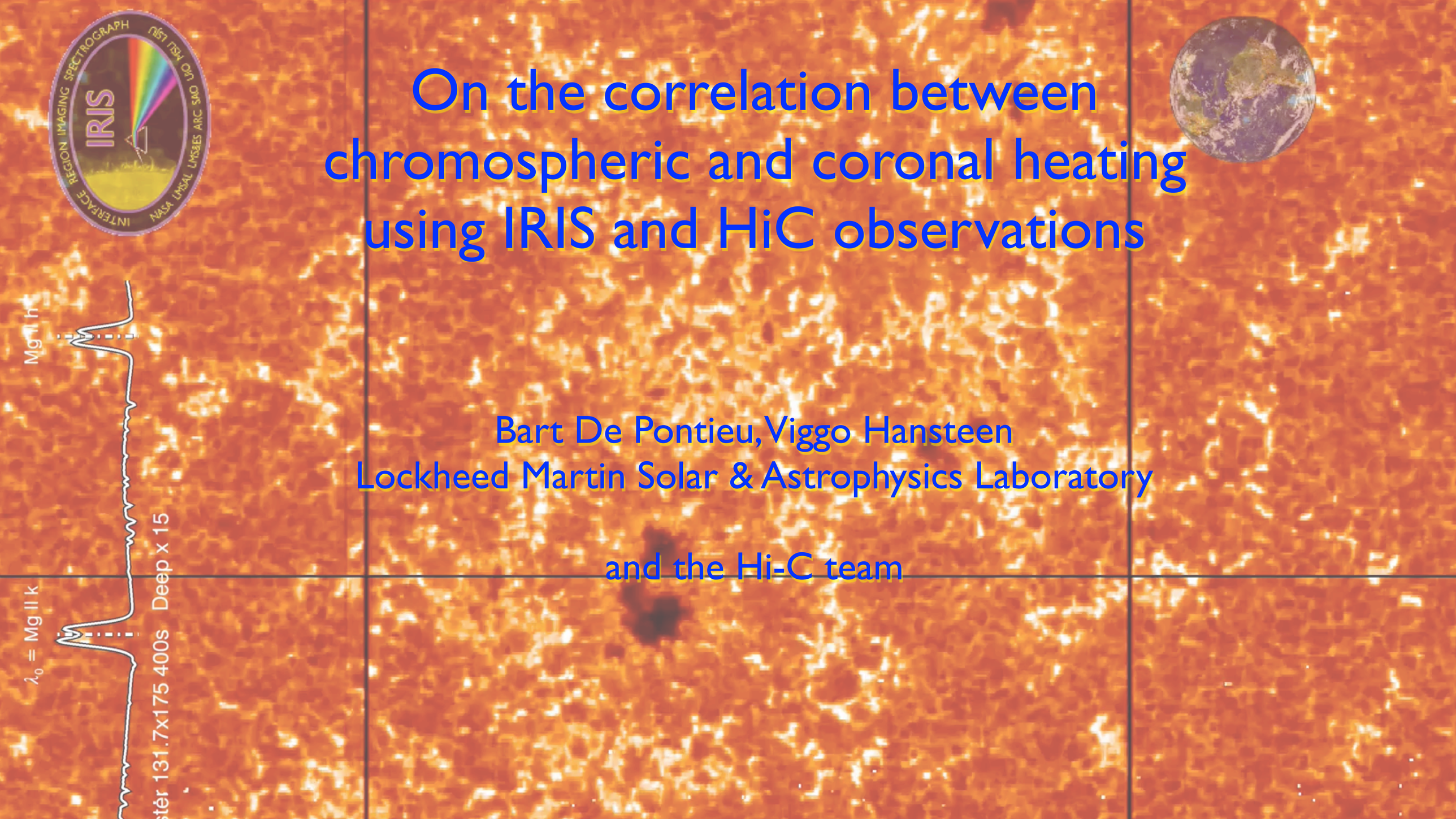


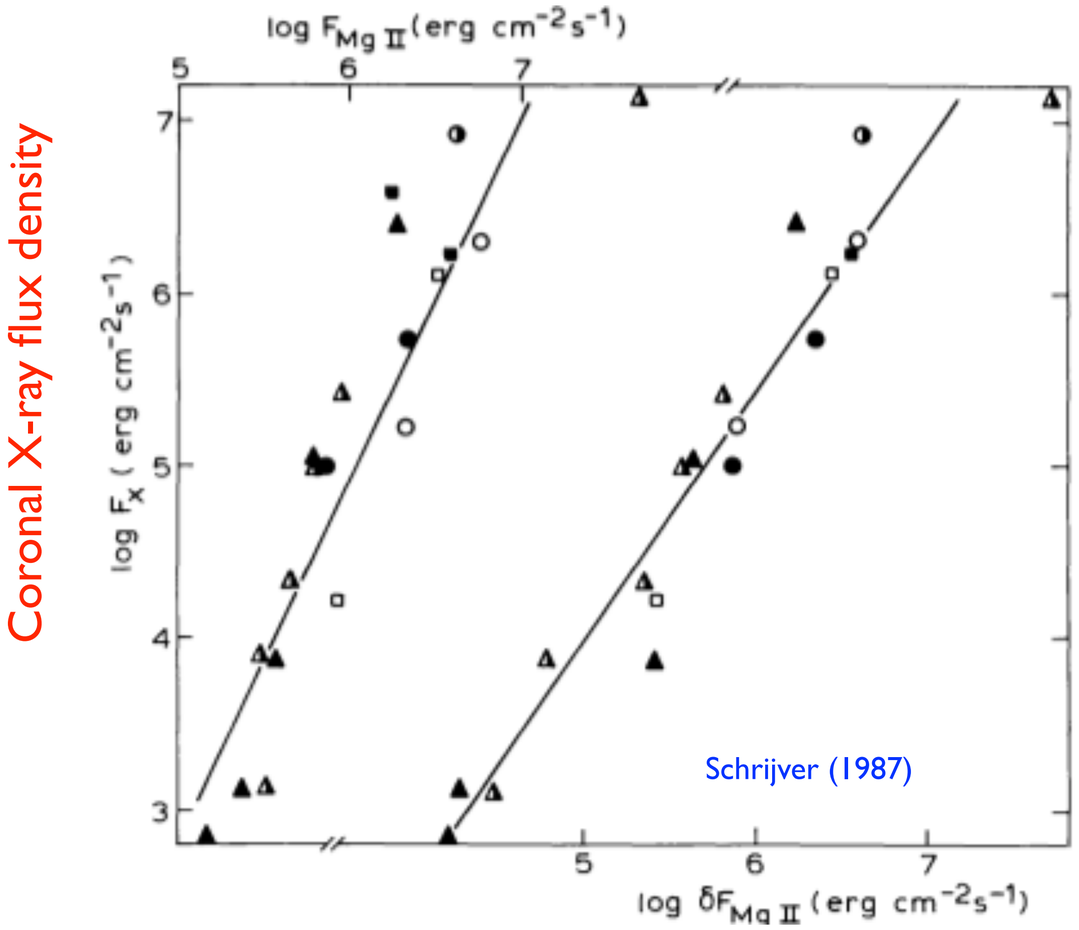
On the correlation between chromospheric and coronal heating using IRIS and HiC observations

