Energy distributions of small brightenings in the solar corona

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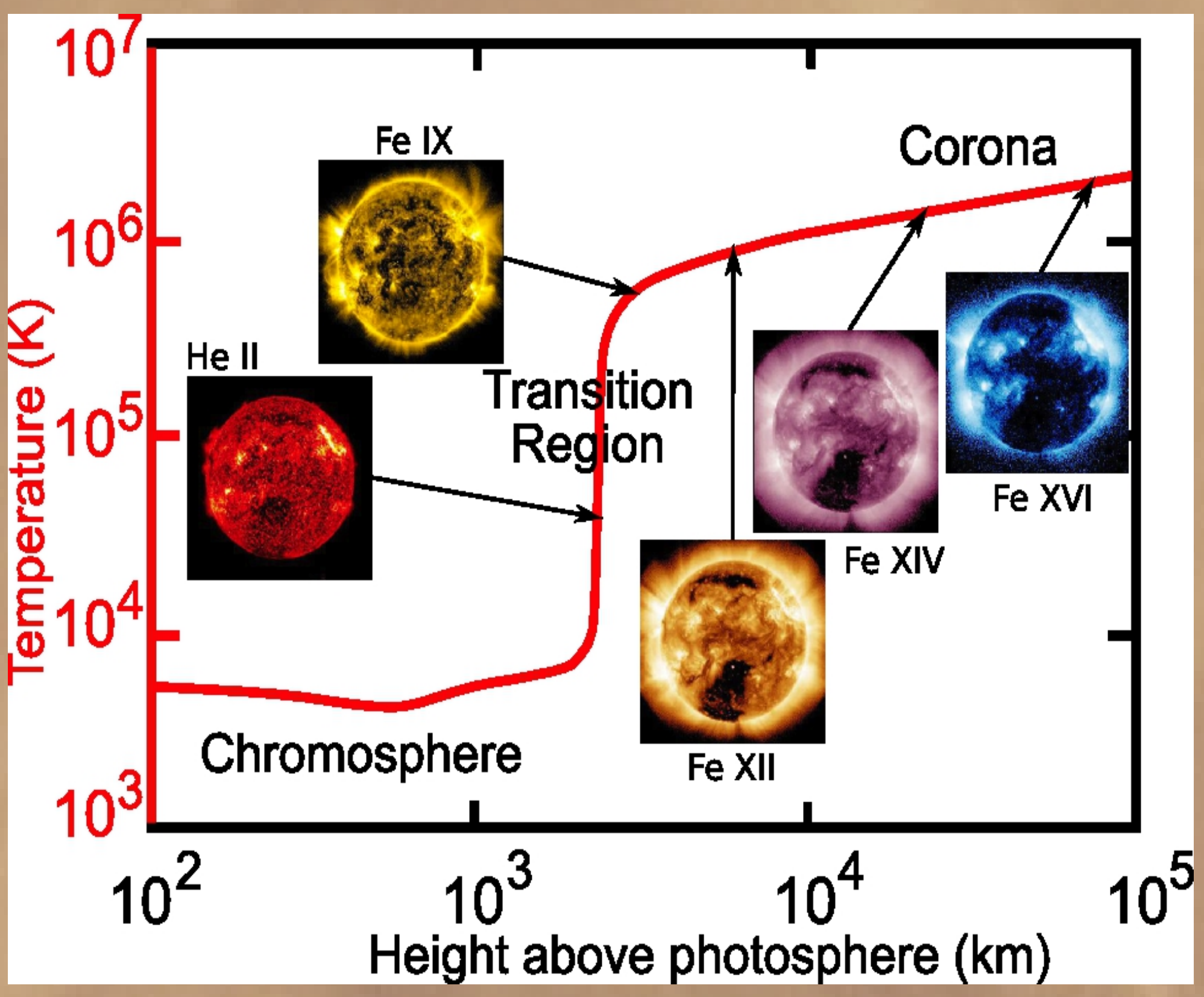
Abstract - As the dissipation power associated to large-scale coronal events like flares is not sufficient to provide enough energy to maintain a high coronal temperature, the corona must also be heated either continuously or by many small-scale, intermittent events. We aim at discriminating between these two scenarios by providing a new insight into the distributions of the smallest events and their energy budget using the best observations to date. We present here our results for the distributions and characterization of small-scale EUV brightening events detected in SDO/AIA data.



- Why is the solar corona so hot ?

- How much energy must be put into the corona to compensate for the heat losses (radiation and conduction)?

- Do small events provide significant energy to the corona ?

Introduction - To explain the high temperature of the corona, much attention has been paid to the distribution of energy in dissipation events. Indeed, if the power-law slope of the dissipated energy distribution is less than -2, the smallest, unobservable events could be the largest contributors to the total energy dissipation in the corona (Hudson 1991).

