Thermal properties of the smallest EUV brightenings observed with SolO/HRI-EUV and SDO/AIA.

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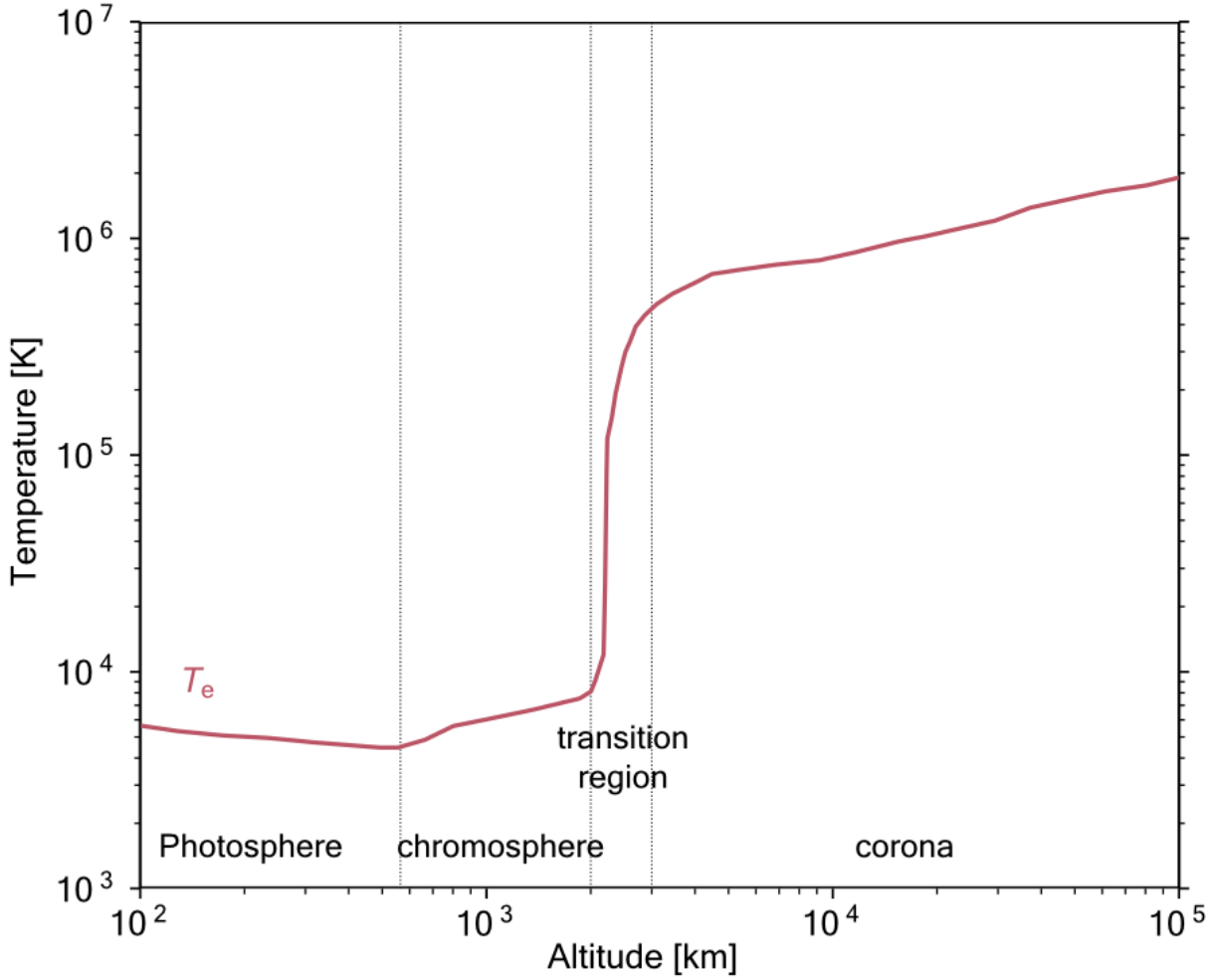
1st year PhD thesis

