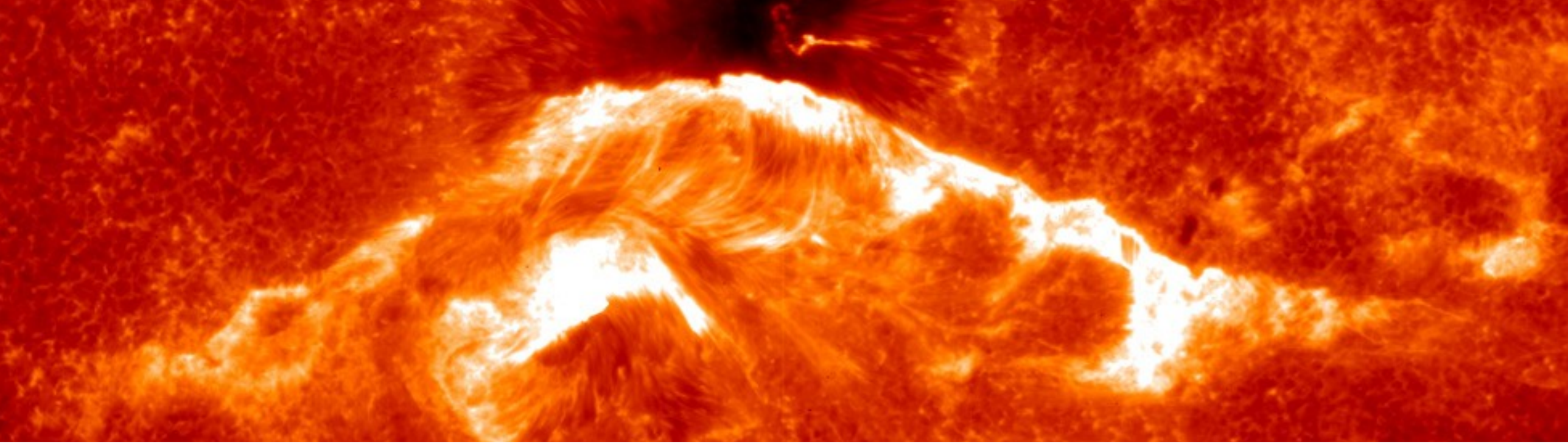
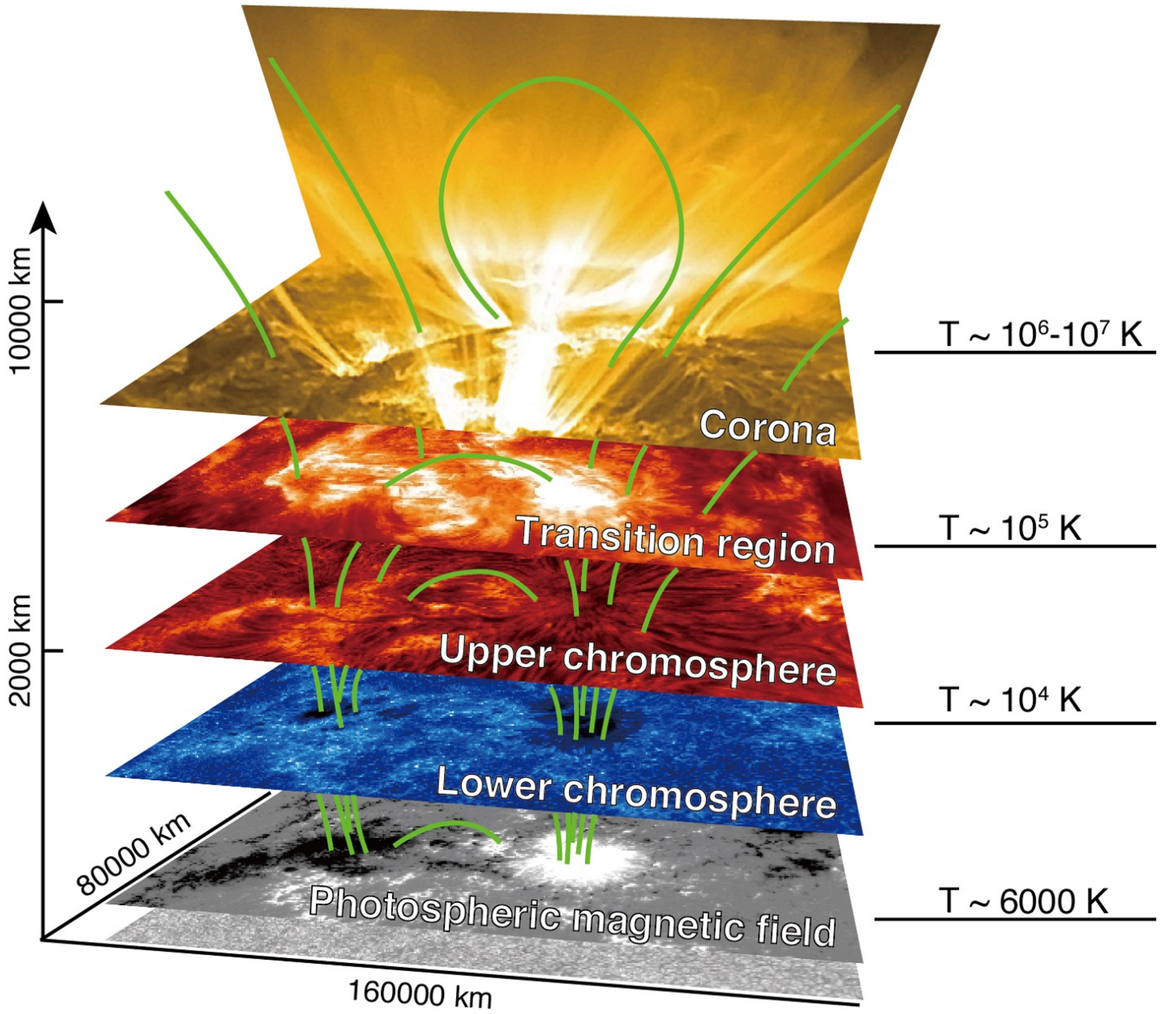


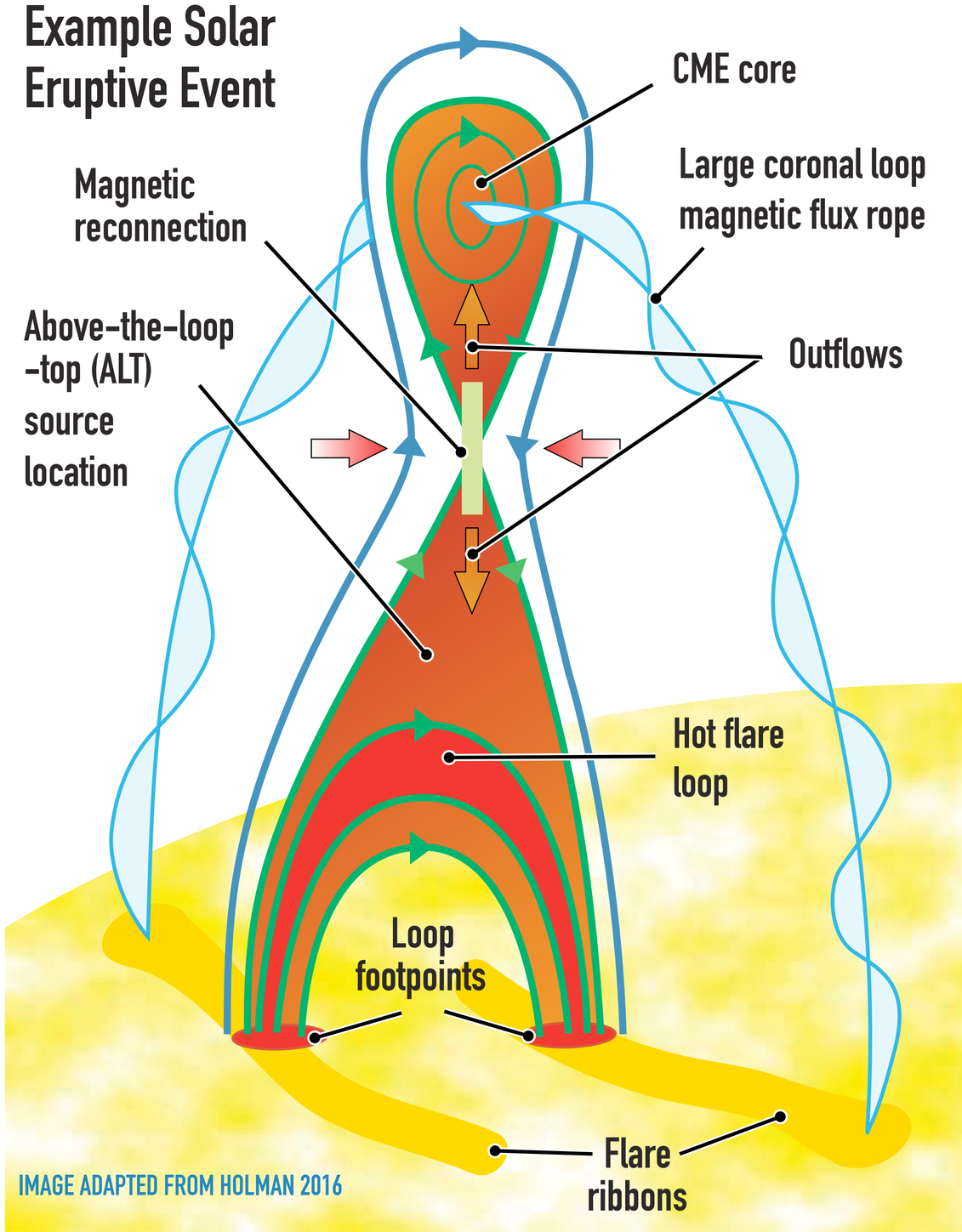
GRAHAM KERR (NASA/GSFC & CUA)

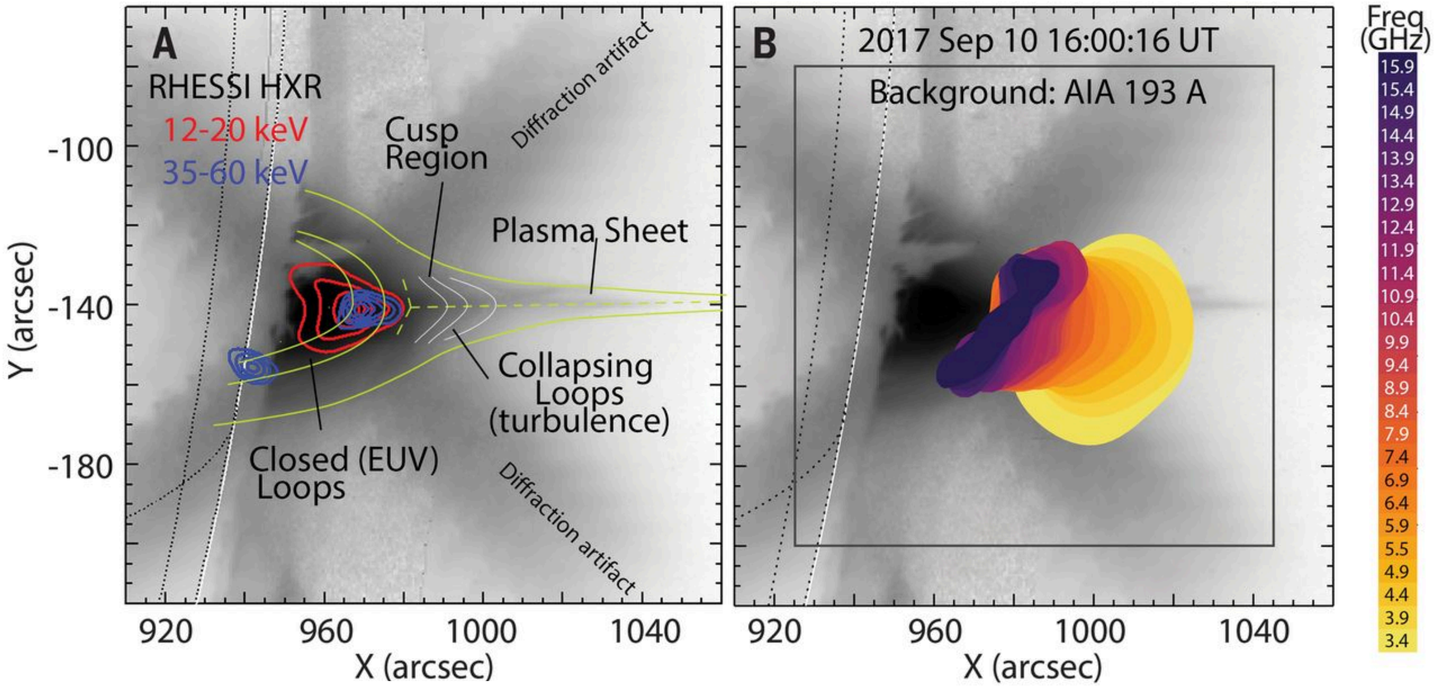
THE OPTICALLY THIN FLARING CHROMOSPHERE:

