High-Resolution Mapping of Renewable Energy Sources

Eversource Energy Center Workshop

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The Team

PI: Manos Anagnostou

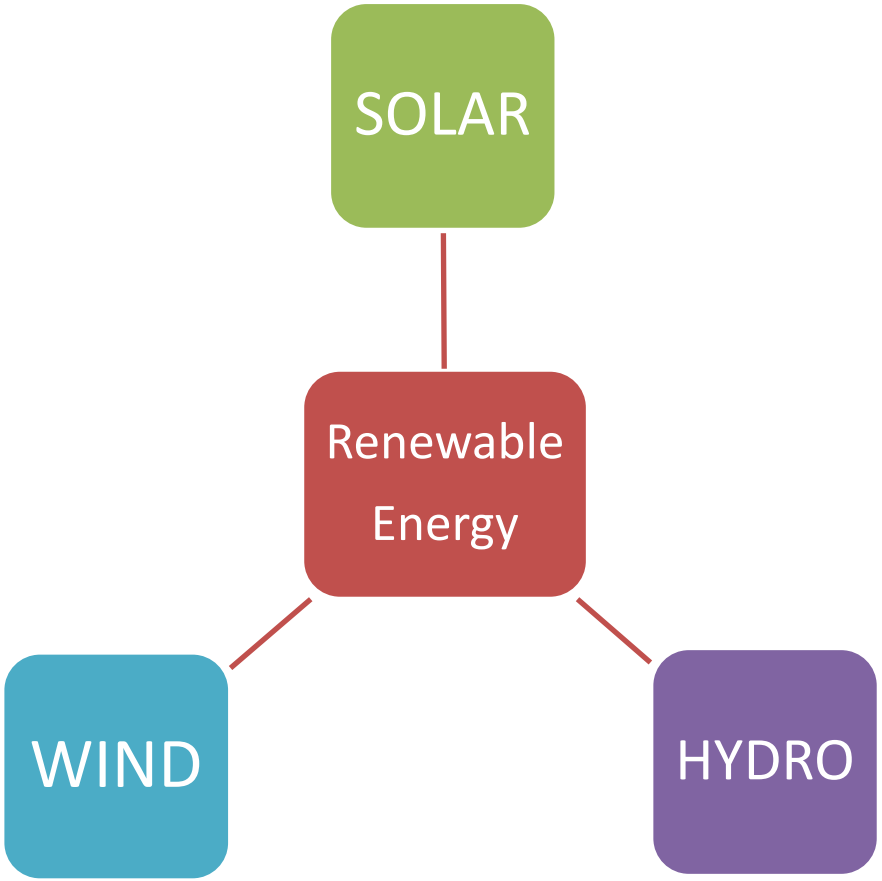
Co-I: Efthymios Nikolopoulos

Co-I: Baptiste François

Stergios Emmanouil

Genevieve Rigler

Motivation



- How much?
- How they vary?
- How can they be combined?

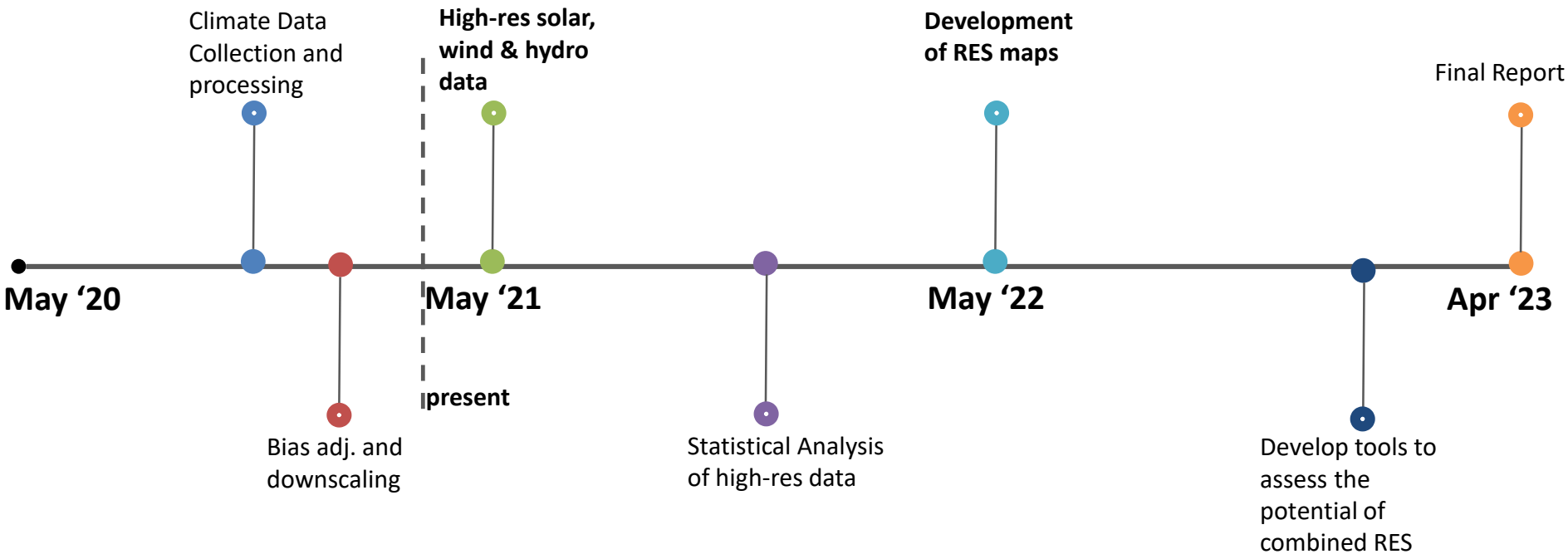
Objective

Goal: *Quantify the potential energy from **Solar**, **Wind** & **Hydro** across the entire state of Connecticut*