Context : The coronal heating problem

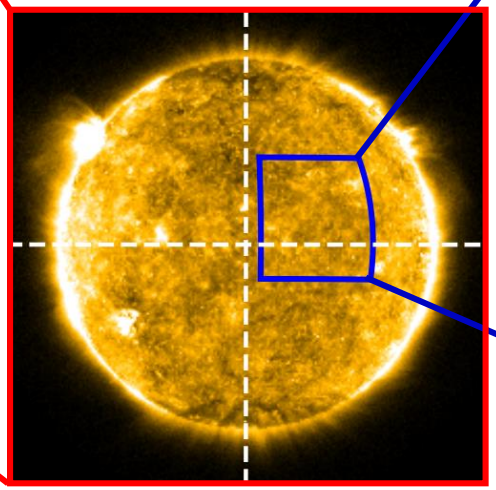
Average temperature in the solar atmosphere



Solar corona observation: SolO/HRI-EUV and SDO/AIA on 30 may 2020

SDO/AIA (launched in 2010)

- Lower Spatial resolution (1300 km at 1 A.U).
- Lower cadence (12 s).
- 6 EUV channels. T ~ 0.2 – 8 MK



SolO/HRI-EUV (launched in 2020)

- Highest Spatial resolution at the time (400 km at 0.558 A.U).
- First time at high cadence (5 s).
- 1 channel at T ~ 1 MK.

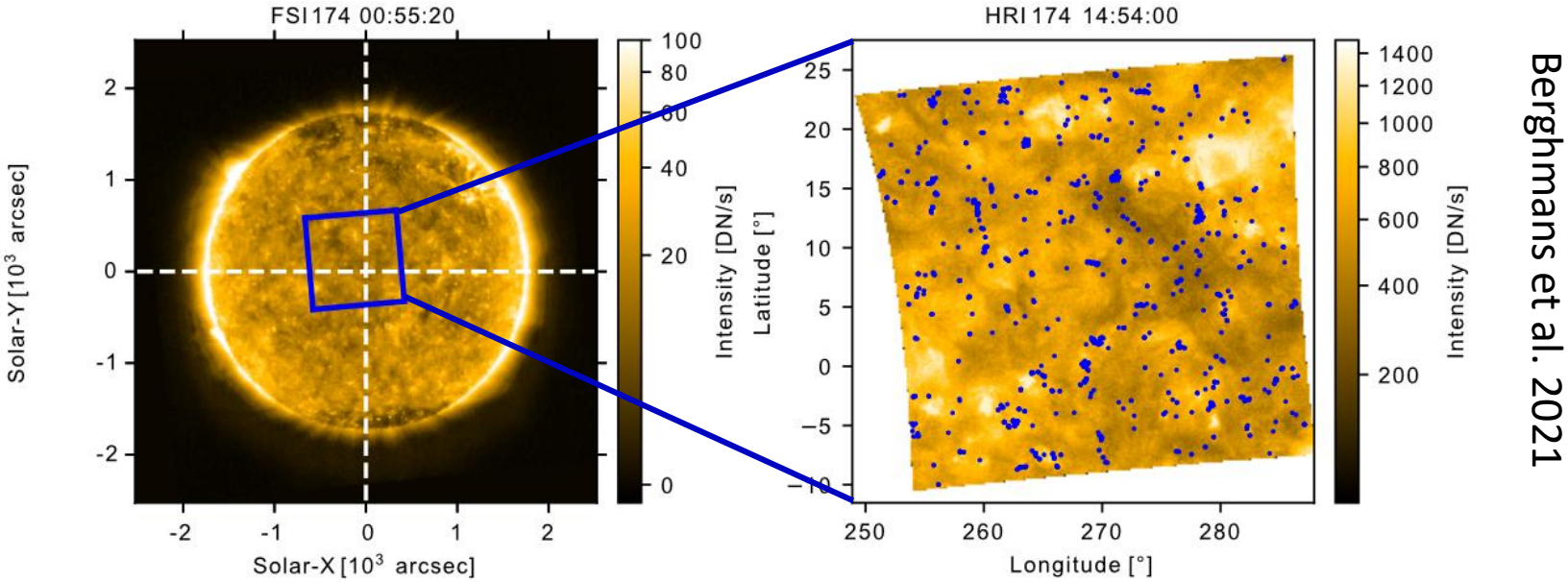
Useful to study the plasma thermal evolution.