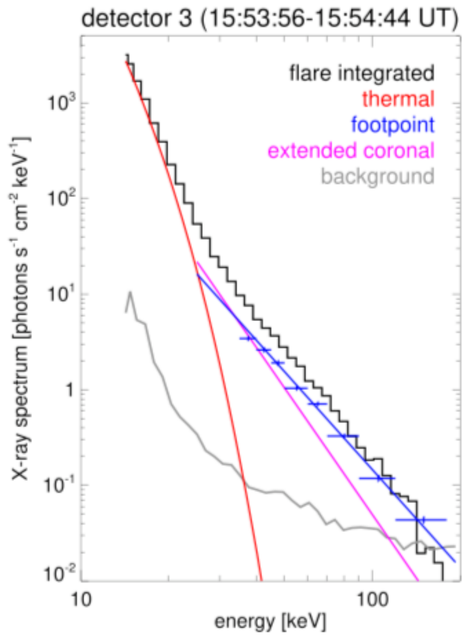
NONTHERMAL LINE WIDTHS FROM A CHROMOSPHERIC CONDENSATION

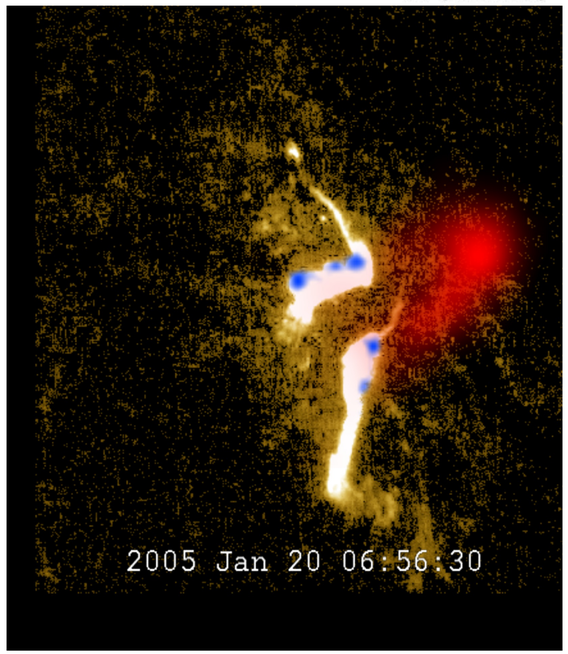
SOLAR FLARES



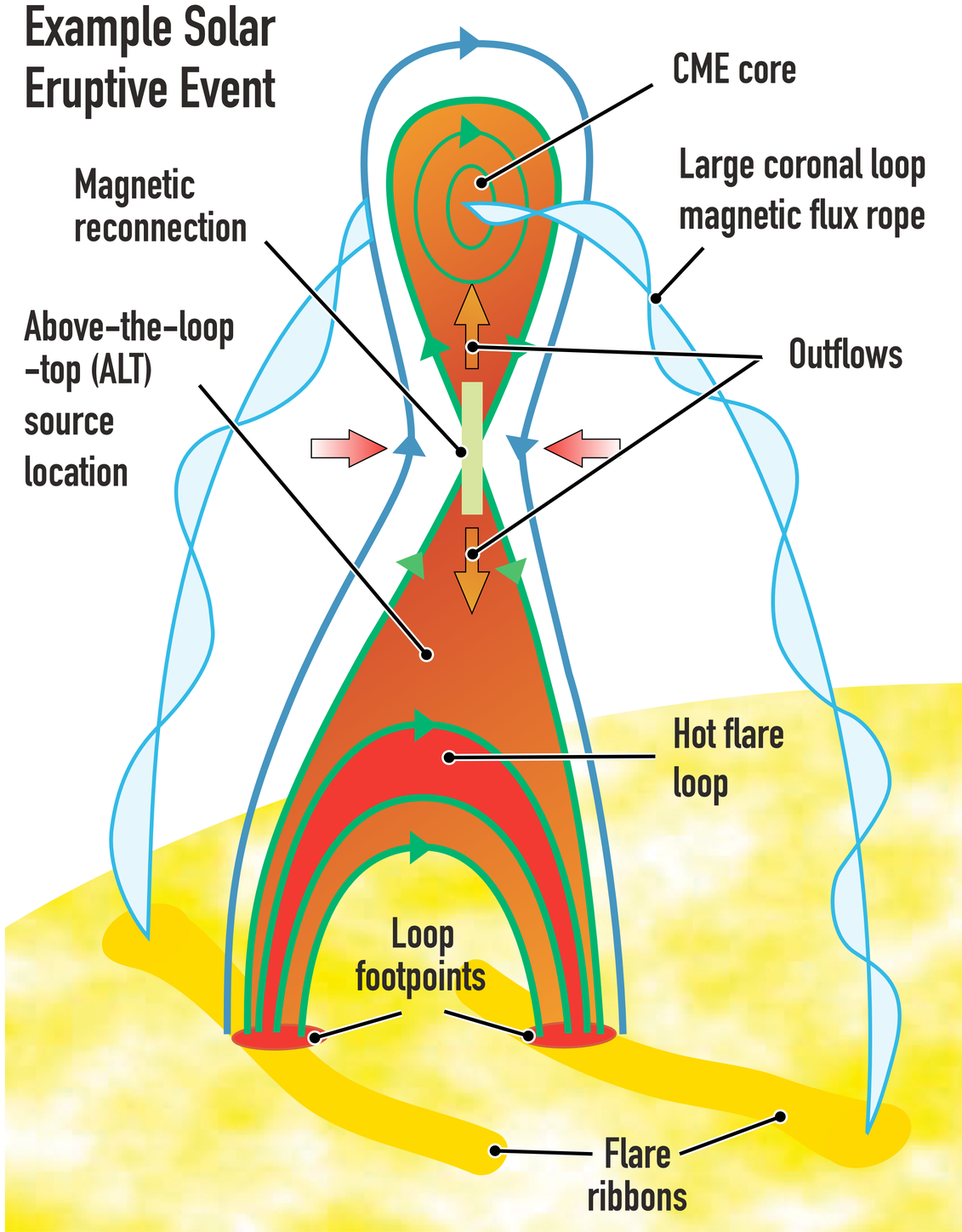








X-ray obs can be used to derive non-thermal electron distributions, which are then used to drive flare models.



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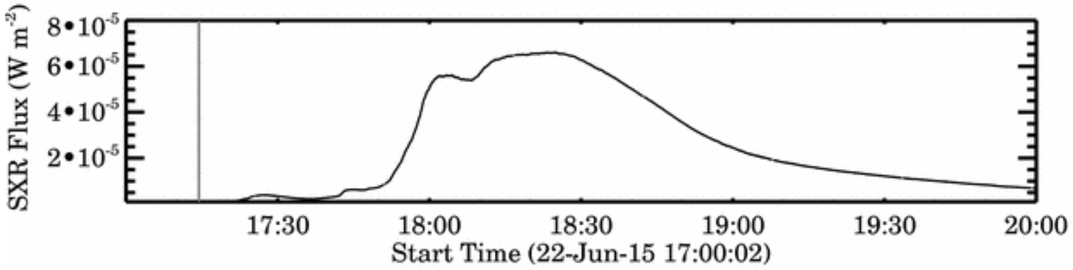
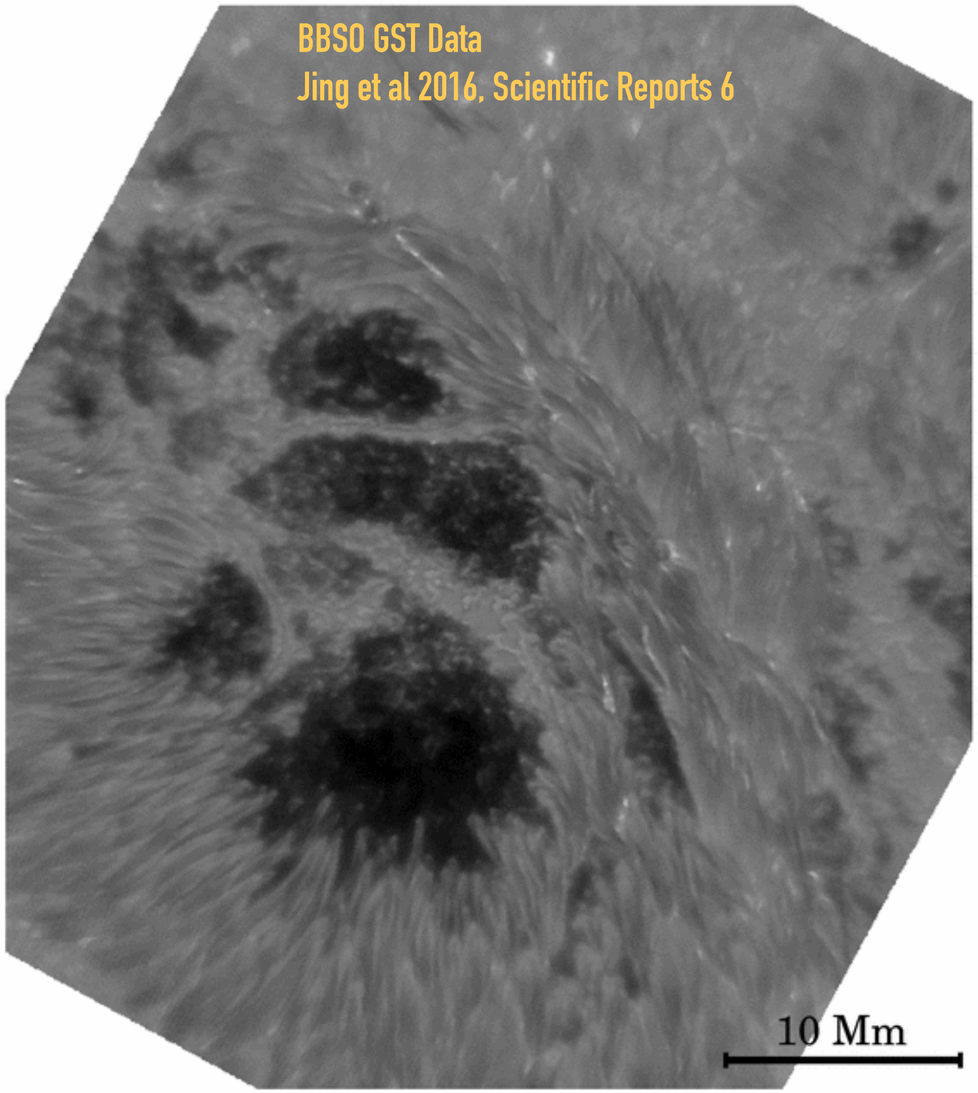
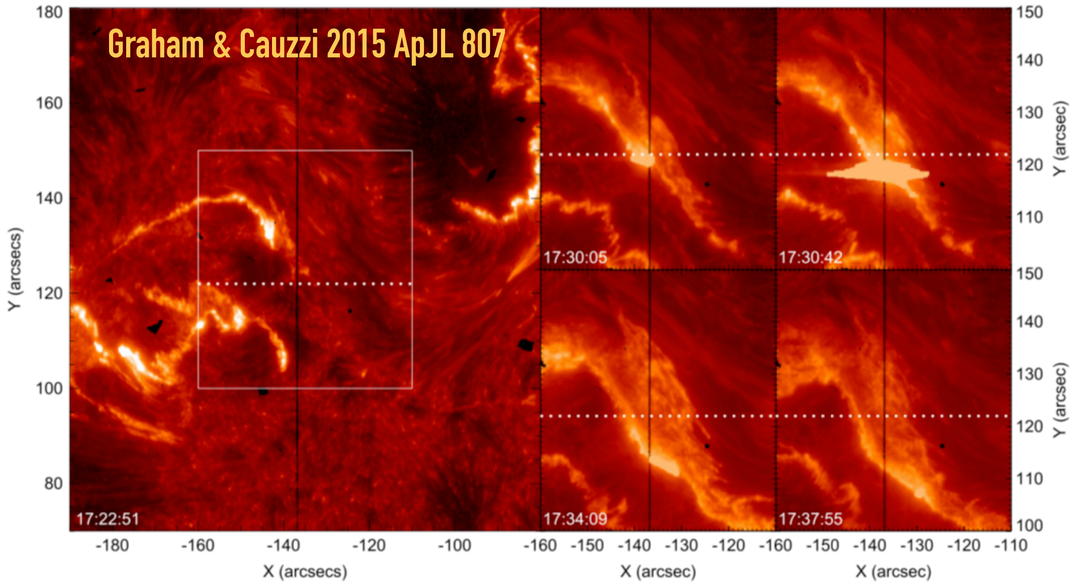
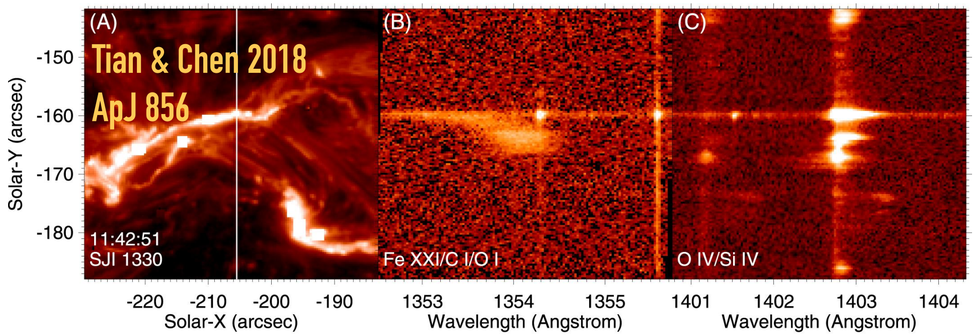
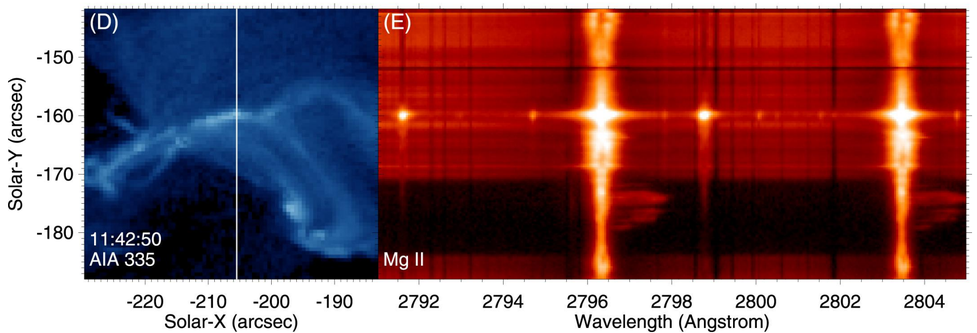






