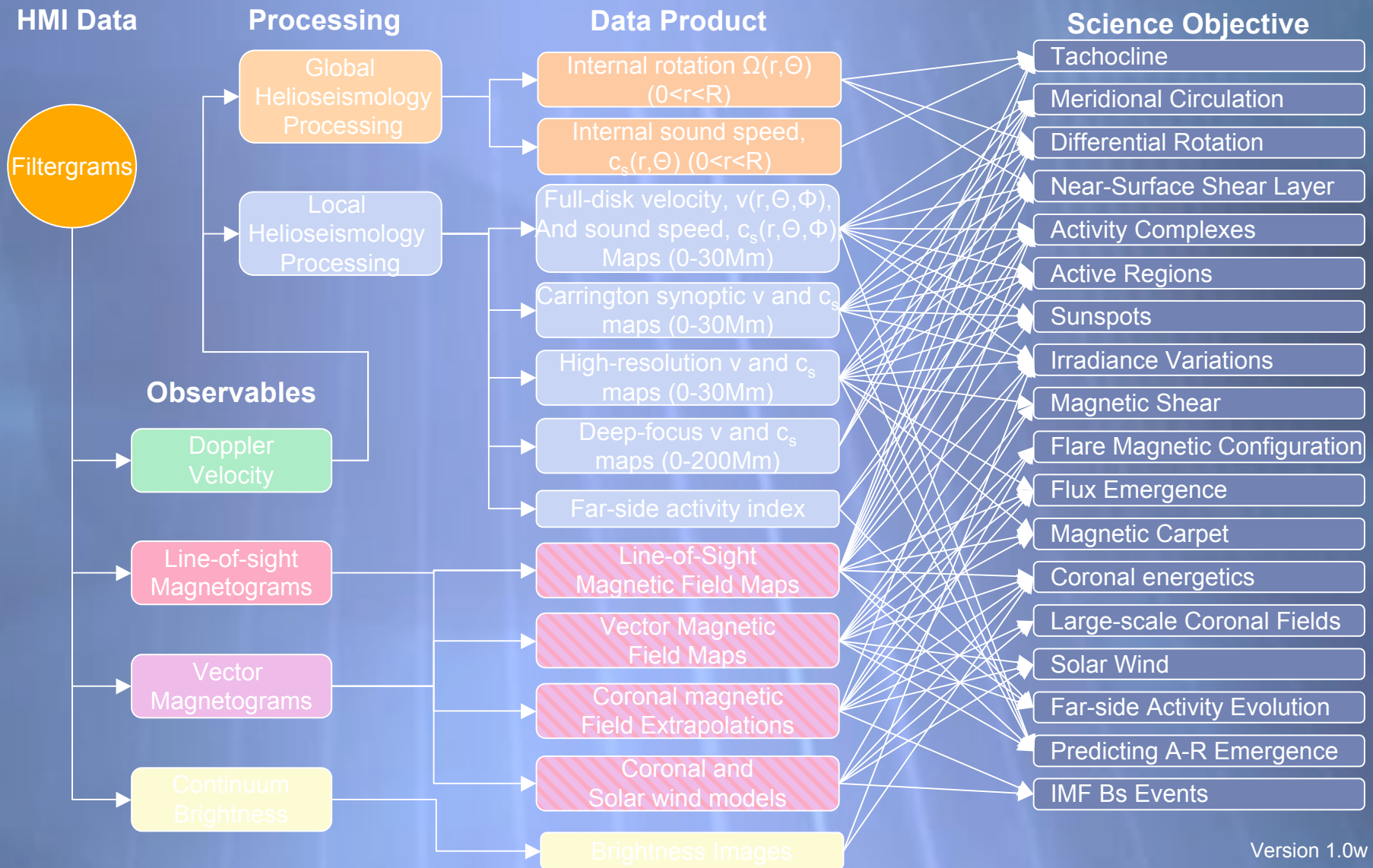


Non-Potential Coronal Field Modeling

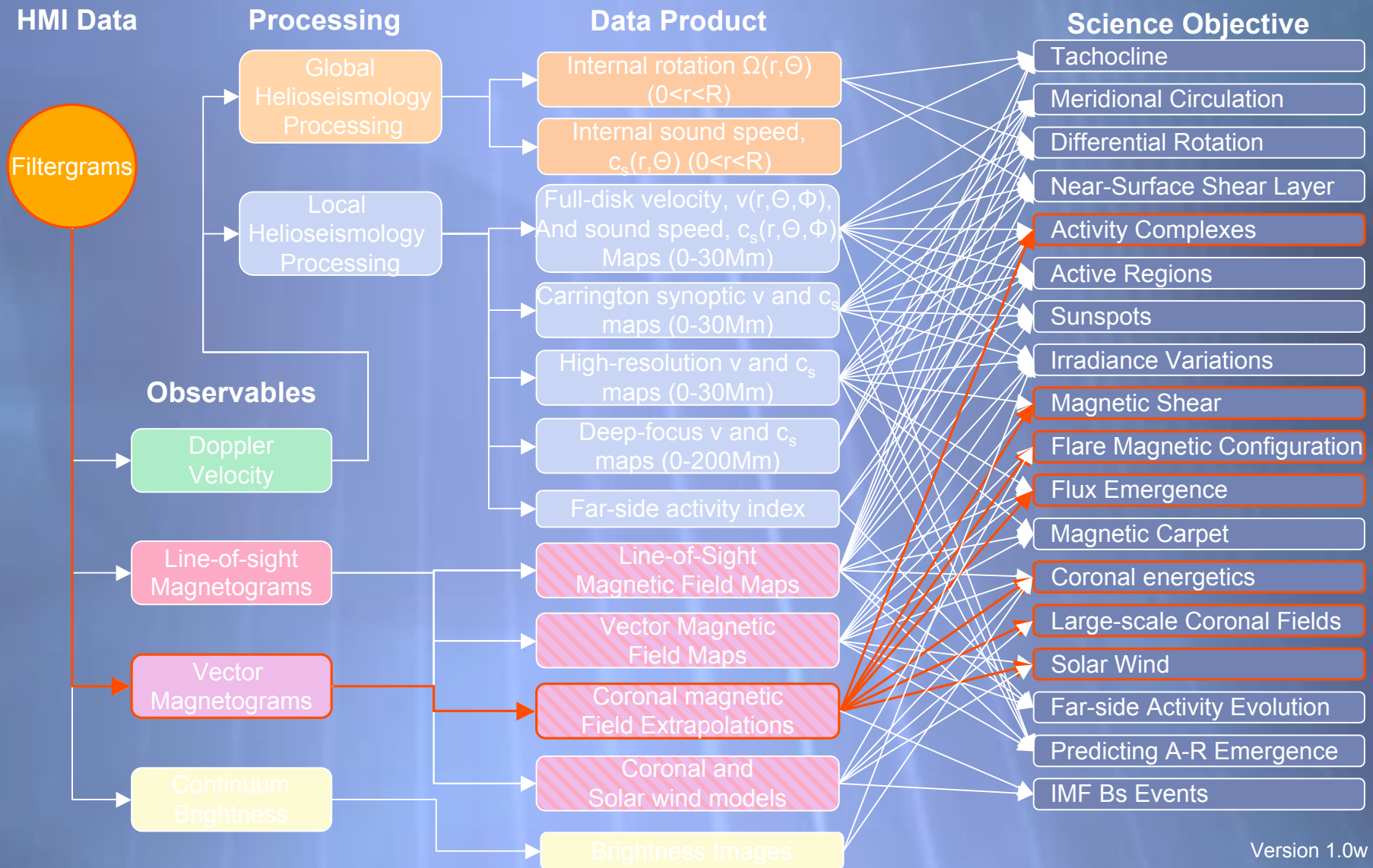
Marc DeRosa
HMI Science Team Meeting

September 9, 2009

HMI Science Analysis Plan

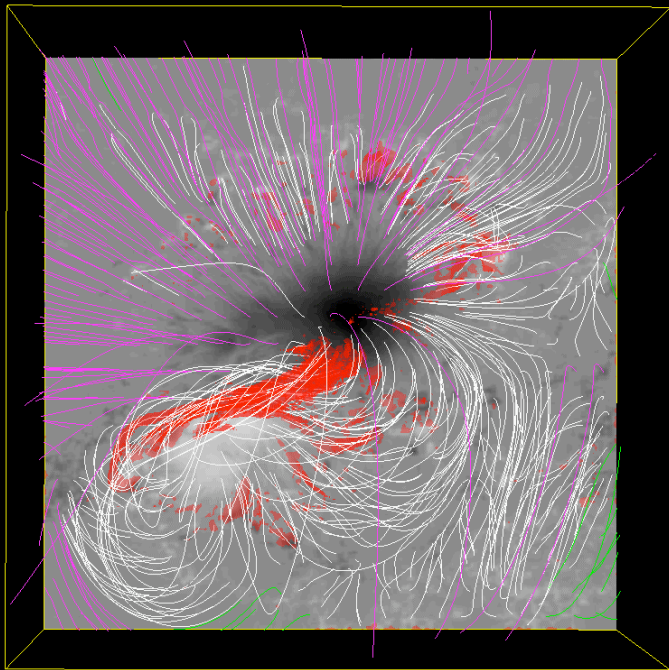