Useful to detect events at small spatial and temporal scales.

➔ My work combines these two imagers.

Coronal heating from small brightenings

HRI-EUV on 30 may 2020



Berghmans et al. 2021

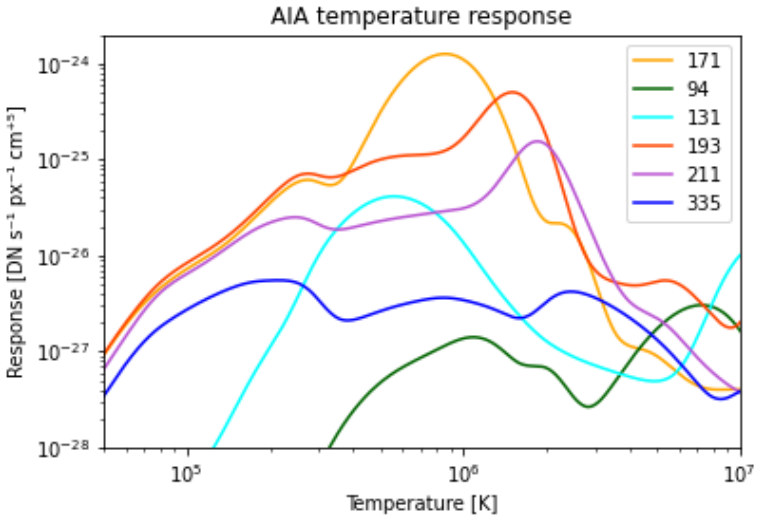
- First detection: 1467 small brightenings during the 5 minute sequence (blue dots).
- T distribution peaks ~ 1 MK. But the method (Differential Emission Measure) used is biaised towards isothermal 1 MK plasma *(Guennou et al. 2012).*

➔ The first step of my work is to confirm if these events are at coronal T.

➔ Apply an alternative method to study their thermal evolution, and deduce their T.

➔ We need observations at different T: 6 AIA coronal channels (no other data available).

