

# FLARECAST

## SCIENTIFIC RESULTS

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2<sup>nd</sup> Stakeholder Workshop  
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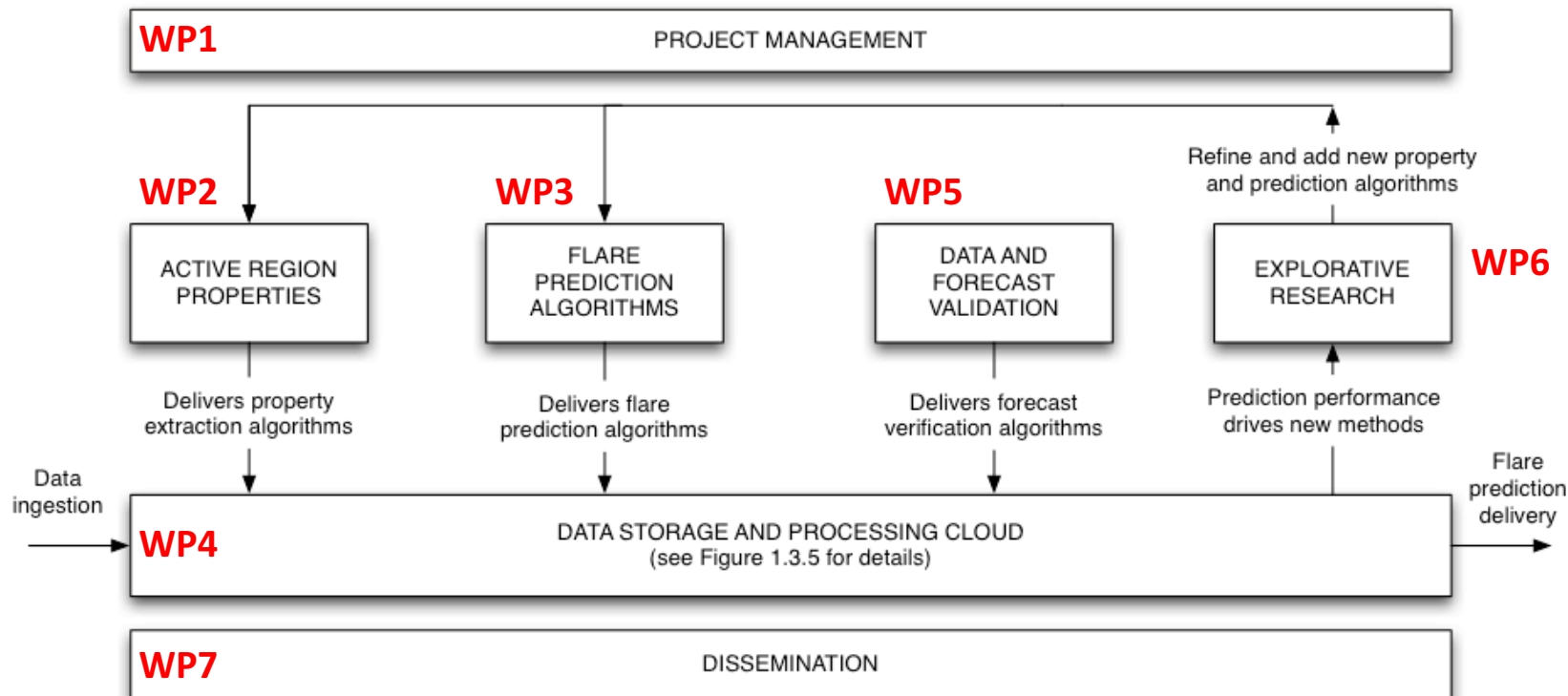


