Studies)

Fellow

- Katie Lange (Science Systems & Applications, Inc., NOAA National Centers for Environmental Information)

Land Acknowledgement

- The team acknowledges that the study area includes parts of the traditional, ancestral, and unceded territories of the Tohono O'odham, Hia-Ced O'odham, Xawiŧŧ kwñchawaay (Cocopah), and O'odham Jewe̱d peoples who have been living on and caring for this land since time immemorial.

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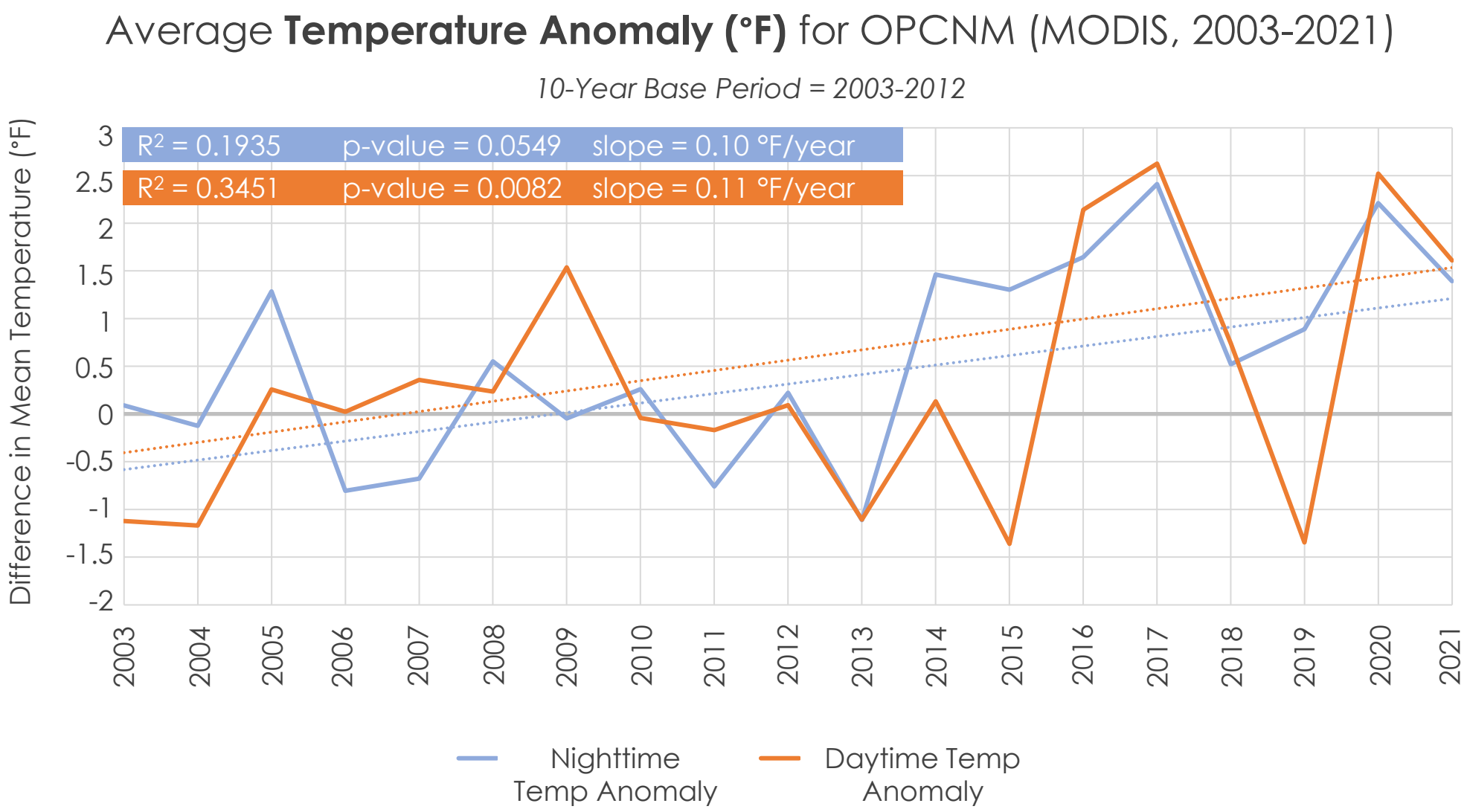
ADDITIONAL SLIDES

