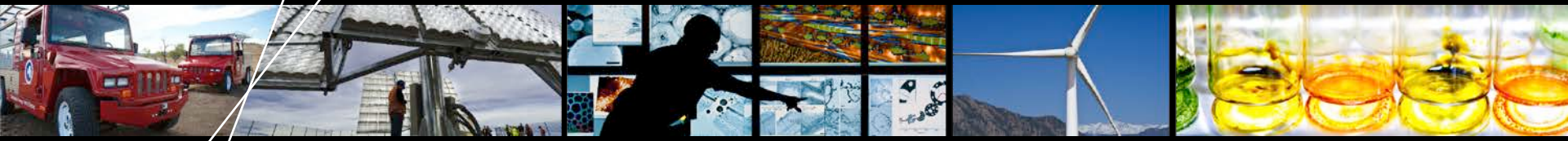
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Eastern Renewable Generation Integration Study Solar Dataset



Marissa Hummon

February 26, 2014

UVIG Forecasting Workshop
Tuscan, Arizona

NREL/PR-6A20-61498

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

ERGIS Solar Data Set

Objective:

Develop a data set is for grid integration studies – meant to mimic the operating conditions of a day-ahead SCUC, intra-day UC, and 5-minute SCED

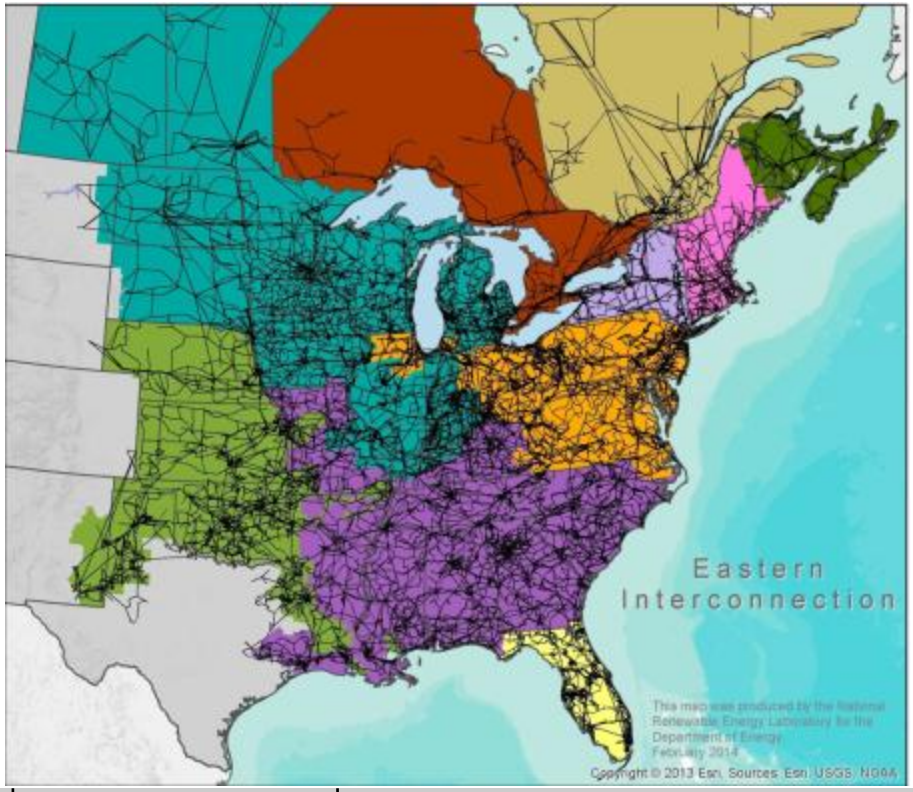
Dataset:

- 5-minute “actual” solar power data
- Day-ahead solar power forecast
- Four-hour-ahead solar power forecast

ERGIS Scenarios

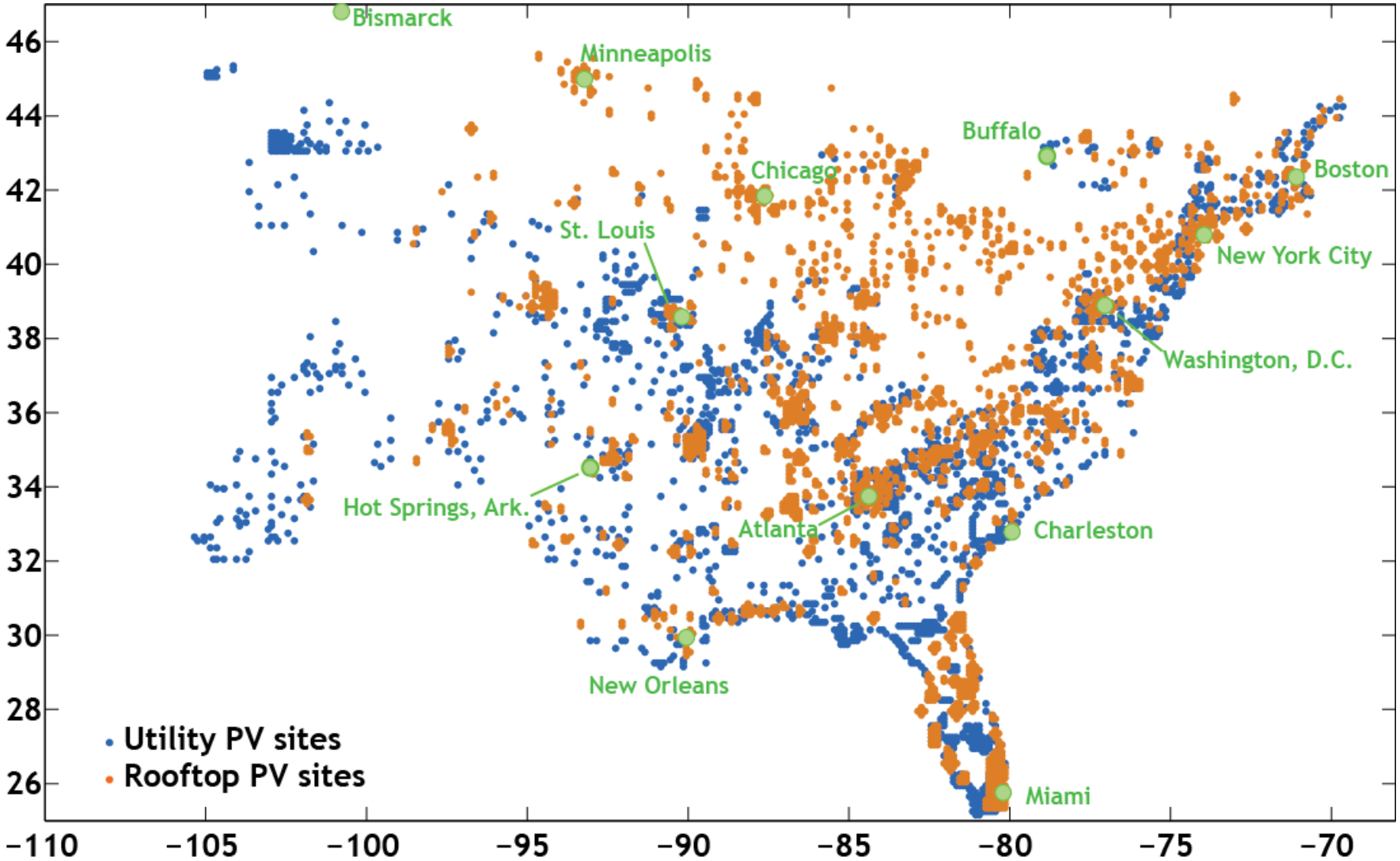
Eastern Renewable Generation Integration Study (ERGIS): How do high penetrations of solar and wind generation impact system operations of the Eastern Interconnection?

- Scenarios are designed to bookend two approaches to renewables
  - National policy implementation
  - Regional policy implementation



	Energy Penetration (%)		Solar PV Capacity (GW)		Wind Capacity (GW)		Conventional Capacity (GW)			
Scenario	Solar	Wind	Rooftop	Utility	Onshore	Offshore	Nuclear	Coal	CC	CT
Low Renewables	0	3	0	0	23	0	88	208	185	187
State RPS	0.2	12	1	2	95	8	88	195	175	198
Regional 30%	10	20	70	104	149	27	88	182	154	145
National 30%	5	25	35	52	199	16	88	171	173	153

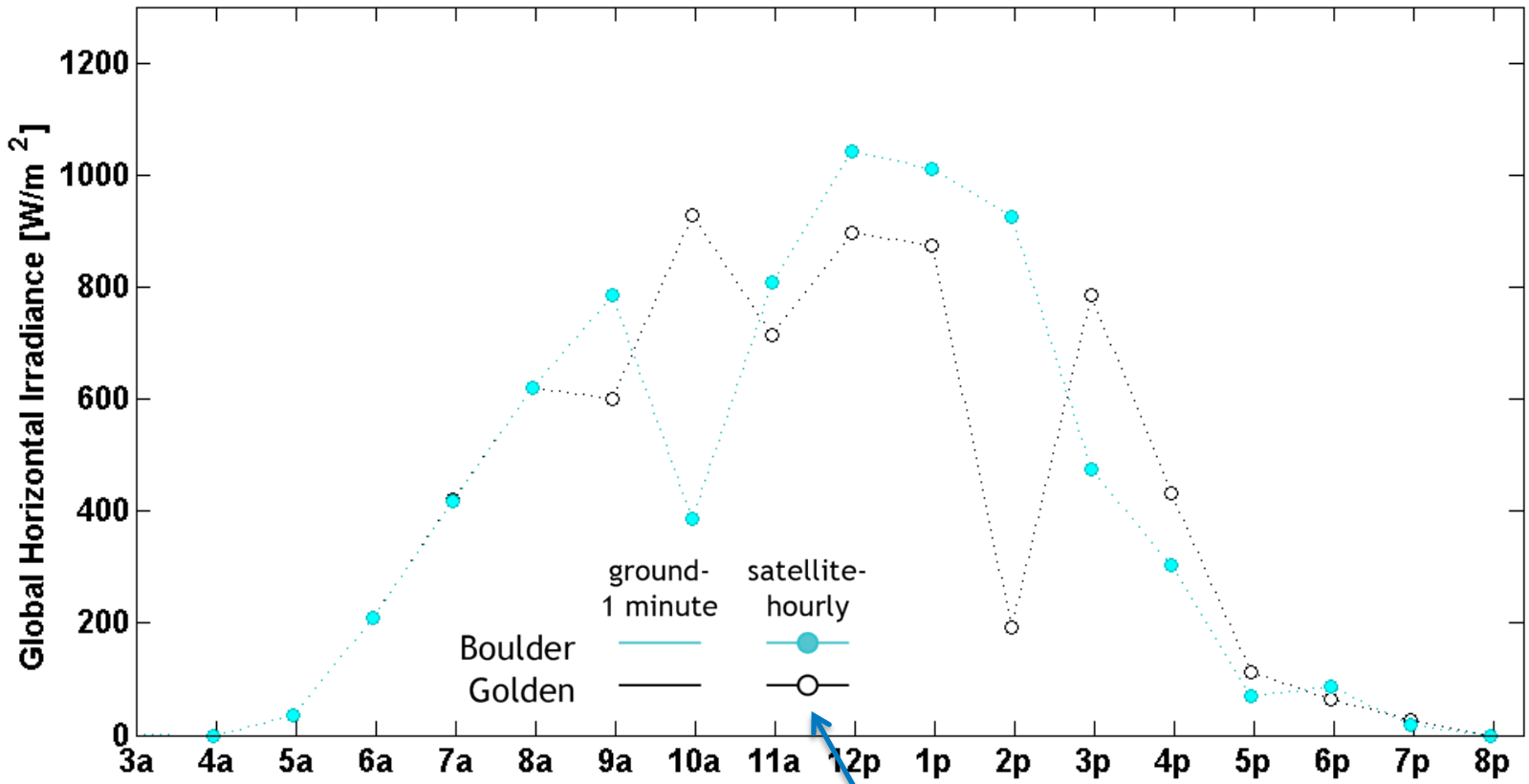
Rooftop and Utility PV Locations in ERGIS