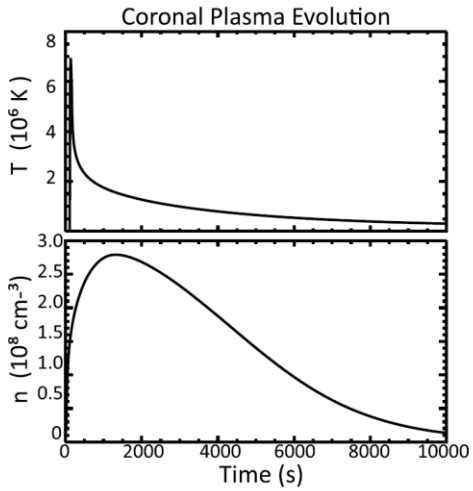
Time lag method on AIA light curves

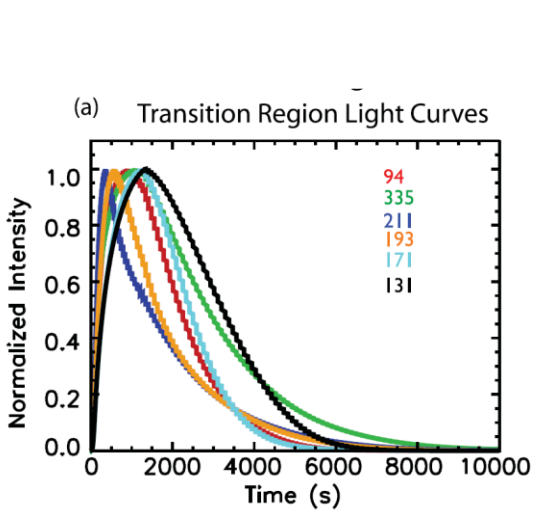


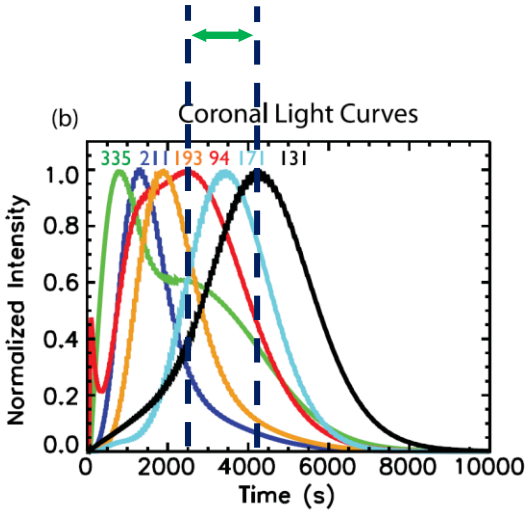
Method: for each event, workout the delay (time-lag) between the peaks of emission within the AIA channels.

From simulations: coronal and transition region plasma show different time lags.

