Projection of SORCE Total Solar Irradiance Measurements 5-10 Days Forward for Near Real-Time Applications

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Background and Motivation

- SORCE TSI Version-14 daily data (up to 30 June 2013) currently in use for CERES processing.

- Planned to use SORCE TSI for a CERES sub-project. FLASHFlux: Fast Longwave and Shortwave Radiative fluxes.

- TOA and Surface LW and SW fluxes in one week of real-time.

- Satellite observations and coincident meteorology from GMAO available within 2 days of real-time.

- TSI data needed to start processing. Seven-day latency of SORCE created the need to project TSI at least 5 days forward.

- Objective was to accomplish this with minimal uncertainty even though no expectation of projecting day-to-day fluctuations.
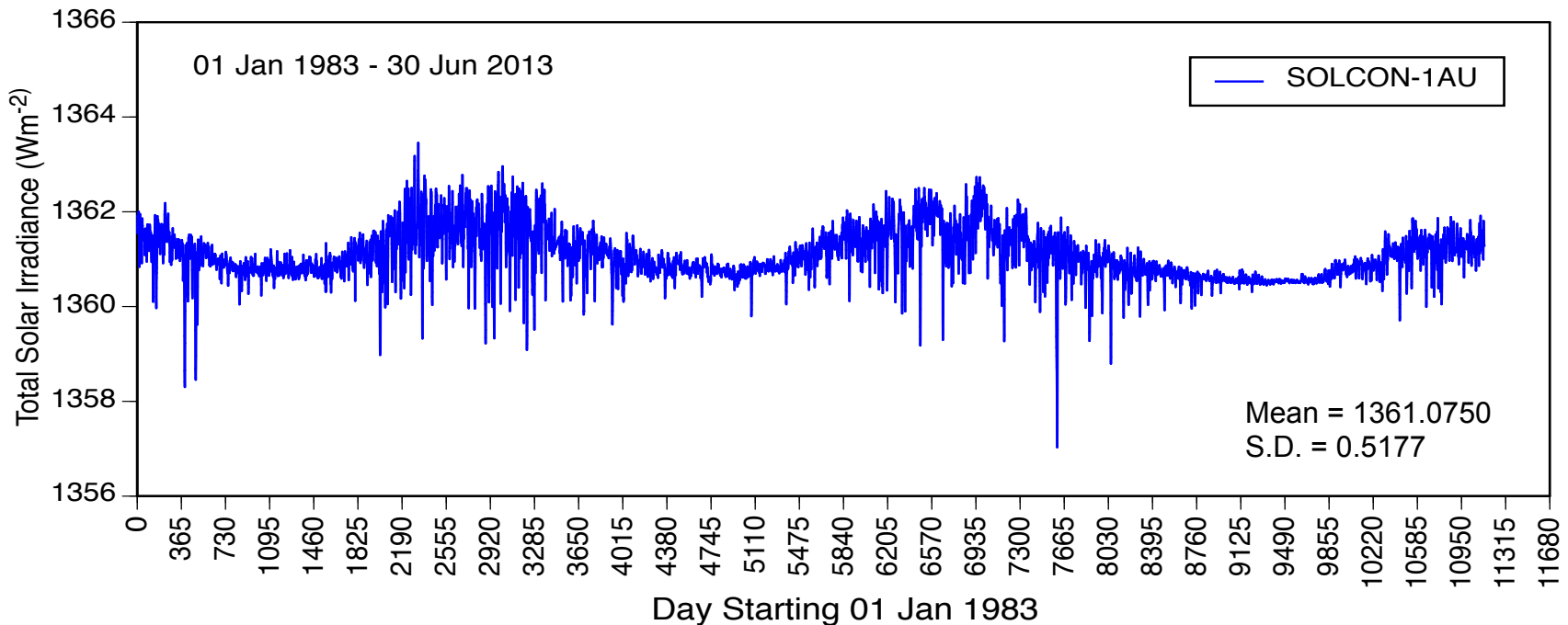
SORCE Interruption and Source Change

- With interruption of SORCE data in July 2013, plans changed.

- ACRIM3 data was considered. Latency generally too long.
  In late January 2014, data available to 17 September 2013.

- Composite dataset from RMIB considered. Latency less
  than one month. Data available up to 07 January 2014.

- RMIB composite can be used for CERES, not for FLASHFlux.

- Hoping that TCTE data will come online soon and will be
  available with a latency comparable to that of SORCE.

- Explored statistics of available data for help in projection.
  Long timeseries in hand allowed testing of our methods.

