Solar surges related to UV bursts:

Characterization through density diagnostics, k-means, and inversions.

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Introduction

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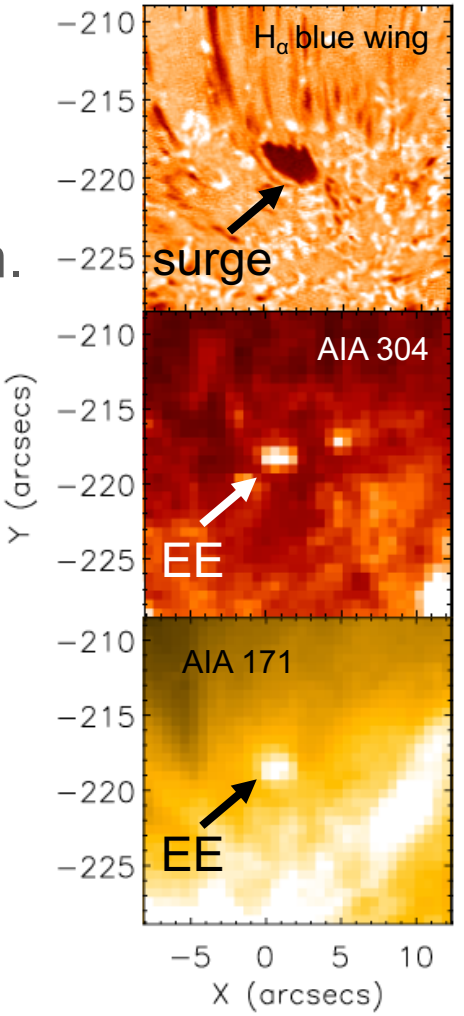
What are surges and why are they important?

- Chromospheric ejections traditionally observed in H_α.
- Closely related to fundamental mechanisms like magnetic reconnection.
- Frequently associated with many other solar phenomena.

Nelson and Doyle (2013)

