IRIS observations of transition region 'unresolved fine structure'

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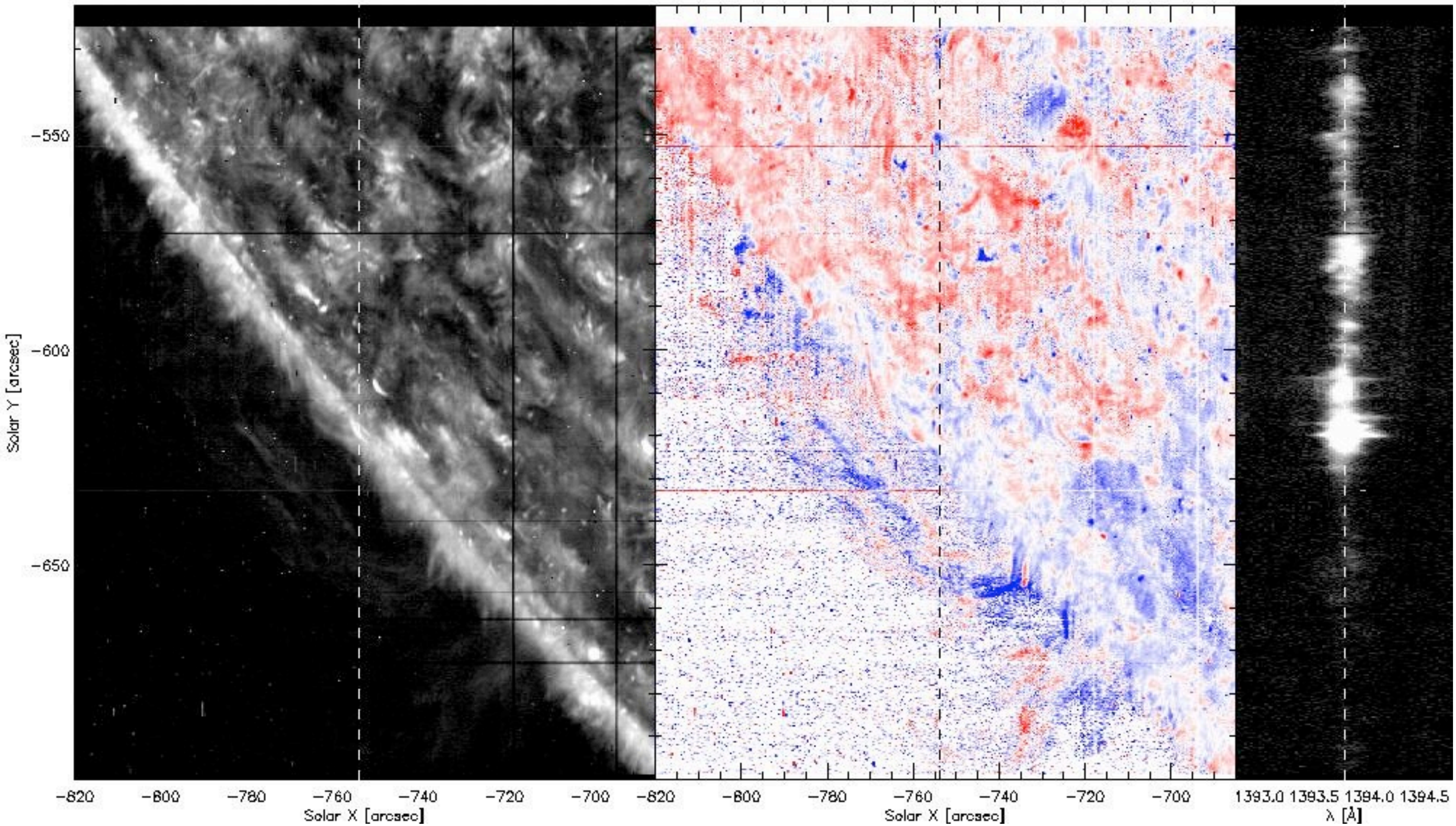
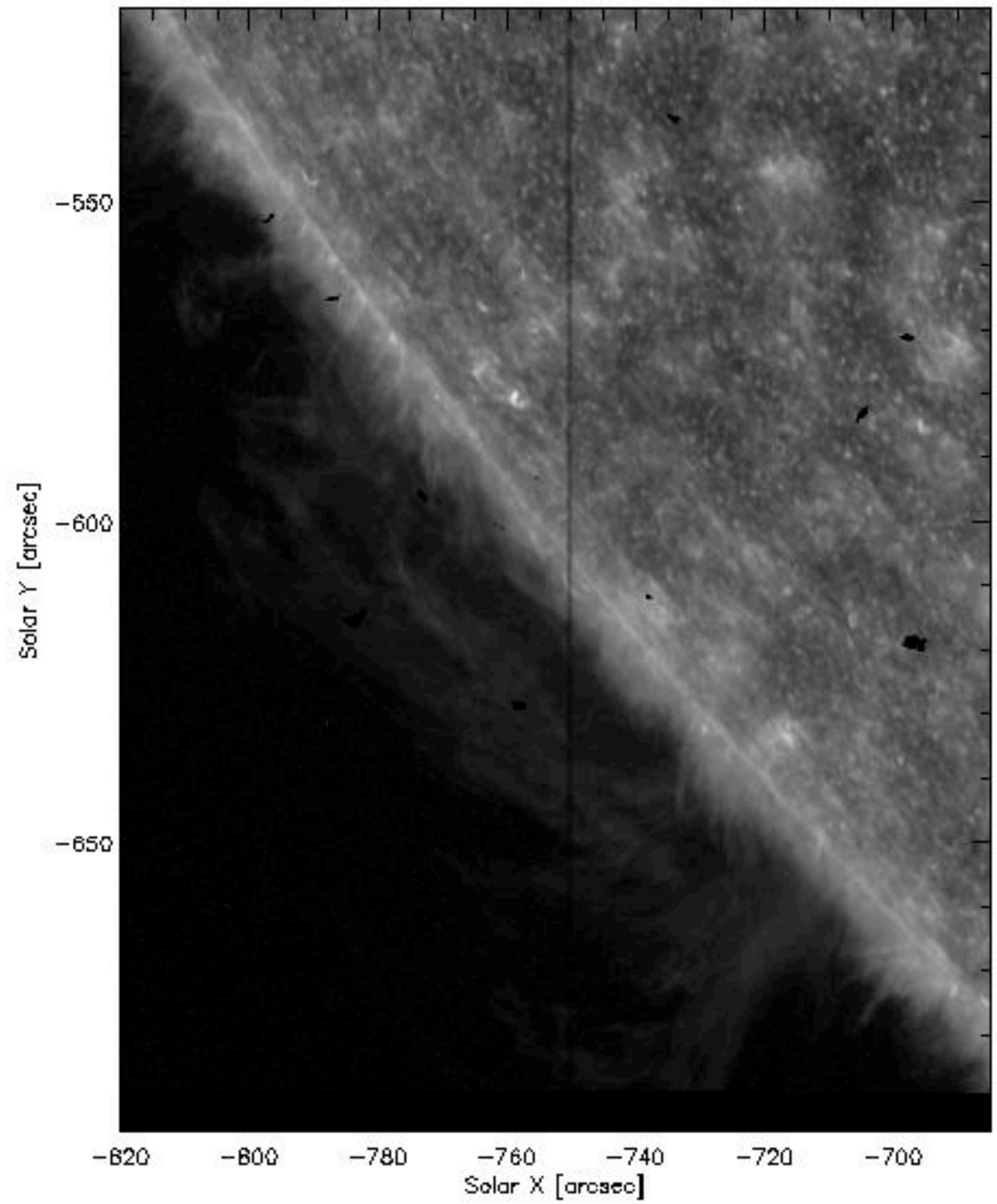
[3]Smithsonian Astrophysics Observatory

Si IV 1393 Å at the limb
dense IRIS raster 2013/10/18

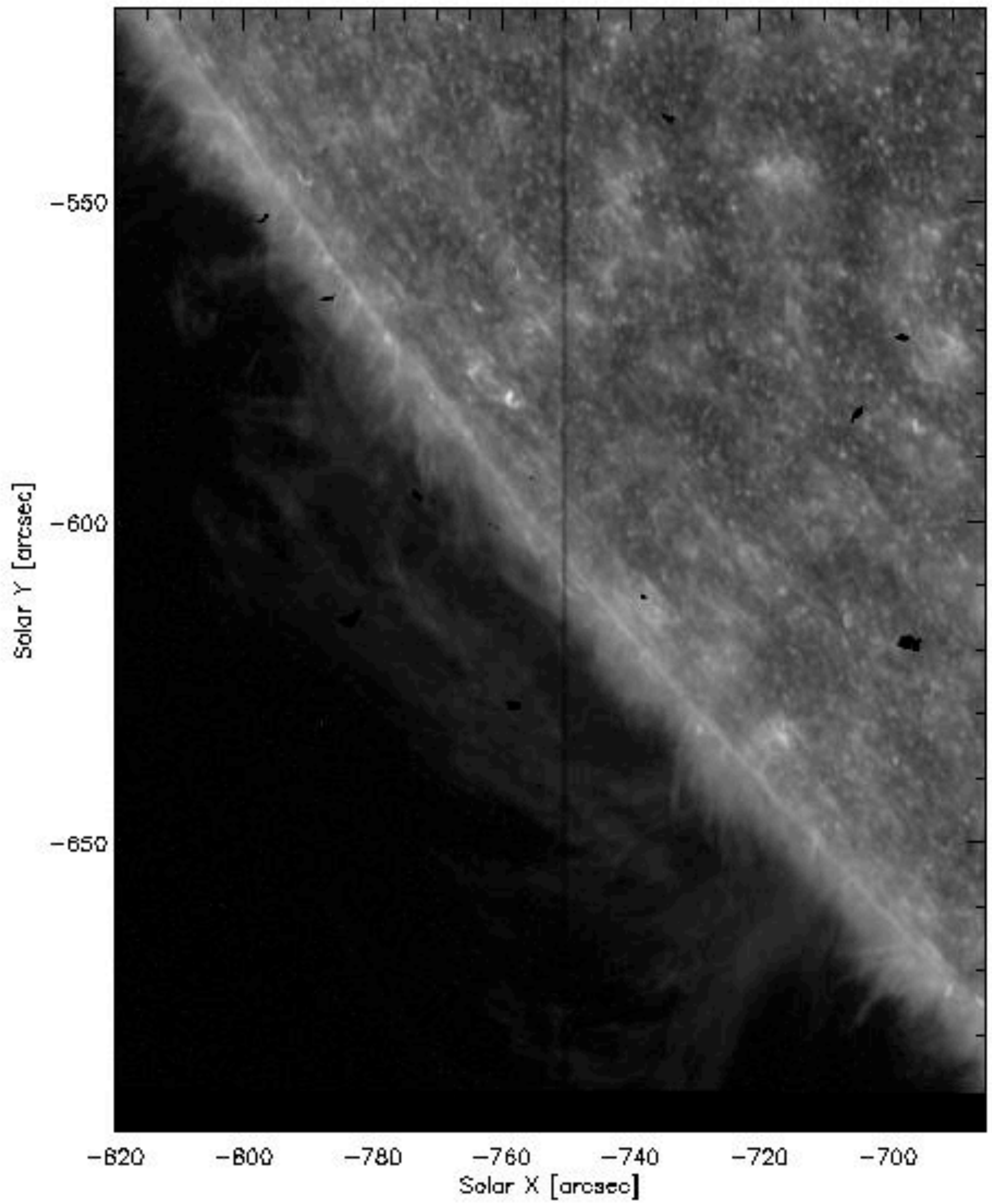


IRIS Si IV '1400' Å slit jaw co-aligned with AIA 171 and 193 Å

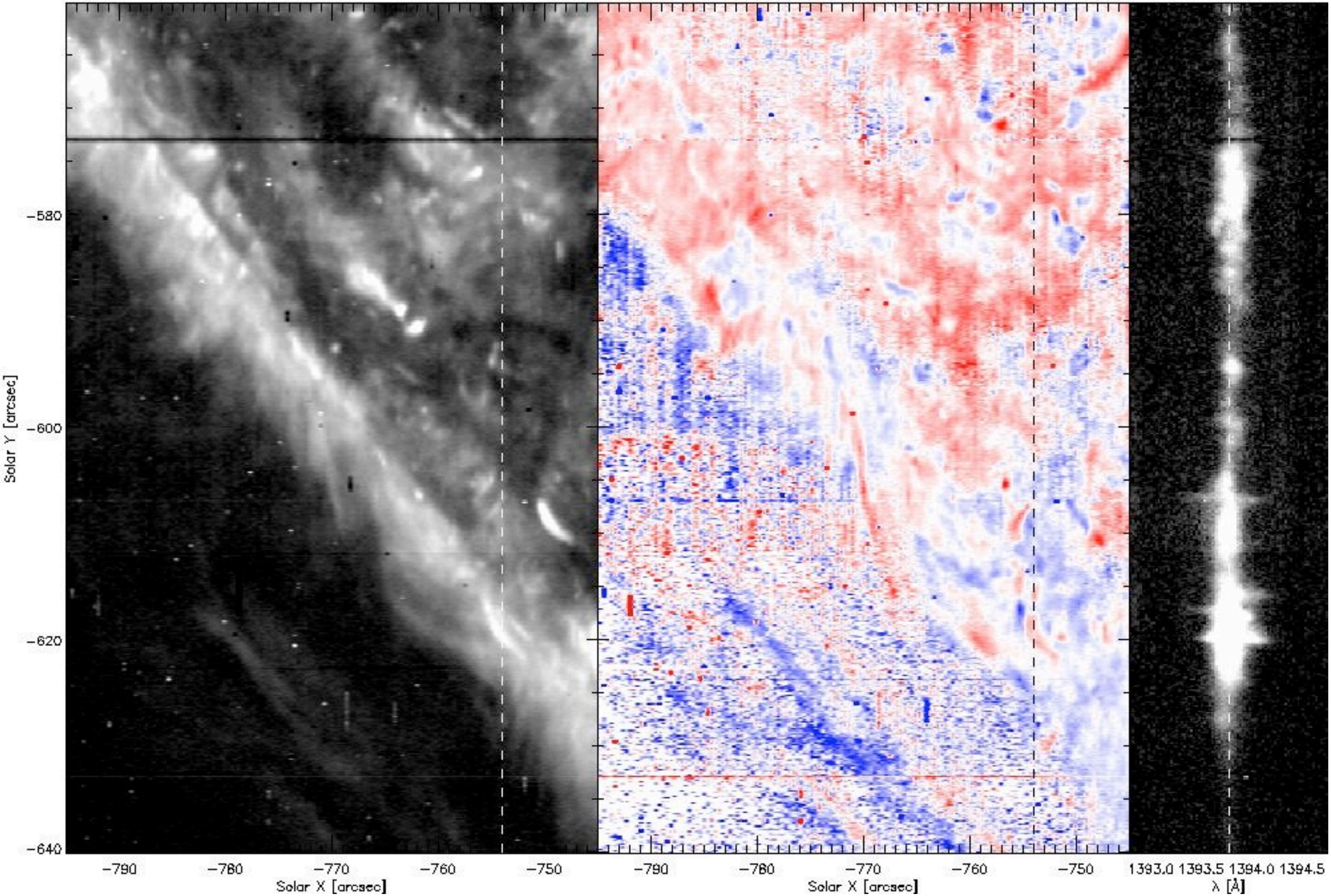


IRIS Si IV '1400' Å slit jaw co-aligned with AIA 171 and 193 Å

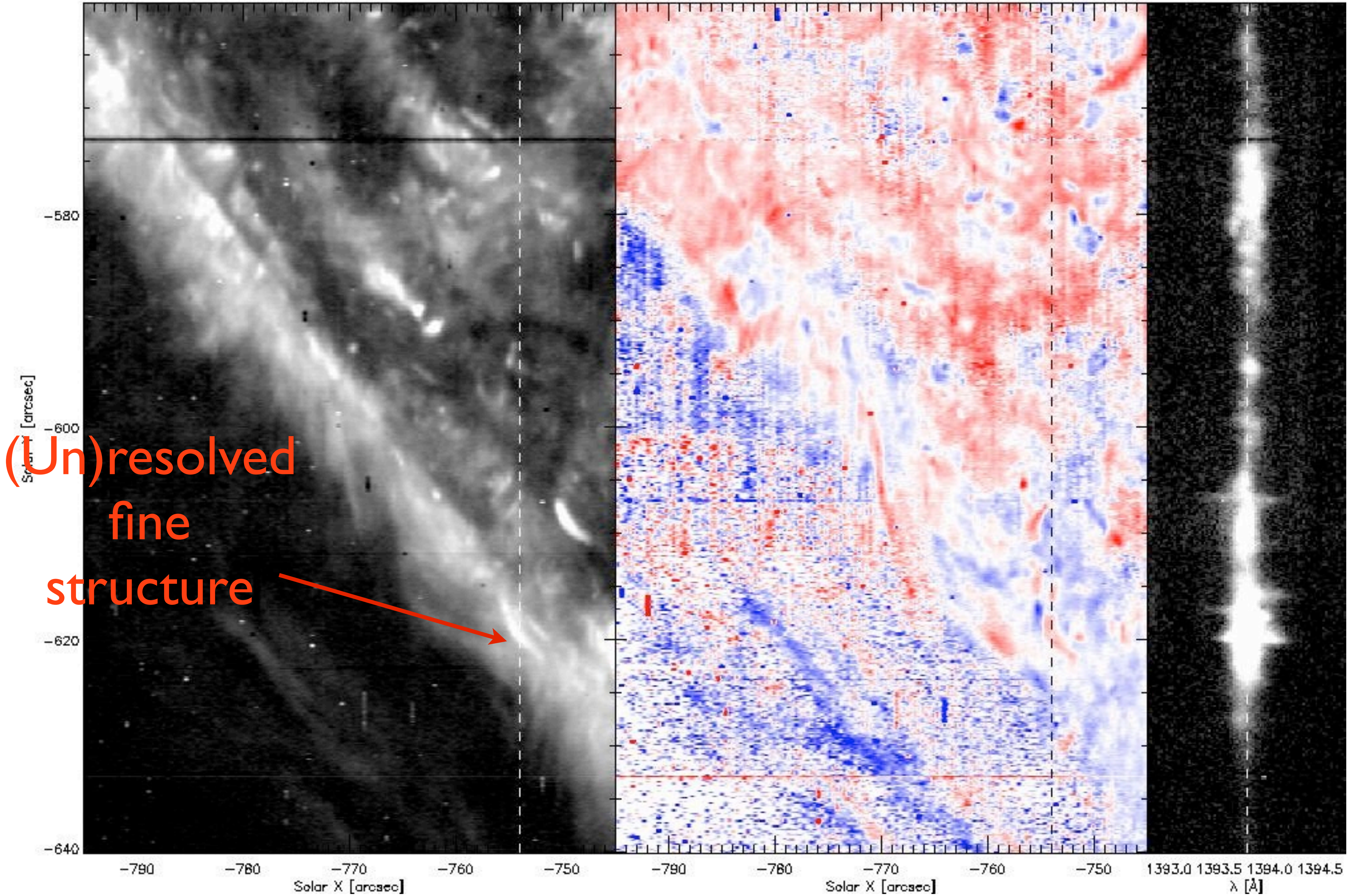
AIA channels are quite opaque at the limb, mainly through continuum absorption of the He II continuum, but also He I and H