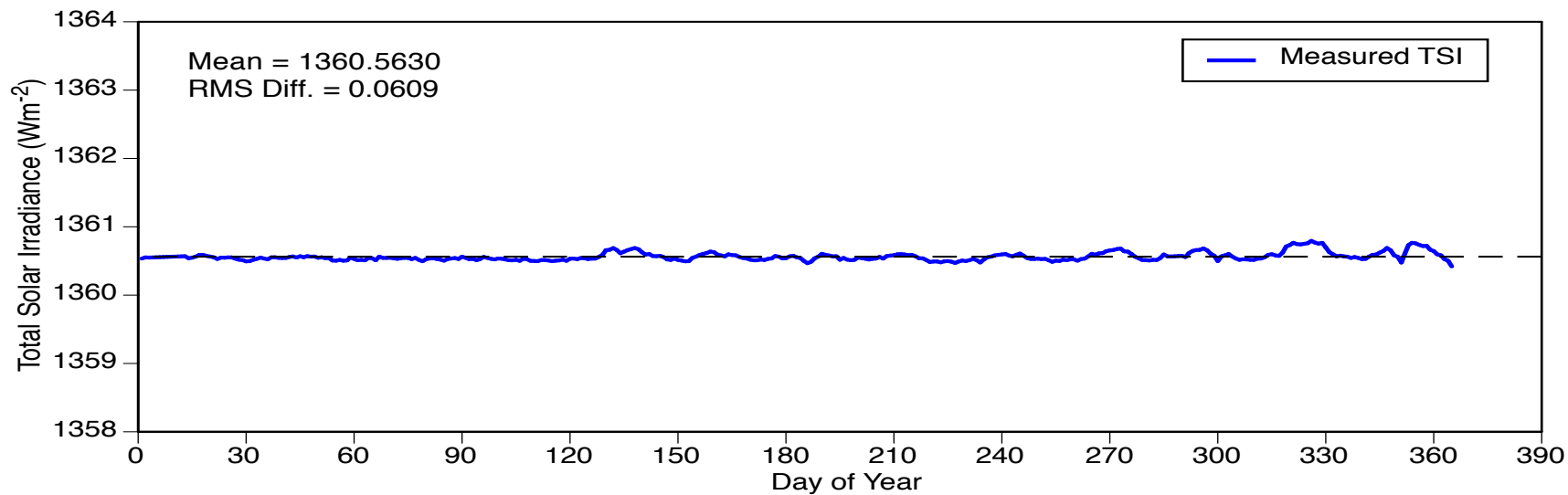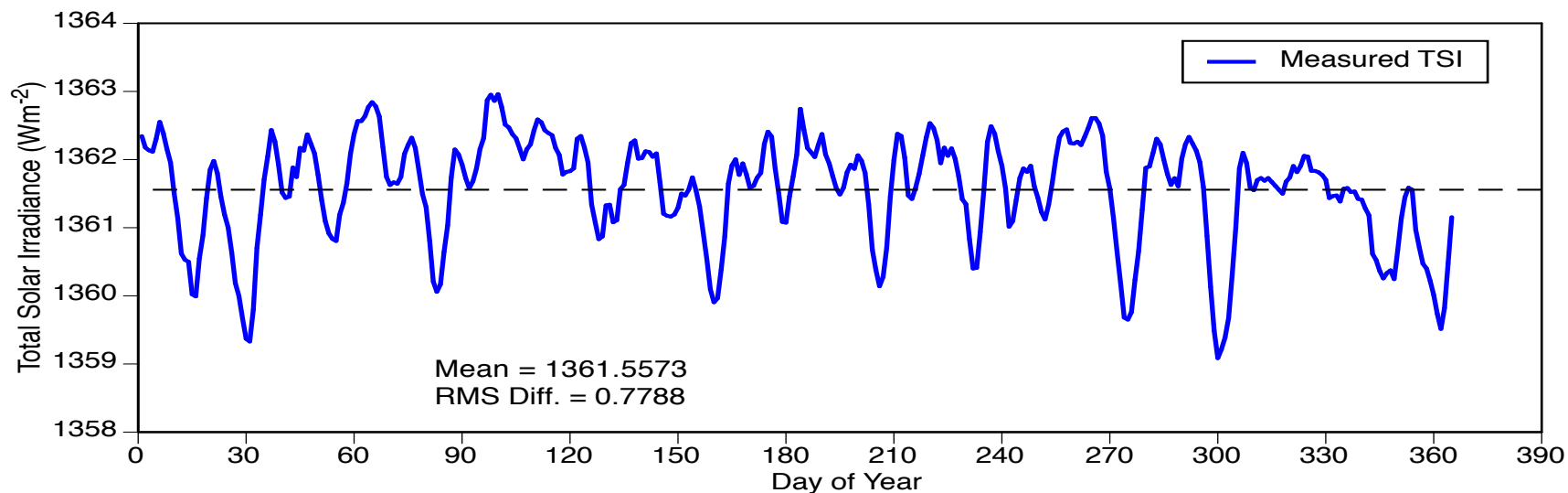Climate Science Branch, NASA Langley Research Center

Statistics Explored

- Value for last available day (i.e., persistence) and averages over previous 10, 30, and 90 days examined.

- Two sample years were chosen for study.

  Year of high sunspot activity - 1991

  Year of low sunspot activity – 2009
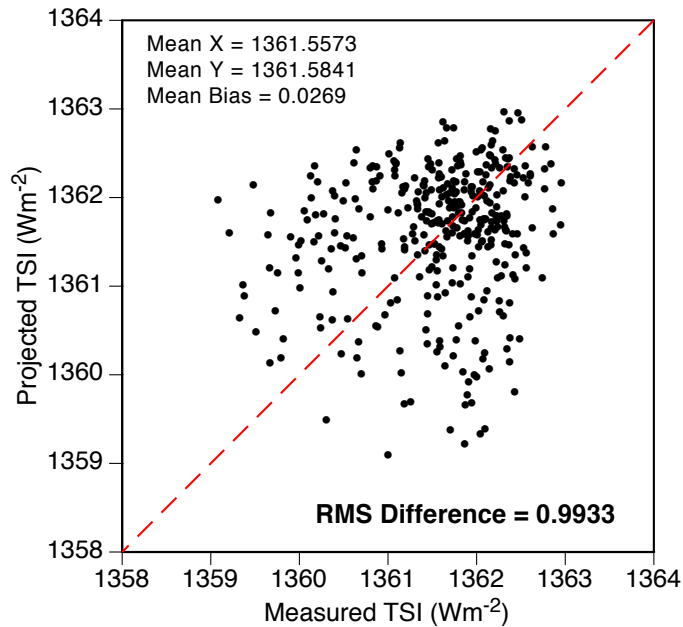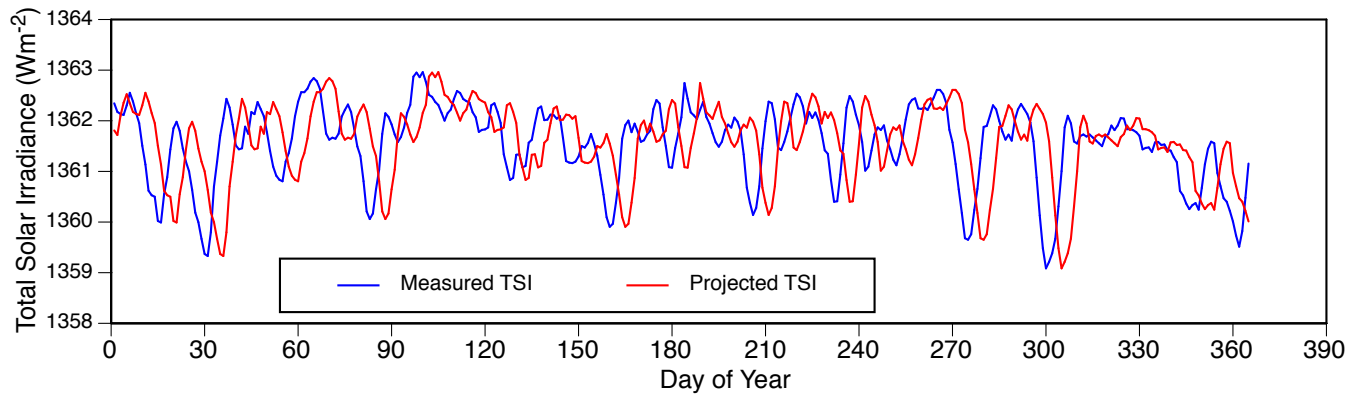
- 1991 data is WRC composite offset to match SORCE.