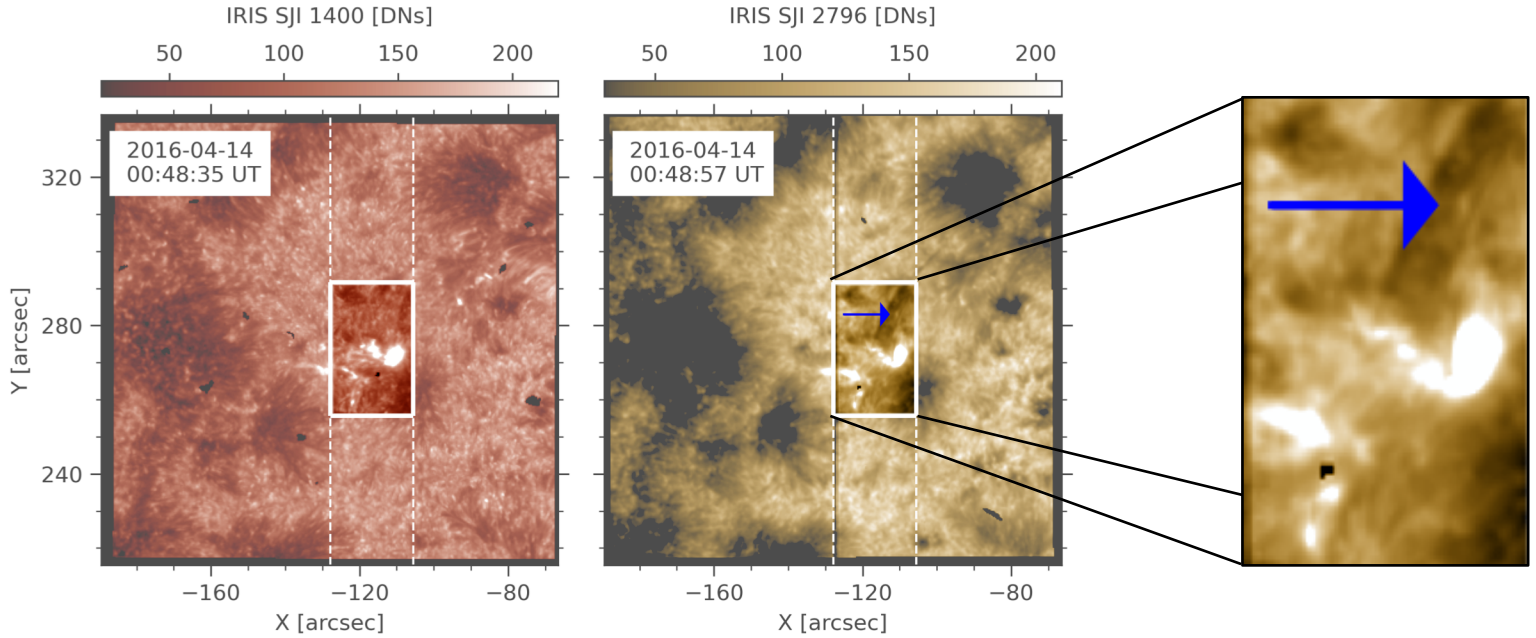


Aim

- Our purpose is to address the current lack of inverted models and diagnostics of surges, as well as characterizing the chromospheric and transition region plasma of these phenomena.