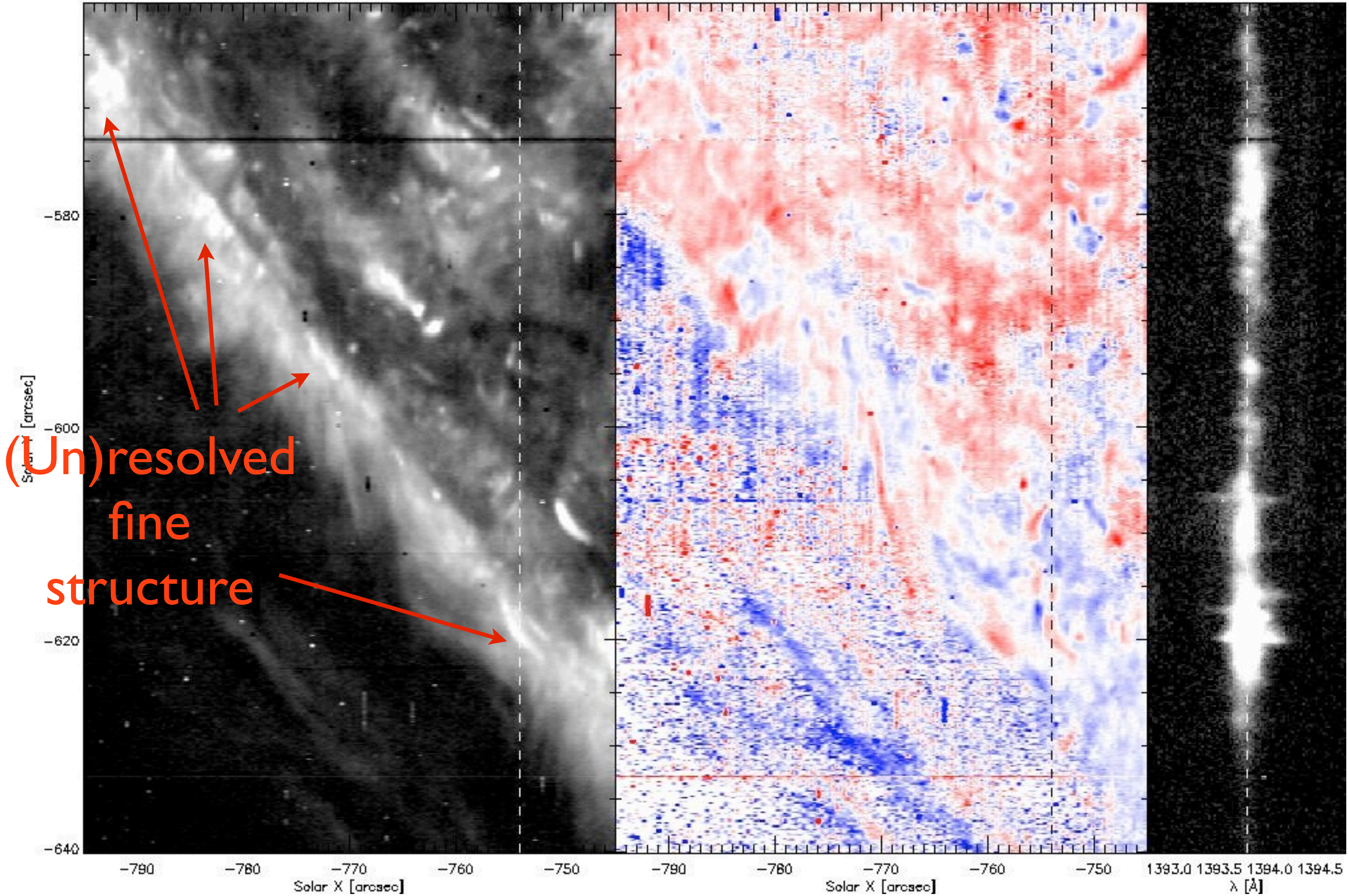
In greater detail...

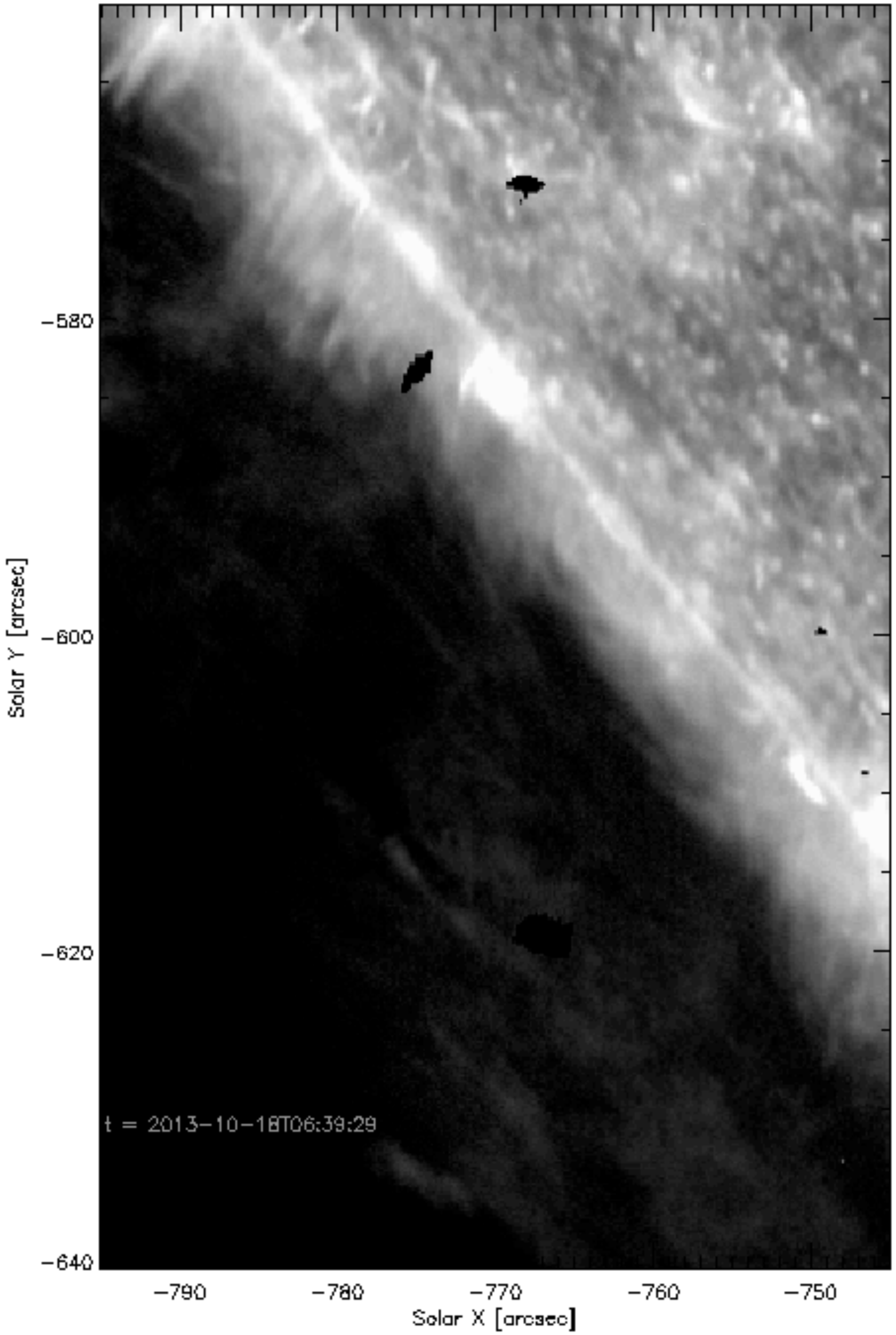


In greater detail...

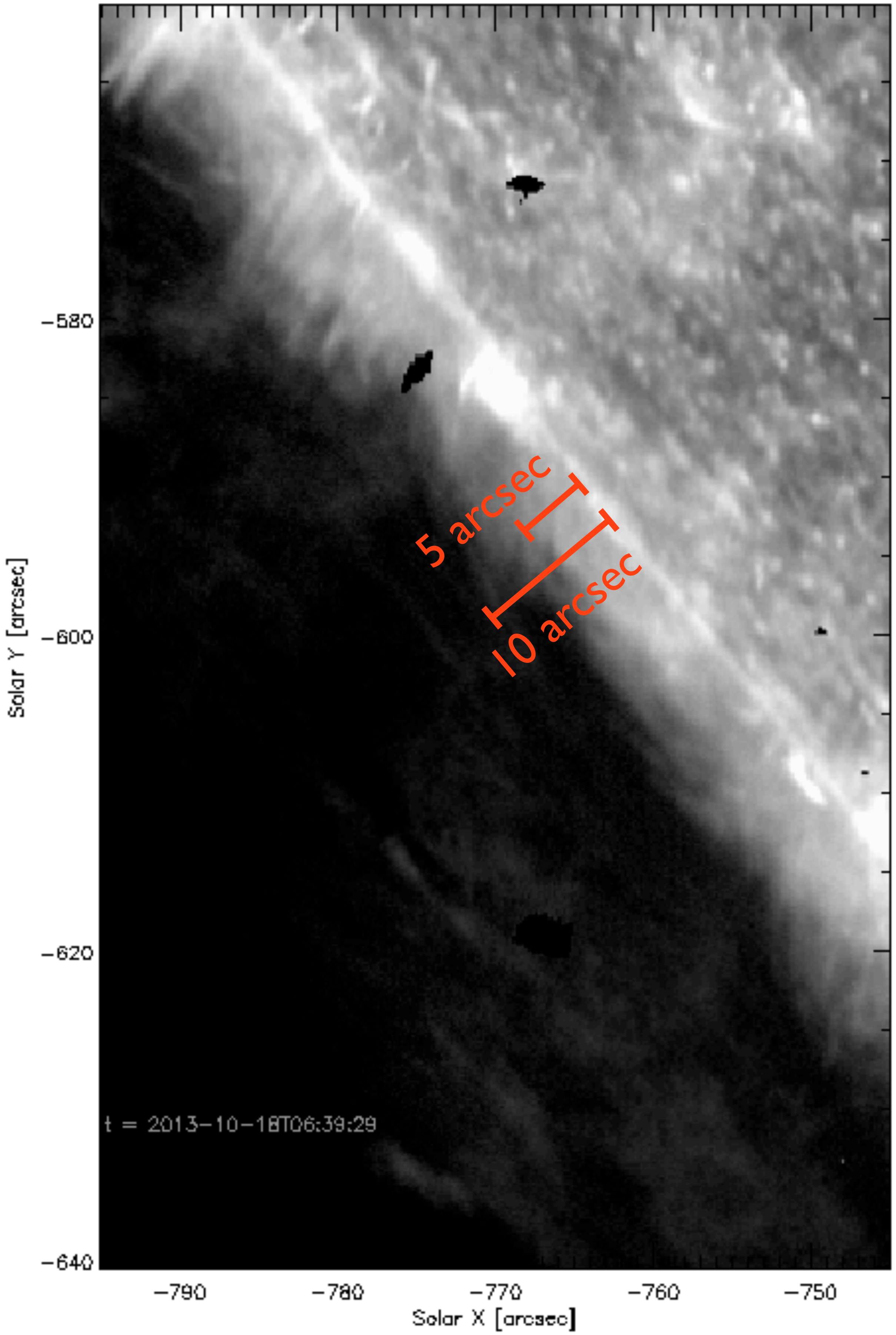


In greater detail...

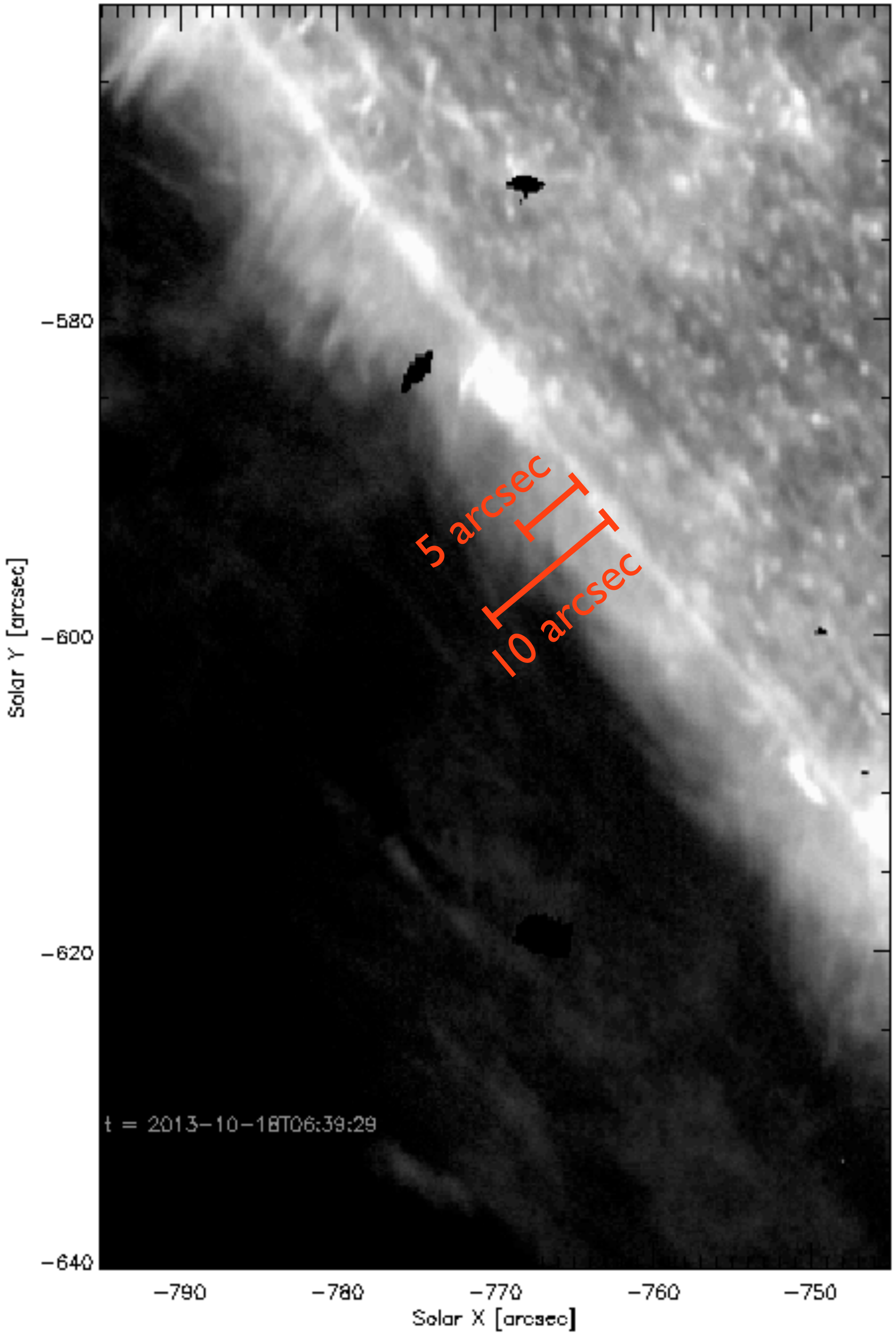




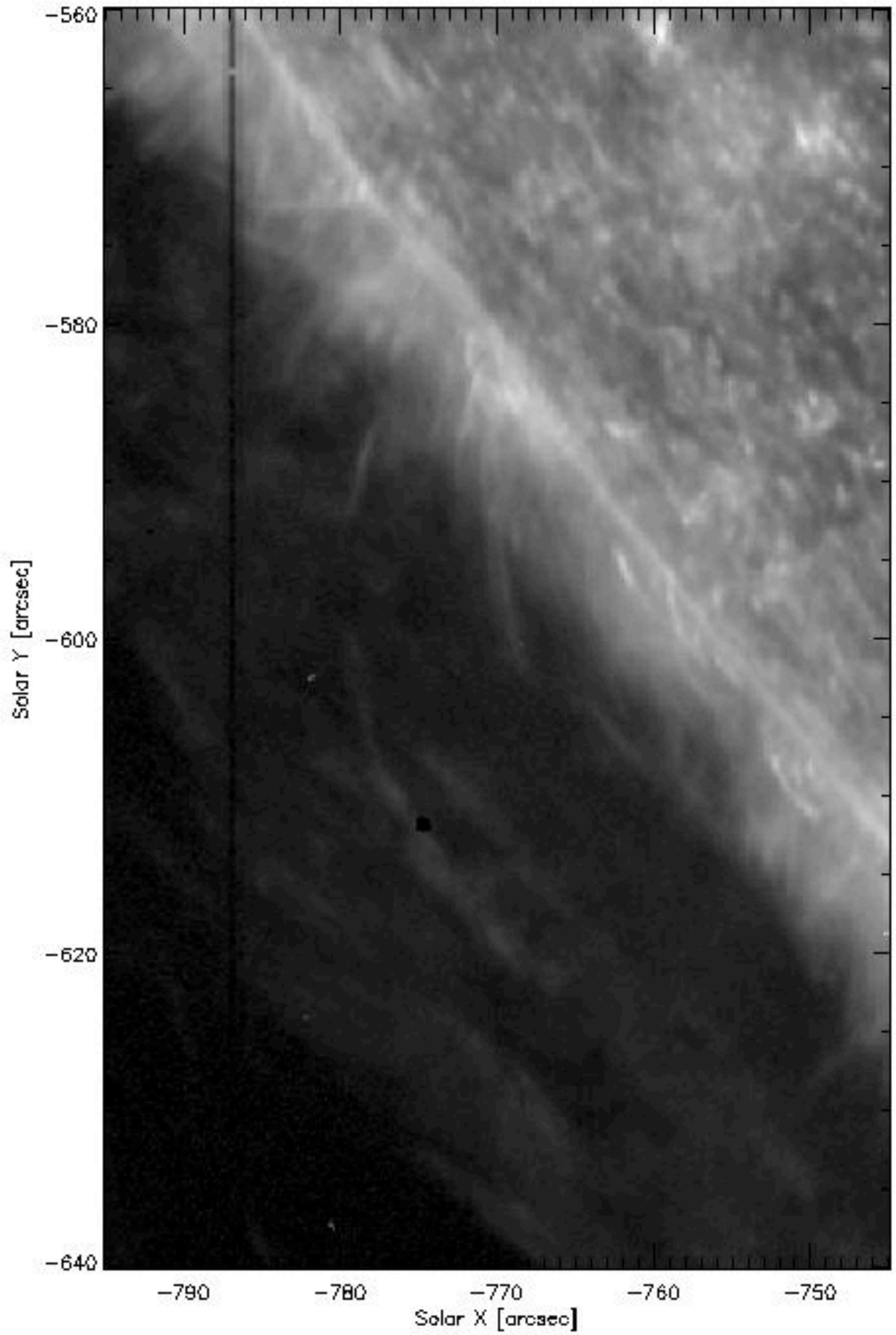
t = 2013-10-18T06:39:29
-580
-600
-620
-640
Solar Y [arcsec]
-790
-780
-770
-760
-750
Solar X [arcsec]


5 arcsec
10 arcsec
t = 2013-10-18T06:39:29
-580
-600
-620
-640
Solar Y [arcsec]
-790
-780
-770
-760
-750
Solar X [arcsec]

There are many low lying, short lived, presumably cool, loops in the C II '1330' and Si IV '1400' slit jaw images.



