Cross-calibration of HRI_{EUV}/SolO and AIA/SDO

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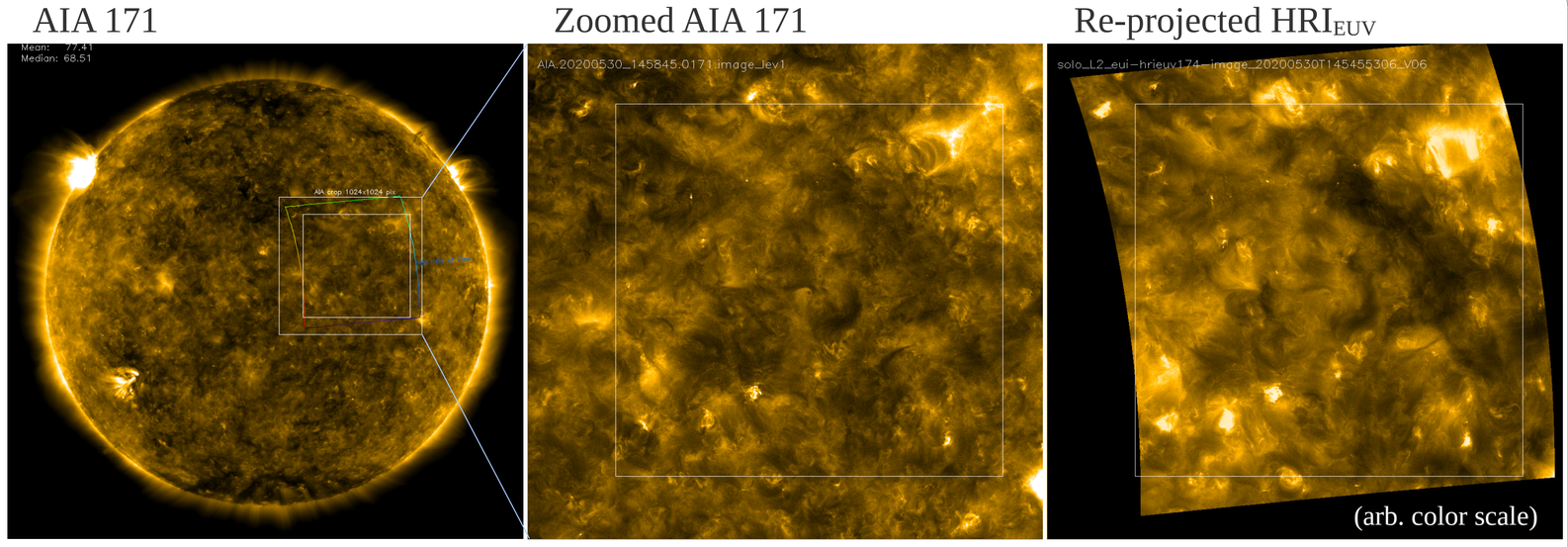
Motivation:

Simultaneous observations of HRI_{EUV} and AIA (and other telescopes) can be used for DEM analysis, stereoscopy, etc.

What to do if all the characteristics of the telescopes are different?

