

# Mapping PV Soiling from ground-measured PV data

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**NoSoilPV**

Novel Soiling Identification Logics for Photovoltaics  
***Awarded 2017 MSCA IF proposal***

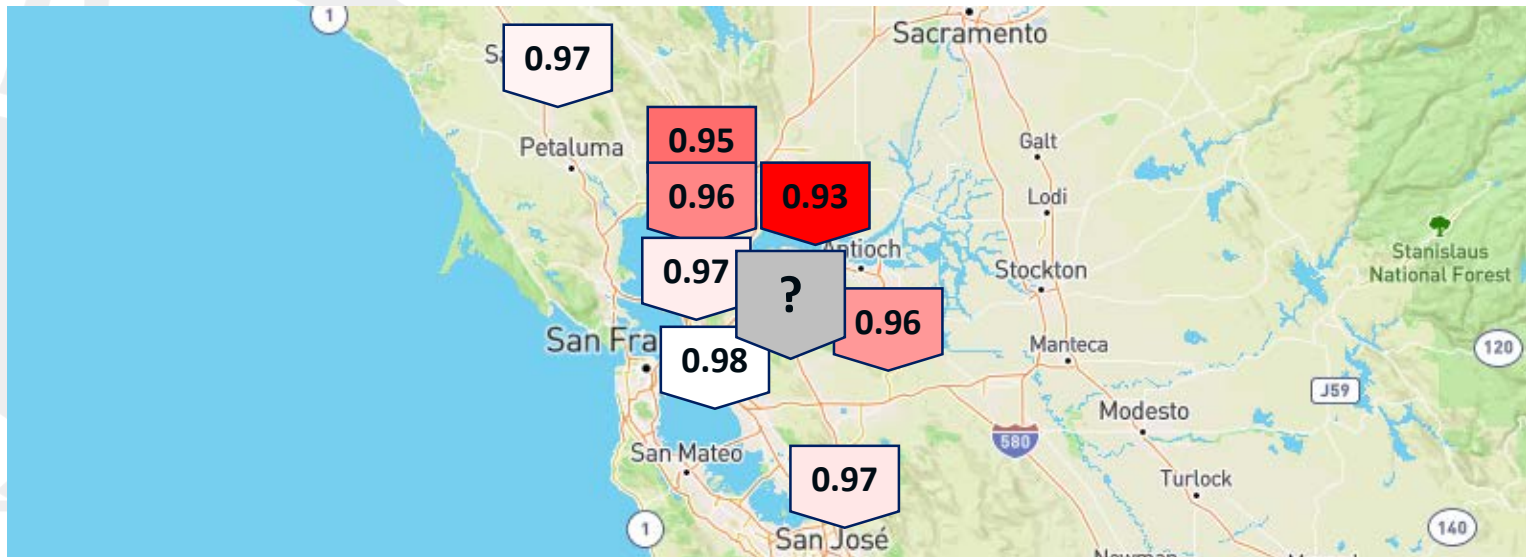
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Results presented in:

L. Micheli, M.G. Deceglie, M. Muller,  
IEEE J. Photovoltaics (2019).

# Mapping Soiling: Motivation

**Can we estimate soiling at a site given the soiling losses at sites nearby?**

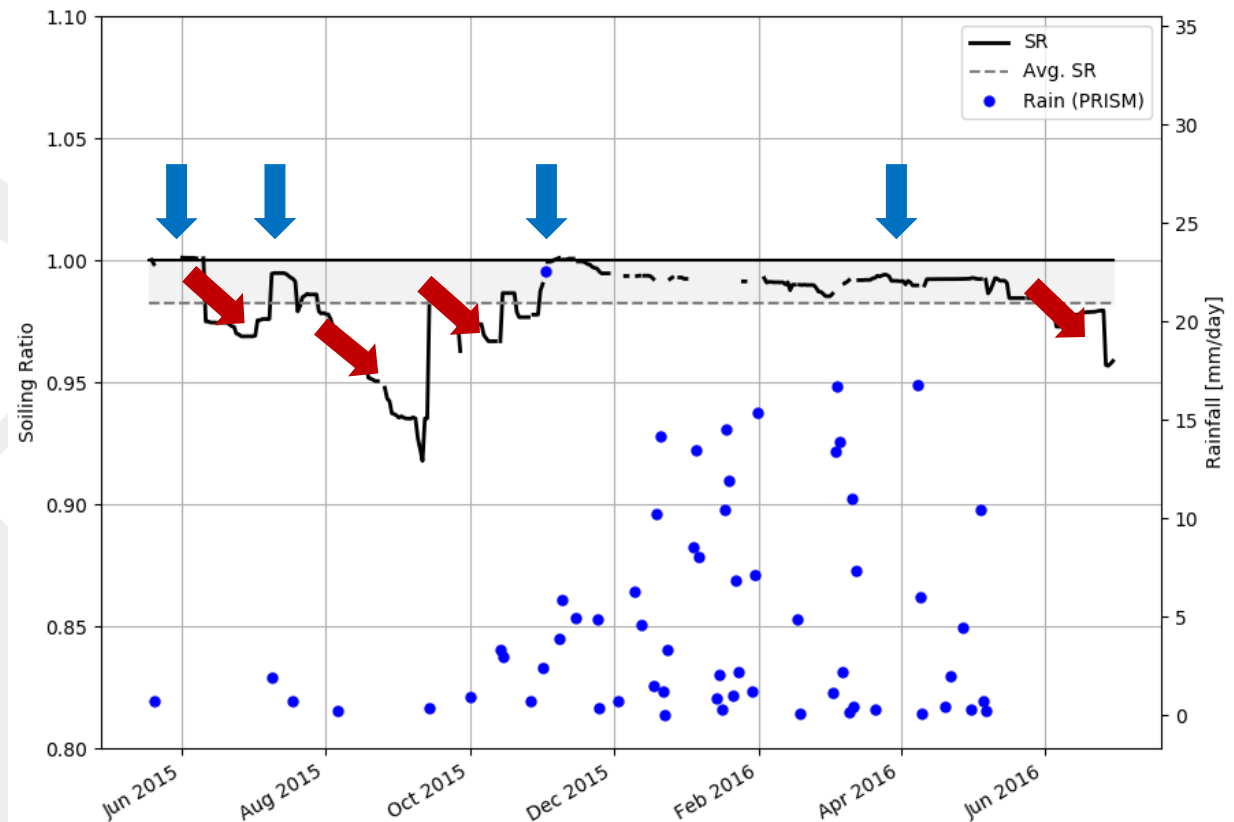


# Soiling: Soiling Ratio (SR)

Daily ratio between the electrical output of the soiled PV device and its electrical output in clean conditions.

**SRatio = 1**  
in clean conditions

**SRatio < 1**  
in presence of soiling



Micheli, L., Ruth, D., Deceglie, M.G., Muller, M., 2017. Time Series Analysis of Photovoltaic Soiling Station Data: Version 1.0, August 2017. Golden, CO.

# Mapping Soiling: Spatial Interpolation

## Soiling at site of interest

$$SR = \frac{\sum SR_{Sx} \cdot weight_{Sx}}{\sum weight_{Sx}}$$



Site of interest



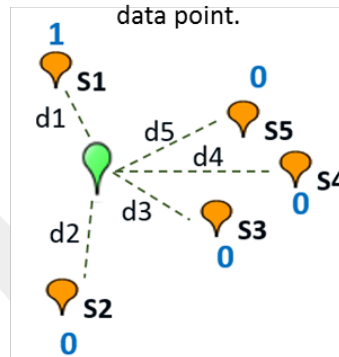
**Sx** Data point "Sx"

**dx** Distance between site and data point "Sx"

**1** Weight of station "Sx"

## Nearest Neighbor (NN)

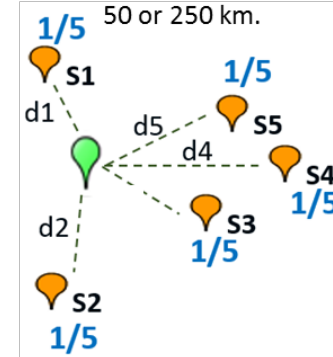
Value of closest soiling data point.