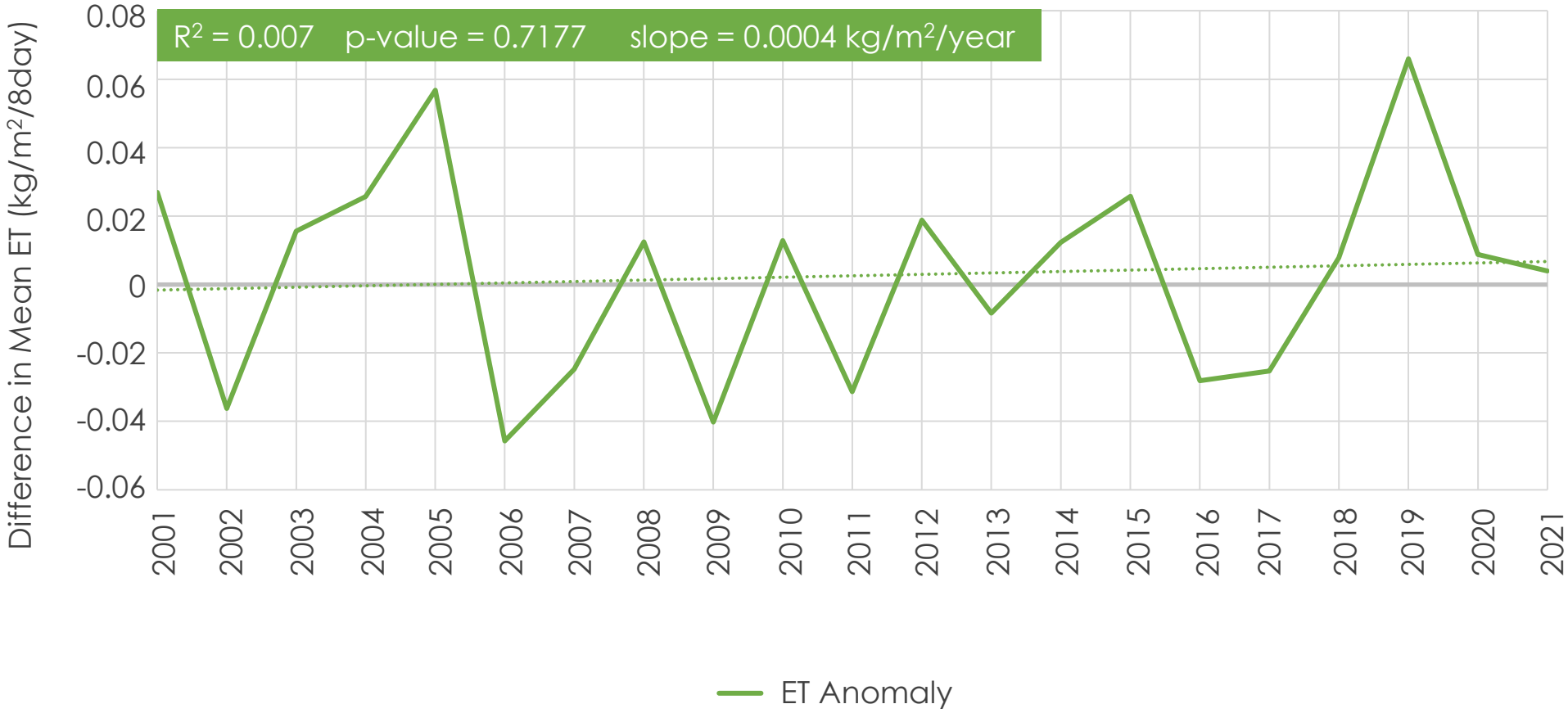
ANOMALY TIME SERIES



ANOMALY TIME SERIES

Average **Evapotranspiration Anomaly (kg/m²/8day)** for OPCNM (MODIS, 2001-2021)

10-Year Base Period = 2003-2012



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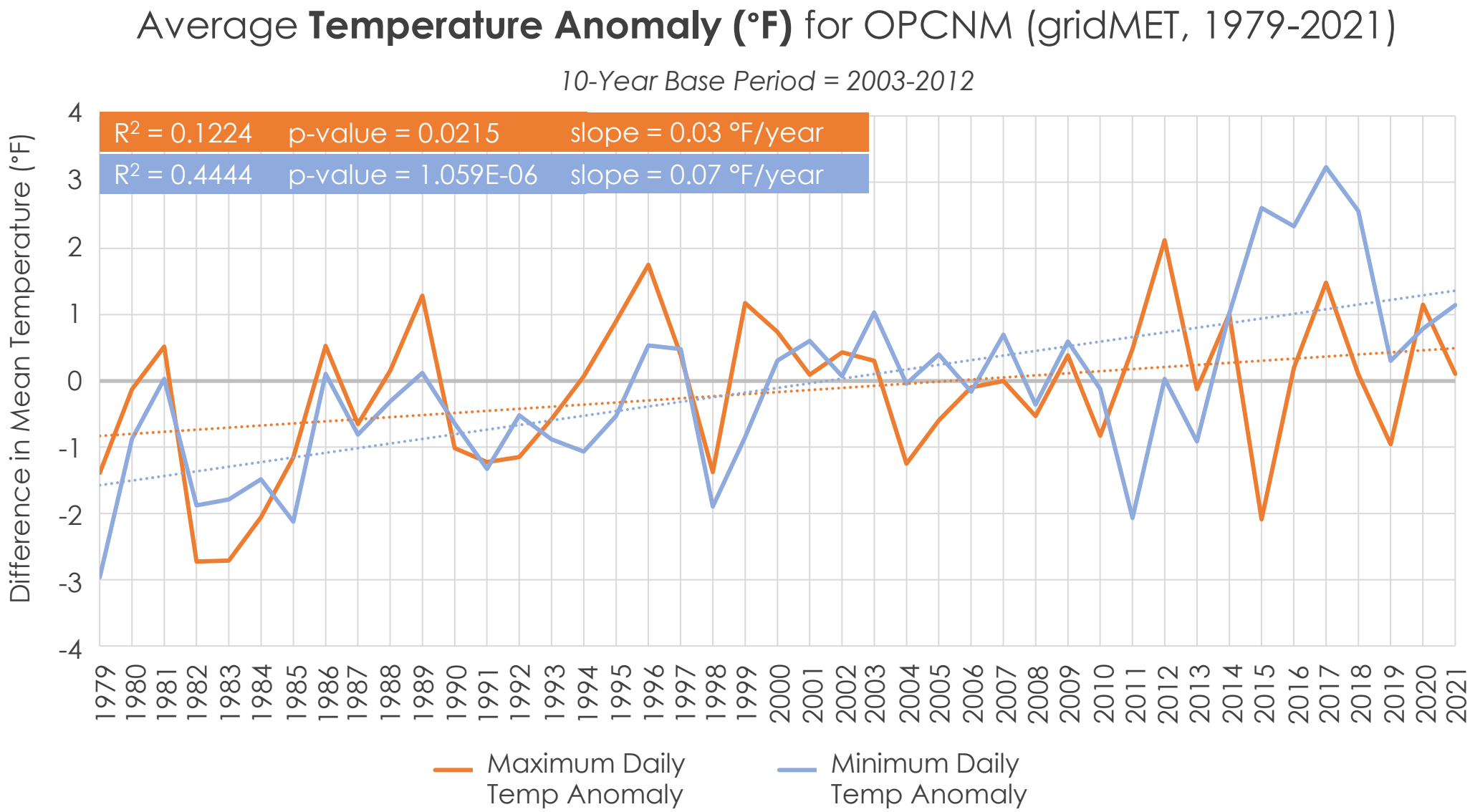