01 Jan 1983 - 30 Jun 2013

SOLCON-1AU

Total Solar Irradiance (Wm^{-2})

Day Starting 01 Jan 1983

Mean = 1361.0750
S.D. = 0.5177

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TSI Timeseries for 1991 (upper) and 2009 (lower)

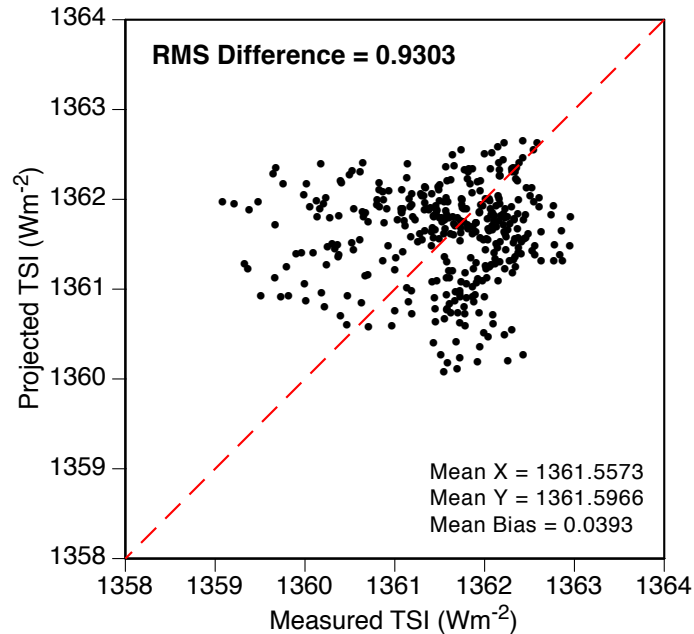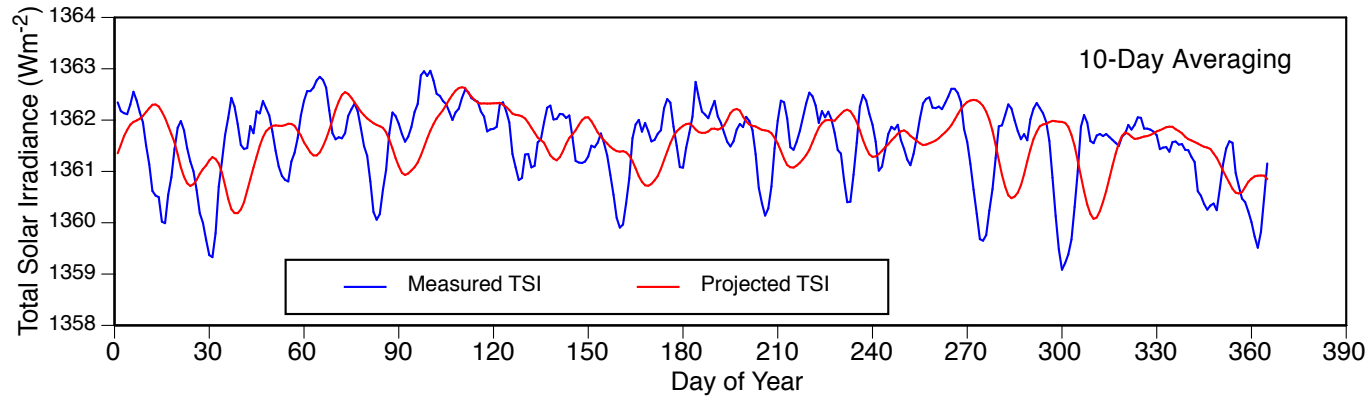Climate Science Branch, NASA Langley Research Center

