TABLE I

ERROR STATISTICS CALCULATED OVER 1200 SATELLITE CLEAR-SKY INDEX ESTIMATES AND OI CORRECTED ANALYSIS. BOTH THE EMPIRICAL (EM) MODEL AND UASIBS MODEL DESCRIBED IN SEC. II-C ARE SHOWN. THE MEAN ABSOLUTE ERROR (MAE), ROOT MEAN SQUARED ERROR (RMSE), AND MEAN BIAS ERROR (MBE) ARE CALCULATED OVER ALL THE WITHHELD SENSORS AND ALL IMAGE TIMES AS A SINGLE TIME-SERIES. STATISTICS WERE CALCULATED FOR ALL DAYS, ONLY CLEAR DAYS (ROUGHLY 700 DAYS), AND CLOUDY DAYS (500 DAYS). ALL NUMBERS ARE IN UNITS OF CLEAR-SKY INDEX WHICH HAS A TYPICAL RANGE OF 0 TO 1.3.

	MAE			RMSE			MBE		
	All	Clear	Cloudy	All	Clear	Cloudy	All	Clear	Cloudy
EM analysis	0.088	0.048	0.149	0.172	0.095	0.245	0.026	0.021	0.033
EM background	0.184	0.152	0.231	0.268	0.213	0.333	0.138	0.140	0.136
UASIBS analysis	0.080	0.039	0.141	0.164	0.088	0.235	-0.005	-0.004	-0.006
UASIBS background	0.094	0.047	0.164	0.190	0.099	0.275	-0.015	-0.003	-0.034

TABLE II

ERROR STATISTICS CALCULATED OVER 1200 SATELLITE GHI ESTIMATES AND OI CORRECTED ANALYSIS FOR THE CALIBRATED NREL MIDC SENSOR. BOTH THE EMPIRICAL (EM) MODEL AND UASIBS MODEL DESCRIBED IN SEC. II-C ARE SHOWN. THE MEAN ABSOLUTE ERROR (MAE), ROOT MEAN SQUARED ERROR (RMSE), AND MEAN BIAS ERROR (MBE) ARE CALCULATED OVER ALL IMAGE TIMES AS A SINGLE TIME-SERIES. STATISTICS WERE CALCULATED FOR ALL DAYS, ONLY CLEAR DAYS (ROUGHLY 700 DAYS), AND CLOUDY DAYS (500 DAYS). UNITS ARE W/m^2.

	MAE			RMSE			MBE		
	All	Clear	Cloudy	All	Clear	Cloudy	All	Clear	Cloudy
EM analysis	56.0	23.4	104.	113.	32.3	174.	16.1	17.3	14.3
EM background	110.	85.7	145.	144.	97.0	194.	75.0	83.8	61.9
UASIBS analysis	50.9	17.5	101.	110.	26.4	171.	2.94	6.96	-3.03
UASIBS background	53.1	16.4	108.	120.	27.9	186.	-12.4	3.02	-35.2

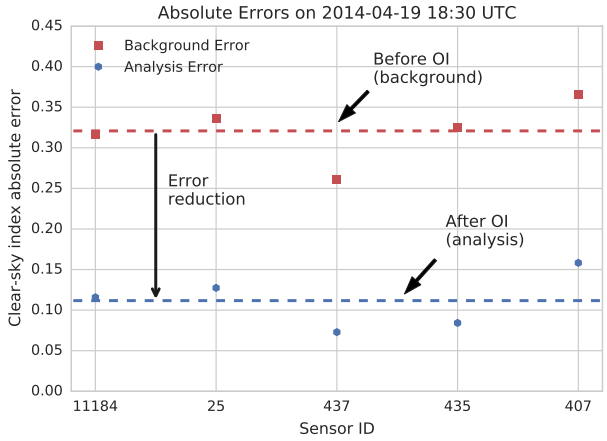

Fig. 3. A plot of the absolute error in the analysis and background images (generated with UASIBS) as compared to observations at some sensor locations showing reduced errors for a single satellite image. The sensors shown were not included in the OI correction routine. Note that sensor 11184 is the MIDC calibrated irradiance sensor and sensors 437, 435, and 407 are rooftop PV systems. The red squares indicate the absolute error in the background image while the blue circles indicate the error in the analysis. The dashed lines indicate the mean absolute errors for the sensors shown.

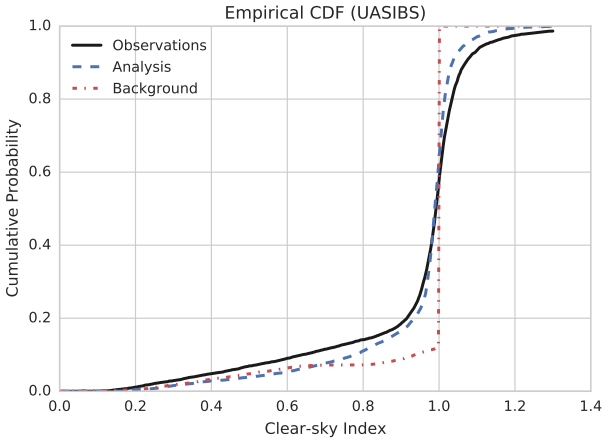

Fig. 4. UASIBS empirical cumulative distribution function. The black line is the CDF of the observations, the red dashed-dotted line is the CDF of the background, and the blue dashed line is the CDF of the analysis. The UASIBS background does not predict clear-sky indices around 0.8 and does not extend beyond 1.0. The analysis shows better agreement with the observed CDF.

IV. DISCUSSION

Our results show significant improvement by the OI for the EM model. Improvements for the UASIBS model are more modest. The reasons for this are as follows. UASIBS is a more sophisticated satellite image to GHI model, so that improvements are harder to obtain. In particular, the average error values shown in the tables above differ from the large improvements we have seen on many days, and illustrated in Fig. 3. We suspect that average errors are likely to be affected by large errors occurring only on some days due to parallax.

Parallax refers to the discrepancy between the actual location of a cloud and the location tagged by a satellite [9]. The GOES-W satellite is located at 135°W on the equator while Tucson, AZ is at roughly 32°N and 110°W, so the satellite is viewing the clouds at an angle. The satellite geolocates each pixel as if it were at the surface. This means that a cloud