Advanced Solar and Load Forecasting Incorporating HD Sky Imaging: Phase III

Presentation to DOE SETO Annual Program Review & Workshop

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NCAR

NEW YORK STATE OF OPPORTUNITY. NY Power Authority

BROOKHAVEN NATIONAL LABORATORY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

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U.S. DEPARTMENT OF ENERGY

UNIVERSITY AT ALBANY State University of New York

SOLAR ENERGY TECHNOLOGIES OFFICE U.S. Department Of Energy

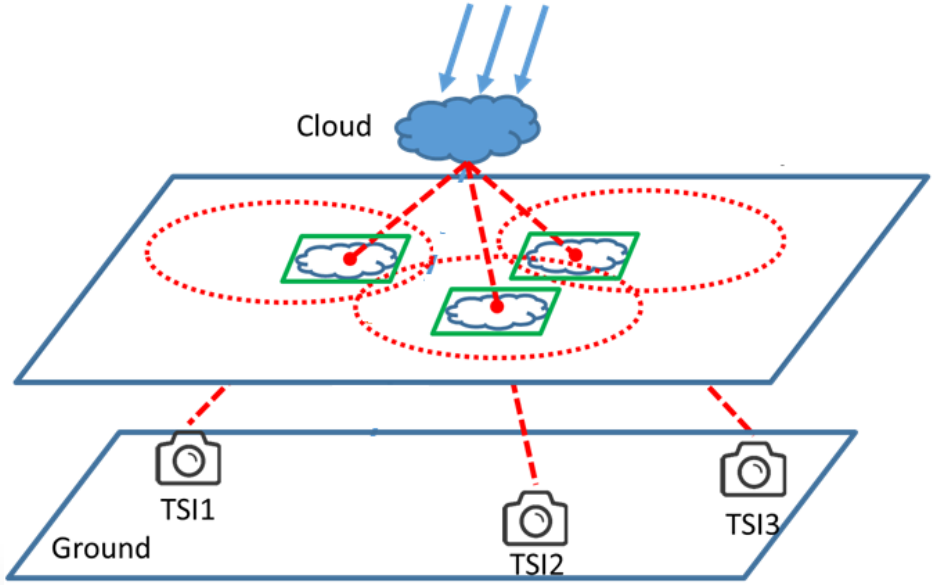
BROOKHAVEN SCIENCE ASSOCIATES

Outline

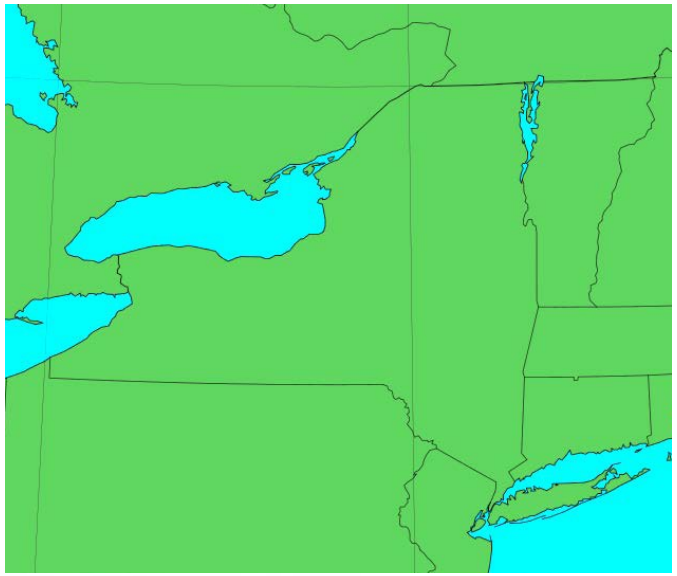
- Background
- Accomplishments in Phases I and II
- Phase III Overview
- Nowcasting Tasks
- Path Forward

Overall Project Objectives

- Develop a platform for large-scale solar forecasting that includes generating facilities and distributed solar resources by incorporating multiple state-of-the-art techniques at varying time horizons, from 0-30 min “nowcasting” through 1 -2 day ahead forecasting



Ground-based imaging networks for Nowcasting



Development/deployment of optimized WRF Solar and Blended Models for 1 – 2 Day Ahead Forecasts

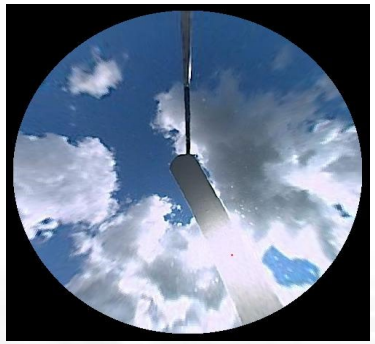
Forecasting Time Horizons

Nowcasting
Need to control variability for grid stability via real-time decisions on power distribution & storage

