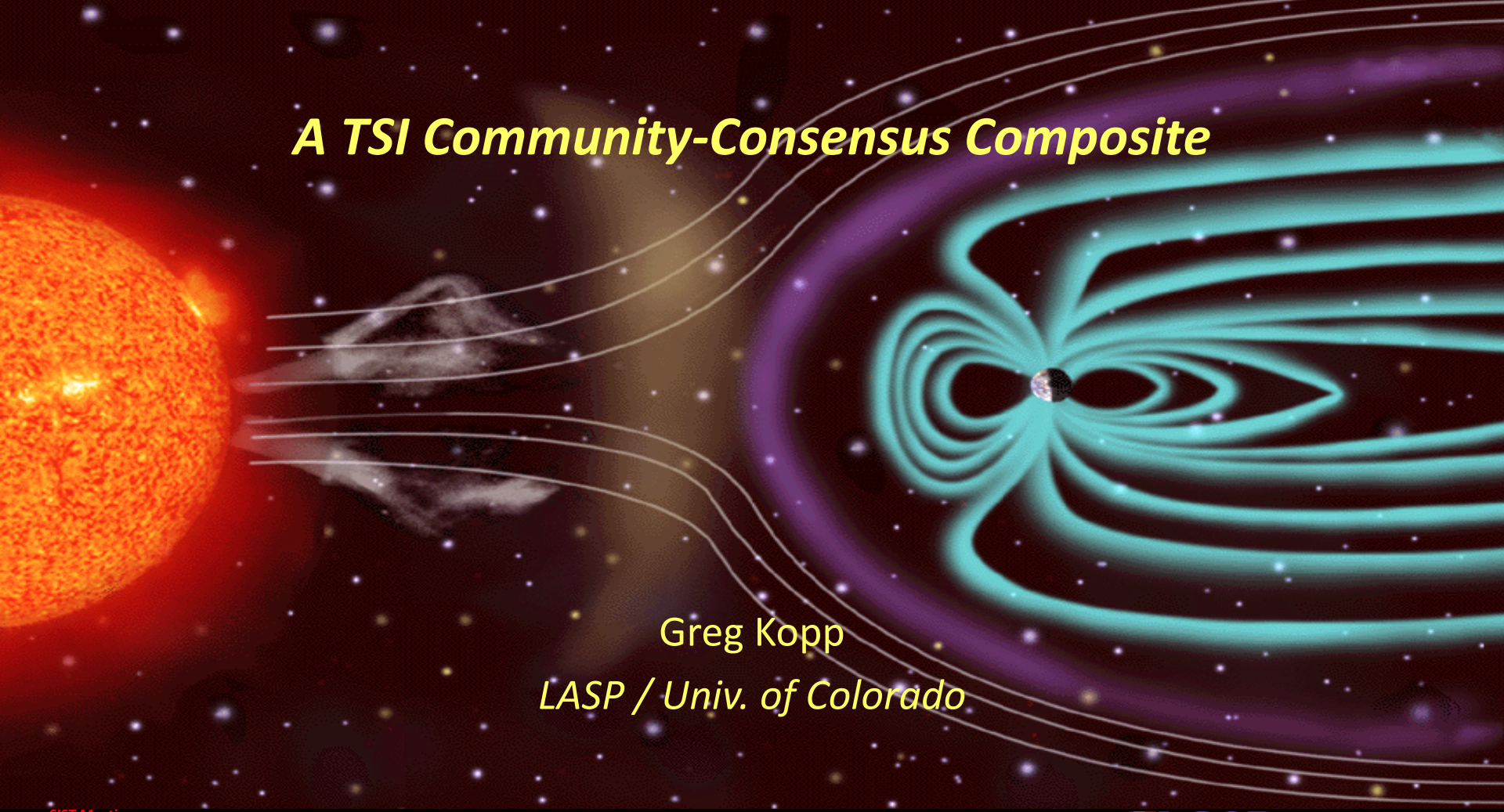
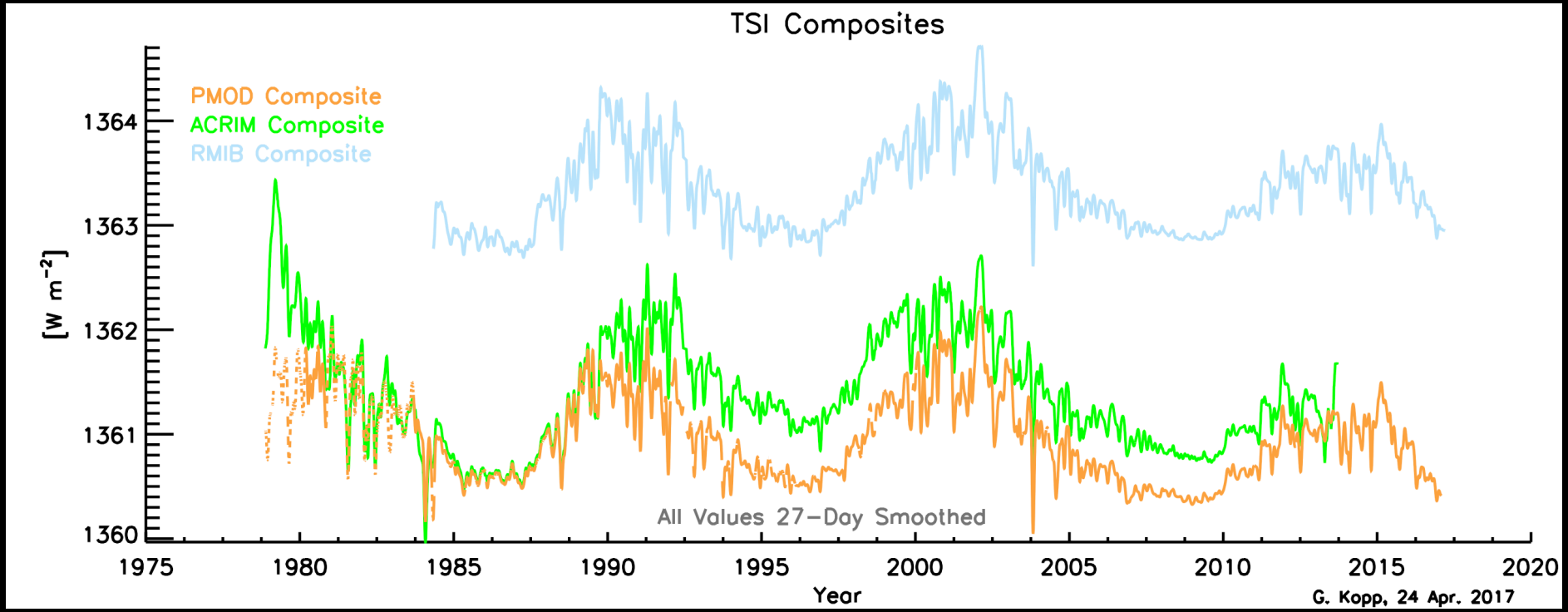
A TSI Community-Consensus Composite