Projection by Persistence - 1991

5-Day Projection Based on Persistence for 1991

Mean X = 1361.5573
Mean Y = 1361.5841
Mean Bias = 0.0269

RMS Difference = 0.9933

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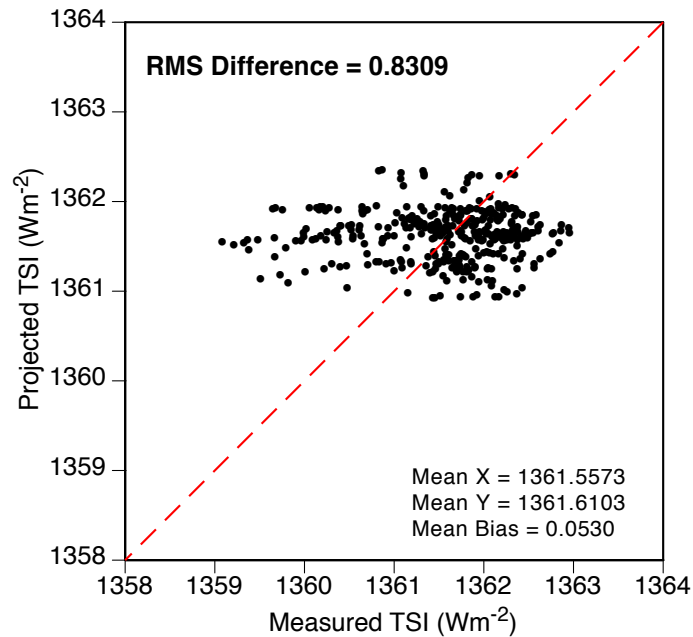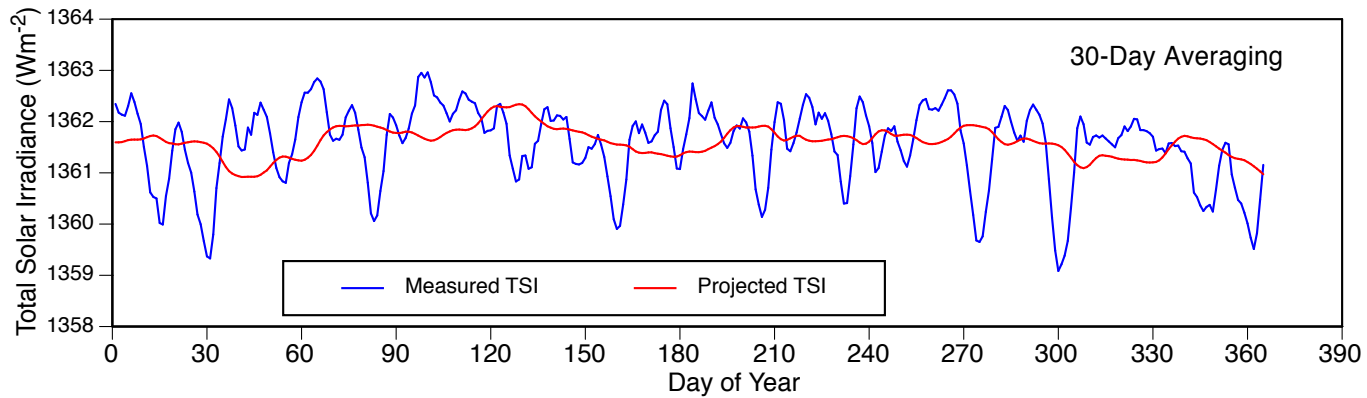
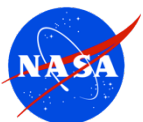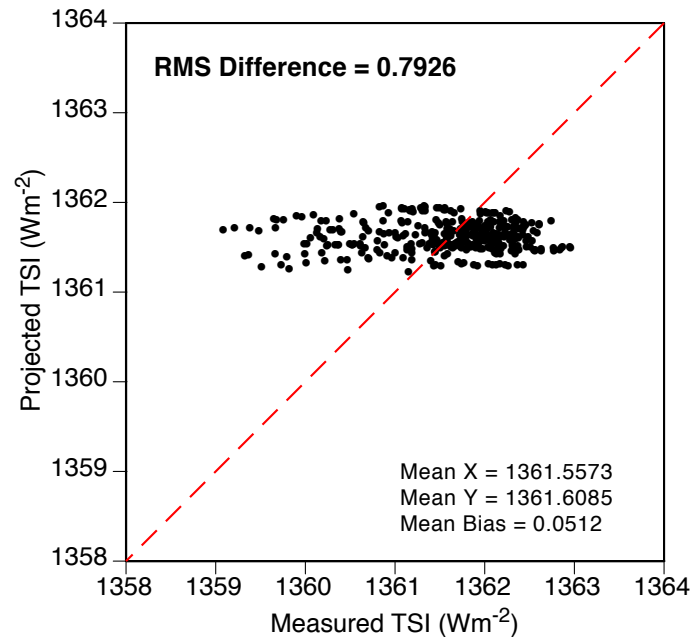Projection by 10-Day Averaging - 1991

Projection by 30-Day Averaging - 1991

5-Day Projection by 30-Day Averaging for 1991

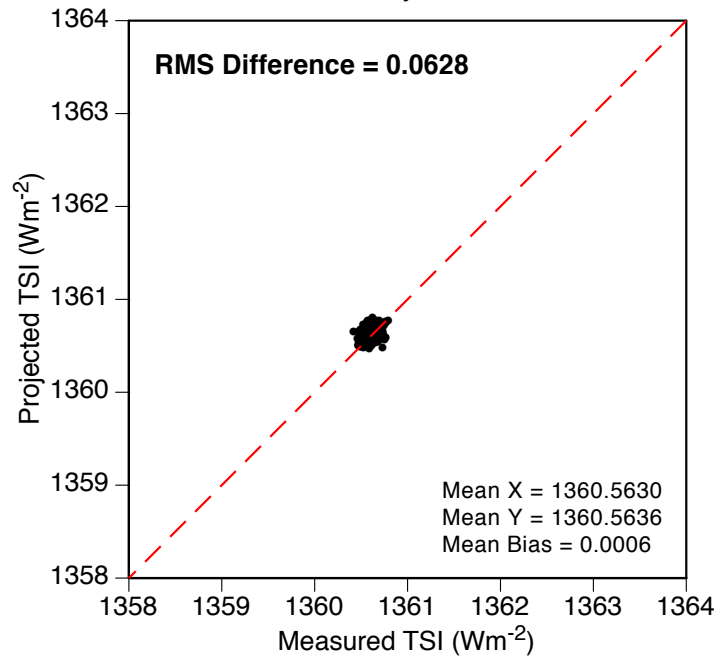**Climate Science Branch, NASA Langley Research Center**

Projection by 90-Day Averaging - 1991

5-Day Projection by 90-Day Averaging for 1991

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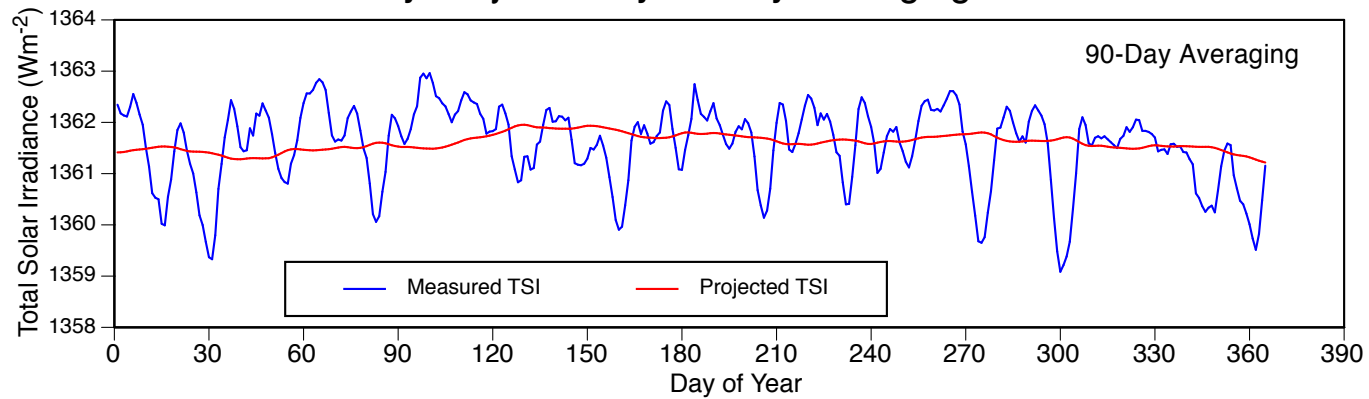
Projection by Persistence - 2009