Any hot counterpart?



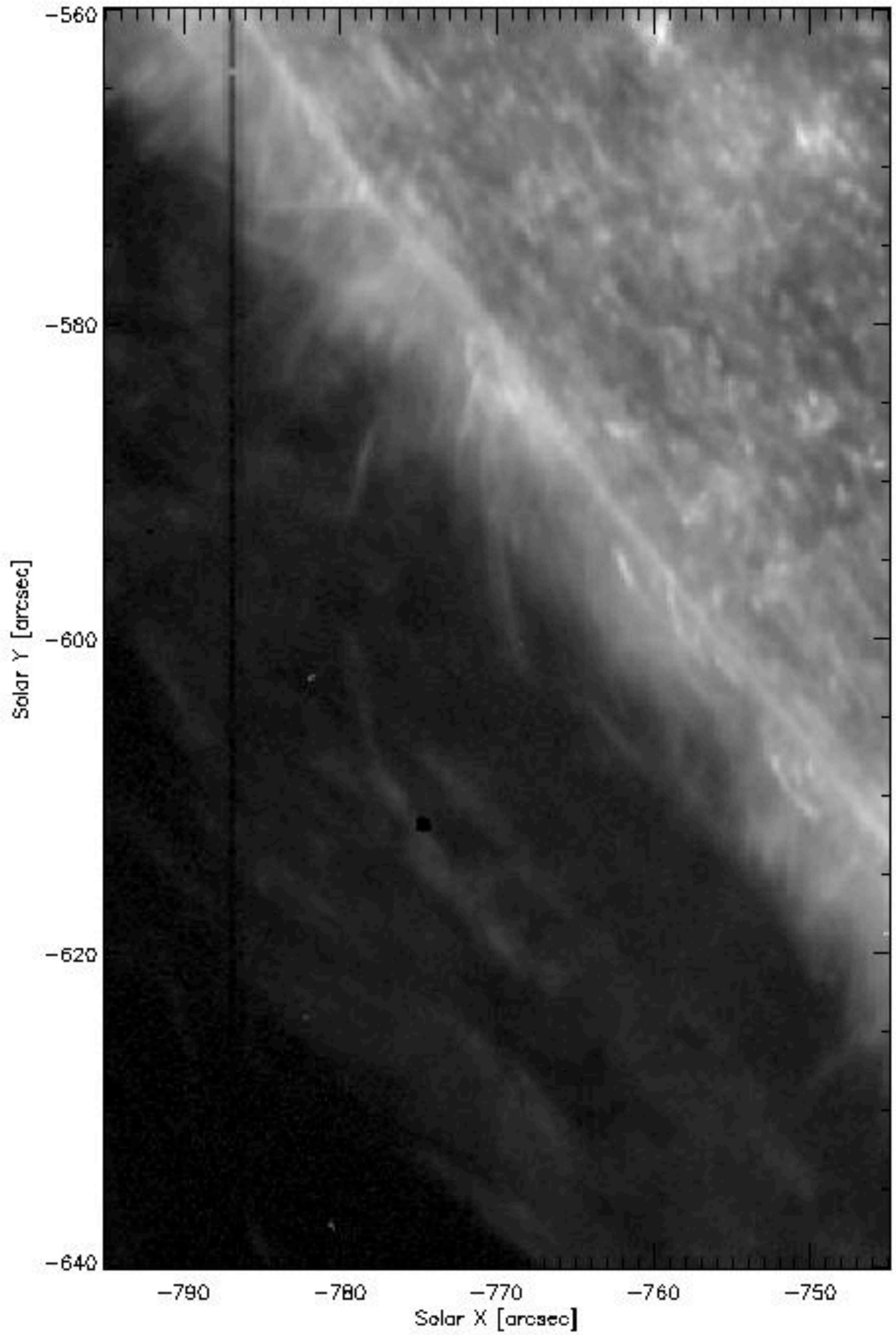
Any hot counterpart?

Use AIA

He II 304 Å

to puzzle this out?

Maybe, but it is very opaque...



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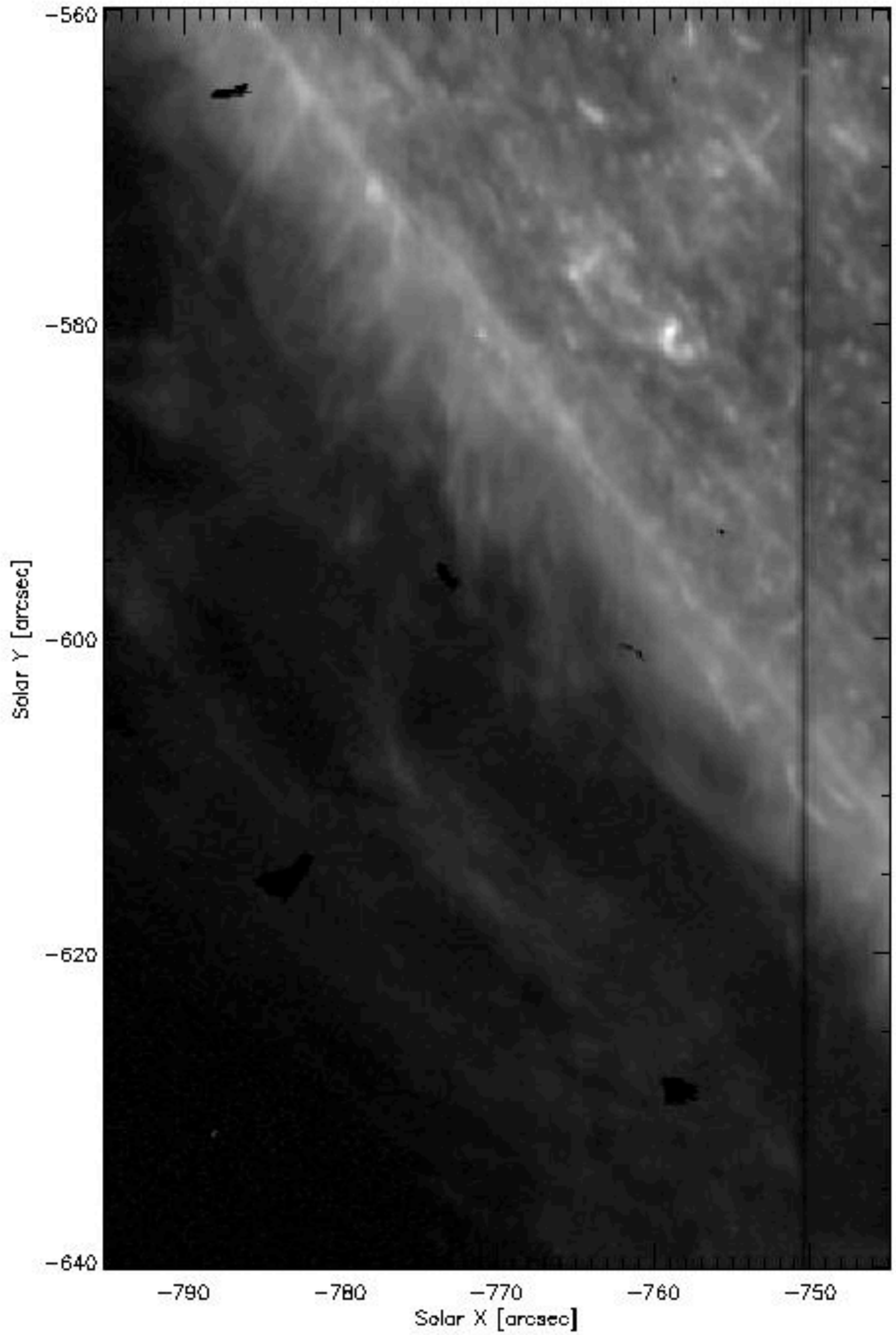

Any hot counterpart?

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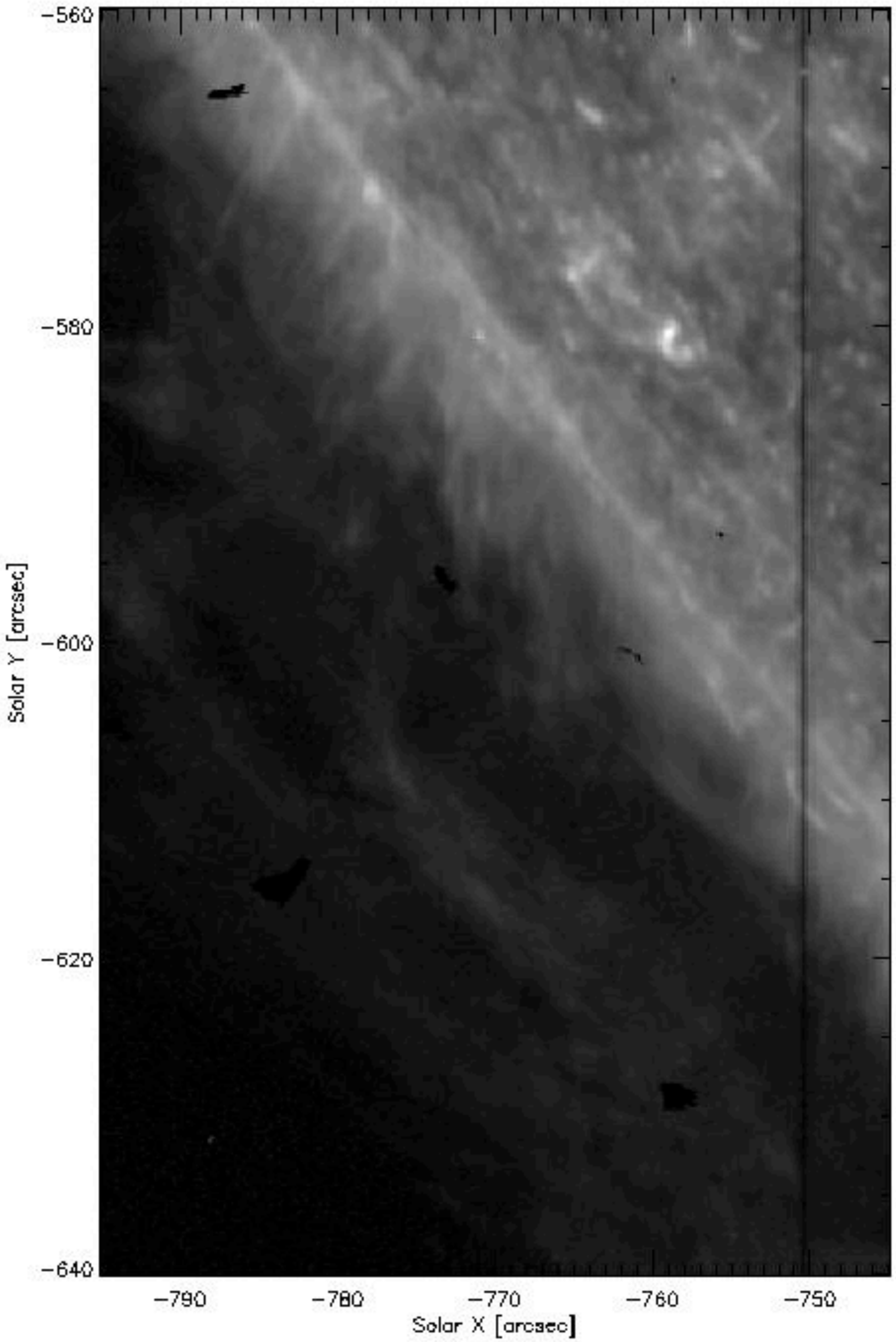
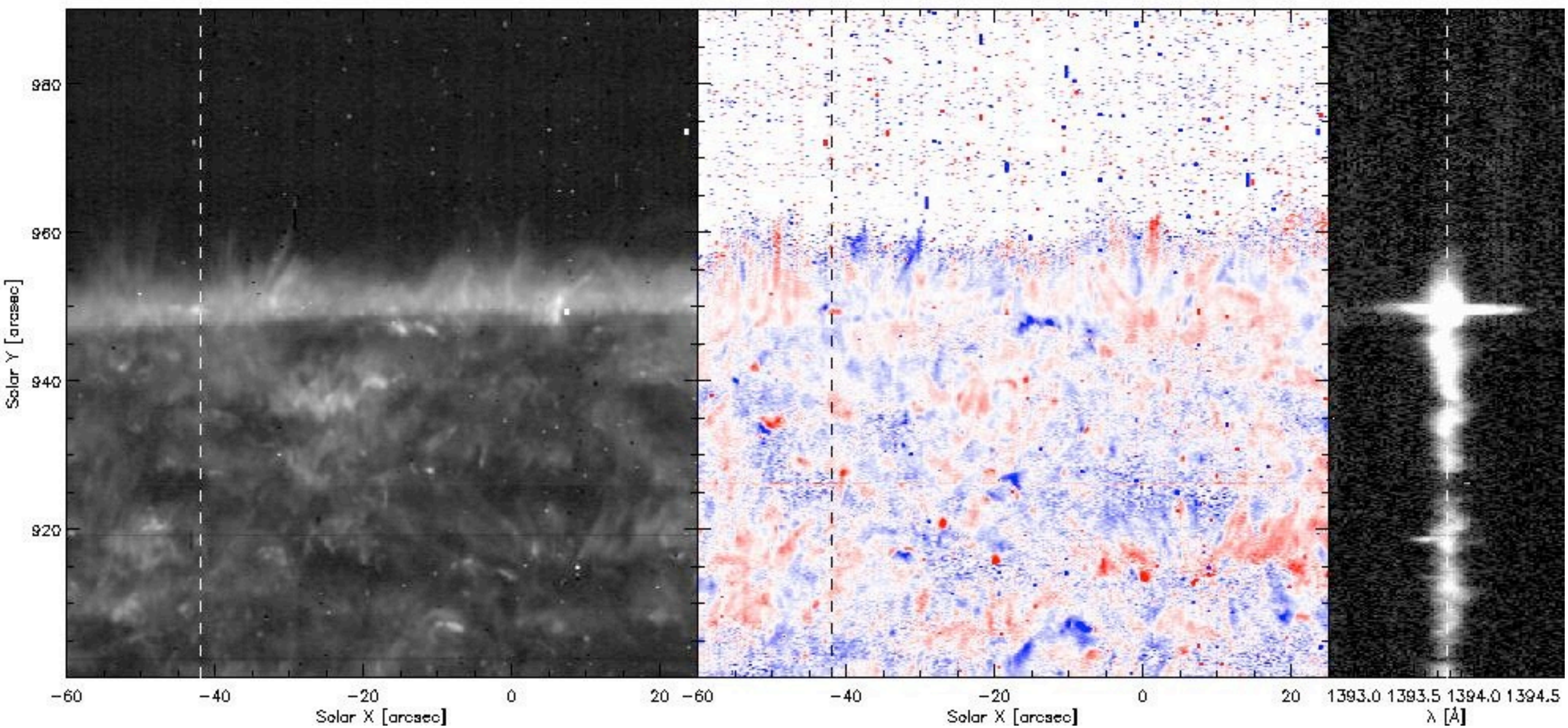
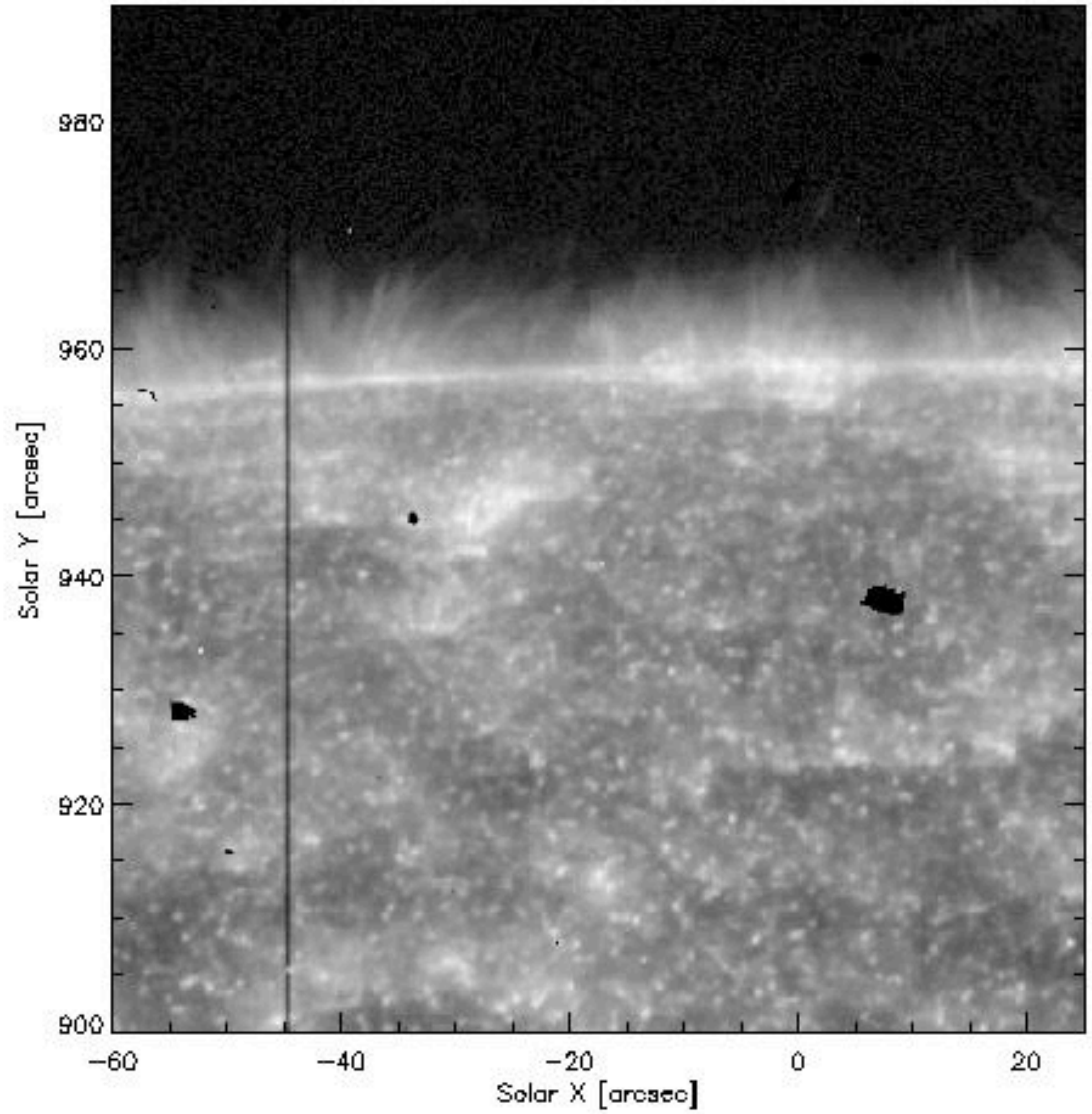