Full Title:      *Flare Likelihood and Region  
Eruption Forecasting*

Acronym:        FLARECAST

Project No.:     640216

# FLARECAST Work Package Structure

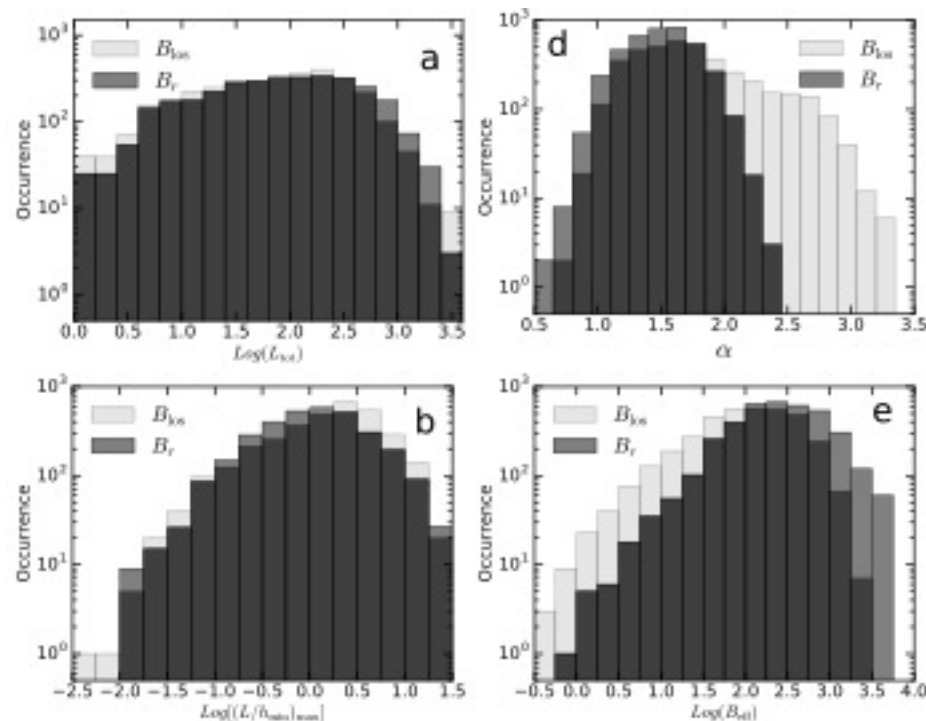


# Active Region Properties (WP2)



## Properties calculated from $B_{los}$ v $B_r$ (Guerra *et al.*, under review)

- Comparison between extracted properties from same algorithms
  - morphologic properties least effected (e.g., PIL length – panel a)
  - spatial pattern properties constrained (e.g., spectral power index – panel d)
  - flux-related properties shifted upward (e.g.,  $B_{eff}$  – panel e)

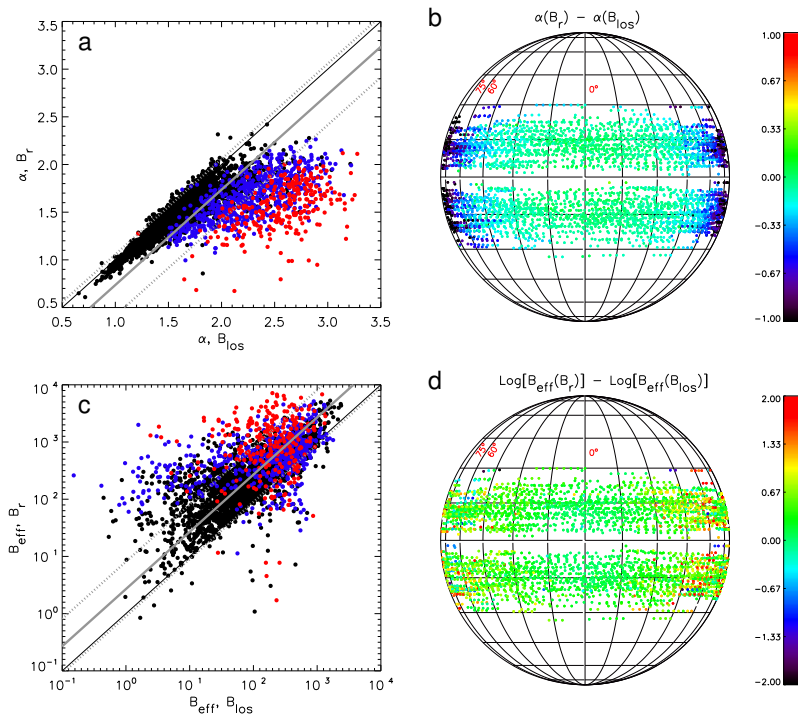


# Active Region Properties (WP2)

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## Properties calculated from $B_{\text{los}}$ v $B_r$ (Guerra *et al.*, under review)