HMI Science Analysis Plan



AR 10930

pre-flare



isosurface of $|J|$ shown in red

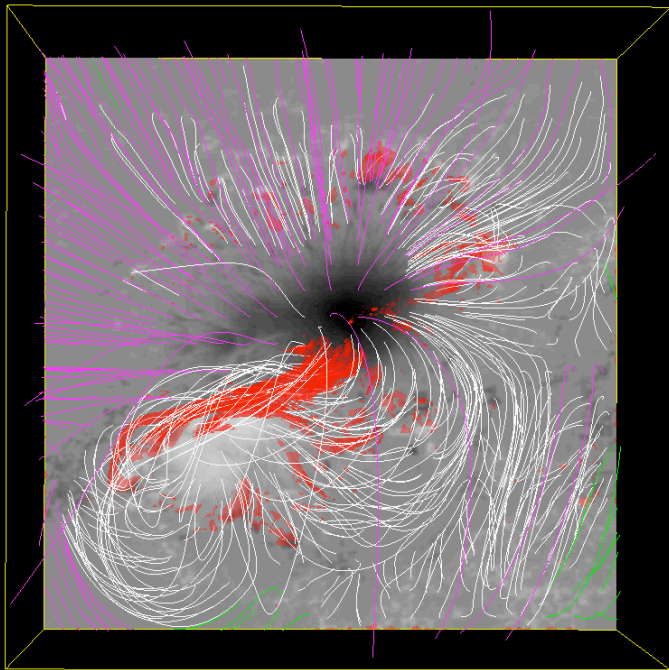
$E/E_{\text{pot}}=1.32$

Model	pre-flare E/E_{pot}
Wh⁺_{pp}	1.32
Wh ⁺ _{np}	1.10
Wie _{wp}	1.09
Val _{pp}	1.10
Wh ⁰ _{pp}	1.04
Wie _{ns}	1.04
Val _{np}	0.88
Wie _{np}	0.95
Wie _{pp}	1.05
McT _{pp}	1.01
Wh ⁰ _{np}	1.03
Wh ⁻ _{np}	1.04
Wh ⁻ _{pp}	1.05
McT _{np}	0.95
Potential	1.00

from Schrijver et al. (2008)