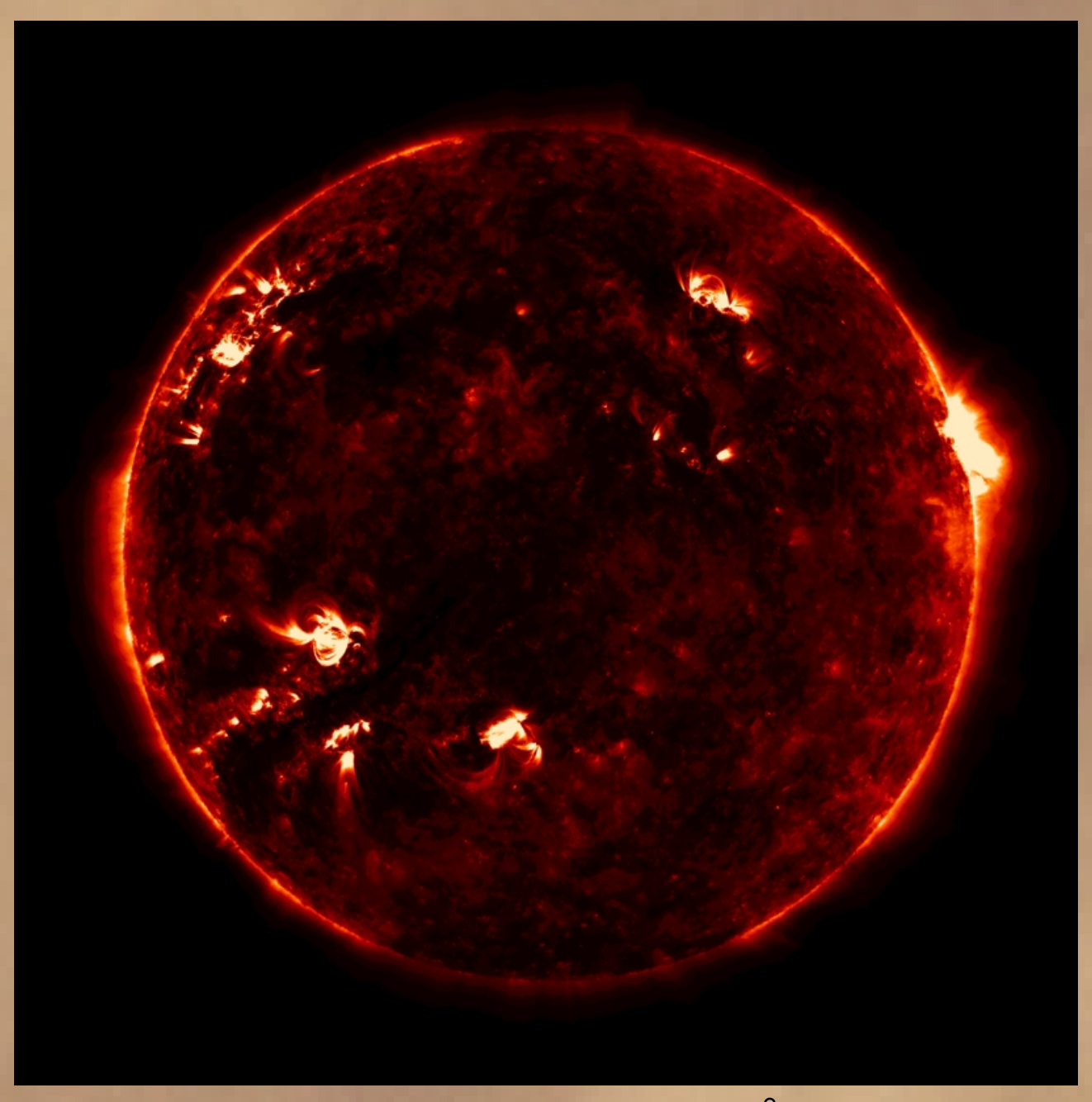
Observations in EUV (Krücker & Benz 1998, Berghmans et al. 1998, Parnell & Jupp 2000...) and X-rays have actually shown a distribution of event energies extending over 8 decades, with a slope close to -2 (Aschwanden et al. 2000), but they remain **inconclusive about the precise slope**. Furthermore, these results rely on a **very crude estimate of the (thermal) energy**. On the other hand, more detailed spectroscopic studies of events such as coronal bright points do not provide statistical information on their total contribution to heating.

In this work we aim at getting **a better estimate of the distributions of the energy dissipated in coronal heating events,** by:

- detecting EUV brightenings at small spatial and temporal scales (minutes to few hours) in high cadence, high resolution and high sensitivity SDO/AIA data.
- using the large number of SDO/AIA coronal channels (94, 131, 171, 193, 211, and 335Å) to compute the energy.

