Hot Onsets of Solar Flares: GOES-R

Hugh S. Hudson (UC Berkeley and U of Glasgow)

We have found, using data from GOES-15 and earlier, that solar flares almost always commence at an elevated isothermal X-ray temperature of 10-15 MK (see the Simões contributed talk and the published paper, Hudson et al. 2021). Recognizing this effect requires delicate treatment of the GOES background signals, given that the hot onset appears at the very beginning of the flare when emission measure is minimal. This poster describes a confirmation of the effect via use of the newer GOES-16 and GOES-17 data, which have much better data sampling at low (background) levels.

GOES-R Data Properties and Caveats

The well-known GOES XRS sensors (Machol & Viereck 2016) have now evolved to use Si photodiodes to generate signal currents, rather than the earlier ion chambers. These have slightly different responses but generally match the two spectral bands, nominally 1-8 Å and 0.5-4 Å, used to make the familiar isothermal fits to volumetric emission measure and electron temperature. The figure below shows an arbitrary we event.

GOES-R Caveats

What do we see in the data products at low flux levels, approaching these data as a naive user of GOES-R/XRS (Machol et al. 2020)?

• GOES-15 has better irradiance sampling at low flux levels
• GOES-16 has better time sampling (1 s)
• GOES-16 has much higher background levels in channel A (short wavelength, high energy)
• The artifact at lower right is a (rare) eclipse (noted by C. Peck)
• High background in 0.5-4 Å may limit 1-s resolution to C class

Analysis issues

• The trickiest part of characterizing the hot onsets lies in the picking the background reference. But even then, the flare excess emission is fundamentally ill-determined even if the background is well behaved; Bornmann (1990) noted that the flare might actually alter the background sources physically. We do not think that this is the case ("What is there before a flare?" – cf. the Fletcher presentation at this meeting). This Sun-as-a-star problem largely vanishes when one has imaging (cf. the Simões presentation at this meeting).

• How distinct is the hot onset phase from the impulsive phase? This depends upon the sensitivity of the HXR observations, since the non-thermal bremsstrahlung signature is highly non-linear,

• This poster just sets the stage for a large-scale survey assessment, and we are grateful that GOES-R and Fermi/GBM data (plus others) are now copiously available as the Sun turns back on.

So what? And who cares?

I think that this is fundamentally interesting for the SoiFER community, because it suggests energy transfer in a manner that may be inconsistent with the absence of HXR (non-Neupertian), but amenable to modeling. How can the T_e be regulated, with little sign of "heating" in the sense of finite values of T = dT/dt, while the emission measure drastically increases? See the upper-rightmost plot above.

Bibliography