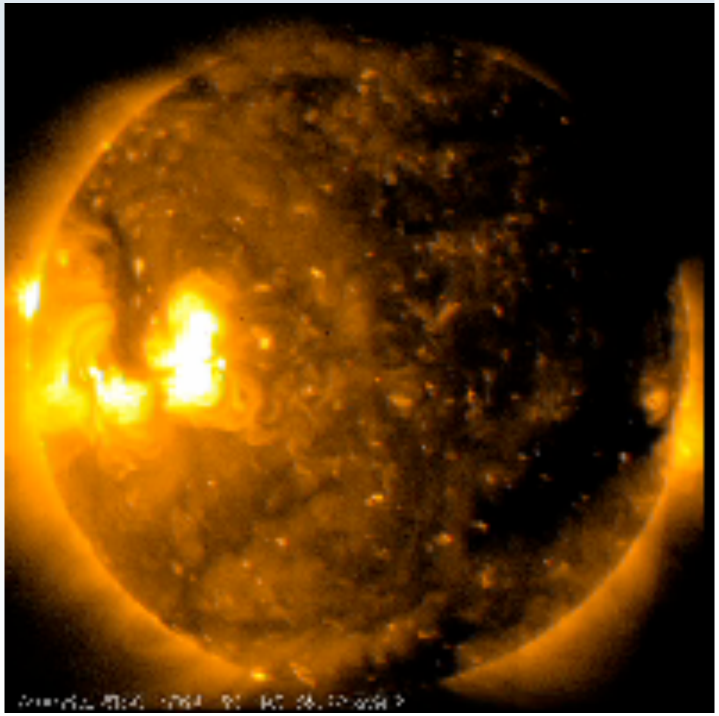
Three years of science from Hinode

Louise Harra and the Hinode team



MV Launch

Launch of Solar-B, now Hinode, at 06:36 JST on Saturday 23rd Sept. 2006

Orbit

680 km Sun-synchronous

- design figure was 630 km

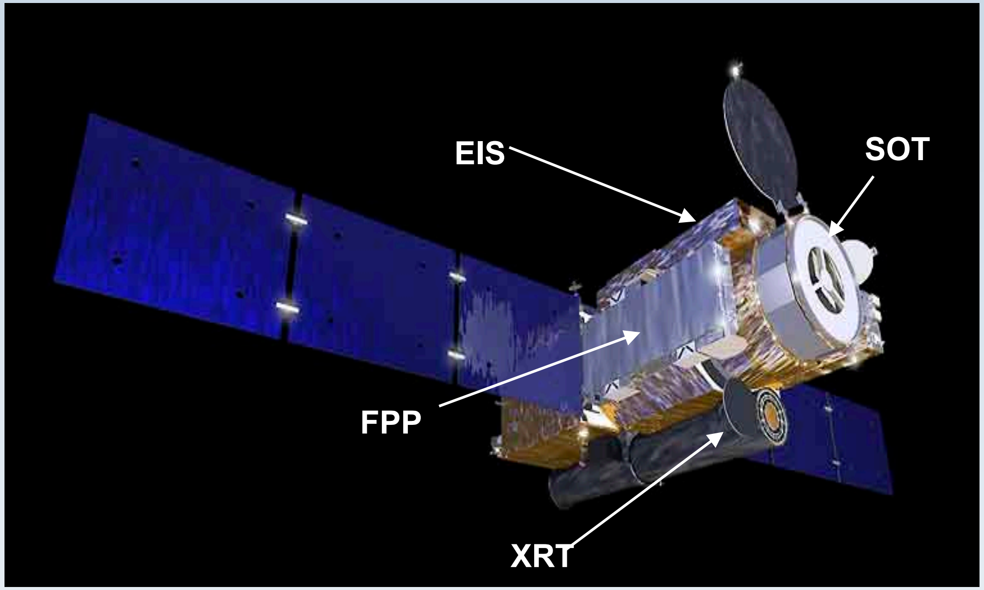
JAXA/ISAS Hinode Spacecraft

Payload:

- 0.5m optical telescope (SOT) with a focal plane package (FPP) for 0.25 arc sec diffraction limited images and vector magnetograms

- EUV Imaging Spectrometer (EIS) with 2 arc sec resolution

- Imaging X-ray Telescope (XRT) with 2 arc sec resolution



Science goals:

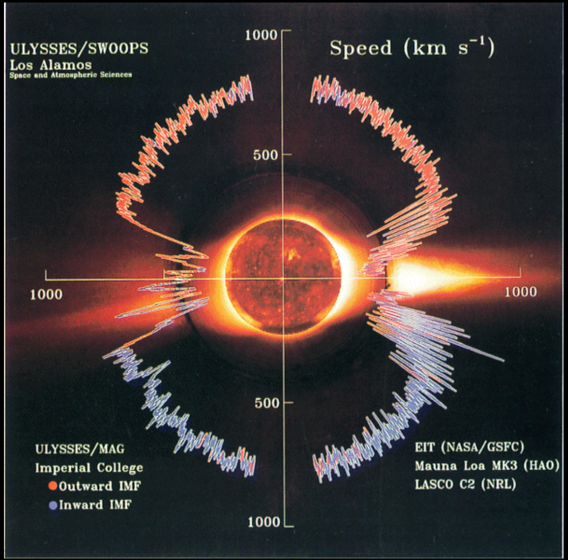
- Determine how the corona is heated in active regions and in the quiet Sun

- Establish the mechanisms that give rise to transient phenomena, such as flares and coronal mass ejections