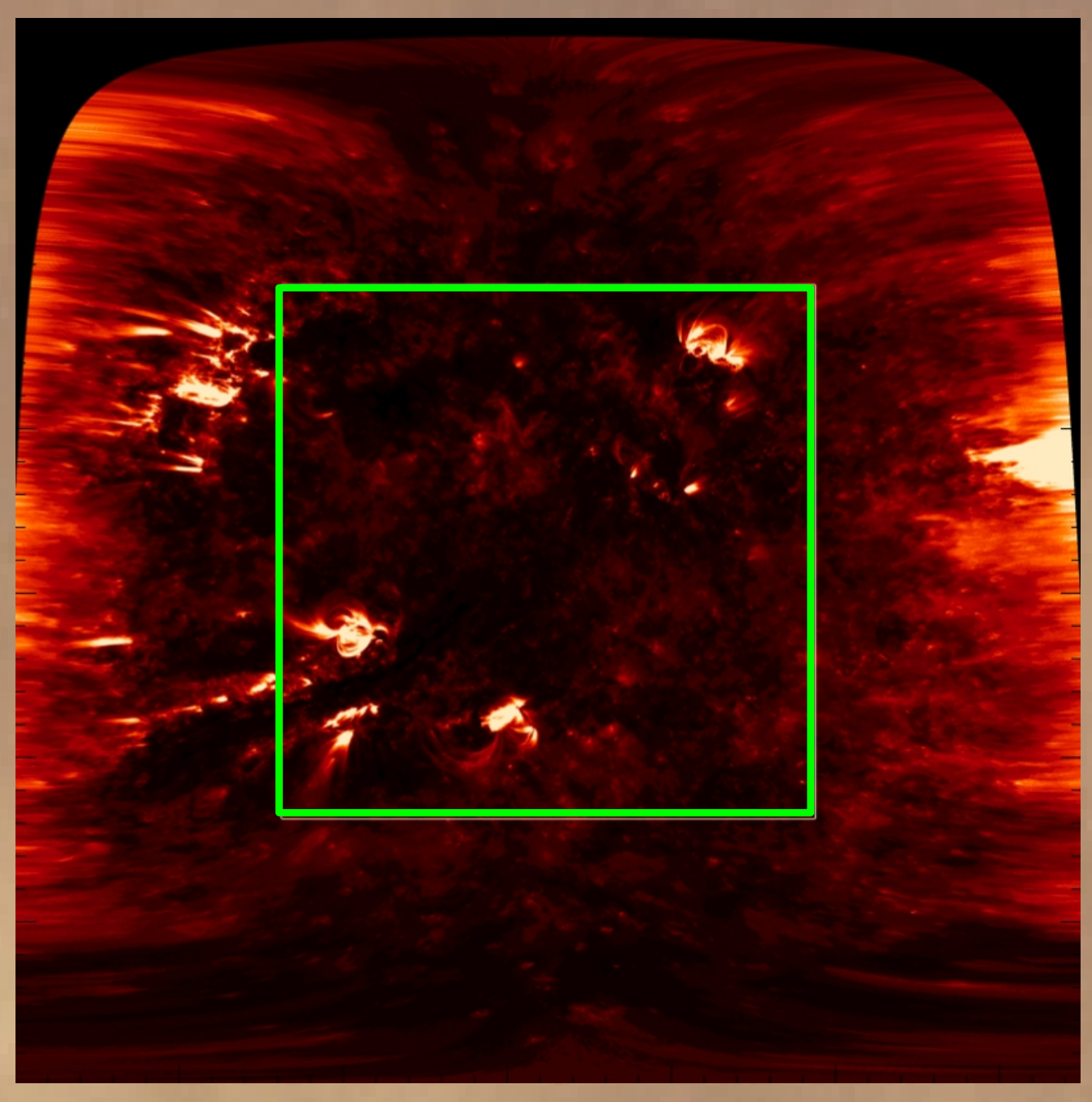
Method for detection and characterization