(S1 closest station)

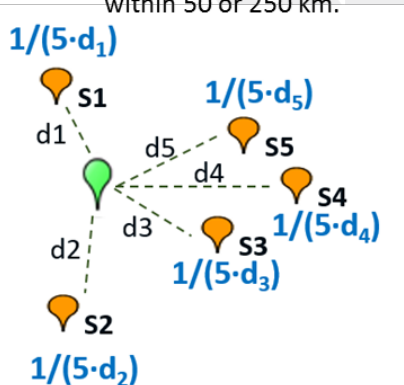
## Simple Average (SA)

Arithmetic average of data points within 50 or 250 km.



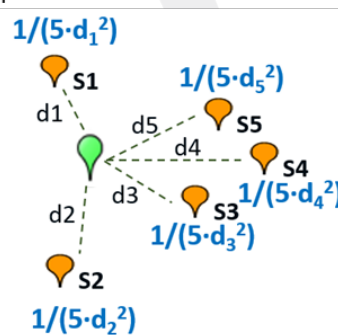
## Inverse Distance Weighting (ID)

Distance-weighted average of data points within 50 or 250 km.



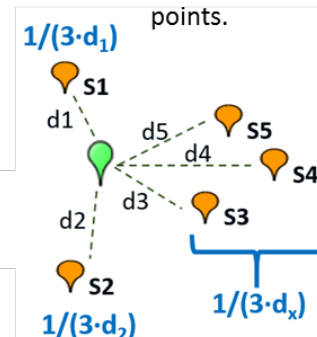
## Inverse Square Distance Weighting (ID2)

Square distance weighted average of data points within 50 or 250 km.



## Declustered Distance Estimation (DDE)

Average of data points within 50 or 250 km, weighted on distance from point of interest and distance from other data points.

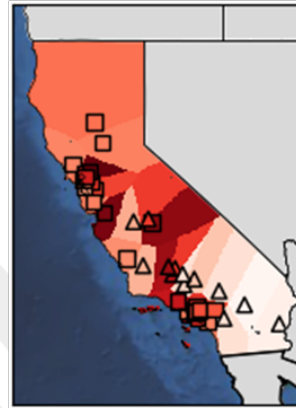


# Mapping Soiling: Spatial Interpolation

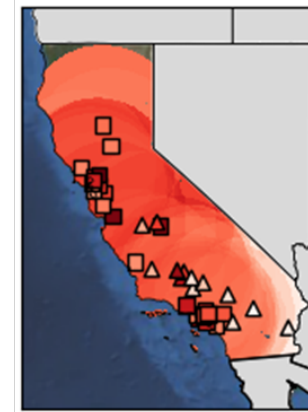
Simple Map



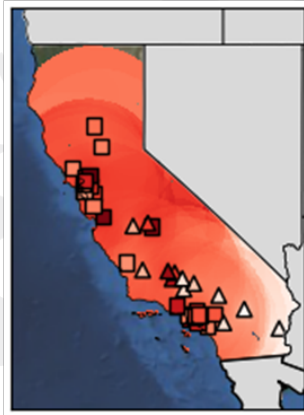
Nearest Neighbor (NN)



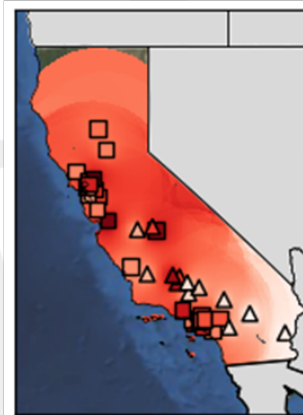
Simple Average (SA)



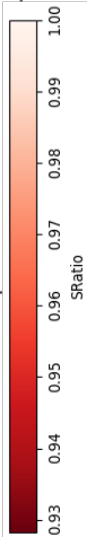
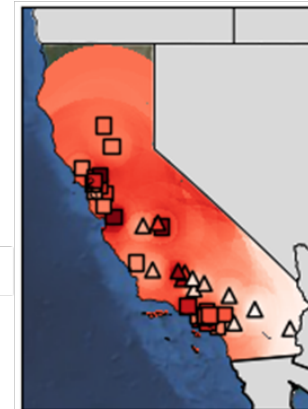
Inverse Distance Weighting (ID)