- Investigate the processes responsible for energy transfer in the quiet Sun

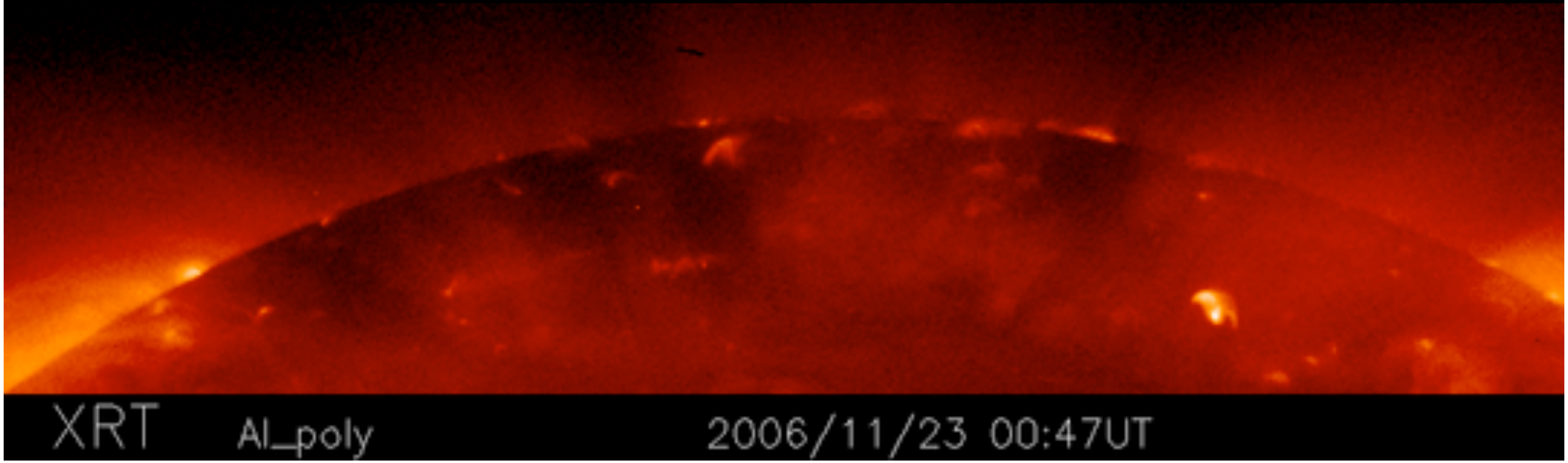
Hinode EIS

FAST SOLAR WIND

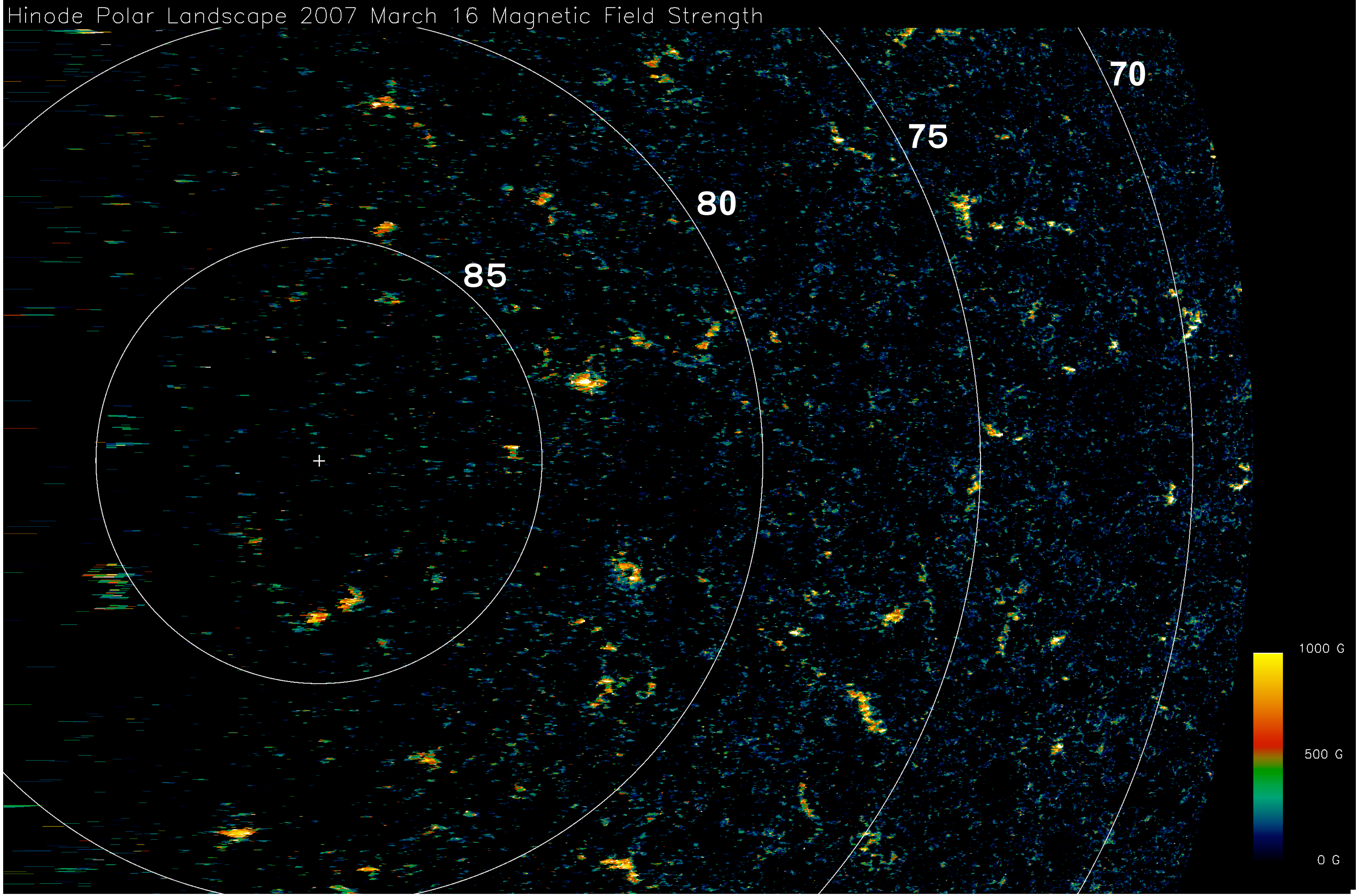


High speed solar wind
Ulysses
(McComas etal 2000)

High coronal activity in polar region
(Cirtain etal 2007)