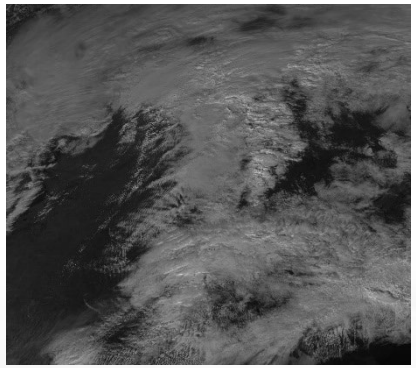
Short-term forecasting
Need to dispatch backup/stand-by power plants to meet demand

Long-term forecasting
Need for daily trading to minimize energy costs

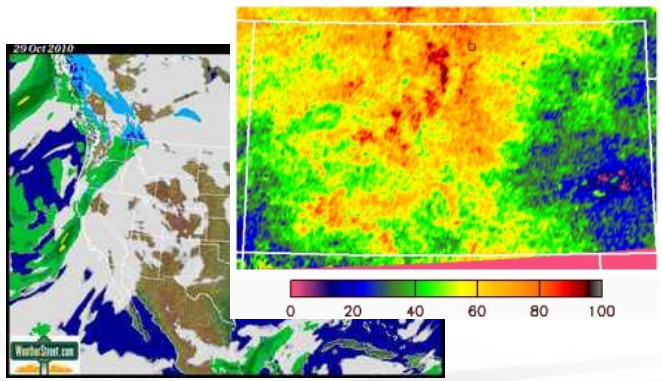
1min 30 min 6 hours 24+hours



Ground-based imagers



Satellite imagery



Numerical Weather Prediction Modeling

Strategic Approach

- Cost and scope of overall effort was challenging
  - Assembled a team with subject matter expertise in specific aspects of solar forecasting
    - BNL: Nowcasting
    - NCAR: WRF and Blended Models
    - EPRI: Model validation, integration into utility and ISO ops (tech transfer
    - U of Albany: NYS Mesonet and installation/maintenance of Albany Region Nowcasting network
  - Developed a phased approach
  - Leveraged funding from multiple sources (NYPA, DOE SETO, and NYSERDA)

Strategic Approach

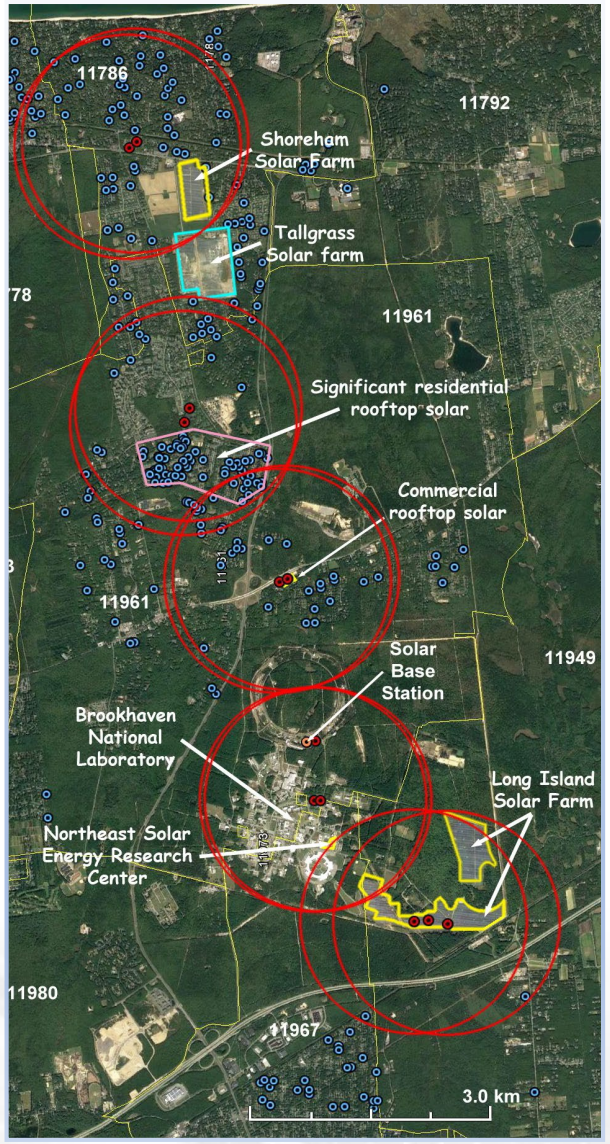
- Phase I: NYPA funded planning and engineering design of statewide demonstration (completed 9/17)
- Phase II: NYPA/DOE funded Deployment at scale for one region in NYS (completed 12/18)
- Phase III: Deployment at an additional region in NYS, continue operations for at least a year
- Phase IV: ???