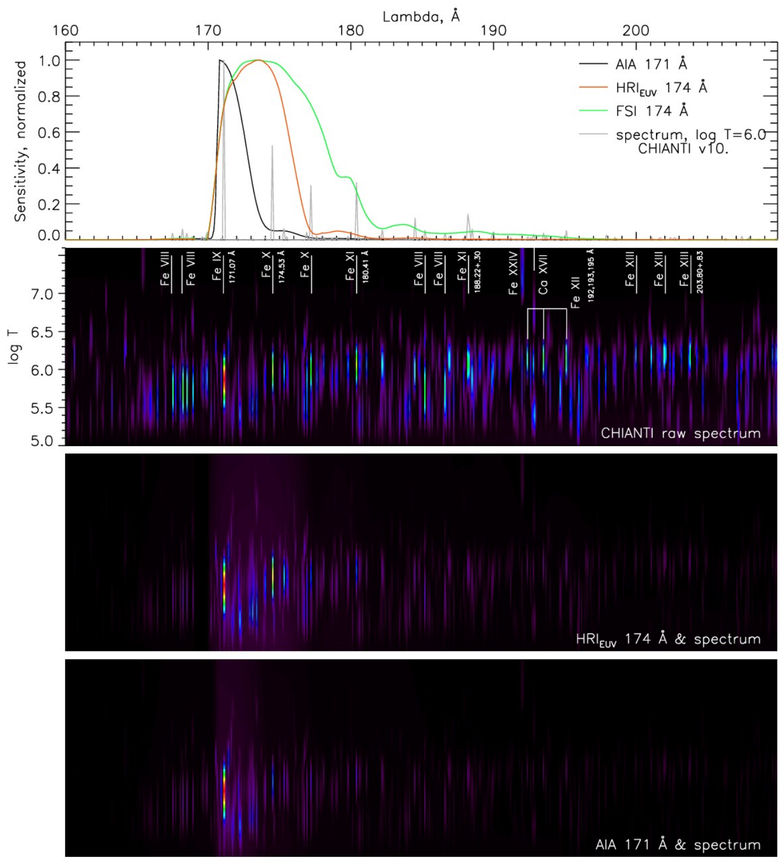
HRI_{EUV}	AIA 171
λ ~174 Å	λ ~171 Å
FWHM ~5 Å	FWHM ~2 Å
0.5 arcsec/pixel	0.6 acrsec/pixel
Different sensitivity	
Different vantage point	

AIA 171 | Zoomed AIA 171 | Re-projected HRI_{EUV}



Observations 30th May 2020, ~15:00UT. Separation 31.3°, distance SolO–Sun 0.55 au. Re-projection is done using `WCS` routines in `SolarSoft`.

Spectral and temperature sensitivities:

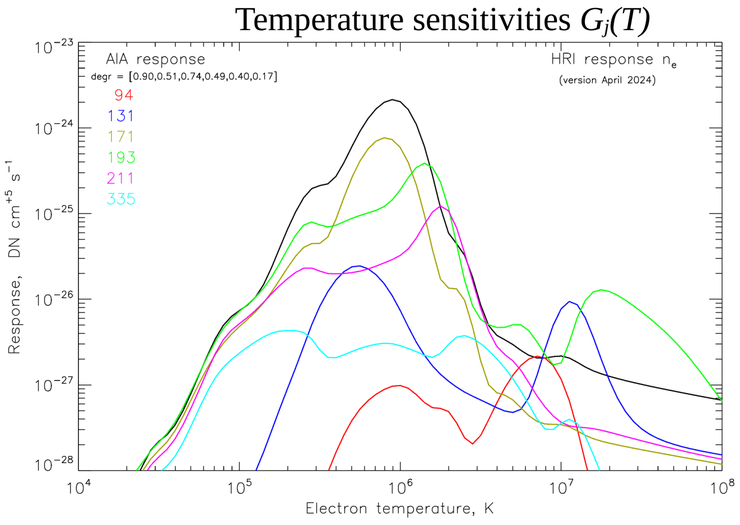


Instead of spectral sensitivity $R_j(\lambda)$ we frequently use temperature sensitivity $G_j(T)$, such that:

$$I_j = \int_T G_j(T) \cdot DEM(T)\, dT$$

Temperature sensitivities were calculated using CHIANTI v.10 using same parameters (coronal abundances, chianti ioneq, $n_e=10^9$ cm^{-3})

Temperature sensitivities $G_j(T)$



Simulated images:

- AIA images → *DEM(T)*
  or
- AIA and re-projected HRI_{EUV} → *DEM(T)*

Then we convert *DEM(T)* into simulated images using $G_j(T)$. We either re-project the simulated image to HRI_{EUV} (AIA data only for DEM) or use initially re-project HRI_{EUV} image before DEM inversion (7 channels for DEM).