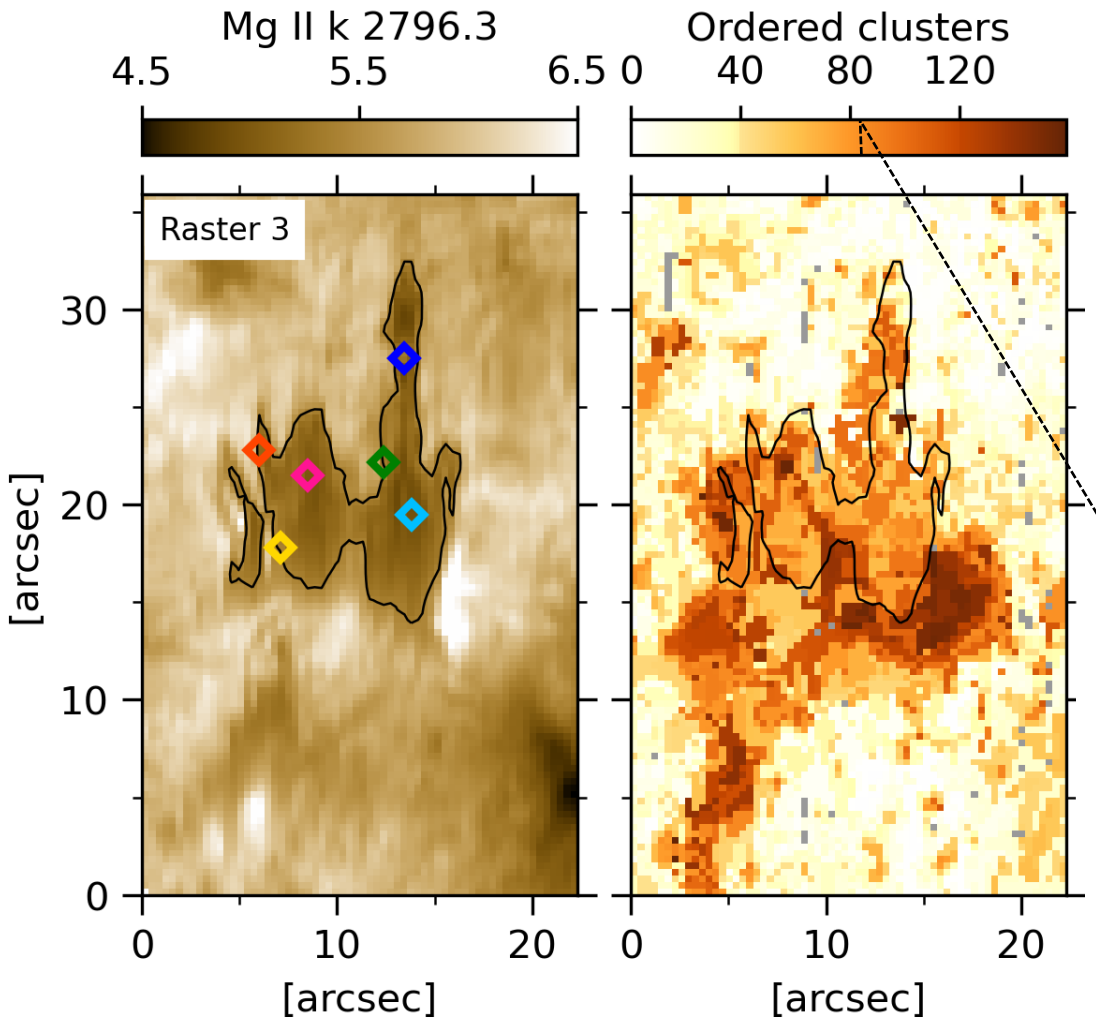
Observations and methods

Episode of recurrent surges and UV bursts observed with IRIS:



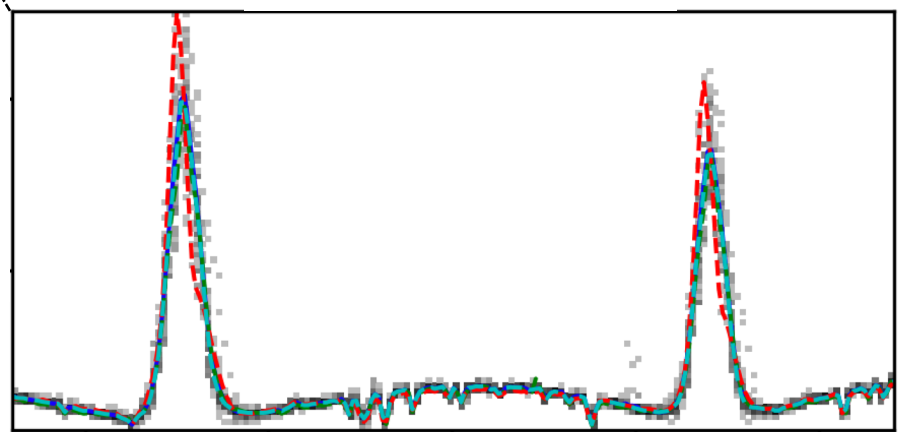
We study	Lines	Method
Low- and mid– chromosphere	Mg II h&k	k-means clustering algorithm. Inversions with the STIC code.
Transition region counterpart	O IV 1399.8 Å O IV 1401.2 Å	Density diagnostics

Analysis of the Mg II h&k line



k-means:

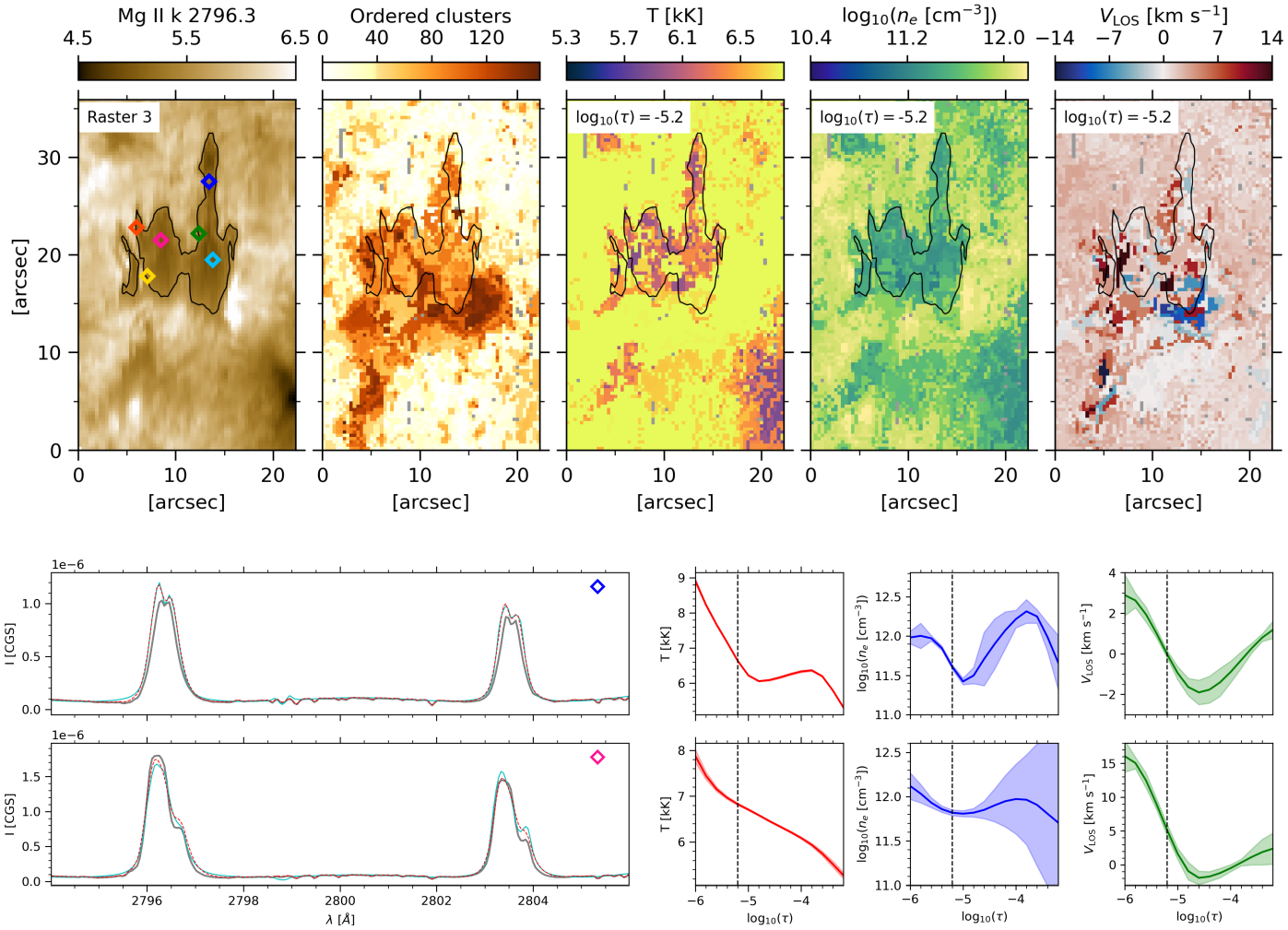
- Algorithm that classifies a set of *n* samples in *k*-disjoint clusters of equal variance, minimizing the inertia.
- It reduces a factor 43.2 the original number of profiles that would be necessary to analyze.



--- RP
--- MEDIAN PROFILE
--- MOST SIMILAR
--- MOST DIFFERENT

Example: Cluster 83 contains 30 profiles

Analysis of the Mg II h&k line



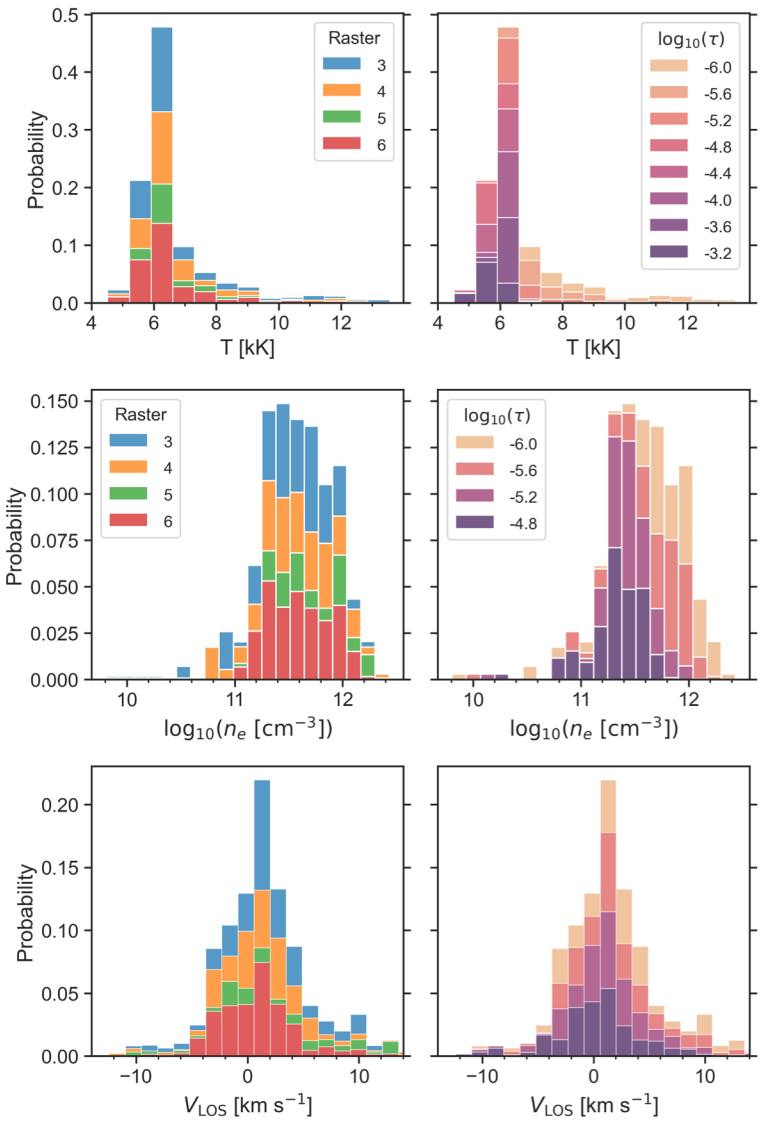
Mg II h&k inversions:

- The STIC[1] code assumes NLTE and includes partial frequency redistribution effects of scattered electrons.
- Inversion scheme:

	Nodes			
	1st cycle	2nd cycle	3rd cycle	4th cycle
Temperature	4	7	9	9
V_{LOS}	3	4	7	9
$V_{microturbulence}$	3	4	4	6

[1] STIC = STockholm Inversion Code (de la Cruz Rodríguez et al.2019, 2016): https://github.com/jaimedelacruz/stic

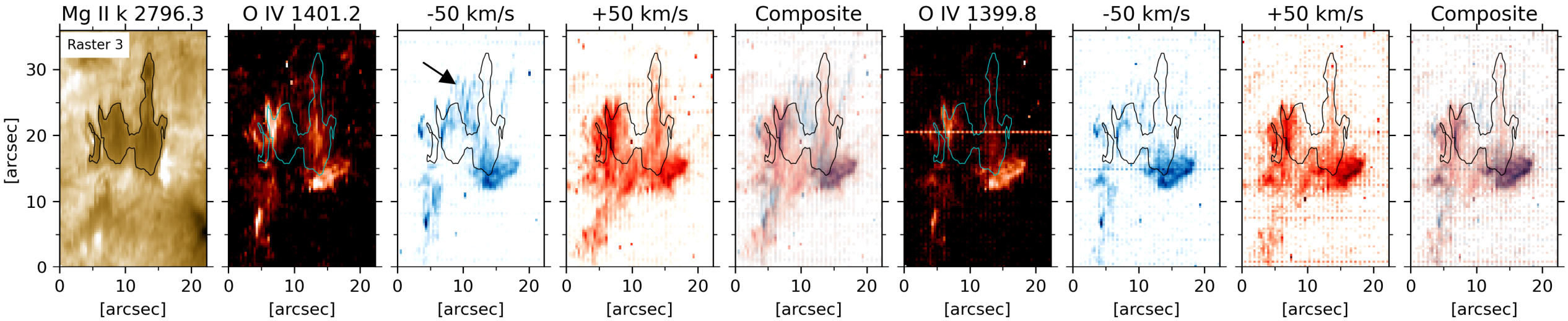
Analysis of the Mg II h&k line



Results:

- Most probable temperature within the surges is around $T = 6$ kK, for optical depths between $-6.0 \leq log_{10}(\tau) \leq -3.2$.
- Most reliable results for electron number density, n_e, and line-of-sight velocity, V_{LOS}, are within $-6.0 \leq log_{10}(\tau) \leq -4.8$, with $n_e \sim [1.6 \times 10^{11}, 10^{12}]$ cm^{-3} and V_{LOS} of a few km s^{-1}.
- The four rasters analyzed show surges with similar properties.
- Cooler plasma with smaller electron number density is located in deeper layers of the surges.