- Comparison between extracted properties from same algorithms
  - property differences largest towards the limb
- indications of E-W asymmetry
  - SDO/HMI noise



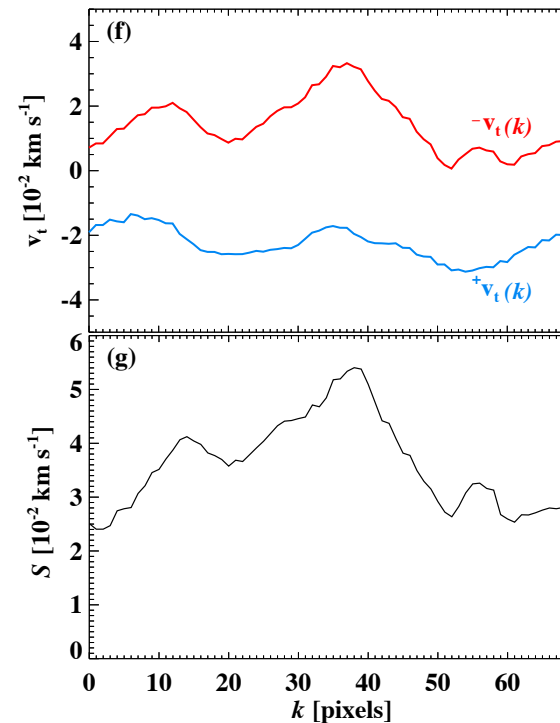
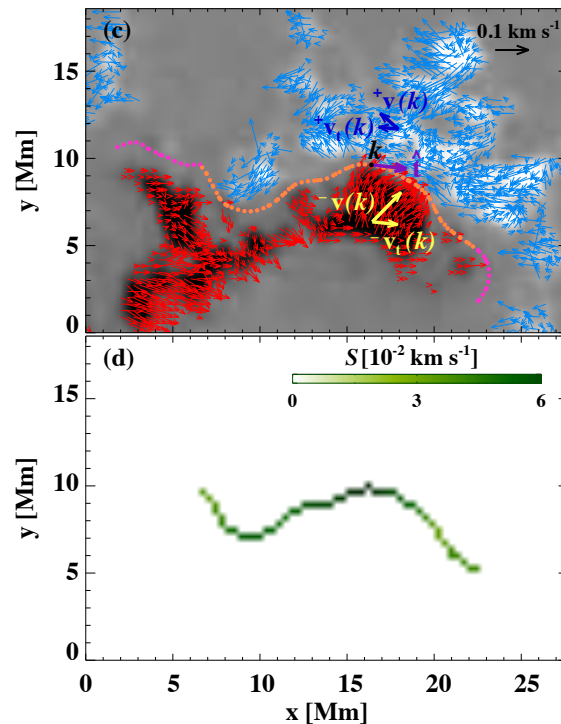


# Active Region Properties (WP2)



## Flows near polarity inversion lines (Park *et al.*, under review)

- Characterising flows in opposite polarity regions
  - decompose into parallel and perpendicular flows w.r.t. PIL
  - velocity shear is difference between flows either side of PIL
  - convergent/divergent flows also accessible

