

THEMIS

Magnetometry from HINODE/SOT/SP data: solving the fundamental ambiguity from the 6301/6302 line pair inversion

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Method developed with the data of the THEMIS telescope, and now applied to the HINODE/SOT/SP data

Inversion: Milne-Eddington inversion, UNNOFIT code (magnetic filling factor in LM algorithm) (Bommier et al., 2007, A&A 424, 323). The two lines are separately inverted

Ambiguity resolution: modified Metcalf et al. ME0 code <http://www.cora.nwra.com/AMBIG/>: minimization of $|\text{div}B| + |J_z|$ with the "simulated annealing" algorithm

- **Modification:** dB_z/dz is not derived from extrapolation (original code), but from the two line observations.
- **Two line formation depth difference:** 64km, from direct measurement from HINODE data of quiet regions by Faurobert et al. (2009, A&A 507, L29) using Fourier phase shift analysis extended to 100 km for active regions from the simulation by Khomenko & Collados (2007, ApJ 659, 1726)
- **Two line requirement:** the two lines must belong to the same multiplet but with different absorption coefficients, for being formed in a similar manner but at different altitudes
The photospheric lines Fe I 6301/6302 are such a pair. Na I D1 & D2 are another such pair, formed higher in the chromosphere. They were successfully also tried with THEMIS (results below)

Results: a unique full magnetic field vector per pixel, at two depths, from which we derive the full current density vector, and from both the Lorentz force vector

