NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Solar Uncertainty Management and Mitigation for Exceptional Reliability in Grid Operations (SUMMER-GO)

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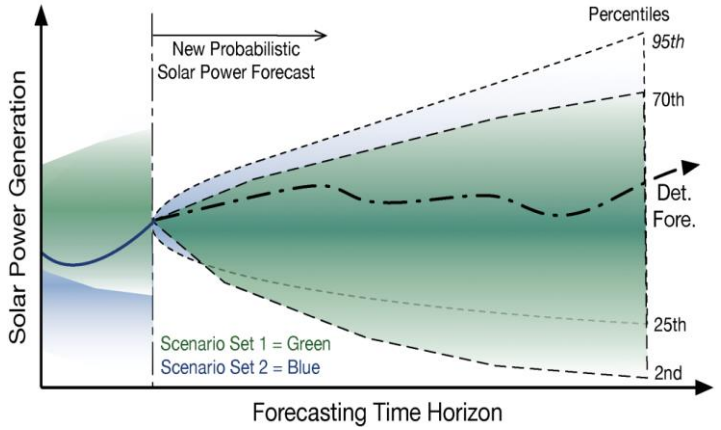
ESIG Meteorology & Market Design Workshop

SUMMER-GO

SUMMER-GO: Solar Uncertainty Management and Mitigation for Exceptional Reliability in Grid Operations

SUMMER-GO will bring probabilistic solar forecasts into ERCOT's real-time operation environment through automated reserve and dispatch tools that increase economic efficiency and improve system reliability.

- Develop accurate, calibrated, and sharp probabilistic solar power forecasts for both ***hourly*** and ***5-minute*** resolution
- Develop and validate risk-parity economic dispatch for ***5-minute dispatch period***
- Develop and validate adaptive reserves algorithm to ***reduce flexibility and regulation reserves*** and ***deploy in ERCOT'S iTest system***
- Produce situational awareness tool to present timely information for ***better decision making***



University of Colorado Boulder · RASEI Renewable and Sustainable Energy Institute · ercot · MAXAR Technologies · UT Dallas · Berkeley University of California

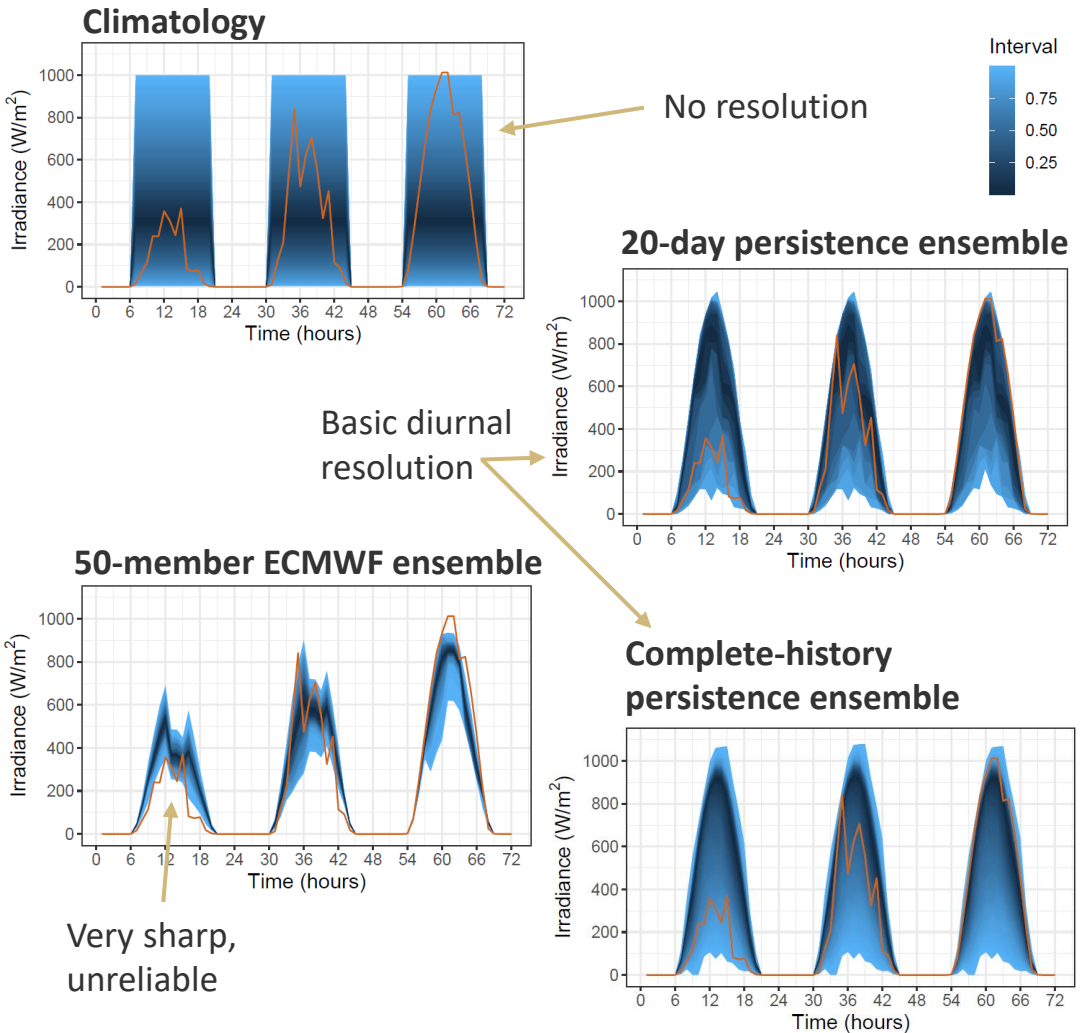
Research on Probabilistic Forecast Benchmarks