Motivation

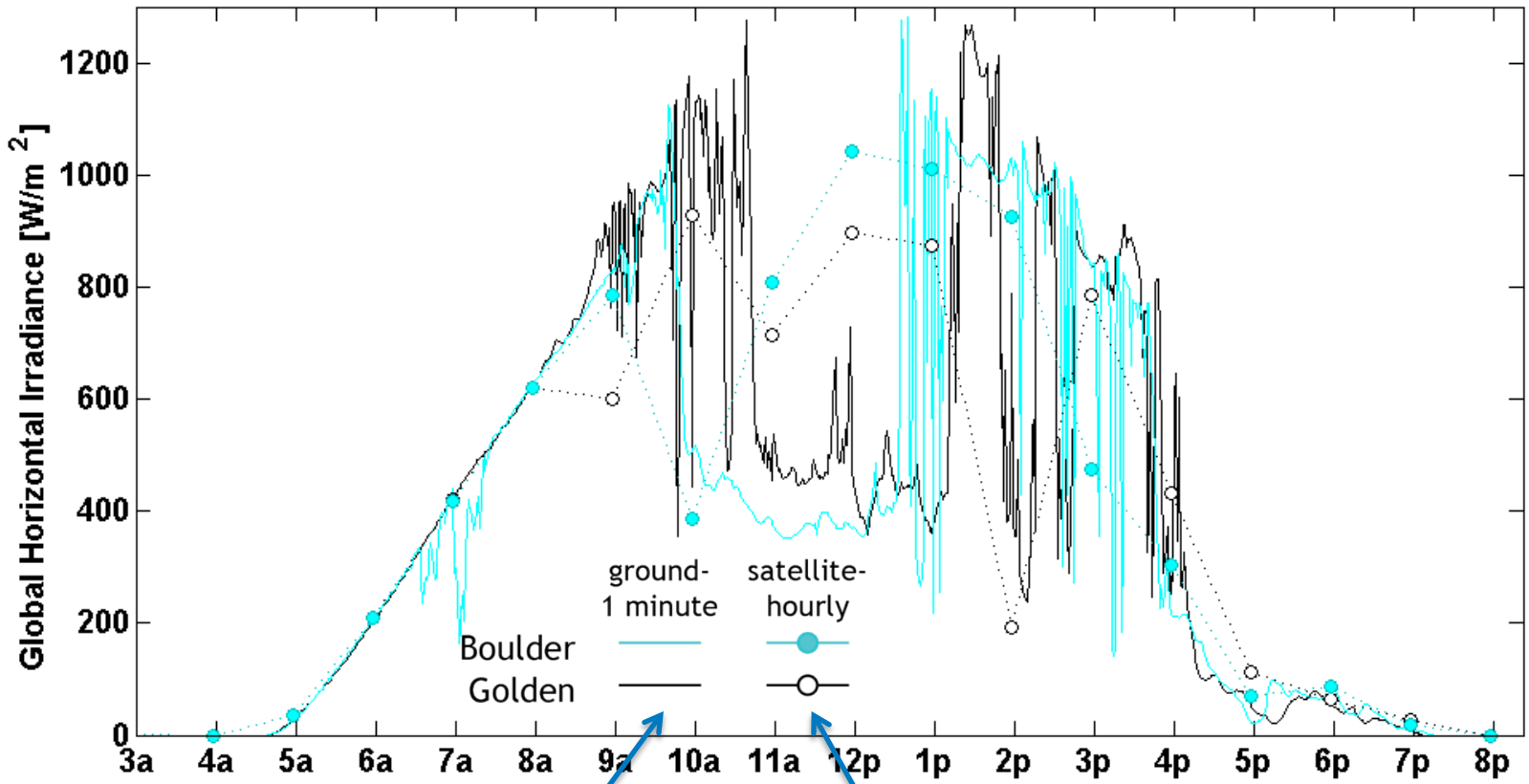
NREL PIX 18625, Peter McNutt, Guam

Motivation



Source: Clean Power Research SolarAnywhere http://www.cleanpower.com/products/solaranywhere/sa-data/

Motivation

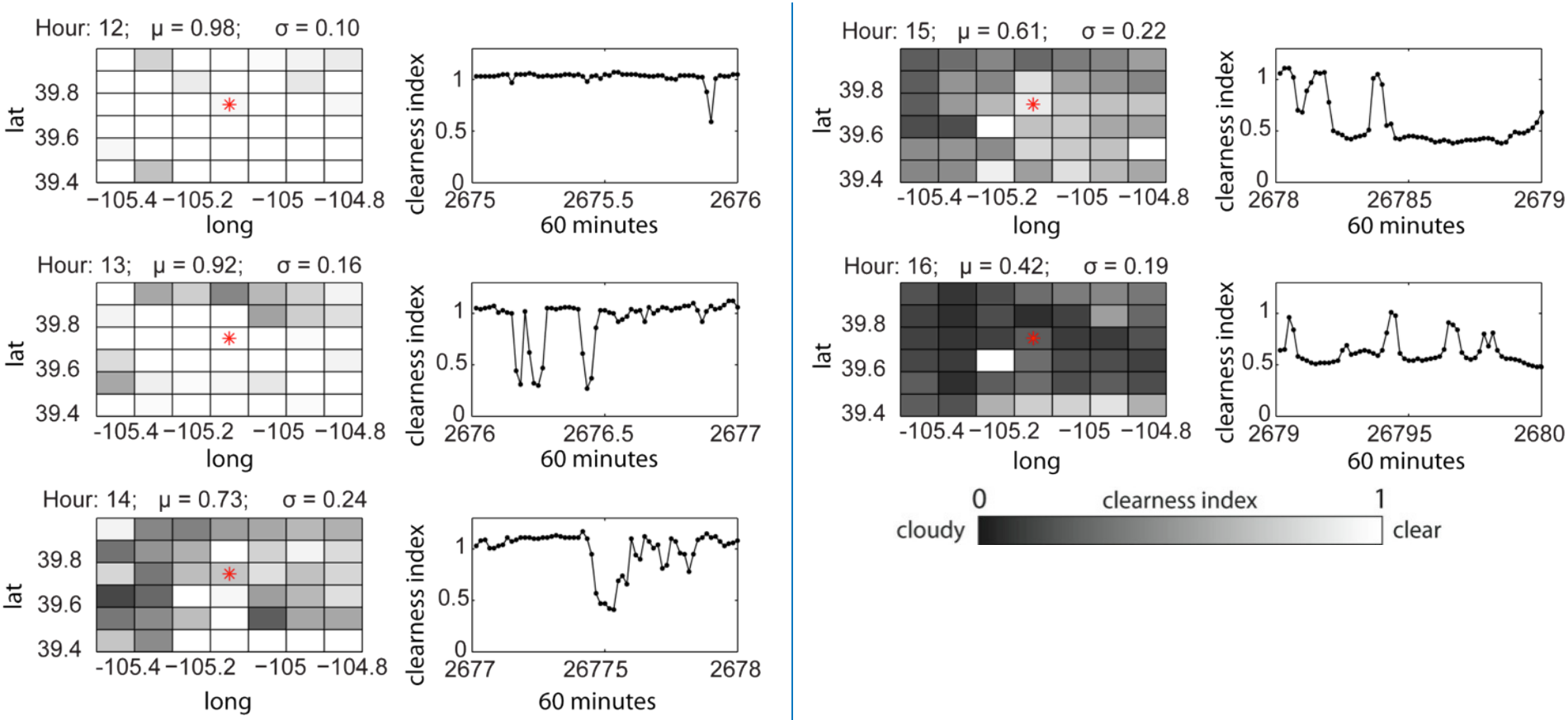


Source: NREL Measurement and Instrumentation Data Center (MIDC) http://www.nrel.gov/midc/

Source: Clean Power Research SolarAnywhere http://www.cleanpower.com/products/solaranywhere/sa-data/

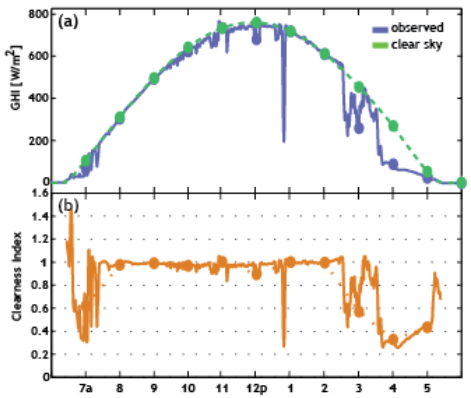
Site Clearness Index Analysis

Spatial satellite data is used to calculate the relative proportions of cloud cover in an area for each hour. This data is related to the sub-hourly measurements of irradiance. These figures show five consecutive hours of aerial satellite data (left) and corresponding minutely ground-based irradiance data (right).