Bart De Pontieu, Viggo Hansteen
Lockheed Martin Solar & Astrophysics Laboratory

and the Hi-C team

Stellar studies: chromospheric and coronal heating appear to be linked

Chromosphere-Corona



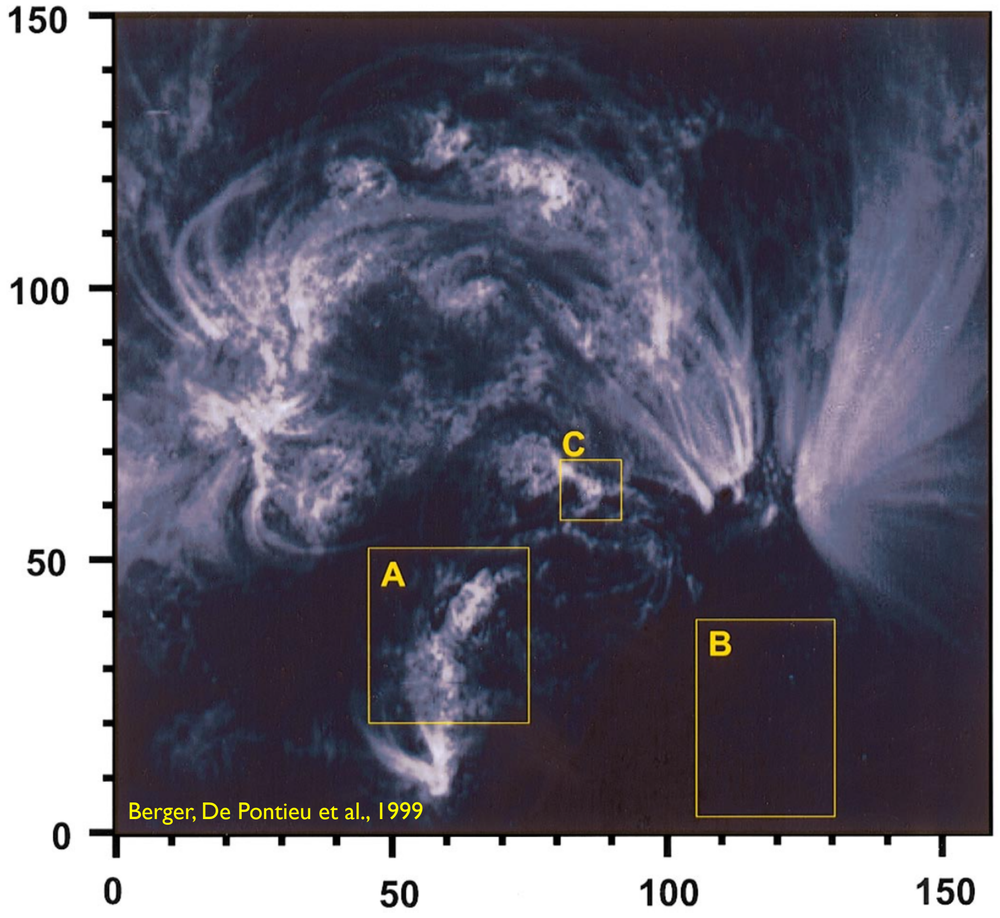
Coronal X-ray flux density

Chromospheric Mg II flux density

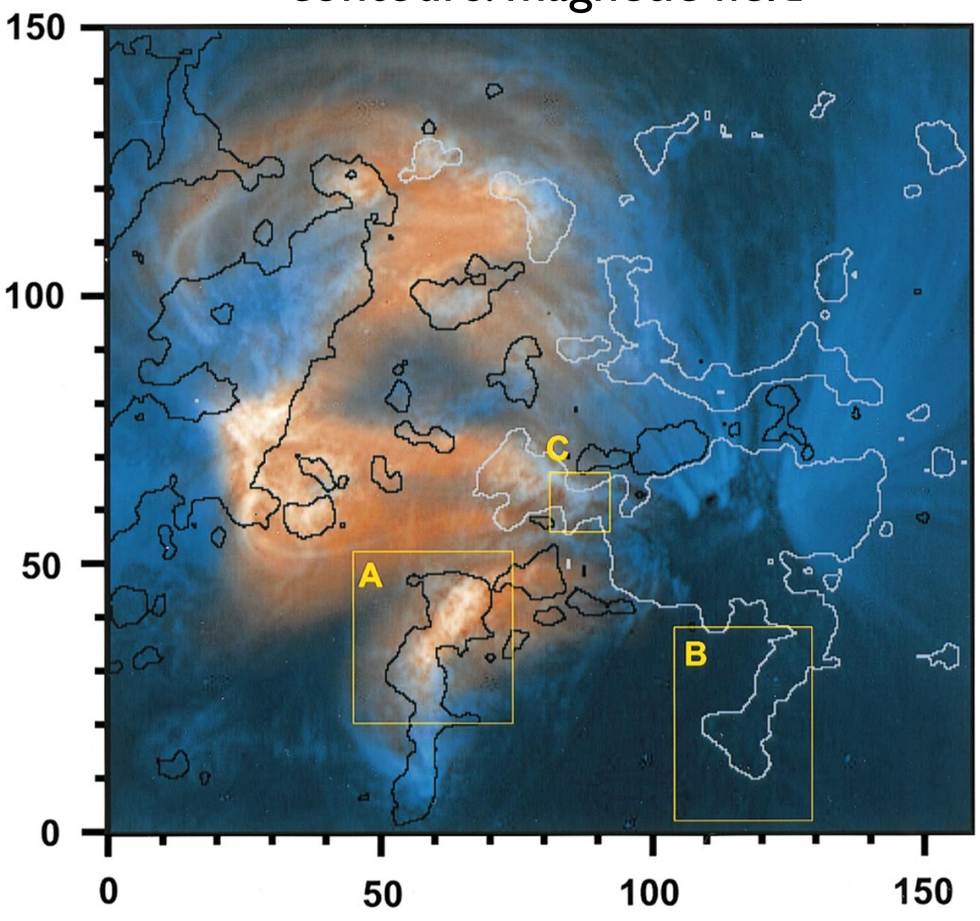
Chromospheric and coronal emission correlated on global scale

How study spatio-temporal correlation of chromospheric/coronal heating on small scales?

Fe IX 171 Å



Blue: 171Å, Red: Soft X-ray, Black contours: magnetic field

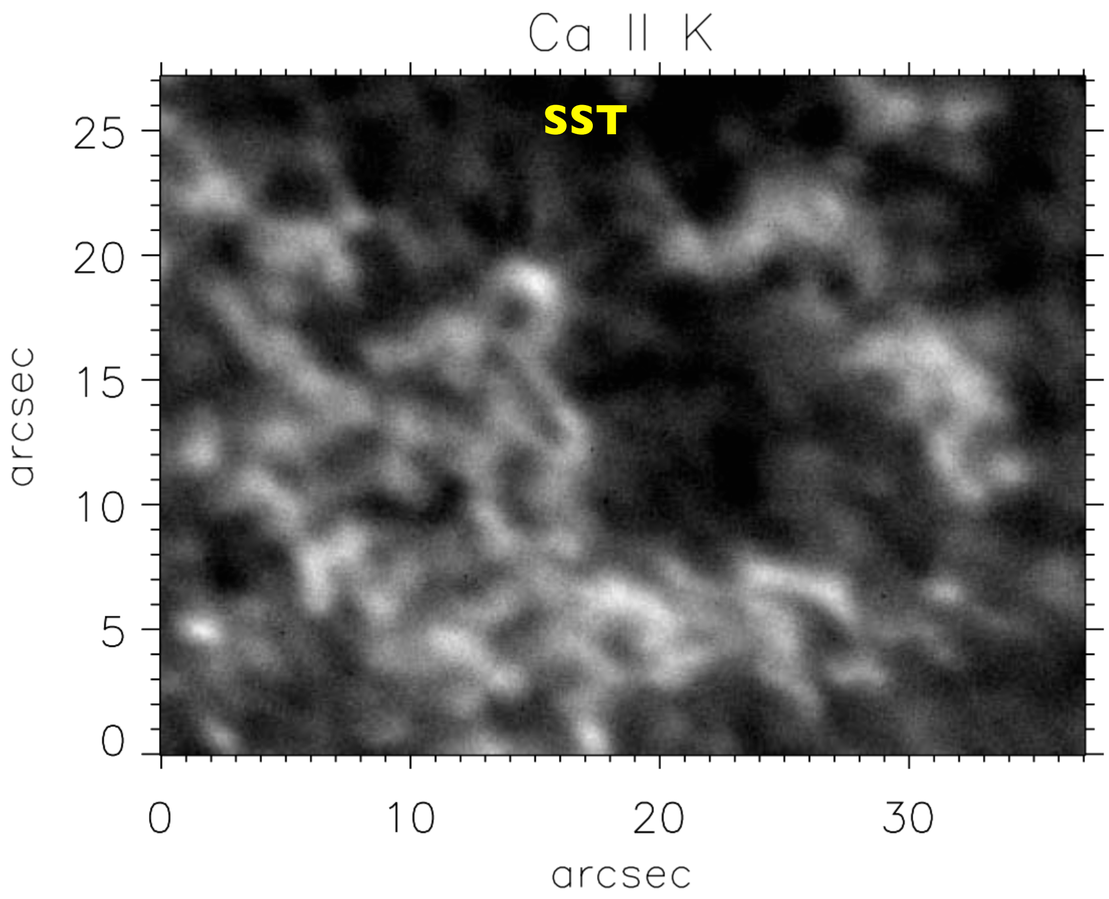


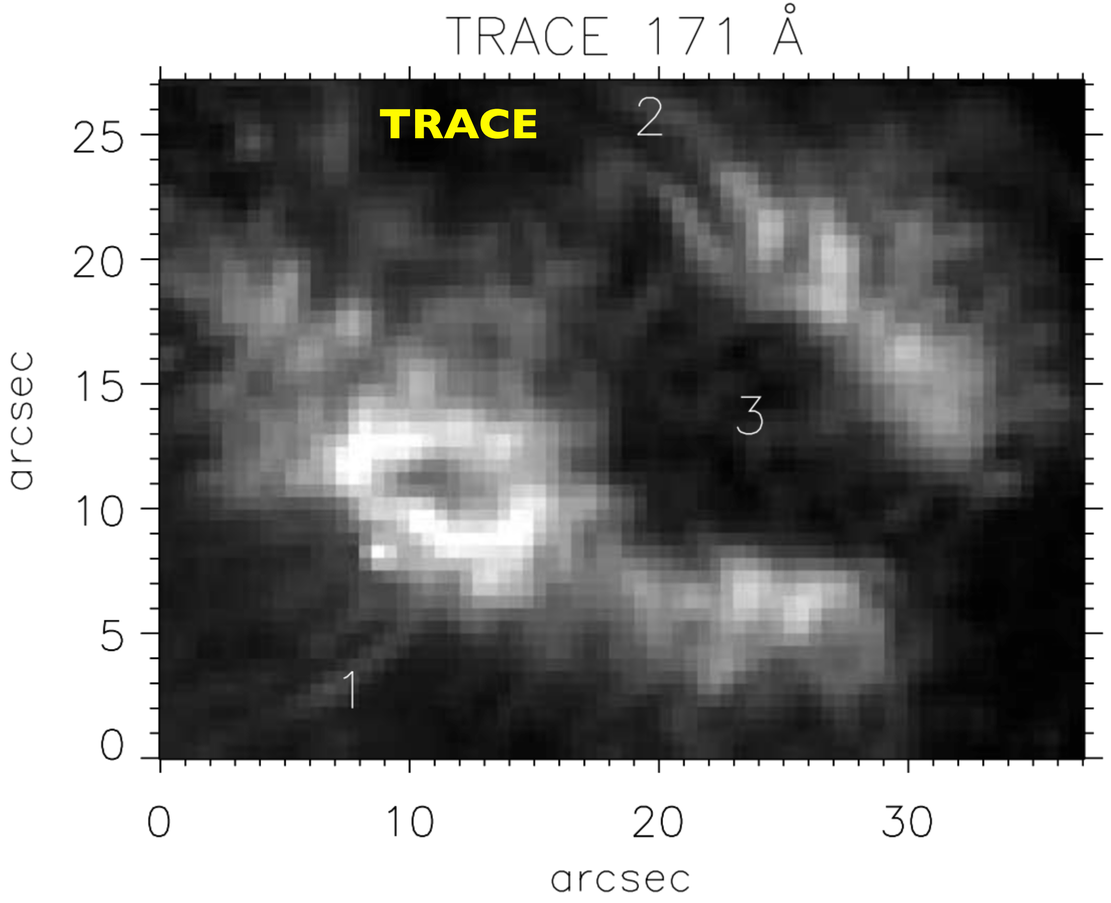
Moss occurs at the footpoints of hot, high-density coronal loops (Berger et al., 1999, Fletcher & De Pontieu, 1999)

