# Relationship between magnetic field and Mg II line profiles in a tornado-like prominence


P. J. Levens[1]

N. Labrosse[1], B. Schmieder[2], A. López Ariste[3], L. Fletcher[1]

1. University of Glasgow, Scotland, UK
2. CNRS LESIA Observatoire de Paris, Meudon, France
3. CNRS IRAP, Toulouse, France

Email: p.levens.1@research.gla.ac.uk


IRIS-6: The Chromosphere, Stockholm, Sweden, 23 June 2016

# Introduction

‘Tornadoes’:

- Apparently rotating columns
- Dense prominence material

Previous studies have measured:

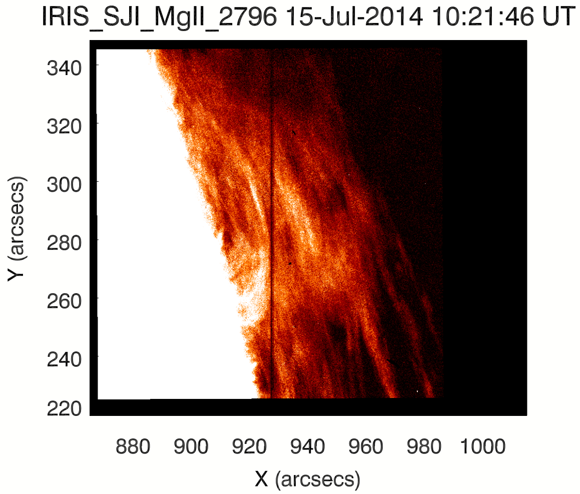
- Plane-of-sky velocities
  - *(Su et al. 2012, Li et al. 2012, Panasenco et al. 2014)*
- L.O.S. velocity
  - EUV *(Su et al. 2014, Levens et al. 2015)*, Hα *(Wedemeyer et al. 2013, Schmieder et al. submitted)*, He I 10830 Å *(Orozco Suárez et al. 2012)*
- Densities, DEMs
  - *(Levens et al. 2015)*
- Magnetic field structure
  - *(Levens et al. 2016a, 2016b, Martínez González et al. 2016)*

**Relationship between magnetic field and plasma parameters remains unclear**

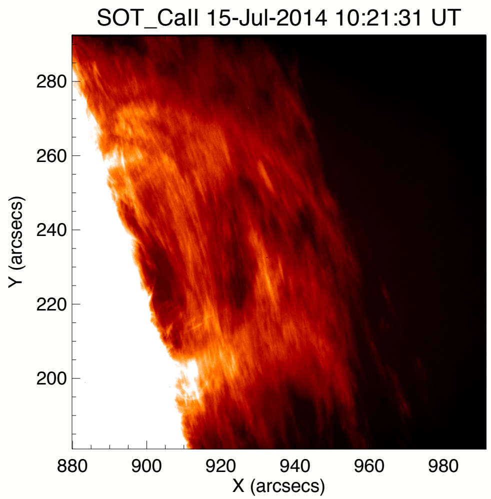
# Coordinated observations

- IHOP 255 - "Magnetic field structure of prominences and solar tornadoes"
- Observation of two tornadoes on 15 July 2014 with THEMIS