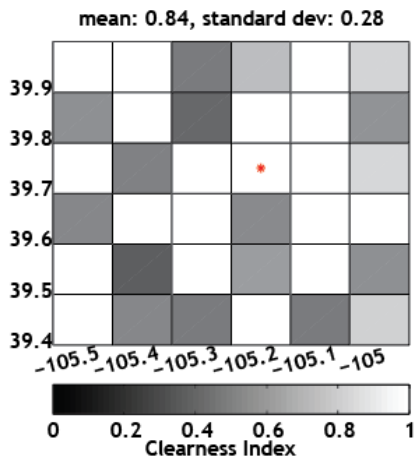


Synthesis of 1-minute Solar Data

1. Calculate clear sky GHI for all locations within the patch (location of interest plus sites within 40 km)



2. Calculate *ci* for all locations within the patch



3. For each satellite time period:

A. Calculate the temporal class probability distribution and randomly draw a temporal class

B. Calculate the input data and statistics for each temporal class:

All classes: $ci_{t=0}$, $ci_{t=59}$

Classes IV & V: distribution of *ci* state probabilities

C. Run appropriate temporal class algorithm to generate 1-minute time step *ci* values

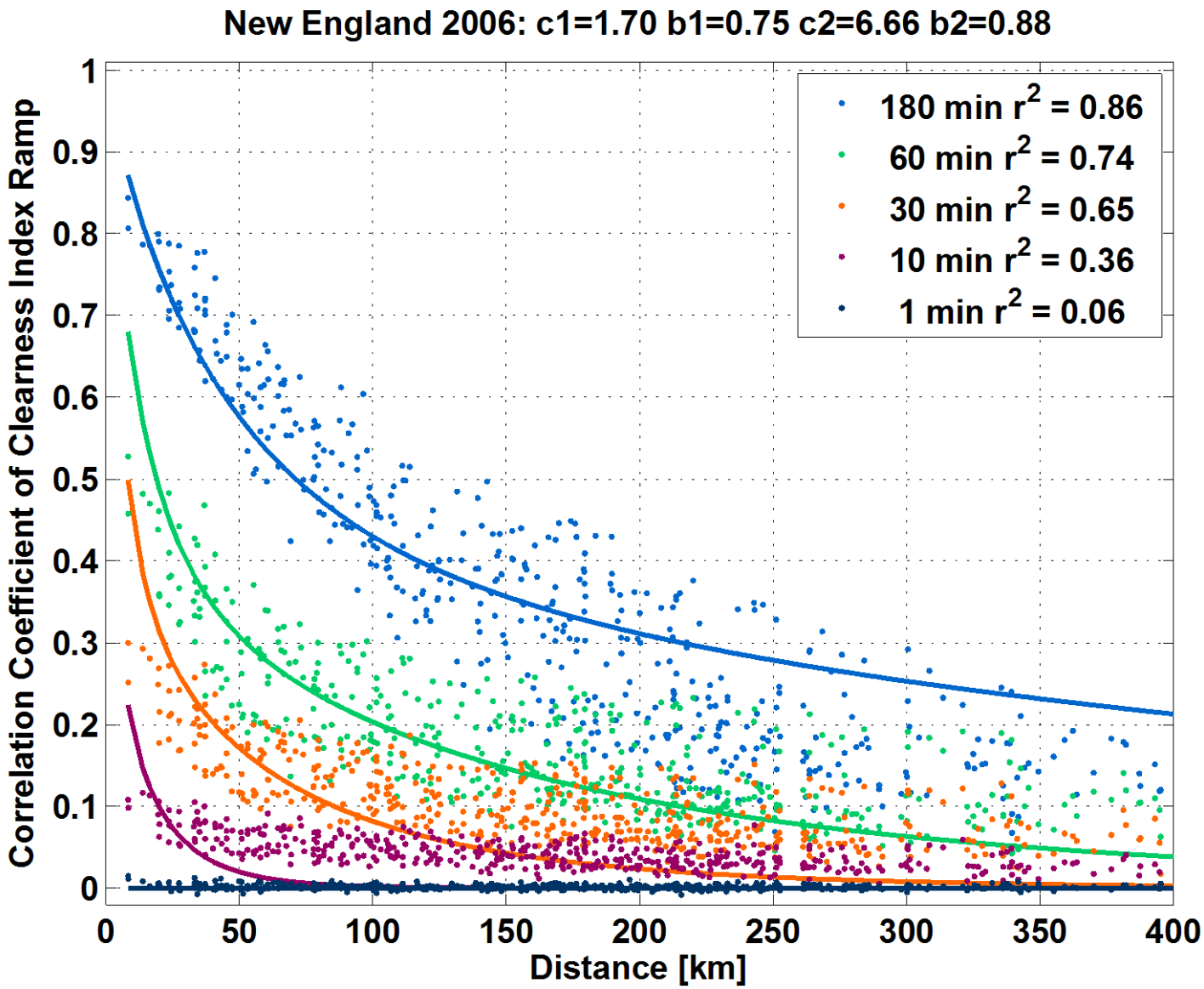
4. Reassemble time series of 1-minute *ci* for the location of interest

5. Apply temporal filter based on the calculated solar plant area (~40 MW/km²)

6. Calculate 1-minute GHI from 1-minute *ci*; then calculate 1-minute DFI and DNI

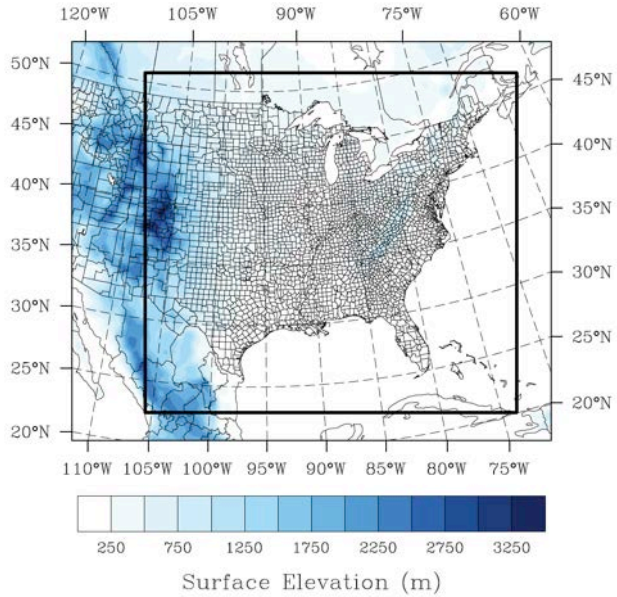
7. Calculate 1-minute solar power output from filtered 1-minute GHI and other values

Site-to-site correlations



Solar Forecast Data Comparison

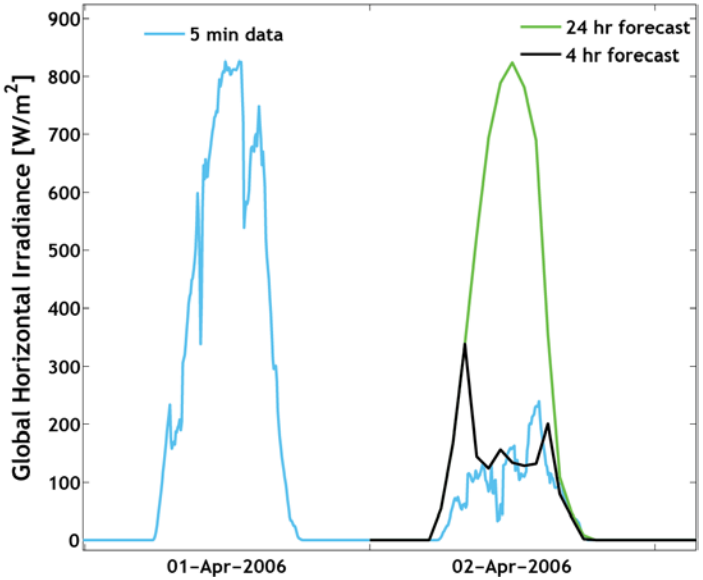
- **Day-ahead**
  - WRF
  - Persistence
- **4-Hour-ahead**
  - WRF
  - Persistence



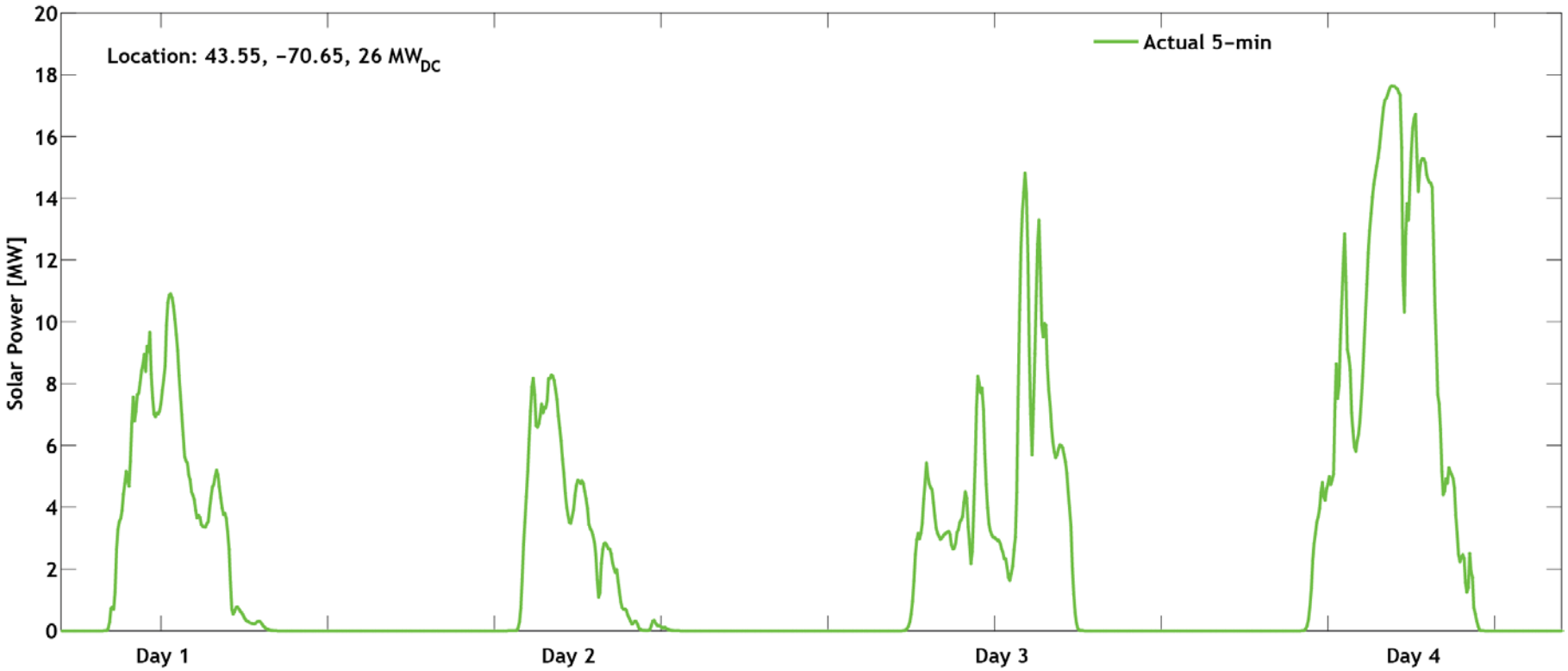
NREL's HPC resource: Peregrine (above)