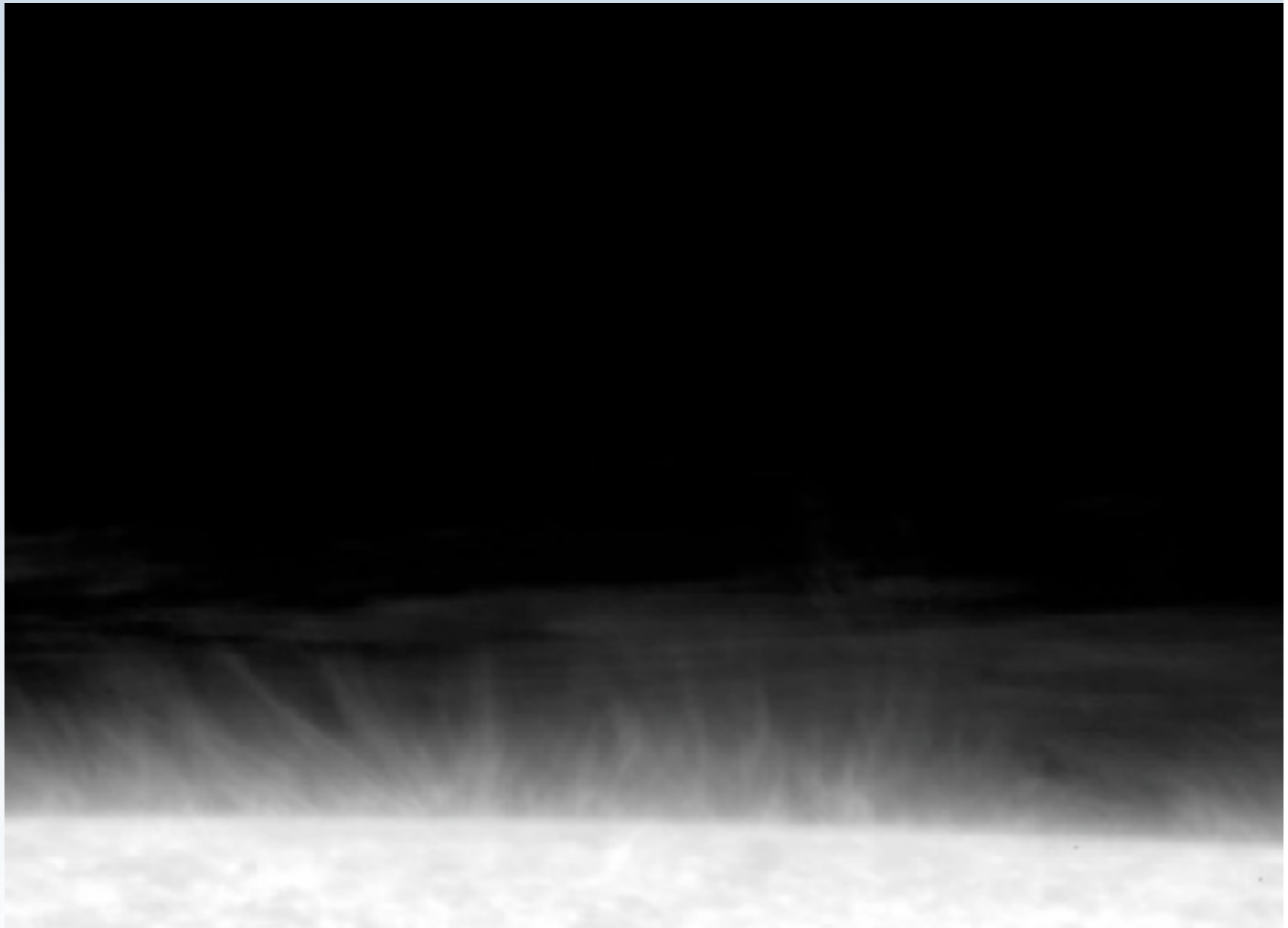


Discovery of Polar kG field



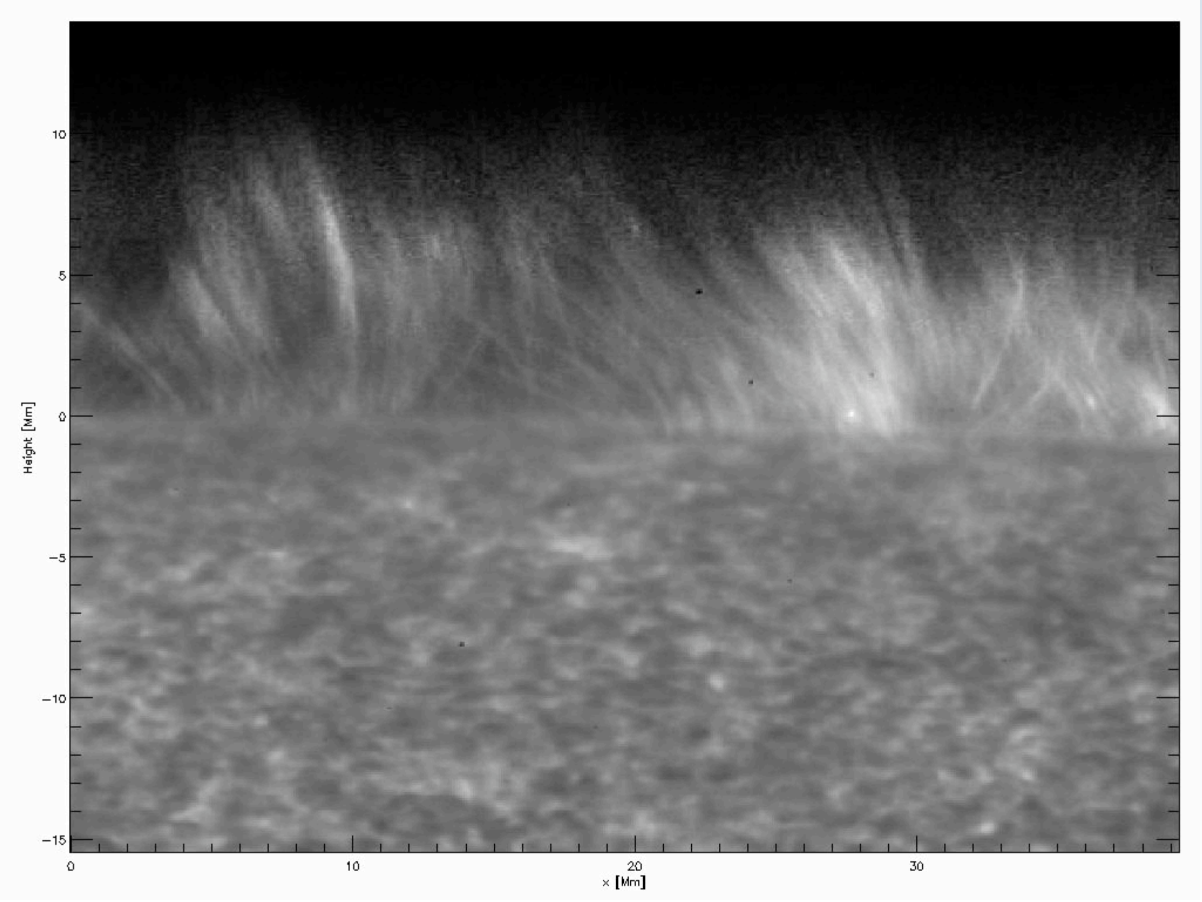
Chromospheric reconnection - a role in coronal heating and solar wind acceleration

Jets are seen at all scales - these are the smallest ones ever observed in the chromosphere (Shibata et al., 2007)