Level 1.5 SDO/AIA images



SDO/AIA - 171 Å

Region in Carrington coordinates

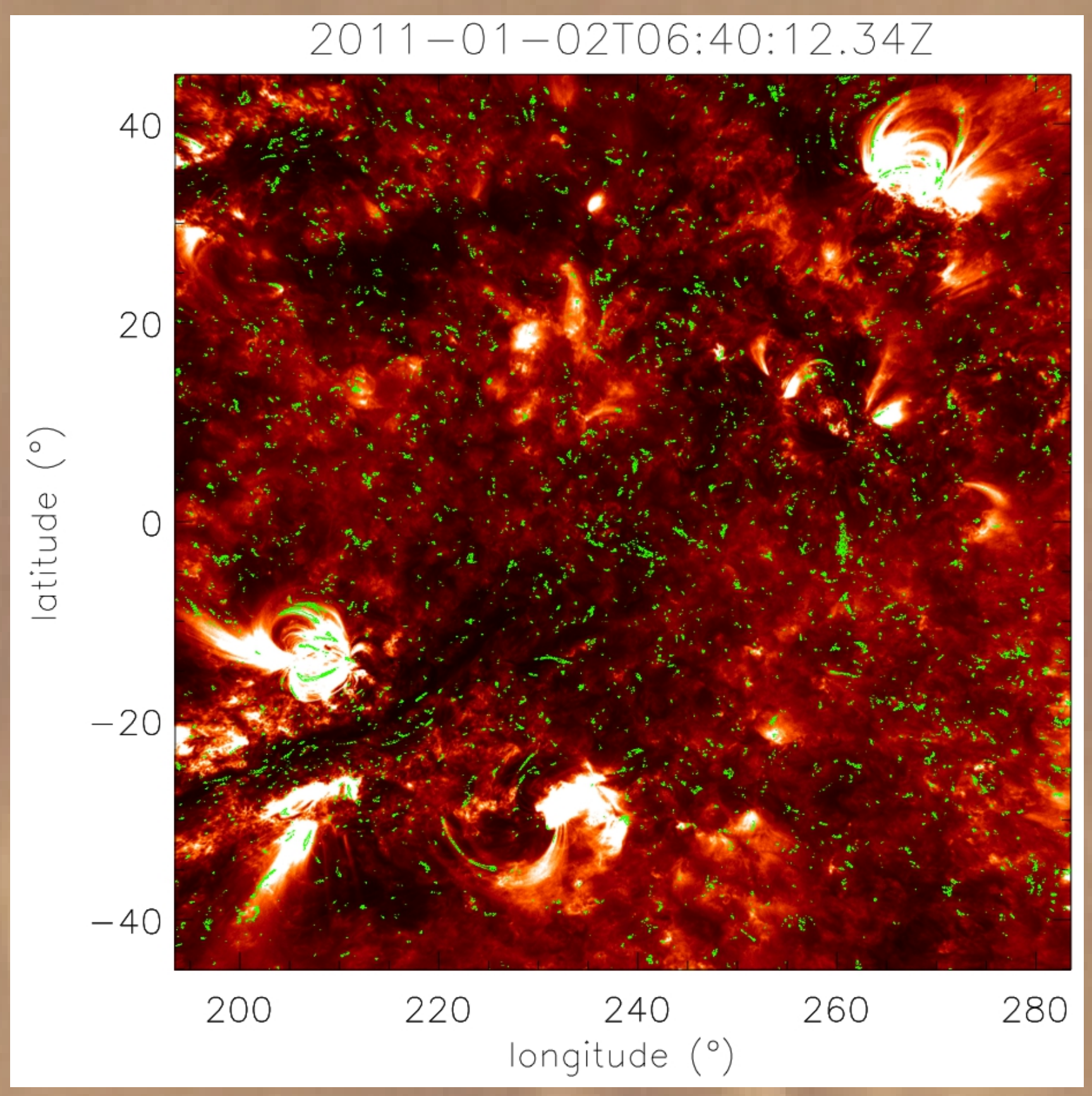


Selected field of view: 90° x 90°

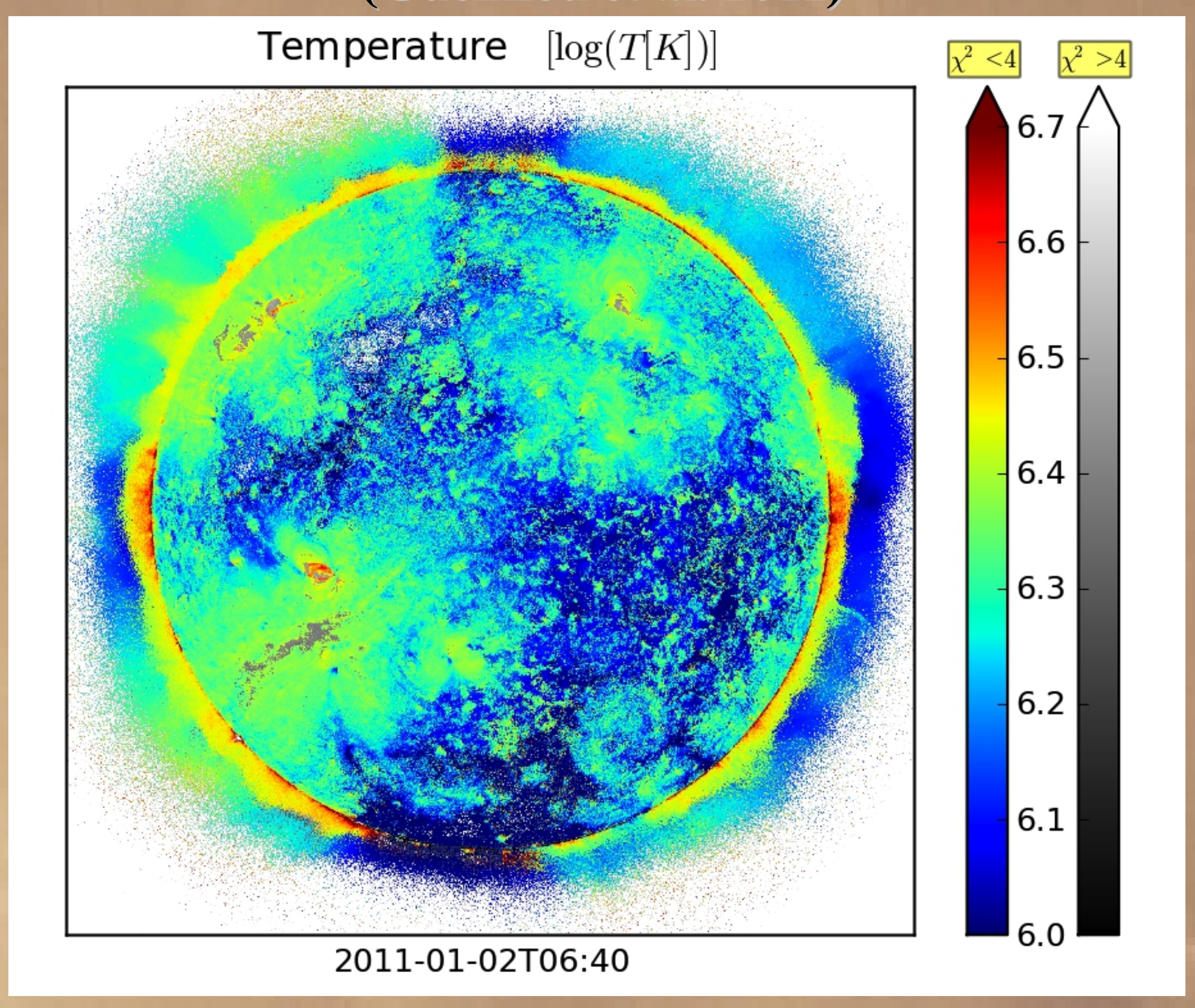
Build a data cube from images

Local threshold (depending on position)