Greg Kopp

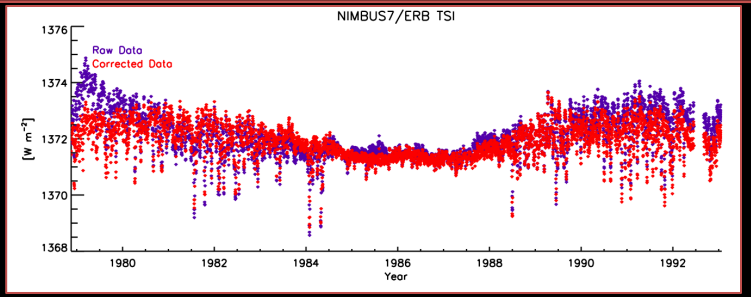
LASP / Univ. of Colorado

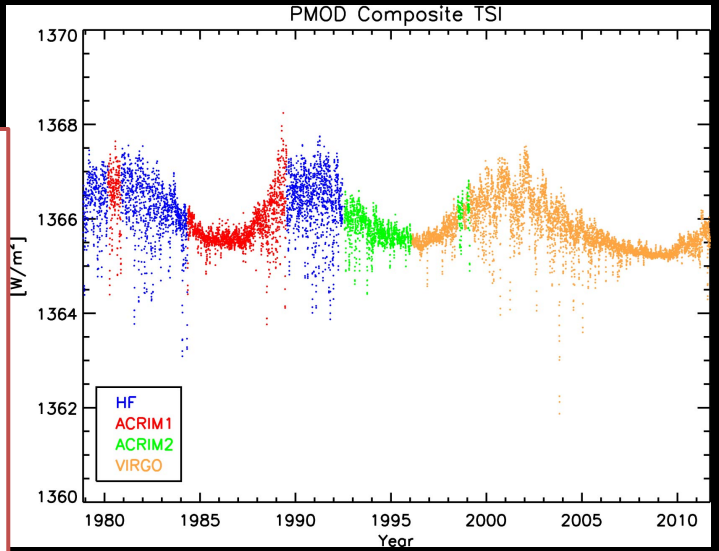
Traditional TSI Composites

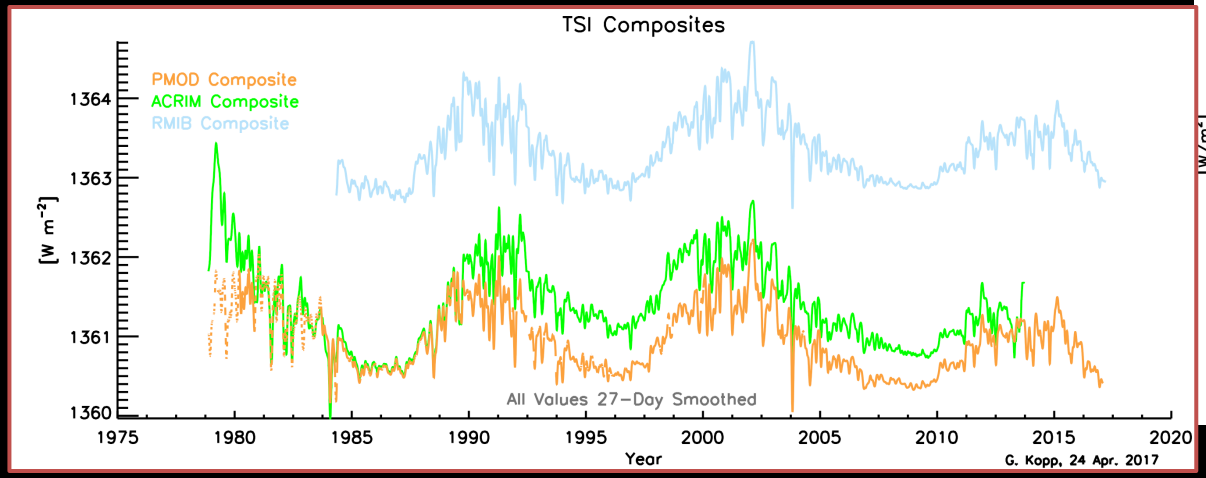


Issues with Traditional Composites

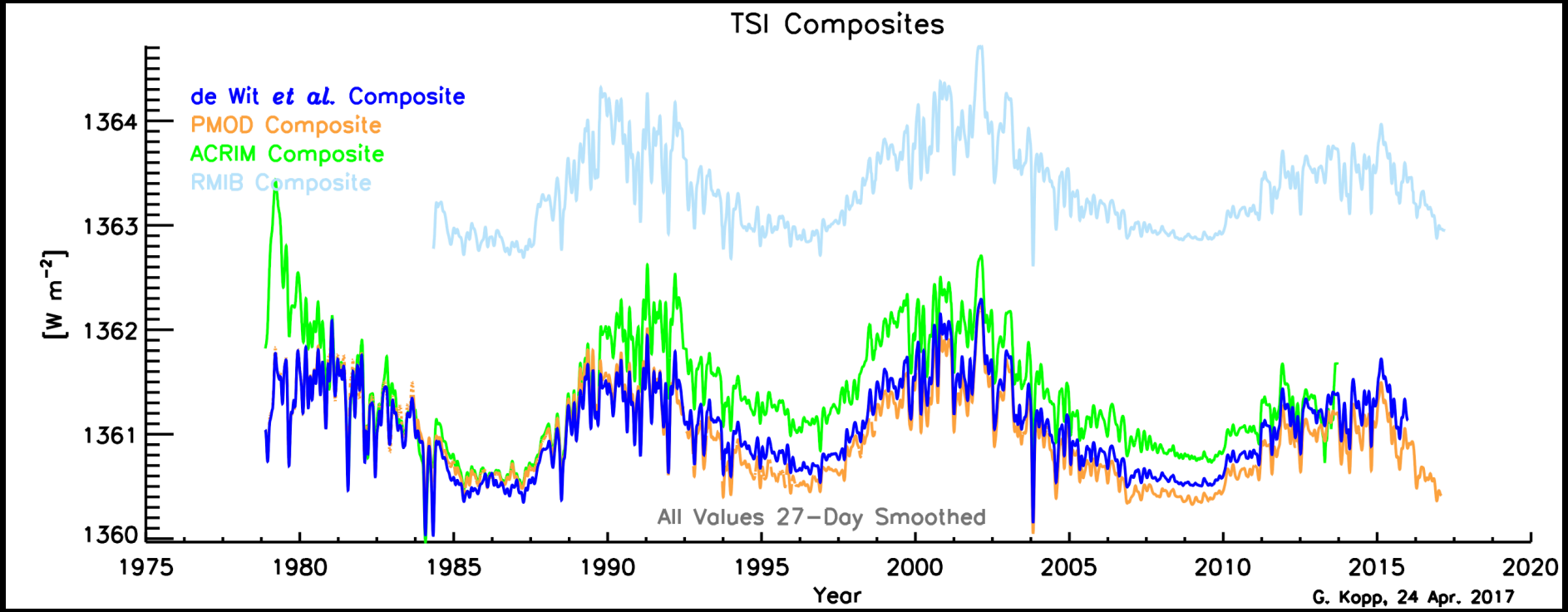
- Created by individuals (PIs)
- Binary (and biased) selection of instrument data used
  - Discontinuities at boundaries
- Controversial corrections applied to data records
- Normalizations incorrect
- Lack uncertainties