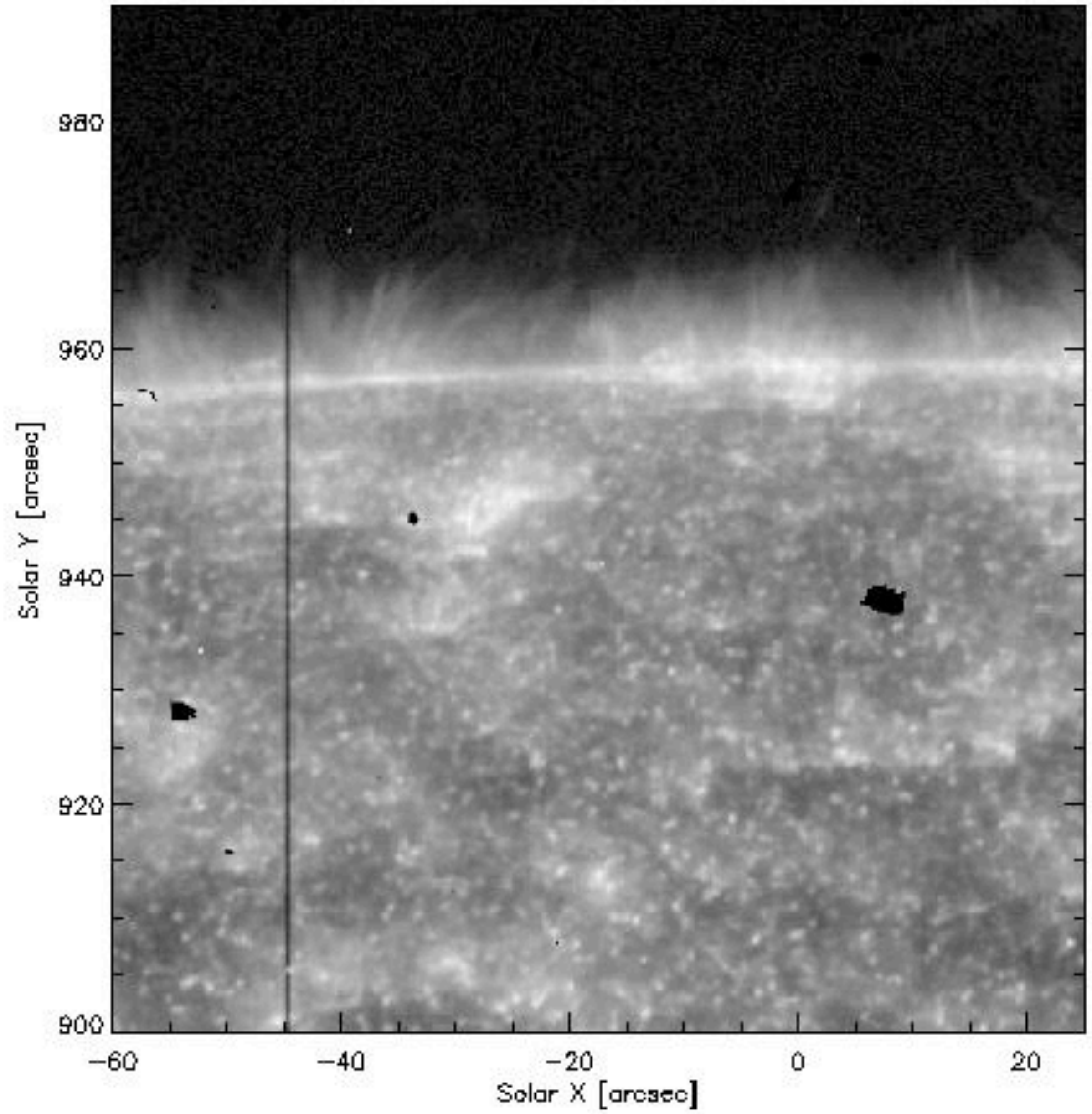
...and ionization state could be tricky: see Poster S3-P-09 Golding et al.

Same story on the north limb: dense IRIS raster 2013/10/05 (also Hinode data for this target)



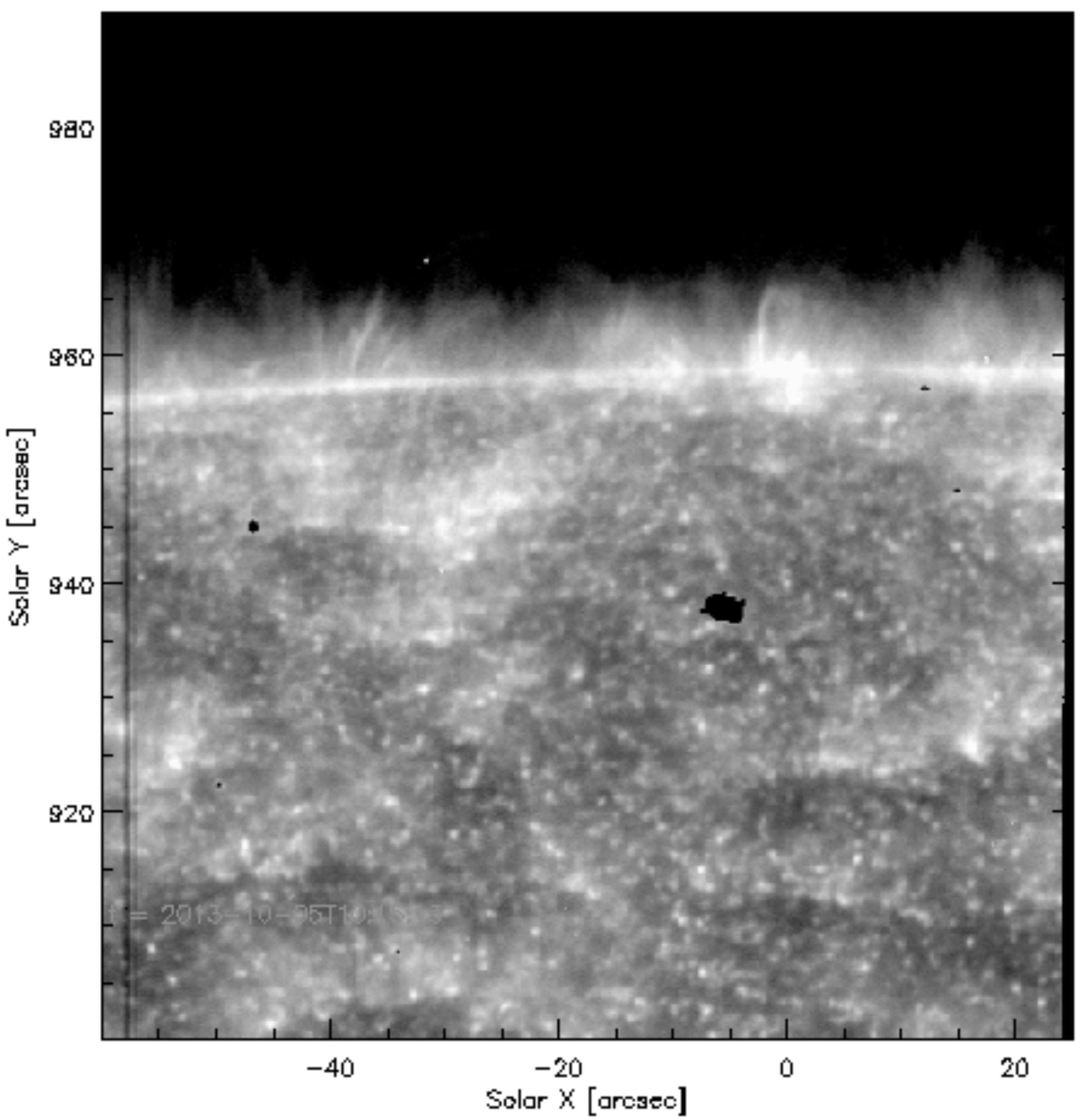
North pole corona less dense and thus less opaque than equator?



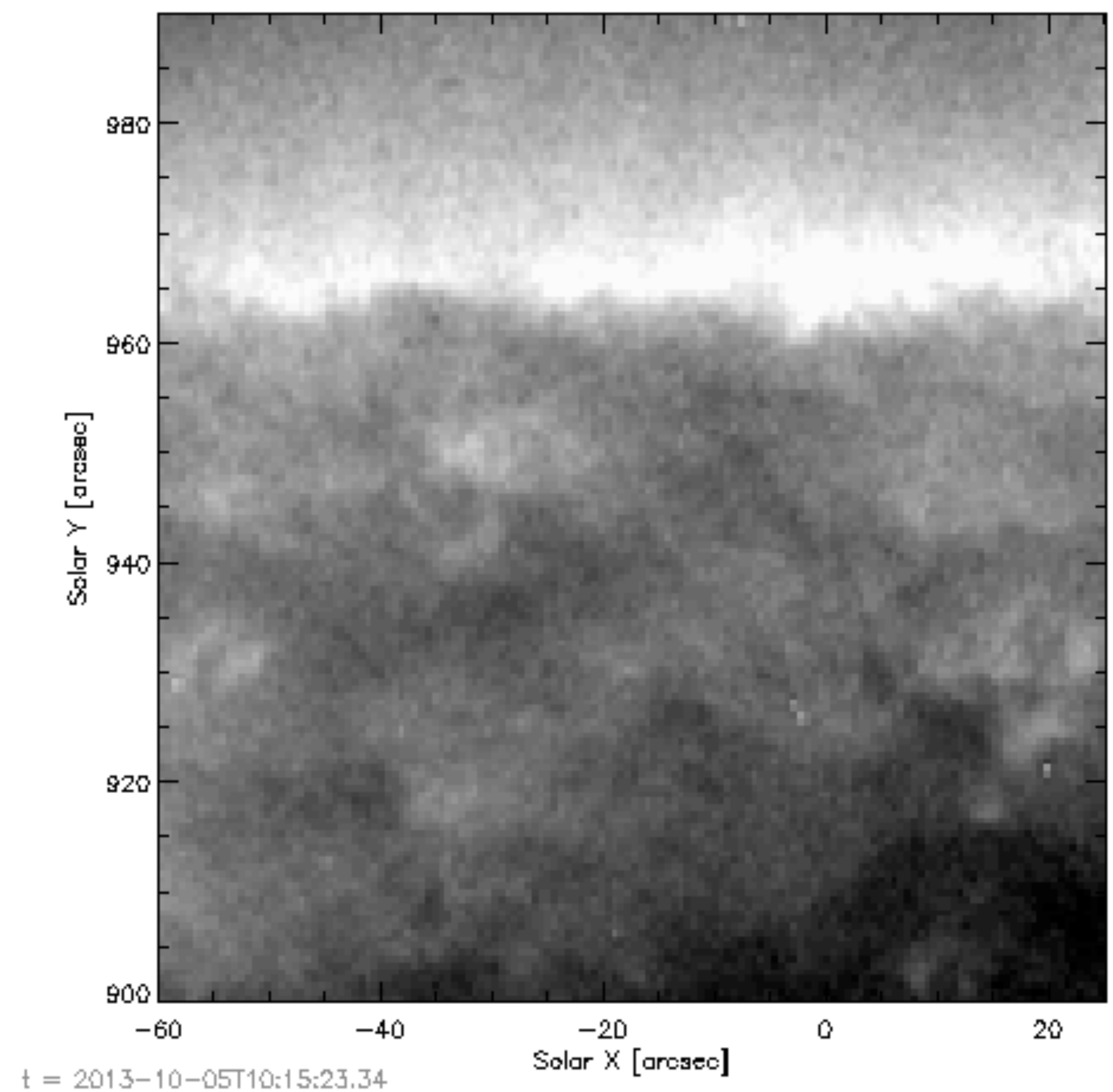


IRIS C II '1330' Å slit jaw co-aligned with AIA 171, 193 and 304 Å

...more type II spicules, but low emission also here dominated by low lying loops



IRIS C II ‘1330’ Å SJI



AIA 171 Å

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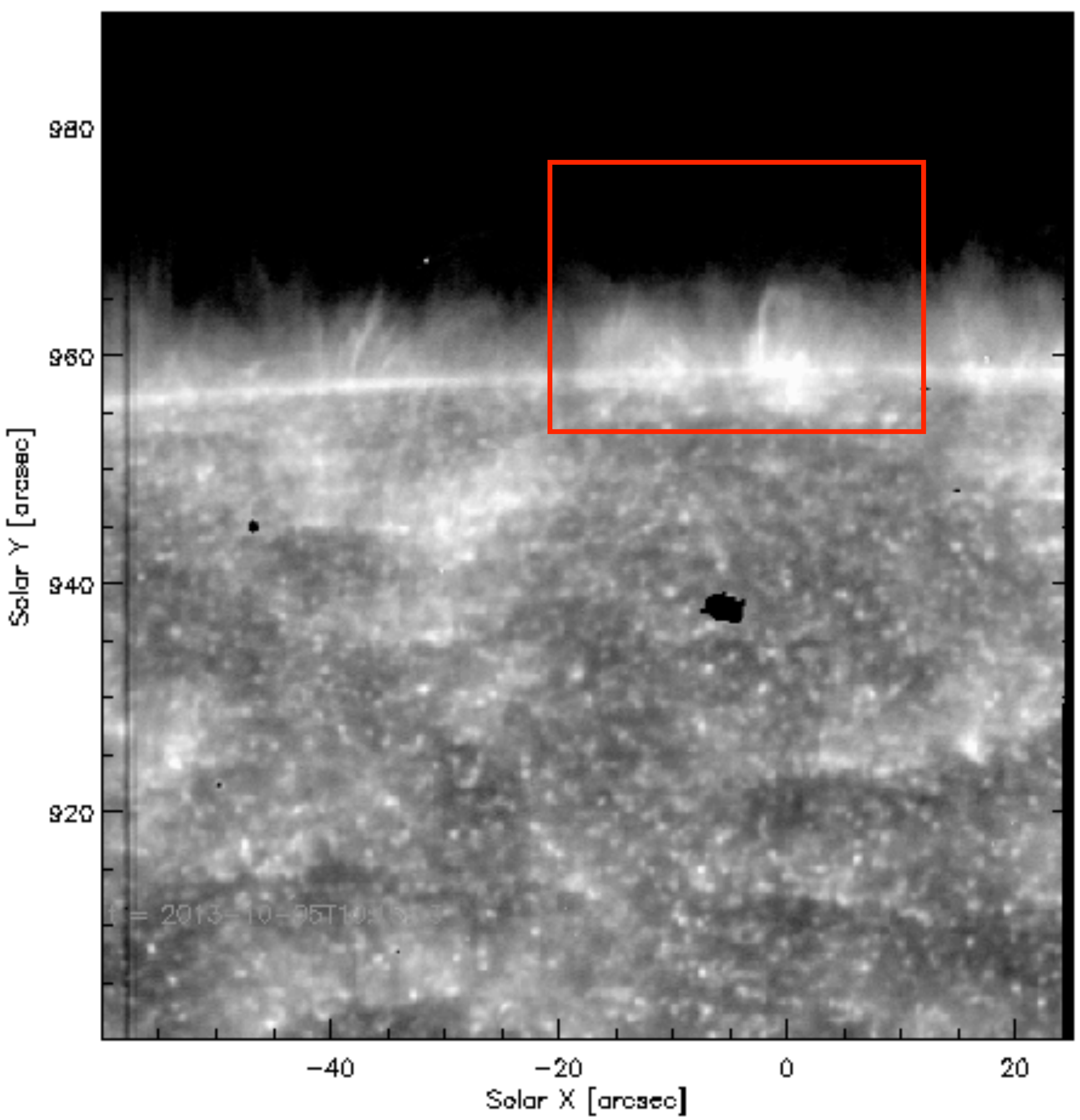
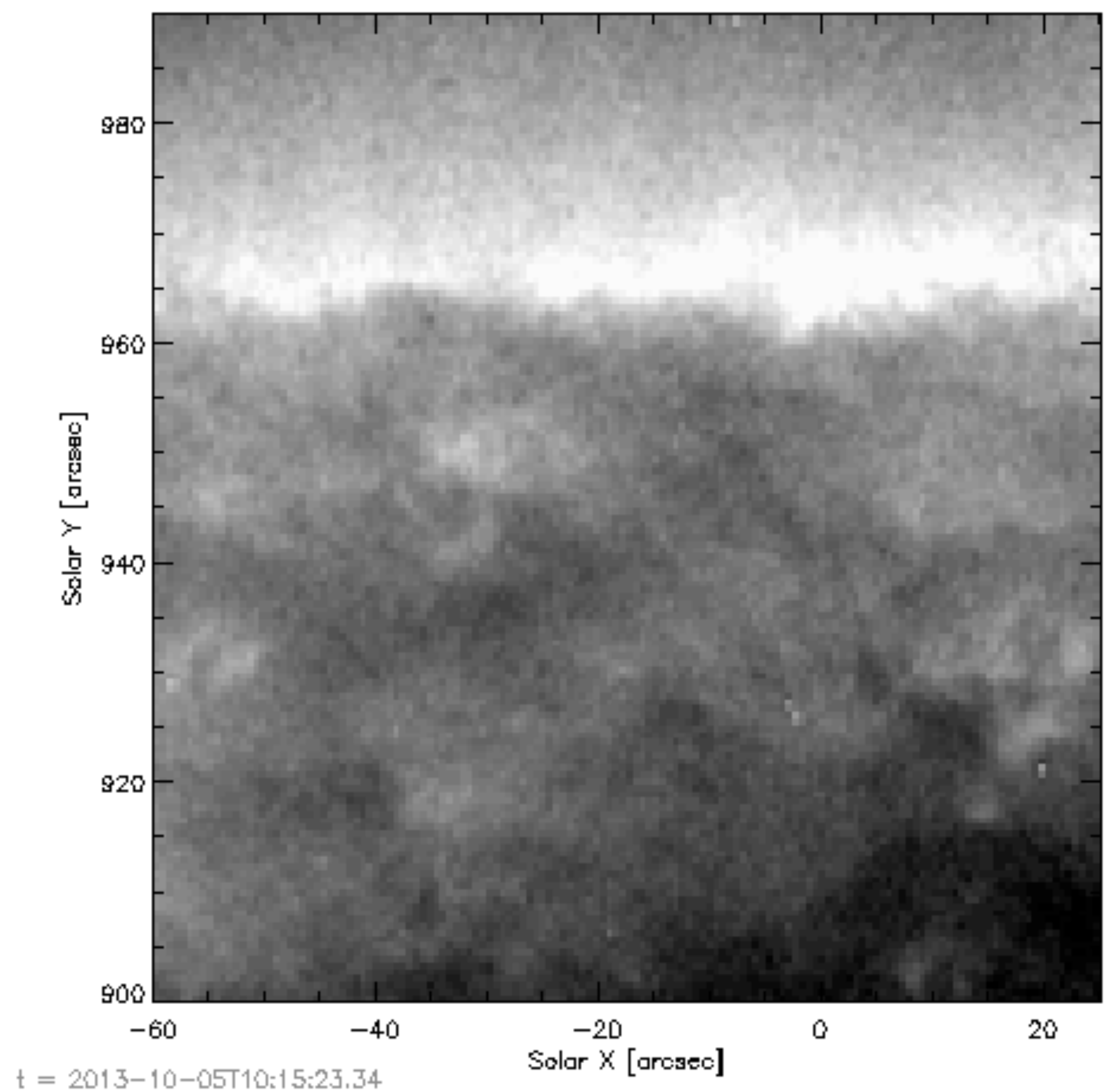