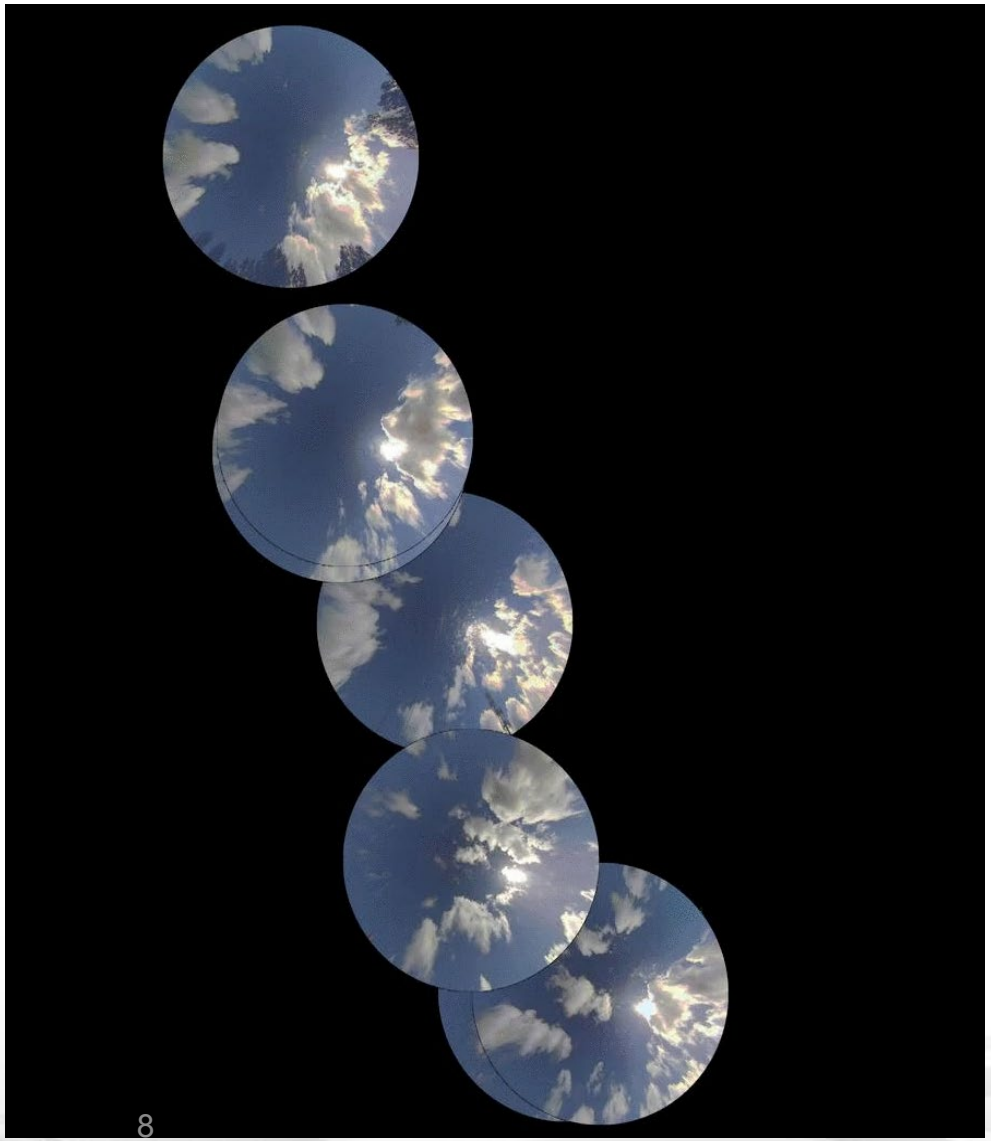
Accomplishments in Phases I and II

- Phase I: Identified regions of interest, collected solar installation data, developed engineering plans for deployment
- Phase II: Scaled up ground-based imager system by 20x (2.5 to 50 km^2) by integrating additional networks and stitching images