Moss brightness good proxy for coronal pressure (Martens et al., 2001)

Recent observations claim some small-scale loops contribute to moss emission (Barczynski et al., 2017)

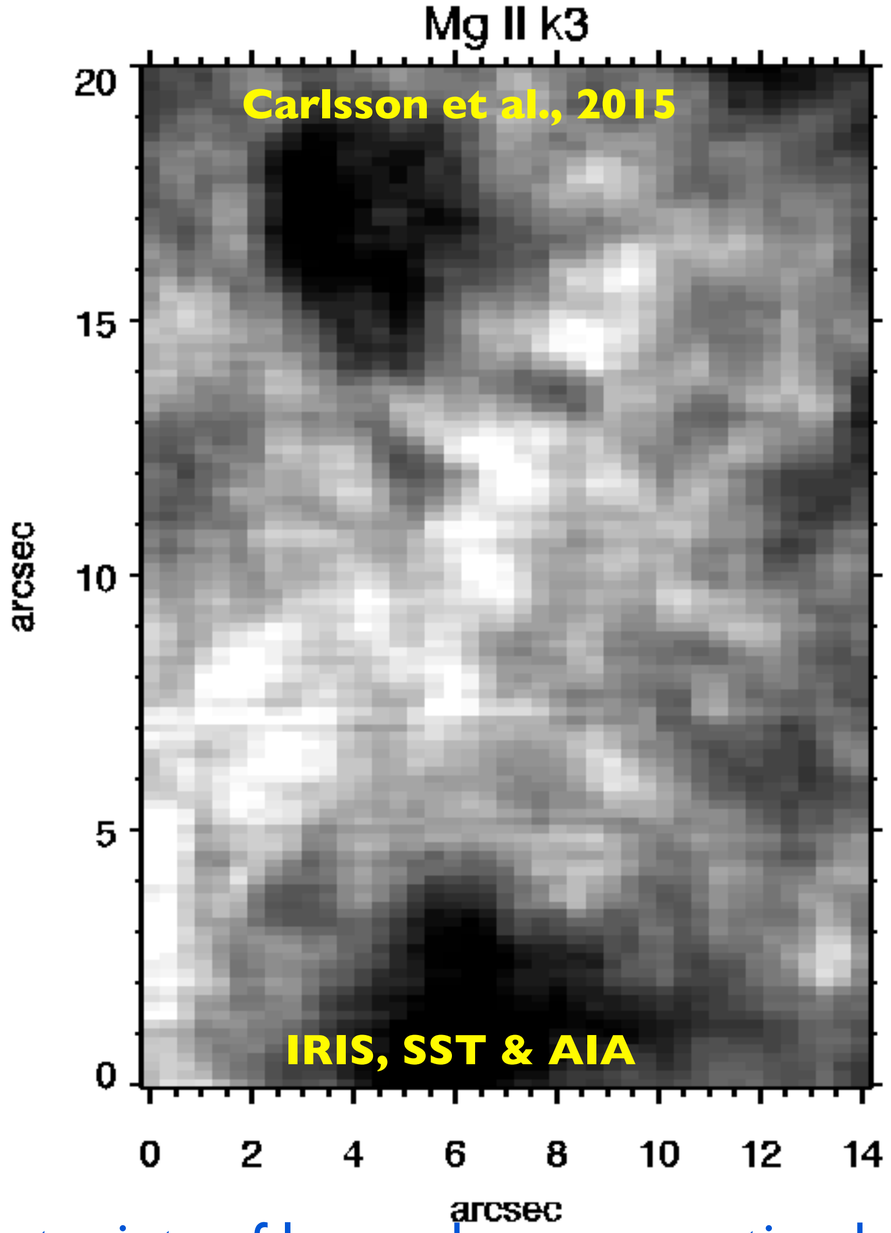
Correlation on smaller spatio-temporal scales more difficult to establish?

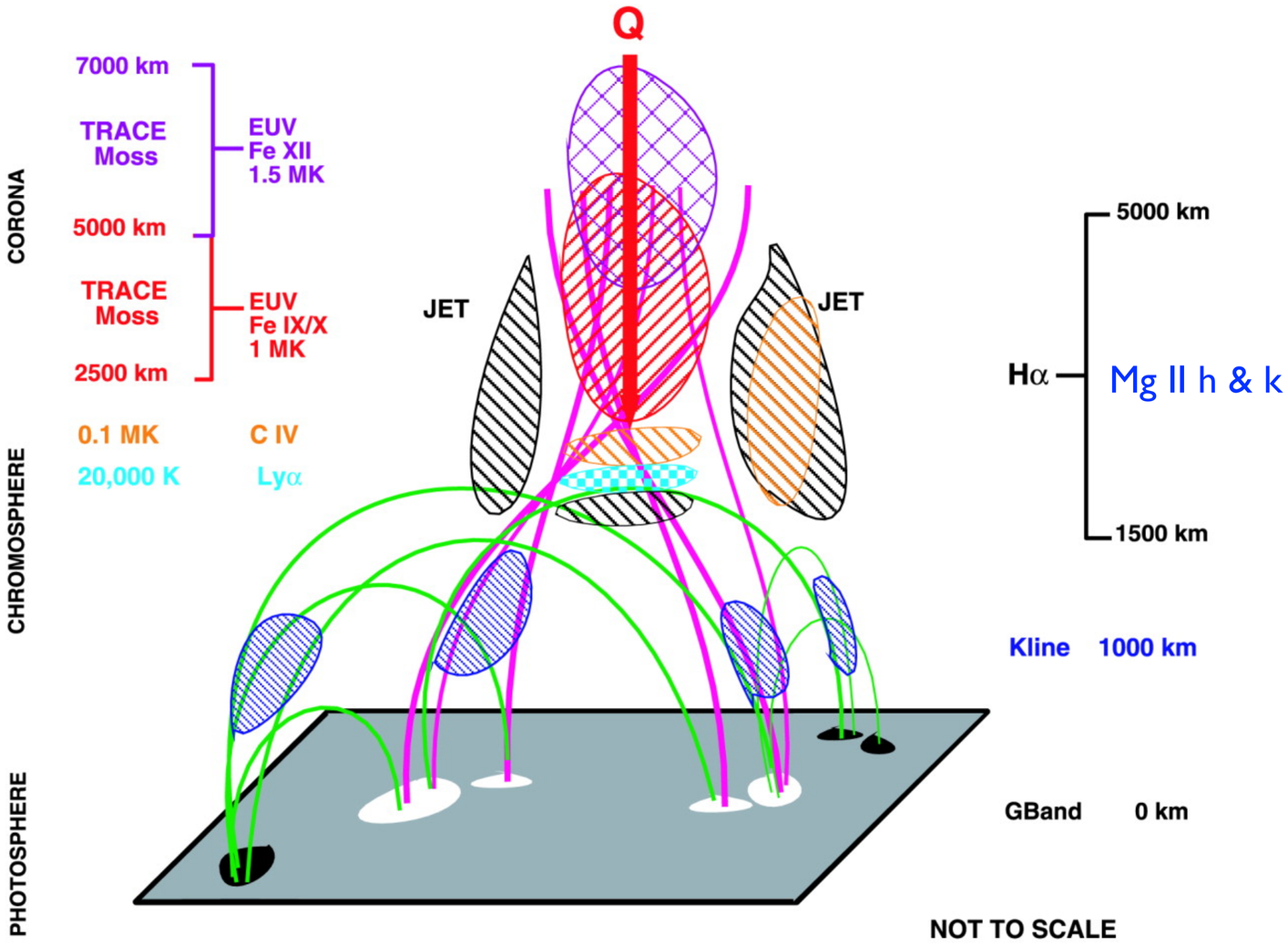




But on small, subarcsec scales, previous observations did not find a good correlation (e.g., moss brightness and Ca II k emission in plage, De Pontieu et al., 2003)