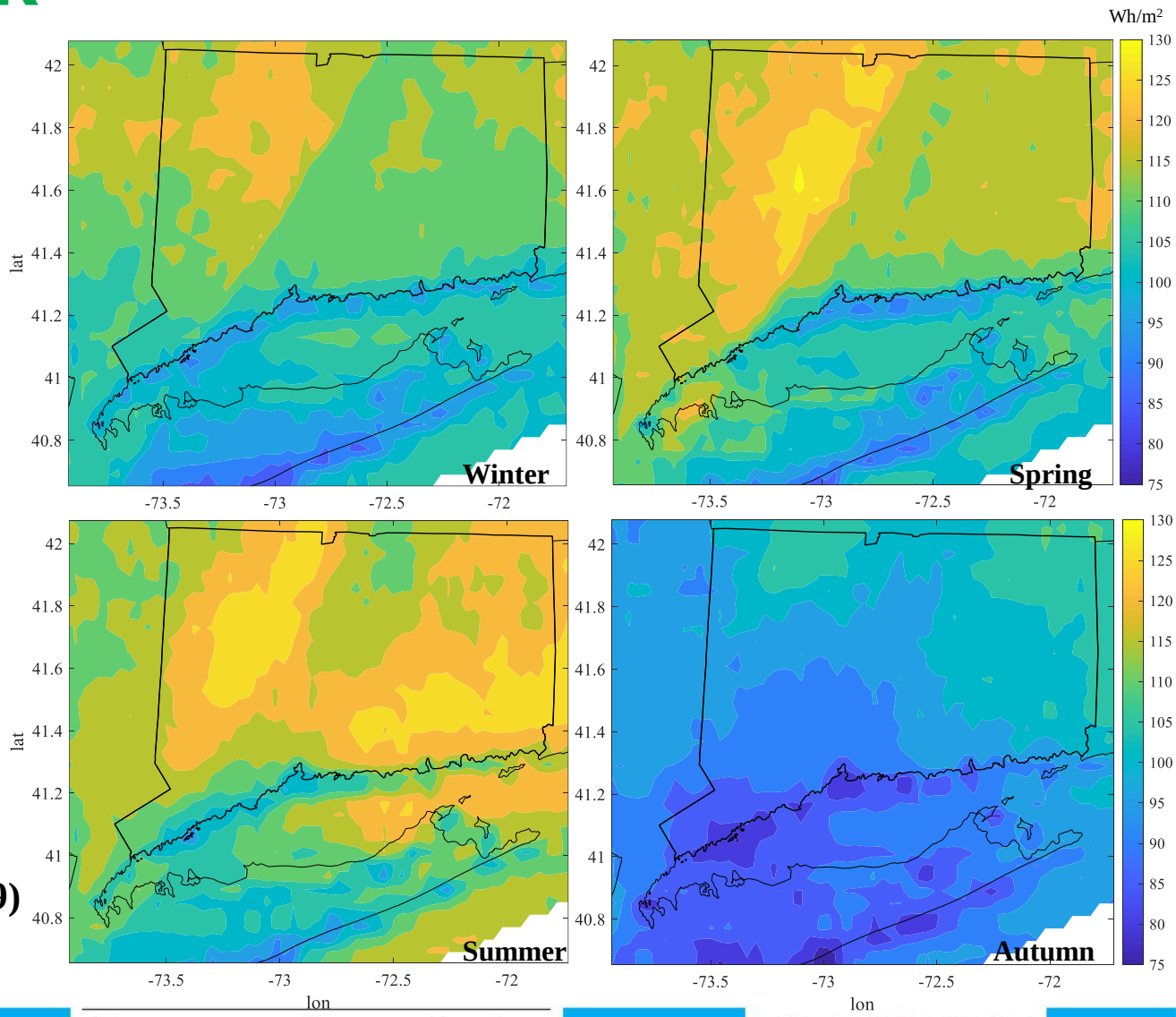
Specific Objectives

- Development of a long record (>30yrs) of solar and wind at high spatial resolution for CT.
- Estimation of potential energy from RES at different temporal scales and generation of GIS layers.
- Development of tools to assess optimal combination of RES.

Timeline of Deliverables



Sneak Peak



POA Solar Irradiance (2011-2019)
Perez Diffuse Model (1990)

Thank you

Appendix

Steps Completed

Data collection:

- ERA5 solar radiation data from 1979-present.
- NSRBD solar radiation data from 2011-present.
- ERA5 wind velocity data from 1979-present.
- ERA5 temperature data from 1979-present.
- RTMA u-component and v-component of wind from 2014-present.