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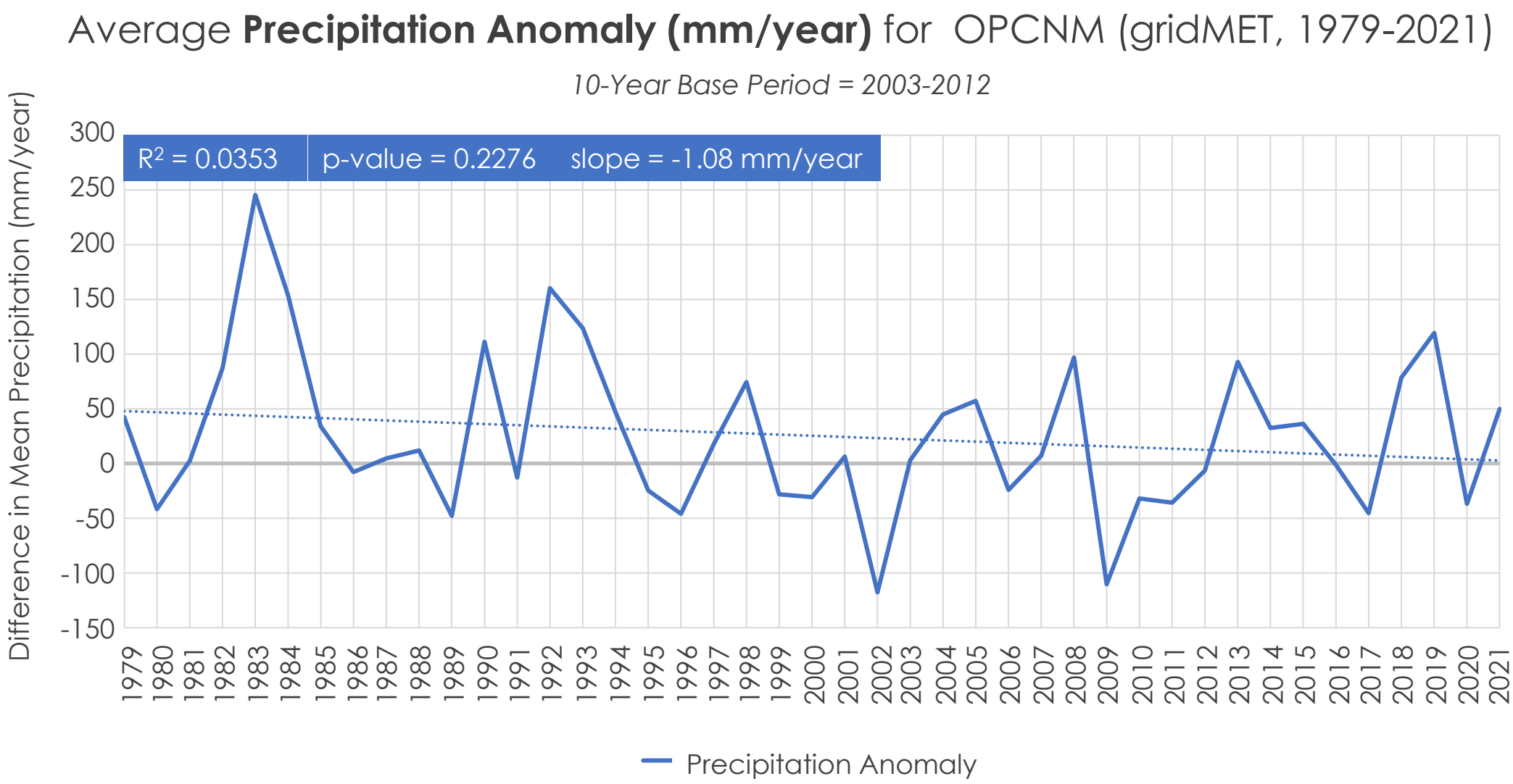

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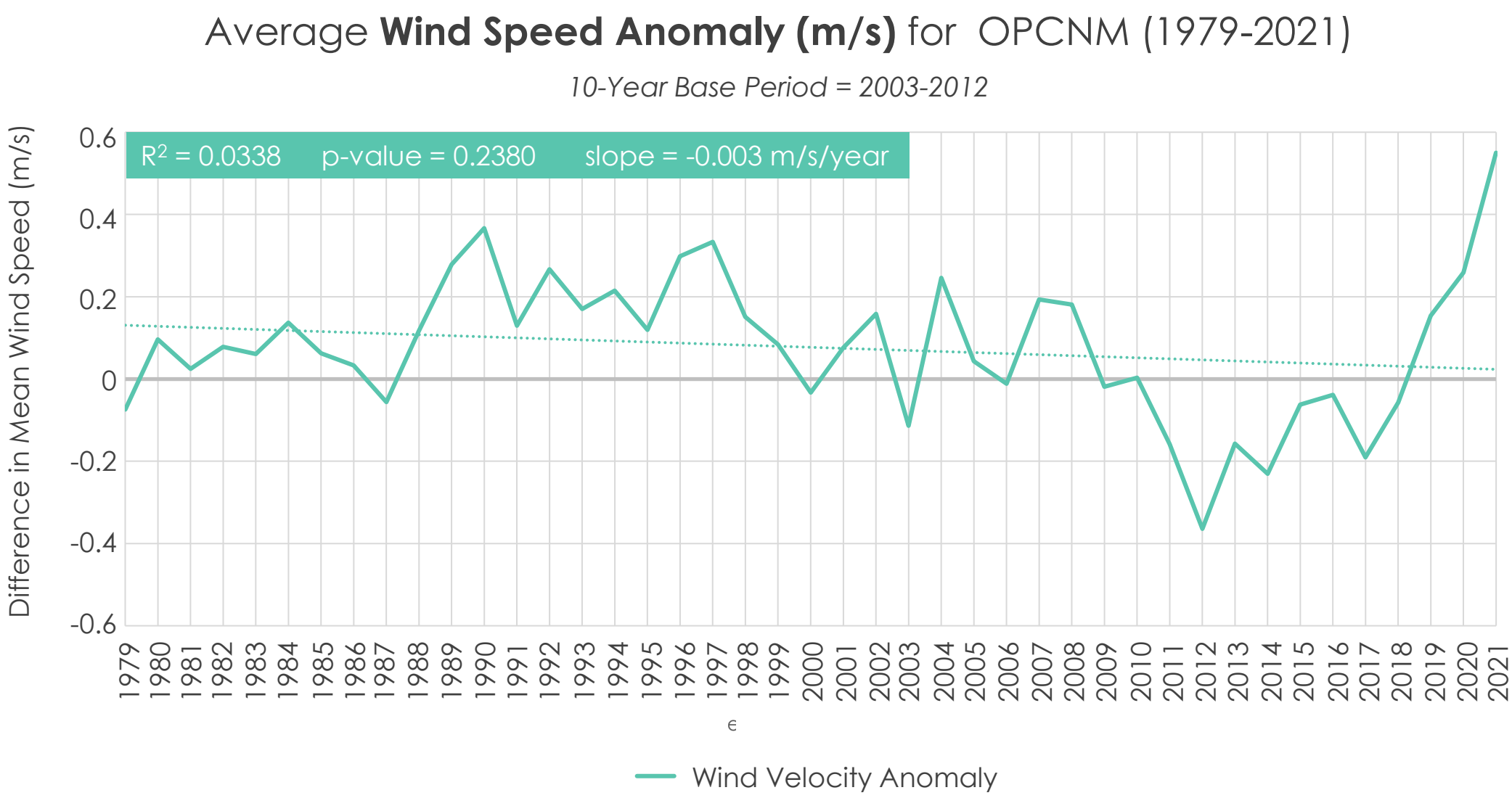