Connection between chromospheric and coronal heating in plage

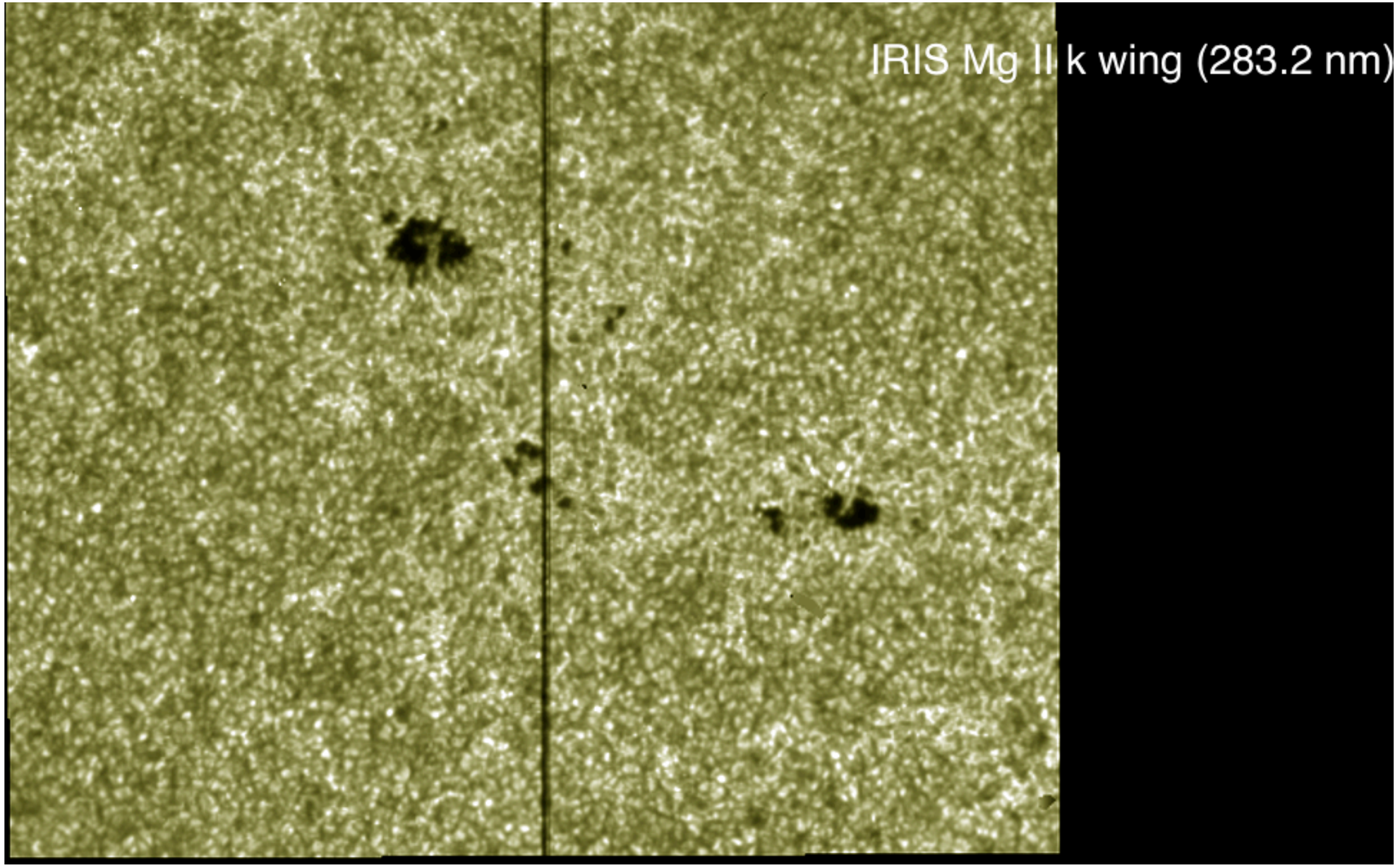




Footpoints of loops show connection between moss and chromospheric dynamics (dynamic fibrils)

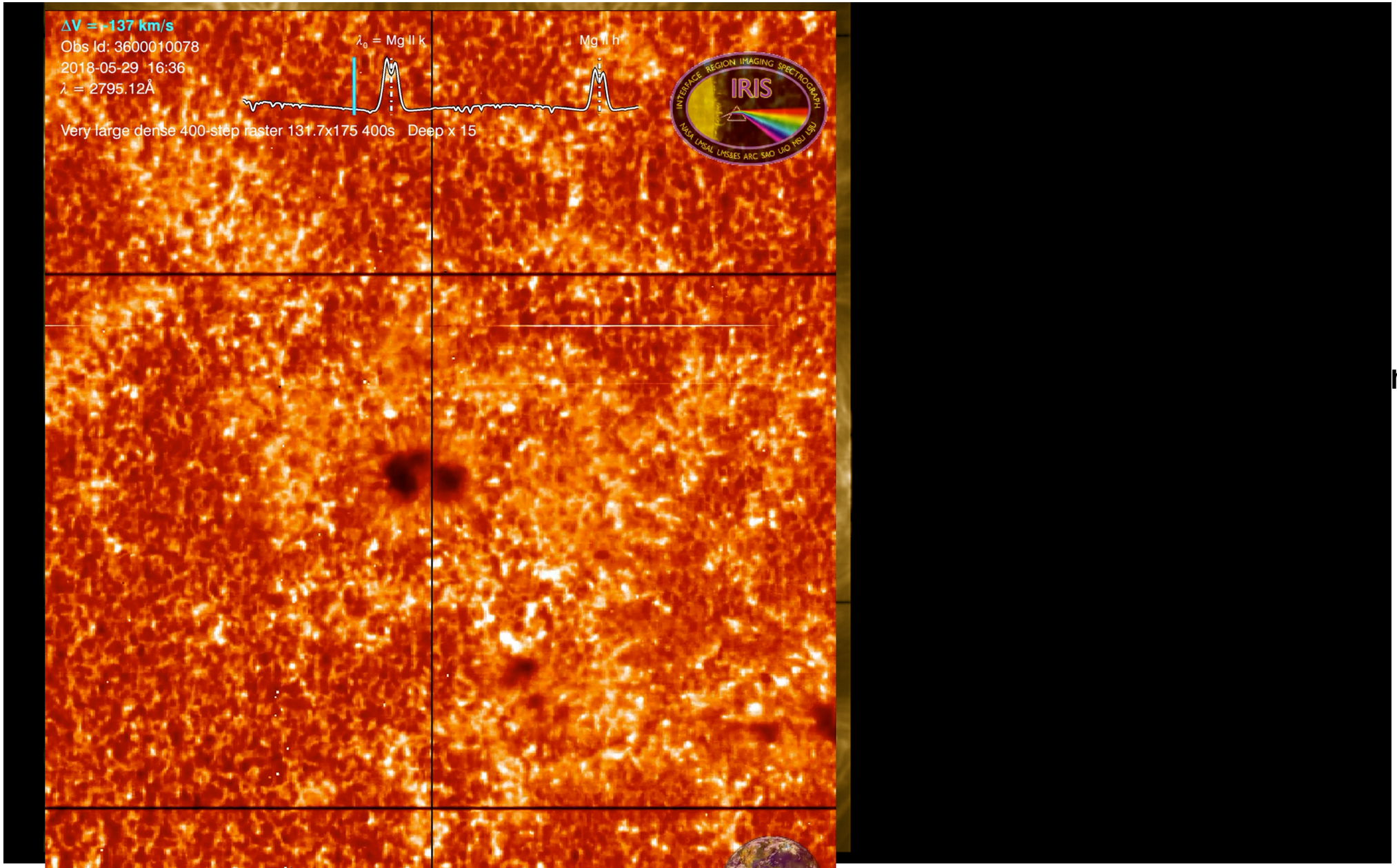
Does this connection hold on sub-arcsecond scales?