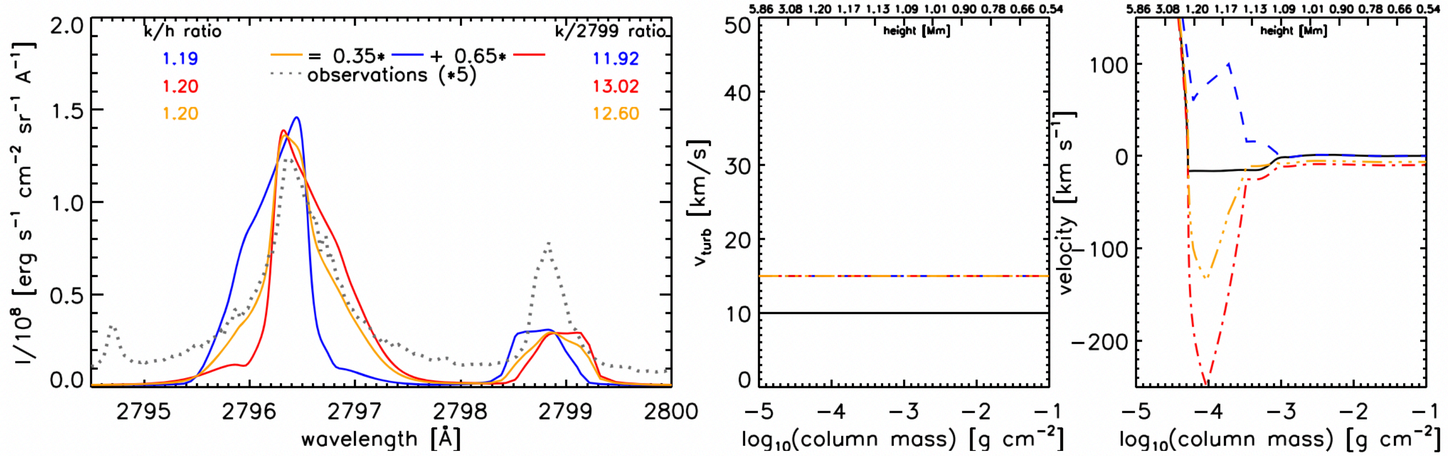




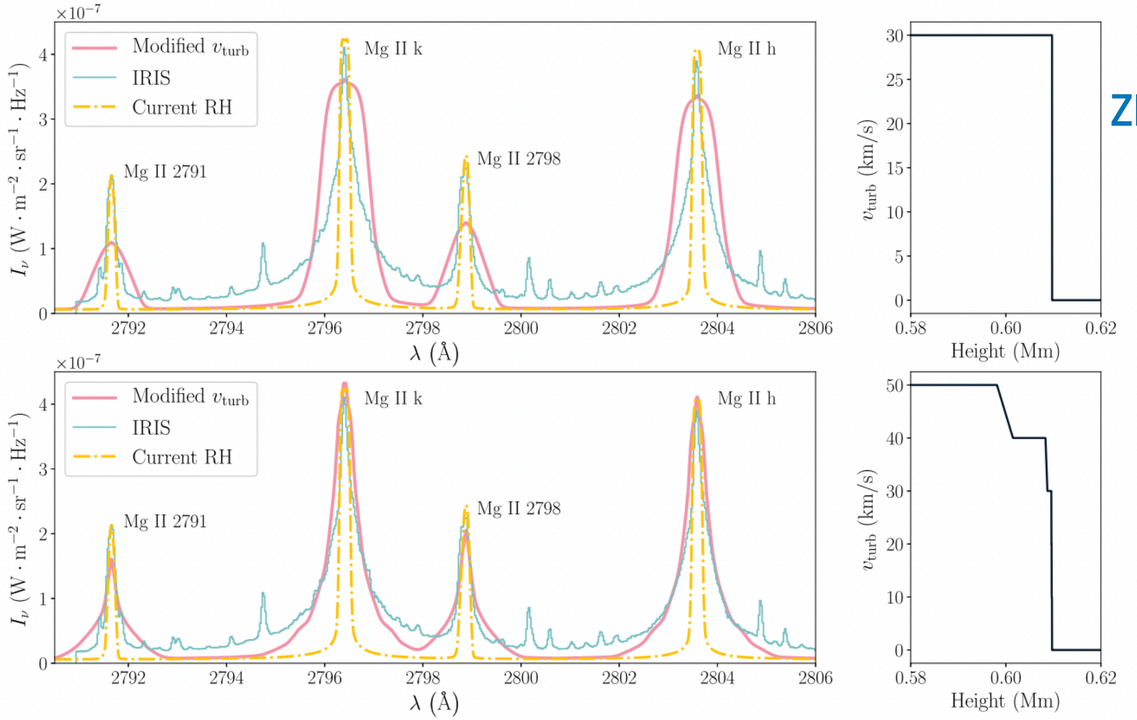
LINE WIDTHS ARE A PERENNIAL MODEL-DATA ISSUE

- Chromospheric and transition region lines are much broader in observations, than those forward modelled in flare simulations.
- Resolutions typical include exploring:
  - Extreme bi-directional flows (any evidence?).
  - Large amounts of microturbulent broadening, in the chromosphere, up to 30-50 km/s (any evidence?).
  - … other?

Rubio da Costa & Kleint 2017



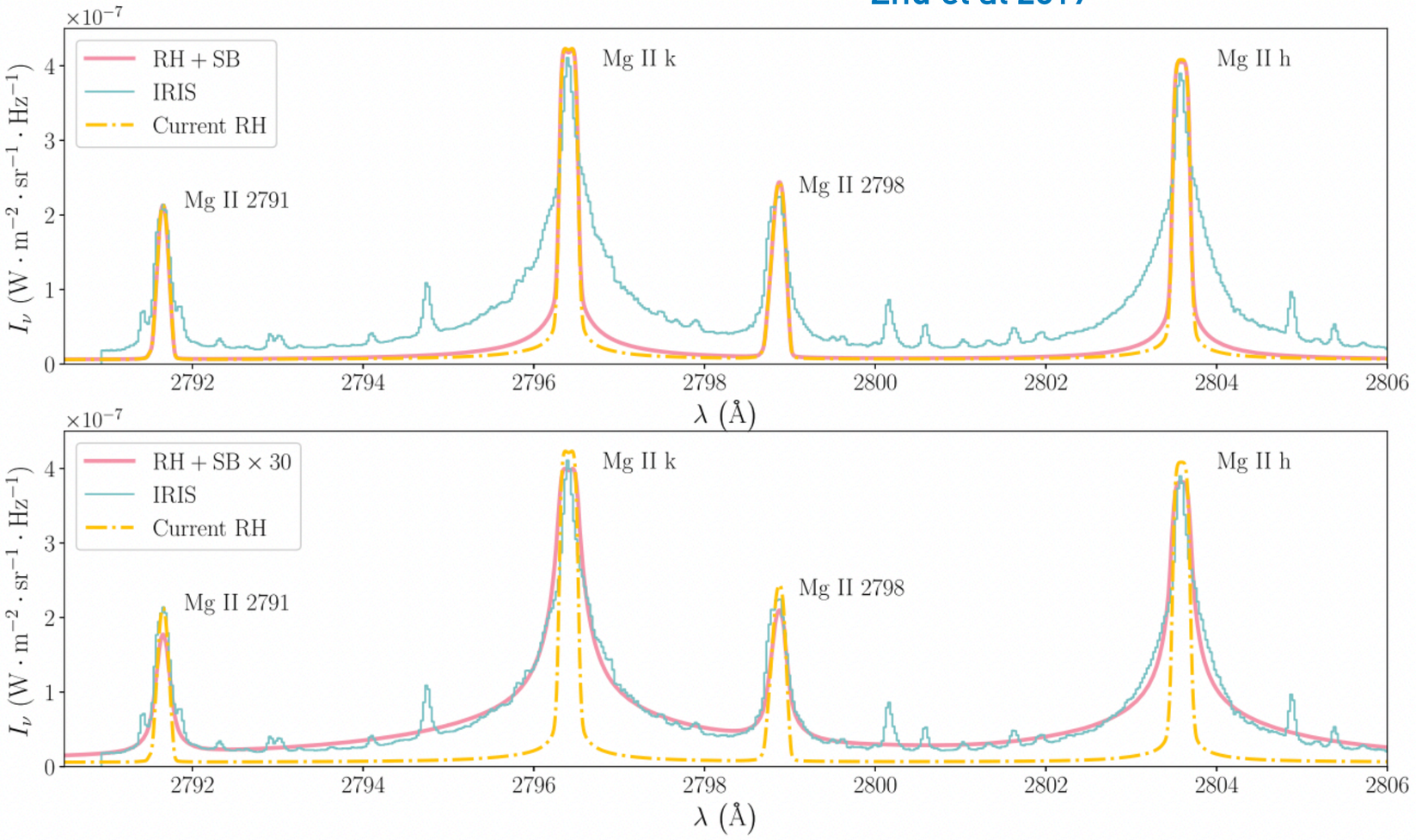
Zhu et al 2019



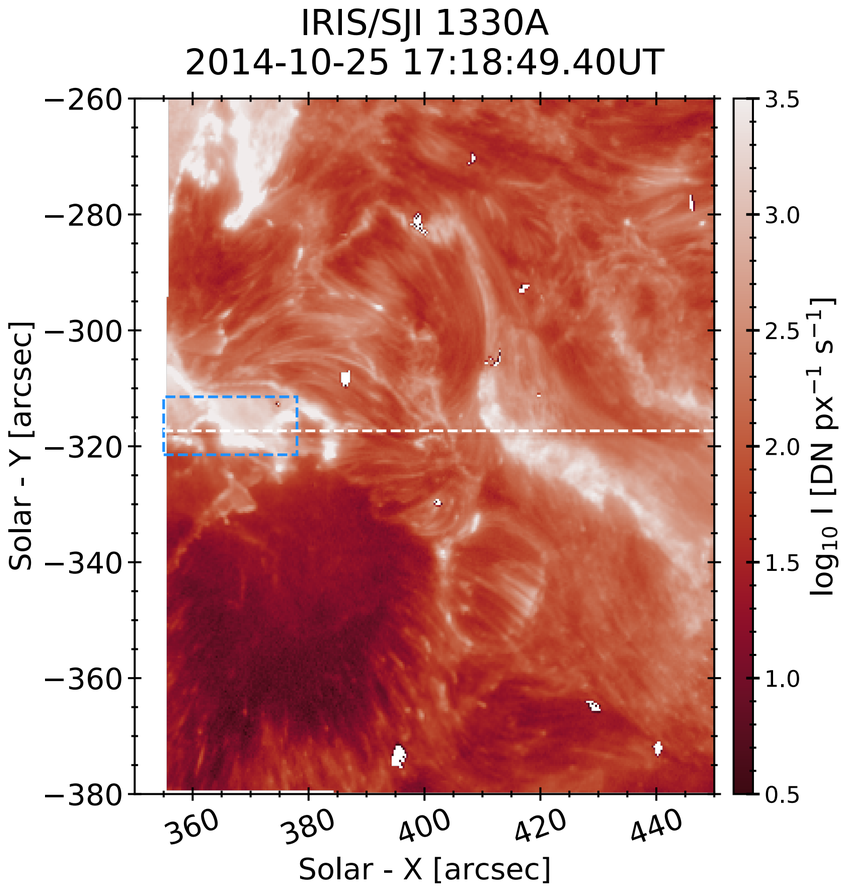
LINE WIDTHS ARE A PERENNIAL MODEL-DATA ISSUE

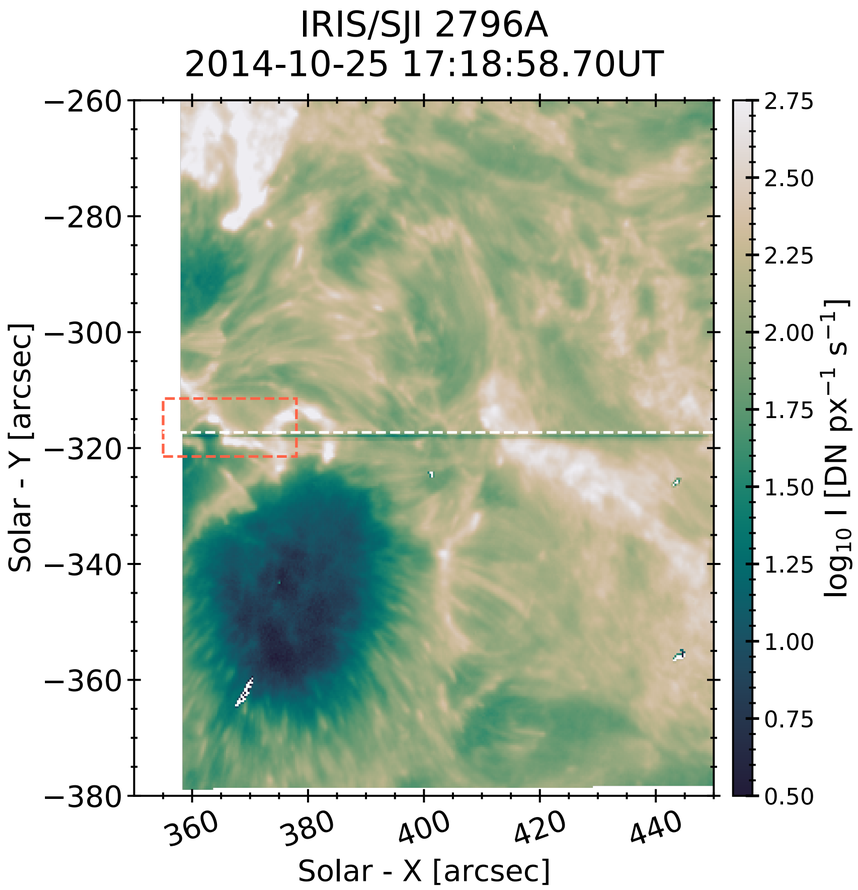
- Improved the treatment of Stark broadening for Mg II, using the STARK-B database broadens the lines but still not enough –another factor of 30x was needed!
- One possibility is that we are not heating the lower atmosphere sufficiently.

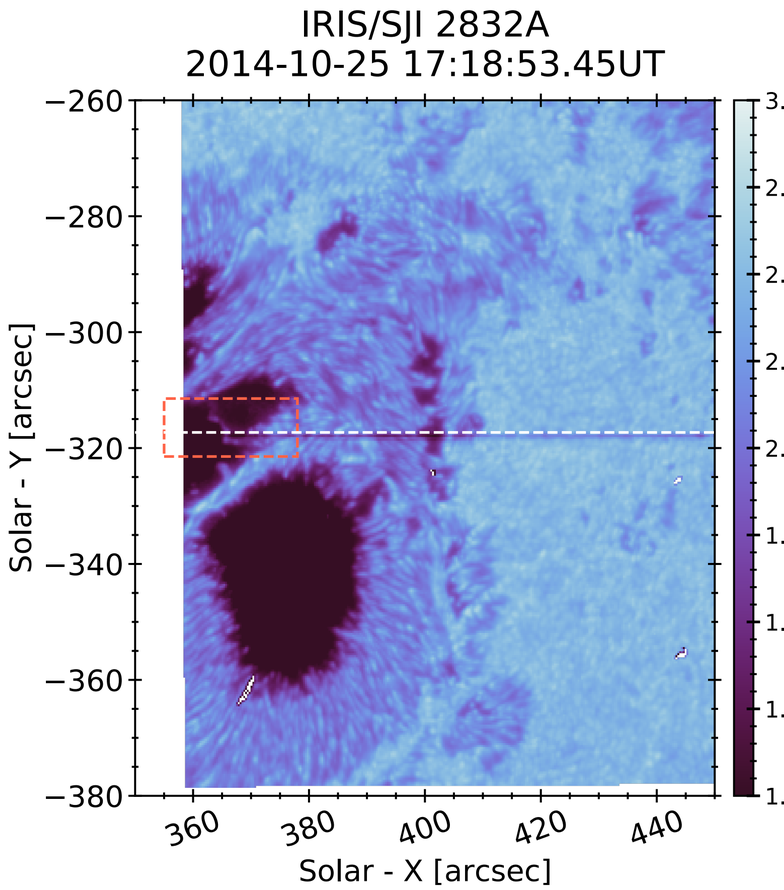
Zhu et al 2019



WHAT IS OBSERVED V_{TURB} IN THE 2014-OCTOBER-25 X1 CLASS FLARE?







