Using GEOS-5 Forecast Products to Represent Aerosol Optical Depth in Operational Day-ahead Solar Irradiance Forecasts for the Southwest United States.

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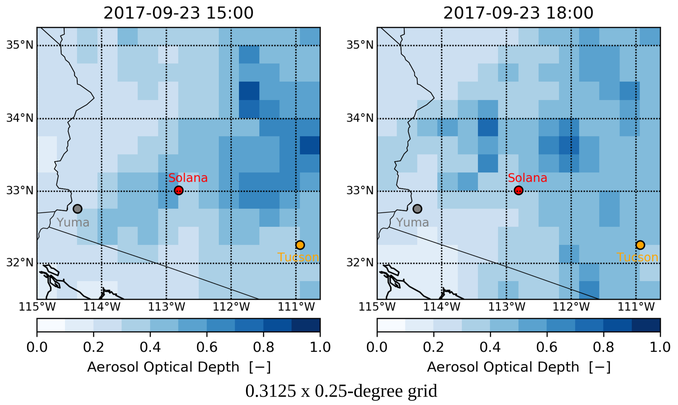
Motivation

- Stakeholders need an accurate forecast of solar variables which can be converted to expected power supply from solar panels.
- Load balancing, dispatching reserves, curtailing production, and energy storage are all management decisions informed in part by solar energy forecasts.
- Default weather forecasts usually do not account for changes in AOD, but WRF has different aerosol options available.

Forecasting AOD

- To target the *direct* effect of aerosols on radiation, the radiation parameterization scheme (RRTMG) allows user specified AOD: climatology (Tegen et al, 1997), single values or gridded data (GEOS-5).
- GEOS-5 is an Earth-system model housing a prognostic aerosol module based on GOCART, provides short-term gridded forecasts of AOD.



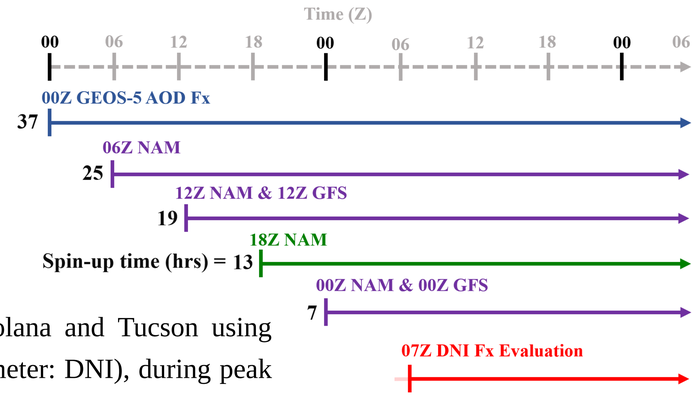
0.3125 x 0.25-degree grid

Data Processing

- GEOS-5 AOD forecasts are extracted and interpolated to a WRF-grid using a 4-point bi-linear method, at the WPS stage.
- Operationally missing forecasts are filled with the previous available day's forecast.