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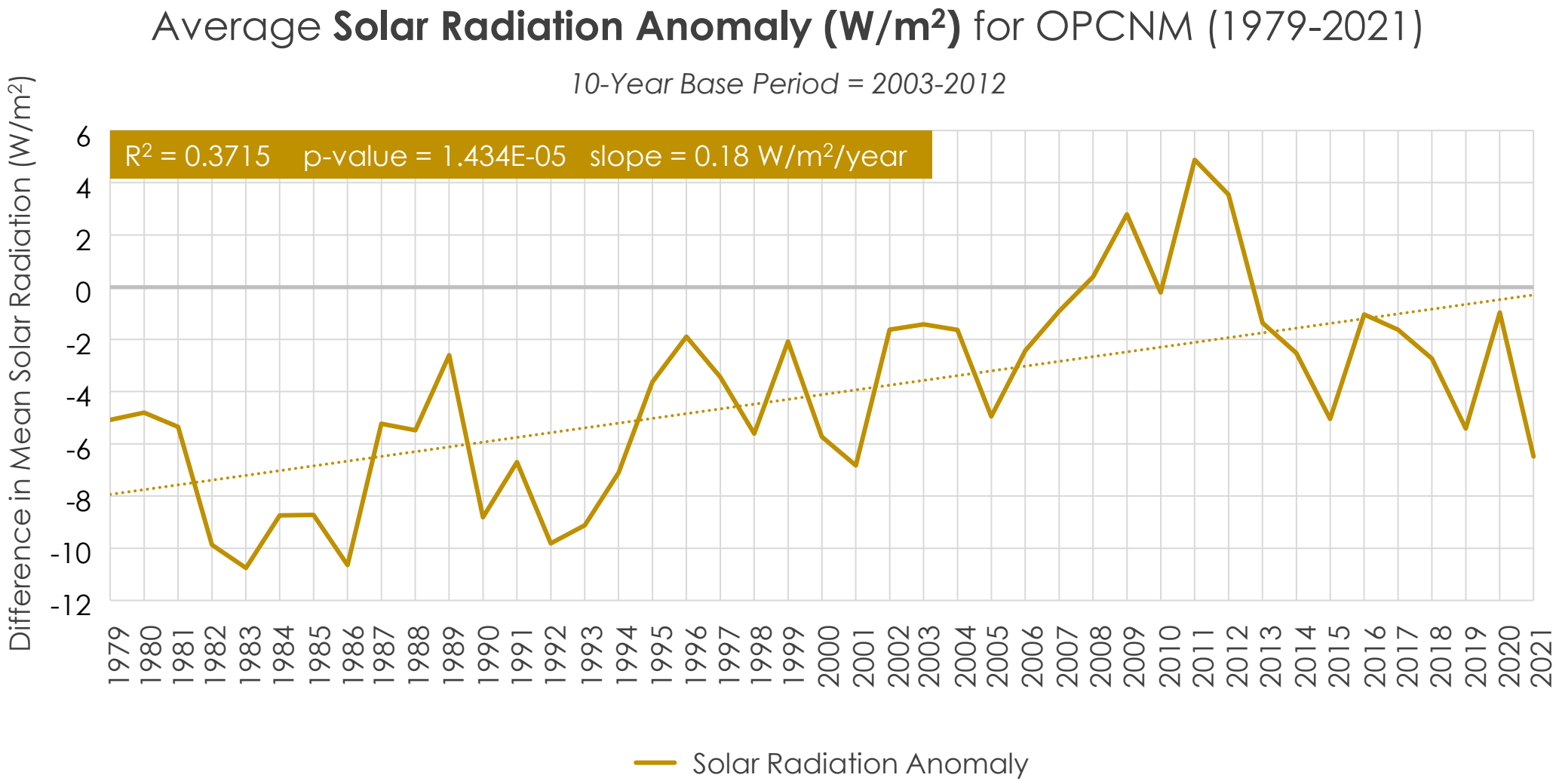
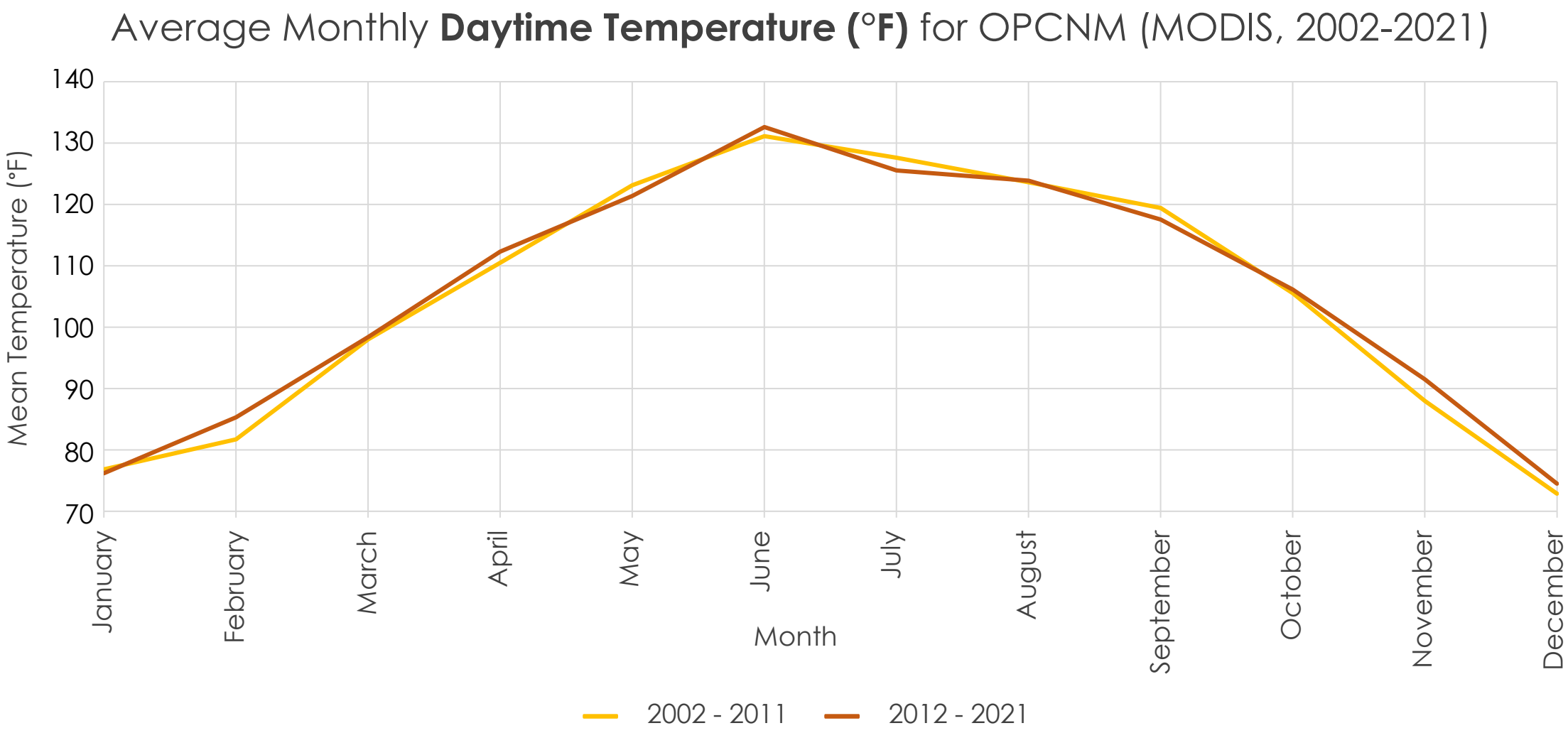