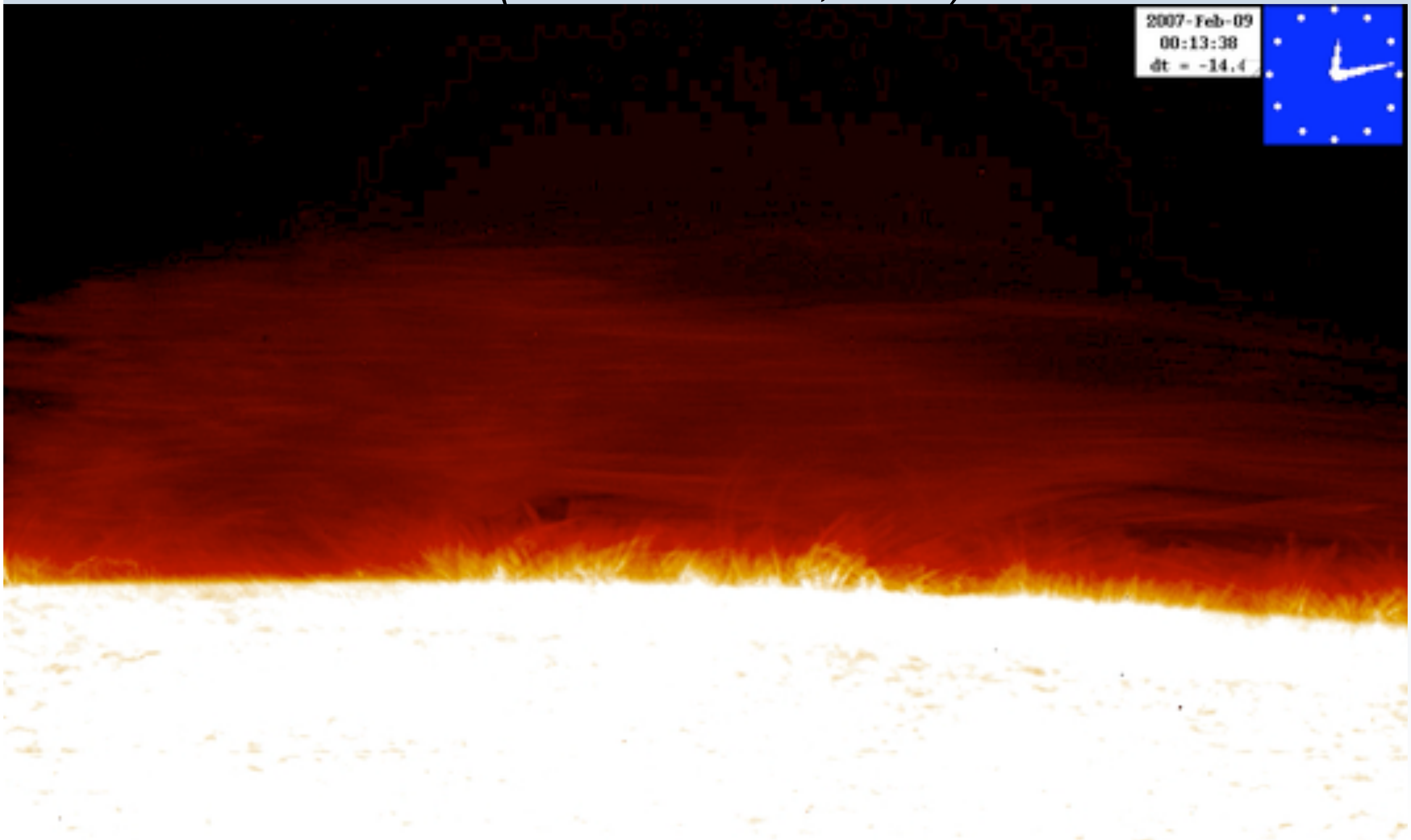
Hinode EIS

Chromosphere permeated by waves….
that could accelerate the solar wind!



Chromosphere is dominated by short-lived (10-60 s), thin (~200 km) jets or “straws” that undergo “lots of swaying”!
De Pontieu et al., 2007

Prominences - cool material ‘held’ by magnetic fields in the corona oscillations observed.. (Okamoto et al., 2007)



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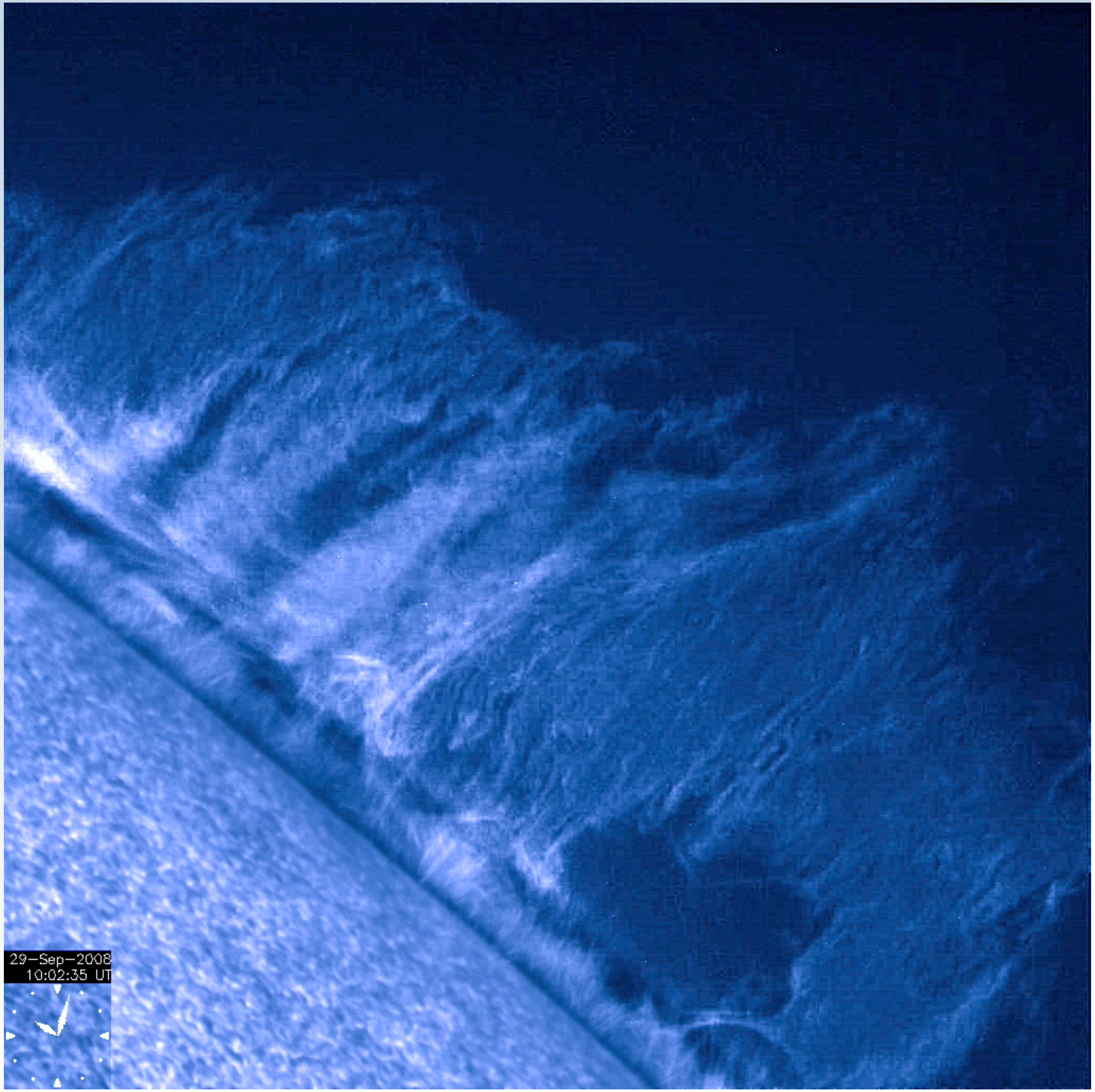
Buoyant instabilities in a magnetised plasma cause these strange flows. Probably triggered by flux emergence… Berger et al., 2007, Berger et al., 2010.