How do we properly assess improvement in probabilistic forecast methods?

What are the most common and/or useful probabilistic solar forecast benchmarks?

Illustrated characteristics and recommended implementations of benchmark probabilistic methods

- 5 methods implemented at hourly-resolution for day-ahead forecast
- 5 methods implemented at 5-minute resolution for hour-ahead forecast
- Code shared with Project Area 1 Team and open-sourced on Github
- SolarArbiter implemented persistence ensemble as a standard benchmark



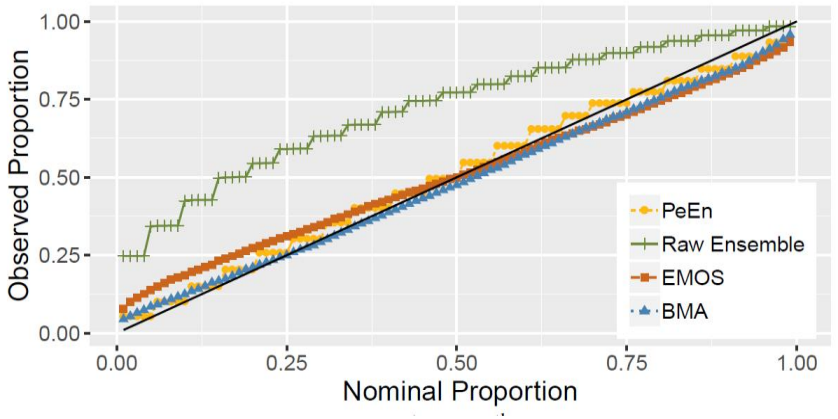
Advanced Probabilistic Forecast Methods

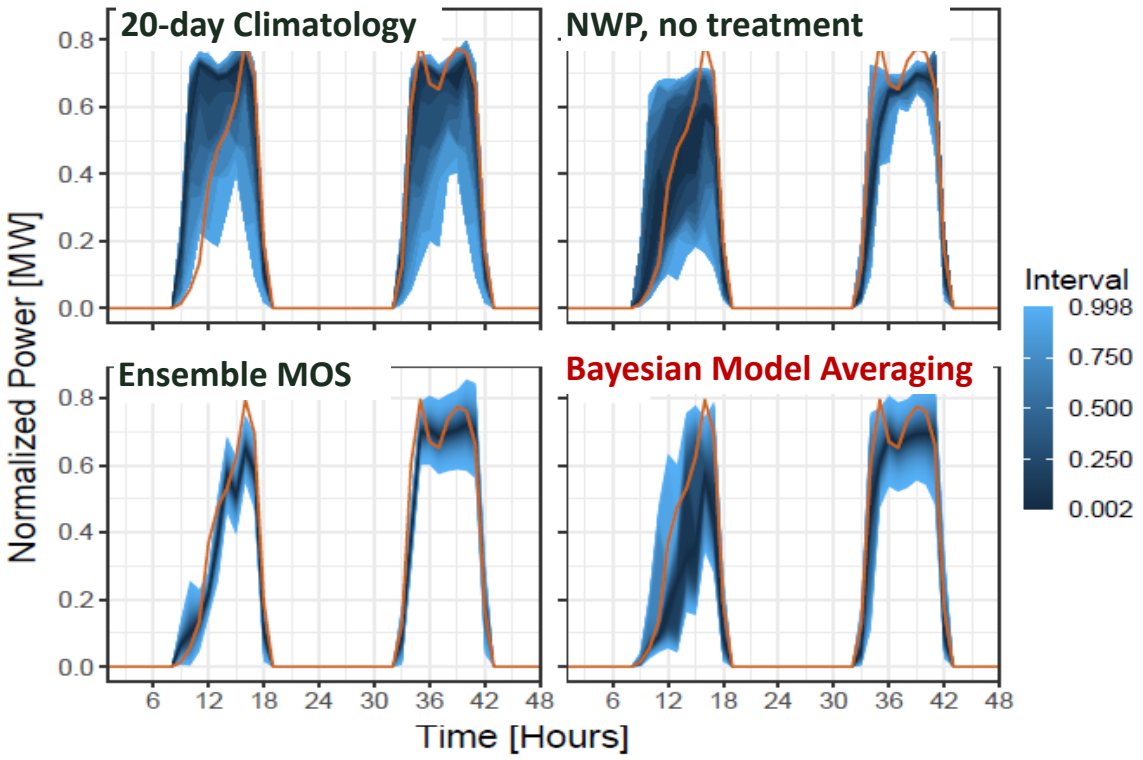
Developed new Bayesian model averaging (BMA) method to post-process NWP ensembles

BMA regularly outperforms ensemble MOS

- Better Continuous Ranked Probability Scores (proper probabilistic metric)
- Better tail behavior
- Ensemble MOS's single parametric distribution can fail to capture disagreements in the ensemble

Ensemble model output statistics (MOS) uses normal kernel based on a weighted sum of members and ensemble variance





Forecast Production - Maxar

Forecast	Start	NWP ensemble set	Percentile Algorithm	Percentiles	Update interval	Lead times
Operational	2016	small	Old: Maxar	20, 50	60 min	Hours 1-168
SUMMER-GO 1	Sep 30 2019	medium	Old: Maxar	1,2,3,…,99	5 min	Every 5 min to 48 hours[2]
SUMMER-GO 2	March 2020	large	Old: Maxar	1,2,3,…,99	15 min[1]	Every 5 min to 2 full hr, then every hour to 48 hr
SUMMER-GO 3	August 2020	large	New: BMA	1,2,3,…,99	15 min	Every 5 min to 2 full hr, then every hour to 48 hr

Table 9. Characteristics of operational and 3 SUMMER-GO experimental power forecasts. [1]Update interval 5 minutes starting February 12, 2021. [2]Lead times to 24 hours starting March 4, 2021