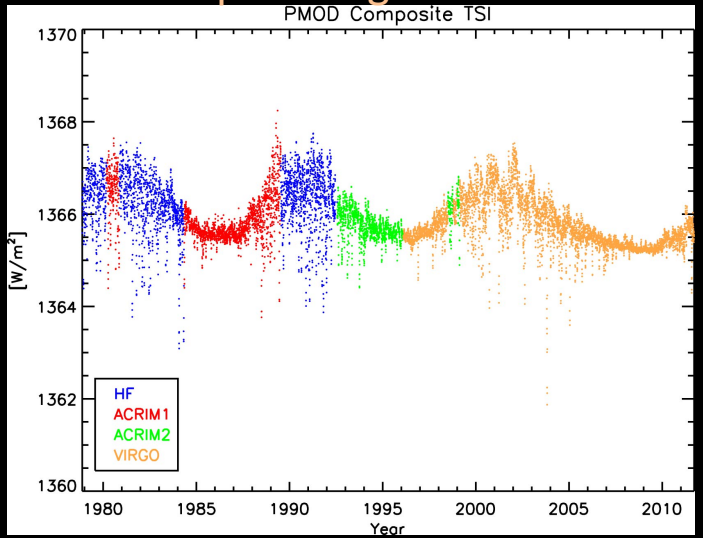
Working on "Community Consensus" TSI Composite



Includes efforts of former ISSI team and current SIST team

Improvements in Planned Composite

- Recent improvements to *absolute accuracy* in the newer TSI measurements have not yet been reflected consistently in TSI composites
  - Picard/PREMOS, TCTE, CLARA, and TSIS help transfer improved ground-based calibrations to space
- Weight data from *all available instruments*
- Use *unbiased statistically-driven approach* rather than favored instrument
- Include *time-dependent uncertainties* to indicate temporal regions where contributing data may be suspect
- Smooth transitions and gaps scale-wise



ISSI Team Laid Groundwork

1. Agreed upon the absolute value to use for the composite TSI record
2. Agreed upon an unbiased computational methodology to create this new composite

Team: Greg Kopp (PI), Will Ball, Steven Dewitte, Thierry Dudok de Wit, André Fehlmann, Wolfgang Finsterle, Claus Fröhlich, Sabri Mekaoui, Werner Schmutz, Richard Willson, Pia Zacharias

SIST Effort

1. Demonstrate, implement, and improve the computational methodology to create a new community-consensus TSI composite including time-dependent uncertainties with (partial) continued involvement from ISSI team
2. Distribute the composite to public and produce a publication detailing the methodology
3. Establish a system to update this TSI composite regularly as new data are available

Summary: *Provide data users with a single TSI composite including, for the first time, time-dependent uncertainties, a non-binary selection of contributing instruments, and an unbiased weighting of those instruments*

SIST Team Collaborators

Collaborator	Expertise & Responsibility
Dr. Will Ball	Modeler for the SATIRE TSI proxy model. Comparisons to this model provide insight into individual data record accuracies and realism of resulting composite.
Dr. Thierry Dudok de Wit	Scientist and mathematician with expertise in statistical analyses methods, PCA, and Bayesian techniques applied to creating composite records. Dr. Dudok de Wit has demonstrated a proof-of-concept TSI composite using the described and agreed upon methodology. He will help tune the Bayesian approach during the initial, more experimental, stages of the proposed effort.
Dr. Wolfgang Finsterle	Instrument Scientist for Picard/PREMOS provides updated PREMOS TSI data and knowledge about that instrument's uncertainties due to on-orbit operations influences
Dr. Claus Fröhlich	PI for SoHO/VIRGO who is responsible for VIRGO TSI and creation of PMOD TSI composite. Dr. Fröhlich provides knowledge not only about the VIRGO but also the oldest TSI instrument, the NIMBUS-7/ERB. He also shares his experience from having created the most prominent TSI composite, that of PMOD.
Dr. Werner Schmutz	PI for Picard/PREMOS provides the absolute value of the PREMOS TSI measurements and insight into the World Radiometric Reference maintained by his organization at PMOD
Dr. Richard Willson	PI for ACRIM-1, -2, and -3, spanning 30 years of TSI measurements. Dr. Willson has knowledge of the older TSI instruments including the NIMBUS-7/ERB as well as experience in creating the ACRIM TSI composite

New TSI-Composite Methodology Has Been Published

- TSI-community based for openness
- Uses all available instrument data
- Scale-wise weightings smoothly fill gaps
- Uses an unbiased statistical approach
- Normalized to most accurate instruments
- Has time-dependent uncertainties