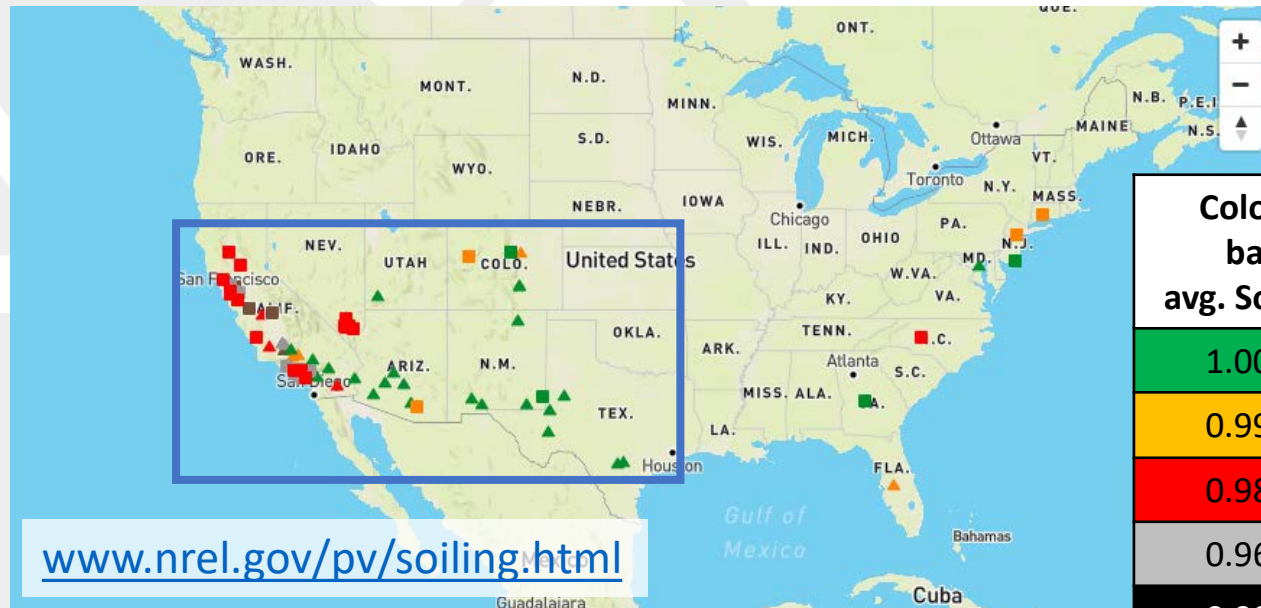
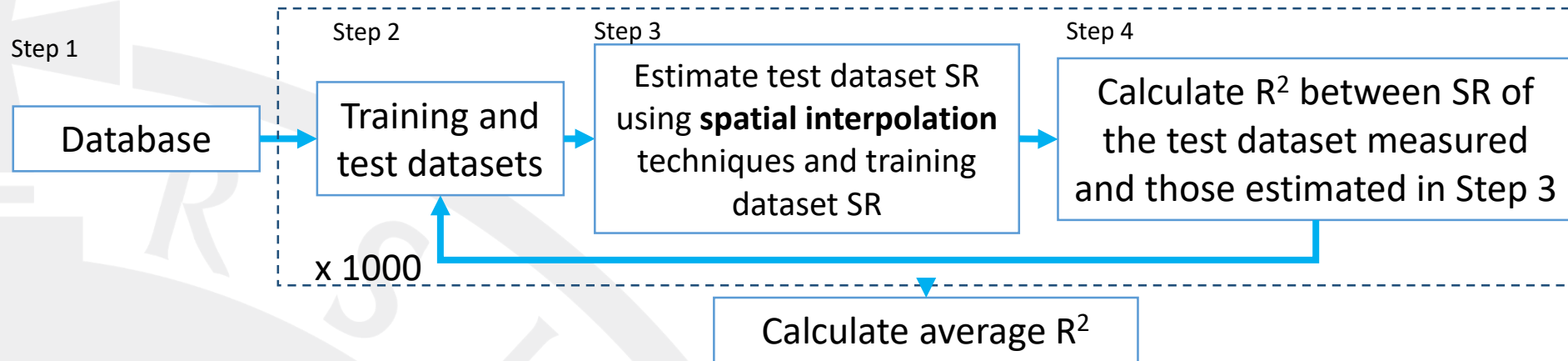
Inverse Square Distance Weighting (ID2)