Preliminary Results on Solar Energy Potential:

- Statistical downscaling scheme to extrapolate NSRDB back to 1979
- 4-km maps of solar irradiance across Connecticut
- Wind turbine identification for evaluation of power for onshore and offshore locations.

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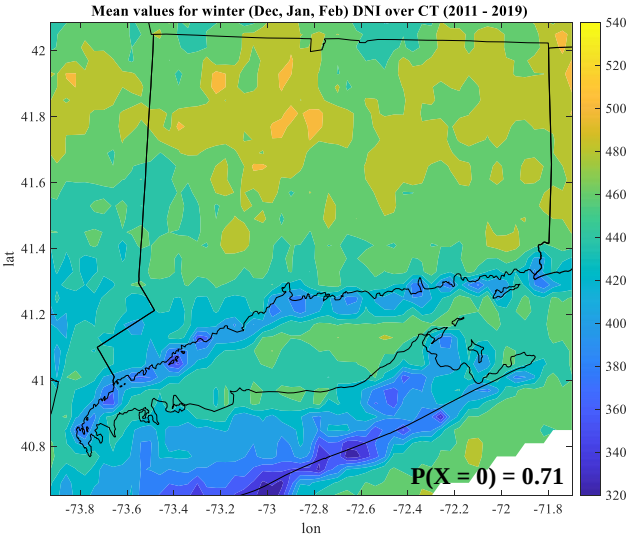
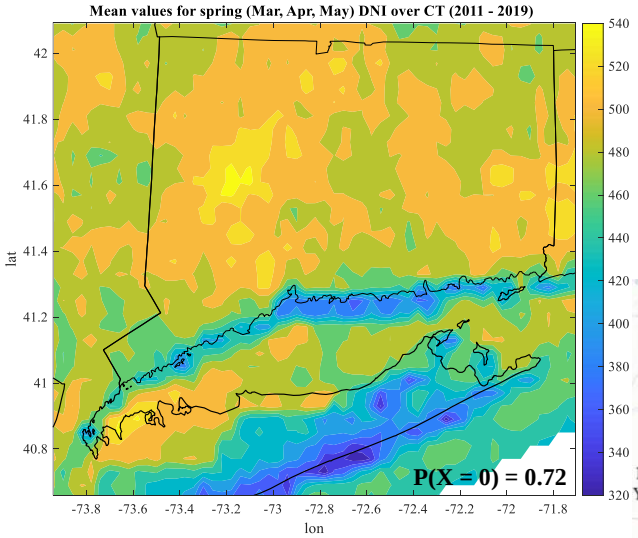
Ongoing Activities

- Creation and employment of a statistical downscaling scheme to extrapolate high resolution RTMA wind data back to 1979.
- Software creation for wind field derivation across Connecticut, including offshore areas, where wind farms are planned.
- 2.5-km map creation for wind power generation potential (stretching back to 1979).
- State-wide evaluation of wind characteristics, namely:
  i. hourly, monthly, and daily wind velocity,
  ii. seasonal, and annual wind velocity,
  iii. wind velocity distribution function
- Incorporation of the Run-of-River (RoR) scheme, where and when available, to supplement solar and wind power.
- Investigation of an optimized utilization of variable renewable energy sources, towards the minimization of the deficit between energy production and usage.

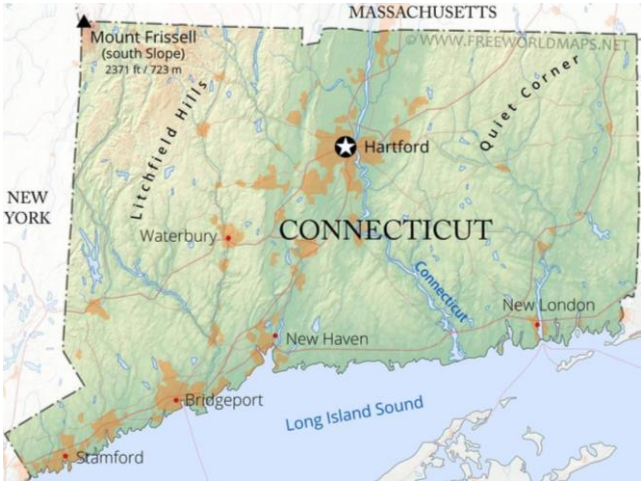
Solar Radiation Components and the Perez Sky Diffuse Model