32 MW Long Island Solar Farm

Accomplishments in Phases I and II





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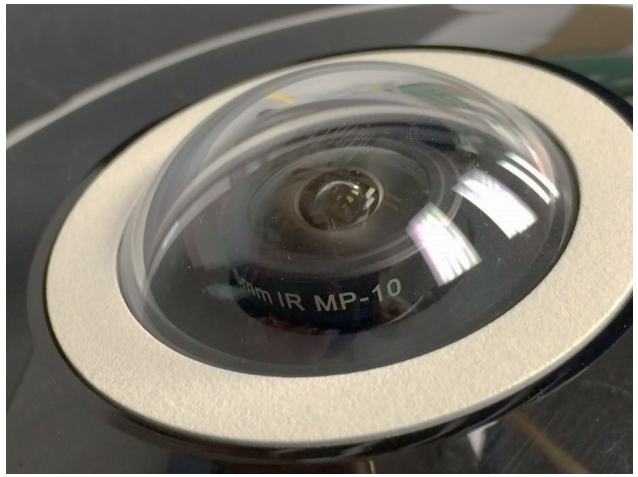
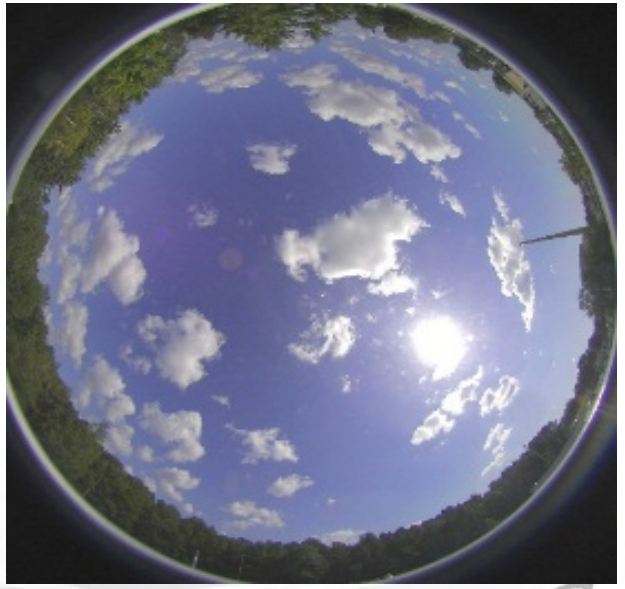
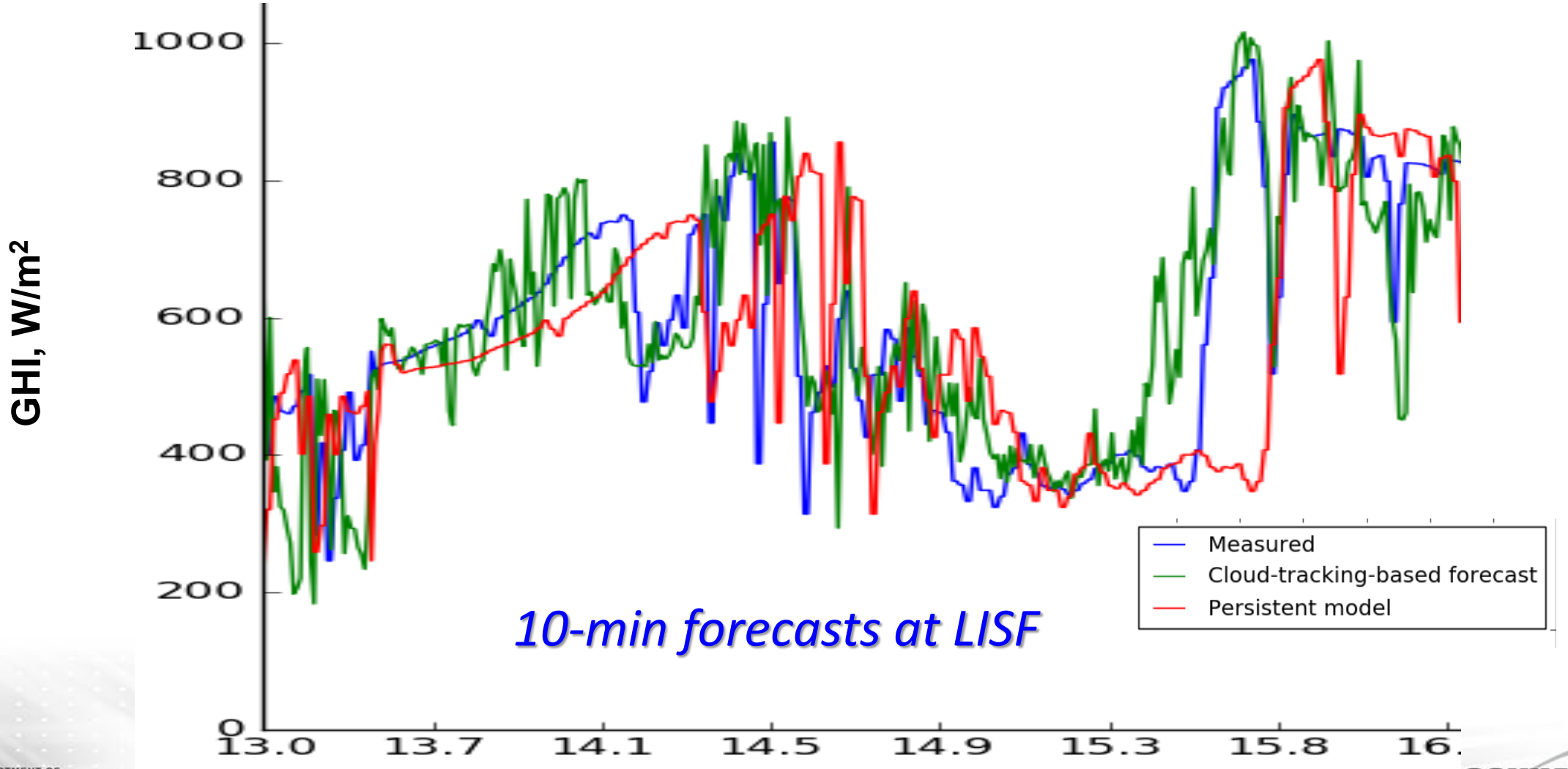
Accomplishments in Phases I and II