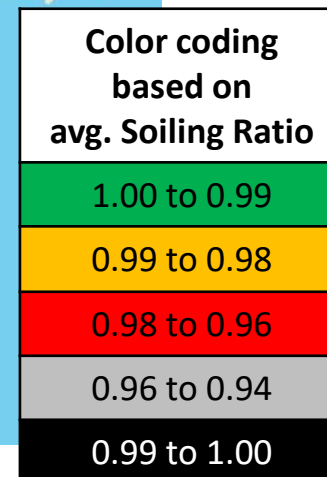
Declustered Distance Estimation (DDE)



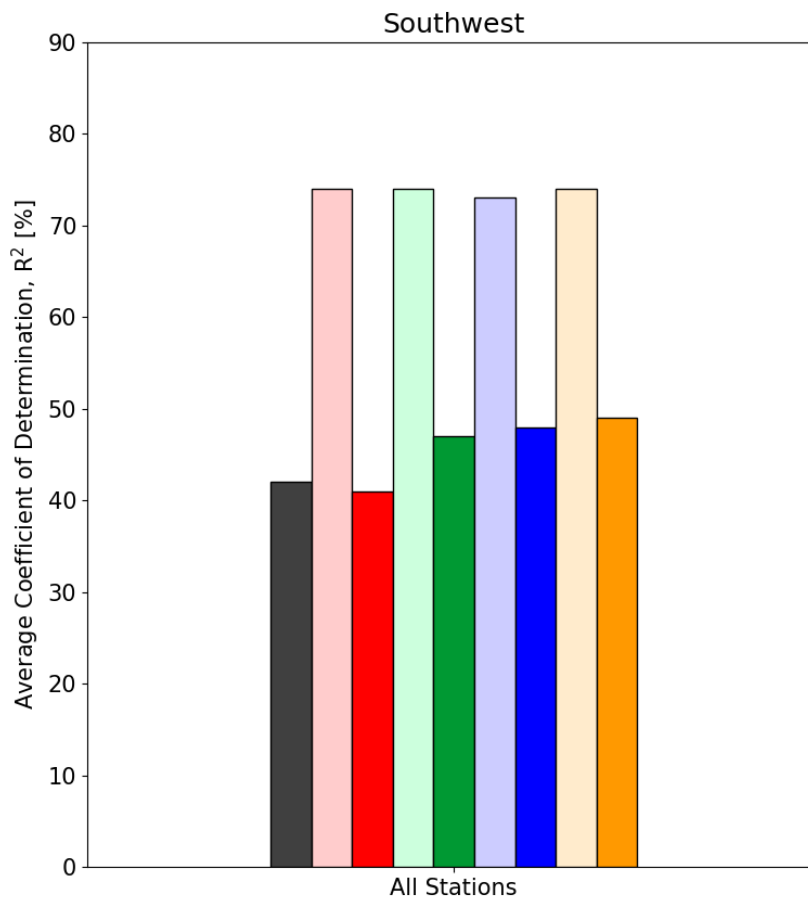
# Mapping Soiling: Methodology



Data Sourced from the  
NREL Soiling Map  
(34 soiling stations in the  
SW)