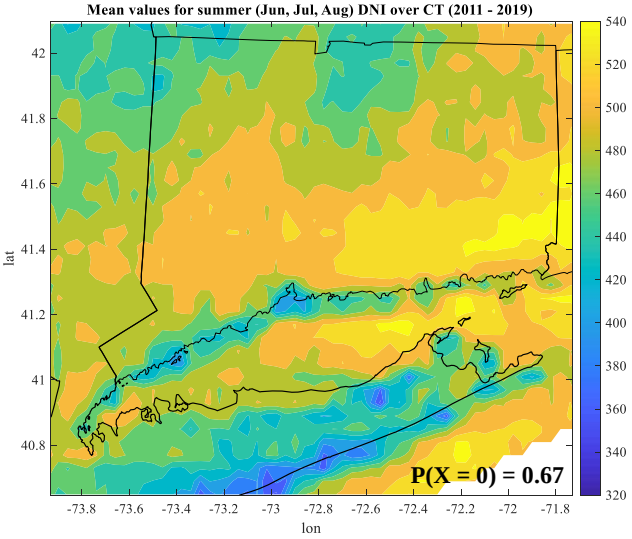


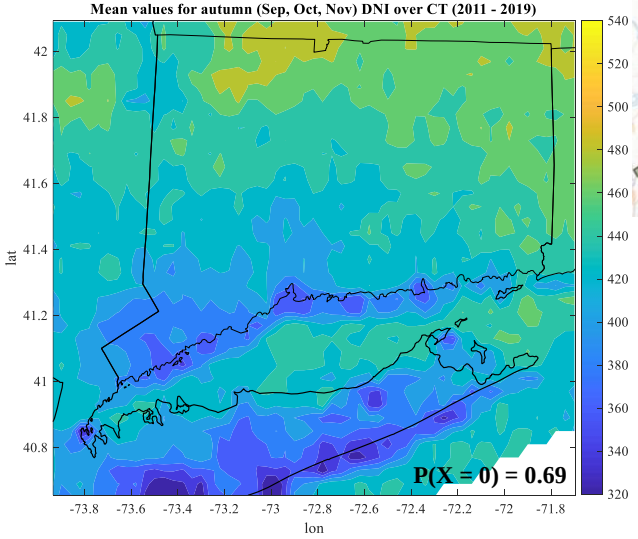
NREL's NSRDB (hourly, 4-km grid)

Wh/m^2



Wh/m^2





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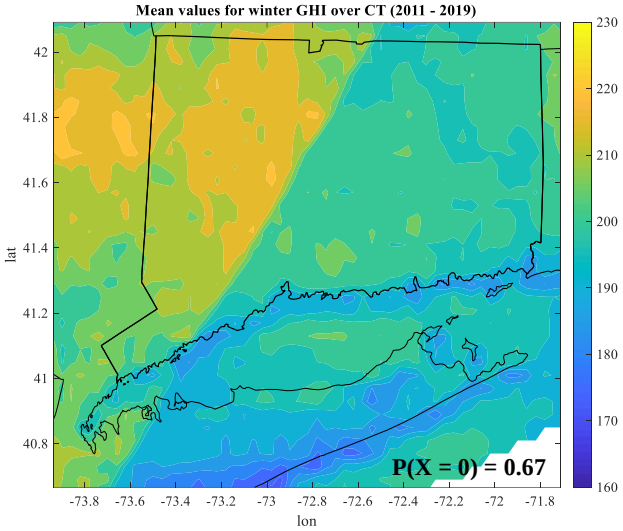
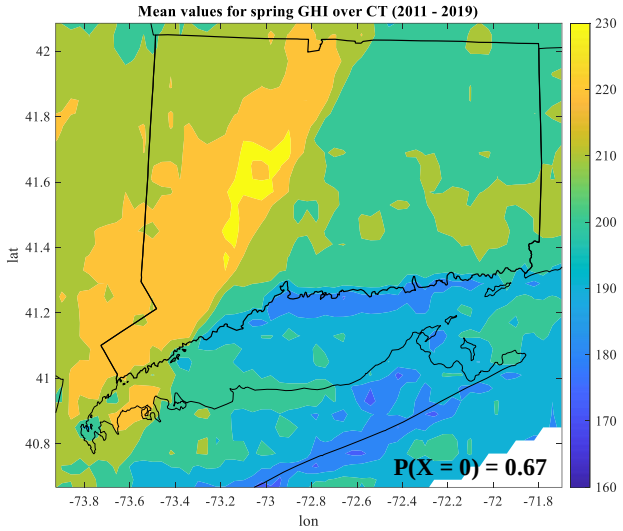
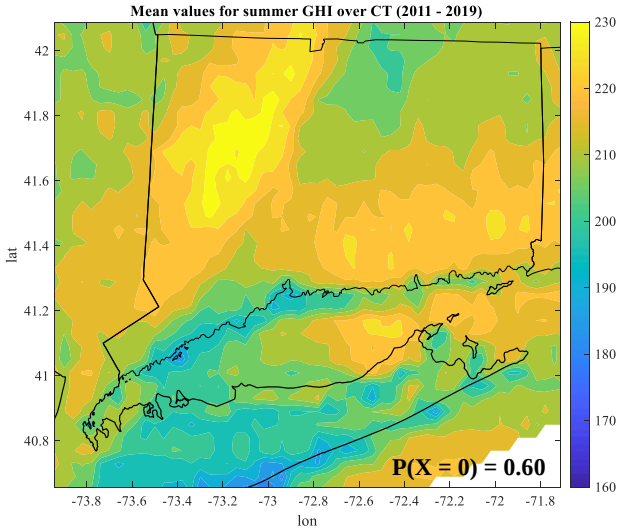
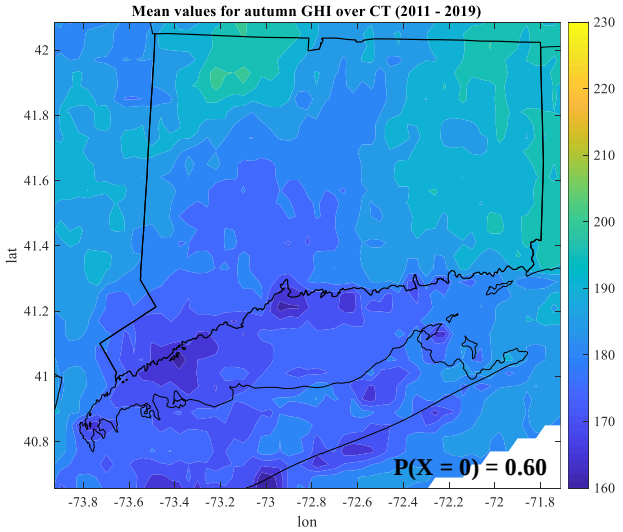