Hi-C 2.1 flight on 29-May-2018, coordinated with IRIS



First dataset at sub-arcsecond resolution from photosphere to corona

IRIS and HiC coordinated observations



upper
rphology

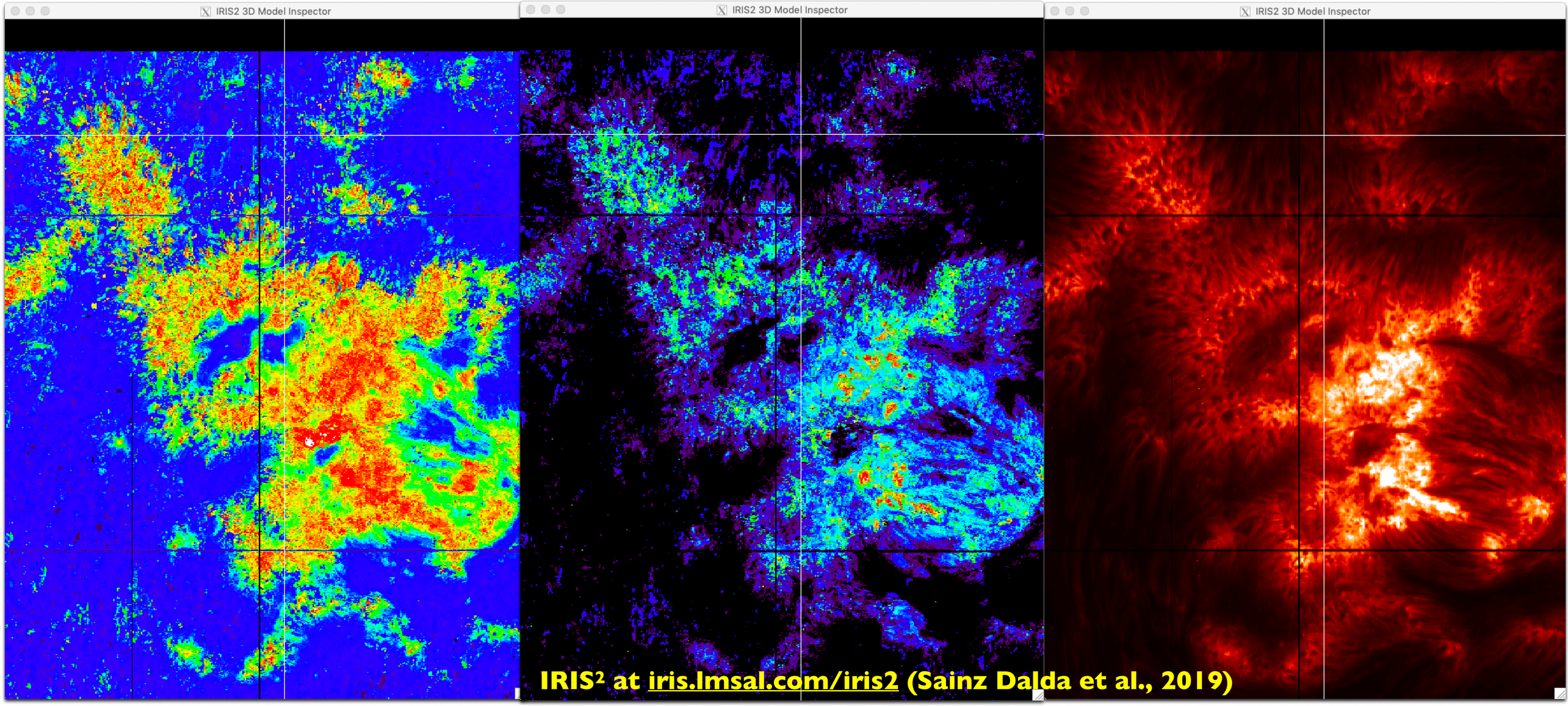
Moss occurs where Mg II k3 is bright

IRIS² diagnostics from context raster

Density at log τ =-4.0

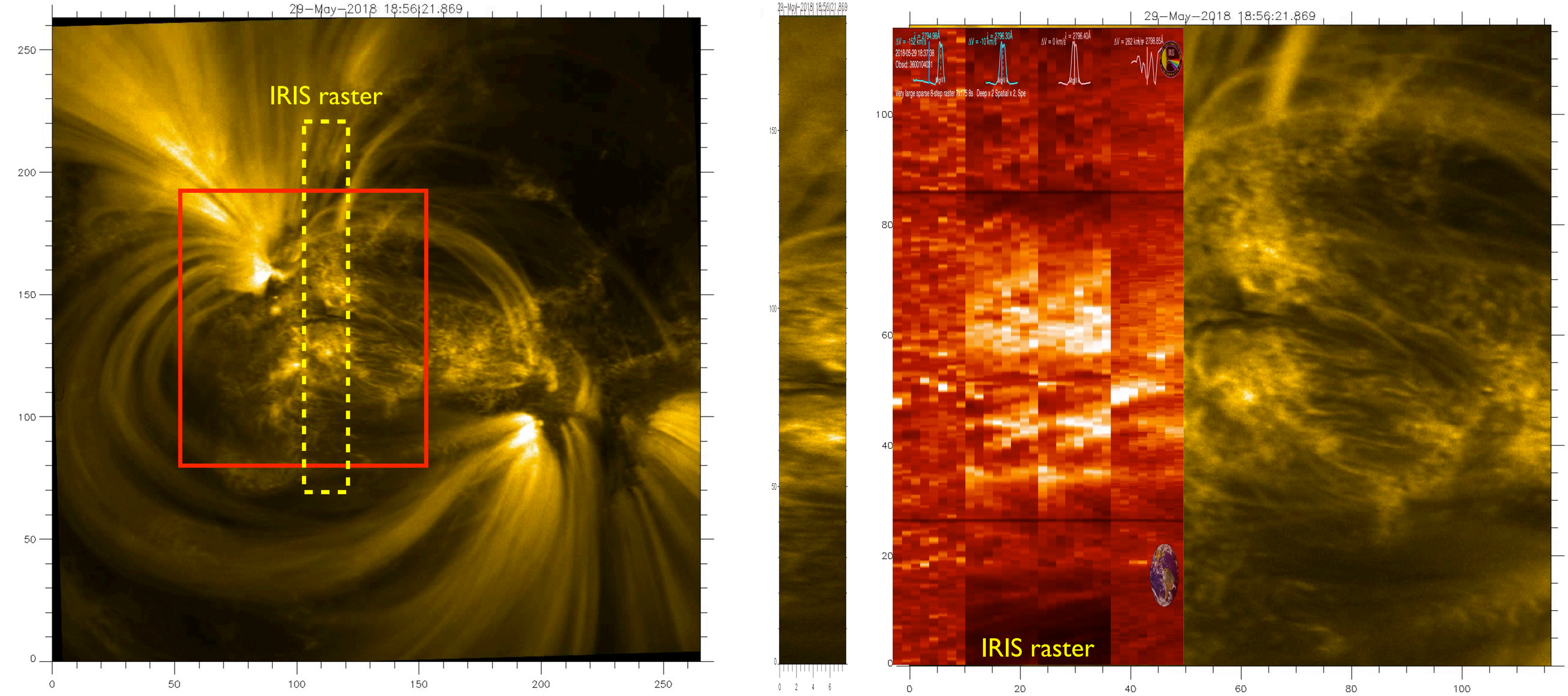
Density at log τ =-5.6

Mg II k3 intensity



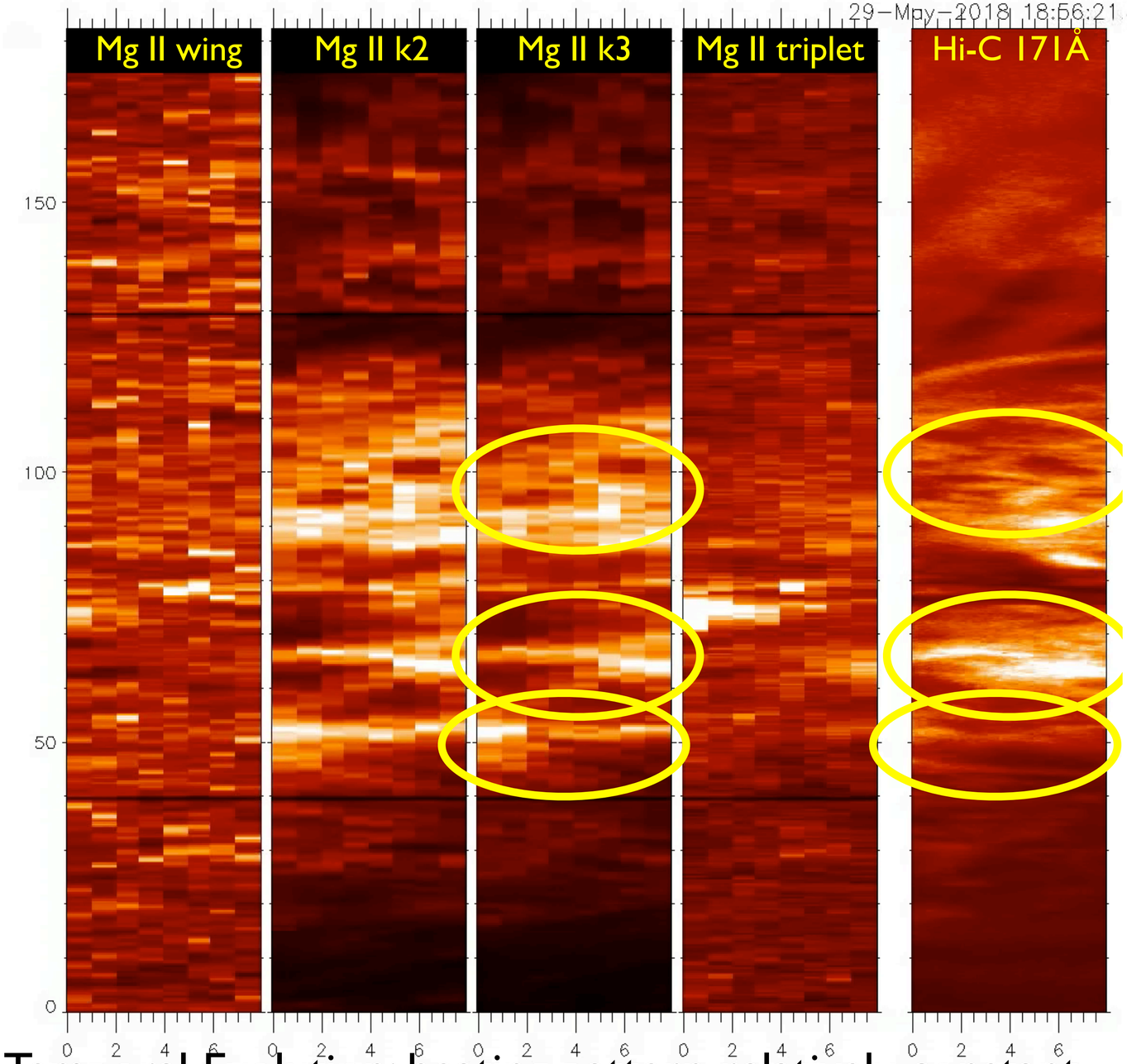
Bright regions in Mg II k3 (i.e., 171Å moss) show high density in middle to upper chromosphere