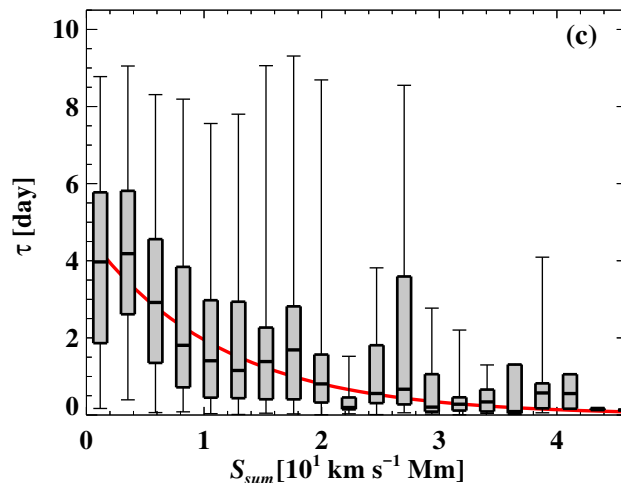
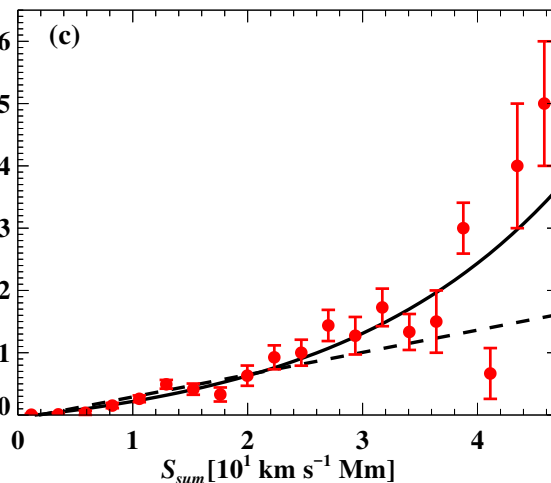
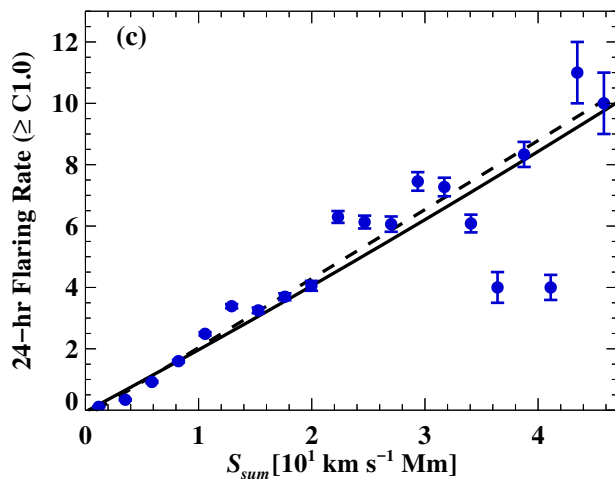


# Active Region Properties (WP2)



## Flows near polarity inversion lines (Park *et al.*, under review)

- Flare productivity scales with total velocity shear along PIL
  - no clear dependence on average or maximum shear
- Time to next major flare ( $\geq M1.0$ ) shorter with greater total shear along PIL
  - broad distribution spread, but inter-quartile ranges drop



# Prediction Algorithm Comparison (WP3/5)



## Forecasting from all $B_{los}$ properties

- Event definition:
  - $\geq M1.0$  flares within 24 hours
- Trained on 14-Sep-2012 to 31-Dec-2014
- Tested on 1-Jan-2015 to 31-Mar-2016
- Only showing verification for flare yes/no classifying algorithms