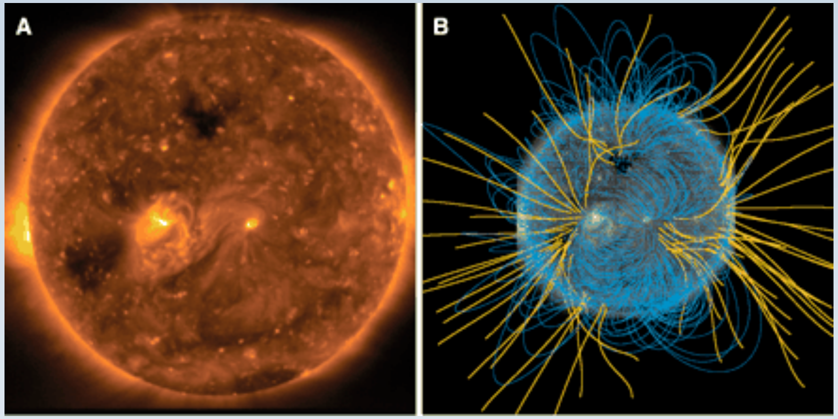
Hinode EIS

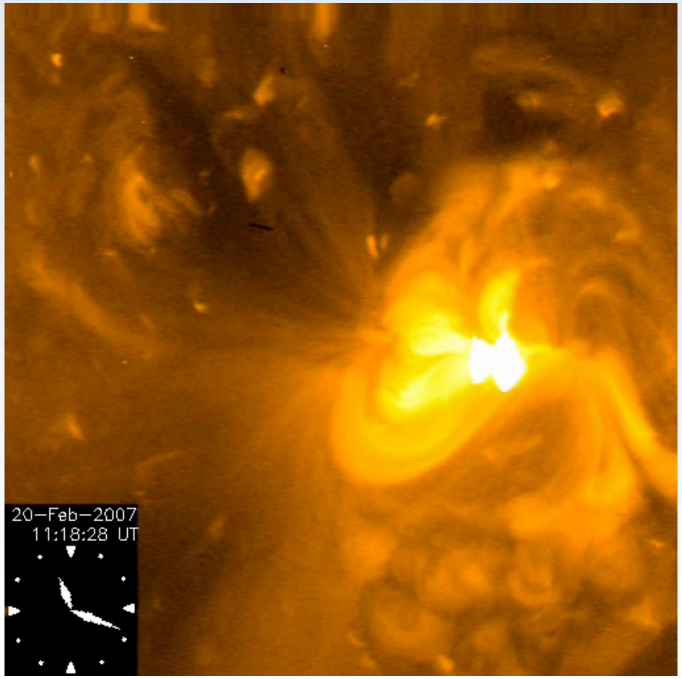


A source of the slow solar wind?

Sakao et al. 2007, showed steady 'spurting' streams of plasma from the edges of active regions.

They estimated about 25% of the slow solar wind could come from such regions.