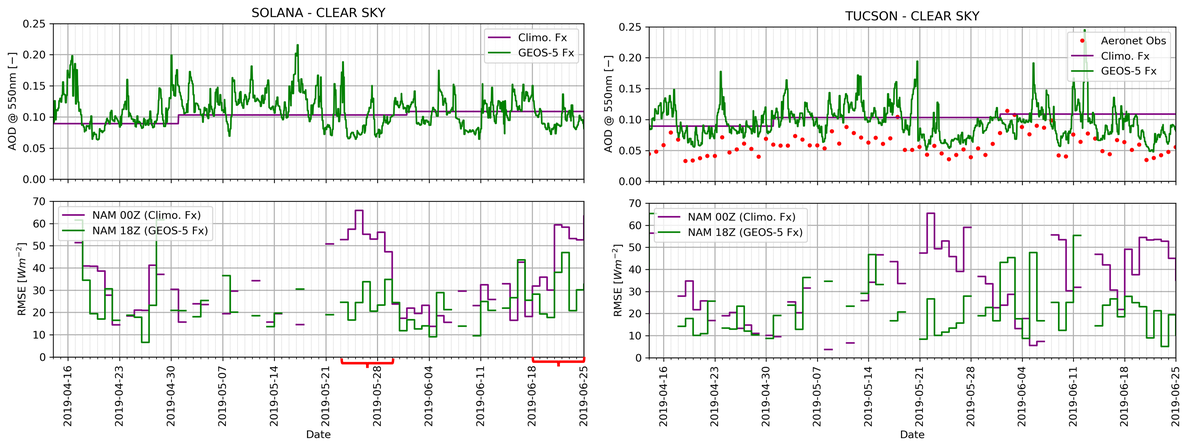
Forecast Configuration

- The script to operationally download and process the GEOS-5 data to be used in WRF is available on GitHub at https://github.com/UARENForecasting/gridded-aerosols
- WRF (version 3.9.1.1) is used on a 456x599 grid with a horizontal spacing of 5.4 km and 38 vertical levels, with specific aerosol options selected: auxinput15, aer_opt = 2, aer_aod550_opt = 2.



- We evaluate WRF DNI forecasts at Solana and Tucson using industry standard instruments (Pyrheliometer: DNI), during peak sun hours (8am-4pm) and during clear sky times.

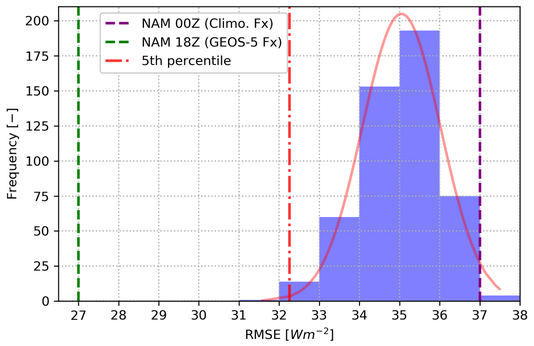
Clear-Sky Operational Analysis



- GEOS-5 AOD forecasts over-estimate AERONET AOD observations at Tucson.
- Using GEOS-5 AOD Fx avoids big misses that happen when using the Tegen climatological AOD data set because GEOS-5 AOD forecasts capture the inter-day variability of AOD.

Solana	**GFS 00Z**	**GFS 12Z**	**NAM 00Z**	**NAM 12Z**	**NAM 18Z**	**Tucson**	**GFS 00Z**	**GFS 12Z**	**NAM 00Z**	**NAM 12Z**	**NAM 18Z**
	Climo. Fx				**GEOS-5**		**Climo. Fx**				**GEOS-5**
RMSE [Wm^{-2}]	36	37	37	37	27	**RMSE [Wm^{-2}]**	34	34	35	36	25
MBE [Wm^{-2}]	-22	-21	-21	-22	-13	**MBE [Wm^{-2}]**	-22	-19	-21	-21	-8
SS_{NAM00z}	0.01	0.01	0.00	0.00	0.27	**SS_{NAM00z}**	0.02	0.01	0.00	-0.03	0.29

- We performed a bootstrap randomization technique on all ensemble members to study statistical significance.



Conclusions

- **No discernible difference in UA WRF DNI forecasts with different initialisations.**
- **NAM 18Z with GEOS-5 AOD forecasts reduces DNI errors by approximately 25%.**
- **Now operational UA forecasts use GEOS-5 AOD forecasts on all ensemble members.**

http://www.atmo.arizona.edu/?section=weather&id=wrf

Future Work

- To address errors in cloudy conditions: we could incorporate an aerosol aware microphysics scheme in the configuration, however there are no short-term forecasts of (non-) hygroscopic aerosols currently available, or WRF options for including these fields.

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