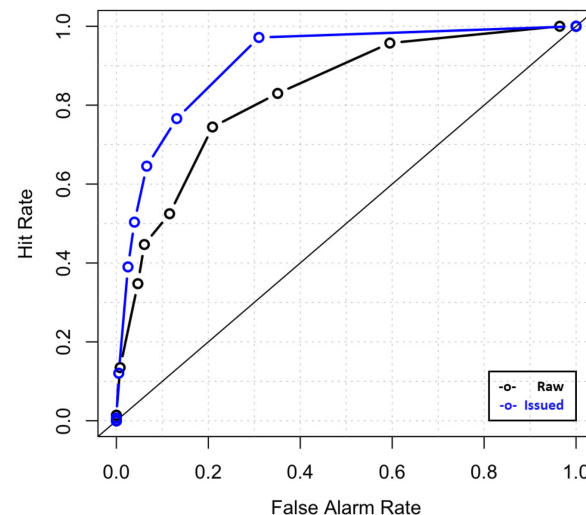
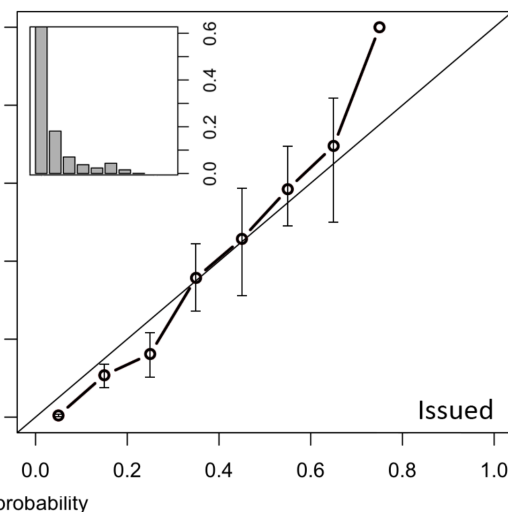
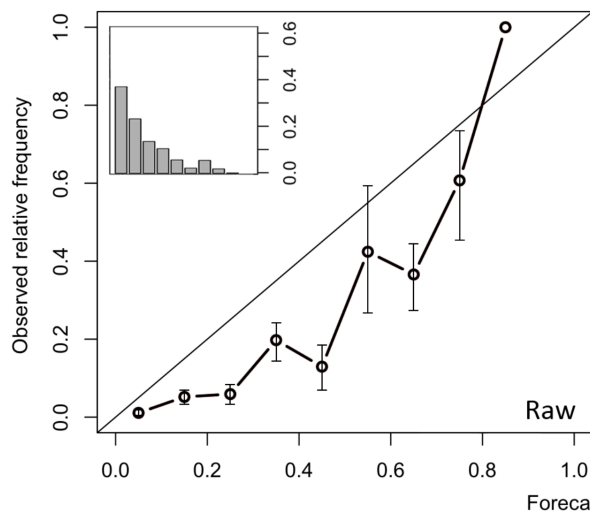
Prediction Algorithm	Probability of Detection POD	Probability of False Detection POFD	True Skill Statistic TSS
Hybrid Lasso	0.94	0.20	0.74
Hybrid Logit	0.90	0.20	0.70
Random Forest	0.71	0.07	0.65
Probabilistic K-means	0.65	0.40	0.25
Support Vector Classifier	0.14	0.02	0.12
K-means	0.02	0.01	0.01
Sim. Ann. K-means	0.00	0.32	-0.32
Fuzzy K-means	0.08	0.66	-0.57

# Met Office Forecast Comparison (WP5)



## Operational benchmark (Murray *et al.*, 2017, *Space Weather*, 15, 577)

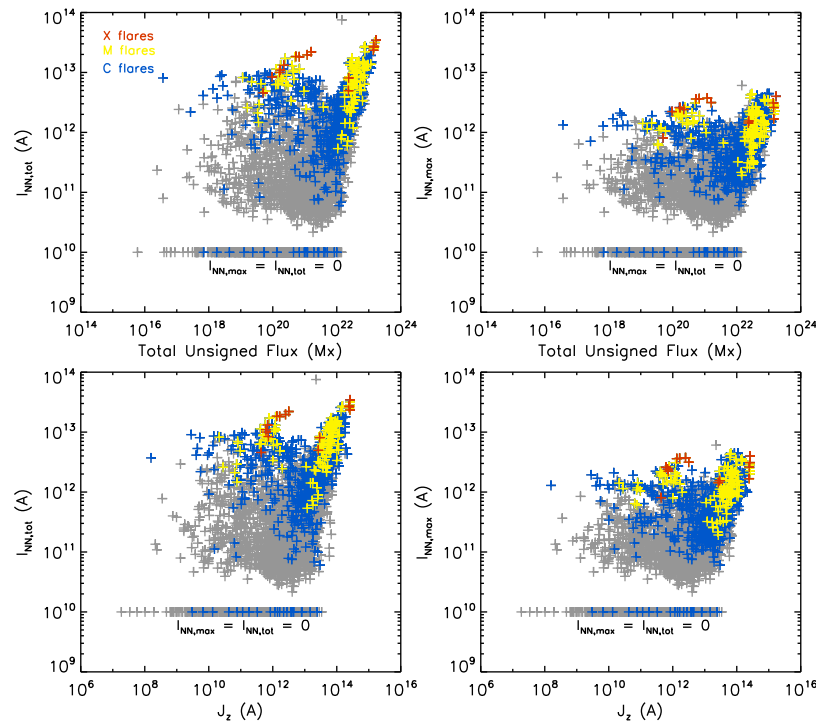
- Human intervention adds skill beyond basic starting model (e.g., Poisson rates  $\rightarrow$  probabilities)