Examples of a single regular spot

HINODE

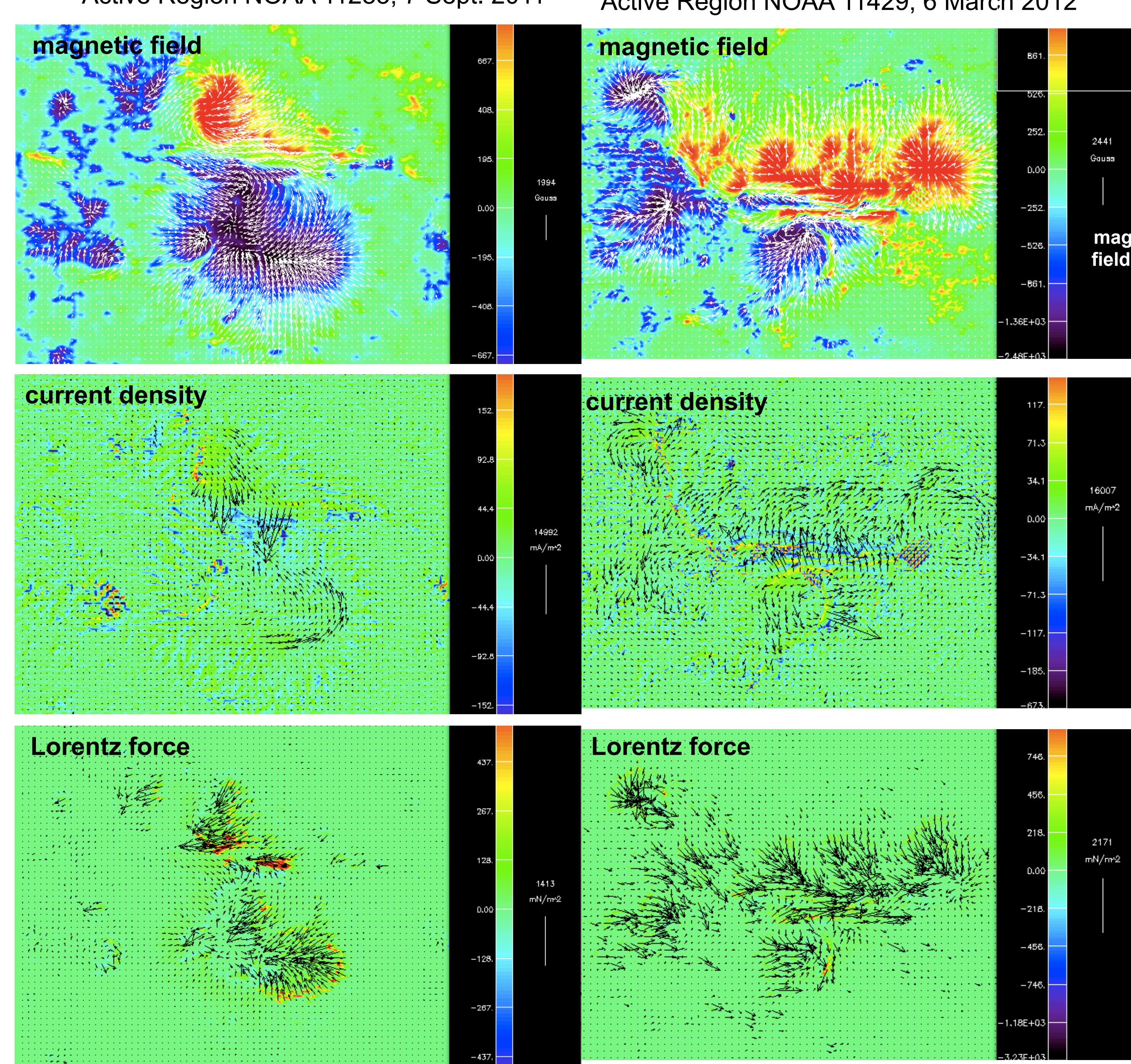
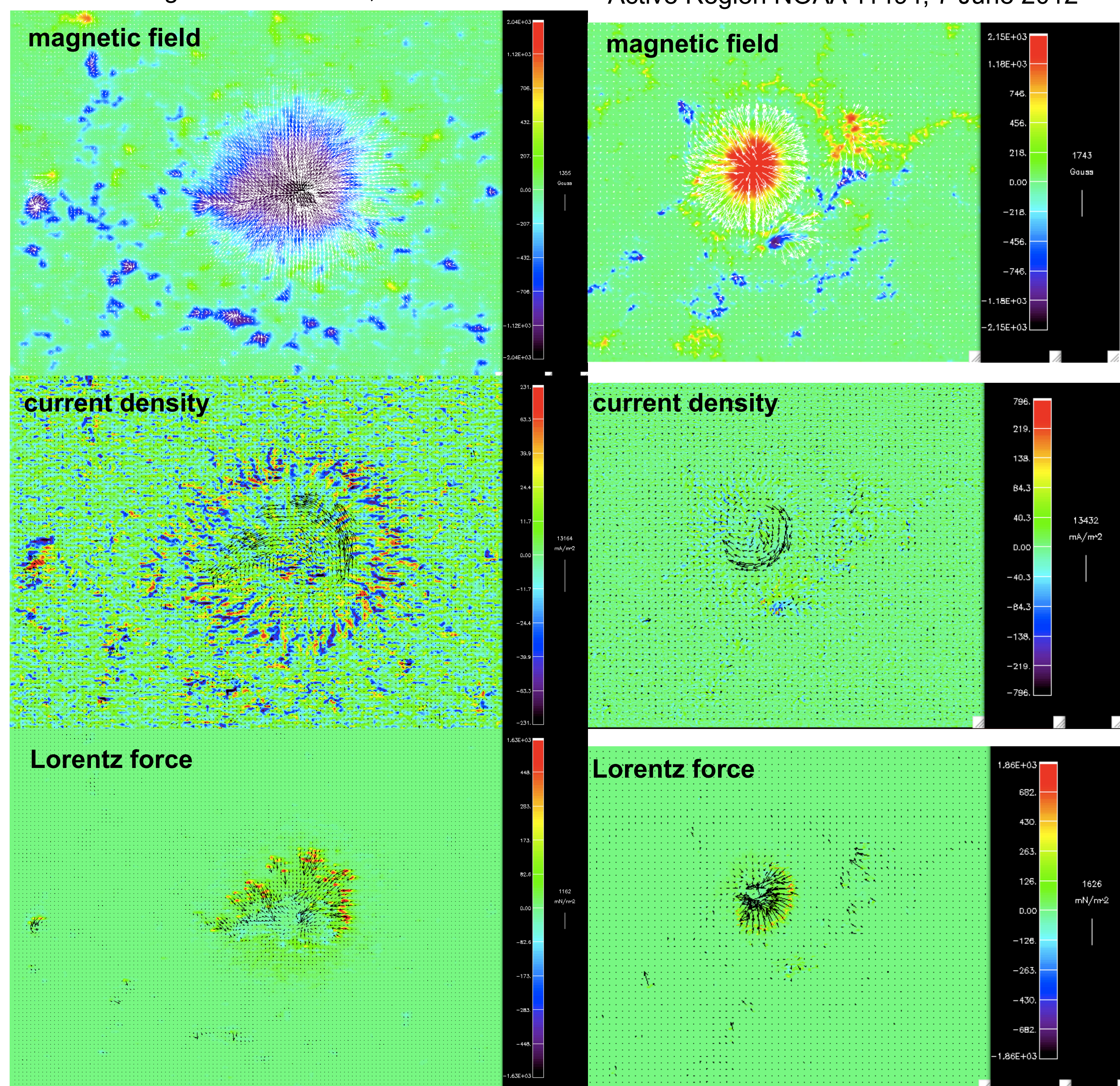
Examples of emerging flux on a neutral line