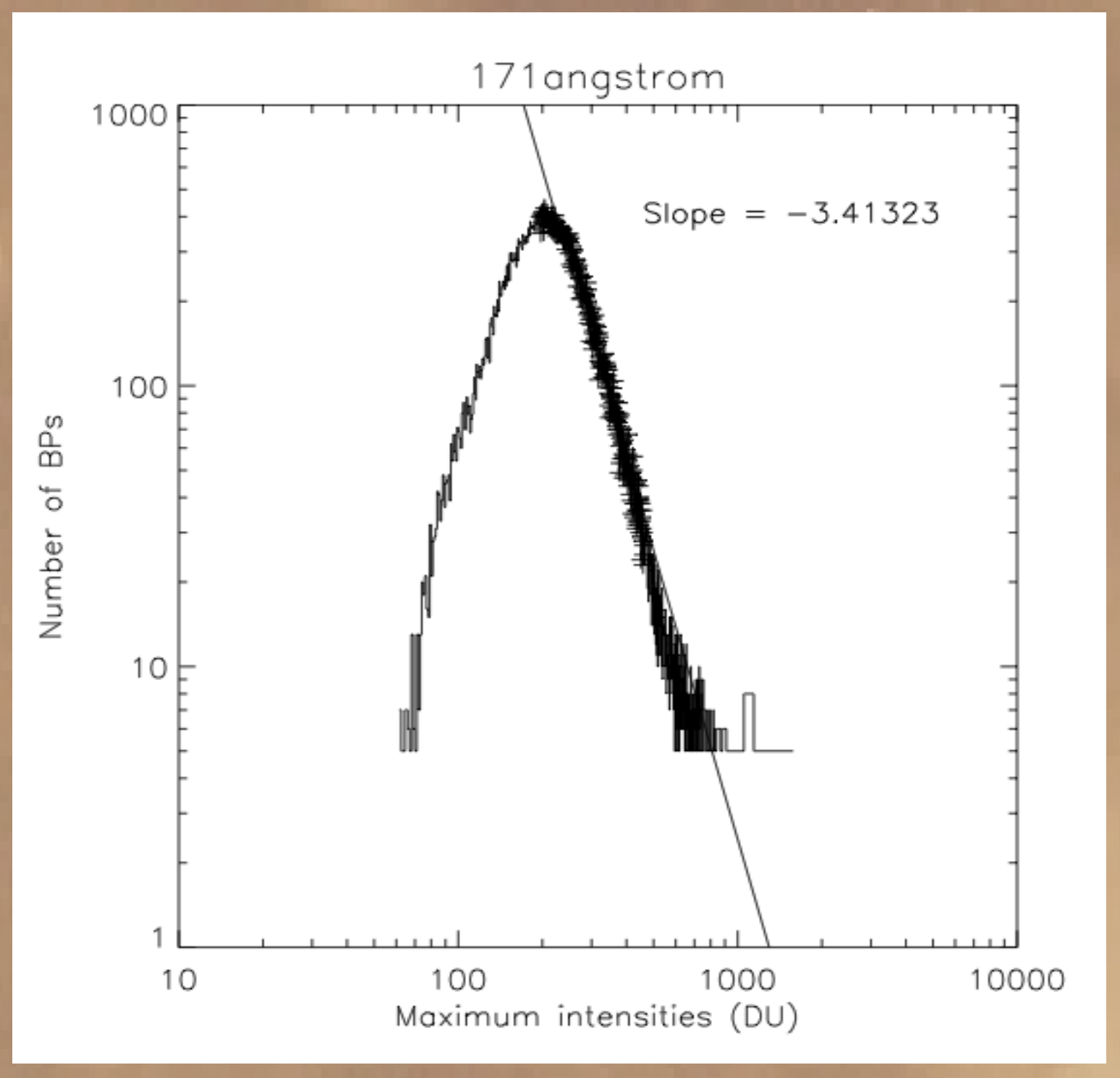
Characterize the brightenings



Use maps of density and temperature (Guennou et al. 2012)



Distribution of maximum intensities



Evaluate the radiative and thermal energies

Thermal energy