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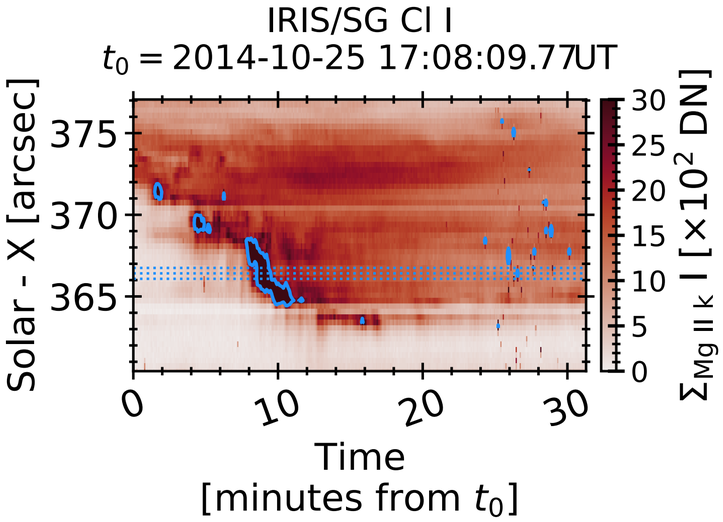
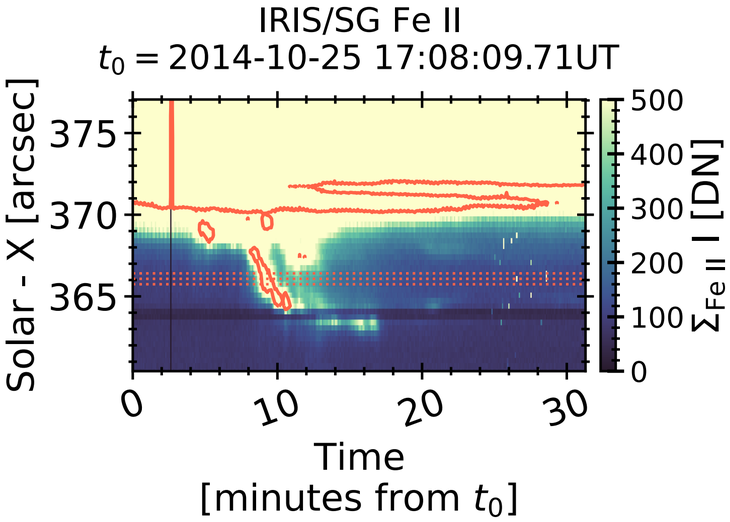
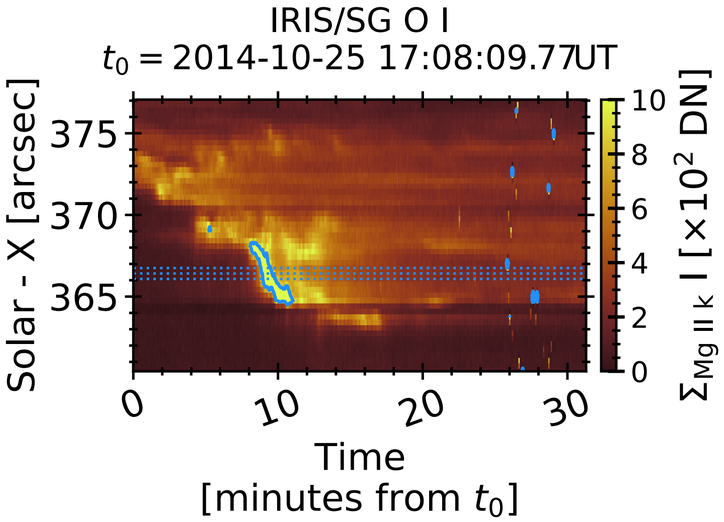
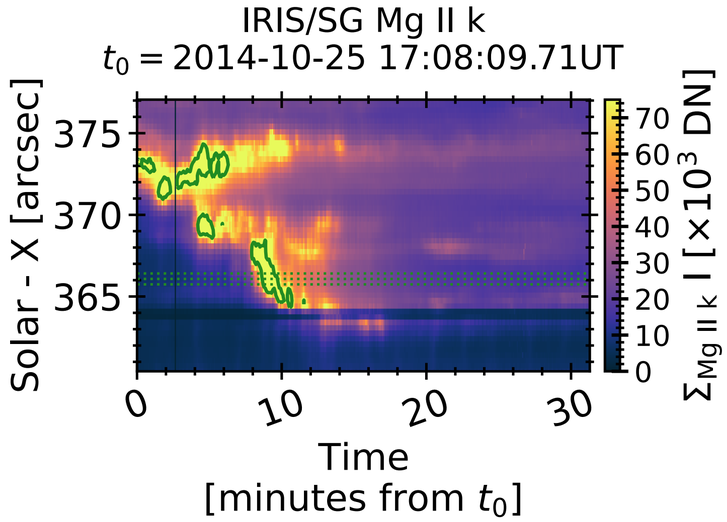
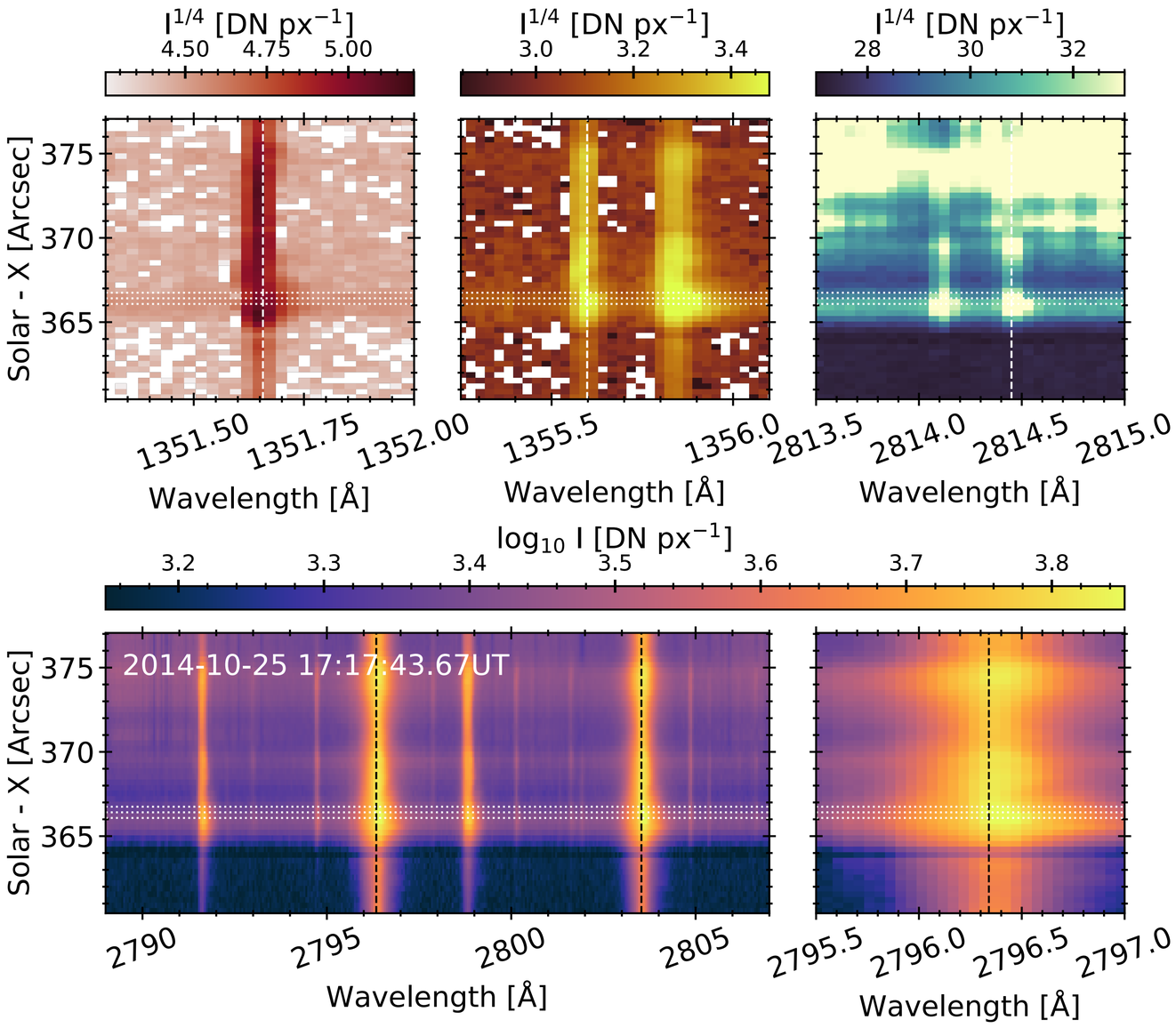