DEM method from Cheung et al. (2015):

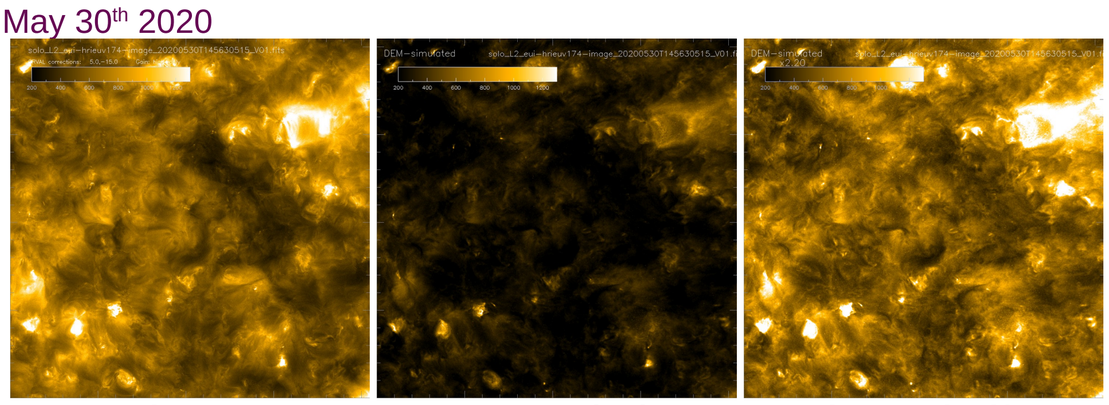
$$I_j = \sum_i G_j(T_i) \cdot EM_i$$

Only 6 channels of AIA are used. Necessity to co-align images and use same UT.

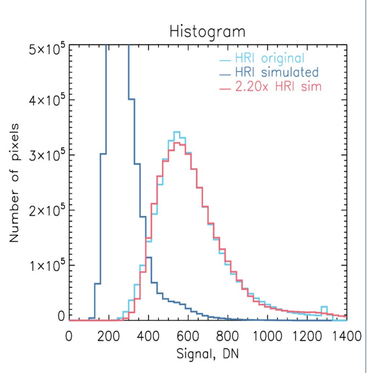
Degradation of AIA is taken into account.

6 AIA images → DEM → simulated HRI_{EUV}

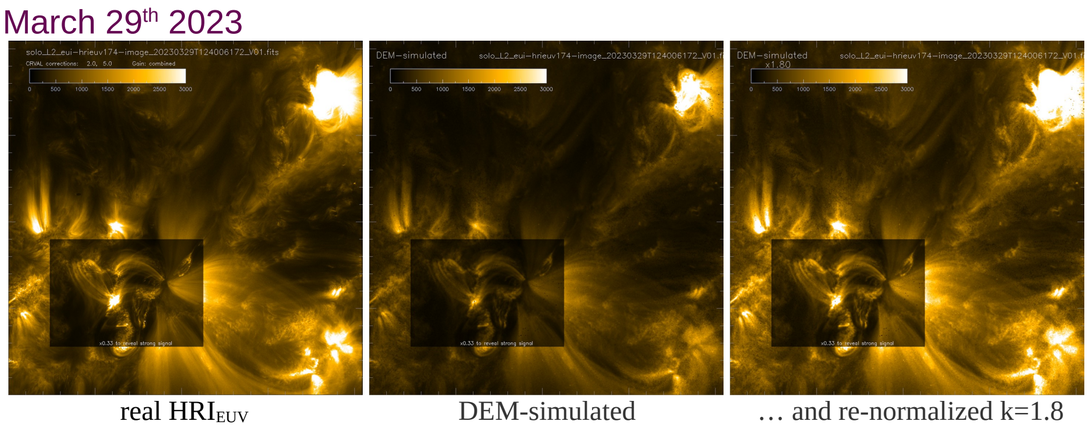
May 30th 2020



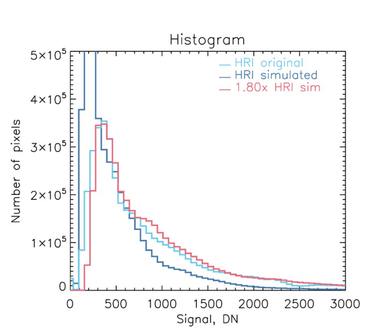
real HRI_{EUV} | DEM-simulated | … and re-normalized k=2.2