AGU PUBLICATIONS

Geophysical Research Letters

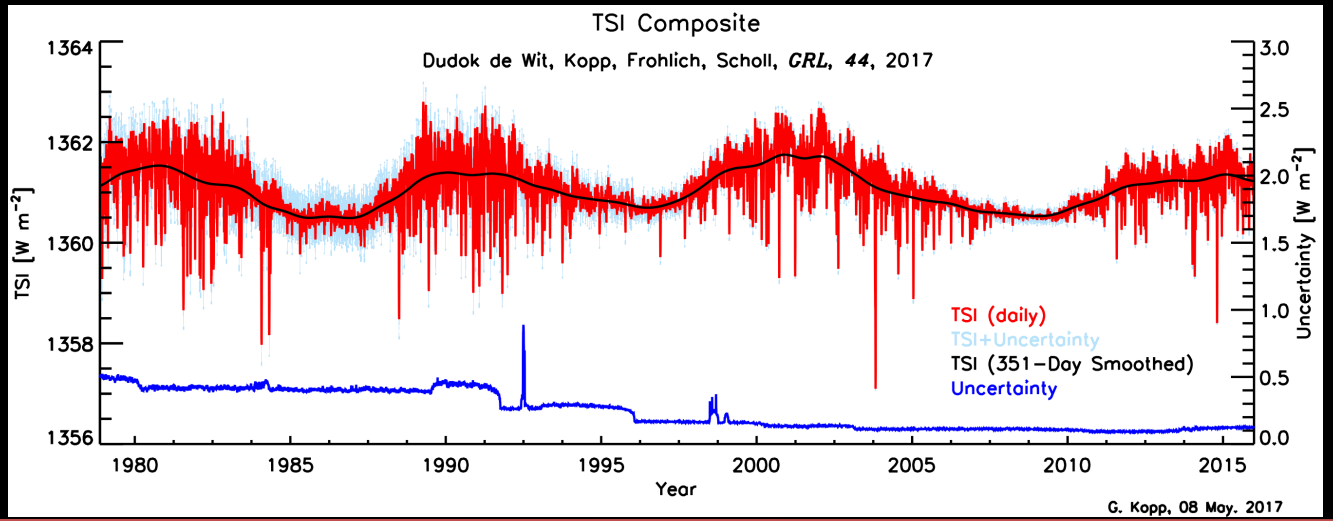
RESEARCH LETTER
10.1002/2016GL071866

Key Points:
- We present a new approach for merging different solar irradiance time series into a single composite
- We provide a new and fully traceable composite of the total solar irradiance
- We quantify uncertainties in the total solar irradiance composite and demonstrate a $1/f$ scaling in them

Methodology to create a new total solar irradiance record: Making a composite out of multiple data records

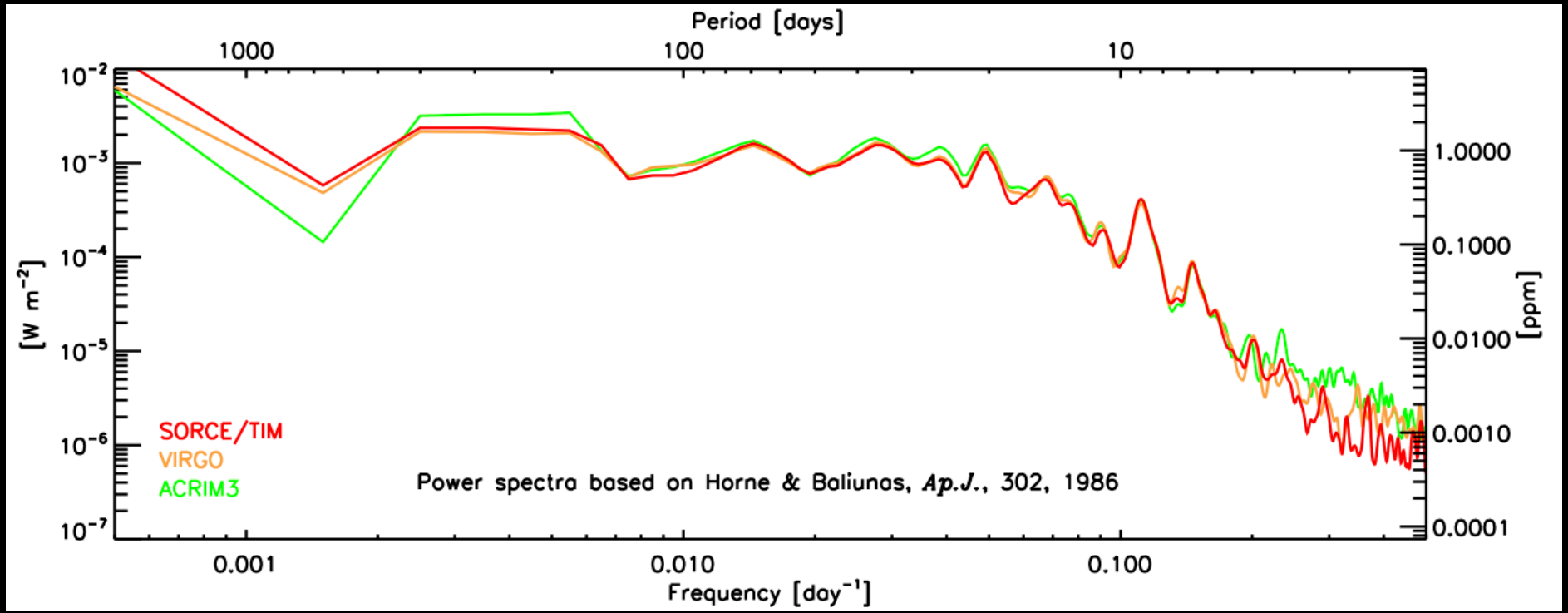
Thierry Dudok de Wit[1], Greg Kopp[2,3], Claus Fröhlich[4], and Micha Schöll[1,5]