5-Day Projection Based on Persistence for 2009

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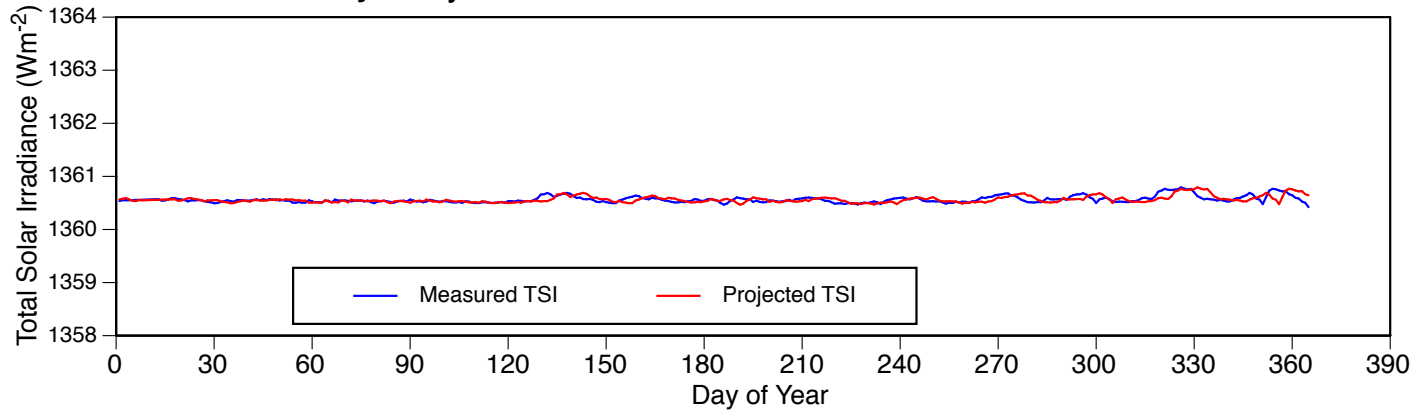
Projection by 10-Day Averaging - 2009

5-Day Projection by 10-Day Averaging for 2009
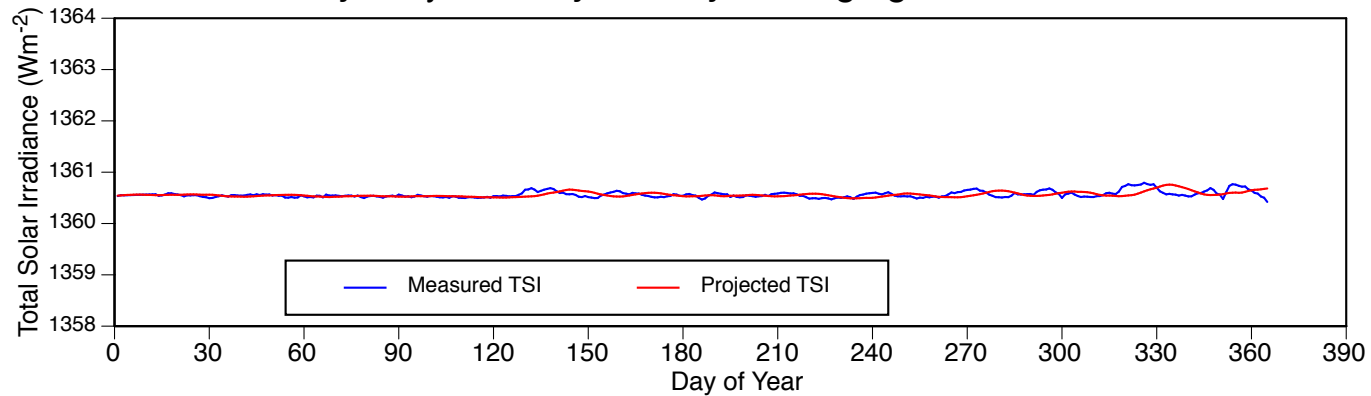
RMS Difference = 0.0707

Mean X = 1360.5630
Mean Y = 1360.5617
Mean Bias = -0.0013

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Projection by 30-Day Averaging - 2009

5-Day Projection by 30-Day Averaging for 2009

RMS Difference = 0.0577

Mean X = 1360.5630
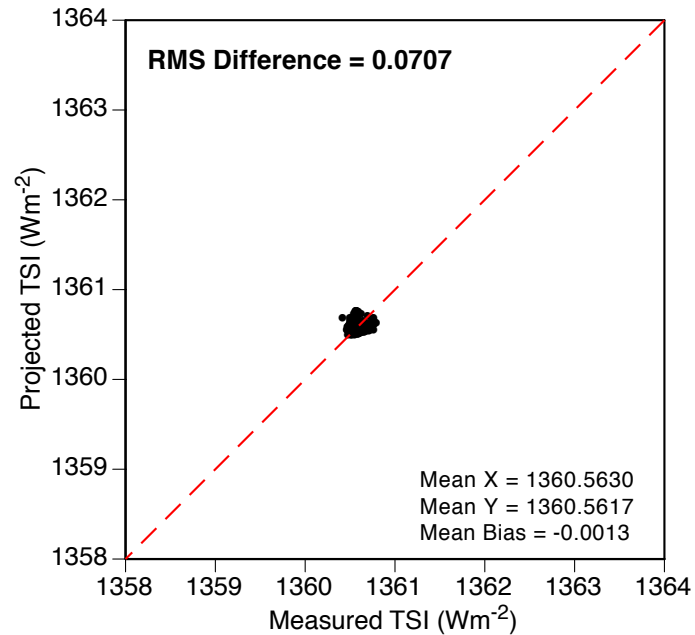Mean Y = 1360.5590
Mean Bias = -0.0040