STACKED TIME SERIES



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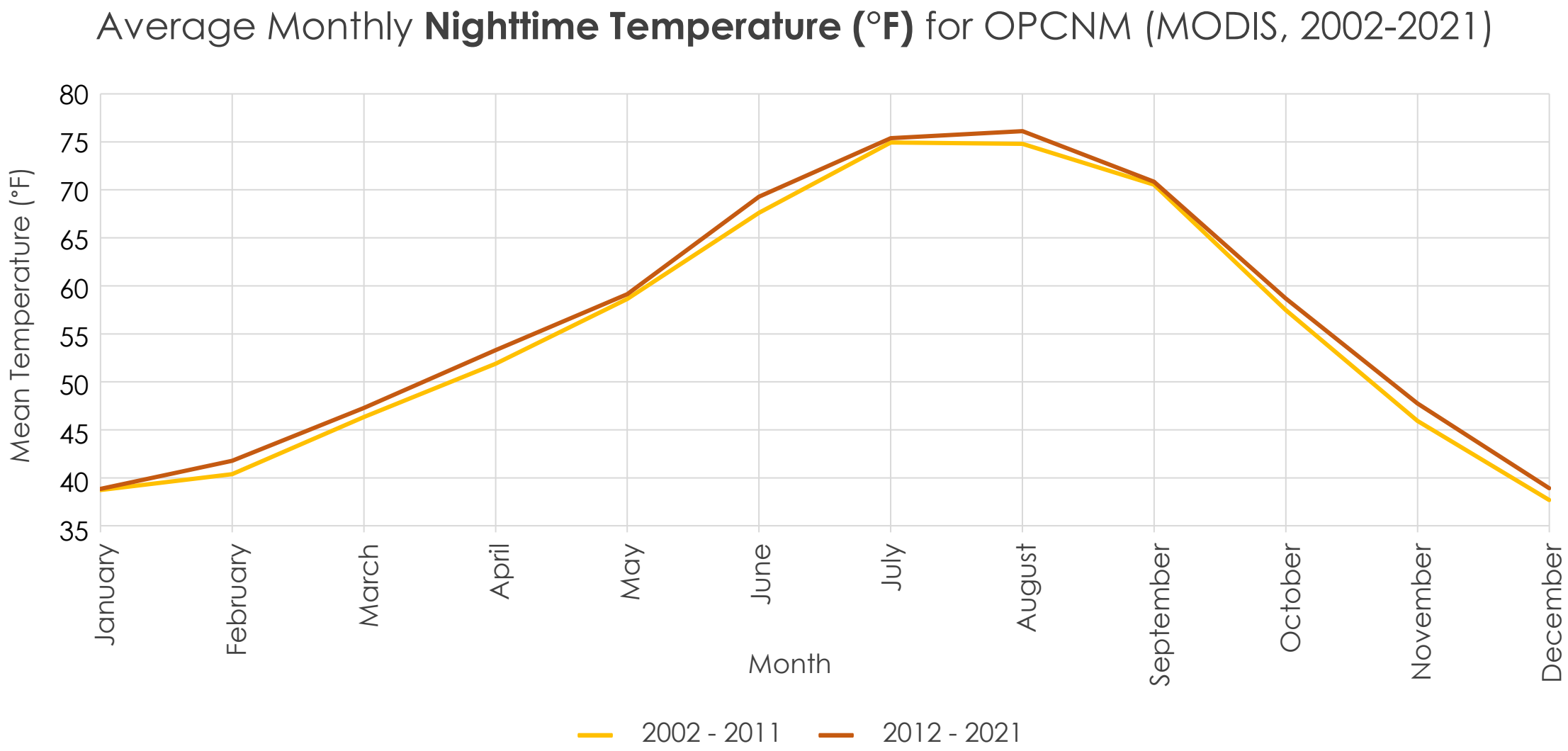