[1]LPC2E, CNRS and University of Orléans, Orléans, France, [2]Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, Colorado, USA, [3]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany, [4]Dählenwaldstrasse 30, Davos Wolfgang, Switzerland, [5]Physikalisch Meteorologisches Observatorium Davos and World Radiation Center, Davos Dorf, Switzerland



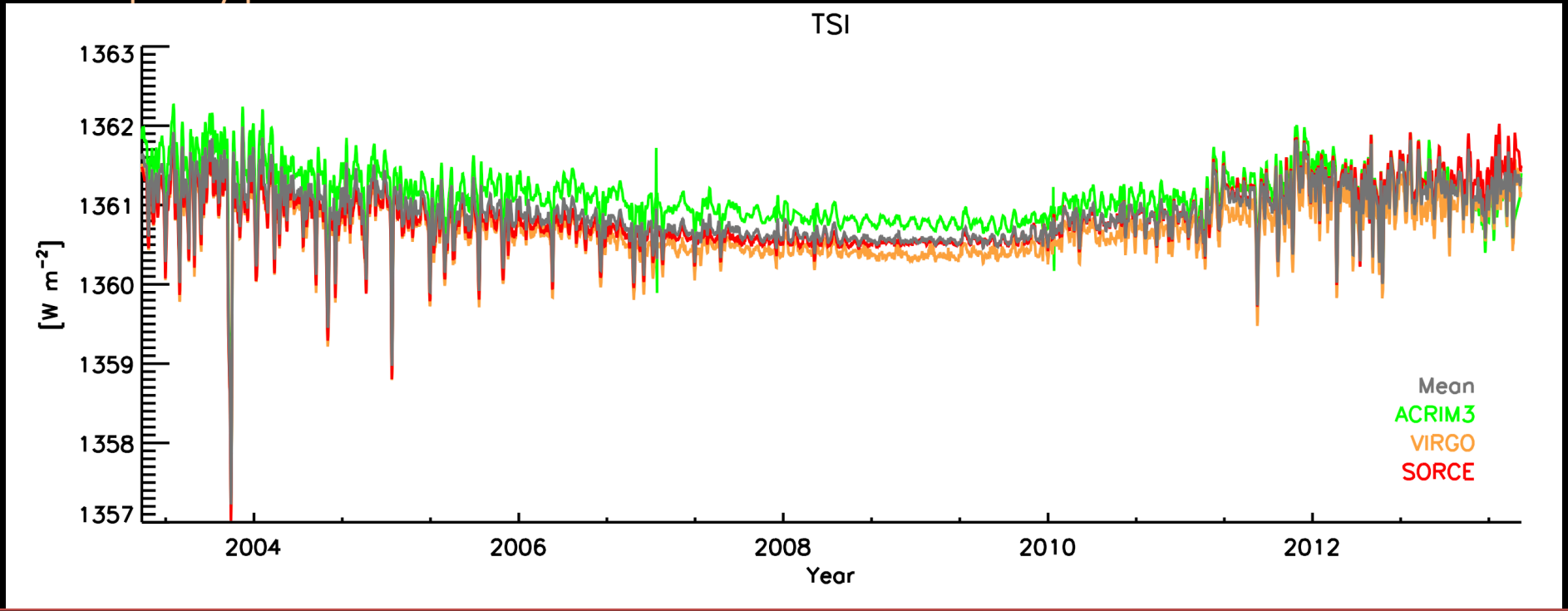
Power Spectra Help Determine High-Frequency Uncertainties

Plotted PSDs include real solar variability plus instrument instabilities & noise