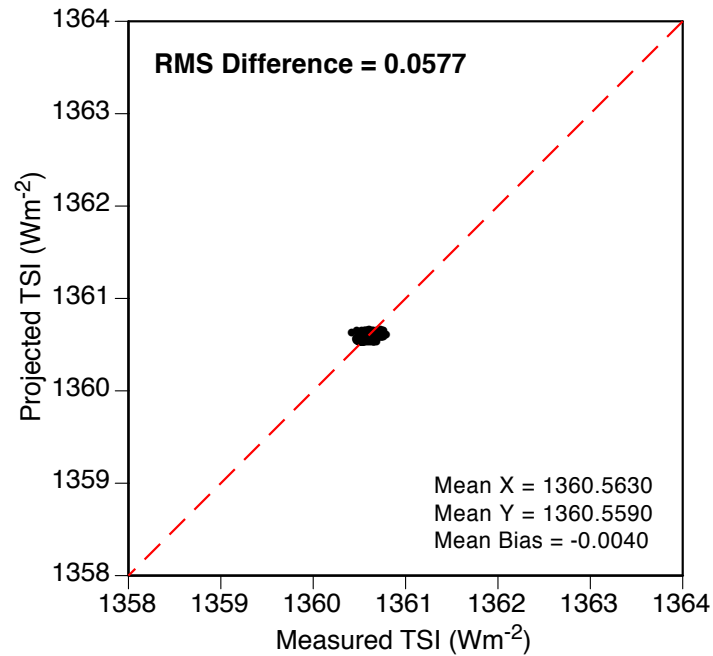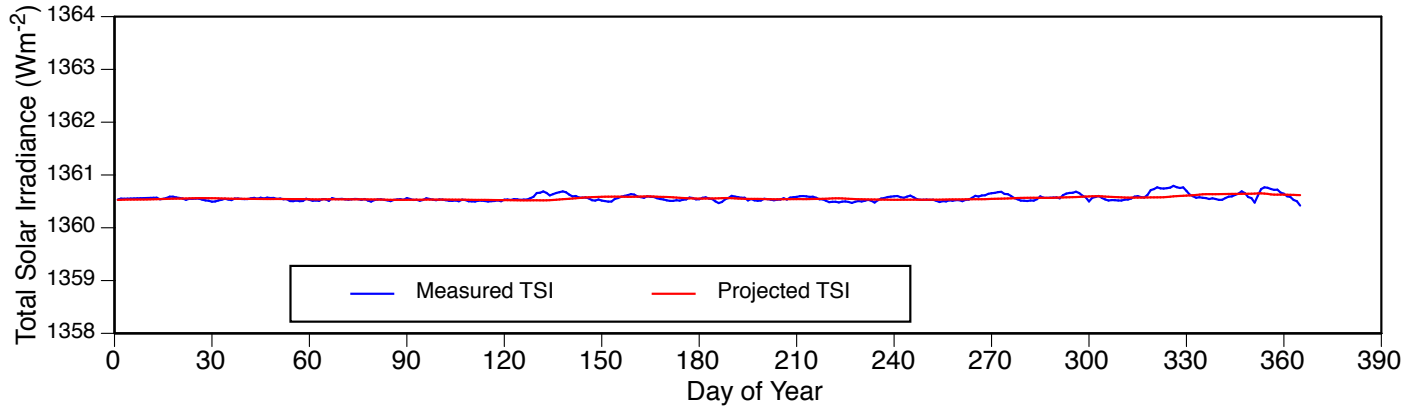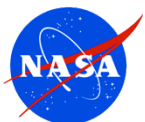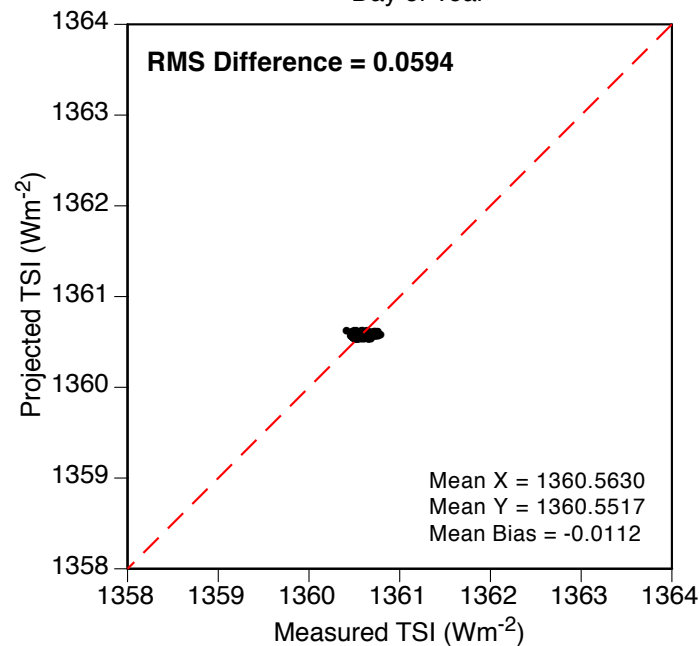Climate Science Branch, NASA Langley Research Center

Projection by 90-Day Averaging - 2009

5-Day Projection by 90-Day Averaging for 2009

RMS Difference = 0.0594

Mean X = 1360.5630
Mean Y = 1360.5517
Mean Bias = -0.0112

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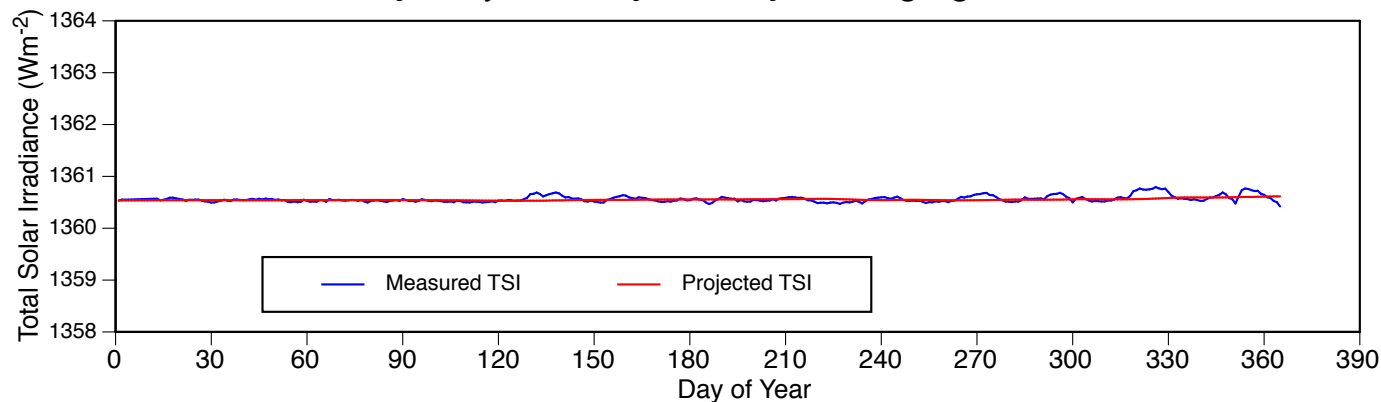
Summary Results - 1991