NREL's WRF study area (left)

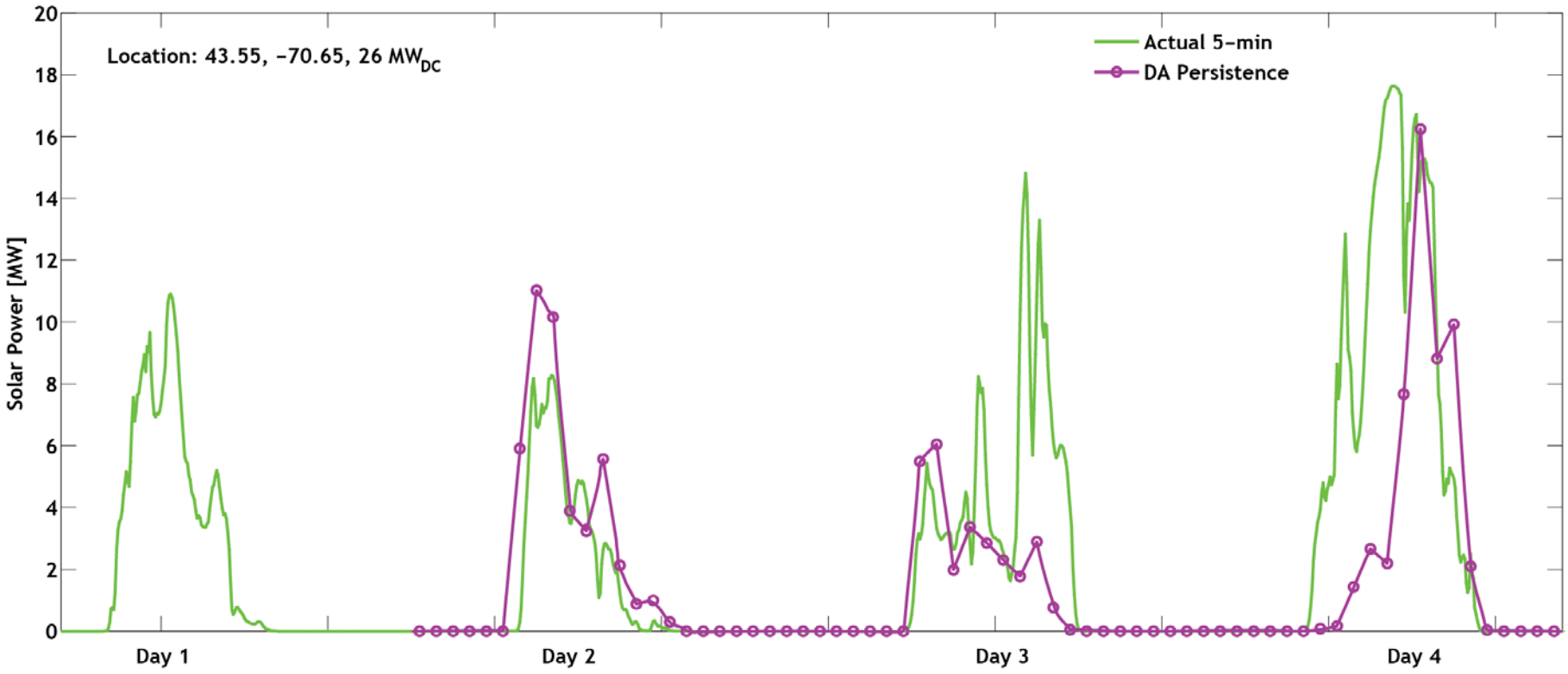
Persistence forecast (below)