Active Region NOAA 11420, 18 Feb. 2012

Active Region NOAA 11494, 7 June 2012

Active Region NOAA 11283, 7 Sept. 2011

Active Region NOAA 11429, 6 March 2012



Results:

- the horizontal current component \gg the vertical current component
- the current wraps round the spot, in the indirect direction (opposed to direct)
- the Lorentz force is centripetal, and generally upwards

Results:

- the horizontal current component \gg the vertical current component
- an horizontal current crosses the neutral line, indicating an emerging twisted flux rope
- both regions produced X flares, and NOAA 11429 produced a CME

Na I D1 & D2 open access to the chromospheric level

THEMIS

Na I D1 & D2 open access to the chromospheric level

Fe I 6301/6302

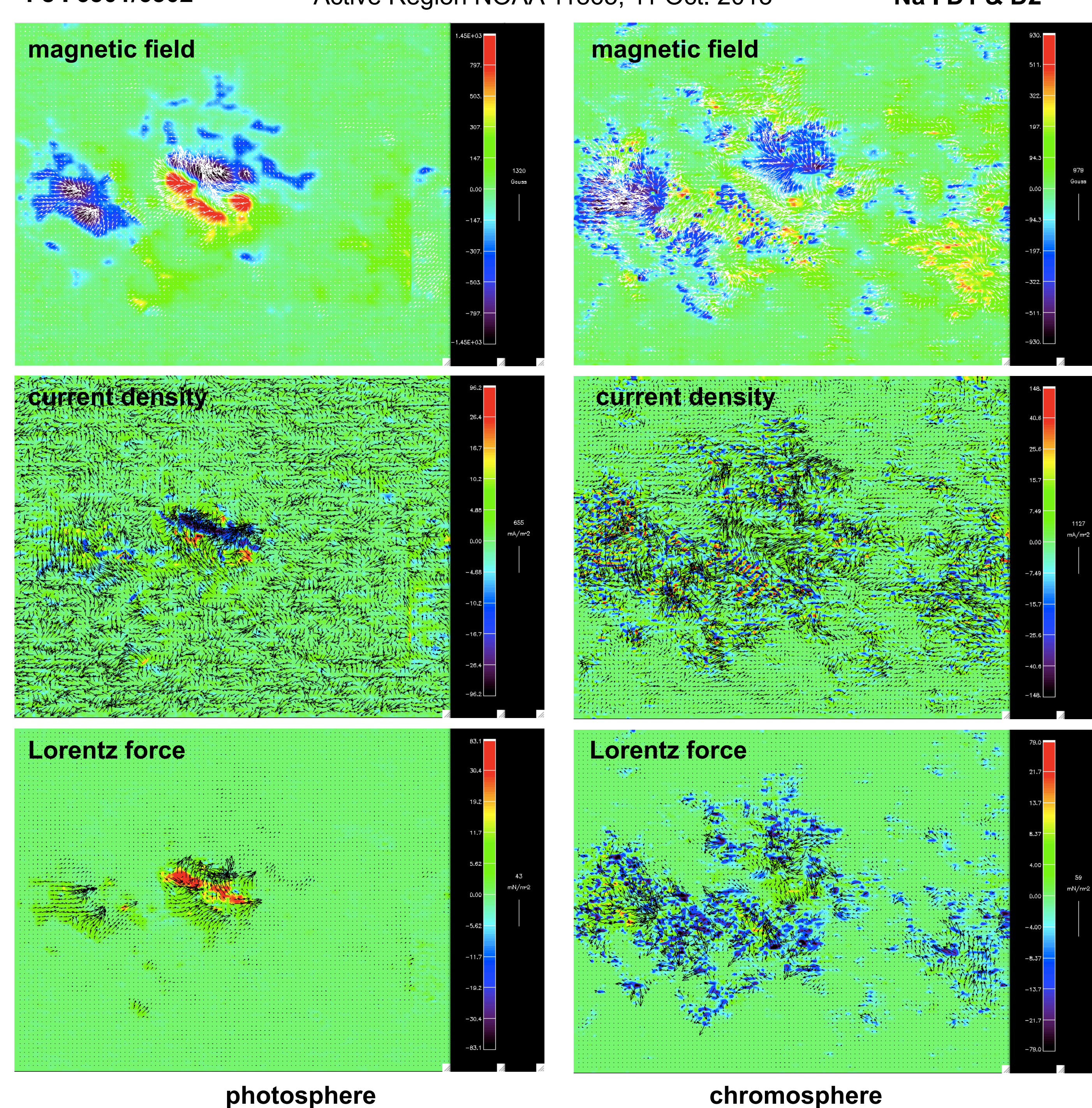
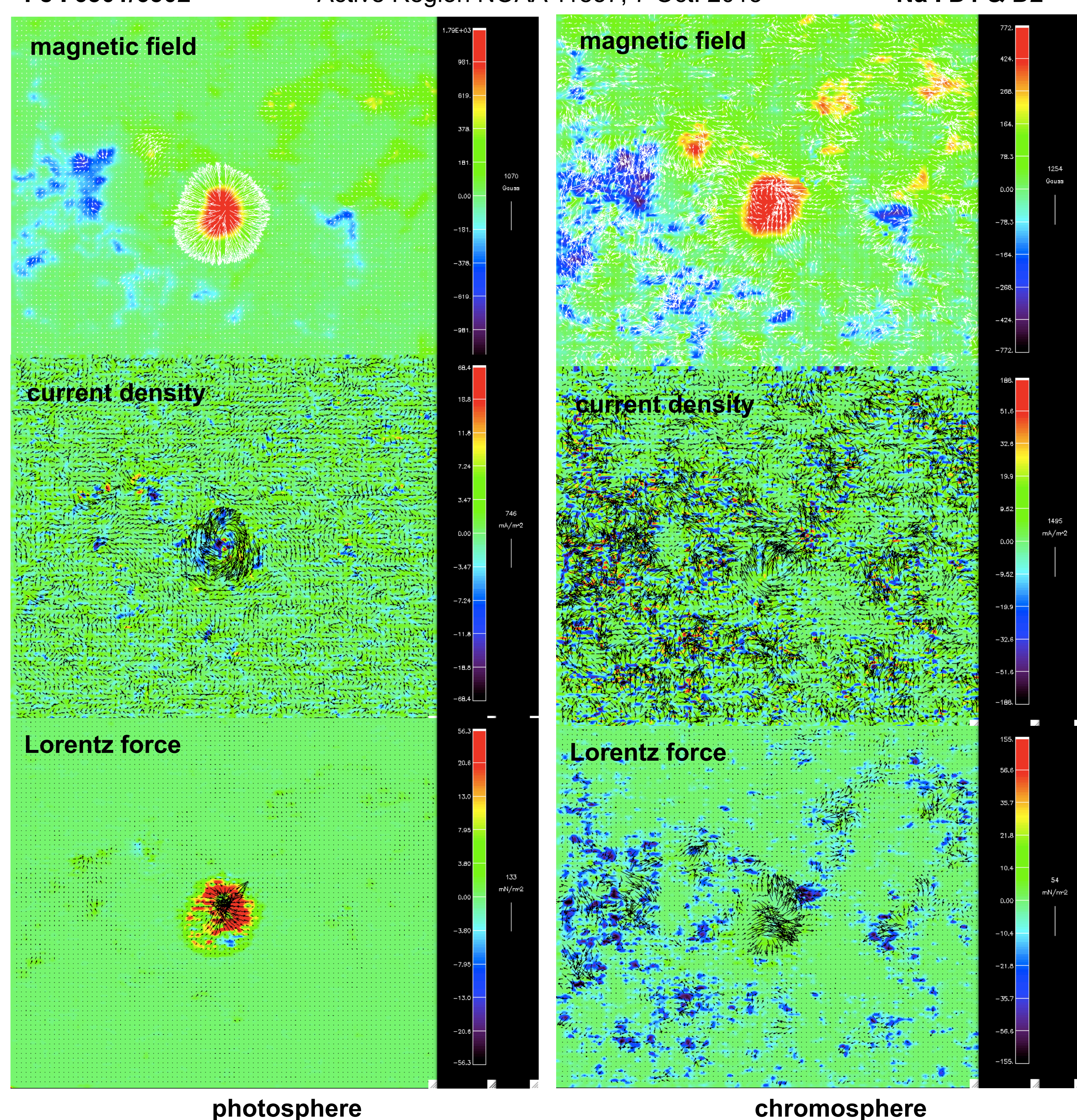
Active Region NOAA 11857, 7 Oct. 2013

Na I D1 & D2

Fe I 6301/6302

Active Region NOAA 11865, 11 Oct. 2013

Na I D1 & D2



photosphere

chromosphere

photosphere

chromosphere