- New, low-cost HD sky imagers based on off-the-shelf components facilitate widespread deployment
- Increased resolution and field of view
- Multiple units provide info on cloud location, height
- Coordinated sensor networks expand spatial and temporal forecast horizon (50 km^2, 30 min. ahead)
- Custom software identifies and tracks clouds, calculates projected impact on solar energy production





Nowcast Performance vs. Persistence



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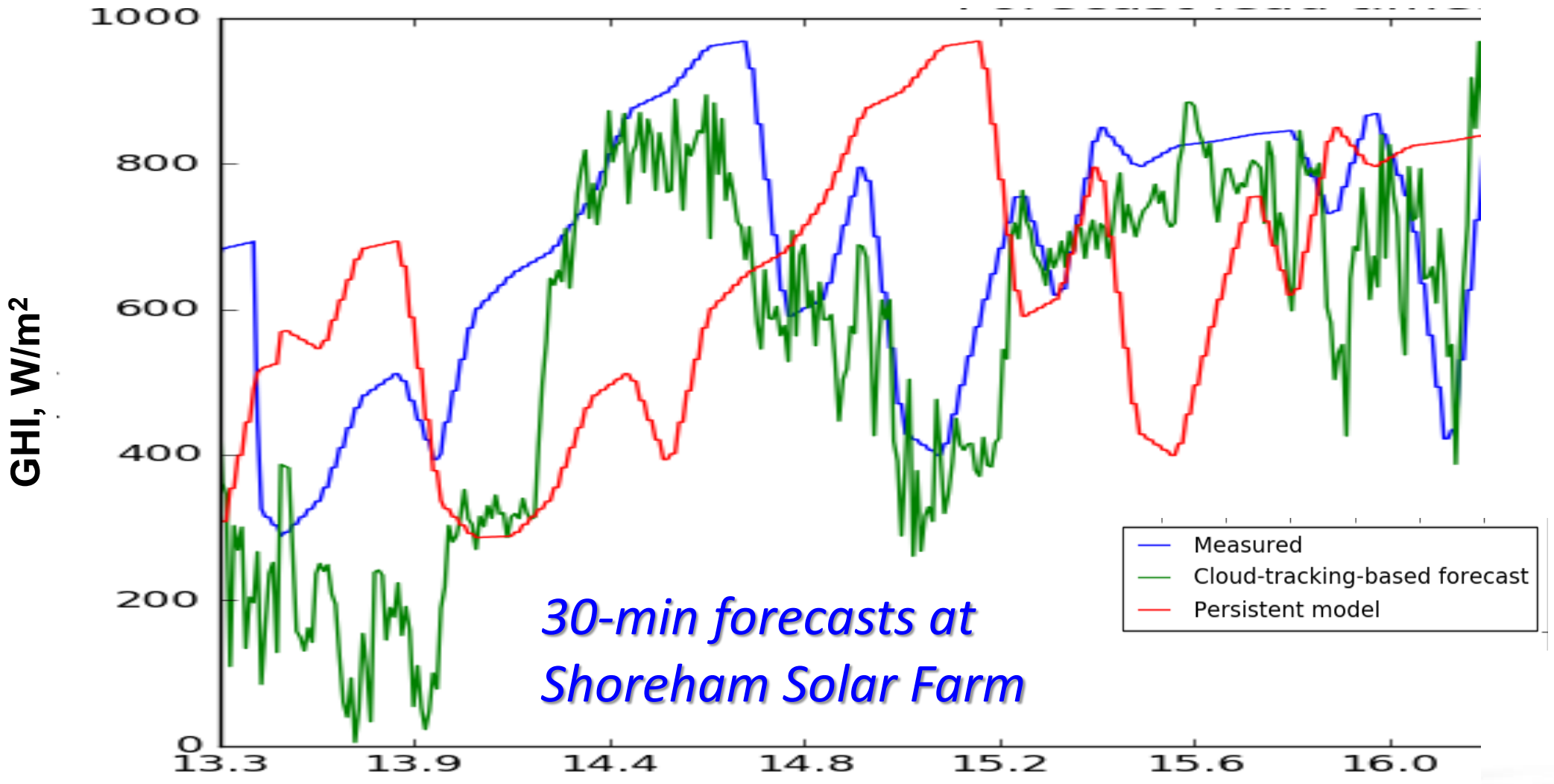
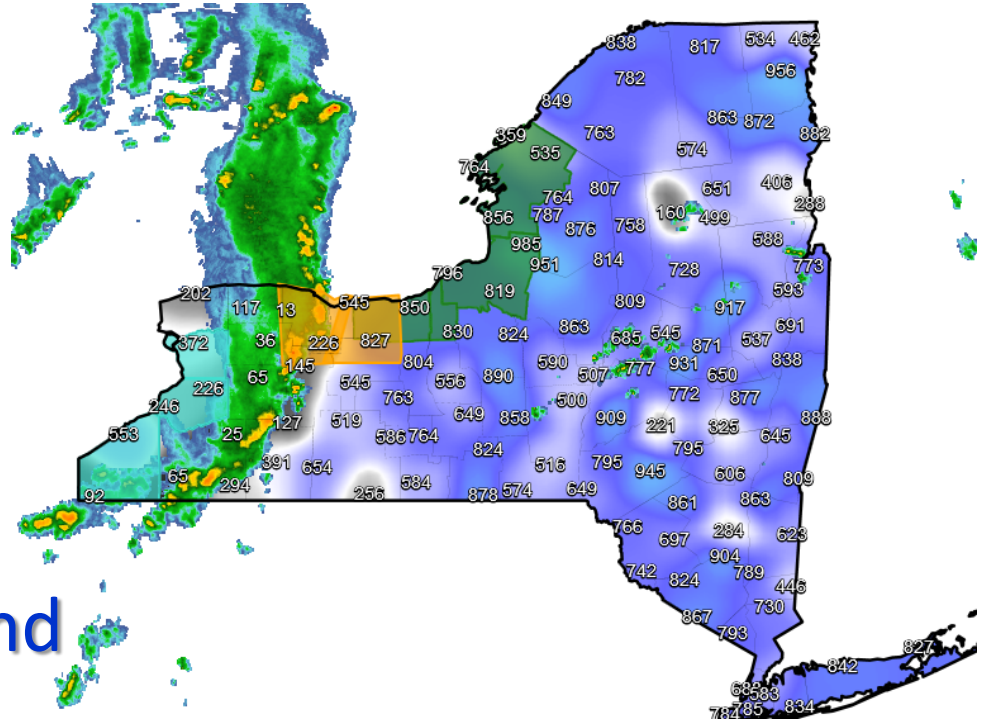