IRIS C II '1330' Å SJI



AIA 171 Å

BIFROST - http://sdc.uio.no/search/simulations

Hansteen 2004, Hansteen, Carlsson, Gudiksen 2007, Sykora, Hansteen, Carlsson 2008, Gudiksen et al 2011

Corona

Transition region

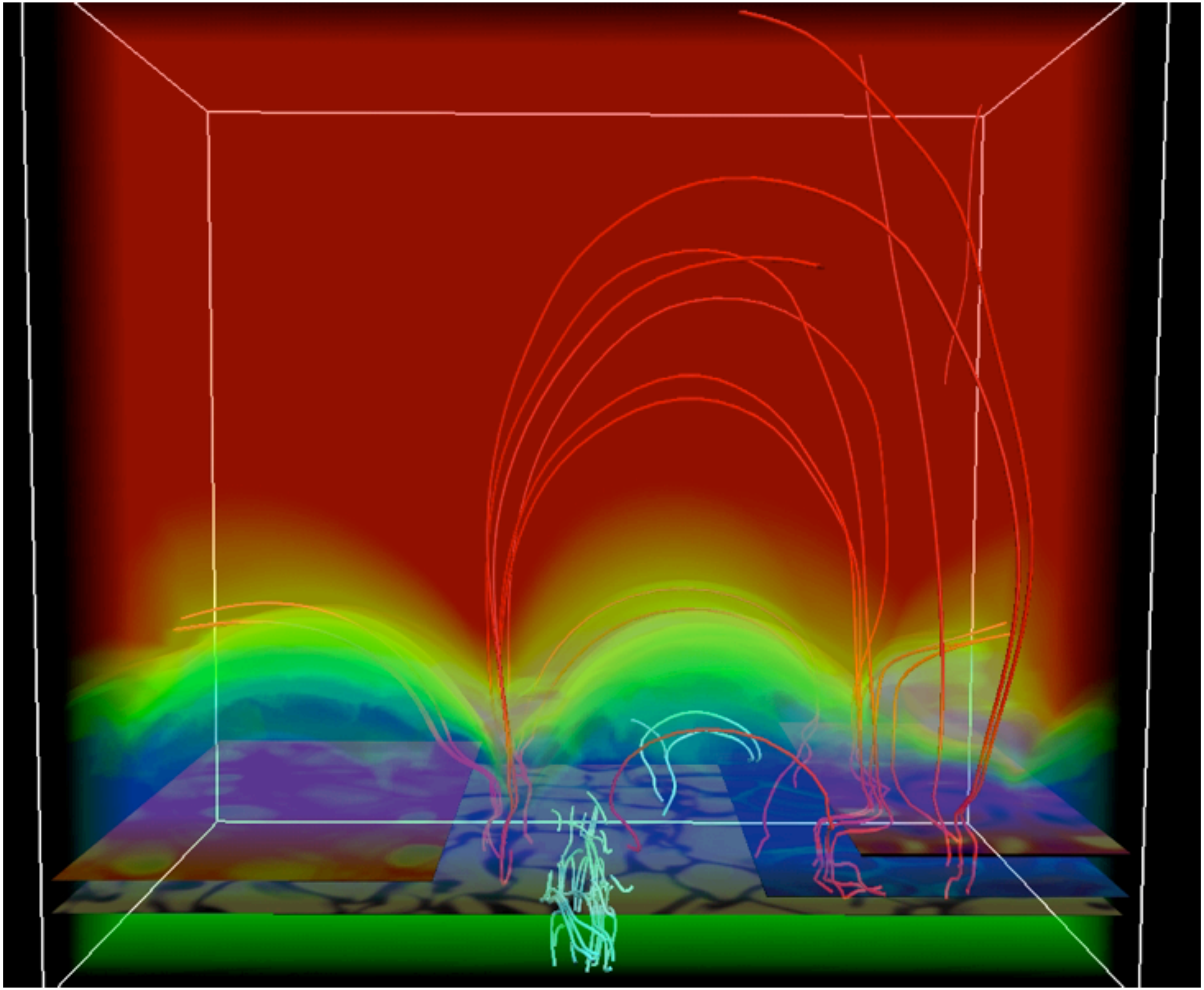
Chromosphere

Photosphere

Convection zone

BIFROST - http://sdc.uio.no/search/simulations

Hansteen 2004, Hansteen, Carlsson, Gudiksen 2007, Sykora, Hansteen, Carlsson 2008, Gudiksen et al 2011



Corona

Transition region

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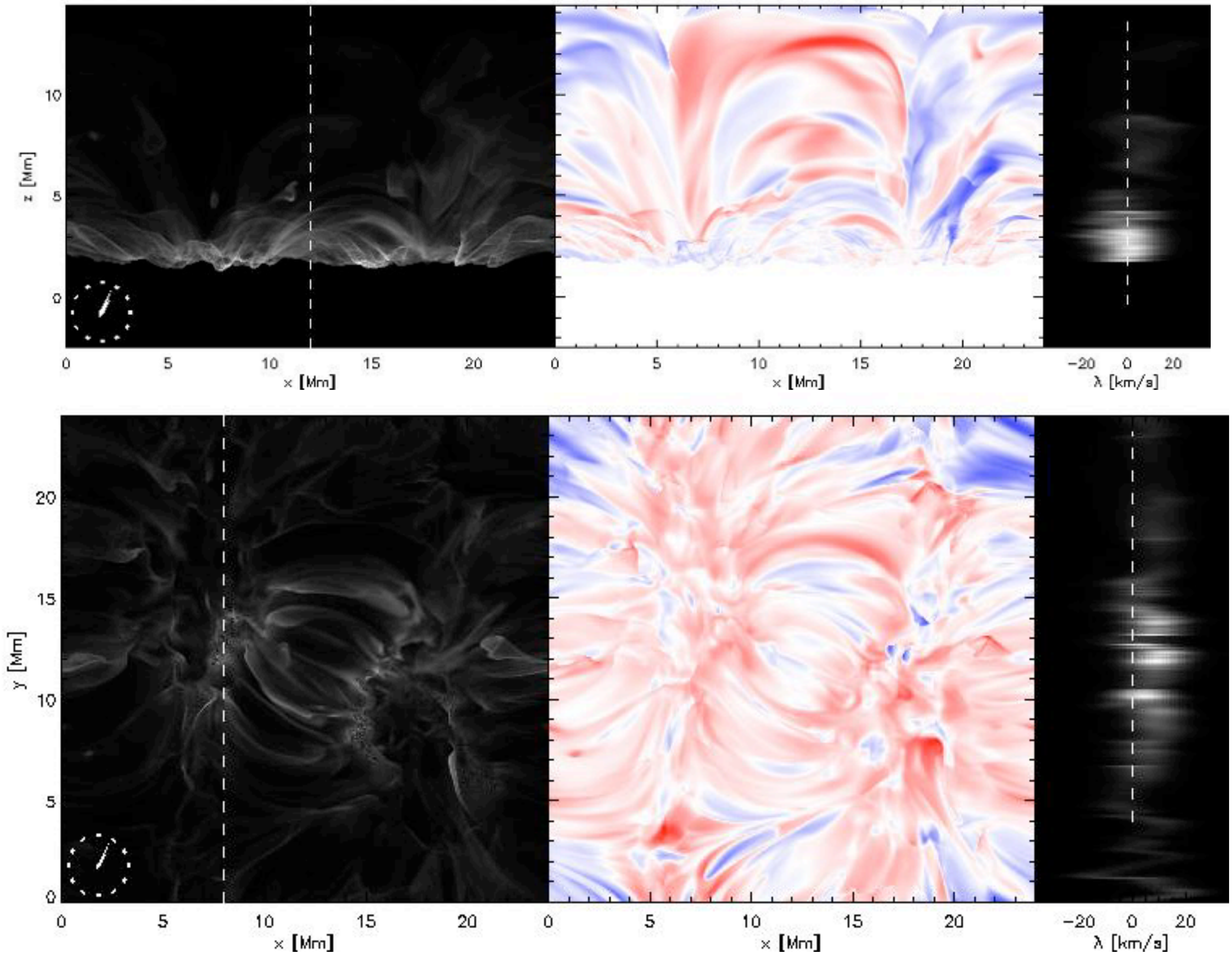
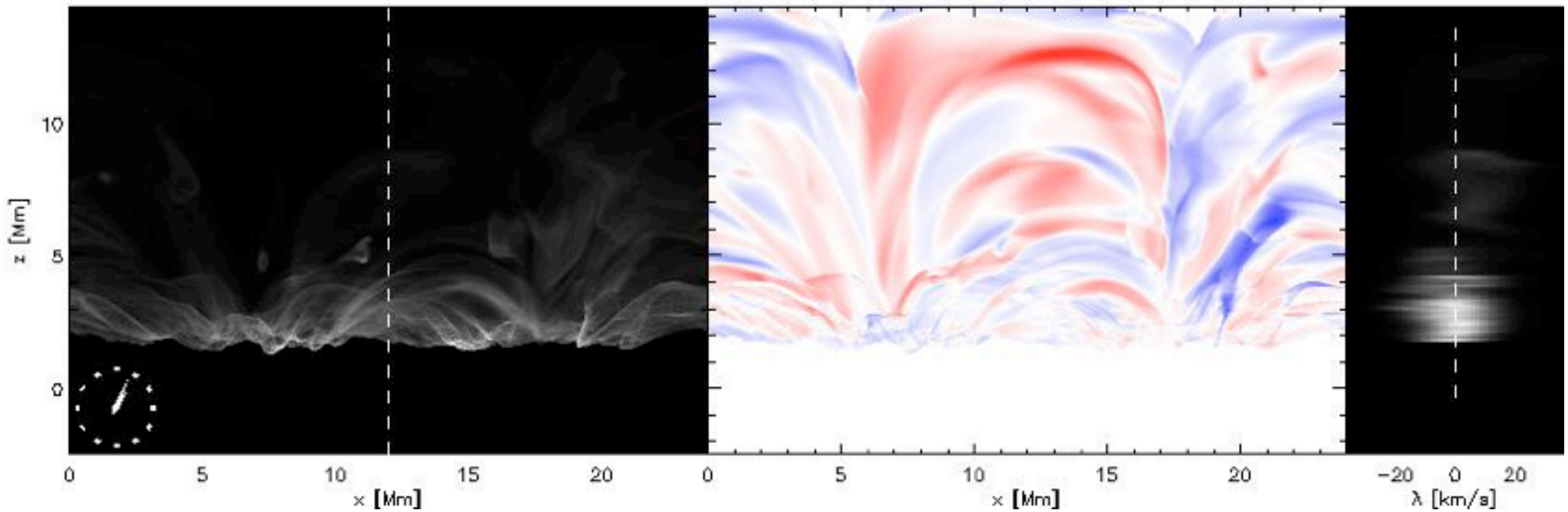
BIFROST simulated Si IV 1393 Å emission



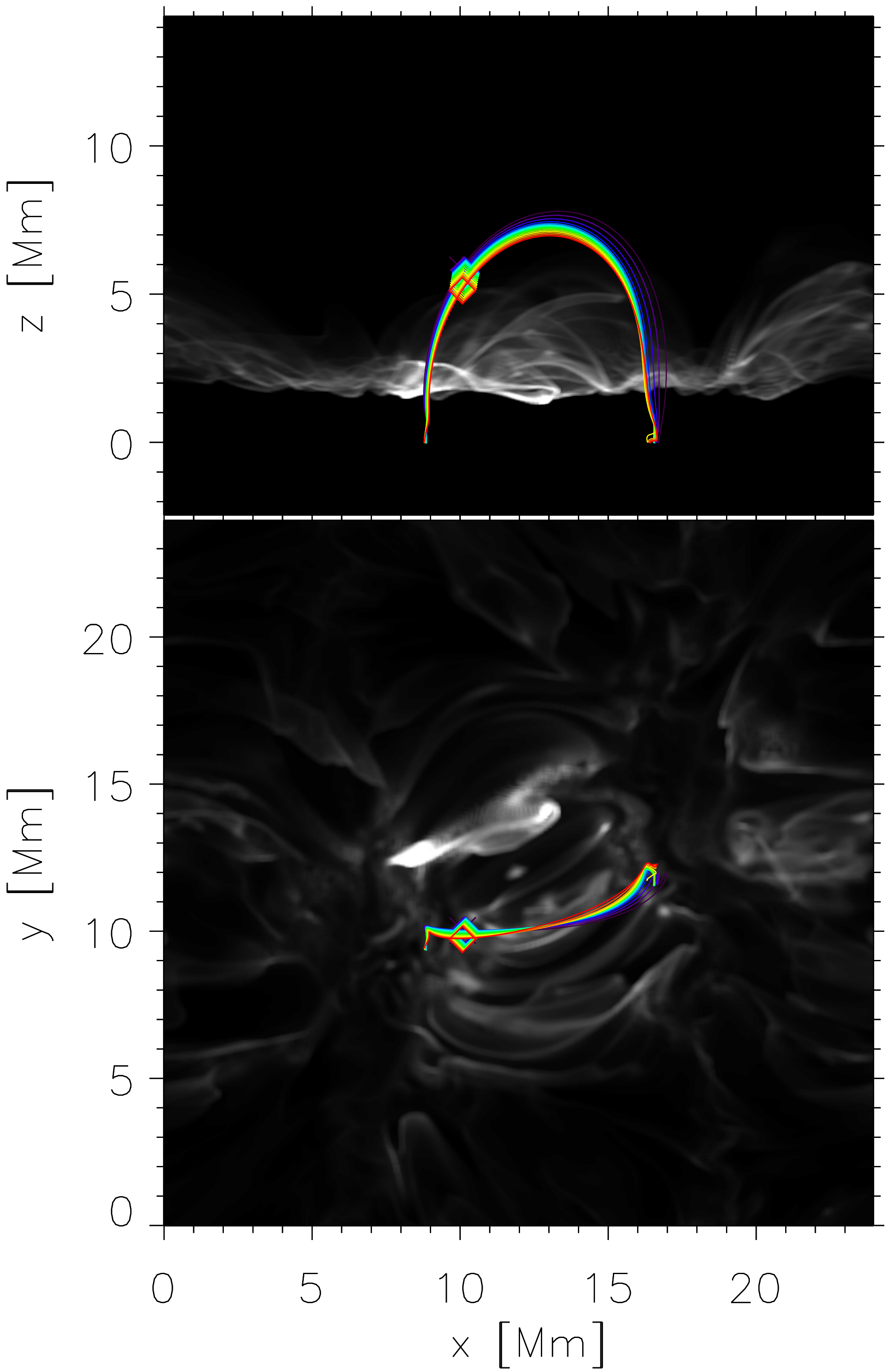
BIFROST simulated Si IV 1393 Å emission



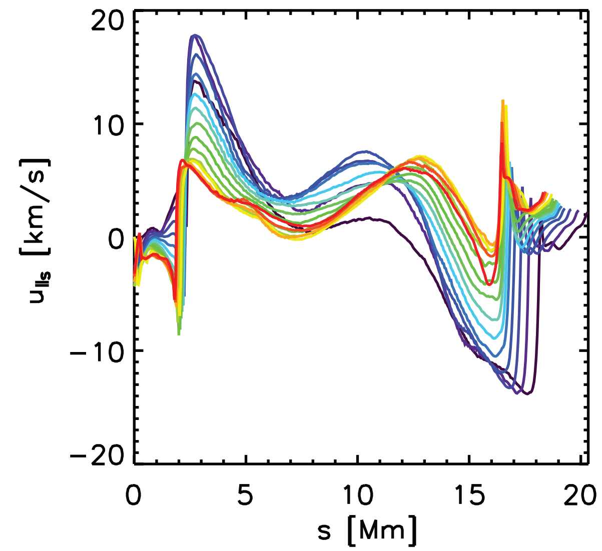
Average TR line properties 'fairly well' reproduced on comparison with observations.

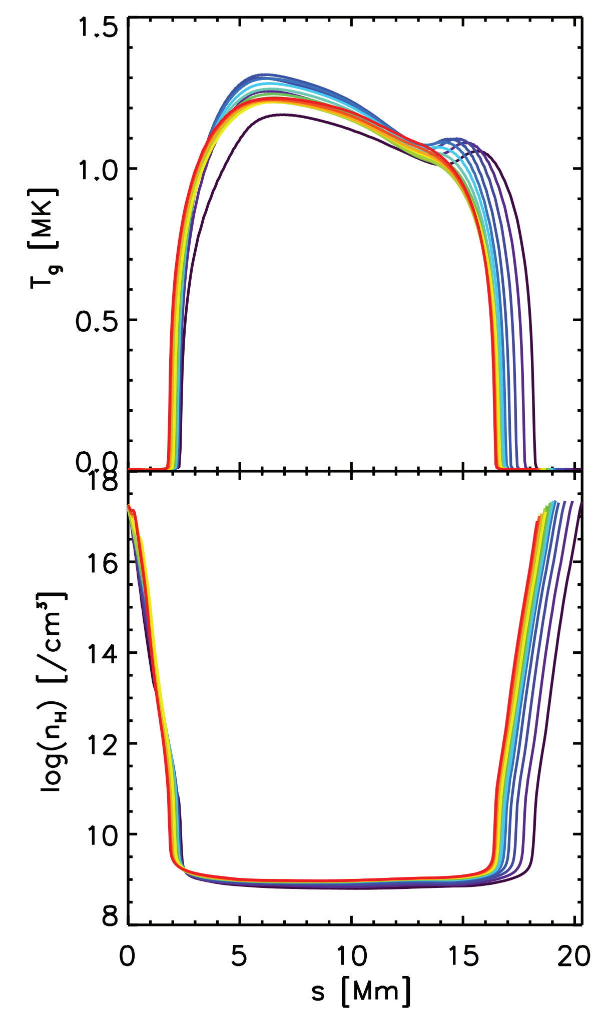
See Poster S3-P-20 Olluri et al.