Bias and RMS Difference Between Projected and Actual TSI Values for Different Averaging Periods and Projection Lengths - 1991
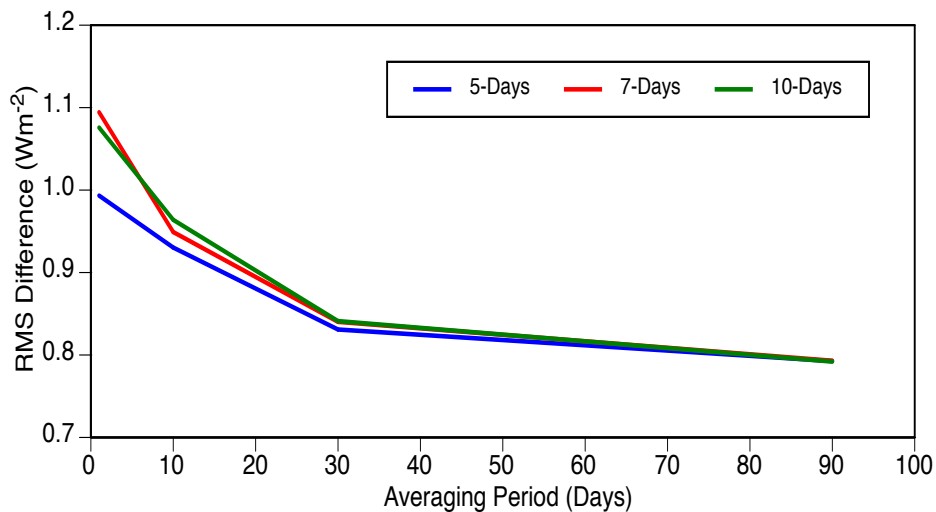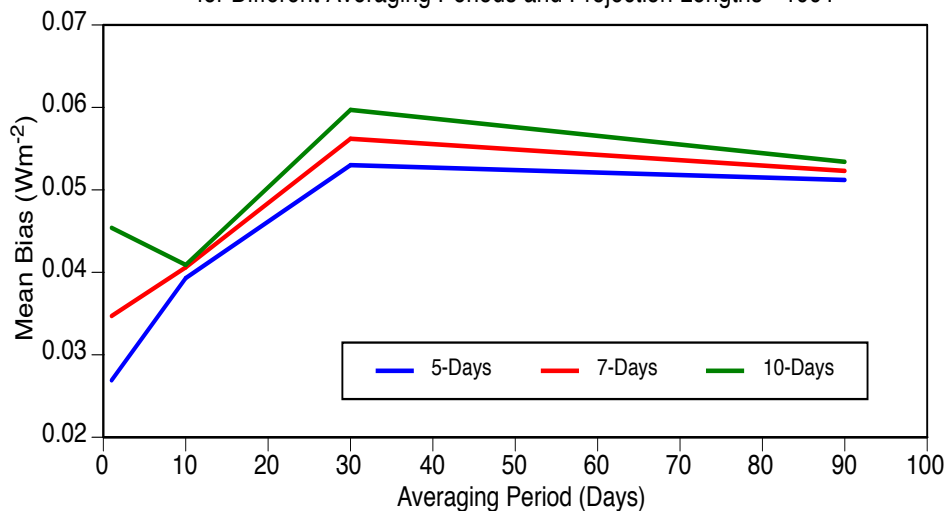
Projection Length (Days)	Statistical Parameter	Averaging Period (Days)			
		1	10	30	90
5	Bias	0.0269	0.0393	0.0530	0.0512
	RMSD	0.9933	0.9303	0.8309	0.7926
7	Bias	0.0347	0.0406	0.0562	0.0523
	RMSD	1.0944	0.9491	0.8402	0.7930
10	Bias	0.0454	0.0409	0.0597	0.0534
	RMSD	1.0758	0.9639	0.8411	0.7920

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Summary Results - 2009

Bias and RMS Difference Between Projected and Actual TSI Values for Different Averaging Periods and Projection Lengths - 2009
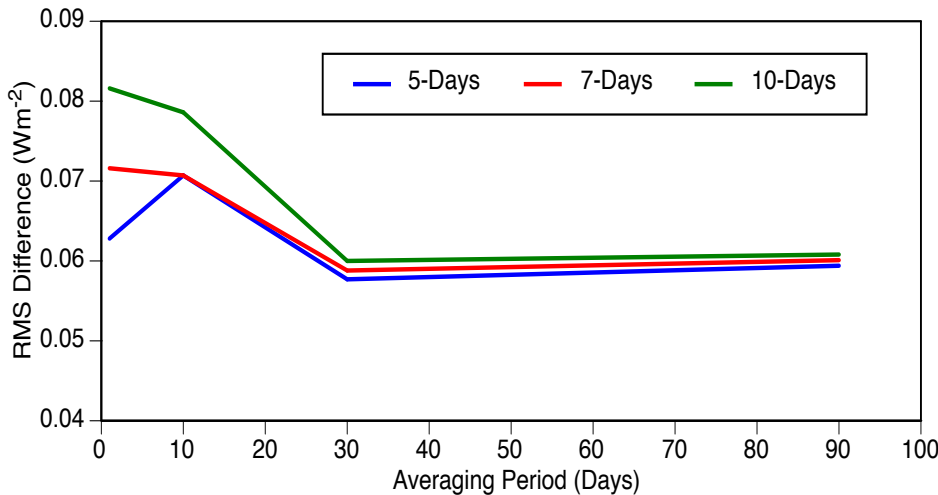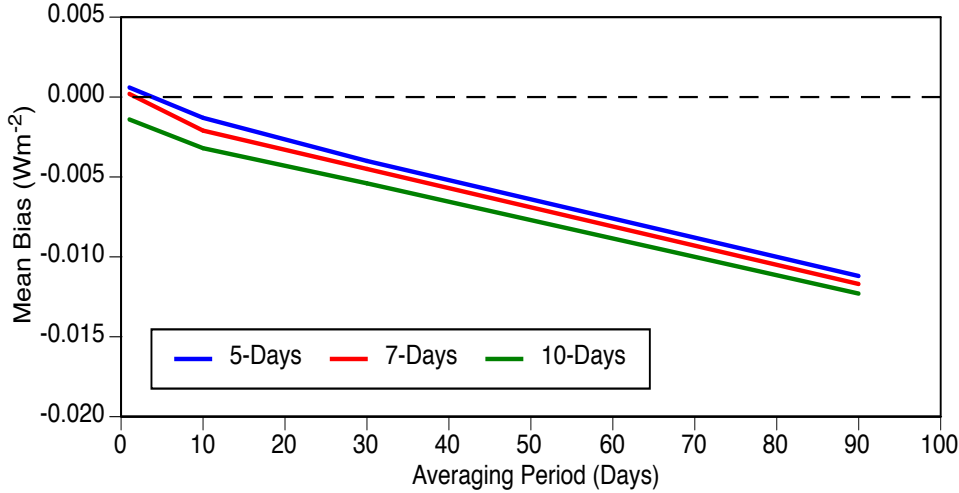