$$E_{th} = \frac{3}{2} k_B \int dA\, T \sqrt{EM h q}$$

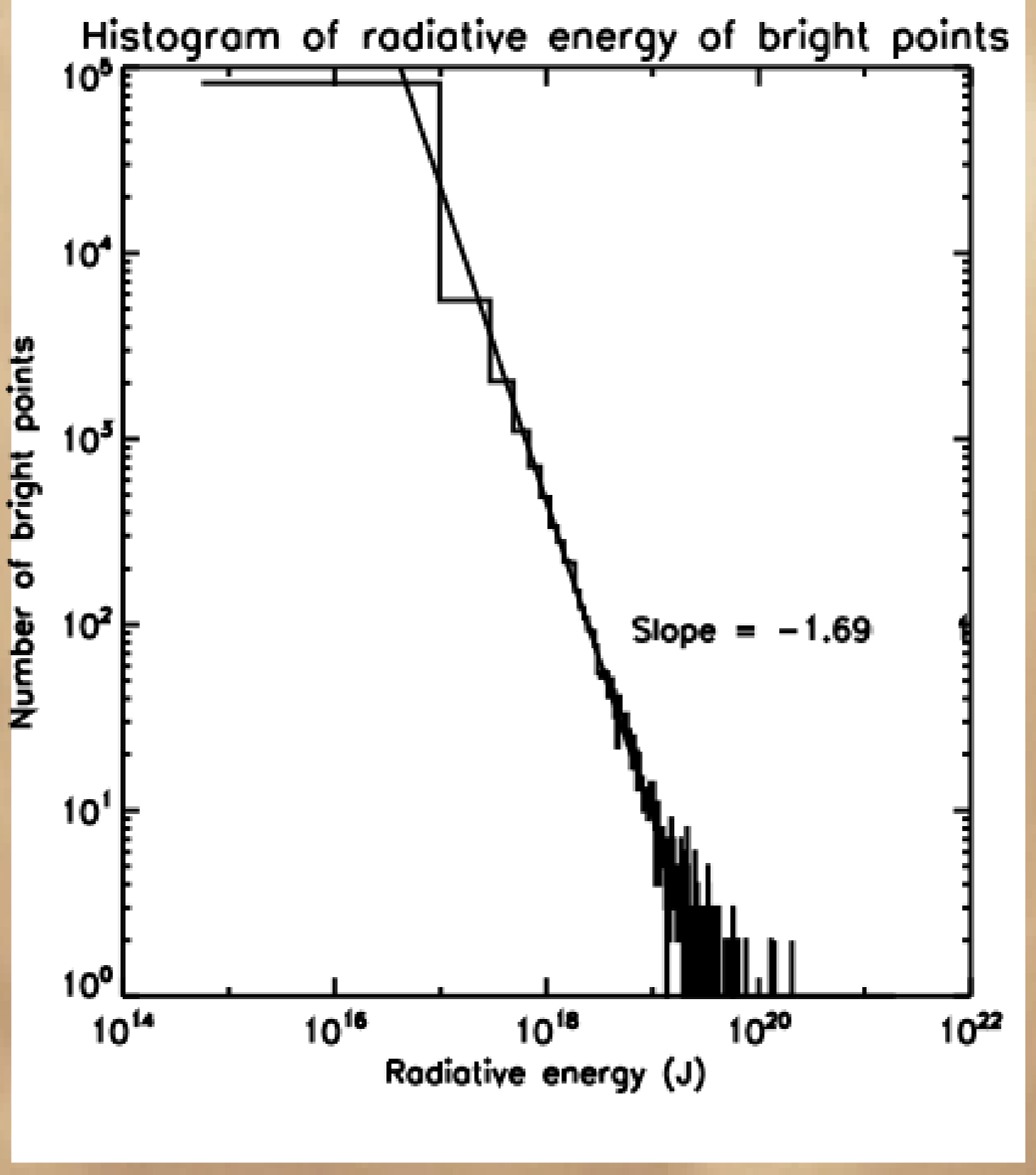
With: k_B the Boltzmann constant, T the temperature, EM the emission measure, A the area, h the height of pixel and q the filling factor.