HiC timeseries

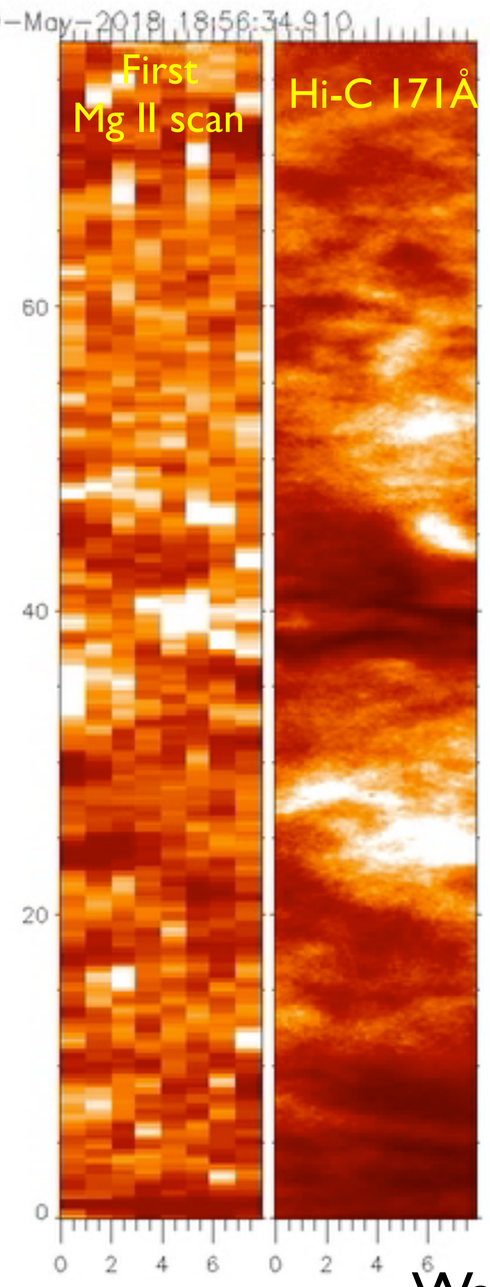


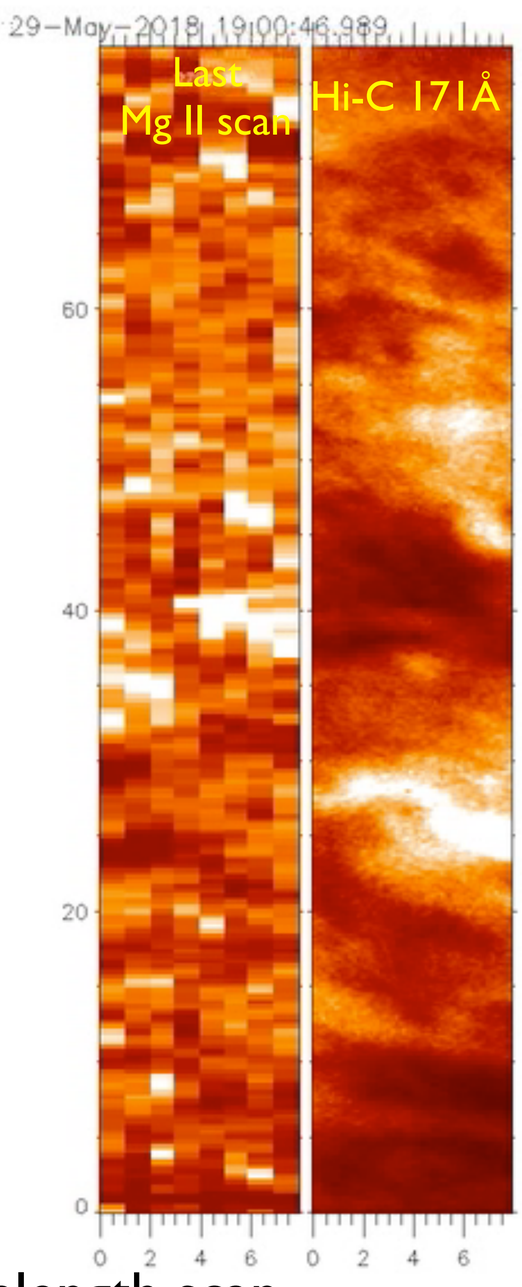
See talks by Tiwari, Panasar, etc.

Middle to upper chromosphere well correlated with moss brightness



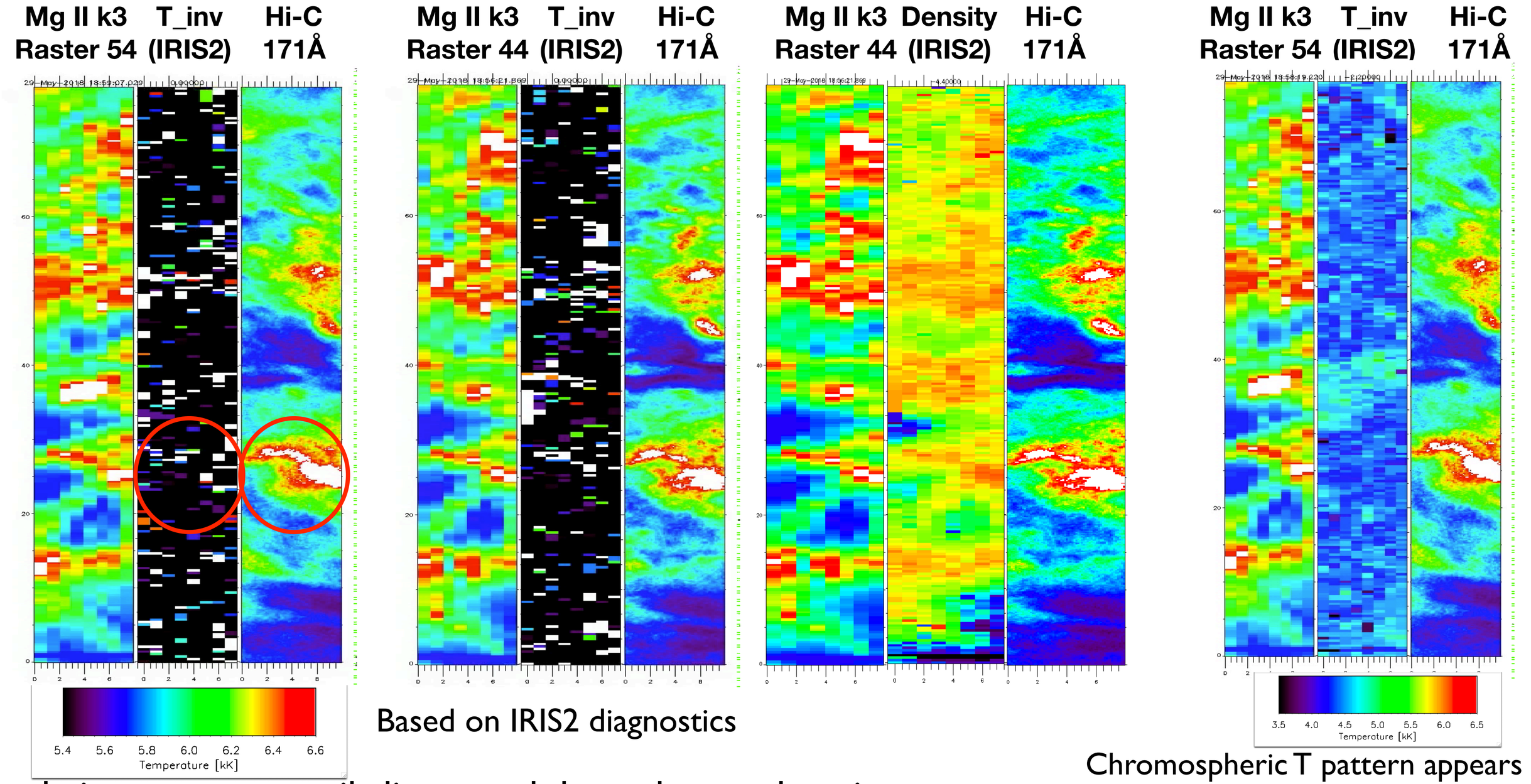
Temporal Evolution: heating pattern relatively constant