# Exploratory Active Region Properties (WP6)

## Non-neutralized currents (Kontogiannis *et al.*, 2017, *SolPhys*, 212, 159)

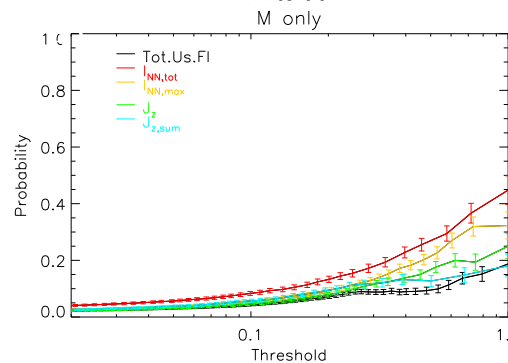
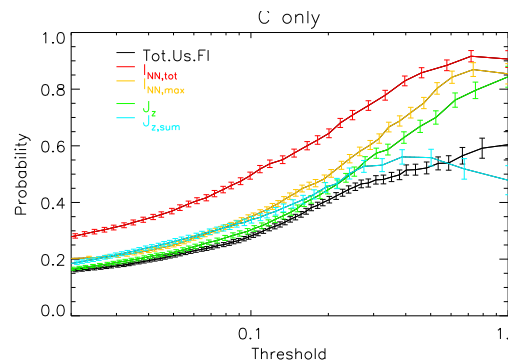
- Correspond to “excess” beyond
  - checks to guarantee suitability of input data
    - currently data are filtered at AR property extraction algorithm stage
    - improved tracking of unprocessed data to be implemented in Year 3



# Exploratory Active Region Properties (WP6)

## Non-neutralized currents (Kontogiannis *et al.*, 2017, *SolPhys*, 212, 159)

- Bayesian probabilities determined from thresholding
  - checks to guarantee suitability of input data



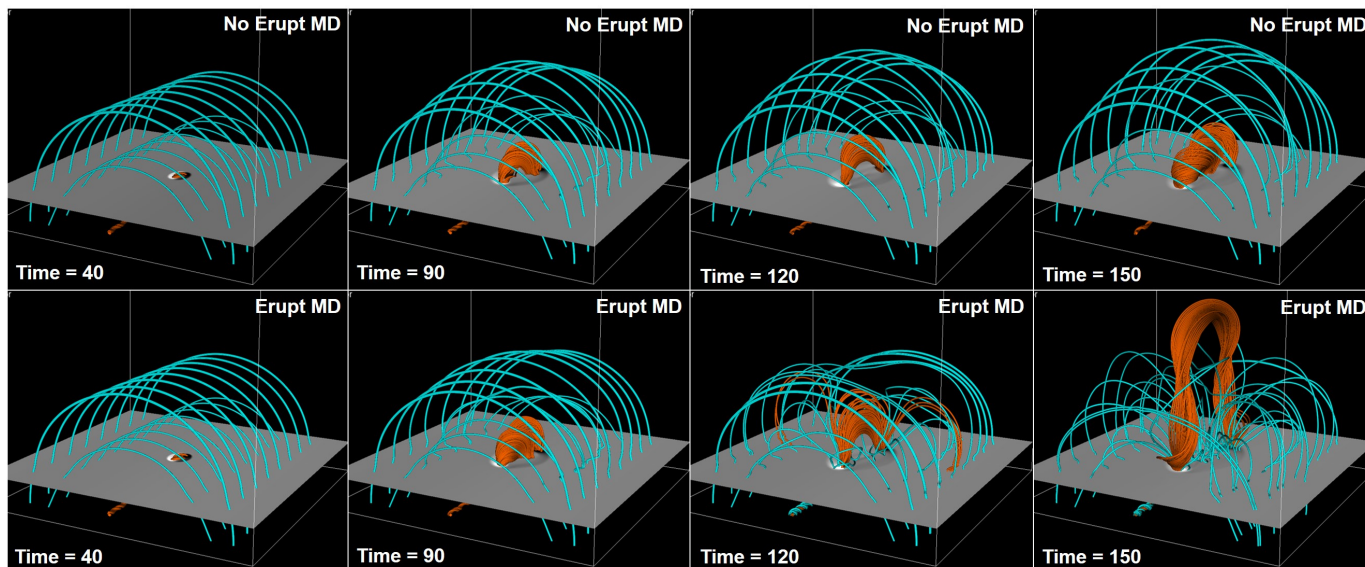
# Exploratory Eruption Precursors (WP6)



## Parametric simulations (Pariat *et al.*, 2017, A&A, 601, A125)

- Orientation and strength of overlying field varied
- Observational properties extracted from simulation surface
- What behaviours do erupting cases share?