March 29th 2023



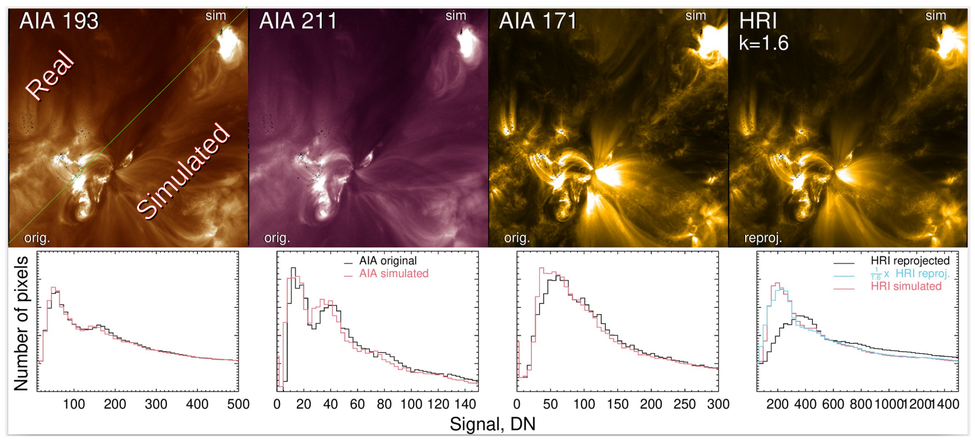
real HRI_{EUV} | DEM-simulated | … and re-normalized k=1.8



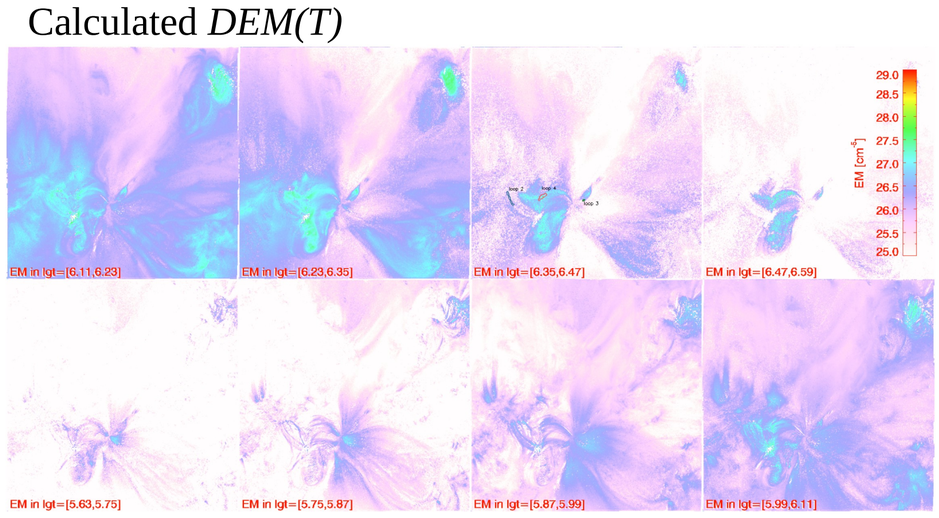
… and similar results for March 7th 2022 (separation ~3°)

HRI_{EUV} + 6 AIA → DEM → simulated images

March 29th 2023



Calculated *DEM(T)*



Conclusions:

- Relative calibration of AIA and HRI_{EUV} is off by 60-80%
- We analyzed variation of the mean signal in HRI_{EUV} during ~3 years and can not confirm/disprove any degradation due to variable solar conditions
- Slightly different results are obtained for (HRI_{EUV} + 6 AIA) data and 6 AIA channels only. Adding of HRI_{EUV} gives better constrain on 1 MK plasma.
- When using HRI_{EUV} + 6 AIA the cross-calibration coefficients are: k=1.8, k=1.6 and k=1.6 for 2020, 2022, 2023
- Good correspondence of real and simulated images, better than with 6 AIA channels only
- With k=1 the DEM inversion does not converge for many pixels

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