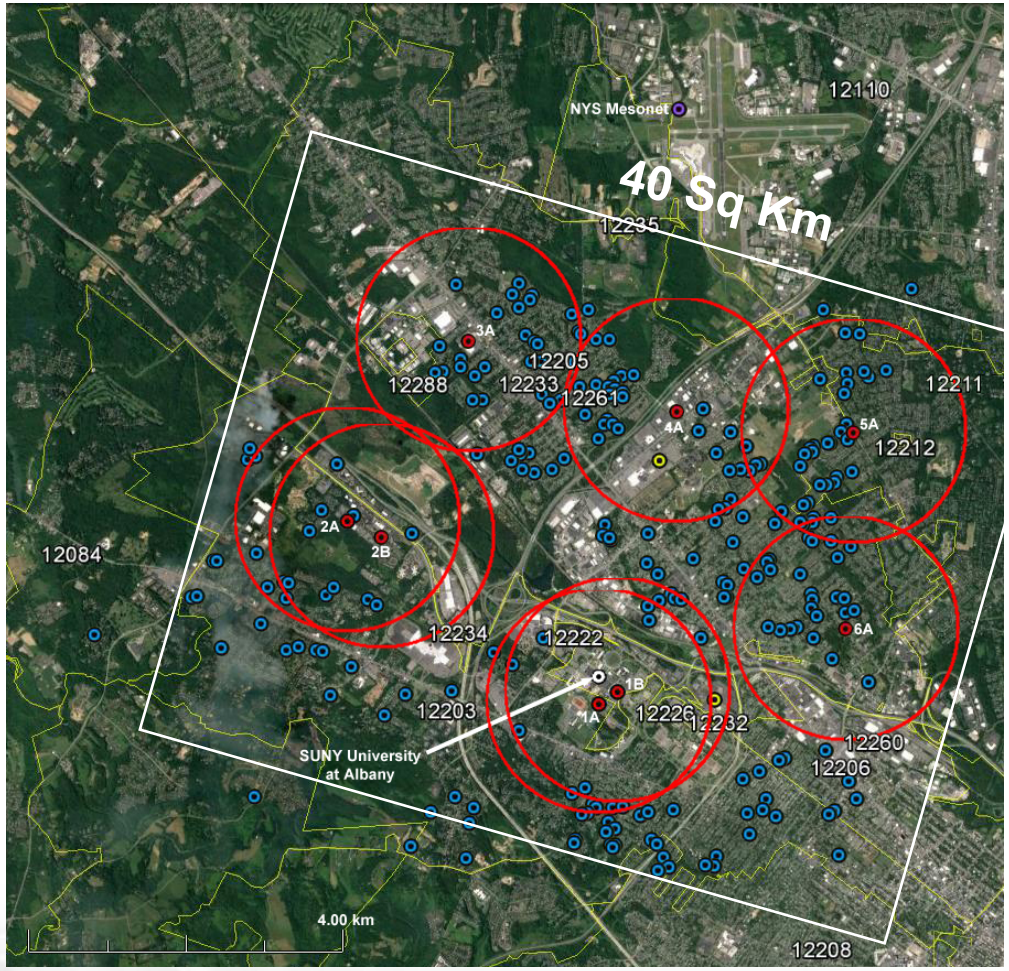
Project Objectives for Phase III

- Deployment of several advanced methods for solar forecasting combined with data from *NYS Mesonet* and other sources over an expanded area in NYS
- Integration of these methods to provide operational