Viall & Klimchul 2015

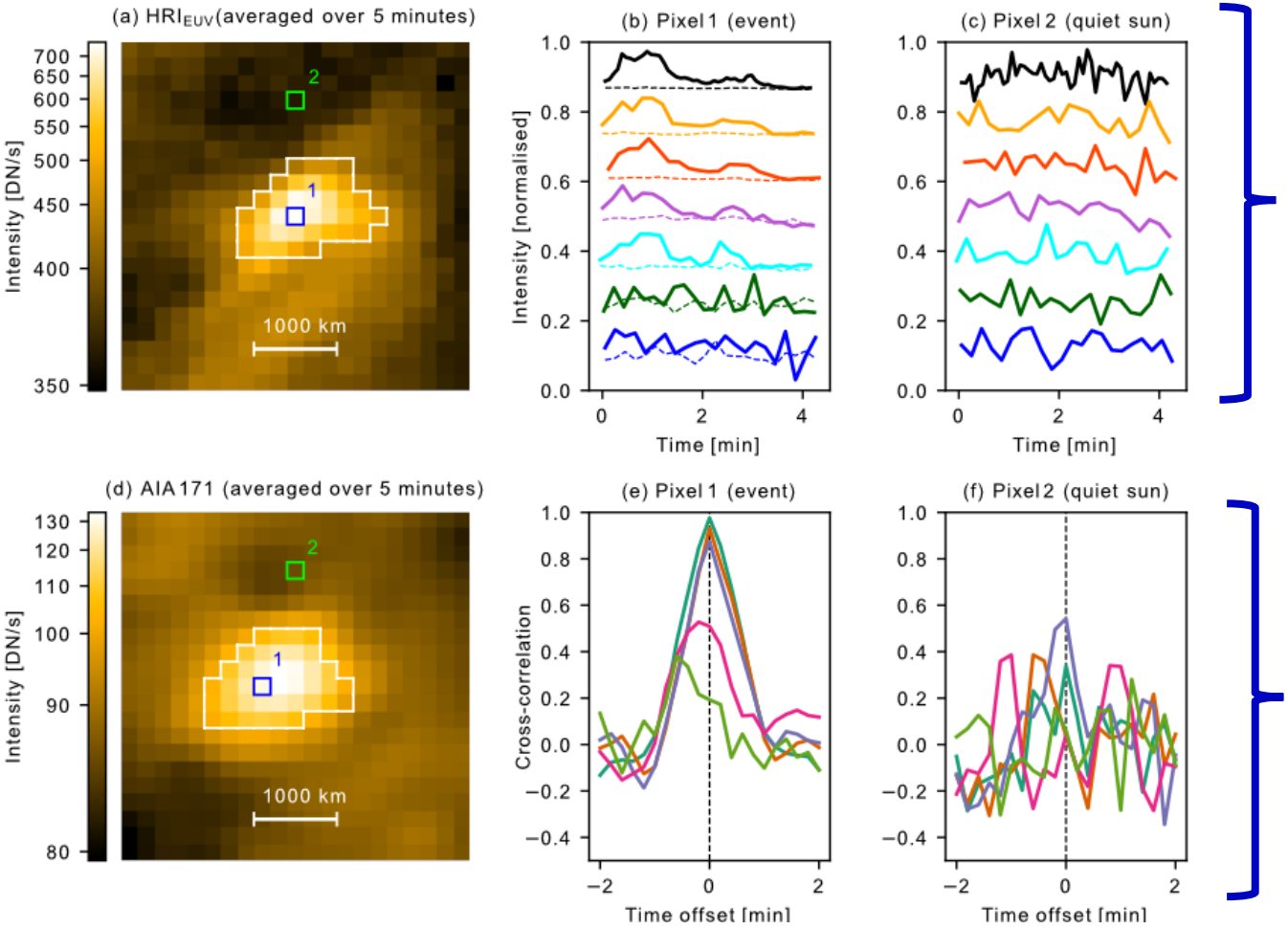






Extraction of AIA time lags pixel by pixel

EUV event pixel (1) vs quiet Sun pixel (2)