Wavelength scan

Moss brightness correlated with T and density in mid to upper chromosphere

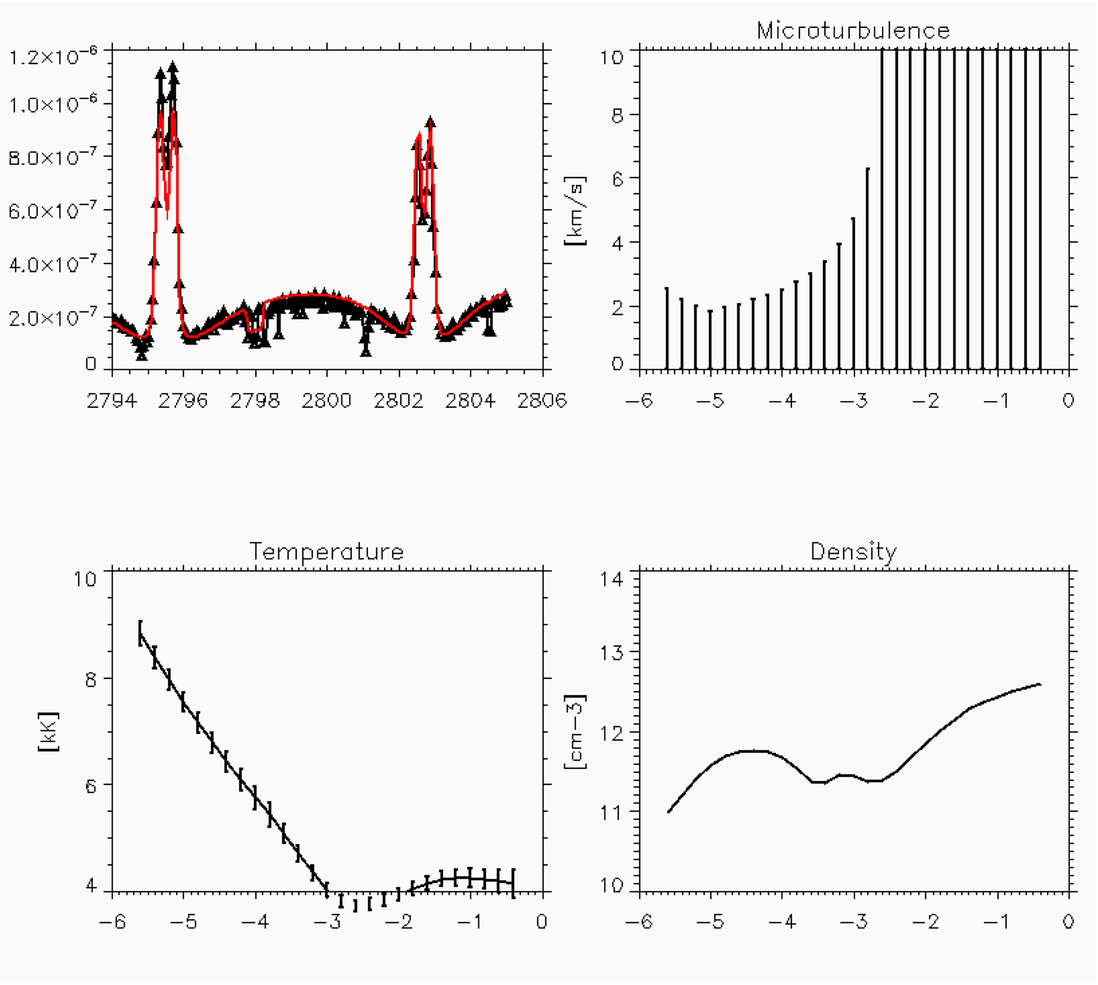


Based on IRIS2 diagnostics

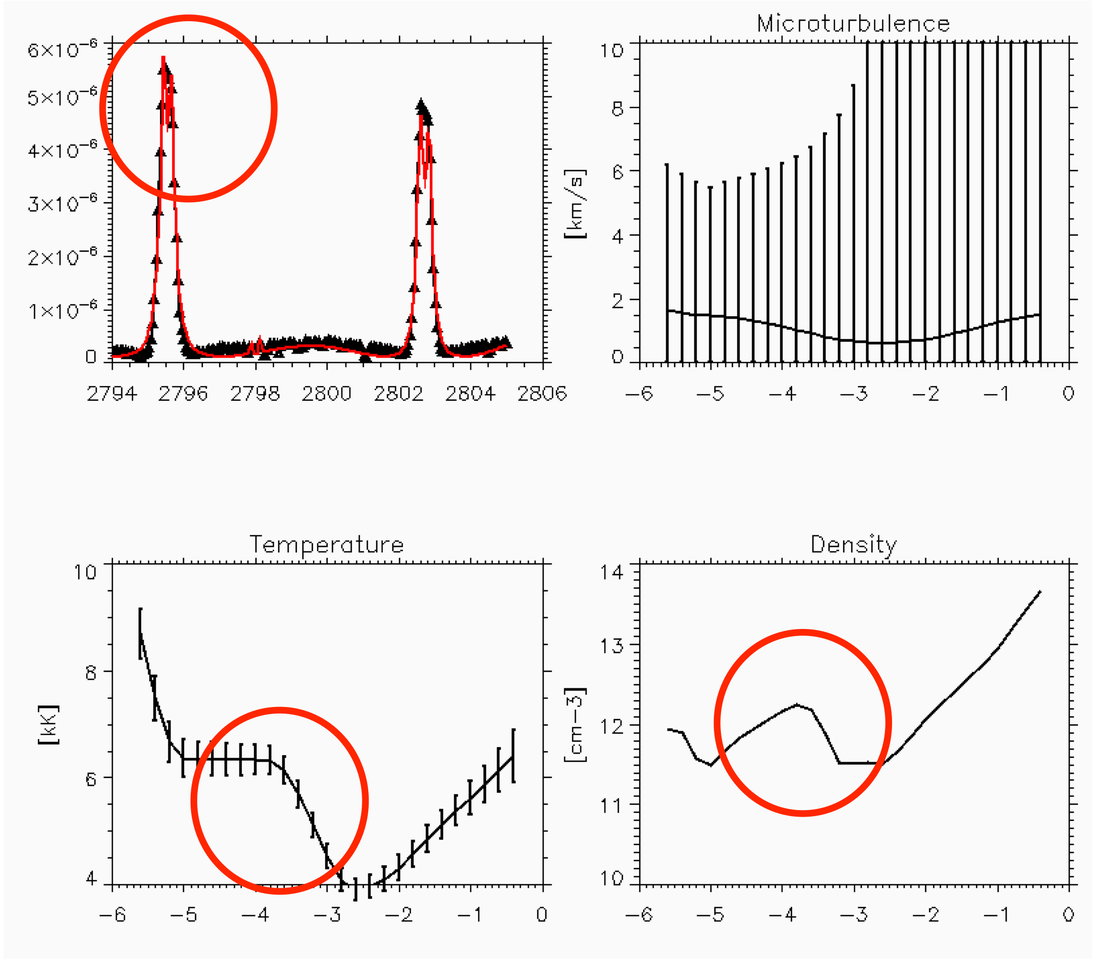
Correlation not necessarily linear, and dependent on location

Chromospheric T pattern appears suddenly, above T minimum

Inversions show dense, hot chromosphere below moss



Typical quiescent profile and inversion (IRIS2)

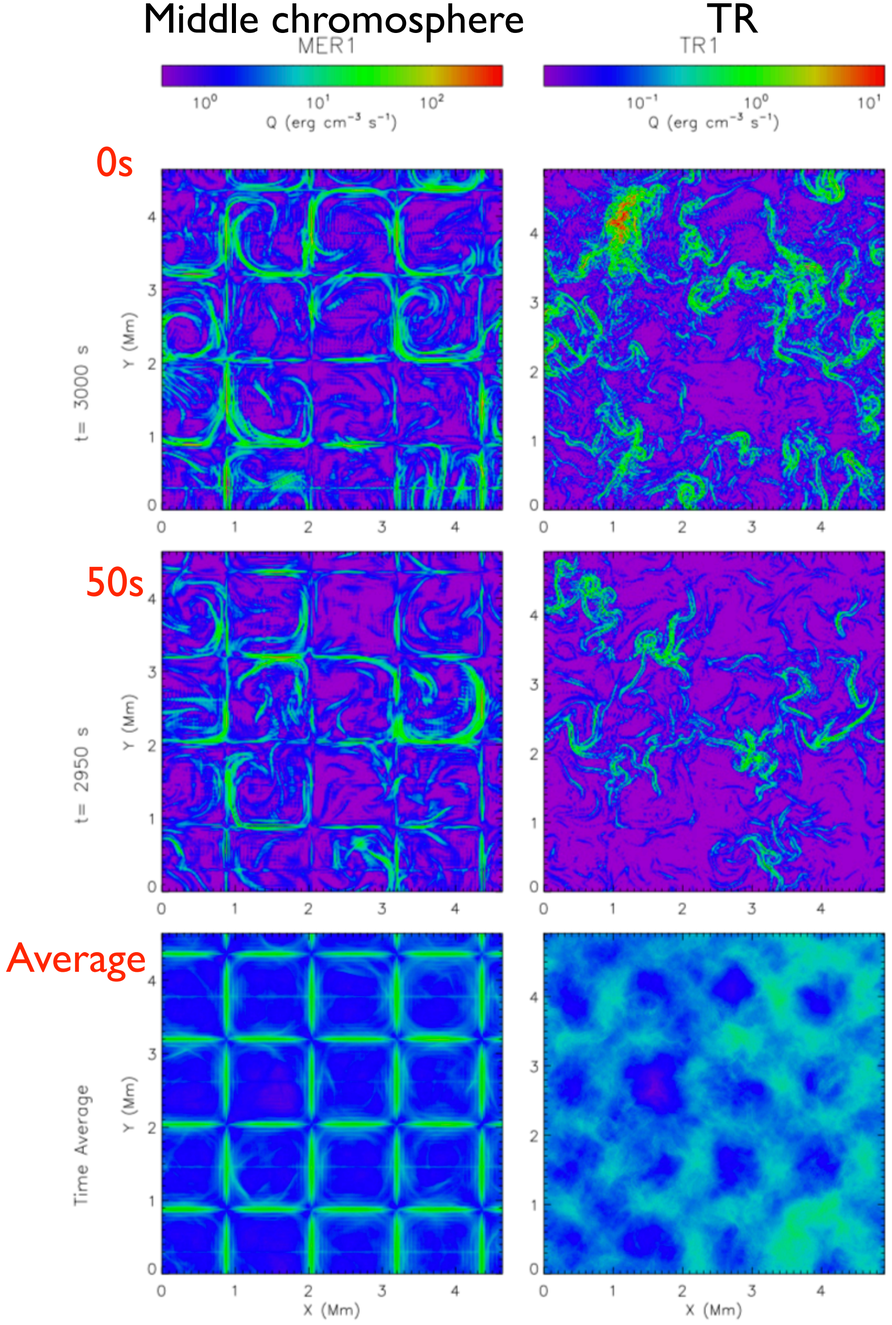


Typical moss/plage profile and inversion (IRIS2)