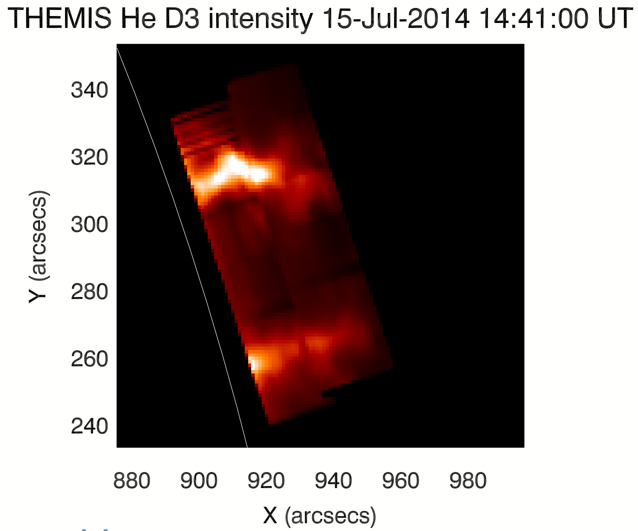
**IRIS**




**Hinode**




**THEMIS**

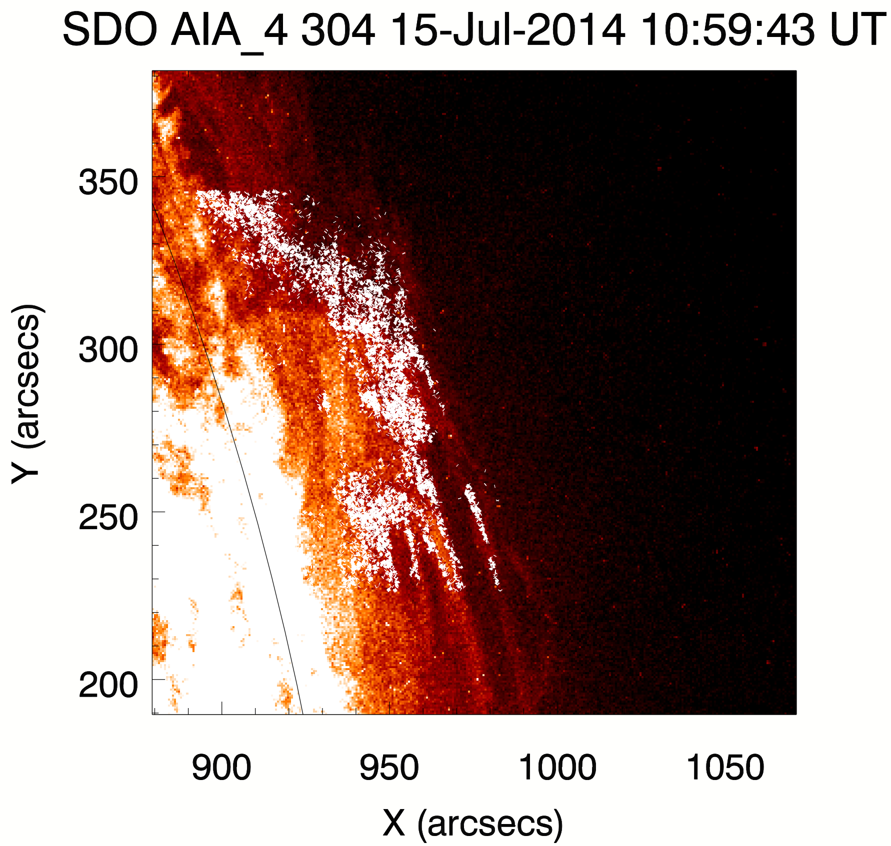



*Note: Different scales and not co-aligned here*

- Observations covered in detail in:
  - *Levens et al. 2016a, ApJ, 818, 1, 31*
  - *Levens et al. 2016b, ArXiv eprints, 1605.05964*

# Cross correlations

- Data sets co-aligned by 2D cross correlation using Mean Absolute Difference algorithm
- Instruments used:
  - SDO AIA (304 Å)
  - Hinode SOT (Ca II)
  - IRIS SJI (Mg II)
  - IRIS raster (Mg II)
  - THEMIS (He I $D_3$)



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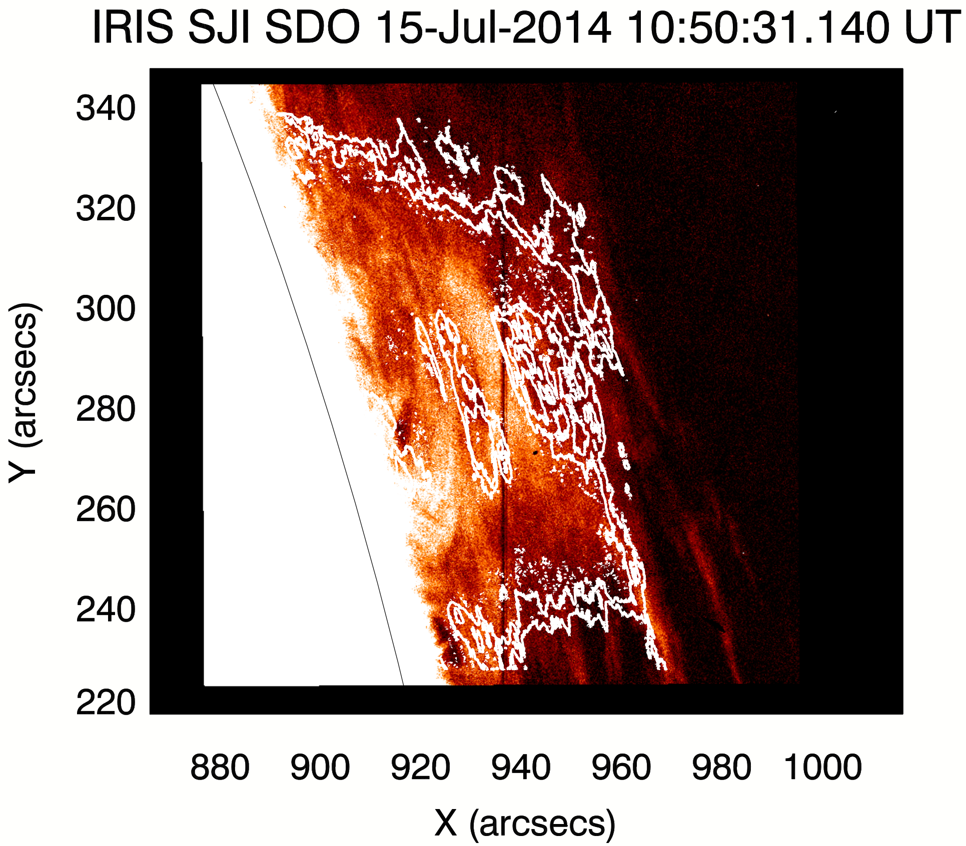

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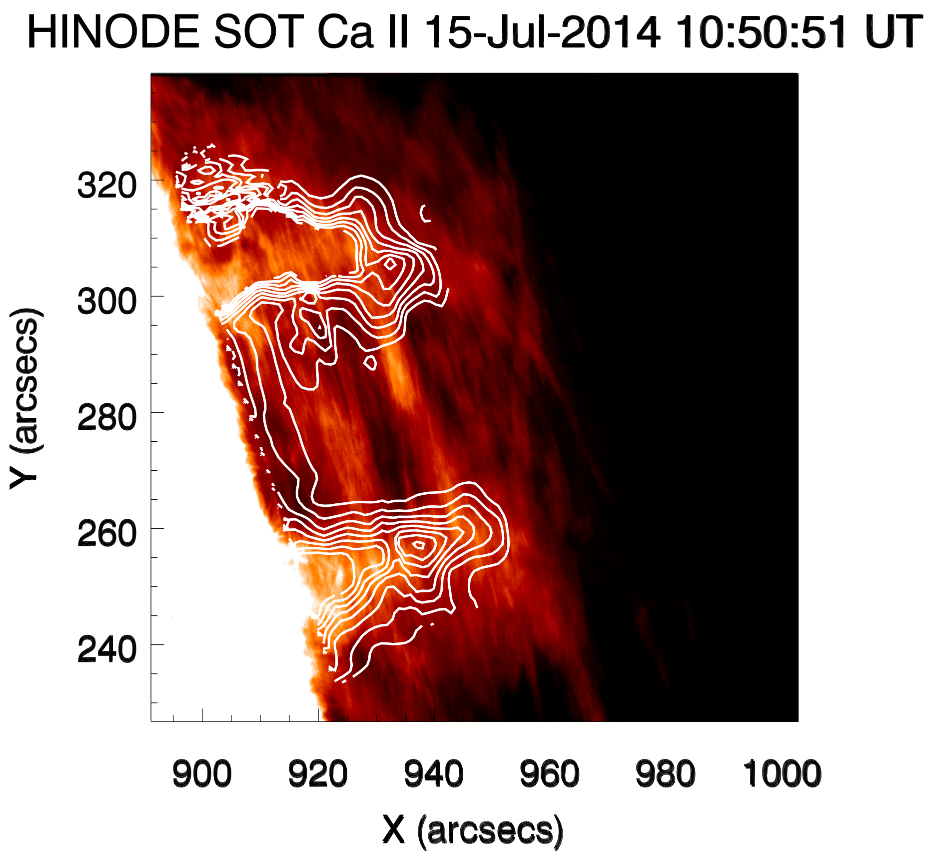