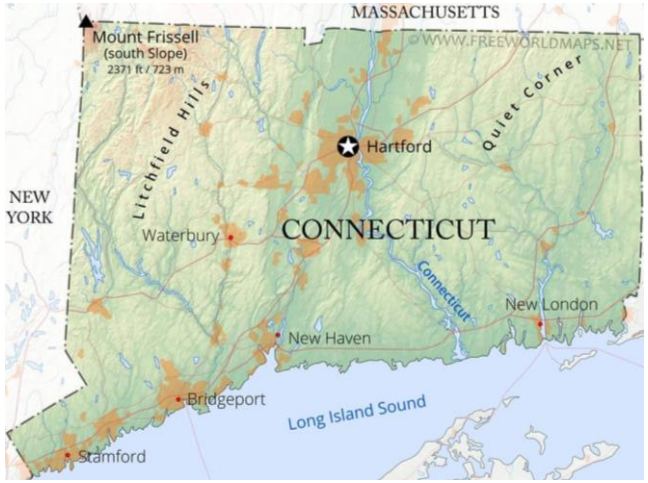






NREL's NSRDB (hourly, 4-km grid)

Wh/m²



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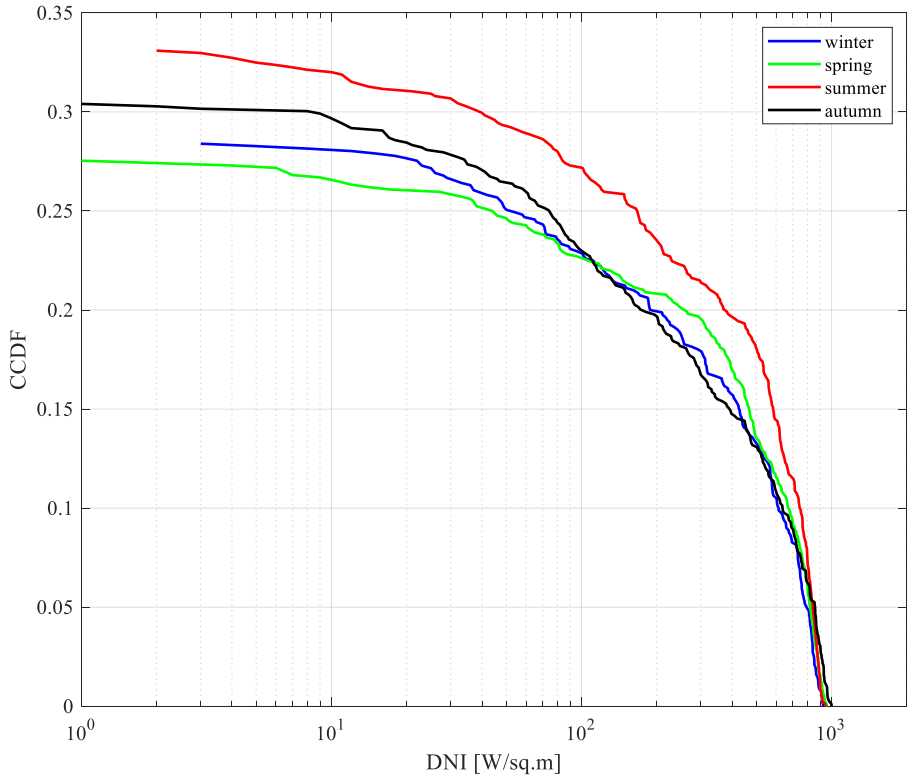
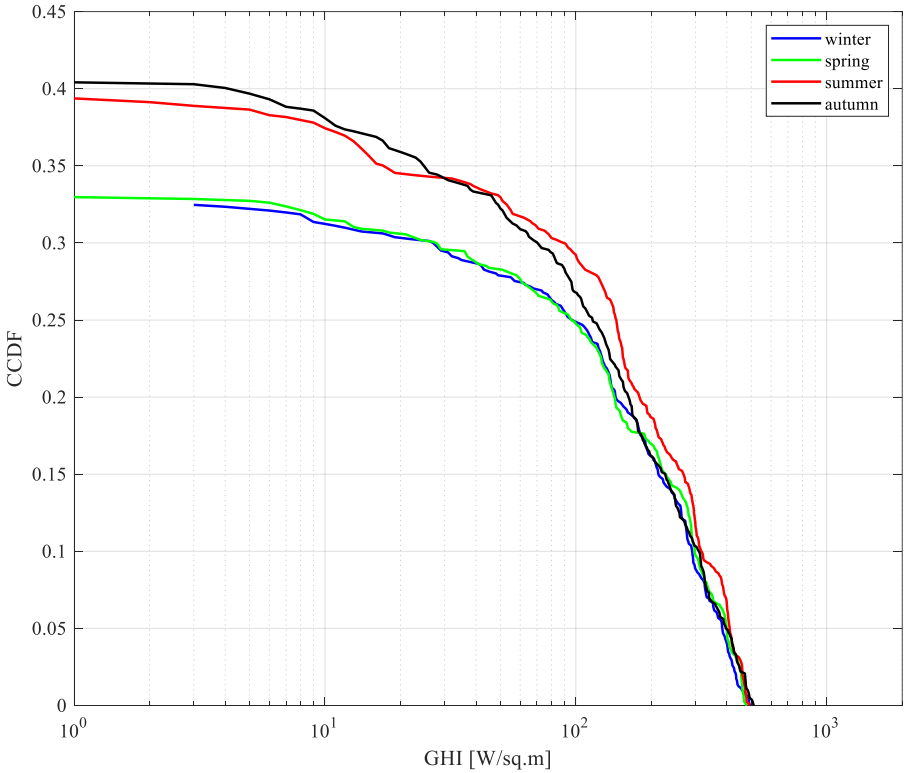