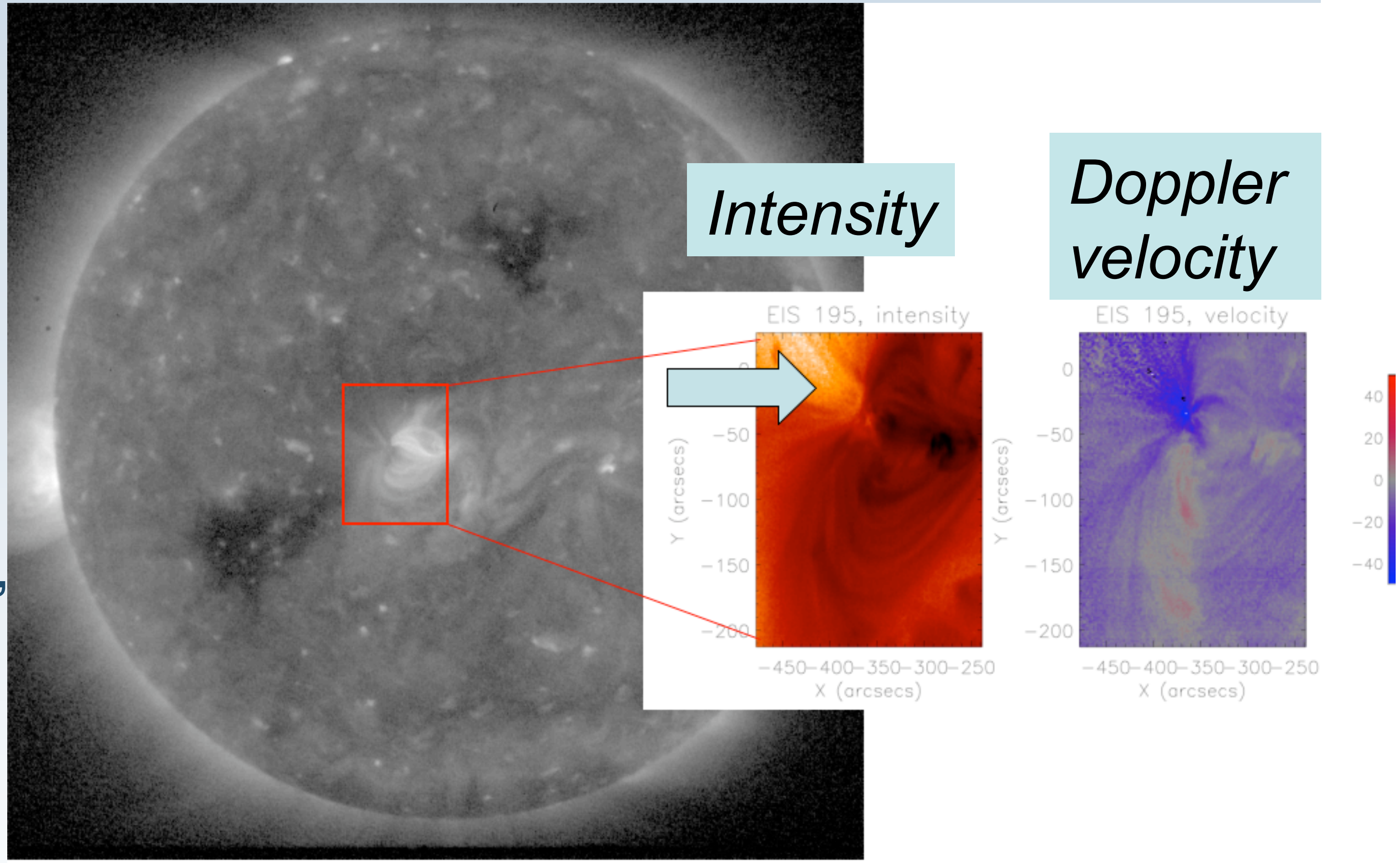




Hinode EIS

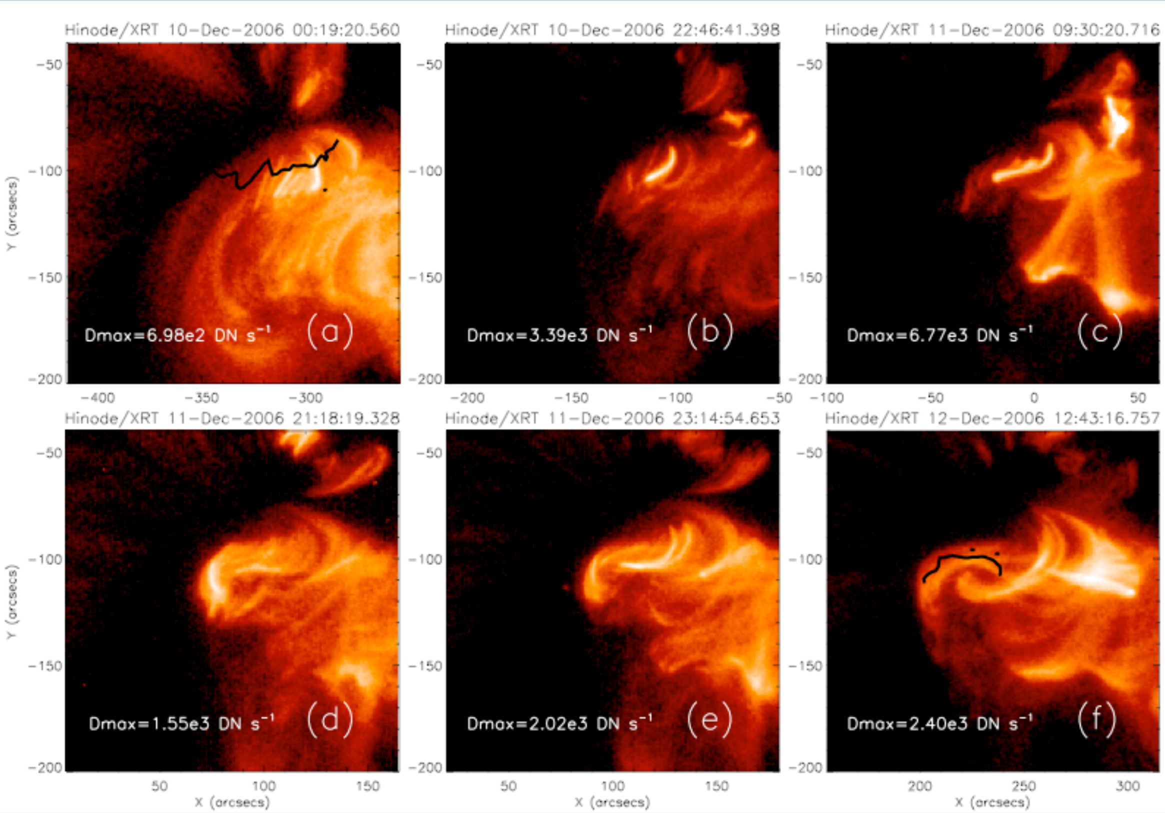
Outflows of up to 50 km/s are seen in the region of outflow in XRT, Harra et al. (2008).

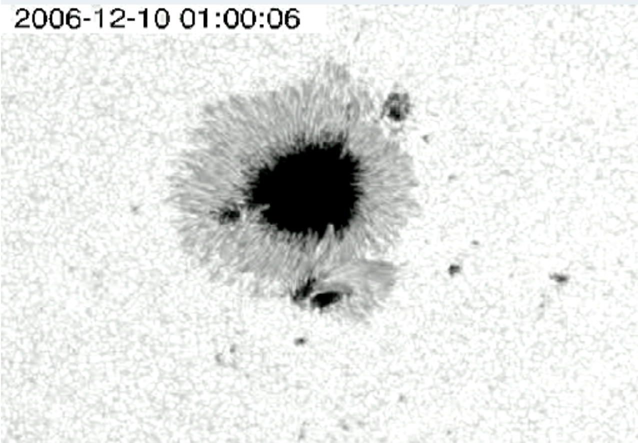
Baker et al. (2009), Murray et al. (2010), Fazakerley et al., 2010

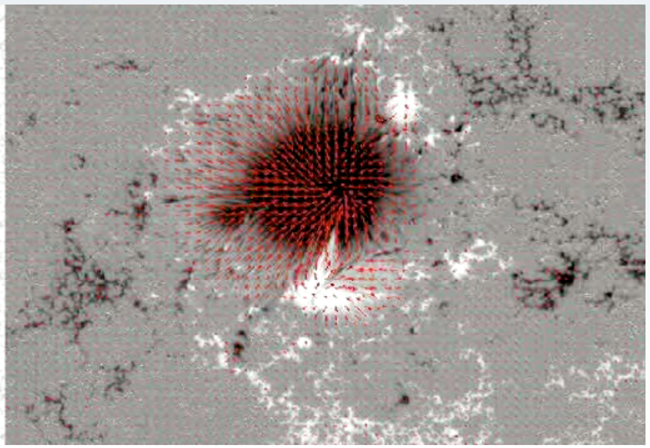


Hinode
EIS

Build-up to a large flare







The shear builds up for several days before the flare goes bang.