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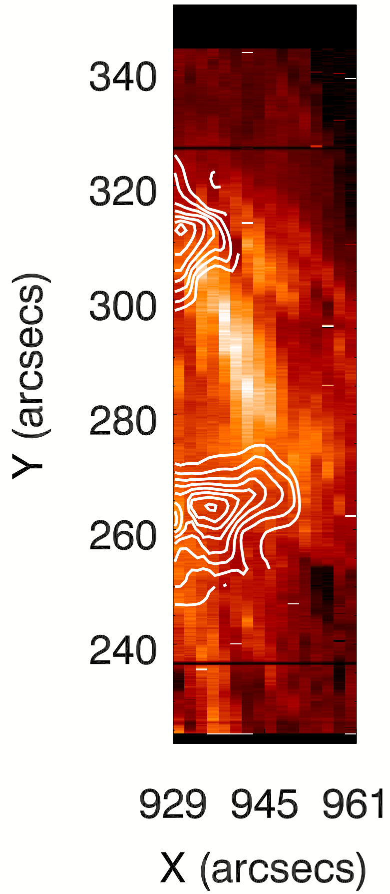
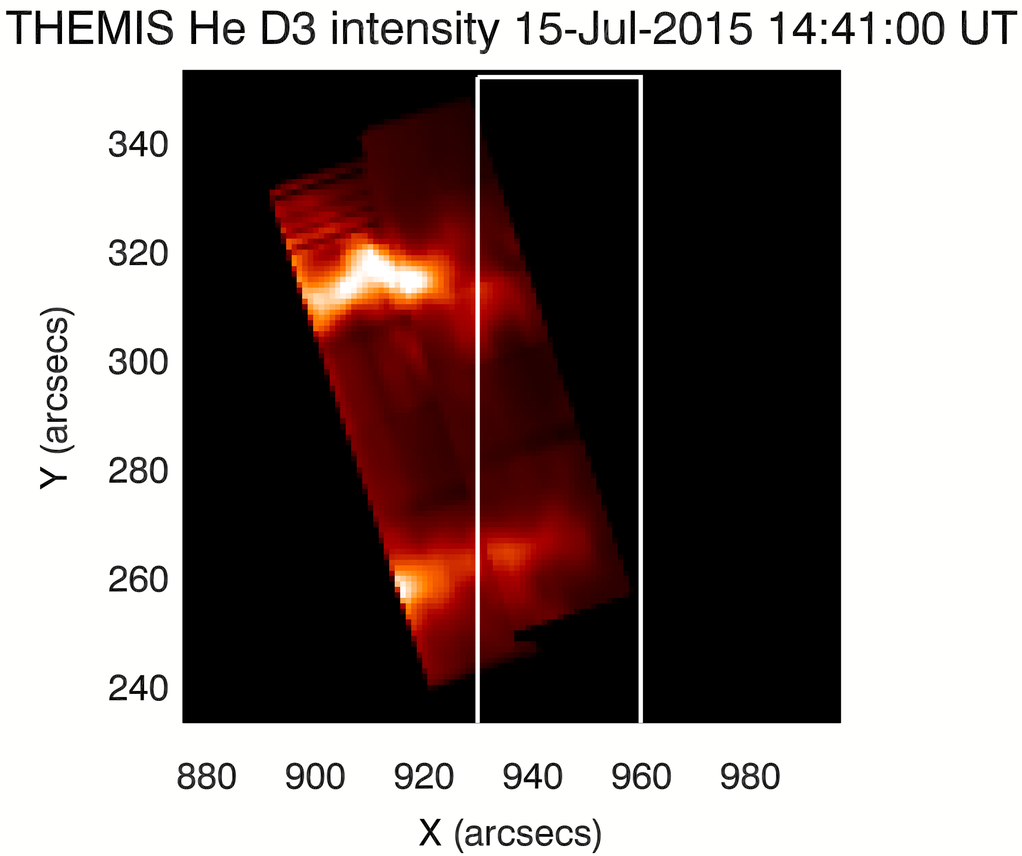
IRIS MgII_2796.20 15-Jul-2014 10:21:46 UT



# IRIS vs. THEMIS

- We focus on overlap between IRIS and THEMIS to look for correlations:



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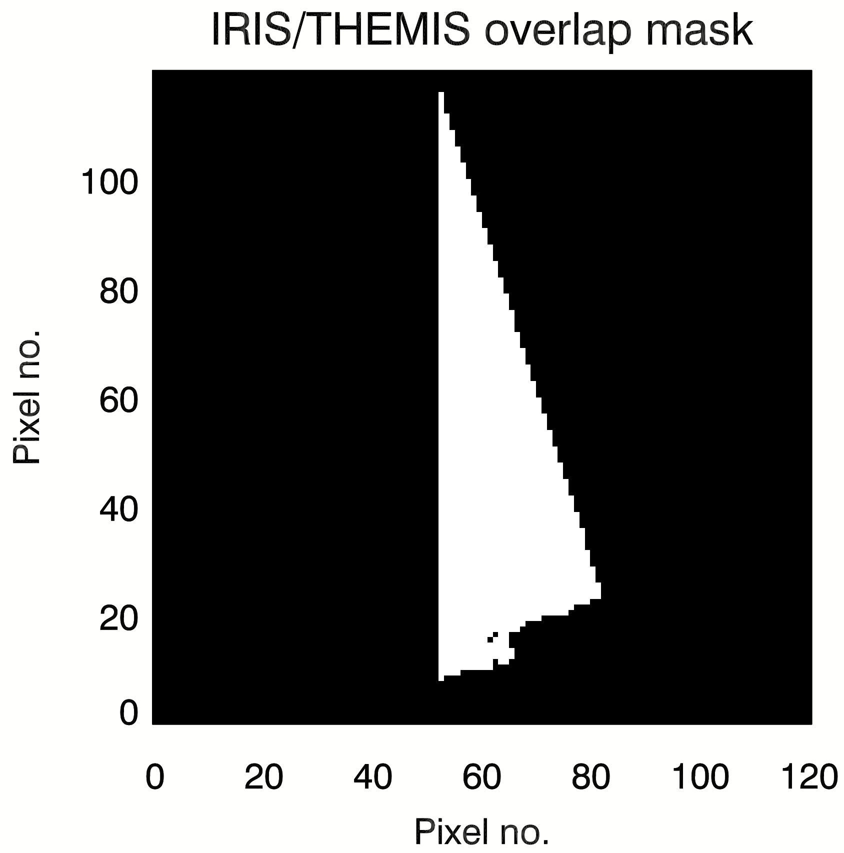

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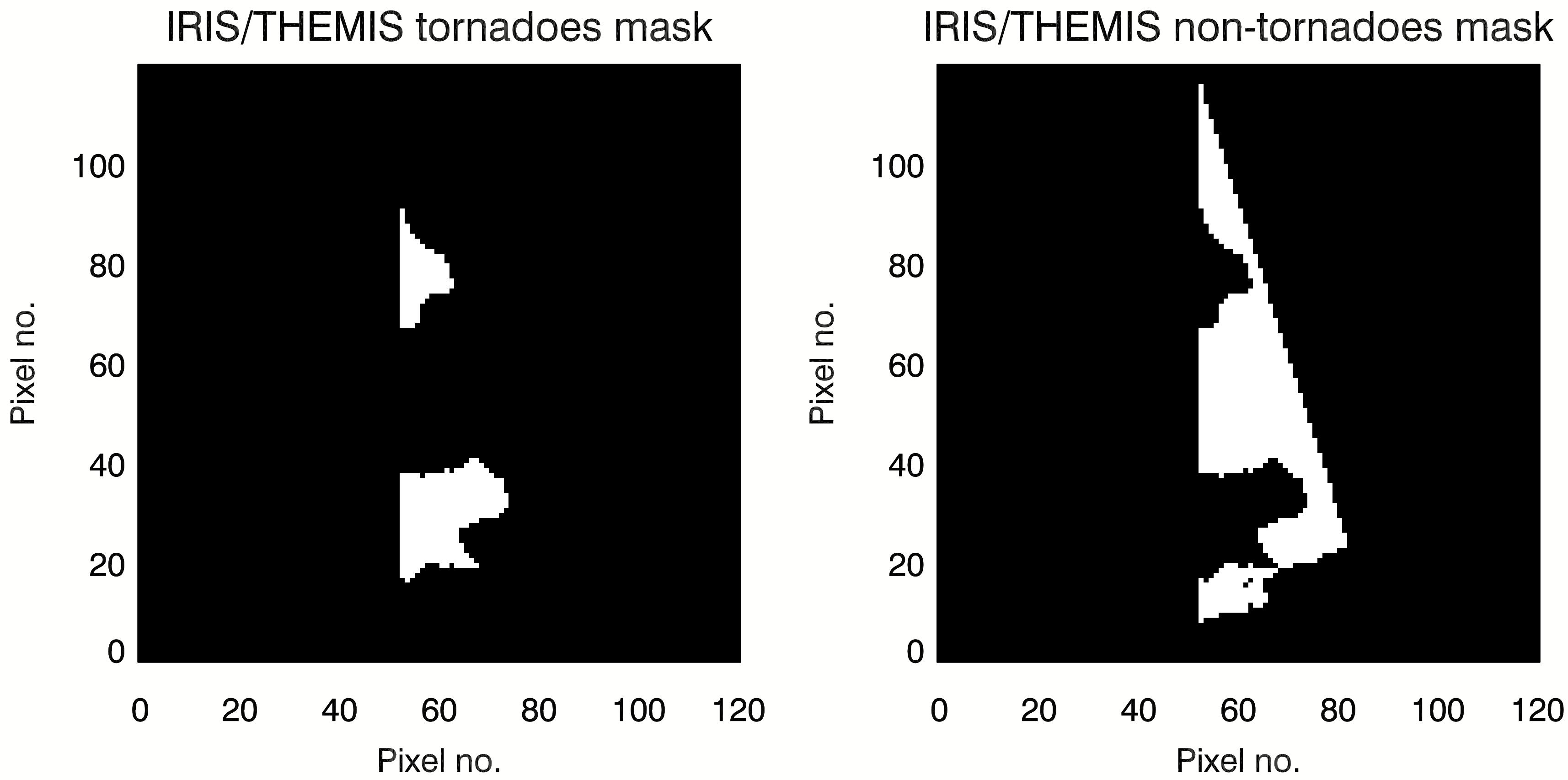
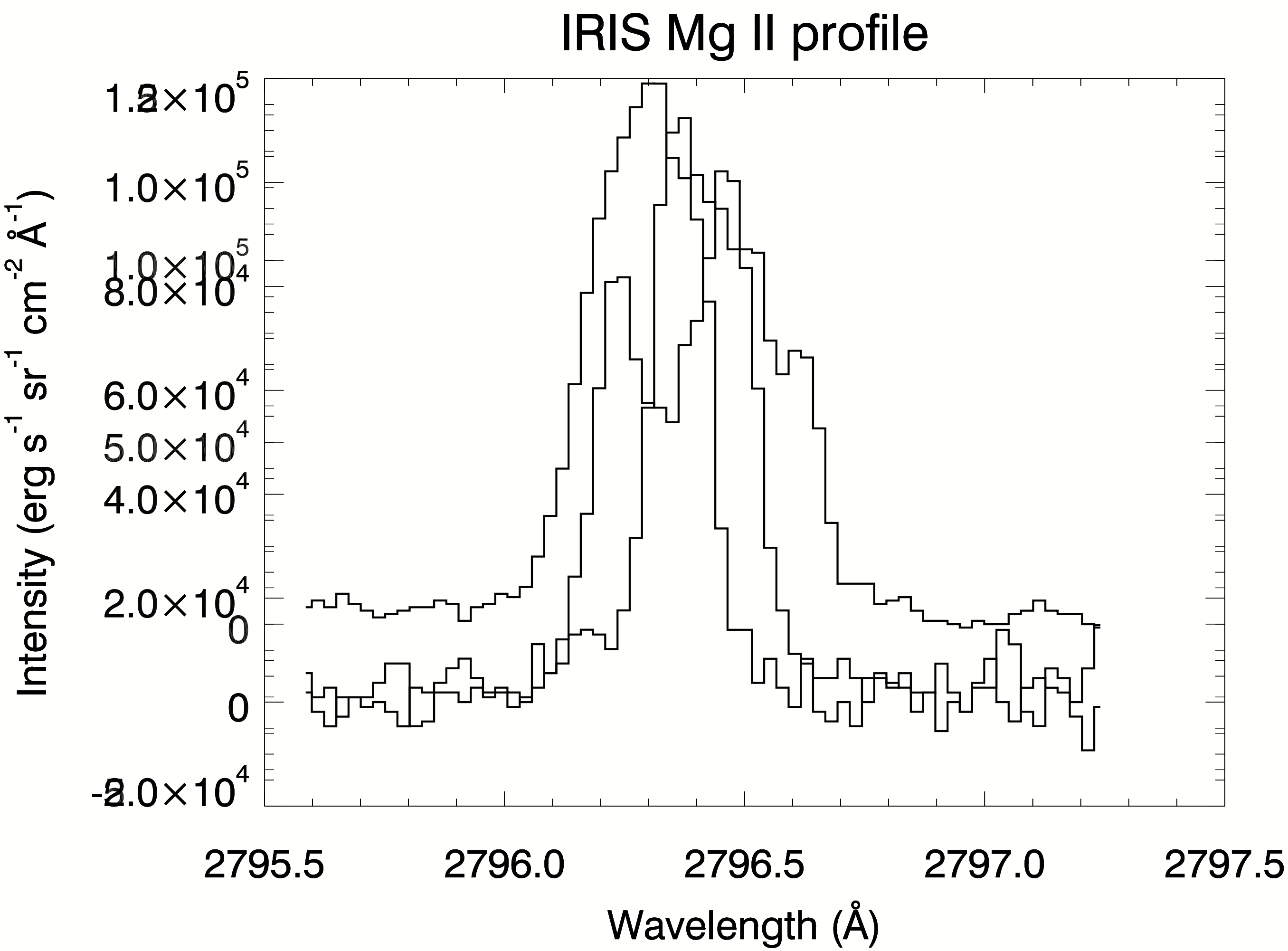