Analysis of the O IV lines



Results:

- We find, for the first time, observational evidence of enhanced O IV 1399.8 and 1401.2 Å emission within the surges, indicating that these phenomena have a considerable impact in the transition region even in the weakest far-UV lines.
- From the density diagnostics, we obtain $n_e \sim [\,2.5\times10^{10}, 10^{12}]$ cm^{-3}.

Comparison with simulations

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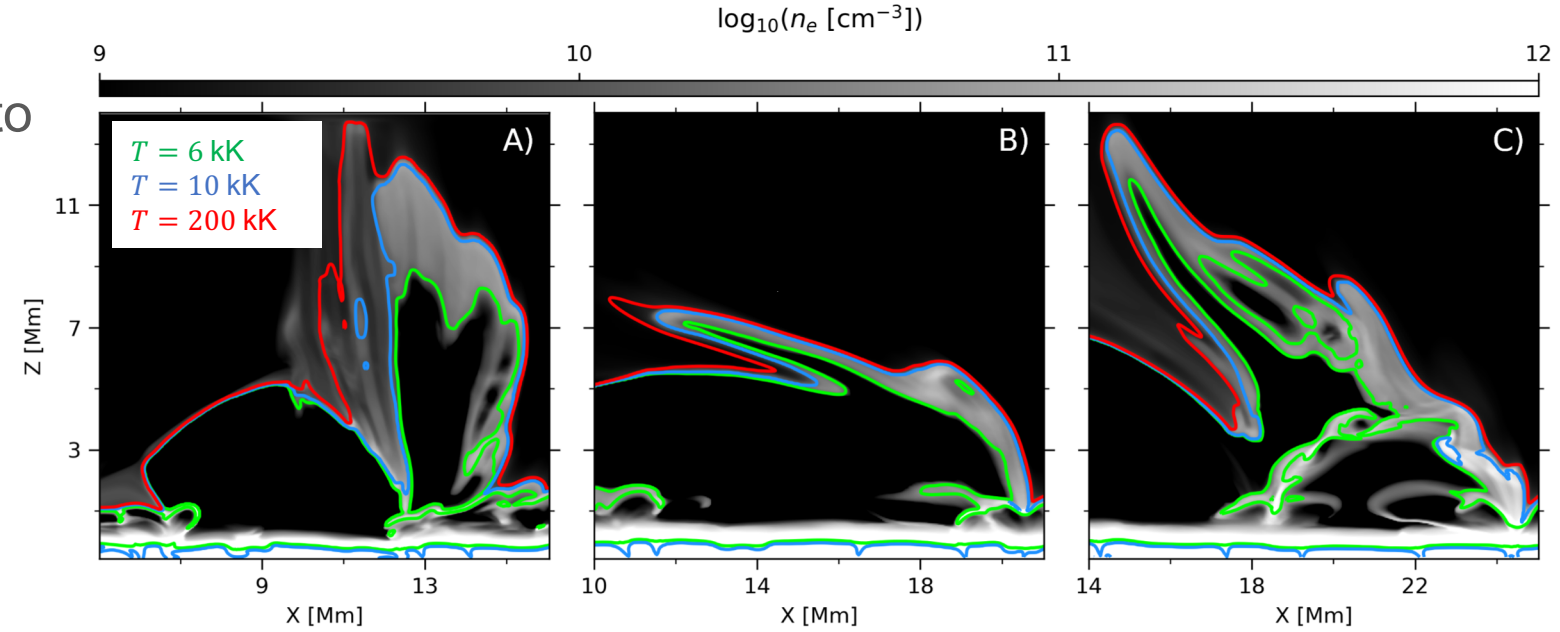
Results:

- The numerical simulations performed with the Bifrost[1] code provide theoretical support in terms of the topology (cool core around $T = 6$ kK and lower n_e deeper in the surge).

- They also provide explanation to the location of the O IV emission within the surges.



Bifrost code (Gudiksen et al. 2011): https://ui.adsabs.harvard.edu/abs/2011A%26A...531A.154G/abstract