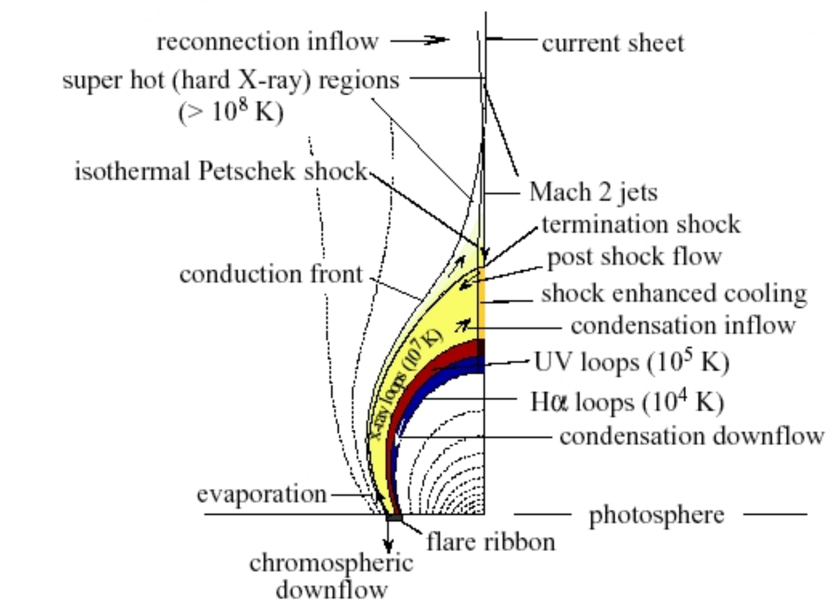
Su et al., 2007

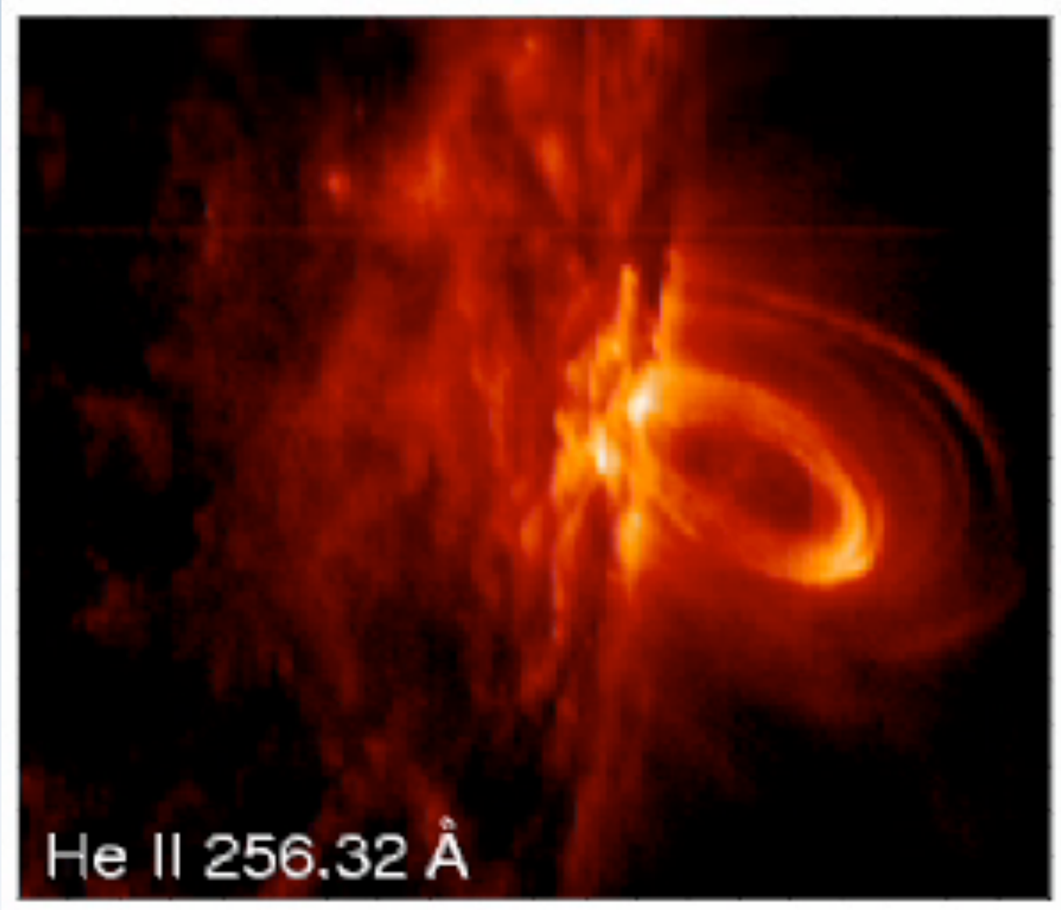
EIS measurements quantitatively increases in turbulence more than 12 hrs before the flare begins. (Harra et al., 2009).

Williams et al., 2009 measured twist with EIS right before the flare erupted.

Wallace et al. (2010) looks at preflare activity in a much smaller event.

The flare itself





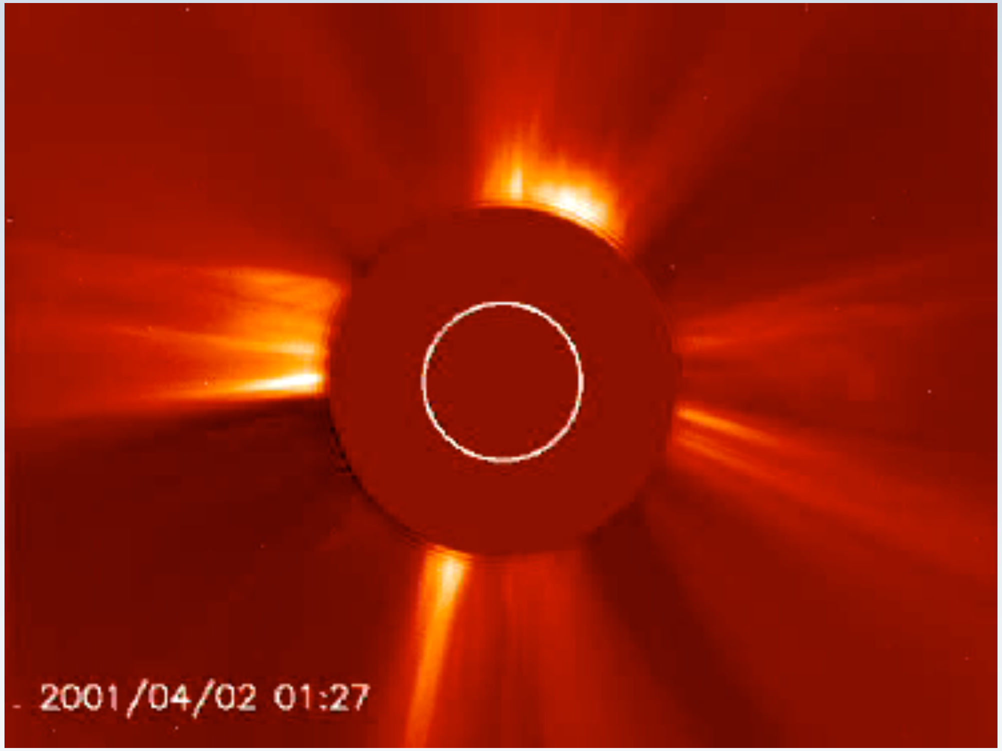
The cooler emission lies below the hotter emission…Hara et al., 2008

Hinode EIS

Coronal Mass Ejections

Approx 10^{14} g is lost (larger than the mass of Mt Everest!).

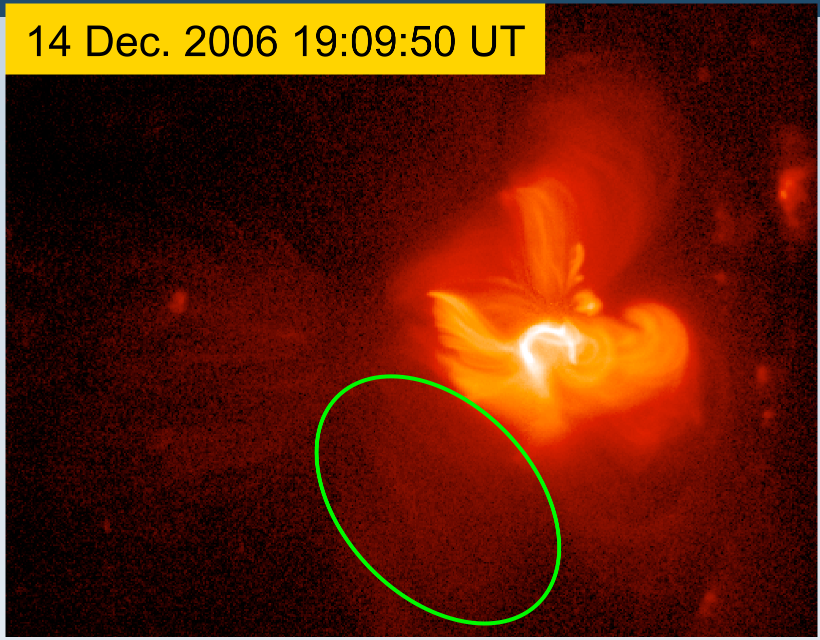
We view these by blocking out the bright solar disk…..