Follow plasma evolution along field lines

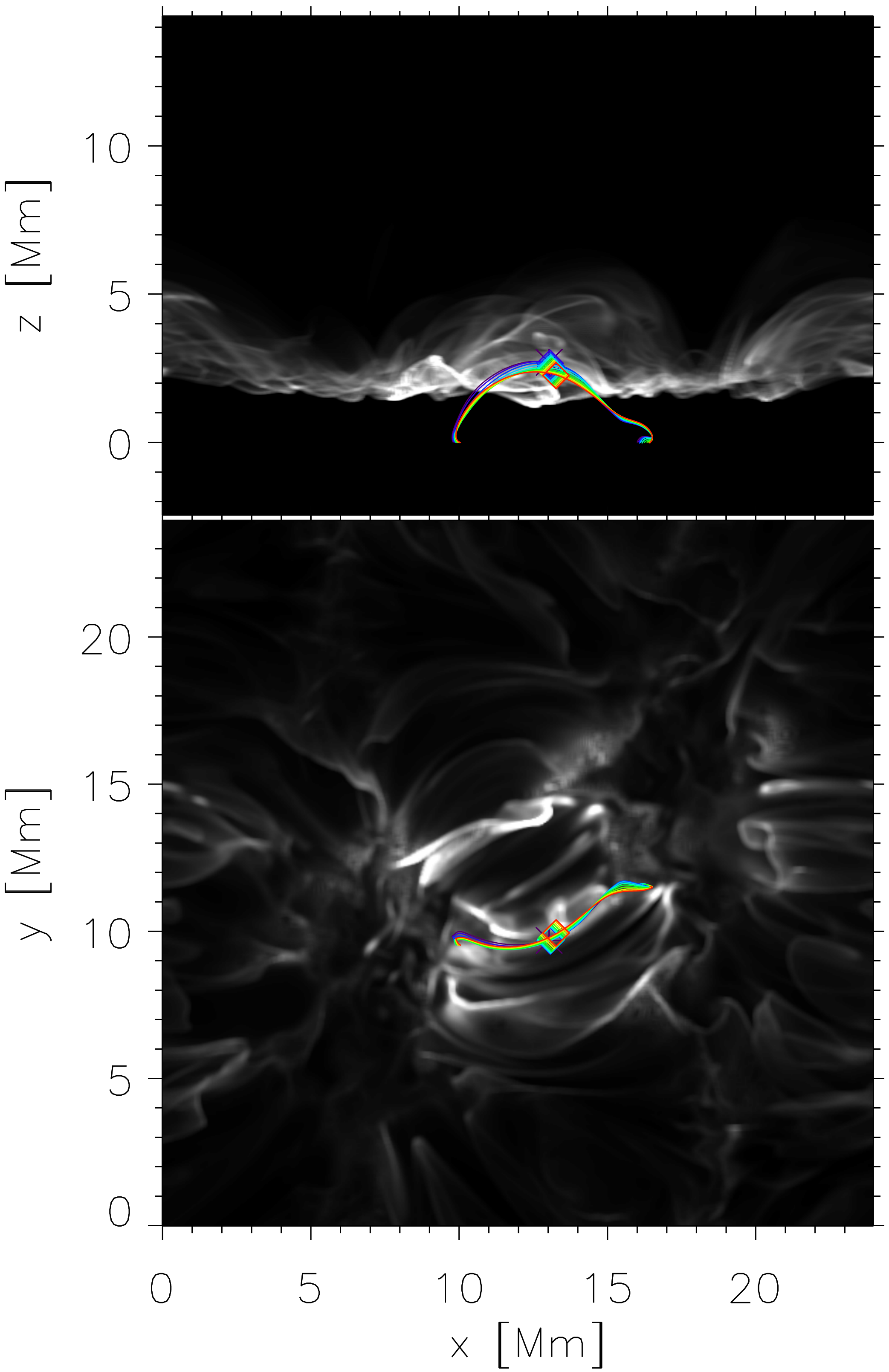


Higher 'traditional' coronal/TR loop

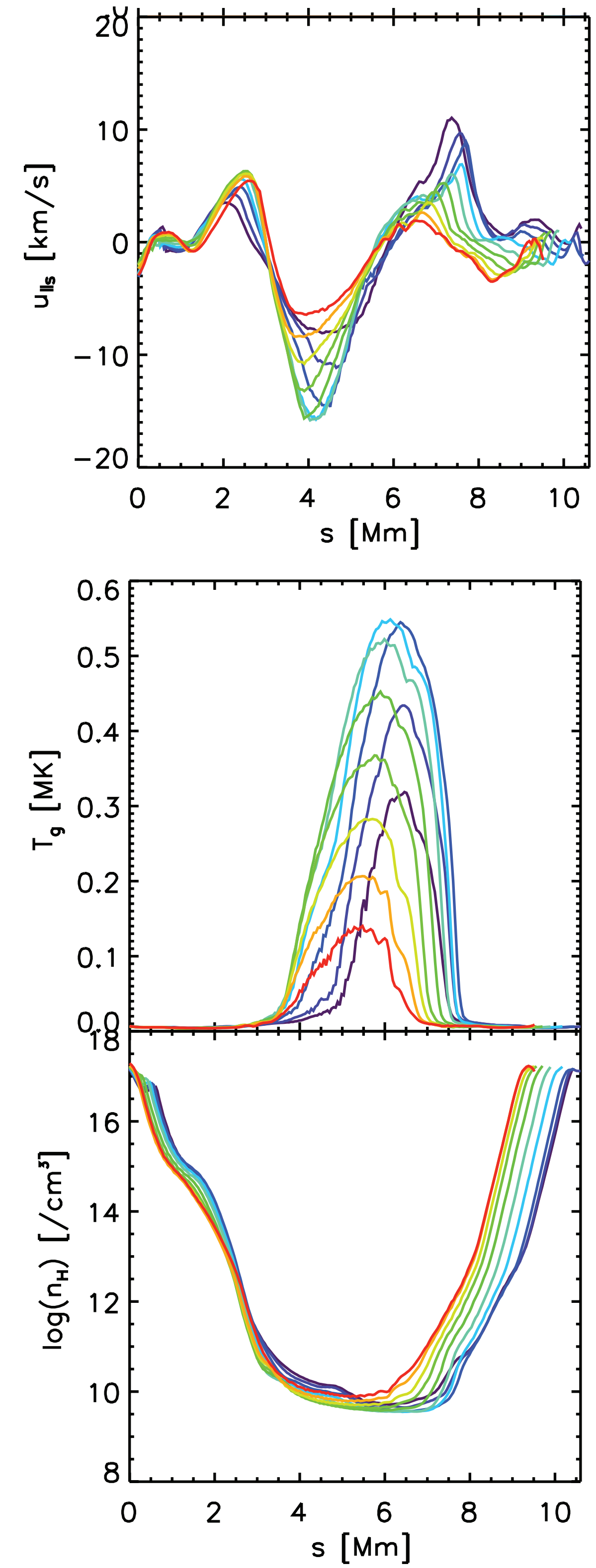




Follow plasma evolution along field lines



Low lying TR loop



THE ASTROPHYSICAL JOURNAL, **301**:440–447, 1986 February 1

Some pre-history...

THE STRUCTURE OF THE STATIC CORONA AND TRANSITION REGION

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AND
G. NOCI
Osservatorio Astrofisico di Arcetri, Firenze, Italy
Received 1985 May 17; accepted 1985 July 9

ABSTRACT

We investigate static models of coronal loops. For loops that are low-lying, heights above the chromosphere $\lesssim 5000$ km, it is shown that a new type of solution appears to the static equations, in addition to the well-known coronal loop solution. The new solution is characterized by a maximum plasma temperature $\lesssim 10^5$ K. The structure and properties of these cool solutions are discussed. We calculate the differential emission measure $Q(T)$ expected for a magnetic arcade, which we argue must naturally contain both hot and cool loops. It is shown that the cool loops have a dramatic effect on the form of $Q(T)$ in the lower transition region. In particular, they can account for the observed rise in Q at low T, which has long been thought to be incompatible with the static-loop model. Finally, we discuss the implications of the cool loops on other observations of both the solar and stellar coronae and transition regions.

Subject heading: Sun: corona

Can drop F_c and look at solutions where

$$n_e^2 f(T) = \epsilon(n, T)$$

...more history. What is the distribution between high and low loops?

THE ASTROPHYSICAL JOURNAL, 275:367–373, 1983 December 1

ON THE UNRESOLVED FINE STRUCTURES OF THE SOLAR ATMOSPHERE IN THE 3×10^4–2×10^5 K TEMPERATURE REGION

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Received 1983 March 7; accepted 1983 May 11

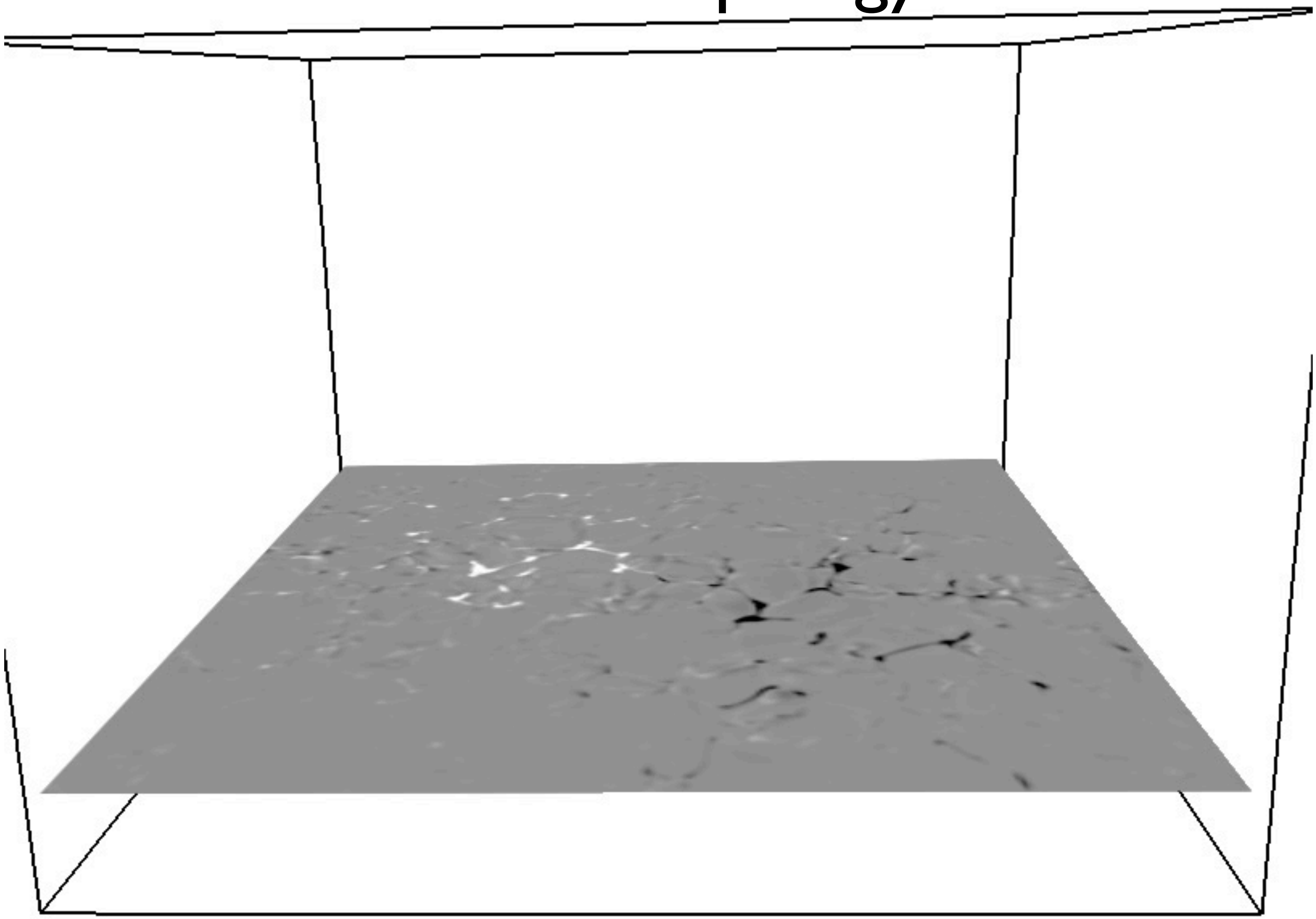
ABSTRACT

The solar atmospheres from the chromosphere through the transition zone and all the way up into the corona usually are considered to be parts of one continuous structure. Now that stellar measurements in the far-ultraviolet have become available, an attempt is being made to apply solar physics ideas to solar type stars. The intention of this paper is to reexamine the experimental facts concerning the relations between the solar chromosphere, transition zone, and corona.

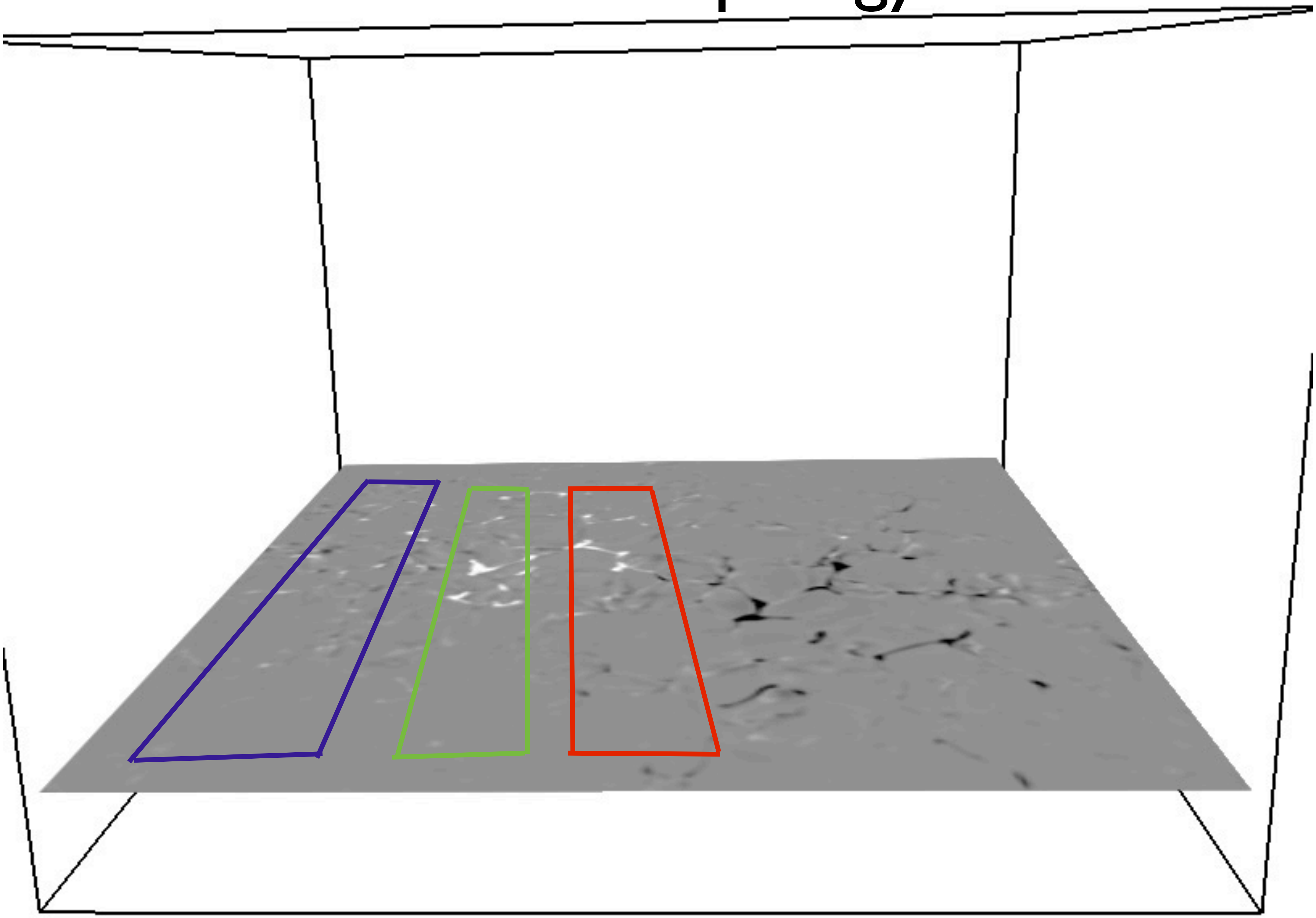
Experimental evidence is presented to argue that the solar plasma in the temperature region 4×10^4–2.2×10^5 K occurs in structures magnetically isolated from the chromosphere and corona. It is suggested that while a small part of the emission detected in the 4×10^4–2.2×10^5 K region consists of the "true" transition zone plasma, i.e., the interface between chromospheric and coronal temperatures, that most of it belongs to an altogether different entity. It is also suggested that this particular entity be called unresolved fine structures.

Subject headings: Sun: chromosphere — Sun: corona

Photospheric field distrubution - coronal topology



Photospheric field distrubution - coronal topology



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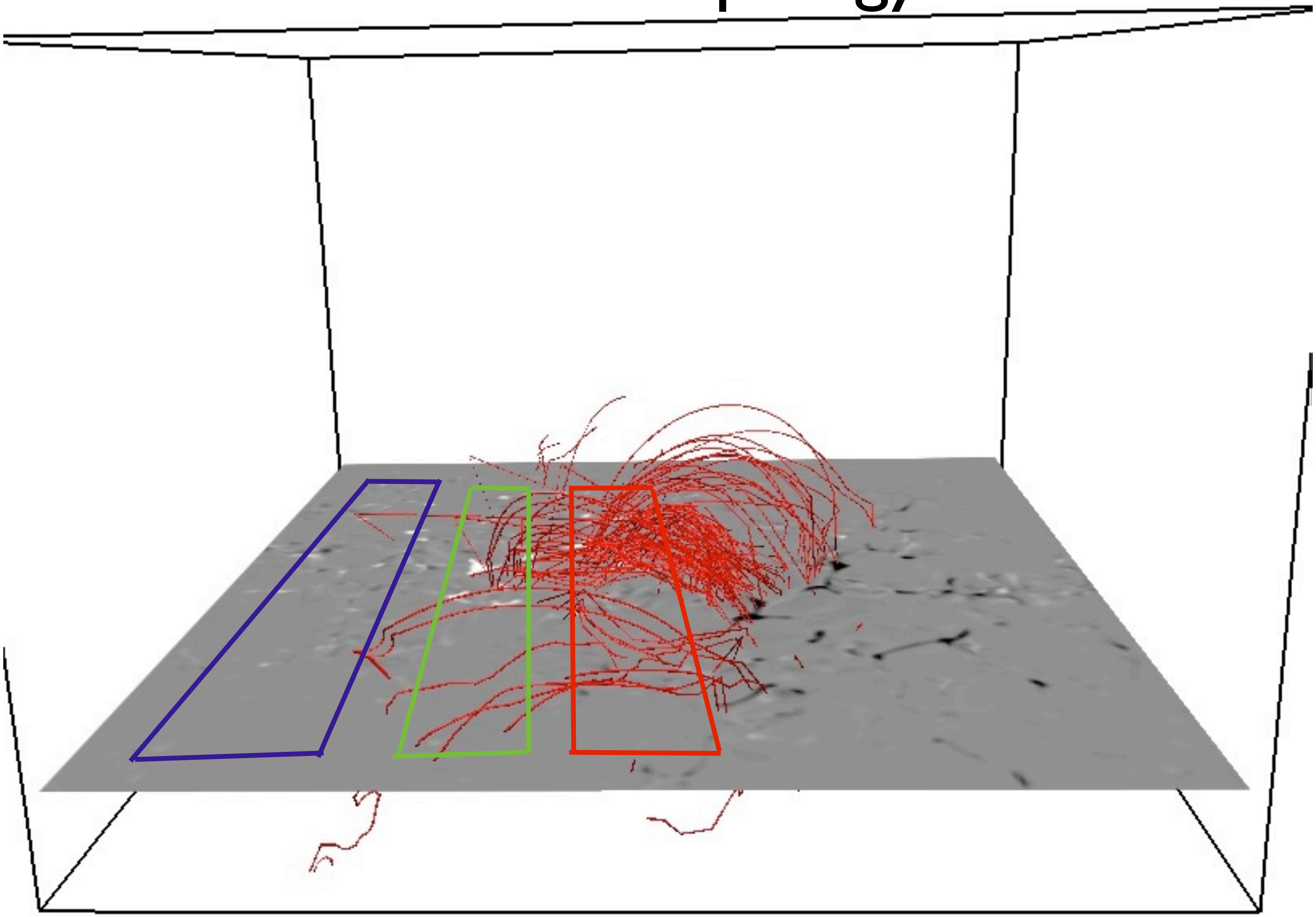