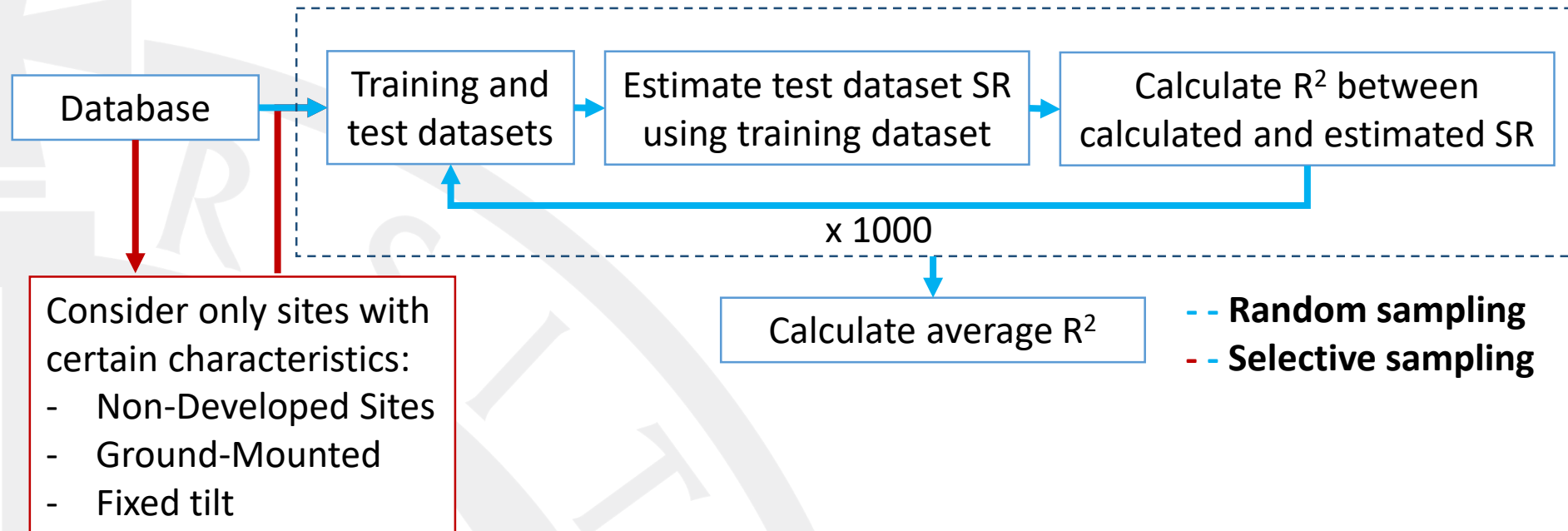
# Mapping Soiling: Results



- Nearest Neighbor (No max distance)
- Spatial Averaging (< 50 km)
- Spatial Averaging (< 250 km)
- Inverse Distance Weighting (< 50 km)
- Inverse Distance Weighting (< 250 km)
- Inverse Squared Distance Weighting (< 50 km)
- Inverse Squared Distance Weighting (< 250 km)
- Declustered Distance Estimation (< 50 km)
- Declustered Distance Estimation (< 250 km)

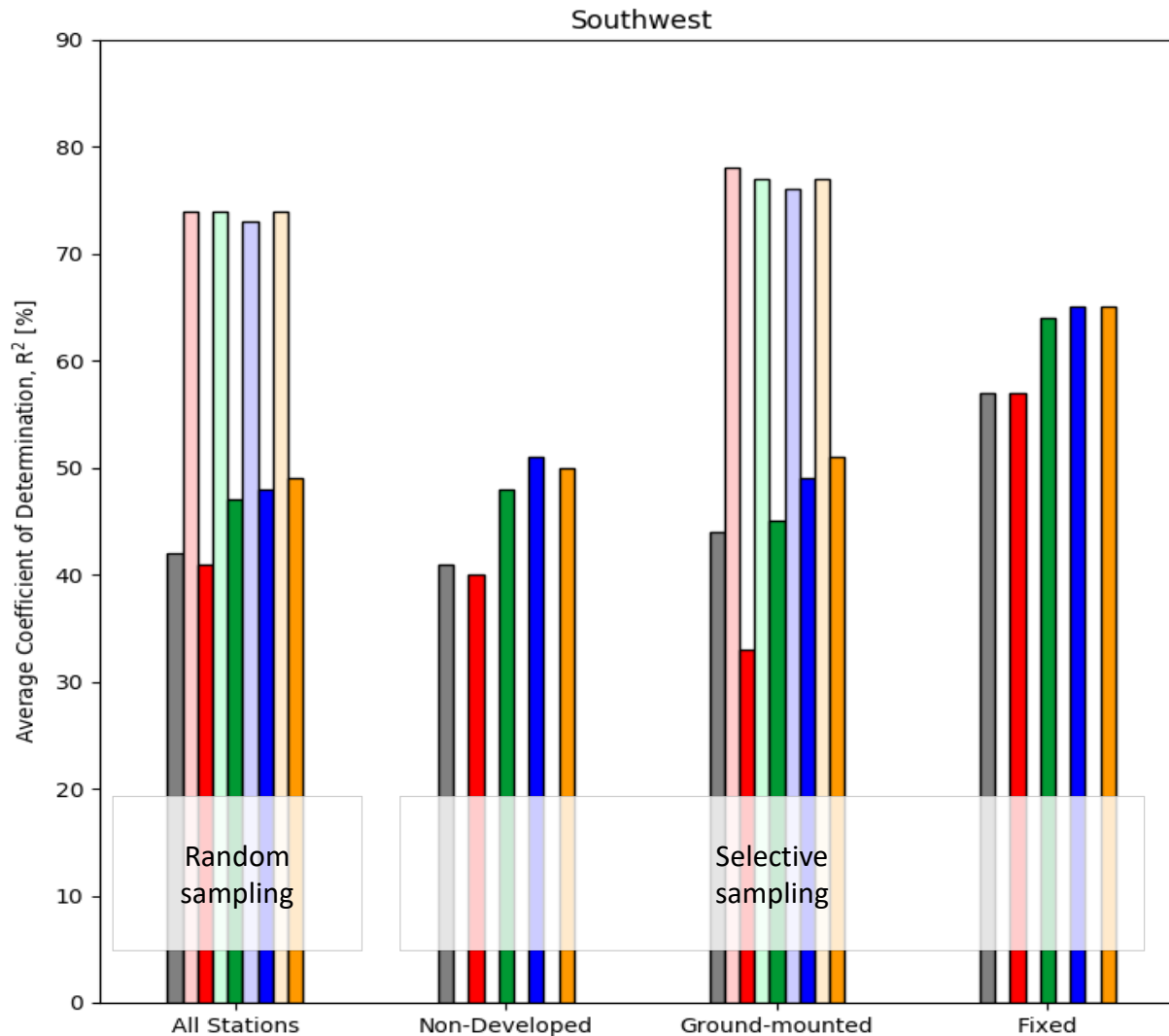
- Maximum  $R^2$  of **74%**, if data points are available within 50 km; otherwise, **46%**.
- Spatial interpolation techniques perform better than Nearest Neighbor.

