Estimating the Precision of TSI Measured from VIRGO, SORCE, TCTE, and TSIS-1 Using the Triple Differencing Technique

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Since the launch of SORCE in 2003, we have entered an era where multiple instruments have been making high-cadence (~hourly or less) measurements of total solar irradiance (TSI). The launch of TCTE in late 2014 increased the number of near-simultaneous high-cadence (six-hourly) TSI measurements to three, while the launch of TSIS-1 in late 2017 and the near-coincident end of the VIRGO mission have kept this number at three for the past 4.5 years. Using the pairwise differencing analysis, it becomes feasible to glean out the precision information of each sensor from these sets of overlapping measurements.

By differencing all three overlapping (and de-trended) datasets with each other (VIRGO, SORCE, TCTE; and SORCE, TCTE, TSIS-1), three difference datasets are generated. Assuming that the sampling difference uncertainties between these three sets of measurements are small and that the instrumental uncertainties are uncorrelated with each other, the problem simplifies into one of adding uncorrelated errors. We organize the variances (rolling multi-day window) of these difference datasets as a series of linear equations with three knowns (the difference dataset variances) and three unknowns (the squared instrumental precisions). Because this technique relies on three overlapping datasets, it is quite complementary to the standard auto-regression technique, which only relies on the dataset being tested. We will present comparisons over both the TSIS-1, SORCE, and TCTE overlap, as well as the longer time-period corresponding to the VIRGO, SORCE and TCTE mission overlap.