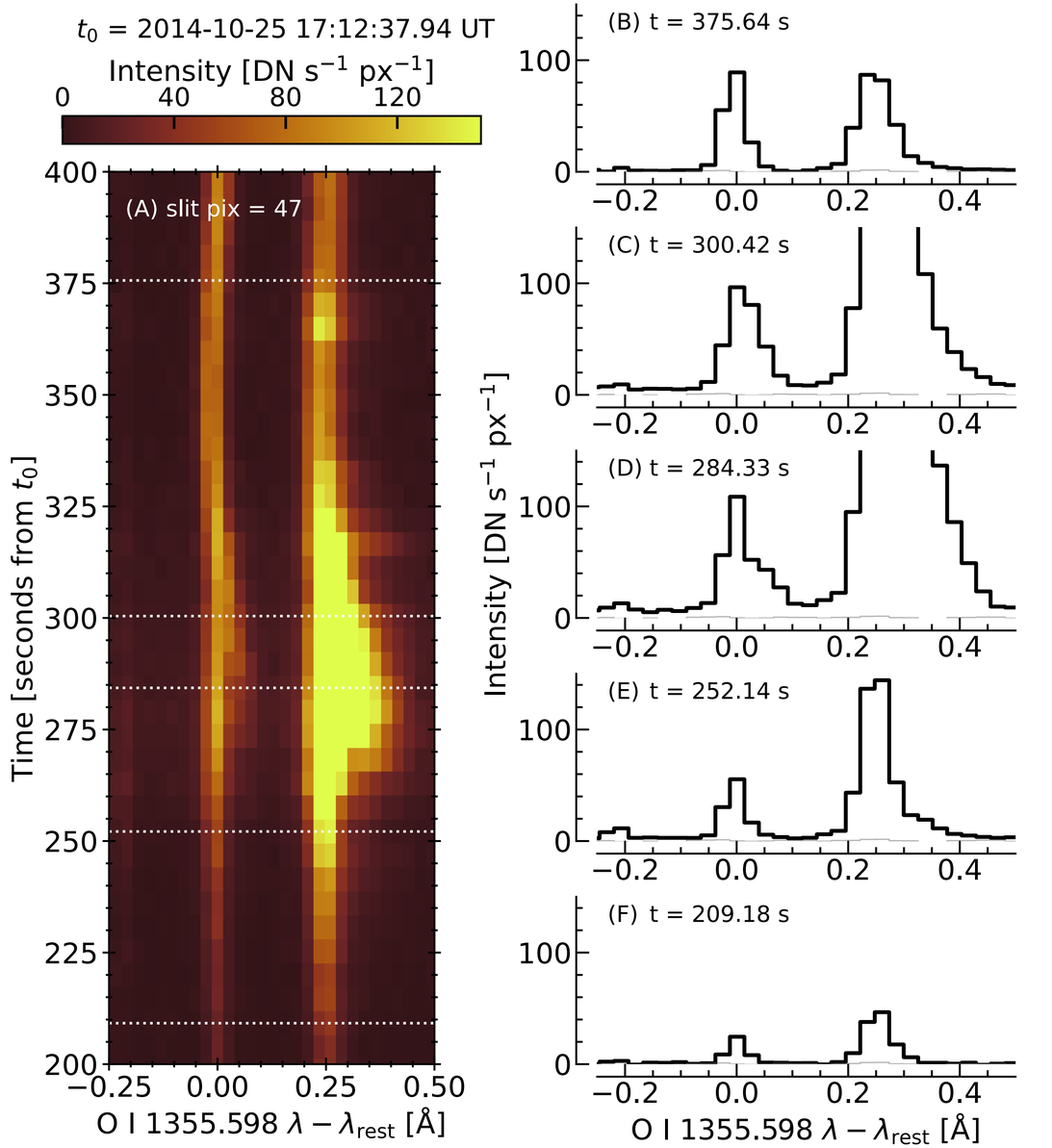




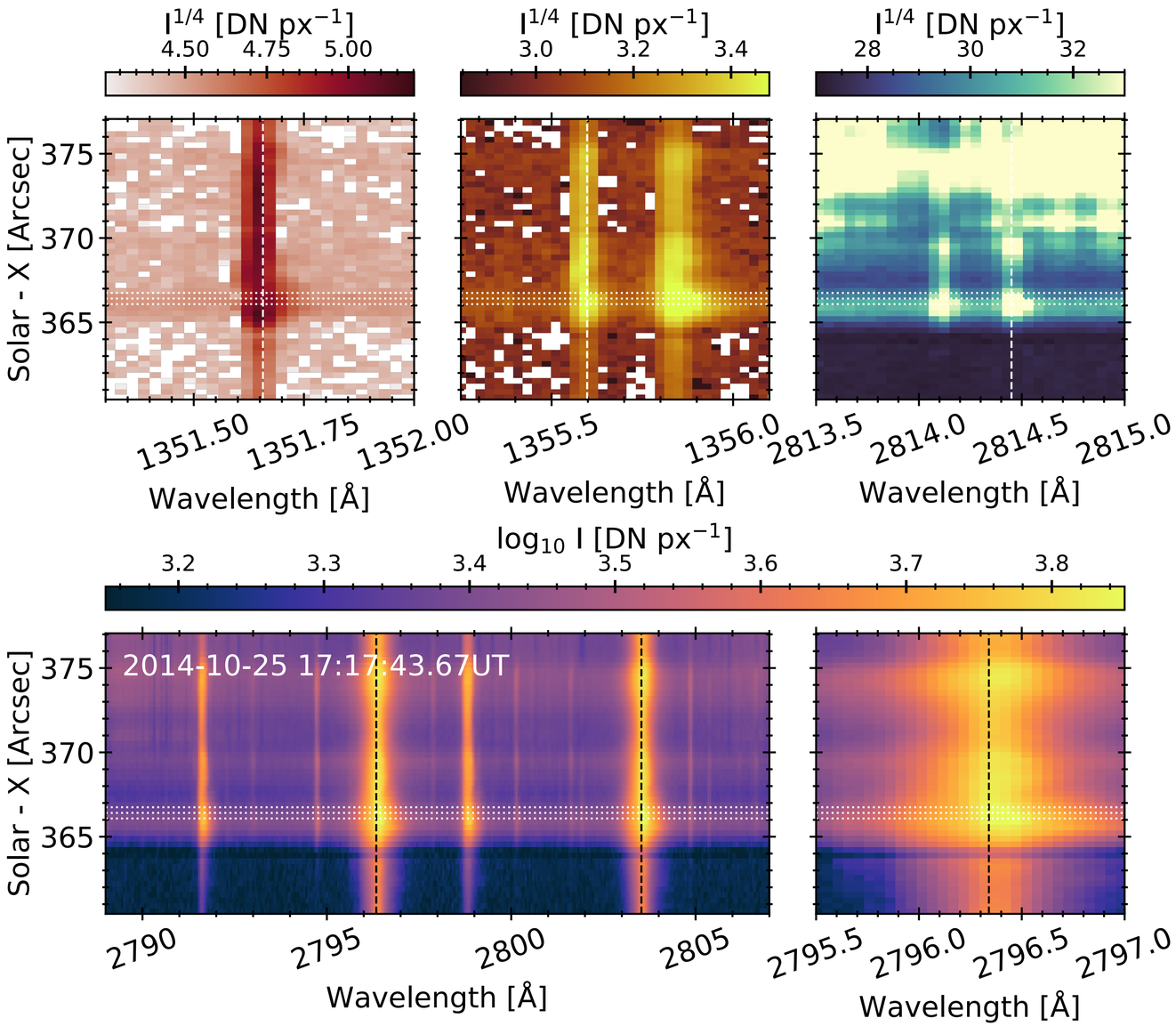


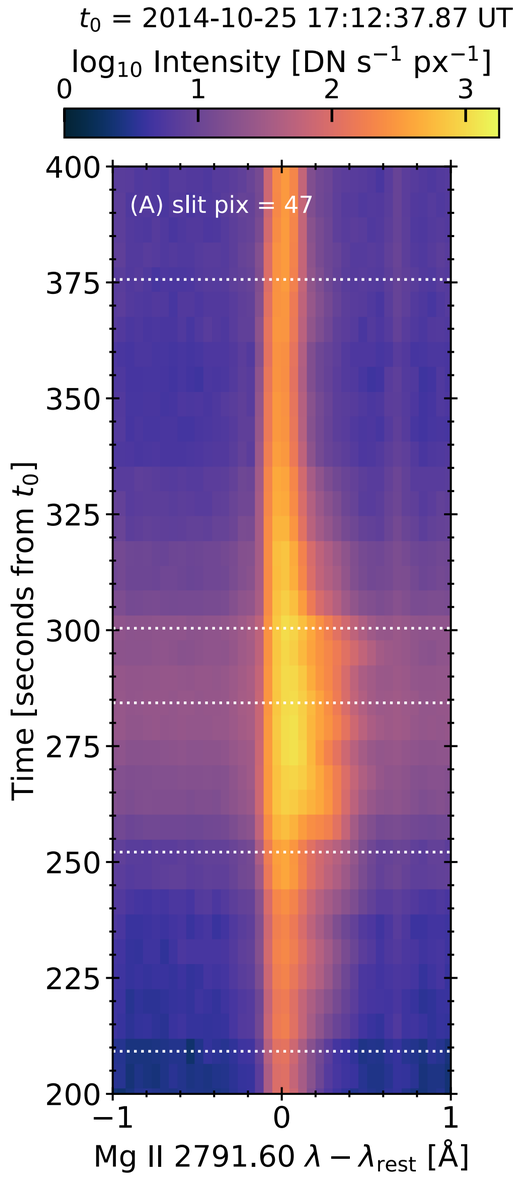
2014-OCTOBER-25 X1 CLASS FLARE

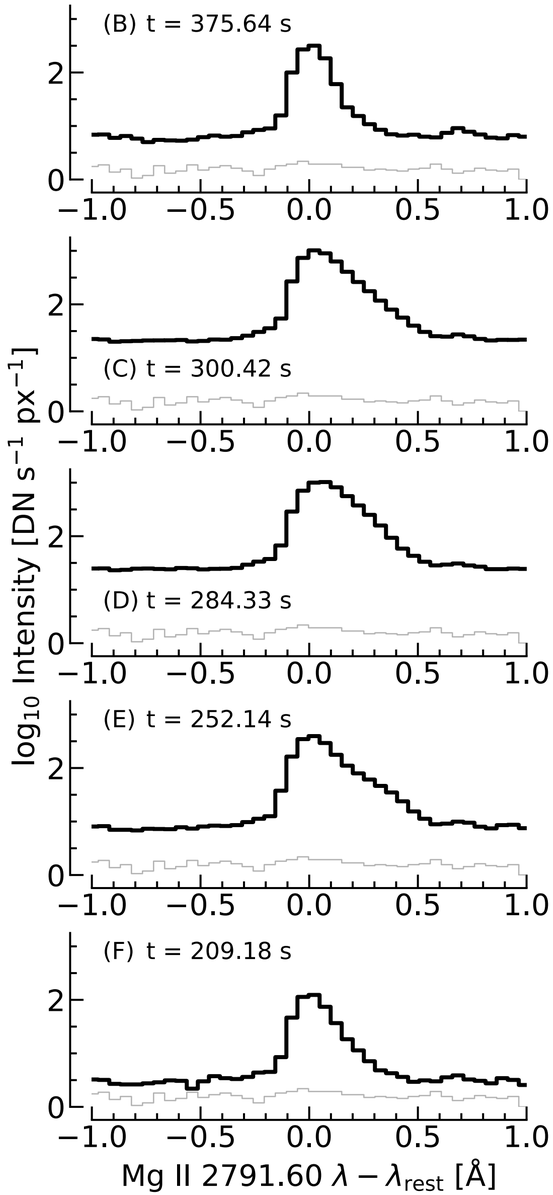




2014-OCTOBER-25 X1 CLASS FLARE







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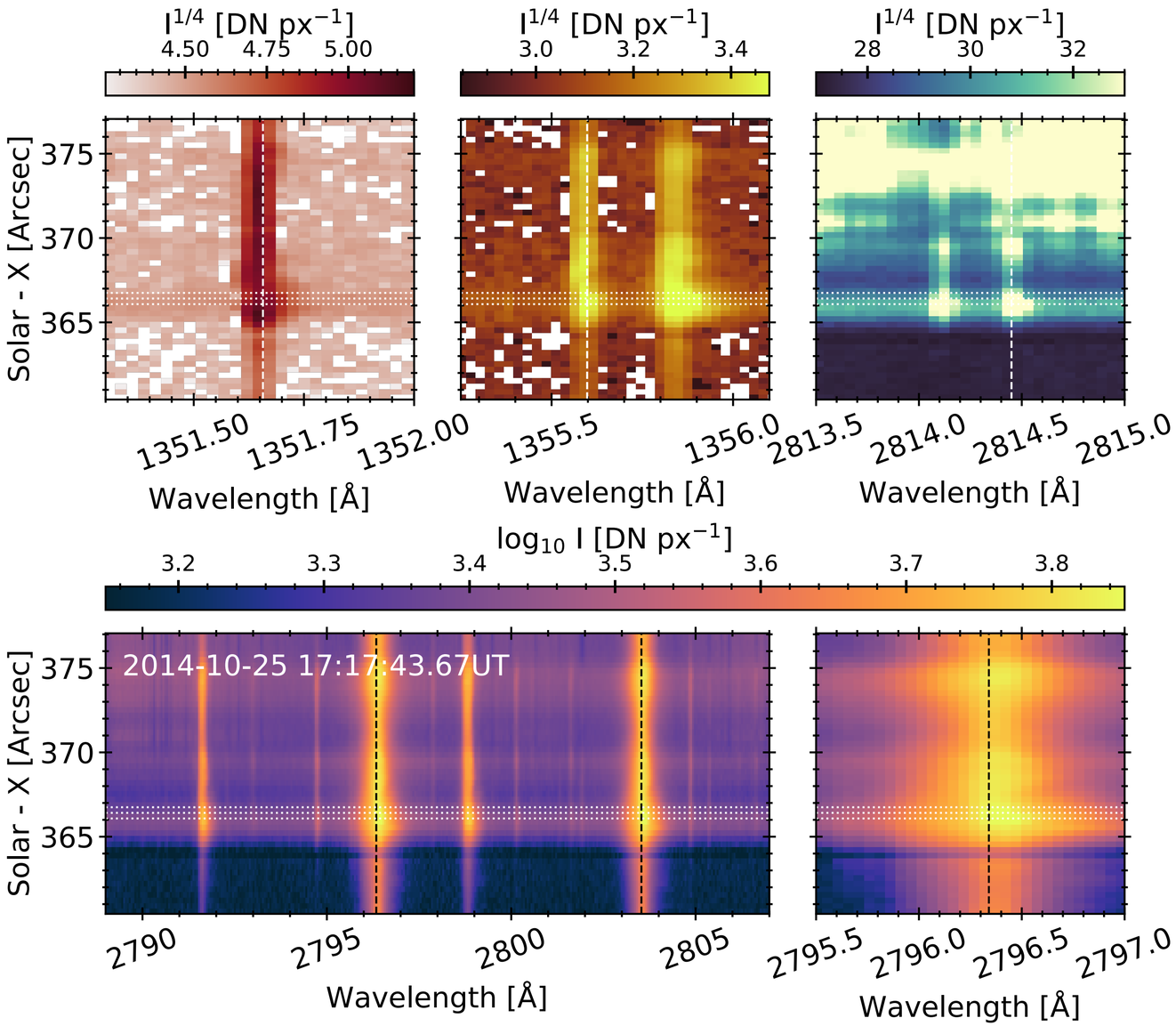