- Extraction of light curves pixel by pixel.
- Estimation of the background.

- Cross-correlate between a couple of 2 AIA channels

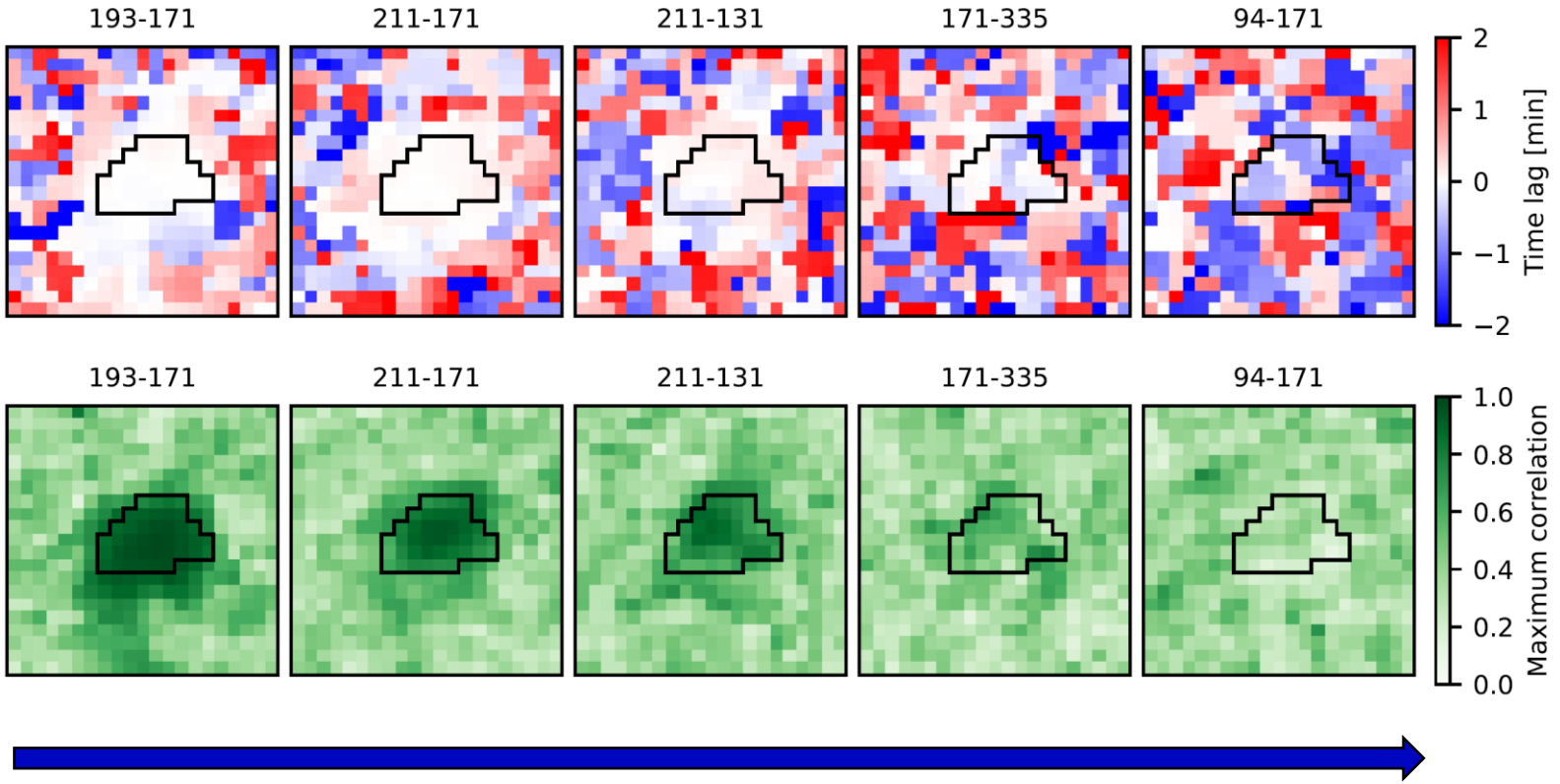
Extract:

1. Maximum correlation value
2. Associated time offset (time lag)

Dolliou et al. 2022 (in prep)

Extraction of AIA time lags pixel by pixel

Time lag & maximum correlation maps

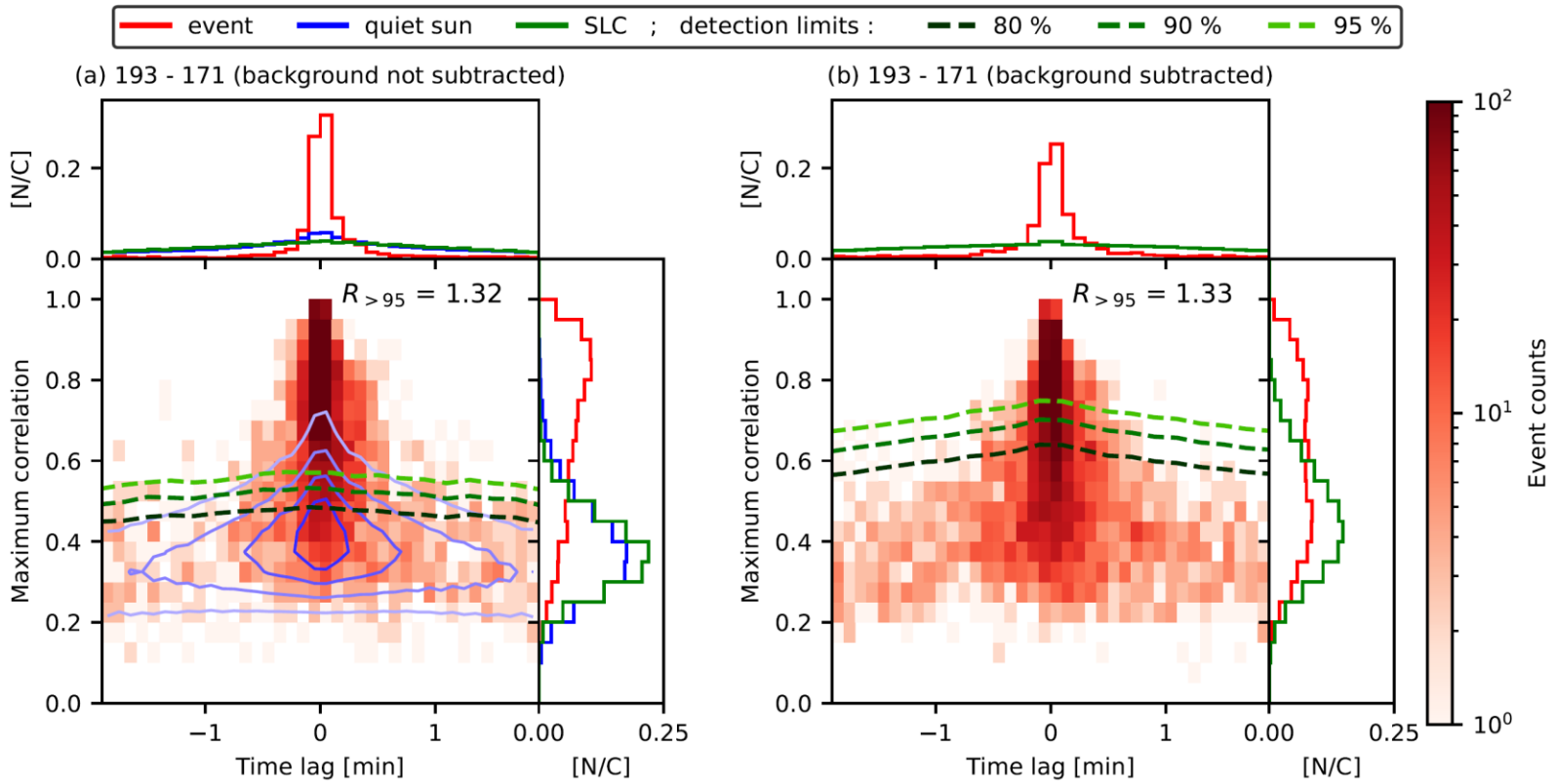


AIA channels with decreasing S/N.

- Events have higher correlations and no time lag, compared to quiet sun?
- Results depend on the S/N ratio: we need to assess the effect of noise.

Dolliou et al. 2022 (in prep)

Statistical analysis (I) : Maximum correlations & time lags for 193 -171



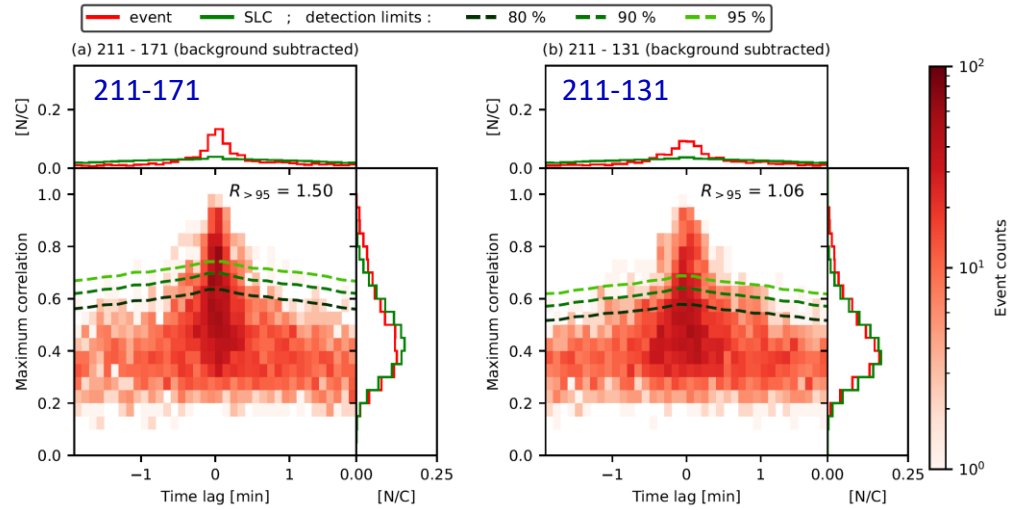
Above 95% detection limit, time lag distributions peak around 0 with a small positive asymmetry.