tools demonstrated at NYPA and NYISO, and evaluated against forecasts currently in use to show the benefits of the more detailed models and data



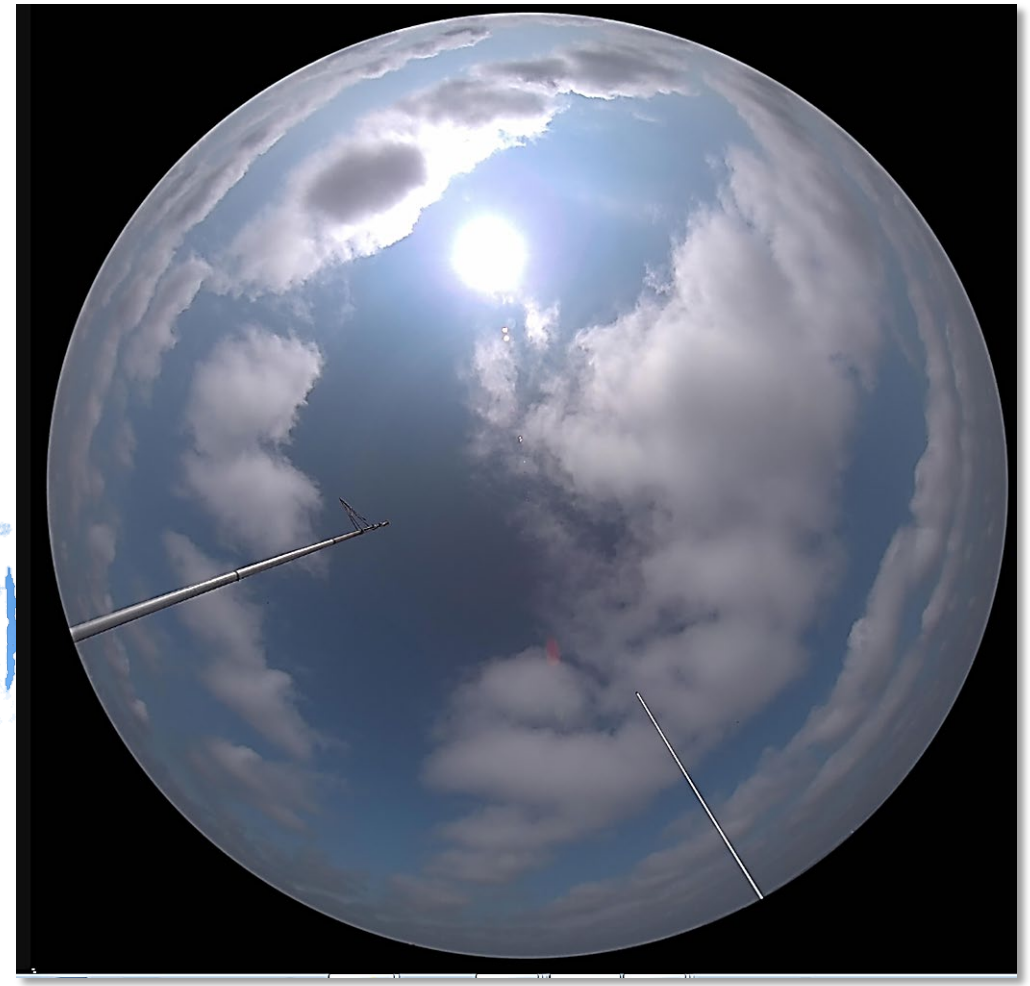
NYS Mesonet: 125 met stations across the state provide data for solar forecasting