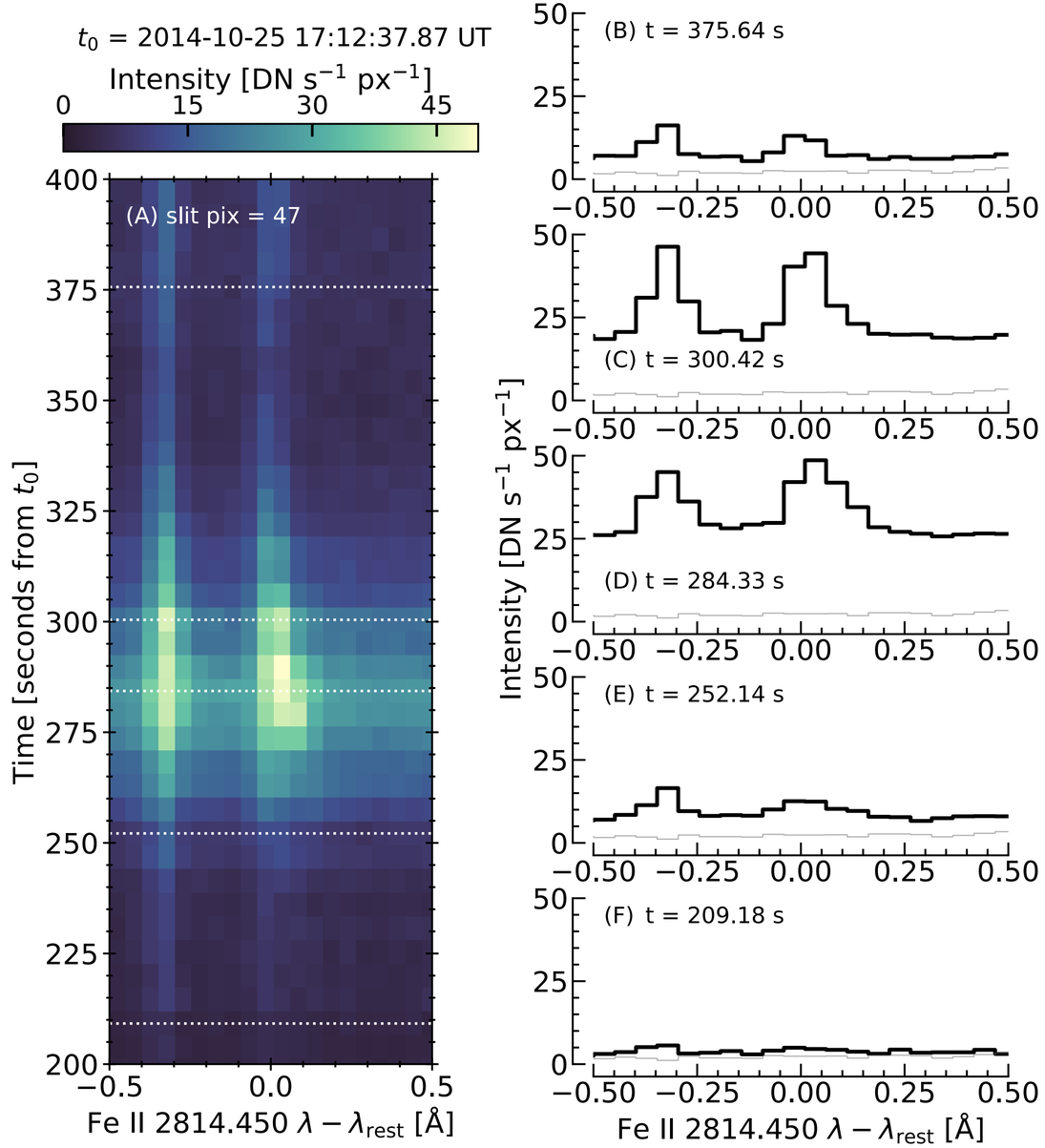

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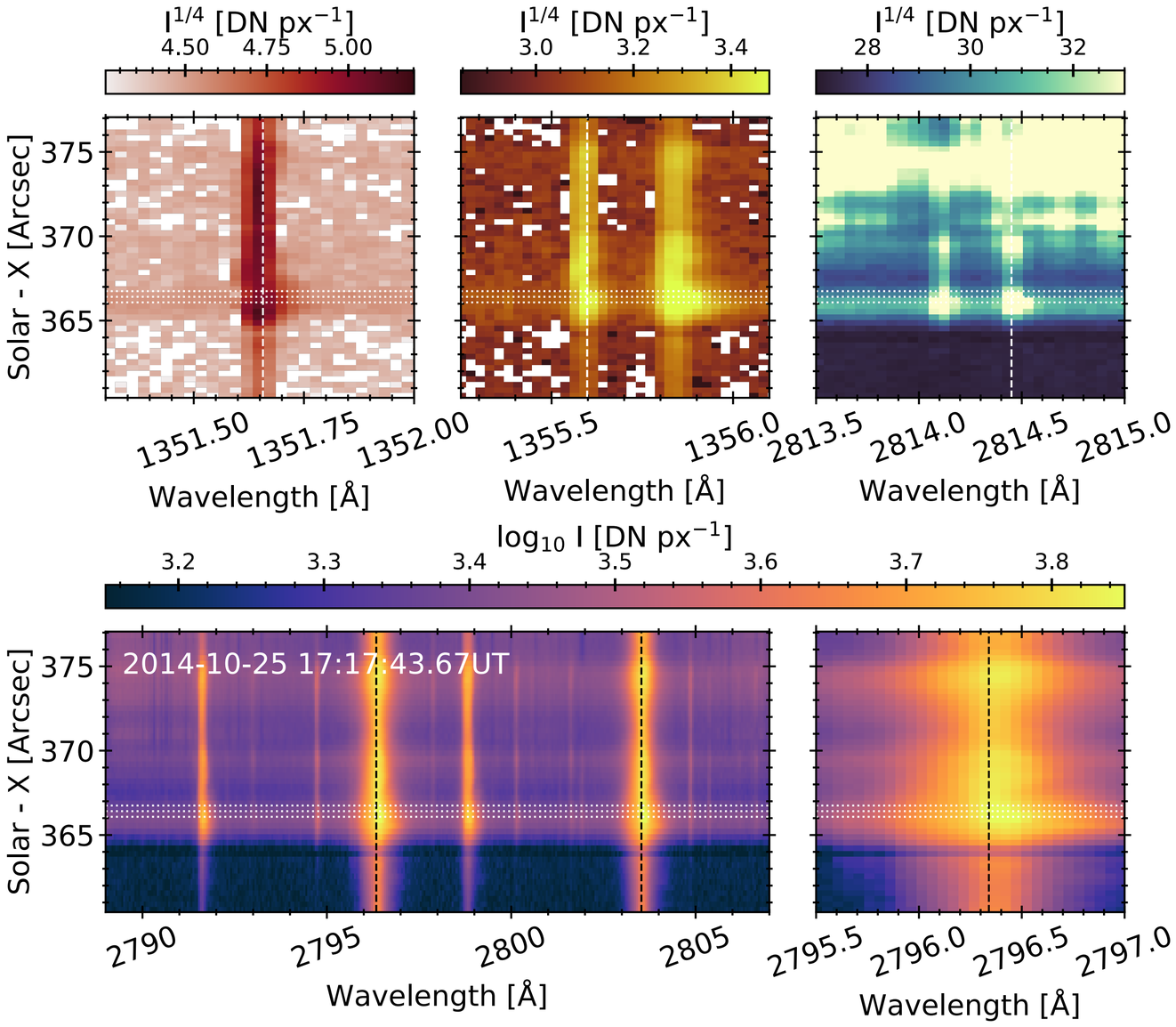
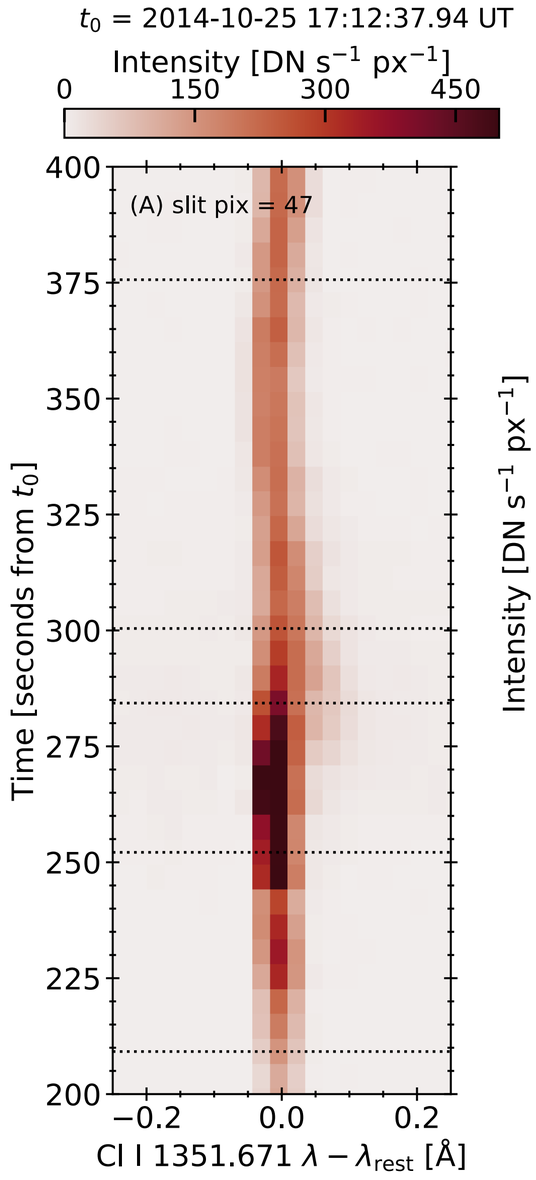
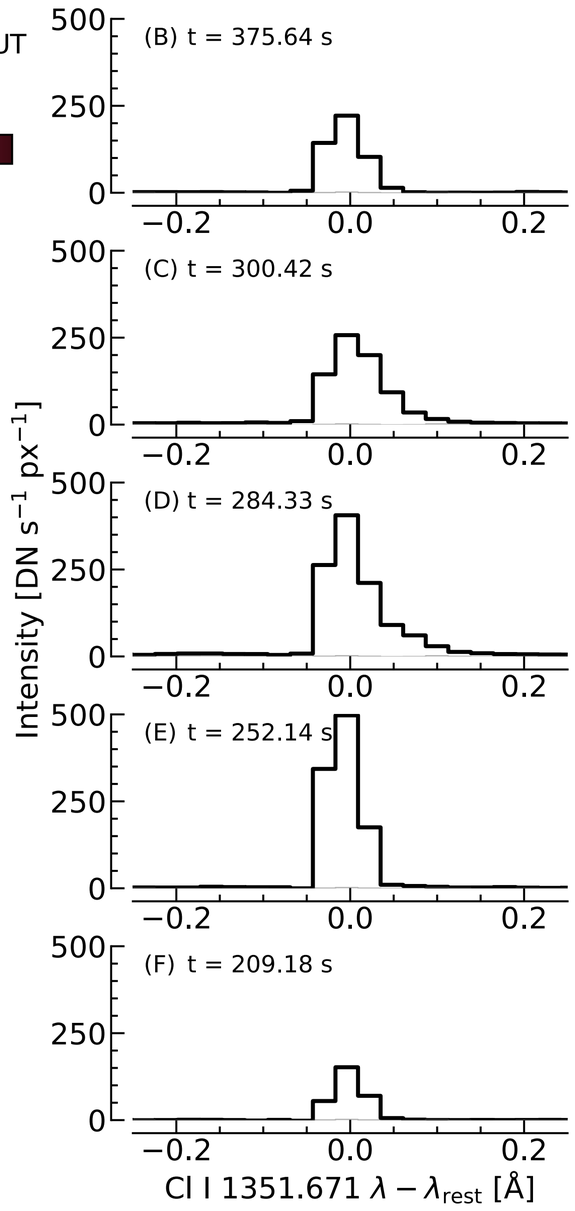
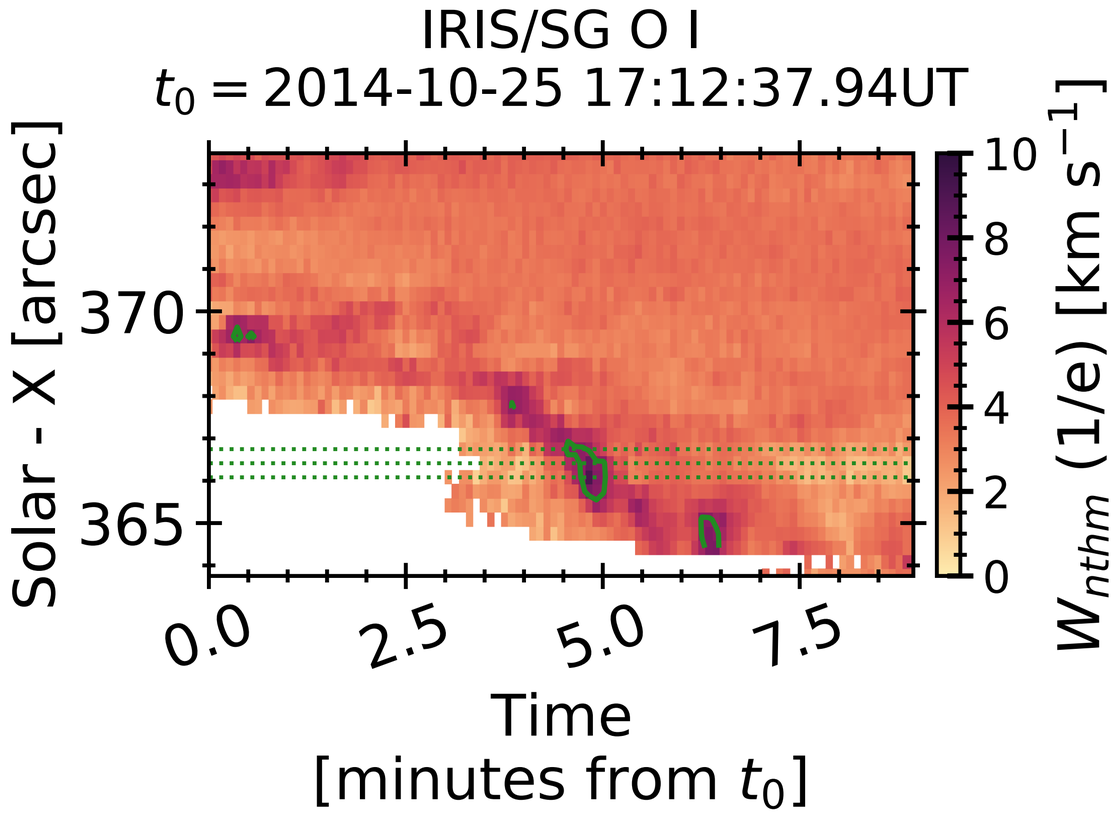




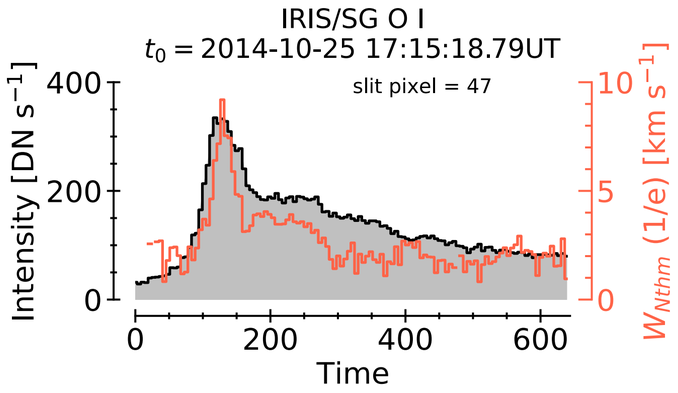


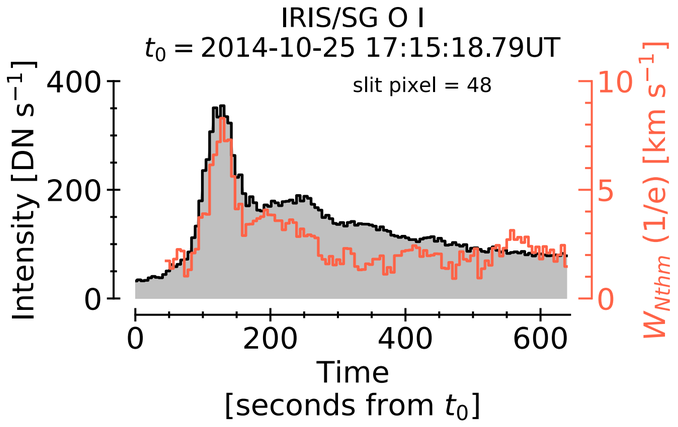
2014-OCTOBER-25 X1 CLASS FLARE

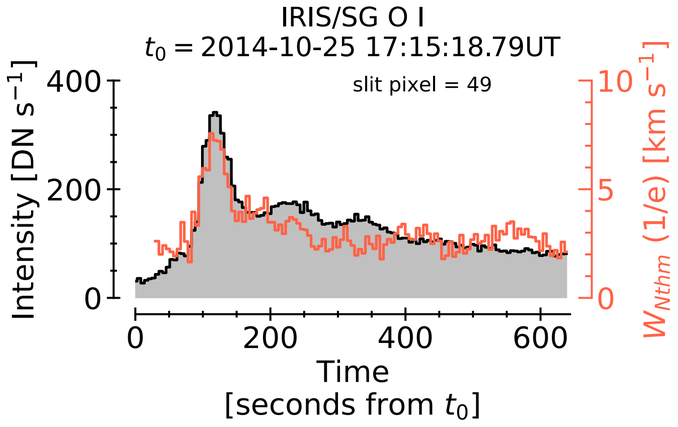
- Background values of v_{Nthm} ~ 2 - 3.5 km/s.
- Short lived (~30-90s) broadening, co-spatial with bright profiles.



- Not shown here: background values of v_{Nthm} ~ 4.5 - 6 km/s in plage, but with flare sources of comparable v_{Nthm} as the umbra.







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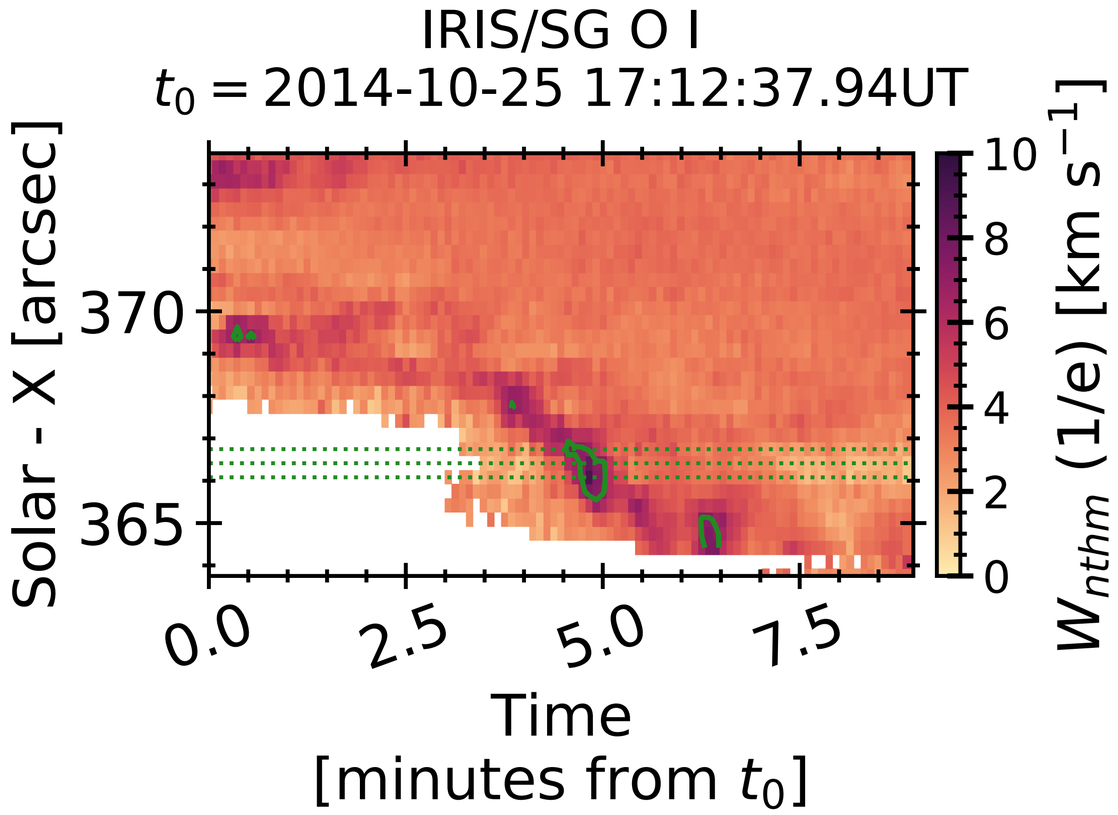