Note that there is a degeneracy between micro turbulence and temperature in the upper chromosphere (Joao's talk)

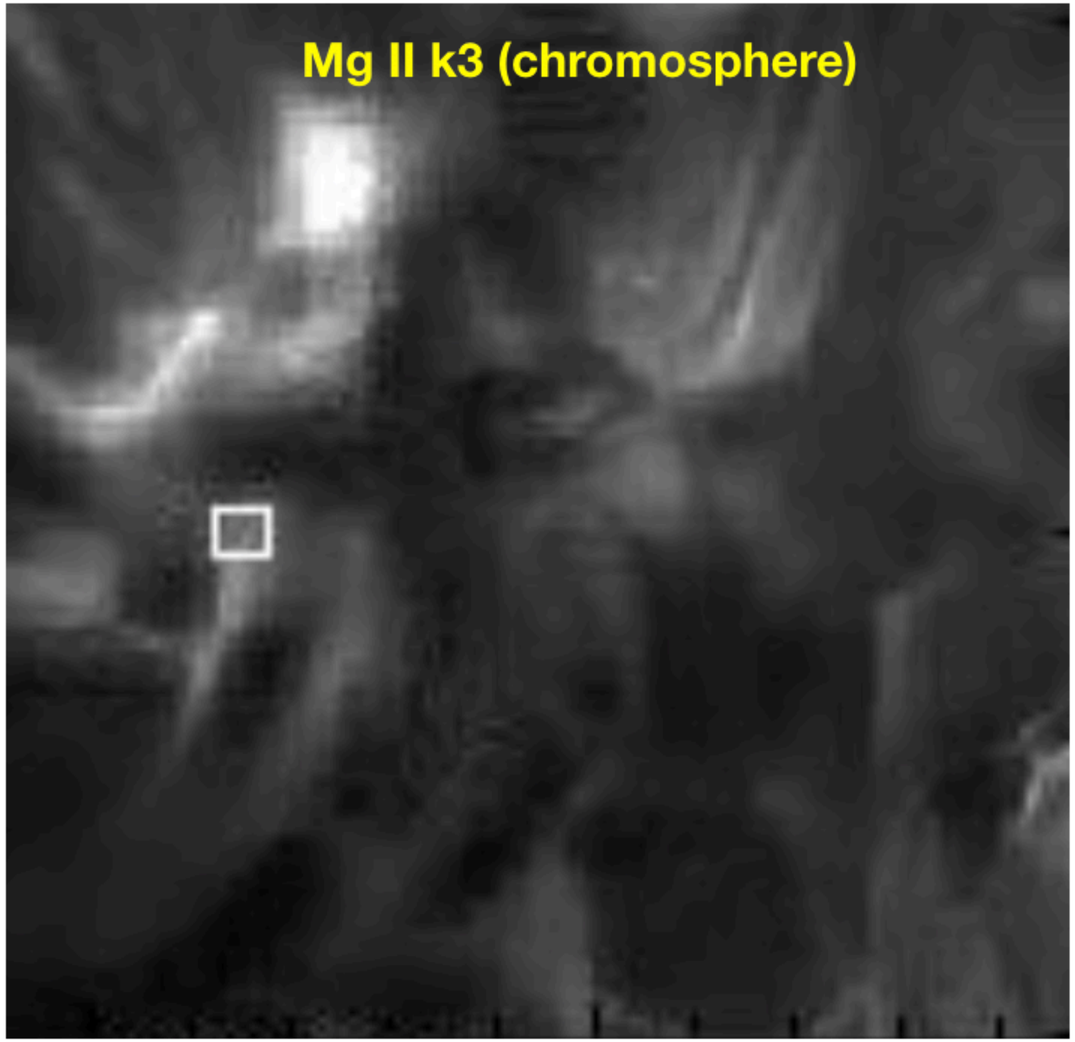
What does this tell us about heating in the solar atmosphere?

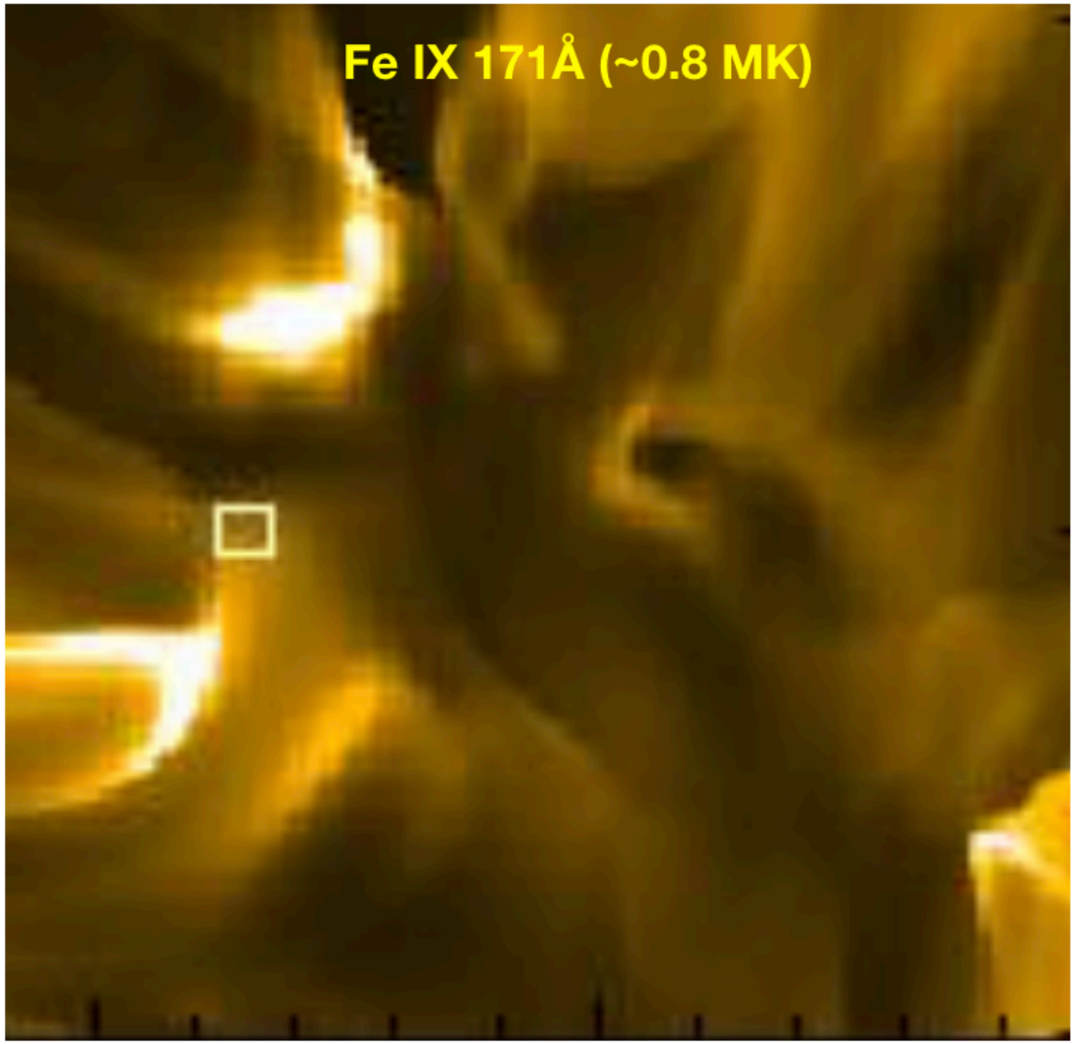
Moss observations less compatible with Alfven wave heating model



- Based on heating model from van Ballegooijen et al., 2018
- Predicts heating that is highly variable in time (because of high-frequency waves)
- Predicts less strong correlation between middle chromosphere and upper TR

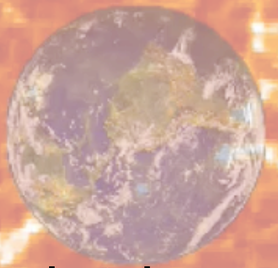
Moss observations more compatible with heating model based on braiding





Mg II k3 core maps show similar brightness patterns as 171Å at footpoints of hot loops,
with step-like (plage) temperature profile with height and single peaked Mg II profiles
Caused by current sheets that traverse chromosphere and low corona

Conclusions



HiC/IRIS observations show good correlation between:

- upper TR brightness (moss) and middle to upper chromospheric brightness (Mg II k)
- upper TR brightness (moss) and temperature/density enhancements in middle to upper chromosphere

Inversions and numerical modeling show for hot loop footpoints:

- Heating in chromosphere and corona in some locations well correlated
- Heating mechanism compatible with predictions from braiding model
- Not as compatible with Alfven wave heating?

Unresolved issues:

- How general are these results? Need for more statistics than a 5 min rocket flight
- Can we find evidence for temporal delays between chromospheric and coronal heating?
- Does the sun know how to heat the chromosphere without a hot corona?