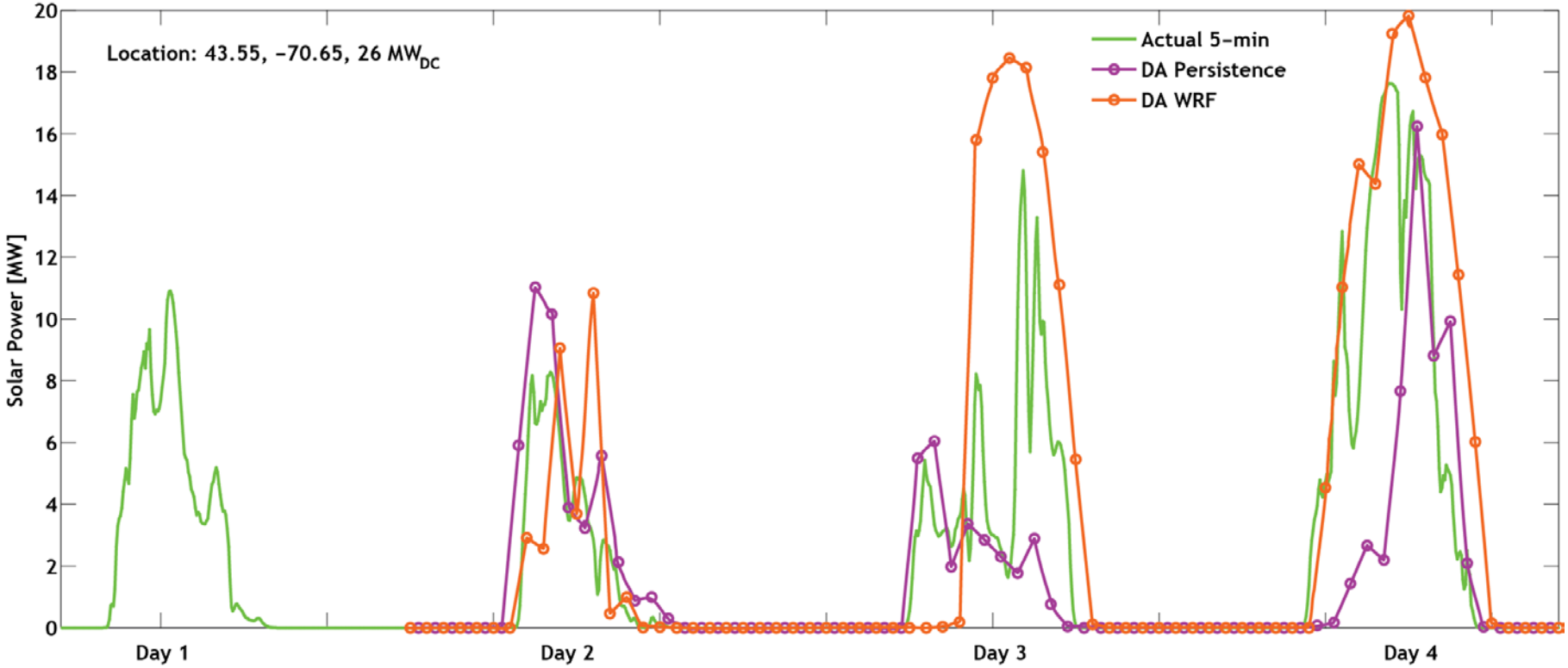
Day-ahead Solar



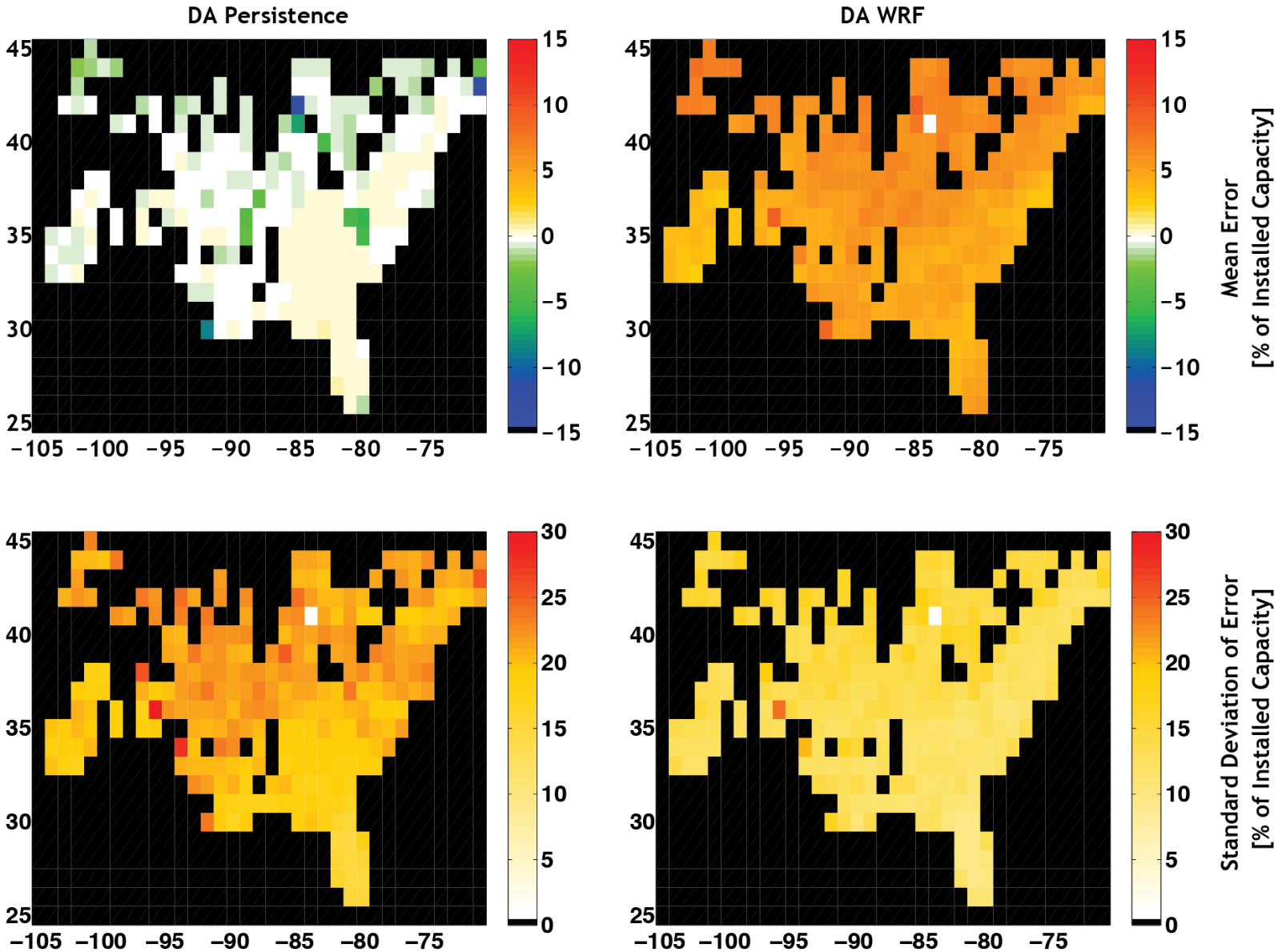
Day-ahead Solar



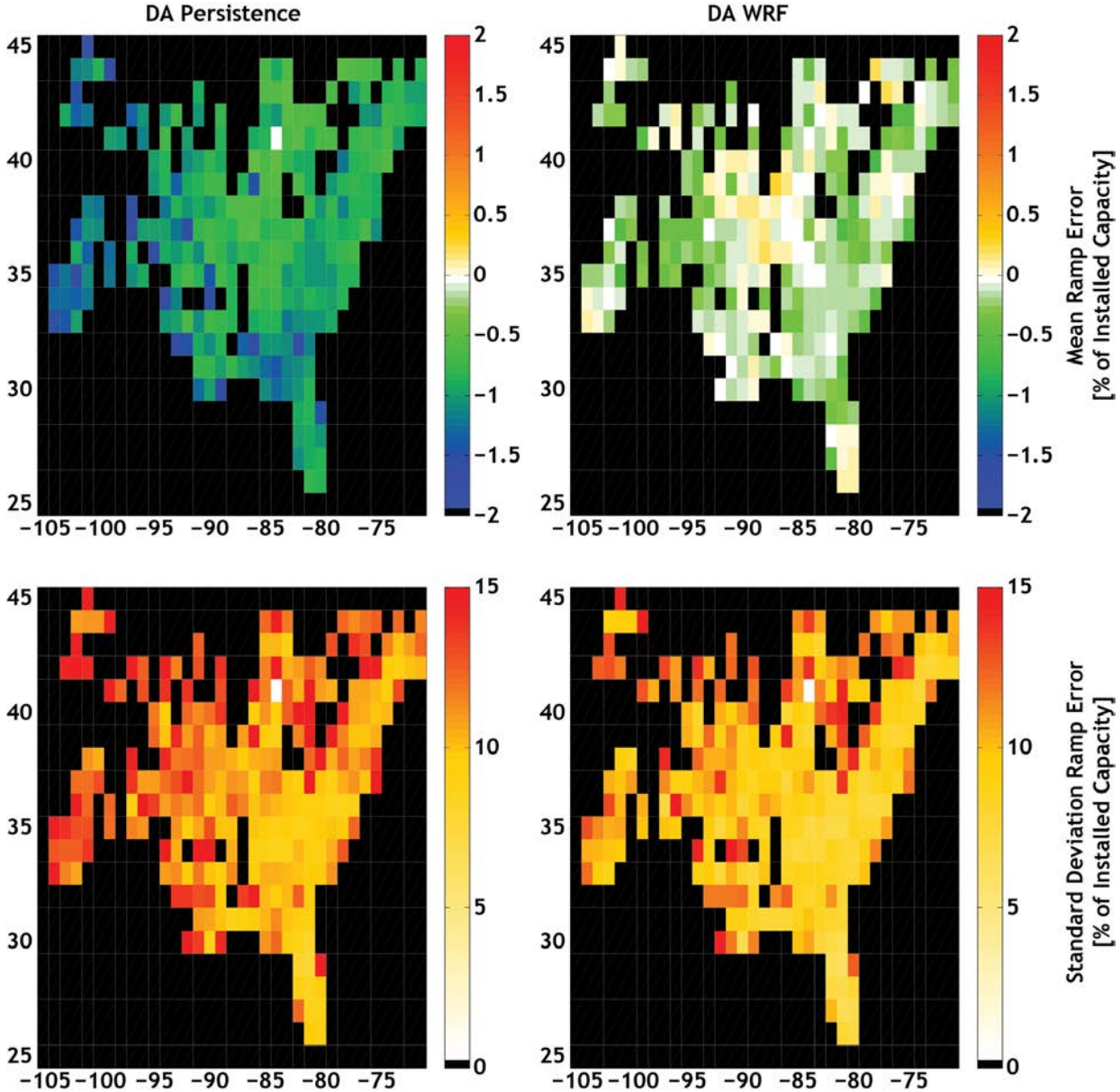
Day-ahead Solar



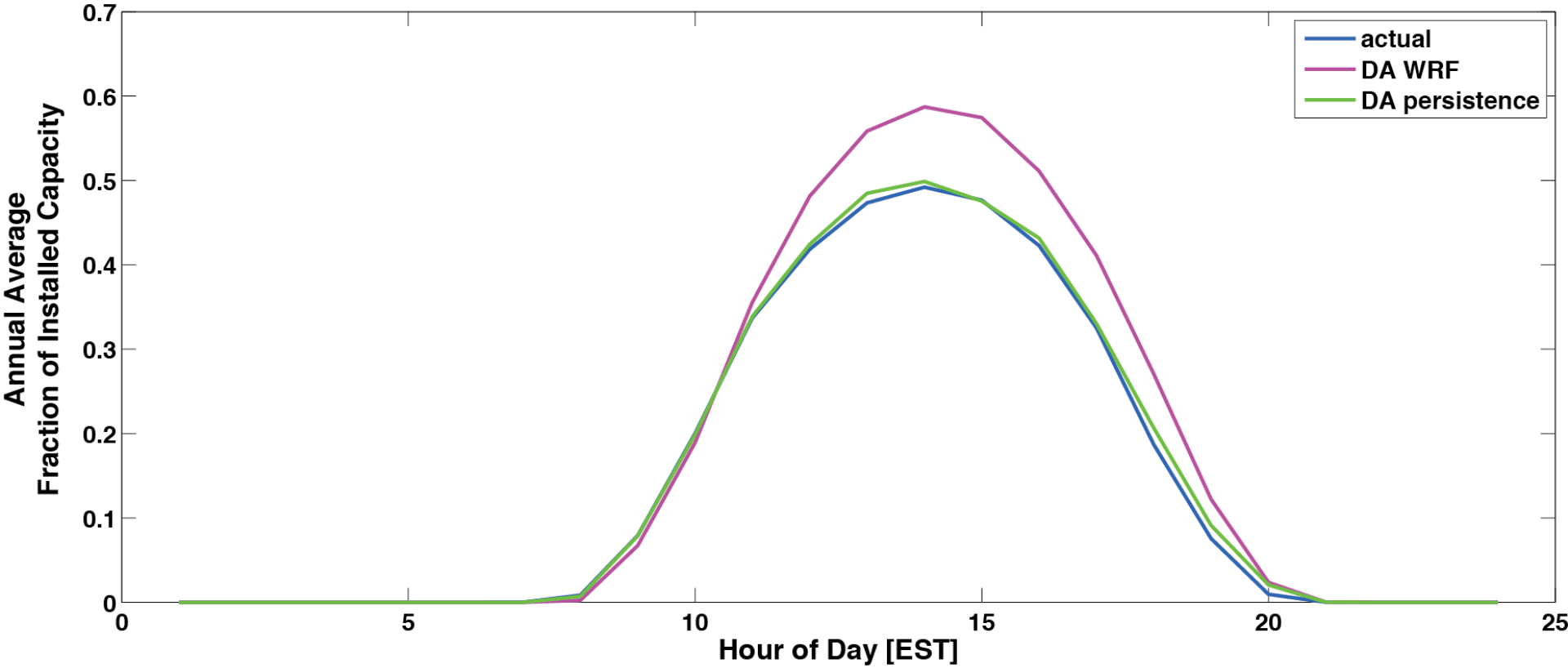
Day-ahead Forecast Error