Model	Updates per day	Medium ensemble # members in set	Medium ensemble # time lags	Large ensemble # members in set	Large ensemble # time lags	total NWP sources/ day
ECMWF	4	1	3	1	3	4
ECMWF ensembles	4	mean only	3	51	1	204
High Res Rapid Refresh	24	1	3	1	15	24
Rapid Refresh	24	1	3	1	15	24
GFS	4	1	3	1	3	4
GFS ensembles	4	mean only	3	30	1	120
SREF – NMMB	4	mean only	3	13	1	52
NAM	4	1	3	1	3	4
Canadian Global	2	1	3	1	2	2
Canadian Global Ens	2	mean only	3	20	1	40
Canadian Regional	4	1	3	1	3	4
Canadian Regional Ens	4	mean only	3	20	1	80
Total NWP		**36 x 2 power curves=72**		**178 x 2 power curves =356**		
5-min Smart Persistence	**288**	**1**	**3**	**1**	**24**	

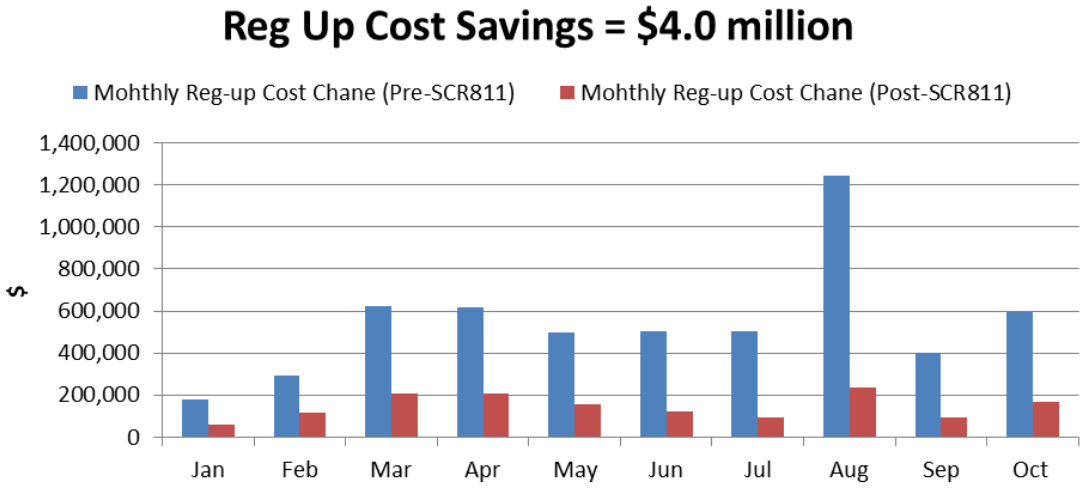
Table 10. NWP ensemble sets used in the experimental forecasts.

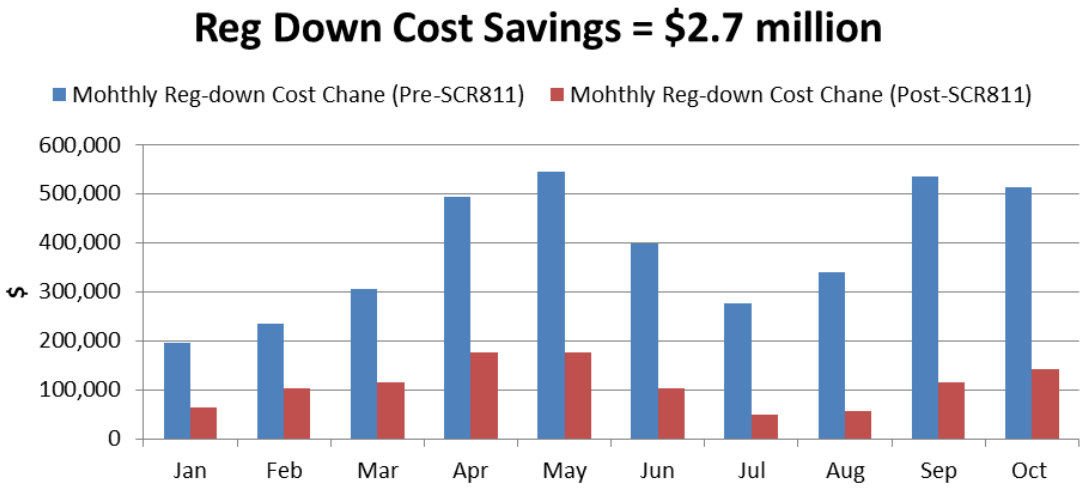
Advances to ERCOT's Operational Solar Forecasts