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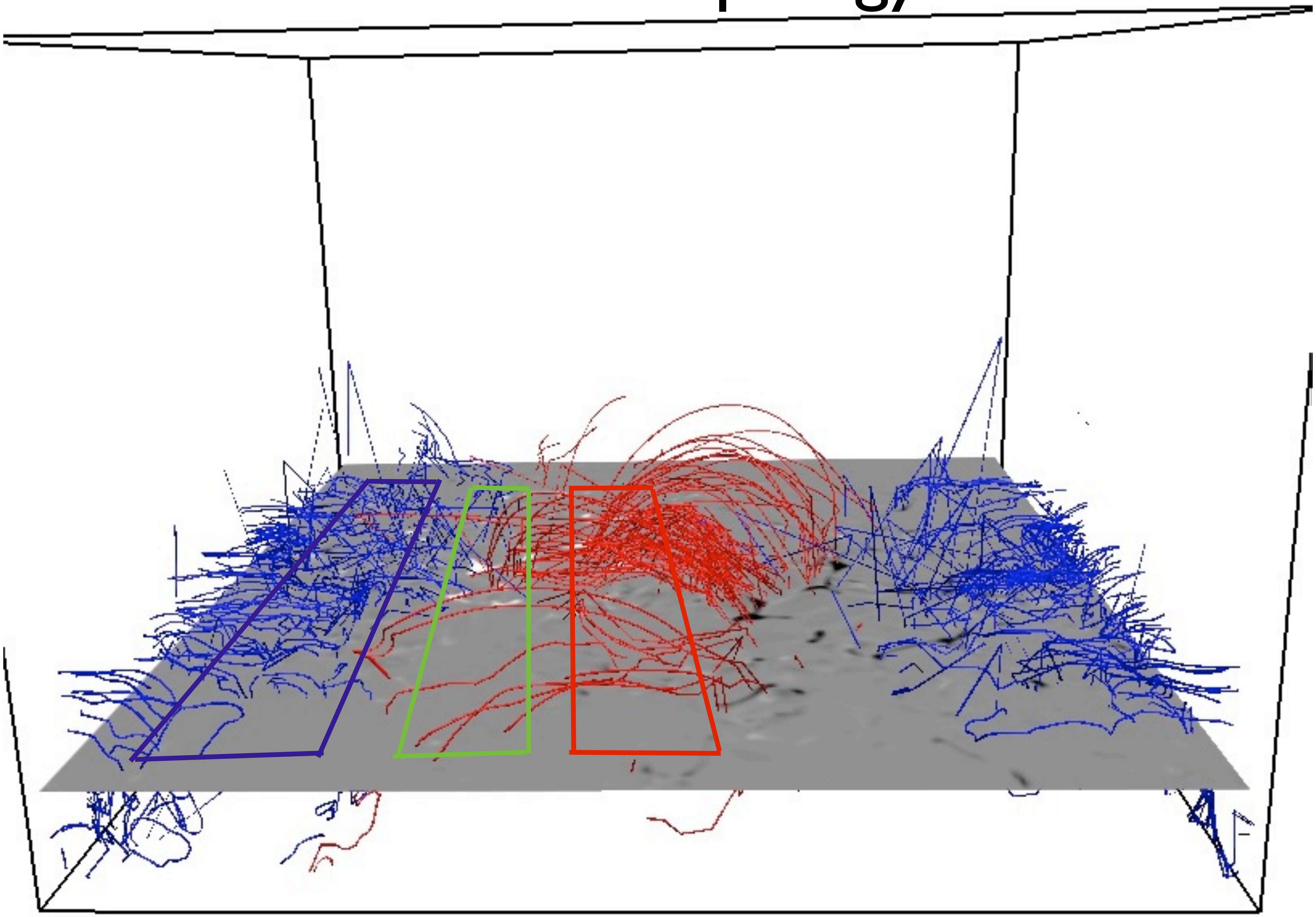

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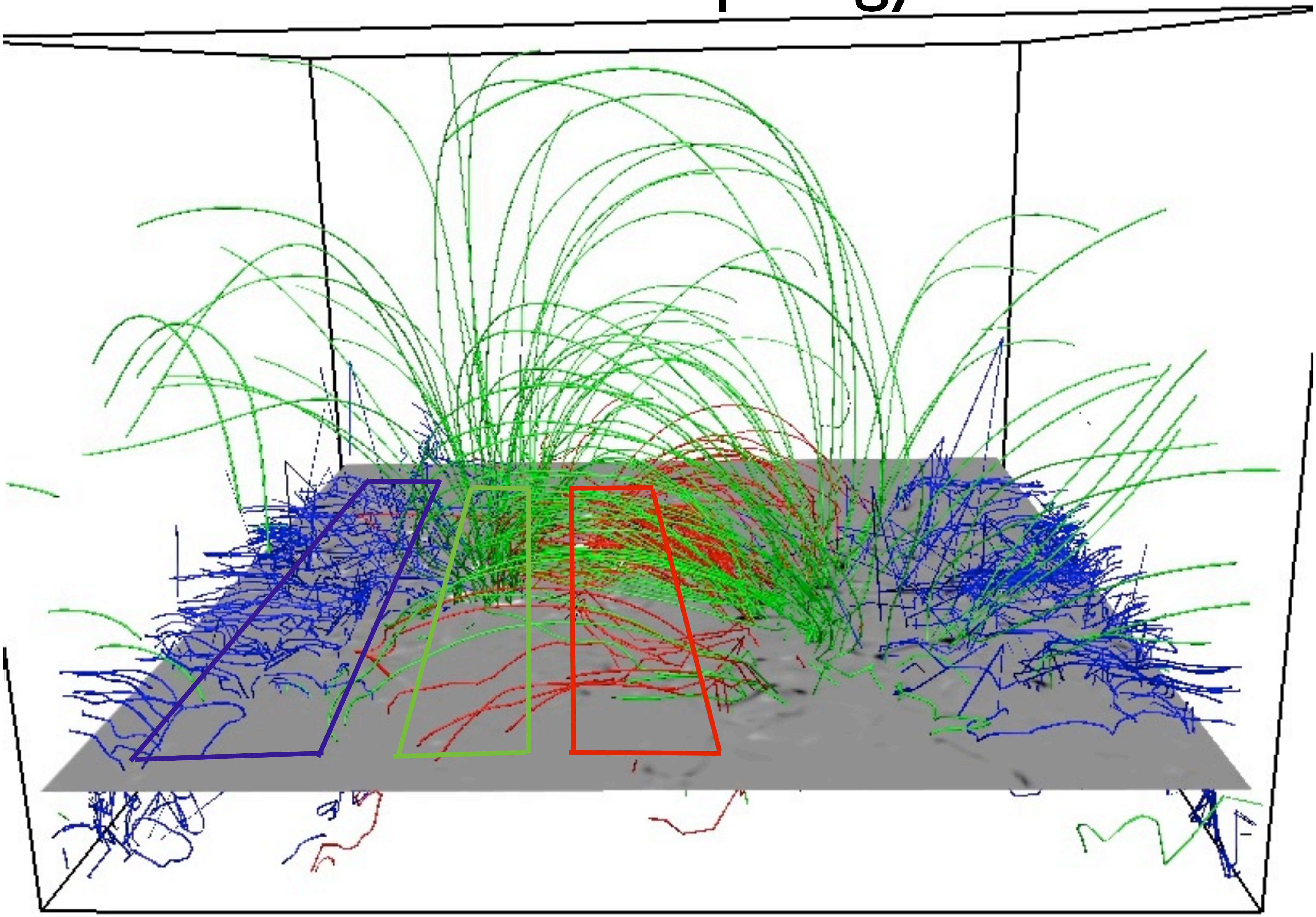
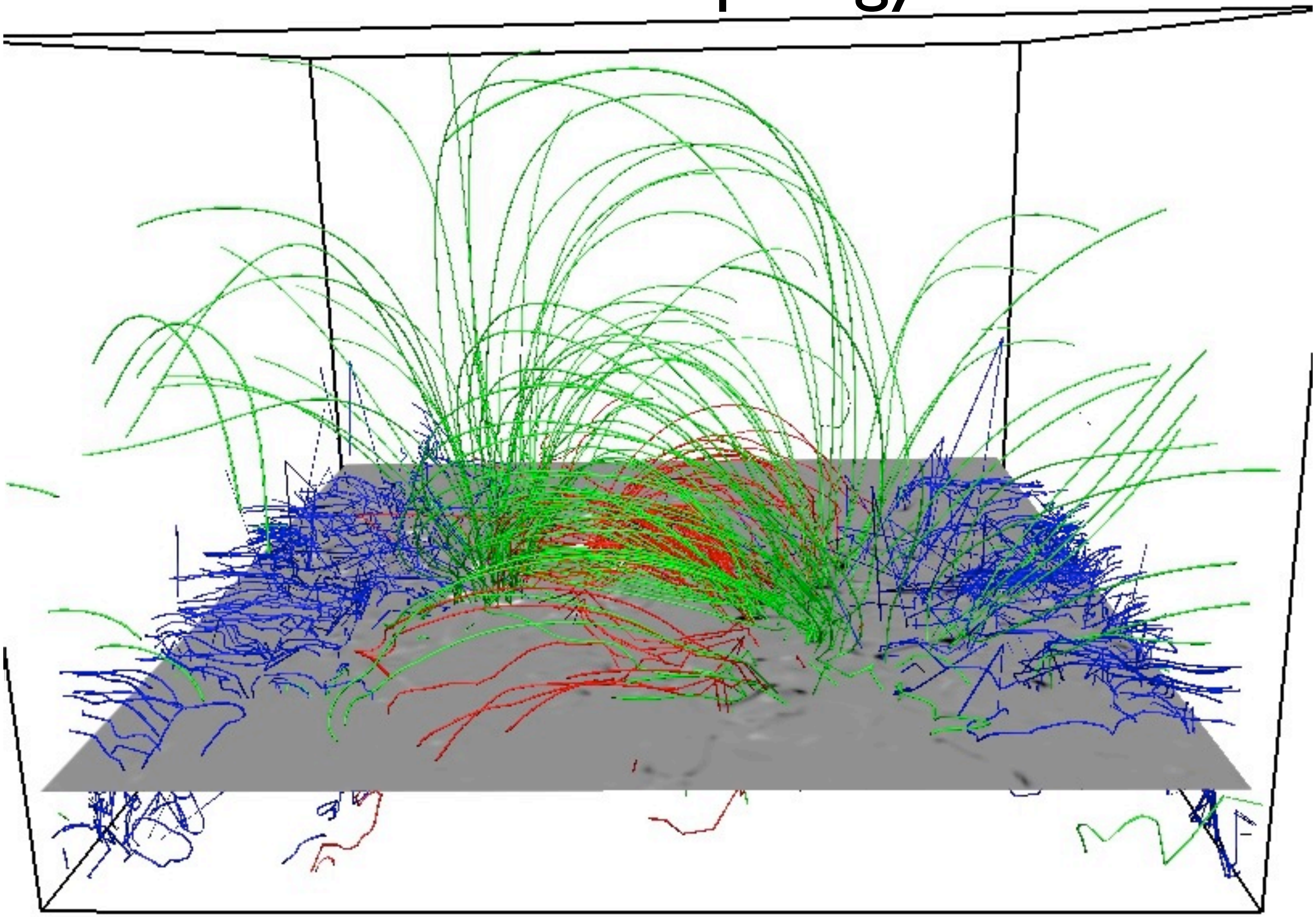


Photospheric field distrubution - coronal topology



THE ASTROPHYSICAL JOURNAL, 769:47 (12pp), 2013 May 20 doi:10.1088/0004-637X/769/1/47

THE CYCLING OF MATERIAL BETWEEN THE SOLAR CORONA AND CHROMOSPHERE

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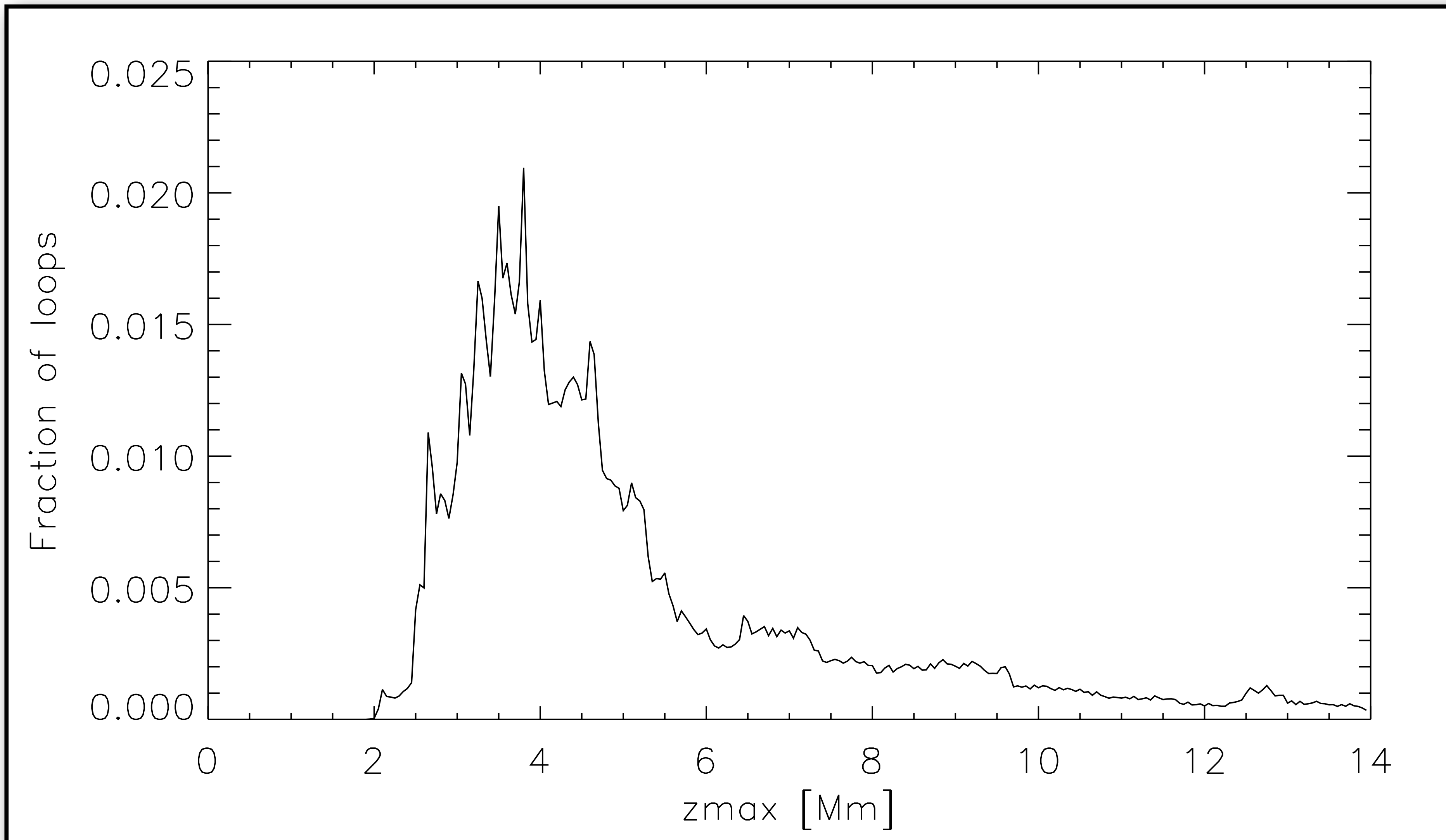
ABSTRACT

Observations of transition region emission lines reveal the presence of redshifts in lines formed from the top of the chromosphere up to temperatures of about 2.5×10^5 K and blueshifts for temperatures above that. However, it is doubtful that the apparent large downward flows in the lower transition region represents an emptying of the corona, so some mechanism must be responsible for maintaining the mass balance between the corona and the lower atmospheric layers. We use a three-dimensional magnetohydrodynamics code to study the cycling of mass between the corona, transition region, and chromosphere by adding a tracer fluid to the simulation in various temperature intervals in the transition region. We find that most of the material seen in transition region emission lines formed at temperatures below 3×10^5 K is material that has been rapidly heated from chromospheric temperatures and thereafter is pushed down as it cools. This implies that the bulk of transition region material resides in small loops. In these loops, the density is high and radiative cooling is efficient.

Key words: Sun: chromosphere – Sun: corona – Sun: transition region

For each loop that reaches TR temperature: What is the distribution of apex heights?



