Correlation of RHESSI and TRACE Observations of the Rise Phase of the 21 April 2002 X1.5 Flare

SH52A-0465

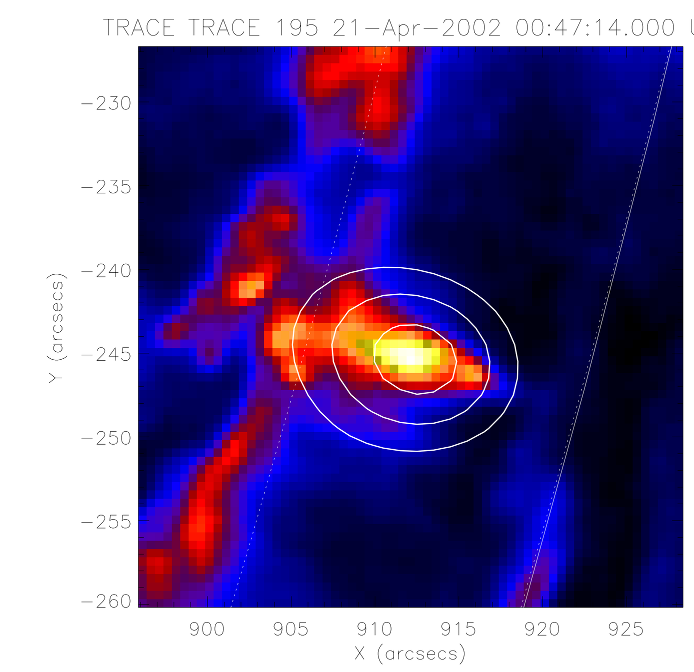
cepheid@ssl.berkeley.edu

http://sprg.ssl.berkeley.edu/~cepheid/agu2002/

Amir Caspi[1,2], Säm Krucker[1], Robert P. Lin[1,2]

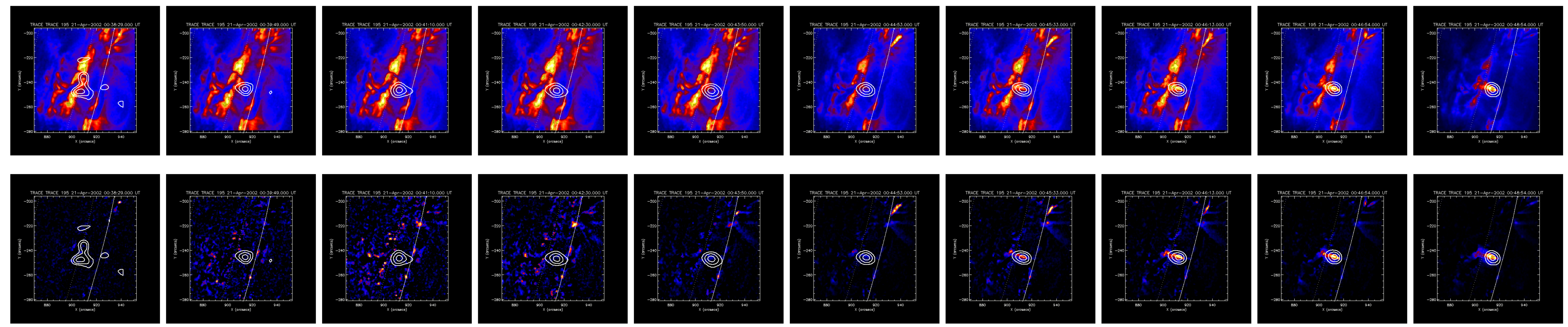
[1] Space Sciences Laboratory, University of California, Berkeley, CA 94720