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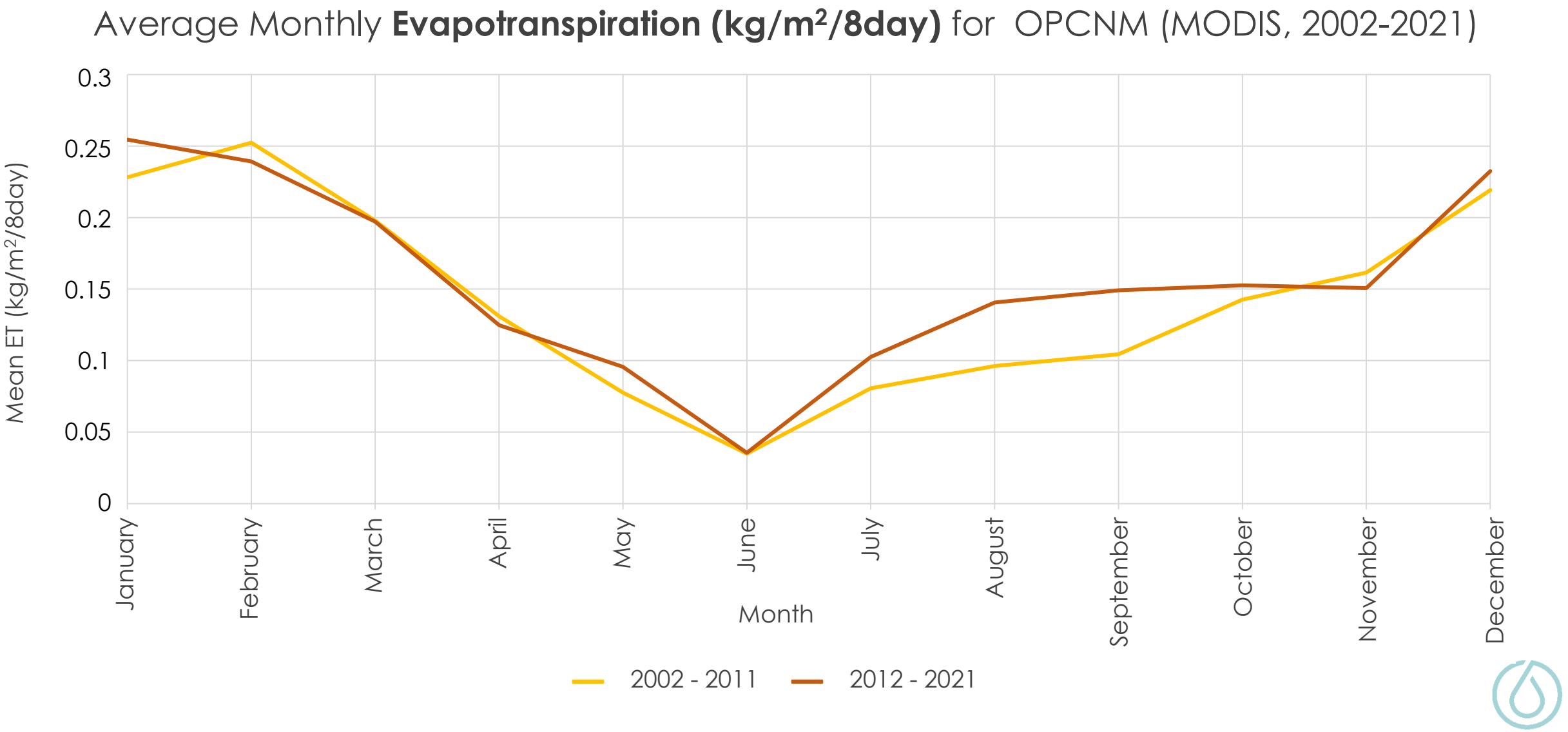

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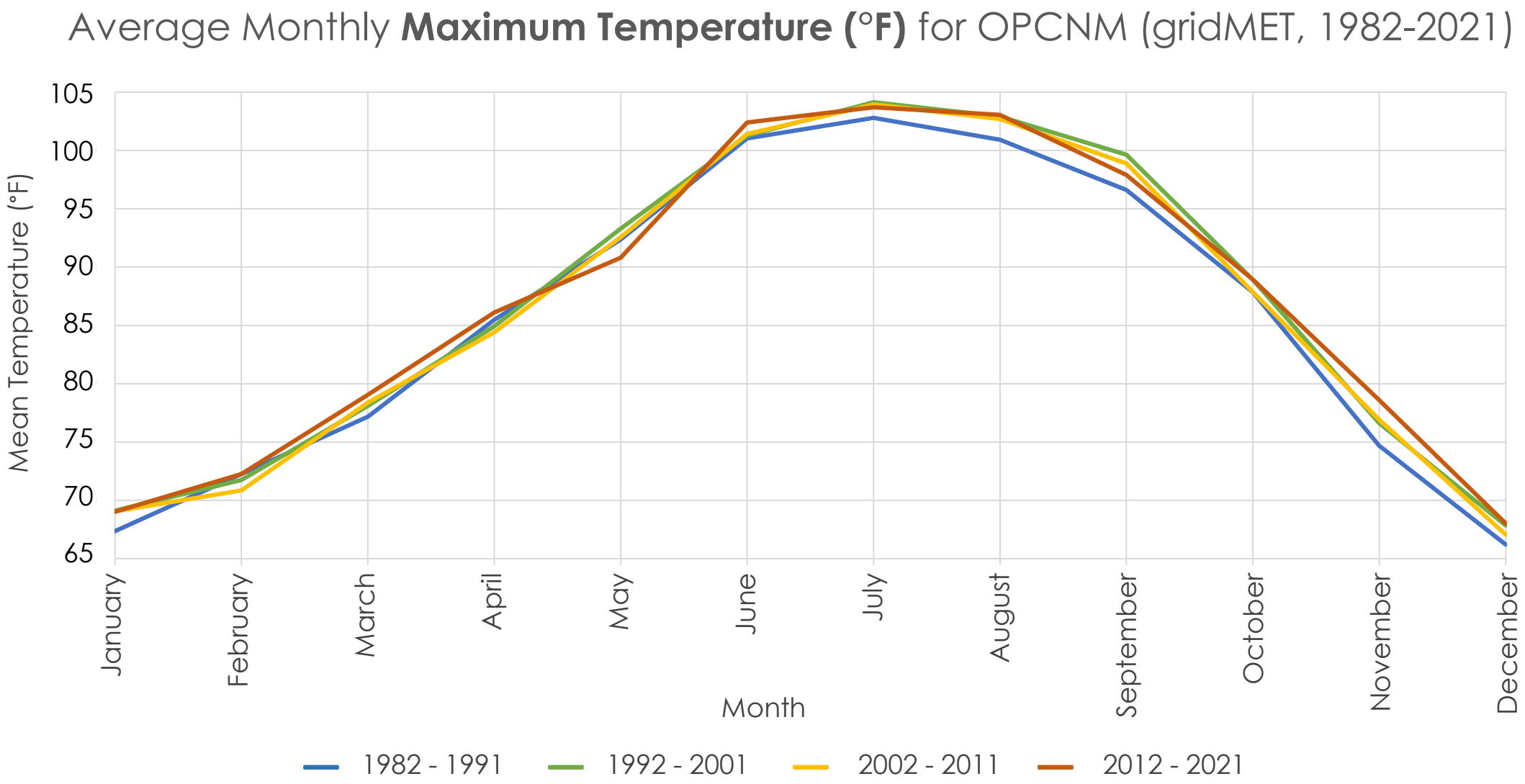