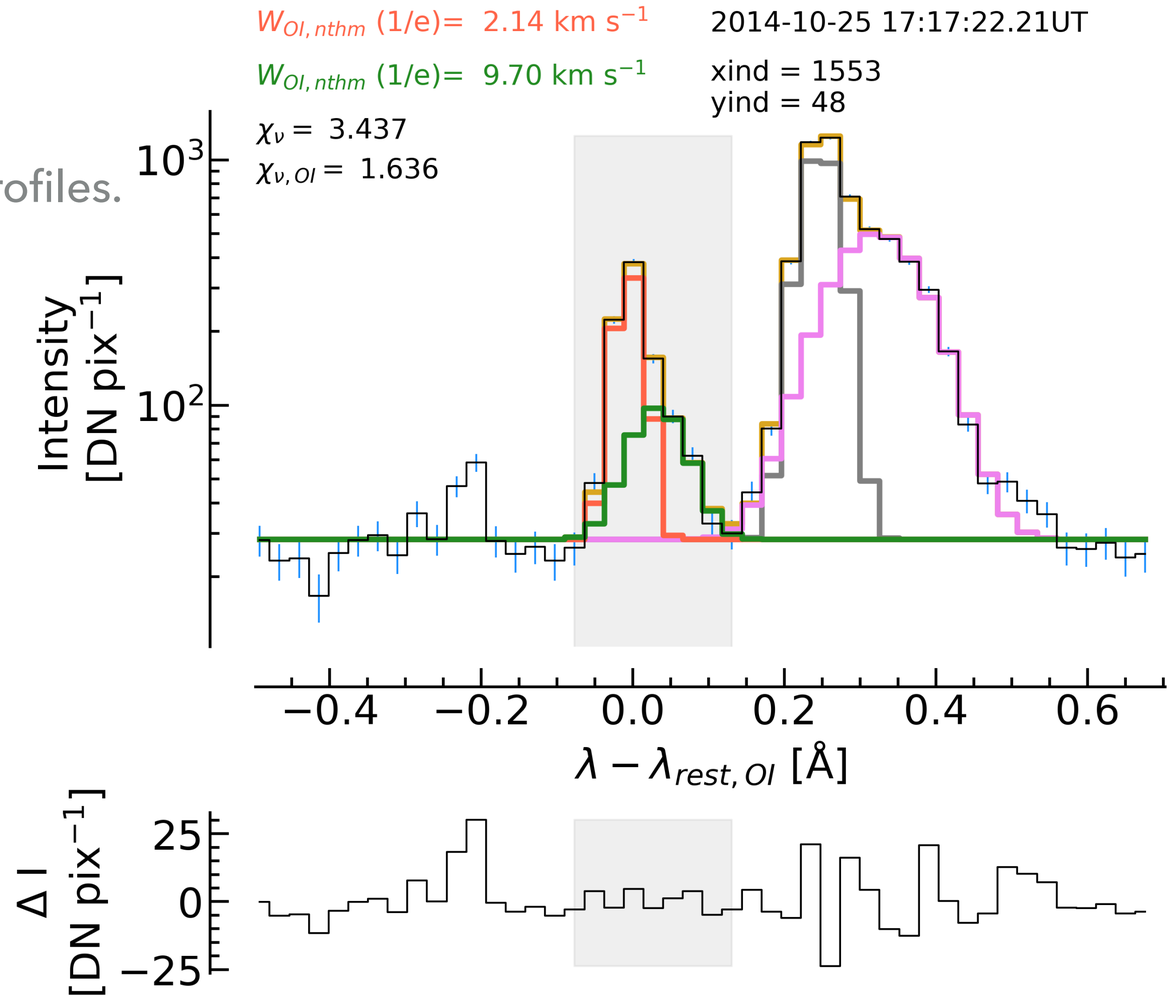

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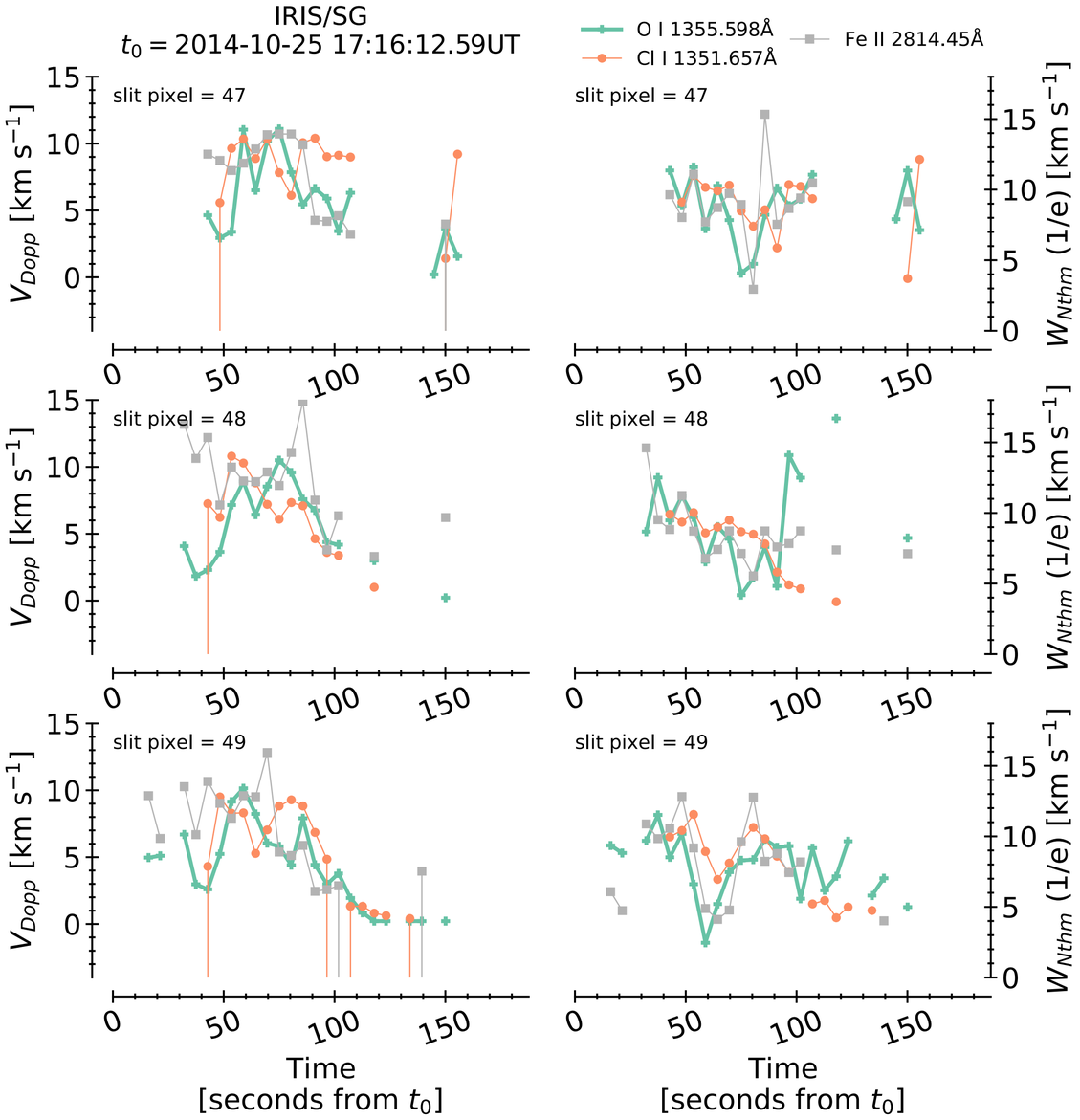
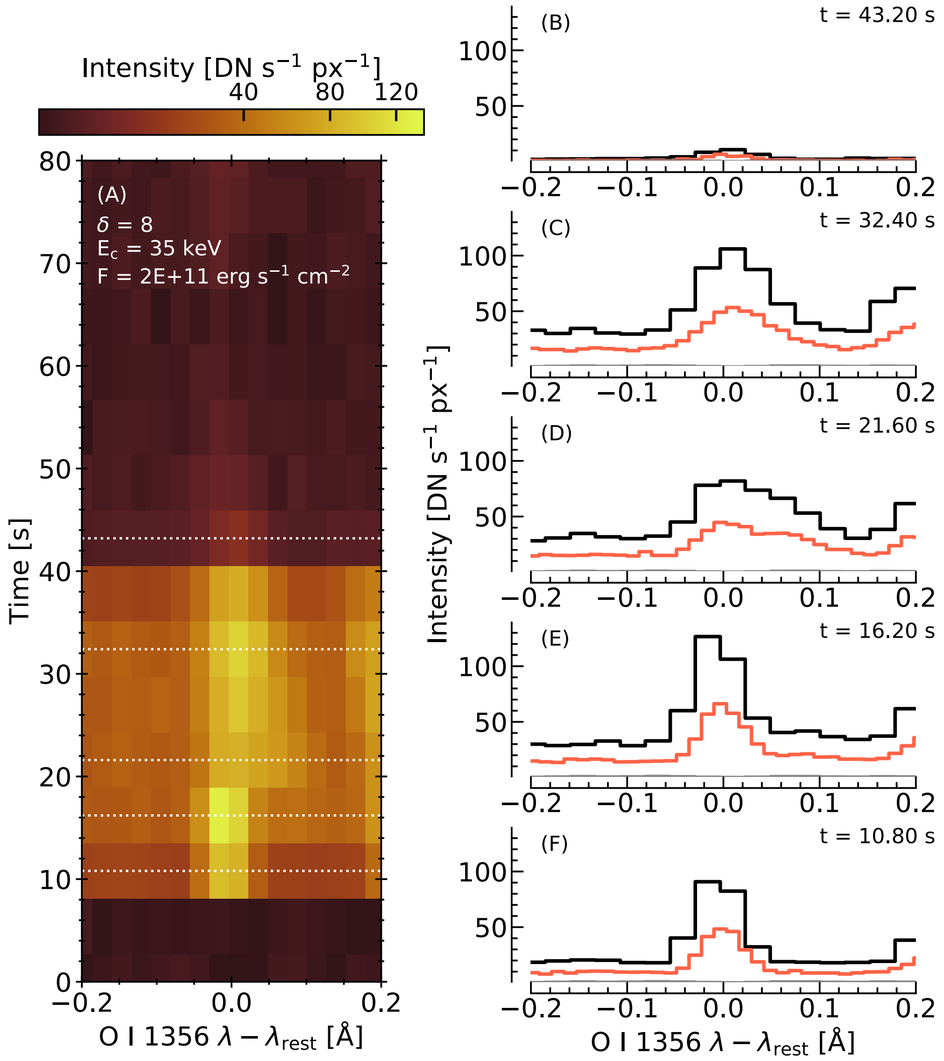
2014-OCTOBER-25 X1 CLASS FLARE

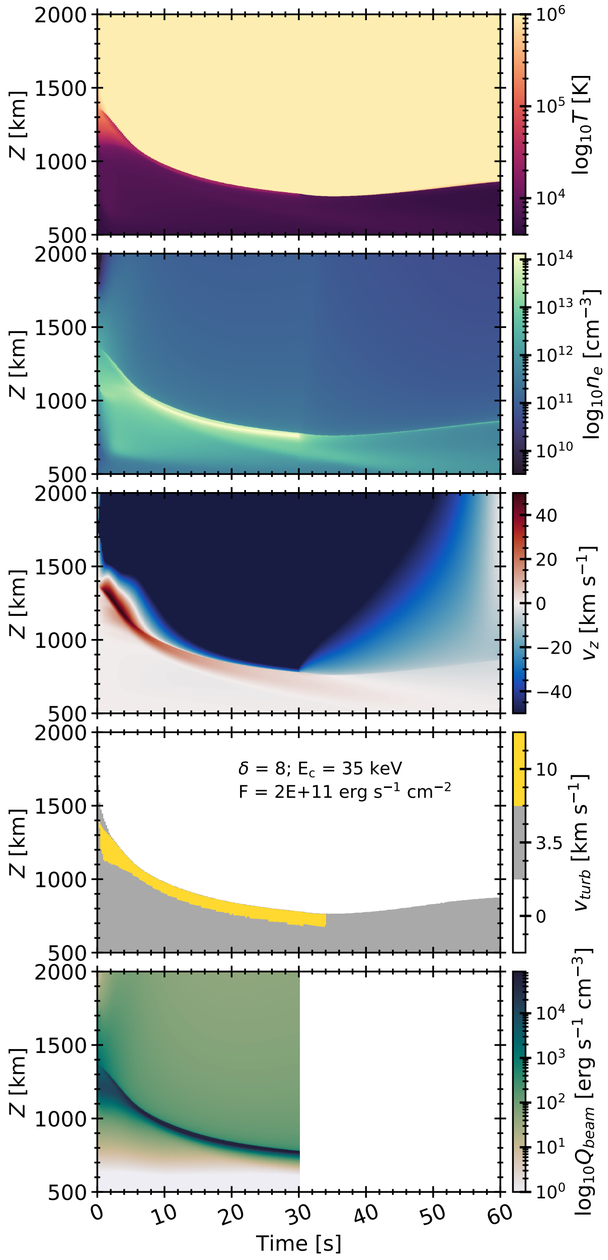
- Observed nonthermal width in the red wing component is ~5-12 km/s (typically 10 km/s).
- True for each line (Cl I, O I, Fe II).
- Stationary components don't show much broadening – no strong broadening below the condensation?



DATA-INSPIRED RADYN MODELLING

- Ran two RADYN flare simulations, with e-beam input from *Fermi* HXR analysis (only showing one of those here).
- When synthesizing IRIS lines with RH15D, imposed a micro-turbulence of 10 km/s within the condensation.
- Both O I and Fe II red-wing remained optically thin throughout.