Projection Length (Days)	Statistical Parameter	Averaging Period (Days)			
		1	10	30	90
5	Bias	0.0006	-0.0013	-0.0040	-0.0112
	RMSD	0.0628	0.0707	0.0577	0.0594
7	Bias	0.0002	-0.0021	-0.0045	-0.0117
	RMSD	0.0716	0.0707	0.0588	0.0601
10	Bias	-0.0014	-0.0032	-0.0054	-0.0123
	RMSD	0.0816	0.0786	0.0600	0.0608

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Timeseries of Annual Averages and RMS Differences

Annual Averages (1983-2013) and RMS Difference From Annual Average

31-Year (1983-2013) Mean = 1361.0774

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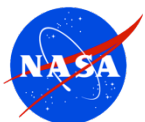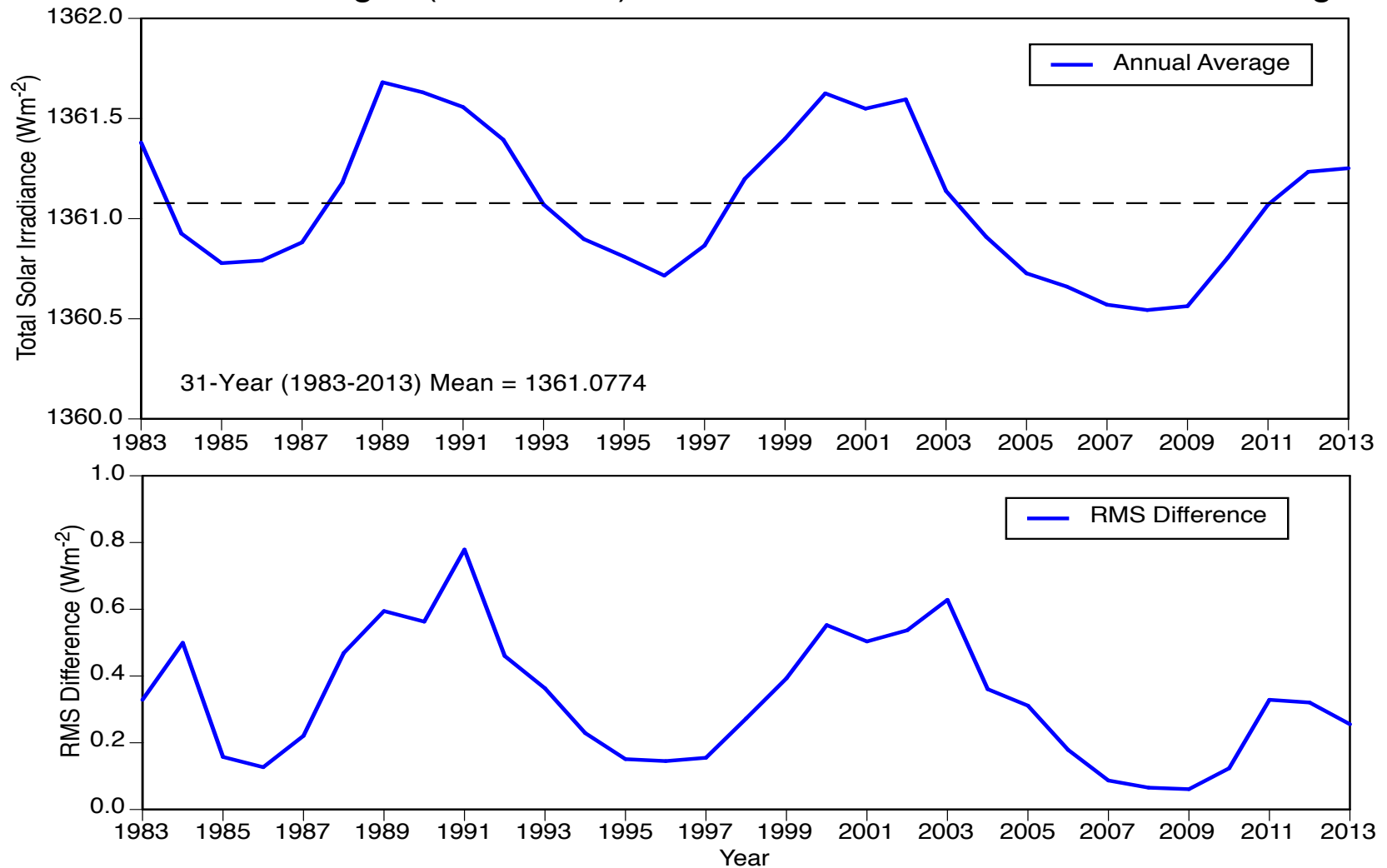
Summary and Concluding Remarks

- The original goal was to use daily SORCE TSI data with 7-day latency and project it 5 days forward for use in FLASHFlux processing.

- With that or similar data stream available, we can project 5 days forward using averages of previous 10, 30, or 90 days with uncertainties < 1.0 Wm^{-2} during years of high sunspot activity; < 0.1 Wm^{-2} during quiet years. Corresponding biases are <0.1 Wm^{-2} and $\cong$0.01 Wm^{-2} respectively. Based on these results, we chose to use 90-day averaging in our projections.

- With the present interruption of SORCE data, its use for FLASHFlux is on hold. When TCTE data become available (hopefully, with similar latency) use for FLASHFlux will be reconsidered. In the meantime, FLASHFlux will continue to use a value of 1361 Wm^{-2}.

- Edition-4 of CERES processing is using SORCE Version-14 up to 30 June 2013. Composite data provided by Royal Meteorological Institute of Belgium (RMIB) scaled to match SORCE data will be used from 1 July 2013 onward until TCTE data become available.

Back-up Slides

Need for Projection

- Today's date: 29 Jan 2014.

- Satellite observations and
  meteorology available for: 27 Jan 2014.
  For processing to start, TSI needed.

- Latest SORCE data available for: 22 Jan 2014.
  Hence, the need to project SORCE 5 days.

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Lag Correlations

Autocorrelation in 1991 and 2009 TSI Timeseries