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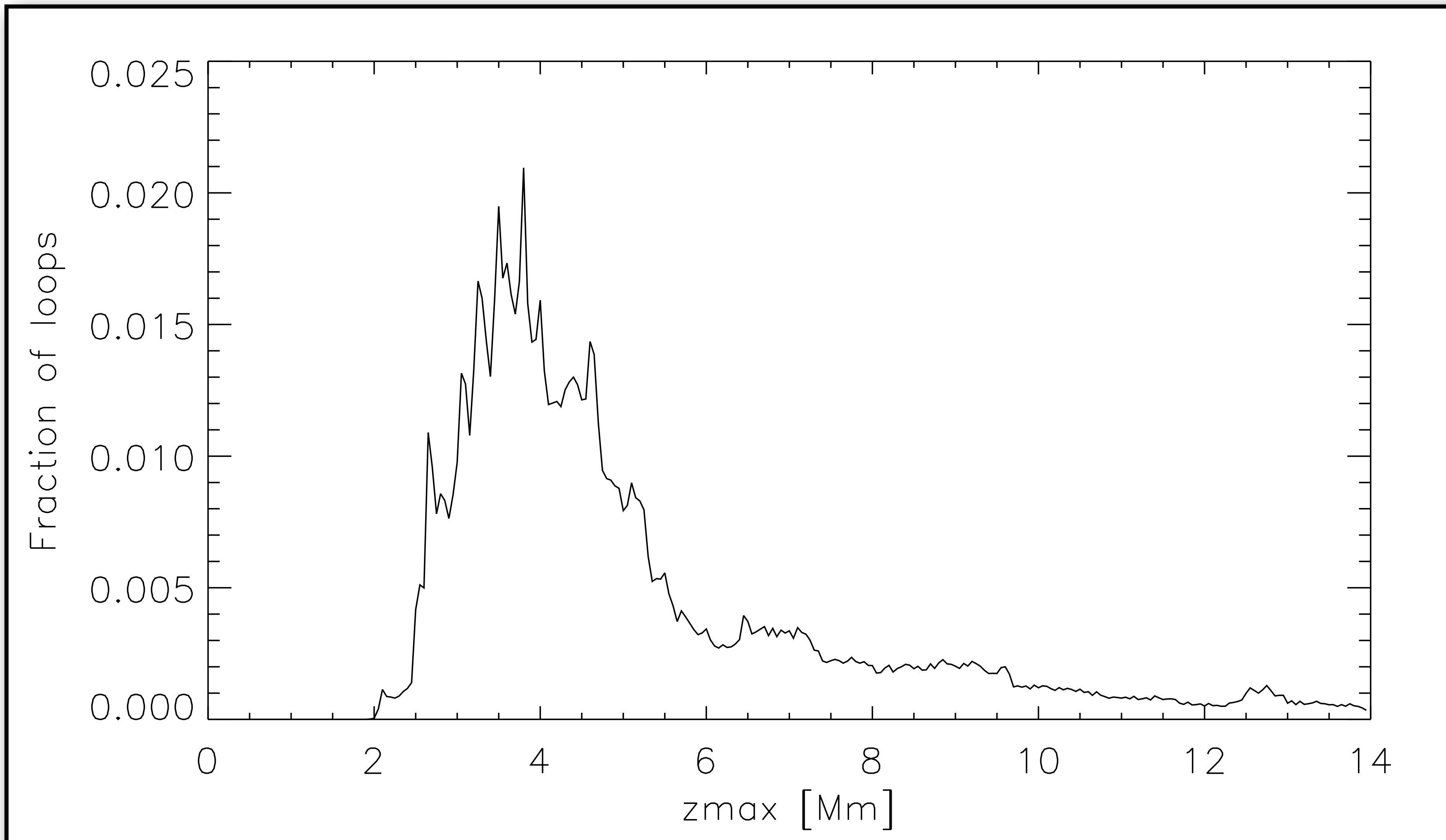
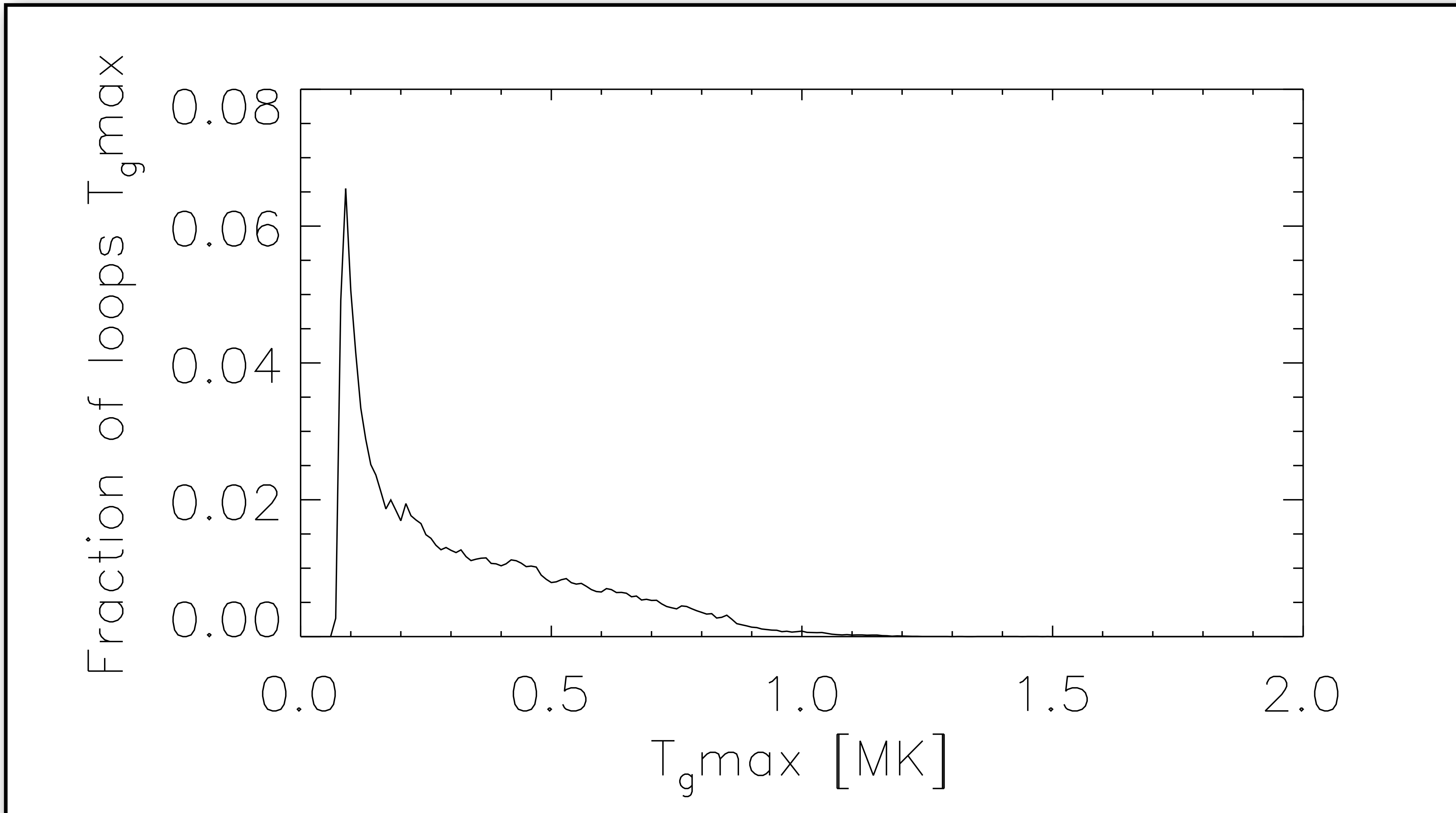


TR loops are low.

For each loop that reaches TR temperature: What is the distribution of max temperature?

For each loop that reaches TR temperature: What is the distribution of max temperature?



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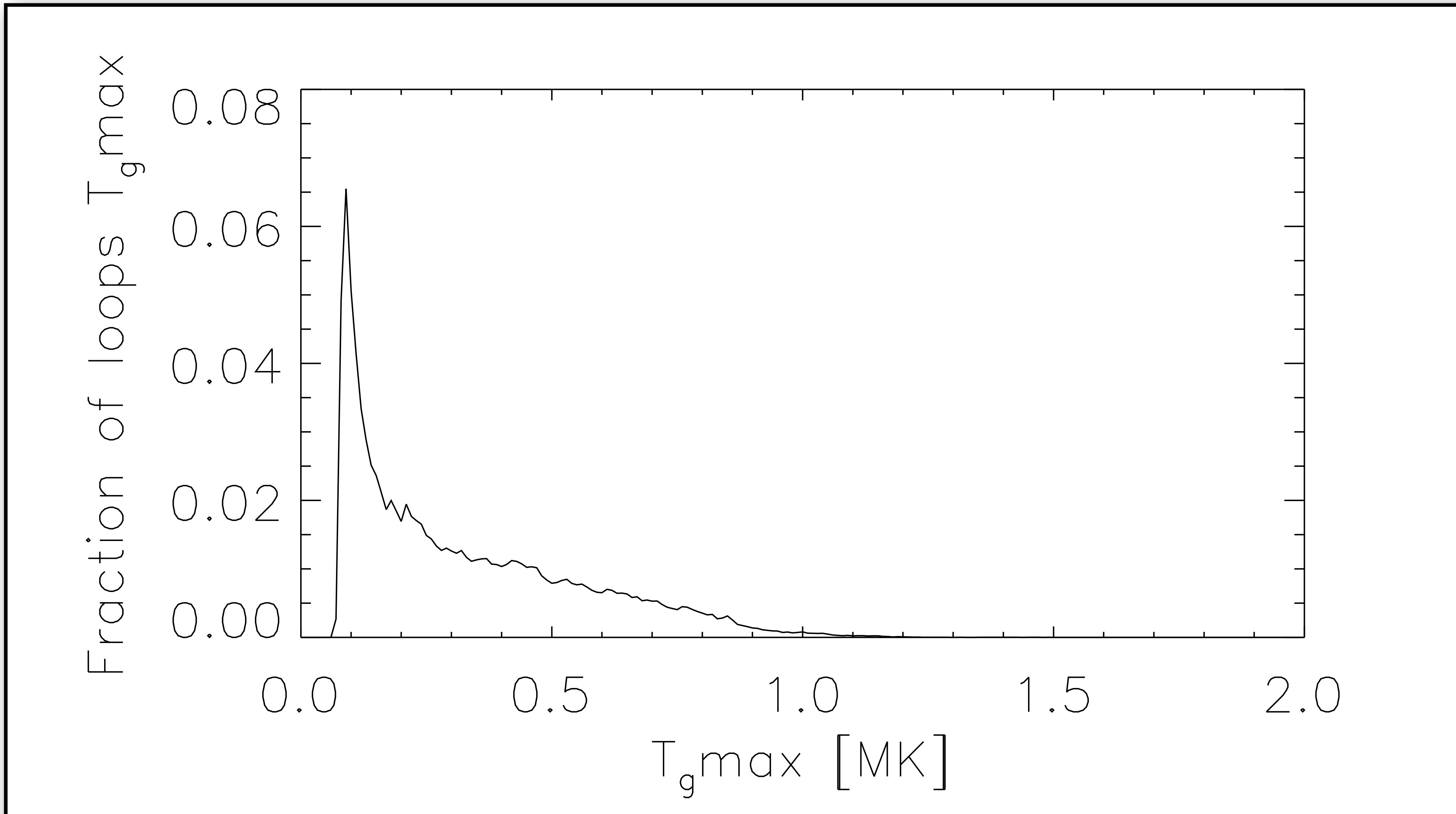
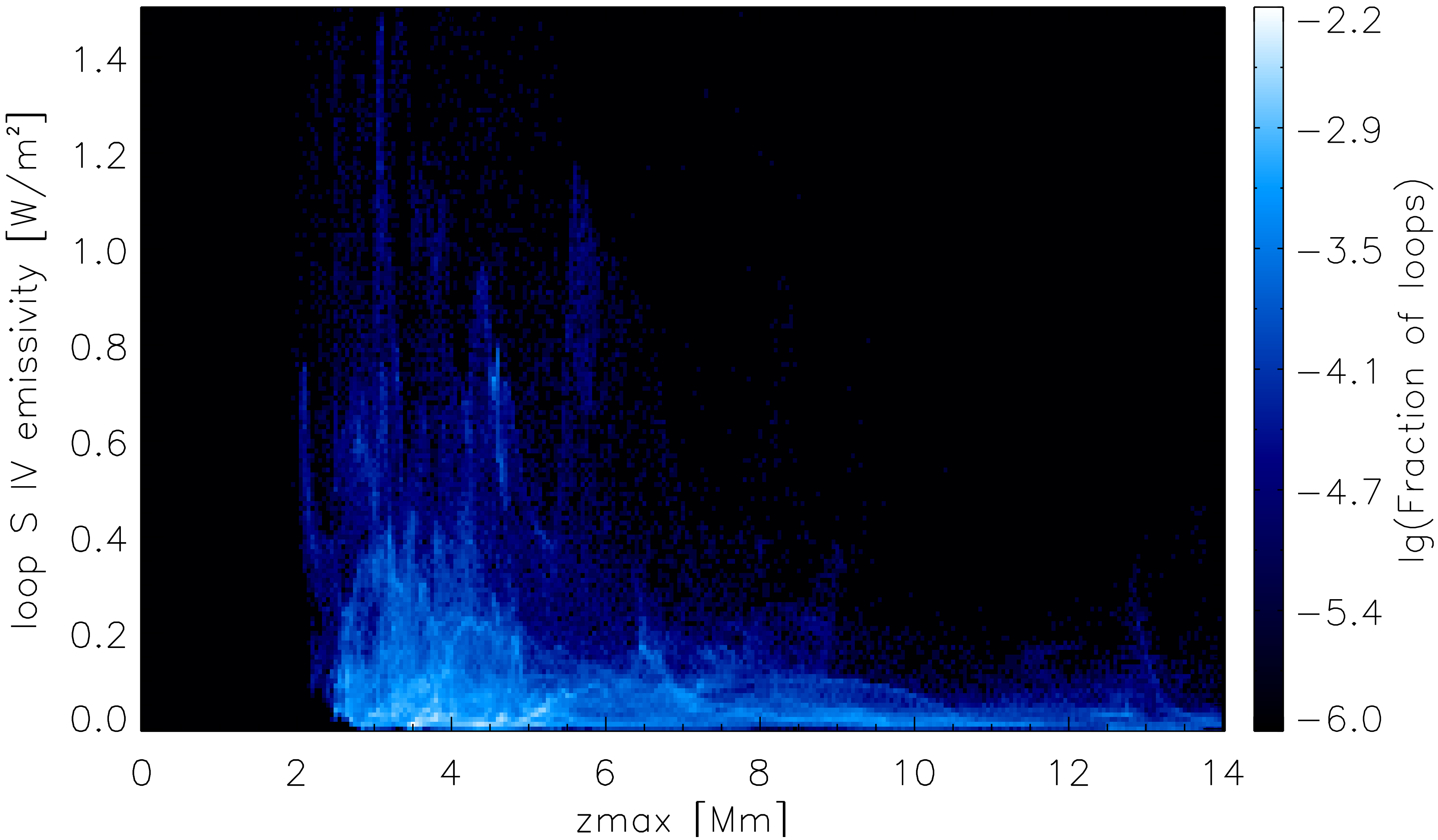


TR loops are cool.

...and finally. For each loop that reaches TR temperature: Which loops are the bright?



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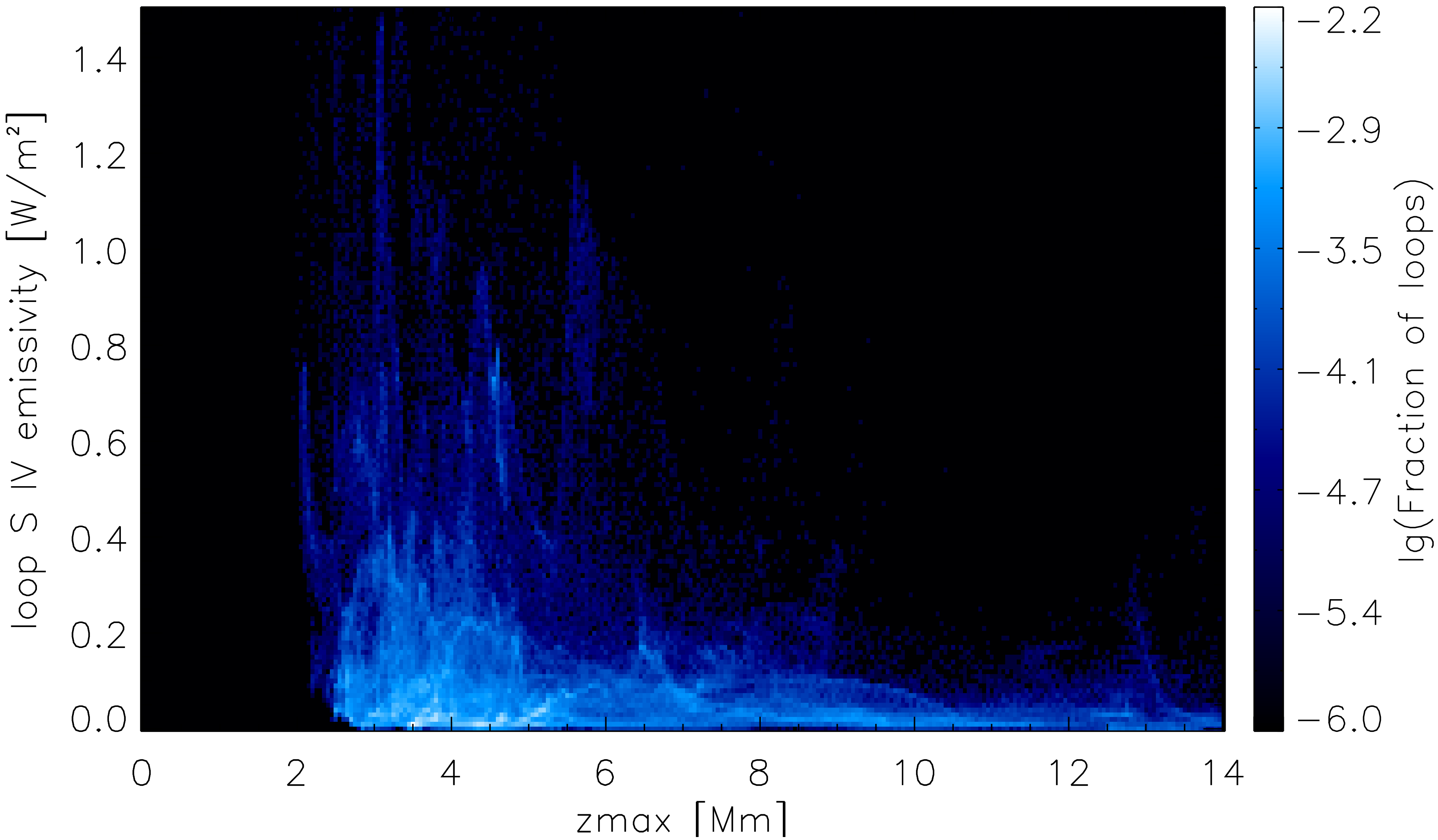

Bright TR loops are low, and cool.

Conclusions

- IRIS slit jaw movies for C II '1330' and Si IV '1400' Å show many short lived, cool loops
- Realistic 3D simulations predict such loops should dominate TR emission
- Topology matters, expect different properties from different types of regions
- Response to heating different than in traditional TR loops
- UFS now no longer unresolved! UFS => RFS

IRIS data: http://sdc.uio.no/search

Simulations: http://sdc.uio.no/search/simulations

The Astrophysical Journal, 771:21 (10pp), 2013 July 1 doi:10.1088/0004-637X/771/1/21

DETECTING NANOFLARE HEATING EVENTS IN SUBARCSECOND INTER-MOSS LOOPS USING Hi-C

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Received 2013 April 14; accepted 2013 May 11; published 2013 June 11

ABSTRACT

The High-resolution Coronal Imager (Hi-C) flew aboard a NASA sounding rocket on 2012 July 11 and captured roughly 345 s of high-spatial and temporal resolution images of the solar corona in a narrowband 193 Å channel. In this paper, we analyze a set of rapidly evolving loops that appear in an inter-moss region. We select six loops that both appear in and fade out of the Hi-C images during the short flight. From the Hi-C data, we determine the size and lifetimes of the loops and characterize whether these loops appear simultaneously along their length or first appear at one footpoint before appearing at the other. Using co-aligned, co-temporal data from multiple channels of the Atmospheric Imaging Assembly on the *Solar Dynamics Observatory*, we determine the temperature and density of the loops. We find the loops consist of cool ($\sim 10^5$ K), dense ($\sim 10^{10}$ cm^{-3}) plasma. Their required thermal energy and their observed evolution suggest they result from impulsive heating similar in magnitude to nanoflares. Comparisons with advanced numerical simulations indicate that such dense, cold and short-lived loops are a natural consequence of impulsive magnetic energy release by reconnection of braided magnetic field at low heights in the solar atmosphere.

Key word: Sun: corona

Online-only material: animation