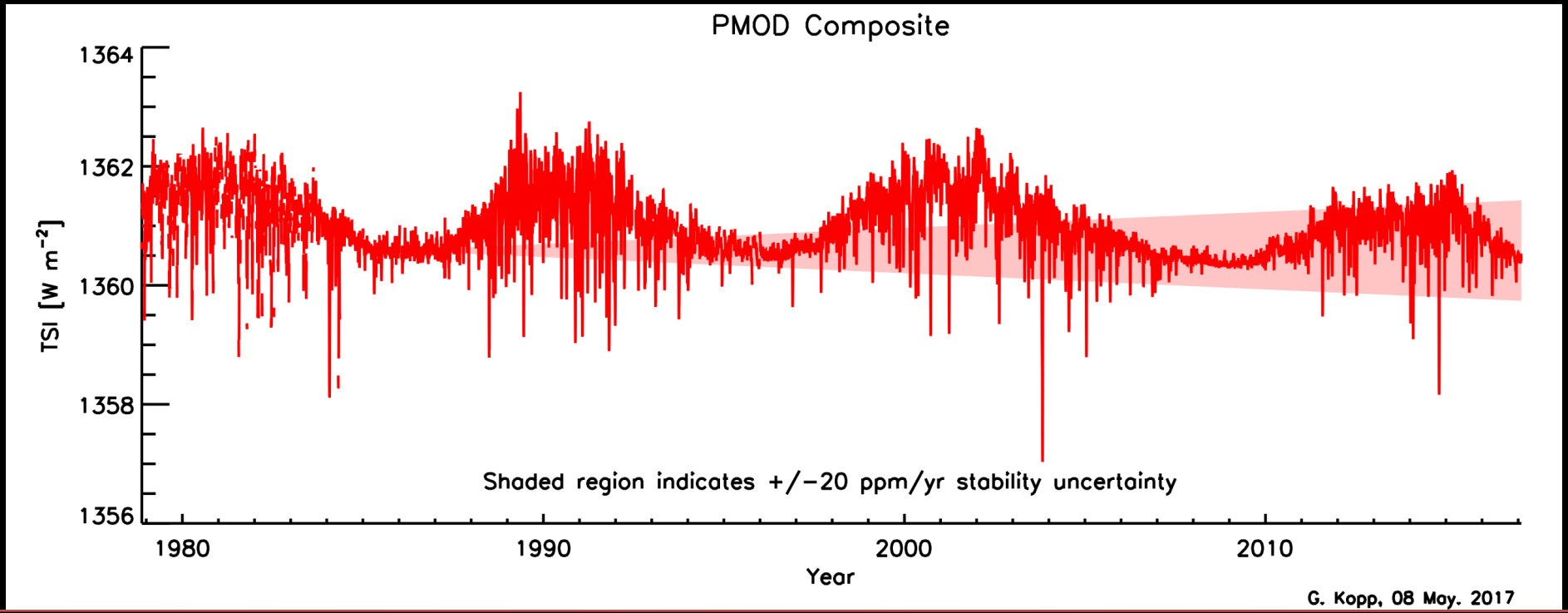
Measurement Differences Show 1/f Power Scaling

- Dispersion is not indicative of linear trends or of white noise
- Use as noise model of each instrument for scale-dependent weightings based on high-frequency predictive-model correlations