Day-ahead Hourly Ramp Forecast Error



Bias in the WRF data



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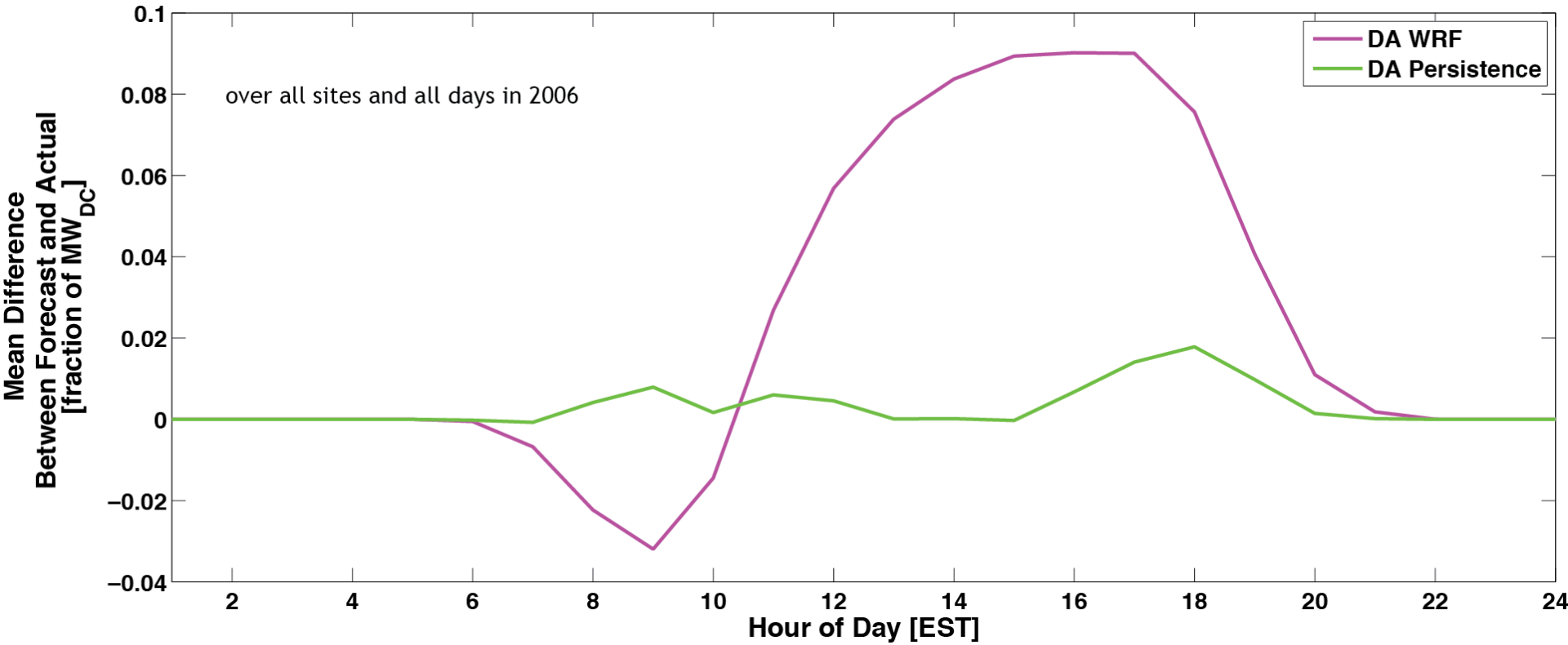
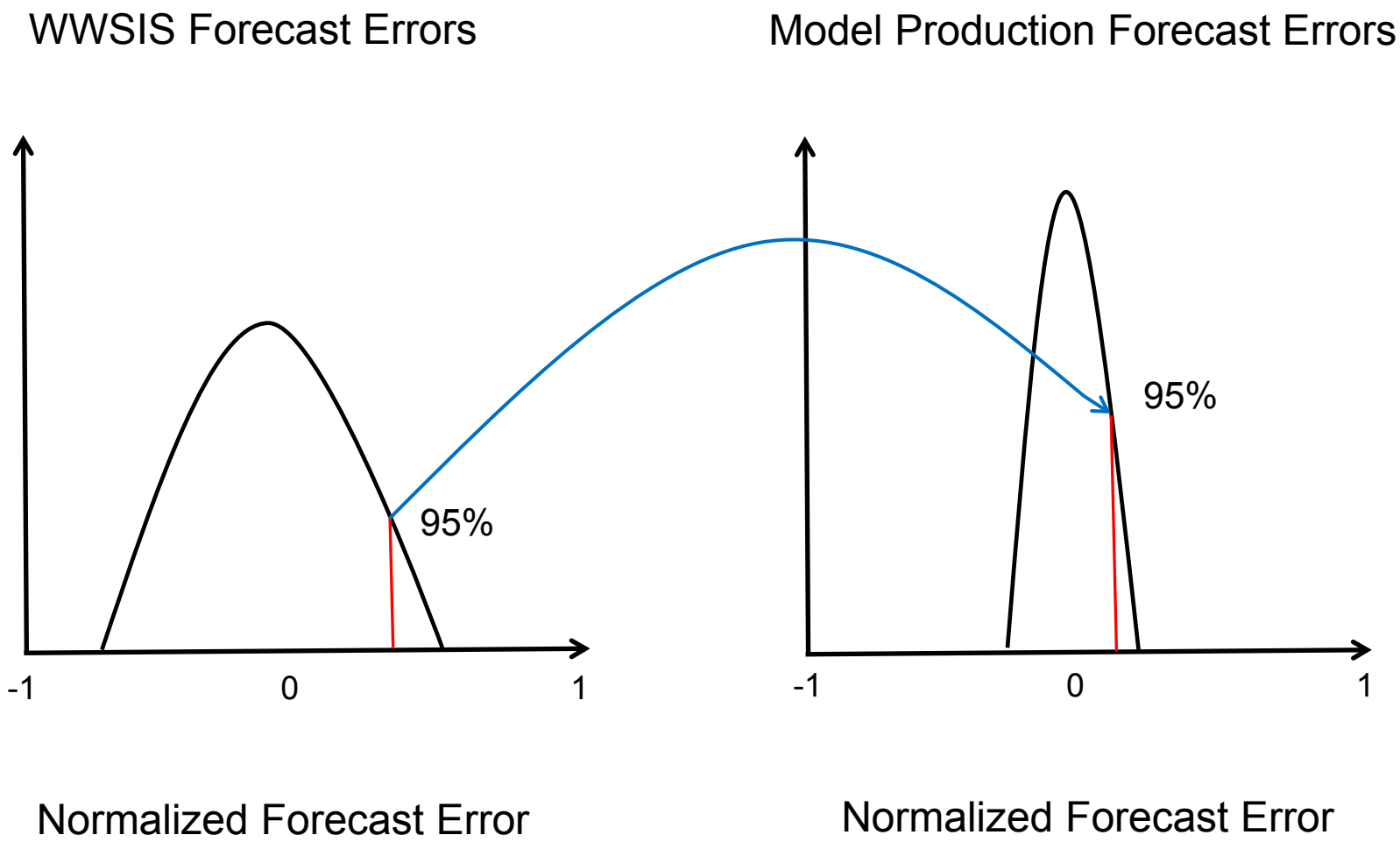
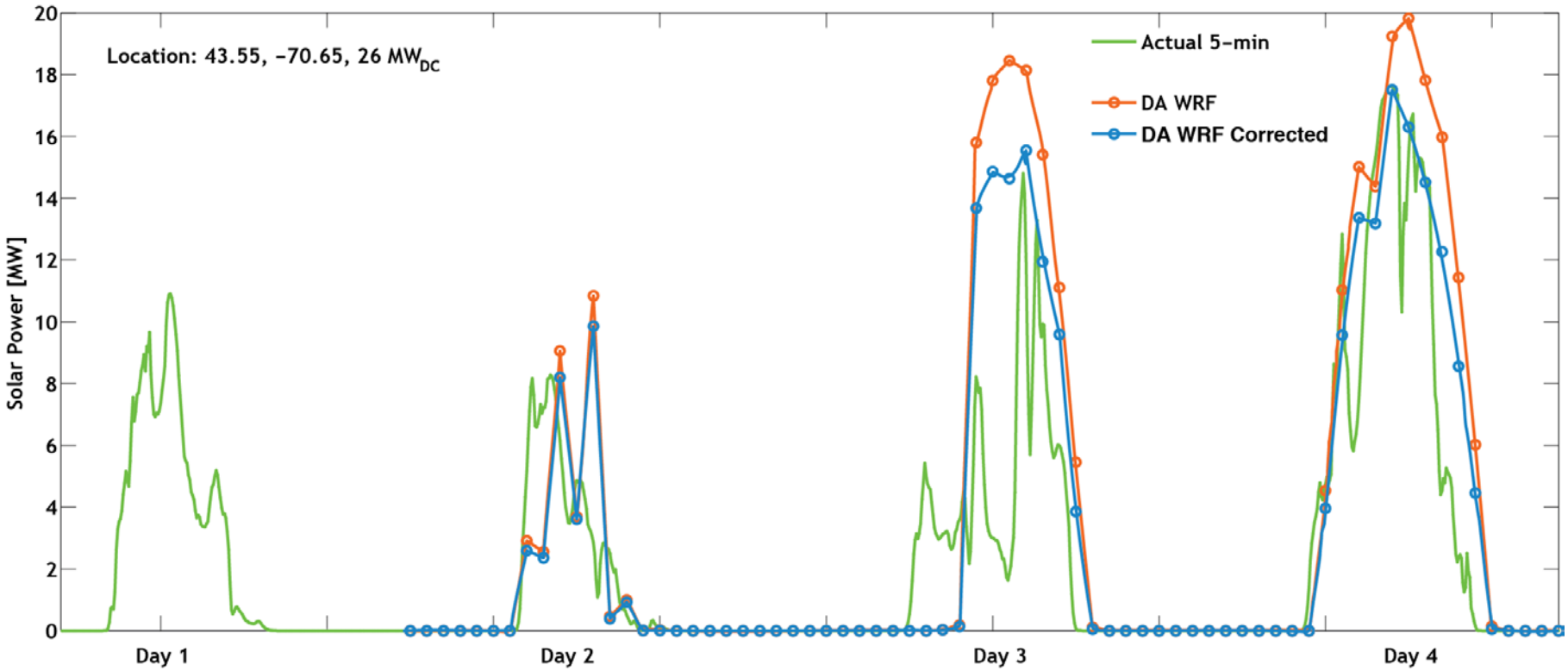