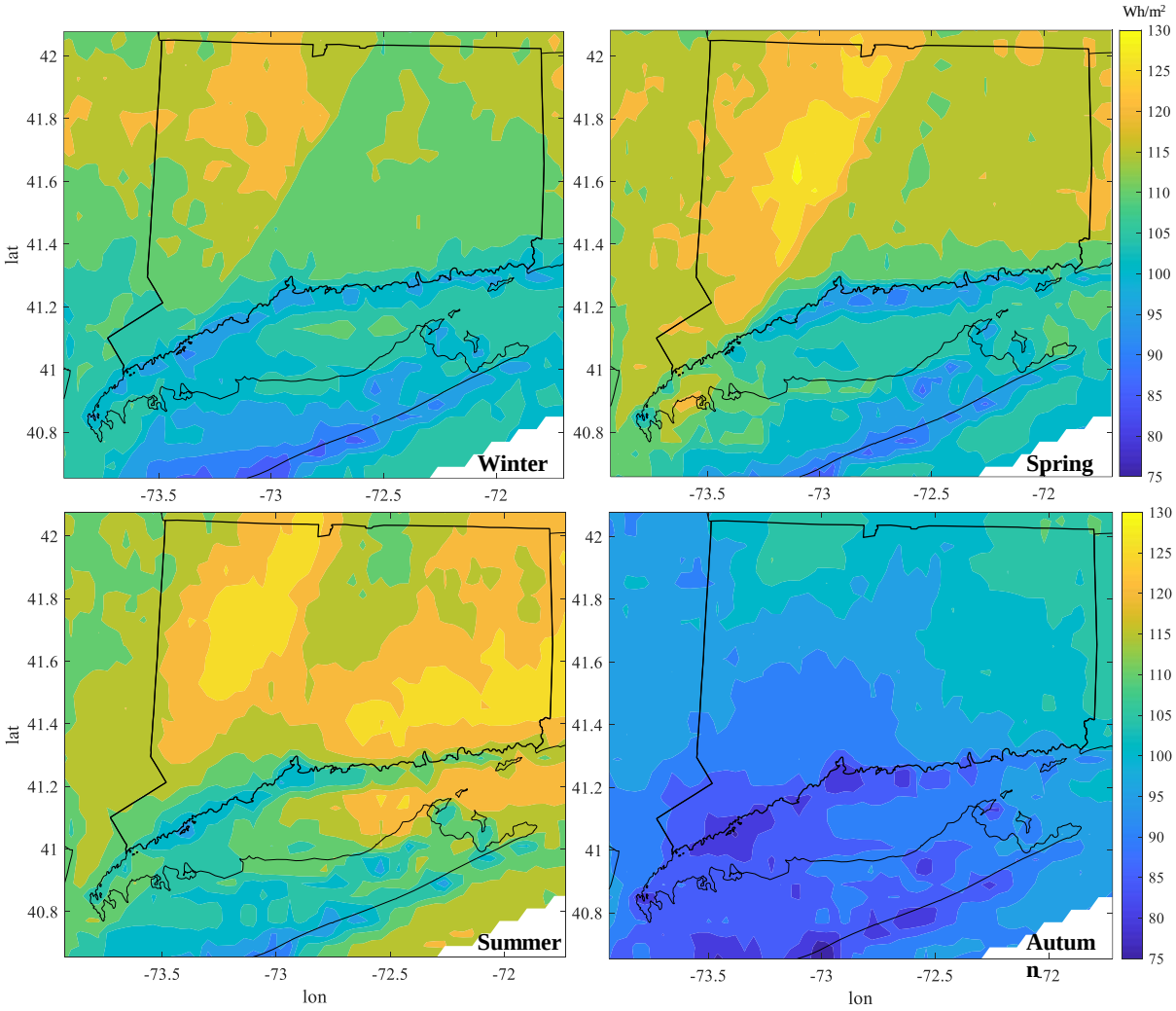
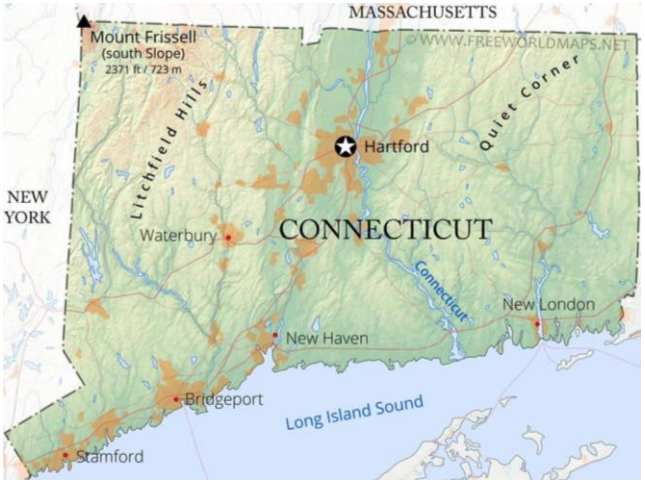
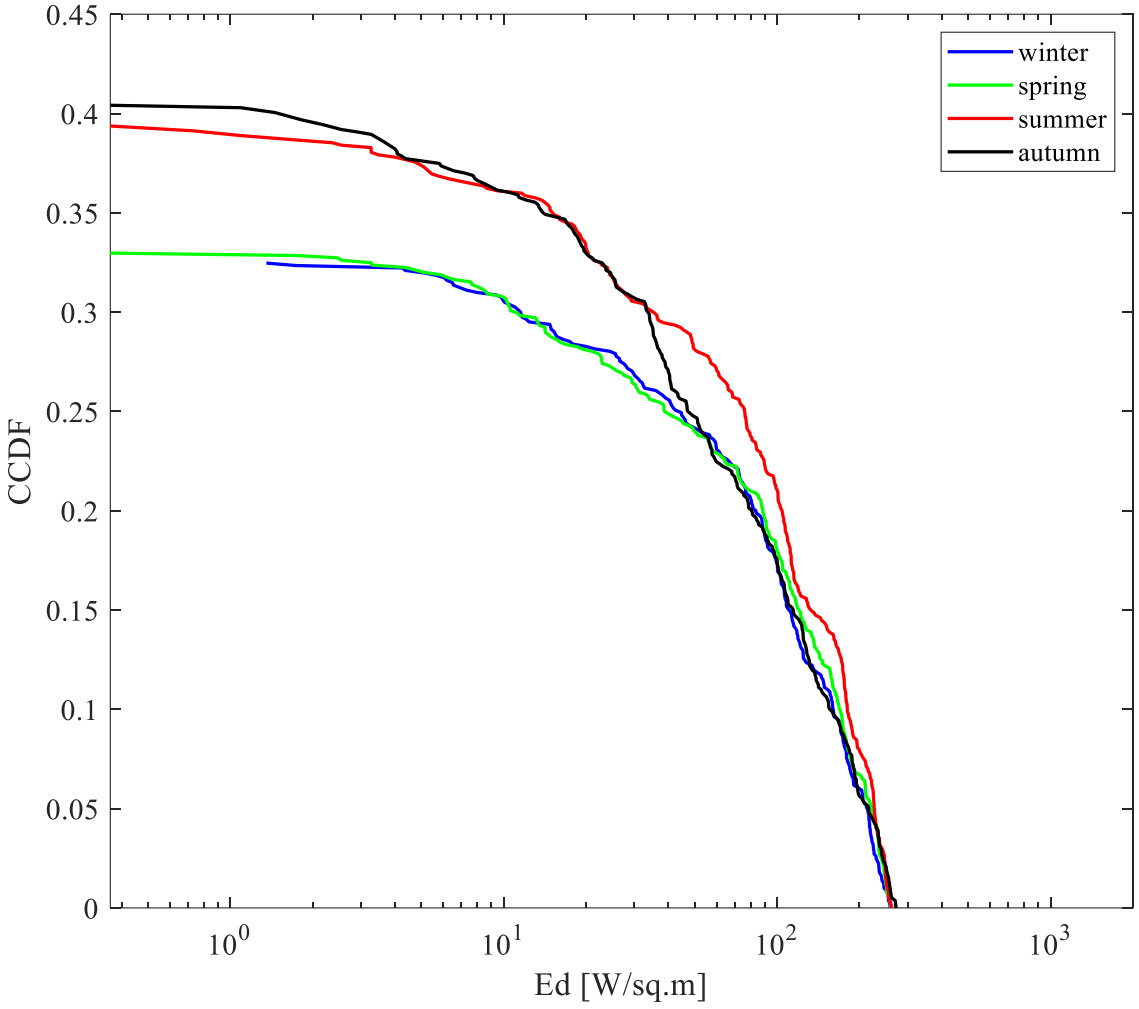