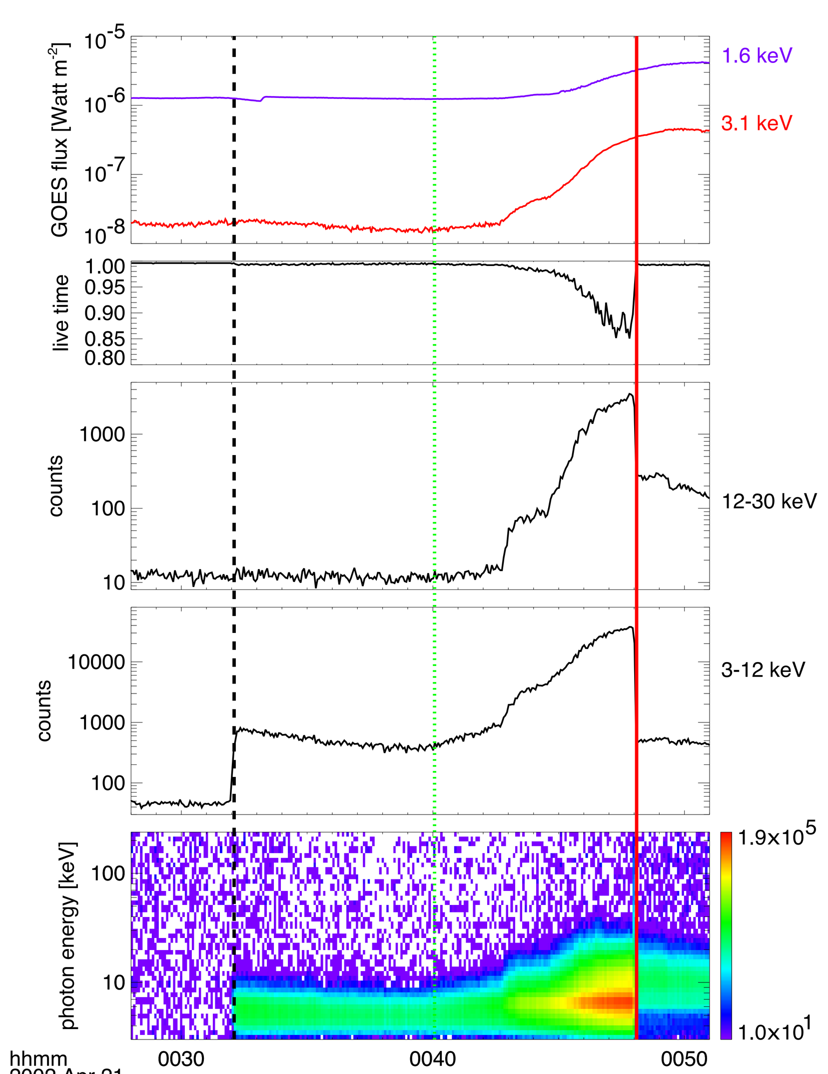
[2] Department of Physics, University of California, Berkeley, CA 94720



Evolution of the early rise phase in TRACE and RHESSI:

TRACE 195 Å images, overlaid with RHESSI 3-12 keV contours (at 50%, 70%, 90%; 30-second integration centered on the time of the TRACE image). Images in the bottom row are "pre-flare subtracted" to enhance brightening features. The images show that TRACE did not register a significant brightening until ~00:44:30 UT, while RHESSI resolved the flare as early as ~00:39:30 UT. Some small brightening is evident in TRACE as early as ~00:42:00 UT, but this is still ~3 min after RHESSI. We seek to explain this delay.



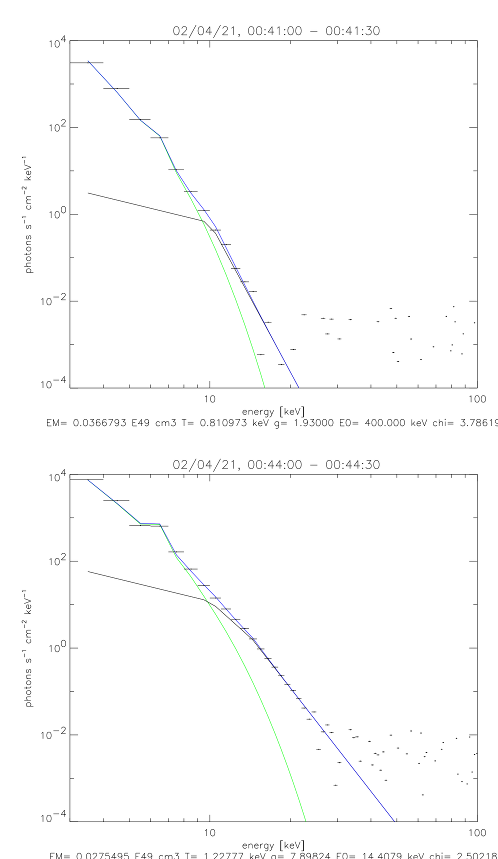


GOES and RHESSI lightcurves:

GOES and RHESSI full-sun lightcurves of the early rise phase, with detector livetime and intensity plot of RHESSI flux. Vertical lines mark RHESSI emergence from night (black dashed), RHESSI flare onset (green dotted), and thin attenuator closed (red solid). The 3-12 keV lightcurve clearly shows increased counts beginning at ~00:40:00 UT, consistent with the RHESSI image contours (above) and the RHESSI source-selected photon flux (below, middle). GOES data also shows this slight increase. Primary brightening occurs at ~00:43:00 UT, very close to the time of TRACE brightening - a possible connection?