AR 10930

pre-flare



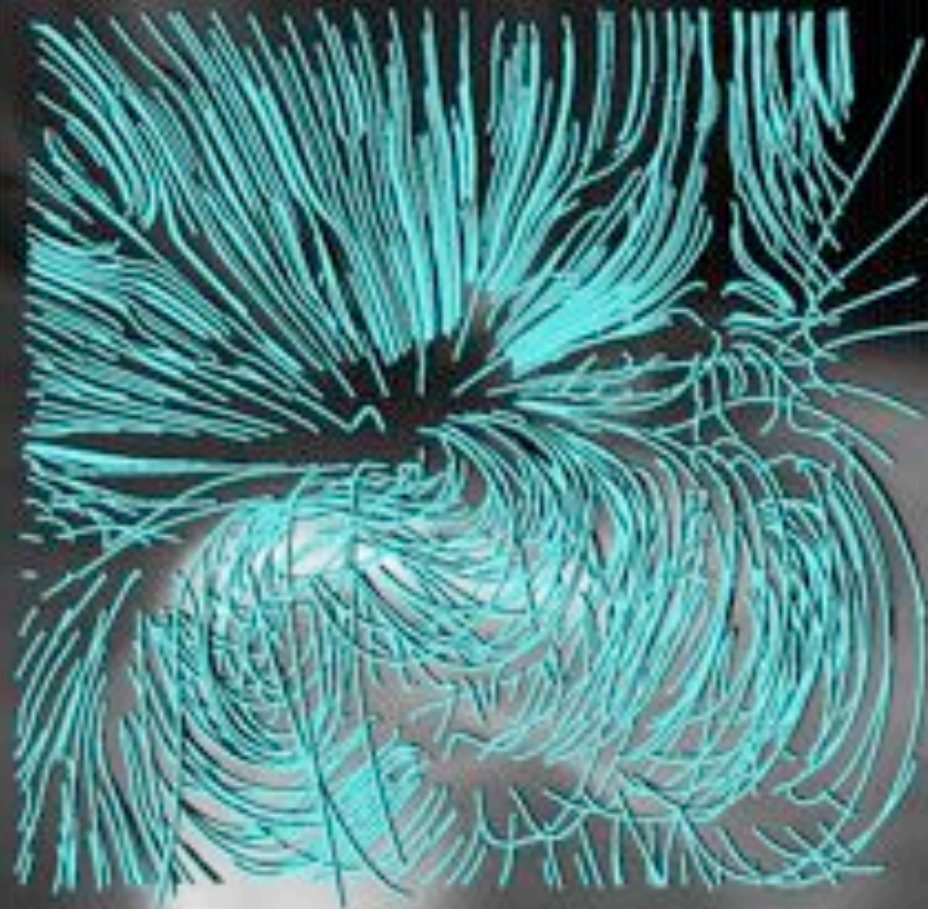
isosurface of $|J|$ shown in red

$E/E_{\text{pot}}=1.32$

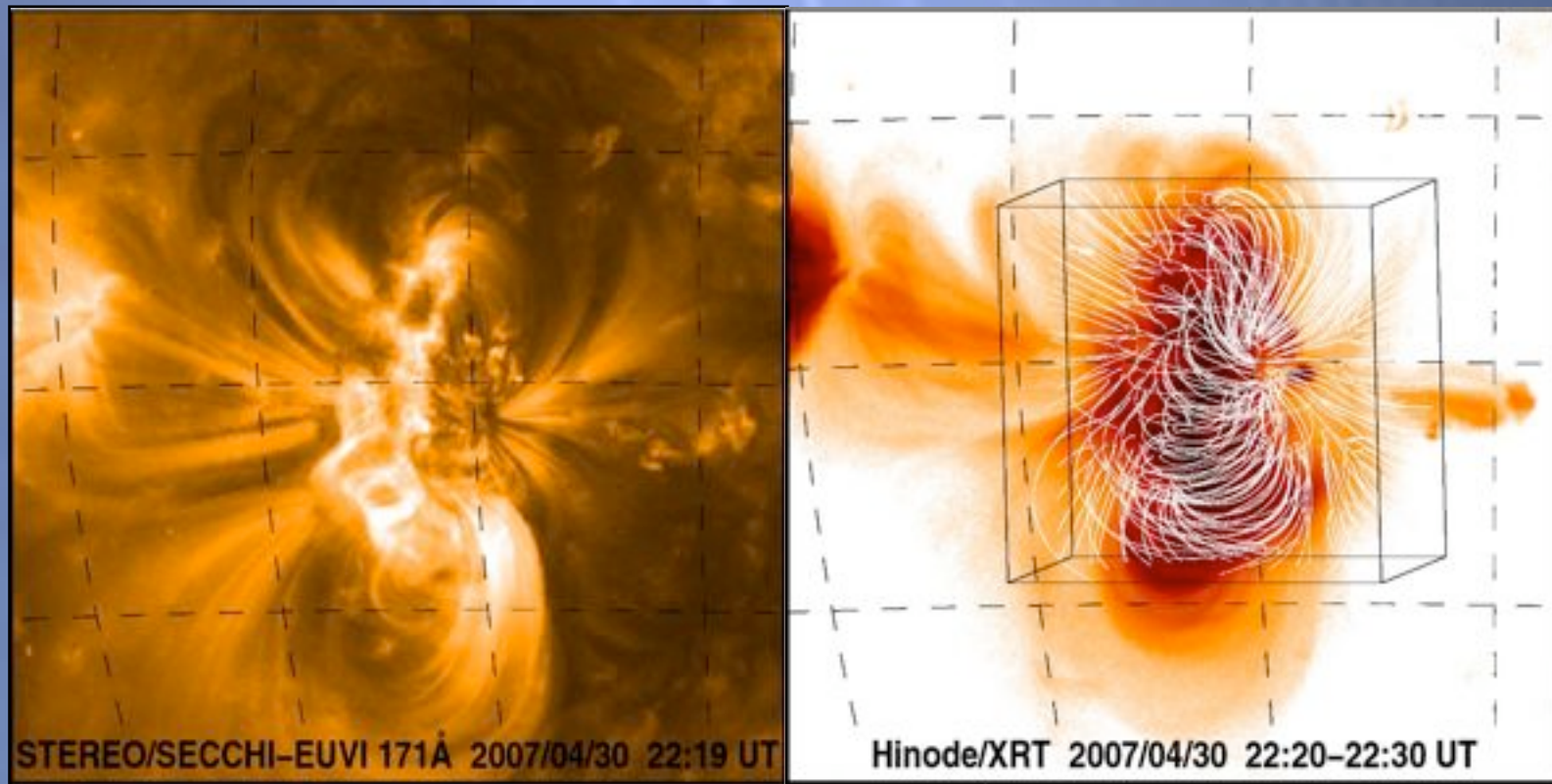
Model	pre-flare E/E_{pot}
Wh_{pp}^+	1.32
Wh_{np}^+	1.10
Wie_{wp}	1.09
Val_{pp}	1.10
Wh_{pp}^0	1.04
Wie_{ns}	1.04
Val_{np}	0.88
Wie_{np}	0.95
Wie_{pp}	1.05
McT_{pp}	1.01
Wh_{np}^0	1.03
Wh_{np}^-	1.04
Wh_{pp}^-	1.05
McT_{np}	0.95
Potential	1.00

from Schrijver et al. (2008)

AR 10930



AR 10953



(images to scale)

from DeRosa et al. (2009)

AR 10953

Table 1
NLFFF Model Extrapolation Metrics^a for AR 10953

Model ^b	E/E_{pot}^c	$\langle \text{CW} \sin \theta \rangle^d$	$\langle f_i \rangle^e (\times 10^8)$	$\langle \phi \rangle^f$
Pot	1.00	...	0.02	24°
Wh ⁺	1.03	0.24	7.4	24°
Tha	1.04	0.52	34.0	25°
Wh ⁻	1.18	0.16	1.9	27°
Val	1.04	0.26	71.0	28°
Am1 ⁻	1.25	0.09	0.72	28°
Am2 ⁻	1.22	0.12	1.7	28°
Can ⁻	1.24	0.09	1.6	28°
Wie	1.08	0.46	20.0	32°
McT	1.15	0.37	15.0	38°
Rég ⁻	1.04 ^B	0.37	6.2	42°
Rég ⁺	0.87 ^B	0.42	6.4	44°

NLFFF modeling assessment

- ✦ Algorithms do well when given consistent boundary conditions
- ✦ When applied to photospheric data, models produce varying results
 - ✦ BC's known not to be consistent with a force-free field (preprocessing is meant to address this)
 - ✦ Models typically do not match loops seen in EUV and x-ray imagery
 - ✦ Some models do work, but we can't predict ahead of time which ones