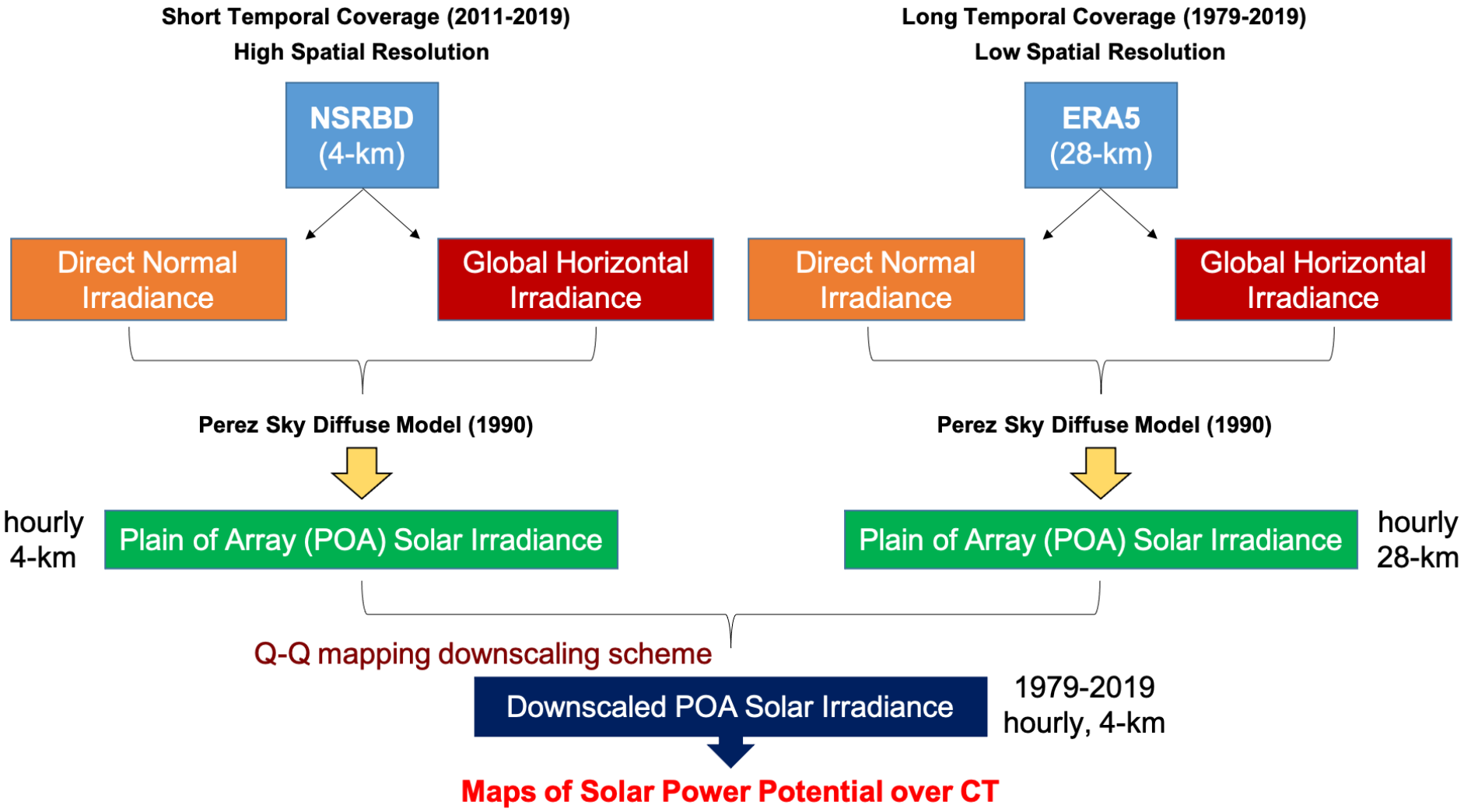
POA Solar Irradiance (2011-2019) Perez Diffuse Model (1990)





POA Solar Irradiance (2011-2019) CCDF

Methodology


Short Temporal Coverage (2011-2019)
High Spatial Resolution
NSRBD
(4-km)
Direct Normal Irradiance
Global Horizontal Irradiance
Perez Sky Diffuse Model (1990)
hourly
4-km
Plain of Array (POA) Solar Irradiance
Long Temporal Coverage (1979-2019)
Low Spatial Resolution
ERA5
(28-km)
Direct Normal Irradiance
Global Horizontal Irradiance
Perez Sky Diffuse Model (1990)
Plain of Array (POA) Solar Irradiance
hourly
28-km
Q-Q mapping downscaling scheme
Downscaled POA Solar Irradiance
1979-2019
hourly, 4-km
Maps of Solar Power Potential over CT

Downscaling of Solar Irradiance

Downscaling of Solar Irradiance over CT