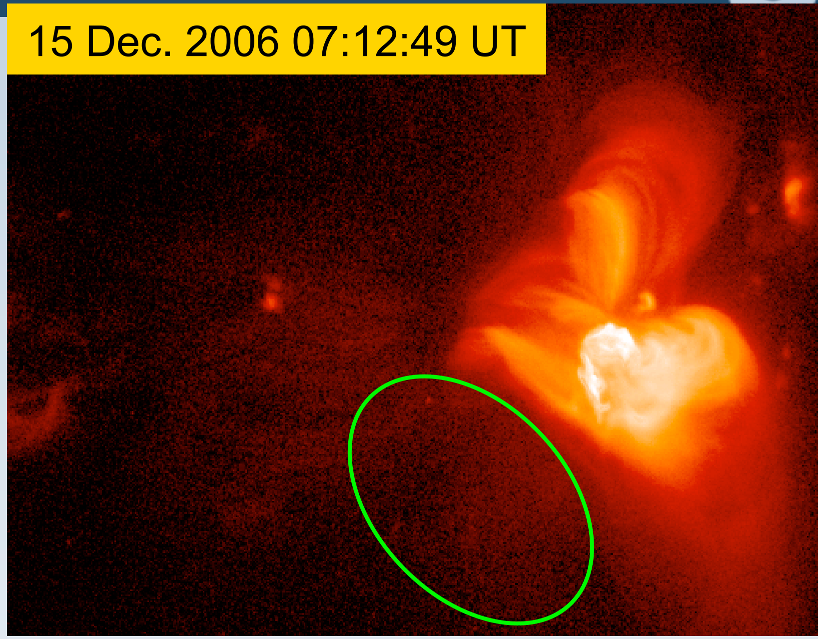


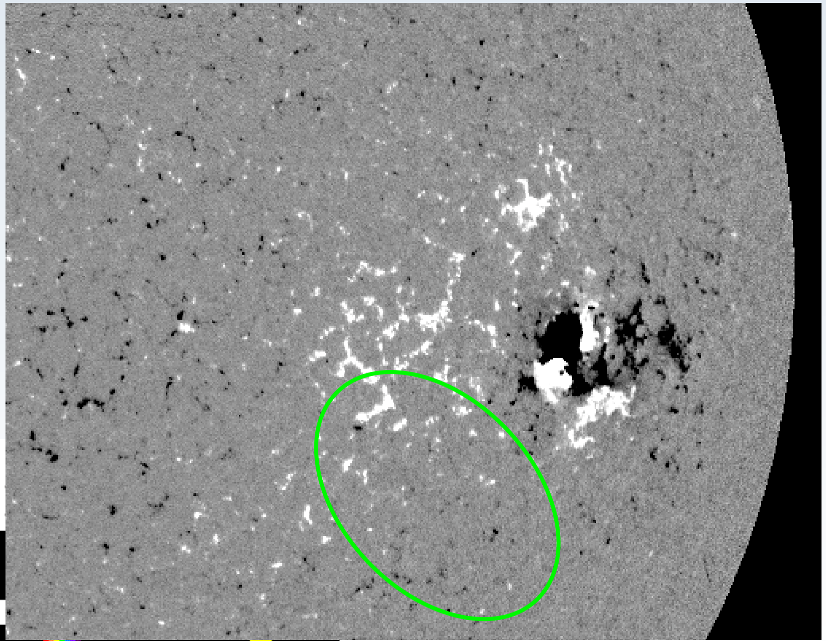
The Earth!

Hinode EIS

Coronal Mass Ejection -what is the source?







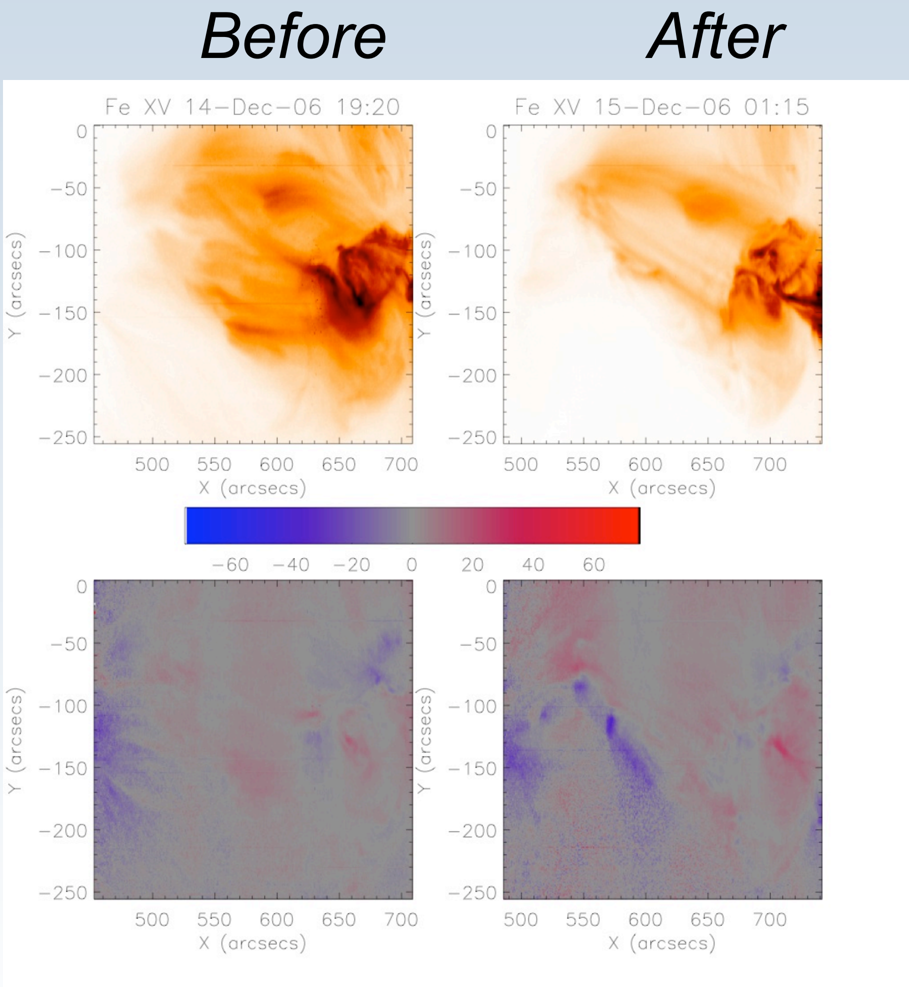
Hinode/XRT & SOHO/MDI

Changes in the coronal strucure due to the CME

The source region of the CME is seen

We can now see structure and measure quantitatively the source regions of CMEs.

Harra et al., 2007



Summary

The results from Hinode are amazing!
EIS is a beautiful instrument and is working well!
Many thanks to all those of you who worked on building it!