Temporal Resolution

- *Previously:* Hourly resolution
- *Now:* 5-minute resolution for first 2 hours, then hourly

- Currently testing in iTest system
- Will be operational on May 27nd
- ERCOT estimates $6-7 million savings from using new forecast in regulation reserve calculations





Advances to ERCOT's Operational Solar Forecasts

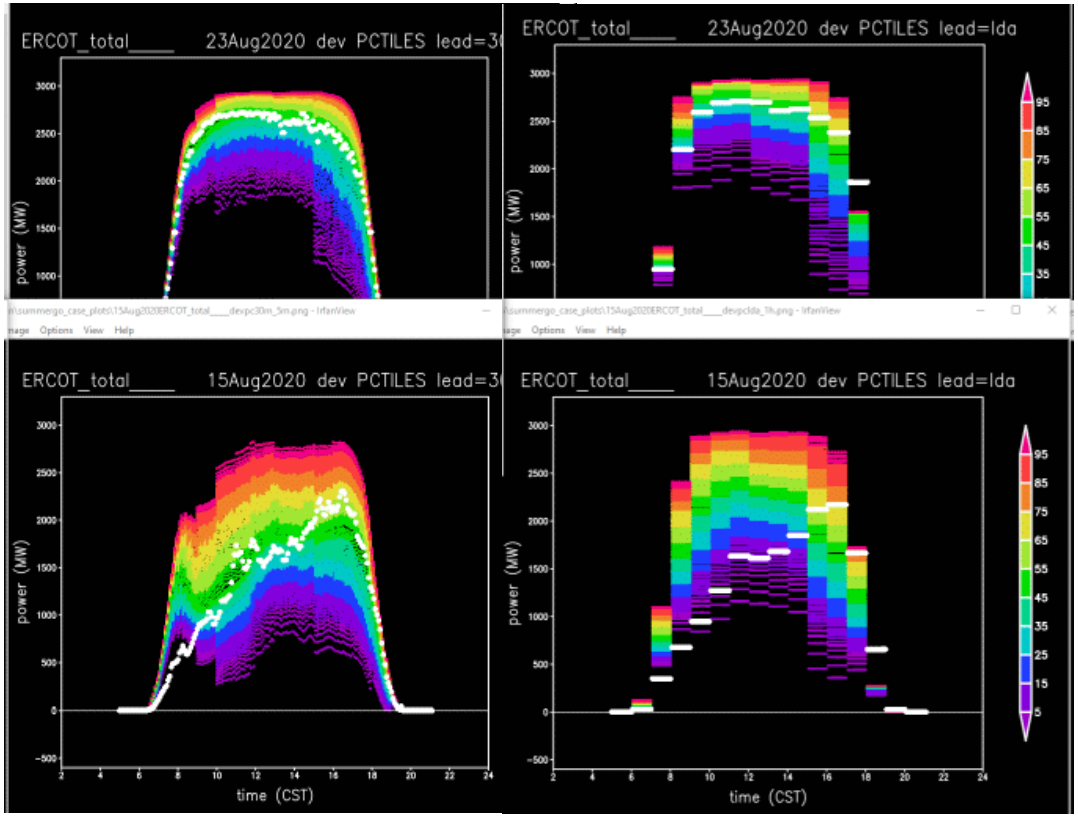
Probabilistic Format

- *Previously*: Point forecast (50th) and 20th percentile
- *Now:* All 99 percentiles available
- Maxar already providing operationally based on much larger NWP ensemble
- Upgrade to ERCOT's EMS to ingest new format

5-minute resolution, rolling 30-minute ahead ***Hourly resolution, Day ahead***

Sunny

Cloudy



Thank You

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