# Mapping Soiling: Selective Sampling





# Mapping Soiling: Results



- The best results for shorter distances (lighter colors).  $R^2$  as high as **78%**.
- For larger distances, the site selection shows the ability to improve the  $R^2$  of the correlations **by up to 25%**.

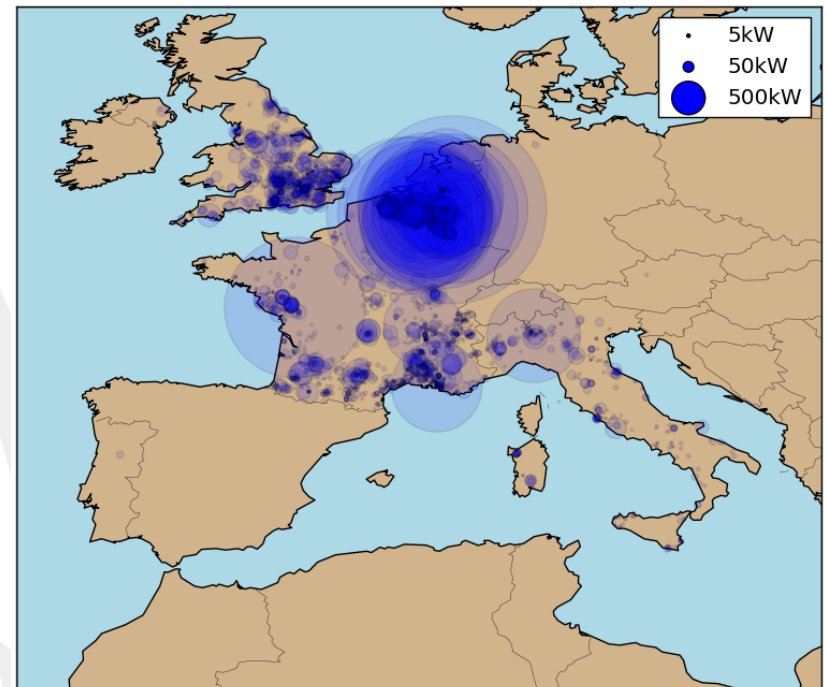
# Mapping Soiling: Conclusions

If no PV or soiling data are available, soiling can be estimated by using **data from nearby locations**.

**Spatial interpolation techniques** can be used to quantify soiling if soiling data are available nearby. The best results are obtained if soiling data are **available nearby (< 50 km)** and/or if a selective sampling is performed.

This investigation is being extended by using PV performance data measured for different sites in Europe.

P  A R L P V



# Thanks for your attention

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[www.nosoilpv.com](http://www.nosoilpv.com)

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