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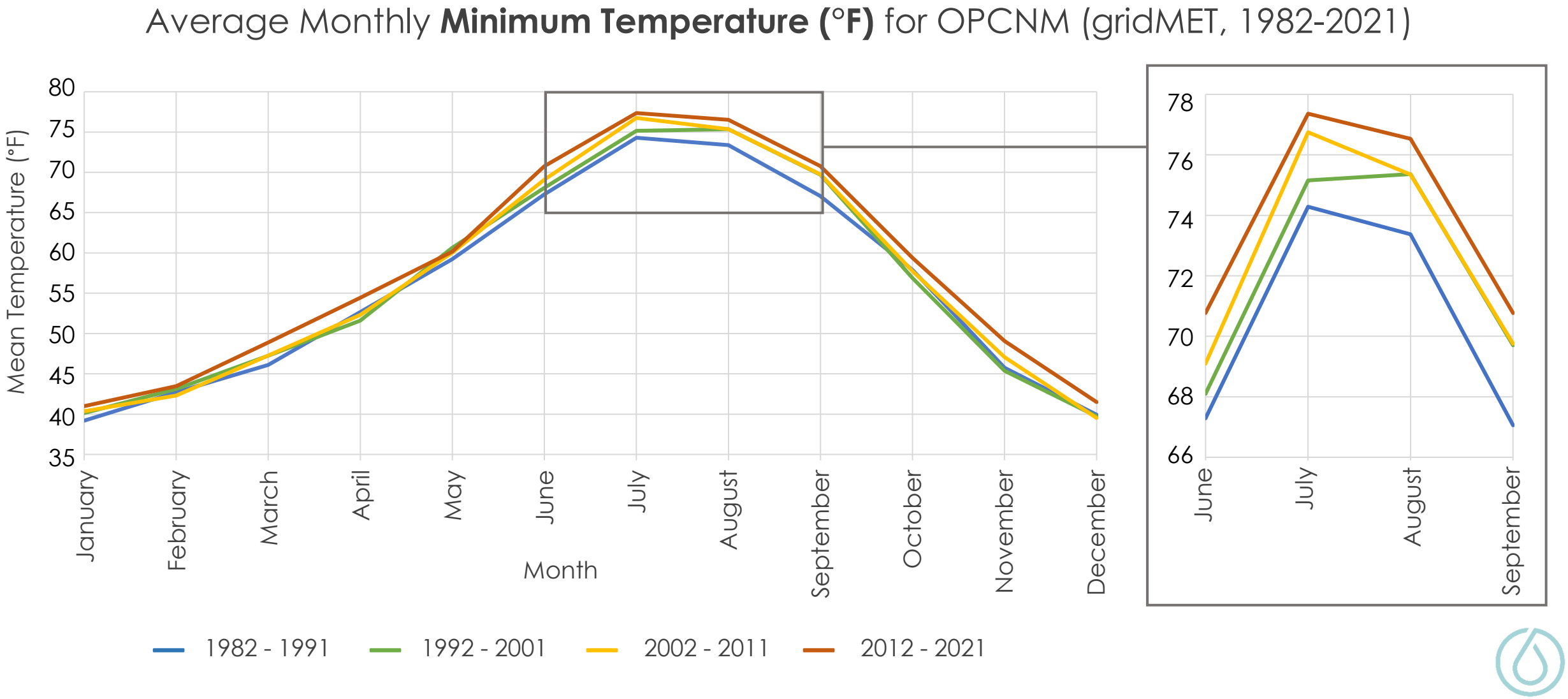