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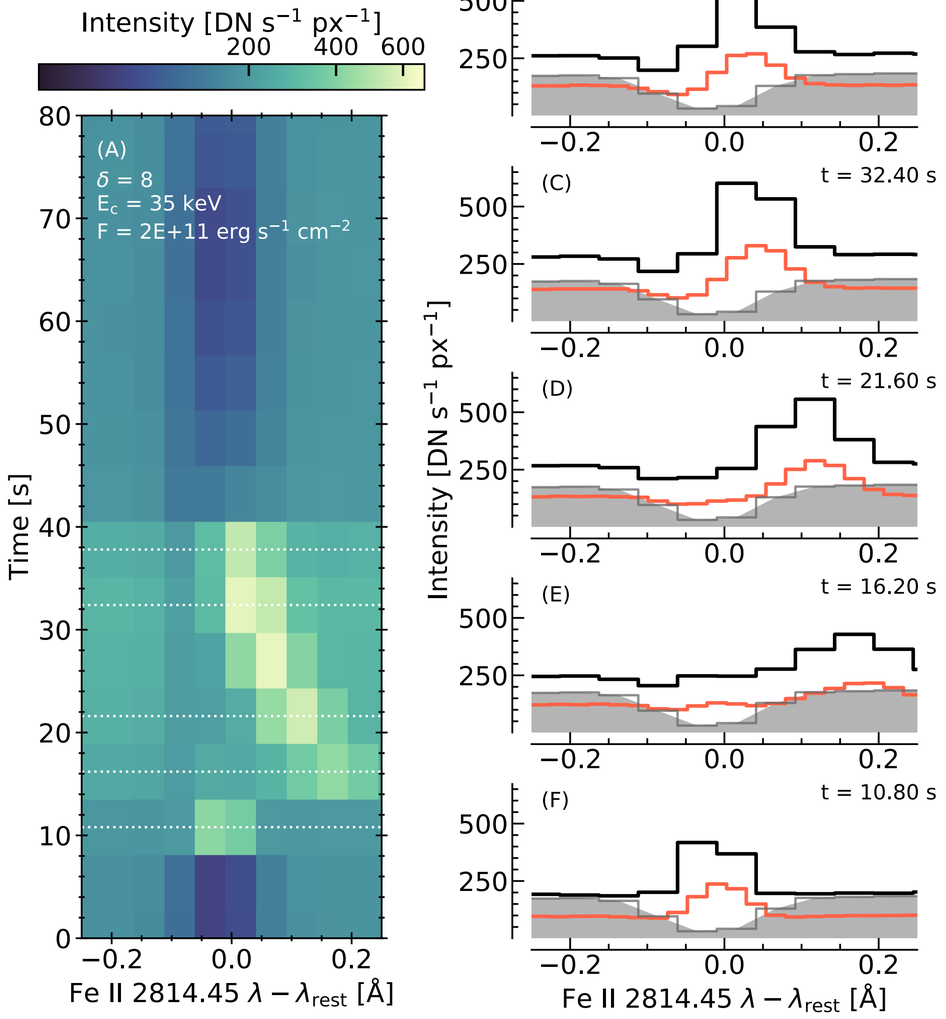
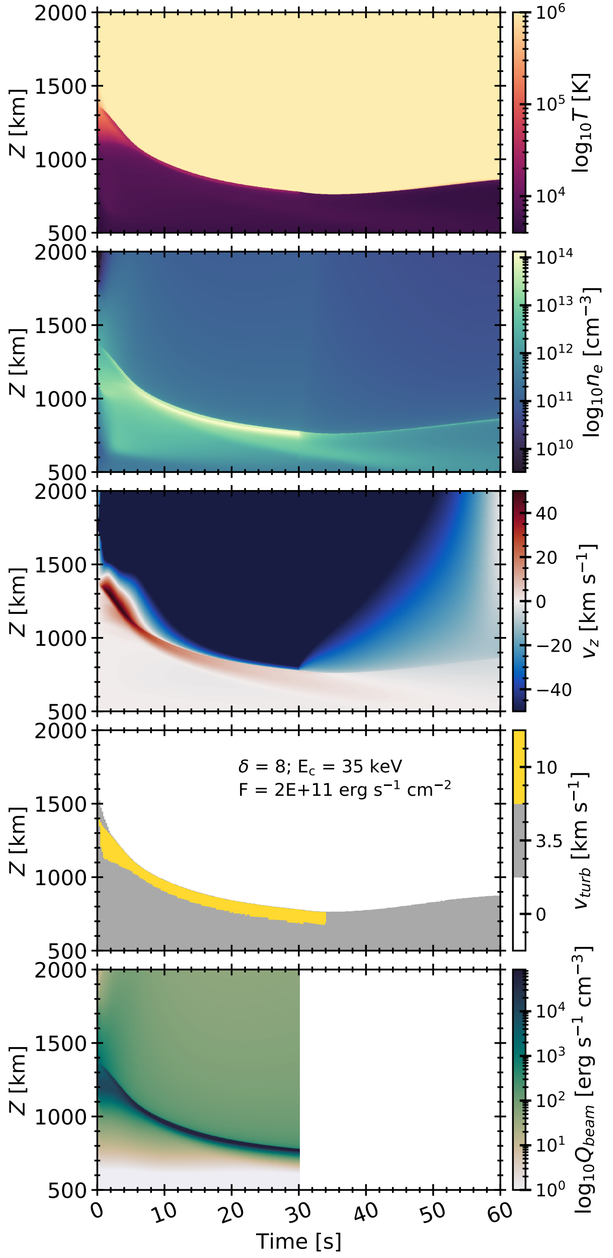
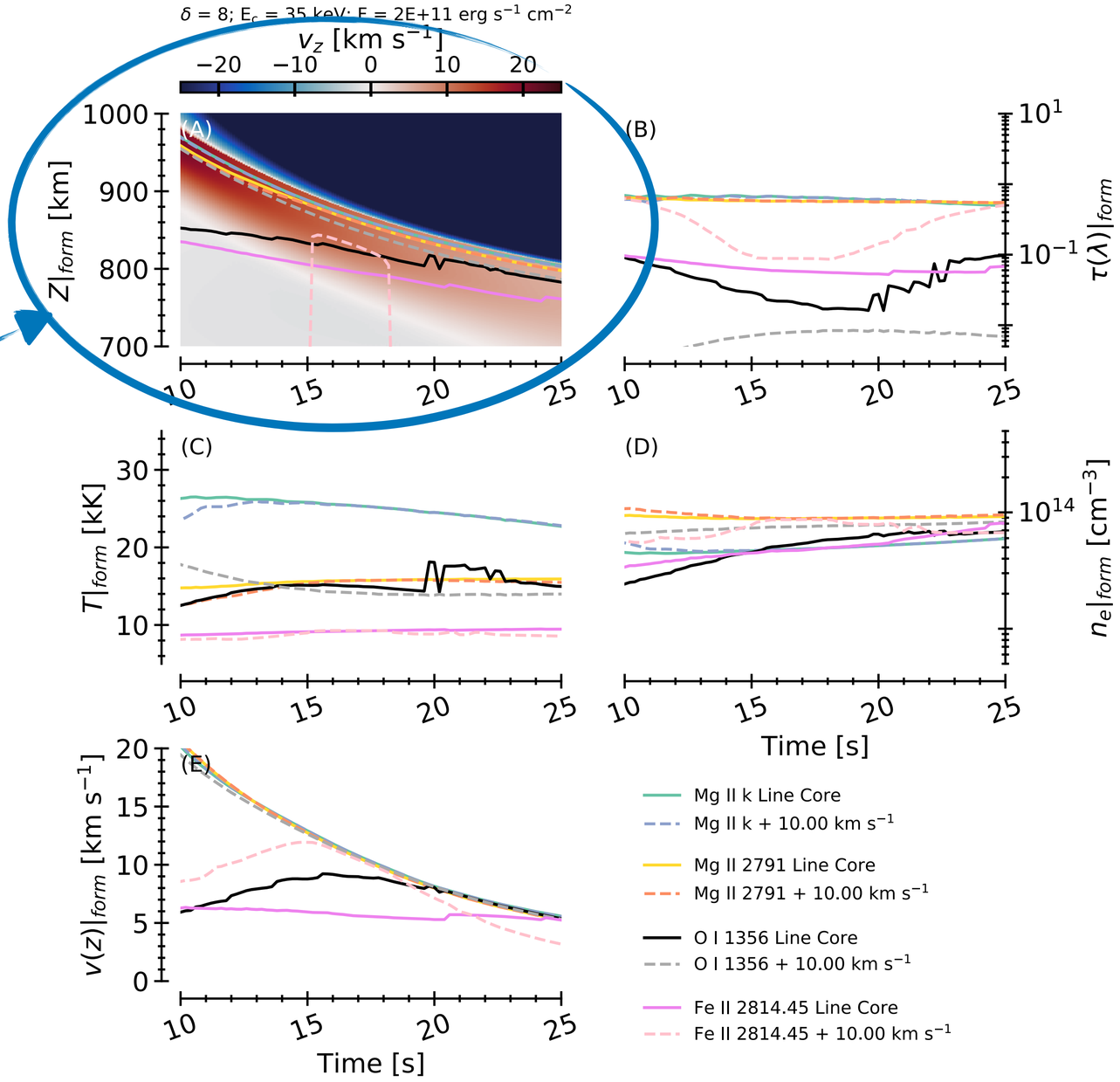




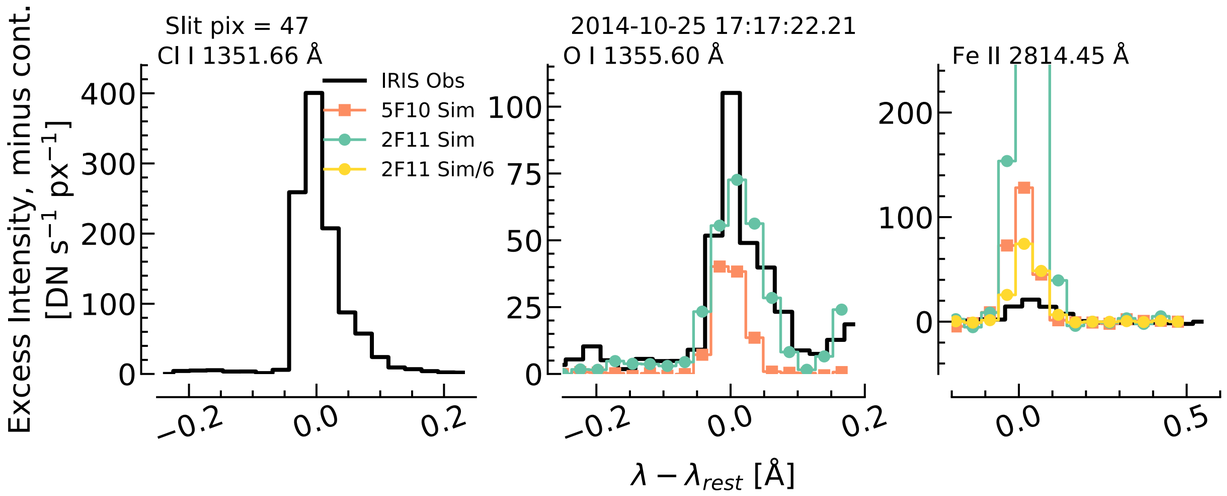
DATA-INSPIRED RADYN MODELLING

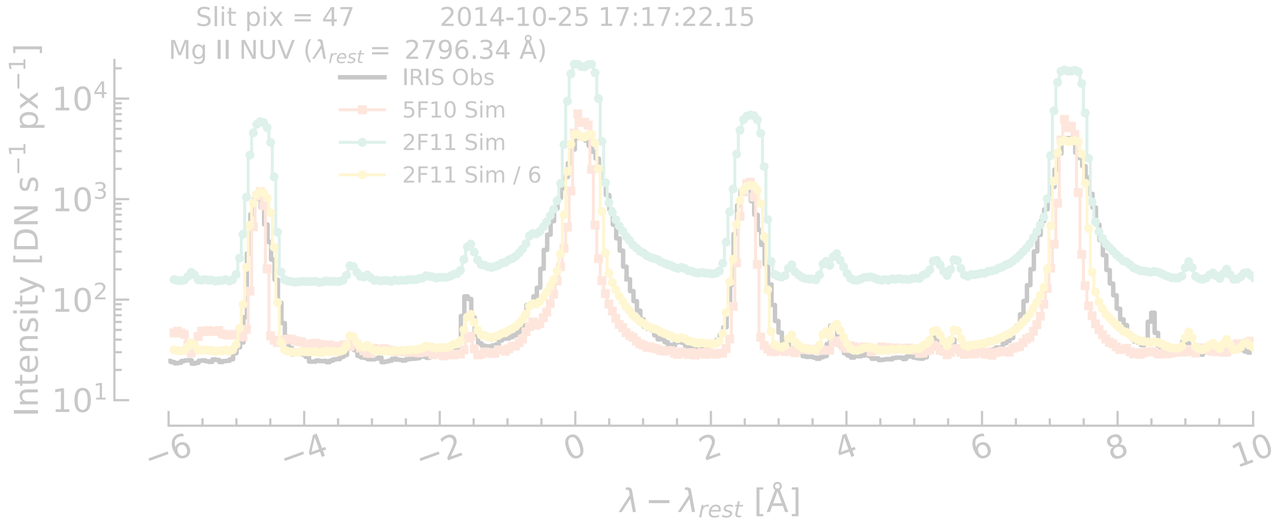
- Both O I and Fe II red-wing remained optically thin throughout.
- Red wing components of both lines form nearby Mg II h & k lines, within the chromospheric condensation.



MG II LINES STILL TOO NARROW!

- O I synthesis is pretty good!
- Fe II line core is too intense.
- Mg II NUV spectra's general shape is good, but too intense (x6).
- Mg II Line wings still too narrow, but can't increase microturbulence deeper since we would see that in the O I line core.





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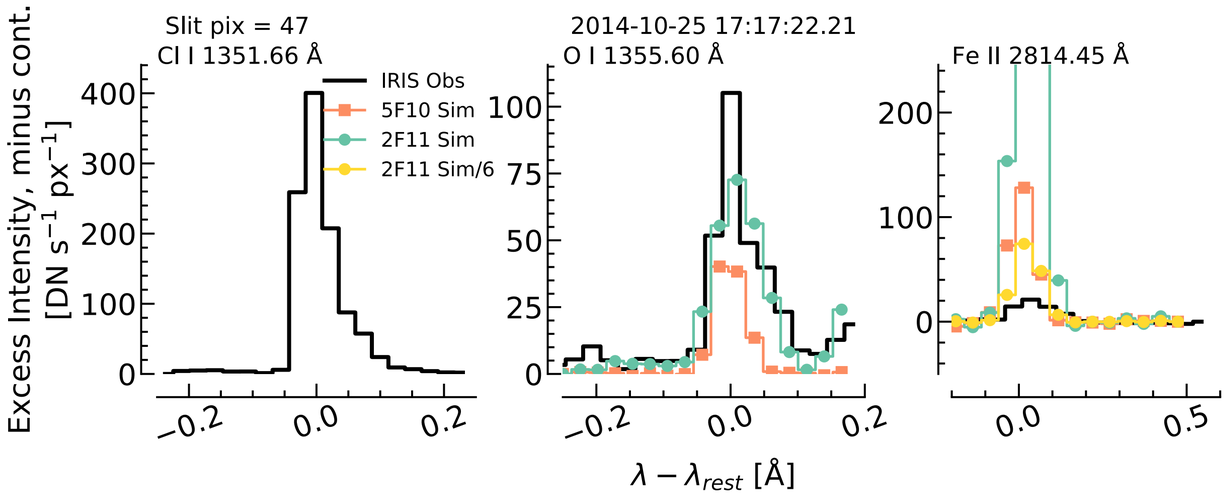

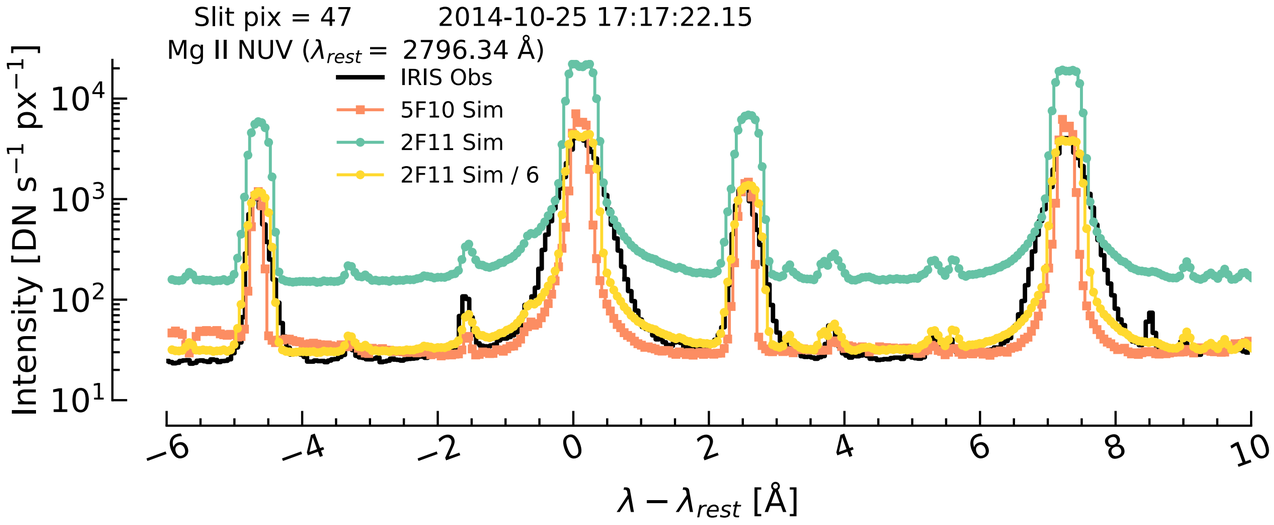

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