Project Objectives for DOE Support of Phase III



Sky imager network in Albany NY

- Assist in deploying a second regional nowcasting network *under different climate conditions* (Albany NY) and oversee its operation for one year. This will provide additional data on system reliability and nowcasting performance in the zero – 30 minute timeframe.



First Imager Installation for Albany Network

Project Objectives for DOE Support of Phase III

- Operate the LI Regional network for one full year to assess system reliability and better define effectiveness of nowcasting predictions under a broad range of seasonal conditions. Compare performance with conventional persistence and “smart persistence” modeling techniques in two distinct climate regions

Tasks and Subtasks for DOE Support of Phase III

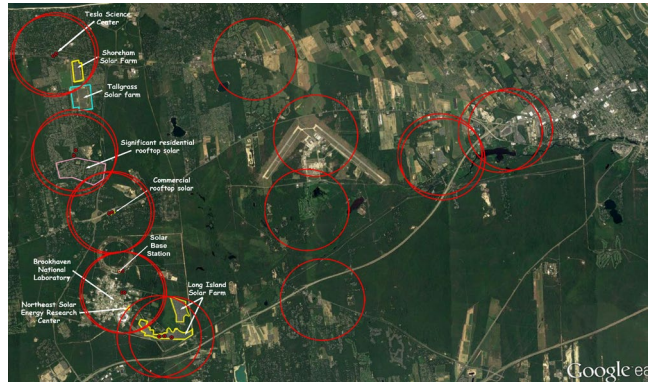
- **Task 1**: Installation/Operation of the Albany Regional Nowcasting Network
- Task Description: Provide assistance to U of Albany in the design, siting, procurement, installation, operation, and assessment of the Albany Regional Nowcasting Network
- Subtasks include Siting, Equipment Procurement, Communications, Hardware, Installations, Software, Operations, and Assessment of Forecast Performance

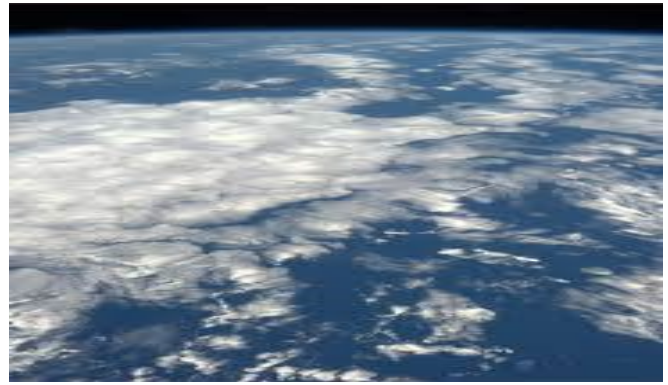
Tasks and Subtasks for DOE Support of Phase III

- **Task 2**: Long Island Regional Forecast Network Installation and Operation
- Task Description: Re-initiate operations of the LI Regional network, collect data for one year, provide quarterly updates on performance compared with persistence and smart persistence
- Subtasks similar to Task 1 (Siting, Equipment Procurement, Communications, Hardware, Installations, Software, Operations, and Assessment of Forecast Performance)

Path Forward

- Expand the spatial and temporal horizons for solar forecasts by:
  - Interpolating between ground-based imager networks
  - Integrating additional data sources, e.g., satellite and/or DSR output
- Enhance the performance of day-ahead forecasts by improving machine learning using satellite and/or DSR output





Path Forward

- Develop documentation, user's manuals, etc. to facilitate tech transfer
- Transfer technology to stakeholder community (utilities, forecast providers, instrument manufacturers)