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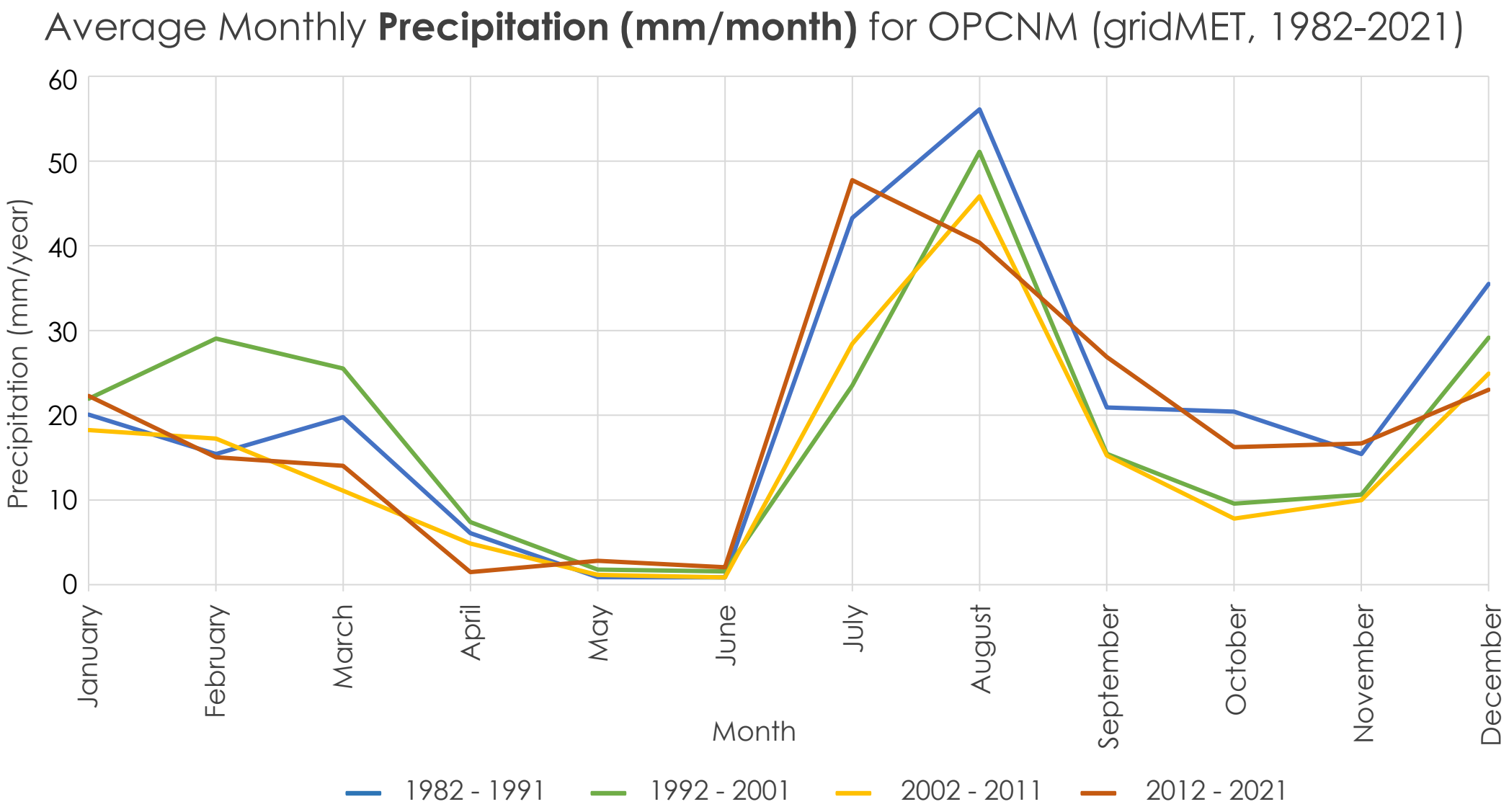

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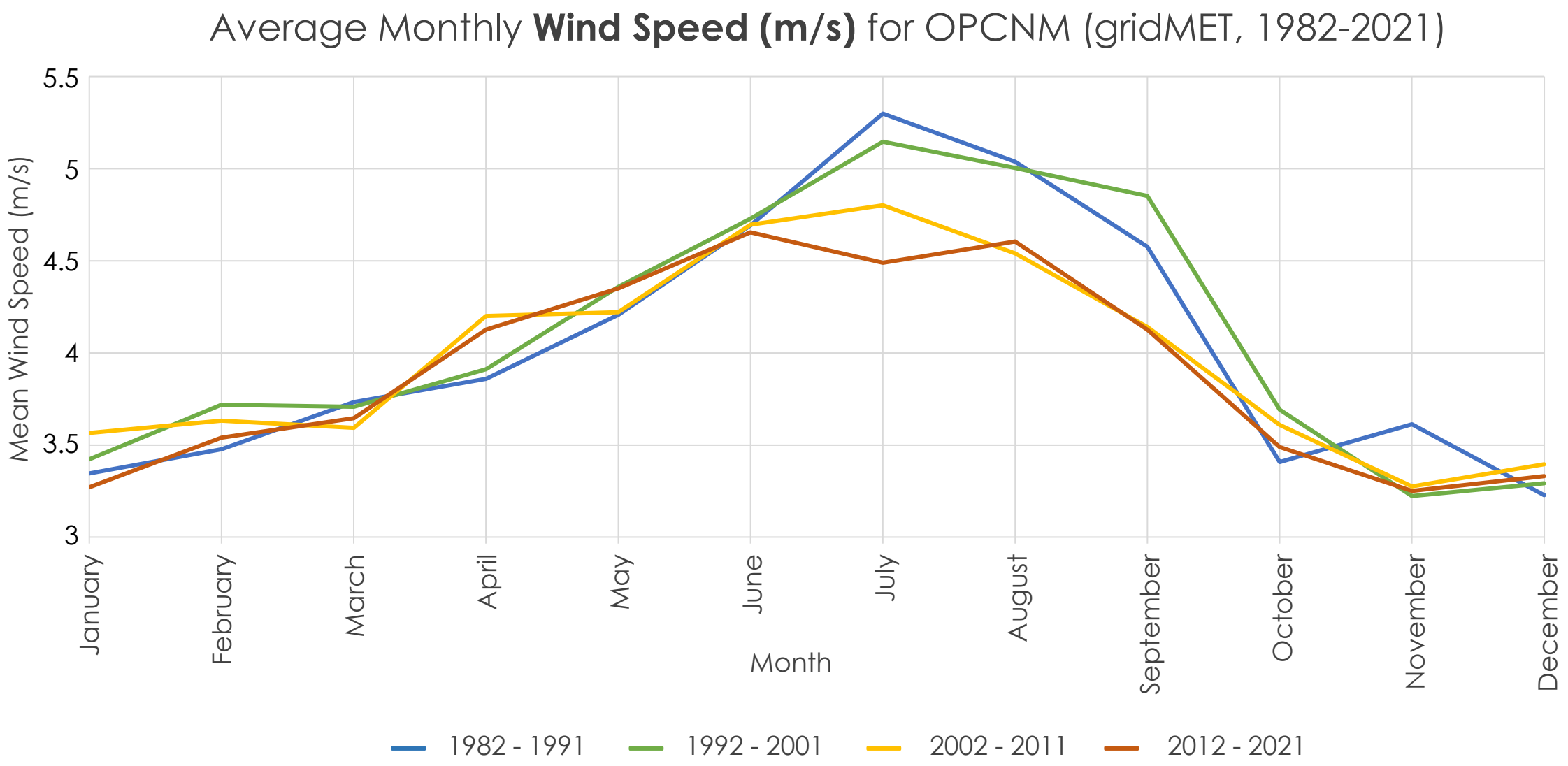

STACKED TIME SERIES

Average Monthly **Solar Radiation (W/m²)** for OPCNM (gridMET, 1982-2021)