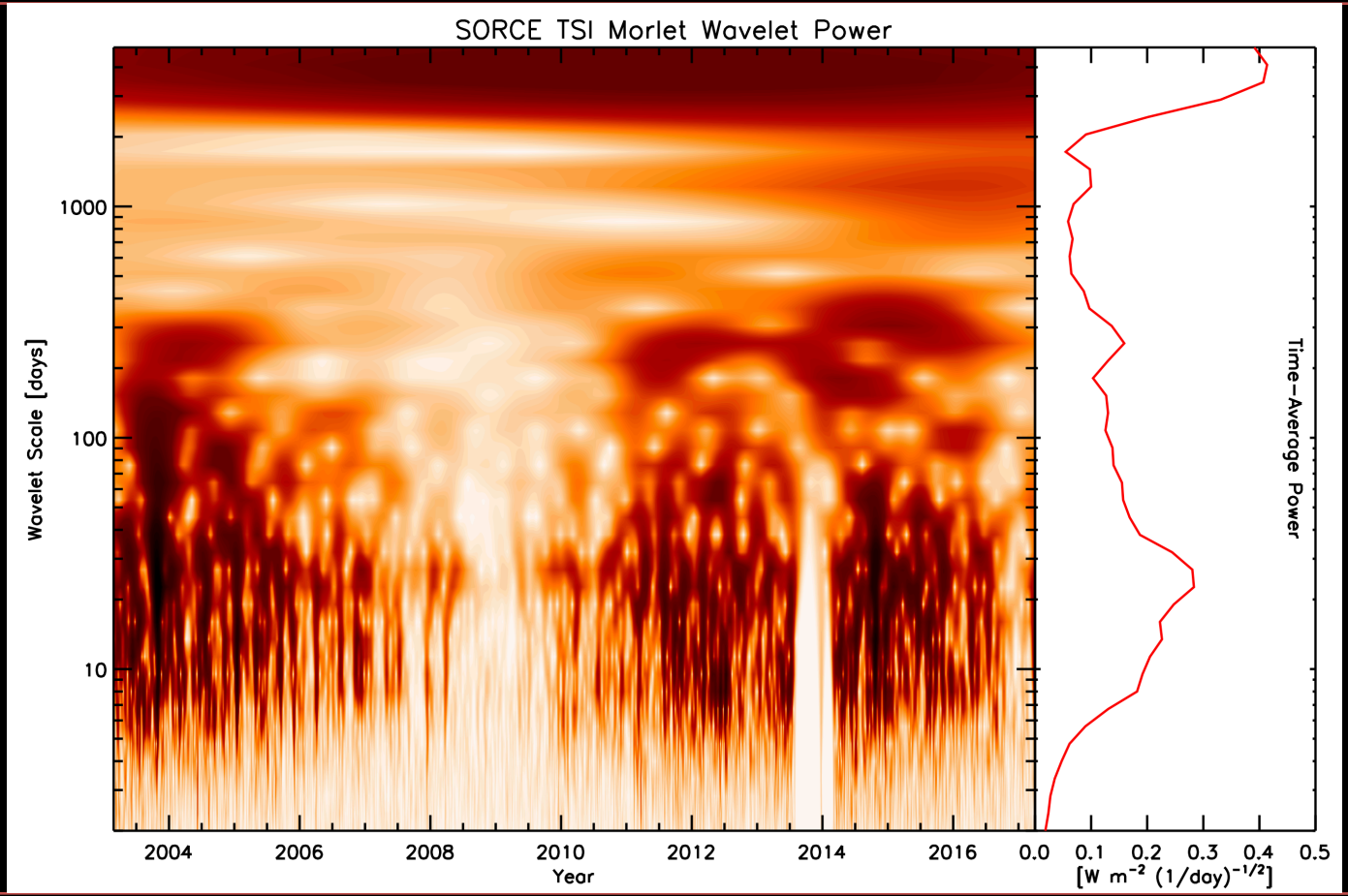


Wedge Trends in Differences Are Misleading

- Linear trends in instrument differences are not what is observed
- Linearly-increasing uncertainties overestimate actual uncertainties in time (eventually)



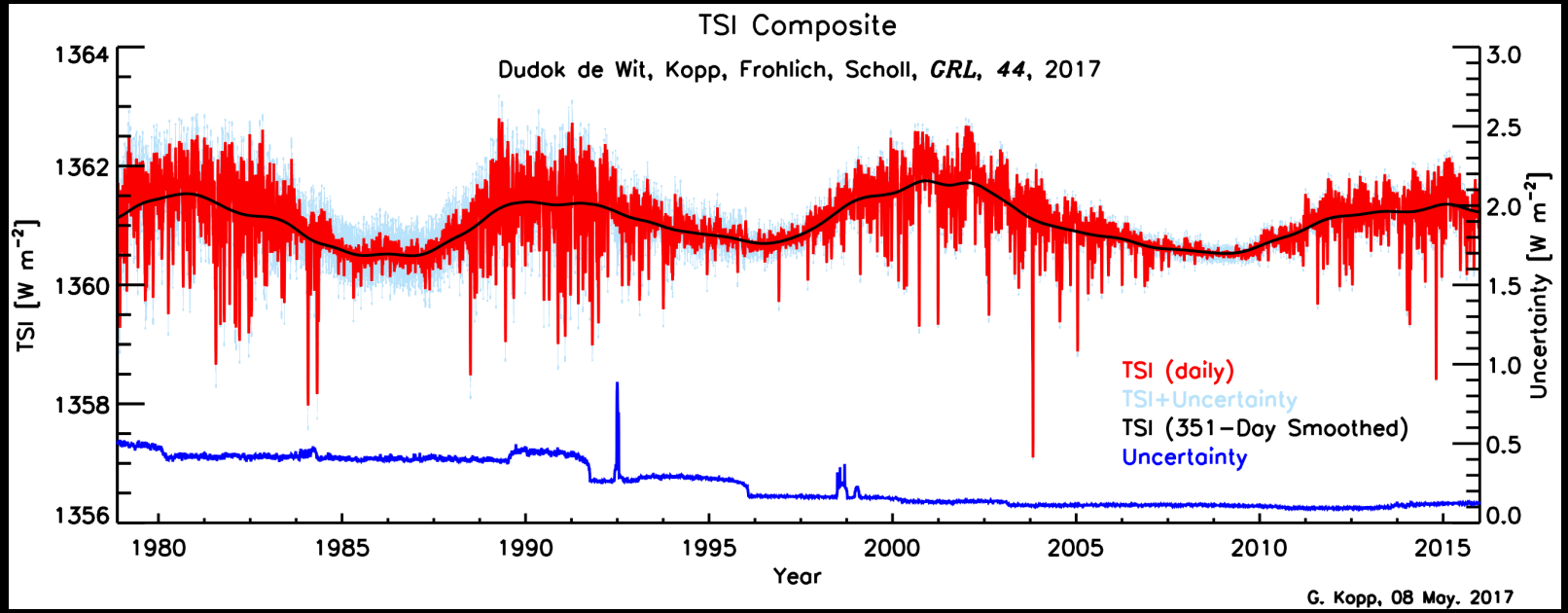
Wavelet Analyses Determine Temporal Regions of Influence



TSI-Composite Improvements. And What Needs Improving

- TSI composite improved with reduced biases and better instrument-transition overlaps
  - Methodology demonstrated, but final composite needs refining
    - Agree on amount of "early increase" correction (if any) to apply
    - Estimate initial uncertainties
    - Update regularly

TSI instrument and composite data are available at:
http://spot.colorado.edu/~koppg/TSI



Future Efforts

- Improvements to composite itself
  - Modify initial weightings based on known instrument artifacts
  - Consider appropriateness of applying 1/*f* spectral variation to all instruments
  - Improve method of adding/losing instruments
  - Normalize to ISSI-team's agreed upon absolute value method of weighting all instruments
- Implement computational methodology to provide regular updates as new data or instruments become available
- Publish and serve resulting composite to research community