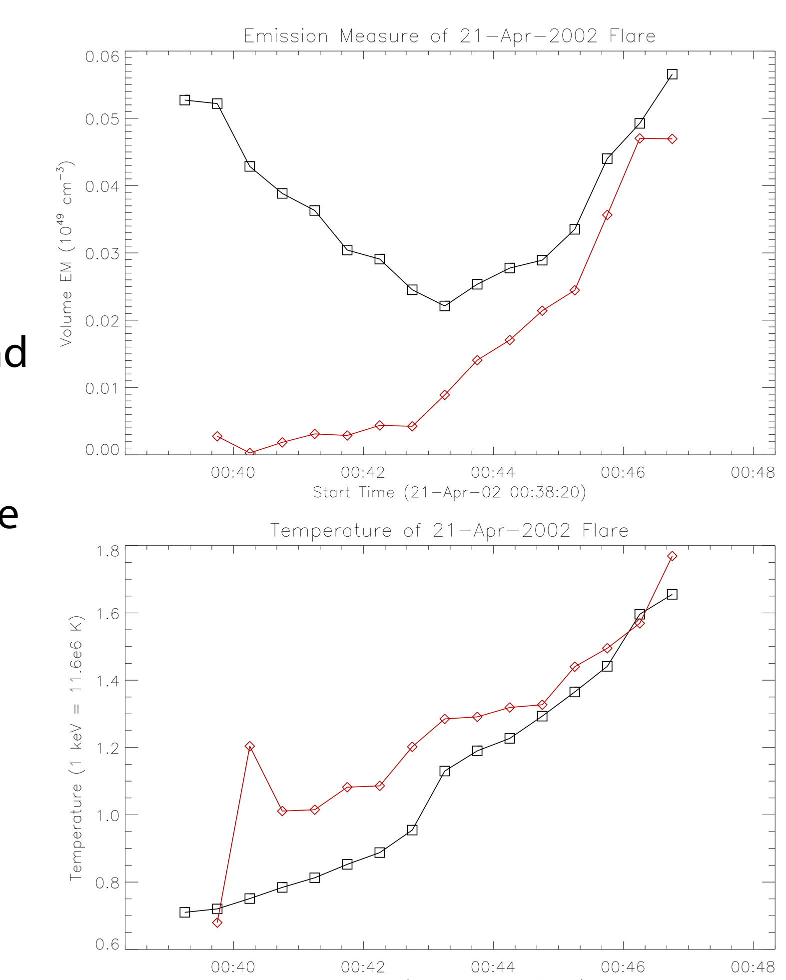
Spectral fitting:

The photon spectrum changes dramatically over the short period we examine. We fit the spectrum with a thermal component and a broken power law (cutoff at 10 keV) using SPEX. Example spectra: early in the flare, the power-law component is quite weak (top), but develops significantly as the flare progresses (bottom). Data from the spectal fits is used to predict the TRACE instrument response (below).



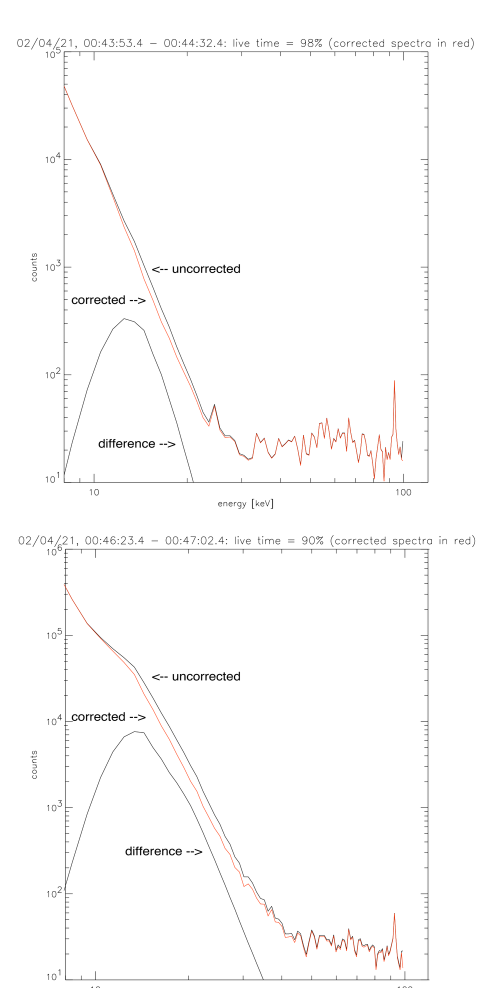
Thermal spectral parameters:

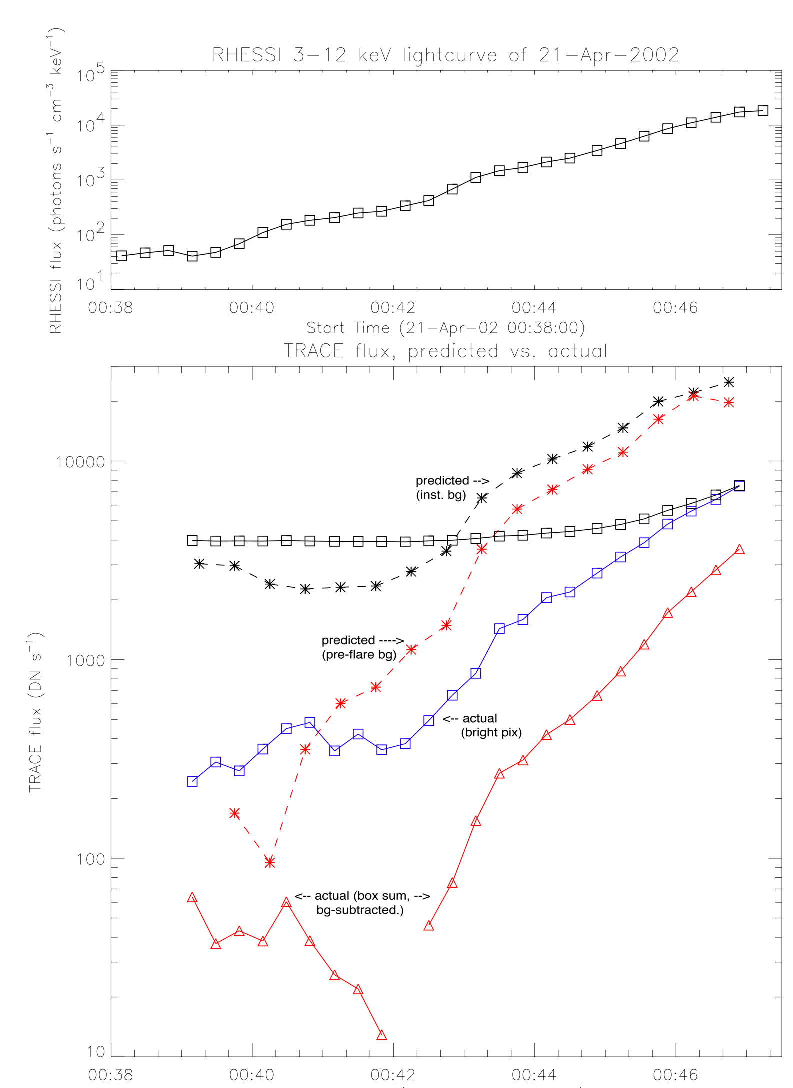
Temperature and Emission Measure estimates obtained from spectral fitting. Spectra were fit with only instrumental background subtracted (black curves) or with pre-flare solar background subtracted (red curves). The dropoff in EM for the black curve is likely an artifact of not subtracting the full solar background, hence the usefulness of that data is questionable. Conversely, the red curve likely underestimates the true EM somewhat. The first two points in the red curves are not trustworthy due to poor statistics. Imaging spectroscopy may help resolve these issues - this is being investigated.



Pileup problems:

Count pileup becomes a problem well before the thin attenuator closes. The livetime plot (above) shows that livetime drops below 95% as early as ~00:45:00 UT. Pileup causes a significant alteration in the spectral fit. Example spectra with 1st-order corrections are shown; the lower curve in each pane is the correction factor. Note that at ~00:44:00 UT, pileup error is ~10%, but increases to ~20% by 00:46:30 UT. Thus, spectral fit parameters after ~00:45:00 UT are suspect, although the extent to which the parameters are affected is not yet known. Pileup correction was only recently implemented in software; work is ongoing to obtain corrected spectra and fit parameters.





TRACE response, predicted vs. actual:

Predicted (dashed) and actual (solid) TRACE lightcurves, with RHESSI comparison. TRACE response was predicted from spectral fit parameters with default assumptions for solar abundances (only instrumental background subtracted [black curve] or pre-flare solar background subtracted [red curve]; the first two points of the red curve are not trustworthy). Actual TRACE flux was summed over a box surrounding the flare (black curve; red curve is background-subtracted) or over pixels brightening more than 5 DN from flare onset (blue curve). The general trends in the red curves match, but quantitatively the predictions fail. That the actual flux curves all lie below the predicted curves implies that the flare is not isothermal and TRACE and RHESSI sample different parts of the dEM. Further investigation is ongoing.

Ongoing and Future Work:

- Imaging spectroscopy should allow better background subtraction and hence a more well-defined spectrum based on emission solely from the flare. Proper background subtraction in SPEX is problematic as SPEX uses all incoming photons (regardless of origin) and thus makes it difficult to subtract all photons not related to our source. Imaging spectroscopy is currently awaiting software development to address image normalization.

- Research is ongoing to determine the cause of the discrepancy between the predicted and actual TRACE response. Better spectral fits (with pileup correction and better background subtraction) are critical for this. Instrument response is unlikely to be the only relevant factor; preliminary results already hint that other physical factors may play a vital role.