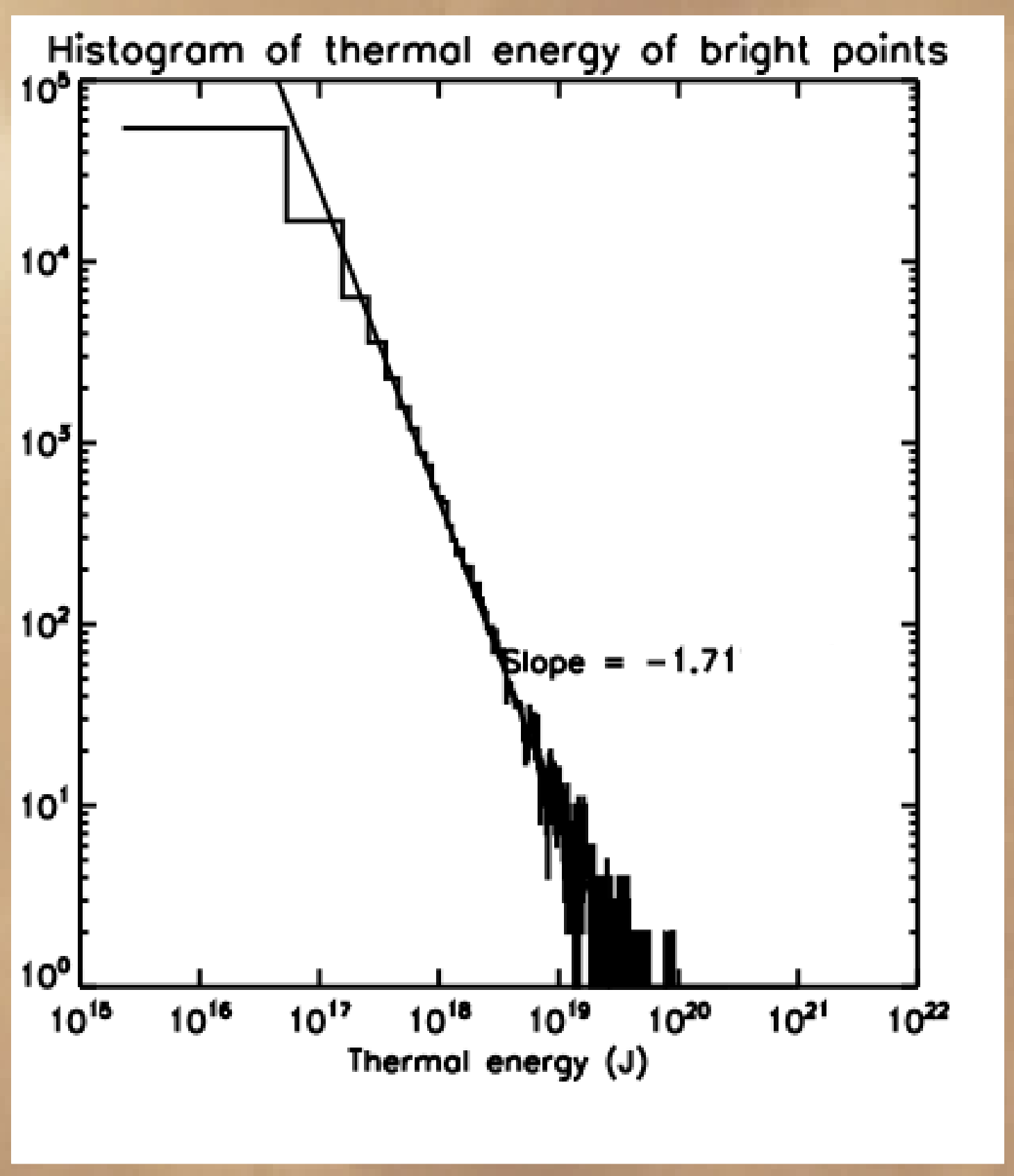
Radiative energy

$$E_{rad} = \int dt \int dA\, EM\ \Lambda(T)$$

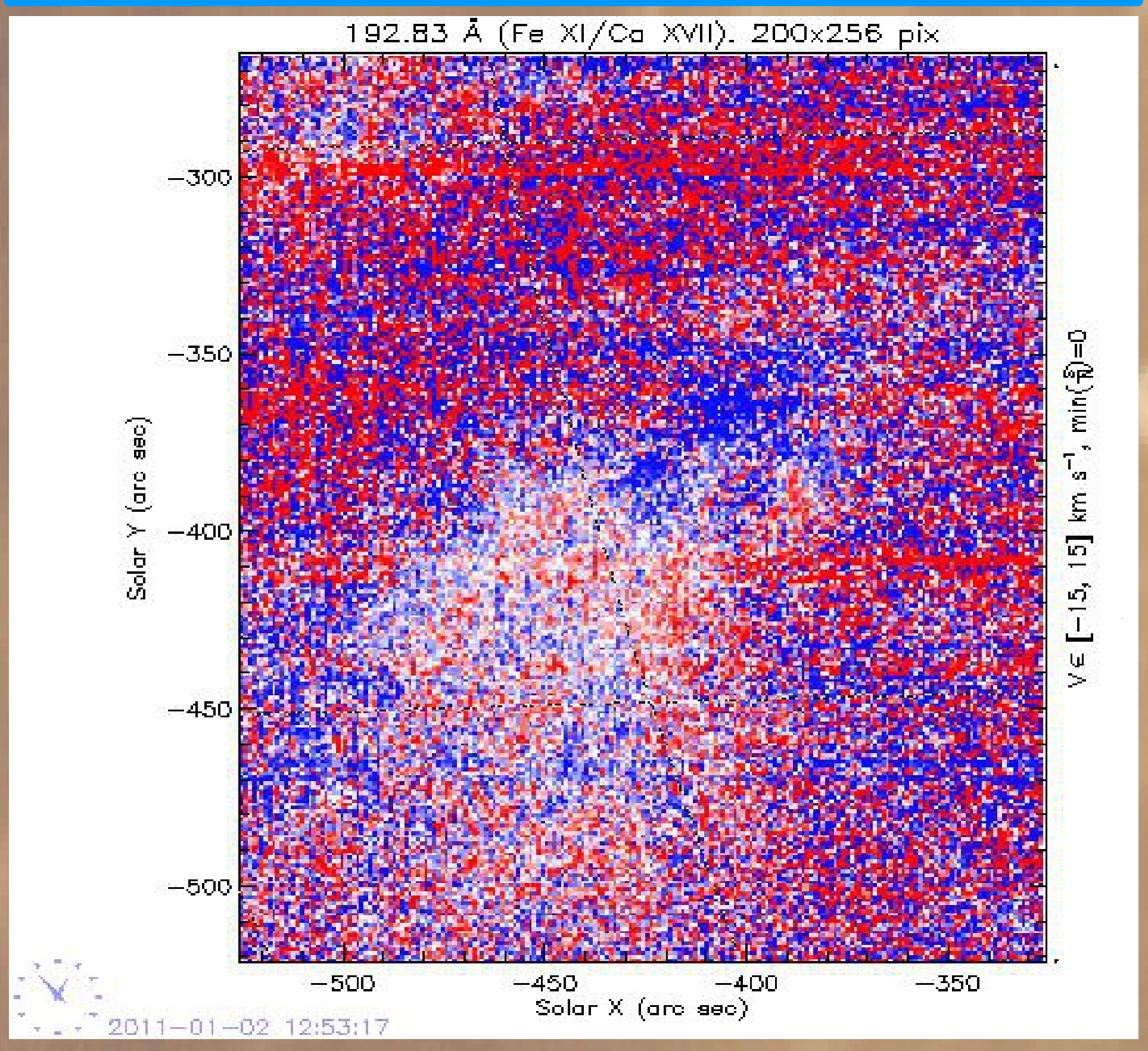
With: Λ(T) the radiative losses function from ***Klimchuk et al. 2008.***

Result: Distributions of event energies





Next step: evaluate kinetic energy distributions from Hinode/EIS density and Doppler velocity.



Conclusion - Coronal brightening events have been detected in SDO/AIA data cubes. I used maps of temperature and density obtained from AIA / SDO, to calculate the total thermal energy and the total radiative energy of brightenings. We obtain a slope of -1.7, indicating that small events do not constitute the majority of the heating of the corona.

In a next step we will estimate the magnetic energy of brightenings with Hinode/SOT or SDO/HMI and their kinetic energy with Hinode/EIS. We will then compare our estimates of event energies to the ones obtained in previous studies. In particular, we will determine whether the slope of the event energy distribution must be updated and we will determine the contribution of small events to the total coronal energy budget.