NLFFF modeling assessment

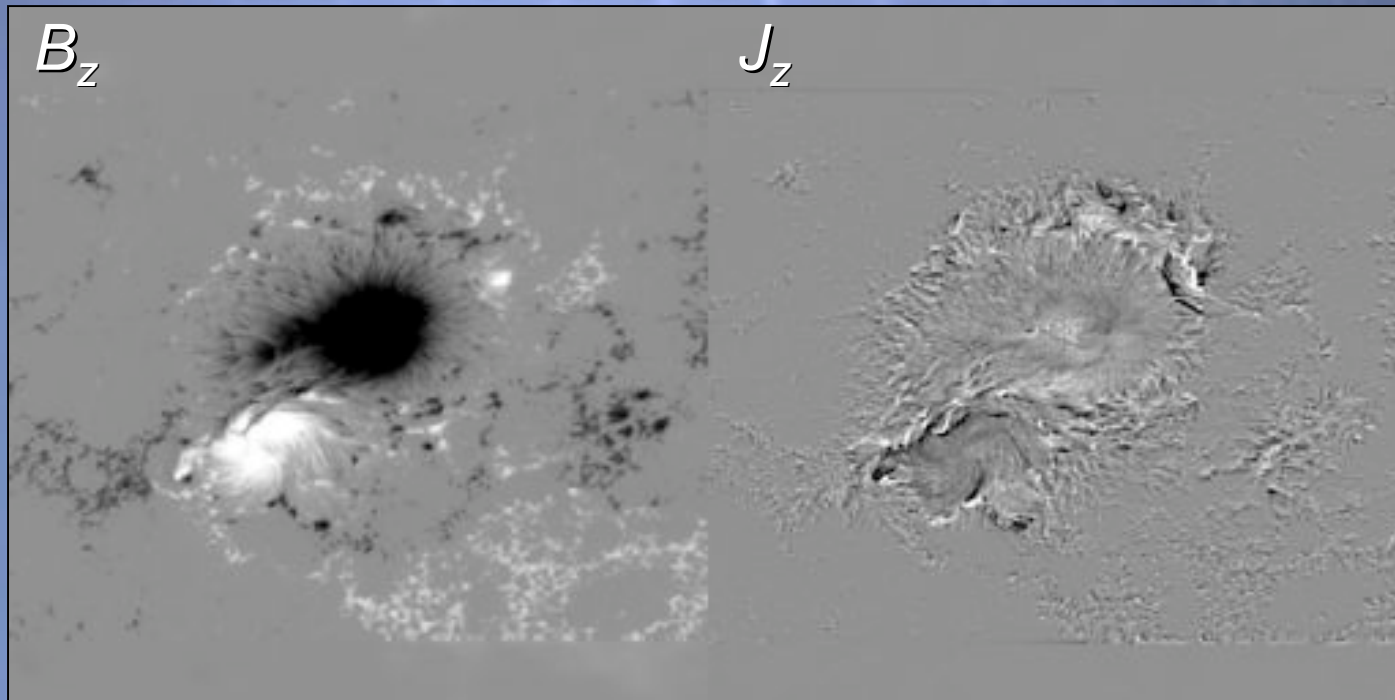
✦ Mitigating factors:

- ✦ Photosphere is not force-free, i.e., many (most?) currents seen at the photosphere do not reach the corona
- ✦ Vector data fields of view are limited to the core of the active region (so far)
- ✦ Maybe also contributing: preprocessing scheme inadequacies, measurement uncertainties, incorrect disambiguation, line formation height variations (e.g., Wilson depression), unresolved structures (e.g., narrow strands of interleaved penumbral fields), ...

NLFFF modeling assessment

- ✦ Mitigating factors:

- ✦ Photosphere is not force-free, i.e., many (most?) currents seen at the photosphere do not reach the corona



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NLFFF modeling assessment

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What to do for HMI?

- ✦ My opinion: NLFFF methods should be run for each active region, but need to be interpreted with extreme care
 - ✦ Thomas Wiegmann's model will be a JSOC module
 - ✦ Suggest running this model using HMI vector data before and after every strong flare (maybe 2 hr before/after all X-class flares?)
 - ✦ Additional models can be run on an on-request basis
 - ✦ CMS tool important for comparing model fields with loops seen in AIA and will be made available via SSW
 - ✦ Yang and I will write a "NLFFF users' guide", available online for anyone to read (placed in JSOC wiki?)