Label	No Erupt SD	No Erupt MD	No Erupt WD	No Erupt ND	Erupt WD	Erupt MD	Erupt SD
$B_d$	10	7.5	5	0	-5	-7.5	-10
Arcade Strength	Strong	Medium	Weak	Null	Weak	Medium	Strong
Eruption	No	No	No	No	Yes	Yes	Yes

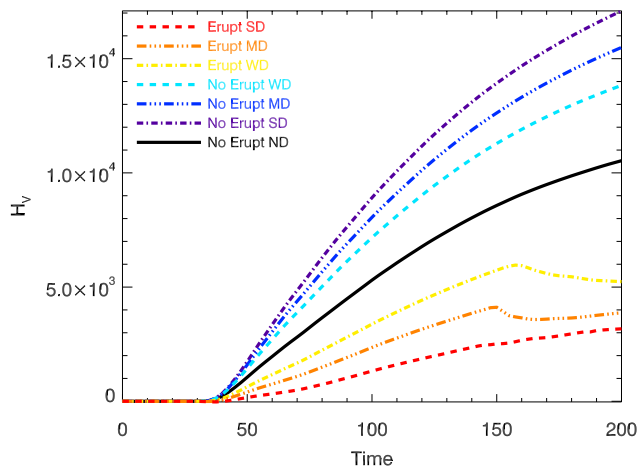


# Exploratory Eruption Precursors (WP6)

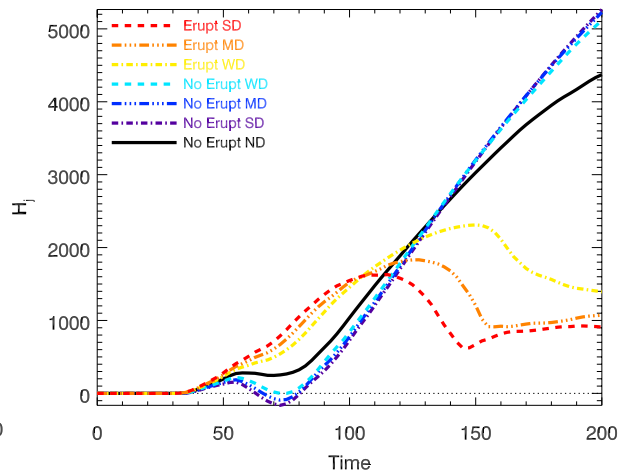
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## Erupting vs non-erupting simulations

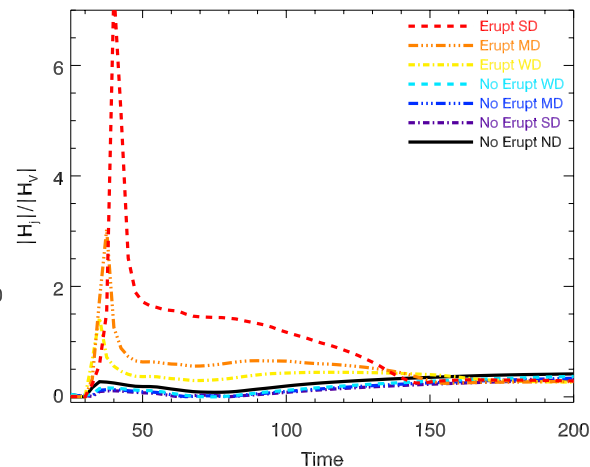
○ Relative helicity



○ Current helicity



○ Current/relative helicity





# Upcoming Results

## Ongoing analysis

- Active region properties
  - non-neutralized currents
  - null points
- Forecast performance
  - full comparison between using properties from  $B_{los}$  v  $B_r$  data
  - inclusion of flare history parameters (persistence)
  - exploration of forecast window latency and duration
  - ensemble forecasting techniques
- Towards CME forecasting
  - active region properties linked to CME production (HELCATS collaboration)