Distinguish two regions – ‘Tornadoes’ and ‘rest of prominence’

# Variety of Mg II profiles

We find both **reversed** and **single-peaked** profiles in this data:



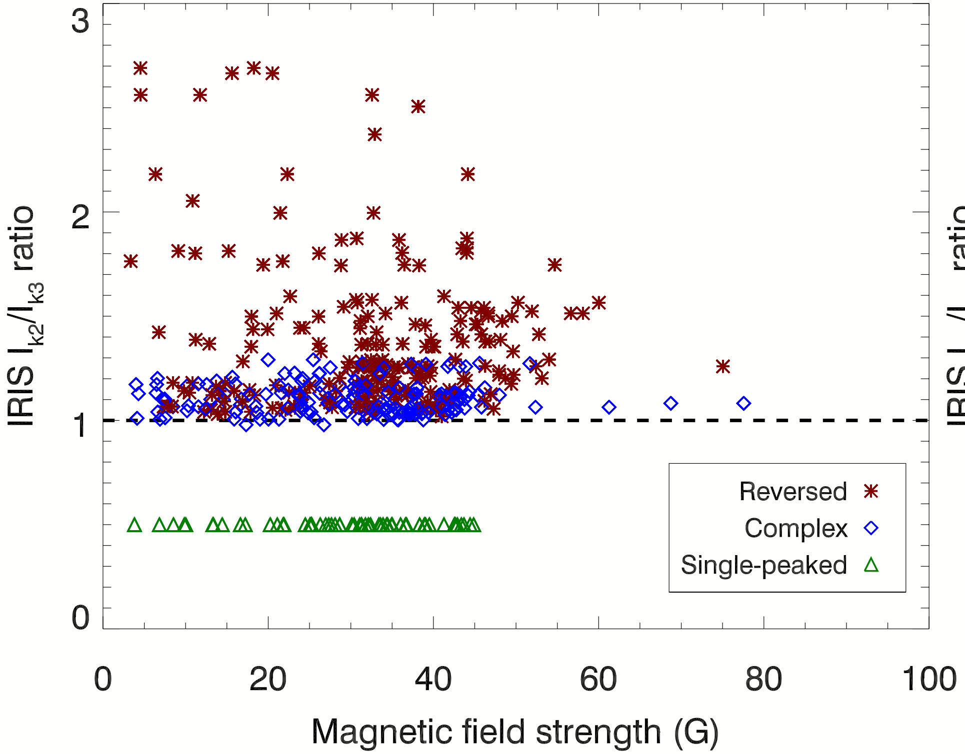

… And some that are more **complex**.