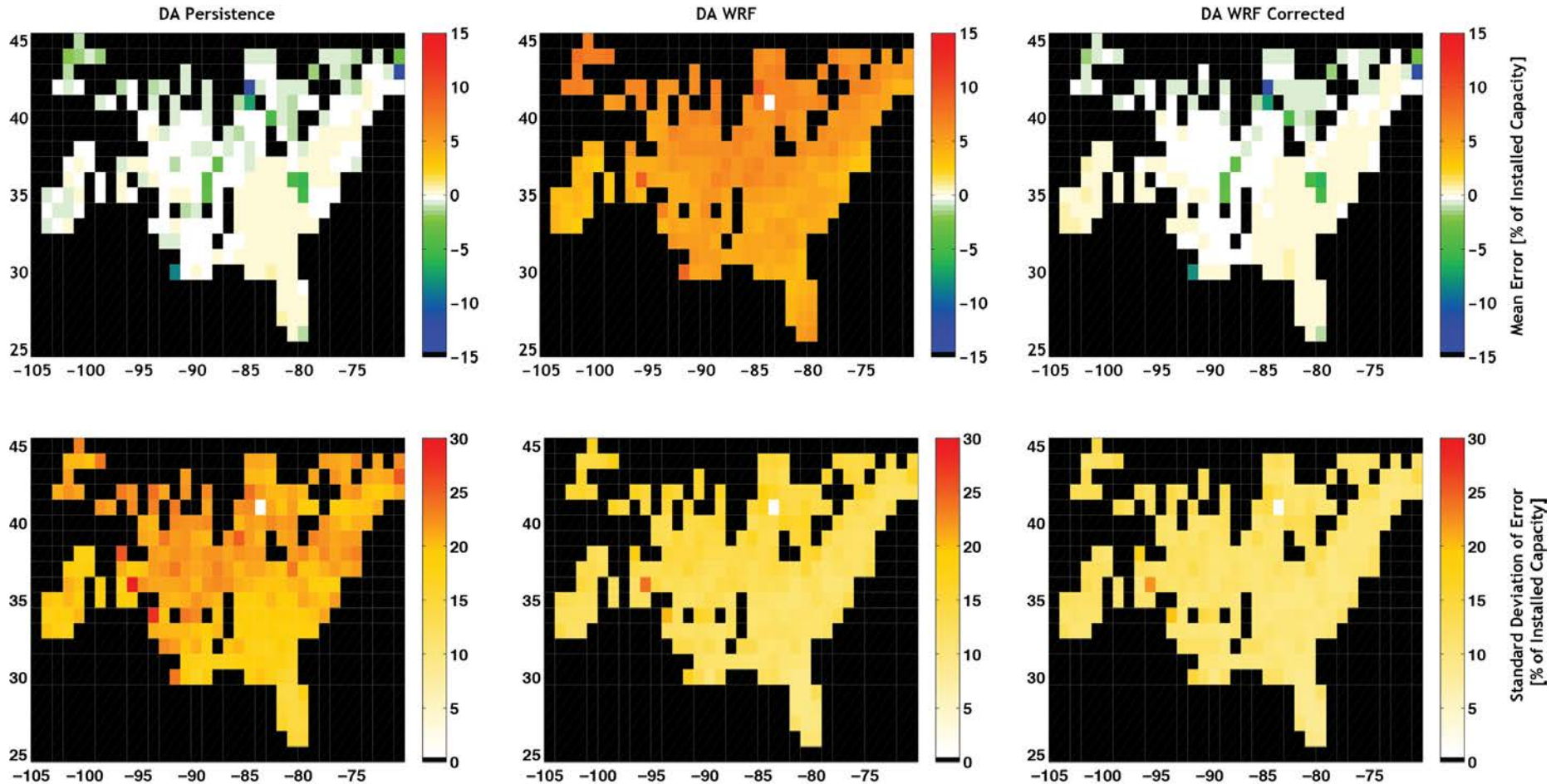
Mapping Forecast Errors



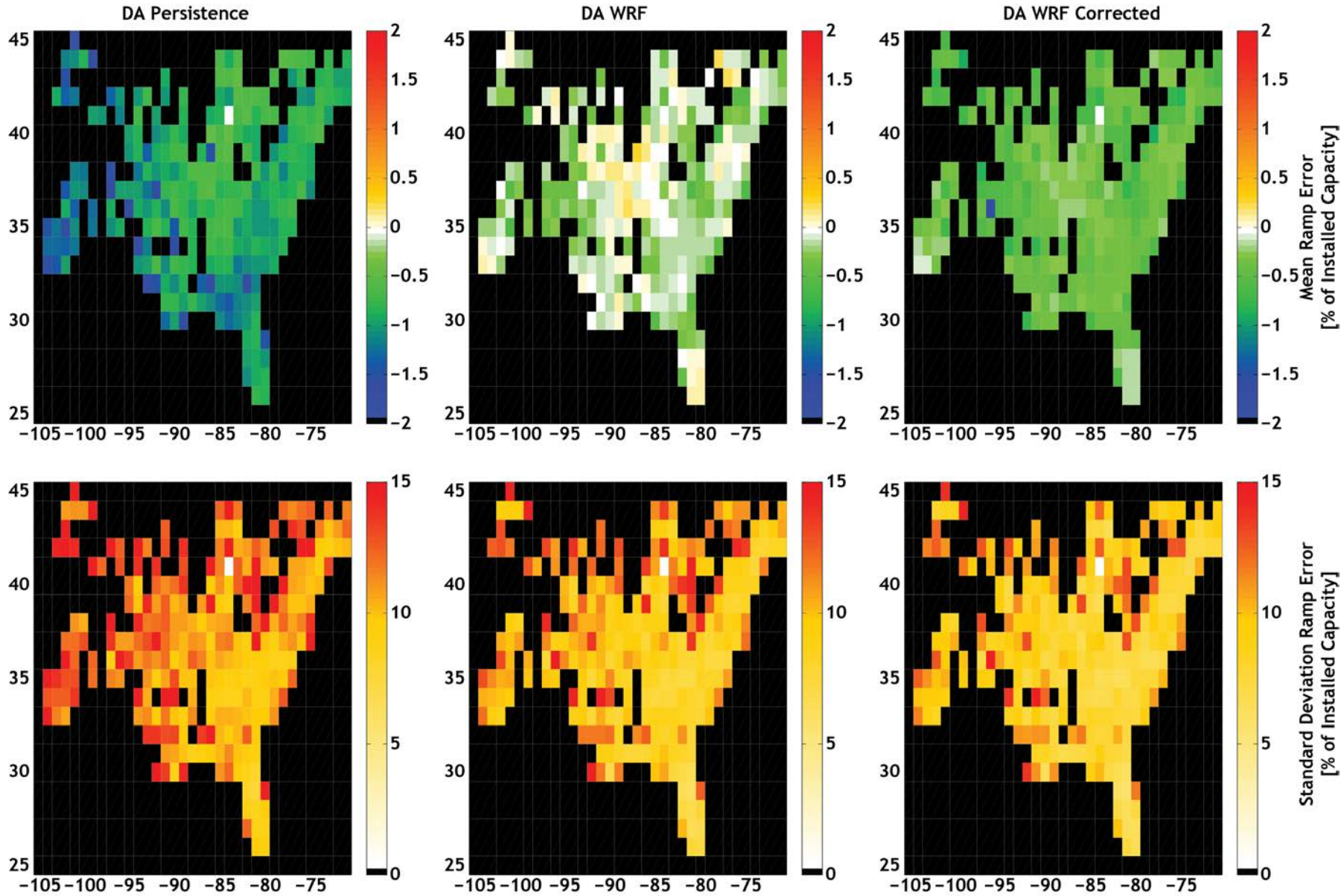
Day-ahead Solar



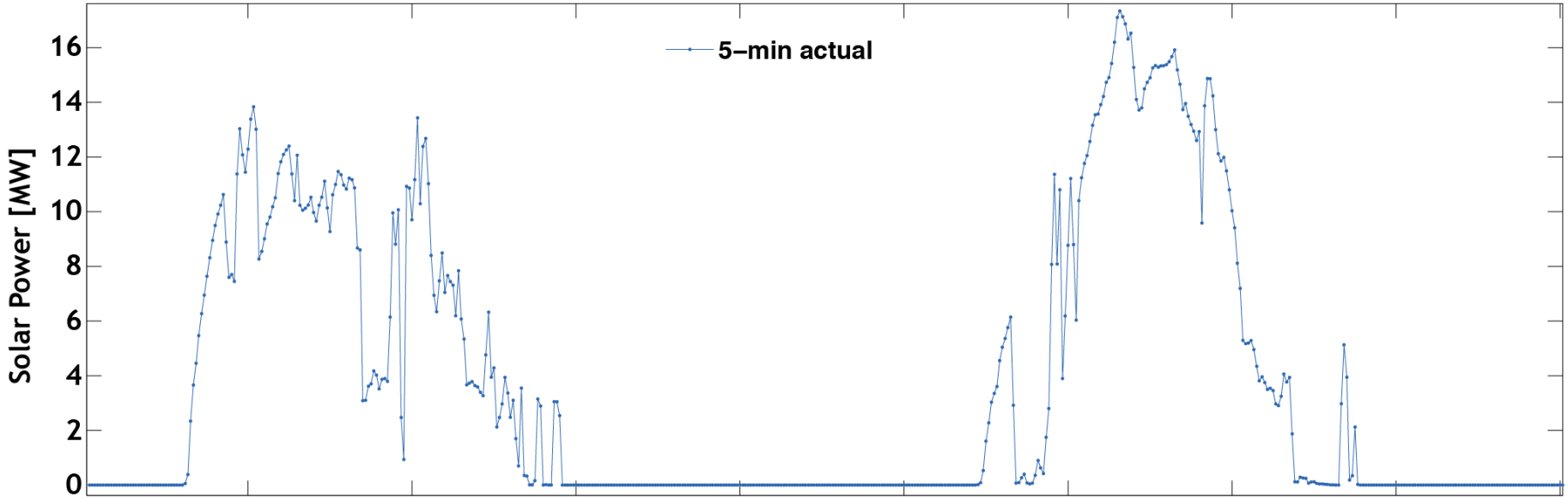
Day-ahead Forecast Error Correction



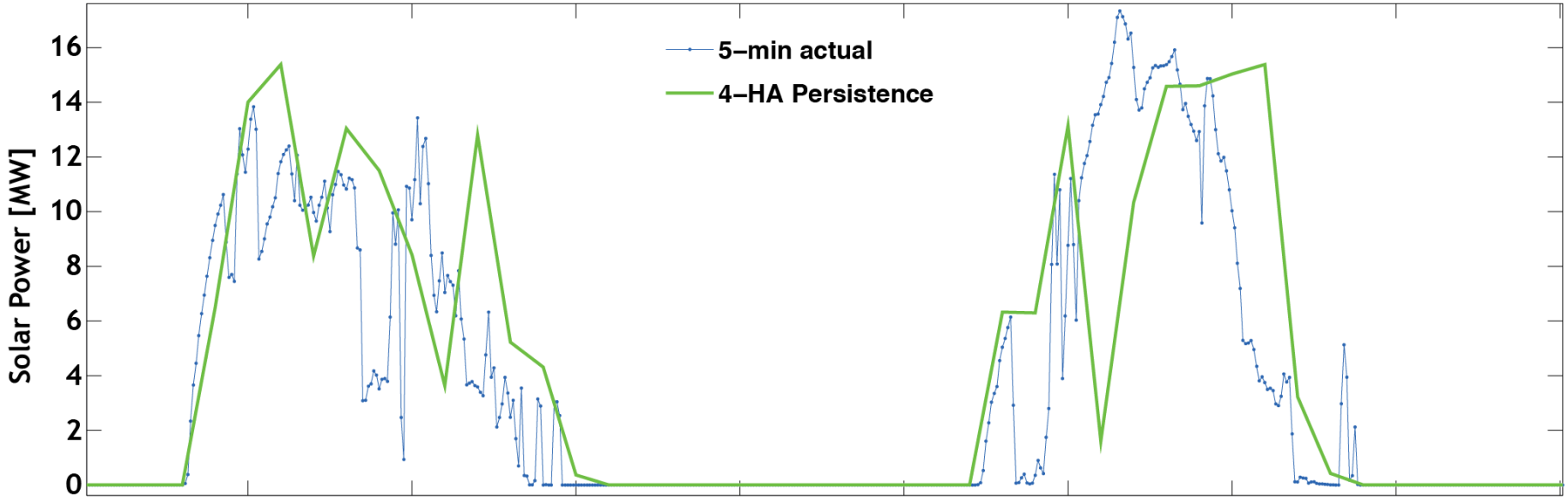
Day-ahead Hourly Ramp Forecast Error



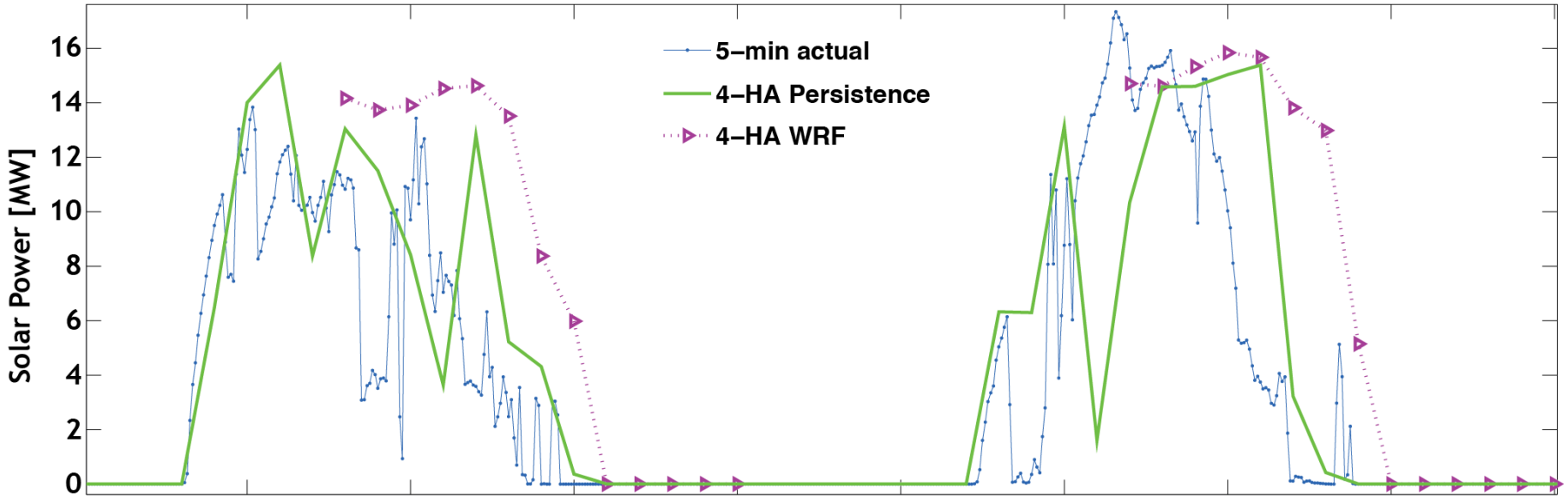
4-hour-ahead Solar



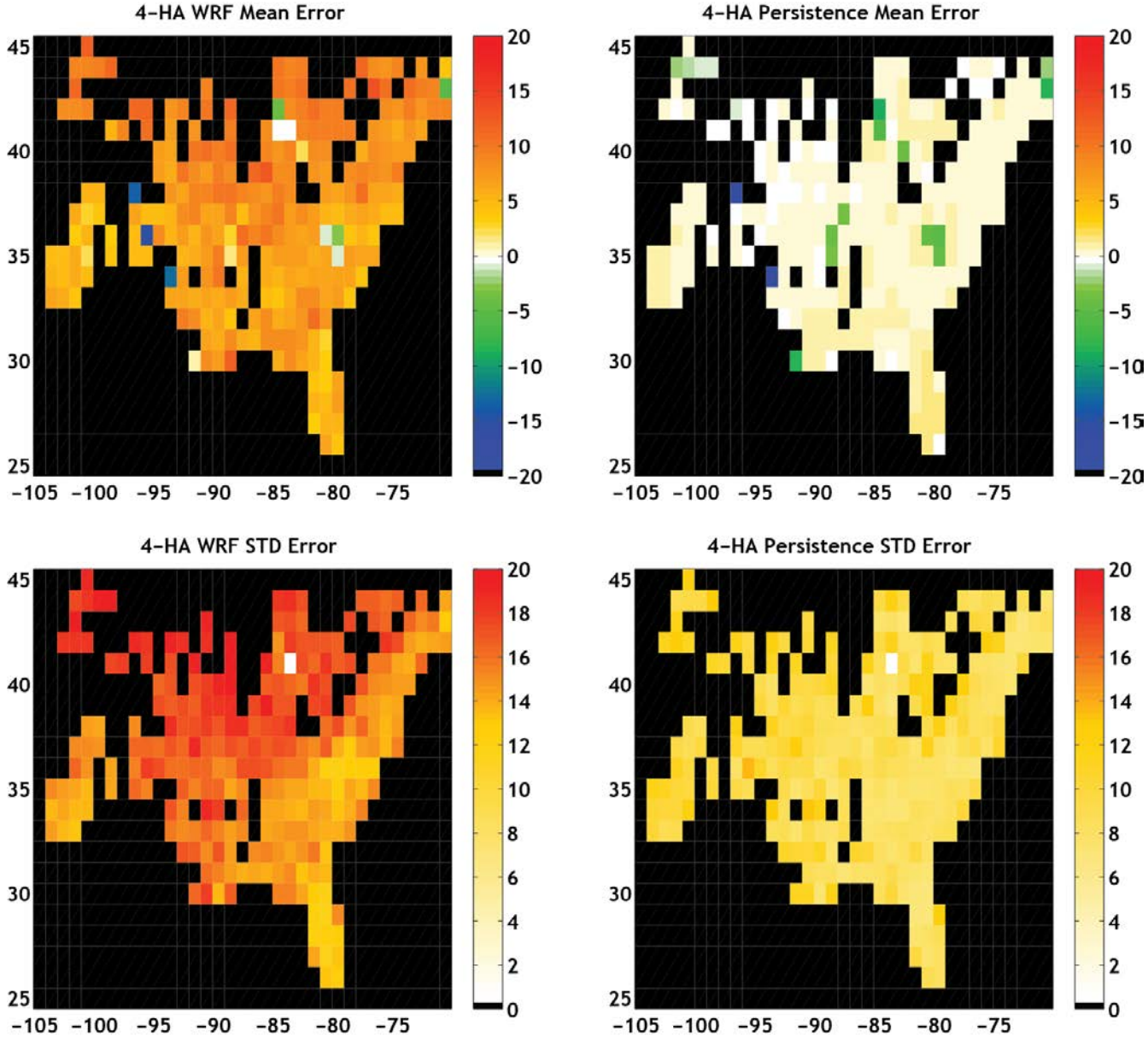
4-hour-ahead Solar



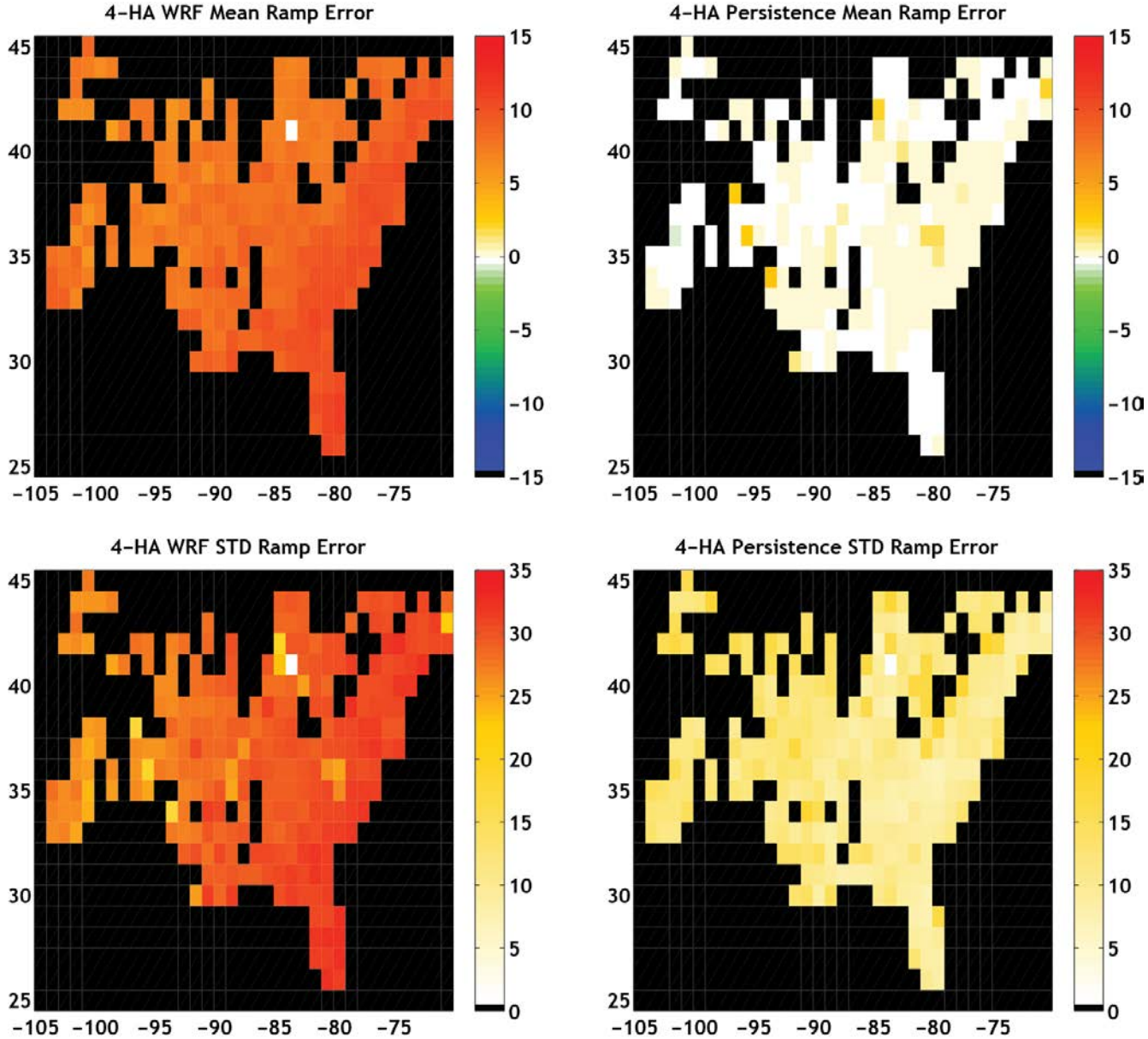
4-hour-ahead Solar



4-Hour-Ahead Forecast Error



4-Hour-Ahead Hourly Ramp Forecast Error



ERGIS Solar Data Summary

NREL will be releasing (at the end of March!):

- 5-minute solar power "actuals"
- Hourly day-ahead from WRF model with statistical correction
- Hourly "four-hour-ahead" for clear power index persistence

Team:

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Marissa Hummon

More information about the ERGIS study can be found at:

http://www.nrel.gov/electricity/transmission/eastern_renewable.html