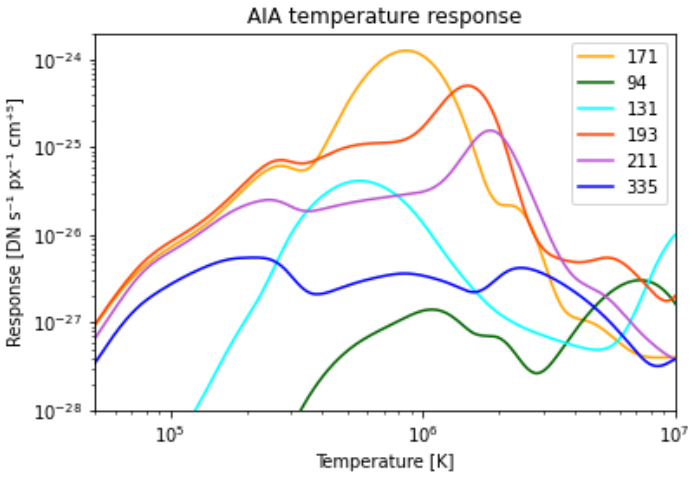
These results are not caused by noise or background variation alone.

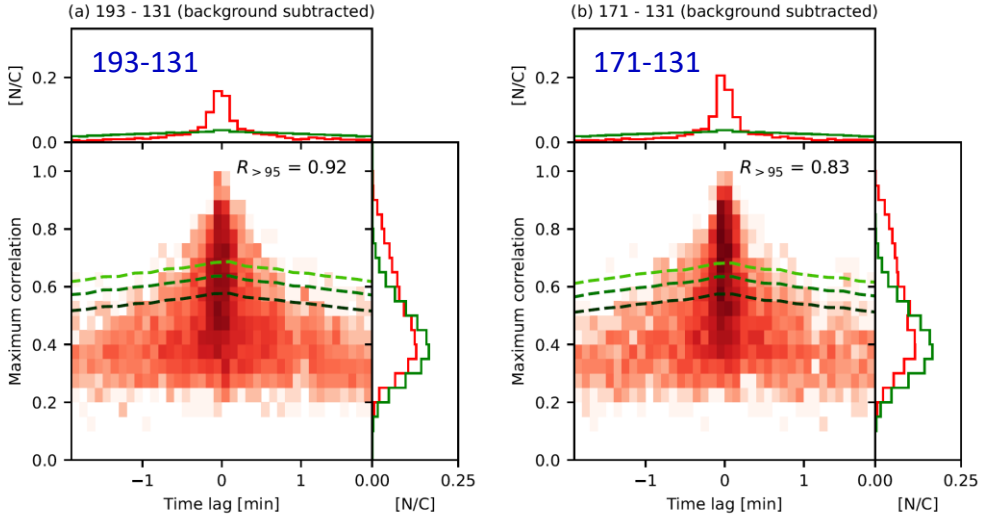
➔ Results are caused by the events.

Dolliou et al. 2022 (in prep)

Statistical analysis (II): generalization to the other AIA couples







All AIA couples return zero time lags, with slight asymmetries.

1. Events colder than 1 MK ?
2. Small loops at coronal temperatures cools very fast ?

Dolliou et al. 2022 (in prep)

Conclusion

- The time-lag analysis shows no strong signatures of delay for each couple of AIA channels.

- In some cases, a small lag is seen above the AIA cadence (12 s).

- Interpretation:
  - Compatible with TR emission.
  - Compatible with the cooling timescale of a tiny 1MK loop.

➔ Work in progress to solve this ambiguity.