*Peak finder algorithm: Waller et al. (in prep)*

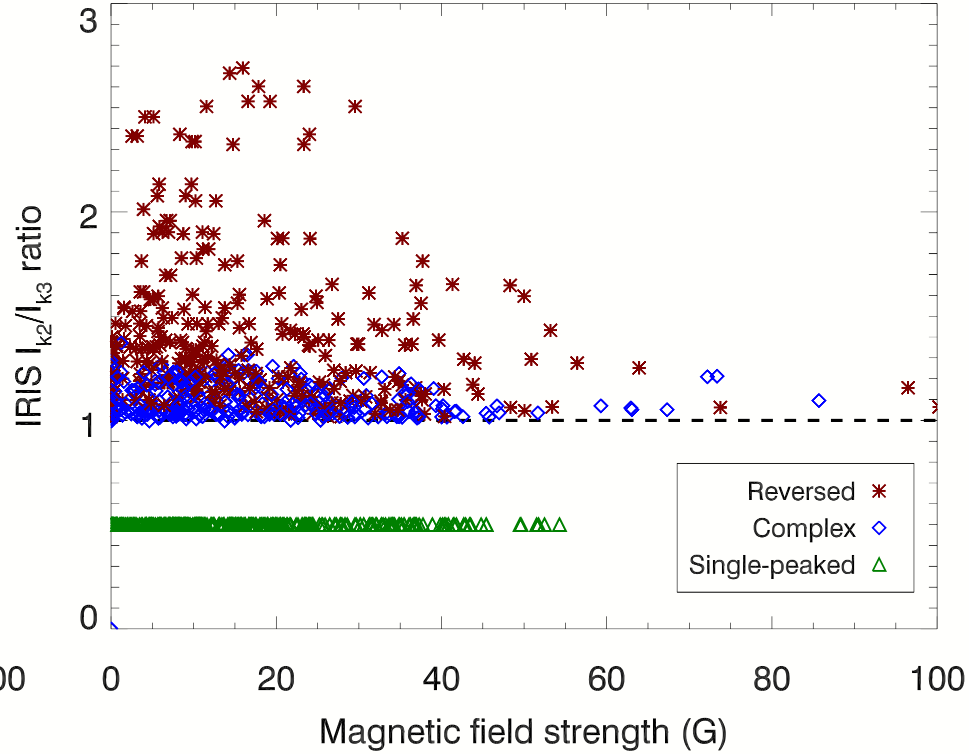
# Mg II reversal level

$I_{k2}/I_{k3}$ ratio vs. B field strength:

***In tornadoes***



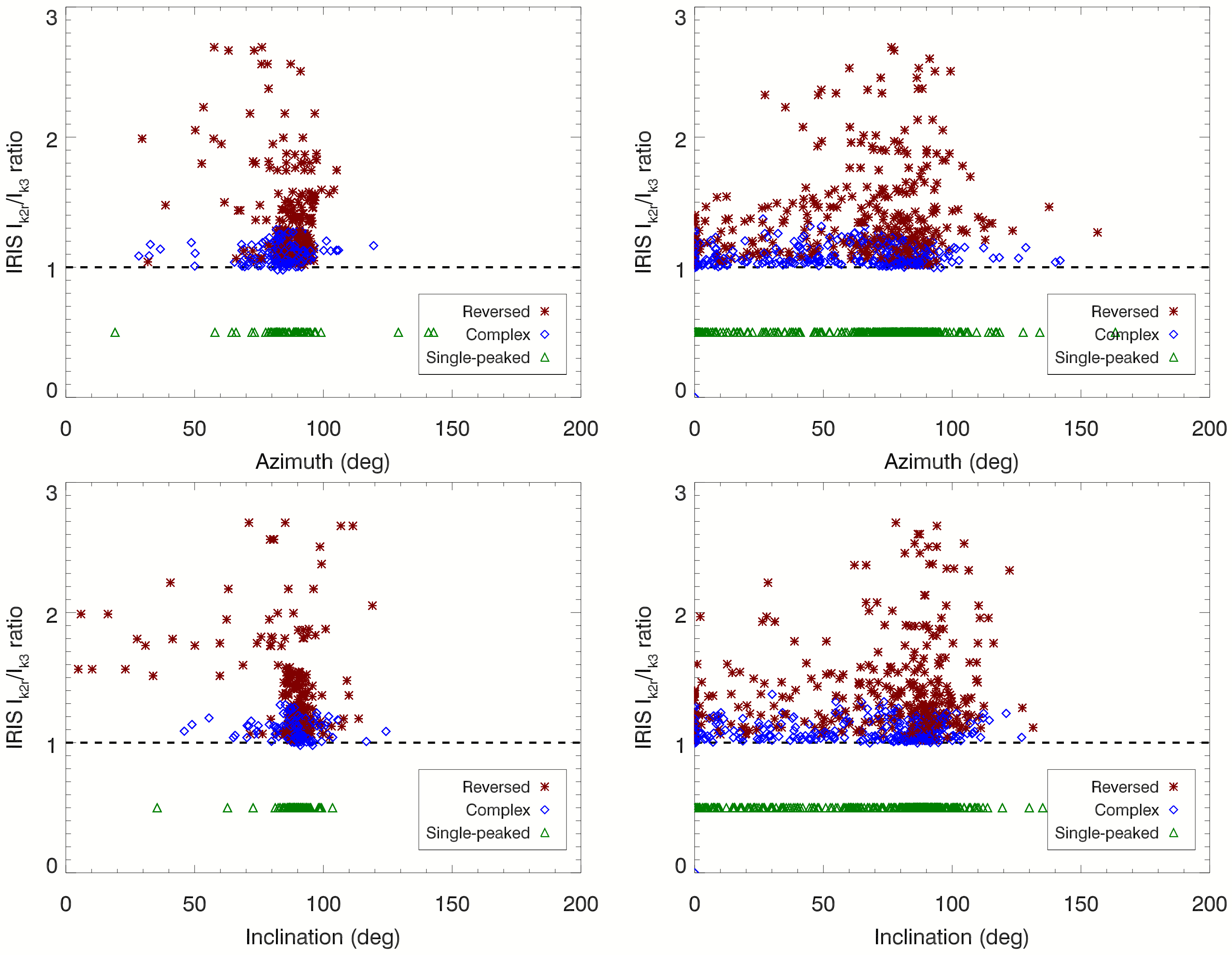

***Rest of prominence***



**In tornadoes** | **Rest of prominence**

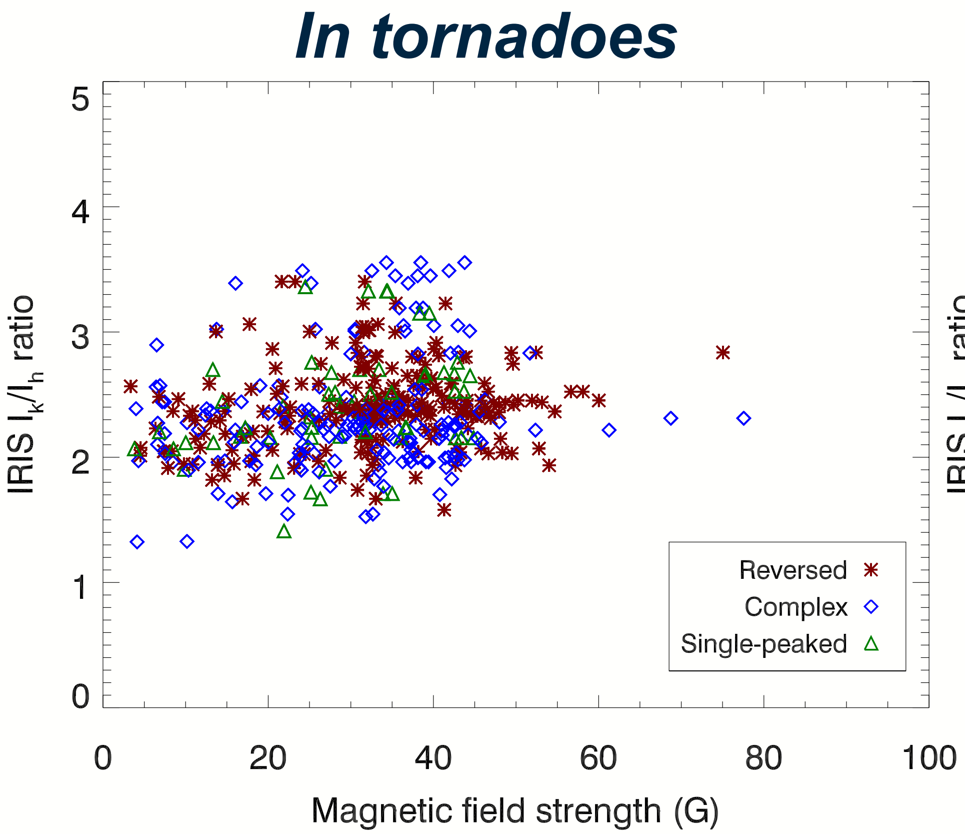
**vs. l.o.s. Azimuth**

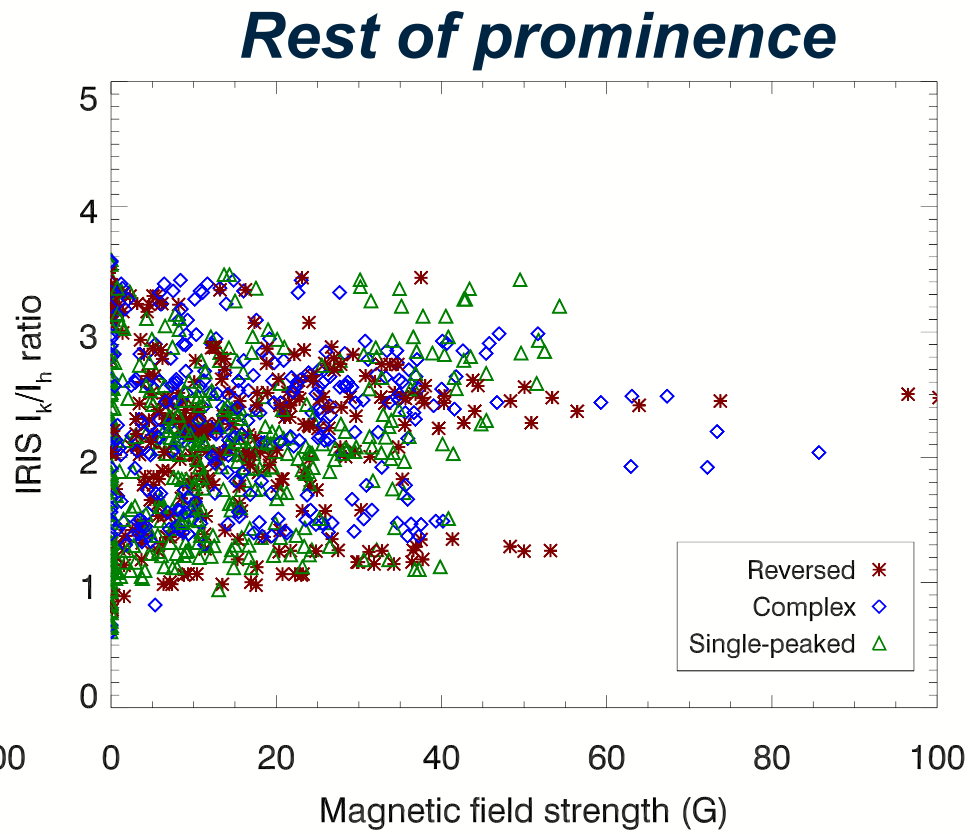
**vs. Inclination**



# Mg II k/h ratio

$I_k/I_h$ ratio vs. B field strength:



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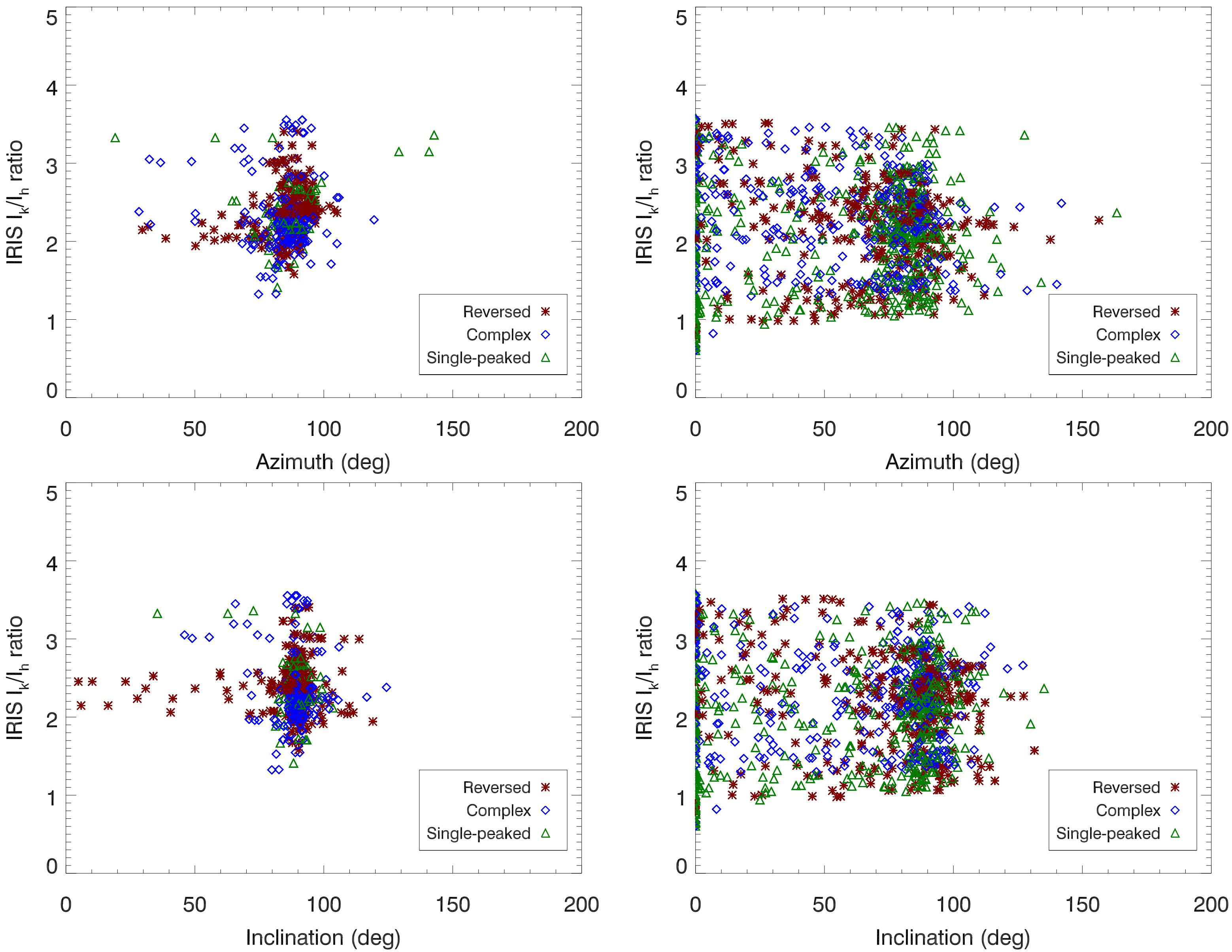

# Summary of results

- Magnetic field strength higher in tornadoes than in rest of prominence
- No apparent correlation between magnetic field and Mg II parameters here
  - Could be due to optical thickness effects
  - Incomplete overlap, as much of northern tornado not overlapping with IRIS raster
- Central reversal of Mg II in tornadoes mostly between 1 (single peaked) and 2.7
- k/h ratio between ~1.5 and 3.5 in tornadoes, can be lower in the rest of the prominence
  - Values similar to those found previously, slightly higher *(Schmieder et al. 2014, Heinzel et al. 2014 Harra et al. 2014, Liu et al. 2015, Vial et al. 2015)*

# Conclusion

- Coordinated observations carefully cross-correlated
- Searched for correlations between magnetic field parameters and Mg II line profile parameters
- No clear correlation found in this data set
- Mg II k2/k3 ratio in tornadoes between 1 and 2.7
- Higher magnetic field in tornadoes than outside
- k/h ratio generally between 1.5 and 3.5 in tornadoes, can be lower elsewhere
- Need new models to fully explain Mg II profiles
- Magnetic field parameters will help constrain these